STUDY EAC SA

Use cases and regulatory requirements for the implementation of an energy attribute certification system for renewable energy and green hydrogen in South Africa

Eskom

Responsible Institutions

Eskom: Eskom Holdings SOC Ltd has the Government of the Republic of South Africa as its sole shareholder, with the shareholder representative being the Minister of Public Enterprises. As a public entity, it is governed by the provisions of the Public Finance Management Act 1 of 1999 (PFMA). Eskom is one of the few remaining vertically integrated utilities connected to the Southern African Power Pool (SAPP) through an interconnected grid, which serves to support grid stability. Eskom relies on The Southern African Development Community (SADC) member states to maintain sufficient and reliable transmission grids in their countries.

SAGEN: The South African-German Energy Programme (SAGEN) collaborates with South African partners to support the country's transition to a sustainable energy future. SAGEN is funded by the German government and implemented by the Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH in cooperation with the Department of Mineral Resources and Energy (DMRE), the National Treasury (NT), Eskom, the South African Local Government Association (SALGA) and the South African National Energy Development Institute (SANEDI).

GIZ South Africa, Lesotho and Eswatini: The Deutsche Gesellschaft für Internationale Zusammenarbeit (GIZ) GmbH is a German development agency which provides services in the field of international development cooperation and international education. Its work in South Africa is carried out primarily on behalf of the German Federal Ministry for Economic Cooperation and Development (BMZ). Some of the core areas of cooperation are climate, energy and just transition. GIZ supports South Africa in developing an environmentally sustainable and secure energy infrastructure and enhancing energy efficiency.

Disclaimer

This study is a product of a collaborative project between Eskom and SAGEN. It focuses on the building blocks of the underlying rules and regulations of an energy attribute certification (EAC) system with a particular focus on the regulatory frameworks and elaborates on the requirements for the implementation of such a system in South Africa. The study was prepared by Elena Chvanova, Dr. Birgit Haller and Dr. Ole Langniss from Dr. Langniß | Energie & Analyse and supported technically by Leshoto Thooe (Eskom) and Elaine Cheung (GIZ). The findings, interpretations, and conclusions expressed in the materials are based on the information compiled by the authors and collaborators. The accuracy or completeness of the information is not guaranteed, and they cannot be held responsible for errors, omissions, or losses arising from its use.

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EXECUTIVE

Summary

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Executive summary

South Africa's electricity sector is undergoing a profound transformation, as climate change demands the massively accelerated deployment of renewable energies (REs). The most recent loadshedding events have revealed huge and aggravated deficits in generation capacity within the public supply system, which show that more investments in both large and small, decentralised, RE production facilities are required.

An energy attribute certification (EAC) system, also called renewable energy certification (REC) when talking about low-carbon energy resources, is seen as a powerful means to bring transparency and market opportunities into the renewables sector and, thus, to foster the transformation of the energy sector. Evidence is provided by long-lasting international best practices.

This study presents the results of the research on "use cases and regulatory requirements for the implementation of an energy attribute certificate (EAC) scheme for renewable energies and green hydrogen in South Africa". It was conducted on behalf of Eskom and the South African-German Energy Programme (SAGEN), funded by the German government and implemented by the Deutsche Gesellschaft für internationale Zusammenarbeit (GIZ) GmbH. The duration of the project was from January 2022 to February 2023. As the outcome of the project, GIZ, Eskom, the public sector, and stakeholders of the energy industry in South Africa (SA) are to be provided with the compiled knowledge to take further decisions on how to implement a national EAC system. The study itself is based on desk research. Additionally, interviews with both South African and international experts in the field of energy certification and trading of certificates and carbon credits were conducted. The study analyses all relevant aspects of an EAC system in detail, including its main elements, international standards, labels as an additional instrument to provide information on an energy product, use cases, green tariffs, the regulatory framework, an electronic registry, operational practice, and governance. The study considers both the international context and the current South African state. As a main priority, recommendations are made on the implementation of a well-functioning and widely accepted EAC system for SA.

Further work packages of the project included stakeholder exchange with Eskom, independent power producers (IPPs), municipalities, energy traders, and industrial off-takers, as well as governmental authorities. These target groups were addressed within four knowledge-sharing workshops, where the results of the study were presented and discussed, both in presence in Pretoria and virtually, between August and September 2022. The outcomes of the study, the interviews, and the stakeholder exchange are documented in the summary report "Progressing an energy attribute certification system for South Africa" as supplementary to this document. Therein 10 key measures are reported that have been derived to outline the decisions and actions that must be taken now and within the upcoming months. They range from getting legal clarity on the ownership of green attributes to governmental involvement and rule setting, to market facilitation and international engagement.

Coming back to this report, it includes an analysis of the international context of different aspects of the existing EAC systems. The main principles, participants, and registry structures are highlighted. Three international EAC standards, the United States Renewable Energy Certificate (US REC), the European Energy Certificate System (EECS), and the International Renewable Energy Certificate (I-REC), are analysed with relation to their geographical distribution, main rules, and governance. Use cases considered most relevant in a decarbonising economy, such as adherence to carbon reporting standards and commitment to the RE100 initiative, compliance with the state Renewable Portfolio Standards (RPS), and disclosure of information on the energy mix are described. The regulatory framework in the European Union (EU) and United States of America (USA) for a regional perspective, and Germany, the Netherlands, Colorado, and Delaware for a state perspective adds to the whole picture of established robust EAC systems. Design and functioning of an electronic registry to issue, track, and cancel EACs in four selected states showed that a registry had to comply with similar requirements on user-friendliness, data security, storage, and transfer.

Examination of the design and functioning of electronic databases demonstrated that all of these registries followed the same or very similar principles of registration of account holders, different account types for issuance, transfer, and redemption of certificates, data security, and the general, rather simple design. While registry operators in Europe are in most cases also the national issuing bodies and can, to a large extent, define the design and functionalities of a registry on their own, in the USA independent service providers oversee the functioning of mostly interstate registries. They are reliant on regulations of state authorities to check compliance of generation facilities with their requirements and reflect state regulations in the design and operation of the registry. The processes related to specific roles, registration of participants, and all certification activities are precisely defined in the operating rules of a registry.

In the same section, examples of cross-border trade within the framework of the EECS in Europe, REC in the USA, and I-REC internationally are cited. In all these jurisdictions, cross-border trade is related to a different degree of complexity. Standardised systems enable uncomplicated cross-border trade. In the final part of this section, innovative approaches connected with better matching of generation and consumption in view of EACs are highlighted, including granular certificates (GCs) with a timestamp and blockchain-based activities. These activities are gaining momentum worldwide and are considered for inclusion in regulation. A general recommendation is to monitor these developments and use these instruments on the basis of established, robust EAC standards.

Governance of EAC systems in Europe and the USA with responsible parties is described tabularly and in the form of model graphs showing actors and relationships. An overview of national regulatory authorities in all members of the European Association of Issuing Bodies (AIB), as well as selected American states, conveys information on the nature and responsibilities of issuing and regulatory bodies responsible for the functioning of Guarantee of Origin (GO) and REC systems. For countries and states analysed in the previous sections, schematic representations of the activities of corresponding regulatory bodies and interactions with other market participants and stakeholders give an impression of the system processes as a whole and their complexity and extent.

Insights into adjacent topics such as labels as an additional quality seal for sustainable energy, green tariffs, and interaction between EACs and carbon offsets are included in the study.

Analysis of green tariffs in the national and international context shows that green electricity products are entering a level playing field with their grey counterparts. At the same time, it is recommended to focus on transparency regarding the sources of electricity generation and on efforts for additional RE projects in certification rather than on diffuse green features of an electricity product.

Carbon offsets and EACs are two kinds of instruments in order to reach the same goal – greenhouse gas (GHG) mitigation – but with different strategies and pathways concerning site and effectiveness of reduction. Both have their own markets with their own standards, protocols, and registries, and they are not thought to be competing or interchangeable instruments but complement each other within the process of continuous improvement of a company on its way to climate neutrality.

First, an analysis of the international landscape of EAC systems was conducted, and then it was applied to the South African context. The second part of the study focuses on the status quo of the regulatory framework in SA and the requirements for implementation of a nationwide EAC system covering the whole electricity market. Key questions for establishing a national certification system refer to the specific use case and comprise organisational, legal, standardisation, and market aspects, among others. SA has been experiencing engagement in energy certification for around 20 years, both at a state and a private business level. This is to be considered when discussing this initiative for a nationwide EAC system.

Considering that previous experiences with using the EECS and the I-REC Standard in a voluntary way were less successful, it is recommended that an EAC system be made mandatory and that adherence to the I-REC Standard rules and best practices be encouraged. Based on the desk research, this will open opportunities to smoothly develop a system alongside governmental support and support from the I-REC Foundation with its wide experience and that adherence to best practices to be encouraged. Discussions with stakeholders about how an EAC system needs to function in terms of governance and the important steps to take to get this system up and running have been held. The findings of these discussions and final recommendations can be found in the Summary Report.

A general finding that has been validated by the stakeholders, is that, with the stepwise market liberalisation, more market participants will get access to an EAC market, thus providing for supply and encouraging demand. The market drivers will most probably be large corporations with operations in SA, those who report on their carbon footprint and have committed themselves to procuring a high share or even 100% of renewable energy (RE). Additionally, customers from Europe, the USA and Asia will be more willing to buy products with reduced or zero carbon emissions, such as green hydrogen. This will open wide possibilities for SA to be an international leader in this industry, selling both the product and its green attributes. More and more local companies will adhere to reporting standards, and an increasing number of end customers will wish to know about sources of energy they receive and to claim that they are using sustainable energy. These trends at the international and national level will, in turn, bring about further expansion of the EAC system.

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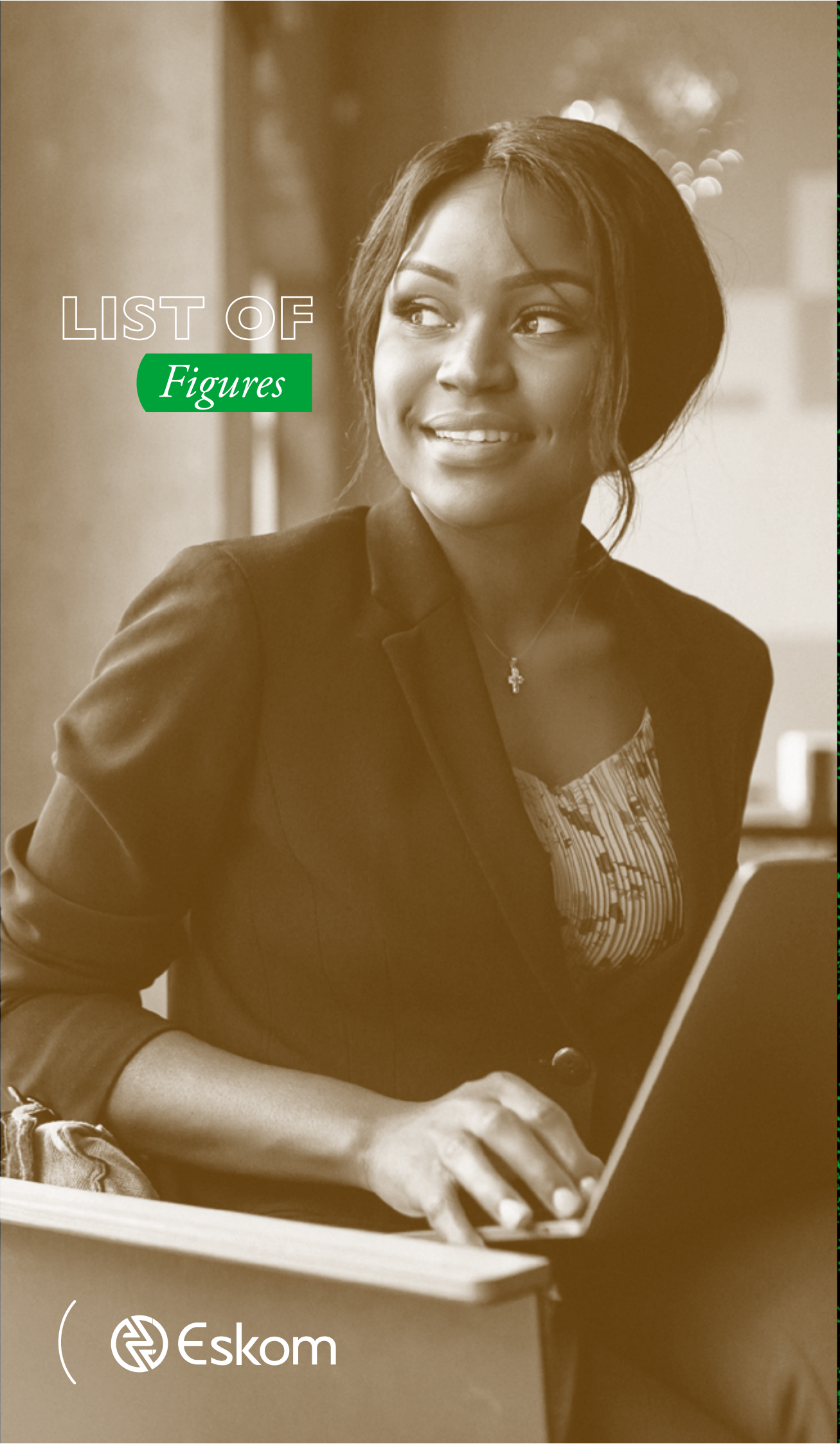

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ABBREVIATIONS

Abbreviations

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Abbreviations

AFOLU	Agriculture, Forestry and Other Land Uses
AIB	Association of Issuing Bodies
CDM	Clean Development Mechanism
CDP	Carbon Disclosure Project
CER	Certified Emissions Reduction
CO	Certificate of Origin
CRD	Central Registration Database
DMRE	Department of Mineral Resources and Energy
DSO	Distribution System Operator
EAC	Energy Attribute Certificate
EEA	European Environmental Agency
EECS	European Energy Certificate System
ESG	Environmental, Social, and Governance
EU	European Union
ETS	Emissions Trading System
EV	Electric Vehicle
FiTs	Feed-in Tariffs
GCC	Green Certificate Company
GCs	Granular Certificates
GHG	Greenhouse Gas
GO	Guarantee of Origin
GS	The Gold Standard
GU	Generating Unit
H_2	Hydrogen
I-REC	International Renewable Energy Certificate
ICS	Independent Criteria Scheme
IOU	Investor-Owned Utility
IPP	Independent Power Producer
ISO	Independent System Operator
ITSMO	Independent Transmission System and Market Operator
JI	Joint Implementation

LSE	Load-Serving Entity
MRV	Measuring, Reporting, and Verifying
NBI	National Business Initiative
NDC	Nationally Determined Contribution
NERSA	National Energy Regulator of South Africa
PPA	Power Purchase Agreement
QRE	Qualified Reporting Entity
RAiSE	Renewables Ambition in South African Electricity
REC	Renewable Energy Certificate or Credit
RECSA	Renewable Energy Certificates South Africa
RED	Renewable Energy Directive
REIPPPP	Renewable Energy Independent Power Producer Procurement Programme
RES	Renewable Energy Sources
RPS	Renewable Portfolio Standard
SA	South Africa
SANTREC	South African National Tradable Renewable Energy Certificates
SARS	South African Revenue Service
SDGs	Sustainable Development Goals
SRO	Standard Rebate Offer
TCR	The Climate Registry
TREC	Tradable Renewable Energy Certificate
TSO	Transmission System Operator
UBA	Umweltbundesamt (German Federal Environment Agency)
UK	United Kingdom
USA	United States of America
VCM	Voluntary Carbon Markets
VCS	Verified Carbon Standard
VER	Verified Emissions Reductions

DEFINITIONS

Definitions

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Definitions

Authorised measurement body	Body established under national regulation to be responsible for the collection and validation of measured volumes of energy used in national financial settlement processes.
Carbon credit	A carbon offset credit or carbon credit is a transferable instrument certified by governments or independent certification bodies to represent an emissions reduction of one metric tonne of CO2 or an equivalent amount of other greenhouse gases (GHGs). The purchaser of an offset credit can "retire" it to claim the underlying reduction towards its own GHG reduction goals.
Carbon offset	A carbon offset broadly refers to a reduction, an avoidance, or a removal in GHG emissions that is used to compensate for emissions that occur elsewhere.
Carbon tax	A South African legal Act put into force in 2019 that imposes a requirement on firms in certain sectors to account for their GHG emissions. The corresponding carbon tax liability is regulated under a scheme of allowances.
Clean Development Mechanism (CDM)	As part of the United Nations Framework Convention on Climate Change (UNFCCC), the CDM is the largest regulatory project-based mechanism. It offers the public and private sector in high-income nations the opportunity to purchase carbon credits from offset projects in low- or middle-income nations.
Disclosure	The provision of information to an end customer on the share or quantity of the energy supplied to it as having specific attributes, for example, being renewable.
Energy Attribute Certificate (EAC)	Generic term for different certification schemes, including renewable energy certificates/credits (RECs) in the USA, guarantees of origin (GOs) in Europe, green certificates/tickets/tags, and tradable renewable energy certificates (TRECs). Such certificates allow energy market participants to track attributes of production of renewable electricity or any other energy product for which the usage of renewable energy (RE) plays a role, from its location of generation to its place of consumption.
Issuer	A competent body responsible for the issuance and tracking of EACs.
Label	Independent, voluntary certifications that are issued by non-governmental bodies and that check and label green electricity products for compliance with certain additional features using specially elaborated criteria.
Production auditor	A special designated body to audit the information provided by registrants in production declarations and, where appropriate, inspects the relevant production device (PD).
Production registrar	A special designated body responsible for assessing applications for registration of production facilities and re-registration after an agreed period, for example, after five years.
Registry	A database operated by an issuing body or its agent, comprising: a. accounts and the EACs in those accounts; b. details of production devices and information; and c. details of EACs that have been transferred out of that registry.
Registry provider	An entity responsible for the creation and operation of an EAC registry on which ownership of EACs is registered, traded, and redeemed/cancelled.
Residual mix	The attributes of the energy mix that remain after certified attributes have been taken out of the mix as a result of cancelling an EAC.

INTRODUCTION

Introduction

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1.1 Importance of certification

Many countries are striving to decrease greenhouse gas (GHG) emissions and minimise consequences of climate change in line with the Paris Agreement pledges. One of the most promising areas of action against climate change is a rapid switch to renewable energy (RE). It has vast technical potential and is currently being actively deployed all over the world. In sectors that have fewer economic and technical opportunities to be decarbonised, for example transport, hydrogen (H_2) is being increasingly deployed. According to the World Energy Transitions Outlook published last year by the International Renewable Energy Agency (IRENA), green hydrogen is an indispensable part of net zero carbon strategies of many countries and brings much-needed solutions in the transport, building, and industry sectors [1]. It can also help keep energy systems with large amounts of RE generation in balance and serve as long-term seasonal storage.

As a country with abundant RE resources and high export potential, SA acts in line with these international trends and has adopted ambitious goals of RE development. The last Integrated Resource Plan (IRP) set a target of an increase in RE share in electricity consumption from about 11% in 2019 to 41% by 2030. This is to be achieved through the installation of almost 16 GW of wind, 7 GW of solar photovoltaic (PV), 2.5 GW of hydro, and more than 2 GW of storage facilities [2].

New impulses for energy transition in SA come from the newly signed energy partnership with the USA, the United Kingdom (UK), France, Germany, and the European Union (EU). The delegations from these countries came together at the United Nations Climate Change Conference (COP26) in Glasgow and agreed to support SA on its way to a phase-out of coal and a just transition. One of the priorities of the commitment is the development of green hydrogen production. A recent feasibility study conducted by the South African government and interested partners from the private sector identified pilot projects in the mobility, industrial, and buildings sectors and investigated opportunities for the export of green hydrogen [3].

The goal of all information systems for green electricity is to make the origin of the electricity transparent to consumers and other energy market actors. The electricity consumed by the end customer does not have any physical properties that allow the customer to infer its origin. If the origin of the electricity is significant, for example, because government subsidies are granted for renewable energies or consumers explicitly want to purchase CO2-neutral electricity, such information systems are necessary. Demand for clean energy by consumers, ranging from individual households to large multinational corporations is at an all-time high; there was a threefold increase in the number of companies pursuing net zero targets in 2020. Green electricity tariffs are gaining popularity among many energy- and sustainability-conscious customers. Energy attribute certificates (EACs) are part of such an information system. They support investment in RE plants by offering owners a mechanism to validate and, in the future, trade clean energy attributes. The same considerations for electricity can also be applied to H_2.

To support the development of RE and production of green hydrogen in SA, while also fulfilling the standards of international carbon accounting (see section 2.4) and the desire of end users to claim green attributes of electricity and H_2, it is necessary to implement a certification system compliant with international standards.

1.2 Objectives and scope of the study

The main objective of this study on behalf of Eskom and GIZ is to elaborate on the use cases and regulatory requirements for the implementation of an EAC system for renewables and green hydrogen in SA. Armed with this study, along with workshops for knowledge-sharing and discussion, Eskom and other relevant stakeholders should gain confidence to participate in further discussions related to use cases and regulatory requirements to implement an EAC system for RE and green hydrogen in SA. The study, which outlines these topics, and the summary report, which contains details of stakeholder engagement as well as recommendations on implementation of such a system in the South African context, offer support for taking next steps towards establishing an EAC system in SA.

In the first part, the study focuses on international best practices regarding EAC systems and describes accepted models in major jurisdictions for RE generation and trading as well as for green hydrogen. Particular attention is paid to the EAC systems in the USA and Europe, comparing the proof of origin definition in competitive USA markets versus traditionally regulated markets, and describing the implementation of the European regime in the context of the member states, including, but not limited to, Germany. Insights into adjacent topics, such as labels being used as an additional quality seal for sustainable energy, the concept of green tariffs, and the interaction between EACs and carbon offsets are included in the first part.

In the second part, the findings of the developed knowledge base on EAC standards and national best practices are applied to the South African context. Recommendations for action by national stakeholders are derived for the implementation of a certification system for RE and green hydrogen, which is robust and accepted by market participants.

PART ONE

Part One

Eskom

2.1 Main elements of an EAC system

In this chapter, EAC systems will be analysed in a generic way to show their central principles, the contents of a typical certificate, and the main participants, including market facilitators, market players, and end users. Major steps in creating and using an EAC are described. Principles of certification of H_2 as a separate energy carrier are presented.

2.1.1 Principles

Once energy is being generated and fed into the power grid, it becomes physically indistinguishable. No distinction can be made between energy generated by a coal power plant and by a solar PV. The allocation of energy attribute information is needed to enable and verify product-specific consumer claims [4]. EACs allow energy market participants to track attributes of production of renewable electricity or any other energy product for which the usage of RE plays a role, from its location of generation to its place of consumption. EACs is a generic term for different certification schemes, including renewable energy certificates/credits (RECs) in the USA and other countries all over the world, guarantees of origin (GOs) in Europe, green certificates/tickets/tags, and tradable renewable energy certificates (TRECs). The attributes contained in EACs are "descriptive or performance characteristics of a particular generation resource" [4] and "factual, auditable statements of an electricity generating facility and an electricity generating event" [5]. They typically include the following characteristics:

- The identity and location of the generation facility (for example, a unique identifying number)
- The type of primary energy input, if any (for example, biomass)
- The technology used for generation (for example, solar PV, combined-cycle gas turbine)
- The date of commissioning
- The installed capacity
- The volume of produced electricity (mostly 1 MWh)
- The time period when the electricity was produced
- Whether the installation received public support (for example, a feed-in tariff (FiT), investment support)

Through the use of EACs, consumers around the world, from multinational corporations to individual households, can claim their RE usage and make such statements as "I produce my products with 100% renewable energy", "with my energy consumption, I contribute to renewable energy development", and "our global electricity usage causes zero emissions". The only reliable mechanism for making claims for an intangible product, such as electricity, is to book all charges injected into the grid as unique units of 1 MWh. These booked units can then be traded separately from the underlying electricity, and only the person or entity that 'redeems' or 'cancels' the certificate associated with this electricity unit can claim the usage of that specific MWh. This mechanism is defined as a book-and-claim principle and is the cornerstone of EACs throughout the world. It is illustrated in Figure 1.

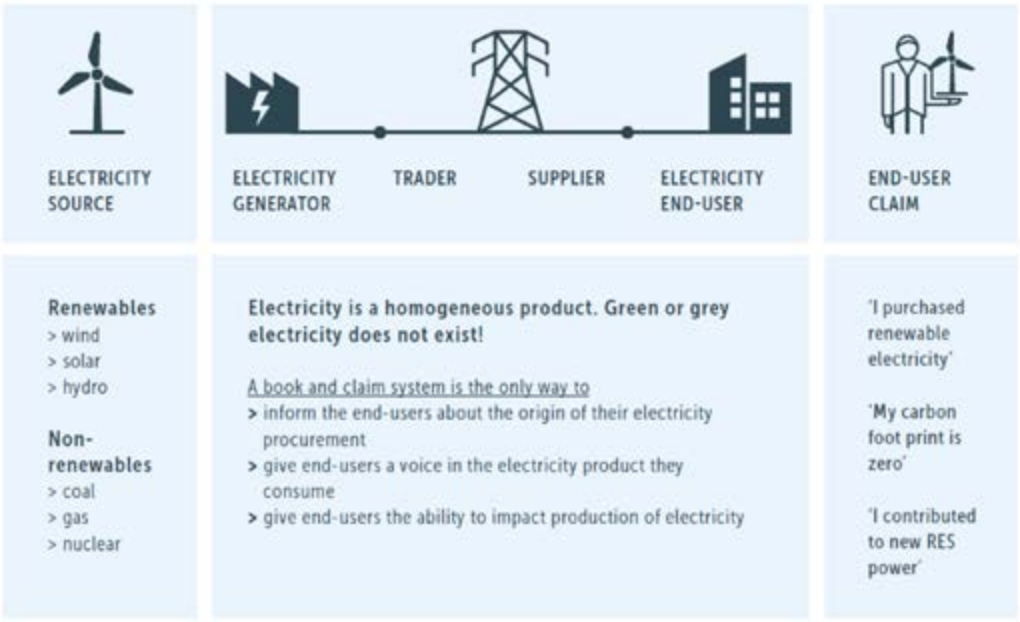


Figure 1: Book-and-claim mechanism of EACs worldwide [6]

The following principles can be attributed to EAC systems worldwide [7]:

- Account holding: account holders have to provide information about themselves and their commercial activities to be registered and adhere to EAC system rules. EACs can only be held in the account of a registered account holder so that it serves as proof of ownership.
- Avoidance of double counting: EACs may only be issued, traded, and redeemed once, and the renewable attributes cannot be claimed other than by redemption of the associated EAC.
- Cancellation/redemption/retirement and expiry: EACs can be cancelled (this action is also called redemption or retirement) by a consumer or a supplier on its behalf, which removes it from circulation. Certificates that are not cancelled expire after a period or by a deadline.
- Disclosure: end consumers are provided with information on their bills showing how the share or quantity of the energy supplied to them has specific attributes (in most cases being renewable). These attributes cannot be claimed by another consumer.
- Issuance: EACs are only issued to registered facilities. A party that is acting as verifier validates the amount of energy produced and assigns the equivalent amount of EACs to the producer.
- Quality control: generation facilities are regularly inspected to identify any changes in their configuration and metering arrangements. Also, the verifying party undergoes an audit of a supervising authority to ensure its compliance with system rules.
- Registration: registration is necessary to be able to request an issuance of EACs. The producer is required to provide information about itself and the facility, including the capacity, energy sources, commissioning date, location, metering arrangements, etc.
- Transfer: EACs can be transferred from a producer's account to that of a trader, supplier, or consumer. Trade agreements are made separately, mostly as a result of bilateral contracts, and followed by the transfer of the related EACs.
- Supervision: EAC systems supervisors are called issuing bodies or registry operators/tracking system operators. They preserve details of registered production facilities and account holders, which are recorded in an electronic registry.
- Withdrawal: the EAC system supervisor may withdraw an EAC issued in error.

2.1.2 Participants

The main participants in an EAC scheme can be divided into three categories:

1) Market facilitators
2) Market players
3) End users

Market facilitators include public authorities, issuers, and registry providers. National or regional/international authorities (such as the EU Commission) can play an active role in the implementation and promotion of an EAC scheme. Although it is possible to have a functioning EAC scheme without any state involvement because certification can be handled by independent entities including state support and embedding the scheme in a regulatory framework can enhance stakeholder confidence and increase system reliability. Public authorities can promote EAC schemes through the following actions [6]:

1. Acknowledging/advocating an EAC scheme. New developments can be brought about in a scheme if a national authority acknowledges the existence of the voluntary mechanism. Therefore, it is very important to recognise only one EAC scheme within a country. There is no need for competition between EAC schemes; it will only create confusion and distrust among market participants. The implementation of an efficient EAC scheme can be seen as a step-by-step process, and its official acknowledgement by a national regulatory body is an important part of this process that requires little effort from the government.

2. Appointing or becoming a national issuer. As a next step, a public body can choose to become or appoint an organisation to take on an issuing and tracking role for EACs. It can be a governmental or private entity. This organisation should be defined in national legislation as the competent issuing body for the EAC scheme.

3. Using the EAC scheme as a tool to achieve policy goals, including by doing the following:
    a. Providing a reliable tool to report the consumption of renewable-energy-based electricity. In many jurisdictions with developed EAC markets, an end user can only claim the consumption of specific energy attributes by cancelling the related EACs.

    b. Providing a tool to measure progress towards RE targets. In some American states, mandatory use of EAC schemes requires either that energy suppliers supply a given amount or share of their energy as renewables or that consumers consume a given amount or share of their energy as renewables. In this way, progress towards the achievement of governmental energy sector goals can be measured.

    c. Complementing a national support scheme. An EAC scheme can represent an addition to public policy measures that support RE. EACs can provide an additional income stream to RE generators and allow public money available for RE support to go to those projects most in need and/or to be spread across a higher number of projects. However, finding a balance between public support schemes and EACs can be challenging. One could say that fully replacing public support with income from EACs could lead to market stagnation. EACs may not provide adequate support either due to inability to call for high enough prices or due to the inability to sell in sufficient numbers to achieve the income required.

    d. Reducing the use of the most harmful energy sources. Energy sources that are in high demand by EAC buyers will have more value reflected in prices than those sources that are seen as undesirable, such as coal. Recently, the practice of full disclosure has started to gain popularity. It obliges market participants on the production, supply, or consumption side to prove the origin of all energy units through the cancellation of EACs. (This is currently applied in the Netherlands and Austria, see more in section 2.6). Full disclosure could lead not only to higher financial benefits being bestowed on the in-demand energy types, but also to the penalisation of the out-of-demand energy types, forcing them to reduce their price even to a negative level.

Issuers are competent bodies in charge of the issuance and tracking of EACs. This role is constrained by the geographic area of the associated EAC scheme. An issuer cannot be engaged in the electricity generation or trade of certificates; its independence must be guaranteed, and the issuer needs to have the capabilities to perform this role. An issuer can be a for-profit or non-profit public or private entity. Issuers are often a grid operator, energy regulator, or other (semi) public entity (see more in section 2.8). Frequently, an issuer takes over the role of a registry provider who is responsible for the setting up and operation of an EAC registry. Otherwise, this function is performed by a third party, such as Grexel in Europe and APX in voluntary markets in North America and other world regions.

Market players are generators, suppliers, and third parties, such as traders and brokers. Generating devices must be registered with the EAC registry through the local issuer and must comply with its rules and fees. After registration, these entities can request EAC issuance. As proof of the underlying electricity production, they send device metering data to issuers. Energy suppliers buy EACs from generators in order to proclaim that the energy mix they deliver to end customers includes a share of RE. Other actors such as traders and brokers may participate in the market transactions on behalf of generators or end users. As most trade agreements are concluded through over-the-counter markets, personal contacts between participants and the involvement of traders and brokers can play a significant role. These relationships rely on a degree of trust, which is explored in section 2.7.

End users can be anyone from an individual household to a large multinational corporation (MNC). Every end user can make claims about the origin of its energy, if an EAC was redeemed by the end user or by a market player acting on its behalf. Participating in an EAC scheme may not be considered important at all for some end users, such as households, but very much important for others, such as many MNCs who use EACs for carbon reporting and maintaining their good image with the public. Robust EAC schemes can benefit end users by providing trustworthy information about the origin of their energy mix, allowing them to make an informed choice about an energy product for which they want to pay. In turn, this gives end users the opportunity to influence the energy sector by giving a signal to the market to generate more of the energy from high-demand energy sources [6].

2.1.3 Creation and registration of an EAC

A certificate tracking system or certificate registry is a database that ensures and stores information on the whole life cycle of an EAC: from issuance to transfer, trade, retirement, and claims. It issues a uniquely numbered certificate for each unit of electricity with certain characteristics generated by a generation facility registered on the system; tracks the ownership changes of certificates as they are traded among account holders, and records certificates that are redeemed or retired to allow end users to make claims based on the attributes of the certificate. A registry prevents double counting and ownership disputes, ensuring that a certificate can only be in one owner's account at any time. It is designed to ensure that no other entity is issuing certificates for the same MWh and that the attributes of that generation unit are not sold as a separate instrument or right of ownership. Registries do not operate as exchanges or trading platforms for the EACs; in that regard, they only record data on the transfer of certificates. The documentation of the registry should be publicly available and open for public consultation [4]. Registries are obliged to remain accurate and adhere to the rules of a standard on issuance, trade, and redemption of certificates (further information on three internationally recognised EAC standards in section 2.2) in order to maintain user confidence in EAC schemes and to ensure that associated end user claims can be internationally recognised and accepted for reporting of company emissions for energy use – also known as Scope 2 reporting under the GHG Protocol [6] (more detail on that in section 2.4 and 2.6.3).

The standard steps in creating and using an EAC can be described as follows [5]:

1. Registering the generation facility with an EAC scheme. It is only done once and is performed by a registrar who could be an issuer, a grid operator, or another actor. Details of the production facility comprise a big part of the attributes that can be claimed by end users when they redeem certificates.
2. Producing electricity with eligible characteristics.
3. Requesting EACs. The generator requests the issuance of EACs on its electricity production from an issuer. Following the assurance that the details of a generating event are accurate, the issuer enters them in the registry.
4. Submitting meter readings. All production data must be audited by a third party and confirmed by evidence provided by, for example, grid operators. The issuer shall conduct frequent audits to make sure that the verified data is accurate.
5. Issuing EACs. The issuer creates EACs in the registry that are contained in a generator's account. EAC systems based on internationally recognised standards have a centralised registry, and EAC issuance can be easily monitored by government bodies, system operators, and third-party observers.
6. Accounts within the registry. There can be different types of accounts in a registry. In the I-REC (more on this in 2.2), participants can open two types of accounts: a trade account allows the I-RECs to be transferred to another market player, including end users, and a redemption account provides the function to redeem the attributes of the certificate. Certificates in redemption accounts cannot be traded or moved to a different account.
7. Trading of EACs. EACs can be traded from the producer to a trader/broker, electricity supplier, and end user or used for cancellation. Issued EACs can only exist in a single account, preventing double counting.
8. Redemption of EACs. Claims to the certificate attributes are only asserted on redemption. This occurs when a certificate is moved to a redemption account.
9. Claiming the attributes of an EAC. The market participant (electricity supplier or end user) has the right to claim the use or consumption of a specific volume of electricity from renewable sources according to the volume of redeemed EACs.

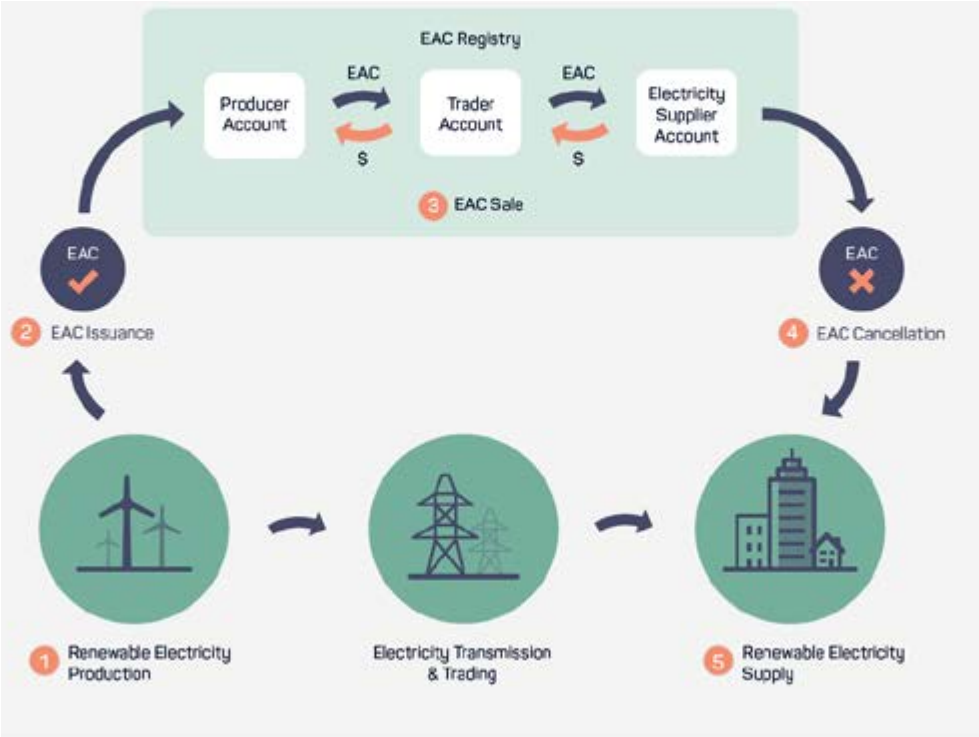


Figure 2: EAC life cycle [7]

The process of creating an EAC is presented in a simplified way in Figure 2 with the principle steps of an EAC life cycle, including RE production, EAC issuance, trade, redemption, and end user claims.

2.1.4 Certification of H_2

Because it is an emerging field and is an energy carrier that differs from renewable electricity, certification of H_2 from low-carbon and renewable sources warrants a separate chapter.

The increased use of H_2 is one of the key measures in the energy sector decarbonisation strategy of the EU and other developed countries. There are significant differences between the GHG emissions footprints of green, blue, and grey hydrogen. The treatment of green, blue, and grey hydrogen, therefore, varies in some jurisdictions from a regulatory or compliance perspective. Currently, 98% of the H_2 produced worldwide comes from fossil fuels. To guarantee that the H_2 use will contribute to a substantial decrease of emissions, importers need a functioning tracking system certifying its origin as green or low carbon. Tracking systems are necessary to track attributes across the entire value chain, create transparency, boost demand, and encourage transferability [8].

Tracking systems can be based on different chain-of-custody models [8]:

1. **Book-and-claim model** (depicted in 2.1.1): the "book-and-claim" system, commonly used for renewable electricity, allows energy providers to "book" the renewable electricity they have produced and energy customers to "claim" the energy they have consumed as renewable. Proving a physical link for energy from the point of production to the point of consumption is not required, so the claim regarding consuming RE is separate from the physical flow. In the case of green hydrogen, using these certificates will require temporal and geographical correlation between RE generation facilities and H_2 production to ensure the renewable nature of their consumption of electricity.

2. **Mass balancing:** mass balancing, commonly used for biofuels, requires a physical link between the production and consumption of RE, and consignments must be in contact (that is, in a container, at a processing or logistical facility, site, etc.) to prove physical traceability. There are different possible gradations with varying levels of strictness. For example, in the EU Database, which is defined in the EU's Renewable Energy Directive (RED) for tracing biofuels used in the transport sector, the mass balancing requirements are based on actual transactions between operators.

Accordingly, there are two different ways in which EACs could be used in relation to H_2 made from electrolysis [9]:

- Electrolysis with dedicated renewables: An electrolyser directly connected to renewable generation would be able to issue H_2 EACs. There would be no need to use renewable electricity EACs to prove its renewable credentials. Any H_2 produced in this way would qualify as 'renewable/clean'.
- Electrolysis from the grid. An electrolyser connected to the electric power grid could purchase renewable electricity EACs to 'green' its electricity input. It could then issue an EAC that certifies it as 'clean/renewable' H_2. This way of 'greening' the H_2 is questionable, since it would make no sense from a GHG emissions point of view because the use of renewable electricity to produce H_2 incurs conversion losses, and most countries, such as those in the EU, wishing to use green hydrogen do not have enough renewable electricity capacity to meet existing electricity demand.

There are several obstacles to the creation and implementation of green hydrogen tracking systems [8]. Firstly, it remains challenging to enforce clear regulations internationally, making it difficult to create compliance with the same standards and rules, which is very important for international trade. In the absence of international regulations, multiple tracking systems will likely emerge and be implemented across the world.

Furthermore, given that H_2 is not a primary energy, creating a bridge between certificates for green and certificates for renewable electricity is necessary to avoid double counting the renewable attributes of its primary source of generation. However, two main challenges exist to establishing this bridge:

- Communication issues between different tracking systems may lead to misuse.
- Transparency issues may arise if information on the production process and transport, particularly relating to links with non-renewables, is not clearly traced, documented, and verified.

Finally, it must be ensured that the growth and the development of a green market support the energy transition. Without a parallel increase of renewable electricity capacity, the development of green may, in fact, negatively affect the energy transition efforts of different countries.

There are four requirements with which green tracking systems should comply [8]:

- Temporal correlation: to ensure that the electricity used in electrolysis is renewable, green hydrogen tracking systems should operate at an appropriate time interval that will both meet the demand and support the establishment of future power purchase agreements (PPAs), as well as include available production forecasts.
- Geographical correlation: green hydrogen tracking systems should require some degree of physical link to ensure that electrolysis powered with renewables is involved in the process of producing H_2 that is claimed to be green.
- Additionality: green hydrogen development should contribute to the build-out or financing of new electricity capacity in order to avoid its development leading to increased shares of fossil-generated electricity elsewhere in the electricity system. Therefore, green hydrogen certification systems should have an additionality requirement. Given that the green hydrogen market is still nascent, a transitional period could be allowed during which the electrolyser used to produce the H_2 is enabled to take electricity from existing renewable plants, backed by renewable electricity certificates. The introduction of any transitional measure shall ensure that the robustness, integrity, and credibility to consumers of the certification are not compromised.
- Technological specifications: it is essential that specifications provide full transparency and information on the resource used to produce electricity and ensure its renewable nature.

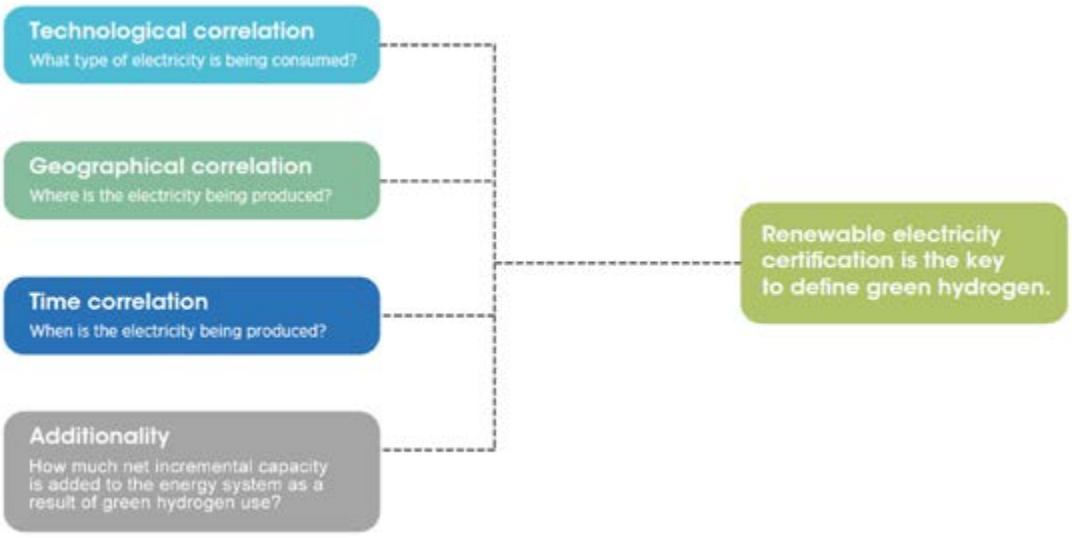


Figure 3: Requirements for green hydrogen tracking systems [8]

In addition, to credibly certify green hydrogen, tracking certificates should provide information on the GHG content of each produced kilogram of green hydrogen that occurs along the value chain, from production to transport. On the production side, the tracking system should supply information on potential GHG emissions and air pollution occurring if the electricity used is from the grid. On the transport side, in addition to tracking the emissions from the transportation mode, the emissions produced in the event of conversion should also be considered (ammonia, synfuels such as renewable methane, reconversion, etc.).

There are proposals for the EU-wide standard on GOs for different energy carriers, the CEN 16325 Standard (discussed in more detail in 2.6), to include information on primary energy savings or GHG intensity in GOs. Some industry groups support establishing the link between the EU Emissions Trading System (ETS) and the GO system, for example, in the form of an 'exchange rate' between 1 MWh of H_2 based on a renewable-sourced GO and 1 metric tonne of CO2. In that case, it would be possible to use green hydrogen GOs for meeting the emissions targets of companies or end users of H_2 and reducing costs associated with the EU ETS. Time and regulatory and market developments will show whether these proposals have a future.

2.2 Internationally recognised EAC standards

EAC standards are the rules and regulations that govern EAC schemes across the whole life cycle of an EAC. At an international level, there are distinctions between three main EAC schemes based on internationally recognised EAC standards. The EACs follow a geographic distribution: Northern America operates under the US REC Standard; the EU, European Environmental Agency (EEA), and Energy Community Treaty countries use the EECS Standard; and some countries in Latin America, Africa, and Oceania use the I-REC standard (Figure 4). In the following sections, the three standards are described with their specificities.

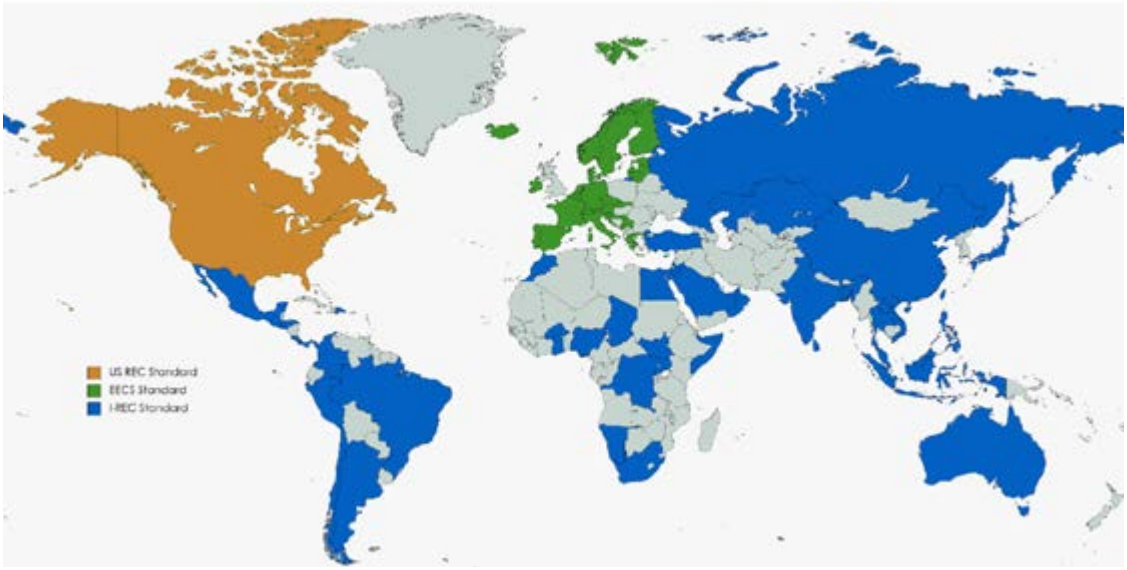


Figure 4: Geographic distribution of internationally recognised EAC standards

2.2.1 US REC standard

In the USA, EACs are called RECs. The first mention of certificate trading took place in 1995 during the design of a renewable portfolio standard (RPS) for the California Public Utilities Commission. In 1999, RE projects in California began producing a certificate of generation to accompany energy supply.

US REC schemes are governed at both the federal and state level. Government bodies, such as the US Federal Trade Commission and US Federal Energy Regulatory Commission, recognise RECs as an instrument to make environmental claims and to enable energy attributes to be traded separately from the physical energy flow [6]. All decisions regarding the implementation of an EAC scheme and regulatory framework are left to the states. As a result, US RECs are much less standardised than GOs in Europe and I-RECs worldwide. As opposed to the EECS scheme, they lack a shared legal basis and interoperability. The lack of a common standard, leading to a less efficient market organisation, motivated the non-profit Center for Resource Solutions (CRS) to establish the Green-e standard for RE products, which was adopted nationally in 2002 [7]. This standard sets strict guidelines, determines what kinds of facilities can request EACs, and ensures that products fulfil carbon reporting guidelines.

Since 2002, establishing regional REC electronic tracking systems has been an important milestone. There are now 10 different issuers in the USA and Canada, each of which operates a separate registry in one or more states (see section 2.7 for more information). RE certification has been handed over to private organisations completely.

One major distinction can be made between states with compliance REC markets and states with voluntary REC markets. In compliance markets, electricity suppliers are required to provide a given share or volume of energy from renewable sources to their customers and prove that the activity has taken place by showing trade and/or cancellation of EACs. EAC compliance markets have been established in most American states with RPS. They are a tool to measure progress towards meeting an RPS. A total of 30 American states, Washington DC, and two territories have active renewable or clean energy targets in the form of an RPS. An additional three states and one territory have set voluntary RE goals (Figure 6). Figure 5 shows the development of US REC sales in the compliance and voluntary segments over the last number of years.

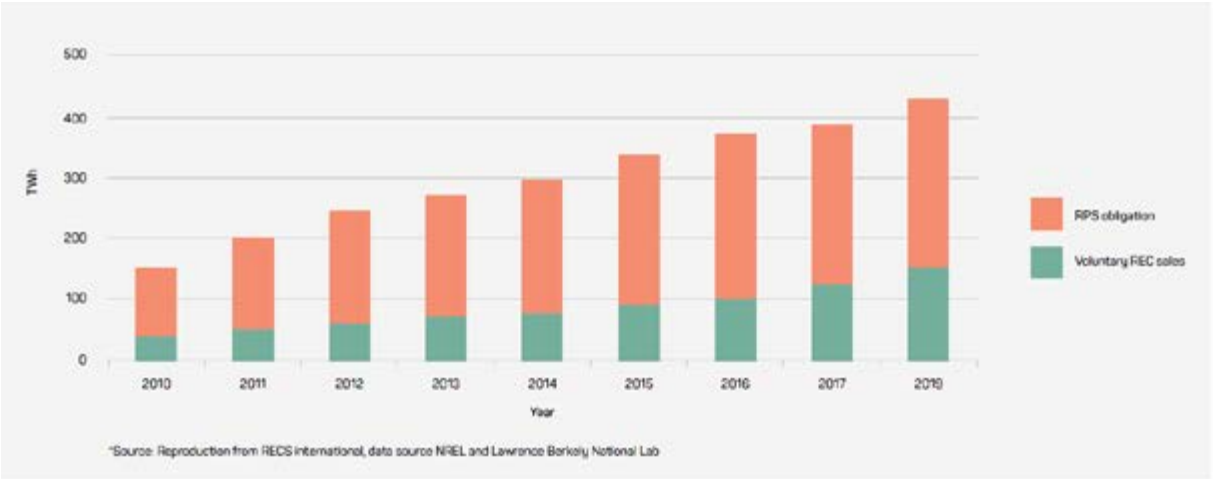


Figure 5: Development of US REC sales in the compliance and voluntary markets [7]

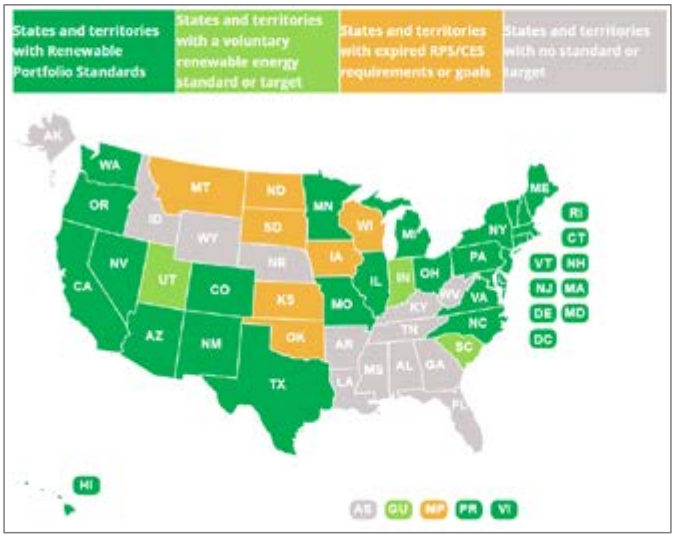


Figure 6: Overview of RPS standards in the USA [10]

2.2.2 EU EECS

Europe is the largest standardised and legally enforceable EAC market worldwide, with its GO system enshrined in EU law. In 1997, Dutch electricity suppliers developed an EAC trading programme for voluntary targets, supported by an electronic tracking system. This stimulated the creation of the voluntary EU-wide Renewable Energy Certificate System (RECS) initiative in 1998, which was active from 2001 to 2015. In 2001, the development of GO schemes was stipulated in the Renewable Energy Directive (2001/77/EC, RED). In 2002, the RECS initiative divided itself into two bodies: RECS International, representing market parties, and the Association of Issuing Bodies (AIB), representing the EAC issuing bodies. The RECS standard got custody of the AIB and later evolved into the European Energy Certificate System (EECS).

In the amended Renewable Energy Directive (2009/28/EC, RED-I), the use of GOs was specified by making them the tool for energy suppliers to disclose information on the fuel mix they were delivering to end customers. Despite providing a more robust legal basis for GOs, the RED-I set out that GOs had no function regarding compliance by EU member states with EU RE targets.

Further reinforcement of the GO system came with Directive 2018/2001, or the RED-II. This law declared GOs to be the sole instrument for claiming the use of electricity from renewable sources. In addition, this directive extended the use of GOs from renewable electricity to all RES and allowed for the issuance of GOs from all other energy sources [6]. The EECS provides a basic set of rules for energy certificates for all energy carriers. The EECS Electricity Scheme has been in operation for almost two decades, and the EECS Gas Scheme was implemented in November 2019 and fully facilitates GOs for gaseous energy carriers, including H_2.

Although the establishment of an EAC scheme is mandatory for the EU member states, they are free to decide how to transpose the prescriptions from RE directives into national law and can choose their own certificate system design. Therefore, differences between countries regarding quality assurance and market organisation exist. The use of the scheme by market participants in Europe is voluntary, so they can, but are not required to, use EACs to make a claim about RE use.

The AIB now consists of issuing bodies from 26 EU, EEA, and Energy Community Treaty countries. Membership there is voluntary, and the AIB is not an EU body. The AIB members have each been appointed by a respective national government to exclusively supervise national GO systems. The AIB developed rules for intercommunication between national registries via a central communication hub, which gives connected parties access to a database of account holders and market monitoring tools and supports calculation of the European residual mix. Adherence to a widely used standard such as the EECS has been observed to have a strong positive effect on market volumes. Standardisation enables international certificate trade, allows for simplified consumer claims, and guarantees the elimination of double counting and double certificate issuance [11]. The AIB manages the issuance, transfer, and cancellation of more than 700 TWh of clean energy trades per year across EU, EEA, and Energy Community Treaty countries, from major corporate PPAs to consumer-based energy products.

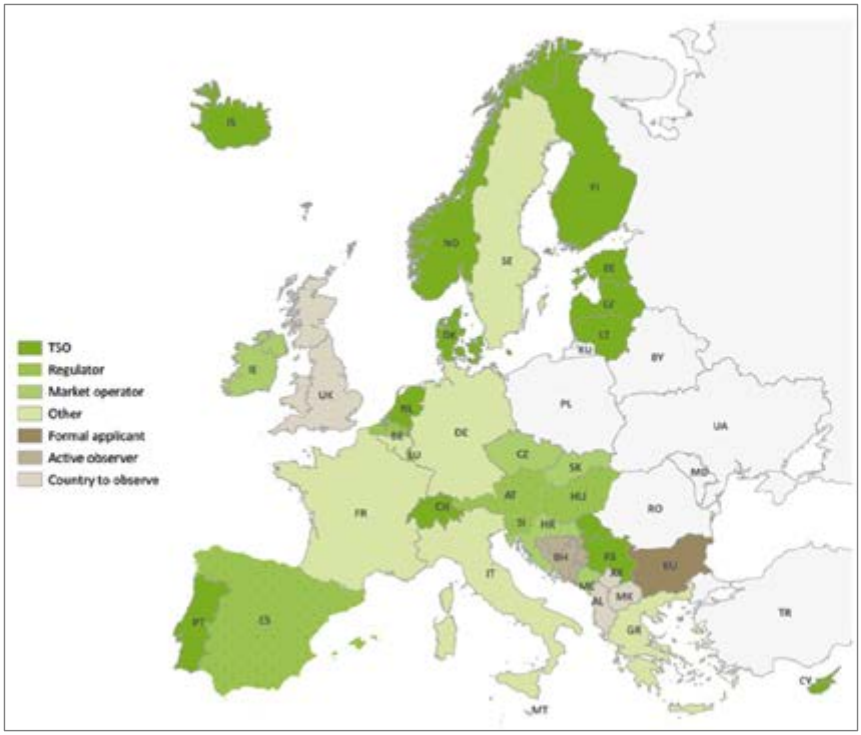


Figure 7: AIB member countries with the type of issuer [12]

2.2.3 I-REC

The I-REC is a set of rules, regulations, and best practices to be used by all related national tracking systems and a global standard widely adopted by a growing number of countries in Asia, Africa, the Middle East, and Latin America where no scheme similar to the EECS or US REC exists. The I-REC Standard is facilitated by the International REC Standard Foundation, a non-profit organisation. The I-REC provides for tracking compliance with state RE requirements and enables voluntary customers to track and verify progress towards their environmental goals.

The legal basis of the I-REC-adherent national EAC schemes varies substantially. It is often contractual rather than regulatory. Therefore, in nearly all countries with the I-REC Standard in use, the national authorities have approved the completion and facilitation of the market. This state involvement is explicitly welcomed by the I-REC, since it encourages acceptance of the scheme among stakeholders and market participants and adds to its robustness. In addition, in many jurisdictions, government bodies have appointed an issuer.

In contrast to other EAC standards that were at least initially intended to track one form of energy – electricity – the I-REC Standard was designed to be energy neutral, that is, to enable reliable claims to be made, regardless of the specific energy type. This was enabled by formulating definitions, basic principles, and a set of rules applicable to the tracking of any energy product, be it electricity, gaseous fuels, heating and cooling, or other technologies. In 2021, the new International Attribute Tracking Standard was introduced by the I-REC. As a result, I-REC has expanded the capacity for other assets to comply with the standard and become "I-REC-accredited" products. Green H_2 can be one of these products. The standard builds on the I-REC experience of offering accreditation services to tracking system providers. Accreditation means that a tracking system has been proven to be compliant with the principles and rules of the International Attribute Tracking Standard, thus guaranteeing the credibility of RE claims and fulfilment of high security standards, technical rigour, and market expectations [13].

2.2.4 Green hydrogen standards

To boost the market of green hydrogen, a definition of green hydrogen must be agreed on. Several initiatives aim to develop standards and principles of its certification.

According to the Green Hydrogen Standard, issued by the Green Hydrogen Organisation, a non-profit foundation under Swiss law, green hydrogen is H_2 produced through the electrolysis of water with 100% or near-100% RE and close to zero GHG emissions. The standard requires that green hydrogen projects operate at ≤ 1 kg CO^2e per kg H_2 (taken as an average over a 12-month period). The standard is based on project-level certification and accreditation. Projects that meet the standard are licensed to use the label "GH_2 green hydrogen" and will be eligible to obtain and trade GH_2 certificates of origin (COs). Additionally, the standard tracks the overall social, environmental, and governance performance of green hydrogen production. The principle of additionality also plays a role in the accreditation of projects. Green hydrogen project operators are required to prepare an evaluation of the utilisation of electricity in the project and the impact on the energy market. It is expected that green hydrogen projects can contribute to the build-out of new RE capacity and avoid leading to increased use of fossil-fuel-generated electricity elsewhere in the energy system (i.e., the additionality principle). The accreditation and certification body of GH_2 establishes and oversees the operation of the GH_2 Registry, which issues, tracks, and cancels GH_2 green hydrogen GO certificates.

Green hydrogen producers may count electricity taken from the grid as fully renewable if they have concluded one or more PPAs with operators producing renewable electricity in one or more installations, generating renewable electricity for an amount that is at least equivalent to the amount of electricity that is claimed as fully renewable, and the electricity claimed is effectively produced in this or these installations. PPAs should make use of credible GO certification schemes (or similar proofs) where available. There is an expectation that the project operator addresses temporal correlation (ensuring that the demand of the electrolysers matches the renewable power generation) as well as a geographical correlation (ensuring that the electrolyser and the renewable power generation covered by the PPA are located in the same power market). The granularity of the information in PPAs and GO certificates should be aligned with the electricity market where the PPA and GO certificates are issued. Where regulatory bodies have imposed requirements on temporal or geographical correlations between the consumption of electricity by the electrolysers and the generation of the additional renewables-based electricity, GH_2 certification requires that these requirements be met.

Up to 5% of electricity from any source may be consumed by electrolysers in a given year if it can be reasonably demonstrated that there have been technical or market constraints requiring such use. The overall threshold for the GHG intensity of produced hydrogen (1 kg CO2/kg H_2) must not be exceeded in a given calendar year.

In developing these standards, the GH_2 has drawn on a variety of international best practices, in particular the International Finance Corporation's (IFC) Environmental and Social Performance Standards, the Hydropower Sustainability Council's Hydropower Sustainability Standard, and the UN Sustainable Development Goals (SDGs).

Table 1: Requirements of the Green Hydrogen Standard [14]

Requirement	Objective	Content
Project overview and outlook	To ensure that the project operator can demonstrate the strategic fit of the project with relevant policies and plans of the host government and that the project is a priority option to meet identified market needs.	The project operator must publish a publicly accessible and transparent overview of the project addressing the expected outcomes and impact, including: a. An overview of the project (scope; technology used; capacities; time frames; involved parties; how key decisions will be made and who will make them; local and regional impacts). b. A summary of the contribution of the project to local and national policy and plan objectives and to the UN Sustainable Development Goals (SDGs), where applicable. c. A summary of the environmental, social, and economic impact of the project and plans to mitigate them. d. A summary of plans for ongoing consultation and community outreach and engagement; and e. A summary of how project operators intend to meet and sustain compliance with the requirements of the GH_2 Green Hydrogen Standard over the whole lifetime of the project.
Stakeholder engagement and government approval	To demonstrate that the project has been (a) subject to a proper approval process in accordance with national laws and regulations, (b) that any concerns regarding the project can be addressed through the appropriate channels and with the relevant government authority, and (c) that the project has widely engaged relevant stakeholders to build trust and maximise its social licence to operate and identify local economic development opportunities.	The project operator must publish a publicly accessible summary of the government licences and approvals associated with the project. This should address property rights, land use, water rights (if applicable), environmental, public health, and foreign investment approvals as appropriate, with links to the associated documentation where publicly available. The documentation should be made available to the independent assurance providers, with appropriate caveats and safeguards to protect personal and commercially sensitive information.

Table 1: Requirements of the Green Hydrogen Standard [14] Continued

Project location and design	To demonstrate that the location and design of the project have been optimised as a result of an iterative and consultative process that addresses the most significant technical, economic, financial, environmental, and social considerations.	A publicly accessible evaluation of the project location and design options is needed, including the renewable electricity and water sources, H_2 production facilities, and associated storage and transportation infrastructure, with appropriate attention to sensitive and protected areas.
Social impact	To demonstrate that the project has been subject to social impact assessment (SIA) or other similar assessment to help understand the potential impacts that a proposed project may have on a community. The expectation is that due consideration and planning can be demonstrated to maximise local development opportunities and engage smaller businesses in the supply chain.	1. Affected communities and livelihoods: obligatory identification and monitoring of issues relating to project-affected communities, public health issues, and human rights impacts; assessment of the development impact of the project and contribution towards the SDGs. 2. Resettlement: the project operator must avoid involuntary resettlement wherever possible and minimise its impact on those displaced through mitigation measures such as fair compensation and improvements to living conditions. 3. Indigenous peoples: business activities must minimise negative impacts; foster respect for human rights, dignity, and the culture of indigenous populations; and promote development benefits in culturally appropriate ways through informed consultation and participation with indigenous peoples throughout the project process. 4. Labour and working conditions: project operators must undertake an assessment of human resource and labour management requirements for the project, including recruitment, project occupational health and safety issues, risks, and management measures. 5. Modern slavery, child and forced labour: the project proponent must not employ children and forced labour.

Table 1: Requirements of the Green Hydrogen Standard [14] Continued

Environmental impact	To demonstrate that the project has been subject to an environmental impact assessment – a rigorous process of identifying, predicting, evaluating, and mitigating the biophysical, social, and other relevant effects of the project in accordance with applicable regulatory requirements, including appropriate stakeholder consultation and publication of the results. It is also expected that the project operator has established an environmental management plan to safeguard and improve environmental performance over the lifetime of the project.	1. Renewable energy sources (RES): the project operator has to demonstrate that H_2 is produced through the electrolysis of water with 100% or near-100% RE (hydropower, wind, solar (solar thermal and solar PV), geothermal energy, or tidal, wave, and other ocean energy sources); the project operator has to undertake an evaluation of the utilisation of electricity of the project and the impact on the energy market, including, where applicable, network congestion and the impact of their operations on the GHG emissions from the electricity grid. 2. Water use and quality: evaluation on the utilisation of water of the project and the approach to wastewater treatment and water pollution is needed. 3. Waste, noise, and air quality: identification and monitoring of waste, noise, and air quality issues relevant to project implementation and operation. 4. Biodiversity: identification and monitoring of biodiversity issues relevant to project implementation and operation. 5. Climate change impact and mitigation: independent verification that green hydrogen production facilities have robust systems to accurately and comprehensively measure the GHG emissions for production periods/shipments, including appropriate documentation for the purposes of certification.
Health and safety	To demonstrate that the livelihoods and living standards affected by the project are improved relative to pre-project conditions for project-affected communities.	Project operators are expected to have undertaken an assessment of human resource and labour management requirements for the project, including project occupational health and safety issues, risks, and management measures.
Governance, transparency, and accountability	To demonstrate that the project operator complies with governance, transparency, and accountability requirements.	The project operator must show that it has sound corporate business structures, policies, and practices; addresses transparency, integrity, and accountability issues; can manage external governance issues (for example, institutional capacity shortfalls, political risks, including transboundary issues, public sector corruption risks); can ensure compliance with codes of conduct and anti-corruption standards; and procurement processes are equitable, transparent, and accountable.

In 2021, the European Commission approved a recast of the Renewable Energy Directive (RED II), which outlines green hydrogen and its derivatives as a key aspect of the EU's net zero strategy. To facilitate the growth of this market, new rules regarding the certification and traceability of these fuels will be introduced. Renewable fuel of non-biological origin (RFNBO), including green hydrogen, will be tracked and certified under a new mechanism, which will likely be part of a newly set up "Union database" or through certification schemes such as CertifHy (more information below). The EU H_2 strategy specifically mentions the role that GOs can play in facilitating the most cost-effective production and EU-wide trading of H_2. H_2 GOs will not only enable consumers to know the 'quality' of the H_2 they consume but will also help identify the projects likely to receive financial support. The commission also notes the importance of introducing EU-wide instruments, including "a common low-carbon threshold/ standard for the promotion of H_2 production installations based on their full life-cycle GHG performance, which could be defined relative to the existing ETS benchmark for H_2 production". The commission established a limit of 70% GHG emissions reductions compared to the benchmark of existing fossil-fuel-based transportation fuels [8] [9].

The CertifHy Project has developed a framework on the first EU-wide voluntary scheme for the certification of premium H_2 according to the European RED. CertifHy has been initiated at the request of the European Commission.

The CertifHy scheme includes two different certificate labels:

- CertifHy green hydrogen (from renewable sources and having a GHG balance below 60% of the baseline for H_2 produced by steam methane reformation (SMR))
- CertifHy low-carbon H_2 (from non-renewable sources but having a GHG balance below the same threshold)

The proposed GO for premium H_2 decouples the green attribute from the physical flow of the product and makes premium H_2 available EU-wide, independently from its production sites. The H_2 GO life cycle and key actors participating in the certification process resemble those of RE GOs (Figure 8, Figure 9). A CertifHy certificate is an electronic document providing proof that a given quantity of H_2 is produced by a registered PD with a specific quality and method of production. The CertifHy certificates are maintained in a CertifHy Registry, a central database that manages their life cycle for every account holder.

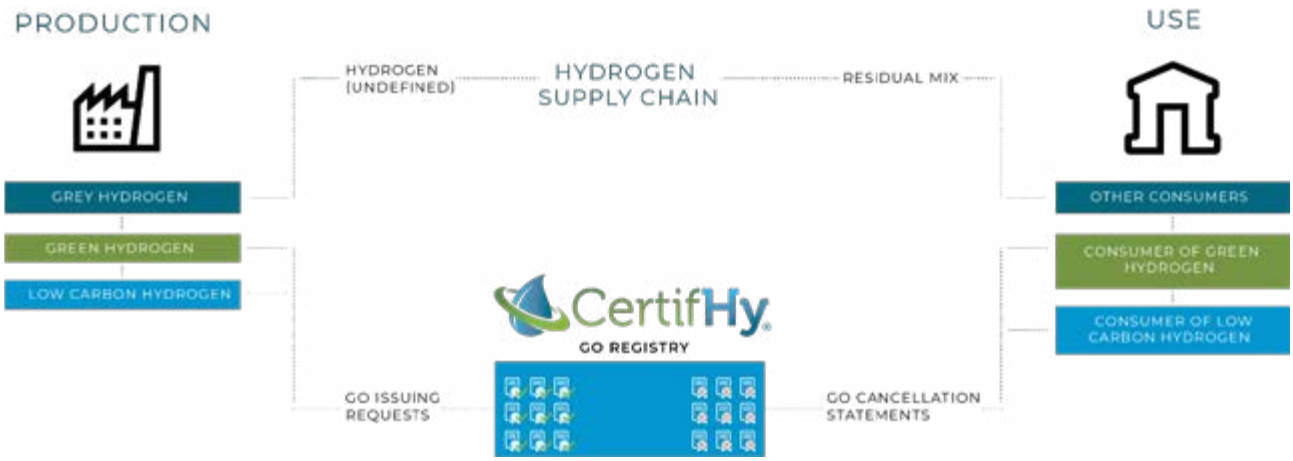


Figure 8: Flow of H_2 and CertifHy certificates [15]

Each certificate shall have a value of 1 MWh based on the lower heating value. CertifHy GOs provide information about the following:

- CertifHy GO identity: unique ID number, date of issuing, cancellation date
- Information on the plant that produced the H_2 (location, start date of operation, operator, etc.)
- Time of production of the H_2
- Energy source of the H_2 (fuel or heat) and technology
- Whether the H_2 production has received financial support or not
- Share of RE for each input energy carrier for producing the H_2
- GHG intensity (amount of CO^2 equivalent per unit of energy) of the H_2
- CertifHy label: green hydrogen or low-carbon hydrogen

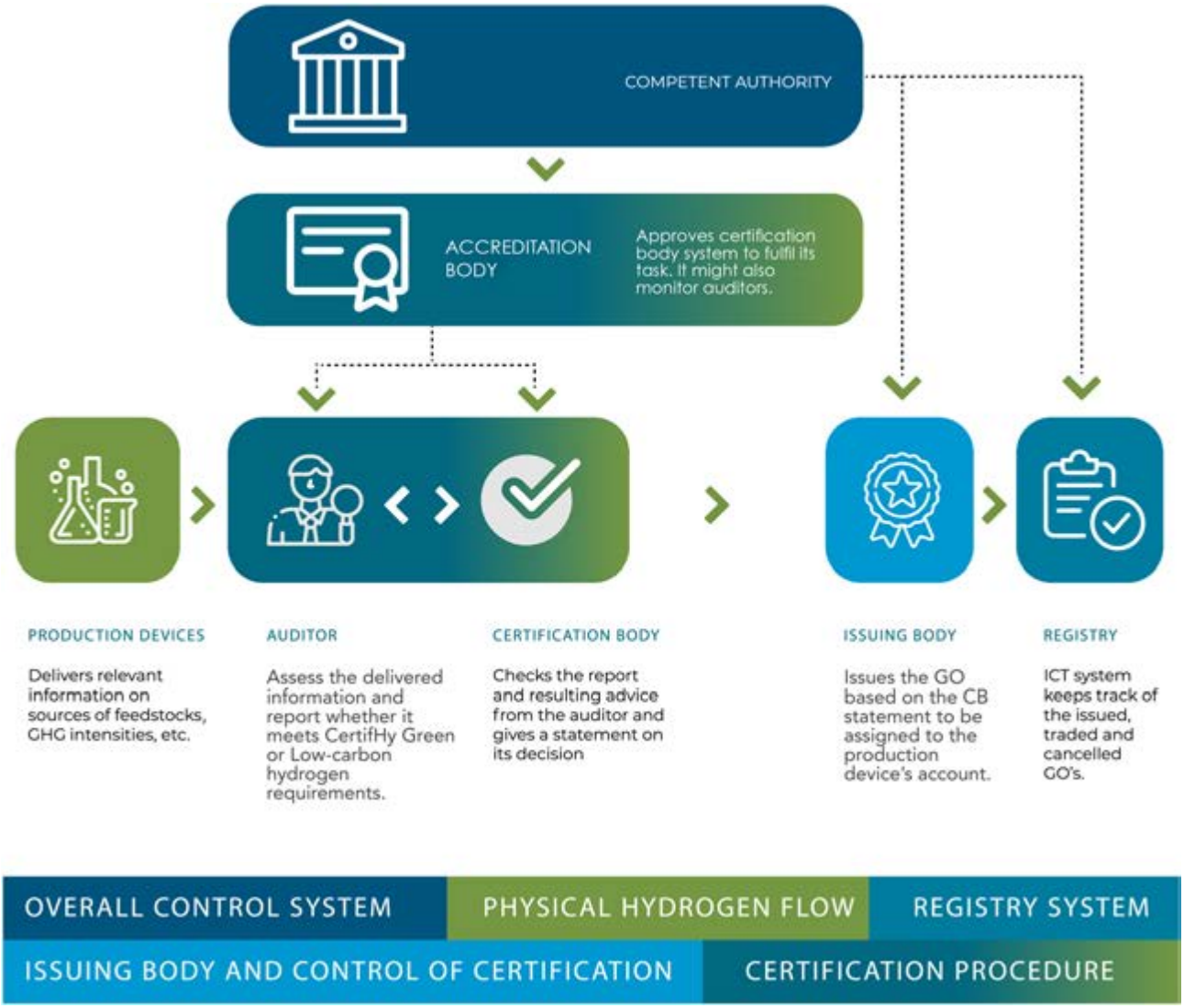


Figure 9: Key actors of the CertifHy certification process [16]

CertifHy™ is compliant with AIB's EECS by adjusting the CertifHy scheme documents to changes of the EECS as well as the CEN EN16325 standard applicable to all GOs in Europe (see section 2.6 for more details). The plan is to expand this certification framework to other jurisdictions outside the EU and EEA.

German certification body TÜV SÜD introduced green hydrogen certification in 2020 (TÜV SÜD Standard CMS 70, version 11/2021) [17]. A certificate to produce H_2 from renewable energy sources (RES) can be issued if the basic requirements are met, and the H_2 has a GHG reduction potential of at least 70% compared to a fossil fuel benchmark for fuels or combustibles. The certification mark GreenHydrogen can be used for this purpose.

Beyond the basic requirements, additional requirements are formulated in the standard. If the following additional requirements are met, TÜV SÜD's GreenHydrogen+ certification mark can be used:

- Mass balanced (the physical H_2 and the certified renewable attribute must be marketed together (bundled) at all times)
- Electricity from RE from new plants
- Simultaneity between electricity generation from RE and electricity consumption of the electrolyser
- Avoidance of grid bottlenecks when supplying electricity between the regenerative powergeneration plant and the electrolyser
- Increased requirements for the use of certified H_2 for heating purposes only

It is intended that the TÜV SÜD GreenHydrogen certification standard will be recognised as an independent criteria scheme (ICS) once a GO system for green hydrogen has been adopted in the EU.

2.3 Labels as an additional quality seal

Labels are an important part of a liberalised energy sector and are created to convey additional features of certified energy. This chapter includes a description of their main characteristics compared to EACs, an analysis of selected labels operating in different regions, as well as the steps required to set up a functioning and widely accepted label.

2.3.1 Main characteristics of labels

An EAC shows only the origin of the electricity, but not whether the construction of new RE systems is being promoted or whether the electricity generation meets certain ecological criteria. This is where private-sector green electricity labels come in as additional information systems. These labels can be based on relevant EAC tracking systems and add important assurances and quality criteria [18]. They often form a basis of green electricity tariffs.

Green electricity labels are independent, voluntary certifications that are issued by non-governmental bodies and that check and label green electricity products for compliance with certain additional features using specially elaborated criteria. Green electricity labels enable a standardised, qualitative classification of green electricity products [19].

A green electricity label is a marketing-oriented product of the green electricity sector. It should also stimulate the generation of additional RE capacities. If a supplier wants to obtain a green electricity label for its electricity product, certain criteria must be met. For this purpose, the organisations certifying green electricity labels usually offer different models according to which the electricity product can be certified.

For differentiation of various features that generate additional ecological benefits that labels could identify, these are some of the options (the list is not exhaustive) [19]:

- Bundling of electricity supply and EAC
- Connection of electricity supply and EAC, for example, within the so-called simultaneity whereby EACs are not issued for a quarter of an hour, but rather for a production month
- Requirements for generating plants, for example, regarding age or energy sources
- Requirements for the owners of generation plants, for example, by excluding companies involved in nuclear power
- Imposed ecological company principles, for example, through a (self)-commitment that (part of) the profit is to be invested sustainably
- Connecting the actual, physical delivery with the product, for example, as part of energy community projects
- Measures associated with the sale of the green electricity product, for example, by investing a portion of the electricity price received from the electricity bill in the construction of new facilities.

There is often a further differentiation regarding characteristics of eligible power plants. Many of the labels, based on the example of Germany, use the following differentiation regarding the selection of the RE systems included in the portfolio:

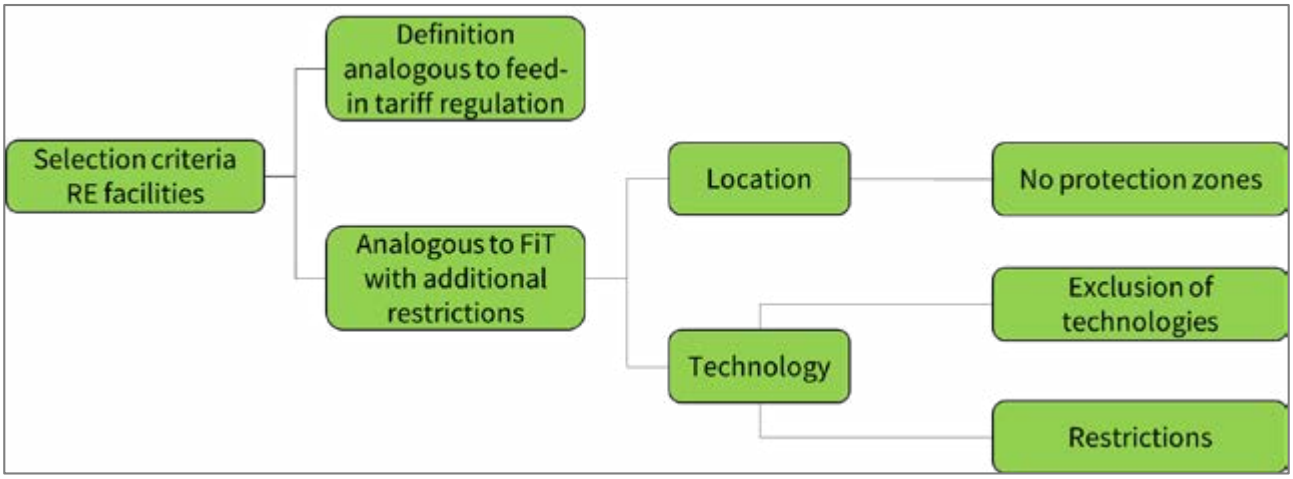


Figure 10: Differentiation regarding the selection of eligible RE systems [19]

The 2019 Market Analysis of Green Electricity II [19] provides a valuable assessment of added features that are promoted by different labels. This assessment tries to find out whether these features bring about additional environmental benefits, that is, expansion of RE generation, energy efficiency increase, reduction of GHG emissions, and the like (see Table 2). An overview of the features can be seen in Figure 11.

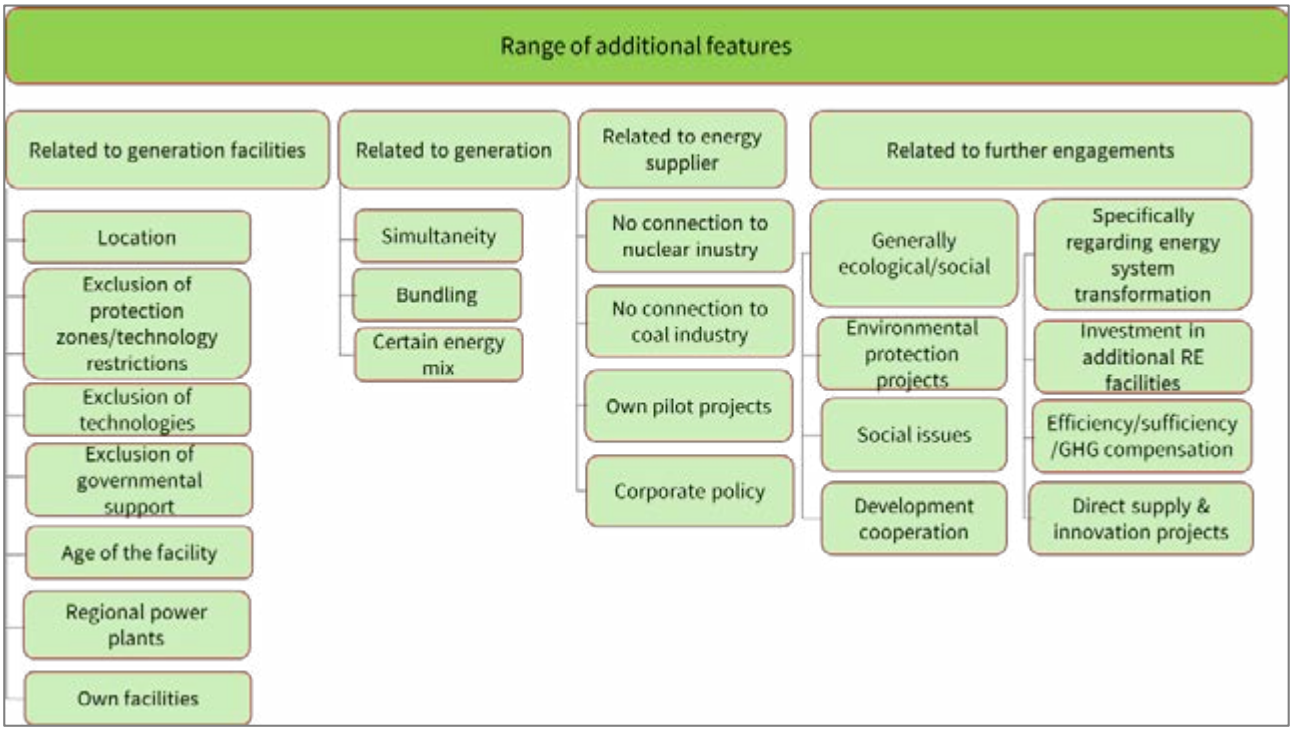


Figure 11: Overview of added features promoted by electricity labels (based on [19])

Table 2: Assessment of added features promoted by labels (based on [19])

Added feature	Description	Assessment
Related to generation facilities		
Facility location	Option to choose electricity from specific locations, for example, near the customer	The motivation behind this is to increase the connection between customers and various facilities. A direct energy transition benefit can hardly be identified just because of the choice of location. If necessary, this could lead to greater individual acceptance of the RE expansion, but it is difficult to say to what extent this offer is of particular interest to people who are already open to the energy transition.
Exclusion of protection zones/technology restrictions	Some labels select certain areas within which they, for example, do not want to contract for nature and species protection reasons. As for technology restrictions, additional criteria are applied for certain technologies with which the ecological interventions that can result from different types of RE systems are to be minimised.	If additional systems are involved, the main effects of these two additional features could lie in possible additional environmental benefits if nature or species conservation concerns, etc. are taken into account. However, in the case of production plants that have already been built and are not contracted by certain suppliers, there is no additional environmental benefit.
Exclusion of technologies	Option of excluding electricity from certain RE technologies.	The benefit of this feature is primarily at the level of individual preferences. It is, however, difficult to assess which technology mix will really be needed in the medium and long term so no benefit for the energy transition can be identified here.

Table 2: Assessment of added features promoted by labels (based on [19]) Continued

Added feature	Description	Assessment
Related to generation facilities		
Exclusion of government support	Plants that do not receive FiTs or other state support and need to refinance themselves independently on the electricity market can receive a label.	This feature makes it possible to find ways in which plants can be refinanced in other ways than FiTs and can serve as a supplement to the FiT scheme. It is not yet possible to say to what extent such forms of innovation are suitable for replacing the FiT remuneration mechanism in the long term.
Age of the facility	Option to choose a power plant the age of which does not exceed a certain threshold, for example, five years	The claim that most electricity should be sold from facilities with a maximum age has an indirect effect on RE expansion in that, if the demand for electricity from new facilities is high enough, more will be built.
Regional facilities	Customers are given the opportunity to obtain green electricity from "regional" power plants, although the term "region" is not generally defined.	As with the feature "location", there is no direct energy transition benefit from an additionally induced RE expansion, but it can create an additional impetus at the regional level because the proximity to the plants means that further energy transition activities are undertaken, or the acceptance of the RE expansion generally increases. A possible benefit of such models could also be their contribution to the organisational transformation of the energy system. Soon, more and more systems will be excluded from the FiT scheme. These models can help enable targeted marketing of these (small) quantities and ensure that these systems continue to operate. In addition, local energy communities can encourage consumers to install storage systems and gain experience in using decentralised flexibility options.
Own facilities of the energy supplier	Here the providers advertise that the green electricity comes from systems that are owned by the provider itself.	If the electricity comes from facilities outside governmental support, a positive effect on additional RE expansion can be expected. Advantages when the provider acquires know-how are that it can be used in developing and marketing additional facilities and the knowledge gained can be shared. This experience can also be used for additional plant extensions.

Table 2: Assessment of added features promoted by labels (based on [19]) Continued

Added feature	Description	Assessment
Related to generation		
Certain energy mix	This additional feature enables customers to buy a specific energy mix.	Hardly any specific energy transition benefit can be identified from this. On the one hand, it is currently difficult to assess which technology mix will really be needed in the medium and long term. On the other hand, it can be assumed that – if the desired energy mix is put together with EACs from existing systems – this is a "book-and-claim" measure in which the purchase of a specific energy mix leads to a redistribution to other customers who do not express any specific preferences.
Simultaneity	In simplified terms, the consumption of all customers in a consumption group (for example, households) is aggregated in a distribution network. The respective suppliers must now provide the percentage of the aggregated production that corresponds to the consumption of their customers in terms of quantity.	The term "simultaneous generation" must then be questioned as to whether and to what extent it is feasible and expedient in terms of the energy transition. In the context of a generation structure characterised by fluctuating renewables, the core challenge is not the adaptation of renewable generation to consumption, but the best possible use of the supply, be it through targeted compensation of the fluctuation through controllable renewables and flexibility options or through an adaptation of consumption or network withdrawal by consumers in relation to the (fluctuating) supply.
Bundling of supply and an EAC (from abroad)	The balancing groups must be kept balanced to ensure that generation and consumption in the grid are always in balance. The obligation to feed in or consume always exists for both generators and consumers towards the "grid". As part of the balancing group system, it is possible, within the framework of so-called balancing group swaps, to "construct" a supply of renewables from abroad, which is de facto not possible at all, for example, because the necessary transmission rights are not available.	Options within the framework of balancing (such as swaps) can be used to construct deliveries that have no systemic effect (neither on the addition nor on the income streams of the RE plant owners). With swaps, it is possible to construct a delivery from a country where the import balance does not show a single MWh of electricity imports. As a result, no advantage can arise from the "bundling" of renewable energies from abroad to EACs.

Table 2: Assessment of added features promoted by labels (based on [19]) Continued

Added feature	Description	Assessment
Related to generation		
Optional coupling (more in 2.7)	The optional coupling in the German regulation means that a GO and the amount of electricity for which it is issued are linked at the request of the plant operator. Electricity and GOs are then delivered or transmitted in parallel to the same utility, which then uses the GO for the delivery of the electricity to a specific end customer. Coupling, therefore, has the purpose of linking a specific generation of electricity from a specific installation with the supply of electricity by a specific energy supply company, possibly even to a specific end customer [20]. The level of the balancing groups is regarded as the best possible approximation to the physical delivery, since actual electricity deliveries can be traced within the 15-minute timetable in the form of balancing group bookings. The prerequisite for issuing the coupled GOs is, therefore, that the plant operator has delivered electricity to the balancing group of the utility, which is not offset by an offsetting booking within the 15-minute timetable.	The procedure of issuing a coupled GO is cumbersome since environmental auditors must confirm relevant data. A direct delivery from the balancing group of the power plant to the balancing group of the utility is hardly feasible and, if so, then enormously complex. This would, therefore, only allow certain contract and delivery constellations and make the balancing group management of the energy supplier considerably more difficult. In addition, the process flow excludes the coupling of foreign GOs, since the German register administration is neither authorised to issue GOs for electricity generation abroad (due to lack of responsibility) nor to enter a coupling feature on an imported foreign GO after the issue (the principle of immutability of GOs). As a result, optional coupling in its German version is not used enough: less than 1% of all cancelled GOs have an optional coupling feature.
Related to energy supplier and further engagements		
No connection to nuclear or coal industry	Suppliers must have no personal, proprietary, or other financial ties to the nuclear or coal industries.	This is a gradual change of the existing regime. The previous "fossil-nuclear regime" is weakened by the demand for green electricity from providers without such interdependencies, and new players can emerge or grow. These additional features can, thus, make an actor-related contribution to the energy transition.
Investment in additional RE facilities	As part of the direct investment in the expansion of RE, the providers invest a specific premium in the new RE power plants.	If these investments are exclusively in facilities that could be built within the FiT framework, this feature does not contribute to additional RE expansion, but with an extension abroad using this model, positive effects can arise. Direct investments in energy-sufficient systems can now, in some cases, bring an additional energy transition benefit.

Table 2: Assessment of added features promoted by labels (based on [19]) Continued

Added feature	Description	Assessment
Related to generation		
Direct supply, innovation, and research projects	The direct supply of electricity customers (not in the sense of a balance sheet allocation) with renewable electricity could – in rare cases – mean a grid-independent supply or various self-consumption models. Further, it could mean investments in RE technologies that cannot yet be operated economically at the time but are considered important for the further implementation of the energy transition, for example, "power-to-X" applications or storage technologies.	There is a large variety of possible "future projects" that green electricity providers can implement in terms of contributing to the energy transition. However, the evaluation and comparability of such projects are difficult. With the issue of direct supply, it is not possible to make a general assessment here as to what extent this brings about an additional expansion of RE. However, there are other important energy transition benefits that arise during the implementation of such projects. These include not only people's direct experience with RE technologies and, if necessary, direct engagement with the energy transition, but also the various possibilities that can result from this for organisational, personnel, or infrastructural innovations in the context of the energy transition as well as the possibly resulting diffusion effects.
Efficiency measures	This applied to all the projects whose purpose is to contribute to relative or absolute savings in consumption. There is a wide spectrum of possibilities to support this goal.	Effectiveness is important for the evaluation, namely, the de facto implemented target achievement of these measures. No general assessment can be made here; nevertheless, both energy efficiency and sufficiency are genuine overarching goals of the energy transition, which is why there can be a clear energy transition benefit here – with a positive evaluation of the effectiveness.
Environmental protection projects	A wide range of different measures can be summarised here, which can be financed with the price surcharges of the green electricity customers.	The diverse need for action in these areas (creation of effective carbon sinks and other environmental protection projects) can hardly be disputed. However, the effectiveness of these projects cannot be assessed here. It is even more important in these cases that the providers value extensive transparency and verifiability (also through documented external certification of these projects).
Development co-operation and social projects	The same as with environmental protection projects.	The same as with environmental protection projects.

In summary, it can be said that labelling green electricity products has a function within the framework of energy system transformation. At the present time, however, this potential lies less in terms of stimulating the additional construction of RE facilities and, thus, not in a direct GHG reduction, but more so in the social area where building trust among consumers and using the psychological benefit of green electricity products as a catalyst for energy system transformation is of importance. These positive effects, however, should not distract from the fact that the explicit naming and identification of the benefits of green electricity products are still necessary to advance the energy transition and to make a serious contribution to the expansion of RE. In this regard, a unified assessment and certification of green electricity products is desirable.

2.3.2 *Selected labels in Europe, the USA, and worldwide*

ICS can complement the EECS by adding a flag to the EECS certificate that proves compliance with certain requirements maintained outside of the EECS. An ICS informs consumers on aspects that may go beyond minimum legal requirements. To participate in the EECS, the ICS operator must sign an agreement with both the AIB and the national issuing bodies of the EECS certificates on which the ICS label shall be recorded.

ICSs are not certificates in themselves: they classify energy sources or supplier products according to specific criteria set; and an indication of such can be placed on each EAC. Their connection with EECS certificates prevents confusion and double counting that could be associated with separate handling of the ICS and an EAC system. ICSs that are recognised by the EECS are EKOenergy, TÜV SÜD, and nature made (see Table 3 for more detail on EKOenergy and naturemade).

In Austria, the issuing body E-Control is authorised to issue quality labels on the GOs (GOs plus the TÜV quality label). In Croatia, a combination of EECS GOs and the TÜV SÜD label can be issued. In Finland, the issuing body can issue certificates related to an ICS with an EKOenergy label. In France, certificates with TÜV SÜD and naturemade labels can be issued by the European Energy Exchange AG (EEX), the official issuing body. In the Netherlands, CertiQ has been properly appointed as an authorised issuing body for ICS: NTA8080. In Switzerland, GOs with the labels naturemade and TÜV SÜD Generation EE can be issued.

In the USA, the Green-e certification programme for voluntary RE transactions is very well distributed. In 2020, bundled certified RE options were available in 32 states and Washington DC (Figure 12). Customers can purchase the certified energy through their local utility or electricity provider. RECs unbundled from electricity are available to buyers, regardless of location. Businesses with high electricity demand tend to opt for unbundled RECs, often from multiple locations, while smaller businesses and household customers tend to choose a bundled electricity product contracted through their utility or electricity provider. Green-e is the only organisation that certifies green power products in the USA. It has programmes in place that not only certify green power products, but also independently verify the products on an annual basis.

Green-e Energy specifies that a "Green-e Energy certified product may include only renewables that are generated in the calendar year in which the product is sold, the first three months of the following calendar year, or the last six months of the prior calendar year". This design aspect of the Green-e Energy programme meets the vintage quality criteria of the GHG Protocol Scope 2 Guidance that seeks to ensure temporal accuracy of Scope 2 calculations, namely, that the generation occurs close in time to the reporting period for which the certificates are claimed. Green-e Energy-certified RECs must be transacted ahead of the 1 June audit deadline. Green-e Energy requires all marketers maintaining certified products to submit a third-party audited report for the prior reporting year (RY) by 1 June in the following reporting year. Audited documentation includes a checklist of items, such as sales contracts, purchase contracts, retirement reports, and other delivery documents, invoices, and materials as required under the then-applicable process audit protocol [21].

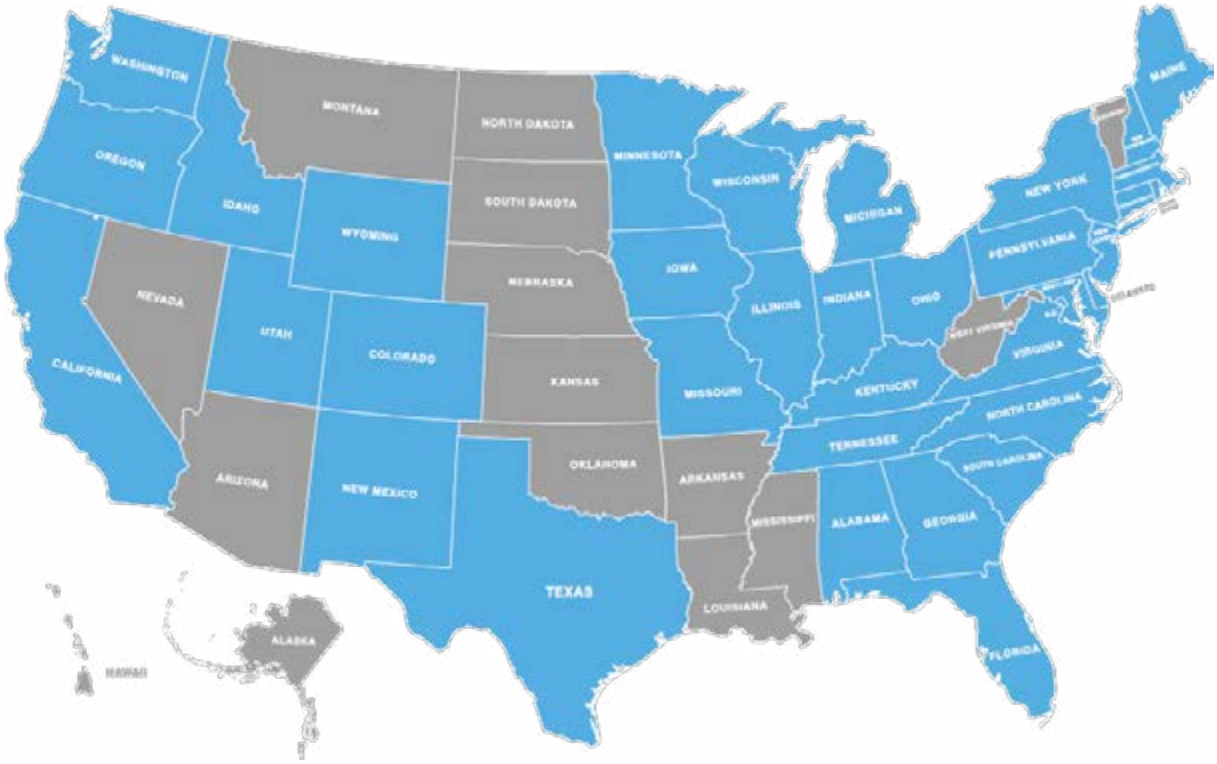


Figure 12: States with Green-e Energy-certified renewable electricity options [22]

An overview of a selection of widespread internationally recognised ecolabels explicitly highlighted for the Carbon Disclosure Project (CDP) reporting goals can be found in Table 3.

Table 3: Overview of internationally recognised labels

Labels Characteristics	EKOenergy	Green-e	Gold Standard	Naturemade
Definition/ main features	The only electricity label that has resulted from a pan-European consultation process, EKOenergy is a label for electricity, which is managed by a network of over 30 environmental non-governmental organisations (NGOs) from over 20 European countries. EKOenergy does not set up its own initiatives but makes use of existing mechanisms and instruments. Possible measures are: • support for RE projects in developing countries; • support for RE projects in other countries with significant potential for RE development, but lacking resources; • small-scale RE projects with a high environmental and social added value; • the cancellation of carbon allowances (such as the EU ETS) if there are signs that there are shortages in the market. Involvement, transparency, and 'deeds not words' are important principles of EKOenergy's work.	Green-e Energy is the leading global certification programme for voluntary RE products. In 1997, it was the first certification programme of its kind. Green-e Marketplace verifies that the RE purchased or generated by participants meets the strict environmental and consumer protection standards of the Green-e Energy certification programme and that each participant purchases qualifying amounts relative to electricity usage. Green-e Marketplace licenses the Green-e logo to participants for use with their RE claims to certify their RE purchases and provide effective promotional tools to market those purchases. Since 1997, the Green-e logo has served as a nationally recognised symbol to help consumers identify superior, certified environmental commodities.	The Gold Standard is an ecolabel for EAC systems, including for use in combination with the I-REC Standard, the EECS, and other national/regional systems that abide by their quality standards. It distinguishes the highest-quality carbon offset projects in the voluntary and compliance environmental markets and is a key policy tool for the NGO community to influence the development of the rapidly growing global carbon markets. (Learn more in Chapter 2.6.4.) It requires validation and verification by UNFCCC-accredited designated operational entities (DOEs). The Gold Standard was established by the World Wide Fund for Nature (WWF) and other NGOs and is endorsed by over 49 NGOs worldwide. The Gold Standard focuses on new project development for grid-connected RE in least-developed countries, small-island developing states, conflict zones, and those countries facing unusual challenges to modernise their energy supply.	"naturemade star" and "naturemade" basic quality labels are Swiss quality labels for energy from 100% renewable sources. The naturemade basic label is awarded for 100% RE electricity and heat; mainly large hydroelectric power plants and waste incineration plants are certified. The purchase of naturemade basic-certified energy helps fund the construction of new eco-energy plants. The naturemade star label is awarded for energy generated through particularly environmentally friendly processes. All naturemade star eco-energy comes from 100% renewable sources such as water, sun, biomass, and wind, and the label certifies that further stringent, comprehensive environmental conditions are met. Certification of energy generation under the naturemade star label takes the natural environment into account.
Geographic coverage	Worldwide	US and Canada	Worldwide	Switzerland and other European countries
Established	2013	1997	2003	1999

Table 3: Overview of internationally recognised labels Continued

Labels Characteristics	EKOenergy	Green-e	Gold Standard	Naturemade
Criteria	- Ecological requirements are related to specific energy sources, especially hydropower. - Per MWh of EKOenergy sold, a contribution of a minimum of EUR 0.10 must be made to EKOenergy's Climate Fund. The fund money will be used to stimulate further investments in RE.	– For new projects, eligible renewable facilities must have started operation or have been declared repowered in the last 15 years or otherwise been approved for extended use. Facilities must be built for the voluntary market. - Energy must be marketed with complete transparency and accuracy; a regular review of sellers is conducted twice a year to check marketing compliance. - No double counting: certified RE cannot also be counted towards a state's RE goal (for example, an RPS).	Certified projects must: - add new renewable electricity to the grid (there is a strict age limit for power plants, and revenue from the sale of labelled products should go towards maintaining or expanding the power plant); - contribute to three or more UN SDGs; - adhere to safeguarding principles; - engage local stakeholders; and - perform robust measurement, reporting, and verification (MRV) (regular monitoring and assurance by an accredited third-party auditor).	Energy production (power plants) and supply to end customers (energy products) are certified separately. All certified plants must operate below certain environmental pollution levels. There are especially stringent ecological requirements for hydro power plants). - It is an environmental management system for large licensees. - The Green Fund levy is 0.7 c/kWh for all naturemade star electricity sold to end customers. - Hydro power plants must establish and manage an "environmental improvement fund" to be awarded the naturemade star label (0.7 c/kWh).
Business model	For each MWh sold as EKOenergy, the supplier pays a minimum of EUR 0.08 to the EKOenergy network.	Energy certification fees are payable at the time of certification and are assessed on a calendar year schedule after that.	Fees include annual registry fees, certification review fees (preliminary, design, performance review), fees for the first year of issuance and subsequent issuances, Microscale Validation and Verification Fund fees, other services, and conversion fees.	There are membership fees for the VUE Association for Environmentally Sound Energy plus a certain financial contribution per MWh of certificates sold.

Table 3: Overview of internationally recognised labels Continued

Labels Characteristics	EKOenergy	Green-e	Gold Standard	Naturemade
Number of certified electricityproviders/ share of certified electricity/ other market volume indicators	55 certified electricity providers (for 2020) [23]	Green-e Energy: over 2.5% of the total USA electricity mix (enough to power four out of every five USA households for a month; the output from almost half of the installed wind facilities in the USA is sold in Green-e Energy-certified transactions); and there are over 1.4 million retail purchasers of Green-e-certified RE, including over 104 000 businesses (2020). In 2020, 329 companies participated in Green-e Energy [22]. Green-e Climate: more than 598 700 carbon offsets in 2020. Green-e Marketplace: 26 participating companies with approximately 700 products.	In total, the Gold Standard has issued 191 million carbon credits from projects based in more than 98 different countries around the world.	Its share is 11% of the total Swiss electricity consumption, about 16 TWh of certified production quantities, and 7 TWh of certified energy products [24].

2.3.3 Steps in the process of implementing a label

Within the "Clean Energy Network for Europe" (CLEAN-E) project, general recommendations for introducing a label were developed [25]. The following section is based on these recommendations for action [25]. They are divided into five categories.

Favourable market conditions for setting up a label

The following market conditions create a supportive environment for establishing a new label:

- The electricity market should be fully liberalised, and all customer groups, including households, should be able to switch their energy supplier. All switching barriers, such as switching charges, should be abolished. New market entrants should not have restrictions, which enables non-discriminatory access to green generation facilities.
- The power market shall provide mature conditions for green energy products, for example, providing for smoothing of big price differences between conventional and green products.
- On the supply side, there should be a group of forward-looking suppliers willing to participate in the labelling scheme from the very beginning, no matter whether they are new market players or incumbent utilities.
- On the demand side, consumers of different types (businesses, public authorities, households) should be aware of the environmental benefits associated with green power compared to conventional energy generation. Additionally, consumers should be mindful about their opportunity to switch supplier.
- On the generation side, there should be sufficient capacity available that fulfils the labelling scheme requirements and can satisfy growing demand after setting up a label. If this is not given, labelling bodies should consider opening the scope of the label to electricity imports from eligible sources.

If the listed market characteristics are not fully in place, respective labelling bodies have to address specific deficits by way of taking political actions to improve market conditions or developing awareness-raising tools and campaigns to trigger demand.

Developing appropriate communication

As labelling represents a transparency tool and marketing instrument mostly applied in the voluntary energy market, good communication is key. Only labels that have been able to formulate a clear and simple message that is aligned with what consumers expect from the associated green products will become successful. Most consumers are more persuaded by an attractive marketing campaign than by considering the whole range of benefits provided by the applied label criteria.

One may seek endorsement by NGOs, especially those focusing on environmental and consumer protection issues. The promotion of a label through NGOs can provide a push for market success.

It is also important to clearly delineate the labels on the voluntary energy market from the public support of RE. Labels should be shown as an additional instrument for RE expansion and not the replacement of state measures.

Developing labelling criteria

The starting point for developing labelling criteria should be the existing legal framework that is applied to energy sources eligible within the labelling standard. The specific support framework for RE generation also must be considered.

In defining labelling criteria, one should find a compromise between the ecological claims of organisations standing behind the label and the economical constraints of the market players who will be direct users of the label. On the one hand, the labelling standard should be ambitious enough to differ from green products with no additional environmental benefits. If the standard is too low, its credibility will be undermined by NGOs. On the other hand, labelling criteria should allow suppliers to offer compliant products at acceptable costs. If the criteria will result in premiums lying far above the price level of conventional electricity products, sufficient demand cannot be created.

To avoid duplication of efforts and enable harmonisation with other standards, labelling bodies should consider transferring standards that are already well established abroad. However, one must consider institutional frameworks and the regulatory context in which one operates. Consequently, standards from abroad must be examined carefully to avoid counteracting national legislation.

Generally, labelling bodies should consider starting with a relatively moderate standard. A low entrance should allow many suppliers to apply for a label for their products from the very beginning. However, it should be communicated that this level will be gradually increased over time, where labelled companies will have an opportunity to keep up with the evolution of the standard.

Developing sound auditing procedures

The key element of the auditing procedures related to labels is the tracking mechanism that provides proof that a labelled energy product was really generated by the energy sources claimed by the supplier and fed in the grid. Labelling bodies should adopt clear rules about which tracking mechanisms are accepted in the scope of the label. One of the main requirements here is to avoid multi-counting of certain attributes of an energy product. The tracking mechanism needs to make sure that the "green characteristics" of the energy unit are owned by only one entity and will not be claimed in green products other than the labelled one.

Introducing a label to the market

The new labelling standard should be supported by as many stakeholders as possible. Representatives from all relevant stakeholder groups should be involved from the very beginning. These groups mostly include environmental and customer protection NGOs, RE associations, recognised EAC standard-setting organisations, energy agencies, and so on.

Additionally, it is recommended that specific NGOs be invited to actively join the labelling body. This can help establish a well-recognised labelling standard. Also, some forward-looking energy suppliers should be involved in the development process from the start. When a handful of pioneers commit themselves to going through pilot labelling, the market introduction of a new label can proceed more smoothly. A good relationship and co-operation between a label and its customers are one of the success factors and shows the openness and customer orientation of a labelling body. any major amendments to a labelling standard should be discussed with the labelled suppliers, thus undergoing a reality check.

Another success factor is the involvement of businesses and public authorities on the demand side. The stimulation of demand can be a key condition to motivate energy suppliers to apply for a label. An overview of the presented steps and recommendations to set up a successful label is shown in Figure 13.

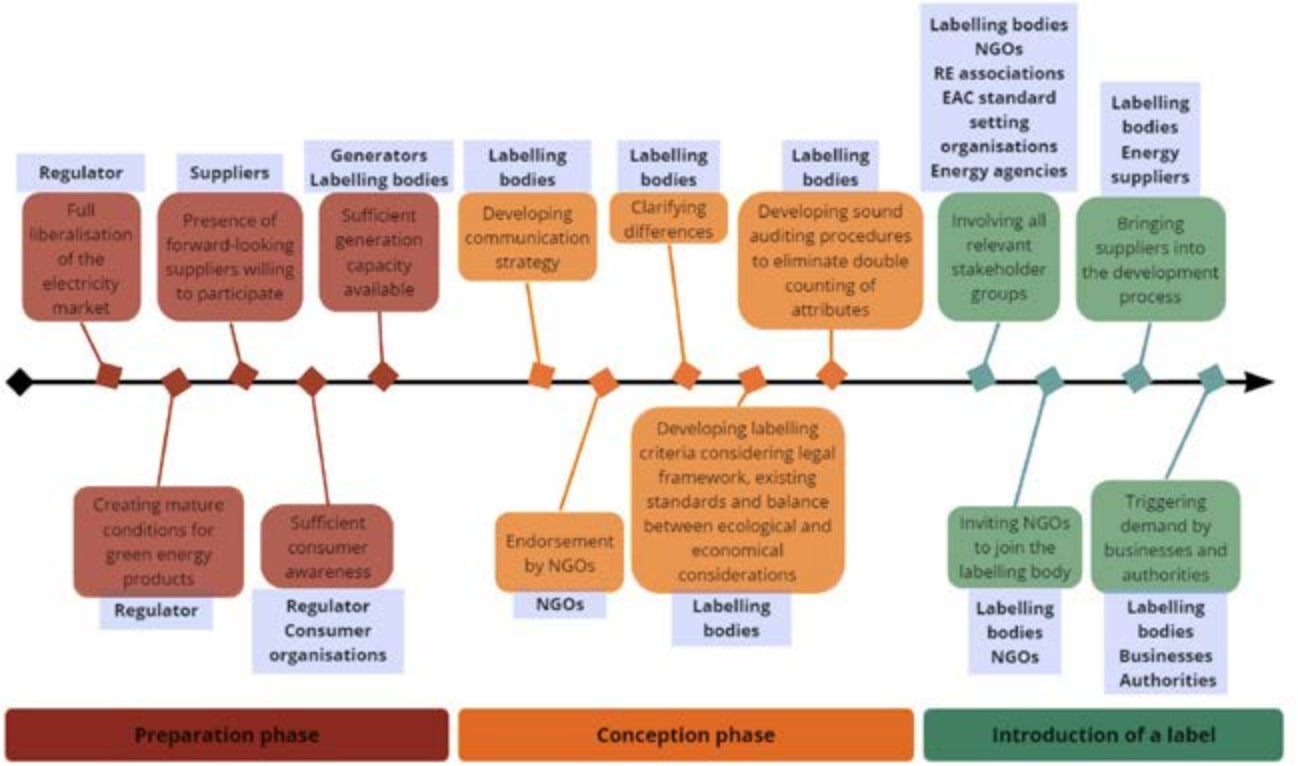


Figure 13: Developing a green power label: steps and recommendations (based on [25])

2.4 Use cases for EAC and labels

In this section, different use cases for EACs in renewable electricity labelling generation and trading, as well as green hydrogen production and consumption/processing, will be explained in detail. This will include a description of why and for what EACs are needed in the respective use case, by whom, and what benefits EACs have for the parties involved as well as for the development of the respective RE/green hydrogen market in general. An additional question is who the "owner" or, more specifically, who the economic beneficiary of the EAC is in the respective EAC system.

2.4.1 Overview of EAC use cases along the main beneficiaries

To analyse the EAC use cases, they have been categorised into the different stakeholder groups who are the main beneficiaries of the advantages brought about by functioning EAC schemes.

Table 4: Overview of main EAC use cases

Use case	Purpose of using EACs	Benefits of using EACs		Companies,mostly larger ones
		For parties involved	For market development	
Claims about the RE usage of companies	- Voluntary proof of the usage of a specific amount of RE - Showing progress towards achievement of self-imposed goals	- Tradable universal instrument recognised in many countries of the world - Book-and-claim principle - Avoidance of double counting	- Universality of the instrument contributing to the wide and rapid adoption of sustainable energy procurement	Companies, mostly larger ones
Carbon accounting, reporting, and disclosure	- Adherence to different reporting standards - Usage for calculation of Scope 2 emissions	- Tradable universal instrument recognised by all reporting standards - Book-and-claim principle - Avoidance of double counting - Possible international trade	- Facilitated compliance with carbon reporting standards	Companies, mostly larger ones
Use of certified RE for production of green hydrogen and other products with added value	- International trade of green attributes - Selling the products with added value to the EU and other countries with strict regulations	- Additional income source for local manufacturers - Adherence to carbon reporting standards for buyers - Possibility to buy sustainably produced products	- Implementation of the European Commission's Carbon Border Adjustment Mechanism - Greening the production process, reducing the emissions - Development of the standard and verification system for green hydrogen	Export-oriented manufacturers, especially from developing countries
Data transparency on the energy mix	- Legal requirements (Renewable Energy Directive (RED) in the EU) - Pressure from end users, government, and competitors to disclose information on the energy mix delivered to customers	- Access to reliable information on the origin of energy sources - A choice about an energy product with specific characteristics being possible - The opportunity to influence the energy industry with their choices	- Market transparency - Increased competition among suppliers - More demand for RES => higher prices => more motivation for project developers to build new facilities	End users, especially smaller ones, such as households
Data transparency:full disclosure	- Legal requirements at the national and, in the future, possibly at the EU level	- Full transparency on an end user's electricity consumption - Increasing awareness of end users of their electricity consumption	- Complete market transparency - Level playing field between RE and non-RES - Motivation of end users to buy more renewables	End users, regulatory bodies, RE developers, and energy suppliers

Table 4: Overview of main EAC use cases Continued

Use case	Purpose of using EACs	Benefits of using EACs		Companies,mostly larger ones
		For parties involved	For market development	
Competitiveness of energy suppliers with high shares of RE	- Guarantee of EACs that the energy product sold under the green tariff is from renewable sources	- Reliability regarding the source of energy - Price predictability and stability - Reduction of long-term supply risks for customers - Contract compliance	- Higher efficiency in sales compared to PPA - Allocation of cost corresponding to the production source - Level playing field between RE and non-RES - Depending on tariff features, the stimulation of new RE facilities being built	Both household customers and companies/larger end customers
Regulatory requirements to source a portion from RE	- Reliable proof of the specific share of electricity coming from RE	- Universal instrument - Easy to use for reporting - Easy to use for comparison between suppliers - Additional income stream for RE facility owners	- Diversification of energy sources - Promotion of domestic energy production - Triggering economic development - Easily measured progress towards RE goals - Emissions reduction - Complementing public support for RE	Regulatory bodies and RE facility owners
International trade of certificates with or without physical transmission of electricity or H_2	- The only available tool to make international RE claims - Reliability and robustness - No double counting	- Universal internationally recognised instrument - Complementing public support for RE - Additional income stream for RE facility owners	- RE expansion - Compliance with getting more and more stricter environmental protection regulation - Diversification of energy sources - Promotion of domestic energy production - Triggering economic development	Regulatory bodies and RE and H_2 production facility owners

For companies/corporate clients, the following use cases are the most important:

- Claims about the energy usage of companies (RE100, 24/7 RE procurement; advertising, good image, and competitive pressure from NGOs, consumers, and industry peers)
- Carbon accounting, reporting, and disclosure (CDP Protocol Scope 2 emissions, Dow Jones Sustainability Index, Global Reporting Initiative (GRI), The Climate Registry (TCR) reporting, etc.; for more details on different reporting standards, see Table 5)
- Use of certified RE by export-oriented manufacturers to produce products with greater added value than electricity, such as green hydrogen or renewable-produced aluminium.

Many energy users, from large companies to individual households, want to claim that they consume RE. As described in section 2.1, such claims can only be made if a consumer or a supplier on behalf of the consumer cancels or redeems an EAC, so the associated "green" attributes contained in the certificate cannot be claimed by another user. Particularly large customer-facing organisations demand such claims. Sustainable energy procurement is becoming part of the marketing strategy of many corporations. If a large company does not commit itself to sustainable energy procurement, and it is a widespread practice among its industry peers in the country or region or is an industry standard worldwide, then competitive pressure from NGOs, customers, competitors, and government may be exerted as a result. The high demand of corporations for RE claims is evidenced by the ever-increasing number of companies who are members of the RE100 initiative. Members of the RE100 initiative (in partnership with CDP) are committed to using 100% renewable electricity. There are already over 340 RE100 members, which include some of the largest companies in the world. Any organisation that is a member of RE100 needs to use EACs to prove its RE consumption. As more renewable power plants are built and the availability of carbon-free energy becomes more volatile, organisations (including Google, Microsoft, and the USA's federal government) have started announcing commitments to source 24/7 clean energy. Recently, President Joe Biden made a commitment in the infrastructure plan to 24/7 carbon-free energy (CFE) for federal buildings [26].

Closely linked, many corporations do their sustainability reporting by buying and claiming EACs to prove progress towards their voluntary sustainability goals. According to the KPMG Survey of Sustainability Reporting 2020 [27], 80% of a worldwide sample of 5 200 companies (the top 100 companies by revenue from 52 countries, called the N100) and 96% of the world's 250 largest companies by revenue from the Fortune 500 ranking (G250) now report on sustainability – and this indicator has substantially increased in the last few years. In SA, this share is at an equally high level, with 96% of the top 100 companies reporting on sustainability; the highest level among its neighbours on the continent and in the Middle East.

Recent developments show many efforts to harmonise sustainability reporting, increase its implementation, and improve its quality and reliability. The EU is taking further steps towards harmonising European reporting requirements, which may lead to the adoption of a European reporting standard for environmental, social, and governance (ESG) information. More and more companies are addressing the risk of climate change in their financial reporting. This trend has, to a large extent, been influenced by the work of the Task Force on Climate-Related Financial Disclosures (TCFD), which aims to raise corporate and regulator awareness of climate change as a financial risk and has developed recommendations for disclosure of climate-related risk. In SA, 67% of the largest companies now acknowledge climate change as a financial risk, which is relatively high on an international scale. Companies lagging behind these reporting trends are experiencing pressure from NGOs, governments, and industry peers and are increasingly forced to comply with the reporting requirements.

In 2015, the World Resources Institute (WRI) and the World Business Council for Sustainable Development (WBCSD), two leading NGOs on environmental impact quantification, issued guidance on GHG Protocol Scope 2 emissions, which are GHGs resulting from a company's energy use. The GHG Protocol was established to provide an international framework to account for emissions related to purchased electricity. It has been adopted by reporting programmes such as the CDP, the GRI, and TCR. EACs play an important role by underlying every contractual instrument used for electricity procurement of companies.

Contractual instruments include all kinds of procurement methods for electricity that convey specific data from the supplier on the source of energy, in the form of EACs, contracts with generators or suppliers for electricity from a specified source, supplier labels, supplier emission rates, green tariffs, contracts (PPAs), or residual mixes. Eligibility criteria for contractual instruments used to measure emissions for Scope 2 market-based reporting and other reporting programmes are presented here [4] [28]:

Contractual instruments must do and be the following:

1. **Disclose GHG information:** they must disclose the direct GHG emissions rate attribute associated with produced electricity.

2. **Prevent double counting:** (a) The instrument must be the only one that carries the GHG emission rate attribute claim associated with the specified portion of electricity generation. Clear and explicit ownership must be demonstrated by either third-party verification that includes a chain-of-custody audit or documentation of permanent retirement in an electronic tracking system in a dedicated retirement account for a particular reporting year. (b) The instrument must be distinct from offsets. A MWh generated by a RE project and claimed as an offset cannot also be claimed as a contractual instrument (for example, US REC).

3. Be retired: certificates must be tracked, redeemed, retired, or cancelled by, or on behalf of, the reporting organisation.

4. **Not be too old:** for reporting standards, it is common for certificates to have been issued reasonably close to the reporting year of the electricity consumption. For example, in TCR, they must be generated within a period of six months before the reporting year to up to three months after the reporting year. Green-e has a 21-month eligibility window for certified sales of RE in a given year. The GHG Protocol requires that certificates shall be issued and redeemed as close as possible to the period of energy consumption to which the instrument is applied.

5. **Be sourced from the same market as operations:** the market in which the electricity-consuming operations of the reporting organisation are located and to which the instrument is applied must be the same. Market boundaries are assumed to match national boundaries, except where international grids are closely tied.

6. **Utility-specific emission factors must be calculated based on delivered electricity:** these are calculated based on contractually delivered electricity, incorporating US RECs or other instruments sourced and retired on behalf of customers.

7. **Organisations using on-site generation must convey GHG claims to the organisation:** the instrument must ensure that all emission claims are transferred to the reporting organisation only.

8. **All contractual instruments must operate in a market with a residual mix:** organisations must disclose the residual mix emission factor (see the text box below).

Grid emission factor (GEF)

If a reporting organisation does not apply any contractual instrument, Scope 2 emissions shall be reported based on the location-based method only. To calculate GHG emissions within these boundary conditions, an average energy generation emission factor for a defined geographic location, including local, subnational, or national boundaries, is required. Databases and methods to calculate GEFs differ. On a global scale, the International Energy Agency (IEA) publishes national electricity emission factors: GHG Protocol Scope 2 Guidance describes this data source as "average emission factors representing all electricity production information from geographic boundaries that are not necessarily related to dispatch region, such as state or national borders. No adjustment for physical energy imports or exports, not representative of energy consumption area".

For SA, so far GEFs have been published by Eskom. The specific calculation method is currently under revision. To achieve higher transparency and accuracy, the revision process could be an opportunity to take some advanced methodological components into consideration. Further aspects are described in the next box ("Residual grid mix") and within the Reliable Disclosure Systems for Europe (RE-DISS) project [110].

Currently, over 13 000 companies are reporting to the CDP, a non-profit foundation that developed and operates the global disclosure system for investors, companies, cities, states, and regions to manage their environmental impacts. Over 590 investors with over USD 110 trillion in assets specifically request companies to disclose through the CDP framework.

Regarding the import of EACs, countries from outside the EU and EEA willing to sell EACs to EU member states encounter difficulties related to restrictive EU legal and market barriers. The voluntary reporting standards considered in this study do not accept RE attributes bought outside of the European market boundaries. For these countries, one interesting use case that can be imagined is to use certified RE for production of green hydrogen and other products with added value. This option may become particularly attractive, as the proposals of the European Commission for a Carbon Border Adjustment Mechanism (CBAM) will be further developed. It is a climate measure to prevent the risk of carbon leakage equalising the price of carbon between domestic products and imports, thus minimising the share of carbon-intensive imports. The CBAM will encourage producers in non-EU countries to green their production processes.

Residual grid mix

EACs provide the instrument for consumers to deliberately choose electricity from renewable sources. The residual grid mix (or residual mix) is represented by the attributes of the electricity mix that remain after certified attributes have been taken out of the mix as a result of cancelling EACs. As long as not all consumption is tracked using EACs (full disclosure), a residual mix is needed to define the attribute values of electricity that was not documented with a tracking instrument. If the renewable attributes had a certificate attached, but were not removed from the mix, then these could be counted by suppliers when disclosing their energy mix and result in double counting. Therefore, only certificates that are not cancelled can be returned to the residual mix.

Most notably, this concerns carbon intensity. Where the carbon emissions associated with renewable attributes are zero, the carbon value of the residual mix is an average of the carbon emissions of all the remaining resources.

Consumers who, deliberately or not, choose not to purchase EACs automatically consume the residual mix. The more RE attributes are documented and consumed, the more these will be removed from the residual mix of the country. As such, the residual mix will become "dirtier", containing more non-renewable attributes, with higher carbon intensities. Ultimately then, this creates an incentive for companies to deliberately consume renewable electricity, as proven through certificates that detail their attributes.

Reporting of the residual mix is usually done at a country level on a yearly base. Imported and exported attributes need to be considered. In the EU, the AIB calculates the residual mix of each country on a central base and publishes it (Figure 14). The European attribute mix represents the part of electricity supply in the total European grid that is not tracked with GOs.

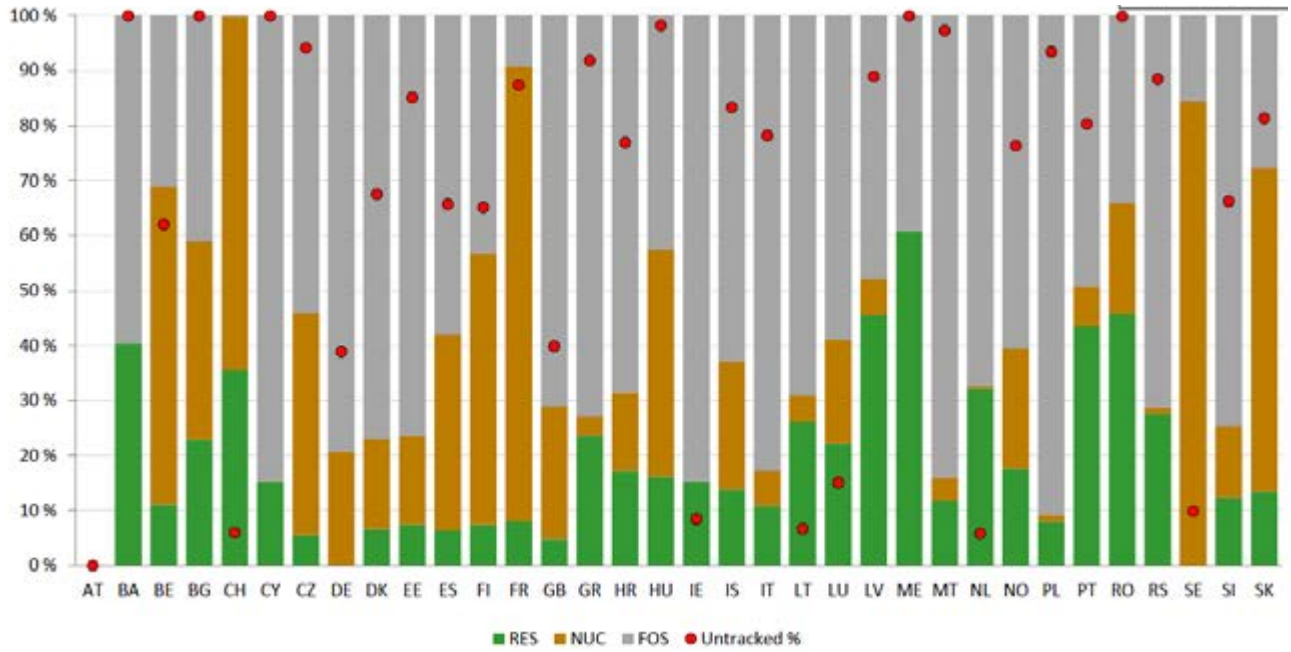


Figure 14: European residual mixes 2021
(RES: renewable energy sources; NUC: nuclear; FOS: fossil fuels) (Source: AIB) [113]

Table 5: Overview of international sustainability reporting standards, programmes, and decarbonisation initiatives

Reporting standard	Coverage	Principles	Requirements
GHG Protocol Scope 2	At least 92% of Fortune 500 companies responding to CDP used GHG Protocol	- Relevance: GHG inventory appropriately reflects the GHG emissions of the company and serves the decision-making needs of both internal and external users. - Completeness: report on all GHG emission sources and activities within the inventory boundary. - Consistency: use consistent methodologies to allow for meaningful performance tracking of emissions over time. - Transparency: address all relevant issues in a factual and coherent manner, based on a clear audit trail. - Accuracy: enable users to make decisions as to the integrity of the reported information with reasonable confidence.	Reporting emissions are calculated using location-based and market-based methods. The market-based method reflects emissions from electricity that companies have purposefully chosen, while the location-based method reflects the average emissions intensity of grids on which energy consumption occurs. Market-based reporting requires that organisations share the tools they are using ("contractual instruments") to address the emissions from this electricity consumption. Organisations must match location-based electricity consumption with market-based contractual instruments, meaning that these instruments must be in the same electrical grid as the electricity consumption itself. Certificates form the basis of energy attribute tracking in the market-based method, often being conveyed with contracts for energy and integrating into supplier specific-emission rates. EACs underlie every contractual instrument and can be used alone or can be bundled with PPAs, contracts, and supplier labels.
Carbon Disclosure Project (CDP)	Over 13 000 companies; over 1 100 cities, states, and regions	- Disclosure - Transparency - Accountability	A questionnaire on climate change, water, and forests is filled out, enabling corporations and governments to disclose information in a structured way and allowing investors and other interested parties to compare the performance of respondents, thereby showing the environmental performance of the entity.
Dow Jones Sustainability Index (DJSI)	The top 10% of the largest 2 500 companies in the S&P Global broad market index (BMI)	- Tracking the stock performance of the world's leading companies in terms of economic, environmental, and social criteria - Assessing issues such as corporate governance, risk management, branding, climate change mitigation, supply chain standards, and labour practices - Creating portfolios of companies that fulfil certain sustainability criteria better than most of their peers within a given industry.	The selection process is based on the S&P Global ESG score of the companies, calculated under the annual Corporate Sustainability Assessment (CSA) of S&P Global ESG Research. The first step in the CSA process is the definition of the companies to be invited to participate in the CSA. Companies are asked to respond to an extensive industry-specific CSA questionnaire. Companies that do not operate in a sustainable and ethical manner (for example, that are involved in the nuclear power sector) are excluded.
Global Reporting Initiative (GRI)	The most used reporting standard, used by ⅔ of N100 reporters and ¾ of G250 reporters [27]	Mainstreaming a firm's disclosure on environmental, social, and governance (ESG) performance; transparency about a company's impacts.	- Identifying and assessing impacts using sector standards (standards will be developed for up to 40 sectors) - Prioritising impacts, determining material topics (grouping impacts into topics), and reporting on these topics - Using the GRI content index in the report, providing an overview of the organisation's reported information and what was not reported

Table 5: Overview of international sustainability reporting standards, programmes, and decarbonisation initiatives Continued

The Climate Registry (TCR) reporting	377 USA and Canadian organisations and municipalities have publicly reported GHG inventories to TCR	TCR designs and operates voluntary and compliance GHG reporting programmes globally and assists organisations in MRV the carbon in their operations to manage and reduce it. TCR's Carbon Footprint Registry is aligned with international standards. Isolation of emission hotspots in the organisation is done so that one can take action to manage them. Otherwise, the same principles as in the GHG Protocol Scope 2.	TCR members report their GHG emissions to the Carbon Footprint Registry annually using the Climate Registered Information System utilising the methods of the GHG Protocol, including Scope 2 (location- and market-based method). EACs have to meet the TCR's eligibility criteria (see the information above in the section). Certified RECs from Green-e (see section 2.3 and Table 3) inherently meet the eligibility criteria.
RE100	349 members, including the largest and most influential companies worldwide	The mission of RE100 is to accelerate change towards zero carbon grids at scale, switching the demand of commercial and industrial companies to renewable electricity. RE100 addresses the existing market and policy barriers preventing companies from sourcing renewables by advocating change at both global and local levels. One of the six promoted policy measures is to support a credible and transparent system for issuing, tracking, and certifying competitively priced EACs.	Joining criteria: - Significant electricity demand - Public commitment to source 100% renewable electricity throughout their entire operations, declaring a target year (100% at least by 2050) - Emissions reporting according to the GHG Protocol - Ability to make unique claims on the use of renewable electricity generation and its attributes, through EACs - Annual reporting on progress towards set goals - Exclusion of companies from some sectors, including fossil fuels, and restricted adoption of members from RE sector The technical criteria of RE100 are mostly an interpretation of the GHG Protocol Corporate Standard market-based Scope 2 accounting guidance (see the first row of this table). In October 2022, technical criteria for RE procured by members became stricter. Electricity or underlying EACs must come from facilities in operation for 15 years or less (excluding self-generation facilities and direct procurement). The new criteria must be applied to RE procured after 1 January 2024. Additionally, stricter criteria are stipulated for biomass and hydropower. RE100 recommends that these power generation methods should be certified by third parties such as the International Organization for Standardization or the Green-e standard. Hydropower should be certified as environmentally low impact by NGOs or other third parties. With respect to energy sources, H_2 is excluded. RE100 considers H_2 an energy carrier (a means of energy transmission), not an energy source. The type of energy source producing H_2 determines whether it meets the criteria. Currently, H_2 produced from wind, solar, geothermal, sustainable biomass, and hydro meets the criteria. Similarly, energy storage forms such as batteries are not considered energy sources, and the energy source of the electricity to be stored is the determining factor.
24/7 RE procurement	Growing number of corporate and governmental market players	Procuring electricity and associated attributes to match a buyer's electricity demand, hour by hour, 24/7, with corresponding clean electricity generation within the same grid region; incentivising the right behaviour (the uptake of storage facilities and improved grid infrastructure).	Hour-by-hour 24/7 matching of power consumption and clean electricity generation within the same grid; focusing on regional grid needs and hourly load matching, instead of annual, volume-based goals; data granularity, time-stamping of electricity production

For households, the most important use case is data transparency on the energy mix for end customers (facilitated in the EU through the RED) and full disclosure.

This use case is very pronounced in the EU, where EACs are embedded in the law. The amended RED, or RED-I, stipulated that EACs were the tool through which energy suppliers had to disclose information on the fuel mix they were delivering to customers. Although only a share of households is aware of EACs and has indicated they consider them by choosing a provider and a specific tariff, EACs nevertheless represent a robust tool when making RE claims. Through EACs, energy customers can get access to reliable information on the energy sources from which their tariffs are made up, make an informed decision about a specific energy product, and influence the energy industry by signalling demand for specific energy sources, which can, in turn, lead to a price increase and consequently motivate developers to expand their in-demand generation facilities.

In case of full disclosure [29], that is, the mandatory proof of the origin of all electricity production or consumption by cancelling EACs, a level playing field between renewable and non-renewable electricity sources is created. Full consumption disclosure has more impact, that is, cancellation of EACs for every MWh consumed. It brings about complete transparency on electricity consumption. Consumers can mandate suppliers to redeem certificates on their behalf. As for now, end customers willing to consume renewable electricity must undergo an official procedure, while consumers of non-renewables have no such requirements getting the residual mix. It is likely that if all end users must prove the origin of their electricity consumption, they will be more aware of where their power comes from and more inclined to buy renewables.

For energy suppliers/utilities, the important use case is the competitiveness of energy suppliers offering green tariffs and sourcing all or a big part of the energy from renewable sources (see section 2.5).

For regulatory bodies, the following use cases play a significant role:

- Regulatory requirements to source a portion of electricity from renewable sources
- International trade of certificates with or without physical transmission of energy or H_2

A widespread part of energy strategy in many American states is the RPS, which requires that a specified share of the electricity supply by utilities comes from renewable sources. EACs are a reliable tool to verify this. As for organising international trade of certificates, it is a promising use case, especially for developing countries that want to boost their economic growth and ensure expansion of RE and green hydrogen production facilities. With regulation of developed countries becoming stricter and stricter regarding carbon aspects of imports, this use case will get more attractive in the course of time.

In general, the following positive consequences of the implementation of an EAC system for the whole economy may arise:

- Acceleration of the energy transition by putting an additional, marketable value on the production of RE
- Proper design of an EAC system (for example, full consumption disclosure) possibly leading to more active procurement of RE
- Reduction of the reliance on national public RE support schemes for RE producers seeking to ensure the economic viability of their projects.

2.4.2 Economy-specific use case considerations

RE100 companies are a main driver of the demand for EAC in many countries that have not yet established a regulatory framework for EACs. To adhere to the RE100 standards of consuming 100% RE, a company can choose from among three instruments:

- Purchasing EACs
- Concluding PPAs with generators
- Installing on-site generation

Every instrument has its advantages and disadvantages. For example, on-site generation is limited by the availability of space, topological conditions, and RE potential in a given territory. Mostly, only a small share of total electricity demand can be covered by on-site generation facilities. To increase this share, additional investments in storage are needed.

Application of all three instruments requires certification of RE for alignment with the RE100 standards. In the case of PPAs, certificates must be bundled with electricity flows. With on-site generation, electricity power flows used for own consumption and possibly injected into the power grid to be rewarded with FiTs or to participate in the net metering scheme must be measured and verified separately. In this case, third-party verifiers must be involved, which makes the whole process more complicated and time-consuming.

RE100 companies, which are mostly MNCs, require their local suppliers to use RE for production and operational processes. In that way, local companies create demand for locally issued EACs. It is the main driver of demand for EACs in many developing countries and countries with no established EAC system.

Companies in SA are the largest electricity consumers. More than 50 companies with operations in SA have committed themselves to the RE100 initiative to procure 100% RE by 2050 at the latest. In 2021, a hub called RAiSE (Renewables Ambition in South African Electricity) was launched by the WBCSD, the National Business Initiative (NBI), and RE100. Its aim is to bring together many of the largest RE buyers with stakeholders from the RE sector to help unlock corporate procurement of renewable power [30].

In the EU, demand for certificates is mainly created by households wanting to have the sources of purchased energy disclosed on their energy bills and striving for a high share of renewables in their green electricity contracts as well as by the carbon accounting obligations. According to the CDP Protocol, companies must calculate Scope 2 emissions coming from their energy consumption, and in order to reduce emissions, they purchase EACs.

2.5 Green tariffs as a means of selling RE for utilities

2.5.1 General characteristics and applications

RE tariffs or green tariffs are offered by utilities or energy retailers worldwide. Based on the definition of the German Federal Grid Agency, a green tariff is an "electricity tariff with particular relevance of the share/promotion of efficient or RE generation on the basis of green electricity labels which is offered/traded as a separate tariff". The label indicates that the product offered under the special tariff fulfils specific certification criteria (see section 2.3). Instead of selecting from multiple different criteria, the customer can rely on the label and the criteria behind it. The utility offers a competitive, long-term fixed price for generating and delivering RE to a customer. The energy product sold under the green tariff is typically bundled with RE credits.

Referring to both producers and consumers, on the one hand, green tariffs may satisfy specific needs. The energy producer/supplier may:

- raise demand for green electricity from its portfolio;
- contract compliance of customers, depending on the competitiveness of the contract, such as rates, duration, and price stability;
- allocate costs corresponding to the production source;
- raise efficiency in sales: depending on the certification scheme, it may be challenging to get a green tariff proposed and approved, but once a green tariff has been approved, any customer can use it if the customer is located within defined boundaries. In contrast, traditional PPAs with third parties must be renegotiated for each new project; and
- need to protect itself against dubious competitors.

Referring to the customer, on the other hand, special focus is placed on larger energy consumers or corporations that may:

- meet sustainability and RE goals and publicly account for it;
- commit themselves to the development of new RE projects;
- reduce long-term energy risks;
- achieve price predictability; and
- achieve potential cost savings on electricity.

Green tariffs are a sales option both in regulated and liberalised electricity markets, although with a higher variety of products in a deregulated system, where each household customer may choose its supplier. In Germany, liberalised since 1998, a large variety of green energy tariffs, retailers, and products have arisen, with a growing share of RE production. Table 6 shows the numbers and some characteristics for the typical 100% RE labels applied to green tariffs.

Table 6: Implementation of RE tariffs in Germany based on private business 100% RE labels

100% RE labels	ok-power	Grüner Strom Label	TÜV SÜD
Label stages	Innovative projects; further operation of formerly funded generation plants; funding of new generation plants	RE plants	Different funding options
Eligibility criteria	Investment of 0.003 EUR/ kWh of sold electricity into innovation fostering energy transition; support for formerly funded generation plants; minimum 33% new generation plants per year	Bundled certificate for green energy products (not generator); minimum 33% RE from new generation plants per year; investment in energy transition projects	Minimum 30% new generation plants per year; funding pool; generation mix; minimum 30% direct supply (EE01); time equivalence of generation and consumption (EE02)
Number of certified tariffs/ products (by end of 2017)	70/165	94/> 100	N/a/57

In the USA, although regulation of electricity markets differs between the states (see section 2.6.2), green pricing programmes and green tariffs in general have been developing dynamically over the last years in several states. The RE market is mainly driven by large corporate customers striving to meet their carbon emission reduction goals. As green tariff/pricing programmes offered by utilities, they have been developed mainly in regulated electricity markets. They allow large commercial and industrial customers to buy bundled renewable electricity from a specific project. A special utility tariff rate is applied. A state public utility commission approves the tariff. Depending on the regulation scheme in the state and the specific needs of the customer, there are other options for providing RE products and/or RECs. Table 7 shows the range of options from the perspective of corporate customers.

Table 7: Green electricity procurement options for corporation customers in the US

RE procurement option	Programme	Bundling of REC and physical product	Cost-saving potential for customer	Pricestability	Contract length	Choice of RE resource
Green pricing programme	Flexible option; RE can be combined with "brown" energy; 850 utilities in 2017 offered some type; not always "additional"; available in regulated markets	Utility buys physical RE and RECs in the same grid region	Low; premium varies between USct 0.09 and 11.2 per kWh; average around USct1.5 per kWh	No; utility rate is subject to change	Shorter contract terms (typically month to month)	No; determined by utility

Table 7: Green electricity procurement options for corporation customers in the US Continued

Green tariff	Sleeved PPA; utility/retailer contracts RE projects and provides RECs to the customer; sometimes available in regulated markets	Utility buys physical RE and RECs in the same grid region	May be cost-competitive, depending on structure and term	Possible under certain programme structures; retailer carries financial risk; option "market-based rate" is based on the wholesale electricity market price	Three to seven years; longer agreements possible (10 to 20 years)	Customer may have input
Purchasing unbundled RECs	Customer buys RECs from retailer; most flexible way to reach RE targets; no additionality	Unbundled; not assigned to a grid region	RECs are cheap due to oversupplied market, but ongoing expense	No potential to hedge energy costs	No contract	No; determined by traders' portfolio
PPA	Contract between corporate and RE project developer; results in new RE projects (additionality)	Bundled (physical PPA) or unbundled (virtual PPA, in regulated markets)	High cost saving and revenue potential, but financial risks	High; price stability over contract term	10 to 20 years	Yes; a certain RE project is financed by the PPA
On-site generation	Generation of RE on own property; optional as on-site PPA	Direct physical supply	Determined by production costs	High	Life cycle of production plant	Yes; implemented

2.5.2 Green tariff rates in selected countries

To achieve a better understanding of pricing within the green electricity sector, a benchmark study of selected countries in the EU and of the EU in general was carried out. Prices for green and grey electricity were compared at different levels and for different customer groups. "Grey" or "conventional" categories comprise electricity generated from various technologies such as fossil fuels, nuclear, and renewables, whereas "green" refers only to renewable sources.

For Germany and the Netherlands, prices for electricity for different customer groups were identified based on online comparison platforms and by retrieving specific price information from the websites of certain energy suppliers. Table 8 describes standardised customer groups for the benchmark study. Prices include all mandatory price components and value-added tax (VAT).

Table 8: Customer groups and their characteristics [31] [32]

Customer type	Description
Household customer	Households with average yearly consumption of 2 500 to 5 000 kWh (standard case for Germany: connection to low-voltage grid at 0.4 kV)
Industry customer A	Commerce, services, small industries with average yearly consumption of 50 MWh (standard case for Germany: operation period 1 000 h, maximum load 50 kW, connection to low-voltage grid at 0.4 kV)
Industry customer B	Companies with average yearly consumption of 24 GWh (standard case for Germany: operation period 6 000 h, maximum load 4 MW, connection to medium-voltage grid at 10 kV or 20 kV); 20 GWh to 70 GWh (Eurostat)

Germany

The price level for electricity in Germany is one of the highest in the EU. For adequate interpretation of tariff rates, it is important to know the price components for electricity, of which there are several (Figure 15). The variable component of generation and sales, the only component that may be influenced by the supplier or retailer, represents a share of around 36%.

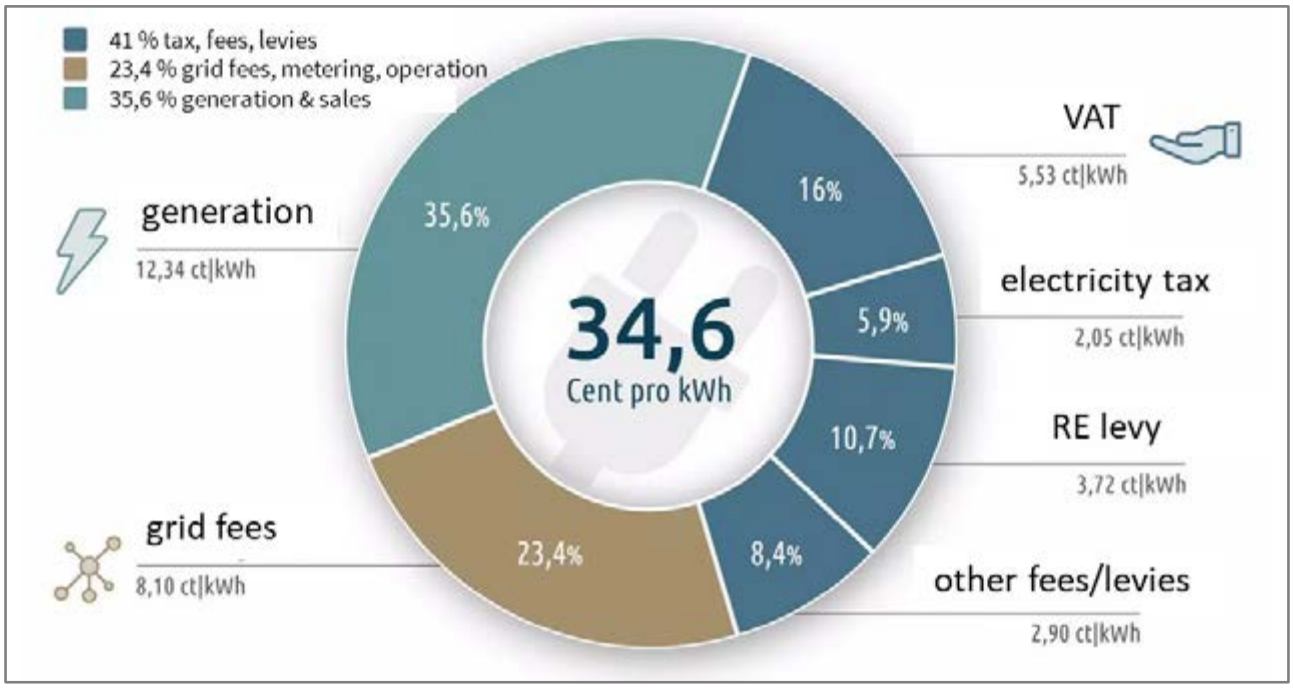


Figure 15: Electricity price components – Germany 2022 (for household customers, yearly consumption of 4 000 kWh) [33]

Basic tariffs in the German supply scheme refer to the compulsory supply for each household. In each grid area, the basic supplier is the one who provides most end customers with energy. In many cases, this is the local municipal energy supplier and grid operator (Stadtwerk) or the corresponding supplier with regional extension. The tariff rates within the basic supply scheme are often higher than in a specific contract offered by the same or another supplier since the basic supplier carries default risks and the duty to admit all customers in case of insolvent competitors.

Table 9: Green tariffs compared to conventional tariffs for selected providers in Germany. Prices for each customer group in EURct/kWh. *GOs: guarantees of origin.

Provider	Electricity product/label	Household customer	Industry customer A	Industry customer B
Green tariffs by independent 100% RE providers (with label) 2022				
Naturstrom **Prokon** **Polarstern**	Grüner Strom Label ok-power Grüner Strom Label	42.90 43.00 47.62	40.51 N/A Subject to bilateral negotiation	Subject to bilateral negotiation
Green tariffs (100%% RE) by municipal services 2022				
Hamburg Energie **Berlin (Vattenfall)** **Stadtwerke Stuttgart** **EnBW (regional supplier)** **Stadtwerke Schwäbisch Hall (municipal supplier)**	Elbstrand; Steuermann (GSL) Natur12 (TÜV NORD) 100% Ökostrom (TÜV NORD) Privatstrom (GOs*) Premiumstrom (GOs*)	38.40 33.70 49.85 41.56 31.69	37.37 47.78 N/a 40.21 31.79	Subject to bilateral negotiation
Basic tariffs for electricity service (without contract) 2022				
Hamburg (Vattenfall) **Berlin (Vattenfall)** **Stuttgart (EnBW)**	Provider's electricity mix (65% RE) Average national electricity mix (49% RE)	33.31 33.25 31.73	N/A 33.42 N/A	---
German average 2020 based on [31]				
"Ökostrom"	100% RE, indicated by GOs and, if applied, RE labels	32.54	N/A	N/A
"Conventional"	Average national electricity mix (49% RE)	32.63	23.23	16.94

According to national statistics, in 2020, around 25% of end customers were in the basic supply scheme with a standard contract. A total of 37% had a different contract with the basic supplier, and 38% had a contract with a different supplier. These choice options for specific contracts or different suppliers result in a competitive electricity market. Customers make their decision based on economic and, with growing significance, ecological preferences. This is where green electricity tariffs offered by both basic and alternative suppliers come into play.

For price comparison between conventional and green electricity products, see Table 9. To read the table adequately, it is important to know that current prices (the second half year of 2021 and the beginning of 2022) are difficult to compare, since pricing is extremely dynamic, at a high level, due to turbulence in the European energy market. The prices retrieved from the providers' online information are snapshots of the overall situation and may change significantly during the next months. Some electricity service providers do not even offer special tariffs on their websites or have stopped accepting new clients. To plausibly interpret the pricing for green tariffs, one approach is to directly compare the tariffs of the same supplier in a certain supply area, given the case that the supplier offers both a conventional and a green tariff. Examples are Vattenfall in Berlin, with both a basic tariff and a green tariff, with a price difference of only 0.45 EURct/kWh. The EnBW in Stuttgart as basic supplier (31.73 EURct/kWh) and with a special green tariff (41.56 EURct/kWh) shows a bigger price difference, with the latter in the range of independent green tariff providers. Green tariffs of some independent providers (the upper part of the table) are shown to indicate the price range on the green tariff market. Many providers of both green and conventional electricity products offer additional benefits or features, for example, price stability over a certain period of months, choice of duration of contract, and singular incentive pay. Many green tariffs contain a fixed share (for example, 1 EURct/kWh) to be invested in the expansion of RE.

Another approach for price comparison is a review of statistical values to monitor prices in comparison to past supply periods where prices were more stable. Therefore, average prices for electricity in 2020, based on the German monitoring report of the Federal Grid Agency 2021, are reported: green tariffs were, on average, slightly cheaper than conventional tariffs.

The observed convergence of rates for green and conventional electricity is discussed below in the section on the EU context. For now, the focus is on the pricing components of green electricity and the potential higher willingness to pay for green attributes. In addition to the above-mentioned price components of electricity in general, a retailer or supplier offering a green tariff may take account of further variable costs in the supply chain. One component is the fees for the EAC imposed both by the issuer and the producer. In the case where an additional label is adopted (for example, the Grüner Strom Label or TÜV NORD), a fee for the label may also be included, in many cases with a special investment contribution for new RE projects imposed by the label issuer. Whether the retailer or supplier allocates these costs to the end user's tariff or not is up to its internal economical operation and the issue of competing market participants. Due to competition, there is no or, at the most, little margin to skim the market for a higher willingness to pay among those customer groups with a strong ecological orientation. This may only apply in a special segment of private customers with very high ecological preferences where very strict RE features are coupled with electricity products, for example, 100% RE from a certain region. On the wider green electricity market, price competition is high, and even more intense in the segment of industrial clients. Green electricity providers are reporting a growing demand for 100% RE-labelled products from industrial or institutional consumers, but in view of the high price level for electricity in Germany, an additional willingness to pay for greenness is not the case.

The Netherlands

For the Netherlands, price information on 2022 electricity tariffs was requested from different online comparison platforms. The Dutch energy market is fully liberalised, with around 25 independent energy providers mostly offering both electricity and gas supply. As the variety of providers is lower than in Germany, the resulting range of rates per kilowatt-hour was the same on different platforms. This fact may also be an effect of the extraordinary increase of electricity and gas prices in Europe during the last months which resulted in many providers withdrawing public price information. Table 10 reports the identified rates for household and small industry customers [34].

Table 10: Green tariffs in the Netherlands. Rates for each customer group in EURct/kWh.

Provider	Electricity product/label	Household customer	Industry customer A	Industry customer B
Different providers	Green electricity/green electricity from NL	39.04 to 55.82	50.59 to 58.01	N/A

The tariffs offered on the comparative platforms were all green tariffs. The customer may select between green energy and green energy from the Netherlands. According to energy market information, the RE share in electricity consumption was 26% in 2020. The Dutch RE production is mainly based on wind and biomass [35]. Conventional electricity products, mainly based on oil, coal, and gas, are probably prevailing in the basic supply scheme, like in Germany. Price information on basic tariffs was not available in a direct comparison. Vattenfall NL reports that there is no longer any price difference between grey and green electricity. A different situation is reported for the gas sector [36]. The Dutch government compensates social risks of price increases by reimbursement to households of up to EUR 825.00 per year.

European Union (EU)

The database for the European average electricity prices for 2020 from Eurostat may deviate from the single national statistics, so the prices are only comparable within the same scheme (Table 11).

Table 11: Electricity prices for selected states in the EU in 2020, for household and industry customers, including both green and grey national electricity mixes. Rates in EURct/kWh.

Provider	Electricityproduct/label	Household customer	Industry customer A
EU average	EU electricity mix	21.34	8.89
Germany	National electricity mix	30.06	12.71
Italy	National electricity mix	21.53	10.01
Greece	National electricity mix	16.41	7.77
Sweden	National electricity mix	17.18	5.14
The Netherlands	National electricity mix	13.61	6.26

Comparing the price levels within the EU of 2020, it is apparent that Germany has the highest values for both monitored customer groups. The Netherlands was in the lower price range in 2020.

Statistics for the European power markets over the past years show that electricity prices for industrial clients have remained at a high level. The majority of off-takers are still using standard electricity contracts where transparency on the generation sources is limited [37]. Today, due to the decreasing levelised cost of electricity (LCOE) for renewable production (Figure 16) and the additional costs for purchasing EACs, prices for a grey electricity product might be higher than a 100% green product.

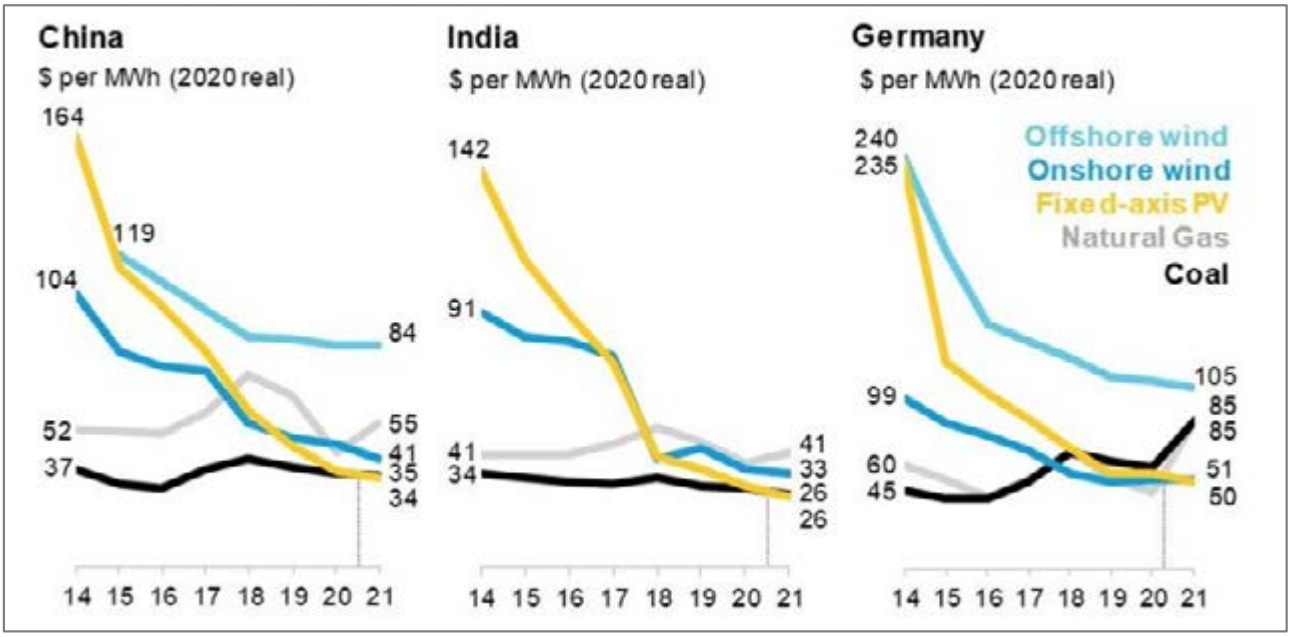


Figure 16: Levelised cost of electricity for new solar and wind versus running costs of existing coal- and gas-fired plants, 2014 to 2021 (note: LCOE excludes subsidies or tax credits and reflects utility-scale power plants) [38]

These insights into the European electricity market with Germany and the Netherlands as specific examples should give an impression of pricing frameworks for electricity overall and for green electricity specifically. In conclusion, it may be noted that green electricity products are entering a level playing field with their grey counterparts. Due to a growing number of corporates committing themselves to climate protection and emission reduction goals, the demand for such green products is increasing. It does, however, must be noted as well that the competitiveness of green electricity on the overall electricity market and the competition within the green sector especially do not give room for a "green margin" for utilities. It is recommended, therefore, that the focus be placed on transparency regarding the sources of electricity generation and on efforts for additional RE projects in certification rather than on diffuse green features of an electricity product.

2.6 Regulatory framework

In this section, the building blocks of the underlying rules and regulations of international EAC systems are analysed and explained, with an emphasis on the regulatory frameworks commonly found in the USA and the EU, including Germany, as well as on the differences between them.

2.6.1 Regulatory framework in the EU and selected member states

The two important aspects of EAC regulation include mandatory or voluntary certification and mandatory or voluntary market participants' use of an EAC scheme. The EU is the most representative example of the mandatory certification and voluntary use of an EAC scheme. Every member state must have a functioning EAC system in use. Market players can, but do not need to, use it. The process of establishing a robust, region-wide regulatory framework has been conducted in a step-by-step manner by adopting more and more elaborate regulation over time (Table 12, Figure 17). The EU legal basis for GOs has been gradually strengthened, especially through the REDs adopted in 2001, 2009, and 2018.

Table 12: Main EU regulatory Acts governing the European GO system (based on [39], [40], [41], [42], and [43])

Main regulatory Acts	Contents
RES Directive 2001/77/EC (Article 5)	- The first appearance of a GO in the European regulation.
Electricity Internal Energy Market Directive 2019/944/EC (and its predecessors 1996/92/EC, 2003/54/EC, and 2009/72/EC)	- Requires member states to introduce "electricity source disclosure" schemes for electricity sold to end consumers regarding the contribution of each energy source to the overall fuel mix of the supplier and to inform consumers on the environmental impact. - Requires a means of allocating electricity generation "attributes", such as fuel type, CO2 emissions, etc., to electricity suppliers and their customers.
RED I 2009/28/EC	- The purpose of GOs is clarified as evidence of the origin of electricity generated from RES. - GO is defined as "an electronic document which has the sole function of providing proof to an end customer that a given share or quantity of energy was produced from renewable sources as required by Article 3(6) of Directive 2003/54/EC" [42]. - All EU member states were required to establish and maintain a RE GO certification scheme. - It specified the minimum information that each guarantee had to contain. - It underlined inherent differences between the so-called "green certificate" (used for support schemes) and the GO (whose purpose is transparency and reliability of the information). - It allowed for transfers of GOs between member states. "A Member State may refuse to recognise a GO only when it has well-founded doubts about its accuracy, reliability or veracity. The Member State shall notify the Commission of such a refusal and its justification." However, if the European Commission finds that a refusal to recognise a GO is unfounded, the Commission may adopt a decision requiring the member state in question to recognise it.

Table 12: Main EU regulatory Acts governing the European GO system (based on [39], [40], [41], [42], and [43]) Continued

RED II 2018/2001/EU	- The definition of GO from the RED I is upheld by Article 2(12) of the RED II (the word "proof" has only been replaced with the word "evidence"). - GOs issued for the purpose of said directive have the sole function of showing to an end customer that a given share or quantity of energy was produced from renewable sources. - A GO can be transferred, independently of the energy to which it relates, from one holder to another. - With a view to ensuring that a unit of RE is disclosed to a customer only once, double counting and double disclosure of GOs should be avoided. - RE in relation to which the accompanying GO has been sold separately by the producer should not be disclosed or sold to the end customer as energy from renewable sources. - Member states may arrange for GOs to be issued for energy from non-renewable sources (Article 19(2)). - GOs are valid for 12 months and expire after 18 months; GOs must be cancelled at least six months after validity ends; expired GOs shall be included in the calculation of the residual energy mix. - When a producer receives financial support from a support scheme for RE production, the market value of the GO for the same production is appropriately considered in the relevant support scheme. - Member states or designated competent bodies shall supervise the issuance, transfer, and cancellation of GOs. The designated competent bodies shall have non-overlapping geographical responsibilities and be independent of production, trade, and supply activities. - GOs shall be compliant with the standard CEN-EN 16325. - A GO shall specify at least: a. the energy source from which the energy was produced and the start and end dates of production; b. whether it relates to the following: electricity; or gas, including H_2; or heating or cooling; c. the identity, location, type, and capacity of the installation where the energy was produced; d. whether the installation has benefited from investment support and whether the unit of energy has benefited in any other way from a national support scheme, and the type of support scheme; e. the date on which the installation became operational; and f. the date and country of issue and a unique identification number. - Simplified information may be specified on GOs from installations of less than 50 kW. - A member state may still decide not to issue a GO if a producer receives financial support from a support scheme. - Member states shall recognise GOs issued by other member states (the same as in the RED I). - Member states shall not recognise GOs issued by a third country, except where the Union has concluded an agreement with that third country on mutual recognition of GOs issued in the EU and compatible GO systems established in that country, and only where there is direct import or export of energy (strict restriction of GO imports). - The Commission shall present a report assessing options to establish an EU-wide green label with a view to promoting the use of RE coming from new installations. Suppliers shall use the information contained in GOs to prove compliance with the requirements of such a label.
CEN-EN 16325 (now being updated)	This European standard, first set up in 2013 and revised in 2015, specifies requirements for GOs of electricity from all energy sources. As part of the implementation of the RED II, there is an upgrade to develop an accurate, reliable, and fraud-resistant GO system for electricity, gas (including H_2), and heating and cooling. It is being updated to facilitate the requirements of the RED II and to strengthen the reliability and robustness of the GO system in general.

Table 12: Main EU regulatory Acts governing the European GO system (based on [39], [40], [41], [42], and [43]) Continued

Fit for 55 amendments	The European Commission's proposals for amending the RED to make it "Fit for 55" contain two significant changes to the GO system: - Removing the provision allowing member states to deny issuing GOs for RE generation facilities that benefit from a support scheme. - Introducing a provision to ensure that when end users buy RE benefiting from support, they can receive the related GOs. It may go even further by introducing full disclosure schemes in European single-market countries. This could replace the residual mix, representing a more accurate tool of providing evidence of the true energy source and its environmental mix.

Figure 17: Timeline of development of the GOs regulatory framework [44]

GOs for gaseous energy carriers, including H_2, are prescribed by Article 19 of the EU RED (2018/2001) and implemented by the EECS Gas GO Scheme. It also represents a building block towards Articles 25 to 31 of RED II certification [45]. The trend of certifying every unit of energy produced and/or consumed is visible at the level of the EU and individual member states. The process of embedding it in the regulation is now actively taking place.

In the following section, the regulatory framework for building an EAC system in two EU member states – Germany and the Netherlands – is analysed. These countries were selected because of the high level of sophistication of the adopted systems and forward-looking developments such as the full disclosure scheme in Holland.

Germany

German electricity suppliers are legally obliged to report the composition of the electricity they supply end customers. The quantity is broken down according to the individual energy sources. This identification of the energy source mix and the environmental impact of electricity production is called electricity labelling. This is regulated in Section 42 of the German Energy Industry Act (EnWG). Furthermore, this article stipulates that the electricity labelling of electricity from renewable energies must be accompanied by GOs. According to section 3, no. 29 of the German Renewable Energy Act (EEG) 2017, a GO is an electronic document that is used exclusively to prove to an end consumer as part of electricity labelling in accordance with section 42, paragraph 1, no. 1 of the German Energy Industry Act that a certain proportion or a certain quantity of the electricity was generated from RE [46]. Starting from January 2013, electricity suppliers were only allowed to disclose information on a share of renewable electricity delivered to end customers on electricity bills and in advertisements if they had cancelled GOs for the delivered amount of RE energy.

However, according to Section 79 of the EEG, this does not apply to publicly supported electricity under the Renewable Energy Act (EEG) or to electricity that was not clearly generated and is assessed using the residual mix or European Association for the Co-operation of Transmission System Operators for Electricity (ENTSO-E) mix. GOs must be cancelled to identify electricity that is not subsidised under the EEG in the form of a FiT or market premium. This measure has to prevent the paying out of double benefits to RE producers. Furthermore, German GOs are not issued for electricity that is used for (plant) self-consumption and transformer losses before feed-in nor for self-consumption in the area network. GOs are also not used if the electricity in the area network is supplied to consumers without an electricity bill and, therefore, without an electricity label.

The GO must contain information about the generation plant, the amount of electricity generated, the type and scope of subsidies, the date of issue, the country of origin, and a unique identification number. Guarantees of origin are issued for each 1 MWh of electricity from renewable sources that is generated and delivered to end consumers.

On the one hand, the purpose of using GOs is the prevention of double marketing of the green attributes of an energy unit. This leads to greater credibility of the electricity labelling of green electricity through uniform specification and monitoring by the issuing body, the Federal Environment Agency (Umweltbundesamt, UBA). GOs help to create transparency on the green electricity market and contribute to customer protection. On the other hand, it is expected that an economic added value of the directly marketed electricity from RE will be created by marketable GOs. A higher demand for GOs leads to a price increase, with correspondingly better revenue opportunities for plant operators. As a result, more plant operators would decide to operate RE plants outside of the market premium, which helps renewable electricity to better integrate into the market [47].

The addressees of the labelling are both natural and legal persons, that is, households and industrial and commercial customers. Charging points for electric vehicles (EVs) are also classified as end consumers.

The GOs and the processing of the HKN (Herkunftsnachweis = GO) system are described in Section 79 of the EEG. The UBA is responsible for the issuance, transfer, and cancellation of GOs in Germany as well as the recognition of foreign GOs. The UBA operates the electronic database in which the issuance, recognition, transfer, and cancellation of GOs are registered – the Registry of Guarantees of Origin (Herkunftsnachweisregister, HKNR). The HKNR was introduced on 1 January 2013 (further detail on this in 2.7).

Netherlands

The certification scheme is defined in the Dutch Electricity Act (1998), which was adopted prior to the European GO regulation. Responsibility for its execution lies with the Dutch Ministry of Economic Affairs. The Act states that [48]:

a) an electronic system is in place for issuing and registering GOs for electricity from renewable sources and from high-efficiency cogeneration;

b) a GO for renewable electricity is the only accepted proof that electricity was produced from renewable sources;

c) a GO for electricity from high-efficiency cogeneration is the only accepted proof that electricity was produced from high-efficiency cogeneration;

d) GOs issued by independent issuing bodies in other EU member states are considered equal to Dutch GOs as long as they are similar in nature and purpose;

e) the Minister of Economic Affairs shall set fees to cover the costs incurred in relation to the execution of the system for GOs; and

f) the Minister of Economic Affairs shall issue a ministerial regulation that sets out the rules for issuing GOs, the information to be included in them, and their lifespan (including how they may be traded and cancelled).

The Ministerial Regulation on Guarantees of Origin for energy from RES and electricity from high-efficiency cogeneration ("Regeling garanties van oorsprong voor energie uit hernieuwbare energiebronnen en HR-WKK-elektriciteit") contains the following rules governing the GO system:

1. The information to be included in a GO:

   - The energy medium (electricity) to which the GO relates
   - The energy source used
   - Where such energy source is biomass, the type of biomass and any appropriate ICS labels
   - The start and end dates of production
   - The identity, location, and electrical capacity of the originating production device and the type of device
   - The date on which the originating production device was commissioned
   - Whether and to what extent the production device has benefited from support and the type of support
   - A unique identification number
   - The date and country of issuance

2. The lifetime of a GO, being one year after the end date of production

3. The way the amount of renewable electricity eligible for GO is determined:

    - For renewable electricity produced from hydro, solar, or wind: 100% of the electricity that is fed into the grid
    - For renewable electricity produced from waste: the amount of electricity that is fed into the grid, multiplied by a percentage that is fixed by the Minister of Economic Affairs annually
    - For renewable electricity from other biomass: the amount of electricity that is fed into the grid, multiplied by the energy input factor
    - Net of any auxiliary and on-site consumption

As per the ministerial regulation on GOs, electricity suppliers are obliged to cancel GOs to prove the origin of any renewable electricity supplied to end customers in the Netherlands. Suppliers have to disclose their supply mix annually and inform customers of its impact on the environment. For electricity under public support, GOs must be cancelled as well (in contrast to Germany, where such electricity is excluded from the GO system). Apart from that, there is no interaction between the support schemes and electricity disclosure, other than that the promotion scheme for RE production (SDE) relies on data collected by CertiQ for issuance of GOs. For installations approved for a subsidy, it is necessary to register with CertiQ.

The issuing body for GO in the Netherlands is CertiQ, a full subsidiary of TenneT, a transmission grid operator. CertiQ's role is to administer the EECS Registration Database and its interface with the AIB Communications Hub. The Dutch Minister of Economic Affairs is responsible for the operation of the GO system in the country. Under Article 74 of the Act, the Minister can mandate the task to a party that is independent of electricity producers, suppliers, and traders. Such mandate was given to TenneT, a Transmission System Operator (TSO) on 1 January 2015 and handed over to CertiQ. The functioning of the GO system is supervised by the Authority for Consumers and Markets as the regulator. The Authority for Consumers and Markets is also the competent authority for disclosure.

At first, CertiQ issued only certificates for renewable electricity. These certificates were mainly used by electricity suppliers to qualify for a reduced energy tax rate. Later, they became GOs, which form the basis for obtaining subsidies for the generation of sustainable energy to this day.

Currently, CertiQ issues GOs for renewable electricity and renewable heat. For non-renewable electricity, the document analogous to the GO is called the certificate of origin (CO). COs, as part of full consumption disclosure, have been issued from 1 January 2020 onwards. This obligation applies to energy suppliers. In this way, 100% of consumption is certified; certification of production is voluntary. The Act on Energy Transition, including full disclosure, was approved by the Dutch Senate in April 2018. GOs and COs are valid for one year from the date of manufacture.

Starting from 2022, the Netherlands is implementing the certification of green hydrogen. Vertogas, a subsidiary of Gasunie, is responsible for it. In December 2021, new regulations were adopted that prescribe the issuance of renewable fuel units (HBEs) for the supply of electricity and H_2 to the transport sector. In order to claim usage of HBEs, GOs will have to be cancelled. CertiQ is now working on the implementation of this regulation. As one can see, the clear trend is to gradually cover all energy carriers with respective GOs or COs to ensure full transparency of energy consumption and, in this way, make people and organisations aware of it and more motivated to switch to sustainable energy.

The EAC system in the Netherlands is a very successful one. About 70% of Dutch energy consumers source renewable electricity. Due to the high demand, almost all RE producers request the issuance of GOs for their generation.

In the Netherlands, an ICS, NTA8080, as an additional quality seal, is available and regulated by the Dutch standards organisation, NEN. NTA8080 is an international standard on sustainability criteria for solid, liquid, and gaseous biomass. CertiQ places NTA8080 as an ICS flag onto eligible EECS certificates at issue [48].

2.6.2 *Regulatory framework in the USA and the selected states*

In the USA, most states have mandatory RPSs and, associated with these, mandatory use of the EAC scheme existing in this territory. RPSs require that a specified percentage of the electricity utilities sales should come from RE resources. Roughly half of the growth in USA's RE generation since the beginning of the 21st century can be attributed to state RE requirements. An overview of mandatory RPS policies in the USA is presented in Figure 18. These policies exist in 30 states, the Washington DC, and two territories. An additional three states and one territory have set voluntary RE targets. Recent trends in the RPS legislation show that many states are expanding or renewing those goals. On the one hand, in the last three years, 15 states, two territories, and Washington DC have adopted legislation to increase or expand their RPS targets. On the other hand, 11 states and one territory have allowed their RPS targets to expire.

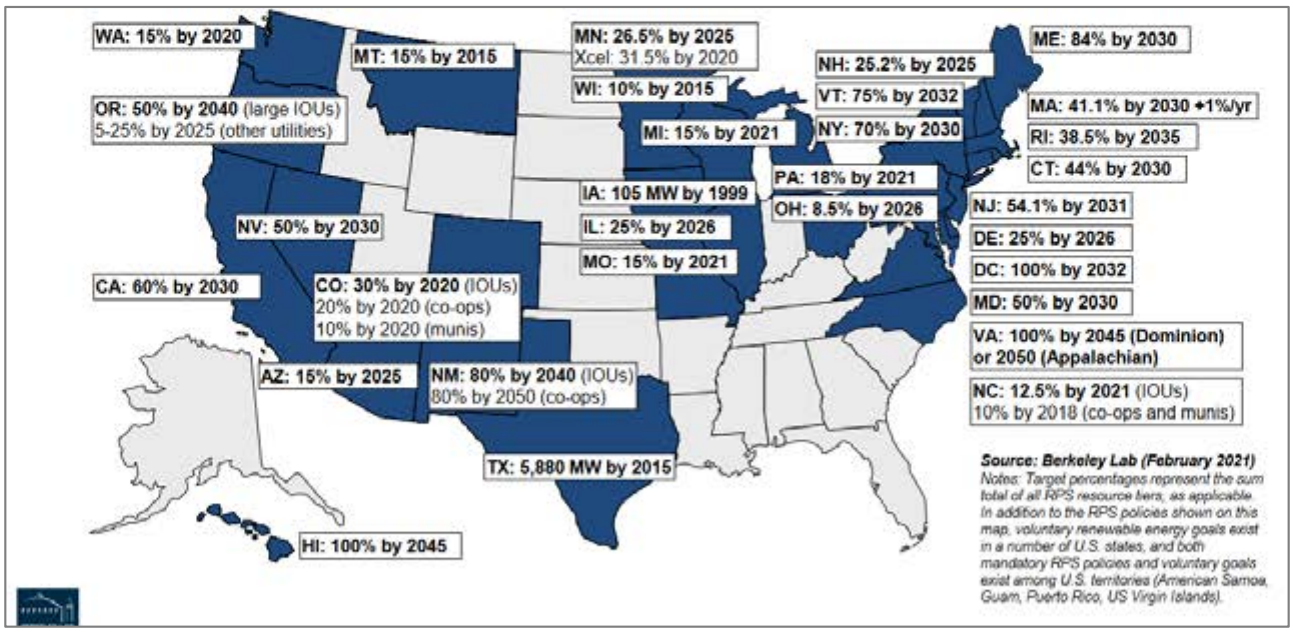


Figure 18: Renewable portfolio standards (RPS) in the US states [49]

State RPSs vary widely on such elements as RPS targets, the entities they include, the eligible resources, and cost caps. RPS requirements can apply only to investor-owned utilities (IOUs), but in many cases also include municipalities and electric co-operatives ("munis" and "co-ops"). Utilities that must meet RPS requirements must obtain RECs representing the environmental benefits of RE generation.

A total of 20 states and Washington DC have cost caps to limit increases to a certain percentage of ratepayers' bills. To encourage deployment of specific energy technologies, some states have established carve-outs and RE credit multipliers. Carve-outs require a certain percentage of the total RE requirement to be met with a specific technology, for example, solar PV or wind. Credit multipliers award additional RE credits for electricity produced by certain technologies or in a certain type of project, for example, by energy communities.

Since RECs in the USA are, in most cases, used to show the progress of utilities towards achievement of the state RE goals, the regulation at the state level is much more prescriptive than in European countries regarding where RECs can be obtained from, how they can be traded, and how they are combined with public support schemes.

Regarding issuance of retroactive RECs, it turns out to be a rather complicated endeavour. For example, in November 2015, an owner of several solar generating facilities in California requested the California Energy Commission (CEC) to issue retroactive RECs for the period of March 2014 through to November 2014. In order to approve the request, an independent auditor had to be engaged who, firstly, determined whether the RECs in question were eligible to satisfy any state regulatory or voluntary programme. A letter from the administrator of each such state programme documenting that RECs generated during the respective period were not redeemed to satisfy that programme was needed for the CEC to issue retroactive RECs [50]. Tracking systems can issue retroactive RECs if the generation occurred maximally 30 to 75 days prior to the registration of a facility on the tracking system (the specific timeline depends on the rules of the tracking systems) [51].

In the following sections, some examples of the REC regulation in selected American states are described.

Colorado

Colorado was the first state that enacted an RPS by ballot initiative (that is, via an initiated state statute) in 2004. The target a is 100% clean energy supply by 2050 for utilities serving 500 000 or more customers if meeting such requirements is technically and economically feasible and in the public interest. Electric co-operatives and municipal utilities have set lower targets. Carve-outs and multipliers support distributed generation facilities, community-based projects, solar power located in the territory of a co-operative or municipal utility, and smaller RE facilities interconnecting to electric transmission or distribution facilities owned by a co-operative electric association or municipally owned utility up to 30 MW. For example, for munis and co-ops, each kWh of energy generated from solar electric generation technology shall be counted as 3.0 kWh of energy eligible to meet a RPS, provided that the solar facility commenced producing electricity prior to 1 July 2015. For all types of utilities, each kWh of eligible energy generated from a community-based project is counted as 1.5 kWh of eligible energy.

According to the definition in the Rules Regulating Electric Utilities 4 CCR 723-3 adopted by the Public Utilities Commission (PUC) in Colorado [52], an REC is defined as "a contractual right to the full set of non-energy attributes, including any and all credits, benefits, emissions reductions, offsets, and allowances, howsoever entitled, directly attributable to a specific amount of electric energy generated from a RE resource". An REC contract means "a contract for the sale of RECs without the associated energy" (unbundled RECs), while an RE supply contract means "a contract for the sale of renewable energy and the RECs associated with such renewable energy" (bundled RECs). An REC represents 1 MWh of RE and shall be used for a single purpose only and retired on use for that purpose. Notwithstanding the foregoing, RECs counted towards compliance with a federal RPS may also be counted towards compliance with the state RPS.

The rules also stipulate that RE supply contracts entered after 2 July 2006:

1. shall be for the acquisition of both RE and the associated RECs;
2. may reflect a fixed price or a price that varies by year;
3. shall have a minimum term of 20 years (or shorter at the sole discretion of the seller); and
4. shall require the seller to relinquish all REC ownership associated with the contracted RE to the buyer.

RE credit contracts entered after 2 July 2006:

1. shall be for the acquisition of RECs only;
2. may reflect a fixed price or a price that varies by time period; and
3. shall have a minimum term of 20 years if the REC is from an on-site solar system, except that such contracts for on-site solar systems of between 100 kW and 1 MW may have a different term if mutually agreed to by the parties.

RE credits may be used to comply with the RE standard and may include:

1. RECs generated by RE resources owned by the utility or by its affiliate;
2. RECs acquired by the utility pursuant to RE supply contracts;
3. RECs acquired by the utility pursuant to REC contracts;
4. RECs acquired by the utility pursuant to a standard offer programme (for example, a Standard Rebate Offer);
5. RECs acquired through a system of TRECs, from exchanges or from brokers;
6. RECs carried forward from previous compliance years; and
7. RECs borrowed forward from future compliance years.

A REC shall expire at the end of the fifth calendar year following the calendar year during which it was generated, so its life cycle is much longer than that adopted in European countries. This characterises the difference between the mandatory approach of using EACs such as in the USA and the voluntary approach in Europe. It also highlights the different purposes of using certificates: compliance towards RE state goals or information disclosure.

On receiving applications for competitive solicitations to obtain RECs, in addition to the criteria of cost, utilities may also consider the characteristics of the underlying energy resource that may have an impact on the ability of the bidder to fulfil the terms of the bid, including, but not limited to: the project in-service date, resource reliability, viability, energy security benefits, the amount of water used, fuel cost savings, environmental impacts, including tradable emissions allowances savings, load reduction during higher-cost hours, transmission capacity and scheduling, employment, the long-term economic viability of Colorado communities, best value employment metrics, and any other factor the utility determines is relevant to its needs. Utilities must submit PUC compliance plans to the regulator regarding how they plan to meet RPS requirements, including the treatment, tracking, counting, and trading of RECs. Compliance plans must be approved by the PUC.

The utility shall have the discretion to sell or trade RECs at any time as long as it obtains and retires sufficient levels of RECs to comply with the RE standard established in Colorado and the requirements for renewable distributed generation (Figure 19). Proceeds from the sale of RECs shall be credited to the account associated with the renewable energy standard adjustment (RESA). The utility may seek approval to retain, as earnings, a percentage of the funds from REC sales that the utility expects to have available to acquire eligible energy and RECs for the compliance year. In considering the percentage of funds to be retained as earnings by the utility, the PUC shall consider the development of the REC market and the expected value added by the utility in marketing and trading the RECs.

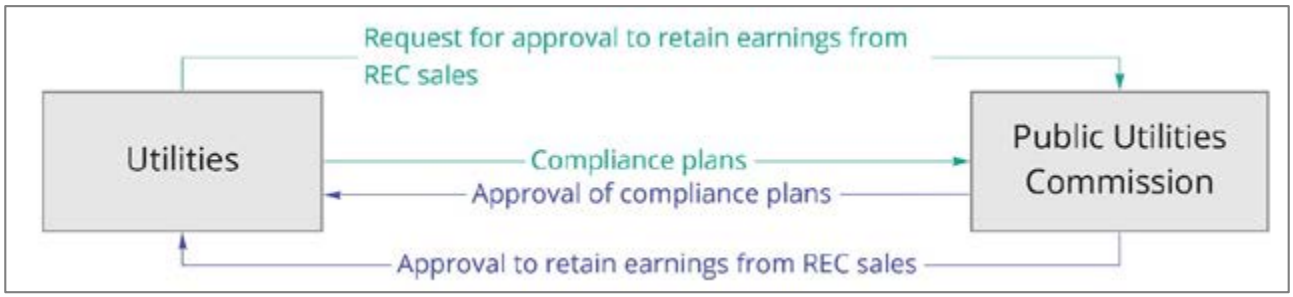


Figure 19: Interactions between the Colorado Public Utilities Commission and utilities

RECs in Colorado are tightly connected to public support schemes of RE such as the Standard Rebate Offer (SRO), which is a standardised incentive programme offered by a utility to its retail electric service customers for installation of on-site solar systems. The SRO is expressed in terms of dollars per watt. Any RECs acquired by the utility pursuant to such an SRO programme, regardless of whether the associated RE is specifically metered or contractually specified without specific metering, may be counted by the utility for purposes of compliance with the RE standard (Figure 20).

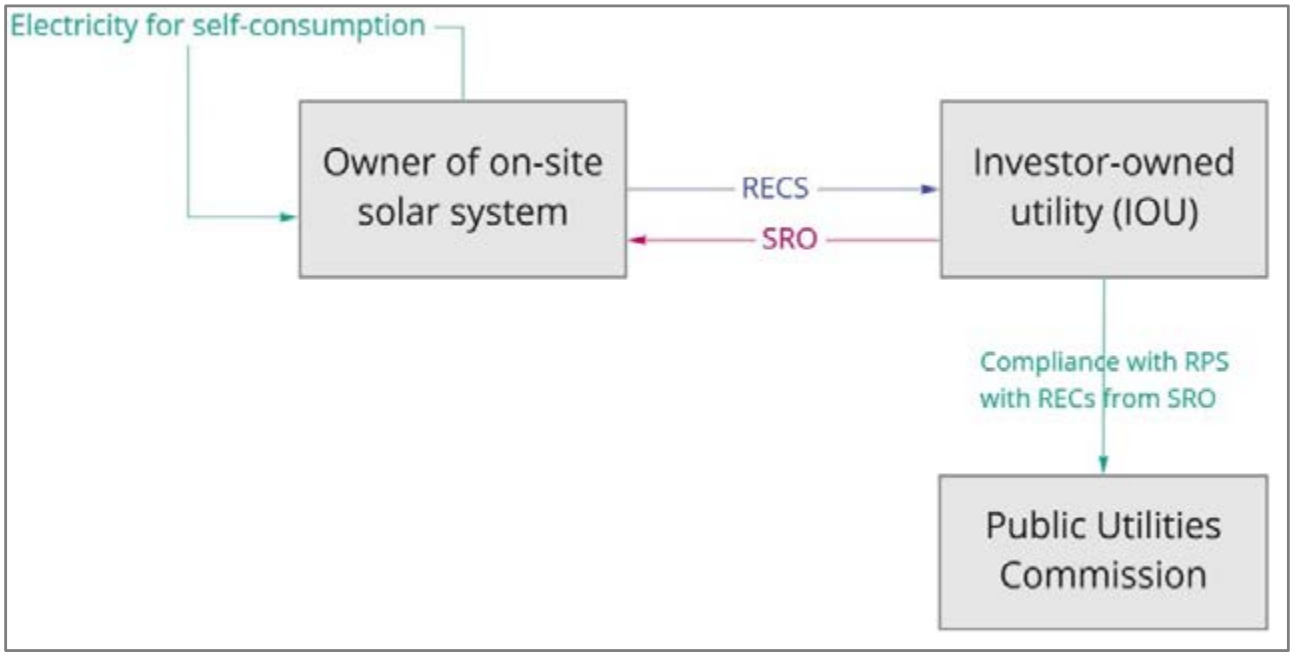


Figure 20: Relation between RECs and support schemes for on-site PV SRO in Colorado (own representation)

Delaware

Delaware's RPS is established by the Renewable Energy Portfolio Standards Act, first adopted in 2005 and most recently amended in 2021. The Act is intended to establish a market in Delaware for electricity from renewable sources and to lower the cost of RE to consumers. The Act allows utilities to meet their portfolio standards by buying RECs and solar renewable energy credits (SRECs) from wind, solar, and other renewable sources. The RPS applies to the state's investor-owned utilities, retail electric suppliers, municipal utilities, and rural electric co-operatives. The RPS includes a carve-out for PV and multipliers for in-state customer-sited PV and fuel cells, in-state wind turbines, offshore wind, solar and wind in-state installations with at least 50% in-state manufactured equipment, and solar or wind installations sited in Delaware and installed with a minimum 75% state workforce.

A REC is defined as a tradable instrument comprised of all the generation attributes equal to 1 MWh of electricity derived from eligible energy resources and that is used to track and verify compliance with the provisions of this regulation. A REC does not include emission reduction credits and/or allowances encumbered or used by a generation unit for compliance with local, state, or federal operating and/or air quality permits associated with the 1 MWh of electricity. an SREC means a tradable instrument that is equal to 1 MWh of retail electricity sales in the state that is derived from solar photovoltaic energy resources and that is used to track and verify compliance with the provisions of this regulation [53]. The lifetime of RECs and SRECs is three years.

The Delaware Public Service Commission determines, verifies, and assures compliance with the state RPS as well as develops rules for RECs and SRECs to track and transact renewable electricity on the grid and demonstrate compliance of regulated entities with state laws requiring provision of renewable electricity representing specific attributes of generation.

Starting from 2007, any commission-regulated utility must submit an annual report on compliance with the RPS, including the submission of the required amount of RECs. Should the utility fail to meet the RPS requirements, it must make an alternative compliance payment for each MWh deficiency between the credits available and used.

2.6.3 Regulatory framework in selected countries using I-REC

"The use of I-RECs is restricted to making voluntary disclosure claims, meaning that I-RECs cannot replace other (national) certificates that are used to meet national targets, unless authorities specifically recognise I-RECs as an instrument for complying with their targets" [54]. Usually, countries first introducing EACs start with a voluntary system and then embed it in the regulation. Some countries, such as Turkey, have two parallel systems: one regulated by the government and one based on the I-REC Standard. How this can be reflected in the regulatory framework will be discussed in this section.

Issuing of I-RECs is restricted to countries authorised by the I-REC Foundation. The process of adding a new issuance country of I-RECs is typically initiated by market players or stakeholders with knowledge of the respective national electricity market. Prior to providing services in any additional country, Evident (the code manager for electricity and I-REC registry operator) must complete and submit a country report to the Foundation for authorisation. The purpose of a country report is to both justify the introduction of I-REC in a particular country, and determine and document any conditions that may be applied to the provision of services within that country.

All issuers and platform operators and any infrastructure they operate (a registry or platform created to facilitate the ownership, transfer, trade, or visualisation of products) must be accredited according to the I-REC Standard. All accredited entities must be authorised by Evident to provide services under the electricity product code (a document or set of documents setting out the rules and procedures, and other information required to form the specification of a product). Applicants shall provide Evident with copies of all relevant local working instructions for the provision of their intended service. The local working instructions must show how the applicant will manage the full scope of intended services to ensure compliance with the electricity product code and, where applicable, be compliant with the standard. Issuers operate under a contract with Evident that contains geographic restrictions on where they may provide services, defined in collaboration with the Foundation.

Regarding the validity period of I-REC certificates, there are some restrictions. The main deadline is the residual mix submission. The GHG Protocol Scope 2 Guidance establishes that residual mix calculations are necessary for the reliability of EACs and the avoidance of double counting. The I-REC system is designed to support residual mix accounting by establishing a cut-off date for I-REC issuance. After that date, no further I-RECs can be issued for the prior calendar year, and issuance data is made available for the purposes of calculating the residual mix. The deadline for issuing I-RECs for the prior calendar year will be 15 May of the current year. There are no time-bound restrictions for transacting I-RECS once issued [21].

An I-REC issued for renewable electricity does not, by its nature, include the same attributes as a carbon offset certificate (for example, those included within a certified emissions reduction (CER) certificate, verified emissions reduction (VER) certificate, or similar instrument). However, some market actors assert that the conveyed attributes are similar.

Unless relevant legislation dictates otherwise, carbon offset rights shall, by default, be associated with an I-REC. In requesting issuance of an I-REC, the registrant shall confirm that it holds the right to any such avoided emissions, carbon offsets, or similar market instruments and irrevocably assign such rights as may be held within each issued I-REC.

Where relevant, the exclusion of carbon offset rights shall be clearly stated on each I-REC and be visible to participants and beneficiaries [55].

As the CBAM (see section 2.6.4), once approved, will be very important for Europe's trading partners, I-REC has expressed its position on this mechanism, stating that, in the current form, the CBAM threatens the goal of encouraging local RE use. If the embedded emissions of a CBAM-adherent product are calculated based on national averages or sector standards, the CBAM would treat producers the same, regardless of their efforts to reduce their climate impact by using on-site or off-site RE as a production input. Indeed, producers of goods covered by the CBAM would pay twice: once for the RE they contract to purchase and a second time for emissions based on national averages or sector standards for which they are not accountable due to their explicit procurement of RE. This will undermine the motivation for producers outside of the EU to proactively use, and invest in, RE.

I-REC proposes that the way to encourage these commodity producers to purchase more RE or low-carbon technologies is to require them to substantiate the actual embedded emissions of their products based on contractually defined emission rights – such as EACs. The issuance, ownership, and cancellation of tradable EACs provide proof of the emissions related to a given product. To promote the use of low-carbon technologies and RE by the EU's trading partners, the CBAM should directly reference the surrender of EACs or similar contractual instruments as a part of the calculation method for embedded emissions, and the European Commission should be tasked with taking this into account in its calculation methodologies [56].

2.6.3.1 Turkey

Turkey recently completed regulations for the RE resource guarantee certificate (YEK-G certificate) market, and from 1 June 2021, power producers and consumers can certify electricity from renewable sources. In the three weeks after rolling out the system, 100 participants with 127 power plants joined. The issuer and registry operator are EPİAŞ (the Energy Market Operations Company). TEİAŞ (TSO) and EDAŞ (the Distribution System Operator (DSO)), assigned as the meter measurement agency, transmit the generation data to EPİAŞ. All processes and market operations of the YEK-G system are carried out under the control and supervision of the Energy Market Regulatory Authority (EMRA). Regulation on the RE resource guarantee certificate was published in November 2020. Participation in the YEK-G system is voluntary. YEK-G certificates are valid for 12 months from the end date of the energy generation period. From June 2021 to August 2022, almost 18 million certificates had been issued, mainly from hydro (89%) and geothermal (10%) power plants. Solar PV facilities are not represented in the system because relevant producers do not have a generation licence.

The government hopes to be well prepared for the EU's upcoming carbon border tax with the help of the CBAM certification system (see section 2.6.4). The system was developed with domestic blockchain technology. Parallel to the national EAC system, the YEK-G system, an I-REC Standard has been in operation since 2016, with Foton Energy as the local issuer. Foton is conducting a test with the I-REC database mirrored on a blockchain as test setting. Different transactions can be tested. I-REC does not want to implement the CBAM system in blockchain yet, and further testing must be done.

To avoid double counting, one production facility cannot be registered with both systems. In the national YEK-G system, only producers with a generation licence or supplier licence owners from EMRA can be registered. Public companies that together own 10% of the installed renewable capacity are also members of the system. Currently, YEK-G certificates are sold mainly within green tariffs for smaller customers. The market, which is also characterised by a low certificate price (0.01 EUR/MWh) has yet to be developed.

Facilities, independent of their size, for example, rooftop solar, can be registered in the I-REC system. Licence-exempt producers can participate; they represent 6 000 MW to 10 000 MW installed capacity. Demand is mainly created by corporate customers, especially those with international business relations. A substantial share of the Turkish industry manufactures products for export (textiles, automotive, metal, food, plastics, and information technology (IT), among others). Although the price for an I-REC is much higher (0.35 EUR/MWh) than a YEK-G certificate (0.01 EUR/MWh), the facilities prefer to purchase I-RECs over YEK-G certificates due to a standardised range of attributes (type, local distance, and age of generation) and a trusted and internationally recognised certificate.

To date, there has been no interaction between the two systems. Each has its own components (database, registry, and trading platform) (Figure 21). Foton (the I-REC issuer in Turkey) presented a modification to bring together the two systems (Figure 22) whereby EPİAŞ as the operator of the YEK-G systems, would take over responsibility for the I-REC platform as well. Bringing the two systems together and sharing the same database would benefit the national EAC system in Turkey as it would increase efficiency and improve data consistency. Double counting could be avoided more easily, since each account could be registered only once on the common database.

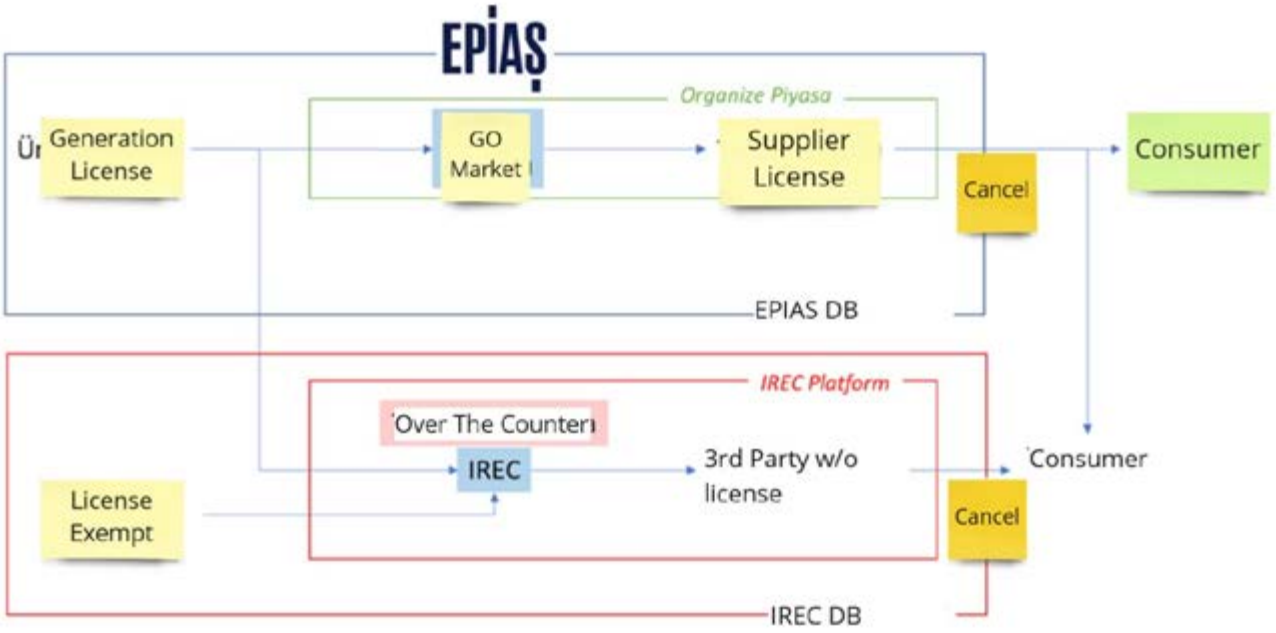


Figure 21: Currently-not-connected Turkish national YEK-G database (above) and I-REC registry (below)

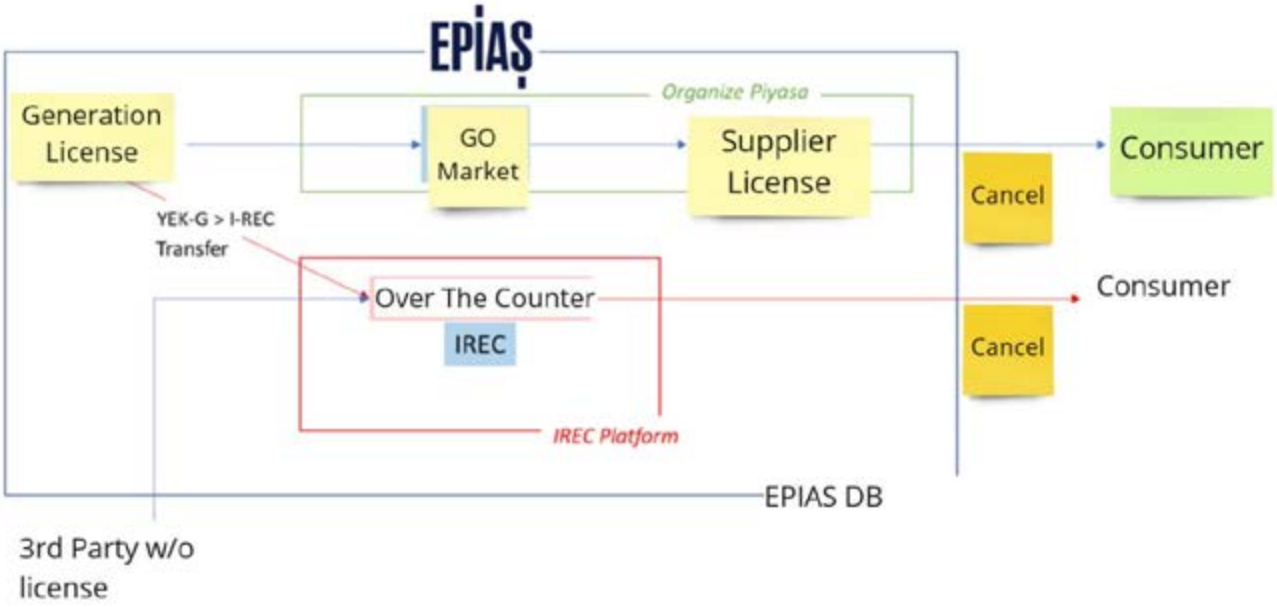


Figure 22: Proposed modification of Turkish certification system with one database for two systems

EPİAŞ organised a marketplace for trade with YEK-G certificates where contracts oblige participants to receive or deliver the YEK-G certificate at the matched price for the matched amount. These are processed by the market operator in line with the continuous trading model. YEK-G certificates issued within the scope of the documentable generation amount are traded in the contracts opened with the source type of the generation source. Market participants can give buying and/or selling offers on the contracts that are open during the session. During the market process, the maximum price and minimum price are determined by EPİAŞ, and the market transaction collateral is obtained against the financial risks that may arise regarding the invoice payments of the transactions made by the market participants. Market participants shall trade in the organised YEK-G market as much as at the amount of transaction collateral in the current market.

2.6.3.2 Russia

The I-REC system existed in Russia from December 2020 until March 2022, and its activity was suspended due to the sanctions following the Russian invasion of Ukraine. Despite such a short period of time, it was very successful and quickly gained popularity among RE producers and end users of certificates. In February 2020, the NGO Goal Number Seven (GNS) was accredited by the I-REC as the local issuer for Russia. In September 2020, the first agreements between GNS and RE generators in Russia were signed. In December 2020, the first I-RECs were issued. Before the suspension of GNS operations, almost all RE power plants in Russia were registered in the I-REC registry, and all large RE generators in the country became I-REC members. About 3.7 million certificates were issued in a period of slightly more than a year. Of these certificates, 73% were redeemed, which is also a high value, confirming the existence of high demand. In September 2021, RusHydro (the owner of hydro and other RE power plants in Russia) announced the start of a competitive request for proposals for the purchase of I-REC certificates due to high demand.

Among the market participants of the I-REC system in Russia were:

- generators of all types of RE electricity, including hydro;
- consumers (corporations); and
- traders.

Traders bought most volumes (about 90% of issued certificates). They included over 15 Russian participants, among them independent organisations and parts of generator companies, as well as five foreign traders. Traders purchased certificates for redeeming them for end beneficiaries. End beneficiaries were seldom active participants. They were foreign companies with offices, warehouses, and production facilities in Russia, often RE100 members, as well as large Russian companies.

Eligible power sources included solar PV, wind, hydro of all types, tidal, wave, and biomass. It was up to customers to decide which technology to choose.

The main use case for participants in the I-REC system in Russia was compliance with international sustainability standards such as the GHG Protocol, CDP, and initiatives such as RE100. Western pressure from investors and customers on companies to increase consumption of renewable electricity and cut emissions was present. For companies, buying I-REC certificates was the cheapest and easiest way to become active in RE. Investors supported these activities, but then required more: either PPA or investments in RE capacity.

The GNS aimed to create the first cases of PPAs between an investor/project developer and consumer and building new capacity. The I-REC can be used as an instrument to track RE. Previously, PPA was only a contract between an existing generator and a consumer without new investments.

Regarding the CBAM, it was a highly discussed topic among I-REC members in Russia, but it was still not clear whether RECs would work to reduce Scope 2 emissions. Members wanted to take the first steps with the help of certificates.

Table 13: The purchase of I-REC certificates in Russia [57]

Aspect	The buyer is registered in the I-REC registry as a member	The buyer buys a certificate from thealready-registeredparticipant
Legal	The contract is concluded with the Dutch non-profit (I-REC Services). In this case, it is also necessary to conclude an agreement with a generator that sells certificates.	The contract is concluded only with the I-REC registry participant.
Fees	• One-time commission for creating an account – EUR 500 • Account maintenance fee – EUR 2 000 per year • Commission for redemption of an I-REC certificate – 6 EURct/MWh • The cost of the I-REC certificate is determined as a result of bilateral negotiations with the registrant of the I-REC registry and depends on many factors	The cost of the I-REC certificate is determined as a result of bilateral negotiations with the registrant of the I-REC registry and depends on many factors.

Previously, the Market Council, the government authority responsible for organising an efficient system of wholesale and retail trade of electric energy and capacity, was supposed to be a local I-REC issuer, but movement in this direction was too slow, and the I-REC Standard Foundation decided to select a private entity. The Market Council had planned to introduce a national EAC system since 2019 and developed a draft law ("On Amendments to the Federal Law 'On the Electric Power Industry' in connection with the introduction of generation attributes and certificates of origin of electric energy into civil circulation"), which has not been adopted yet. The Russian Energy Ministry, which supported the idea of implementation of a national certification system, supposed that the mechanism would allow, in particular, the creation of conditions for attracting investments not related to mandatory support mechanisms by activating voluntary demand for electricity produced on the basis of RES. In addition, this would help Russian producers exporting energy-intensive products to maintain and strengthen their positions in world markets in the light of tightening carbon regulation by importing countries. It was expected that the industry would be able to use certificates to confirm the reduction of the carbon footprint of products when introducing a cross-border tax in the EU (the CBAM; see section 2.6.4).

Russian consumers have an alternative to an international certificate system: the conclusion of free bilateral agreements directly with RE generators. In addition, the closure of the I-REC platform may become an additional incentive to accelerate the creation of a national system for the circulation of "green" contractual instruments in the electric power industry, the Market Council believes.

2.6.4 EACs and their relationship with carbon offset schemes and carbon markets

Companies, especially large MNCs, are the main drivers of voluntary markets for both renewable electricity commodities and carbon offsets worldwide. Measuring and reporting their sustainability performance have been part of the business strategy of many multinational companies for 20 years and more and are based on constantly evolving global standards and protocols. Prevailing examples are the GHG Protocol for comprehensive climate impact disclosure or the Global Reporting Initiative (GRI) as a global corporate social responsibility guideline. While governmental accounting schemes (the Clean Development Mechanism (CDM)) or trading systems (the EU ETS) are evolving their regulation, global business or not-for-profit initiatives are growing and intensifying their knowledge-sharing networks for climate action. As procurement options for carbon offsets and RECs play an increasingly important role in the emission reduction strategy of companies both for their own operations and the supply chain, these international standardisation processes are becoming crucial for effective monitoring, reporting, and verification. Accountability requires transparency and traceability in national or regional markets for credits in both carbon offset and RE schemes. This need must be considered carefully for SA where a market for RE has recently begun to evolve, while a carbon offset scheme may be further established.

Under the CDP (also see section 2.4.1), a global not-for-profit organisation working to transform businesses worldwide to prevent dangerous climate change and protect natural resources, over 13 000 companies worldwide report on climate change, water security, and forests. The CDP South Africa Climate Change Report 2018, supported by the NBI, focuses on a set of extremely concerning climate change risks in SA. Both the archaic energy systems and industry/export composition may result in a high level of vulnerability to change in the system. A total of 97% of the companies responding to the CDP questionnaire stated they integrate climate change into their business strategy, but further analysis has revealed ongoing deficits in the ambition level of goals compared to real emissions reductions [58].

RE100, a global corporate RE initiative, reports 50 companies with operations in SA that have already committed themselves to procuring 100% renewable power by 2050 or sooner through RE100, ahead of plans to decarbonise the national grid. The RAiSE initiative, launched in 2021 and comprising the WBCSD, the NBI, and RE100 (led by the Climate Group in collaboration with CDP), strives to bring together government, cities, the private sector, and civil society in the energy transition [59].

In addition to the urgent need to promote a national market for renewable electricity in SA, the development of carbon markets is moving towards stronger global networking. COP26 highlighted the need for transparency and globally recognised rules for the registration, issuance, trade, and redemption of carbon credits.

In the following section, deeper insights will be given into how the GHG Protocol, a globally recognised knowledge base and standard for GHG emissions measuring and reporting, is being used in SA. An analysis of the potential relationship between EACs and carbon credits from the perspective of companies and its significance for a future EAC system in SA will also be presented. The current dynamics in global carbon markets should be considered as framework conditions. A summary will be given in the section "International carbon markets after COP26"

The GHG Protocol

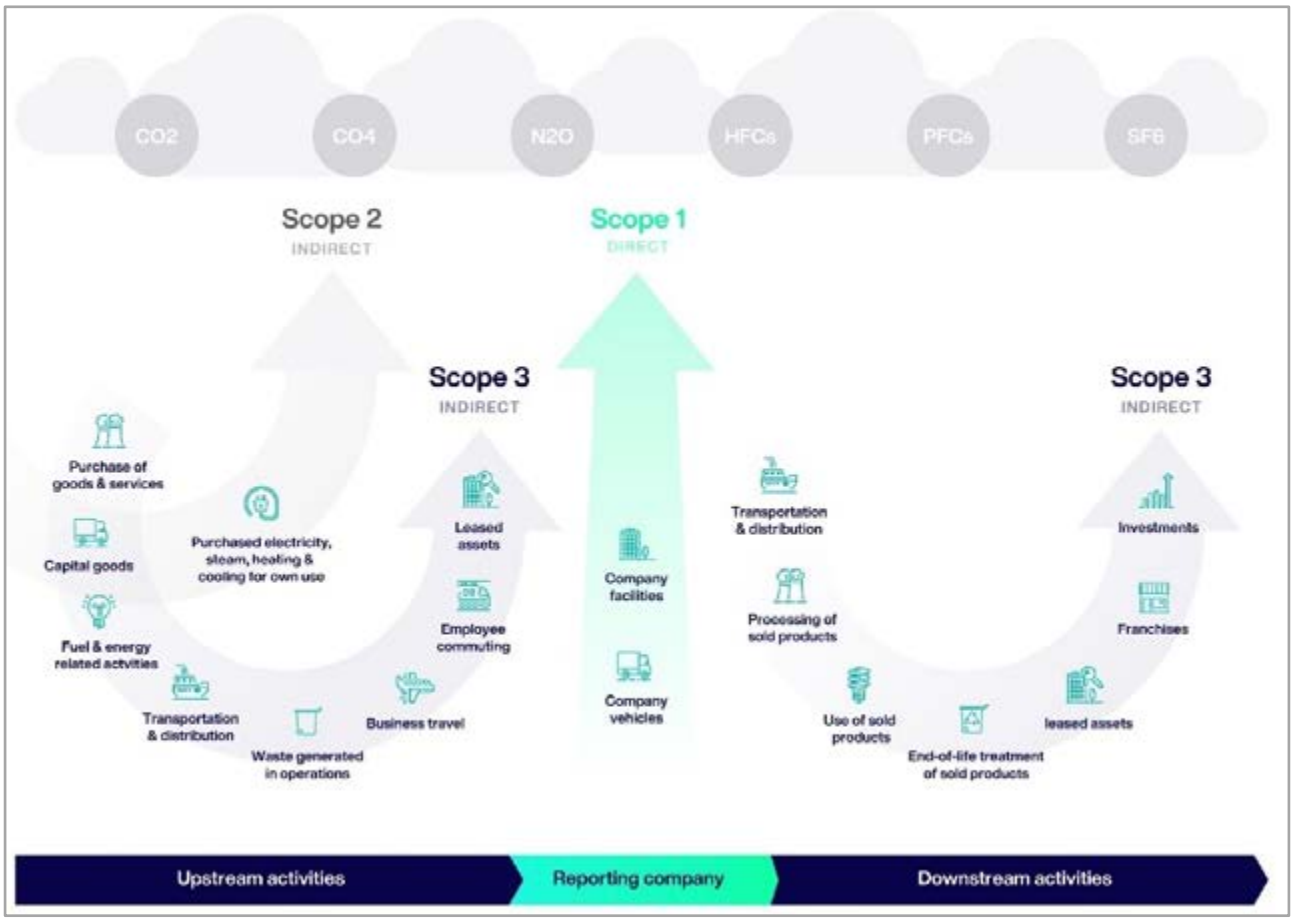
The GHG Protocol is an international platform that establishes comprehensive global standardised frameworks to measure and manage GHG emissions from private and public sector operations, value chains, and mitigation actions. Building on a 20-year partnership between the WRI and the WBCSD, the GHG Protocol works with governments, industry associations, NGOs, businesses, and other organisations. Besides standards, the GHG Protocol provides guidance, tools, and training for business and government.

The GHG Protocol Corporate Accounting and Reporting Standard provides requirements and guidance for companies and other organisations preparing a GHG emissions inventory. Emissions are grouped in scopes referring to their source (Figure 23):

- Scope 1 emissions: direct emissions from own facilities or vehicles
- Scope 2 emissions: indirect emissions through purchasing of energy
- Scope 3 emissions: indirect emissions within the upstream and downstream value chain

It should not be used to quantify the reductions associated with GHG mitigation projects for use as offsets or credits. For this purpose, other standardisation sections such as the GHG Protocol for Project Accounting or UNFCCC CDM (see below) may be consulted.

Figure 23: System boundaries for emissions according to the GHG Protocol [60] for corporate GHG accounting



Scope 2 is where the procurement of RE comes into play. When RES are selected for electricity, steam, heating, and cooling, the consumption of fossil energy carriers is replaced or reduced, and thus, carbon emissions are reduced. Since Scope 2 refers to purchasing from external suppliers, emissions reductions occur indirectly. Depending on the market design and regulatory framework (compliance or voluntary markets) in the country of operation, there are different options for the company to account for the purchased energy as "green" or "renewable".

Referring to green electricity, purchasing EACs (RECs, I-RECs, and GOs) is the easiest and quickest way to reduce a company's Scope 2 emissions (also see Table 7). Certificates might be obtainable as unbundled or bundled (see section 2.2.1). Responding to widespread criticism of unbundled EACs that they do not necessarily stimulate investments in renewables, many label issuers provide an additional environmental quality seal to EACs, for example, Green-e (USA), EKOenergy (EU), and Grüner Strom Label/ok-power (Germany) (see section 2.3).

The next option for purchasing renewable electricity from the grid is by means of green pricing programmes or green tariffs where utilities offer this. PPAs are the most sophisticated grid-related form of external procurement since they require negotiations on the specification of the electricity supply (see section 2.5).

Renewable-based on-site generation of electricity as a process of internal operation refers to Scope 1 and reduces demand for carbon emission allowances or carbon credits.

Thus, whereas EACs may contribute to Scope 2 emissions reductions, carbon offsets should be considered as an instrument for compensation of emissions within all scopes, most prevalent within Scopes 1 and 3.

2.6.4.1 International schemes for carbon offsets

A carbon offset refers to the reduction, removal, or avoidance of GHG emissions that is used to compensate for emissions that occur elsewhere. A carbon offset credit is a certified token representing an emission reduction of one metric tonne of CO2 or an equivalent amount of other GHGs (see Figure 23). It turns the emission reduction into a tradeable asset. A certification body is either a governmental authority or some independent organisation. The purchaser of an offset credit can "retire" it to claim the underlying reduction towards its own GHG reduction goals. The key concept is that offset credits are used to convey a net climate benefit from one entity to another. Carbon offsets are intended to make it easier and more cost-effective for organisations to pursue emission-reducing activities. Carbon offsetting is possible because climate change is a non-localised problem. GHGs mix throughout the atmosphere, so reducing them anywhere contributes to overall climate protection [61].

Table 14 compares EACs in terms of voluntary RECs, which are prevalent in the USA and carbon offsets. These should be considered as two kinds of instruments with their specific characteristics referring to their objectives and accounting procedure**s.**

Table 14: Comparison of the carbon offsets and RECs instruments [62]

Basic differences	Offsets	RECs
Unit of measure	Metric tonnes of CO2 or CO2 equivalent	Megawatt hours (MWh)
Source	Projects that remove, avoid, or reduce GHG emissions	Renewable electricity generators
Purpose	Represent GHG emissions reductions; provide support for emissions reduction activities; and lower costs of GHG emissions mitigation.	Convey use of renewable electricity generation; underlie renewable electricity use claims; expand consumers' electricity service choices; and support renewable electricity development.
Corporate GHG inventories and reporting	Reduce or "offset" an organisation's Scope 1, 2, or 3 emissions as a net adjustment.	Can lower an organisation's gross market-based Scope 2 emissions from purchased electricity.
Consumer environmental claims	Can claim to have reduced or avoided GHG emissions outside their organisation's operations.	Can claim to use renewable electricity from a low- or zero-emissions source.
Additionality test requirements	Required. Each project is tested for additionality to ensure that it is beyond business-as-usual. Tests include legal/ regulatory and financial aspects, barriers, common practices, and performance tests. The combination of tests that is best suited to demonstrate additionality depends on the type of project.	Not required. Project additionality is not required for a RE usage claim or to report use of zero-emissions power.

Carbon offset projects and eligibility

Carbon offset credits are produced through activities, often undertaken as discrete projects, that reduce GHG emissions or increase carbon sequestration. A carbon offset project, for example, may involve:

- RE facilities (displacing fossil-fuel emissions from conventional power plants), for example, photovoltaic lighting for non-electrified homes in rural areas (a CDM) project);
- the capture and destruction of high-potency GHGs such as methane, N2O, or HFCs, for example, the capture and combustion of methane from livestock manure to produce electricity; and
- avoiding deforestation (which can both avoid the emission of the carbon stored in trees and absorb additional carbon as trees grow), for example, forest conservation where transformation to agricultural land is planned.

To get a carbon offset project accepted, registered, and commercialised, a standardised project cycle must be conducted by the project developers in alignment with authorised parties, such as the executive board of the corresponding programme and an accredited third-party auditor. Table 15 shows the cycle, following the CDM protocol as an example. Registration processes of other offset programmes may differ slightly from the CDM cycle, but the core elements are the same.

The project design includes developing a project concept, choosing or developing a baseline and monitoring methodology, and stakeholder consultations. The CDM documents all these elements in the project design document (PDD). Rational baseline definition is crucial for plausibility in the subsequent monitoring and verification processes.

Because the purchasers of offsets use them in lieu of reducing their own emissions, it is extremely important that offsets represent additional emissions reductions. GHG reductions are additional if they would not have occurred in the absence of a market for offset credits. The economic incentives afforded by offset credit value should be reasonably expected to have enabled the implementation of an offset project. All high-quality offset programmes require rigorous demonstrations of additionality. If the reductions would have happened anyway – that is, without any prospect for project owners to sell carbon offset credits – then they are not additional. For an activity or project to be additional, the possibility to sell carbon offset credits must play a decisive ("make or break") role in the decision to implement it [63]. Evaluating the additionality of the emissions reductions of a project is one of the most challenging issues within the eligibility cycle and is crucial for the credibility of the programme. GHG-reducing activities occur in many cases, for example, because the activities are required by law, or investments that reduce emissions are made simply because they are profitable, without any consideration of carbon offset credits. Similarly, RE technologies, such as wind and solar, are increasingly cost-competitive with fossil fuels, without revenue from carbon offset sales.

After the issuance, the CER can be commercialised. At this stage, a project developer sells the offset credits from a project to a buyer. The credits can either be sold directly to a company that uses them to meet its legally binding or voluntary emissions reduction obligations, or they can be sold to a trading company that facilitates the transaction between the seller and the end user of the credits.

Table 15: Steps from approval to credit issuance of a carbon offset project for CDM as an example [63] [64]

CDM project cycle	Activity
Project Design	- The project participant prepares the project design document, making use of an approved emissions baseline and monitoring methodology. - The project participant secures a letter of approval from the party, indicating ratification of the Kyoto Protocol, voluntary participation, and the contribution of the CDM project to sustainable development. - Validation is the process of independent evaluation of a project activity by an accredited designated operational entity (DOE) against the requirements of the CDM based on the project design document. - The DOE submits the project and requests registration from the CDM Executive Board. Registration is the formal acceptance by the Executive Board of a validated project as a CDM project activity. - The project participant is responsible for monitoring actual emissions according to the approved methodology. - The DOE verifies that emissions reductions took place, in the amount claimed, according to the approved monitoring plan. Certification is the written assurance by the DOE that, during the specified period, the project activity achieved the emissions reductions as verified. - The DOE submits the verification report with a request for issuance to the CDM Executive Board.
National Approval	
ValidatioIn	
Registartion	
Monitoring	
Verification	
CER Issuance	

Carbon offset programmes

For quality assurance of their products, standard-setting organisations ranging from international or governmental regulatory bodies to independent NGOs have been establishing carbon offset programmes. Historically, governmental bodies certified offset credits for regulatory purposes ("compliance programmes"), while NGOs primarily served voluntary buyers ("voluntary programmes"); more recently, both types of programmes have begun to serve both types of markets. Each carbon offset programme issues its own labelled "brand" of credit (Table 16).

Offset programmes perform three basic functions:

1. They develop and approve standards that set criteria for the quality of carbon offset credits.
2. They review offset projects against these standards (generally with the help of third-party verifiers).
3. They operate registry systems that issue, transfer, and retire offset credits.

Carbon offset programmes not only provide standards, including protocols and guidelines, but also training and support for their stakeholders. In many cases, they host a platform for global or regional commercialisation of carbon offset credits, for example, the Gold Standard. Trading systems following the cap-and-trade principle are described in the following section.

Table 16: Selected international carbon offset programmes and their specifications

Programme	Type	Regulatory body	Geographic coverage	Label used for offset credits
Clean Development Mechanism (CDM)	Compliance	United Nations CDM Executive Board, under Kyoto Protocol	Developing countries	Certified emissions reduction (CER)
Joint Implementation (JI)	Compliance	United Nations Joint Implementation Supervisory Committee (JISC), under Kyoto Protocol	Industrialised countries	Emission reduction unit (ERU)
The Gold Standard (GS)	Voluntary	Gold Standard Secretariat (NGO-supported)	International	Verified emissions reduction (VER)
Plan Vivo	Voluntary	Plan Vivo Foundation (NGO)	International	Plan Vivo certificate (PVC)
The Verified Carbon Standard (VCS)	Voluntary	Verra (NGO)	International	Verified carbon unit (VCU)
The Climate, Community & Biodiversity Alliance (CCBA)	Voluntary	CCB Standards Team at Verra (NGO)	International	Standards for site-based projects

2.6.4.2 International cap-and-trade schemes

Emissions cap-and-trade systems are mandatory markets for allowances for GHG emissions. Offsets come from emissions outside of the boundary of the cap and may be used instead of an emissions reduction that would otherwise have been made by an emitter within the boundaries of the emissions cap.

The EU ETS is the world's first major carbon market and remains the biggest one after China. It was introduced in 2005 to implement the international Kyoto Agreement on Climate Change and is the central European climate protection instrument.

The emissions of around 11 000 plants in the energy sector and energy-intensive industry throughout Europe are recorded. Together, these plants account for around 40% of GHG emissions in Europe. Since 2012, intra-European air transport has also been included in the EU ETS.

The EU ETS works on the cap-and-trade principle. The yearly total amount of certain GHGs that can be emitted by the installations covered by the system is set as the cap. The cap is reduced over time so that total emissions fall. Within the cap, installations buy or receive emissions allowances, which they can trade with one another as needed. The limit on the total number of allowances available ensures that they have a value. After each year, an installation must surrender enough allowances to fully cover its emissions; otherwise, heavy fines are imposed. If an installation reduces its emissions, it can keep the spare allowances to cover its future needs or else sell them to another installation that is short of allowances. Trading brings flexibility that ensures that emissions are cut where it costs least to do so. A robust carbon price also promotes investment in innovative, low-carbon technologies.

The EU ETS is organised in trading periods (or phases), of which four are currently decided and more may follow. Currently, the system is in its fourth period from 2021 to 2028. Until Trading Phase 3 (2013 to 2020), in addition to the emissions allowances, operators in the EU ETS could also use **international credits from CDM and JI projects** (CER/ERU) to a specified extent. International credits are financial instruments that represent a tonne of CO^2 removed or reduced from the atmosphere as a result of an emissions reduction project.

The international mechanisms increase the emissions cap. Figure 24 shows the development of the cap and emissions in the EU ETS over the last two trading periods and the share of international project credits. As the world's largest carbon market, the EU ETS was the biggest source of demand for international credits until Phase 3, making it the main driver of the international carbon market and the main provider of clean energy investment in developing countries and economies in transition.

A surplus of emissions allowances has built up since 2009, largely due to the economic crisis (which reduced emissions more than anticipated) and high imports of international credits. This has led to lower carbon prices and, thus, a weaker incentive to reduce emissions. The European Commission is addressing this through short- and long-term measures, the so-called backloading of auctions and the market stability reserve, respectively.

The EU legislation specifies maximum limits on the eligible international credits that can be used under the EU ETS for compliance in Phase 3. Since Phase 3, CERs and ERUs are no longer compliance units within the EU ETS and must be exchanged for EU ETS emission allowances. Operators must request the exchange of CERs and ERUs for general allowances up to their individual entitlement limit set within the Union Registry.

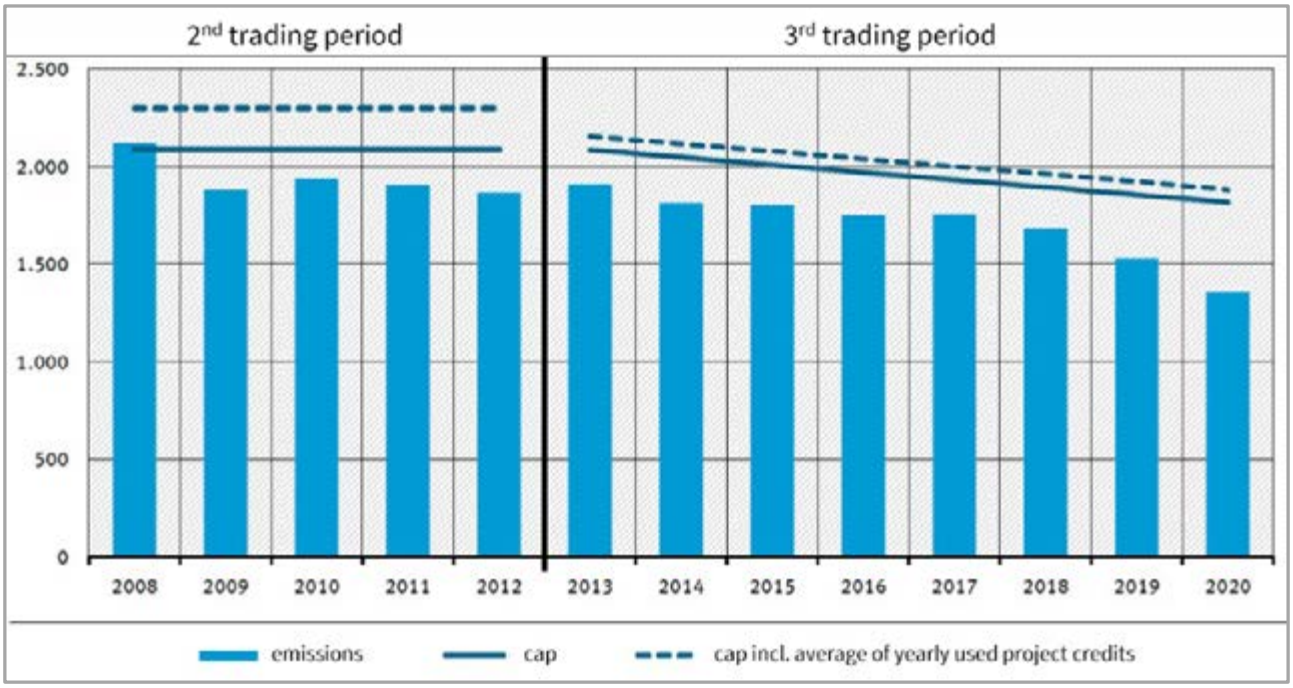


Figure 24: Total cap and emissions in the EU ETS, in Mt CO^2e (Source: Umweltbundesamt/Deutsche Emissionshandelsstelle)

There is an increasing number of cap-and-trade ETSs around the world. Besides the EU ETS, national or subnational systems are already operating or under development in Canada, China, Japan, New Zealand, South Korea, Switzerland, and the USA. Table 17 shows a selection of ETSs worldwide in operation. The International Carbon Action Partnership (ICAP) is a forum for policymakers worldwide to share best practices and learn from experiences designing and implementing ETSs [65].

Table 17: Selected national and subnational compliance cap-and-trade systems in force (ICAP Status Report 2021)

ETS (start year)	Sectors (covered emissions)	Geographic coverage	Cap	Gases	Average price	Allocation	Offsets and credits	Total revenue
EU ETS (2005)	Power, industry, aviation (40%)	All EU member states, Iceland, aLiechtenstein, Norway, linked with Swiss ETS	1 610 $MtCO^2e$ (2021); 1 572 $MtCO^2e$ for stationary installations; 38 $MtCO^2e$ for aviation operators	CO^2, N_2O, PFCs	EUR 24.76/ tCO2 (USD 28.28	Free allocation: benchmarking; auctioning	Offsets and international credits can no longer be used for compliance since Phase 4 (2021 to 2030).	EUR 69.7 billion (USD 80.7 billion) since beginning of programme, EUR 19.2 billion (USD 21.8 billion) collected in 2020
California Cap-and-Trade Program	Power, industry, transport, buildings (70%)	California (USA), linked with Québec	321 $MtCO^2e$ (2021)	CO^2, CH4, N_2O, SF^6, HFCs, PFCs, NF^3, and other fluorinated GHGs	USD 17.04/ tCO2	Free allocation: benchmarking; free allocation with consignment auctioning	Domestic	USD 14.24 billion since beginning of programme, USD 1.7 billion collected in 2020
Regional Greenhouse Gas Initiative (RGGI, 2009)	Power (10%)	12 states in northeast USA; first USA cap-and-trade programme	119.8 million short tonnes CO2/ 108.9 $MtCO^2$ (2021)	CO^2	USD 7.06/ tCO2	Auctioning	Domestic (within RGGI states only)	USD 3.8 billion since beginning of programme, USD 416.3 million collected in 2020
Mexican ETS Pilot Program (2020	Power, industry (40%)	Mexico (first ETS in Latin America)	273.1 $MtCO^2$ (2021)	CO^2	Not yet available	Free allocation: grandparenting	Domestic	Not yet available
China National ETS	Power; limited compliance, intensity-based (40%)	China (several provincial ETS pilots preceded it; now the world's largest ETS)	Set bottom-up: estimated over 4 000 MtCO2 / year for 2021	CO^2	Not yet available	Free allocation: benchmarking	Domestic	Not yet available
Korea ETS (2015)	Power, industry, domestic aviation, buildings, waste (74%)	Republic of Korea; East Asia's first nationwide mandatory ETS	592 $MtCO^2e$ (2020) 609 $MtCO^2e$ (2021)	CO^2, CH^4, N_2O, PFCs, HFCs, SF^6	KRW 32 595.83 (USD 27.62)	Free allocation: benchmarking; free allocation: grandparenting; auctioning	Domestic, international	KRW 480.7 billion (USD 407.3 million) KRW 248.3 billion (USD 199.4 million) in 2020
The New Zealand ET Scheme (2008)	Power, industry, domestic aviation, transport, buildings, waste, forestry, agriculture (51%)	New Zealand	40.3 $MtCO^2e$	CO^2, CH^4, N_2O, SF^6, HFCs, PFCs	NZD 30.83 (USD 19.99	Free allocation for emissions-intensive and trade-exposed (EITE) activities: benchmarking; auctioning; allowances granted for forestry and other removal activities	None	None NZD 215 million (USD 139 million) in 2020

Carbon Border Adjustment Mechanism (CBAM)

The European Commission has proposed the introduction of a carbon border adjustment mechanism (CBAM) as part of the European Commission's energy legislation package "Fit for 55" in order to improve carbon leakage protection for European energy-intensive industries that are subject to the carbon price in the EU ETS. Introduction of the CBAM will make the EU the very first market to adjust carbon at its borders. Carbon leakage can shift emissions outside of Europe and, therefore, seriously undermine EU and global climate efforts. The CBAM will equalise the price of carbon between domestic products and imports and ensure that the EU's climate objectives are not undermined by production relocating to countries with less ambitious policies. A further ambition is to promote RE and carbon trading schemes among Europe's trading partners.

Designed in compliance with World Trade Organization (WTO) rules and other international obligations of the EU, the CBAM system will work as follows: EU importers will buy carbon certificates corresponding to the carbon price that would have been paid had the goods been produced under the EU's carbon pricing rules. Conversely, once a non-EU producer can show that it has already paid a price for the carbon used in the production of the imported goods in a third country, the corresponding cost can be fully deducted from the EU importer. The CBAM will help reduce the risk of carbon leakage by encouraging producers in non-EU countries to green their production processes.

CBAM is only necessary in the absence of a carbon price in the EU's trading partners. Applying a reduction factor on CBAM certificates equivalent to the CO2 price paid in the jurisdiction of origin is an important additional element both to avoid illegal double taxation of CO2 and to ensure fair treatment between domestic and imported products. On this issue, technicalities remain to be defined in the delegated acts, which leaves room for international co-ordination before the entry into force of the CBAM regulation between 2023 and 2026 [66].

The CBAM will be phased in gradually and will initially apply only to a selected number of goods at high risk of carbon leakage: iron and steel, cement, fertiliser, aluminium, and electricity generation. A reporting system will apply as from 2023 for those products, with the objective of facilitating a smooth roll-out alongside dialogue with third countries; importers will start paying a financial adjustment in 2026.

To complement the EU ETS, the CBAM will be based on a system of certificates to cover the embedded emissions in products being subsequently imported into the EU. The CBAM departs from the ETS in some limited areas, however, since it is not a cap-and-trade system. Instead, the CBAM certificates mirror the ETS price. The price of the certificates will be calculated depending on the weekly average auction price of EU ETS allowances expressed in EUR/tonne of CO2 emitted. Importers of the goods will, either individually or through a representative, must register with national authorities where they can also buy CBAM certificates. Importers will have to report emissions embedded in their goods without paying a financial adjustment in the transitional phase starting in 2023 and finishing at the end of 2025, giving time for the final system to be put in place. Once the definitive system has become fully operational in 2026, EU importers will have to annually declare the quantity of goods and the amount of embedded emissions in the total goods they imported into the EU in the preceding year and surrender the corresponding amount of CBAM certificates [67].

The implementation of CBAM will proceed simultaneously with a gradual phase-out of the free allowance system currently under the EU ETS. It would be phased in over a period of 10 years, during which the free allowances for the sectors concerned would be reduced from 100% in 2025 to 0% in 2035.

With its proposed regulation, CBAM does not allow for EACs to be recognised as emissions reduction. In this sense, it is to be expected that CBAM will vitalise international carbon markets, on the one hand. International trading of EACs, on the other hand, may not benefit from it.

2.6.4.3 International carbon markets after COP26

The 2015 **Paris Agreement** provides a new framework for how parties (countries and other entities) should address climate change. Both developed and developing countries must communicate their nationally determined contributions (NDCs) every five years. Aiming at higher ambition in sustainable development, the Paris Agreement has presented a comprehensive basis for the use of international markets that reinforces international targets, transparency, and the accountability of the parties. Recognising the importance of international carbon markets, **Article 6** of the Agreement allows parties to use international trading of emissions allowances to help achieve emissions reduction targets. It establishes a framework for common accounting rules, recognising environmental integrity, and creates a new, more ambitious market mechanism. It provides for a mitigation mechanism to replace existing mechanisms (such as the CDM and JI) and provides for certification of emissions reductions for use towards NDCs.

In the Paris Agreement, emissions reductions that pass from the GHG inventory of one country to the inventory of another country are called **internationally transferred mitigation outcomes (ITMOs)**. Like all carbon credits, ITMOs are created by projects that either reduce emissions or remove gases in one place, with the payments coming from another place.

COP26 (Glasgow 2021) implemented Article 6 of the Paris Agreement and established a new global carbon market with clear, transparent rules for the trading of carbon credits. The market will be supervised by the UN, and it is the UN that certifies which carbon projects can generate credits for governments.

In practice, credits are generated from emissions reduction projects, such as solar or wind farms, or pollution allowances allocated by government cap-and-trade systems, and the credits are then sold to buyers. Buyers are typically governments or private companies who are looking for cost-effective ways to cut emissions or meet a target. The EU has a domestic emissions reduction target and does not currently envisage continuing the use of international credits for EU ETS compliance after 2020.

By establishing rules for international carbon markets, Article 6 strives to resolve the most important challenges of existing carbon trading schemes:

- **Double counting:** when both the country that sells carbon credits achieved by an emissions reduction project and the country that purchases these credits count these emissions reductions as part of their progress to achieving their NDC, double counting occurs. Article 6 specifies that double counting must be avoided on the basis of a "corresponding adjustment": when one country sells emissions reductions to another, it must adjust its own emissions figures accordingly; in other words, it must increase its level of emissions reductions in its NDC to make up for the fact that it sold some emissions reductions to another country. Conversely, the country that purchased the credit adjusts its own emissions reductions downward. The extent to which double counting can be avoided depends on the operationalisation of the accounting rules. The biggest practical challenge will be that the countries' NDCs under the Paris Agreement differ in comprehensiveness, timeliness, and metrics. Time targets are mostly set for one single year (for example, 2030), rather than as a multi-year pathway. Many countries have targets expressed in GHG emissions, but others have targets in other metrics, for example, RE percentages or hectares of afforested land. Moreover, many NDCs do not include all emissions, but only cover part of the economy.

- **Additionality:** in comparison to the CDM, the new mechanism has better rules to ensure that emissions reductions are robustly quantified and that the mitigation activities are additional, meaning that they would not occur without the carbon market. In contrast to the CDM, the mechanism also requires the application of robust environmental and social safeguards and establishes a grievance mechanism to appeal decisions.

- **Ambition level of NDCs:** countries have the flexibility to express their NDCs in different metrics, but accounting for transfer of carbon credits must be done in GHG metrics, thus in CO^2 equivalents. Countries are encouraged to increase the coverage of their NDC to all sectors of their economy, such as power, industries, transport, buildings, waste, agriculture, forestry, or others. There are no accounting exemptions for countries that included only a part of their economy in NDC targets. This means that emissions reductions that are not covered by NDCs may not be double-counted, and hence, corresponding adjustments are necessary, too. Countries that have determined their NDCs as a single-year target – which is the case for most countries – should apply the same accounting method as the transfer party over the whole NDC implementation period. Averaging is allowed.

- **Overall mitigation of global emissions:** existing carbon offset markets provide flexibility in financing mitigation activities, but do not result in a global net reduction of GHG emissions. Article 6 stipulates that the achieved emissions reductions should be shared between the seller country, the buyer country, and a small proportion of 2% that accrues to the atmosphere, referred to as overall mitigation in global emissions (OMGE).

- **Climate change investments in developing countries:** 5% of the carbon credits must be transferred to the Adaptation Fund, which has the mandate to finance concrete adaptation projects in developing countries that are particularly vulnerable to the adverse impacts of climate change.

- **Transfer of CDM units**: Article 6 allows the predecessor to carbon credits, certified carbon emissions (CERs), to be traded on the new carbon market if they were issued between 1 January 2013 and 30 December 2020.

The introduction of the new global carbon market framework is welcomed by both climate protection experts and economists, as a stimulation of cross-emissions reductions trading is expected. The rules on double counting, the establishment of common quality standards, and the approaches for net reduction of global GHG emissions are assessed as positive. Nevertheless, the effectiveness of the rules is considered to depend a lot on how countries will apply them. Environmental integrity may be at risk, since there are loopholes that could undermine the effectiveness of climate protection activities, such as the regulations for averaging emissions reductions over several years of an NDC period. In addition, the transition of CDM certificates into the new scheme is seen as critical in terms of additionality. Discussion on Article 6 is continuing, and adjustment of the international rules is expected in the coming years.

Future of voluntary carbon markets (VCMs)

Voluntary carbon markets (VCMs) encompass all transactions of carbon offsets that are not purchased with the intention to surrender into an active, regulated carbon market. The emissions reductions generated in the VCM are called voluntary emissions reductions or VERs. Since they are not created to meet a legal requirement, they do not have to be entered into a national inventory. A host country can, if it chooses, apply a corresponding adjustment to VERs that leave its border, but this is not required [68].

While compliance carbon markets require corresponding adjustments between the trading countries, voluntary markets do not. As such, they facilitate trading of carbon offsets mainly for private companies, organisations, or individual consumers who have committed themselves to reducing or cutting their GHG emissions and who want to claim this for their products or services. The buying entities can purchase offsets that were created either through the voluntary or compliance markets.

For example, one multilateral manufacturing company is purchasing offsets to create a product that it can market as "climate neutral" rather than to meet a legal requirement. It is buying the offsets from a private company in one country to create a climate-neutral product that will be sold in another country, but the emissions reductions will be credited to the GHG inventory of the country where the reductions take place. The buying company is, in a sense, helping another country reduce its GHG emissions, but its only real claim is having a climate-neutral product. As a result, there is no need for a corresponding adjustment [69].

Voluntary carbon markets have been stimulated a lot over the last couple of years due to the evolution of carbon taxation systems and growing reporting requirements for corporations. One example is Colombia, where industrial taxpayers are allowed to reduce their tax liability completely with carbon credits.

Article 6 of the Paris Agreement does not regulate voluntary markets for carbon offsets. Programmes such as the Gold Standard, Verified Carbon Standard (VCS), or Climate Action Reserve are enduring and will continue to satisfy the demand of private companies and facilitate trading of emissions reductions of smaller-scale climate action projects. Although VCMs are not regulated by Article 6, it will have a significant impact on them and will lead to changes in regulations. Market activity is, therefore, anticipated to increase, as the new trading mechanism established by the Agreement lends transparency, reliability, and liquidity to voluntary markets. Figure 25 shows that the amount of issued carbon credits for the four major standards almost doubled from 2020 to 2021.

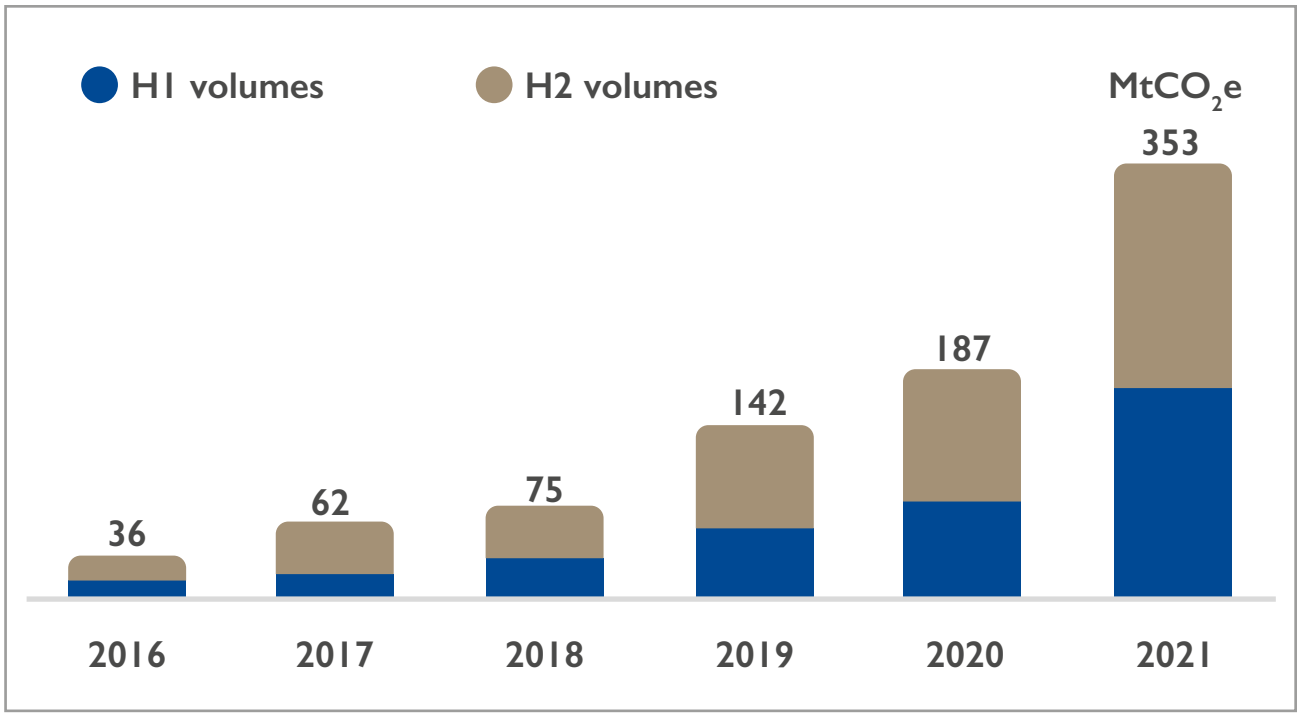


Figure 25: Total issuance of carbon credits in VCMs. Covered carbon standards: Verra's Verified Carbon Standard (VCS), the Gold Standard (GS), the American Carbon Registry (ACR), and the Climate Action Reserve (CAR). H_1/H_2 means first/second half year. [70]

According to Climate Focus, nature-based solutions (NBSs) and RE projects dominated credit issuances in 2021, jointly representing over 80% of total VER issuances. NBSs generated VER issuances of 59 $MtCO^2e$ in 2020, with an almost threefold increase to 159 $MtCO^2e$ in 2021. The NBS market is dominated by 10 countries, accounting for 90% of the total amount of credits issued, with Brazil, Cambodia, and Indonesia as the top three. In Southern Africa, Zimbabwe, as one of the top 10, accounted for 6 $MtCO^2e$ credits from NBSs in 2021. RE projects increased from 88 $MtCO^2e$ of total VER issuances in 2020 to 133 $MtCO^2e$ in 2021.

2.6.4.4 Differentiation of EACs and carbon offsets

In the previous sections, how issuance and trading schemes for carbon offsets have developed at an international level was described. Against the background of evolving energy attribute certification systems, it should be noted that carbon markets are to be considered as an instrument for climate protection, undergoing its own evolutionary development over the last two decades.

From the perspective of a reporting organisation, it may be of interest where and how to apply which instrument when implementing climate action measures. Figure 26 shows relationships and interactions of both RE purchasing and carbon offsetting under the monitoring and reporting scheme of the GHG Protocol. As explained above, procurement of RE products – except from on-site generation – is related to Scope 2 "indirect emissions from purchased energy", with EACs allowing an organisation to lower its market-based Scope 2 emissions (also see Table 5). If the purchased RE production replaces fossil-based production, the purchasing organisation can claim to reduce or avoid GHG emissions through this strategy. More precisely, the organisation may claim that its purchase of EACs is renewable electricity from a low- or zero-emissions resource, which reduces the emissions associated with the electricity use. Depending on the standards underlying the specific national or regional certification system, the replacement claim in the sense of additional renewable sources may not be fulfilled comprehensively. A discussion of two crucial criteria for the integrity and credibility of EACs follows below: additionality and ownership.

By now, it can be stated that EAC deployment follows the strategy of reducing carbon emissions indirectly through RE consumption and should be prioritised before starting to compensate for own emissions by carbon offsets. The GHG Protocol Scope 2 Guidance recognises GOs, RECs, and I-RECs as mainstream instruments for documenting and tracking electricity consumed from renewable sources [71].

Offsets can be used to negate or "offset" an organisation's Scope 1, 2, or 3 emissions. A buyer of an offset can claim to have reduced or avoided direct GHG emissions outside its organisation's operations by compensation.

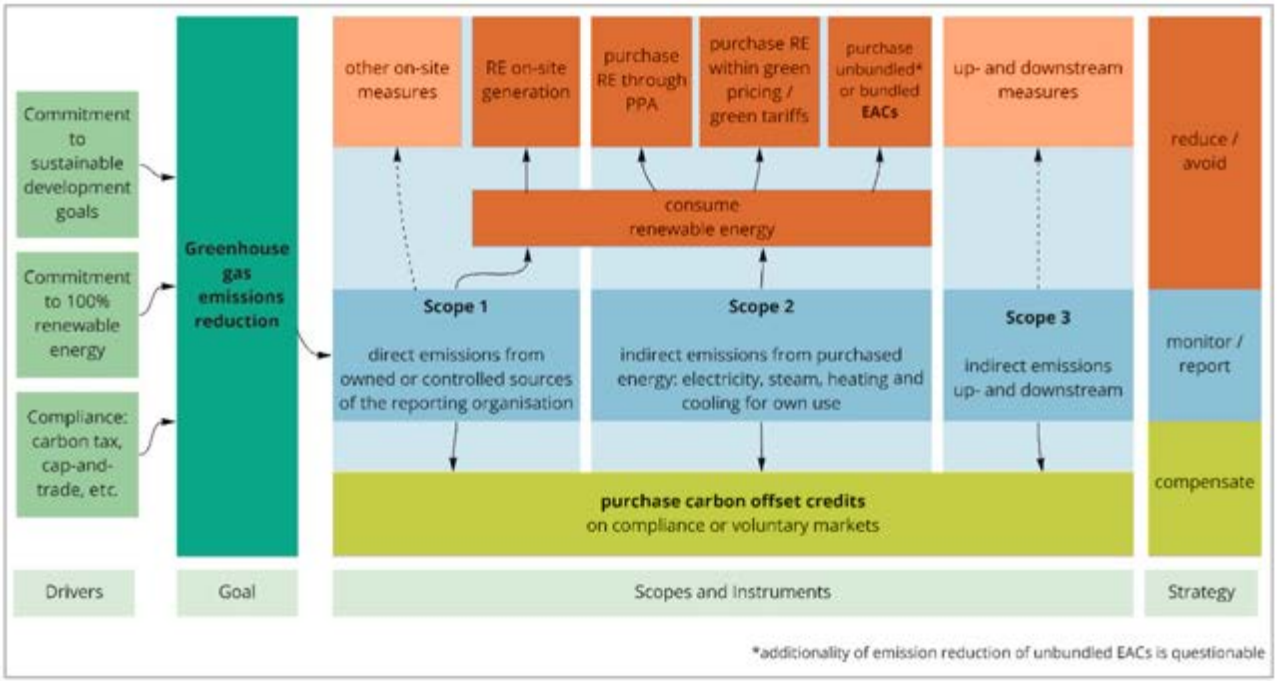


Figure 26: Instruments to achieve GHG emissions reductions for a reporting organisation referring to GHG Protocol scopes

The specific capabilities of EACs and carbon offsets have been discussed, particularly in the American context, where the accounting landscape for climate protection consists of different instruments and state-specific systems, such as mandatory and voluntary REC markets, cap-and-trade emissions trading, and energy efficiency credits. Table 14 shows the basic differences between carbon offsets and RECs as prevalent energy certificates in USA jurisdictions, although specific regulatory frameworks between states differ (see section 2.6.2). From the perspective of a renewable electricity project developer, it may be of interest if one can issue both EACs (MWh of renewable electricity production) and carbon offset credits (CO_2e emissions reduction) with the same project. An analysis for how this is handled within the USA, in the EU scheme, and within the GHG Protocol Guidelines makes it clear that double counting between different instruments (double issuance) and non-additionality are risks that could prejudice the integrity and credibility of climate action in all of these.

Ownership and double counting between instruments

In the USA, direct GHG emissions are reported by each power plant where the emissions occur. These power plants fall under a GHG emissions cap, where it exists (for example, the RGGI or California Cap-and-Trade), and are required to obtain GHG allowances for each metric tonne they emit. Emissions reductions from any activity associated with electricity use or generation, such as energy efficiency or RE, actually occur at these fossil-fuel-fired power plants, which are covered sources under a cap-and-trade programme. In their reports, the effects of these activities will show up as reduced emissions from fossil-fuel-fired plants and reduced allowance requirements. If a renewable generator were to get credit for indirect reductions as well, as would be by issuance of an REC, then emissions reductions would be double-counted. It is, therefore, crucial to define RECs in anticipation of a future cap-and-trade programme with an eye towards avoiding the possibility of double counting.

In order to avoid double counting of emissions reductions, the Offset Quality Initiative, therefore, recommends that the seller of emissions reductions has to have a clear and uncontested claim to them, established by contractual assignment and/or government recognition of ownership. In the case of indirect emissions reductions, such as those that might result from a grid-connected RE project, clear ownership is generally difficult or impossible to achieve without government intervention. Furthermore, the transfer of ownership for a reduction (for example, in the form of an offset credit) must be unambiguous and documented [111].

Clear transfer of ownership cannot take place where the reduction itself is not clearly defined, quantified, and documented, as is the case with the environmental benefits attributed to RECs. It has been criticised that there are a variety of sometimes contradictory definitions between state and regional, as well as voluntary and mandatory, REC programmes and no clarity how different environmental claims should be quantified, verified, guaranteed, or exclusively assigned to the purchaser of an REC [111].

International practice shows that RE markets and carbon offsetting markets have developed independently and have their own registries. Some power plants are, indeed, registered in both types of registries. In theory, it is possible that the production of a MWh of RE leads to the issuance of an EAC and to a carbon credit. The avoided carbon can then be sold on the voluntary offsetting market.

GHG Protocol Scope 2 Guidance itself does not specify the need to avoid double issuance of both types, since "avoided carbon" and "RE production" are different, from a theoretical point of view. It states: "Offsets, and their global avoided emissions claim, represent a different instrument and claim from the energy attributes associated with energy production. Offsets convey tons of avoided CO_2 using project-level accounting, but they do not convey information about direct energy generation emissions occurring at the point of production, like contractual instruments do. An offset credit does not confer any claims about the use of electricity attributes applicable to Scope 2 ... Unless otherwise adjusted by local rules, RE generation facilities producing and selling offsets will inherently still provide energy attribute information – directly and indirectly – to other entities in the local energy supply system, including energy consumers reporting scope 2 emissions" [72, p. 71].

However, this is not a widely accepted practice. Since the publication of the Scope 2 Guidance, several practices have developed. EKOenergy, for example, does not allow EKOenergy-labelled volumes to also be used for carbon offsetting. In most cases, sellers of carbon credits and sellers of RE contractually agree that both carbon credits and RE will not be sold separately. I-REC certificates also have an information field specifying whether such a contract has been signed in order to inform the consumer [73].

Even more explicitly, the Verified Impact Standard within the Verra Programme, the largest programme on voluntary markets, Version 1.0 from 2019, section 4.3.1, specifically excludes double issuing:

"Projects may generate other forms of social or environmental credits, such as renewable energy certificates (RECs), Verified Carbon Units (VCUs), or W+ units, though the sustainable development benefits presented for SD VISta asset issuance shall not also be recognized as a similar form of saleable, tradeable claims/credits/units/assets for the same time period. Where a project generates a benefit that could be used as either an SD VISta asset or a similar form of saleable, tradeable claim/credit/unit/asset for the same time period, the project proponent shall demonstrate that the benefit has not been issued more than once or that any duplicative issuance has been cancelled under the relevant program(s).

For example, a renewable energy certificate (REC) may represent property rights to the environmental, social and other non-power attributes of renewable electricity generation. Projects generating RECs shall provide evidence to the Verra registry administrator that the megawatt hour presented for SD VISta asset issuance has not also been recognized as an REC, or that any such RECs have not been used and have been cancelled under the relevant program."

Additionality

ICarbon offsets must represent real, permanent, verified, and enforceable reductions. Most importantly, they must come from activities or projects that are additional to what would occur without the carbon market. This "additionality" requirement for offset projects is central to ensuring that the tonne of emissions reductions issued as an offset is fully equivalent to a tonne of emissions reductions from the buying organisation. In contrast, there is no requirement to demonstrate additionality when applying RECs to an organisation's market-based Scope 2 emissions [111].

As seen in section 2.4, EACs have the potential to influence the transition to cleaner energy production by means of various factors, such as market stimulation, additional income sources for producers, or increased acceptance of RE. Nevertheless, many of the international EAC schemes do not include additional RE project development as a material criterion of eligibility. That is the case for most of today's established labels (see section 2.3), but there is not a fundamental consensus on what additionality means for EACs as there is for carbon offset credits. Historically, EAC markets have had phases where there has been an oversupply of certificates issued. This resulted in price drops and, thus, less incentive for additional investments in RE production. Under such conditions, EACs may not allow the buyer to claim to foster overall emissions reductions, since existing EACs do not represent an additional fuel shift or replacement, but only serve to stabilise existing market segments (for example, RE from old hydro).

Growing markets for EACs and carbon offsets

Market experts are currently observing fast growth in VCMs (see above) as well as in REC markets. For example, I-REC issuance more than doubled from 2020 to 2021 (Figure 27), and the amount of redemption (cancelling) has followed the same trend. The leading country in the I-REC market is China, with almost 18 million certificates issued in 2021, followed by Brazil. Other large I-REC issuers are Turkey, Russia, and India. There is potential for further growth because, to date, in these countries, only a small percentage of RE plants have been registered in the I-REC scheme.

Demand is mainly driven by corporations with voluntary commitments to 100% renewables consumption accounted for in Scope 2, with CDP for climate disclosure and the RE100 for RE usage as the prevailing business initiatives.

Another factor pushing the uptake of the I-REC market worldwide is the system integrity, robustness and relative simplicity for project developers to register their energy devices, trace their electricity production, and trade such attribute certificates with market players. Against the background that rules for carbon credits are being tightened. The Gold Standard and Verra are excluding renewable electricity from mid-income countries from the eligible projects list, and this will lead to a migration of former carbon credit issuers to the I-REC scheme. However, there is a vast difference in prices, with issuance of RE carbon credits achieving much higher rates than RE certificates. It is expected, in the long run, that demand for the I-REC will increase and that prices will reach the same levels [74].

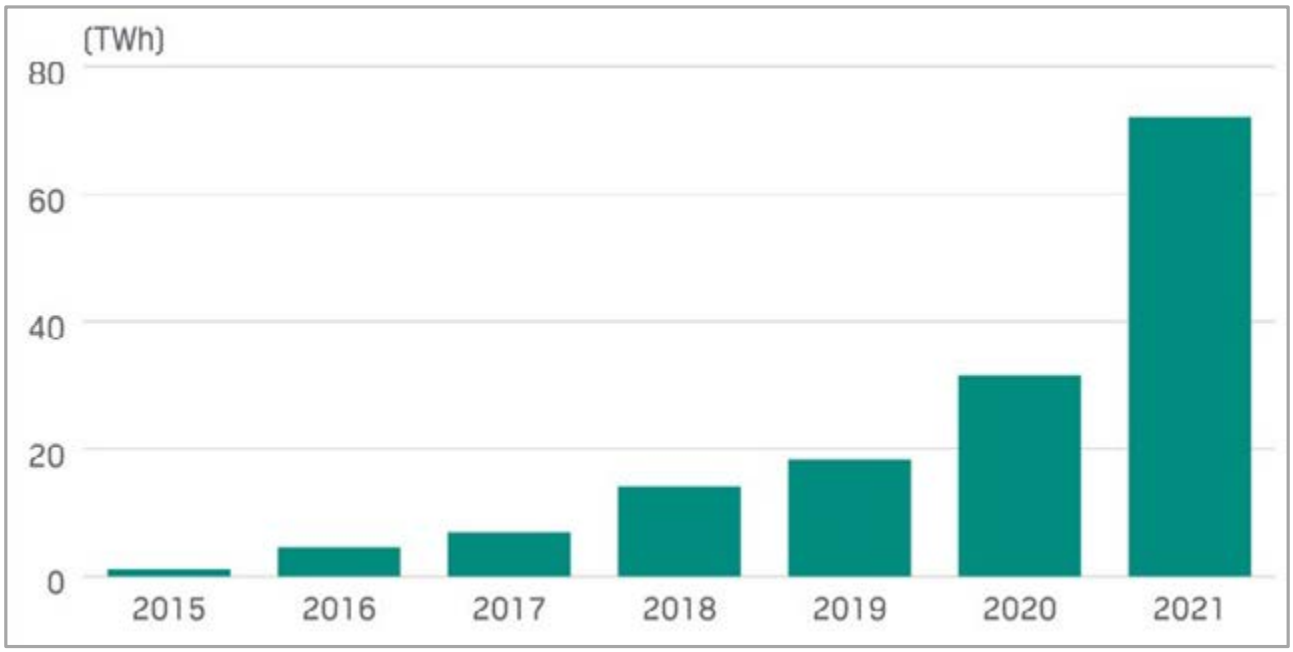


Figure 27: Global issuance of I-REC for electricity (in TWh) (Source: I-REC Standard Foundation)

At an international level, an analysis of carbon markets and electricity markets shows that carbon offsets and EACs are treated as two kinds of instruments in order to reach the same goal – GHG mitigation – but with different strategies and pathways concerning site and effectiveness of reduction (see Figure 26). Both have their own markets with their own standards, protocols, and registries. They are not viewed as competing or interchangeable instruments, but rather as complementing each other within the process of continuous improvement of an organisation on its way to climate neutrality. It can be described as an iterative process following three steps: (1) measure and report all GHG emissions; (2) reduce emissions of own facilities and processes, including indirect emissions; this is where production or procurement of renewable electricity fits its goal; and (3) compensate emissions where active emissions reduction is not possible or cost-effective; this is where carbon offsetting is considered the best option.

Discussion on challenges such as double issuance and additionality is ongoing, and it is expected that standardisation bodies will incorporate these considerations into adapted rules. Hence, it is recommended to keep observing both carbon offset and EAC markets.

2.7 Design and functioning of an electronic registry for EACs

This section provides an overview of the structure and functioning of an electronic registry for EACs. Where applicable, the technical requirements for hosting an EAC system are shown. The processes whereby an EAC is issued, both in the case of RE and green hydrogen, and in terms of how certificates are transferred, used, and, if necessary, deleted is described. The functioning of a cross-border international EAC use case is outlined to explain, for example, how an EAC acquired in one country can benefit a company in another country, with or without the physical flow of electricity.

As every jurisdiction has its own registry for EAC tracking, this section also gives a detailed summary of the national electronic registries for Germany, the Netherlands, and the USA. Because electronic tracking systems typically cover more than one state in the USA, this analysis focuses on states with two different tracking systems: the Western Renewable Energy Generation Information System (WREGIS) and the PJM Generation Attribute Tracking System (PJM-GATS).

2.7.1 HKNR in Germany

Registry processes and roles

When disclosing information on renewable electricity delivered to end customers, German electricity suppliers must cancel GOs in the German Registry of Guarantees of Origin (Herkunftsnachweisregister, HKNR). The rules and regulations related to the HKNR are stipulated in the Implementing Ordinance on Guarantees of Origin and Guarantees of Regional Origin (Herkunfts und Regionalnachweis-Durchführungsverordnung – HkRNDV). Information on participant fees can be found in the Fees Ordinance of Guarantees of Origin and Guarantees of Regional Origin (Herkunfts und Regionalnachweis-Gebührenverordnung – HkRNGebV). The most important document for the registry itself is the HkRNDV. It describes the preconditions and procedures for most activities within the registry in great detail.

Based on the HkRNDV, the UBA enacted the Terms of Use (Nutzungsbedingungen). According to their legal basis (Section 34 of HkRNDV), the Terms of Use contain detailed provisions regarding how users' obligations derived from the HkRNDV are to be implemented in practice. The Terms of Use, for example, provide for rules on:

1. availability of the registry, communication, and submission of documents;
2. power of representation, the PostIdent procedure, and authentication by smsTan;
3. change of plant operator and reimbursement of costs for the submission of documents and/or the commissioning of an environmental verifier;
4. additional information on the GO and specification of cancellation cause;
5. authorisation of service providers;
6. registration of environmental verifiers;
7. biomass plants, among others, multifuel plants;
8. waste incineration plants;
9. border plants; and
10. confidentiality, IT security, and passwords.

The life cycle of the GOs contains the following stages (Figure 28): the electricity producer who operates RE systems and is registered in the HKNR applies to the UBA for the issuance of a GO worth 1 MWh of electricity generated. After the application has been checked, the GO is registered in the system operator account in the HKNR. Next, the GO is transferred to the account of its buyer (a trader or supplier). The energy supplier who has come into possession of the GO applies for GO cancellation on physical delivery of an amount of electricity corresponding to the GO value to the end consumer. The supplier then uses the GO to disclose electricity sources on electricity bills that it sends to its customers. Use of GOs for other purposes, for example, the product carbon footprint, is not allowed.

GOs are generally issued monthly. After the end of the month of generation, the grid operator sends the energy generation data to the HKNR. These amounts of energy are the basis for issuing the GO. If the plants have not produced anything during the month, no GO will be issued. The issuing can take place automatically by standing order; exceptions are for mixed firing systems and pumped-storage power plants.

The following roles have an account in the HKNR:

- Plant operators
- Traders
- Energy suppliers

The roles of service provider, grid operator, and environmental experts can receive access to the HKNR, but do not have an account.

The UBA sets up a fee-based account for power plant operators, traders, and utilities once they have submitted all the documents and undergone an identification procedure. In the case of the combination of roles in one entity, this entity can have several standard accounts for each respective role. For each standard account, the actor can (free of charge) set up and name any number of sub-accounts (for example, "biomass plant xy2017", "wind power 2018", "municipal utility xy", or "electricity labelling 2019").

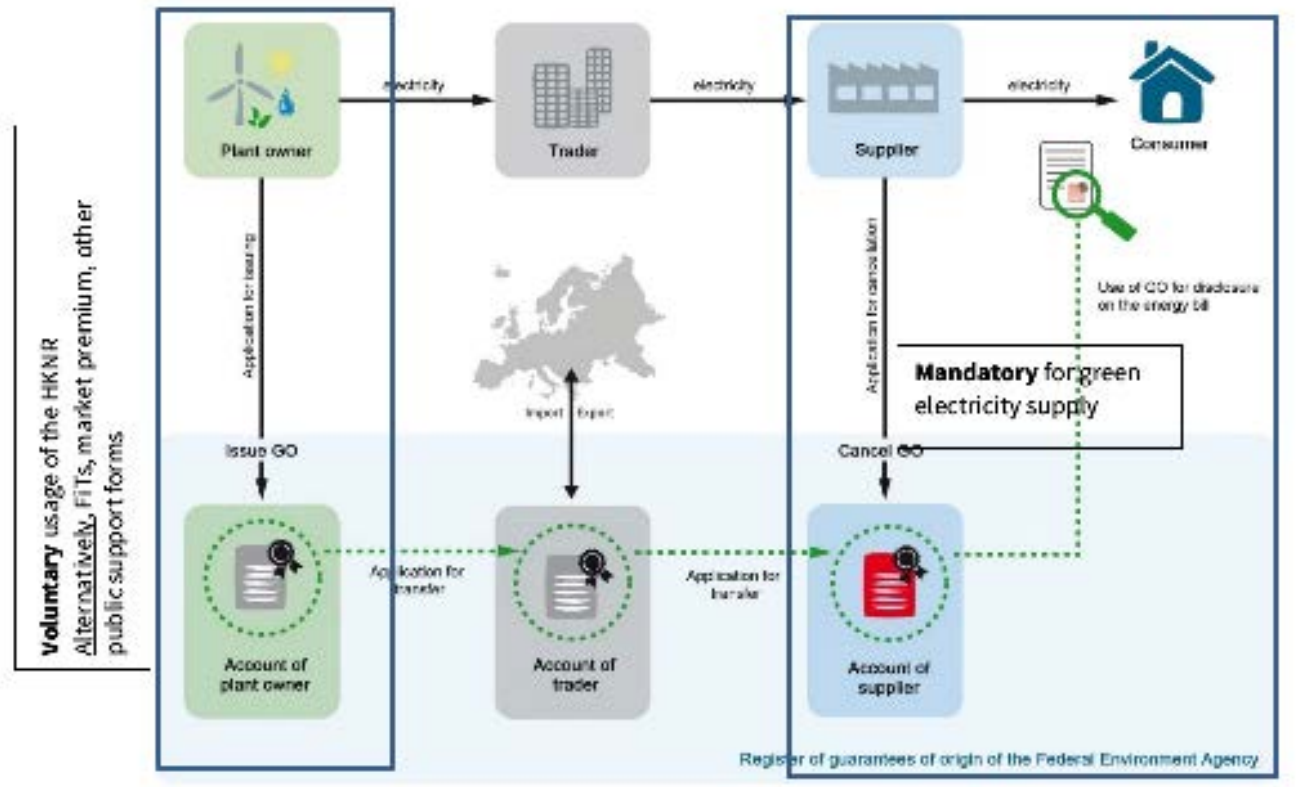


Figure 28: Flow chart of GOs in Germany and voluntary or mandatory participation of different market players [75]

Table 18: Definition and description of roles in the German GO system (based on [47], [19])

Role	HKNR account	Definition	Functions and responsibilities	Rights
Power plant operator	Yes	A plant operator is anyone who, regardless of ownership, uses the facility to generate electricity. Only facilities located in Germany can be registered in the HKNR. - Natural or legal persons (also operating companies) - Criteria for plant operators: • Carry the costs and economic risks of plant operation • Right to use the system for one's own account to generate electricity, determination/determining influence over the use of the system ("power of disposal" over the system – control of the specific operation on site is not required)	- Registration with the HKNR - Generation of the renewable electricity - Application for issuing of a corresponding amount of GOs - Trade with GOs - Obligation to notify the UBA of all changes - Duty to pay fees for using HKNR - Plant operators' forecasts for future production largely determine the course of prices during the year.	Right to choose whether to participate in the HKNR: - if no (full) subsidy of electricity according to section 19 of the EEG 2017 with a market premium or FiT - but (at least in part) other direct marketing without a market premium or system not eligible for EEG funding Additional information on GOs is possible after confirmation by environmental experts: - Special ecological system quality contribution for green electricity label - "Direct delivery" optional coupling
Trader	Yes	The traders are divided into those for whom GO trading is just a side business and those for whom it is the core business. Plant operators of large hydroelectric power plants usually also maintain a trading company that markets the GO from the facilities. Independent traders usually obtain GOs directly from power plant operators.	- Buy and sell GOs via their own account and deliver them to electricity suppliers. - Duty to pay fees for using HKNR - Most traders obtain GOs directly from power plant operators. - Traders maintain close relationships with both plant operators and energy supply companies. Strong competition among traders leads to low margins.	Only traders may import and export GOs
Energy supplier	Yes	Companies, but also natural persons or authorities - Supply of electricity to end consumers as: • physical supply of electricity via own/external network; and/or • contractual obligation to supply electricity (for a fee) conclusion of electricity supply contracts • Already sufficient "appearance in legal transactions" as a supplier, that is, primarily externally recognisable sales activities, for example, website • End consumers are to be differentiated from mere (intermediate) dealers who do not ultimately use the electricity for an electrical application but pass it on to third parties.	- Registration with the HKNR - Purchase of GOs - Cancellation of GOs according to sales volumes - Utility obligation to use GOs when supplying end consumers with green electricity (section 42 of the EnWG) - Use only for electricity that was delivered in the same year as the generation period of the GO. - Duty to pay fees for using HKNR - Need their own account if they supply green electricity.	- Exclusive right for cancellation of GOs exclusively for electricity labelling - Suppliers may state the electricity product or electricity customer when cancelling GOs; otherwise, use in the overall energy mix of the company. - Service providers may cancel GOs on a supplier's account. - Who transfers the GO to the supplier's account or who cancels it on the supplier's account – the supplier itself or the commissioned service provider – is irrelevant.
Service provider	No	Natural or legal persons	- Registry participants can engage service providers. - Service providers perform professional actions in the HKNR for one or more registry participants. - Activities range from the mere delivery of a GO (in this case, the service provider only acts as a trader to a supplier) to the complete administration of the GO in the registry, which often includes electricity delivery ("optional coupling") and processing of certification with a quality seal (label). - Procure GOs from various countries and, if required, from specific power plants, without the supplier having to establish commercial relationships with the plant operators, who are mainly located abroad. - Most of the service providers also have access to the GO registries in other countries such as Norway, Finland, and Austria and import GOs from hydroelectric power plants there directly from the power plant operators or their representatives in the registry. - Act in the name and on behalf of the registry participant; the registry participant remains responsible - Registry participants must carry out the following activities themselves: • First registration/account opening due to the identification procedure • Commissioning of the service provider informing the UBA ("external authorisation") • In the case of multiple roles, the registry participant must assign the service provider for each role.	- Have different rights in the HKNR, depending on the person (= role) they work for. - Can then take over all activities of the corresponding roles, apart from commissioning a service provider themselves or deleting the account.

Table 18: Definition and description of roles in the German GO system (based on [47], [19]) Continued

Role	HKNR account	Definition	Functions and responsibilities	Rights
Grid operator	No	Respective operators of the grid to which a facility is connected	Data supply to the HKNR: - Obligation to transmit the master data of the systems and the electricity quantities to the UBA (section 41, paragraph 2, clause 1 of the HkRNDV) as well as on the kind of marketing of the electricity (information if the power plant operator requests support for the electricity and, if so, what kind of support). - Orientation towards existing data, formats, and transmission paths = use of EDIFACT. - Immediate data delivery obligation on request by the UBA. - Assigning the metering points to the power plants, which must be specified when registering power plants. - Delivery method: only encrypted email (S/MIME) - Data delivery frequency: • RLM facilities: at least once a month (eighth working day of the following month), also possible daily; 15-minute exact • SEP facilities: at least once a year - Master data subscription: as long as the facility is managed in the HKNR - Measurement subscription: as long as RE status is relevant	CO2
Environmental auditors and auditing organisations	No	- Only those according to the Environment Audit Act (UAG), which implements the EU EMAS (Environmental Management and Audit Scheme) regulation in Germany - Also, environmental expert organisations from abroad after notification before each individual assignment	- Registration with the HKNR through an identification procedure Tasks: Confirmation of information at the following: - Facility registration • Systems > 100 kW and in the last five years ≤ six months of direct marketing with a market premium or FiT • Mixed firing systems > 100 kW • Systems with a "special meter situation" • Efficiency factor for pumped-storage power plants - Facility changes: • Confirmation of the system master data if the plant operator changes essential parameters of the system, for example, power, metering point designation, or converter factor (section 12 of the HkRNDV) - Confirmation of the amount of electricity: • Prior to GO issuance for mixed firing systems > 100 kW (entry biogenic proportion in percentage) and for pumped-storage power plants • After the GO issuance for biomass systems > 100 kW and systems in the area network - Additional information: • On the way in which electricity is generated in the facility (additional criteria) • Optional coupling - At the request of the UBA: confirmation of the information provided by the plant operator to the UBA	-

Table 18: Definition and description of roles in the German GO system (based on [47], [19]) Continued

Role	HKNR account	Definition	Functions and responsibilities	Rights
UBA	No	Germany's central federal scientific authority on environmental matters under the jurisdiction of the Federal Ministry for the Environment, Nature Conservation, Building, and Nuclear Safety	- Regulator - Operation of the HKNR (administration, prosecution of administrative offences) - Supervisory body (in addition to the Federal Network Agency for Electricity, Gas, Telecommunications, Post, and Railway, or Bundesnetzagentur, BNetzA) - The UBA issues GOs based on electricity measurement data from the grid operator. - The UBA maps ownership of a GO and trading activities in software but is not a trading platform. - The UBA transfers the GO within Germany at the request of the current owner. - The UBA can refuse a GO import if the GO does not comply with the requirements of Directive 2009/28/EG (RED I). - Transfer of GOs (and other processes with a significant impact on HKNR or actors) secured by smsTAN - Cancellation of GOs if not used after 12 months - Acceptability assessment of GOs from foreign countries prior to import; criteria are agreed on EECS countries (Article 15, paragraph 9 RL 2009/28/EG, sections 36 and 37 of the HkRNDV) (import possible from the EU, EEA, Energy Community, and Switzerland) - Import requires, among other things, compliance of the GO with the specifications of the EE-RL 2009/28/EG (RED I), which the UBA has to check.	- Export/import is possible via the international interface of the AIB to other registry offices.

Issuance, transfer, including import/export, and cancellation of GOs take place in the HKNR. Trade in GOs occurs outside the HKNR: users can neither buy GOs from the UBA nor sell to the UBA; traders, brokers, and the European Energy Exchange (EEX) in Leipzig (Germany) are available for this. Pricing takes place on the market or the EEX.

For the import and recognition of GOs, the issuing country must be connected to the Hub of the AIB. As a legal prerequisite, recognition can take place as long as there are no reasonable doubts about the correctness, reliability, or truthfulness of the proof of origin (Section 36, paragraph 1, sentence 2 of the HkRNDV, based on the European RED). A European working group agreed on common criteria for GO recognition, which was developed as a questionnaire. Using a questionnaire such as this can help provide the foundation for a coherent GO system to fulfil the requirements of electricity disclosure.

The concept of the so-called optional coupling is worth mentioning in the German context. It represents an opportunity for the utility to document that it purchased its GO, together with the electricity produced by the RE plant, and is regulated in section 16, Paragraph 3, of the HkRNDV.

- Concept: the coupling certifies that the GO is linked to the underlying amount of electricity and that the system operator delivered this, together with the electricity, to the utility.
- Objective of the coupling: fulfilment of the consumer expectation that a utility buys not only the GO when supplying green electricity, but also the associated renewable electricity from a plant.
- Check by environmental verifiers: the name, market partner ID, and balancing group of the electricity supplier and, if applicable, the percentage breakdown

Implementation:

- Transfer of the GO from a power plant to the account of an electricity supplier.
- Actual delivery of power from the power plant to the supplier:

- "Actual delivery" means "a balanced flow of electricity from the plant operator to the supplier" (section 16, paragraph 3 of the HkRNDV).
- A "balanced flow" of electricity is present if the electricity generated from the power plant at the meter point that "is the basis of the GO" (section 16, paragraph 3, clause 1 of the HkRNDV) is booked in the first balancing group of the supplier by means of a schedule registration.

- Coupling is not possible if the electricity is supplied to a second balancing group.
- Resale of the GO leads to the loss of the additional information "coupling".

Technical specifications and fees

Some technical specifications of the German GO registry HKNR can be found in Table 19.

Table 19: Technical specifications of the HKNR in Germany (based on [76])

Feature	Specification
Developer and operator	Atos Austria
Technology (database, spreadsheet, etc.)	Oracle database
Measures to ensure IT security	– Username and password – Passwords must be changed annually. – Captcha – mTAN procedure for important transactions – Post Ident procedure for secure identification of users – The website is encrypted using https. – Current IT-security concept – Penetration test
Measures to ensure validity of the GO content	– Only gauged meters may be used. – The grid operator reports necessary data of produced electricity. – Use of environmental auditors for checking generation facilities and, in some cases, the amount of produced electricity
Measures to ensure that only one GO is issued for each energy unit	The UBA is the only competent body to issue GOs in Germany. In order to issue GOs, the UBA uses only validated measures from the grid operator.
Measures to limit fraudulent behaviour	The UBA uses a technical registry which helps avoid fraudulent behaviour. Moreover, the UBA asks for the VAT identification number to prevent VAT carousels. If the UBA becomes aware of fraudulent behaviour, it may impose a fine (exclusion from the system, administrative fine) and hand over the case to the body of public prosecutors.
Outsourced parts of UBA operations	– Hosting of the IT system: Atos Austria – Reporting necessary data: grid operator – Validating data: environmental verifiers

The following screenshots show a visualisation of the Internet representation of the HKNR.

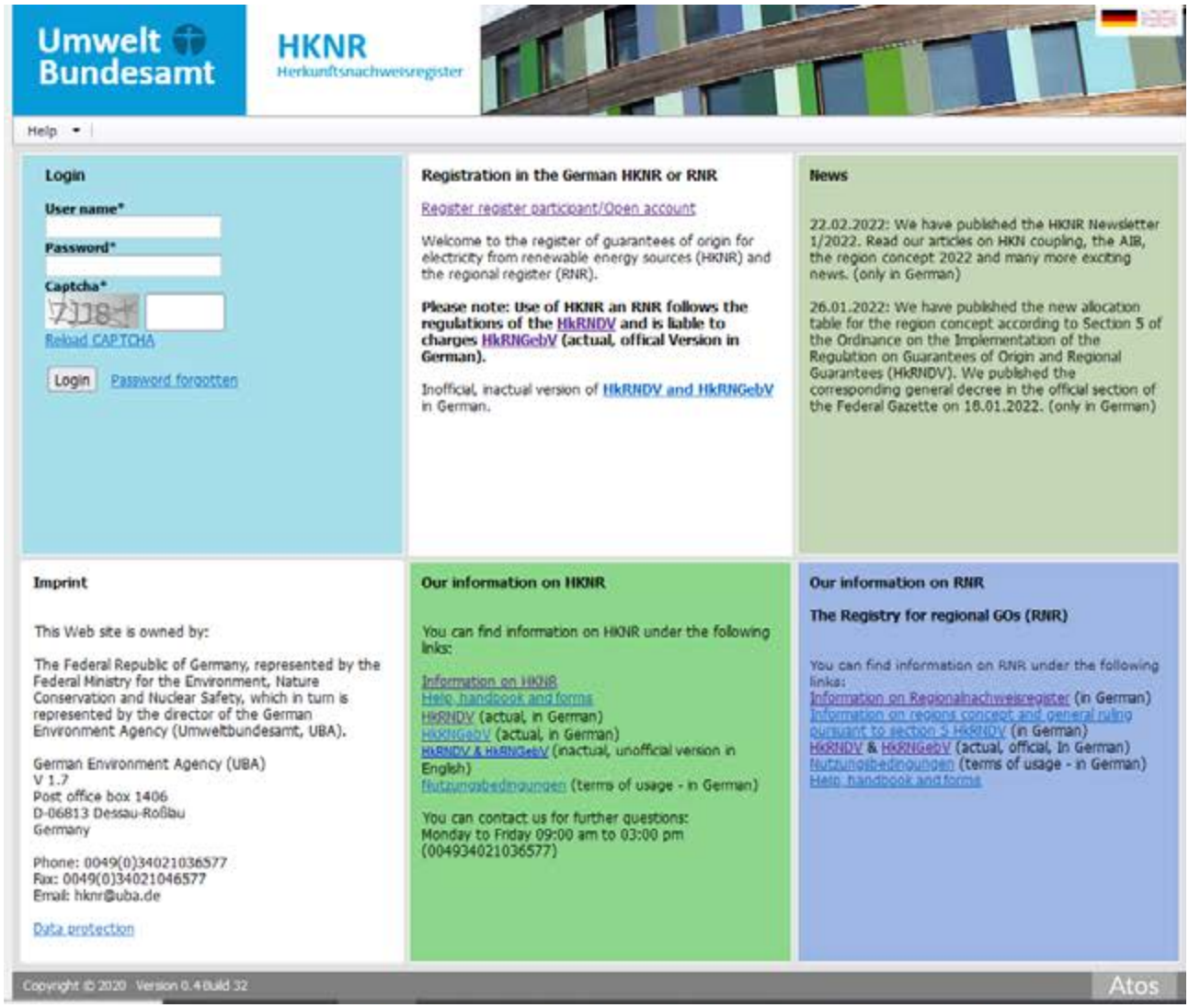


Figure 29: Front page of the HKNR

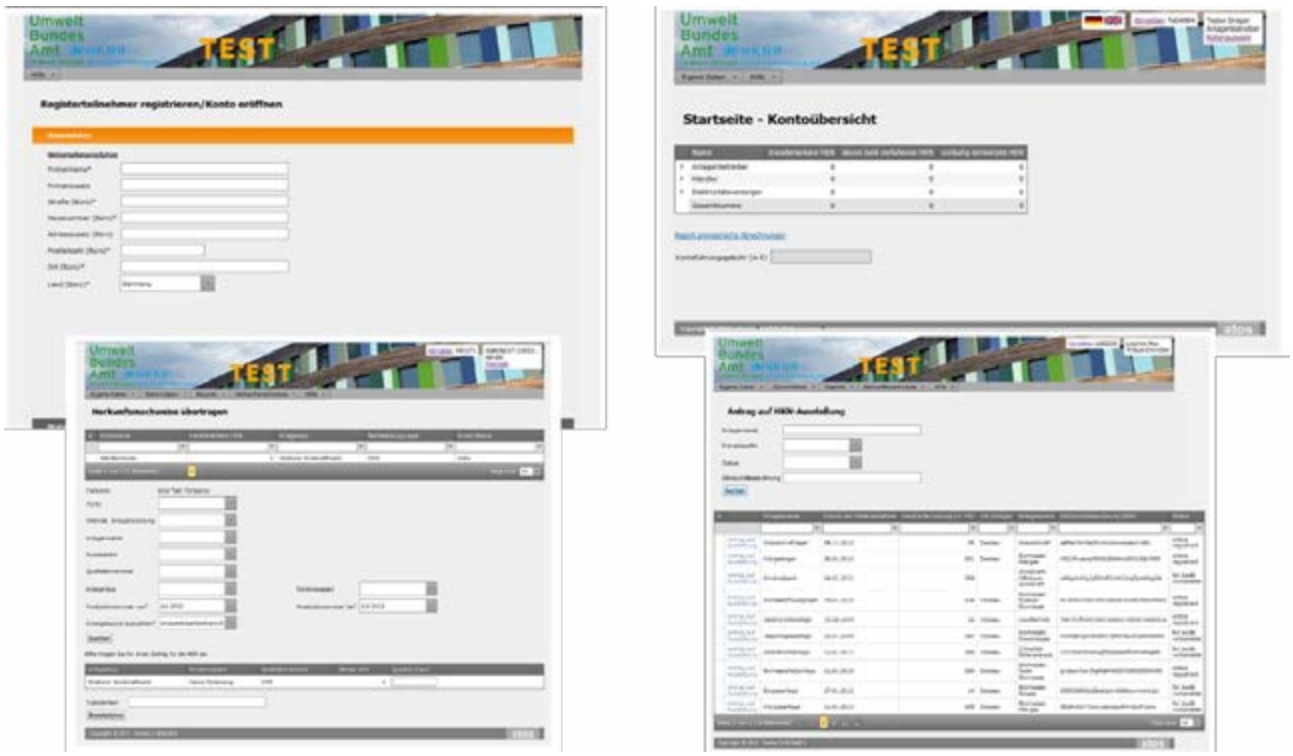


Figure 30: HKNR screenshots from top left: master data on the registry participant; personal cover page; international transfer of GOs; request for issuance of a GO [77]

The fees to be paid for using the HKNR are cited in Table 20.

Table 20: Fees for using the HKNR [78]

Charge	Level of charge per GO/transaction in EUR
Charges in connection with the issuance, transfer, recognition, and cancellation of GOs	
Issuance of a GO	0.0025
Transfer of a GO to another account within Germany	0.0010
Transfer of a GO to another account in a registry maintained by a foreign competent authority	0.0025
Transfer of a GO from an account in a registry maintained by a foreign competent authority to an account in Germany	0.0025
Cancellation of a GO for electricity labelling	0.0050
Charges that relate to facilities in the HKNR	
Registration of a facility in the HKNR	120
Allocation of the facility to a new account of the same account holder	40
Fees for using the HKNR by maintaining an account	
Annual fee for account holders per account with more than 500 000 fee-based transactions regarding GOs per year	750
Annual fee for account holders per account with 15 001 up to 500 000 fee-based transactions regarding GOs per year	500
Annual fee for account holders per account with 2 501 up to 15 000 fee-based transactions regarding GOs per year	250
Annual fee for account holders per account with fewer than 2 500 fee-based transactions regarding GOs per year	50

2.7.2 MyCertiQ in the Netherlands

Registry processes and roles

The Dutch GO registry is called MyCertiQ. Any legal person who is not an AIB member or such member's affiliate or agent can apply for a transferables account or an end-user account. Every producer and trader enters into a participation agreement with CertiQ. This contains the mutual rights and obligations regarding participation in the e-certificate system.

The process of GO issuance is automated; once CertiQ has received measurement data from the grid operator, it can be initiated. Where CertiQ is in receipt of all the required information, the issuing automatically takes place the following day. All measurement data is automatically verified by MyCertiQ against the registered capacities of the relevant production devices.

Issuance, transfer, and cancellation of GOs and newly introduced COs for non-renewable electricity are the same.

Many of the main operations in the registry happen in the trader's account. After GOs for renewables and COs for non-renewables have been digitally created, they are posted to a trader's account. The producer itself determines who its trader is. A trader can then start trading in GOs and COs. CertiQ offers a traders' platform for this. A trader can sell certificates on the Dutch and European market via the traders' platform, for example, not only to energy suppliers, but also to other traders. The prices for GOs and COs are mutually determined by the traders. After electricity has been consumed by an energy supplier or an end user, the trader cancels a certificate. As many certificates are cancelled and removed from the market as power is consumed.

A transferables account holder may request cancellation of EECS certificates held in its account by specifying the following in MyCertiQ:

- The type of beneficiary (either "energy supplier" or "end user") and its identity.
- The EECS certificates to be cancelled.
- The period during which the associated energy has been consumed.
- The effective date of cancellation.

The country where the electricity associated with the cancellation is consumed shall be the Netherlands.

Table 21: Definition and description of roles in the Dutch GO system (based on [48])

Role	Registry account	Definition	Functions and responsibilities	Rights
PP operators	No	The owner of a PD or a duly authorised representative on its behalf	- Registration of a PD - Re-registration of a PD in case of changed details - Informing CertiQ of the trader with which it does business	The power plant owner determines who its trader is.
Traders	Yes	For registration as a trader, one needs eRecognition, a global location number, and a filled-in Know-Your-Customer questionnaire.	Crediting of the certificates to the certificate account of the producer's designated trader - Selling of GOs on the Dutch and European market - Cancelling of GOs after consuming energy, debiting the used certificates the from trader's account and marking them as used	Only traders can sell and transfer certificates to other traders/suppliers/ end users.
Energy suppliers	Yes	An energy supplier is a company that purchases energy (including grey and green electricity) and sells it to commercial and private users. Every energy supplier in the Netherlands that wishes to supply green electricity must have a certificate account with CertiQ.	- Disclosure after cancellation of GOs and COs to prove the origin of any renewable and non-renewable electricity delivered to end consumers	
Grid operators	No	TenneT as TSO and DSOs	- Collection and validation of measured volumes of energy - Passing measurement data to CertiQ on a yearly or monthly basis - Production registrars: verification of the registration of PDs; on-site review, if necessary - Production auditors for all PDs, except biogas and biomass	
End users	Yes	Any legal person who is not an AIB member or such member's affiliate or agent using energy for own consumption	- Requesting a personal certificate account and receiving GOs there	- Request cancellation of GOs held in their account.
CertiQ	No	Full subsidiary of TenneT TSO	- Administration of the database - Interface with the AIB Communications Hub - Issuance, transfer, and redemption of GOs on expiry	
Authority for Consumers and Markets	No	Authority	- Supervision of the functioning of the GO system - Verification of GO cancellation - Supervision of disclosure	

Technical specifications and fees

CertiQ is constantly improving the certification IT system MyCertiQ in order to meet political, market, and consumer demands. The new trading platform ('handelsportaal') went live in 2021.

Table 22: Technical specifications of MyCertiQ in the Netherlands (based on [48])

Feature	Specification
Developer and operator	CertiQ
Technology (database, spreadsheet, etc.)	N/A
Measures to ensure IT security	- Registration, including a Know-Your-Customer questionnaire - DigiD (the system used by authorities in the Netherlands for authentication of natural persons by means of an e-identity); from 1 April 2022, it was replaced by iDin - eRecognition (a system for authentication of companies by means of an e-identity)
Measures to ensure validity of the GO content	- The grid operator reports necessary data of produced electricity - Verification of registration of PDs by grid operators
Measures to ensure that only one GO is issued for each energy unit	CertiQ is the only competent body to issue GOs in the Netherlands. In order to issue GOs, CertiQ uses only validated measures from TenneT and DSOs.
Measures to limit fraudulent behaviour	CertiQ uses an electronic registry, which helps avoid fraudulent behaviour. CertiQ checks Know-Your-Customer modalities among traders.
Outsourced parts of operations	- Reporting necessary data: grid operators - Validating data: environmental verifiers

Fees for using the Dutch GO registry are set by the Minister of Economic Affairs and Climate Policy and are updated annually. Only traders pay a membership fee. No fees are charged for end-user accounts.

Table 23: Fees (in EUR) for using MyCertiQ in 2022

Charge	Level of charge per GO/transaction in EUR	Costs for
Annual membership fee for traders	500	Trader
Creating GO for water, wind, and solar	0.004	Trader
Creating GO for biomass	0.028	Trader
Creating GO heat	0.028	Producer /trader
Creating COs	0.004	Trader
Cancellation	0.012	Trader
Transfer within the country	0.004	Receiving trader
Export	0.008	Exporting trader
Import	0.008	Receiving trader

To visualise the MyCertiQ database, screenshots of different certificate tracking activities are shown below

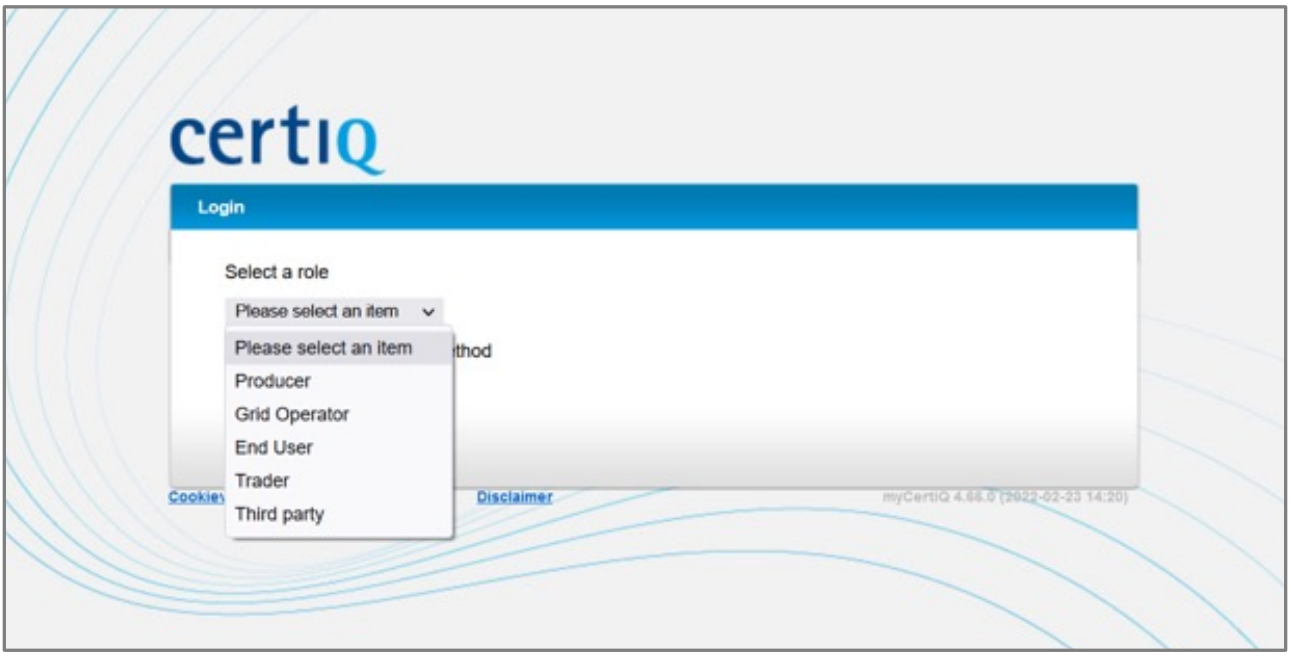


Figure 31: Front page of MyCertiQ

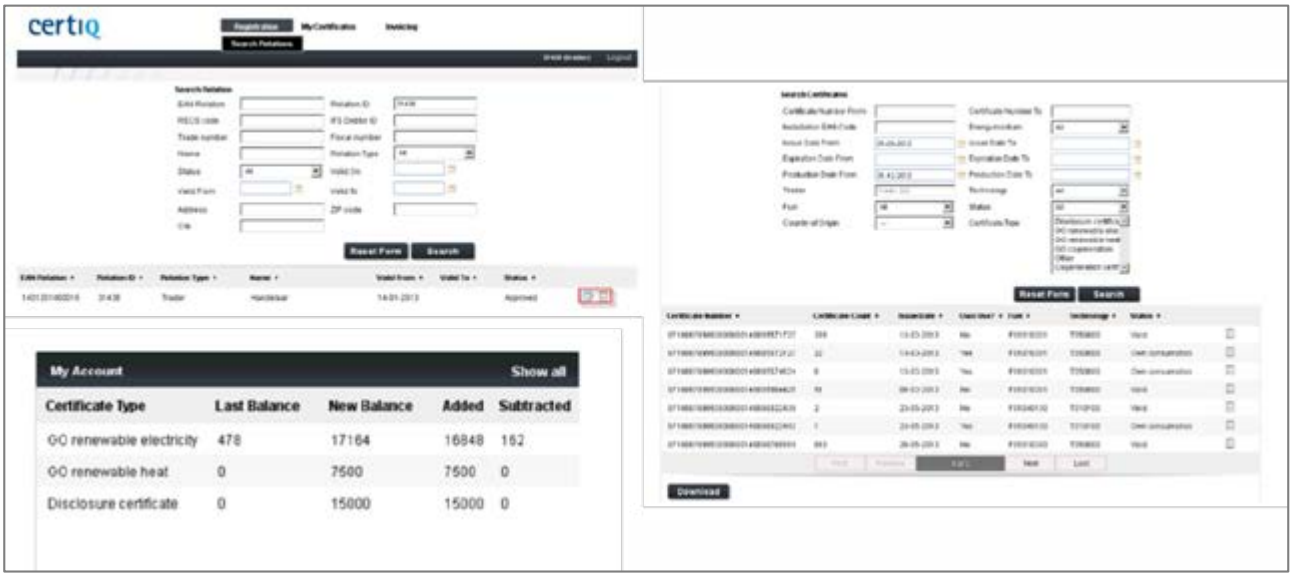


Figure 32: Screenshots of MyCertiQ database from top left: participant contact details; search of certificates with list of results; overview of transactions on a trader's account [79]

2.7.3 *WREGIS in the region of the Western Electricity Coordinating Council, USA*

According to the Rules Regulating Electric Utilities 4 CCR 723-3 adopted by the Public Utilities Commission [52], "All renewable energy resources located in the region covered by the Western Electricity Coordinating Council (WECC) that generate RECs used by an investor-owned utility (IOU) for compliance with the renewable energy standard shall be registered with the Western Renewable Energy Generation Information System (WREGIS) and shall record their RECs in WREGIS, after August 11, 2010, with the exception of retail renewable distributed generation facilities less than one MW". All investor-owned utilities should also register with WREGIS. Through the RESA, the utility shall recover the costs associated with WREGIS that are allocated to its retail customers.

To the extent that the IOU acquires RECs from RE resources that are not recorded in WREGIS, the utility shall record such RECs in a central database. The database shall include, but not be limited to, a list of the renewable distributed generation whose RECs the utility intends to use for compliance with the RE standard and the requirements for renewable distributed generation, including its type, location, owner, operator, and start of operation. The database shall also record the RECs generated and the ownership, transfer, and retirement of those RECs.

WREGIS is an independent RE generation tracking system for the Western Interconnection. From a geographic standpoint, WREGIS is the largest tracking system in the USA. WREGIS has been tracking renewable and environmental attributes of RE since 25 June 2007. Each WREGIS certificate corresponds to 1 MWh or an equivalent amount of thermal energy and is assigned a unique serial number.

WREGIS certificates can be used by electricity suppliers and other energy market participants to comply with relevant state and provincial policies and regulatory programmes and to support voluntary "green" electricity markets or as determined by state or provincial policy. The data collected by WREGIS includes meter information from qualified reporting entities (QREs) and static information regarding the generating unit that has been inputted by the account holder and verified by the WREGIS administrator. WREGIS was developed through a collaborative process between the Western Governors' Association, the Western Regional Air Partnership, and the California Energy Commission. The functional design of WREGIS was developed and guided by stakeholder input from more than 400 participants gathered over more than three years.

Renewable and environmental attributes in WREGIS terms are defined as: "Any and all credits, benefits, emissions reductions, offsets, and allowances – however titled – attributable to the generation from the Generating Unit, and its avoided emission of pollutants. Renewable and Environmental Attributes do not include (i) any energy, capacity, reliability, or other power attributes from the Generating Unit; (ii) production tax credits associated with the construction or operation of the Generating Unit and other financial incentives in the form of credits, reductions, or allowances associated with the Generating Unit that are applicable to a state, provincial, or federal income taxation obligation; (iii) fuel related subsidies or 'tipping fees' that may be paid to the seller to accept certain fuels, or local subsidies received by the generator for the destruction of particular pre existing pollutants or the promotion of local environmental benefits; or (iv) emission reduction credits encumbered or used by the Generating Unit for compliance with local, state, provincial, or federal operating and/or air quality permits."

WREGIS covers the same geographic territory as the Western Interconnection. WREGIS issues certificates only for registered generating units whose first point of interconnection is in the Western Interconnection or in a state bisected by the boundaries of the Western Interconnection. However, generating units located within WECC states of which the generation is reported to another generation tracking system cannot register in WREGIS.

The WREGIS administrator oversees all aspects of programme and application administration. The administrator manages the WREGIS budget, fee collection, billing, and technical infrastructure at WECC. The WREGIS administrator also verifies generating unit registration information and prepares and maintains standard operating procedures for the programme, including change and issue management, configuration management and verification, and acceptance testing processes.

When a WREGIS account holder account is opened and approved, the following three subaccount types are created:

1. Active
2. Retirement
3. Reserve

Multiple active, reserve, and retirement subaccounts can be established at the account holder's discretion, in numbers allowed by system functionality, to assist with certificate management. WREGIS certificates are deposited into the active subaccount listed on each generating unit (GU) registration at the time of certificate creation. Account holders can then transfer WREGIS certificates to their other subaccounts or to another account holder or export them to another tracking system.

The retirement reason options are designed to be consistent with state and provincial regulatory programmes and any voluntary programmes or voluntary market activities.

Account holders can use a retirement subaccount for WREGIS certificates sold outside the WREGIS system or for certificate disaggregation by the owner. For example, an account holder transferring active certificates to a third party who is neither a WREGIS account holder nor an account holder in a compatible tracking system can reserve the certificates within WREGIS to indicate that the transfer outside of the system has occurred.

Possible deposits, transfers, and withdrawals from and to different types of subaccounts in WREGIS are depicted in Figure 33. Features of different subaccount types are also described in Table 24.

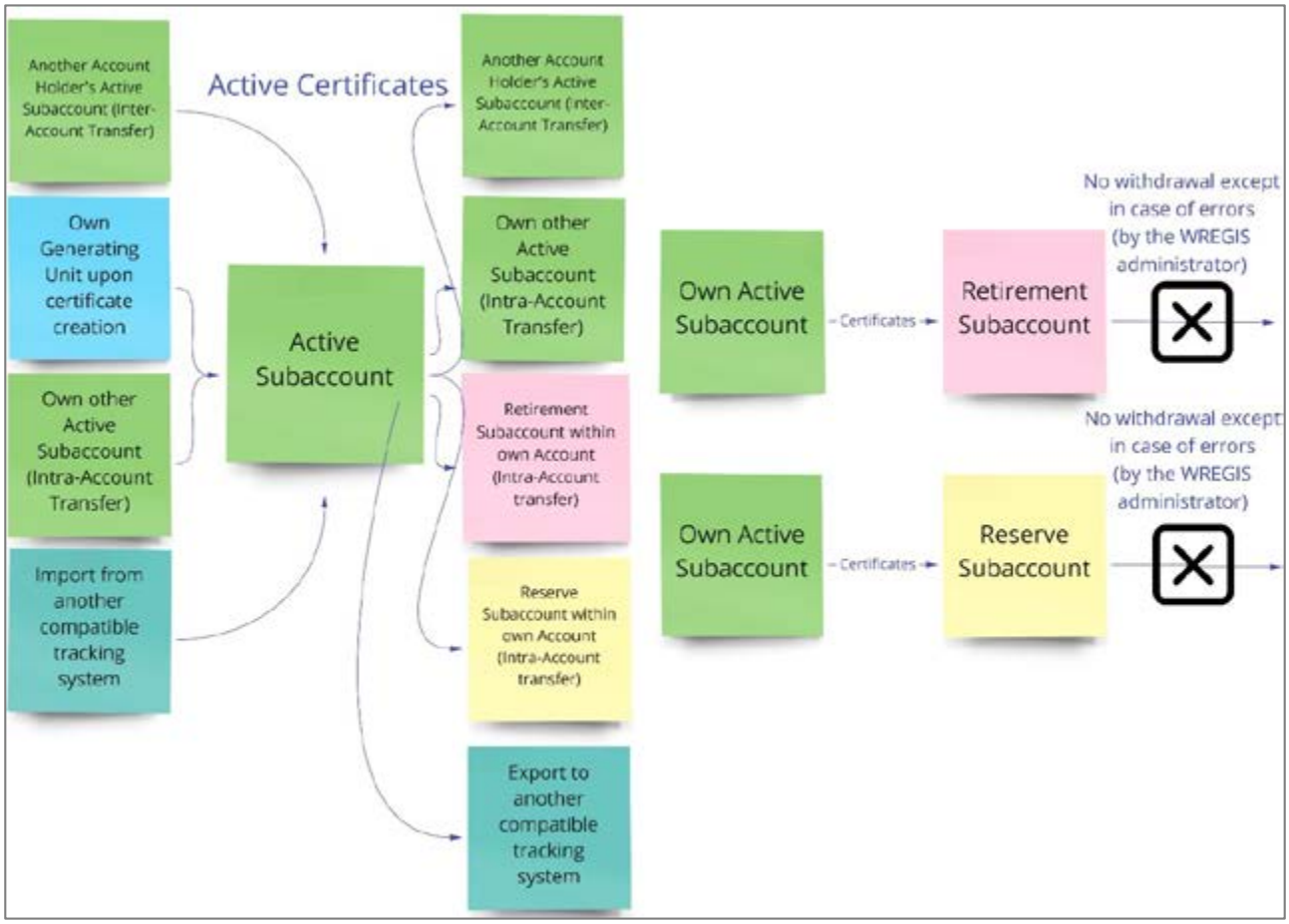


Figure 33: Deposits, transfers, and withdrawals of active, retirement, and reserve subaccounts in WREGIS (based on [80])

In Table 25, the main roles in WREGIS are presented. They include the GU owner or representative, programme administrator, qualified reporting entity, and WREGIS administrator. Further specified players who can be an account holder are the GU aggregator, community choice aggregator, small utility aggregator, IOU, municipal utility, rural electric co-operative, irrigation district, electricity service provider, joint power authority, retail marketer, broker, tribal organisation, customer-owned utility, public interest organisation, federal marketer/power administration, wholesale marketer, state programme director, provincial programme director, qualified independent party, balancing authority, other load-serving entity, or other legal entity.

Verification of generator eligibility for a state, provincial, or voluntary certification programme is the responsibility of the relevant state, provincial, or voluntary programme administrator. In accordance with the State, Provincial, and Voluntary Program Interface Control Document (ICD), each such agency may either upload a file of eligible GUs into WREGIS or manually verify the eligibility of each GU identified as eligible for its programme.

For GUs to participate in WREGIS, they must have their generation data submitted to WREGIS by a qualified reporting entity (QRE) at monthly or quarterly intervals, except for small, customer-sited distributed GUs that are allowed to self-report generation data. WREGIS does not define the lifetime or expiration date of certificates. States and provinces may do so outside of WREGIS to meet their own requirements. The certificate issuance cycle in WREGIS is presented in Figure 34. The cycle begins the first day after the end of the generation month. WREGIS creates certificates 90 days following the end of each generation month. Reported generation data should reflect a minimum of 30 days or one full month of generation and must be accurately represented by the start and end dates included in the upload. QREs and self-reporting generators have 75 days following the end of the generation period to report generation data.

Each GU registered in WREGIS has a generation activity log associated with it. The generation activity log is an electronic ledger where generation and related activities are posted. Each time generation data is received by WREGIS for a GU, the date and quantity of MWhs are recorded in the generation activity log. When adjustments are received, they are recorded similarly.

On the day of certificate creation, certificates are issued based on the total whole number of MWhs on the generation activity log that have been accepted by the account holder either actively or automatically after accounting for any prior-period adjustments. Any fractional MWh is rolled forward until sufficient generation has been accumulated for the creation of a WREGIS certificate.

The generation activity log includes, but is not limited to, the following entries:

1) Opening balance/prior month's balance brought forward, reflecting the kWh (fraction of a MWh) remaining after the prior month's certificate creation date
2) Reported generation (via QREs or self-reported) during the current month
3) Prior-period adjustments
4) Number of WREGIS certificates created

Besides the standard data on the GU and period of generation, WREGIS certificates include detailed information about the reporting entity, the utility, whether a GU receives public support, and whether it is eligible for labels such as Green-e (see section 2.3) and ECOLOGO.

The WREGIS administrator considers GUs of which the fuel source is H_2 as multi-fuel GUs for purposes of creating WREGIS certificates. WREGIS certificates for H_2 created from RES, stored, and later converted into electricity through a combustion or fuel cell technology may be created, reflecting the RES used to create the H_2.

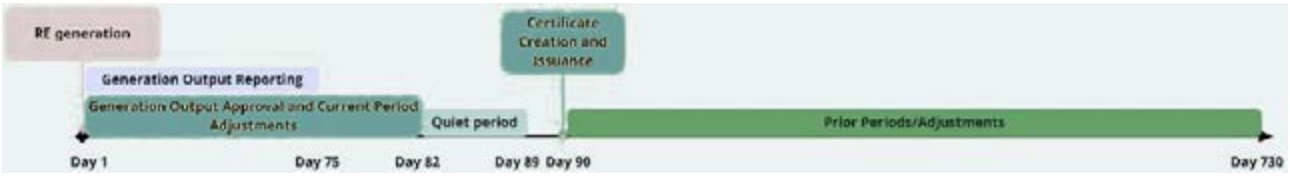


Figure 34: Certificate issuance cycle (based on [80])

When an account holder wishes to retire a certificate or batch of certificates, it selects a batch(es) of certificates from its active subaccount(s) and indicates that such certificates are to be retired. The account holder selects the retirement subaccount to which the certificates will be deposited and is required to select a retirement reason and associated details. For certain state, provincial, or voluntary programmes, an account holder may be required to show delivery of energy using e-Tags. This is accomplished by matching e-Tags and certificates before or during the retirement process. Account holders who need access to e-Tags will be required to sign up for additional functionality with the WREGIS administrator and pay all associated fees.

The import functions related to WREGIS certificates are unavailable, as WREGIS does not have import protocols set up with any other tracking system. Exports from WREGIS are currently limited to NC RETS (North Carolina) and NAR (the North American Renewables Registry) but may be expanded as demand and protocols dictate. WREGIS certificates may be exported by the WREGIS account holder from an active subaccount to another account holder in a compatible tracking system.

Table 24: Features of different WREGIS account types (based on [80])

Account type	Features	Deposits	Withdrawals/ transfers	Available functions
Active	- Holding place for all active WREGIS certificates - The WREGIS certificates in it can be transferred, exported, or otherwise transacted at the discretion of the account holder.	1) From another WREGIS account holder's active subaccount after a mutually agreed-on transfer with another account holder has been executed (inter-account transfer) 2) On certificate creation from an approved GU associated with the active subaccount in one's own account 3) To another active subaccount within one's own accoun (intra-account transfer) 4) Imported into WREGIS from another compatible tracking system	Transfers: 1) To another WREGIS account holder's active subaccount (inter-account transfer) 2) To another active subaccount within one's own account (intra-account transfer) 3) To a retirement subaccount within one's own account (intra-account transfer) 4) To a reserve subaccount within one's own account intra-account transfer) 5) Exported out of WREGIS to another compatible tracking system	- Deposit and withdraw WREGIS certificates - View and sort the account holder's certificates by certificate fields - Generate reports about the account - Create additional active subaccounts - Transfer active certificates between active subaccounts
Retirement	- Repository for WREGIS certificates that the account holder wants to designate as retired or used to show compliance with a state, provincial, or voluntary RE programme or to otherwise show that the certificates have been used and removed from circulation - WREGIS certificates in a retirement subaccount are no longer transferable to another party and serve as an electronic record of use. Certificates cannot be transferred back into an active or reserve subaccount or into any other retirement subaccount	- Through transfer by the account holder or the agent or representative from the account holder's active subaccount - Information entered during the retirement process cannot be altered after certificates have been deposited into a retirement subaccount. - The name of that subaccount cannot be changed once the certificates are there.	- Account holders cannot withdraw certificates from a retirement subaccount. - The WREGIS administrator has the ability, but not the obligation, to withdraw certificates from an account holder's retirement subaccount that were placed there in error. If such a withdrawal is to be granted, the WREGIS administrator will require documentation.	- View and sort WREGIS certificates by certificate fields - Generate reports about WREGIS certificates held in the account holder's retirement subaccount - On retirement, indicate for what purpose the WREGIS certificates were retired

Table 24: Features of different WREGIS account types (based on [80]) Continued

Account type	Features	Deposits	Withdrawals/ transfers	Available functions
Reserve	- Repository for WREGIS certificates the account holder wants to designate as reserved - Transferring a certificate to a reserve subaccount removes it from circulation in WREGIS without making usage claims. - WREGIS certificates in the reserve subaccount are no longer transferable to another party. WREGIS certificates in a reserve subaccount cannot be transferred back into an active or retirement subaccount or into any other reserve subaccount. - The reserve subaccount is to be used for certificate disaggregation or in instances where the renewable energy certificates may be used outside of WREGIS. From a WREGIS standpoint, these certificates will no longer be tracked, and WREGIS will make no claims as to the certificate status.	- Through transfer by the account holder or the agent or representative from the account holder's active subaccount - Information entered during the certificate reserve process cannot be altered after certificates have been deposited into a reserve subaccount. - The name of that subaccount cannot be changed once the certificates are there.	- Account holders cannot withdraw certificates from a reserve subaccount. - The WREGIS administrator has the ability, but not the obligation, to withdraw certificates from an account holder's reserve subaccount that were placed there in error. If such a withdrawal is to be granted, the WREGIS administrator will require documentation.	- View and sort WREGIS certificates by certificate fields - Generate reports about WREGIS certificates held in the account holder's reserve subaccount - Voluntarily indicate for what purpose the WREGIS certificates were reserved

The fees for using WREGIS depend on the size of the GU. GUs with a capacity under 10 MW do not have to pay for any transactions with certificates. No annual fees are charged to the following: (1) non-transacting state, provincial, or federal regulators; (2) qualified reporting entities whose sole purpose is to report generation output on behalf of a GU that is not owned by the reporting entity (for example, the California Independent System Operator Corporation); and (3) voluntary programme directors, such as Green-e, Low-Impact Hydro, or ECOLOGO.

Table 25: Definition and description of roles in WREGIS

Role	Registry account	Definition	Functions	Responsibilities	Rights
Generator owner/ Generator agent	Yes	The entity that owns the GU (s). - An entity designated by a generator owner, via a notice of agent designation or other legal assignment, to act on the generator owner's behalf for interaction with WREGIS. - A generator agent may represent more than one GU.	- Applying for registration of generation unit(s): filling out the forms and paying fees - Generating electricity - Transferring certificates to other account holders' active subaccounts	- Ensuring that WREGIS contains accurate information regarding each GU and that eligibility indicators are verified by the appropriate programme administrator - Reporting to WREGIS within 30 days if there is a change in any of the essential characteristics for any of the aggregated GUs - Updating its GU registration data within 30 days after the annual review date	- Conducting forward certificate transfers: requesting that certificates from a specific GU be directly deposited into another WREGIS account or into another internal subaccount when the certificates are created
Programme administrator	Yes	A state or provincial regulator or voluntary certification administrator who administers a RE programme that registers for use of WREGIS's services.	- Determining whether a GU qualifies for its programme - Verifying and formally approving qualification claims - Facilitating updates to programme eligibilities for GUs	- Providing the information on qualification of a GU to WREGIS if the information needs to appear on WREGIS certificates - Establishing a formal relationship with WREGIS under the ICD[44]	
Qualified reporting entity (QRE)	Yes	An organisation providing renewable generation data to WREGIS for registered GUs - QREs meet the guidelines established in the QRE ICD. - QREs may include balancing authorities, the interconnecting utility, scheduling co-ordinator, independent third party meter reader, or other appropriate party, as long as the QRE has a signed agreement with the WREGIS administrator and is meeting and following the established guidelines.	- Undergoing the registration procedure, including providing information regarding the entity's ability and qualifications to act as a reporting entity to establish an account - Following the QRE-ICD for format and procedures to report generation data in WREGIS	- No interaction between the QRE and the account holder, except regarding reporting logistics in WREGIS or, more broadly, REC or RE marketing-related activities not related to WREGIS data	

Table 25: Definition and description of roles in WREGIS Continued

Role	Registry account	Definition	Functions	Responsibilities	Rights
WREGIS administrator	No	The entity contained within the WECC with the authority to oversee the administration and implementation of the WREGIS Operating Rules.	- Managing the WREGIS budget, fee collection, and billing; the technical infrastructure of the program at the WECC - Verifying GU registration information - Preparing and maintaining standard operating procedures for the programme, including change and issue management, configuration management and verification, and acceptance testing processes - Overseeing registration and information management for account holders, qualified reporting entities, programme administrators, and GUs - Performing generation data validity checking - Helping with generation data uploads - Acting as the first line of technical support help	- Keeping the WREGIS tracking system running and in good order	- Access to all accounts through system operation functions - Changing or retiring any active certificates for mistakes, fraud, or other reasonable cause consistent with these rules, the Terms of Use, and/ or the purposes of the WREGIS programme

The fees for using WREGIS depend on the size of the GU. GUs with a capacity under 10 MW do not have to pay for any transactions with certificates. No annual fees are charged to the following: (1) non-transacting state, provincial, or federal regulators; (2) qualified reporting entities whose sole purpose is to report generation output on behalf of a GU that is not owned by the reporting entity (for example, the California Independent System Operator Corporation); and (3) voluntary programme directors, such as Green-e, Low-Impact Hydro, or ECOLOGO.

Table 26: Fees for using WREGIS in 2022 [81]

Account holder types	Total GU size per WREGIS account	Annual per year, USD	Issue/Transfer/ Retire/Reserve/Export
GU production size < 10 MW			
GU micro: GU owner/ representative only	< 30 kW	50	No certificate fees
GU small: GU owner/ representative only	30 kW to 1 MW	75	
GU medium: GU owner/ representative only	1 MW to 10 MW	100	
GU large: GU owner/ representative only **Load-serving entities: municipal utility, irrigation district, joint power authority, investor owned utility, rural electric co-operative, electric service** **Retail marketers: federal marketer/power administrator** **Wholesale marketers: federal marketer/ power administrator** **Utility aggregators** **Generator aggregators: community choice aggregator account holder; other: broker, public interest organisation, tribal organisation**	> 10 MW	125	0.004/certificate
Reports and other service fees			
Report/Service type		Monthly, USD	Per item, USD
Authorised report			25 (email), 50 (hard copy)
WREGIS deliverability (e-Tag) user		212	
Change control			Variable
Fuel and/or aggregated meter modifications (per generator and vintage)			75
Failure to complete GU annual review (per generator)			50

2.7.4 PJM-EIS GATS in Delaware (and other Eastern states), USA

RECs and SRECs in Delaware are created by the PJM-EIS GATS (Environmental Information Services Generation Attribute Tracking System). Eligible energy resources are subject to applicable PJM-EIS GATS rules and pay applicable PJM-EIS GATS fees. The GATS is a software application programme that (a) creates certificates to uniquely define generation attributes, and (b) tracks said certificates. The PJM control area includes the states of New Jersey, Maryland, Washington DC, Pennsylvania, Delaware, Illinois, Ohio, and Virginia. The PJM GATS can issue certificates for all types of energy sources (the difference compared to WREGIS). Data in RECs issued by GATS includes:

- generator location;
- emissions output;
- the fuel source of the generator; and
- the vintage or date the generator went online

Buyers of RECs are utilities, brokers, aggregators, environmental firms, and enterprises looking to reduce their carbon footprint.

Benefits of GATS to state agencies include:

- an effective tool for implementing policies and regulations;
- access to centralised on-demand REC reports;
- fuel mix and emissions disclosure information;
- up-to-date information direct from the GATS database;
- a system to help monitor, verify, and document compliance; and
- data supplied by two major grids – PJM Interconnection and the Midcontinent Independent System Operator (MISO).

Certificates issued by the GATS can be used for the following:

- Information disclosure by electricity suppliers to retail customers. Information disclosure requires a supplier to periodically (quarterly, biannually, or annually) inform its customers of the fuel source, emissions, and other characteristics of the electricity resources supplied to the customer.
- The Clean Energy Portfolio Standard (CEPS), also known as RPS, obligations of electricity suppliers. A CEPS requires an electricity supplier to include a minimum percentage of renewable or environmentally preferable resources in its mix of electricity resources supplied to retail customers.
- Emissions/Generation Performance Standard (EPS or GPS) obligations of electricity suppliers. An EPS or GPS requires a supplier not to exceed a maximum threshold of specific pollutants in its mix of electricity resources supplied to customers.
- Voluntary green power markets. State policies generally require suppliers to provide documentation that supports and substantiates claims that suppliers may make when selling renewable electricity to customers through voluntary green power markets.

The functional design of the GATS has been developed through considerable deliberation of a stakeholder group that included representatives from various state agencies (state public utility commissions, state environmental protection offices, state energy offices, and consumer advocates), market participants, environmental advocates, and PJM staff. The design of the GATS is an "unbundled" certificates-based tracking system. This means that the attributes or characteristics of the generation are separated from the MWh of energy and recorded on a certificate after the MWh of energy has been produced. There is one certificate, with a unique serial number, representing the attributes of the generation for each MWh produced. The value of the certificate is that it can be traded separately from the actual MWh of energy in a voluntary bilateral market.

The GATS is designed to be policy neutral, and it supports a variety of state policies and voluntary green markets.

The GATS is designed to:

- ensure accurate accounting and reporting of attributes;
- facilitate bilateral transactions of the attributes via certificates between market participants;
- support the current requirements of various state agencies and have the flexibility to accommodate varied and evolving state policies or programmes;
- mitigate seams issues with adjoining markets to allow the potential of trading certificates across regions; and
- promote a robust renewable market.

The following subaccounts (Figure 35) exist in the GATS:

- Active subaccount (the holding place for all active certificates);
- Clean Energy Portfolio Standard (CEPS) subaccount (the holding place for unsold, unused, CEPS-eligible certificates; CEPS eligibility and certificate lifespan are determined by states; the CEPS subaccount enables certificates eligible for state CEPS/RPS requirements to continue to be active (that is, banked) beyond the trading period);
- Retail load-serving entity (LSE) subaccount (designates certificates to be used for disclosure label purposes by the retail LSE; each retail LSE must obtain certificates equal to all its retail LSE certificate obligations);
- Reserve subaccount (repository for certificates that the account holder wants to withdraw from circulation within the GATS that are reserved by the account holder, exported from the GATS, or retired).

Certificates are created monthly on the last business day of the month following the month of generation. The GATS creates certificates each month with the revenue meter data that has been provided via the PJM Market Settlement System, entered by the account holder, or provided by the Generation Reporting System. The GATS does not define the lifetime or expiration date of certificates. States may do so outside of the GATS to meet their own requirements.

Certificates are originally deposited in either the active or CEPS subaccount based on the source of generation. Possible movements of certificates from and to different types of subaccounts are presented in Figure 36.

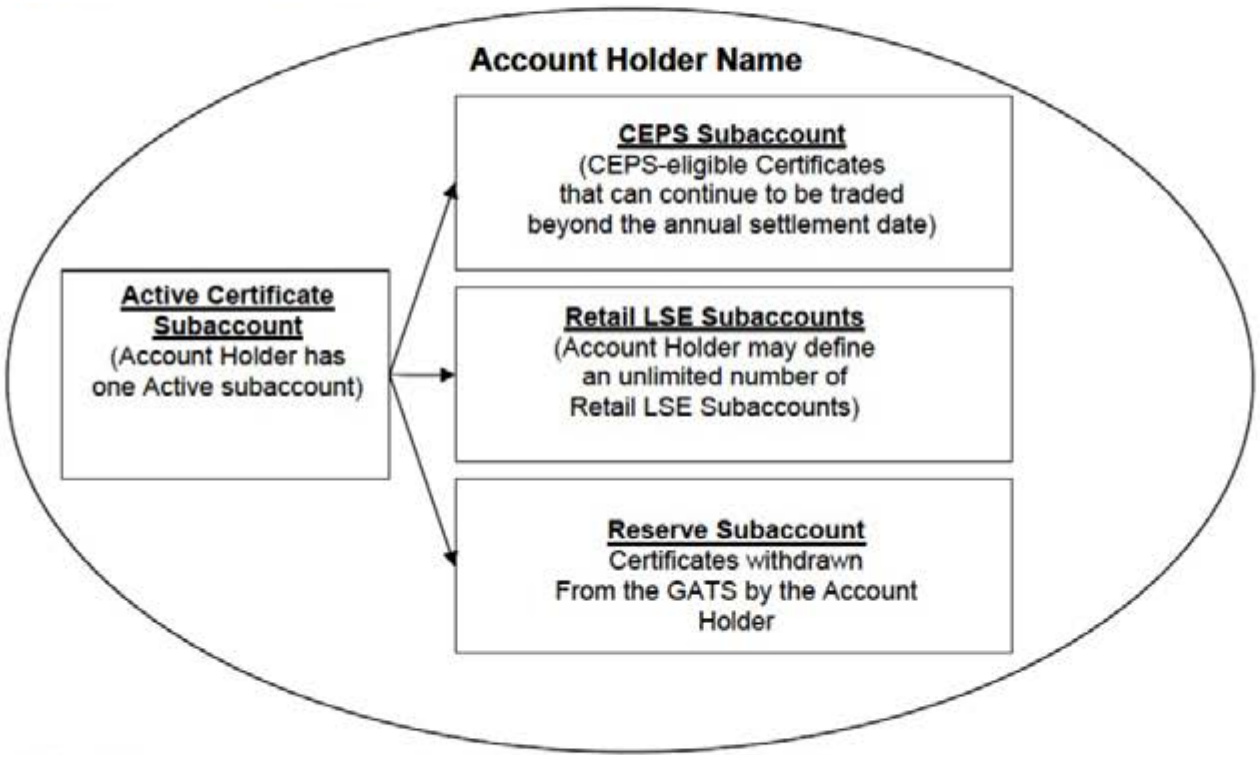


Figure 35: Basic account structure in the PJM GATS ([82])

The GATS includes a posting system or Bulletin Board where account holders can voluntarily post certificates for purchase and where the attributes of posted certificates can be viewed. Interested account holders can contact the seller directly. The bulletin board also allows for potential buyers to post purchase requests to allow for sellers to reach out to the buyers.

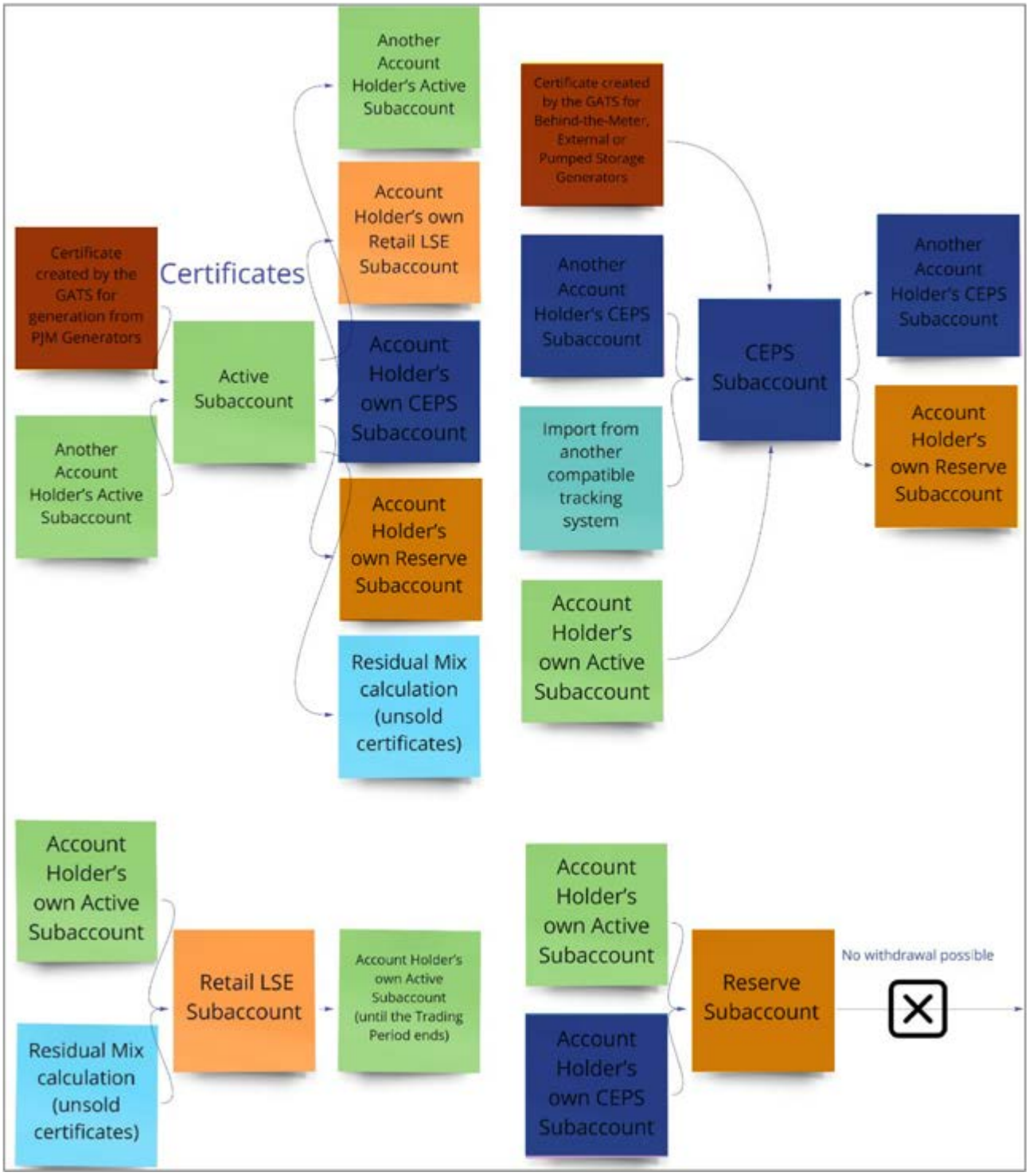


Figure 36: Deposits, transfers, and withdrawals from active, CEPS, retail LSE, and reserve subaccounts in the PJM GATS (based on [82])

The unused certificates after the trading period, which have not been transferred to CEPS, the retail LSE, or the reserve subaccount, become part of the residual mix. The GATS assigns residual mix certificates to each MWh of certificate obligations of retail LSE in corresponding subaccounts that do not have a certificate already associated with it.

The disclosure label of the LSE is based on the certificates in its retail LSE subaccounts. Certificates in the active, CEPS, and reserve subaccounts are excluded from the disclosure label.

Table 27: Definition and description of roles in the PJM-EIS GATS (based on [82])

Role	Registry account	Definition	Functions	Responsibilities	Rights
Generator owner	Yes	The person or entity holding legal title to a particular GU	- Delivering static data on GUs as part of the initial registration and subsequent updates - Confirmation of an assignment of registration rights to a broker, if it exists - Verification of generation data on a monthly basis	- Registry with the GATS and accepting the Terms of Use - Requesting pre-certification of GUs as eligible for state programmes - Entering a state certification number registering with the GATS when the generator is registered with a state programme - Notifying about changes in static data of GUs in due time	- A generator may assign the rights to register a GU in the GATS directly to an account holder other than the generator. The generation owner within the GATS can select the designated third-party reporter (TPR) of its preference. - Providing suggestions as to implementation of the GATS and its administration through a GATS subscriber group
Generator broker	Yes	An account holder designated by a generator owner or offtaker who registers and represents specific GUs with the GATS. A generator broker may also be called an aggregator if it represents more than one distinct GU.	Assignment of registration rights of the generator gives the assigned generator broker full account management and authority within the GATS over the certificates from the GU: authority to manage certificates and approve transfers, imports, retirement, or any other action taken with regard to certificates deposited into, or transferred out of, the generator broker's accounts for its registered generators.	- Registering with the GATS and accepting the Terms of Use - Confirmation of an assignment of registration rights - Notifying the GATS which party(ies) can initiate a change of registration rights assignment	- A generator broker may be the account holder for more than one GU. - Providing suggestions as to implementation of the GATS and its administration through a GATS subscriber group
Trader	Yes	- An account holder that participates in the buying, selling, and trading of certificates	- Buying, selling, and trading of certificates	- Registering with the GATS and accepting the Terms of Use	- Providing suggestions as to implementation of the GATS and its administration through a GATS subscriber group
Third-party reporter (TPR)	Yes	An entity that gathers metered data for generators and reports those readings to the GATS	- Submitting metered generation on behalf of generators registered within the GATS	- Registering with the GATS and accepting the Terms of Use - A TPR cannot hold certificates.	- In their TPR account, TPRs can see which generators have elected them to report metered generation data and view the generation after it has been loaded. - TPRs are able to update generation data multiple times on unprocessed generation data. - They can also provide suggestions as to implementation of the GATS and its administration through a GATS subscriber group.

Table 27: Definition and description of roles in the PJM-EIS GATS (based on [82]) Continued

Role	Registry account	Definition	Functions	Responsibilities	Rights
Retail load-serving entity (LSE)	Yes	Any entity (or the duly designated agent of such an entity), including a load aggregator or power marketer serving end-users, that has been granted the authority or has an obligation pursuant to state or local law, regulation, or franchise to sell electric energy to end-users	- Accumulating certificates - Retiring certificates to comply with state requirements	- Registering with the GATS and accepting the Terms of Use - Specifying the PJM state(s) for which the retail LSE will use the GATS. The states selected are considered billable states.	- Viewing data for billable states - Only being able to create retail LSE subaccounts for billable states
State agency	No	Authorities whose policies are being effectuated through the system	- Providing the GATS administrator with a list of generators eligible for programmes under its jurisdiction	- Verification of generator eligibility for state or private certification programmes - Pre-certification of GUs as eligible for state programmes	- Access to quarterly and annual reports generated by the GATS administrator - Providing feedback and suggestions on implementation of the GATS and its administration through a State Agency Advisory Committee
GATS administrator	No	The entity with the authority to administer or oversee the administration and implementation of the GATS Operating Rules	The primary interface for all account holders, the administrator reviews and manages all customer activity. - Managing the operation of the GATS database in accordance with the publicised operational timeline - Supporting the account holders in the GATS registration process and supporting the account holders in their monthly attribute entry required before certificates can be created, in researching any discrepancy with the data, and in providing the required data for claiming import and export unit contracts - Approving protocol agreements for the import/ export of certificates to compatible certificate tracking systems - Creating the certificates and obligations on a monthly basis at the specified time defined by the GATS Operating Rules - Opening the trading period at the specified time - Supporting the account holders in certificate and obligation transfers and subaccount management - Closing the trading period at the specified time - Publishing in due time all GATS reports once the trading period is closed - Supporting the regulators in obtaining their login IDs, accessing the GATS, viewing regulator reports, and accessing and changing the GATS generator RPS programme eligibility - Holding the administrator's account (the account that holds certificates that are not associated with a specific account holder, that is, certificates for emergency energy imports) - Maintaining databases and records in connection with the GATS and ensuring that the GATS database is backed up daily - Preparing and utilising a GATS disaster recovery process	The GATS administrator is responsible for the day-to-day operations of the GATS, acting as the primary contact for GATS support, assisting account holders, and technical operations. The GATS administrator also ensures that security and confidentiality are maintained.	- The GATS reserves the right to withhold issuing certificates or to withhold participation in the GATS for GUs that have wilfully misrepresented static data. - GATS reserves the right to deactivate generating systems that have not had generation reported for two years or longer. - The GATS administrator has the right, but not the duty, to change, retire, or delete certificates once they have been created if the GU, or its associated account holder, has submitted inaccurate data that resulted in the faulty creation of a certificate for the GU.

Table 28: Technical specifications of the PJM-EIS GATS (based on [82])

Feature	Specification
Developer and operator	PJM GATS
Technology (database, spreadsheet, etc.)	Database
Measures to ensure IT security	- Username and password - The company account manager is the only user that can create additional logins for the GATS account. The company account manager can also edit permissions on the logins for the GATS account. Besides the GATS administrator, no other party has access to an individual account holder's information, other than the account holder himself/herself. - Entering data through a secured web portal interface with password protection
Measures to ensure validity of the REC content	– Validation rule check on all registration or modified existing account entries for completeness. The registration or update process will not be completed until all data entered, both mandatory and voluntary, has successfully passed data entry validation checks and met the GATS verification criteria. - Generation Reporting System validation checks - Only revenue-quality meters may be used; otherwise, recognition of such generation for creation of certificates will only be at the direction of GATS regulators. – Data of produced electricity come from the PJM Market Settlements System
Creating COs	To ensure that double counting does not occur, GUs participating in the GATS must have 100% of their output tracked in the GATS. Once an account holder indicates the reason for certificate retirement, this cannot be changed later. This is to prevent someone using the same retired certificate for multiple purposes.
Cancellation	As part of the registration process, the account holder must sign and submit an affidavit declaration to the GATS administrator that the information being provided is true and correct. - The GATS reserves the right to deactivate accounts due to inactivity for a period of 12 months or longer. - The GATS reserves the right to deactivate generating systems that have not had generation reported for two years or longer.
Outsourced parts of operations	- Geocoding services: Geocodio

The following fees are applied to account holders in the GATS. Generators with less than 10 MW generating capability, non-renewable generators, and non-transacting state regulators do not pay subscription fees. An interesting detail is that the certificate fee is dependent on the reason for certificate retirement: this is a unique feature in the tracking systems that have been considered.

Table 29: Fees for using the PJM GATS in 2022 ([83])

Fee type	Periodicity	Account holder types	Level of charge, USD
Subscription fee	Annual	Load-serving entities	1 500
		Non-LSEs, generator brokers, large traders, and renewable generators	1 000
		Small traders (< 5 000 annual traders)	500
Volumetric fee	Monthly	LSE serving more than 100 000 MWh of load annually	Delaware: 0.004/MWh
Certificate fees			
Code	**Retirement reason**		**Level of charge, USD**
RPS	Used by the account holder for compliance with a state renewable portfolio standard (RPS)		0.05
ENV	Used by the account holder to make environmental claims or to take out of circulation for environmental benefits reasons		0.05
ZES	Used by the account holder for compliance with a state zero emission standard		0.015
SOLD	Sold as part of a retail certificate-only product to an end-use customer that does not have a GATS account (that is, voluntary market)		0.01
EXPT	Exported off-system to a third party in a region that does not have a compatible tracking system (for example, New York)		0.05
CTS	Exported to a compatible tracking system		0.05
EXP	Expired RECs removed from circulation (for example, older RECs with no value)		No fee
OTH	Other		0.05

2.7.5 I-REC

The certificate registry is an electronic database where all information related to the I-REC system is registered and stored for the lifetime of the system. The registry is a single database. The registry provides individual accounts to each market player in a simple manner. As a minimum, the registry supports the roles of registrant, issuer, participant, administrator, and public users. Participants can manage their active and previously redeemed certificates from all I-REC Standard countries. Public information is available as well. Public users can view public reports required by the product code; however, contracting I-REC partners (such as national governments) can create customised reports on various elements of I-REC issuance, redemption, and/or use. I-REC has clearly defined roles (Figure 37, Table 30).

Participants can open two types of I-REC accounts (Figure 38): a trade account allows the I-REC certificates to be transferred to another market player or end consumer/client, and a redemption account allows the participant to redeem the attributes contained within the certificate and to designate when and for what purpose certificates have been redeemed. Certificates in redemption accounts cannot again be traded or moved to a different account. It is possible for any end user, market player, or generator to open a trade account and redemption account, effectively becoming an I-REC participant. It is possible for a single participant to have multiple redemption accounts in the I-REC registry. As such, market players and end users are welcome to create any number of redemption accounts, each with different authorised users as needed. It is likely that smaller end users of I-RECs will contract for a single redemption account with an existing participant/market player. Larger consumers of I-RECs may opt for opening a trade account and redemption account in the I-REC registry, becoming an I-REC participant and, under a RE requirement, electricity suppliers may be required to register as participants to demonstrate compliance with the requirement. Additionally, a marketplace account can be operated by a platform operator and can receive and send I-RECs from or to another account. A self-consumption redemption account can be operated by a registrant, issuer (on behalf of a registrant), or platform operator and is capable only of receiving I-RECs from another account. An issue account is operated by an issuer and is capable only of sending I-RECs to another account. An issue account is the point of origin of all product certificates.

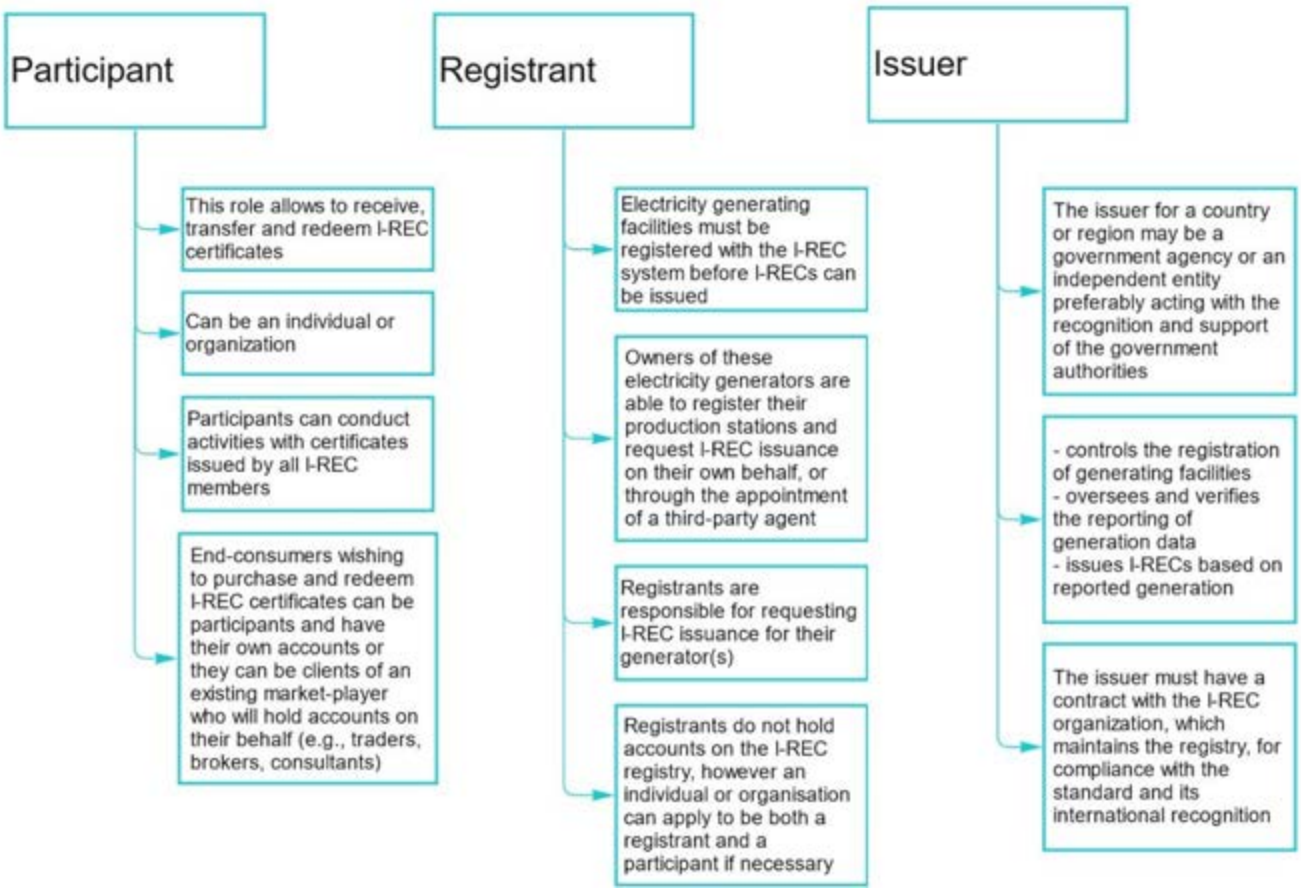


Figure 37: Main roles in the I-REC Standard [5]

Market players, generators, or end users interested in opening an I-REC trade account pay a yearly fee and one-time registration fee. Smaller I-REC end users may prefer to contract with a market player for a redemption account under its name.

The I-REC registry is provided by an independent service provider working on behalf of the I-REC Standard organisation. The registry provides access to the I-REC standardised certificate database for all registered market players, end users, generators, issuers, national governments, and informed stakeholders. In addition, the registry provides public reports on non-confidential information. The registry is a flexible mechanism for both the voluntary and potential compliance uses of the I-REC certificate. Audits of the registry to ensure adherence to the I-REC Code are completed at the request of the I-REC Standard organisation.

It is the responsibility of the purchaser of an I-REC to ensure the validity of the I-REC under national legislation or for the intended purpose or reporting requirements.

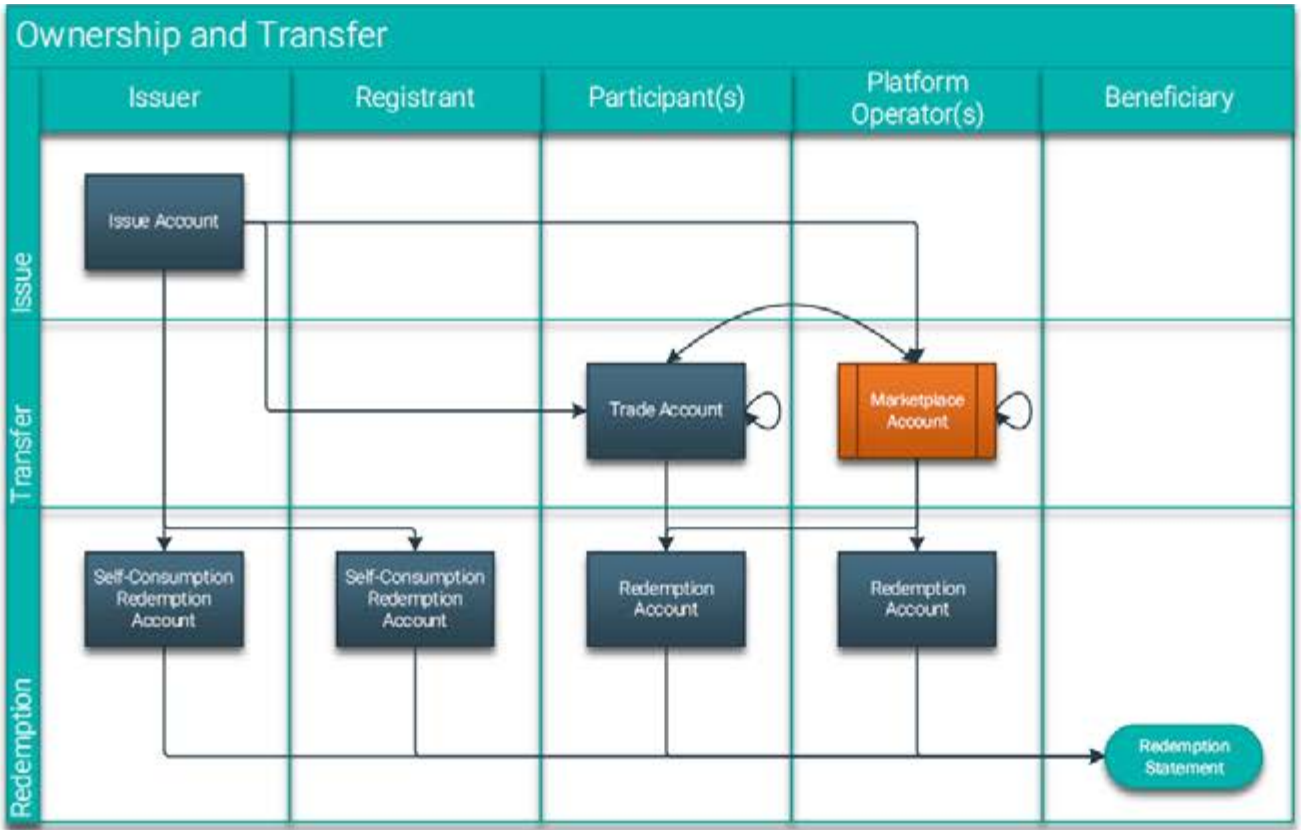


Figure 38: Ownership and transfer overview in the I-REC system [55]

Table 30: Definition and description of roles in the I-REC Standard (based on [55])

Role	Registry account	Definition	Functions and responsibilities	Rights
Code manager	No	An entity that is responsible for defining a product (an energy carrier, for example, electricity) and co-ordinating service operators within the scope of that product. The nature of that product and the services provided are defined in a product code that is owned by the relevant code manager.	The code manager is responsible for delivering and ensuring the quality of the service, implementing the principles and rules of the standard in specific services for associated markets, including: - development of a product code; - appointment or commercial organisation of all necessary accredited entities and accredited infrastructure; - organisation of issuers; - maintenance of procedures and governance arrangements; and - overall compliance with the standard. The code manager may not be a participant, registrant, or production facility owner. The code manager may be any form of legal organisation entity, including a government authority, NGO, or commercial enterprise.	
Registry operator	No	An entity responsible for providing and operating a registry that records the issuance, transfer, and use of a product certificate as an immutable source of information.	Delivering and ensuring the quality of the registry. The registry operator may not be a registrant or production facility owner. A registry operator shall own all relevant infrastructure to perform its functions.	The registry operator always has the right to either refuse to enter into or terminate with immediate effect agreements with entities that have not satisfied their reasonable requirements for compliance with international best practice in commercial agreements and anti-money-laundering regulations. The registry operator can also be a platform operator within the same product code if permitted by the relevant product code and accredited by the Board.
Issuer	No	An accredited entity that may be accredited for multiple geographical areas and products. The issuer always works under the guidance of a code manager and adheres to the rules of the relevant accredited product code.	- Receiving accreditation for each product it wishes to support and for each country or geographical area where it intends to provide services (act of acknowledging that an entity is compliant with the I-REC Standard) - Ensuring compliance with a product code - Processing production facility registrations - Issuing I-RECs	The issuer at all times has the right to either refuse to enter into or terminate with immediate effect agreements with entities that have not satisfied their reasonable requirements for compliance with international best practice in commercial agreements and anti-money-laundering regulations.

Table 30: Definition and description of roles in the I-REC Standard (based on [55]) Continued

Role	Registry account	Definition	Functions and responsibilities	Rights
Registrant	No	An entity responsible for acting on behalf of the owner of a production facility regarding the registration of the facility for a specific product and associated issue requests. The owner of a production facility may act as a registrant. Registrants do not require accreditation.	- Entering a contract with an issuer to register production facilities by signing standard terms - Registration of production facilities - Requesting the issuing of I-RECs - Updating registration details for production facilities - Applying for renewal of registration after five years from the registration date A registrant may either be the production facility owner or be appointed by the production facility owner. A single production facility may only be registered with one issuer at any one time. Any changes to registrations to other tracking systems must be notified by the registrant to the issuer.	Any legal person or organisation can be a registrant. A registrant may also be a participant. A registrant may contract with more than one issuer.
Participant	Yes	An entity who manages one or more trade or redemption accounts within a registry. Participants are the specified owners of product certificates held within their accounts. At the time of redemption, a participant may nominate a beneficiary to receive rights to the product certificate. Participants do not require accreditation.	Participants hold accounts in the registry through which they can hold, transfer, and redeem I-RECs. Participants are required to enter a contract with the registry operator in order to gain access to the registry. A participant may also be a registrant.	Participants may hold accounts in the registry. Any legal person or organisation can be a participant. A participant may also be a registrant.
Production facility owner	No	The legally defined owner or owners of a production facility or production group	A production facility owner is an entity that owns a production facility eligible to be registered in accordance with the product code.	It is possible for a production facility to be registered for other tracking systems, but it must not receive more than one production attribute tracking certificate for any MWh produced.

Table 30: Definition and description of roles in the I-REC Standard (based on [55]) Continued

Role	Registry account	Definition	Functions and responsibilities	Rights
Beneficiary	No	An end user to which a product certificate may be irrevocably assigned as part of a redemption transaction	Beneficiaries are the end users of I-RECs that have been assigned as part of a redemption transaction.	Any entity may also be a beneficiary.
Labelling authority	No	An entity that has established a set of criteria to indicate that a production facility or product certificate meets its standards (for example, environmental). The labelling authority is solely responsible for determining whether its criteria are met.	A labelling authority is an entity that imparts additional criteria beyond the scope of an I-REC, but may be associated with an I-REC. Where a labelling authority has an agreement with the code manager, the I-REC may carry the label if the labelling authority's additional criteria are met and the relevant registrant or a holding participant requests it.	
Platform operator	No	An entity responsible for providing and operating a platform that provides functions that extend the functionality of a registry. Platforms do not constitute a primary record of the custody of a product certificate but may remotely initiate actions within a registry.	A platform operator is an entity responsible for the provision and operation of a platform that provides functions that extend the scope of a registry. A platform operator shall own all relevant infrastructure to perform these functions. Platforms do not constitute a primary record of the custody of an I-REC, but may act as a custodian on behalf of entities and hold details of legal title to an I-REC. Platform operators may have varied commercial relationships, depending on the nature of their platform.	

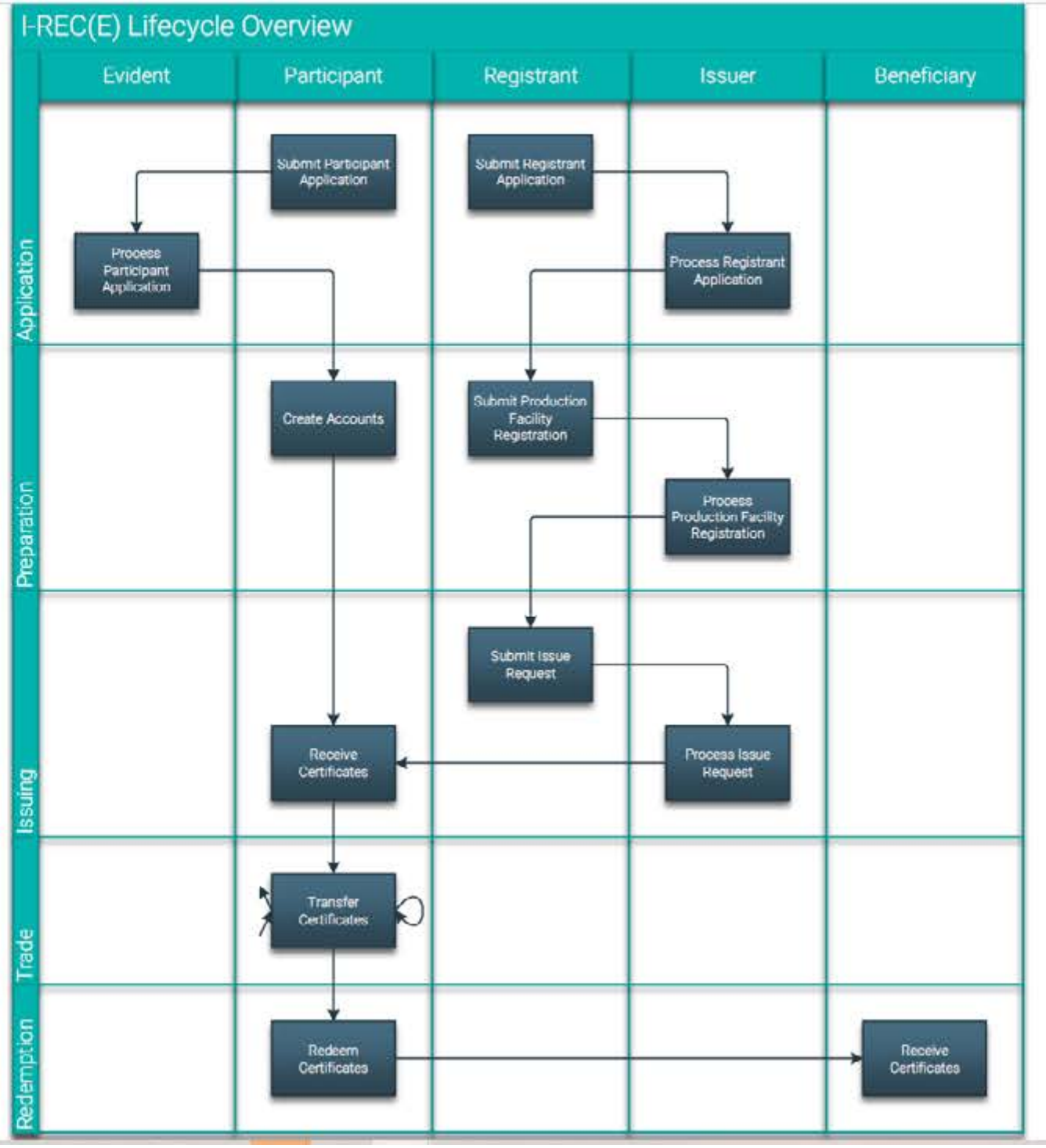


Figure 39: I-REC life cycle overview [55]

An I-REC life cycle (here for electricity) is shown in Figure 39. It is evident that the role here is that of registry operator; therefore, it processes applications of participants (the only role in the system having an account in the registry), while local issuers process the applications of registrants registering production facilities and submitting issuing requests. All operations with certificates are handled by participants that receive I-RECs on their accounts, trade them, and transfer and redeem them. The applicant (participant and/or registrant) must be a legal entity (for example, a registered incorporated or unincorporated business, public sector entity, or private individual).

Information required for production facility registration includes:

- unedited project photos (ideally with the production facility location embedded);
- sample metering evidence;
- a single-line electrical diagram using industry standard notation. This must show all existing network entry/exit points and any directly connected consumer supply points; and
- proof that the registrant is the owner of the energy attributes.

The registrant may be required to nominate a verification agent and indicate its selection as part of the application. Where a production facility is to be associated with a production facility label, the registrant shall provide evidence of the eligibility for the relevant label to be applied.

An I-REC can only be issued against the provision of evidence of a production event that has occurred. That evidence can be in a direct form through measurement data relating to a production facility registered in the registry, or it can be indirect through the transfer of information from an approved tracking scheme (an attribute tracking system accepted by a code manager as indirect evidence of production and production attributes). The evidence should be electricity market settlements metering data; if it is not available, appropriate metering data that has not been through settlement validation, measured volume documentation for the periodic commercial/legal energy transfer from the generator to another person, or a system of measurement approved by both Evident and the issuer may be used. In most cases, verification of measured volume takes place within the electricity settlement process, and secure reports from this mechanism are deemed acceptable. In such instances, the settlement system operator is deemed to be the production auditor.

Table 31: Fees for using the I-REC in 2022 [84]

Fee type	Level of charge, EUR
Participant fees (trade and redemption accounts)	
One-time trade account opening fee	500.00
Annual trade account fee	2 000.00
Redemption fee (per MWh)	0.06
Green Certificate Company (GCC) (I-REC issuer in South Africa)	
Registrant application fee	0.00
One-time device registration fee (five-year validity)	1 000.00
One-time device registration fee (< 3 MW)	500.00
One-time device registration fee (< 1 MW)	100.00
One-time device registration fee (< 250 kW)	0.00
Device renewal fee after five-year validity	40% of registration fee
Issuance fee (per MWh)	0.025
Issuance fee for self-consumption	0.035

2.7.6 Cross-border trade

Association of Issuing Bodies (AIB)

The AIB organises the trade in European GOs, among other things, by drawing up a set of EECS Rules so that GOs are comparable in Europe. In addition, the AIB also manages the "AIB Hub", an IT platform on which trade with standardised GOs takes place. The cross-border transfer of the certificates, organised in a standardised way, is efficiently handled and ensures trust. Standardisation is necessary in multivolume markets; otherwise, the cost of manual administration would simply jeopardise market development [85].

The EECS Rules consist of generic rule sets containing the main principles as well as subsidiary documents. They include the concept of country-specific domain protocols in a standardised template. The issuing body responsible for that domain elaborates the rules and principles of its own system. Domain protocols are peer reviewed by the AIB members and updated regularly. Details for the efficient operation of cross-border transfers are jointly agreed upon by the issuing bodies in the EECS and constantly adapted to the changing regulatory environment and market needs.

According to the European RED II, member states are obliged to import GOs and can only refuse to do so based on criteria of reliability and accuracy. The European standard CEN-EN 16325, which is now being updated, facilitates a sufficient level of reliability, accuracy, and veracity of GO systems to ensure smooth international GO trade.

The RED has a limited geographic scope, especially on imports. Countries outside the EU find it difficult to participate in GO trade with the EU member states, even being a member of the AIB and following the EECS Rules. Export and import restrictions are based on technical rather than political criteria and aim at ensuring the avoidance of double counting. For example, Switzerland, despite having multiple bilateral agreements, is not allowed to export GOs to the EU. The trade goes only in one direction: from the EU to Switzerland.

The Netherlands may only import and export GOs made by an AIB member body. In addition, the country of this body must belong to the European Economic Area (all EU countries plus Liechtenstein, Norway, and Iceland). This means, for example, that importing from, and exporting to, Switzerland and the UK are not allowed.

Export from the Netherlands: if a trader wants to export certificates, the receiving trader must be registered with CertiQ.

Import to the Netherlands: if a trader wants to import certificates, its trading account must be known to the issuing body of the relevant country. If this is not the case, the trader must contact the issuing body of the trading partner, from which the trader will receive the GOs or disclosure certificates.

Export from Germany: the account holder gets access to the account to make transfers of GOs to another account of the German domain or the domain of another issuing body in another domain through the registry website. It indicates the name of the addressee (national transfer) or the account number of the addressee (export) of the GOs. Only GOs for renewable electricity may be exported from the German domain. For the export, the UBA (the German issuing body) gets in contact with the foreign issuing body and provides all relevant information for the transfer of the GOs. The export takes place via the Hub of the AIB. The rules of the AIB apply, for example, concerning special environmental qualities, which are earmarked on the GO and are not transferable as long as they are not foreseen in the Hub User Compliance Document, or AIB-EECSSD03: EECS Registration Databases, which is a subsidiary document to the EECS Principles and Rules of Operation (the EECS Rules), and/or the EECS Rules Fact Sheet 17 setting out the members of AIB accredited under the various EECS schemes. In the process of transferring or exporting the GOs, the UBA deletes them from the account of the sender [86].

Import to Germany: the foreign account holder can only transfer RES GOs into the German domain. The UBA checks whether the GOs are acceptable according to Article 19 of Directive 2018/2001/EU. If the GOs are acceptable, the UBA places the information in the addressee's account. ICS (see section 2.3) flags are not displayed in the HKNR. Account transactions remain visible for at least a year. The UBA keeps necessary data of transfers at least 10 years after closing the specific file. If the account number that has been specified in the import request does not exist in the HKNR registry, the UBA, together with the importing registry, tries to find out who the addressee of the import in its registry is and to provide the importing registry with the correct account number. If an import fails due to the correct account number of the addressee being unknown, the certificates are re-booked to the sending account, and the records reflect that no import has taken place. Non-EECS GOs are technically prevented from entering the HKNR.

US REC

Exports and imports of certificates can occur only between compatible tracking systems that have operating agreements with each other regarding the conversion and transfer of certificates. A protocol for converting generation attribute certificates must be developed prior to any export and import activities between the tracking systems.

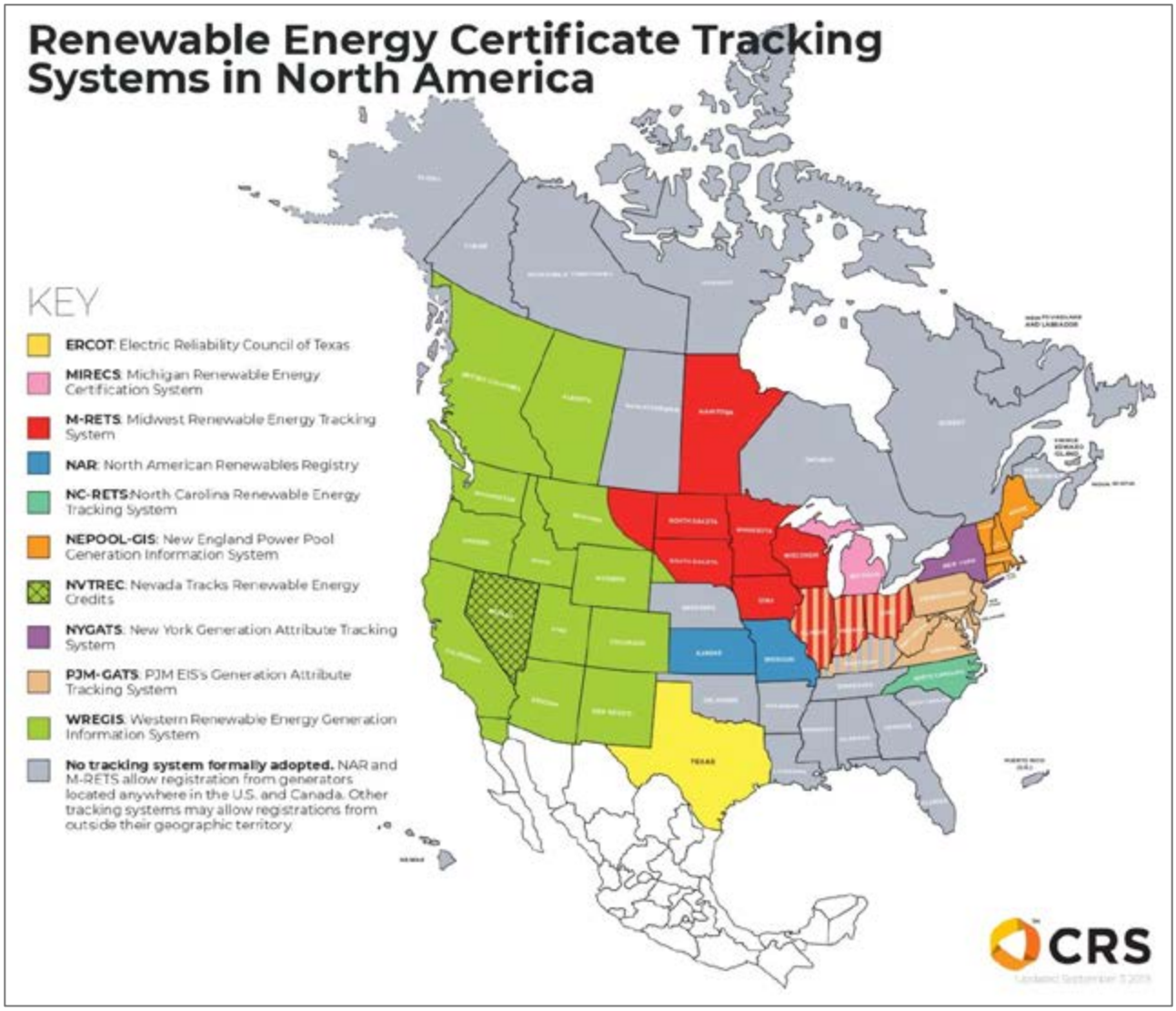


Figure 40: REC tracking systems in North America [87]

The PJM GATS defines a conversion as: "A process by which Certificates from a Compatible Certificate Tracking System are made available for import into the GATS. The process involves designating the certificate as exported from the Compatible Certificate Tracking System according to the protocol agreed upon jointly by the Administrator of the Compatible Certificate Tracking System and the GATS Administrator. After such designation is made, the GATS Administrator will issue corresponding Certificates that are placed in the purchasing Account Holder's CEPS Subaccount and can be used within the GATS" [82]. One overarching requirement for all certificates imported from another tracking system is that the certificates must meet the Clean Energy Portfolio Standard definition of one of the PJM states (that is, it must be CEPS-eligible). The GATS strives for compatibility with other USA tracking systems. This compatibility is based on minimum standards to ensure the security and integrity of the certificate information and reciprocity of conversion. To date, the GATS is compatible with NYGATS, the tracking system in New York, the Michigan Renewable Energy Certification System (MIRECS), and the North Carolina Renewable Energy Tracking System (NC-RETS). All these states are neighbours of the PJM control area.

To import certificates into the GATS, the account holder must notify the GATS administrator of the desire to import certificates. The account holder must identify the name and account information of the party that is exporting the certificates from one of the compatible systems. The GATS administrator will communicate with the administrator of the compatible system and arrange for the conversion of certificates. Such a conversion will involve the export of the certificate from the exporting system and the issuance of a new certificate by the GATS. The converted certificate will designate the system of origin, and the GATS will maintain a record of the serial number that was assigned in the exporting system.

Export from the GATS to another compatible certificate tracking system works in the same fashion. Export of certificates out of the GATS can occur without associated energy deliveries out of the PJM. Certificates can only be exported out of the GATS to a compatible certificate tracking system using the reserve subaccount. The account holder's accounts shall include one reserve subaccount. The reserve subaccount will include all the data related to each export, including the name of the compatible certificate tracking system to which the certificate was exported.

For certificates that are being imported/exported from another tracking system, the problem of double counting is handled through the co-operative agreements between the two tracking systems.

I-REC

The certificate trade between countries with adopted I-REC standards is the easiest, since this system aimed to provide standardisation and cross-border compatibility to the largest extent possible from the very beginning. The I-REC Registry is a single central registry and provides access to the I-REC standardised certificate database for all registered market players, generators, issuing bodies, end customers, national governments, and other stakeholders. Since international trade occurs within one registry, the process is greatly simplified and does not differ from certificate trade where both trade partners are in one country.

Regarding trade with countries with established EAC tracking systems, such as the EU and USA, I-RECs can only be issued in these countries following country approval by the I-REC Foundation and where there is clear evidence that the same unit of electricity is not separately eligible for an end-user claim or use within a residual mix. Such evidence may include cancellation of another attribute certificate.

2.7.7 Matching of production and consumption

The issue of how to improve temporal matching of production and consumption regarding EACs has been brought up more and more often recently. Many key market players in the EAC systems worldwide participate in the EnergyTag Initiative (founded in 2020), aimed at defining and building a market for hourly electricity certificates (granular certificates, or GCs) for verifying the electricity source and carbon emissions in real-time. The EnergyTag Initiative is an independent, non-profit, industry-led initiative. Real-time matching differs from current EAC reporting frameworks, which are typically based on annual matching of consumption and production (Figure 41). Through newly published EnergyTag standards and guidelines, GCs will have a chance to become an internationally recognised, robust, and tradable instrument if accepted by regulators, consumers, service providers, and other market participants.

By setting up a market for GCs, the constantly growing consumer demand for clean energy will be harnessed. The launch of this new market instrument can bring about the following benefits:

- Stimulate the synchronisation of demand with periods of higher RE production, which will ease the integration of RE in the grid.
- Enhance trust in clean energy claims by increasing transparency of energy supply and addressing consumer confidence.
- Support new carbon accounting approaches, paving the way for more temporally precise emissions accounting.
- Unlock additional revenues from flexibility resources, which enable a better match of clean energy generation and demand.
- Send a price signal, driving investments in the technologies needed to reach carbon neutrality, such as energy storage and flexibility facilities.
- Enable the allocation and tracking of the carbon footprint of production of H_2 and other electricity-based fuels.

Politically, the importance of the concept has also been recognised: the EU RED III, currently being developed, may include granularity of certificates. In a move to consider green hydrogen for the European renewable transport fuel targets, a regulation is under development that refers to the temporal correlation and sustainability of the electricity with which H_2 is produced. Increasing pressure from governments in countries with established EAC systems is encouraging market players to adopt system innovations with high temporal resolution. However, this depends on the roll-out of smart meters with technology that can provide detailed production and consumption data over the course of a day. Not all meters are capable of hourly granularity. Registered energy producers or QREs shall submit an interval start and end timestamp (UTC "HH:MM: SS, DD/MM/YYYY" interval starting, for example, "00:00:00 01/01/2021") and production quantity (Wh).

The EnergyTag expands the scope of 24/7 RE procurement initiatives (further information on this appears in section 2.4) from corporations and cities to the mass market, bringing about a much-desired and still-lacking standard for how to track and confirm hour-by-hour carbon-free energy trades [88]. EnergyTag does not want a complete disruption of existing EAC systems, but it aims at defining the minimum adjustments necessary for the prevailing EAC systems to include a timestamp on the existing certificates. Its guidelines should serve as an extension to the rules governing established EAC schemes in different jurisdictions.

Large corporations such as Google and Microsoft, which have already committed themselves to 24/7 RE procurement, had to work without this type of granularity. Google has even developed its own version of 24/7 carbon-free energy credits, calling them time-based EACs, and has been using them in energy trading pilot projects with North American tracking system M-RETS (like WREGIS and the PJM GATS) and Danish TSO Energinet. But Google aims for data consistency and interoperability and has, therefore, joined EnergyTag to work on the development of common standards, along with Microsoft and many other utilities, governmental supporters, and corporates. The South African national private-based EAC system RECSA is an organisation supporting EnergyTag as well. The AIB in Europe, the I-REC Foundation, and the Energy Web Foundation are also on the list.

Figure 41: The difference between the "conventional" EACs and GCs [7]

Twenty-four-hour clean heat from power – a Dutch demonstrator project

EnergyTag is currently implementing a set of demonstration projects, one of which is being conducted by CertiQ, Microsoft, FlexiDAO, and Eneco. During a six-month period, Microsoft (the consumer), Eneco (the supplier and consumer), CertiQ (the GO issuing body), and FlexiDAO (the software solution provider), through two pilot projects, successfully demonstrated the technical and regulatory feasibility of issuing, transferring, and claiming hourly GCs in sync with the existing European system for GOs. These projects represent the first real-life implementation in Europe, in line with the new EnergyTag standard. The pilots included Eneco's Princess Amalia Wind Farm, one of Microsoft's data centres in the Netherlands, and Eneco's district heating network in Ypenburg. It also demonstrated the use of GCs as effective instruments for the development of a methodology for carbon accounting that is more reflective of the physical reality of the power grid. All the GCs created on FlexiDAO's platform

were pegged to the official GOs issued by CertiQ as underlying assets, resulting in a 0% mismatch between the two certification layers. In this way, the pilot validated FlexiDAO's software solution and the GC methodology as an accurate ledger of complex hourly energy market data, compatible with official Gos. The GCs were then transferred and matched to the consumer's hourly load profile and, finally, redeemed on behalf of the consumer. CertiQ sees the GCs as a further improvement to the existing GO scheme in Europe and will contribute to its ongoing development [89].

Application of distributed ledger and blockchain technology

Along with that work on GCs, there are some other activities focused on developing distributed ledger and blockchain technologies for secure and verifiable data transfers. RECS International published a position paper on blockchain and energy attribute tracking [90], which acknowledges that blockchain-based energy attribute tracking systems can provide a potential refinement of the legacy systems. However, the RECS recommends that, as these systems will add a degree of complexity, they should only be instituted/allowed within schemes that are already based on robust practices such as GOs, RECs, and the I-REC. It is only appropriate to implement blockchain projects in energy tracking systems and markets where a clear local framework is in place and is based on national legislation and/or internationally recognised standards, such as the EECS Standard or the I-REC Standard. Where blockchain projects can build on, and add value to, existing attribute tracking systems, they could be supported, as long as they adhere to well-established market norms and practices.

Building a blockchain-based EAC marketplace

The non-profit Energy Web Foundation (EWF), also a member of the EnergyTag, has developed the EW Origin exchange software development toolkit, which can be used to build an open and transparent marketplace for EACs. The EWF is convinced that EAC markets could benefit greatly from sellers and buyers transacting more directly and from opening up the market to all buyers, including corporations that have not yet set or made progress towards RE goals, as well as small- and medium-sized enterprises, households, and electric vehicles.

Today's certificate trade takes place almost exclusively over the counter. Therefore, the market is quite non-transparent and driven by bilateral contacts and private bargaining. In contrast, an EAC marketplace proposed by the EWF would allow for an open display of supply and demand along with universal price setting. This way of trading is beneficial for buyers because they can simply state their requirements without the need for an already-existing offer on the market.

Being able to buy and sell for the market price on an exchange opens up trade for many more (and maybe less-experienced) traders because they know that they can buy and sell at the established market price, which is the same for all market participants. Access to an exchange also means that traders do not have to rely on their networks to trade, but that they can buy and sell from anyone that puts down an order. It basically means that traders no longer must know and trust one another because this function is taken over by the exchange. This also means that trading on an exchange reduces the transaction costs, which are part of the cost of creating a deal, to nearly zero.

The EWF tracks the entire life cycle and ownership of the EAC on-chain using blockchain technology. This provides greater levels of easy-to-observe traceability, which are desired by RE buyers, sellers, regulators, and other stakeholders. By recording only the most relevant aspects of the trade, the EWF could move the order book and matching algorithm off-chain to create a smooth trading experience that is comparable to that of regular exchanges with which users are familiar [91].

The EW Origin platform can be fully integrated with the existing EAC standards. An example is its integration with the I-REC registry. To request certificates, generating device owners send an issuance request to the Origin platform and provide the required evidence of RE production. The request is stored on-chain, but also forwarded to the I-REC registry by calling its public API. This triggers the approval process on the I-REC side, where the issuance request and evidence are evaluated. By integrating with the registry in this way, the job of determining whether the provided evidence is correct and fulfils the requirements of the standard is outsourced to the I-REC issuing body. Once verified, the certificate is created in the I-REC registry. EW Origin's issuer issuer module can then query the API and retrieve the certificate information. If everything is correct, the issuance request is approved, and the certificates are minted on-chain. In the issuance request, users can choose to have the certificates minted to their own or some beneficiary's account [92].

PJM GATS: Modernising a legacy USA REC tracking system

Another example from the EW Origin landscape is a collaboration with the PJM GATS tracking system to explore the potential for bringing new functionality and benefits to the GATS and evaluate how blockchain technology could be integrated into existing IT systems seamlessly and create value for PJM stakeholders. The pilot used EW Origin to create new functionality for the GATS Bulletin Board and assess the potential for decentralised technologies to support wider improvements to the GATS beyond the Bulletin Board. The Bulletin Board is a place on the GATS where REC buyers and sellers can post their bids and ask for specific REC volumes, respectively. Selling or buying those RECs, however, remains the responsibility of the counterparties in bilateral agreements. Historically, the Bulletin Board has been an underutilised feature aimed at facilitating trading of voluntary RECs. The central aim with this pilot was to test new functionality that could enhance the Bulletin Board to grow the REC market in the PJM footprint while also improving security, increasing transparency, and reducing transaction costs for PJM stakeholders. This pilot assessed how improving the technical functionality and user experience of the Bulletin Board could remove market barriers and grow the local REC market — and possibly even attract greater REC imports from other USA REC markets.

EW Origin provided the back-end infrastructure for the marketplace functionality and the use of a public blockchain — the Energy Web Chain — to digitise the RECs in the GATS and anchor the proof of any REC transactions that occurred on the pilot Bulletin Board system. The pilot illustrated that it was possible to integrate blockchain-based functionalities into legacy IT systems and improved user experience. The challenges that arose were related to the large amount of time required to integrate two systems, which took more time than the design and implementation of an entirely new IT system would have from scratch [93].

2.8 Governance and registration body

This section identifies the roles of the governance and registration bodies in the jurisdictions in question and explores whether there are certain principles to be observed when selecting a suitable institution.

To depict actors (certain roles), assets, and the relationships between them, the so-called e3-value model was used. The symbols used in the e3-value model graphs throughout this section are shown in Figure 42.

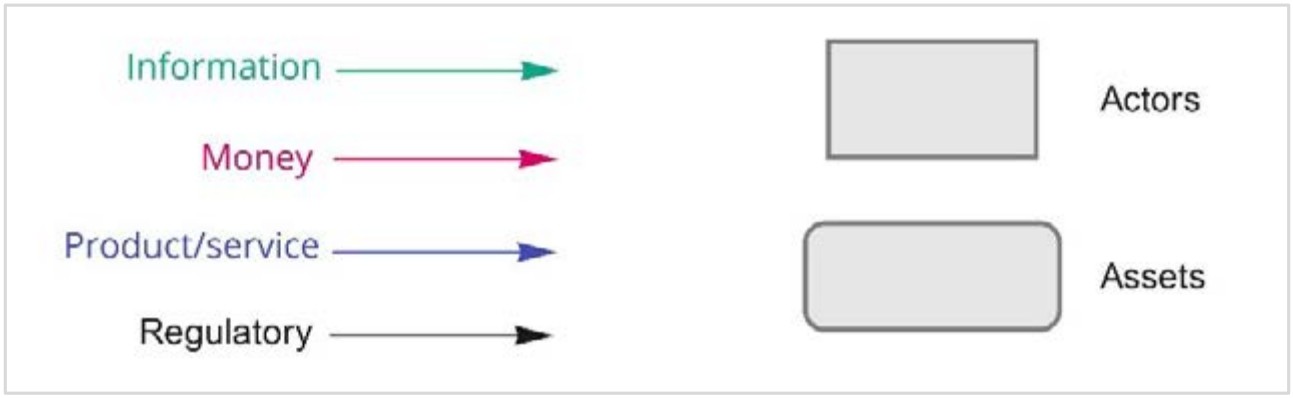


Figure 42: Symbols used for e3-value models

2.8.1 Europe

The organisational form of the registrars in Europe varies greatly (see Table 32). In some countries, the role of registry manager is held not only by regulatory authorities and transmission system operators, but also by private companies or registry operators specially created for this purpose. Accordingly, the influence of the registry managers on the design of GO trade and registry operations differs significantly. Some authorities have regulatory powers and can help shape the legal framework for the operation of the registry. Others are exclusively executive bodies with no regulatory powers. In the case of network operators who are also registry managers, they are part of the energy market in some countries, although not necessarily a player in the GO market. The EU Directive 2008/2001 (RED II) also makes it clear how important the independence of the registrars from market participants is (section 19, (5)): Member states or designated competent bodies oversee the issuance, transfer, and cancellation of GOs. The designated competent bodies shall not have geographically overlapping responsibilities, and the bodies shall be independent of the production, trade, and supply sectors [43].

The production registrar is responsible for assessing applications for the registration of PDs and their re-registration after an agreed period, for example, five years. The production auditor oversees whether the data of the production facilities is correct. The authorised measurement body takes the form of the bodies established under national regulation and is responsible for the collection and validation of measured volumes of energy used in national financial settlement processes.

The UBA, the issuing body in Germany, has significant regulatory power and decides, to a large extent, on the design and functionalities of the HKNR as well as the definitions of actor roles. The many processes related to GOs in Germany are represented in Figure 43.

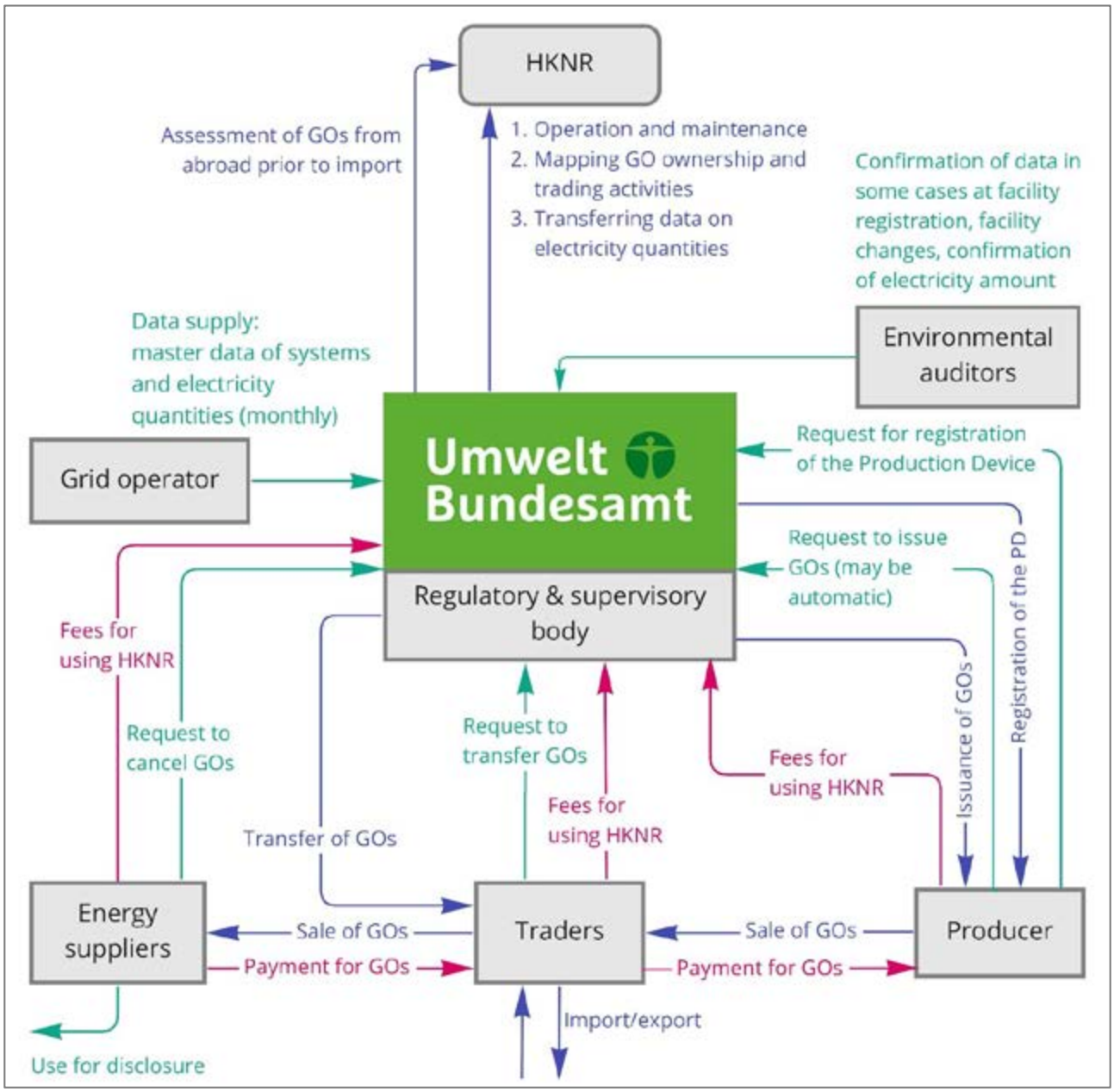


Figure 43: Main processes in the GO system with interactions between actors in Germany (own representation)

The process of disclosure of a countrywide energy mix, including interactions between two regulatory bodies that are responsible for the GO system in Germany (BNetzA and UBA), is shown in Figure 44.

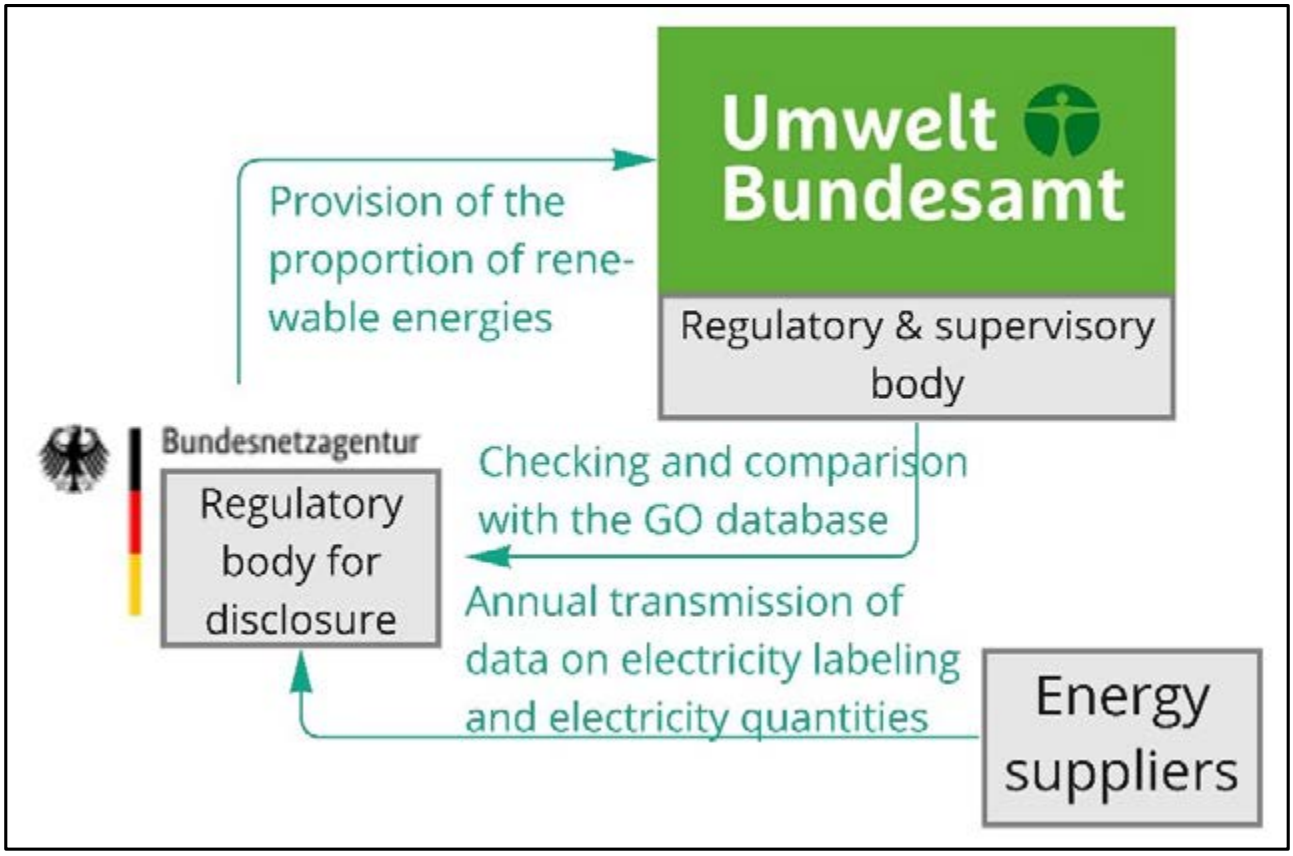


Figure 44: Process of energy mix disclosure in Germany (based on [94])

As for the Dutch issuing body, it has no regulatory power and must comply with the regulatory requirements of the Dutch Ministry of Economic Affairs. The stakeholders, involved in the GO process to a different extent, are depicted in Figure 45. The Netherlands Enterprise Agency (RVO), responsible for RE support schemes, and the Central Agency for Statistics (CBS) also play roles in the EAC system. The role of the authorities and the interactions between CertiQ, grid operators, and regulatory bodies in the Netherlands who ensure electricity disclosure are depicted in Figure 46.

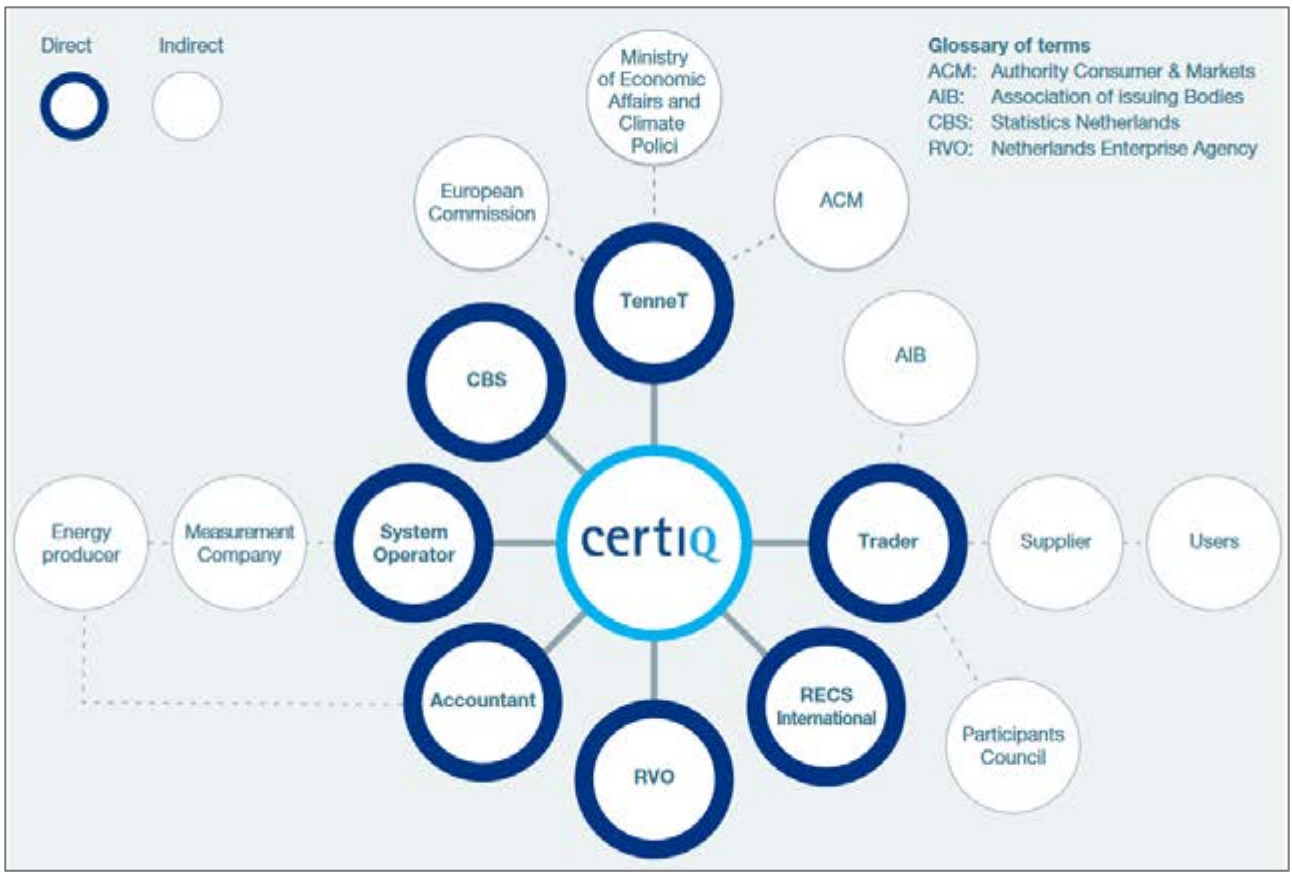


Figure 45: Stakeholders of the issuing body in the Netherlands [95]

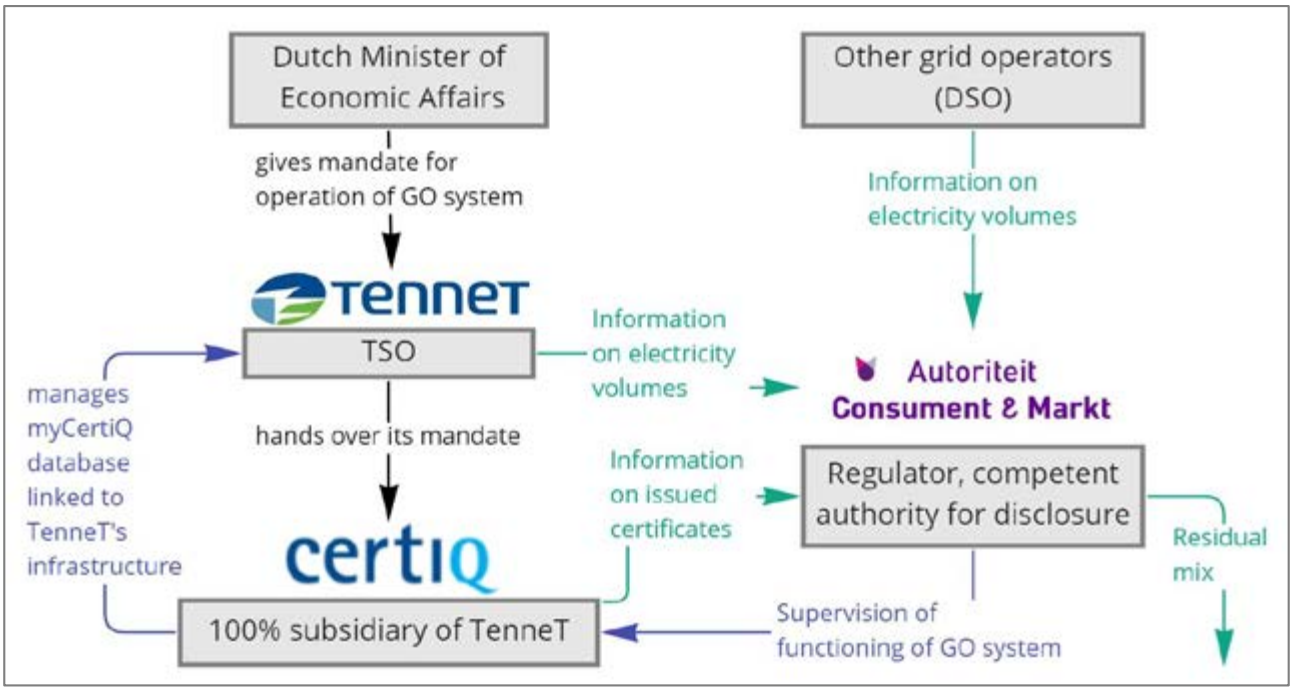


Figure 46: Interactions on electricity disclosure between regulatory bodies and the issuing body in the Netherlands (own representation)

The main processes that take place via the interactions between the actors in the Dutch GO tracking system, and the role played by the issuing body are represented graphically in Figure 47.

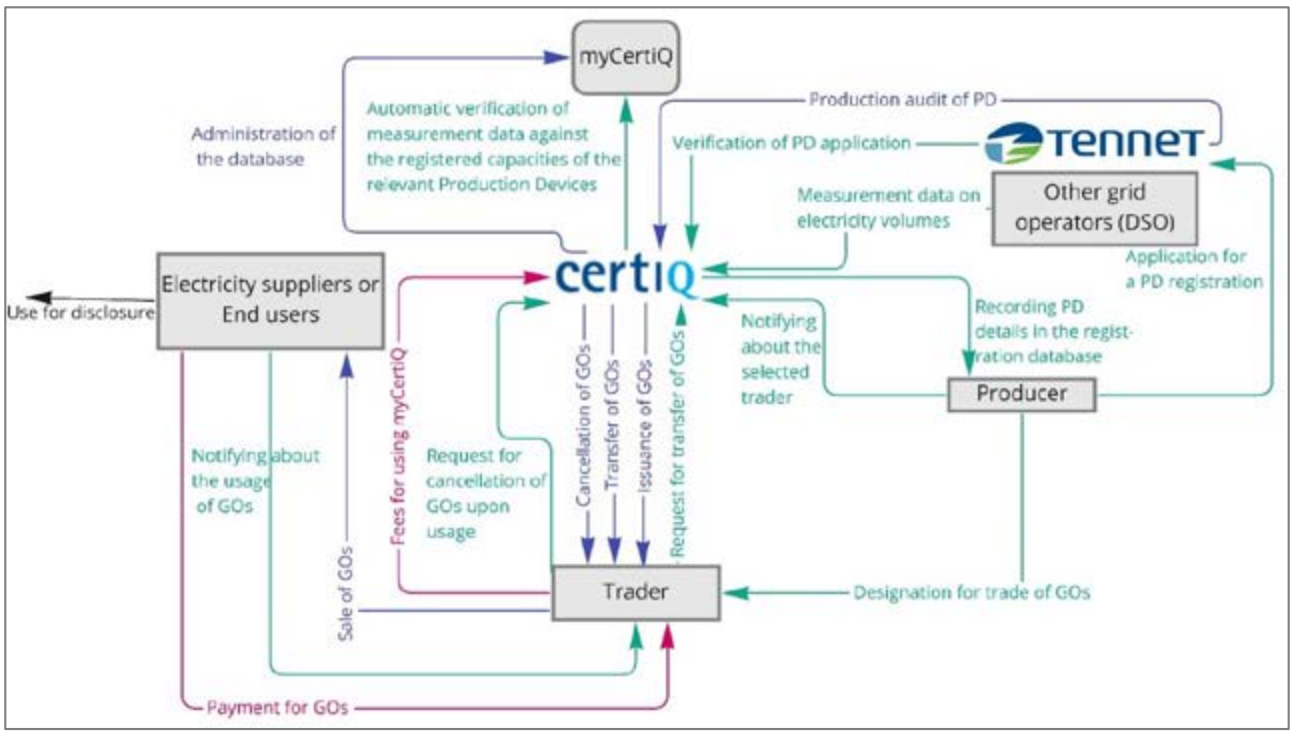


Figure 47: Main processes in the GO system with interactions between actors in the Netherlands (own representation)

Table 32: Governance and issuing bodies in national certification schemes in the EECS system (based on [96])

Country	Implementation of international standard	Nature of issuer	Name of issuer	Type of issuer	Competent authority	Production registrar	Production auditor	Measurement body
Austria	2004	Public	E-Control	Regulatory authority responsible for establishing and ensuring compliance with the regulations of the electricity and gas sectors	E-Control	E-Control	Regional governments (for supported PDs)	Grid operators
Belgium (offshore)	2015	Public	CREG	Commission for Electricity and Gas Regulation; independent body answerable to the federal parliament	CREG	CREG	Listed on the website of the Federal Economy Ministry	Grid operators (TSO and DSO)
Belgium (Brussels)	2008	Public	BRUGEL	The Brussels regulatory authority in the areas of electricity, gas, and water price control	BRUGEL	BRUGEL	BRUGEL	Sibelga (DSO) and Elia (regional TSO)
Belgium (Flanders)	2006	Public	VREG	Flemish Regulator of the Electricity and Gas Market	VREG	Flemish Energy Agency VEA, DSO for solar PV	Inspection bodies accredited by the Belgian Agency for Accreditation (BELAC)	Grid operators (TSO and DSO)
Belgium (Wallonia)	2006	Public	CWaPE	Energy Regulator of Wallonia	CWaPE	DSO (solar PV ≤ 10 kW) and accredited inspection bodies (others)	Accredited inspection bodies	Elia (TSO) and DSO
Cyprus	2014	Public	TSO-Cy	Transmission System Operator – Cyprus; Market Operator of the Cyprus Electricity Market	CERA (Cyprus Energy Regulatory Authority)	TSO-Cy	TSO-Cy	TSO-Cy and DSO

Table 32: Governance and issuing bodies in national certification schemes in the EECS system (based on [96]) Continued

Country	Implementation of international standard	Nature of issu-er	Name of issuer	Type of issuer	Competent authority	Production registrar	Production auditor	Measurement body
Czech Republic	2013	Private	OTE, AS	Czech electricity and gas market operator, joint-stock company	OTE, AS	ČR – Státní energetická inspekce	ČR – Státní energetická inspekce	Grid operators
Denmark	2004	Public	Energinet	Danish national transmission system operator for electricity and natural gas	Energinet	DSO with con-cession	DSO	DSO
Estonia	2010	Public	Elering, AS	Independent electricity and gas transmission system operator	Estonian Competition Authority	Elering and local DSO	Elering AS, local DSO, Estonian Competition Authority, the Environmental Investment Centre, Ministry of the Environment	Elering and local DSO
Finland	2001	Public	Finextra	Fully owned subsidiary of Fingrid Oyj, established for the tasks required by statutory public service obligations not part of actual main grid operations or system responsibility, including the power reserve service and GO services	Fingrid Oyj (TSO)	On-site auditors nominated by the Energy Authority, and Finextra	Finextra	TSO and DSO
France	2013	Private	European Energy Exchange AG (EEX)	Energy exchange offers contracts on power, natural gas, and emission allowances as well as freight and agricul-tural products. EEX also provides regis-try services and auctions for GOs on behalf of the French state.	Direction Générale de l'Energie	Free allocation: benchmarking; free allocation: grandparenting; auctioning	Domestic, international	KRW 480.7 billion (USD 407.3 million) KRW 248.3 billion (USD 199.4 million) in 2020
Germany	2013	Public	Umwelt-bundesamt (German Federal Environment Agency – UBA)	Germany's central federal scientific authority on environmental matters under the jurisdiction of the Federal Ministry for the Environment, Nature Conservation, Building, and Nuclear Safety, responsible for the most di-verse range of topics	UBA; Bundesnet-zagentur for disclosure	The respective grid operator of a plant	Environmental auditors as stated in the data bank of the German inspection body DAU and registered in the HKNR	The respective grid operator of a plant
Greece	2013	Public	DAPEEP, SA	RES operator and GOs, fulfilling multiple tasks, including being the competent body appointed by the EU for the management of state aid support schemes related to electricity	DAPEEP, SA	DAPEEP, SA	Respective	KRW 480.7 billion (USD 407.3 million) KRW 248.3 billion (USD 199.4 million) in 2020
Iceland	2011	Public	Landsnet, HF	Icelandic TSO	Landsnet, HF	Landsnet, HF	Listed on the Landsnet homepage	Landsnet hf.
Ireland	2015	Public	SEMO	Single Electricity Market Operator for Ireland and Northern Ireland; contrac-tual joint venture between EirGrid plc (the transmission system operator for Ireland) and SONI Limited (the system operator for Northern Ireland)	Commission for Regulation	EirGrid (trans-mission-connected devices), ESB Net-works Ltd (distribution-connected de-vices)	EirGrid, ESB Networks Ltd	Metered data providers (EirGrid and Meter Registration System Operator)

Table 32: Governance and issuing bodies in national certification schemes in the EECS system (based on [96]) Continued

Country	Implementation of international standard	Nature of issu-er	Name of issuer	Type of issuer	Competent authority	Production registrar	Production auditor	Measurement body
Italy	2013	Public	GSE	State-owned company that promotes and supports RES in Italy. The sole shareholder of GSE is the Ministry of Economy and Finance, which exercises its rights in consultation with the Minis-try of Economic Development.	GSE	The owner of the respective PD or its legal representative	GSE	Grid operators
Latvia	2020	Public	AST	Transmission system operator	AST	AST	Auditor who has valid accreditation issued by the Latvian National Accreditation Bureau (LATAK) or the State Construction Control Bureau of Latvia (BVKB)	TSO and DSO
Lithuania	2021	Public	Litgrid AB	Transmission system operator	Litgrid AB	Litgrid AB	Litgrid and the National Energy Regulatory Council	Litgrid and DSO
Luxembourg	2009	Public	ILR	Institut Luxembourgeois de Régulation, independent authority in charge of regulation of the electricity and natural gas markets	ILR	A list of accredited bodies	A list of accredited bodies	DSO
Netherlands	2004	Public	CertiQ	Full subsidiary of TenneT TSO	Dutch Minister of Economic Affairs; Authority for Consumers and Markets (for disclosure)	TenneT and DSO	Accredited metering company and accountants, TSO, and DSO	TenneT and DSO
Norway	2006	Public	Statnett	Transmission system operator	Statnett	Norwegian Water Resources and Energy Directorate, NVE	NVE	Statnett
Portugal	2020	Public	REN – Rede Eléctrica Nacional, SA	Electricity transmission system operator	REN	REN	REN	TSO and DSO
Netherlands	2004	Public	CertiQ	Full subsidiary of TenneT TSO	Dutch Minister of Economic Affairs; Authority for Consumers and Markets (for disclosure)	TenneT and DSO	Accredited metering company and accountants, TSO, and DSO	TenneT and DSO
Norway	2006	Public	Statnett	Transmission system operator	Statnett	Norwegian Water Resources and Energy Directorate, NVE	NVE	Statnett
Portugal	2020	Public	REN – Rede Eléctrica Nacional, SA	Electricity transmission system operator	REN	REN	REN	TSO and DSO
Serbia	2019	Public	EMS JSC	Full subsidiary of TenneT TSO	Dutch Minister of Economic Affairs; Authority for Consumers and Markets (for disclosure)	TenneT and DSO	Accredited metering company and accountants, TSO, and DSO	TenneT and DSO

Table 32: Governance and issuing bodies in national certification schemes in the EECS system (based on [96]) Continued

Country	Implementa-tion of inter-national standard	Nature of issu-er	Name of issuer	Type of issuer	Competent authori-ty	Production reg-istrar	Production auditor	Measurement body
Slovakia	2019	Public	OKTE	Short-term electricity market operator, subsidiary of the transmission system operator (Slovenská elektrizačná prenosová sústava, AS), which is the owner of 100% of its shares	OKTE	OKTE	Regulatory Office for Network Industries (RONI)	Listed on the websites of TSO and DSO
Slovenia	2004	Public	Agencija za energijo (AGEN-RS)	National regulatory authority	AGEN-RS	AGEN-RS	AGEN-RS	TSO and DSO
Spain	2016	Public	CNMC	National regulatory authority for Spain	CNMC	Itconic, SA	CNMC	TSO and DSO
Sweden	2006	Public	Energimyndigheten	Government agency, subordinate to the Ministry of the Environment and Energy	Energimyndigheten	Energimyndigheten	Energimyndigheten	Grid operators or, in rare cases, independent measurement consultants
Switzerland	2009	Public	Pronovo	100% subsidiary company of Swissgrid, the Transmission System Operator of Switzerland	Pronovo, Swiss Fed-eral Office of Energy (SFOE) (for disclosure)	Accredited auditors	Accredited auditors	Accredited auditors

2.8.2 USA

Operators of REC tracking systems in the USA are private companies not having decision power over REC systems of individual states. Governance bodies, which are typically public utilities commissions, develop and adopt a regulatory framework with which tracking systems ensure compliance. Commissions are free to decide which types of energy resources are eligible for RECs and which carve-outs and multipliers should be chosen to encourage deployment of specific types of RE projects.

The main interactions between actors in the WREGIS tracking system are presented in Figure 48.

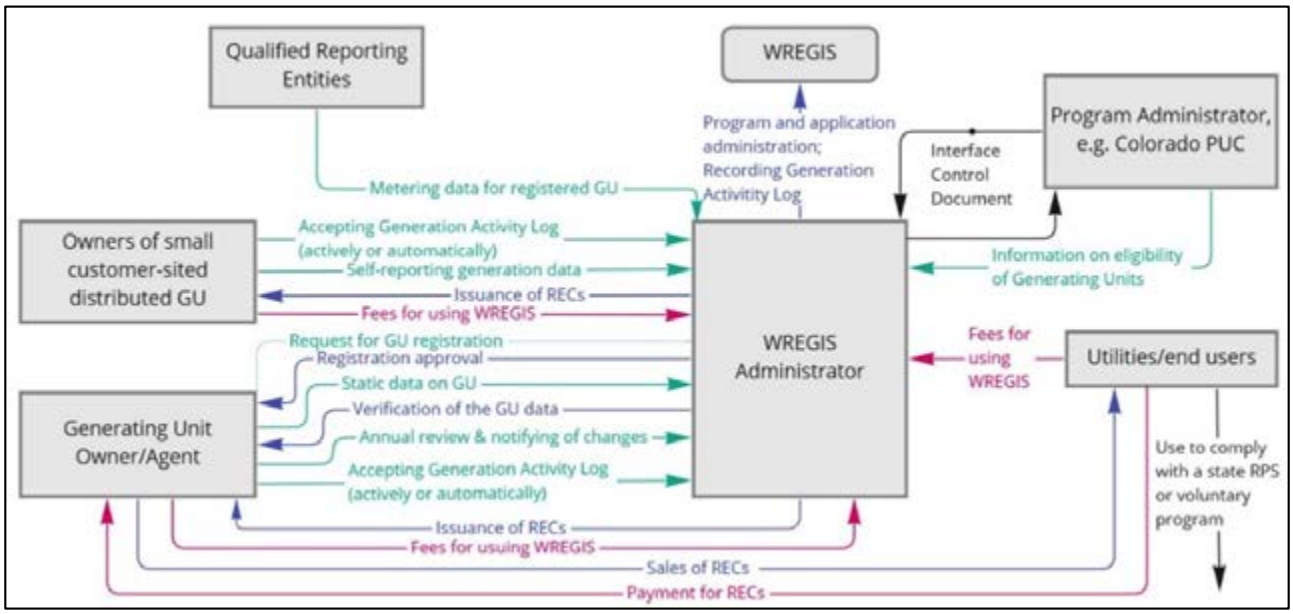


Figure 48: Main processes in the REC system with interactions between actors in WREGIS (own representation)

Processes in the GATS are more complicated since this tracking system allows for all types of electricity sources to be issued a certificate. Emissions data also plays a role for compliance with state emissions performance standards and for information disclosure of electricity suppliers to retail customers.

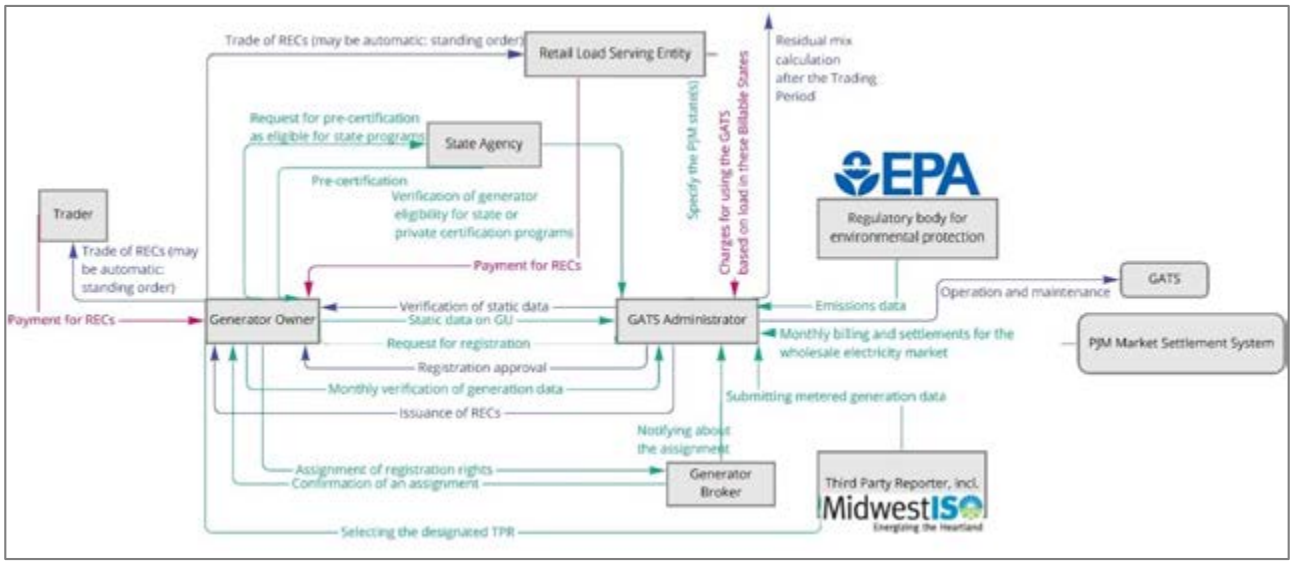


Figure 49: Main processes in the REC system with interactions between actors in PJM GATS (own representation)

2.8.3 I-REC countries

The issuer is responsible for the creation and eventual redemption of an I-REC certificate because an issuer provides I-REC issuance services for a given country or region. Issuers can be appointed in one of two ways:

1. As a result of a governmental order, appointment, or decree
2. By the I-REC Standard as elected by the market players involved

The defining criteria for becoming an issuer is the issuers' pledge to independence, reliability, and transparency. This commitment is part of the I-REC issuer agreement, which is signed by the issuer organisation and the I-REC Standard. The agreement guarantees the quality of I-REC certificate issuance, use of the registry, and other aspects related to the functioning of the I-REC system.

In some instances, the local situation will not be conducive to setting up a local issuer; as such, the issuer of last resort, known as the Rest-of-the-World (RotW) issuer, can provide the services needed to enable the issuance of I-RECs in a specific location or region. This RotW issuer is currently a UK-based company that is authorised by the I-REC Standard to conduct the issuance where no local issuer is appointed. The RotW issuer operates under the direct supervision of the I-REC Standard and adheres to the quality qualifications as laid down in the I-REC Code. This is the case in SA where the RotW issuer, the Green Certificate Company (GCC), does the certificate issuance. Since there was already an established local RECSA system when the I-REC came to SA, it was decided that establishing a local I-REC issuer would be a duplication.

Local issuers may be appointed by the national or regional government; in some cases, the government authorities themselves become local issuers. Governments can mandate issuance or consumption of I-RECs for compliance or mandatory system purposes (such as a national or regional RPS, quota system, or support system).

Issuers bear significant costs that must be paid for by the users of the system. Issuer costs include the registration, issuance, verification, and auditing of production data and production facilities. These costs are covered through the tariffs that market players pay for using the I-REC system. Electricity generators are charged by the issuer for the registration of PDs and the issuance of I-REC certificates.

In order to guarantee the quality of the I-REC system, including the avoidance of double attribute or certificate counting, a set of rules is published by the I-REC Standard. The rules are known as the I-REC Code and its subsidiary documents. The I-REC Code sets out the rules for all actors in the I-REC system. The RotW issuer is appointed by the I-REC Standard and in direct communication with the organisation. All issuers, as well as other I-REC contractors, must adhere to the I-REC Code documents. Their adherence to the I-REC Code is frequently audited by third parties at the request of the I-REC Standard.

Local issuers sign "issuer agreements" with the I-REC Standard. This allows a government-appointed local issuer the opportunity to apply additional national or regional regulations. These additional regulations cannot interfere with the reliability or robustness of the I-REC tracking system. However, it is possible for local government-appointed issuers to create additional regulations for each national situation, including renewable electricity compliance mechanisms, I-REC issuance eligibility rules, or additional information fields. This allows the flexibility needed for the I-REC system to comply with international standards with respect to REC attributes and GHG accounting and the ability to comply with local/national regulations or renewable market support. In all situations, third-party auditing must be conducted to ensure that the issuer is following the regulations of the I-REC Standard and local regulations.

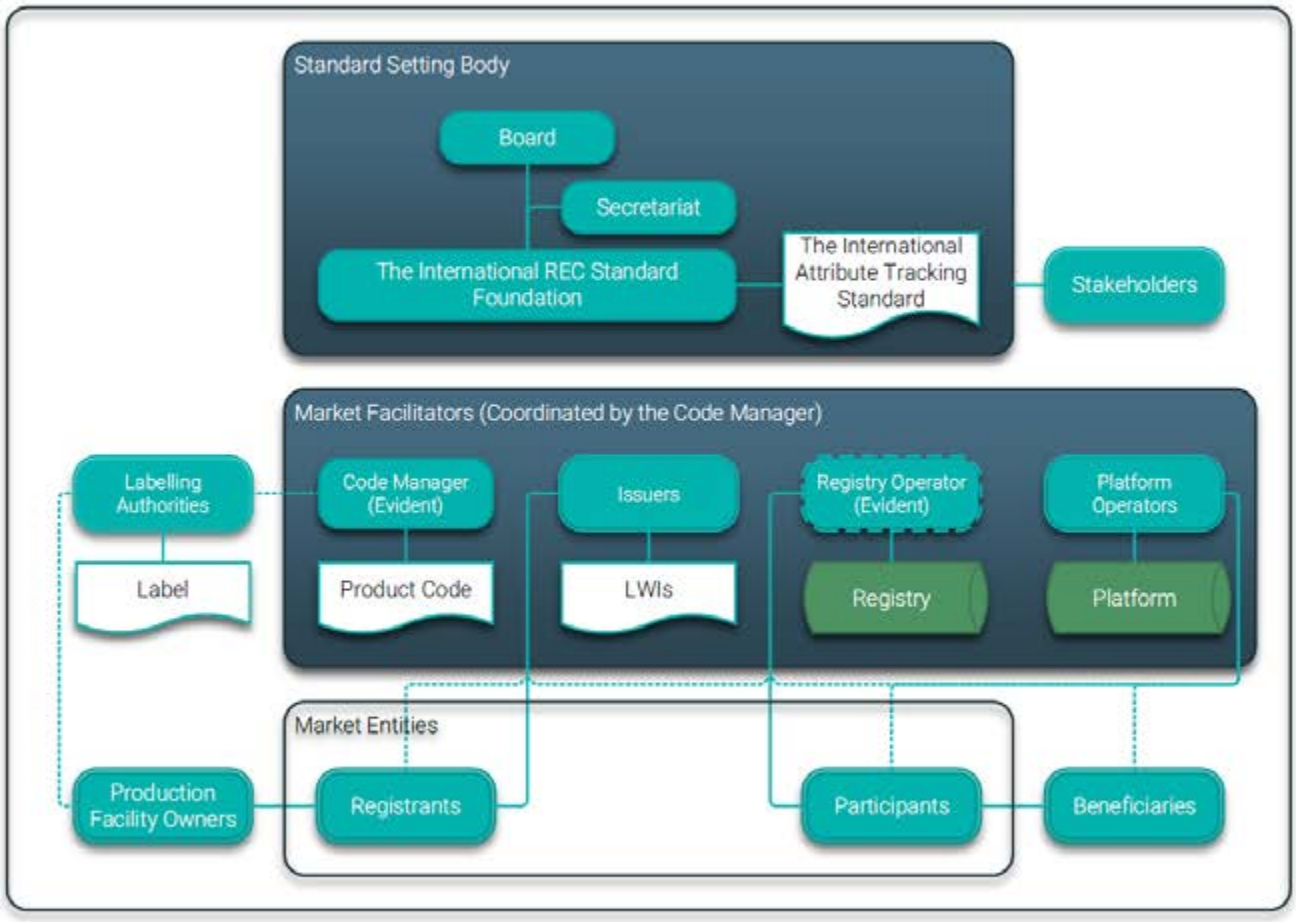


Figure 50: Structure of I-REC roles [55]

The code manager is a trade name of I-REC and is responsible for:

- authorisation of issuers;
- maintenance of procedures and governance arrangements; and
- overall compliance with the standard.

It also performs the role of registry operator.

2.9 Conclusions

In Part I of this study, EAC systems and their most important aspects were analysed. A description of the main principles, participants, features of an electronic database, and steps of certificate creation is provided (section 2.1). The defining principles of every EAC system include the book-and-claim principle and avoidance of double counting of green attributes. Market facilitators such as authorities, issuers, and registry operators are an essential part of the system, be it a mandatory or a voluntary one. Acknowledgement of an EAC system by a national authority can build trust among market participants. Generators, electricity suppliers, and end users are drivers of market development, as they must perceive it as being profitable to participate in the market and directly from market supply and demand. An electronic tracking system ensures and stores information on the entire life cycle of an EAC: issuance, transfer, trade, retirement, and claims. Prior to the creation of a certificate, a corresponding generation facility and its owner must be duly registered on the system. The process of EAC creation has the same steps across all the EAC systems worldwide. The main features and challenges of the certification of H_2 were also highlighted.

Then three of the most-distributed EAC standards in the world were described: the US REC, EU EECS, and I-REC (section 2.2). These standards are well established, robust mechanisms for creating, trading, and claiming green attributes. For example, the EECS is a highly standardised and legally enforceable standard enabling a relatively high degree of compatibility between national systems and easy cross-border trade through membership of the AIB. The US REC is an example of using certificates for compliance with state RE goals. The I-REC allows for the easy implementation of a national EAC system where it did not exist before and provides conditions for uncomplicated international trade. Standards for green hydrogen, which are now in the developmental stage, were described in the section.

Section 2.3, examined the concept of labels as a voluntary certification that adds a quality seal to a unit of energy. Together with EACs, labels ensure that the corresponding electricity product or energy unit has not only been generated by renewable sources, but also complies with certain additional features using specially elaborated sustainability criteria. Not all additional features required by labels bring about some measurable environmental benefits, but they can draw the attention of consumers to different energy supply aspects and, in the long term, contribute to moving energy supply in a more sustainable direction. Selected international and regional labels show that they can make a difference for sustainability-aware customers and have the potential to gain much popularity among market participants. Furthermore, the process of introducing a label to the market demonstrates that facilitating a fully liberalised market and encouraging enough forward-looking suppliers and consumers willing to participate are keys to success. Carefully chosen criteria, a sound marketing campaign, and elaborated auditing procedures are also among the important factors for setting up a label.

In section 2.4 the most important use cases for EAC and labels are described along with the main beneficiaries. For companies, it was determined that claims about green energy usage, carbon accounting, and international trade played a significant role and drove demand for EACs. In order to navigate around the ever-increasing popularity of carbon reporting standards, an overview of internationally recognised standards, programmes and initiatives was provided. For households and smaller end customers, data transparency regarding their energy usage is coming to the forefront and is increasingly embedded in the law. In the case of full disclosure, customers will be more aware of the energy mix with which they are supplied and may switch to more sustainable energy products. As for electricity suppliers, of primary importance are the national requirements to supply a share of RE electricity and competitiveness by means of green tariffs (green tariffs are presented in more detail in section 2.5). For regulatory bodies, requirements to source a portion of electricity from renewable sources, as well as international trade of energy and H_2, are of the greatest interest. Subsequently, country- and economy-specific considerations of the most significant use cases were presented.

Analysis of green tariffs in the national and international context (section 2.5) showed that green electricity products are entering a level playing field with their grey counterparts. At the same time, it was made clear that the focus should be on transparency regarding the sources of electricity generation and efforts to build additional RE projects for certification rather than on diffuse green features of an electricity product.

The part of the document on the international regulatory framework (section 2.6) aimed to demonstrate the similarities and differences between the EU and USA legislation and took as an example two EU member states (Germany and the Netherlands) and two American states (Colorado and Delaware) for more detailed analysis. Due to the principal differences between the USA and EU along the features of mandatory or voluntary certification and mandatory or voluntary market participants' use of an EAC scheme, their legislation differs in many respects.

The EU regulation at the regional and national level is much less prescriptive than the USA regulation at the state level and sees the main goal of certificates in data disclosure for end customers. Every EU member state is free to define what its GO system will look like. For more standardisation, the AIB offers EECS Rules, which determine standardised processes and enable easy international trade at the EU level. In Germany and the Netherlands, GOs are embedded in the national law. In both countries, electricity suppliers are obliged to cancel GOs to prove the origin of renewable electricity supplied to end customers. Energy receiving state support is excluded from certification in Germany. In contrast, in the Netherlands, full disclosure, including electricity under public support and non-RE, is in place. In both cases, government authorities are responsible for the implementation of the GO system, but in the case of the Netherlands, a subsidiary of the TSO oversees it according to mandate.

In the USA, RECs are seen as a tool to check the compliance of electricity suppliers with the state RPS. That is the case in Colorado and Delaware. Both states clearly define the responsibilities of electricity suppliers regarding RECs. The lifetime of RECs in the USA is much longer than in Europe in order to make this instrument more suitable to prove compliance with state goals. Turkey and Russia were taken as examples of I-REC member states and demonstrated the development of the regulatory framework.

Carbon offsets and EACs are two kinds of instruments designed to reach the same goal – GHG mitigation – but with different strategies and pathways concerning site and effectiveness of reduction (see Figure 26). Both have their own markets with their own standards, protocols, and registries. They are not viewed as competing or interchangeable instruments, but rather as complementary efforts for the continuous improvement of an organisation on its way to climate neutrality.

Examination of the design and functioning of electronic databases (section 2.7) demonstrated that all of these registries follow the same or very similar principles of registration of account holders; different account types for issuance, transfer, and redemption of certificates; data security; and a general, rather simple design. While registry operators in Europe are, in most cases, also the national issuing bodies and can, to a large extent, define the design and functionalities of a registry on their own, in the USA, independent service providers oversee the functioning of mostly interstate registries. They are reliant on the regulations of state authorities to check compliance of generation facilities with their requirements and reflect state regulations in the design and operation of the registry. The processes related to specific roles, registration of participants, and all certification activities are precisely defined in the operating rules of a registry.

In the same section, examples of cross-border trade within the framework of the EECS in Europe, the REC in the USA, and the I-REC internationally were cited. In all these jurisdictions, cross-border trade is related to a different degree of complexity. In the final part of this section, innovative approaches connected with better matching of generation and consumption in view of EACs were highlighted, including GCs with a timestamp and blockchain-based activities. These activities are gaining momentum worldwide and are being considered for inclusion in regulation. A general recommendation is to monitor these developments and use these instruments based on established robust EAC standards.

In the final section of Part 1 of the study (section 2.8), considerations regarding the governance and issuing bodies of national certificate tracking systems in Europe and the USA, as well as general governance in the I-REC Standard, were presented. An overview of national regulatory authorities in all members of the AIB, as well as selected American states, conveyed information on the nature and responsibilities of the issuing and regulatory bodies responsible for the functioning of GOs and REC systems. For countries and states analysed in the previous sections, schematic representations of the activities of corresponding regulatory bodies and interactions with other market participants and stakeholders gave an impression of the processes of the whole system, their complexity, and their extent.

In Part 2 of the study, the aim is to apply the developed comprehensive knowledge base on EAC standards and national systems to the South African context and derive plausible recommendations for action for national stakeholders to implement a robust certification system for RE and green hydrogen that is accepted by market participants.

PART TWO

Part Two

Eskom

Part Two: National EAC scheme for South Africa (SA)

The second part of the study focuses on the status quo of the regulatory framework in SA and the requirements for implementation of a nationwide EAC system covering the whole electricity market.

The following are key questions for establishing a national certification system:

- What organisation should be the issuer (public/private)?
- What government bodies should participate in the certification system?
- Should certification be obligatory or voluntary?
- Should a market participant's use of an EAC scheme be mandated or voluntary?
- Should a system adhere to an international standard?
- Which are eligible power sources?
- Which generation facilities can be registered?
- What relation to public support schemes should a certification system have?
- Should any export restrictions be in place?

Prior to the analysis of how an EAC system can evolve in SA, it is necessary to look at existing conditions of the South African energy sector in a broader context. Together with the participants of the knowledge-sharing workshops, several different important issues to consider while developing a nationwide EAC system were defined.

Table 33: Aspects to consider when establishing a nationwide EAC system (results of knowledge-sharing workshops)

Environmental and sociocultural aspects - The commitment of SA to the Paris Agreement pledges needs to be pursued. - The large GHG Scope 2 impact leads to the high grid emission factor on a national scale. - The difference between carbon credits and green certificates must be determined. - Electrification and affordability goals must be kept in mind.	**RE capacity** - Despite the abundance of natural resources, SA has a long journey towards sufficient RE generation. - For now, demand for RE is latent, but for the future, its potential is high. - To exploit this potential, capacity building and training are necessary. In that way, more profes-sionals can be trained to participate in the system; government can become the driver or choose an accredited body to drive the system and more citi-zens can become aware of the significance of energy certification. - There is also the question of defining what 100% green means (24/7 procurement).
Electricity market Strong demand to **liberalise the electricity market**: - Separating generation, transmission, distribution, and supply revenue streams: a vertically integrat-ed monopoly must be unbundled to resolve load-shedding issues. - Dealing with the issue of a limited choice of end users - Offering/adapting the standard offer tariff and wheeling tariff - Developing a market platform - Introducing the new market structure - Changing market rules leaving the Renewable Energy Independent Power Producer Procure-ment Programme (REIPPPP) behind - Setting the regulatory scope to consider the EAC system - Moving to a liberalised market under the Electrici-ty Regulation Act (ERA) Amendment Bill There should be a move from an opportunistic to an available market. **Regarding an EAC market**, for now, its adoption is slow. - It could move from a voluntary to a "compulsory" system, which will create a tradable market. - Given the early stage of the market and the lack of supply, market development will lead to higher RE penetration. It can have a commercial impact to facilitate RE projects. - SA has great RES potential with available land, so it can become an EAC exporter. - RE does not need a premium, but there is still a value for green attributes. - Green benefits are currently diluted. - The question of ownership of RE attributes for the REIPPPP is unsolved yet; therefore, revenue on these "unsold" attributes is lost. - The EAC market can become a catalyst for an ac-celerated rollout of RE.	**SA economy and global context** - The economy of SA is energy intensive, and it is vulnerable to actions that are taken by its trading partners. - The economy of SA is a relatively open and export-oriented economy. It has great potential for a green hydrogen export. - There is a necessity to provide "green" exports. - SA has an active export and import relationship within the SADC region. - There are, however, policy delays, and the market is not progressive. - African standards and African markets must be taken into consideration. - SA has great RES potential with available land, so it can become an EAC exporter.

3.1 RECs in SA

3.1.1 History of South African RECs

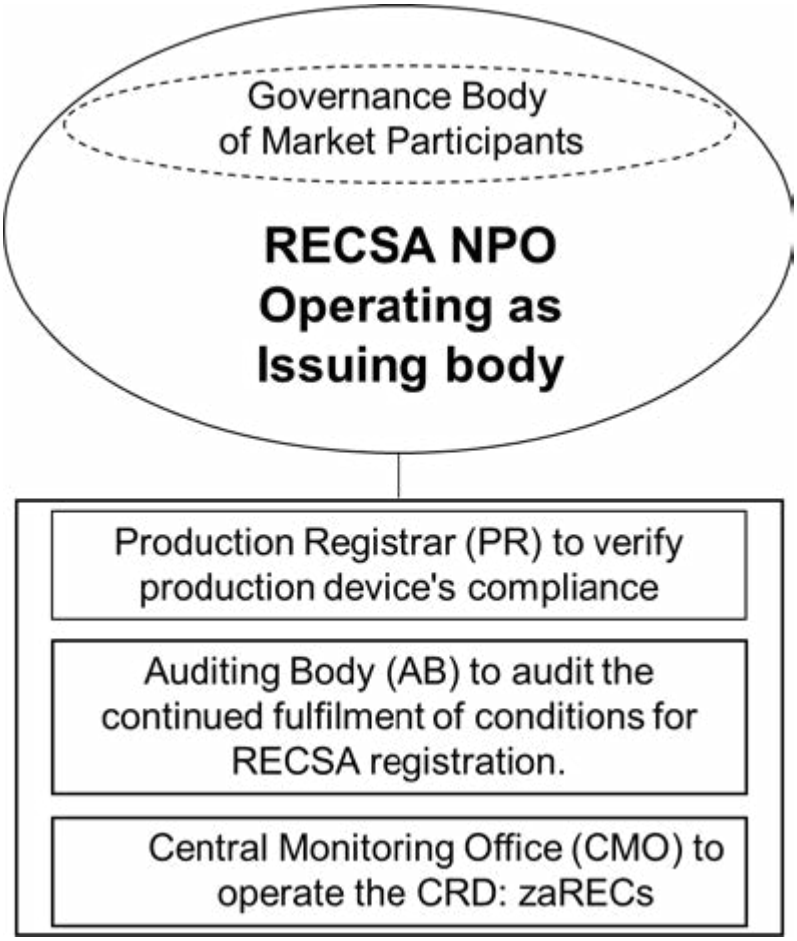
South African RECs are a voluntary tradable commodity. A REC is a certificate that indicates the generation of 1 MWh of electricity from an eligible source of renewable power. Each REC denotes the underlying generation source, location of generation, and year of generation.

REC activity in SA started as a pilot project in 2002 during the Johannesburg-based World Summit on Sustainable Development (WSSD). The National Electricity Regulator (NER) (now called the National Energy Regulator of South Africa, or NERSA) acted as the issuing body, and City Power (a distributor and supplier, which acted as the electricity supplier to WSSD venues) purchased green certificates in quantities to match green electricity demand from the WSSD venue. The project supplied 845 MWh of green power. The TRECs, which were bought from RE generators in SA, Italy, and Costa Rica, were used by City Power to back up the supply under its newly developed green electricity tariff.

In 2005, a voluntary market association of RE market participants (the Tradable Renewable Energy Certificate South Africa, TRECSA), serving as an interim issuing body set up by green certificate trading companies GreenX Energy and Amatola Green Power, was established. In 2006, the Green Power Voluntary Market Programme started in SA, through which the national REC market got its impetus. A Working Group on Feasibility created by the Department of Energy (DoE) was initiated. A feasibility study issued by the DoE in 2007 established a mandate for the creation of a South African issuing body based on the experience in Europe of the framework of the Basic Commitment of the AIB. As a result of its activities, a business plan for the issuing body in SA was developed. The organisation functioned according to the Principles and Rules of Operation (PRO) of the EECS-based AIB.

In 2011, it culminated in the adoption of the Renewable Energy Certificates South Africa (RECSA) constitution and the establishment of zaRECs (Pty) Ltd. RECSA administers the South African voluntary REC market along the lines of the EECS specifications on behalf of members of the voluntary Renewable Energy Certificates Market Participants Association – Southern Africa (RECSA). The domain protocol of RECSA is based on the Domain Protocol Template Version 1 of the AIB. RECSA operates as an issuing body and production registrar to verify the compliance of a PD with REC requirements as well as an auditing body to audit the continued fulfilment of conditions for RECSA registration. RECSA interacts with international standards to exploit export potential. It monitors policy measures related to the RECs market in SA. zaRECs operates the Central Registration Database (CRD) as a central monitoring office.

Figure 51: Roles in the RECSA system



It is a self-governing market; all market participants are members of the association. Every producer signs an RE declaration to avoid double counting. RECSA adheres to international best practices. It has quite rigorous rules but decides case by case whether certificates fit customers' requirements.

3.1.2 Recent developments of ZA-RECs

In 2019, 249 804 MWh of certificates were issued (uniquely identified), with 482 199 MWh being issued in 2021 (a clear growth trend). There are more than 100 market participants in this voluntary market association according to the zaRECs website. Most participants are private companies, but a number of municipalities and state agencies are also engaged. Municipalities buy certificates for private customers.

RECSA has reporting obligations towards the government and regularly reports the number of certificates issued to the Department of Forestry, Fisheries, and the Environment (DFFE) as part of the GHG Monitoring Programme to avoid double counting. According to zaRECs, its administration cost associated with an REC is significantly less than that of other international carbon credit schemes [97] [98].

The first utility-scale wind turbine (Darling Wind Farm) in SA was built in 2008. For several years, development was slow. From 2014, when the IPP Programme started, SA went from eight to 800 utility-scale facilities in three years; today, it has 1 200. The increased number of IPPs is a very recent development. The high proportion of IPPs participating in RECSA was driven by demand. In the beginning, there were very thin market volumes. Initially, participation was driven by people who wanted to green events and office spaces. Corporate targeting and GHG targets are relatively new.

There are now 200 generators in the RECSA network, and this number is growing very quickly. Between 10 MW and 30 MW of additional capacity comes to RECSA every month. Certificates are readily available from rural PV, wind, biogas, and hydro RE facilities. RE100 and CDP disclosures, along with the South African carbon tax, have driven demand beyond supply for the first time since inception.

Recent trends show an increase of small consumers and generators in the system and the entrance of new participants such as aggregators, consolidators, and contract management systems that operate between the registry and customers/generators. The way trade platforms are interacting with the registry is becoming more sophisticated, and the value chain is lengthening.

3.1.3 ZA-RECs processes

The process of issuance, transfer, and redemption of RECs in SA is depicted in Figure 53. The countries where RECSA operate in terms of REC issuance and/or redemption are mostly in the Southern African Development Community (SADC), which can be considered a nascent market at the moment (see Figure 55). Figure 52 shows what a redemption statement looks like. The template for the redemption statement comes from the AIB. RECs are redeemed when the following applies:

- Prior to green labelling in voluntary markets (products, events, or general disclosure of environmental performance);
- In claiming production-based support;
- In proof of compliance with purchase or supply obligations;
- On international export (transfer to an international customer's CRD account – or cancellation and ex-domain issuance).

The entire trading process is demonstrated in Figure 54.

3.1.4 The I-REC and its relationship with ZA-RECs

Besides the voluntary EECS scheme, SA is a member of the I-REC. The issuer in SA is the GCC, which is also the central I-REC issuer. Between 2014 and 2021, about 136 million I-RECs were issued worldwide in 36 countries. SA was responsible for about 1% of this sum (just above 1 million I-RECs), starting from the end of 2016. The capacity of production facilities ranged from 2 MW to 138 MW, with 57 MW on average. Certificates from solar, thermal, hydro, and wind production facilities were issued. Twelve devices were registered in the I-REC system, among them six solar PV and one wind power plant. Approximately 404 000 certificates were redeemed in favour of SA, with more than 50% of them from solar facilities.

When the I-REC considered entering the South African market, it was decided not to involve a local actor as an issuing body. The reasoning was that RECSA was already in SA as a local issuing body, and RECSA decided not to get involved in setting up I-RECs directly.

The main reason RECSA has been pursuing its own goals is related to concerns about the validity of using I-REC certificates in SA. RECSA members have highlighted that the I-REC and other international standards have less stringent verification rules,

which I-REC justifies as being due to a global need for standardisation. In addition, RECSA is concerned that there is quite a high risk for double counting of generators that do not register in the South African domain. Therefore, RECSA insists that it be made aware of all generators so that it can report their production and consumption to the SA authorities.

To avoid double counting, but to still facilitate the use of the I-REC system, RECSA interacts with the GCC through ex-domain issuances: RECSA cancels a requested volume from the SA registry in the SA domain and requests the issuance of I-RECs. The production registrar is common to those transactions. Management of the production entity is by the same entity. Due to this process, the use of I-RECs in SA incurs additional transaction costs (zaRECs fees + I-REC fees). RECSA itself is more expensive than the I-REC but provides for coverage of customer-specific requirements, for example, RE100.

The combination of I-REC having entered SA, the new GHG Protocol Scope 2 Guidance, and the increasing number of companies relying on EACs to meet their targets, has helped to increase visibility of ZA-RECs. In order to explore whether these two EAC systems, the EECS-based ZA-RECs and I-REC, can coexist in one country and whether it is efficient to do so, a series of interviews and workshops were conducted. Participants included relevant stakeholders from EAC-implementing organisations and those with experience of using EACs in SA. The findings are discussed further in the concluding recommendations.

REC Redemption Statement

This Redemption Statement acts as a receipt for the redemption of the Renewable Energy Certificates listed below and for the purpose shown.

Account Holder	SANEDI	**Account Number**	30XSANEDIW
Address of Account Holder	152 Ann Crescent Sandton South Africa	**Registry Redeemed from**	RECSA Country Code 27 South Africa
Total of Redeemed Certificates	7	**Total number of MWh represented**	70 (Seventy)
Redemption Date	2019 01 12	**Redemption category**	Disclosure
		Beneficiary	Switch Africa Green (30XSWITCHE)
		Redemption purpose	Offset of Greenhouse gas emissions related to the SWITCH Africa Green project titled 'Sustainable Energy Consumption and Production in Agriculture and Integrated Waste Management, which ran in South Africa from November 2016 to January 2019.

Production Device ID	Energy Source	Domain of Origin	Public Support	Additional Remarks by the Issuing Body
00000027000000030	Biomass: Agricultural co product	South Africa	None	

From Certificate ID	To Certificate ID	Certificates	MWh	Production Period from / to	Issue Date
000000270000000038127521446 38	000000270000000038127521446 44	7	70	2017-04-28 19:00 To 2017-04-29 03:00	2017-12-05

Figure 52: Redemption statement in ZA-RECs

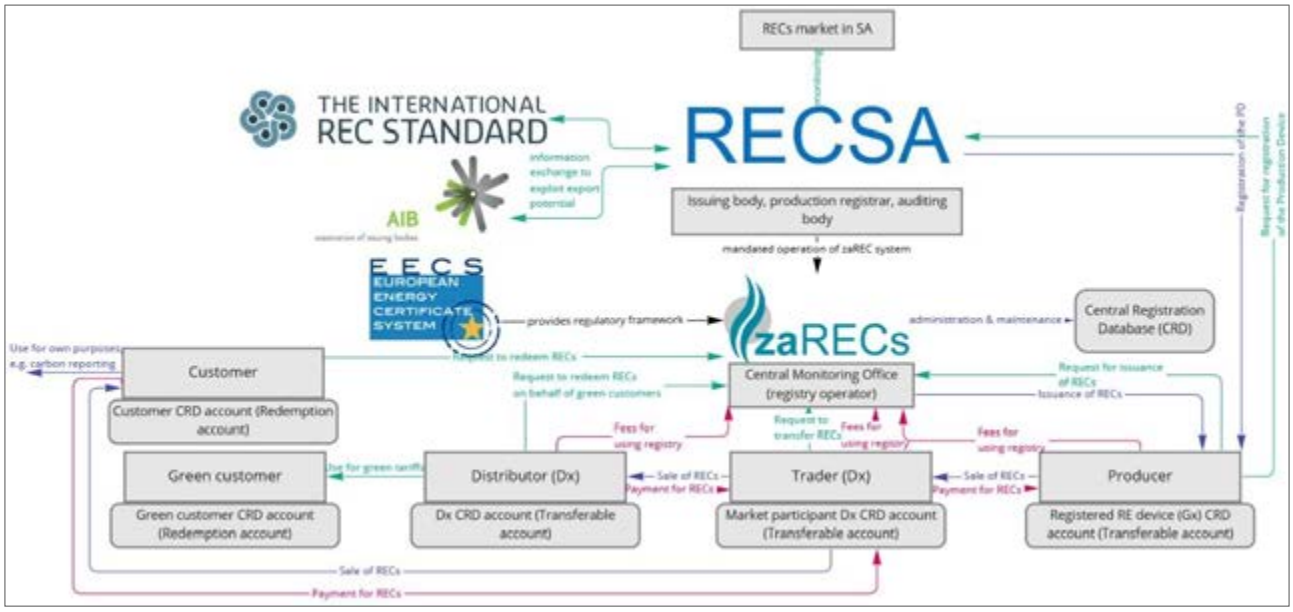


Figure 53: Certificate issuance, transfer, and redemption in SA (own representation)

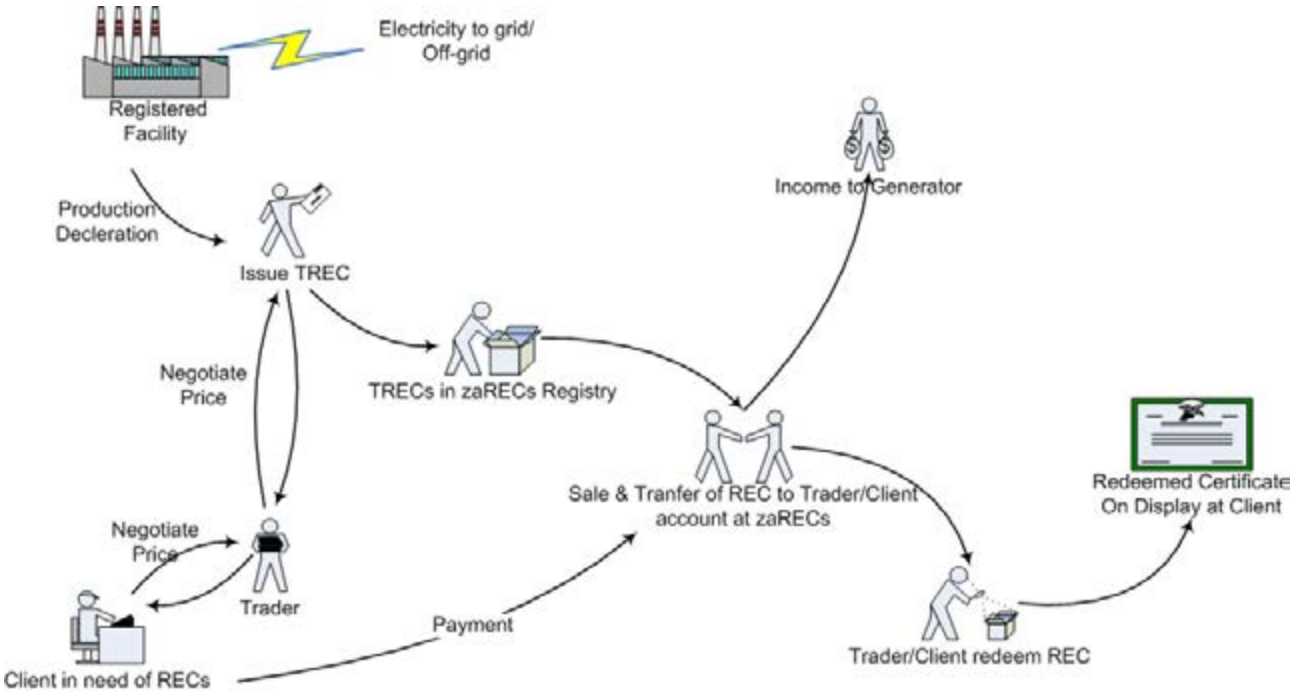


Figure 54: Trading with RECs in zaRECs

3.1.5 African Renewable Energy Certificate (AREC) Facility

The African Renewable Energy Certificate (AREC) Facility is a non-profit, African-based membership organisation working to:

- develop a continental REC registry that facilitates RE market access;
- provide capacity-building programmes for the development of local and regional REC systems and practices in Africa that promote local ownership; and
- develop rules and procedures that facilitate reliable national and international trade of ARECs.

The facility intends to build local capacity to increase financial flows into RE in Africa. African members have secured at least two-thirds of the voting rights. In the meantime, it operates as an issuing body for local systems.

Figure 55: Countries in which zaRECs operate

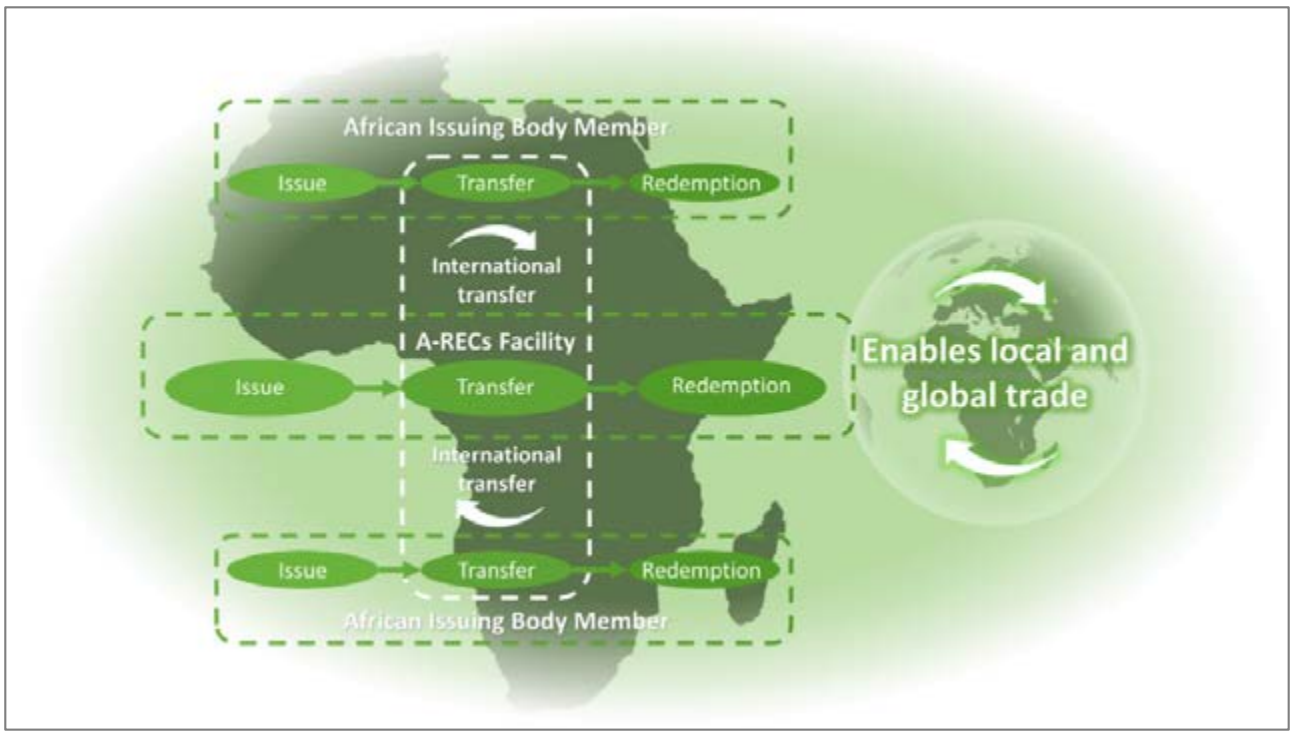


Figure 56: AREECs Facility as a hub between national African REC systems [99]

International trade could increase supply, but carbon reporting standards have not accepted certificates from other regions up to now. This could change if the Southern Africa region were to be considered one market in the way that RE100 considers AIB member countries and the USA plus Canada as one market. AREC Facility is currently in communication with the AIB, discussing the need for geographical boundaries. Tracking of certificates between different EAC systems is important to reduce the risk of double counting.

Enabling local ownership is one of the major goals of the AREC Facility. Often neglected in international initiatives such as the I-REC, AREC insists that fees should be collected inside the African continent and, thus, contribute to domestic capacity building. AREC could also contribute to greater disclosure of renewables in the energy mix of a country/region/continent.

The Basic Commitment, a set of rules developed by AREC, is based on the AIB model as it offers a good fit for the African continent with respect to facilitating the need for local development on a system basis.

3.2 Potential use cases in SA

In the following, the potential use cases for EACs in SA are investigated and described, differentiated by RE and green hydrogen, on the one hand, and the various market participants involved, on the other, such as in the context of RE generation, transmission and/or the future Independent Transmission System and Market Operator (ITSMO), distribution/retail, and the end customer.

In the Domain Protocol for the South African Voluntary TRECS Market published in 2010 within the South African Wind Energy Programme [100], the following use cases for TRECs are highlighted:

- Possible international trade with green attributes separate from physical power trade without grid connection costs and grid access challenges;
- Additional revenue stream for project developers;
- Monitoring and verification of RE production;
- Administration and verification of the greening of events and products.

The interest of potential users in green tariffs was documented in the White Paper on the Renewable Energy Policy of the Republic of South Africa in 2003. A “green” market survey indicated that there was a growing, albeit small, demand by consumers (household and commerce) who were willing to pay a premium for the benefit of receiving “green” electricity. This “green” premium should help to accelerate the commercialisation of RE technologies, thus reducing the government financial assistance required [101].

3.2.1 *Use case specifications*

For determining and evaluating specific use cases relevant to SA, the use cases analysed in section 2.4 were taken as a basis. Additional use cases contributed by stakeholders were also considered. The relevance of these cases was assessed in the national context, with the benefit to their main stakeholders as the benchmark.

Table 34: Assessment of the relevant use cases for certification of RE and green hydrogen in SA and their main beneficiaries

	Main beneficiaries									
Use case	govern-mental / regulatory bodies	RE production facility owners	hydrogen production facility owners	grid operator	producers of products with added value	potential RE project developers / investors	energy suppliers & retailers	(potential) customers in general	corporate customers	small end customers
Monitoring and verification of renewable energy production	4	4		4						
International trade of certificates with or without physical transmission of energy or hydrogen	5	5	5					5		
Additional revenue stream for project developers		4	4							
Administration and verification of the greening of events and products		2	2					2		
Claims about the RE energy usage of companies								5	5	
Carbon accounting, reporting and disclosure								5	5	
Use of certified RE for production of green hydrogen and other products with added value			5		5			5		
Data transparency on the energy mix		2				2	2	2		2
Special case of data transparency: full disclosure	2	2					2	2		
Offering green tariffs and sourcing all or a big part of the energy from renewable sources						2	2	2		
Regulatory requirements to source a portion of electricity from renewable sources	1	1								

Relevance Classification	
Low	1
Low to Medium	2
Medium	3
Medium to High	4
High	5

In the following, each use case is described in a text box. The summary considers its rationale, its market participants and their roles, and its beneficiaries in the South African context. From this, recommendations are derived on how to facilitate this use case.

Monitoring and verification of RE production

Rationale: *the regulatory regime in SA currently does not allow for excess energy to be sold back into the grid, so a reform to allow for this would stimulate and promote faster growth in the rooftop solar market. Reforms are, however, coming: according to the latest President's Address, the government wants to enable businesses and households to invest in rooftop solar by developing rules and a "FiT" pricing structure that would enable homeowners and businesses to sell surplus power to Eskom. If the RE production subsidy were finally to be introduced, for example, for rooftop PV, then monitoring and verification of generation data could occur automatically as is the case in the Netherlands. As such, a GU registered in the EAC registry would automatically get a subsidy based on the metering data delivered to a registry by grid operators in whose network a GU is connected.*

Possible market participants and their roles: *GU owners register in the EAC registry with their personal or company data and include information on their generation facilities. Grid operators send metering data on the generation of eligible generation facilities to the registry. Third-party actors, such as environmental verifiers, may validate the data sporadically or after an agreed period of time, if necessary. The registry operator sends metering data to the body responsible for subsidy disbursement. This body pays it to GU owners.*

Main beneficiary(ies):

- *Government (monitoring and verification of generation data are handled only once for both systems: the RE subsidy and EAC)*
- *GU owners (data submission is automated and does not require additional efforts; they receive a double benefit, getting both the subsidy and tradable EAC)*
- *Grid operators (the process of data transfer is streamlined, and fewer intermediaries are involved)*

Recommendations: *monitor regulatory developments on RE support mechanisms and enable mutual benefits using the same metering data.*

International trade of certificates with or without physical transmission of energy or H_2

Rationale: *international trade with certificates for RE and green hydrogen is in line with government development strategies. SA has abundant renewable sources and a good chance of becoming a large green hydrogen exporter. As the country is located far from the main consumption centres, trade with certificates is a way to provide an additional revenue stream. High prices, which one can expect in a green hydrogen market with few market players, provide good conditions for investment in production facilities. As regulation regarding energy use for production in developed countries is getting stricter in terms of carbon emissions of imports, this use case will gain more attractiveness over time. If SA were to take the initiative to develop and implement an EAC system for green hydrogen, it could greatly boost this sector and provide for stable revenues from imports by developed countries.*

Possible market participants and their roles: *government, together with the private sector, engages in research and development activities regarding green hydrogen production, distribution, and storage facilities. Once production has been established, a certification system can be implemented. It is necessary to work in collaboration with potential buyers and worldwide leading market players to develop a universal certificate standard that will enable international trade. In the case of RE, a standardised EAC scheme should be developed or elaborated on the basis of two existing schemes (I-REC and EECS) with enhanced involvement of the state.*

Main beneficiary(ies):

- *Government (complementing public support for RE and green hydrogen)*
- *RE and H_2 production facility owners (an additional income stream, which can be significant in the case of low supply and high demand for certificates from specific energy sources)*
- *Potential buyers (fulfilling the demand for standardised certificates)*

Recommendations: *monitor market developments in potential importing countries and international efforts to establish a green hydrogen certification standard to be ready to get on board early; monitor market developments regarding demand and import restrictions of unbundled RE certificates.*

Additional revenue stream for project developers

Rationale: *at the moment, it is difficult to predict whether this use case will play a significant role. Principally, public support schemes cannot be replaced by EAC trade. Through relevant price developments, this can be changed, especially for green hydrogen, for which the supply may be lower than the demand.*

Possible market participants and their roles: *GU owners by themselves or with the help of traders sell certificates at a national or an international level. Buyers with the corresponding demand will purchase them either on a marketplace (if this were to be implemented on the basis of, for example, a blockchain-based solution; see section 2.7.7) or through bilateral contracts.*

Main beneficiary(ies): *RE and H_2 production facility owners*

Recommendation: *monitor pricing developments on the EAC market; in this way, it will become clearer whether this use case can motivate project developers to invest in new projects.*

Administration and verification of the greening of events and products

Rationale: *the main target group for certificates from SA will be countries with middle to high income economies. The greening of products is gaining importance, so it could represent a reasonable use case. However, unbundled EACs from another part of the world may not be a very attractive option for greening events and could be viewed as greenwashing. The same would probably apply to products not produced in SA. Certificates for locally procured energy would be more desired.*

Possible market participants and their roles: *buyers with demand for greening an event or product will buy certificates for a corresponding amount of electricity/H_2 on a marketplace or over the counter.*

Main beneficiary(ies):

- *RE and H_2 production facility owners (an additional revenue stream)*
- *Buyers of certificates*

Recommendations: *monitor market developments at an international level to predict demand.*

Claims about the RE energy usage of companies

Rationale: *companies in SA are the largest consumers of electricity. There are more than 50 companies with operations in SA that have already committed themselves to procuring 100% renewable power by 2050 or sooner through the RE100 initiative. To bring together these companies with stakeholders from across the renewable value chain, a hub called RAiSE was launched in 2021 (for more detail, see section 2.4). Studies on corporate RE procurement in SA show that companies are increasingly interested in procuring RE and there is a continuously growing number of self-generation projects ([108]). For this reason, this use case is a very promising one in the South African context.*

Possible market participants and their roles: *companies seek ways to procure a share of, or their entire, electricity demand through renewables and consider several options for this: a PPA, self-generation, and the purchase of EACs. EACs have to be internationally recognised and standardised to enable companies operating in different jurisdictions to use them for RE claims.*

Main beneficiary(ies)*: companies (this instrument allows them to have a good image and withstand pressure from non-governmental organisations (NGOs), government, competitors, and customers)*

Recommendations: *encourage local companies to increasingly use RE and report on it, offering green tariffs and enhancing the importance of RE usage for corporate image.*

Carbon accounting, reporting, and disclosure

Rationale: *South African companies are very active in carbon reporting, with 96% of the top 100 companies reporting on sustainability – the highest level among its continental neighbours and the Middle East. The CDP reporting standard has been used here since 2006. South Africa's reputation for transparency of companies is well known. With further international activities towards harmonisation of reporting standards, an increasing number of companies will report on their carbon emissions and disclose this information to the public. Companies not moving in this direction may experience negative consequences of falling demand and not having a sustainable image. Given South Africa's ambitions to become a globally competitive nation, a boosted need for carbon reporting and disclosure can be predicted with high certainty, thus making this use case very promising.*

Possible market participants and their roles: *companies make an effort to reduce carbon emissions caused by their activities and energy supply, using EACs as one of the options. In that way, they facilitate compliance with the carbon reporting standards to which they adhere.*

Main beneficiary(ies): *companies (having a tradable standardised instrument recognised by all reporting standards)*

Recommendations: *encourage local companies to report on their sustainability and comply with the leading carbon reporting standards such as CDP Scope 2.*

Use of certified RE for the production of green hydrogen and other products with added value

Rationale: *the ambitions of SA to become a leading producer and exporter of green hydrogen, along with wide possibilities to do so, require the introduction of an EAC system to differentiate green hydrogen from H_2 not produced from RE. The additional revenue stream for H_2 producers from trade with green attributes will allow the investment of larger volumes in production facilities. This use case is of great importance for the whole development of a H_2 industry in SA and elsewhere.*

Possible market participants and their roles*: producers of green hydrogen and other energy-intensive fuels use RE and receive certificates for the corresponding amount of energy used. Hydrogen and other products are graded as green, and these attributes can be traded separately from the product. An EAC system will be expanded from certification of RE to certification of other energy carriers: this is the trend that can be observed in many parts of the world.*

Main beneficiary(ies):

- *Producers of green hydrogen and other products with added value (an additional revenue stream);*
- *Buyers of green attributes (adherence to carbon reporting standards and to strict regulation on carbon emissions of imported products).*

Recommendations: *monitor regulatory and market developments at an international level, and act quickly in adhering to certification standards introduced to exploit abundant local RE resources.*

Special case of data transparency: full disclosure

Rationale: *in the future, in order to create a level playing field between RE and conventional energy, full disclosure should be implemented. In that way, end customers will know everything about the energy mix they receive and can make more informed choices about the energy supplier and product. This trend stands out in Europe and some American states where it is, or is planned to be, embedded in the law and will most probably be taken over by other jurisdictions. By implementing an EAC system more or less from scratch, such a provision can be borne in mind. This use case will gain importance in the medium and long term just as the previous one.*

Possible market participants and their roles: *full disclosure assumes that energy producers, suppliers, or customers certify every energy unit they produce, deliver, or consume, independent of its energy source. This brings about full transparency with regard to production, supply, and consumption of energy.*

Main beneficiary(ies):

- *End users (full data transparency on their energy mix and increasing awareness of their energy consumption);*
- *Regulatory bodies (full market transparency, easy of monitoring and checking the compliance of the RE goals, and more investment for RE without public support);*
- *RE generation facility owners (more demand, more revenue);*
- *Energy suppliers (increased customer loyalty due to transparency).*

Recommendation: *this is the next step after the introduction of data disclosure for energy supply of end users.*

Offering green tariffs and sourcing all or a big part of the energy from renewable sources

Rationale: *green tariffs offered competitively imply a liberalised market, where customers can choose between energy suppliers or at least between different tariffs – for example, a conventional and a green alternative – from one supplier.*

Once implemented, green tariffs offer simplistic short-term RE purchases, flexibility, and convenience for the national footprint, with improved environmental credentials. It should be available to any customer who has clean energy targets. For companies, RE tariffs are an option for purchasing green electricity when negotiation requirements for PPAs and on-site generation are too complex. Investment in renewables is supported.

Possible market participants and their roles: *producers of renewable electricity can be contracted by energy suppliers/ retailers.*

For customers, as long as the amount of RE supply is not enough to cover demand, the suppliers have the power to decide whether tariffs are tailored to different segments, such as private, small-, and middle-scale enterprises, or only to a certain group.

With a growing variety of supply tariffs, there is also an opportunity for comparison platforms that provide market transparency and identify best alternatives according to customers' preferences.

Main beneficiary(ies)*:*

For end customers, competitive green tariffs promise user-friendly rates combined with the option to reduce the carbon footprint.

For suppliers/retailers, there is an opportunity to aggregate smaller installations of PV or wind into a bigger portfolio, where the purchasing process for a single end customer would be too complex. This may increase the incentives for project developers and investors.

Recommendations: *start selling the first RE tariffs or products addressing selected customer segments, monitor customers' choices and preferences, and expand the product portfolio while RE generation is expanding.*

Regulatory requirements to source a portion of electricity from renewable sources

Rationale: *it is a fundamental decision regarding the energy policy whether to implement a quota or renewable portfolio standard system to promote renewables. Currently, large renewable facilities are successfully constructed with the help of PPAs included in the REIPPPP. In contrast, for smaller RE facilities and devices, a way should be found to promote them; FiTs for rooftop PV will be developed in the near future. For recently developing RE markets, FiTs or net metering might be a better instrument. The effectiveness of quotas or an RPS is more tangible in mature RE markets, and as long as tendering remains the main public support instrument, an RPS is excluded from the regulatory discussion. Thus, this use case has a low relevance, unless the SA government decides to pursue it by changing the energy policy.*

Possible market participants and their roles*: government assigns requirements to energy suppliers to source a specific portion of electricity from renewable sources. This share increases over time. Suppliers can buy certificates to comply with these requirements.*

Main beneficiary(ies):

- *Government (easy to monitor progress and use for reporting; easy to plan and control emissions reductions; diversification of energy sources; promotion of domestic energy production; and complementing public support for RE);*
- *RE generation facility owners (an additional revenue stream, high predictability of demand, and promotion of mostly local sources).*

Recommendation: *evaluate opportunities to introduce RE regulatory requirements for suppliers in SA.*

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3.2.2 An EAC-related product suite for Eskom as electricity supplier

Whereas RECSA is building up a South African EAC market, Eskom, which is not a member of RECSA, is experiencing growing demand for RE products. Evidence shows that companies are interested in procuring RE. A green tariff pilot programme was implemented to test the appetite of the market for RE and define the price level customers are willing to pay. Green attributes for the tariff are from a registered CDM project and are already used for carbon offsets, so Eskom could only offer the veneer of "being green" and not actual environmental attributes, as this would be double claiming. Customers could use these attributes to report to or claim from environmental bodies; however, they can use these attributes to build a positive public relations image in their market and help shift customers' perception. The demand for the green tariff offered by Eskom – even without the possibility to credibly claim the RE use – proves that the interest is real. Eskom partnered with GIZ to expand on the work done in the pilot to understand what needs to be in place for Eskom and other RE producers to sell RE attributes for energy produced. This study resulted from that activity.

Within a liberalising electricity market in SA, Eskom will be playing a competitive role among other utilities and retailers for energy commodities. Demand for RE products is expected to grow due both to governmental commitments aligned with national and international climate protection goals and to the strengthening of international business initiatives for climate action. To respond to these requirements and to seize the opportunity to shape a RE-based future for the company, Eskom should develop distribution channels for the most important certificate-based electricity products shown in Table 35.

To contextualise the products in the table, the following further short- and long-term market opportunities and challenges were considered.

A green electricity label driven by Eskom

For the green electricity products shown, Eskom could develop a label that integrates additional requirements and environmental attributes for the contracted production facilities, for example, the age of the facility, regionality, and just transition aspects. Eskom could do this on its own or within a joint private business initiative to increase market coverage. Such a label could enhance the transparency and credibility of green electricity products on the domestic market and, hence, influence customers' choice. To support this purpose, an environmental NGO could act as ideational partner during the introduction and dissemination phase.

Is purchasing EACs an option to reduce carbon tax liability?

Whereas a national carbon offset market may benefit from increasing demand due to carbon taxation, this is not expected for a potential EAC market. Taxpayers are driven to reduce their own transport- and process-based emissions (Scope 1) or to offset emissions by purchasing carbon credits. Scope 2-related emissions have not been covered by the Carbon Tax Act so far (see section 3.3.1).

Will EACs play a role in the international trade of green products under carbon border adjustments?

The global demand for green products on the base of renewable electricity, such as H_2, ammonia, e-fuels, synthetic natural gas, and all other manufactured products, will be growing. Depending on the industry sector and on national or regional regulations affected by the supply chain of the product, product-related GHG balances will be requested. Upcoming regulation in the EU – the CBAM – is expected to create a demand for green products from non-EU countries (see section 2.6.4). Currently, only Scope 1 emissions reductions are to be included in the GHG balance of a product imported into the EU under the CBAM. EACs, as indirect (Scope 2) emissions reductions, are excluded. The I-REC Foundation is criticising this and, among others, it proposes stronger market-oriented and demand-driven modifications of the instrument. Under the current perspective, products will have an advantage when they are manufactured in a country with a mandatory EAC system and a corresponding RE quota, over products that are green based on voluntary contractual instruments.

Table 35: EAC-based products/sales options for utilities in a liberalising energy market in SA

EAC-based product	Description	Customer segment	Value proposition for customer	Selection of RE resources and bundling	Revenue stream	Contextual situation	Restrictions and limitations
Green pricing programme	This involves a combined product of RE and "brown" energy; shorter contract terms (typically month to month).	Smaller/ middle-sized companies with early RE engagement	Flexible option to purchase a certain share of RE	This is determined by the utility; buys/ contracts physical RE and EACs in the same grid region.	Rates are competitive with other green or brown products; rates are subject to short-term changes.	It may stimulate new customers to purchase RE.	RE resources are not compellingly "additional".
Green tariff	Sleeved PPA; the utility contracts RE projects and provides EACs to the customer; contract terms of three to seven years, longer agreements possible (10 to 20 years); combinable with labels representing additional (environmental) attributes.	Smaller/ middle-sized companies with RE targets	Stable price for purchased RE; long-term energy supply	The customer may have input on selection; the utility contracts physical RE and EACs in the same grid region.	The utility may allocate costs corresponding to the production source, including a premium, but price competition with other products is to be expected; the option "market-based rate" is based on the wholesale electricity market price.	Growing competition from other market participants is to be expected.	The utility/ retailer carries the financial risk; RE resources are not compellingly "additional".
Unbundled EACs	The utility sells EACs from own RE production or serves as trader; no contract necessary.	Companies of all sizes with RE targets	Cheap and most flexible way to reach RE targets	This is determined by the portfolio of the utilities/ traders; unbundled, not assigned to a grid region.	This has a low, but ongoing, revenue stream, which is not predictable (EACs are still cheap due to an oversupplied market); financial risk is on the customer's side.	Demand and, hence, prices may rise due to strengthening of national regulation or international reporting rules (for example, carbon taxation).	There is no additionality in oversupplied markets.
PPA	The utility installs a new RE production facility and contracts a customer in order to finance the project; contract length is 10 to 20 years; the utility provides residual power.	Larger companies with ambitious RE targets, with sufficient negotiation capacity	Stable, individual price for purchased RE; long-term energy supply; option of project selection (type, region)	A certain RE project is financed by the PPA; bundled (physical PPA).	The utility may allocate costs corresponding to the production source; there is an ongoing revenue stream with rate stability over the contract term; financial risk exists on both sides.	It results in new RE projects (additionality).	This requires individual negotiation; it is limited to both larger production facilities and larger customers.

3.3 Regulatory framework

This chapter reviews the regulatory framework in SA in relation to what exactly needs to change to establish a well-functioning, transparent, reliable EAC system that is ready for mass business and, at the same time, meets international standards so that EACs from SA can be accepted and used in other jurisdictions. Where existing regulations need to be changed or new regulations need to be drafted for this purpose, the need for change is identified, and the responsibilities of specific institutions for making the changes are outlined. To deal with the question of the economic beneficiary/owner of the EAC, a recommendation considering international best practices and the South African regulatory context is derived.

3.3.1 Current state of legal instruments and actors

Elements of the SA energy sector legislation relevant to the subject of this study are presented in Table 36.

Table 36: Elements of legislation of the energy sector in SA

Element of legislation	Yearofadoption	Relevant statutes and contents
Electricity Act	**1987**	The National Electricity Regulator (NER) has jurisdiction over the entire industry and regulates market access through the licensing of all producers (greater than 5 GWh/a), transmitters, distributors, and sellers of electricity. All electricity tariffs must be approved by the NER, which also regulates quality of supply and mediates disputes and customer complaints.
ElectricityRegulation Act (ERA) Second Amendment Bill	**December 2011**	14. "Conditions of licence (1) The Regulator may make any licence subject to conditions relating to the types of energy sources from which electricity must or may be generatedw, bought or sold 34. New generation capacity (1) The Minister [of Energy] may, after consultation with the Regulator, decide that new generation capacity is needed to ensure the continued uninterrupted supply of electricity. (2) A determination referred to in Section (1) must include provisions dealing with: b) the types of energy sources from which the electricity may be generated and an indication as to the amount of electricity that may be generated from each of such sources 35. Regulations, rules, guidelines, directives and codes of conduct and practice (4) The Minister may, by notice in the Gazette, make regulations regarding k) types of energy sources from which electricity must be generated l) the percentages of electricity that must be generated from different energy sources"
ERA Second Amendment Bill	**2022 (not yet adopted)**	The aim of this Bill is as follows: to establish a national regulatory framework for the electricity supply industry; to make NERSA the custodian and enforcer of the national electricity regulatory framework; to provide for licences and registration as the manner in which generation, transmission, distribution, system operation, reticulation, trading, and the import and export of electricity are regulated; to provide for the establishment of the transmission system operator; to provide a competitive multi-market structure for the electricity industry; and to regulate the reticulation of electricity by municipalities. The Minister's powers of determination have been expanded to include additional generation and electricity infrastructure. The Amendment Bill has included clarification language around the procurement of new generation capacity, expressly including capacity derived from new generation facilities, an expansion of existing facilities, or existing facilities not previously connected to the grid, but expressly excluding capacity from direct supply agreements or generation facilities for own use. This means that a facility that supplies electricity to a private customer may not also supply electricity to the buyer designated under a regulated IPP procurement programme, but facilities supplying electricity to Eskom, municipalities, the central purchasing agency, or the trading platform may participate in future IPP procurement programmes. In addition, the Minister may determine procurements for electricity infrastructure. This will result in the private sector being able to bid, own, finance, and operate transmission and distribution infrastructure through Department of Mineral Resources and Energy (DMRE-regulated procurement programmes. The Amendment Bill proposes the establishment and outlines the functions of the TSO, including accommodating an open market and allowing for a non-discriminatory competitive trading platform. It is anticipated that the TSO will initially be the transmission subsidiary of Eskom, for a maximum of five years [102].
White Paper on Energy Policy	**1998**	The White Paper details a policy of restructuring and liberalisation of the electricity supply industry and the primary responsibilities of policymakers and regulators. It includes Cabinet's acceptance of a 70-30 generation split between Eskom and the private sector, and the commencement of work towards the increased participation of the private sector in the electricity supply industry. In addition, it calls for open and non-discriminatory access to the grid for all generators of power.

Table 36: Elements of legislation of the energy sector in SA Continued

White Paper on the Renewable Energy Policy of the Republic of South Africa	**2003**	The goal is the same as in the RE White Paper; the target is to achieve it by 2013. Tradable renewable energy certificates (TRECs) and trade with them are mentioned as a potential financial instrument for the promotion of RE in SA. "TRECs whereby a renewable energy generator obtains a TREC, which he can trade nationally or internationally to users who want the 'Green' attribute, also have possibilities to finance renewable energy generation."
National Energy Regulator Act	**2004**	The Act concerns the establishment of a single regulator to regulate electricity and provide for matters connected with it.
Cabinet Decision on Single Buyer Model	**2007**	The Cabinet decision designated Eskom as the single buyer of (most) new generation.
Integrated Resource Plan	**2019**	This plan governs the overall objectives for the procurement of new generating capacity in the South African electricity sector. It involves the construction of additional PV capacity of almost 7 GW, wind of almost 17 GW, and about 5 GW of distributed self-generation by electricity consumers from 2020 to 2030. A build limit of 1 GW of solar and 1.6 GW of wind per year is in place. These will have to be reviewed in line with demand and supply requirements. In support of regional electricity interconnection, SA will participate in strategic power projects that enable the development of the cross-border infrastructure needed for regional energy trading.
Renewable Energy Independent Power Producer Procurement Programme (REIPPPP)	**2011**	This is related to a competitive tender process that has been designed to facilitate private sector investment in grid-connected RE generation in the RSA. Under the REIPPPP, independent power producers (IPPs) are invited to submit bids for onshore wind, solar PV, concentrated solar power, small hydro, biomass, biogas, or landfill gas projects. Submitted bids must, firstly, qualify for evaluation by meeting minimum compliance requirements, after which they are evaluated based on price and economic development criteria. Winning bidders sign PPAs, which are guaranteed for a period of 20 years. Moreover, the Small Projects IPP Procurement Programme was introduced in 2013, with the aim of procuring 200 MW from projects between 1 MW and 5 MW each. This programme aims to be simpler and less expensive for bidders in order to encourage participation from small and medium enterprises in SA, which are often unable to compete effectively with larger players.
Nationally Determined Contribution (NDC)	**2016, updated in 2021**	The updated 2030 emissions reduction target submitted to the UNFCCC in September 2021 follows the Presidential Climate Commission recommending 350 $MtCO^2e$ to -420 $MtCO^2e$ (including land use, land-use change, and forestry (LULUCF)). The measures include the procurement of RE and the construction of infrastructure for green hydrogen to support EVs and public transport.
Carbon Tax Act	**2019**	On 1 June 2019, the Carbon Tax Act came into effect (Act 15 of 2019). On implementation in 2019, the carbon tax levy was set at a rate of R120 per tonne of CO^2e of GHG emitted by a taxpayer. Tax can be reduced by using the various allowances provided in respect of each activity (such as trade exposure allowances, carbon offset allowances, performance allowances, and carbon budget allowances), which are provided in Schedule 2 of the Act. The carbon tax is paid to, and administered by, the South African Revenue Service (SARS).

Table 37: Actors in the electricity value chain in SA

Electricity generation		Transmission	Distribution	Retail	Export
Conventional	**Renewable**	- Eskom: NTCSA - ITSMO (in the future)	- Eskom: Distribution subsidiary - Municipalities	- Eskom - Municipalities - Traders - Small number of IPPs	Eskom
- Eskom: Generation subsidiary - IPPs - Private sector	- Eskom: Generation subsidiary - IPPs - Private sector				

The H_2 value chain is only just emerging, and actors are prevailingly private (Table 38).

Table 38: Actors in the H_2 value chain in SA

H_2 generation		Distribution	Retail	Export
Conventional	**Green**	- Sasol - Air Products - Air Liquide - Operators of gas pipelines	- Sasol - Air Products - Air Liquide	Not yet established
- Sasol - Air Products - Air Liquide	Future: - Sasol - Eskom - Engie - ENERTRAG			

A first step prior to giving recommendations for governance of an EAC system to be established in SA is to provide an overview of institutions and state-owned entities in the energy sector and their responsibilities.

Table 39: Authorities and state-owned entities (SOEs) relevant to the EAC system for RE and green hydrogen

Institution/Year of establishment	Related government Acts	Responsibilities
Department of Science and Innovation/1996	1996 White Paper on Science and Technology	It acts as custodian of national research, development, and innovation focused on new energy technologies; it has implemented the Hydrogen South Africa Strategy since 2008.
Department of Mineral Resources and Energy (DMRE)/2019 by merger of the departments	Electricity Regulation Act	The DMRE is a government policymaking body and a custodian of policy and planning for the energy sector, focusing on energy security through diversifying the energy mix of the country to include RES. - Considering and approving any application for deviation from any applicable integrated resource plan - Determining, in consultation with NERSA, the necessity for new generating capacity, the type of energy sources from which such new capacity is to be procured, the persons to whom electricity generated by such new generating capacity may be sold, and the requirements of the tendering process and private sector participation - The authority to issue regulations over a wide-ranging conspectus of matters and issues - Responsible for previous studies on TRECs - Responsible for the operation and maintenance of the Carbon Offset Administration System
- IPP Office/2010	REIPPPP regulation	The IPP Office ensures control and implementation of the REIPPPP in line with ministerial determinations for capacity, which reflect the 2019 Integrated Resource Plan. - Professional advisory services - Procurement management services - Monitoring, evaluation, and contract management services It acts as custodian of national research, development, and innovation focused on new energy technologies; it has implemented the Hydrogen South Africa Strategy since 2008.
National Energy Regulator of South Africa (NERSA)/2004	National Energy Regulator Act; Electricity Regulation Act	It is the energy regulator, custodian, and enforcer of the national electricity regulatory framework. - Regulation of electricity from renewable sources - Regulation of electricity tariffs - The powers to issue, amend, and revoke licences for the operation of generation, transmission, or distribution facilities, the import and export of electricity, and electricity trading - Approval of PPAs - Issuance of rules designed to implement the national government's electricity policy framework, the Integrated Resource Plans, and the ERA itself
Central Energy Fund (CEF)/1950	CEF Act 38 of 1977	The CEF contributes to the security of energy supply of SA through exploration, acquisition, development, marketing, and strategic partnership. - Operation and development of the oil and gas assets and operations of the South African government - Providing sustainable energy solutions for Southern Africa

Table 39: Authorities and state-owned (SOEs) entities relevant to the EAC system for RE and green hydrogen Continued

National Treasury/1910	Constitution of the Republic (section 13), Public Finance Management Act (section 2)	It governs fiscal and procurement policies and manages South Africa's national government finances. It is mandated to do the following: promote government's fiscal policy framework; co-ordinate macroeconomic policy and intergovernmental financial relations; manage the budget preparation process; facilitate the Division of Revenue Act, which provides for an equitable distribution of nationally raised revenue between national, provincial, and local government; monitor the implementation of provincial budgets; and support the optimal allocation and utilisation of financial resources in all spheres of government to reduce poverty and vulnerability among South Africa's most marginalised. It is responsible for carbon tax and carbon offsets policy.
Provincial departments and municipalities, South African Local Government Association (SALGA)/1909	Constitution; Organised Local Government Act 52 of 1997; Local Government: Municipal Structures Act 117 of 1998	SALGA regulates private RE generation (embedded generation) through by-laws and policies and is responsible for the procurement of energy services and electricity reticulation to communities
Department of Forestry, Fisheries and the Environment (DFFE)/ 2019	Section 24 of the Constitution of the Republic of South Africa, Act 108 of 1996; National Environmental Management: Air Quality Act 39 of 2004; National Pollution Prevention Plans Regulations, 2017	In 2019, the DFFE was established by incorporating the forestry and fisheries functions from the previous Department of Agriculture, Forestry, and Fisheries into the Department of Environmental Affairs (DEA). The department provides leadership in environmental management, conservation, and protection towards sustainability for the benefit of South Africans and the global community. The DFFE is responsible for mandatory emissions reporting, specifically for operation and maintenance of the South African Greenhouse Gas Emissions Reporting System (SAGERS) (the Greenhouse Gas Reporting Module of the National Emissions Inventory System (NAEIS)). Data on zaRECs flows into it.
Operation Vulindlela/ 2020	The President's Address to a joint sitting of Parliament on 15 October 2020	This is a joint initiative of the Presidency and the National Treasury to accelerate the implementation of structural reforms and support economic recovery. It aims to modernise and transform network industries, including electricity, water, transport, and digital communications. Operation Vulindlela reports directly to the President and to the Ministry of Finance and provides updates to Cabinet and the NERC. It supports the implementation of reforms in three ways:

In the following, some key legal instruments are reviewed with relation to a future domestic EAC system: the Voluntary TREC Initiative, the REIPPPP, and the Carbon Tax Act. Consequences for the ownership of EACs are discussed in each case.

3.3.1.1 Voluntary Tradeable Renewable Energy Certificate (TREC) Initiative

The Department of Minerals and Energy (DME, now called the DMRE) commissioned the feasibility study on TRECs, which was made public in 2007. Following this publication, the DME announced that it supported a voluntary TREC initiative in SA and constituted the South African National Tradable Renewable Energy Certificates (SANTREC) Team. In the research for this study on possible development paths for a certification system for RE and green hydrogen, the decisions made for this voluntary TREC system were considered and which considerations can be applied to the current situation in the international and national energy sector were evaluated.

SANTREC was comprised of a wide range of interested stakeholders: Government, the South African Wind Energy Programme (SAWEP), and public and private sector participants. It was tasked with undertaking and co-ordinating the voluntary TREC initiative.

The main objectives of the initiative were to [100]:

- develop a domain protocol (DP) for the South African REC issuing body (SA-IB) for international TRECs;
- develop a comprehensive checklist that would guide the implementation of the SA-IB Domain Protocol, indicating responsibilities, actions, etc.;
- analyse how the certificates could be used for verification and monitoring of a regulated production subsidy;
- analyse the status of RECs in other developing countries, including solar water heating, biomass (biofuels), and possible CDM-certified emissions reduction trade-offs;
- investigate and advise on any potential tax implications and financial intelligence issues for trading RECs and how these should be accommodated in the SA-IB Domain Protocol; and
- investigate and give advice on security of access and transactions on the web-based trading interface and how it had to be accommodated in the SA-IB Domain Protocol.

3.3.1.2 Renewable Energy Independent Power Producer Procurement Programme (REIPPPP)

The main instrument of RE promotion is the Renewable Energy Independent Power Producer Procurement Programme (REIPPPP, which was adopted shortly after the regulatory experiments with FiTs and has proven to be very successful. The programme started in 2011 and has had five bid windows until now (April 2022). It has attracted a large number of international and local private project developers who have put large amounts of private expertise and investment into grid-connected RE projects in SA at competitive prices. Another programme outcome has been impressive price reductions. Since 2012, SA has ranked among the top 10 countries globally in terms of RE IPP investments. Eskom, the state-owned national utility, is the sole offtaker of electricity from projects under the REIPPPP in the form of PPAs signed with successful IPPs. A single-buyer model facilitates the balancing and matching of electricity supply and demand, given that Eskom, through its Transmission Division, is responsible for real-time dispatch as well as the exclusive right to buy from IPPs or generators and to sell to distributors.

3.3.1.3 The Carbon Tax Act

In legislation in 2016, GHGs were formally declared priority air pollutants under the existing National Environmental Management Act. In 2017, this was followed by the gazetting of GHG reporting regulations, together with the requirement that large emitters had to submit pollution prevention plans detailing plans to cut GHG emissions, as well as document annual progress made in doing so. Company-level carbon budgets were introduced in 2015 for large emitters on a voluntary basis in a first phase, as indicated in the first UN NDC.

The Climate Change Bill, which has been considered by both Houses of Parliament from 2018, was finalised in 2022 and, as framework legislation, will provide a firm legal basis for further action, including mandatory second and subsequent phases of the carbon budget programme, as well as the establishment of sectoral emissions targets (SETs). In 2019, SA passed a Carbon Tax Act and started pricing GHG emissions in all sectors other than waste and agriculture, forestry and other land uses (AFOLU). Carbon taxation is one of the main political instruments for carbon pricing among ETSs (see section 2.6.4) and fuel excise taxes.

SA is the first African nation with a carbon pricing mechanism. According to the Organisation for Economic Co-operation and Development (OECD), South African carbon tax covers around 80% of the nationwide GHG emissions. The initial rate of 120 ZAR/tCO2e (7 USD/tCO2e) is in the lower range of worldwide carbon taxation rates or ETS prices for carbon allowances, and carbon tax revenue is below 1% of the nation's gross domestic product (GDP) [103]. From 2026 – when the second phase of the tax will be implemented – the rate will be increased with larger annual hikes to reach at least USD 30 (about ZAR 450) per tonne by 2030. Allowances will also fall away during the second phase. The first phase was extended by three years to the end of 2025.

Eskom, accounting for about 40% of South Africa's GHG emissions, and other fuel combustion industries will have to balance their investments in RE production against their projected tax rate. The responsibility of the regulator is to split the costs for the transformation in such a way that low-income and middle-class consumers do not have to carry a disproportionate burden. In this sense, EACs could be a means to reallocate part of the investment for RES to those who are interested in claiming to use RE, namely, the target group of companies pursuing emissions reduction goals.

EACs under the Carbon Tax Act

The carbon tax is levied on the sum of GHG emissions, resulting from fuel combustion, industrial processes, and fugitive emissions (Scope 1 of a company's emissions). As such, Scope 2 emissions are not affected by the Carbon Tax Act. Consumers are only indirectly asked to carry the costs when buying energy with fossil components. Hence, there is no option to balance any GHG emissions with RECs, and carbon-tax-related climate action will not result in additional demand for RECs.

According to current legislation, the interesting part in relation to the use of EACs for green energy is whether or not a green energy project has also generated carbon credits and whether such carbon credits are eligible/non-eligible under the Carbon Tax Act. Eligibility and non-eligibility are addressed in the regulations attached to the legislation.

South African Carbon Offsets Programme

As a specific feature on a global scale, a taxpayer under the SA Carbon Tax Act may claim up to either 5% or 10% (depending on its sector) against its carbon tax liability using carbon offsets. Carbon offsets simply mean buying carbon credits that have been certified by one of the schemes listed in the offset regulations (also see section 2.6.4). The carbon offset tax-free allowance permits firms to cost-effectively reduce the volume of taxable emissions by investing in low-carbon, mitigation projects. It also incentivises mitigation in sectors or activities not directly covered by the tax, including the AFOLU and waste sectors.

An offset must be allowed to a taxpayer derived from an approved project that started after 1 June 2019, is undertaken in SA, and is not subject to the carbon tax. Certification of projects follows globally recognised standards (CDM, VCS, including CCBA and GS). Carbon offsets can then be traded on the South African carbon market.

South Africa's designated national authority, the DMRE, was established to support the development and implementation of CDM projects under the Kyoto Protocol of the UNFCCC and operates the Carbon Offset Administration System (COAS) for the following processes [104]:

- The granting of an extended letter of approval (ELoA) for projects of offset credits;
- The listing of credit in the ownership repository;
- The transfer of credit ownership from the project owner to the taxpayer;
- The retirement of credits to gain an offset certificate (that is, to offset the liability of an entity that is eligible for the South African carbon tax) and submission to the South African Revenue Service (SARS).

South African Carbon Market

SA has had a carbon market since 2005, but in the early days, it did not grow as fast as many had expected. The new law from 2019 resulted in a revival of South Africa's flagging domestic carbon offset market, as companies were encouraged to reduce the amount of carbon tax on their books. South African consultancy Promethium Carbon estimated the carbon market to create offsets between 10 and 20 million tonnes of CO_2 per year [105]. Market observers had feared that demand for carbon credits could exceed domestic supply when credits from "old" projects certified under the CDM could lose their eligibility.

As such, the SA Carbon Tax Act was amended in July 2021 in such a way that proposals to include new definitions of national registries, the Verra registry, and certificates of voluntary cancellation were accepted. The regulations were amended to clarify that carbon credits from approved CDM projects issued under national registries would be eligible for listing as South African carbon offsets. The definition of the Verra registry was aligned with the official Verra documentation, and a new definition for a certificate of voluntary cancellation was included.

Under the Paris Agreement, each country must set up a climate action plan to reach its NDCs. Consequently, the need for new emissions reductions in lower-income and emerging countries has increased. One output of COP26 was that "old" CDM projects were allowed to transition to the new carbon market mechanism under Article 6.4 and that CERs issued under the CDM from 2013 to 2020 could be used to meet the first NDCs commitment period, as some emerging countries had requested.

It is the above developments under Article 6 that shone a new light on eligible credits that have been developed under the CDM and the successor mechanism. The authors claim that some of the provisions within the current Carbon Offset Regulations should be reviewed to ensure alignment with the new rules under the Article 6 successor mechanism once finalised. Sections to be adapted include crediting periods, renewals, registry systems, or cut-off dates for eligible offsets, etc.

A South African domestic carbon offset standard

In January 2022, the DMRE launched a draft framework for approval of domestic standards for the SA Carbon Offsets Programme. To ensure that there is no proliferation of credits of insufficient quality, the government was asked to effectively implement a reliable system that safeguards environmental integrity, ensures robust accounting, and encourages the promotion of sustainable development [106].

Use of carbon offsetting should be seen as the last step in the mitigation cascade. Therefore, capping offset use within carbon pricing instruments should be strengthened. The DMRE can use that momentum to develop robust domestic criteria and local standard frameworks to mitigate potential loopholes that could undermine climate mitigation efforts.

A set of additional sustainability effects is attributed to a domestic standard: it will help create jobs, develop capacity within local institutions, reduce reliance on international standards, cater for small-scale and micro community projects, and unlock mitigation potential in the AFOLU sector, which are not well covered by international standards, starting in 2023. With the 2022 draft paper, guidance is provided on the development of a framework for potential domestic standards. Consultation on the draft is continuing to ensure the generation of carbon credits, which can be used as part of South Africa's approach to Articles 6.2 and 6.4 of the Paris Agreement.

Should RECs be convertible into offsets?

In 2015, a report was published by Promethium Carbon, which analysed the possibility of converting RECs from the South African certificates market into carbon offsets. On the one hand, the authors cited the problem of insufficient demand for RECs and, as a result, low incentives to invest in RE plants. On the other hand, the registration of projects for the issuance of carbon offsets was reported to be very complex and not worthwhile for smaller mitigation projects. If a combination of offsets and RECs could be achieved, the study assumed, these challenges could be solved in a single step [97].

From today's point of view, it can be summarised that it is not recommendable to merge offsets and RECs in one instrument.

Research in an international context has shown that carbon offset markets and REC markets are different instruments with their own history, standards, and regulations.

Likewise, the further development of the frameworks points more in the direction of a sharp separation of the two instruments. The topic of double counting in every respect (in terms of issuance, trade, or transfer between countries), which has been intensively discussed until the very end, must urgently be taken into account when using the two mitigation instruments in the context of climate protection strategies at the same time. Both mandatory and voluntary trading systems have tightened their rules to avoid double counting.

Demand for both carbon offsets and RECs will increase worldwide and in SA. This is influenced by regulatory developments such as the Carbon Tax Act and the liberalisation of the electricity market as well as by private sector developments such as international business initiatives (RE 100 and CDP).

In this respect, there is no need to take a very special path in SA, but rather create a mandate to adapt national rules to international standards and, thus, to enable a transfer between the systems, whether international carbon markets or TRECs. Against this background, the 2022 draft paper on a domestic carbon offset standard points in the right direction.

3.3.1.4 EAC ownership

The question of who owns the green attributes of RE comes up frequently in discussions with stakeholders regarding a potential EAC system for SA. The main contractual documentation of the REIPPPP includes a PPA, concluded between the IPP and Eskom, and an implementation agreement (IA), concluded between the IPP and the DMRE. Neither the generation, issuance, retirement, and transfer of EACs nor their ownership, purchase, and sale are specifically provided for under the suite of REIPPPP contractual documents, and these aspects are notably absent from the PPA and the IA [107].

The definition of ownership should be in a designated PPA clause and outline how electricity from the REIPPPP belongs to Eskom but that IPP capacities, not contracted by Eskom, can trade green attributes. Legal advice could be helpful to determine how to handle green attributes in the existing and new contracts. Table 40 provides an overview of advantages and disadvantages if green attributes were to be owned by one or the other party.

Table 40: Advantages and disadvantages of ownership of green attributes from the REIPPPP by Eskom and IPPs Continued

Party	Advantages	Disadvantages
Eskom	- Accountability and transparency of using this additional value stream due to its state-owned nature - Many investment opportunities to construct new RE facilities, upgrade the grid to integrate more RE, and refurbish existing PPs, but also in social welfare projects - The interest of customers in green products is a given. - Portfolio expansion - Secure financing for additional RE capacities, paving the way for the energy transition - Tariff reductions for low-income customers due to higher profits from green tariffs	- This revenue could be used for paying debt and not for investing in RE; a monitoring system has to be implemented. - Legal ownership is unclear as yet, and IPPs may claim green attributes; there should be an agreement between the parties in order to reallocate benefits.
IPPs	- A step to a more liberalised electricity market with more active participants - Additional incentive to participate in the REIPPPP - More investor confidence and attractiveness - The opportunity to invest in more RE capacities and possibly in social welfare projects	- As Eskom as purchaser of energy under the REIPPPP accounts for such energy as having zero emissions in its own sale of electricity, if green attributes go to IPPs, it can be regarded as double counting. - Fewer opportunities to invest the revenue in RE infrastructure and social welfare projects - Possibly less accountability and transparency in using this revenue

Eskom will reduce the cost base of regulated tariffs by subtracting RE attributes from their contracts with IPPs. If Eskom were to be able to sell RECs for the electricity received from the REIPPPP, an independent institution would have to ensure that Eskom uses this extra income for electrification and construction of new RE facilities. From the developer's side, REIPPPP projects should not be able to claim RE credits because they have already been sold to Eskom (projects fully funded by the REIPPPP price) and this could result in a double counting issue.

3.3.2 The way forward

The latest Integrated Resource Plan for South Africa (2019) recognises that decarbonisation of the energy system requires a massive expansion of RE sources with significant shares being provided by solar and wind energy, which can be volatile. The most recent loadshedding events have revealed huge and aggravated deficits in generation capacity within the public supply system, which show that more investments in both larger and smaller decentralised RE production facilities are required.

In this section, the possible development paths for the South African energy sector in the context of certification are analysed. Energy certification cannot be considered separately from the whole framework of energy policy and regulation; therefore, an overview of the entire energy sector needs to be given before examining what direction it should take.

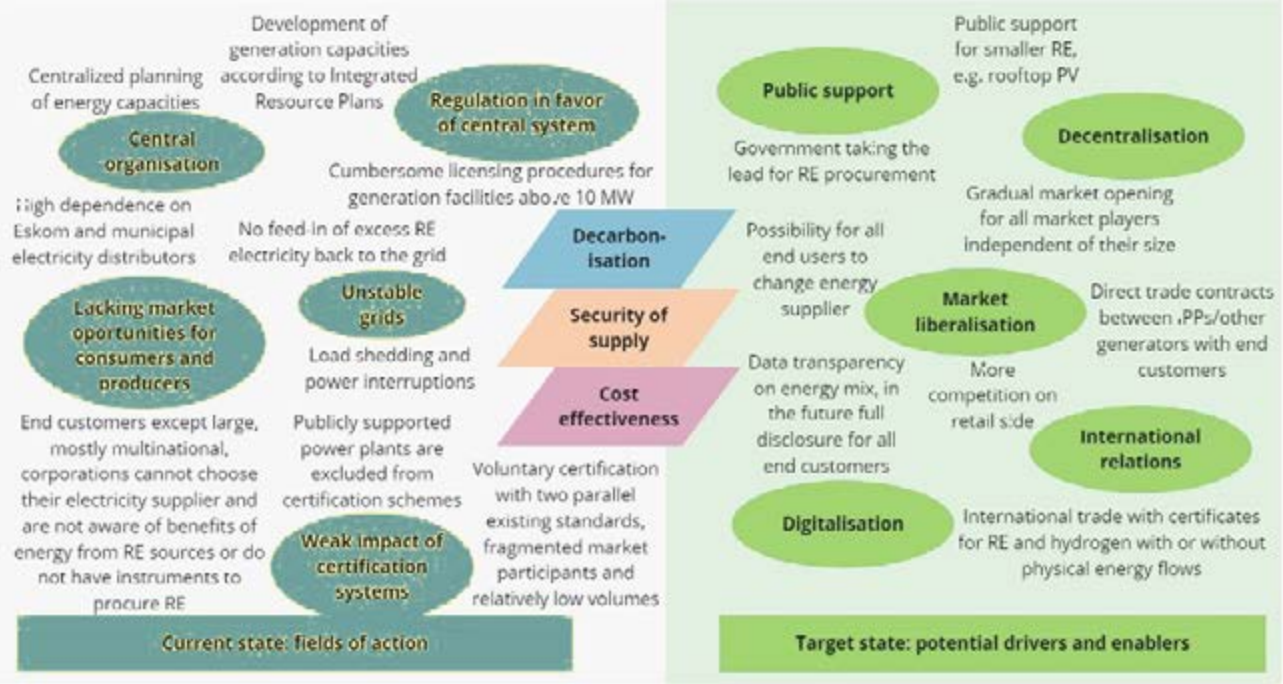

Figure 57: South African energy sector now and its target state in the future with relation to energy attribute certification and with the aim of an emission-free, secure, and economical system (own representation)

Figure 57 provides an overview of the current situation in the energy sector in SA, with attention to some of the imperfections and challenges that, at best, must be avoided. The gradual market liberalisation of the sector and its opening to market players of all sizes are envisaged as a desired state. To encourage more competition on the supply side, raising awareness among end users of the social and environmental benefits of RE is essential. This will help pave the way to open opportunities for international trade with energy and green attributes and to provide for data transparency, a streamlined energy policy, and several important measures at many levels.

In order to analyse how an EAC system for SA could be implemented, which is one of the measures enabling energy market liberalisation, a crucial starting point is to decide whether a certification scheme should be mandatory or voluntary. The research study determined that the implementation of a mandatory scheme like those in Europe and some other countries worldwide is the best proposition. SA already has some experience with voluntary EAC systems based on the EECS and I-REC, and although the DME commissioned a TREC feasibility study and signalled support at that time, institutional engagement has been limited. The degree to which both systems have been used and the number of participants has been quite low. The EECS and I-REC operations are largely non-transparent, and finding information on participants and market development is very difficult. Therefore, to get this system up and running and encourage significantly more producers and buyers to participate in it, one main recommendation is that it be embedded in the national law and it be made mandatory. If this is the case, corresponding legislation should be elaborated and adopted, including:

- inclusion of the certification scheme in the Electricity Regulation Act;
- assignment of responsibilities to supervise and control the functioning and operation of a scheme to a designated body (mostly public; for more detail see section 3.5);
- rules governing an EAC scheme in the form of, for example, ministerial regulation;
- the relationship between an EAC scheme, on the one side, and a public support scheme and carbon offsets, on the other; and
- further provisions if it is deemed necessary.

The world is also seeing a trend of switching from voluntary to mandatory certification systems. For example, in Turkey, the I-REC Standard was first implemented on a voluntary basis in 2015, and following high demand growth in the country, a national certification system is now being embedded in the national law. For investors and potential market participants, a mandatory scheme can bring additional confidence.

The next question is whether a market participant's use of an EAC scheme should be mandated or voluntary. Here, the recommendation is to proceed in accordance with the approach accepted in the EU, where the use of a scheme is voluntary. It should be made mandatory if certificates will serve as a tool to show compliance with state RE goals, such as RPS in the USA. This is currently not envisaged in SA, so it should remain voluntary, and market participants should decide whether they want to participate in the EAC market, depending on their specific benefits.

It is also very important to decide which international standard a South African EAC system should adopt. Table 41 summarises the pros and cons of the various options.

Table 41: Pros and cons of using international certificate standards for SA

Standard	Pros	Cons
US REC	- Very detailed regulation with clearly defined responsibilities and rights of market participants	- Based on compliance with RPS, which is not in place in SA - Not standardised and do not enable international trade
EECS	- First experience already gained with the domain protocol from 2010 and the establishment of RECSA/zaRECs - Standardised and robust tool to claim RE usage - (Potentially) enables international trade. - Clear regulatory framework that can be used as a prototype in SA law - H_2 may be made a part of the EECS soon; relevant operating rules will be developed.	- No export of certificates to the EECS members in Europe allowed - The main use case – data disclosure – does not represent a use case of major importance for SA. - Very regionally focused
I-REC	- First experience being a member of the I-REC already gained - Standardised and robust tool - Enables international trade with a constantly growing number of countries, including the most rapidly developing countries. - Supports both mandatory and voluntary national schemes. - Easy to implement and refine - Low-cost solution - Does not necessarily require regulatory amendments (if it remains voluntary). - Energy neutral; H_2 and other energy carriers will be certified upon development of a corresponding set of rules. - The registry and best practices can be used from the outset. - End users, independent of their size, be they individuals or organisations, can have accounts in the registry to purchase and redeem certificates. - Adherence to carbon reporting standards - A high degree of innovation; a member of the EnergyTag Initiative; encourages blockchain initiatives such as Foton Energy in Turkey [104]	- Local market participants may opt for cheaper certificates from abroad instead of buying certificates from SA. - Less rigorous standard than RECSA, which has been built up by South African stakeholders; certificates may be considered low-quality certificates; - Adopting the I-REC Standard gives less room for a domestic configuration of rules. - A weak relationship with other REC systems raises the risk of double counting.

As this analysis has shown, the standards relevant to SA are the EECS and the I-REC. The US REC standard is very specific and can hardly be used outside North America with its RPS obligations. Therefore, in the following section, two development paths based on the EECS and the I-REC are presented.

SA has already had experience with both standards, and now it is time to decide which experience is more promising and should be built on. Since the initiative on the voluntary TREC scheme based on the EECS was implemented, a lot has changed, including a more defined regulatory framework in Europe and the termination of the activities of RECS International on the voluntary market, as well as the establishment and rapid growth of the I-REC since 2014. As international trade with certificates is seen as a very important use case, the selected standard should allow for the maximal number of potential trade partners. As the EECS does not provide for conditions to export certificates to Europe, one option would be to become the first country outside Europe to use this standard and to become the leader on the African continent, encouraging neighbouring countries to adopt it as well. A more straightforward solution would be to rely on the I-REC, thus having immediate access to trade partners among the ever-increasing number of its members from the outset. The number of I-REC members on the African continent is also growing at an accelerated rate. The establishment of an I-REC Standard is a low-cost and relatively easy process. Users of the I-REC can benefit from harmonisation, recognition, market support, and independent oversight.

The decision about the certification standard was discussed in the stakeholder consultations. It is very important to have a discussion with EAC implementing organisations in SA to gather evidence about their experience with these standards.

Relation to public support schemes, trading restrictions, and eligible sources

Regarding the relationship between public support schemes and the certification system, the recommendation is that EACs also be issued for publicly supported energy. It provides for more transparency and less confusion among market players and can bring about additional benefits due to streamlined information flows and a reduced number of intermediaries. The Dutch model described in section 3.2 represents a well-functioning mechanism of data exchange and monitoring and verification of measured generation data between the tracking system operator and the authority responsible for reimbursement to RE producers. It is conceivable for something like be implemented in SA, especially once net metering or FiTs have been introduced.

Another important aspect in setting up an EAC system is whether any import restrictions will be in place. It depends very much on the selected standard. If the focus will be on trade with neighbouring countries, no restrictions should be implemented. If the I-REC scheme is selected, then South African consumers can freely decide whether they want to trade with international partners.

Further questions such as eligible energy resources and generation facilities should be discussed with relevant stakeholders. If the option of full disclosure were to be found acceptable, all generation facilities and energy resources would have to receive certificates in an amount corresponding to the volume of produced energy.

Separation of EAC and carbon offset schemes

Coming back to the further steps in developing an EAC system in the context of market transparency and climate action, the recommendation is to continue on the path taken over the last three years, both to foster standardisation for a national carbon offset market and to develop a robust EAC system based on international examples and frameworks, and not to mix up the two systems. RE installations should either be regulated to be eligible for only one instrument, preferably for the issuance of EACs or, if they are authorised for both instruments, monitoring of the allocation of certificates/credits must be carried out by an independent body in order to avoid unintentional or fraudulent double issuance.

Carbon pricing is an effective instrument within a nationwide mitigation strategy, but it should not stand alone. To raise the overall effectiveness and acceptability of the strategy, further political measures should be considered. The International Monetary Fund (IMF)/OECD suggests the following as key elements [100]:

- a balance between carbon pricing and reinforcing sectoral instruments (this is where the SA tax liability reduction regulation contributes);
- supporting public investment and technology policies;
- productive and equitable use of carbon pricing revenues;
- fossil fuel subsidy reform;
- measures for a just transition;
- addressing industrial competitiveness;
- reducing broader GHGs.

Markets and grids for an increasingly volatile electricity system

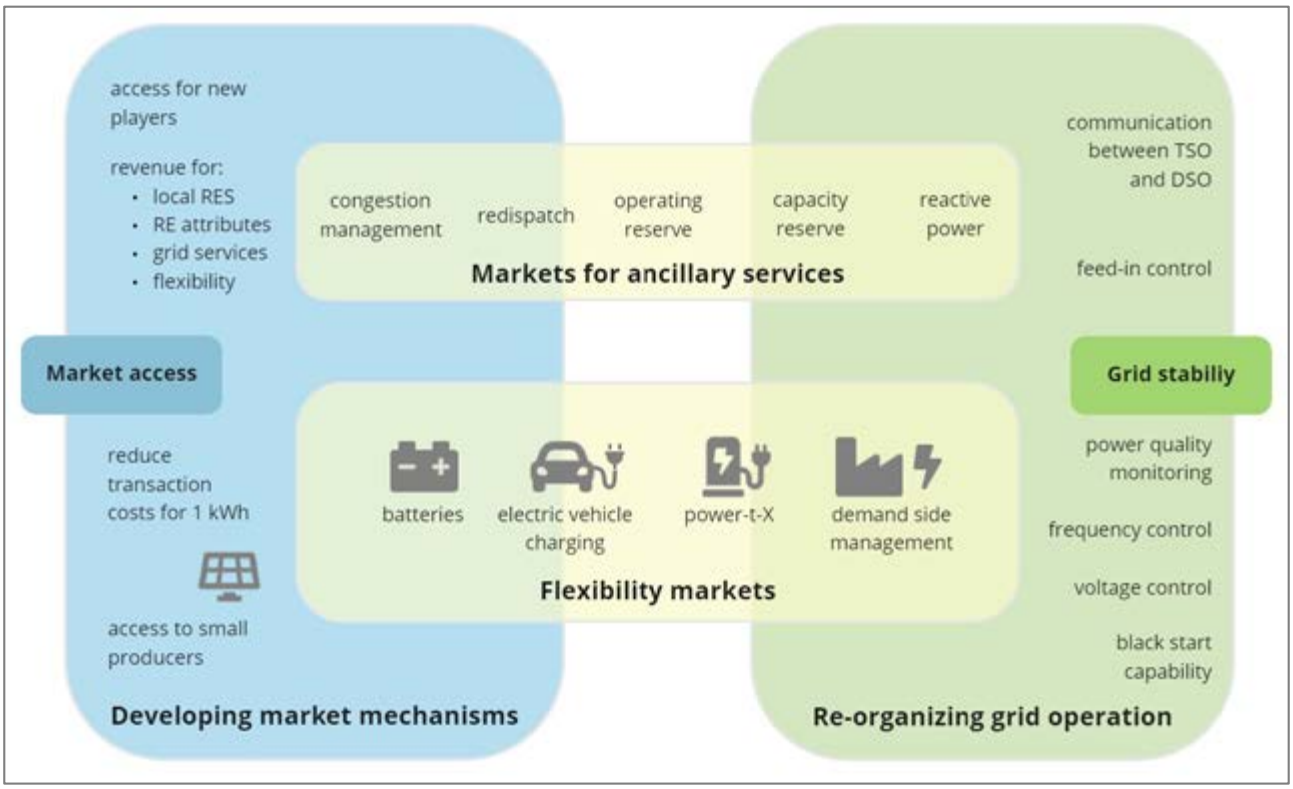

Figure 58: Additional reforms in electricity markets and grids

As an enabling instrument of a liberalising energy market, an EAC system plays a powerful role. To reveal its full impact, further reforms in the energy sector will be necessary. International electricity market developments show that levelised costs of energy for renewables are more and more competitive with conventional energy carriers. Even marginal costs of zero dollars per kilowatt-hour are possible in the shorter run. Consequently, a market mechanism that is based on the cheapest bid for 1 kWh will not be feasible in the future. Additionally, wind and solar as energy sources are volatile and require storage, flexibility, and the intelligent usage of energy. To deal with these challenges, both electricity markets and grids must be organised in a different way from before.

Figure 58 highlights the most important pathways to pursue within the energy sector in SA:

- **Developing market mechanisms**: the electricity market should provide access to a growing number of smaller producers or their providers – as well as to new players such as virtual power plants (aggregators) or flexibility providers (see below) – in such a way that transaction costs for the trade of 1 kWh become competitive. It is worth rethinking which are the assets that a market price should reflect: these may, for instance, be local electricity generation, renewable attributes, grid services, or flexible load.

- **Opening energy markets for flexible products:** the provision of flexibility (the ability to temporarily adapt specific electricity consumption or production to volatile supply) should be incentivised. Flexibility options such as battery storage systems, demand-side management, EV charging, and power-to-X, among others, must be further developed and adapted to local system conditions and their users. Flexibility markets promise both benefits for decentralised market players and added value for system operation.

- **Re-organising grid operation:** grids must reflect the increasing influence of decentralised and volatile generation connected to all levels of voltage, with adequate grid stabilising mechanisms. Ancillary services such as redispatch, congestion management, reactive power, capacity reserve, and power quality monitoring, among others, should be developed as instruments with marketable components. Fallback solutions for grid security should be co-ordinated between all voltage levels. The development of a wheeling mechanism, which has already been started, should be continued, with non-discriminatory access to the grid and fair and transparent cost allocation of grid usage.

Important enablers on the way to a decarbonised energy system are:

- **digitalisation** of both grid operation and market processes, including smart metering, grid transparency and operation systems, market platforms, and forecast and balancing systems;
- **political support** of decentralisation and participation: private or small-scale producers, for example, rooftop-PV owners, should be encouraged to feed into the grid by offering corresponding financial benefits, such as FiTs or attractive revenue from EACs;
- a **regulatory framework** that evolves with the new requirements and opportunities; and
- **professional qualifications** that reflect the future energy system in all affected areas, such as electrical and environmental engineering, regulation and law, business administration, information and communication technology, or systems analysis, among others.

Given these recommendations, the adopted pathway of unbundling the energy system into grid and market resources and the liberalisation of the electricity market should be decisively supported. It should be initiated immediately and with an ambitious time schedule.

3.4 Design and functioning of an electronic registry

In the domain protocol aimed at establishing a voluntary TREC scheme in SA, considerations regarding the registry have been explored. Because the plan was to become an AIB member and adhere to the European EECS, the registry software had to be in line with corresponding regulations. To save costs, two alternatives were proposed in the domain protocol:

1. Buy a registry or the registry services on the market like in those European countries that are not performing functions of a registry operator by themselves (Grexel performs registry operations for several European countries).
2. Be a "co-user" of an existing registry; that is, use a solution already used by other jurisdictions.

Applying the domain protocol to the current SA context would involve that second alternative is likely out of the question since European countries would not allow this. Their stance in view of market participants from other jurisdictions demonstrates that any import/export activities are preferable only within the European borders. Common usage of one registry would most likely be impossible. The utilisation of the I-REC registry, which is used by an ever-increasing number of I-REC members, would be possible if further development and state acknowledgement of the standard in SA were to occur.

The following section presents the major roles and corresponding account types, as well as other aspects of operating an electronic database or registry, to issue, track, and redeem certificates. These roles are analysed in the context of both I-REC and EECS standards. Within the EECS, every participating country can decide independently which roles and registry accounts are to be defined – except governing roles (which will be discussed in the next section). In contrast, the I-REC Standard has clearly defined roles – participant, registrant or generator, and local issuer – that must be adopted. In Table 42, the roles in the I-REC and the EECS are depicted. Market participants in SA who could take over these roles are proposed.

Table 42: Main roles in the I-REC and the EECS and proposed actors in SA

Roles in the I-REC			Roles in the EECS			Potentialactors in SA for this role
Title	**Account (yes/no)**	**Activities**	**Title**	**Account (yes/no)**	**Activities**	
Participant	Yes	- Receives, transfers, and redeems certificates.	**- Trader - Energy supplier - End user**	Yes (end users do not necessarily have an account)	- Purchases, sells, transfers, and redeems certificates and claims green attributes. - Deals with export and import certificates.	- Existing energy traders/traders of green hydrogen - Eskom - Municipalities - Independent energy suppliers, if they were to arise - Green hydrogen suppliers - Eligible customers having a right to choose a supplier
Registrant	No	- Offers registry-generating facilities. - Requests the issuance of certificates based on generation data.	**Power plant operator**	Yes or no (this is decided by an issuer)	- Offers registry-generating facilities. - Requests certificate issuance. - Sells certificates directly or through a trader/broker.	- Eskom Generation - IPPs - Additional energy generators that may arise with evolving market liberalisation and new support instruments being implemented - Producers of green hydrogen
Issuer	No	- Controls the registration of generating facilities. - Oversees and verifies the reporting of generation data. - Issues I-RECs based on reported generation.	**Issuer/issuing body**	No	- Oversees registry operation and the AIB Communications Hub. - Issues certificates based on reported generation. - Maps ownership of a GO and trading activities in software. - Transfers and cancels certificates on expiry. - Assesses GOs from foreign countries prior to import and can refuse the import.	- Public or private body selected to be an issuer

Regarding the design of a registry, the examples of selected registries in Part I of the study show that it has to be very clean, must not have any distracting details, and in order to optimally fulfil its purpose, must have certificate tracking that avoids double counting. The registry must provide an accurate, auditable, and permanent record of the life cycle of all existing certificates in the tracking database. There are also generally defined minimum requirements for storage backup and disaster recovery arrangements as well as requirements regarding data sharing, data security, and data storage. One certificate can only be in one account at one point in time. All transfers must be transparent to their participants, and reports on issued and redeemed certificates should be made available to the public and stakeholders.

The important aspect of fees has to be decided on by the issuing body in order to find a balance between cost recovery for registry operation and the economic interests of the participants, who may not necessarily have trust in the system or an active desire to participate in the beginning. Participants must clearly see how they benefit from using the system, and fees play a significant role and should not demotivate market actors to take part in the certification of energy. If SA decides to follow the I-REC path, fees must be negotiated together with the I-REC Standard. The local issuer can determine the best strategy for setting fees. It may be relevant to think about a cross-subsidisation strategy between registration and issuance fees to allow for the participation of smaller PDs on the market for little or no price.

Innovations such as GCs and blockchain should be considered after the first phase of implementing an EAC system, when market participants will be more aware of the system, and supply and demand will provide for a sufficient number of transactions. Based on a clearly defined regulatory framework, such initiatives can bring refinement to the system. To gain insights into existing activities, a South African issuing body and other relevant stakeholders can become members of the EnergyTag Initiative analysed in detail in section 2.7.7. In that way, they can participate in demonstration projects and understand whether the technology and corresponding framework are suitable for the South African context.

All questions regarding different aspects and functionalities of a registry are part of the implementation phase and, as such, are to be developed on behalf of the designated party. Interaction with market participants accompanying subsequent release steps will help to expand user experience and increase user-friendliness.

3.5 Governance and registration body

Based on the findings in Part I of this study, recommendations for suitable institutions to monitor and supervise the issuance and trading of EACs in SA were derived. These are identified and justified below.

Within the previously mentioned attempts to set up a voluntary TREC scheme in SA, the following candidates were considered for being an issuing body:

- The regulator (NERSA)
- The TSO or the independent system operator (ISO) (currently Eskom Transmission or the ITSMO if it were to be established as a result of transformation of a single buyer model)

The authors of the domain protocol recommend appointing the ISO to be the issuing body in SA, since it is important that the issuing body be under the control and supervision of the regulator.

Regarding the roles of production registrar, production auditor, and registry operator, two options were considered: either the issuing body could outsource the registry operation and perform production registration and auditing, or the issuing body could outsource all three of these functions. The recommendation is to outsource the registry operation to a competent vendor (as in Spain, where the issuing body CNMC sets a tender every two years to outsource administrative operations and IT developments to operate the registration database, or in Serbia and other European countries, where Grexel has taken over the registry operation).

The key functions of PD registration and auditing can be handled by the issuing body or be outsourced. The main tasks of registration and auditing bodies are to verify and audit that the EAC power stations are eligible for renewable certificates in line with the domain protocol. These are principally the same functions that the Renewable Energy Purchasing Agency (REPA) had under the REFiT scheme (a renewable energy feed-in tariff mechanism), where REPA had the right and obligation to inspect RE generators. The same institutions cannot be selected, since REFiT was replaced by the REIPPPP, and REPA no longer exists, but the distribution of responsibilities may serve as an example.

Table 43 outlines the various actors proposed for different governance roles and the pros and cons of taking over this role for a specific organisation. This scenario assumes that a mandatory EAC system will be implemented; otherwise, the whole system can be organised by private actors without state oversight. It is also assumed that the issuing organisation will be a local organisation and not a default issuer as has been the case until now with the GCC, which is responsible for the realisation of the I-REC Standard in SA. Having a local issuer is encouraged by the I-REC and is expected to contribute in a stronger way to the local economy and to acceptance and understanding of the scheme by local stakeholders. The newly designated issuer can build up a system in collaboration with the GCC. The GCC can help by training an issuer to execute its role.

Table 43: Proposed entities for governance of an EAC system in SA

Entity	Pros	Cons
Governance body (may also be responsible for disclosure)		
DMRE	- Government policymaking body - Custodian of the energy policy and planning - Development of a regulation for an EAC system - Overseeing the regulator in every case - The provisions of ERA (Article 34) regulations regarding types and shares of energy sources from which electricity must be generated	- Possibly lacking awareness of an energy tracking attributes system and its benefits, structure, and use cases
Issuing body		
DMRE	- The ability to hold the whole EAC system in one hand	- Possibly not having capacities for this and wanting to give this mandate away to the next hierarchy levels
NERSA	- Energy regulator and custodian and enforcer of the national electricity regulatory framework - Regulation of electricity from renewable sources - Oversight of the H_2 industry - A good overview of market players due to licensing procedures for the whole electricity value chain - Independence from certificate market activities (generation, purchase, sale, trade, and cancellation of certificates)	- Possibly lacking awareness of an energy tracking attributes system; capacity building needed
Eskom	- State-owned enterprise, so is under the control and supervision of the regulator	- In the middle of the unbundling process and possibly not the right time to give it new tasks - Independence criteria not being fulfilled, since Eskom is a possible market participant in an EAC system
NTCSA	- Remaining state-owned - Independent from Eskom's generation and retail activities, so the independence criteria are fulfilled	- Structure not yet settled
ITSMO	- State-owned enterprise, so is under the control and supervision of the regulator - Independence from certificate market activities (generation, purchase, sale, trade, and cancellation of certificates) - May be suitable to give it new tasks because of new flexible structures and responsibilities not yet being settled	- Establishment not yet realised and no specific plans yet
Production registrar		
NERSA	- Licensing and registering of RE generators and H_2 producers/distributors - Easy to add this task to its responsibilities - The ability to combine the roles of the issuer and production registrar - Information going directly to the registry without intermediaries and data losses	No
Authority to supervise a public support scheme such as FiTs	- If the monitoring and verification of production data for an EAC system and RE support scheme will be deemed relevant - The possibility of organising it (almost) automatically, and the RE producer will automatically receive both - Easy to implement and have oversight	- No specific plans about establishing such a body and the launch of relevant public support schemes

Table 43: Proposed entities for governance of an EAC system in SA Contiued

Entity	Pros	Cons
Production auditor		
NERSA	- Licensing and registering of RE generators and H_2 producers/distributors - The possibility of combining the roles of the issuer and production auditor - Information going directly to the registry without intermediaries and data losses	No
Eskom or NTCSA	- The possibility of combining the roles of the issuer and production auditor	- The requirement that unbundling must be completed - The need for access to data from the distribution grid, to which a lot of generating facilities are connected - Information flows with the DSO not set up yet
Specified environmental auditors	- Defined clear responsibilities - Independence	- No such institute yet - The need for substantial training
Authorised measurement body		
Eskom or NTCSA	- Owner and operator OF all the high-voltage electricity transmission network and about 60% of the distribution network - Easy delivery of generation data - A short distance to a future issuer (is either an issuer by itself or reports to NERSA)	- The requirement that unbundling has to be completed - Unbundling of the distribution subsidiary from Transmission - The need for access to data from the distribution grid, to which a lot of generating facilities are connected - Information flows with the DSO not set up yet

In any form in which government institutions take over the essential tasks of the EAC system, the participation of market participants in the targeting, standard setting, and further development of rules should nevertheless be involved. This can be done, for example, in the form of an advisory board.

3.6 Conclusions

In Part 2 of the study, the substantial knowledge base developed in Part 1 was used and ways of setting up a well-functioning EAC system in SA were explored. The prior experience of using the EECS and I-REC standards in SA was considered, and the implementation of a system with a new structure, actors, regulatory framework, and registry building on existing knowledge and international best practices was examined.

The clear recommendation before stakeholder consultations was to implement a mandatory EAC system based on the EECS or I-REC Standard. The I-REC Standard was favoured because it would be easy to implement or refine from previous attempts at building such a system; it would enable international trade and could be launched with almost no cost. Although this standard is overseen by the I-REC Foundation, local stakeholders would have a very active role to play in facilitating national implementation in compliance with national regulations. In this way, the I-REC would ensure that certificates are issued in adherence to international guidelines and leading carbon reporting standards and initiatives such as RE100.

The engagement and support of local stakeholders would be critical to the success of an emerging national EAC scheme. It would be particularly important to secure the understanding and interest of local producers so that they would request the issuance of EACs for their production. Without these requests for issuance, there can be no trade of EACs. It would also be important to motivate energy consumers in SA to buy EACs to claim that they are consuming RE or green hydrogen. The first buyers could be MNCs with operations in SA who are committed to buying 100% RE across their operations, but who would not have been able to buy South African RE before the introduction of the EAC scheme. If it were to come to a mandatory scheme, substantial regulatory work would have to be done.

Discussions were held with stakeholders to explore how an EAC system would need to function in terms of governance and the important steps to get this system up and running were outlined. The findings of these discussions and the final recommendations can be found in the summary report.

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Annexure I

Compliance markets in the USA

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Annexures

Table 44: Compliance markets in selected states in North America

State	RPS	Carve-outs and multipliers	Subject to the RPS	Governance body	Notes	REC tracking system	Links
Arizona	15% by 2025	4.5% being procured from distributed energy technologies	Investor-owned utilities and electricity co-operatives serving retail customers in Arizona	Arizona Corporation Commission (ACC)	Utilities subject to RES must submit compliance and implementation plans to the ACC annually. Utilities recover RES costs through a monthly surcharge. Each affected utility may adopt its own surcharge, but it must be substantially like the sample tariff provided in the rules, and it must receive approval from the ACC.	WREGIS (the Western Electricity Coordinating Council's (WECC) Western Renewable Energy Generation Information System)	https://programs.dsireusa.org/system/program/detail/268
California	60% by 2030	None	All load-serving entities	California Energy Commission and California Public Utilities Commission	The meter of an RPS-certified facility must be tested by a third-party organisation, recognised by the Department of Labor Occupational Safety and Health Administration's Nationally Recognized Testing Laboratory Program.	WREGIS	https://www.energy.ca.gov/programs-and-topics/programs/renewables-portfolio-standard/renewables-portfolio-standard-0
Colorado	30% by 2020 (IOUs); 10% or 20% for municipalities and electric co-operatives, depending on size; 100% clean energy by 2050 for utilities serving 500 000 or more customers	Class I RES (including DG): 40% by 2030; Class I or II (biomass, waste-to-energy, and certain hydropower projects): 4% by 2030; Class III (CHP, waste heat recovery, and conservation): 4% by 2030	Investor-owned utility, local government, and retail supplier	Colorado Public Utilities Commission	RECs expire at the end of the fifth calendar year following the calendar year in which they were generated.	WREGIS	https://programs.dsireusa.org/system/program/detail/133
Connecticut	48% by 2030	Class I RES (including DG): 40% by 2030; Class I or II (biomass, waste-to-energy, and certain hydropower projects): 4% by 2030; Class III (CHP, waste heat recovery, and conservation): 4% by 2030	Investor-owned utility, local government, and retail supplier	Public Utilities Regulatory Authority	The REC lifetime is two years. It is required that utilities enter into long-term contracts (15 years) for renewable energy credits from zero-emission Class I renewable energy facilities (on the customer side of the meter) up to 1 MW and from low-emission Class I renewable energy facilities up to 2 MW. Residential solar is promoted by requiring the electric distribution companies to sell a portion of electric load through solar home renewable energy credits (SHRECs).	PJM-EIS's Generation Attributes Tracking System (GATS)	https://dcpsc.org/Orders-and-Regulations/PSC-Reports-to-the-DC-Council/Renewable-Energy-Portfolio-Standard.aspx

District of Columbia	52% by 2025; 100% by 2032	Solar: 3.45% by 2025; 5.5% by 2032	Investor-owned utility and retail supplier	Public Service Commission	RECs are generally valid for a three-year period from the date of generation. Solar RECs (SRECs) are valid for a five-year period from the date of generation. Solar PV facilities of 10 kW or less and solar thermal facilities that produce or displace less than 10 000 kWh per year are permitted to use an engineering estimate to generate SRECs rather than metered generation data.	PJM-EIS's Generation Attributes Tracking System (GATS)	https://dcpsc.org/Orders-and-Regulations/PSC-Reports-to-the-DC-Council/Renewable-Energy-Portfolio-Standard.aspx
Delaware	28% by 2030; 40% by 2035	Solar: 3.5% by 2025; 5% by 2030; 10% by 2035 Multipliers: 300% for in-state customer-sited PV and fuel cells; 150% for wind turbines sited in Delaware (DE); 350% for offshore wind; 110% for solar or wind installation in DE with 50% equipment manufactured in DE; 110% credit for solar or wind installation with a minimum of 75% workforce	Investor-owned utility, retail supplier, municipal utilities, and rural electric co-operatives	Delaware Public Service Commission	In 2021, the state extended its RPS to include long-term targets of 28% by 2030 and 40% by 2035. The changes retained the state's previous target for 2025 of 25%.	PJM-EIS GATS	https://programs.dsireusa.org/system/program/detail/1231/renewables-portfolio-standard
Hawaii	40% by 2030; 70% by 2040; 100% by 2045	None	Investor-owned utilities	Public Utilities Commission	Hawaii was the first state to adopt a 100% renewable energy goal. The Commission requires the state's retail electric suppliers to disclose details regarding the fuel mix of their electric generation to retail customers and in annual reports.	None	https://programs.dsireusa.org/system/program/detail/606
Iowa	105 MW of generating capacity for IOUs	None	Investor-owned utilities (MidAmerican Energy and Alliant Energy Interstate Power and Light)	Iowa Utilities Board	Iowa first enacted its RPS in 1983, becoming the first state to do so in the USA. Since the implementation of its RPS, Iowa has moved far beyond its original goal, with well over 7 000 MW coming from wind alone.	No (utilities may only participate in REC credit trading programmes for RE production unrelated to fulfilling their RPS requirements)	https://programs.dsireusa.org/system/program/detail/265
Illinois	25% by 2025 to 2026	DG: 1% of annual requirement for IOUs Wind: 75% of annual requirement for IOUs; 60% for alternative retail electric suppliers PV: 6% of annual requirement	Investor-owned utility and retail supplier	Illinois Power Agency	Electric co-operatives and municipal utilities are exempt from RPS requirements.	PJM-GATS and M-RETS	https://www.ncsl.org/research/energy/renewable-portfolio-standards.aspx