Transmission Development Plan (TDP) 2015 - 2024
Public Forum

Transmission Strategic Grid Study 2040

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Powering your world
Integrated Resource Plan

- The Department of Energy (Energy Planner) is accountable for the Country Energy Plan as per recently published regulations.
- The Country Plan is also termed the Integrated Resource Plan (IRP).
- The Integrated Resource Plan (IRP) is intended to drive all new generation capacity development.
- NERSA licences new generators according to this determination.

Strategic Grid Plan

- The Strategic Grid Plan formulates long term strategic transmission corridor requirements.
- Plan is based on range of generation scenarios, and associated strategic network analysis.
- Horizon date is 20 years.
- Updated every 2-3 years.

Transmission Development Plan

- Transmission Development Plan (TDP) presents transmission corridor requirements.
- Plan covers a 10 year window.
- Updated annually.
- Indicates financial commitments required over 10 year period.
Linkages between the various plans

- **Expected demand**
  - Current capacity and expected projects
  - Resource constraints
  - Implementation strategy

- **Adequacy criteria**
  - Determine energy and capacity shortfalls
  - Select preferred options to fill gaps

- **IRP**
  - Determine infrastructure requirements

- **Investment Plan**

- **Disaggregate Demand Spatially**
  - Disaggregate Generation Pattern Spatially
  - Strategic Network Scenario Analysis

- **SGP**
  - Select robust generation scenarios

- **10 Yr TDP**
  - Tx Connection Applications
  - Detailed Network Analysis
  - Adequacy criteria

  - Voltage Limits
  - Thermal Rating
  - N-1 Contingency
  - N-2 Contingency
Capacity Planning vs Transmission Planning

(a) Load Demand Forecast

- System Demand Forecast

(b) Capacity Plan

- Capacity Project Funnel

(c) Capital project funnel

- Volume & type

- Spatial & transportation

- Eskom

40 GW

RTS
Coal
PS etc.

>40 GW

- Eskom position (reference) - 60% peak availability, 33% grid availability, 100% grid security

- Possible 2400 MW Mid Merit Trans Kalahari Interconnector

- Brown outer circle indicates project out of borders

- Delta
- Charlie
- 872
- 2400
- 4200
- 500
- Yankee
- 800
- 2100
- Alpha
- Hotel
- 1332
- 4200
- Foxtrot
- 4200
- 500
- 1800
- Golf

- Concentrating Solar
Current Transmission power flow

(a) Load Demand Forecast
- Generation exceeds local load
- Other load centres require imports
- Tx designed to feed load centers from power pool

(b) Capacity Plan

(c) Capital project funnel
Impact of location on corridors - Inland Scenario

Capacity Roll out
- Matching capacity scenario plan with available project

(a) Load Demand Forecast

(b) Capacity Plan

(c) Capital project funnel

Inland Scenario
- Large coal
- Spatial project location
- Nearest Gx feed nearest load
- Large northern Tx corridor

40 GW

RTS, Coal, PS etc.

40 GW

>40 GW

(c) Capital project funnel

(c) Load Demand Forecast

(c) Capacity Plan

(c) Capital project funnel

(c) Load Demand Forecast

(c) Capacity Plan

(c) Capital project funnel
Impact of location on corridors - Coastal Scenario

Coastal Scenario
- Large nuclear displacing generation from the north to the coast
- Reduced northern corridors
- Reversing flow & increased corridor size

Same Capacity Plan for each scenario
Vastly different Tx plan
Huge transportation risk!

Issues to Consider
Servitude and EIA restrictions
Lead times:
- Long Tx lines 6 - 8 years

Use all appropriate proven technology available
- HVDC, EHV AC, HVDC conversions of existing AC lines

Transmission technology choice must be compatible with strategic power system development plan
Purpose of the 2040 Network Study

- To adapt to the uncertainty of future load and generation

- To identify the critical power corridors and constraints on the transmission network

- Unlock and create a flexible and robust grid to be able to respond to the changing future needs of the country

The 2040 Transmission Network Study was undertaken to determine the development requirements of the future transmission grid to accommodate the expected load demand needs and the potential impact of future generation scenarios using the 2010 Integrated Resource Plan (IRP) as a baseline.
Organisations already engaged

Within ESKOM:
- Generation
- Primary Energy department
- Gas & Liquid Fuel department
- Group Capital
- Project Development department
- Distribution
- Nuclear Department
- Strategy & Risk Management
- Transmission
- Southern African Energy

Outside ESKOM:
- SAWEA
- SASTELA
- SAPVIA
- CEF
- Solar Park Project
- Stellenbosch University
- Govt. Departments
  - DPE
  - DOE
  - DEA
  - DWAF
  - DAFF
  - DPW
The Three Generation Scenarios

- **The IRP 2010 base Scenario (BASE IRP)**
  - 2010 IRP extended to 2040
  - Coal fixed at 2030 level
  - Balance in similar ratio to 2030 mix

- **Increased Renewables Scenario (GREEN)**
  - Replaced nuclear component with RE base generation equivalent
  - CSP (with storage)/ Wind with CCV of 30% / Natural Gas

- **Increased Imports Scenario (IMPORT)**
  - Doubled imported power by 2030
  - Reduced coal & nuclear

*New draft IRP Update was reviewed and found that above scenarios still appropriate and 2040 Study results and findings are applicable*
2040 Network Study – Generation Resource Map
Eskom Coal Areas

Coal A
Coal B
Coal E
Coal D
Coal G
Coal F
Coal C
2040 Network Study – Generation Resource Map
Public Coal Map
2040 Network Study – Generation Resource Map
Coal Map & Eskom Coal Areas
2040 Network Study – Generation Resource Map
Eskom Nuclear Areas
2040 Network Study – Generation Resource Map
Eskom Wind Areas
2040 Network Study – Generation Resource Map
Wind Map of South Africa
2040 Network Study – Generation Resource Map
Public Solar Irradiation Map
2040 Network Study – Generation Resource Map
Irradiation Map & Eskom Solar Areas
Onshore: 18 companies and their subsidiaries, about 40 ERs, 2 TCPs, about 100 applications

Offshore: 8 international and 2 local companies active in 21 concessions with 7 areas under application
Mapping the Demand and Generation

- Demand was allocated to each Municipal Area and then summated by province to get the total Load Demand for each province.

- The Bars represent the relative Demand for 2011, 2020, 2030 and 2040 with the 2040 figure shown.

- Generation was allocated to each Municipal Area and then summated by province to get the total Generation for each province for each Generation Scenario.

- The Bars represent the relative Generation for 2011, 2020, 2030 and 2040 with the 2040 figure shown.
• The Supply and Demand Balance value was calculated for each Generation Scenario for each year to 2040 to determine the change over this period

• The 2011, 2020, 2030 and 2040 scenarios are presented in the report to illustrate the change over each decade

• The Bars represent the relative Demand Balance for 2011, 2020, 2030 and 2040 with the 2040 figure shown for Scenario A in this case

• All three Generation Scenarios can be mapped and compared to show the differences between the scenarios over time
Comparing Demand Balances for each Generation Scenario

DEMAND BALANCE PROGRESSION FOR EACH SCENARIO
(Installed Generation less Maximum Demand in MW)

Net 2011  Net 2020  Net 2030  Net 2040

Marginal scenario difference for the TDP period
MAX & MIN DEMAND BALANCE PROGRESSION CONSIDERING ALL SCENARIOS
(Allocated Generation less Maximum Demand in MW)

Legend
-10,000 - 10,000
-2,000 - 2,000
-1,000 - 1,000
-500 - 500
-250 - 250
-125 - 125
-62 - 62
-31 - 31
-15 - 15
-7.5 - 7.5
0 - 0
1 - 100
100 - 1,000
1,000 - 10,000
10,000 - 100,000
Transmission Centroid Network

- Unconstrained spatial Tx network model developed
- "Relative" electrical impedance between each adjoining centroids was calculated considering physical terrain
- Preferred power transfers for each generation scenario were determined
Inter-Provice Power Transfers for the IRP W60 CBA 2040 scenario

- Power transfers with direction of flow can be plotted between each province for the four Max Scenarios.
- Arrows indicate relative size of transfer in MW
- This case is for the IRP BASE scenario with 60% Wind generation in an east-to-west (CBA) distribution pattern
- Area shading indicates within province where generation excess (red) or high load demand (blue) is physically located
The identified 2040 SEA Corridors

Analysis of the inter-province power flows across the generation scenarios and loading conditions start to indicate where the power flows concentrates under all scenarios.

Five major corridors were identified for the future strategic development of the Tx Grid.
Strategic Grid Plan
The CSIR were appointed by DEA to undertake a study to identify suitable corridors and zones for the efficient and effective rollout of wind and solar PV energy. The selection criteria included amongst others the environmental suitability of the land, the resource potential as well as exclusion areas.

https://redzs.csir.co.za/
The “National” power corridors were then further refined and consolidated into five Major Transmission power Corridors. These were then used as the basis for a national SEA study project by the DEA. This forms part of the SIP 10 project of the Govt. NDP.

The objective is to secure all the needed environmental approvals for Tx lines within the corridors which will be valid in perpetuity.
SGP Tx 2040 Study Corridor Overview
23 Jan 2012 04:15 SAST

Global tilted irradiance

Upington area
Aggregation level: 0
Aggregation area: 5 km x 5 km
Number of PV power plants: 1

Relative PV output

Relative PV output change

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Cloud impact on PV power generation

23 Jan 2012 04:15 SAST

Global tilted irradiance

Upington area
Aggregation level: 1
Aggregation area: 50 km x 50 km
Number of PV power plants: 9

Relative PV output

Upington area
Aggregation level: 0
Aggregation area: 5 km x 5 km
Number of PV power plants: 1

Relative PV output change
Cloud impact on PV power generation

23 Jan 2012 04:15 SAST

Global tilted irradiance

Upington area
Aggregation level: 2
Aggregation area: 250 km x 250 km
Number of PV power plants: 49

Relative PV output

Hour

% of nominal power

0 10 20 30 40 50 60 70 80 90 100

02 04 06 08 10 12 14 16 18 20 22

Relative PV output change

Hour

% of nominal power

-60 -40 -20 0 20 40 60

02 04 06 08 10 12 14 16 18 20 22

Upington area
Aggregation level: 1
Aggregation area: 50 km x 50 km
Number of PV power plants: 9

Relative PV output

Hour

% of nominal power

0 10 20 30 40 50 60 70 80 90 100

02 04 06 08 10 12 14 16 18 20 22

Relative PV output change

Hour

% of nominal power

-60 -40 -20 0 20 40 60

02 04 06 08 10 12 14 16 18 20 22

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RE Project Cluster Areas Study

- Identified cluster areas of potential RE projects
- Green is low number of projects
- Red is high number of projects
- Aligned with identified local and national corridor routes.
Strategic Unlocking of Renewable Access

Legend

- **Planned Substations**
  - Phase, Duration: 1. 2 years
  - Phase, Duration: 2. 3-4 years
  - Phase, Duration: 3. 4-5 years
  - Phase, Duration: 4. 6-8 years
  - Phase, Duration: 5. 8-10 years

- **Existing Substations**
  - Phase, Duration: 1. 2 years
  - Phase, Duration: 2. 3-4 years
  - Phase, Duration: 3. 4-5 years
  - Phase, Duration: 4. 6-8 years
  - Phase, Duration: 5. 8-10 years

Strategic Unlocking Implementation Time
Thank you