Transmission Development Plan (TDP 2012 – 2021)

Public Presentation

6 October 2011

Overview and Purpose

The Objective of the presentation is to:

- Plan for the South African Integrated Power System
- Contextualise the planning timelines relating to the demand forecast and generation patterns
- Share assumptions and results from the Transmission Development Plan 2012 – 2021
- Share information on the process for the Transmission Refurbishment and Capital Spares Plan
- Share information on the estimated Transmission Capital Investment Requirements for period 2012 – 2021
- Share information/progress on the Transmission 30 year Strategic Plan Update
- To solicit comments and inputs from stakeholders on the Transmission Plans

Planning for the South African Integrated Power System

The Different Plans

Integrated Resource Plan

- The Department of Energy (Energy Planner) is accountable for the Country Electricity Plan, which is called 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.

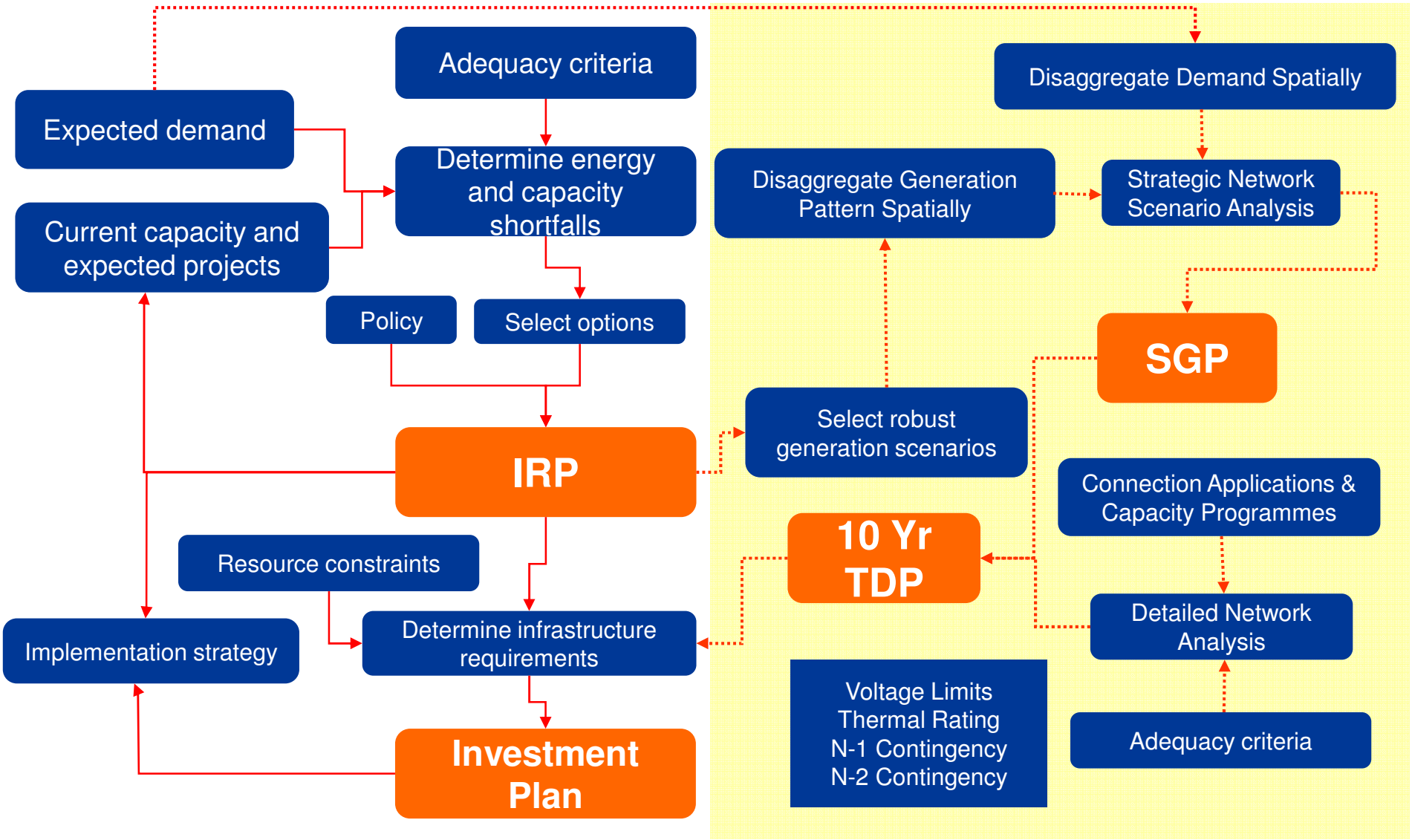
Strategic Grid Plan

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

Transmission Development Plan

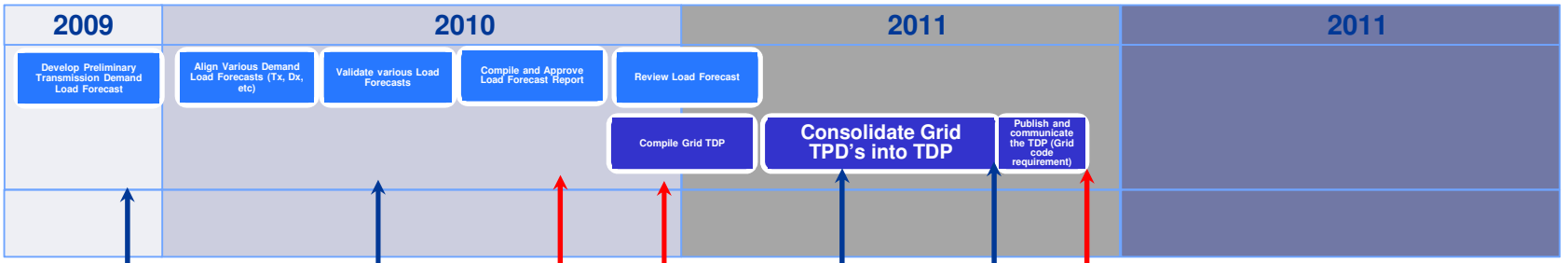
- The Transmission Development Plan (TDP) represents the transmission network infrastructure investment requirements
- The TDP covers a 10 year window
- Updated annually
- Indicates financial commitments required in the short to medium term

Linkages between the various plans



Impact on the TDP: Forecast Process and IRP

Impact of IRP on TDP assumptions



Collate Data

Develop forecast and TDP Assumptions

Approved TDP Assumptions December 2009

Complication of Regional Grid & National Grid consolidation studies

Department of Energy release of the Draft IRP 2010

Department of Energy release of the Final IRP 2010

Publication of TDP 2011 - 2020

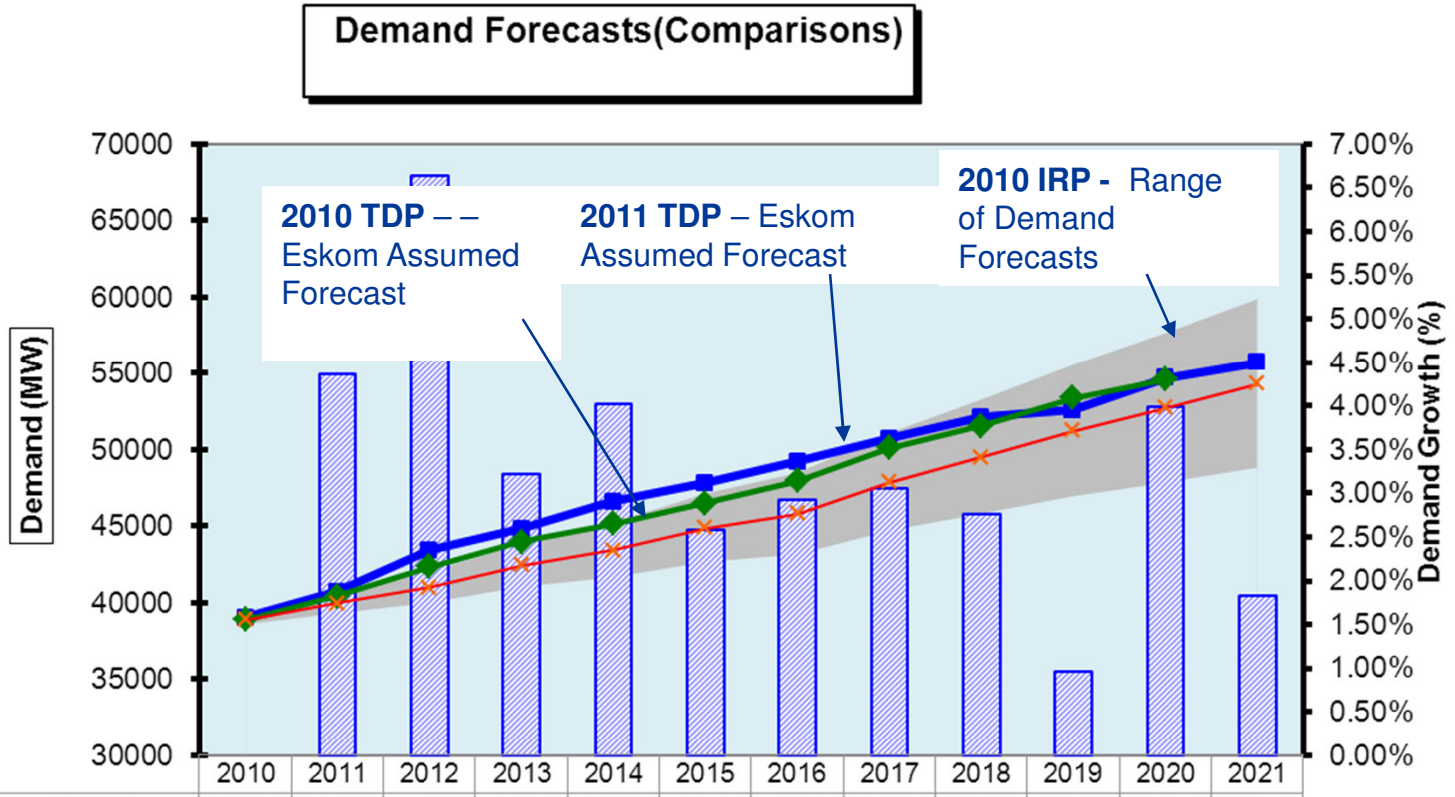
Sensitivity Analyses is between the draft IRP and Final IRP discussed

Transmission Development Plan
TDP 2012 – 2021 (2011 TDP)

Transmission System Planning

- **The purpose of the transmission system is to optimally and reliably transport the power from the source of generation to the location of the load**
- **Role of Transmission System Planner (TSP) is in accordance with the Eskom Transmission License issued by NERSA. TSP is required to conduct the following activities for the *electricity supply industry***
  - To plan and augment the Transmission System
  - Planning and augmentation to be in accordance with the Grid Code
  - Customer connections to take place subject to a connection agreement
  - Compliance monitoring is part of the Eskom Transmission license
- **Network Code of SAGC specifies the following for transmission planning**
  - ***Technical criteria***
    - Voltage and thermal limits, reliability criteria, generation integration, etc.
    - Generator connection conditions (Protection, Islanding, Governing, Black Start, etc.)
    - Connection conditions for generators, distributors and end-use customers (Protection, Power Factor, Fault Levels, etc.)
  - ***Planning Process***
  - ***Investment Criteria***

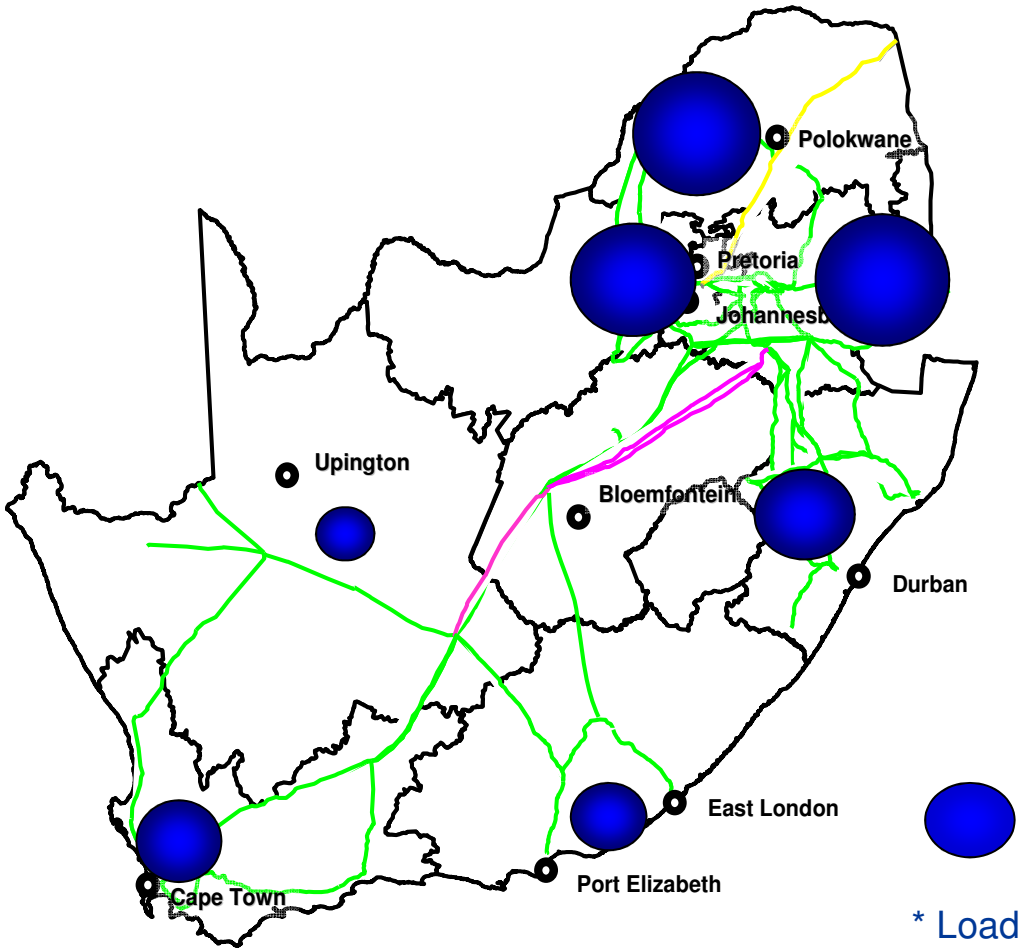
Assumed Demand Forecast and Comparisons



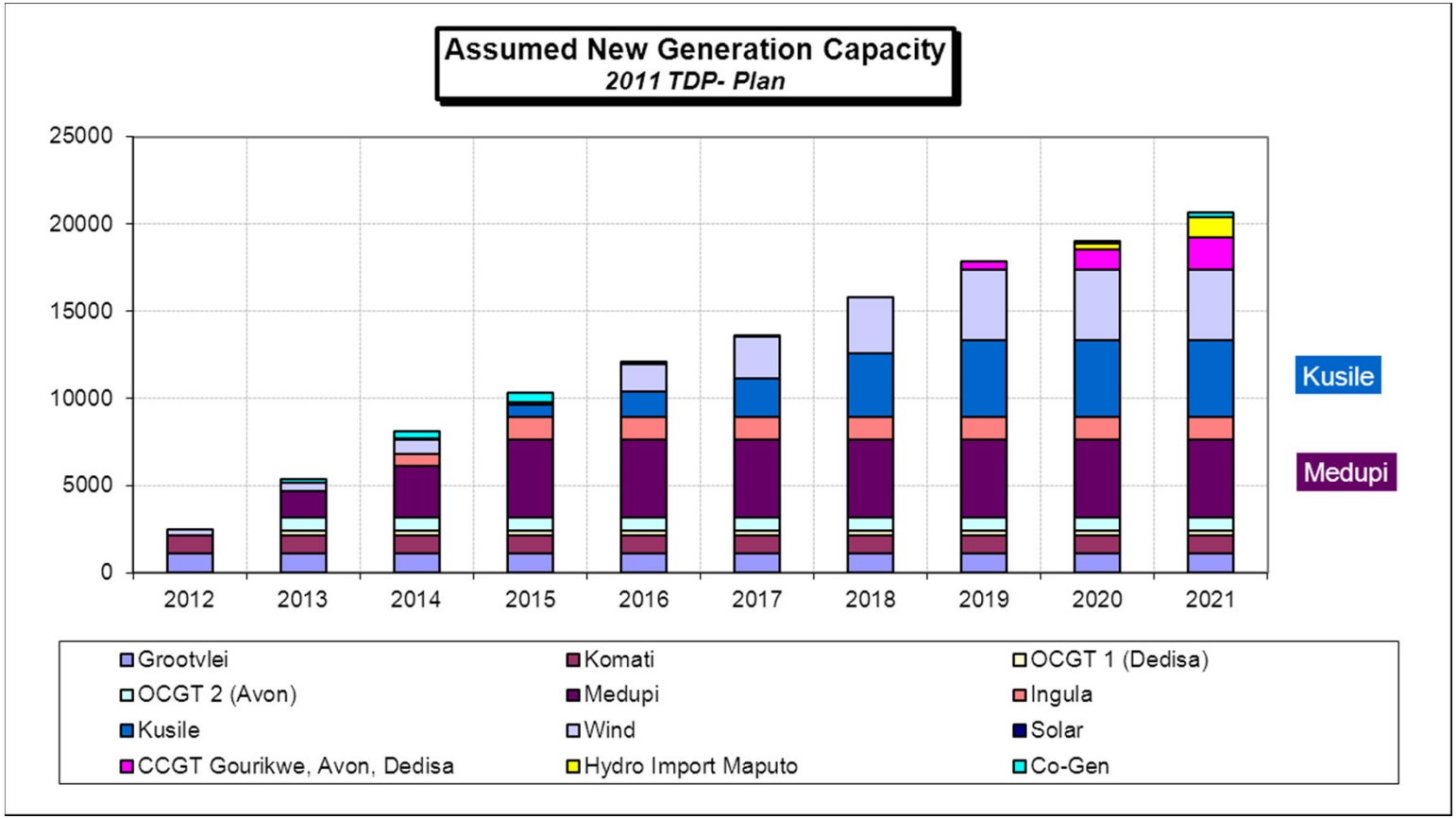
	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
2010 IRP High Demand (MW)	39216	40629	42027	43839	45255	47124	48479	51090	53276	55573	57649	59885
2010 IRP Low Demand (MW)	38587	39319	40002	41040	41669	42666	43157	44710	45815	46952	47848	48828
2011 TDP Growth (%)		4.4%	6.6%	3.2%	4.0%	2.6%	2.9%	3.0%	2.8%	1.0%	4.0%	1.8%
2011 TDP Demand (MW)	39000	40700	43400	44800	46600	47800	49200	50700	52100	52600	54700	55700
2010 TDP Demand (MW)	38893	40447	42357	43974	45134	46493	47957	50123	51571	53356	54600	
2010 IRP Moderate Demand (MW)	38885	39956	40995	42416	43436	44865	45786	47870	49516	51233	52719	54326

Assumed Distributed Incremental Load Growth (2012 to 2021)

GRID	Regional Load Growth (MW) 2012 – 2021
North Eastern	3765
Eastern	1896
Northern	3308
Central	2882
Western	1546
Southern	1219
North Western	814

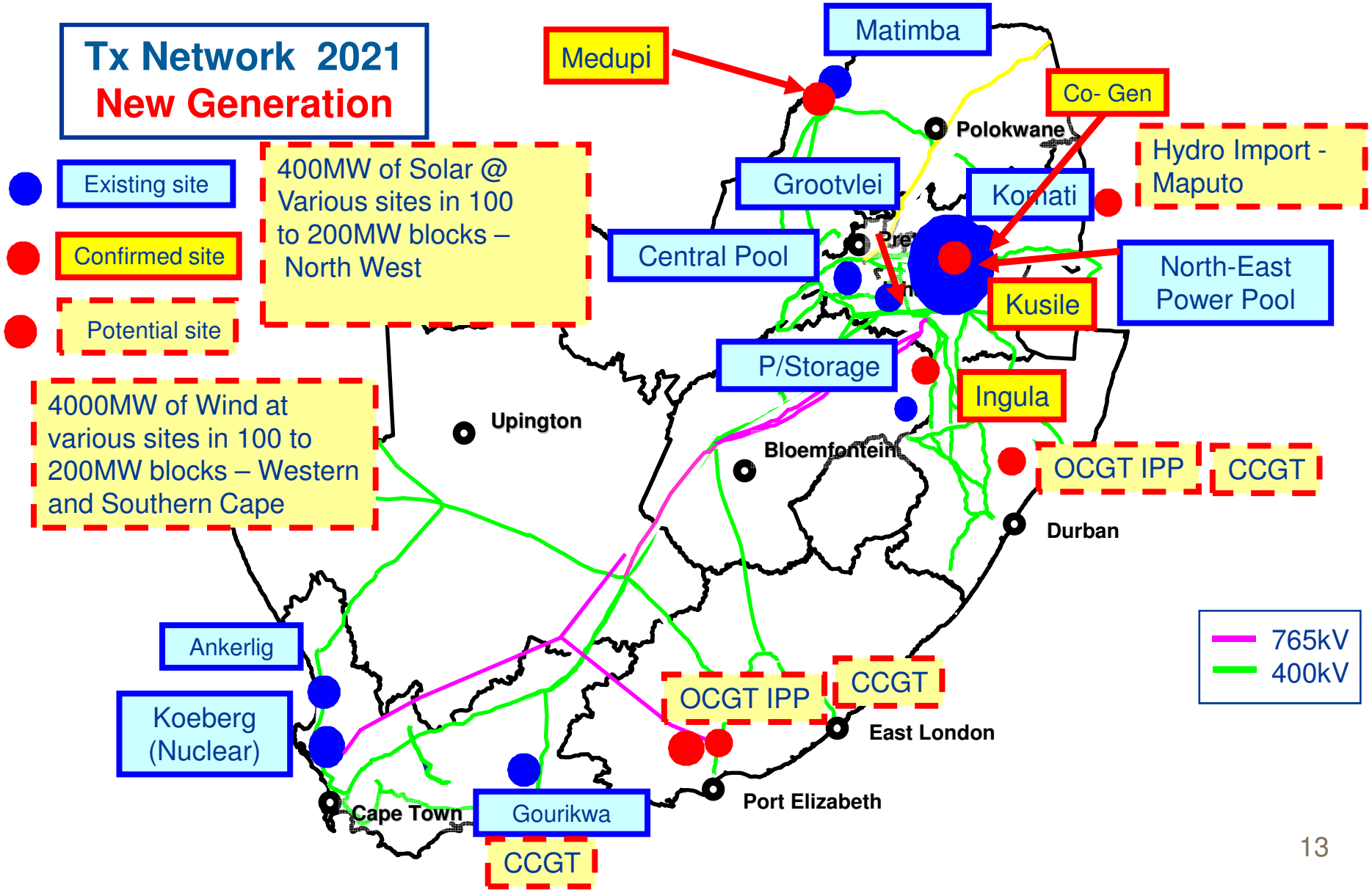


Assumed Generation Capacity Plan



- **Assumptions above are based on the draft 2010 IRP.**
- **Changes from 2010 TDP:**
  - **Exclusion of Coal 3, Thuyspunt, Ankerlig Ext and OCGT Moamba.**
  - **Inclusion of more Wind, Solar, Hydro Import, Co-Gen and CCGTs**
- **<u>Sensitivity analysis between the draft 2010 IRP and the Final 2010 IRP:</u> The difference in the assumptions in the draft 2010 IRP compared to the final 2010 IRP include approx. 3000MW of Solar PV and 750MW of Coal in 2019, 2020 and 2021. This Plan will cater for the Solar PV based on certain assumptions. The plan will have to be updated into the future to cater for the 750MW of coal depending on its location and likelihood. There are plans for Coal 3 and certain of these Transmission projects for Coal 3 can be brought forward (in future TDP updates) if the 750MW is assumed to be in the Waterberg (close to Medupi) area.**

Assumed Generation Pattern



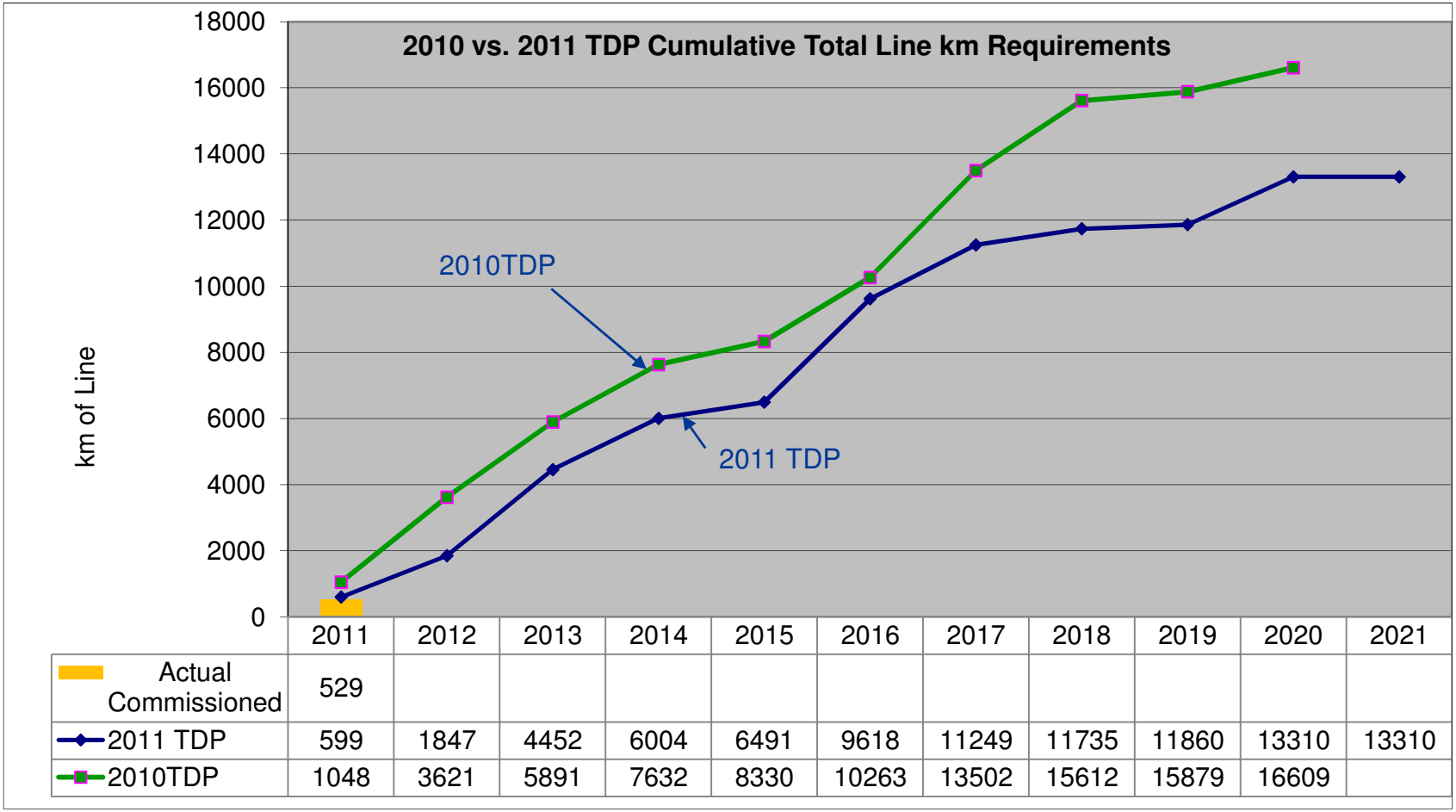
Overview of the TDP – Changes Observed

TDP New Asset	Total
HVDC Lines (km)	0
765kV Lines (km)	4,430
400kV Lines (km)	7,830
275kV Lines (km)	501
Transformers 250MVA+	119
Transformers <250MVA	25
Total installed MVA	73,985
Capacitors	19
Total installed MVAr	2,094
Reactors	55
Total installed MVAr	12,603

TDP Asset differences	Overall Change
HVDC Lines (km)	-1,700
765kV Lines (km)	-1,655
400kV Lines (km)	-253
275kV Lines (km)	-240
Transformers 250MVA+	19
Transformers <250MVA	-3
Total installed MVA	1,595
Capacitors	-11
Total installed MVAr	-718
Reactors	-8
Total installed MVAr	-2,300

- **The net drop in the amount of Transmission Line (by approximately 3 850 km) compared to last year's TDP is due to:**
  - **765kV and 400kV projects being deferred beyond the TDP period based on the assumption of Coal 3 and Thyspunt (Nuclear) not materialising in the TDP period.**
  - **Some of the 765kV Cape Corridor line projects being deferred beyond the TDP period.**
- **The net amount of Transformers have increased *mainly* due to new transformers (12) added based on the Solar and Wind Generation assumptions made. Additional transformers have been added mainly due to the addition new substations linked to more accurate positioning of load.**

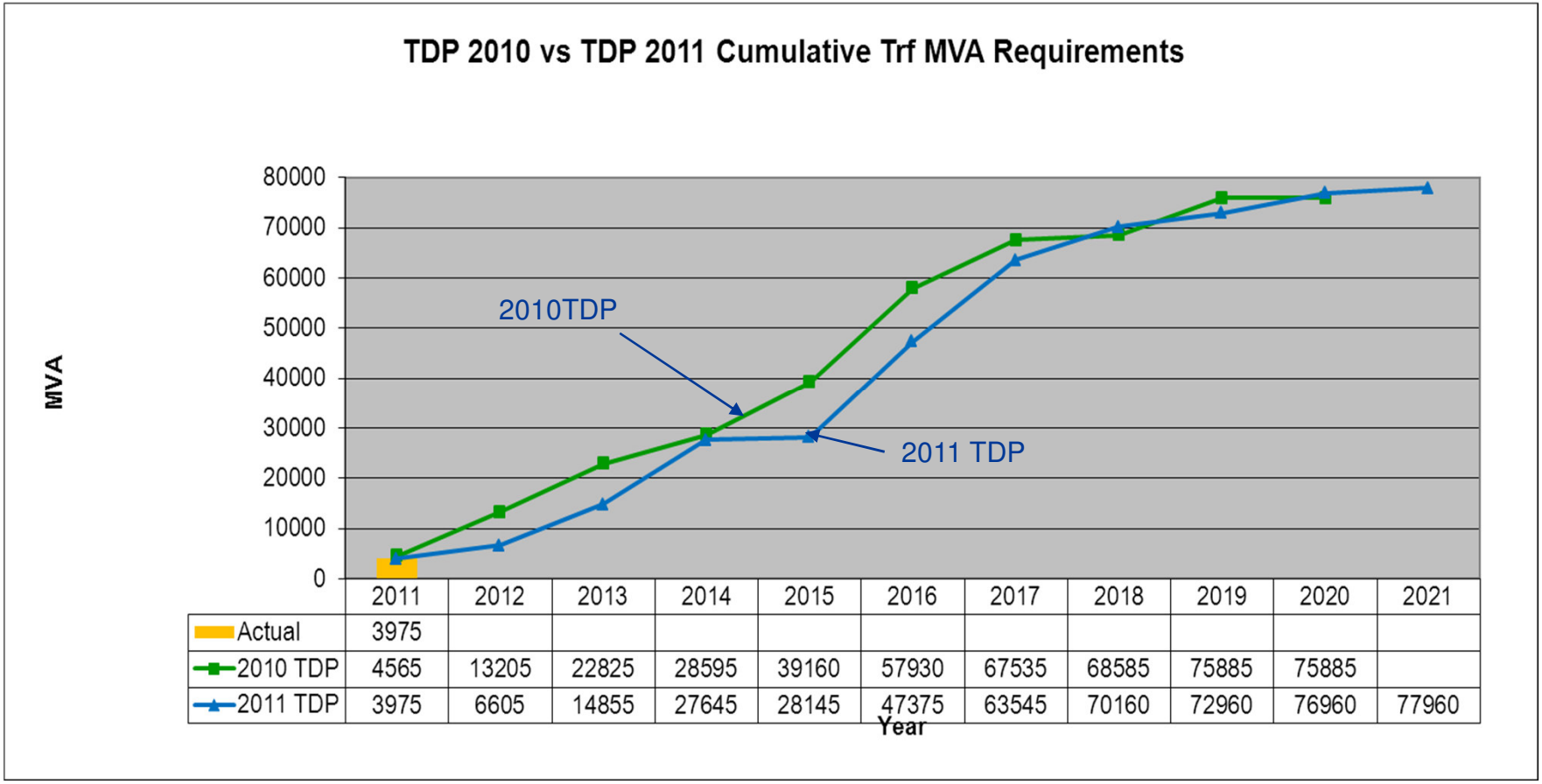
Cumulative Transmission Lines Requirements



	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Actual Commissioned	529										
2011 TDP	599	1847	4452	6004	6491	9618	11249	11735	11860	13310	13310
2010TDP	1048	3621	5891	7632	8330	10263	13502	15612	15879	16609	

- **The change is mainly due to project re-phasing (up to the year 2016/17) meeting more realistic project execution timelines**
- **The change is also due to deferment of lines projects out of the TDP period from the years 2016 onwards linked to Coal 3, Thyspunt (Nuclear) and Cape Corridor integration projects.**

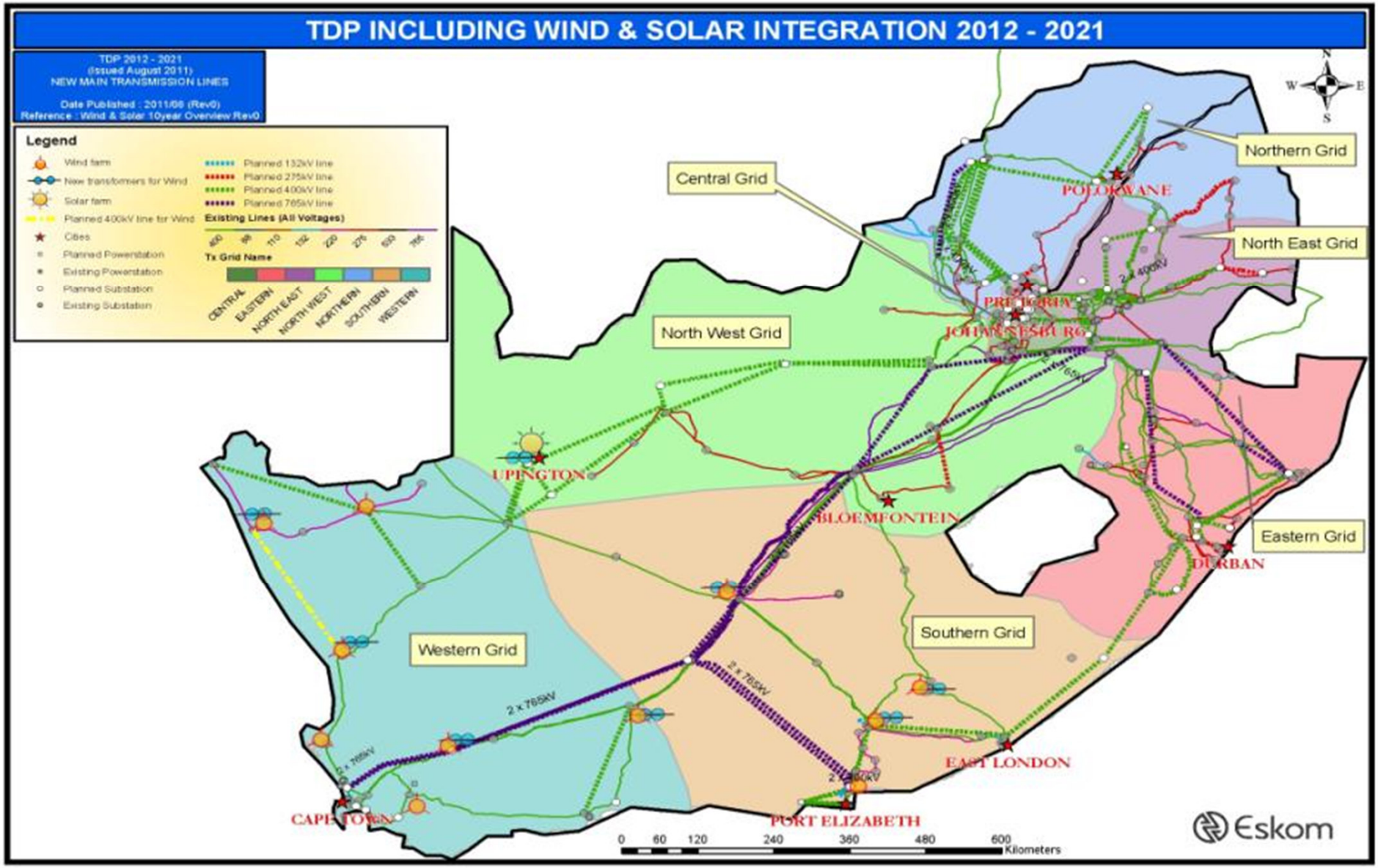
Transformer Requirements



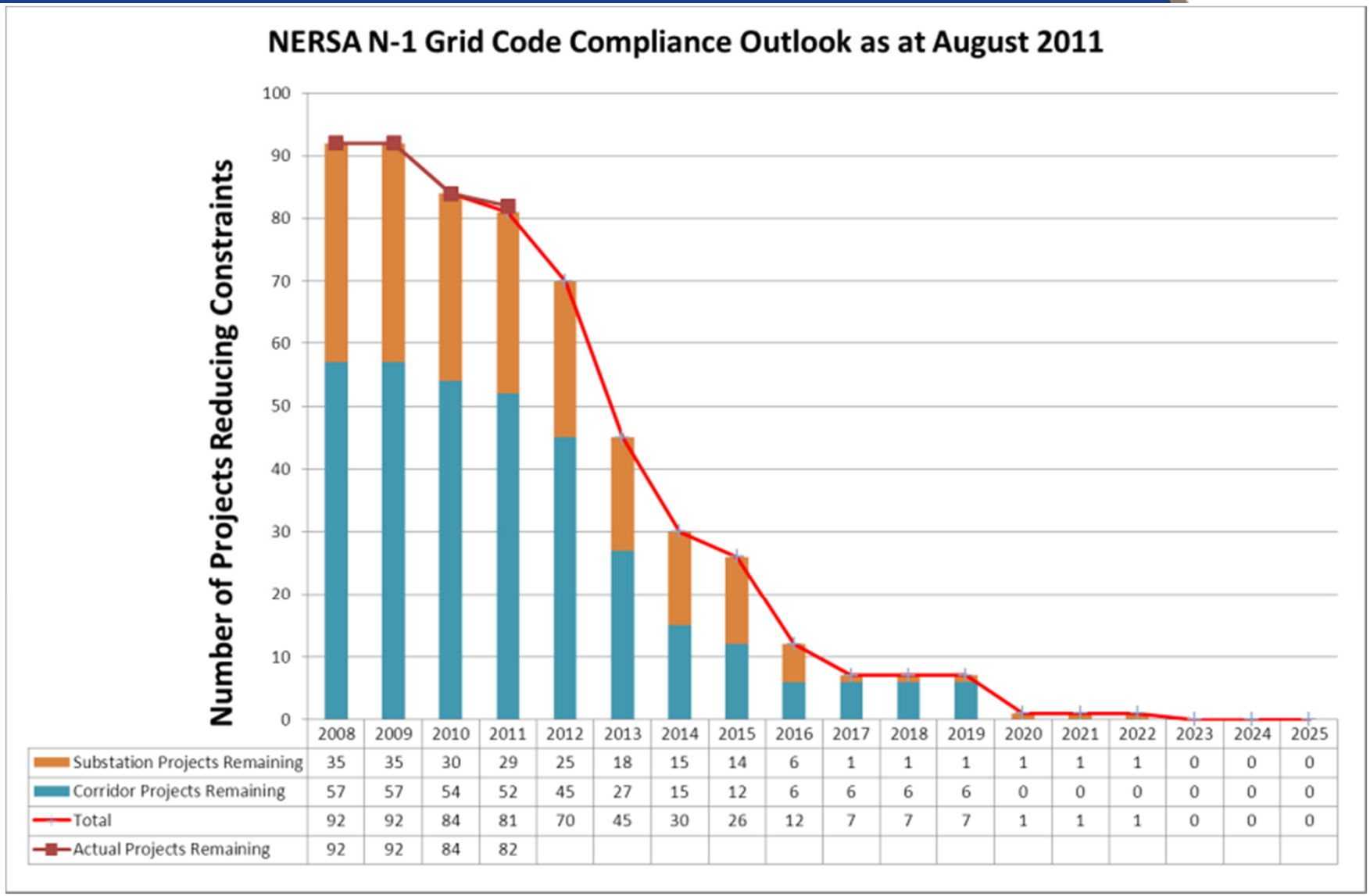
	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021
Actual	3975										
2010 TDP	4565	13205	22825	28595	39160	57930	67535	68585	75885	75885	
2011 TDP	3975	6605	14855	27645	28145	47375	63545	70160	72960	76960	77960

- **The change up to 2014 is due to project re-phasing meeting more realistic project execution time lines.**
- **The change from 2015 onwards is mainly due to 765kV transformer projects being re-phased (East Grid Projects), as well as, due to 765kV transformer projects linked to Coal 3 and Thyspunt (Nuclear) integration being deferred out of the TDP period.**
- **There is convergence in the transformer MVA requirements around 2018, mainly due to new projects added for Wind and Solar integration, as well as, due to new stations added because of more accurate load positioning.**

Transmission Plan Including a Plan for Renewable Energy Integration



N-1 Grid Code Reliability Outlook



	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025
Substation Projects Remaining	35	35	30	29	25	18	15	14	6	1	1	1	1	1	1	0	0	0
Corridor Projects Remaining	57	57	54	52	45	27	15	12	6	6	6	6	0	0	0	0	0	0
Total	92	92	84	81	70	45	30	26	12	7	7	7	1	1	1	0	0	0
Actual Projects Remaining	92	92	84	82														

Projects completed and expected to be completed by end 2011

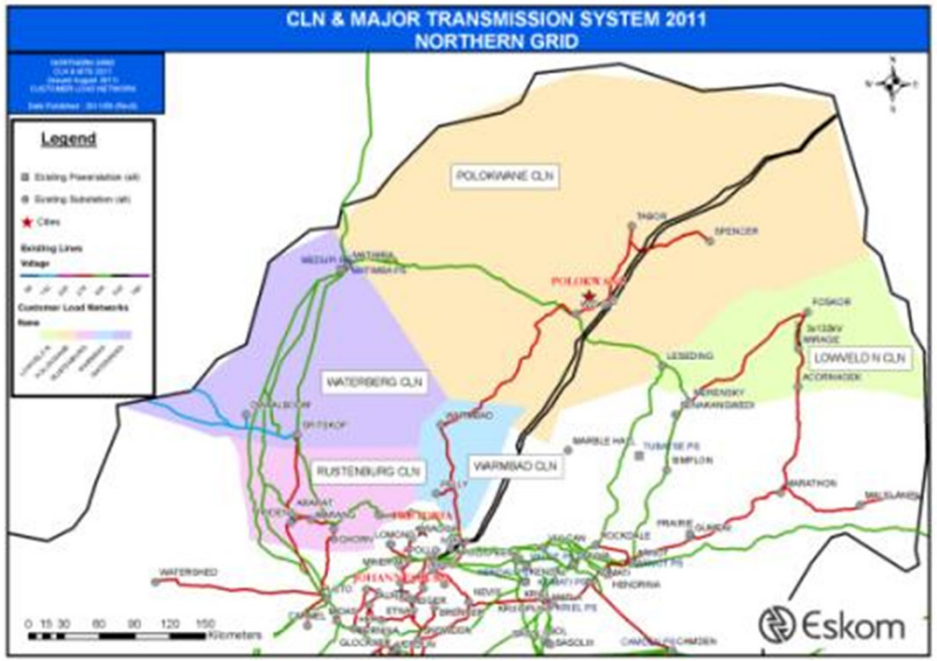
Croydon Ext 3rd 250MVA 275/132kV transformer	Glockner-Etna 2nd 400kV line (operate @ 275kV)
Eiger Ext 3rd 80MVA 88/33kV transformer	Majuba-Umfolozi 1st 765kV line (operate @ 400kV)
Eiger 88kV 48MVAr shunt capacitor bank	Eros Ext 2nd 500MVA 400/132kV transformer
Jupiter 88kV 48MVAr shunt capacitor bank	Hector Ext 3rd 800MVA 400/275kV transformer
Croydon 132kV 72MVAr shunt capacitor	Gumeni 132kV line loop-ins (Prairie-Sappi 1st and 2nd 132kV lines) (includes 132kV switchyard)
Benburg 132kV 72MVAr shunt capacitor	Zeus 400kV By-pass (create new Camden-Sol 1st & 2nd 400kV lines)
Esselen Ext 2nd 315MVA 275/88kV transformer	Duvha-Leseding 1st 400kV line
Kookfontein Ext 2x 88kV 48MVAr capacitors	Spencer-Tabor 1st 275kV line
Snowdown Upgrade 3x 160MVA 275/88kV transformers	Spencer Ext 2nd 250MVA 275/132kV transformer
Hera-Bernina 275kV link closed (upgrade of breakers)	Spitskop Ext 1st 500MVA 400/132kV transformer
Glockner Ext 3rd 800MVA 400/275kV transformer	Ferrum Ext 132kV 1x 72MVAr shunt capacitors
Glockner-Etna 1st 400kV line (operate @ 275kV)	Olien Ext 132kV 2x 36MVAr shunt capacitors

Transmission Grid Strengthening Plans

2012 - 2021

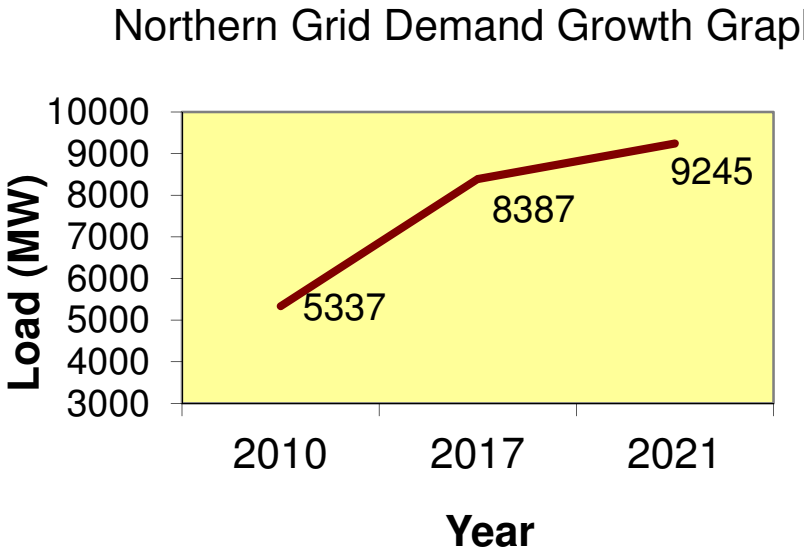
“Regional View”

Northern Grid Profile

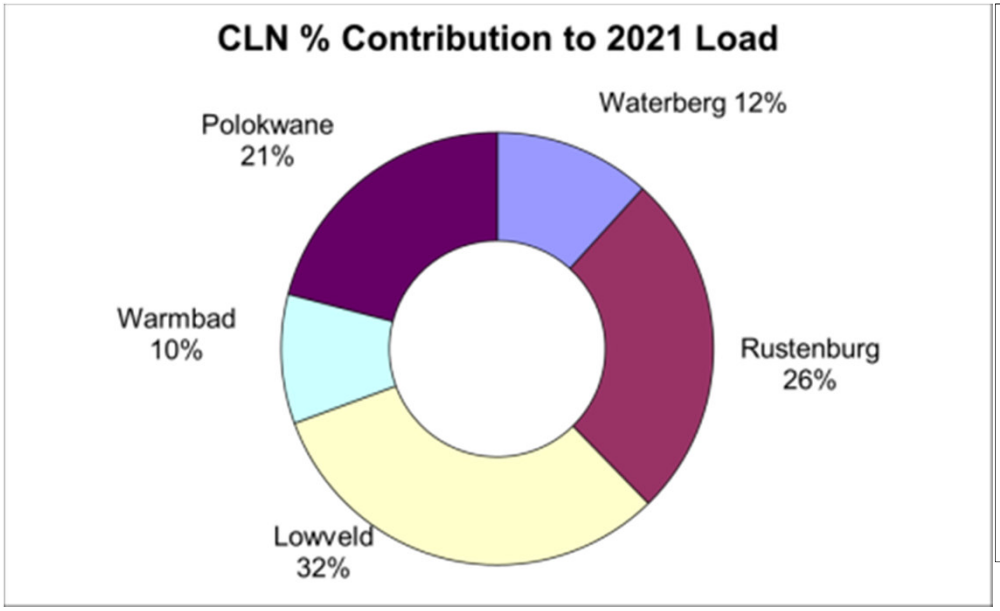


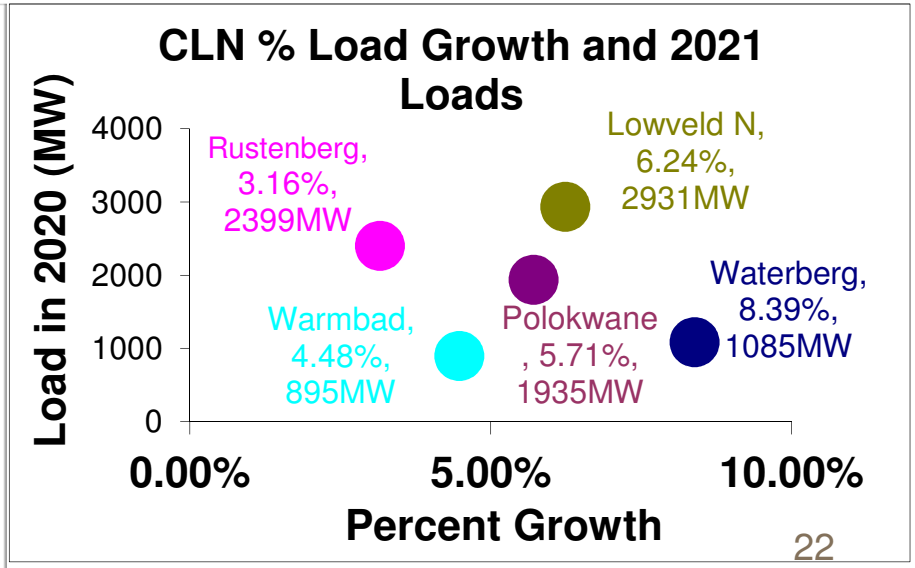
- **Generation**
  - Power Station = Matimba – (Medupi in progress)
  - MW installed = 3690MW
- **Transmission**
  - Load demand = 4081MW
  - Number of MTS = 16
  - No & km of EHV lines = 39 lines & 3730 km
  - Number of CLNs = 5
- **Distribution**
  - Economic activity = Mining (30%), Industrial (30%), Re-distributors (10%), commercial (5%), Agricultural (5%) & Residential (20%).
  - No. customers served = 925 473
  - Number of substations = 284
  - No & km of HV lines = 204 lines & 4 320 km
  - No & km MV feeders = 482 lines & 40 244 km
  - Geographic area = Rustenburg, Lephalale, Bela Bela, Polokwane, Thohoyandou, Tzaneen & Phalaborwa,
- **General**
  - Economic mix - Platinum mining, Coal, high concentration of Electrification, Game Farms, Industrial, Farming, Residential & Commercial, International Tie Line - Botswana

Northern Grid Network Expansion Drivers

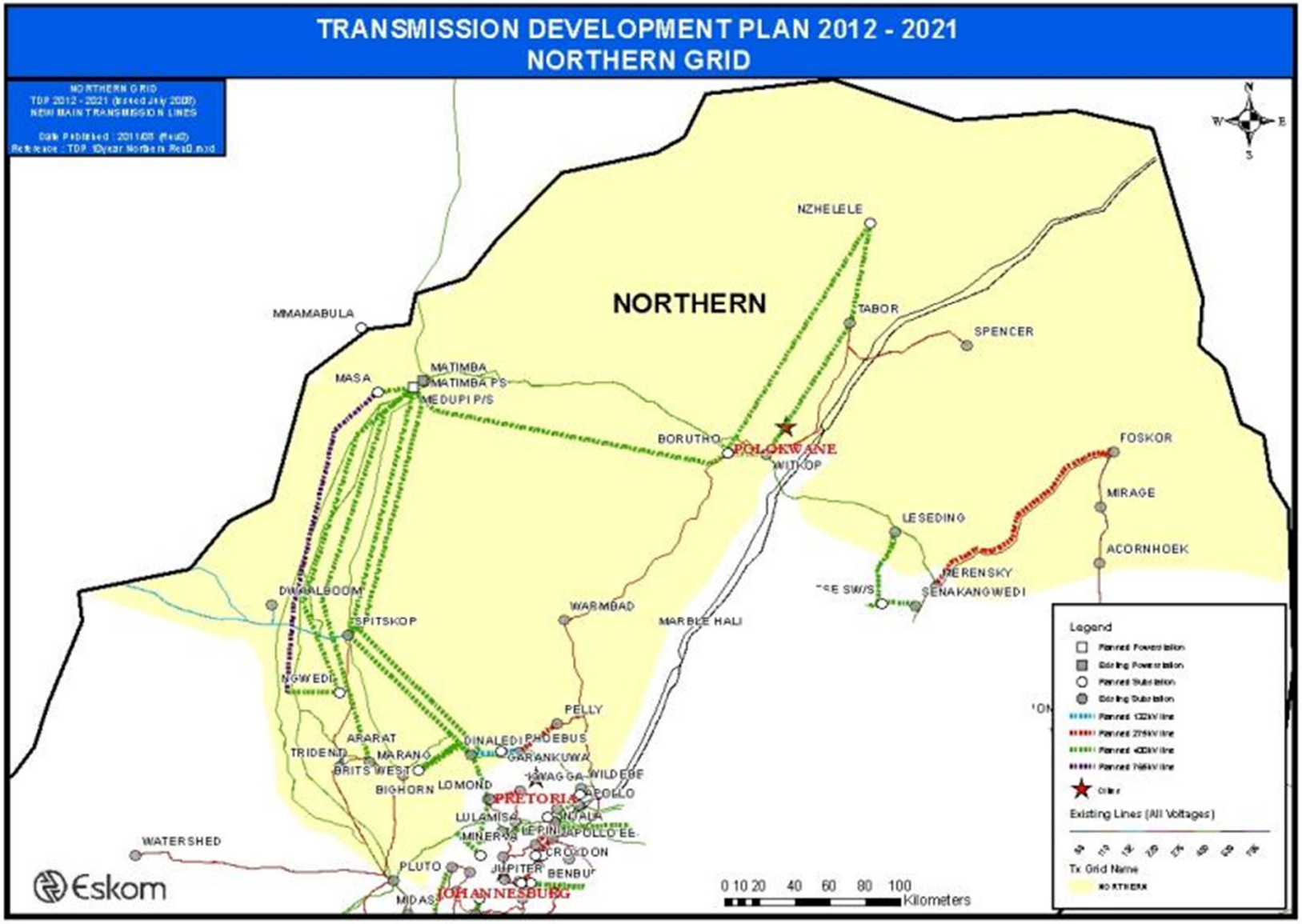


CLN	Forecasted Load (MW)			Ave. Annual % Load Increase
	2012	2017	2021	
Waterberg	680	801	1085	8%
Rustenburg	1763	2305	2399	3%
Lowveld North	1708	2698	2931	6%
Warmbad	642	832	895	4%
Polokwane	1144	1751	1935	6%





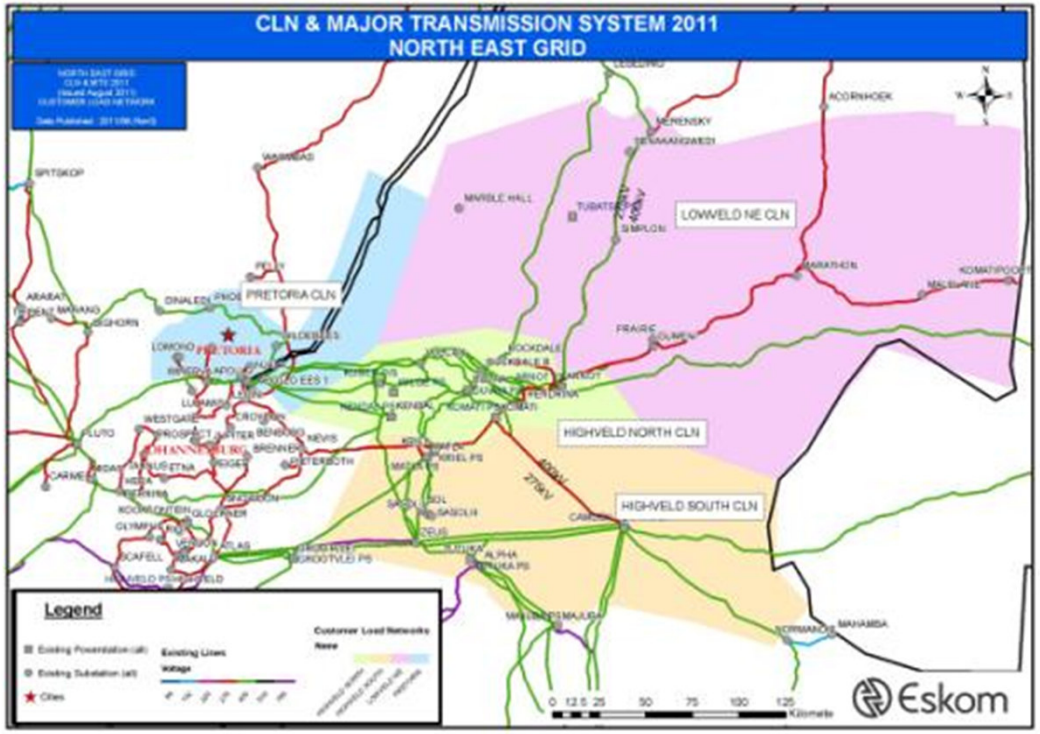
Northern Grid: Development Plan



Northern Grid Major Infrastructure Additions

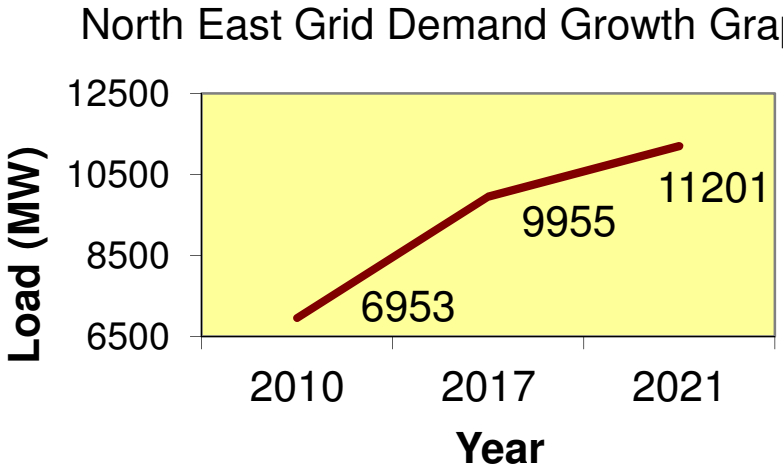
Transmission Assets for Northern Grid	New Assets expected in 2012-2016	New Assets expected in 2017-2021	Total New Assets expected
Total kms of line	1,950	490	2,440
765kV Lines (km)	200	0	200
400kV Lines (km)	1,600	490	2,090
275kV Lines (km)	150	0	150
Total installed Transformer MVA	4,635	1,500	6,135
Transformers (no. of)	12	4	16
Capacitors (no. of)	0	0	0
Reactors (no. of)	2	2	4

North East Grid Profile

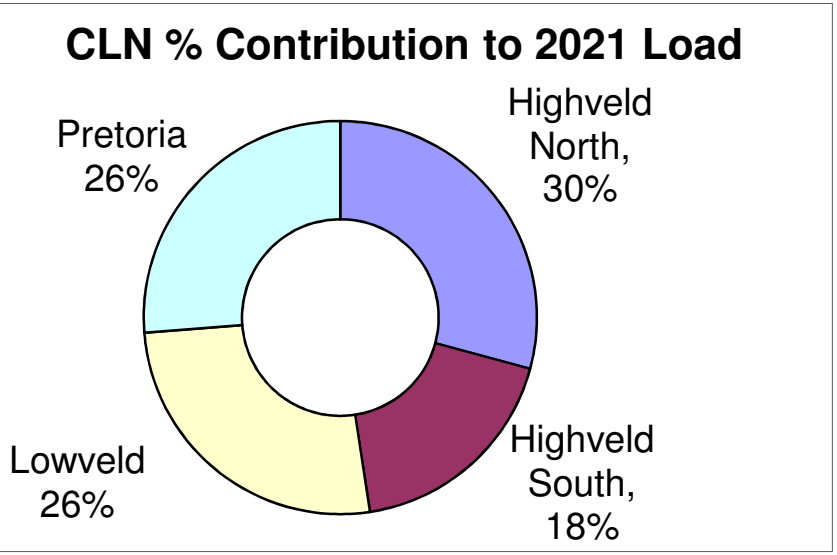


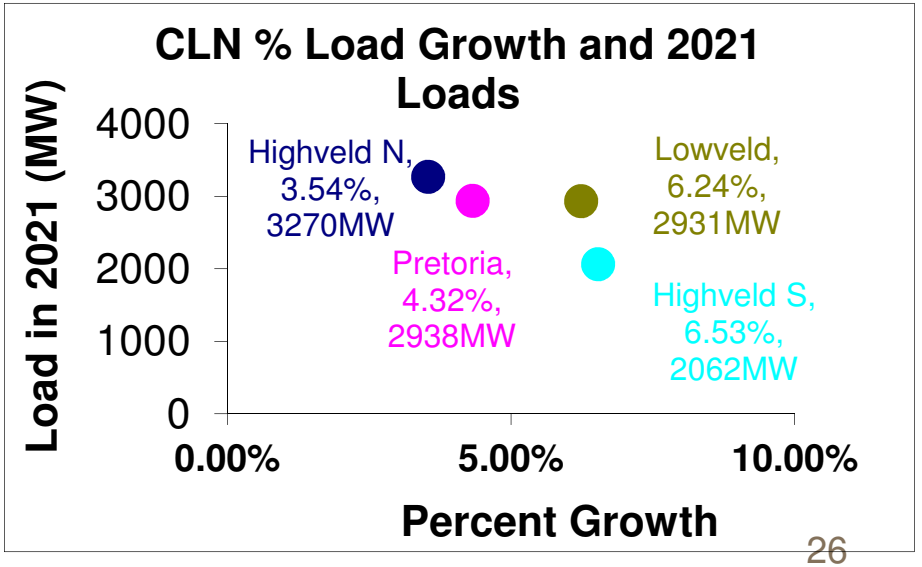
- **Generation**
  - Power Stations = 8
  - MW installed = 16 280MW
- **Transmission**
  - HV / DC converter station = 1900MW
  - Load demand = 7 365MW
  - Number of MTS = 29
  - No & km of EHV lines = 63 lines & 4731 km
  - Number of CLNs = 4
- **Distribution**
  - Economic activity - Industrial (51%), Mining (13%), Commercial (3%), Residential (3%), Agricultural (2%) & Re-distributors (28%).
  - No. customers served = 630 564
  - Number of substations = 589
  - No & km of HV lines = 336 lines & 5 942 km
  - No & km MV feeders = 738 lines & 34 718 km
  - Geographic Area = Tshwane Metro, Witbank, Nelspruit, Groblersdal & Secunda
- **General**
  - Economic Mix - Coal & Platinum mining, Gold, SASOL, Ferro Chrome, International Tie Lines – Mozambique, Swaziland, Zimbabwe

North East Grid Expansion Drivers

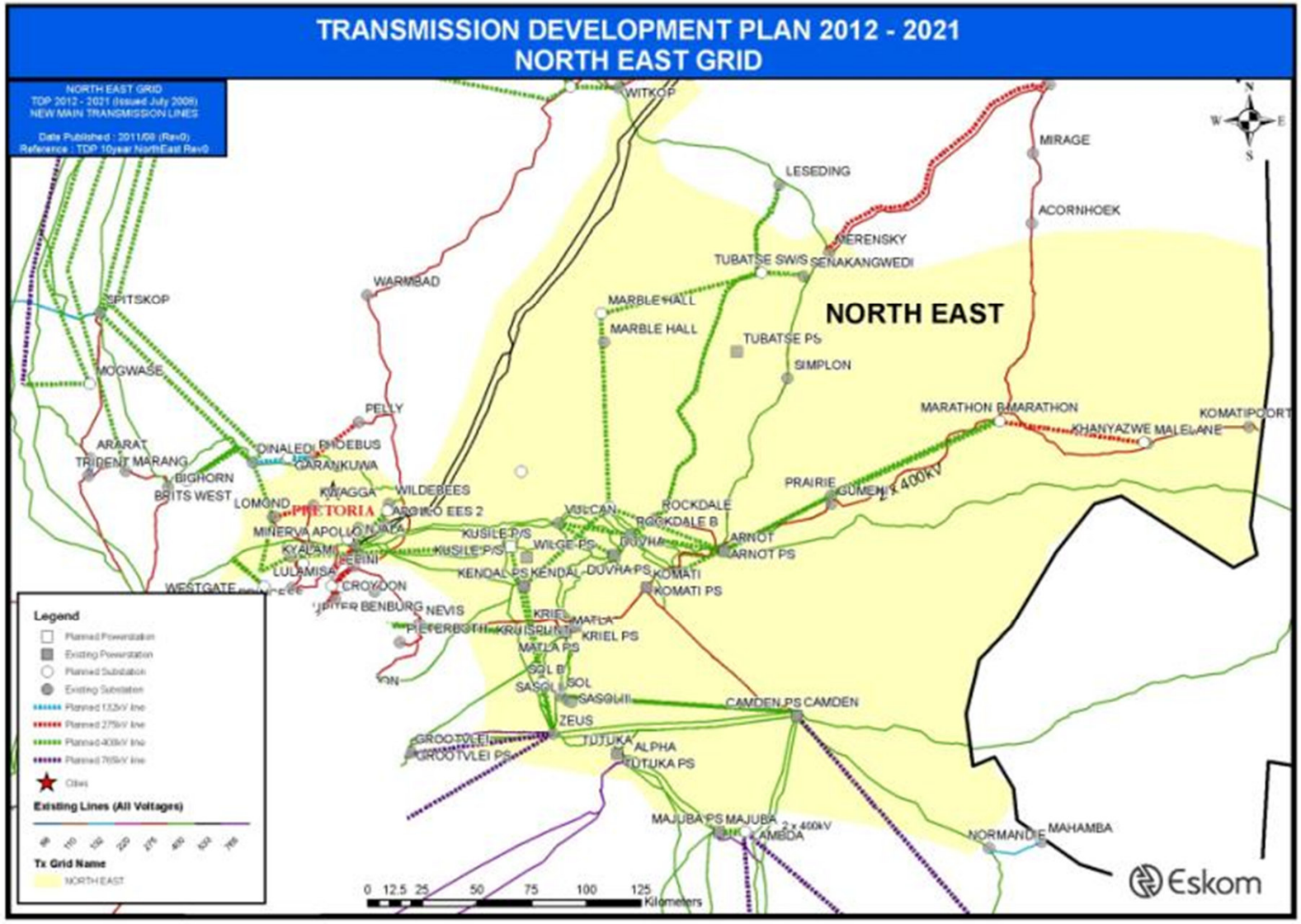


CLN	Forecasted Load (MW)			Ave. Annual % Load Increase
	2012	2017	2021	
Highveld North	2347	2680	3270	4%
Highveld South	1127	2032	2062	7%
Lowveld	1708	2698	2931	6%
Pretoria	2254	2544	2938	4%





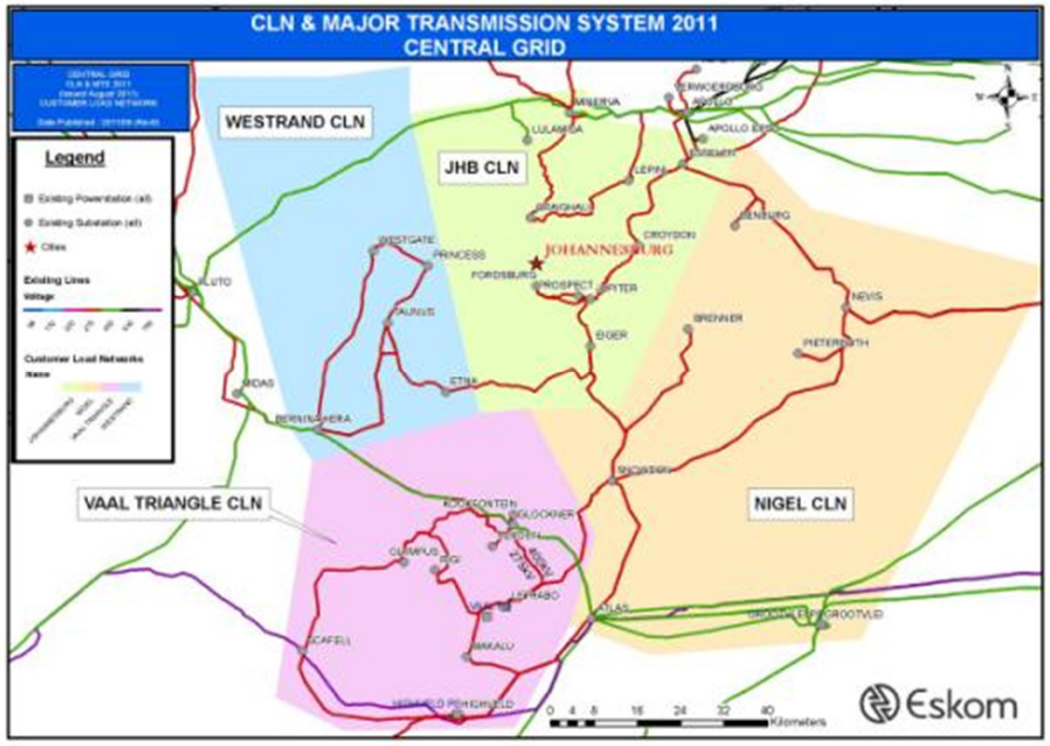
North East Grid: Development Plan



North East Grid Major Infrastructure Additions

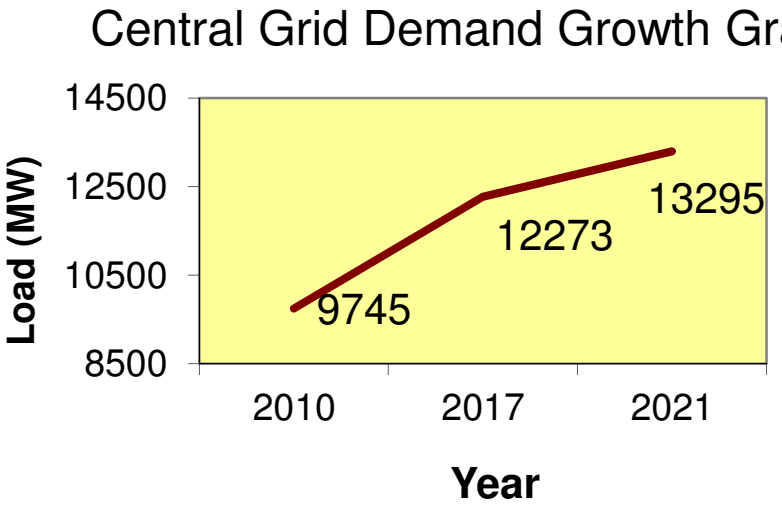
Transmission Assets for North-East Grid	New Assets expected in 2012-2016	New Assets expected in 2017-2021	Total New Assets expected
Total kms of line	864	90	954
765kV Lines (km)	0	0	0
400kV Lines (km)	768	90	858
275kV Lines (km)	96	0	96
Total installed Transformer MVA	8,850	5,365	14,215
Transformers (no. of)	21	8	29
Capacitors (no. of)	3	0	3
Reactors (no. of)	0	0	0

Central Grid Profile

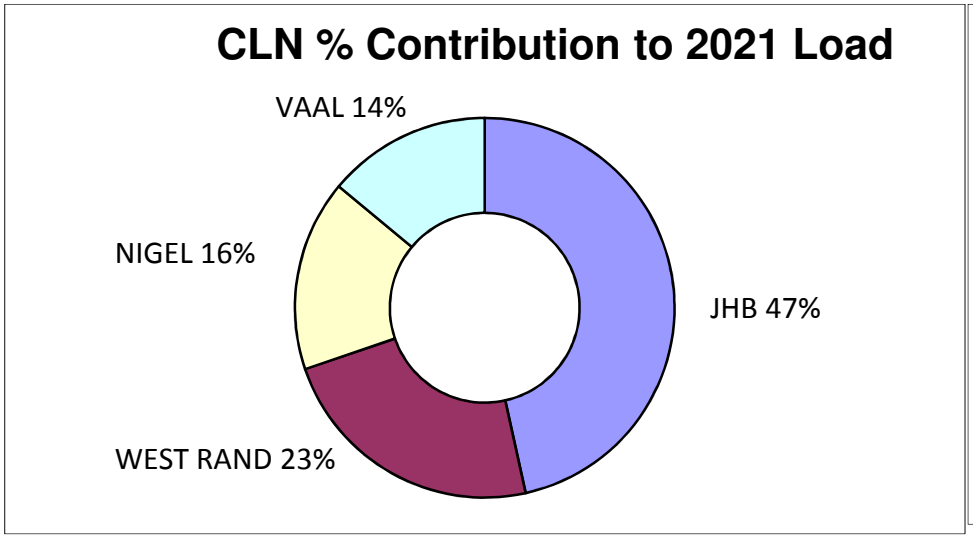


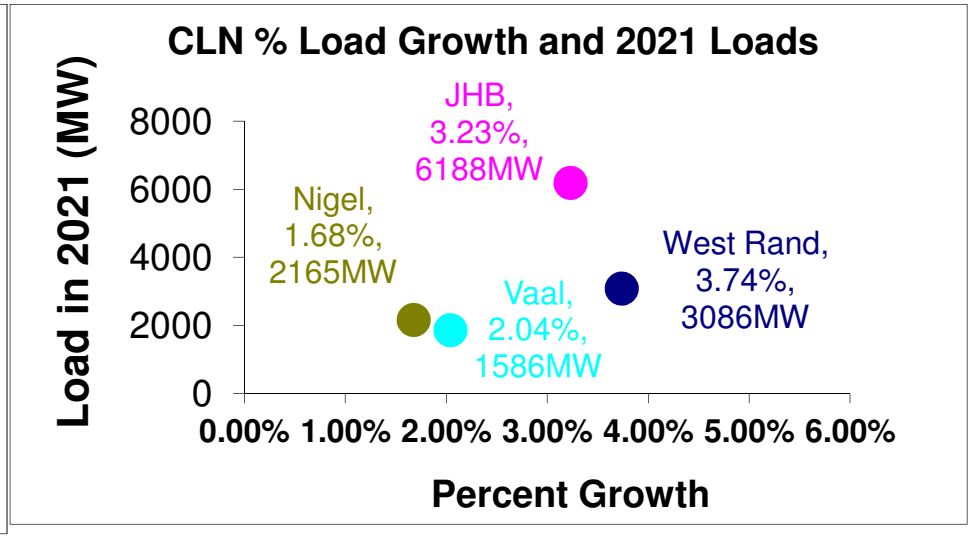
- **Generation**
  - Power Stations = 2
  - MW installed = 4970MW
- **Transmission**
  - HV / DC converter station = 1800MW
  - Load demand = 9339MW
  - Number of MTS = 27
  - No & km of EHV lines = 60 & 2171 km
  - Number of CLNs = 4
- **Distribution – Central Region**
  - Economic activity - Industrial (1.7%), Mining (1.5%), Commercial (10%), Residential (9.8%), Agricultural (1.9%) & Re-distributors (75.1%)
  - No. customers served = 682 323
  - Number of substations = 433
  - No & km of HV lines = 497 & 5 558 km
  - No & km MV feeders = 1280 & 5 3316 km
  - Geographic Area = Nigel, Vaal Triangle, Westrand and Johannesburg
- **General**
  - Economic Mix: Re-distributor, Gold mines and Commercial, SCAW Metal, SAPPI, SASOL, Natref, Anglo Coal

Central Grid Expansion Drivers

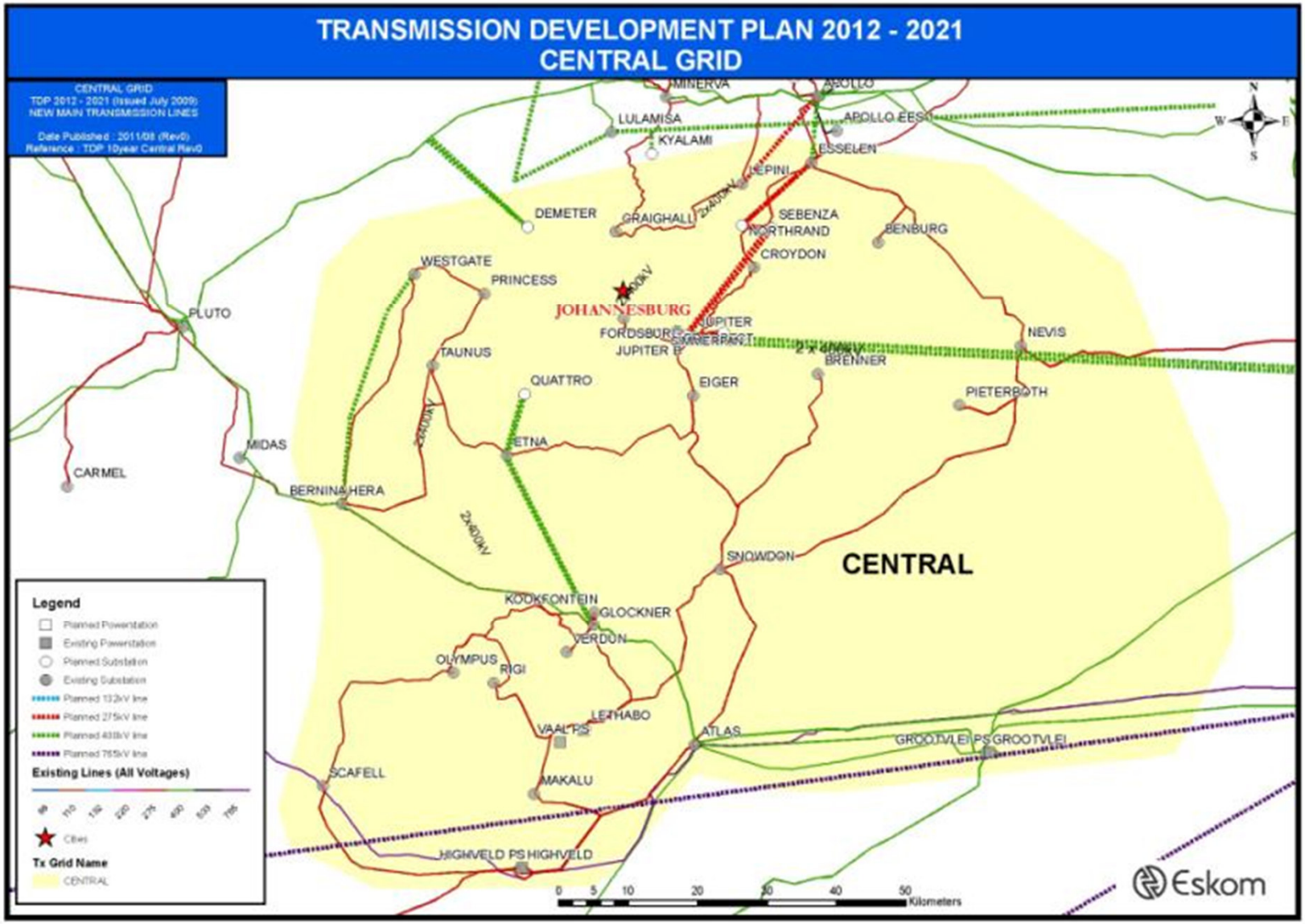


CLN	Forecasted Load (MW)			Ave. Annual % Load Increase
	2012	2017	2021	
Johannesburg	4847	5586	6188	3%
West Rand	2076	2892	3086	4%
Nigel	1854	2016	2165	2%
Vaal Triangle	1636	1779	1856	2%





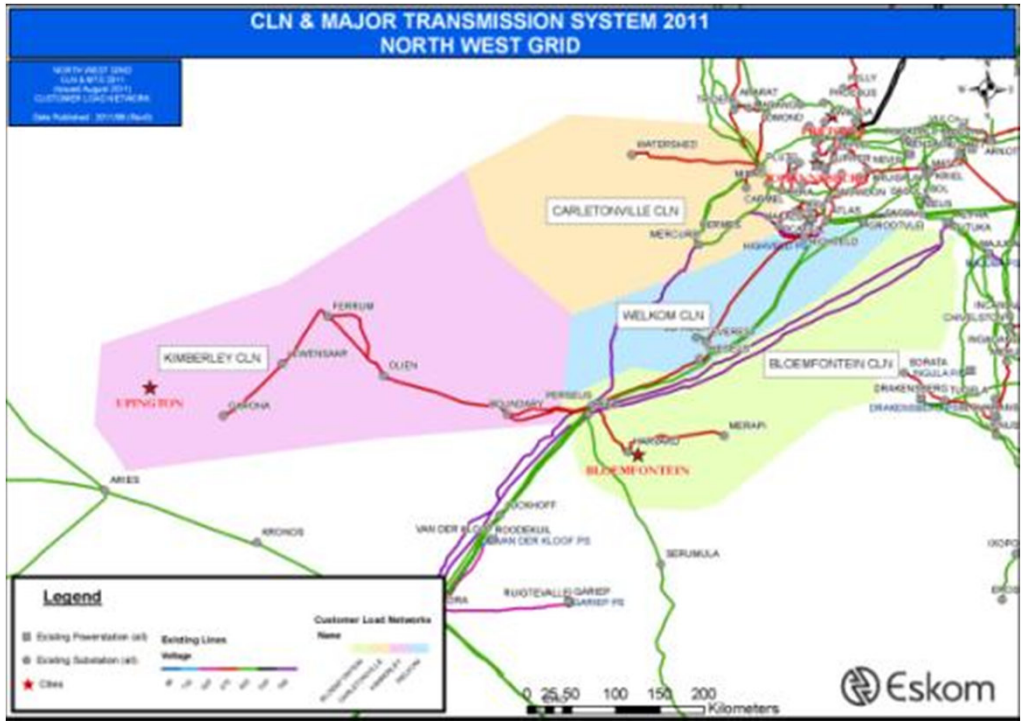
Central Grid: Development Plan



Central Grid Major Infrastructure Additions

Transmission Assets for Central Grid	New Assets expected in 2012-2016	New Assets expected in 2017-2021	Total New Assets expected
Total kms of line	579	234	813
765kV Lines (km)	0	0	0
400kV Lines (km)	539	234	773
275kV Lines (km)	40	0	40
Total installed Transformer MVA	2,925	4,545	7,470
Transformers (no. of)	8	10	18
Capacitors (no. of)	2	0	2
Reactors (no. of)	0	0	0

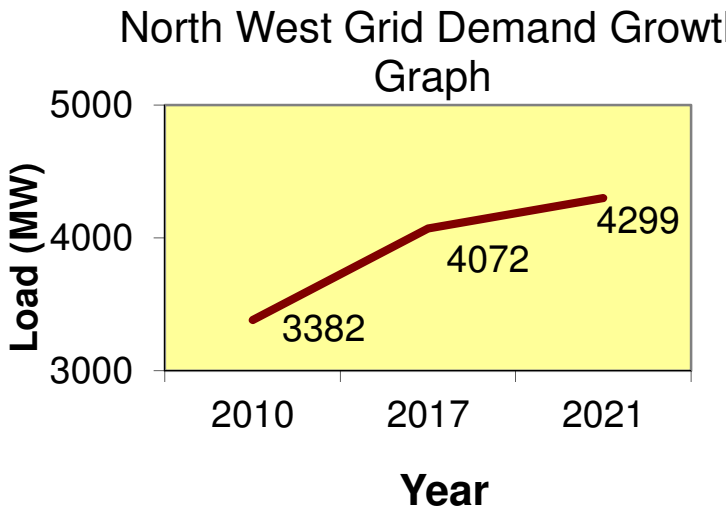
North West Grid Profile



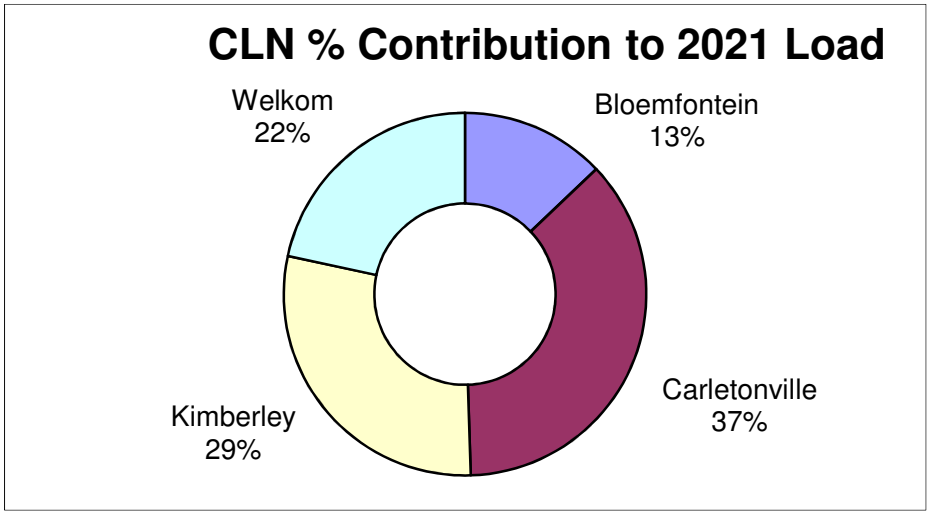
- **Generation**
- None
- **Transmission**
- Load demand = 3304MW
- Number of MTS = 17
- No & km of EHV lines = 33 lines & 4 578 km
- Number of CLNs = 4
- **Distribution - North Western Region**
- Economic activity = Mining (3.2%), Industrial (3.4%), Re-distributors (76.4%), Commercial (3.9%), Agricultural (4.4%), Prepayment (3.2%), Residential (1.3%), Traction (0.8%) & International (3.4%).
- No. customers served = 424 986
- Number of substations = 615
- No & km of HV lines = 688 lines & 9 842 km
- No & km MV feeders = 687 lines & 53 316 km
- Geographic area : Welkom, Kimberley, Carletonville, Karoo and Bloemfontein
- **General**
- Economic mix - Anglo Gold Ashanti, DRD Ltd, Gold fields Mines, Harmony, PPC, Re-distributors,

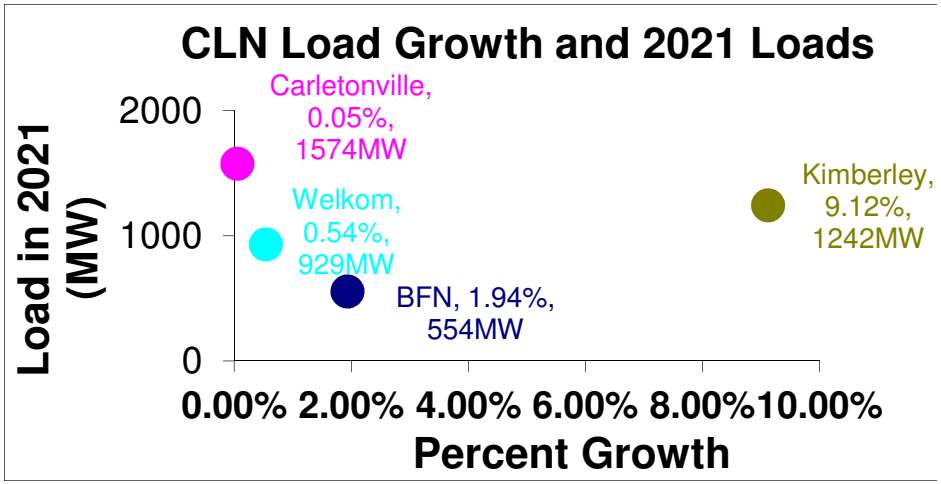
  Water Board, Sasol refinery, Lesotho

North West Grid Expansion Drivers

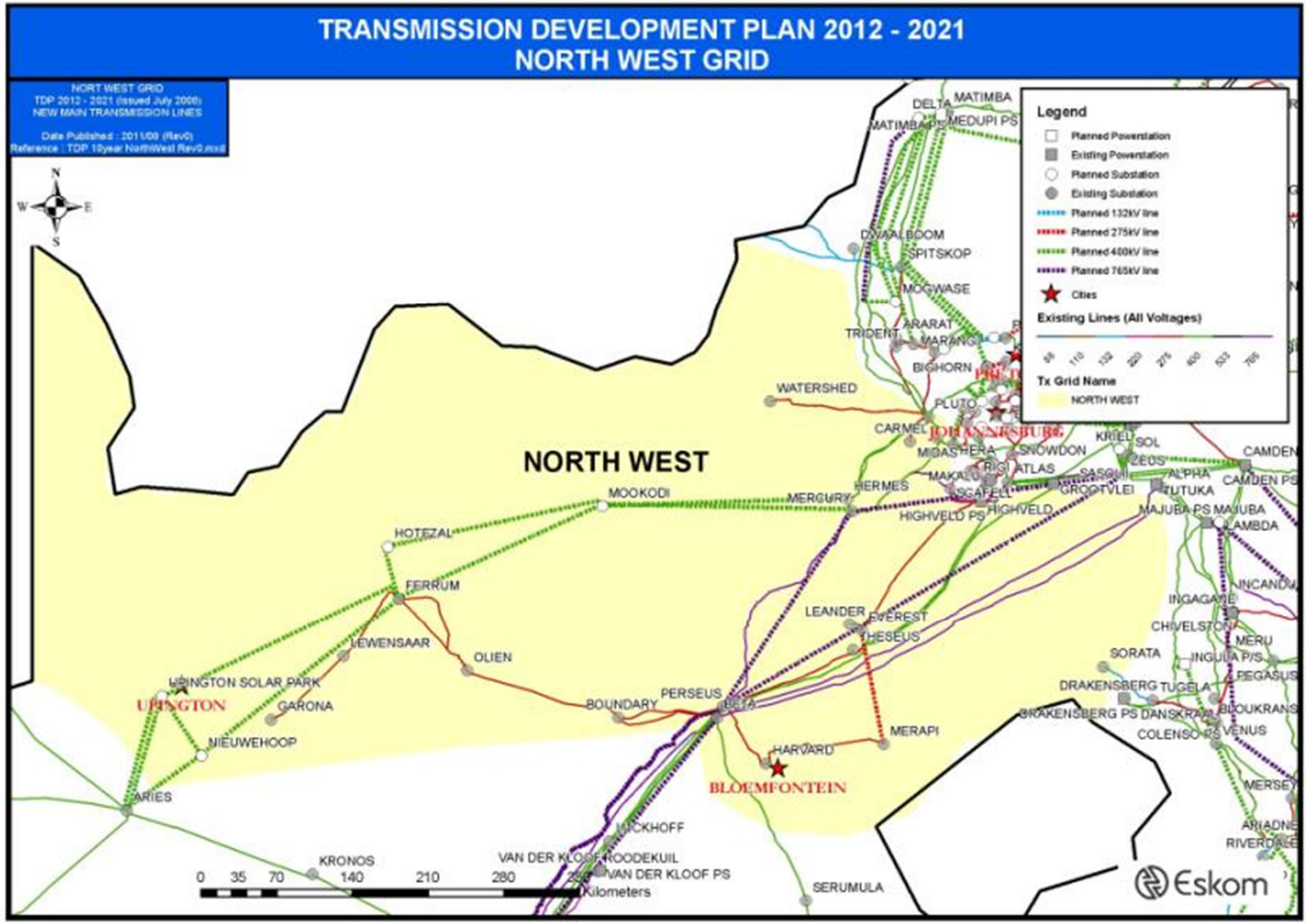


CLN	Forecasted Load (MW)			Ave. Annual % Load Increase
	2012	2017	2021	
Bloemfontein	471	519	554	2%
Carletonville	1580	1558	1574	0.05%
Kimberley	547	1084	1242	9%
Welkom	887	911	929	0.5%





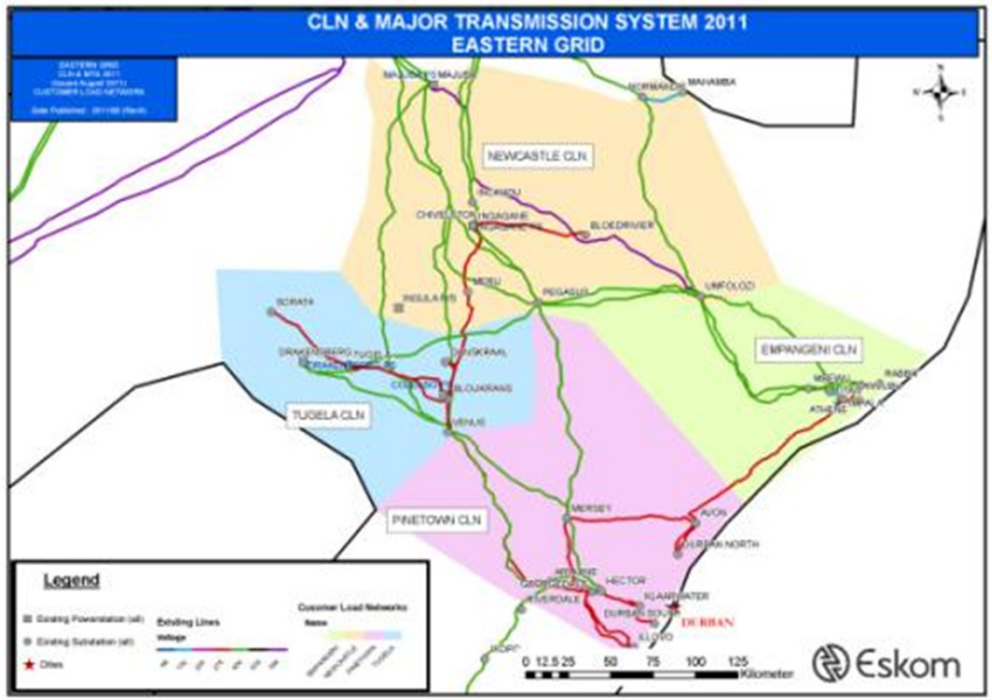
North West Grid: Development Plan



North West Grid Major Infrastructure Additions

Transmission Assets for North-West Grid	New Assets expected in 2012-2016	New Assets expected in 2017-2021	Total New Assets expected
Total kms of line	2,370	875	3,245
765kV Lines (km)	970	870	1,840
400kV Lines (km)	1,290	5	1,295
275kV Lines (km)	110	0	110
Total installed Transformer MVA	7,080	1,000	8,080
Transformers (no. of)	16	2	18
Capacitors (no. of)	6	1	7
Reactors (no. of)	10	4	14

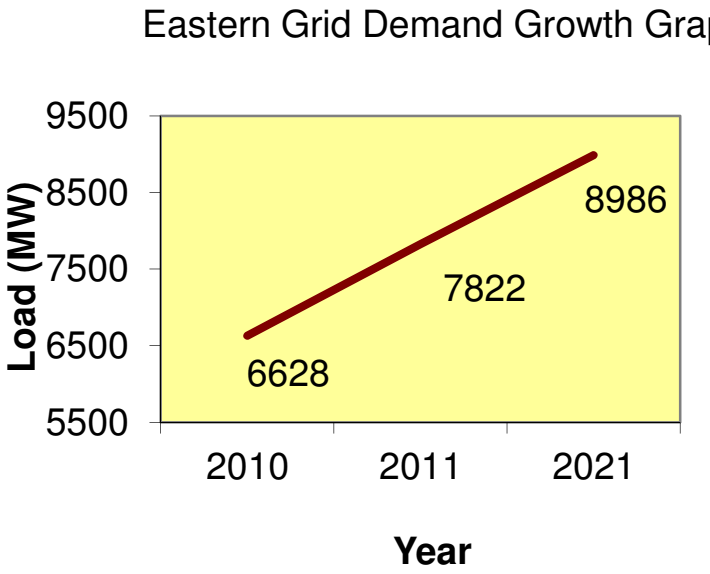
Eastern Grid Profile



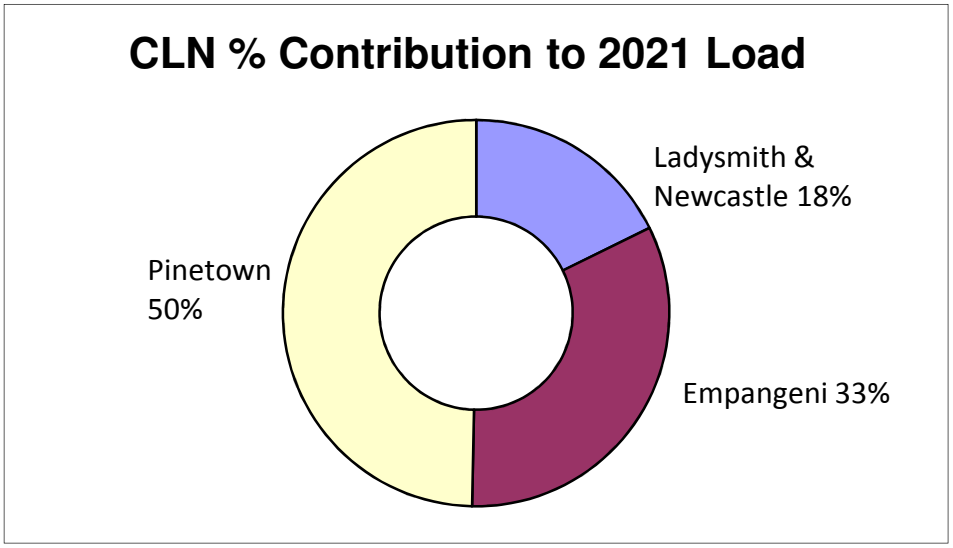
- **Generation**
  - Power Station = Drakensburg Majuba
  - MW installed = 4600MW
- **Transmission**
  - Load demand = 6793MW
  - Number of MTS = 23
  - No & km of EHV lines = 65 & 4 964 km
  - Number of CLNs = 4
- **Distribution**
  - Economic activity = Re-distributors (80.6%), Commercial (5.1%), Mining (1%), Industrial (3%), Residential (3.6%) & Agriculture (2.9%), Prepayment (3.3%), Traction (0.5%)
  - No. customers served = 681620
  - Number of substations = 443
  - No & km of HV lines = 5715 & 226 km
  - No & km MV feeders = 1031 & 41 000 km
  - Geographic area = 113 283 km2

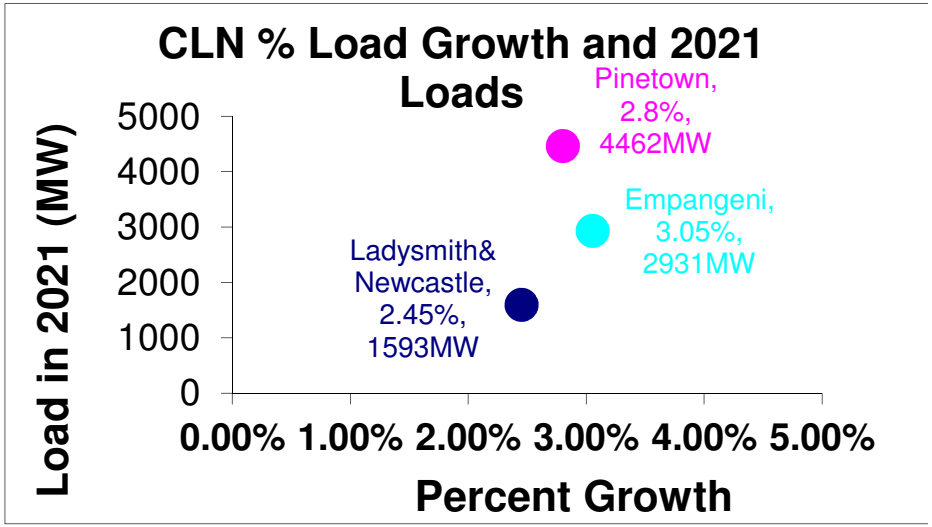
  Empangeni, Margate, Pietermaritzburg & Newcastle
- **General**
  - Economic mix - Mining, Agriculture (Sugar Cane & Timber), Residential, Commercial & Industrial.

Eastern Grid Expansion Drivers

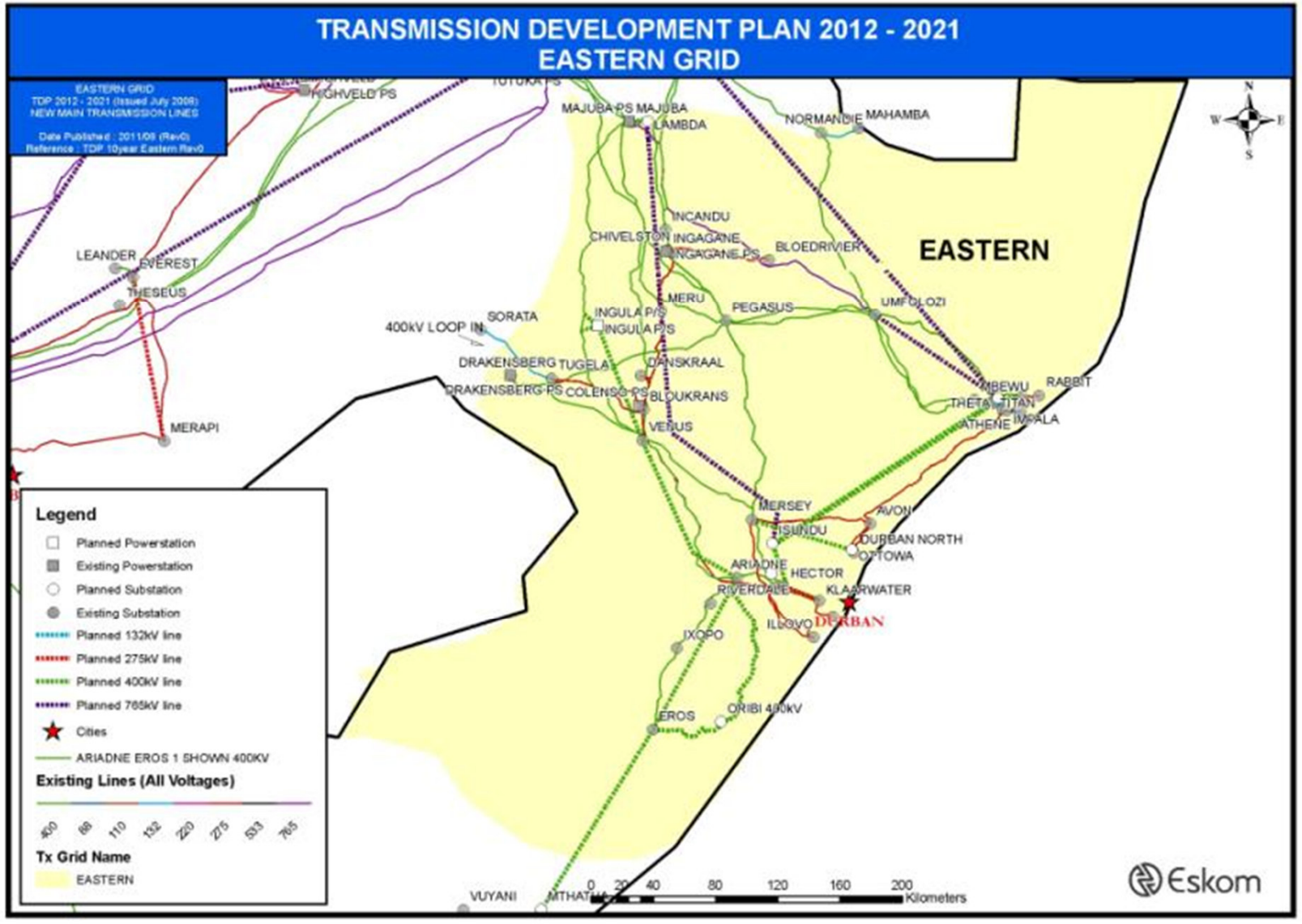


CLN	Forecasted Load (MW)			Ave. Annual % Load Increase
	2012	2017	2021	
Ladysmith and Newcastle	1293	1445	1593	2%
Empangeni	2335	2571	2931	3%
Pinetown	3462	3806	4462	3%





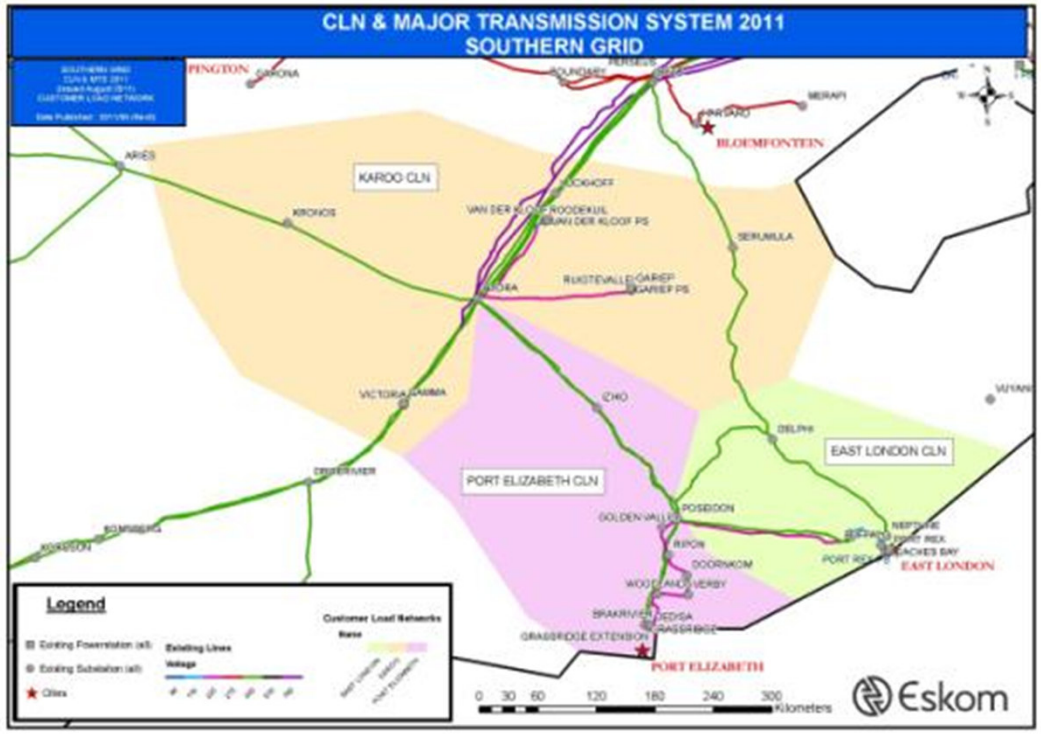
Eastern Grid: Development Plan



Eastern Grid Major Infrastructure Additions

Transmission Assets for Eastern Grid	New Assets expected in 2012-2016	New Assets expected in 2017-2021	Total New Assets expected
Total kms of line	1,487	385	1,872
765kV Lines (km)	490	280	770
400kV Lines (km)	992	105	1,097
275kV Lines (km)	5	0	5
Total installed Transformer MVA	10,795	6,050	16,845
Transformers (no. of)	13	6	19
Capacitors (no. of)	0	0	0
Reactors (no. of)	6	2	8

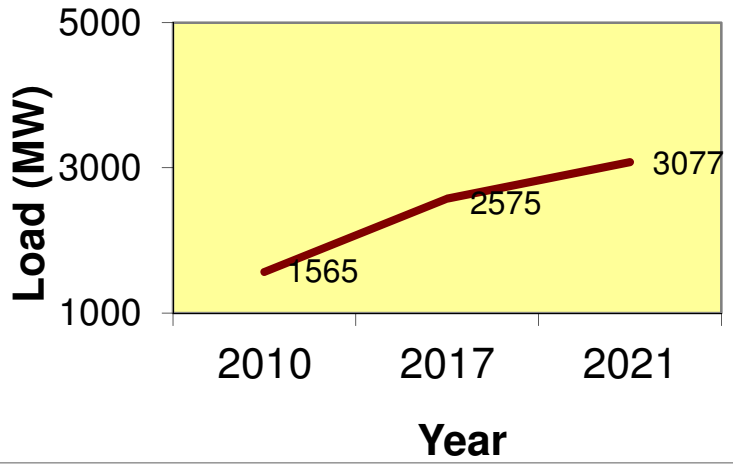
Southern Grid Profile



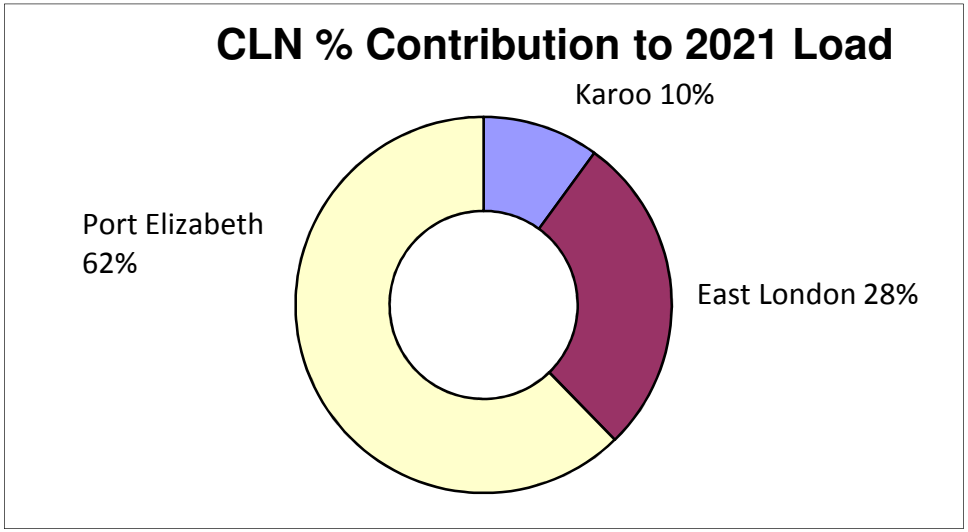
- **Generation**
- Peaking Power Station = Van der Kloof and Gariep
- MW installed = 240MW (Van der Kloof)
  360MW (Gariep)
- **Transmission**
- Load demand = 1 626MW
- Number of MTS = 8
- No & km of HV lines = 17 lines / 2083 km
- Number of CLNs = 3
- **Distribution**
- Economic activity - Industrial (2.2%), Mining (0.1%), Commercial (4.5%), Residential (9.5%), Agricultural (3.4%) & Re-distributors (80.3%).
- No. customers served = 551 267
- Number of substations = 55
- No & km of HV lines = 150 lines / 3 802 km
- No & km of MV feeders = 281 lines / 33 807 km
- Geographic Area = Nelson Mandela Metro, East London, Mthatha
- **General**
- Economic Mix – Motor industry, light industry and foundry, textiles, farming, residential and commercial

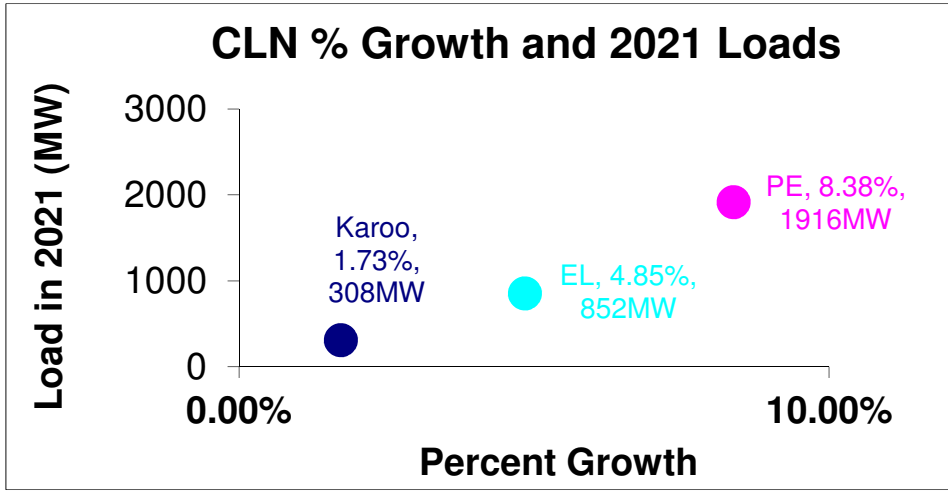
Southern Grid Expansion Drivers

Southern Grid Demand Growth Graph

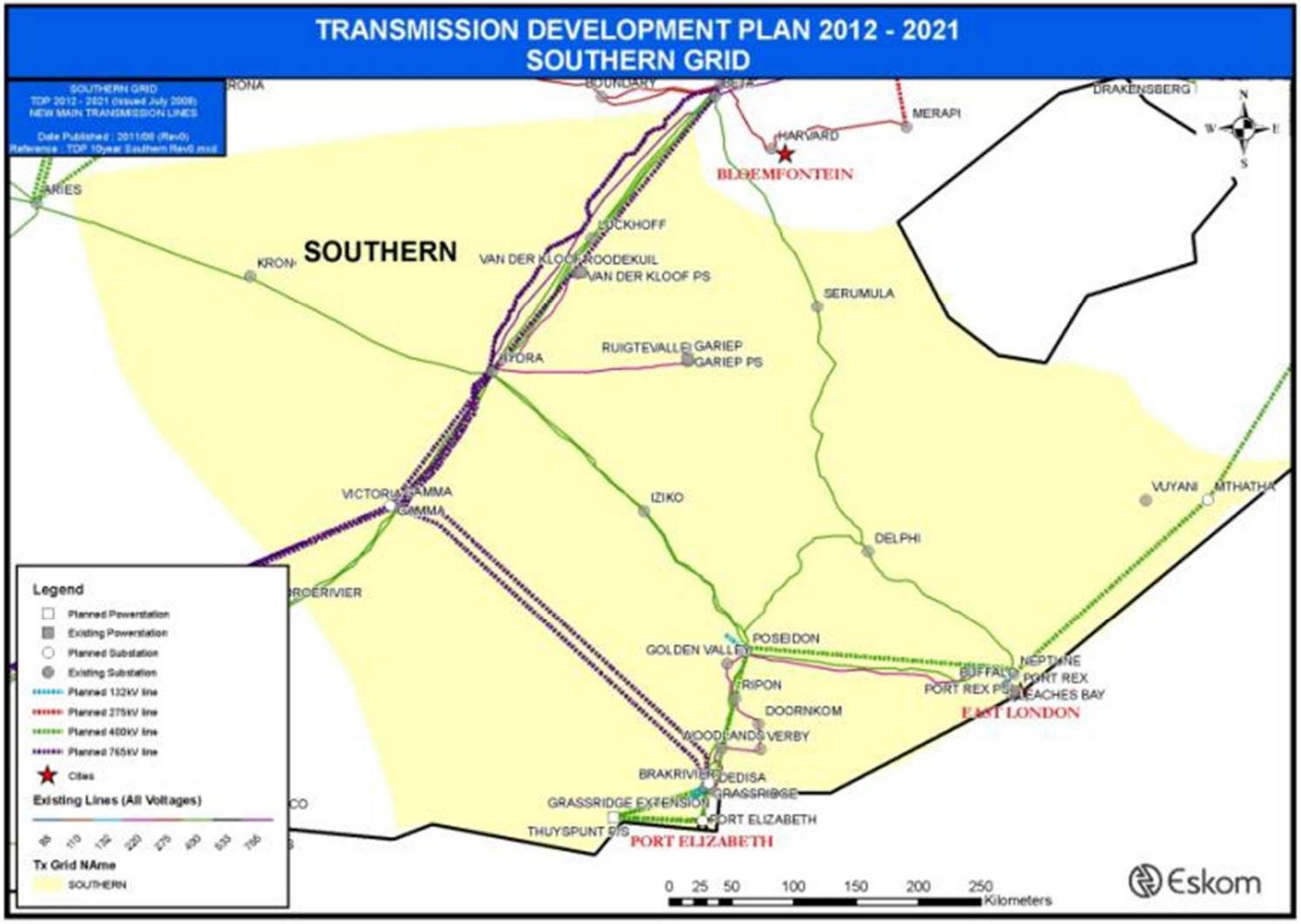


CLN	Forecasted Load (MW)			Ave. Annual % Load Increase
	2012	2017	2021	
Karoo	260	300	308	2%
East London	620	742	852	5%
Port Elizabeth	977	1533	1916	8%





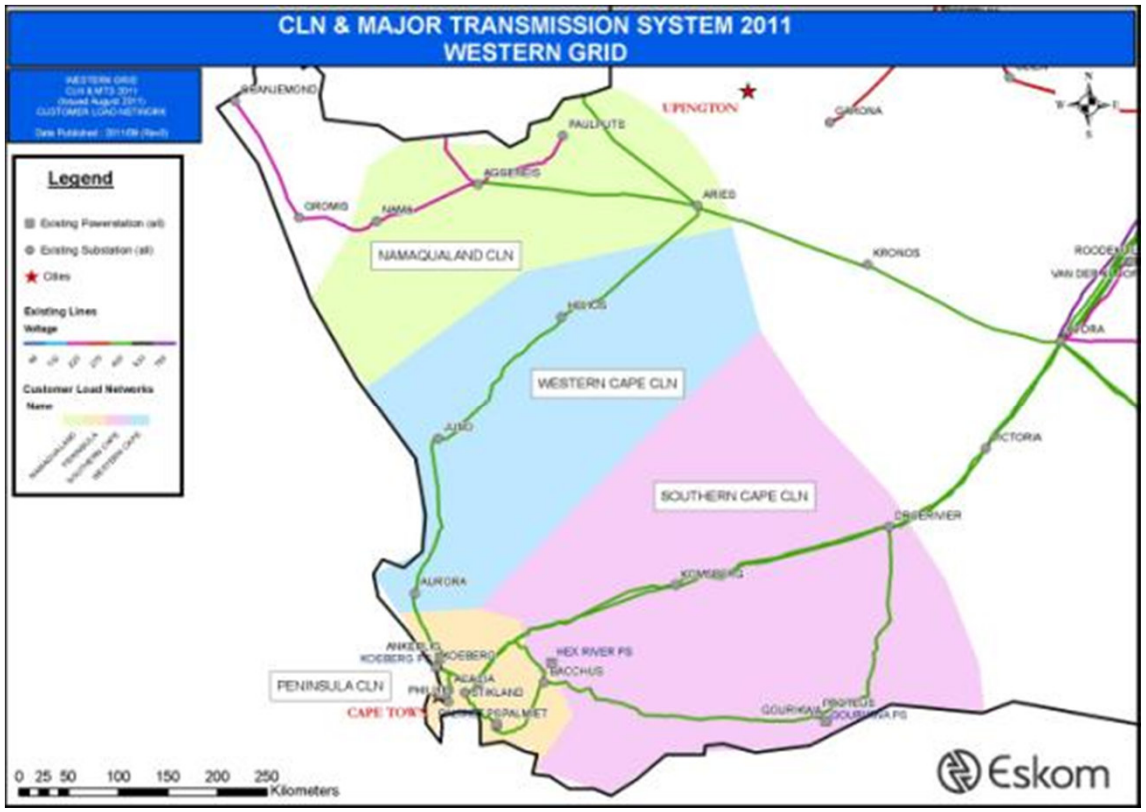
Southern Grid: Development Plan



Southern Grid Major Infrastructure Additions

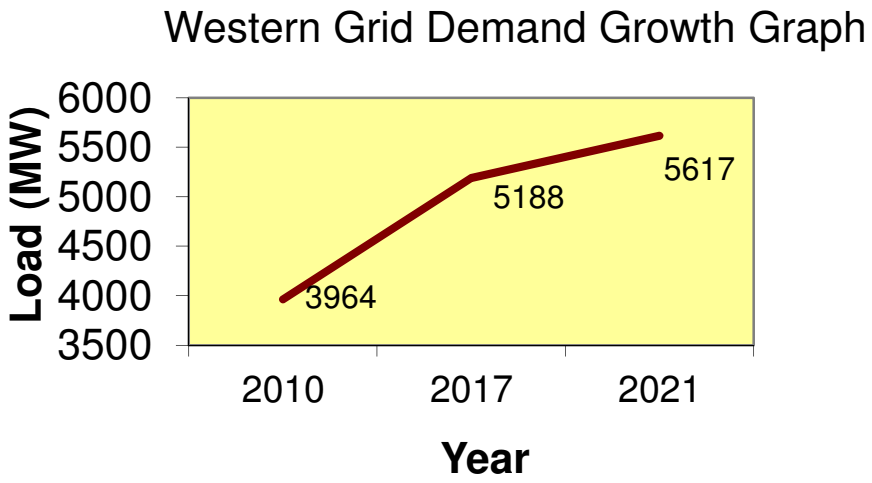
Transmission Assets for Southern Grid	New Assets expected in 2012-2016	New Assets expected in 2017-2021	Total New Assets expected
Total kms of line	931	760	1,691
765kV Lines (km)	560	760	1,320
400kV Lines (km)	371	0	371
275kV Lines (km)	0	0	0
Total installed Transformer MVA	1,295	6,500	7,795
Transformers (no. of)	9	8	17
Capacitors (no. of)	4	0	4
Reactors (no. of)	4	5	9

Western Grid Profile

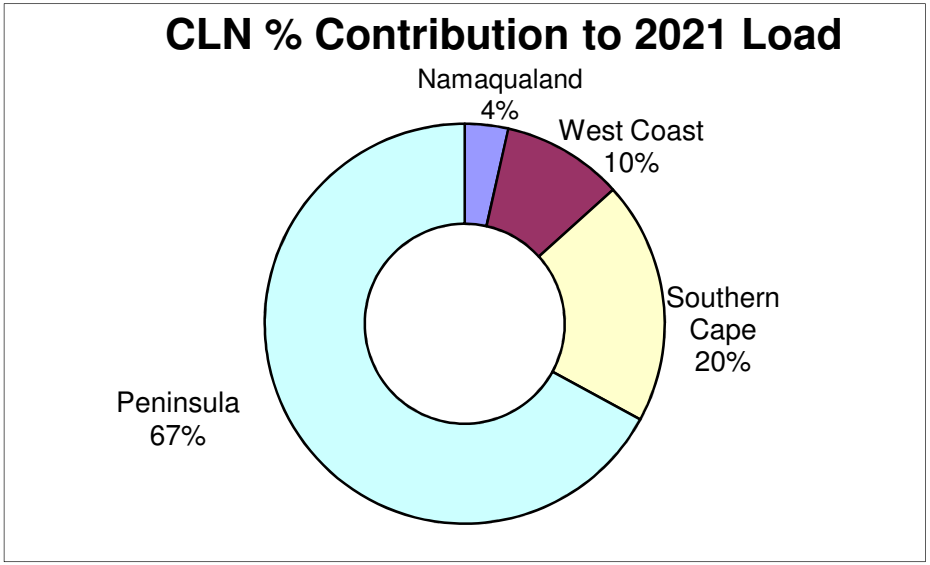


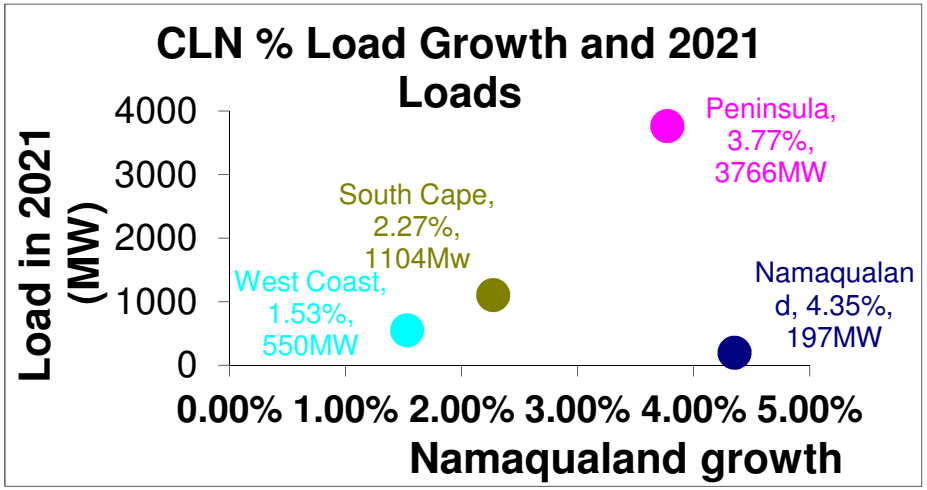
- **Generation**
- Koeberg, Palmiet, Ankerlig,
- Gourikwa, Acacia Power Station
- 4471MW
- **Transmission**
- 4205MW (Regional peak)
- 24 MTS
- 36 lines / 3 752 km
- Number of CLNs = 4
- **Distribution**
- 311 807 customers connected
- 377 substations
- 404 HV lines = 7185 kms
- 1043 MV feeders = 30 009 kms
- 367 703 sq. km
- **General**
- Economic mix: commercial (64%) mining (21%), agriculture (4%)

Western Grid Expansion Drivers

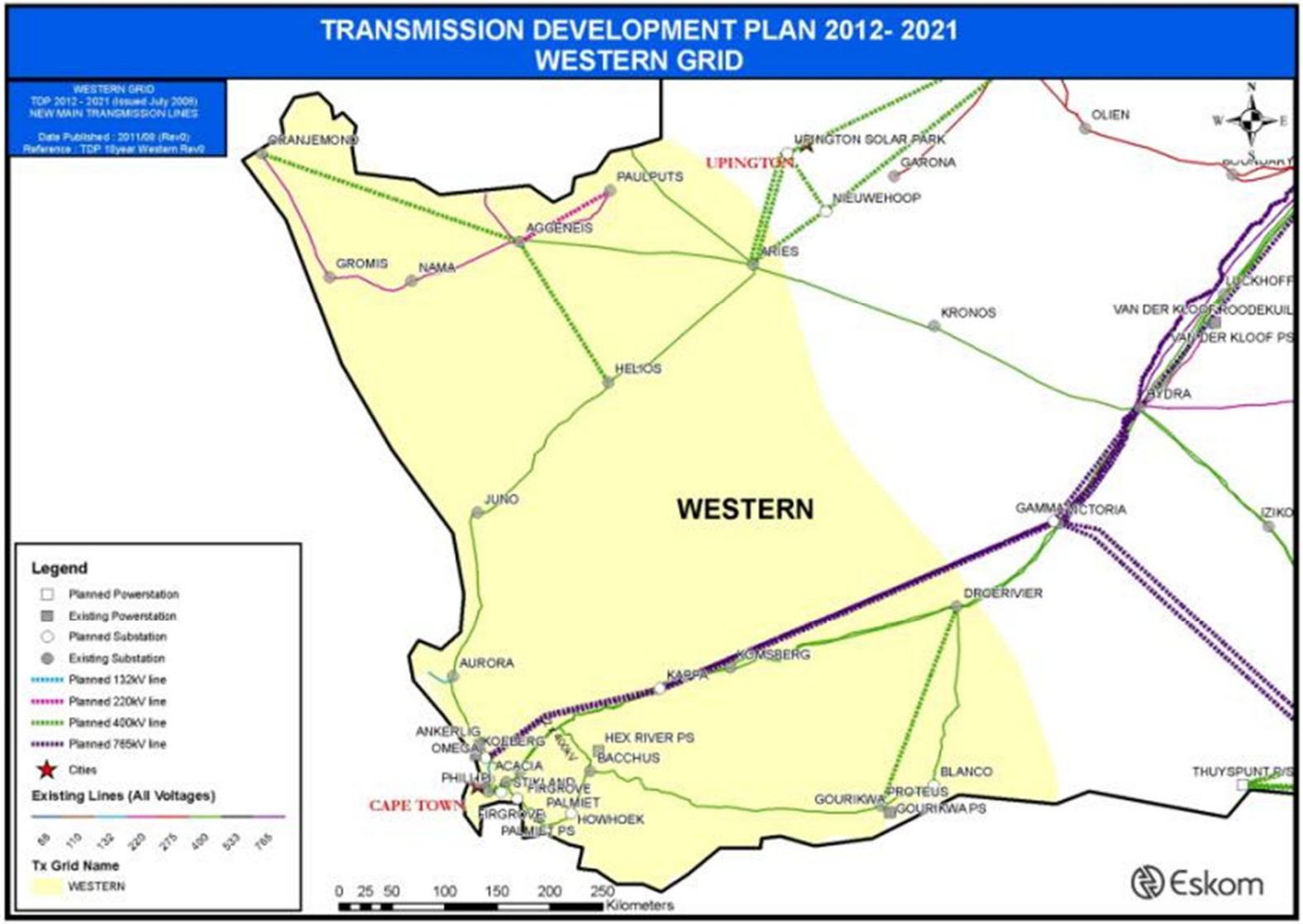


CLN	Forecasted Load (MW)			Ave. Annual % Load Increase
	2012	2017	2021	
Namaqualand	129	181	197	4%
West Coast	479	526	550	2%
Southern Cape	905	1008	1104	2%
Peninsula	2858	3474	3766	4%





Western Grid: Development Plan



Western Grid Major Infrastructure Additions

Transmission Assets for Western Grid	New Assets expected in 2012-2016	New Assets expected in 2017-2021	Total New Assets expected
Total kms of line	838	908	1,746
765kV Lines (km)	150	150	300
400kV Lines (km)	588	758	1,346
275kV Lines (km)	100	0	100
Total installed Transformer MVA	7,820	5,625	13,445
Transformers (no. of)	17	9	26
Capacitors (no. of)	3	0	3
Reactors (no. of)	14	6	20

Capex (Expansion) Observations for 2012 to 2021 TDP

- It is predicted that the new TDP cost for the new period will result in a cost of approximately *R171b in nominal terms* taking into consideration the changes observed.
- The changes observed were:
  - reduction in the amount of line requirements and associated substation projects
  - dates changes of existing projects (deferring projects)
  - the addition of new substation projects, including Wind and Solar integration
- A *value of approximately R8b* has been included for Wind and Solar Integration Projects.

TDP Observations - Conclusions

- The most visible difference between this TDP and the previous year's TDP is the reduction in the amount of Transmission line by approximately 3 800 km. This is mainly due to the deferment of Coal and Nuclear Projects linked to the TDP Generation Assumptions made. There has also been a deferment of Cape Corridor Projects to outside of the TDP period.

- The other difference between this TDP and the previous year's TDP is the phasing and spread of the projects over the planning period. There has been re-phasing of the existing projects (55% of the total amount of projects) using more realistic completion dates based on execution timelines.

- There have been a number of additional projects included in the later part of the planning period, mainly due to new existing substation transformer expansion linked to Solar and Wind Generation assumptions made. There has been few new substations introduced, mainly due to better positioning of loads due to spatial load forecasting techniques applied.

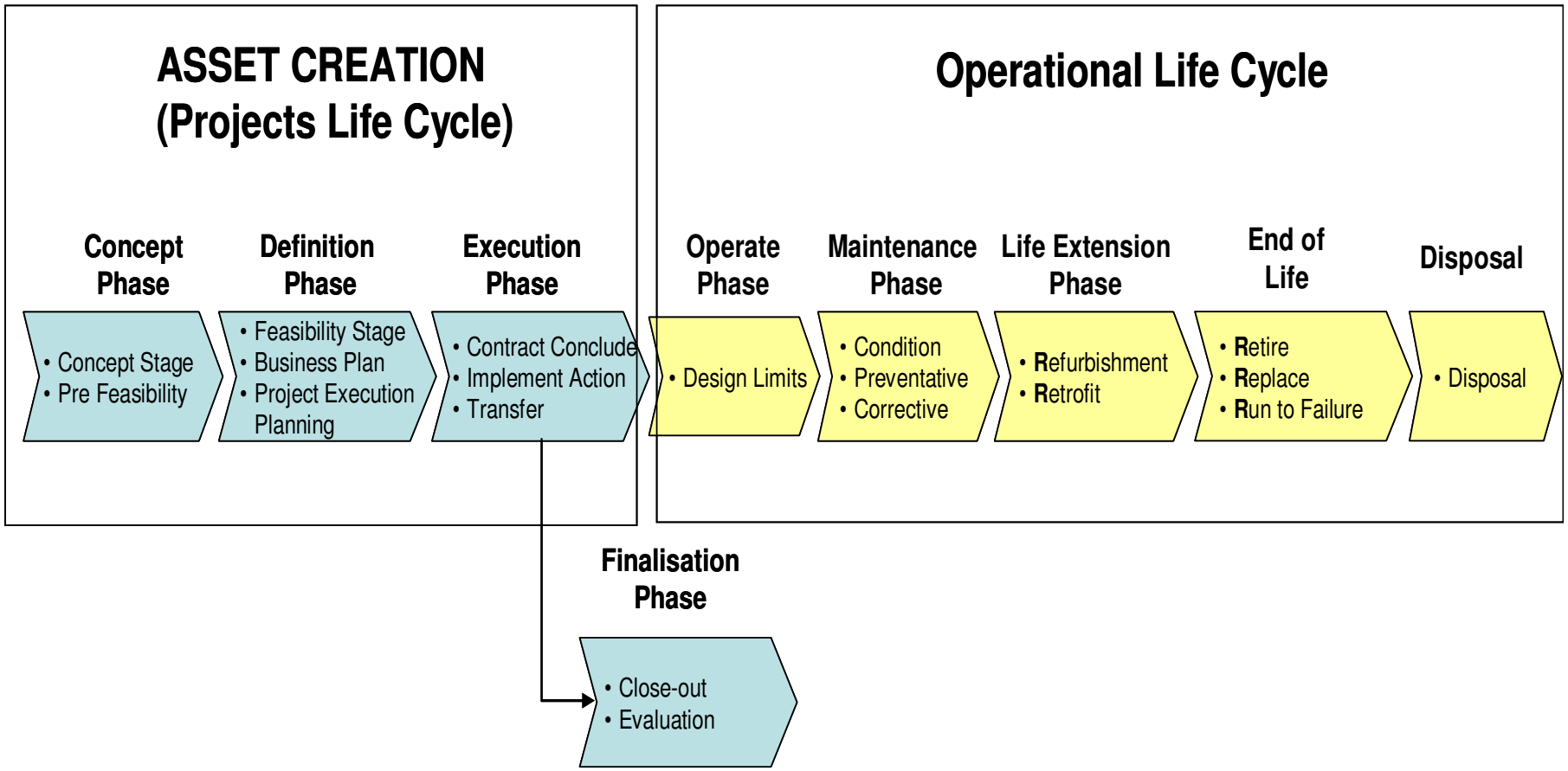
TDP Observations - Conclusions

- The resultant is an improved and more realistic or achievable spread of the transmission line projects and transformer installations. The result of the slower rate of completion of the transmission lines and new transformers increases the overall risk to the network.

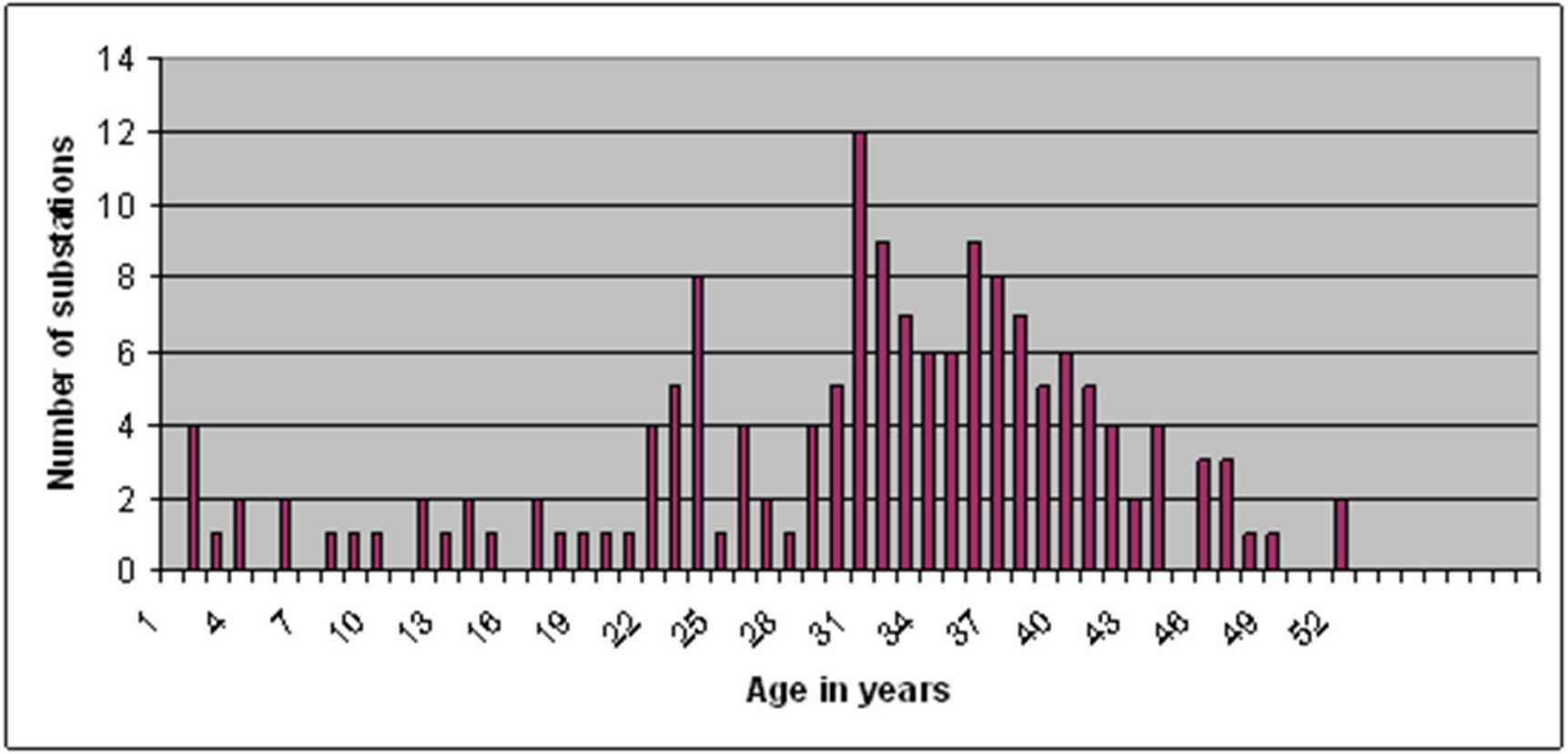
- The conclusion is that the transmission projects in this TDP will result in the overall network becoming Grid Code compliant by year 2018/19, while catering for increased load growth and integration of new generation.

Transmission
Refurbishment & Capital Spares
Principles and Plan

Overall asset life cycle model

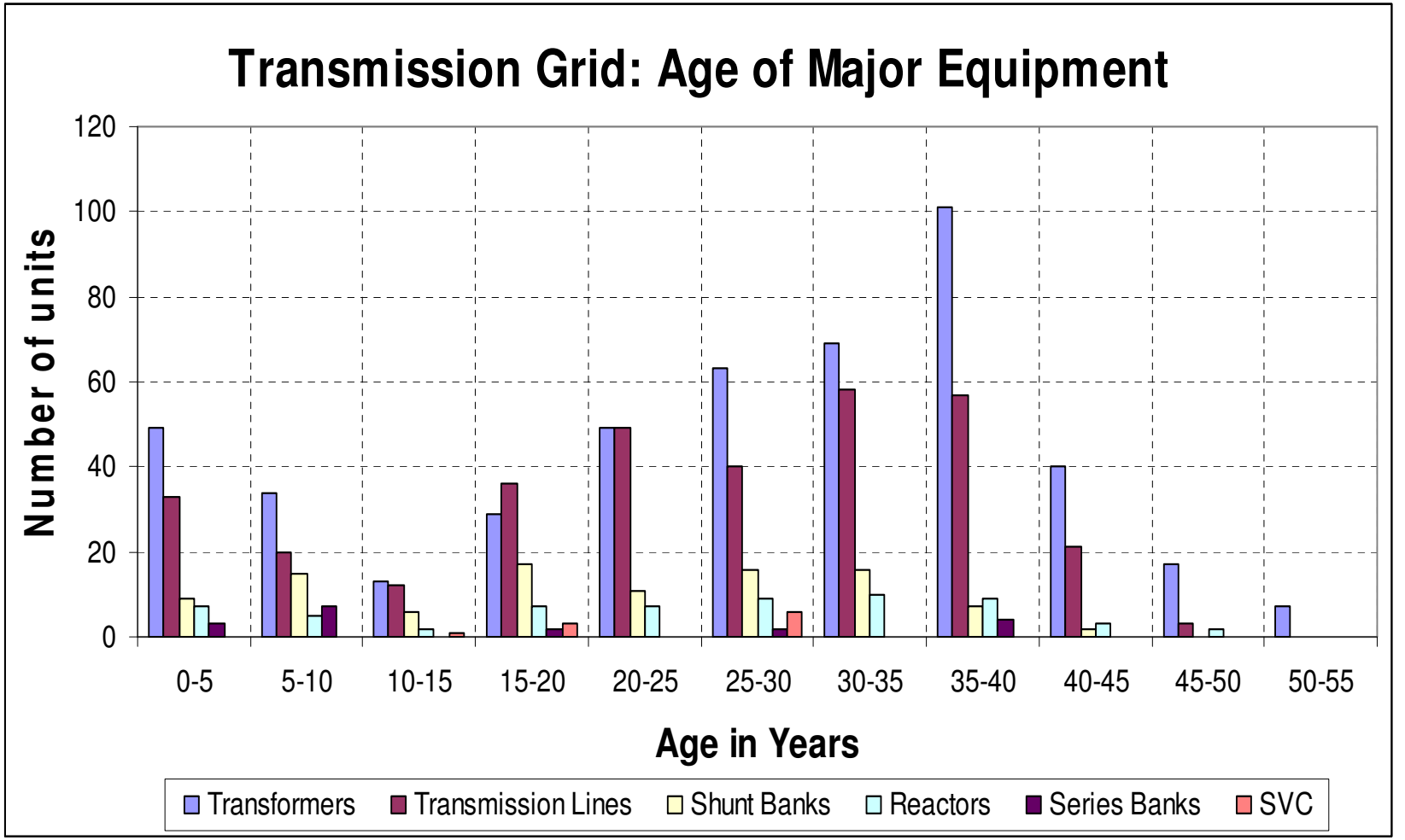


Transmission Substation Age Profile



Note:
Bulk of substations are between 30 and 40 years old.
Performing major refurbishment at 40 years will require an investment as indicated, +-80 Substations.

Equipment Age Profile



Refurbishment - General Principles

- The Eskom project life cycle model to be followed.
- Investment justifications to be based on the following criteria:
  - Least economic cost
  - Operating cost reduction
  - Strategic
  - Statutory
- Assets to be refurbished in accordance with asset life-cycle management plans.
- Condition, criticality & risk assessment (CCRA) principles to be used for refurbishment investment decisions. (Likelihood of asset loss vs. criticality of the asset to the network)

Prioritisation

- Combine refurbishments with expansion
- Corridor refurbishments
- Substation refurbishments
- Bay refurbishments (e.g. transformers)
- Component refurbishments

i.e. Component refurbishments are only remaining after packaging into above priorities.

Secondary Plant Issues

- Secondary Plant will need replacement 2 or 3 times during lifetime of primary plant at a station.
- Allow sufficient space at sites for a new SOR to be built when complete secondary plant refurbishment becomes necessary in the future.
- Future smart substations with full IEC61850 integration will have smaller control rooms for easier refurbishments.
- Need to go for much larger secondary plant refurbishments in future (at least on a per substation level) to keep pace with ageing plant and obsolescence.

Replacement

- Assets are replaced when they have reached the economic end-of-life or technical end-of-life, which ever comes first
- Economic end-of-life brings risk to the customers into the decision which is the least economic criterion in the Grid Code
- The least economic criterion states replace assets when customer interruption costs, CIC (R/kwh) > costs to Eskom

$$CIC > \frac{\text{Annualised Capex costs + Maintenance costs of new asset – Maintenance costs of old asset}}{\text{probability of failure x load lost x duration}}$$

- The probability of failure is a function of the condition of the asset
- The strategic justification is used if the technical end-of-life has been reached and it is not economically justifiable to replace the asset

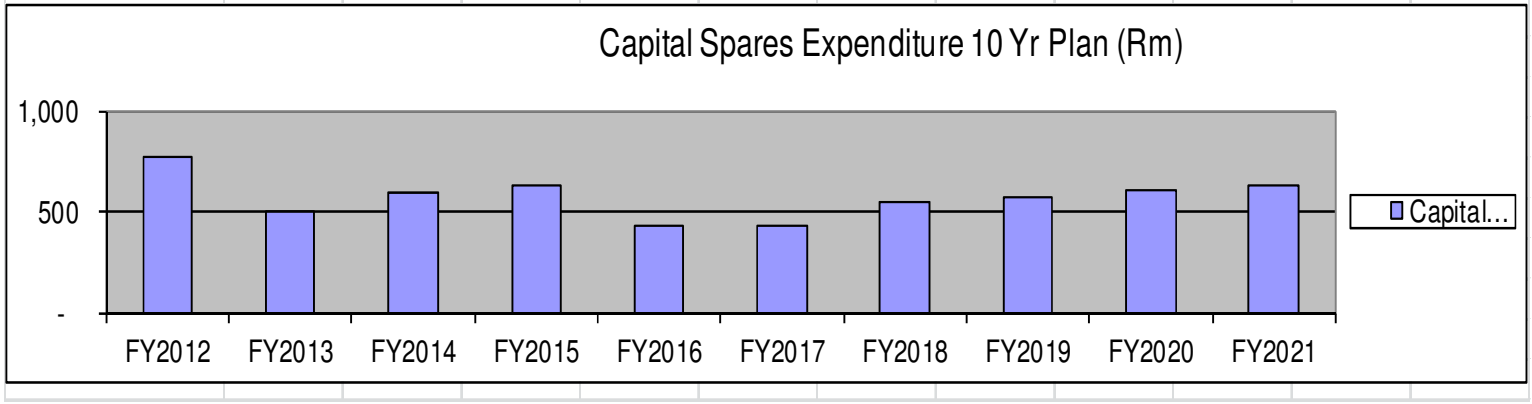
Reasons for Refurbishments

- The bulk of the Transmission network (>100 substations) was constructed between the years 1960 and 1980. This means that from now onwards Transmission will need to cope with substation plant, equipment and infrastructure that has been in service for 40 years and longer.
- Equipment, like the substation batteries and electronic components of protection and control systems, corroded conductors etc. are not repairable and replacement is the only option and is essential to sustain the Transmission network.
- “Aged” equipment like CTs, VTs, Surge Arresters, H.V. Circuit Breakers and Power Transformers, apart from the risk of supply interruptions, can also fail violently and poses a safety risk to staff. These need to be removed from the system if identified as a risk and can not always be run to failure.
- Grid Code and Transmission Licence require certain performance and quality standards, where plant and equipment do not meet these requirements, replacement or upgrading is required.
- Deferring investments in replacing “aged” equipment will:
  - increase maintenance requirements
  - Increase emergency repairs
  - Overall result is higher operating expenditure and unplanned maintenance costs

Drivers for Capital Spares

- 2012 – 2013 a decrease is planned for in meeting the current spares policy and targets.
- From 2014 we will be fulfilling the spares policy in terms of the increase in the installed transformer base.
- From 2013 onwards the majority of the provision is for stores replenishment.
- High risk transformer replacement is planned to assist in reducing replenishment numbers.

Categories	FY2012	FY2013	FY2014	FY2015	FY2016	FY2017	FY2018	FY2019	FY2020	FY2021	Total
Capital Spares	768	503	600	630	429	437	548	575	604	634	**5,729**

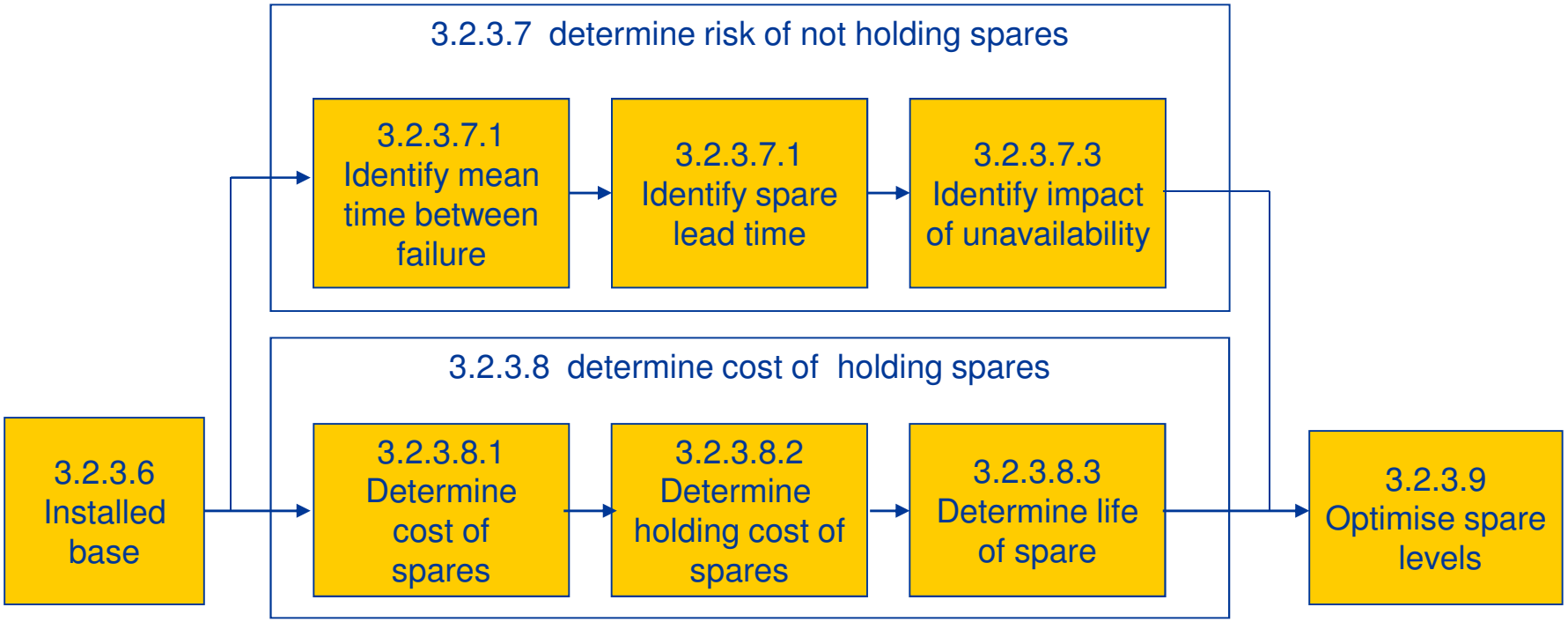


Transformers – number of units

	year	budget	actual
history	2007/2008	15	19
	2008/2009	20	20
	2009/2010	18	16
MYPD 2	2010/2011	26	16
	2011/2012	24	1
	2012/2013	20	

The historical orders of transformers received is in line with the budgeted amounts.

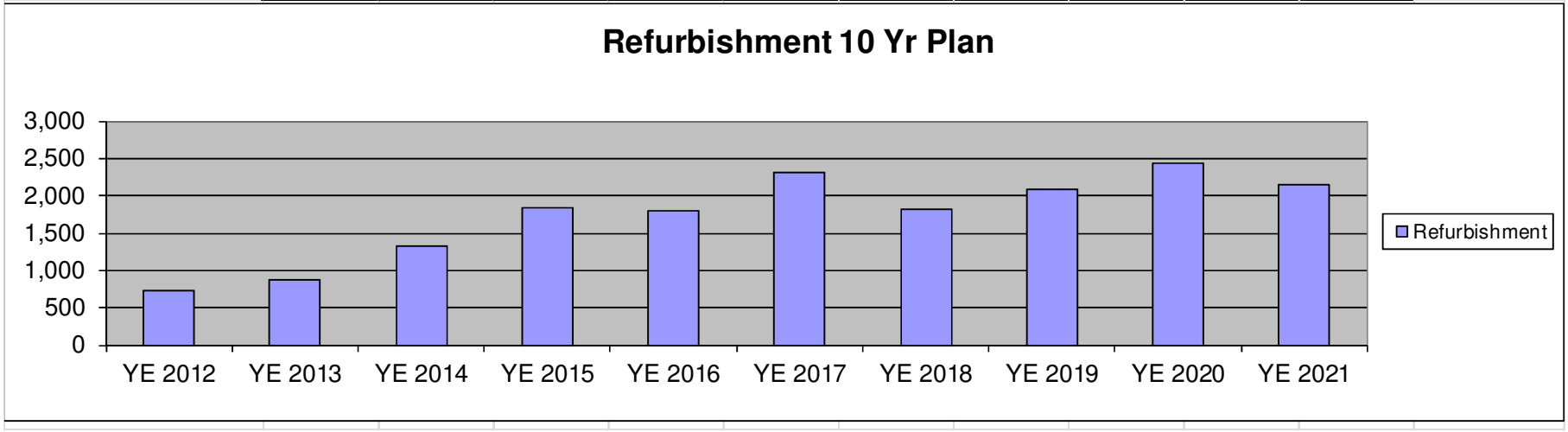
Strategic Spares – Criteria to Set Optimal Levels



The Grid Code criterion for the justification of strategic spares is on strategic rounds. A model is currently under development to determine optimal spares levels

Refurbishment 10 Year Plan

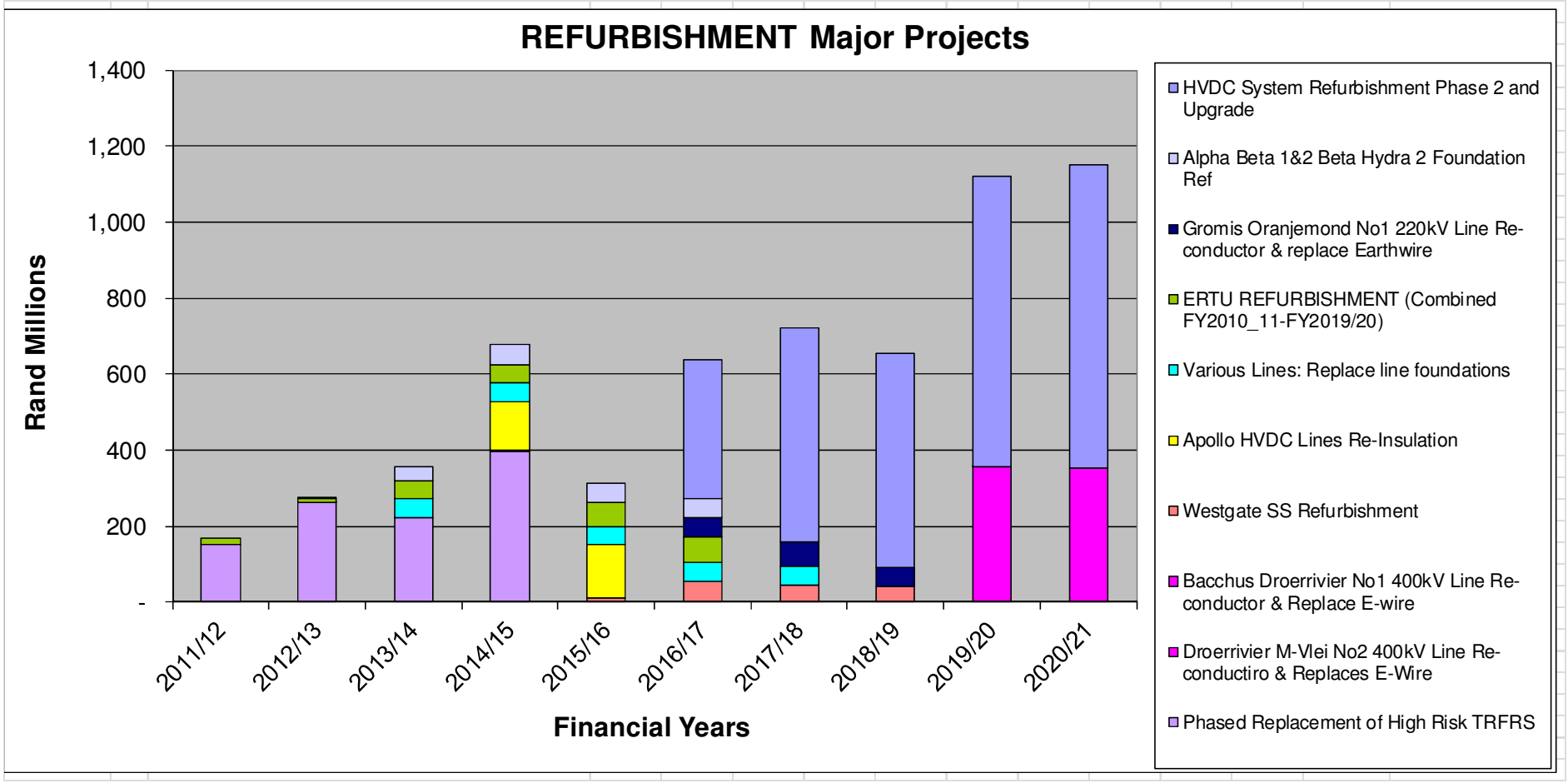
	FY2012-2021 Plan										
Categories	**YE 2012**	**YE 2013**	**YE 2014**	**YE 2015**	**YE 2016**	**YE 2017**	**YE 2018**	**YE 2019**	**YE 2020**	**YE 2021**	**Totals**
Refurbishment	728	875	1,318	1,841	1,795	2,317	1,819	2,084	2,433	2,154	**17,363**
5 Yr Subtotal					6,557					17,363	



- The last 5 years of the 10 year plan is based on the expected refurbishment requirements due to the aging network
- The bulk of the transmission network will be older than 40 years within the next 10 years.
- The details of the future refurbishment projects will be identified through a structured “asset condition assessment” program.

Refurbishment Major Projects (10 Year Plan)

R' millions



Transmission Capital Expenditure Plans

2012 - 2021

The Drivers for Capex

- Asset Management Philosophy
  - Licence compliance as stipulated in the Grid Code
  - Safety Compliance i.e. OHSACT requirements
  - Life Cycle management of assets
    - Ageing infrastructure
    - Strategic Spares to ensure minimum requirements are met
    - Our historical underinvestment as related to benchmarked refurbishment levels (Previous philosophy of “sweat the plant”)
  - For improved asset utilisation specialised equipment to enable optimised outage management i.e. live line equipment
  - Physical Site Security and Monitoring
- Ensuring the adequacy and security of the existing network installation
  - To ensure existing customer base continues to have a secure supply and enable continued growth in these areas

The Drivers for Capex (Expansion)

- Strategic Servitude Acquisitions
  - A long term servitude plan to minimise acquisition challenges
- Funding requirements for new customer connections
  - All Key Customers and Large Power users could potentially use their own funding sources to pay their network capital costs
  - Based on historical trends and known applications
- Network Strengthening
  - Minimum Grid Code Requirements set
  - Ensure reliability and security of supply
- New Generation Connections
  - To ensure the evacuation and transportation of power to the load centres
  - To facilitate construction supplies for the new power stations and for auxiliary supplies

10 Year Transmission Capex Summary (R'mil)

Categories	FY12-21
Expansion	170,888
Refurbishment	17,363
Capital Spares	5,729
L&R	8,134
OTHER	7,021
Production Equipment	744
Total	**209,879**