Eskom

GreenCape Grid Capacity

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Group Technology: Planning Centre of Excellence

Date: 2014-12-02

Powering your world

Contents

- Safety First – Evacuation routes - Mike Mulcahy
- Attendees about 150 – thanks for your support of GreenCape
  About 85 companies listed !!
- Summary of RE projects to date & Location
- Transmission GCCA “Rules” (Grid Connection Capacity Assessment)
- RE Projects grouping
- **GAU RE interest, MTS GCCA capacity before BW4 & RE IPP 1-3 allocated**
- Transmission MTS Strategic IPP Framework under development
- RE IPP Bid 4 Lessons Learnt

Department of Energy RE IPP Programme

Description	RE IPP 1	RE IPP 2	RE IPP 3	RE IPP 4
Cost Estimate Letters	~270	>190	~500	216
DoE Applications	**54**	**79**	**93<97**	**18 Aug '14**
Wind (Nr – MW) Preferred Bidders	8 - 634	7 - 563	7 - 787	590
Photovoltaic (PV) (Nr – MW)	18 - 632	9 – 417	6 - 450	400
Concentrating Solar Power	2 - 150	1 - 50	2 - 200	**Bid 3.5 =200**
Small Hydro (Nr – MW)		2 - 14		60
Landfill (Nr - MW)			1(5) - 18	15
Biomass (Nr - MW)			1 - 16.5	40
Small RE 1-5 MW (MW) **Nov 2014**				50
Preferred Bidders (Nr)	***28***	***19***	***17***	
MW allocated	***1416***	***1044***	***1471.5***	***1105***
Grid connected / Financial close	27 - 1415	8-342	6 by 2014	Next slide

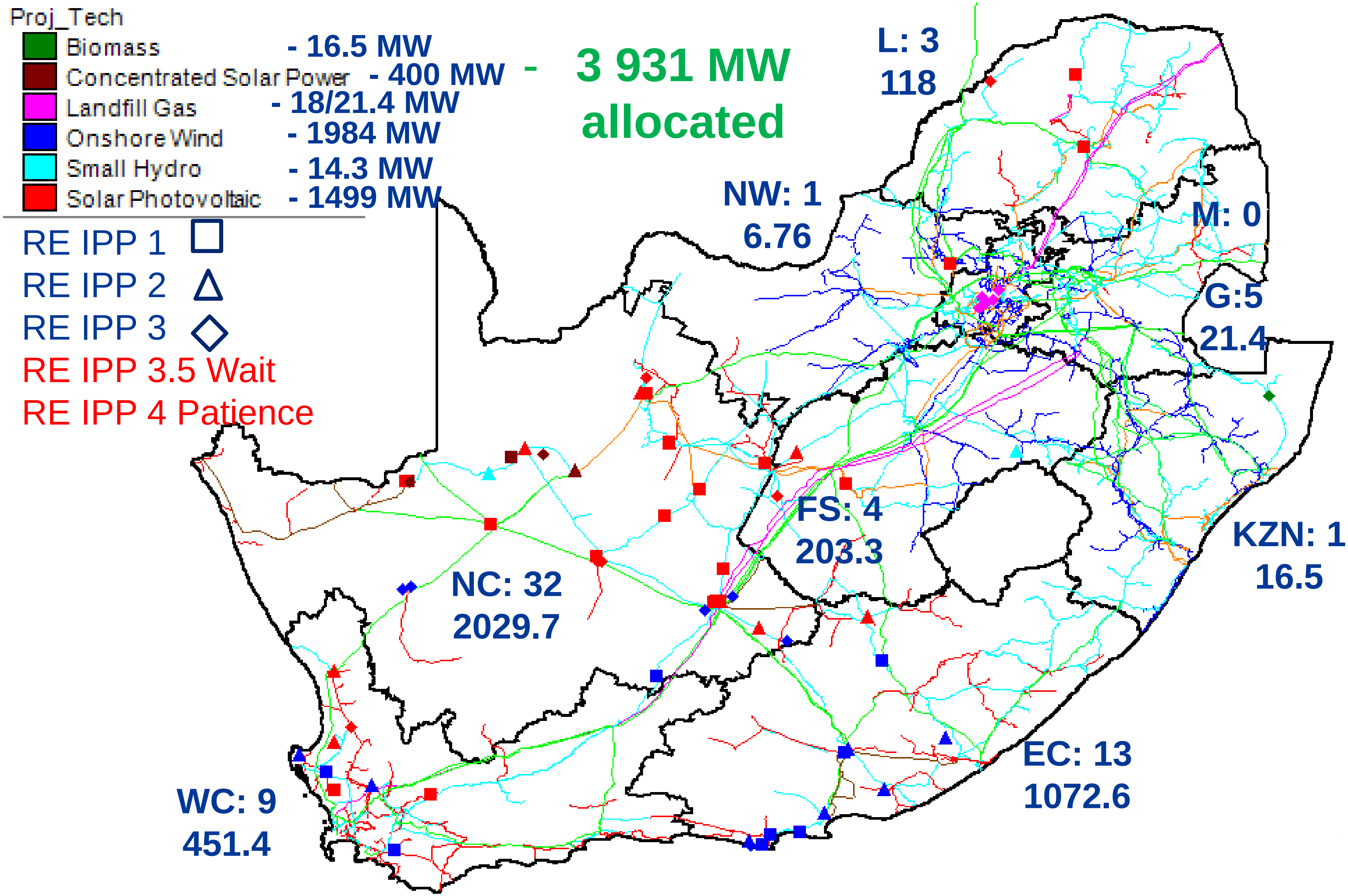
Note: 1x Landfill application, but for 5x sites, no bids for Biogas & Small RE

DoE RE IPP Determinations till 2020

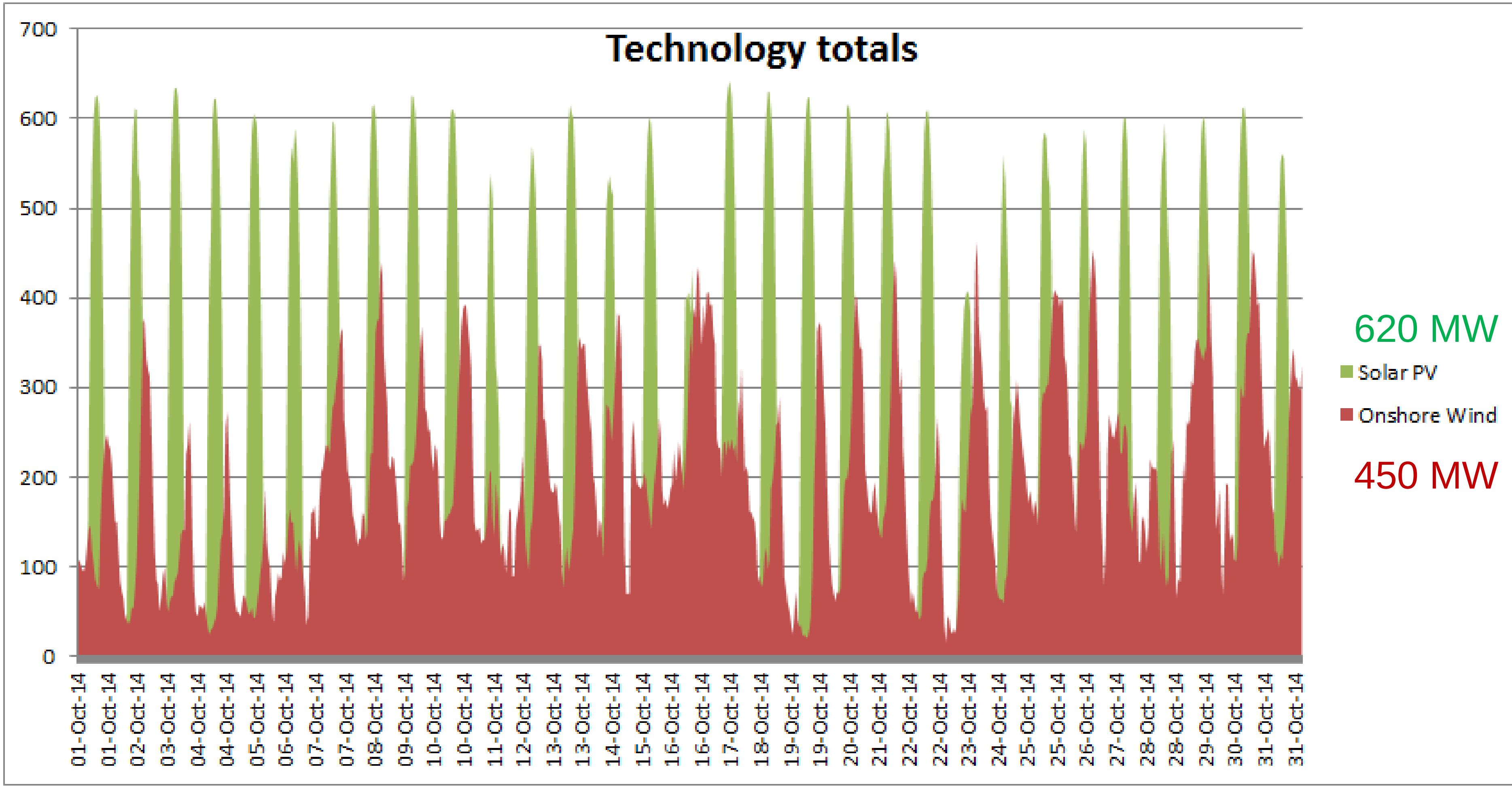
Description	RE IPP Det 1	BW 1-3 allocated	RE IPP Det 2
Wind (MW)	**1850**	**1984 (50.5%)**	**1 470**
Photovoltaic (PV) (MW)	1450	**1499 (38.1%)**	1 075
Concentrating Solar Power (MW)	200	**400 (10.2%)**	400
Small Hydro (MW)	75	14	60
Landfill (MW)	25	18	
Biomass (MW)	12.5	**16.5**	47.5
Biogas (MW)	12.5	0	47.5
Small RE 1-5 MW (MW)	100	0	100
Total MW	**3 725**	**3931.5**	**3 200**

Note: More MW allocated to date versus RE IPP Determination 1
Will be subtracted from Determination 2

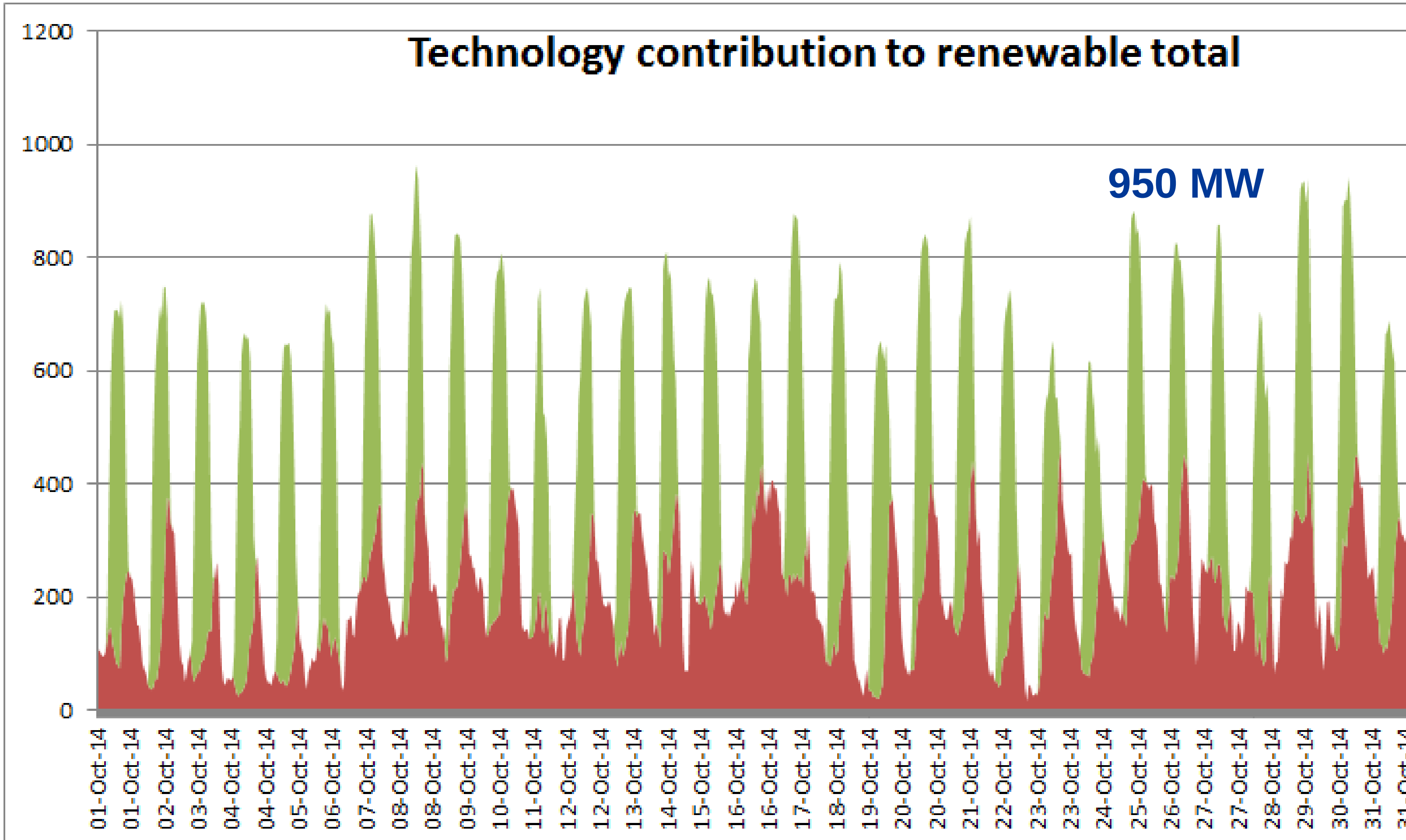
RE IPP 1 & 2 & 3 Preferred bidders



Output per Technology type - October 2014



Contribution of PV and Wind to total Renewable Energy – October 2014



GCD

BW1: 27

1415 MW

BW2: 8

342 MW

1757 MW

COD

BW1: 23

1146.6 MW

BW2: 4

111.5 MW

1258 MW

DoE Evaluation consultation & Tx GCCA “Rules”

- Initially cater for all RE IPPs to be evacuated - Under n-1 + low load
- Grid code does not require n-1 for generation <1000 MW, unless specific design requirements.
- Multiple project dependencies evaluated per MTS and per Network
- No diversity between different technologies, unless operating experience allow for new analysis
  - Consider Transmission and Distribution load flow studies, various load scenarios, voltage variation,….
- Final decision will be with the prudent operator, taking existing contractual requirements into account.
  - Specialist studies are welcome, but needs confirmation by Eskom before sign-off and implementation, as it may impact other customers
- Requires Bid 3 to be announced before Bid 4 to finalise capacity available at few Main Transmission Substations (MTS)
- Project lead times for Transmission and Distribution

RE IPP Bid 4 – Tx GCCA Extract

Substation & Voltage	Province	Supply Area	No. Trfrs	Single Trfr MVA	Total Trfr MVA	Firm N-1 MVA	GCCA 2012	HV Sub Capacity GenCap (n1 or n-1+LL)	Gen MEC MW Allocated	Gen Available HV - undiversified (MW) in 2016	EHV Capacity-diversified (MW)	Supply Area EHV steady-state limit (MW)	Supply Area EHV transient stability limit (MW)	Year in Service
Spitskop 400/275 kV	North West	Waterberg	2	800	1600	800		1000	0	1000				Existing
Boundary 275/132 kV	Northern Cape	Kimberly	2	250	500	250	650	298.6	153.15	258	421			Existing
Ferrum 275/132 kV	Northern Cape	Kimberly	2	250	500	250	380	256.3	224	32	318			Existing
Ferrum 400/132 kV	Northern Cape	Kimberly	2	500	1000	500		545.3	0	545	237			2013-12-31
Mookodi 400/132 kV	Northern Cape	Kimberly	2	500	1000	500		530.9	0	531	421	1838	2580	2014-01-31
Upington 400/132 kV	Northern Cape	Kimberly	1	500	500	0		500	169.9	330	0			2017-12-31
Garona 275/132 kV	Northern Cape	Kimberly	1	125	125	0	90	125	50	75	157			Existing
Olien 275/132 kV	Northern Cape	Kimberly	2	150	300	150	340	172.8	139	210	283			Existing
Hydra 400/132 kV 2	Northern Cape	Karoo	1	500	500	0		500	235	265	3124			2017-08-30
Hydra 400/132 kV 1	Northern Cape	Karoo	2	240	480	240	400	250.5	469	75				Existing
Hydra 400/220 kV	Northern Cape	Karoo	2	315	630	315		366	0	366	186			Existing
Gamma 765/400 kV	Northern Cape	Karoo												
Gamma 400/132 kV	Northern Cape	Karoo												
Kronos 400/132 kV	Northern Cape	Karoo	1	250	250	0		250	169.9	80	697	4315	2398	2016-12-31
Kronos 400/132 kV 2	Northern Cape	Karoo	1	250	250	0		250		250				2019-12-31
Roodekuil 220/132 kV	Northern Cape	Karoo	1	125	125	0	0	125	0	0	165			Existing
Ruigtevallei 132/66 kV	Northern Cape	Karoo	2	20	40	20		27.2	0	0	143			Existing
Ruigtevallei 220/132 kV	Northern Cape	Karoo	2	250	500	250	0	287.2	69.9	0				Existing

Need to monitor 2x 132 kV busbars at Hydra, Poseidon, etc.

Need to cater for existing Hydro stations full capacity.

Need to introduce new substations / transformers

MTS ~ GAU interest (Jun 2014), GCCA capacity before BW4, RE IPP 1-3 allocated

	Sum of GAU MEC MW	GCCA MW Avail<4	RE IPP 1-3 MEC MW		Sum of GAU MEC MW	GCCA MW Avail<4	RE IPP 1-3 MEC MW
Aggeneis 400/220 kV	690	250		Ferrum 275/132 kV	305	32.3	224
Ararat 275/88 kV	15	746.4		Ferrum 400/132 kV	555	545.3	
Aries 400/22 kV		30.35	9.65	Fordsburg 275/132 kV			6.3
Aries 400/132 kV	1275	0		Gamma 400/132 kV	145	0	
Athene 400/132 kV	108			Garona 275/132 kV	85	75	50
Aurora 400/132 kV	174	615.5	245.2	Grassridge 400/132 kV	261	493.61	502.25
Bacchus 400/132 kV	310	593.81	62.19	Gromis 220/66 kV	140	45.4	
Bighorn 275/88 kV		754.8	6.76	Grootvlei	60		
Bloedrivier 275/88 kV	225			Harvard 275/132 kV	155	555.4	64
Bloukrans 275/132 kV	35			Helios 400/132 kV	225	224.1	275.9
Boundary 275/132 kV	1150	258.28	153.15	Hermes 400/132 kV	133	408.6	
Delphi 400/132 kV	41	44.96	97	Hydra 400/132 kV 1		75	469.05
Douglas 275/132 kV	309			Hydra 400/132 kV 2	887.5	265	235.5
Droerivier 400/132 kV	75	153.3		Impala 275/132 kV	135	842.7	16.5
Eros 400/132 kV	108			Ingagane 275/88 kV	26.2		
Esselen 275/88 kV			4	Iziko 400/132 kV	150		
Everest 275/132 kV	75	548.3		Juno 400/132 kV	30	131.2	108.8

Tx GCCA values used for Bid Window 4 evaluation

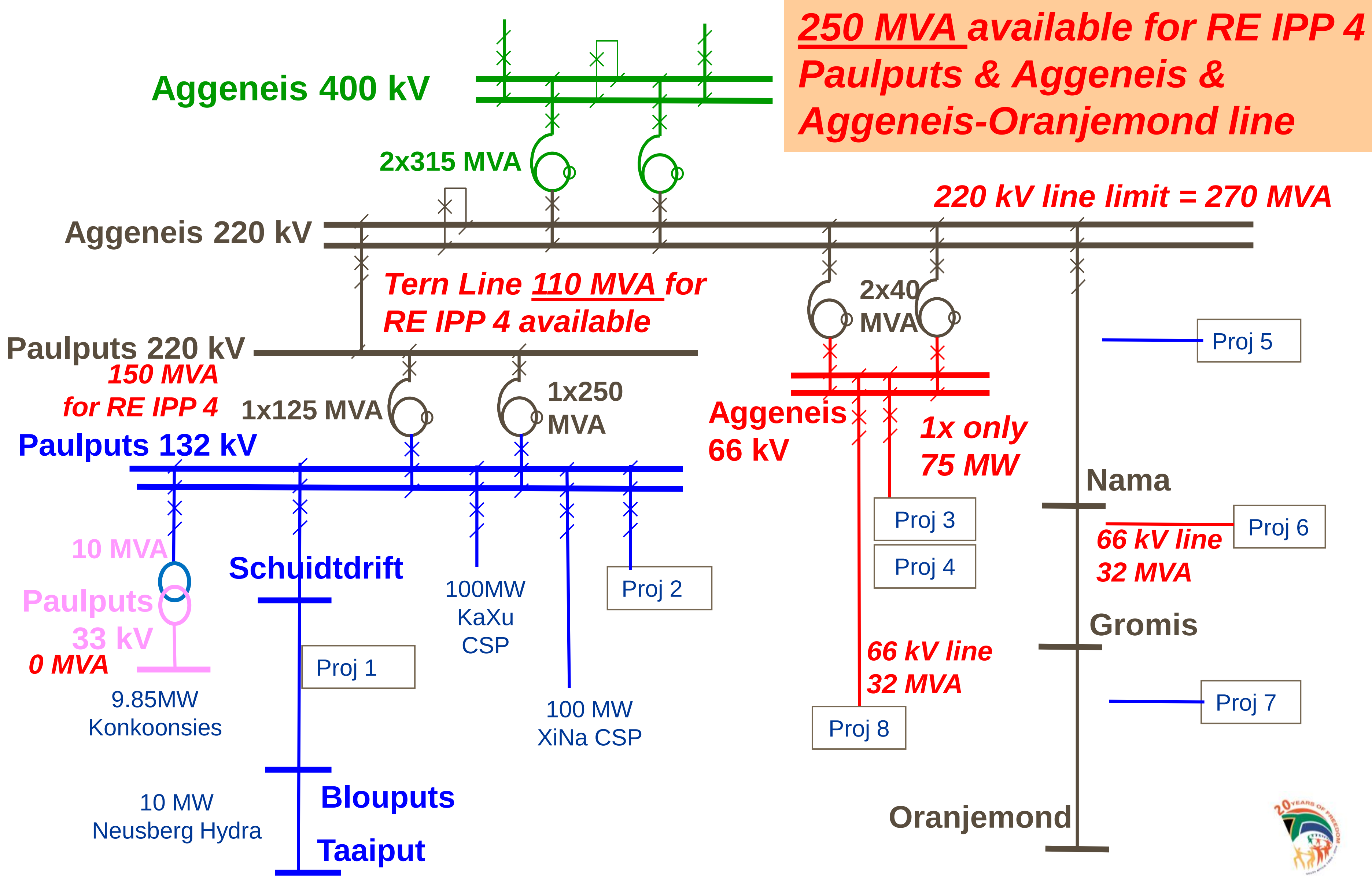
MTS ~ GAU interest (Jun 2014), GCCA capacity before BW4, RE IPP 1-3 allocated

	Sum of GAU MEC MW	GCCA MW Avail<4	RE IPP 1-3 MEC MW		Sum of GAU MEC MW	GCCA MW Avail<4	RE IPP 1-3 MEC MW
Kappa 400/132 kV	250	0		Princesss 275/132 kV			6
Koeberg 400/132 kV	116	250		Proteus 400/132 kV	80	676.4	
Komsberg 400/132 kV	490.4	0		Rockdale 275/132 kV	75		
Kronos 400/132 kV	1037.2	80.1	169.9	Roodekuil 220/132 kV	75	0	
Leander 400/132 kV	5	573.5		Ruigtevallei 220/132 kV	380	0	69.9
Matimba 400/132 kV	250	200	60	Spencer 275/132 kV	50	322.3	
Mercury 400/132 kV	150	601.1		Spitskop 275/88 kV	150		
Mersey 275/132 kV	10			Tabor 275/132 kV	150	500	28
Mookodi 400/132 kV	460	530.9		Taunus 275/132 kV		994	5.1
Muldersvlei 400/132 kV	175	864.8	135.2	Theseus 400/132 kV	150	629.6	
Olien 275/132 kV	656	210	139	Tugela 275/132 kV	39.2	218.3	4.3
Paulputs 220/132 kV	235	115	219.65	Umfolozi 400/88 kV	100		
Pembroke 220/132 kV	74.2	223.4	20.6	Upington 400/132 kV	1256	330.1	158.9
Perseus 400/275kV			60	Warmbad 275/132 kV	75	143.6	
Poseidon 220/132 kV	355	91.14	158.4	Watershed 275/132 kV	254	250	
Poseidon 400/132 kV	560	266.4	224.5	Witkop 400/132 kV		970	30
Prairie 275/132 kV	13.8	261.14		**Grand Total**	**15554.5**		

Competition might exceed capacity available

Actual applications much less than GAU indication

Example - Aggeneis Network



Strategic Environmental Assessments (SEAs)

WESTERN CAPE PROVINCE

PROVINCIAL & LOCAL GOVERNMENT

CONSULTATION WORKSHOP

Identification of Strategic Power Corridors

Kevin Leask

Eskom, Grid Planning

24 November 2014

The Different Development Plans

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.

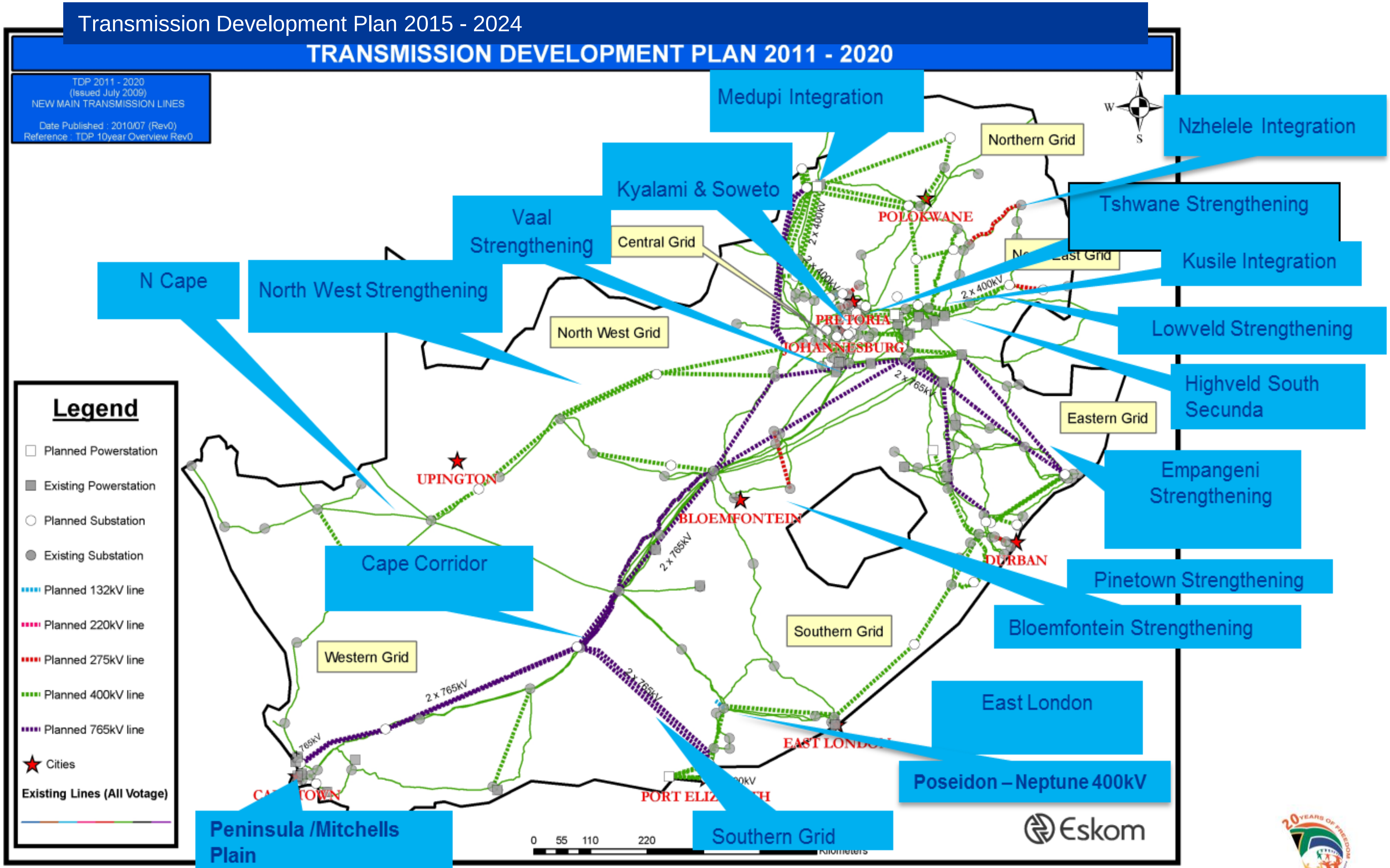
Strategic Grid Plan

- 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

Transmission Development Plan (TDP) Overview



The Strategic 2040 Network Study

- Eskom has updated the 2030 strategic grid study to 2040
- Why 2040 - Most of the existing coal power stations in Mpumalanga will be decommissioned – what is the impact on the grid?
- Major difference between 2030 & 2040 studies is consultation with external stakeholders (such as renewable energy associations) for the development of the new generation scenarios
- 2010 IRP is the base scenario - however there is uncertainty on the location and actual performance of the generation sources, e.g. wind
- Three Generation Scenarios were selected

Proposed three Generation Scenarios

- **The IRP 2010 base Scenario (BASE IRP)**
  - IRP will be extended to 2040
  - Coal will be fixed at 2030 level
  - Balance in similar ratio to 2030 mix
- **Increased Renewables Scenario (GREEN)**
  - Replace nuclear component with RE base generation equivalent
  - CSP (with storage)/ Wind with CCV of 30% / Natural Gas
- **Increased Imports Scenario (IMPORT)**
  - Double imported power by 2030
  - Reduce coal & nuclear

Important Generation Assumptions

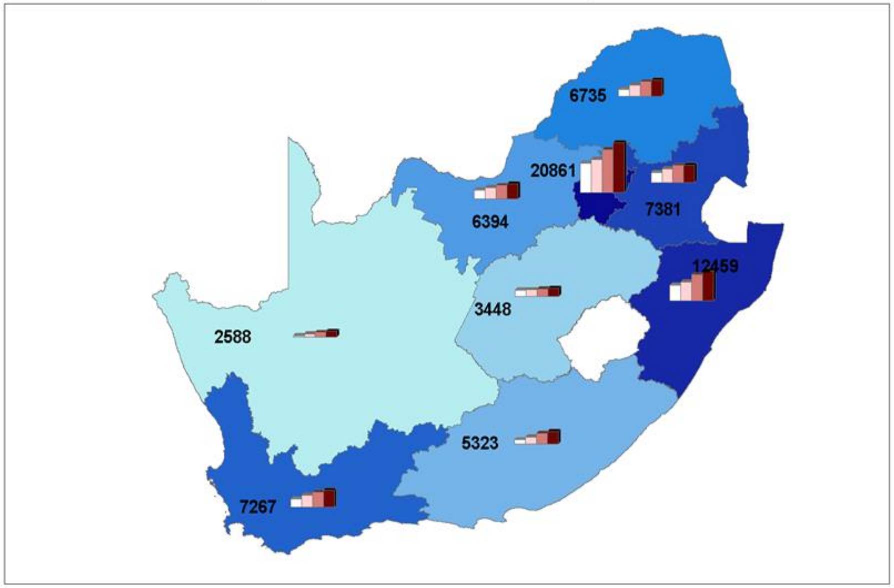
- For 2030 to 2040 will replace decommissioned coal with new coal – this will not increase coal component – however location will be different
- Note that this is <u>17 GW of decommissioned coal generation</u>
- Wind is given a 30% Capacity Credit Value (contribution at time of system peak) for the scenarios – based on the Wind Capacity Credit Study done in 2010 and IRP 2010 assumptions
- In BASE IRP scenario – will test impact on networks if wind output is only at 10% and if as high as 60%
- For GREEN scenario will replace nuclear with "base RE equivalent" as follows:
  - 60% CSP with storage
  - 25% equivalent of Wind (with CCV of 30%)
  - 15% of OCGT & CCGT

Mapping the Demand and Generation

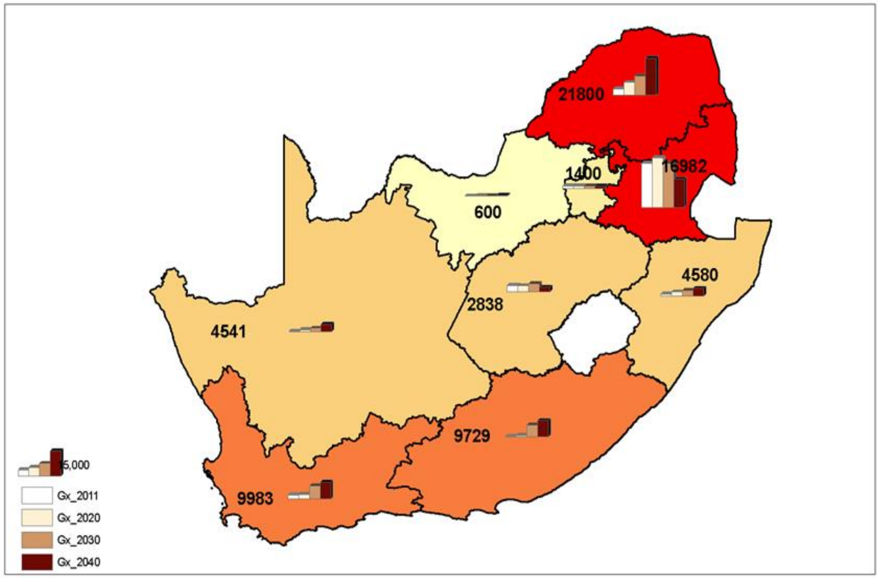
- First the Demand is allocated to each Municipal Area and then summated by province to get the total Load Demand for each province
- The Bars represent the relative Demand for 2011, 2020, 2030 and 2040 with the 2040 figure shown

- Secondly the Generation is 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

LOAD GROWTH BY 2040 PER PROVINCE
(Maximum Demand in MW)

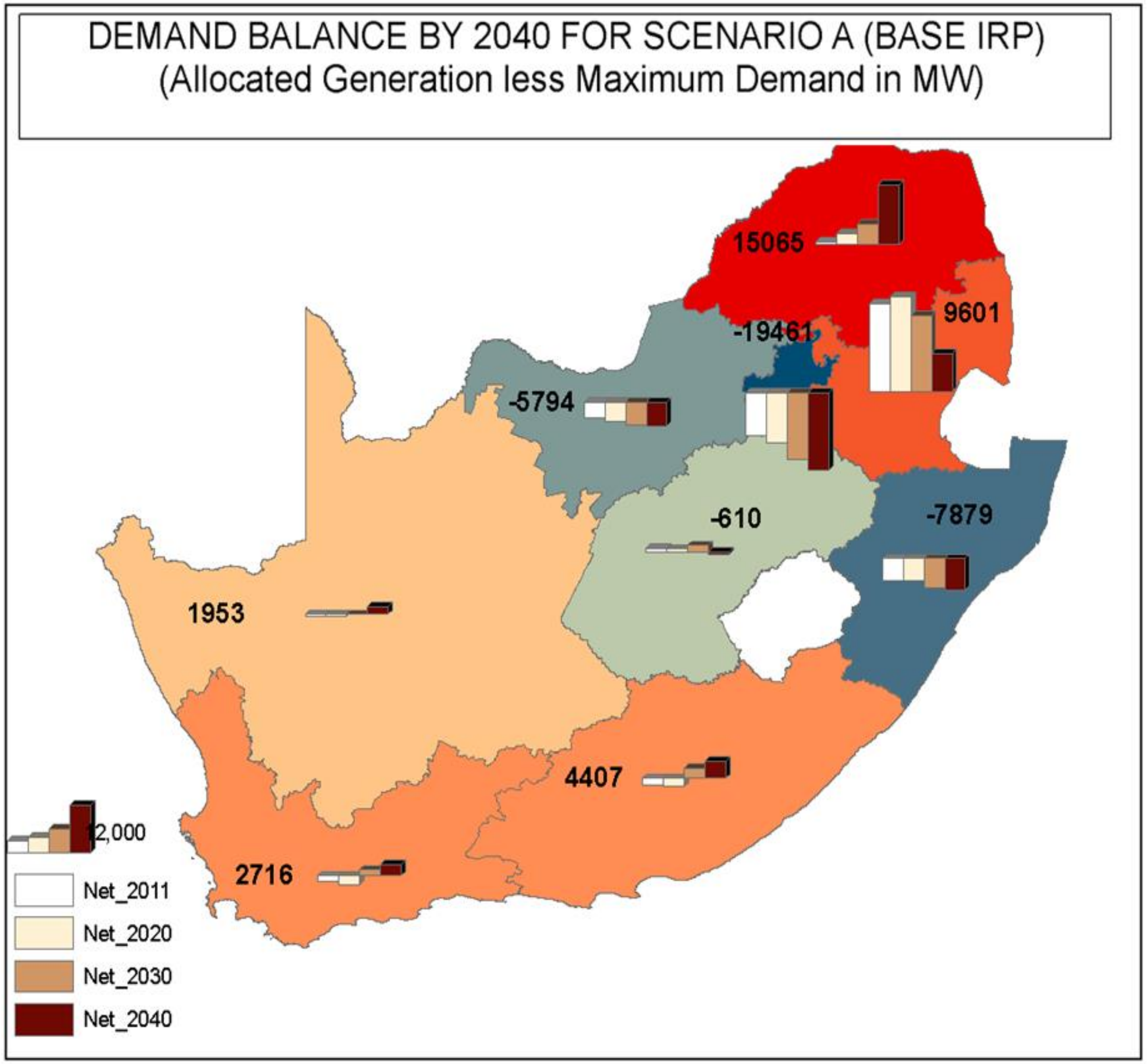


GENERATION DEVELOPMENT FOR SCENARIO A (BASE IRP)
(Maximum Demand in MW)

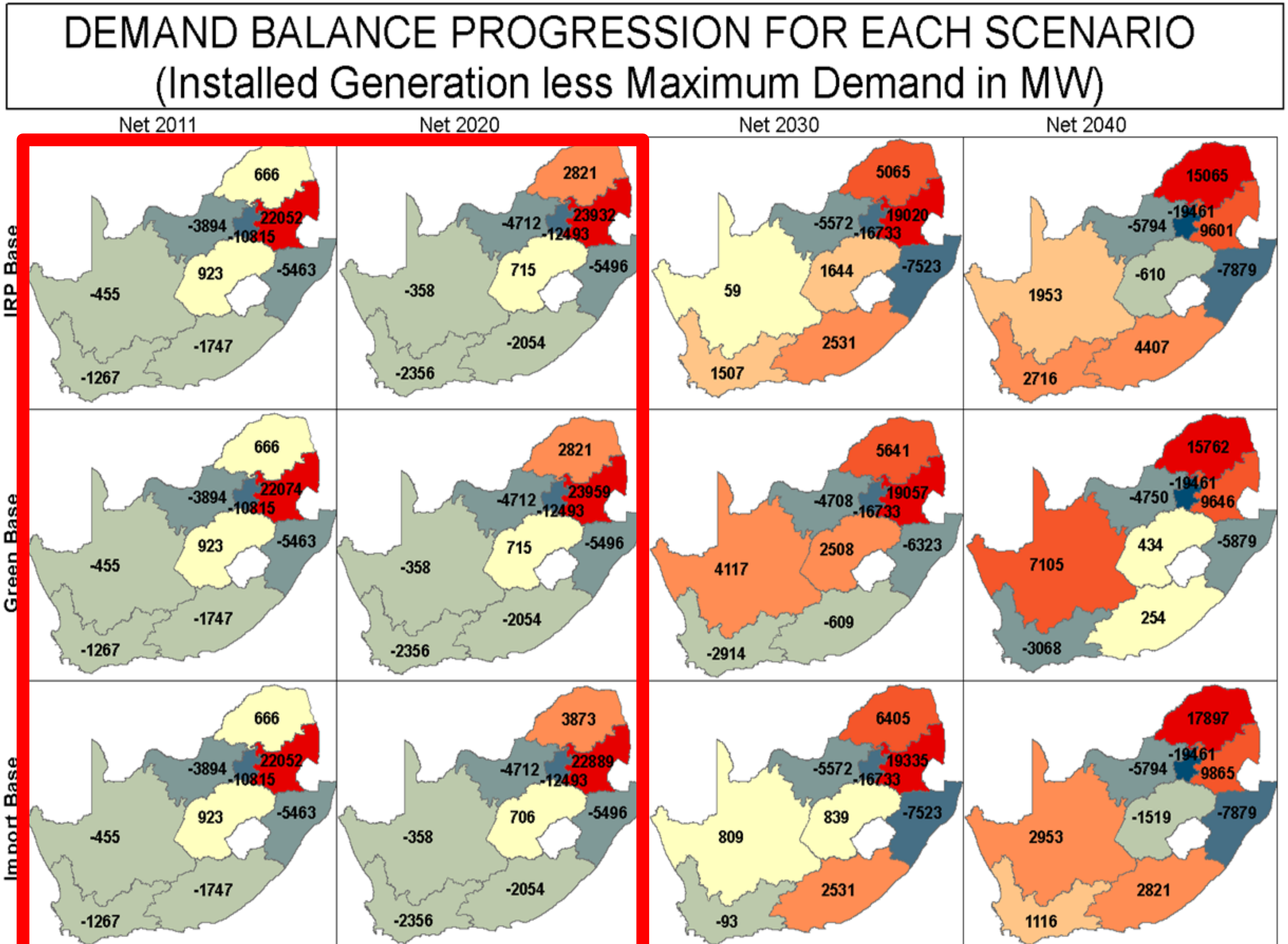


Mapping the Demand Balance up to 2040

- The Supply and Demand Balance value is then 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

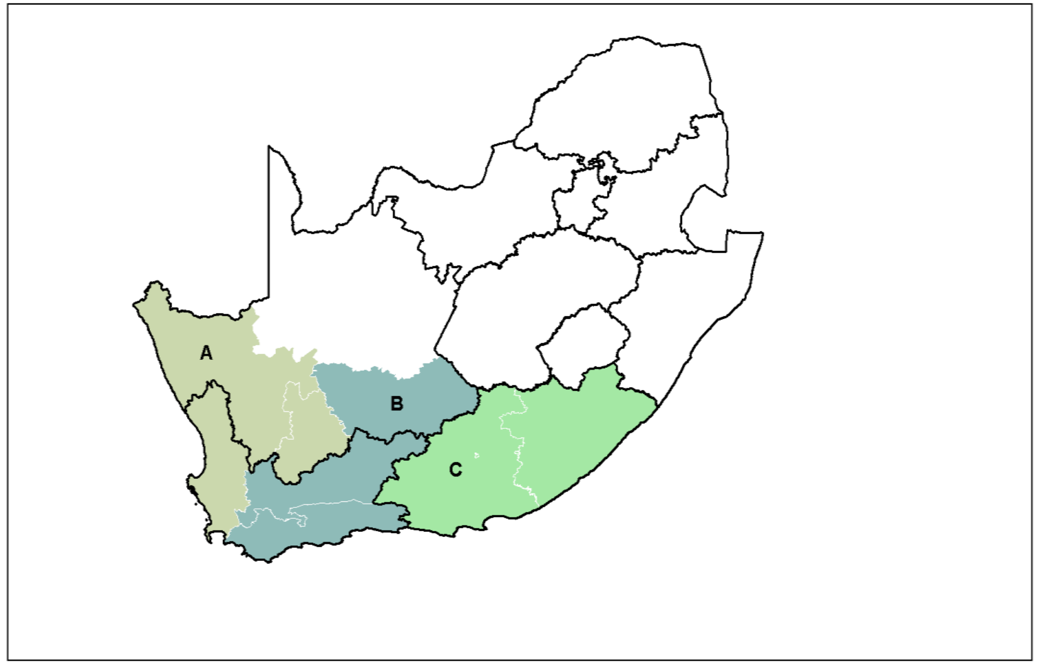


Marginal scenario difference for the TDP period

Impact of variance of wind output

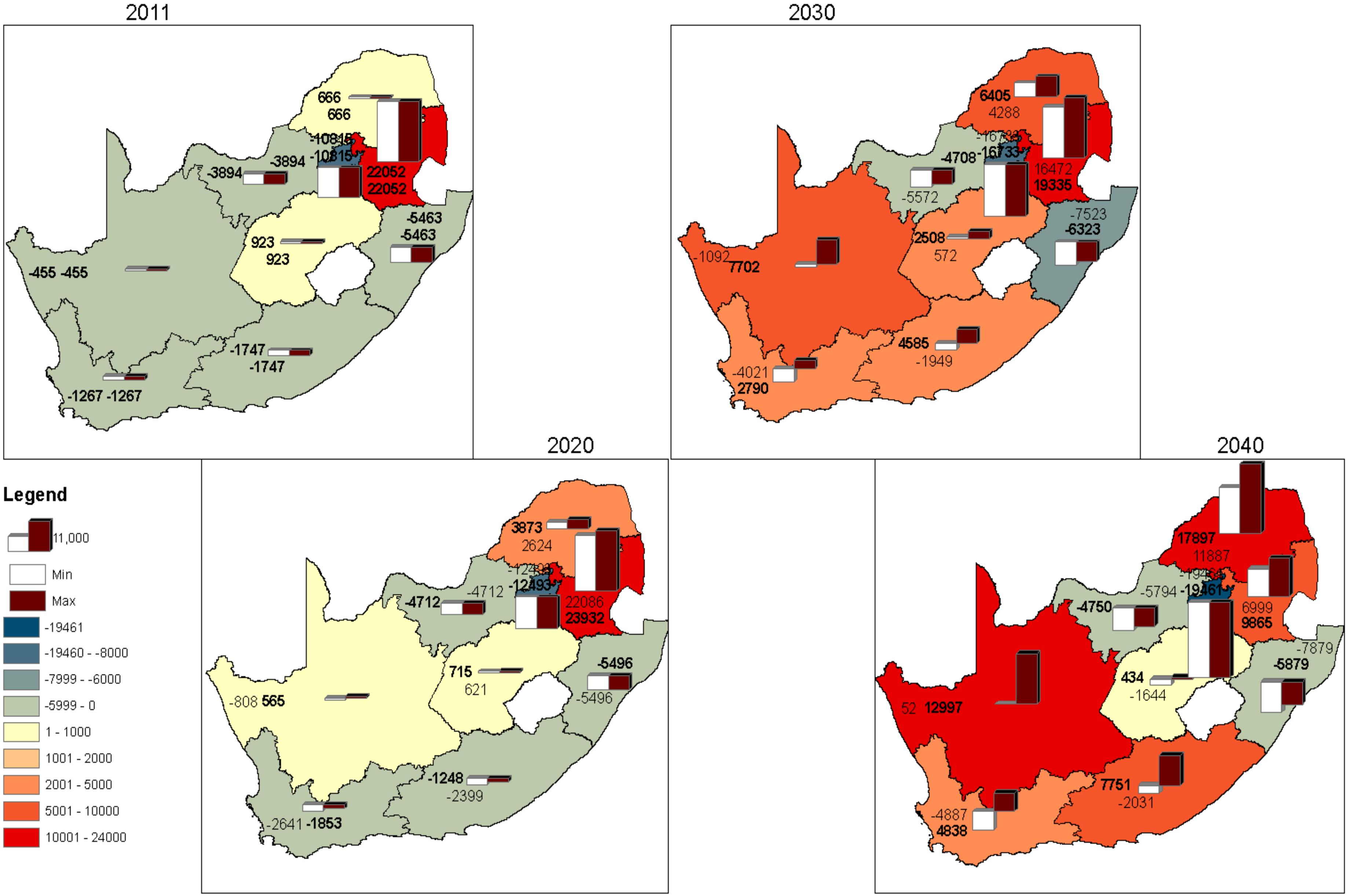
- Large installed wind generation can lead to large variation in wind output
- Considered 30% & 60% output of area totals – assumed even spread
- Also considered impact of wind patterns – wind can blow from west to east zones (ABC) or east to west (CBA)
- High wind at Low Load can also impact on excess or deficit power values in areas

Wind Zones for estimating wind pattern impact

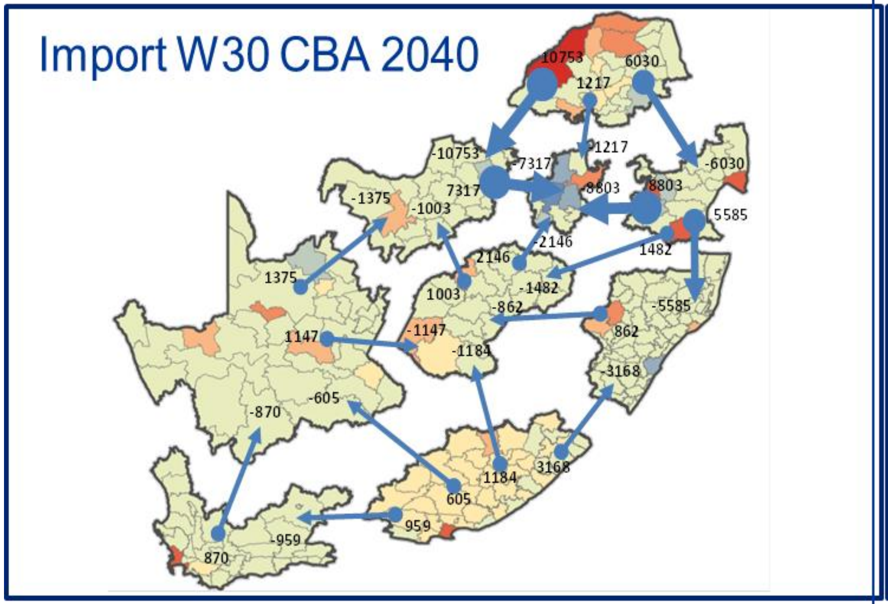


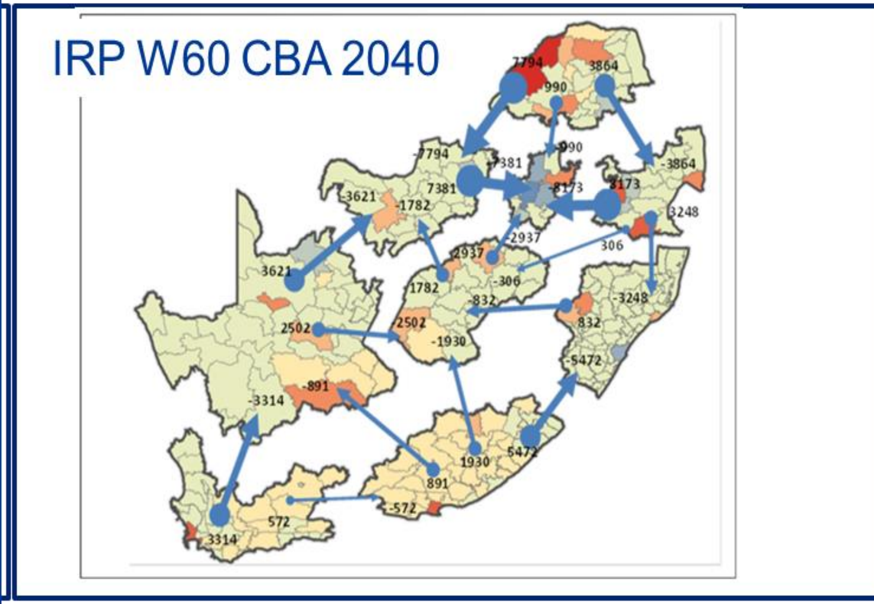
- Considered variations in wind patterns at *Peak Load* and *Low Load* to determine ***the range between maximum and minimum power excess or deficit*** for each scenario
- Identified the largest range variations under all scenarios to highlight areas of highest risk

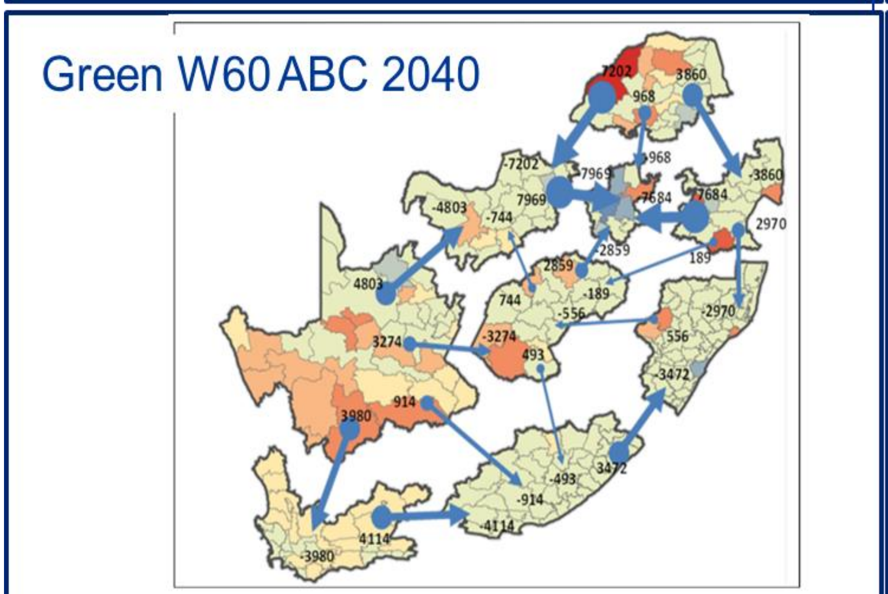
MAX & MIN DEMAND BALANCE PROGRESSION CONSIDERING ALL SCENARIOS
(Allocated Generation less Maximum Demand in MW)

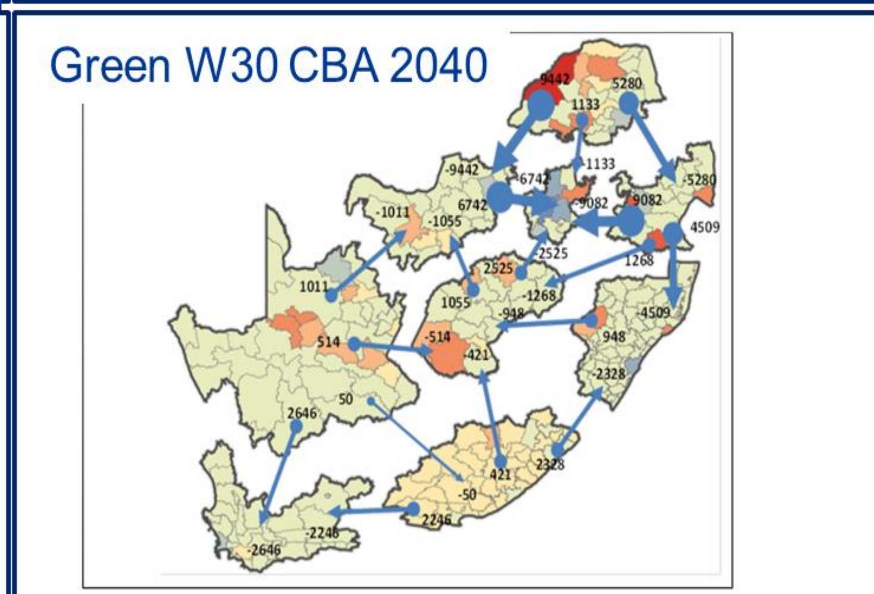


Inter-Province Power Transfers for 4 representative scenarios

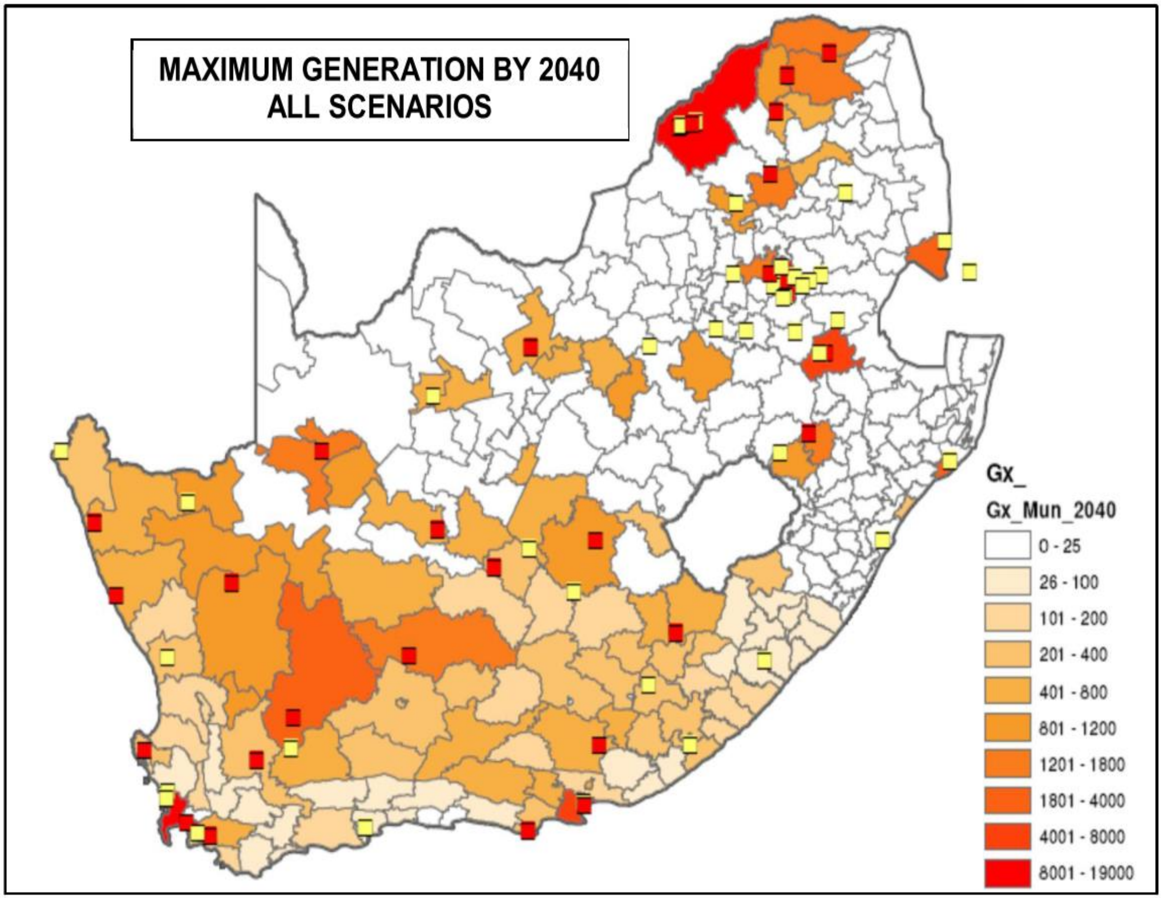


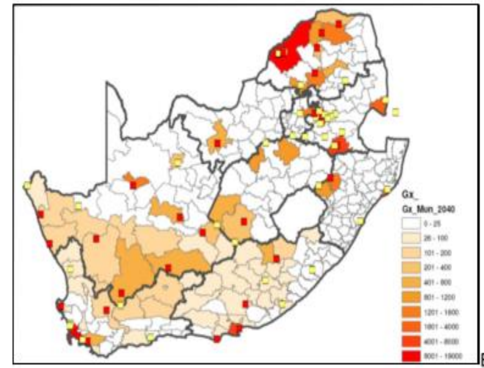




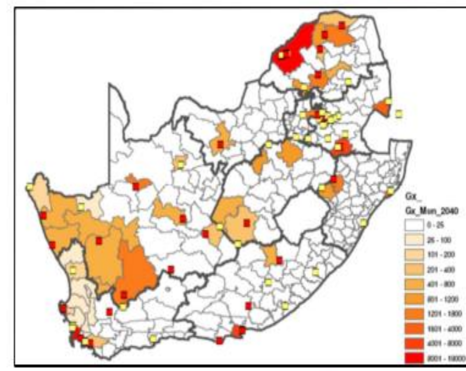


2040 Strategic Grid Planning – Generation Spatial Allocation

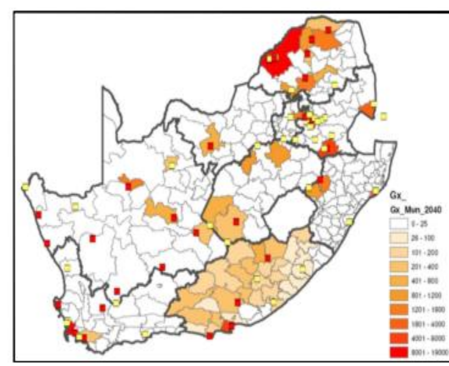




Base IRP Scenario
Even Spread of Wind

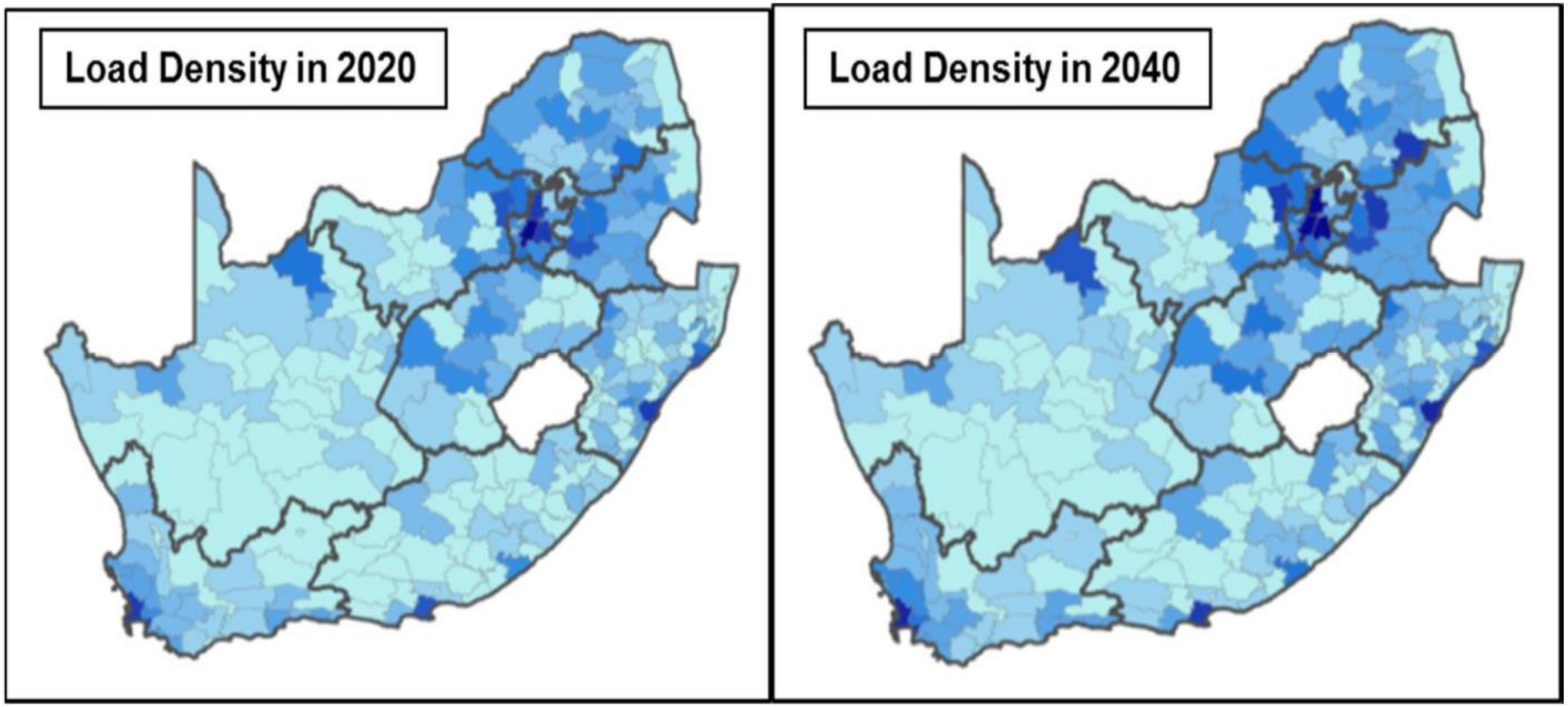


West to East Pattern of Wind



East to West Pattern of Wind

2040 Strategic Grid Planning - Load Spatial Allocation



There is no significant change in the location of the major load centres from 2020 to 2040.

The existing load centres merely get larger and denser

Load in the Steelpoort/Lydenburg area grows rapidly at the expense of Rustenburg

2040 Strategic Grid Planning – Consolidation of Inputs

Supply options

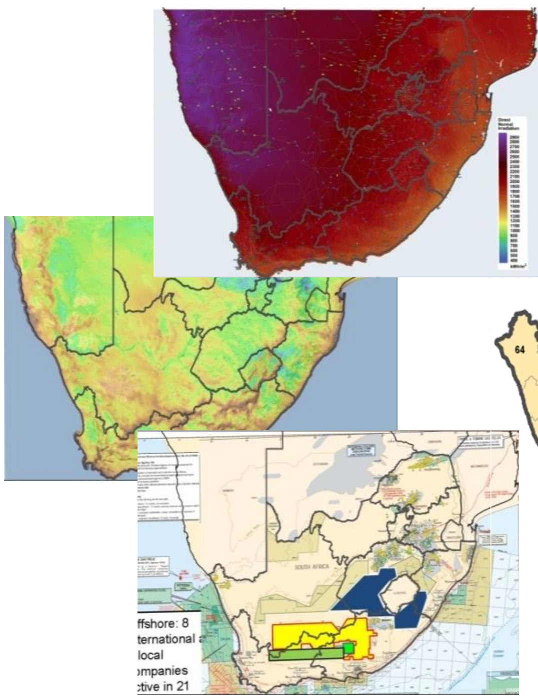
Spatial & Economic impact

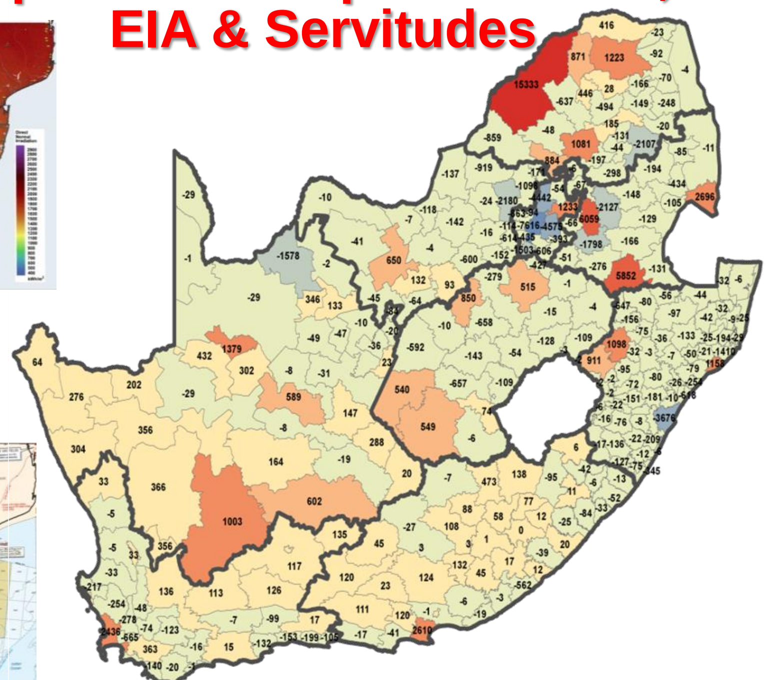
National Planning Scenario's

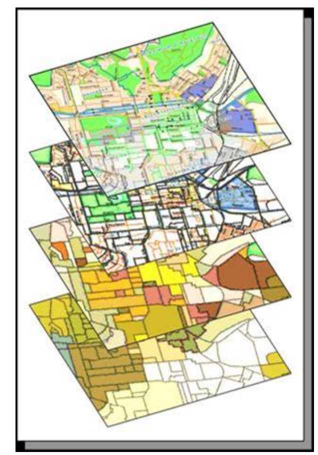
Demand options

Spatial & Economic impact

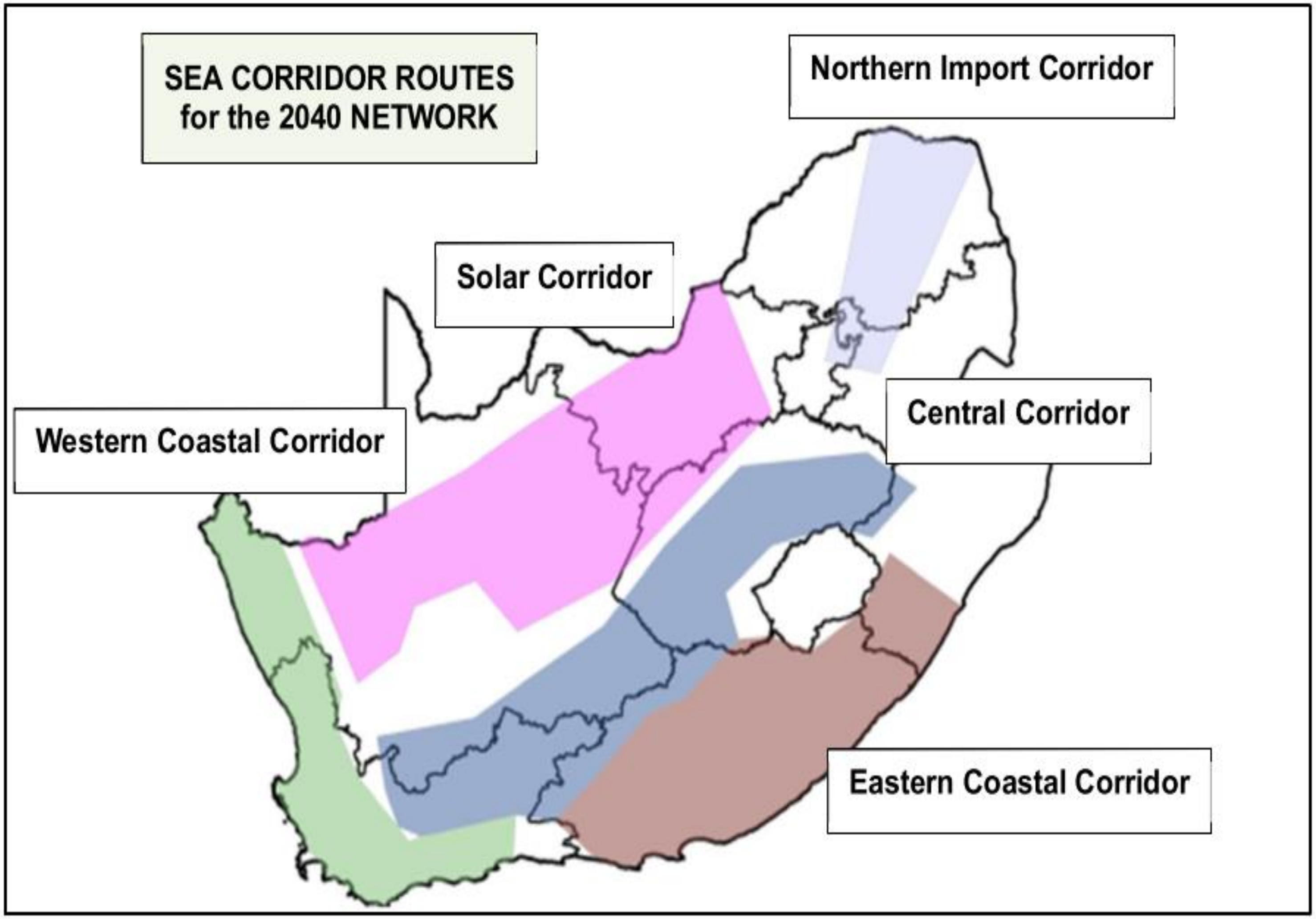
Common Least regret Spatial Development Plans, EIA & Servitudes







2040 Strategic Grid Planning – SEA Corridors

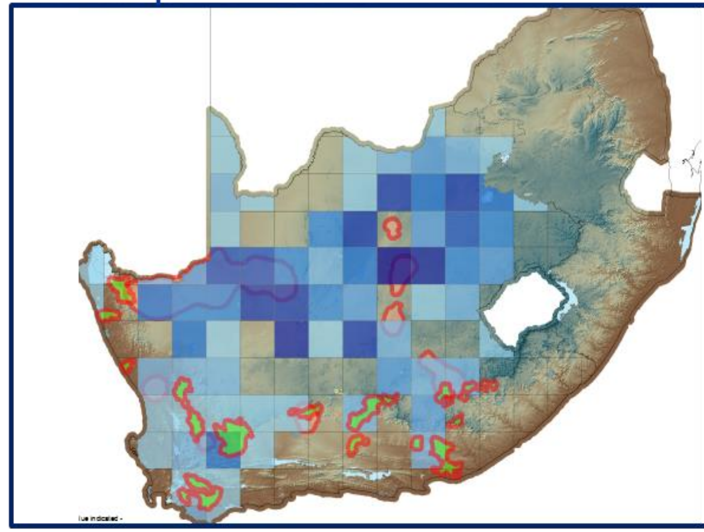


Analysis of the inter-province power flows across the generation scenarios and loading conditions start to indicate where the power flows concentrates under all scenarios.

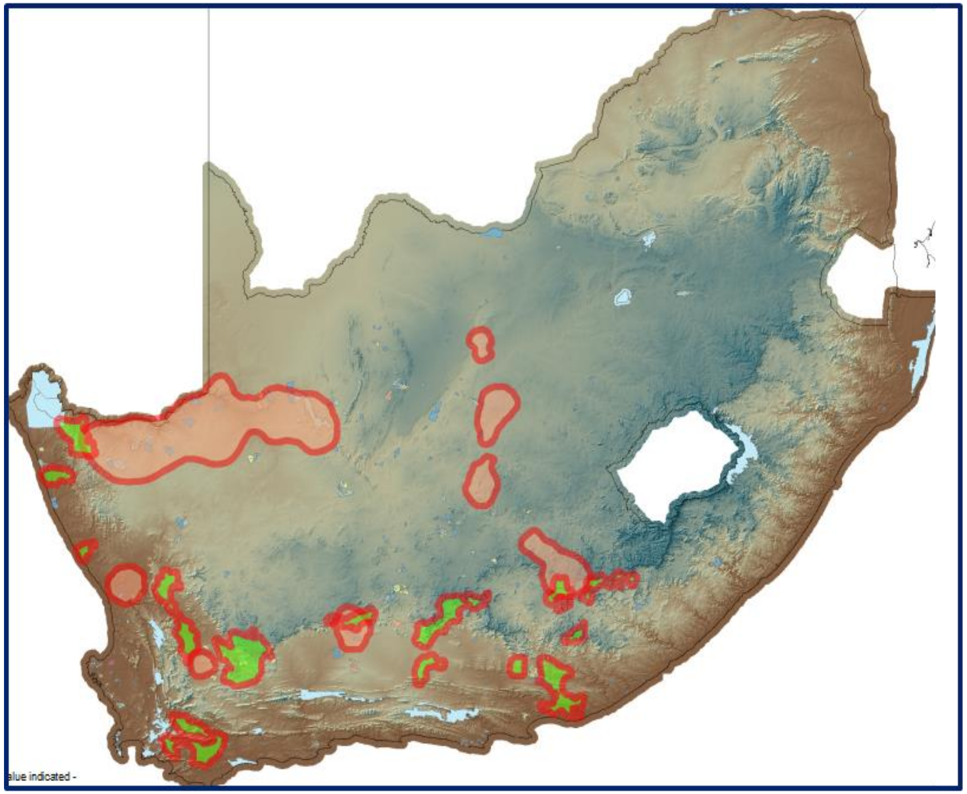
Five major corridors were identified for the future strategic development of the Tx Grid

2040 Strategic Grid Planning – Correlation with Investor Interest

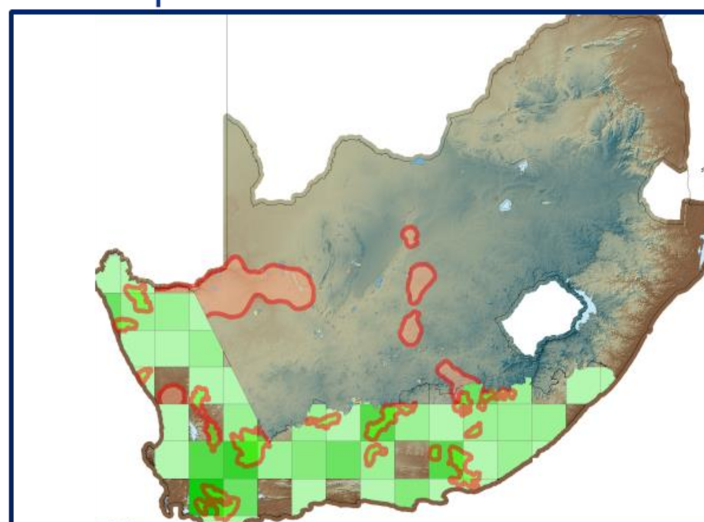
Developers - Solar Preferred Location



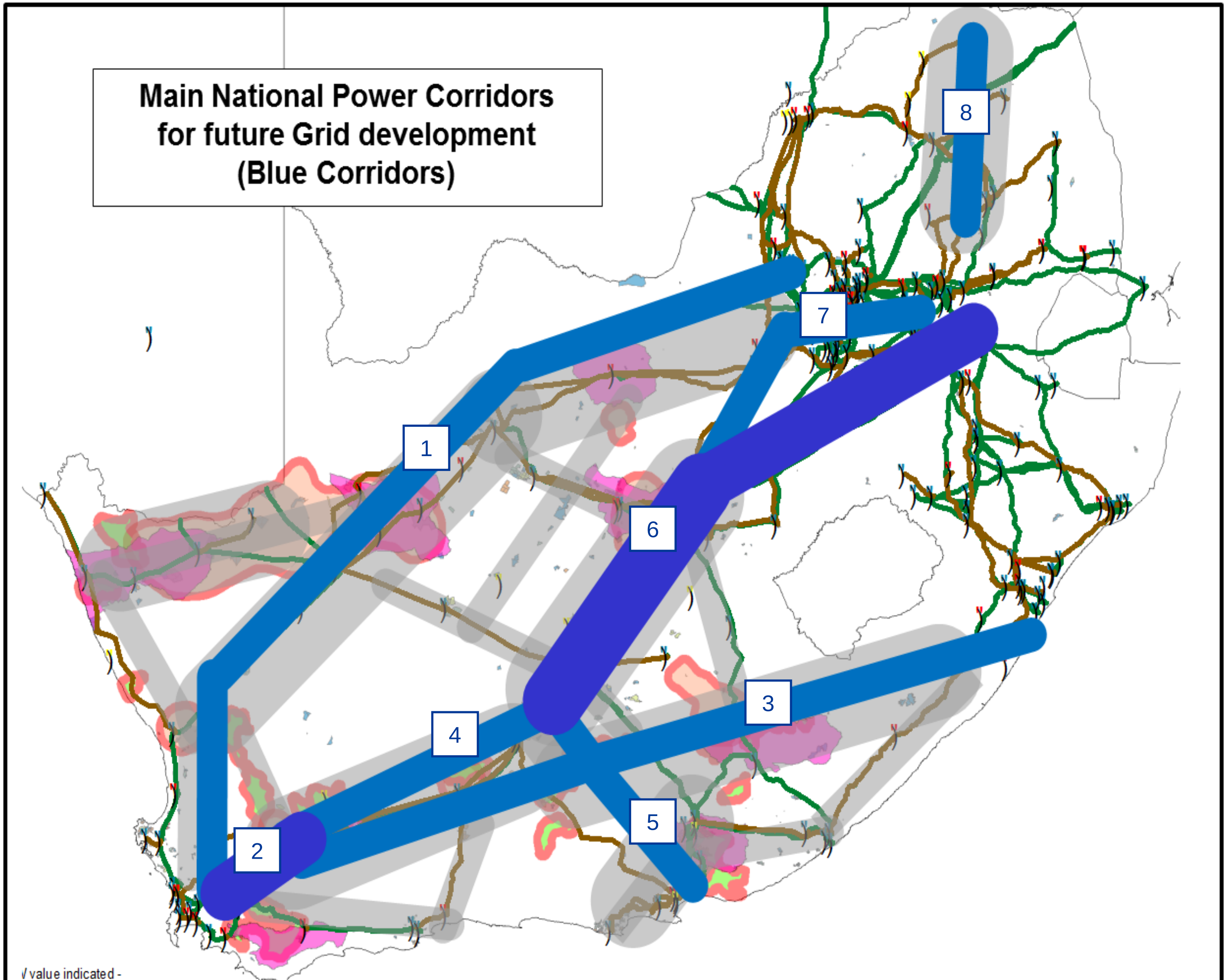
SEA - Wind and Solar Preferred Location



Developers – Wind Preferred Location



2040 Strategic Grid Planning – National Corridors

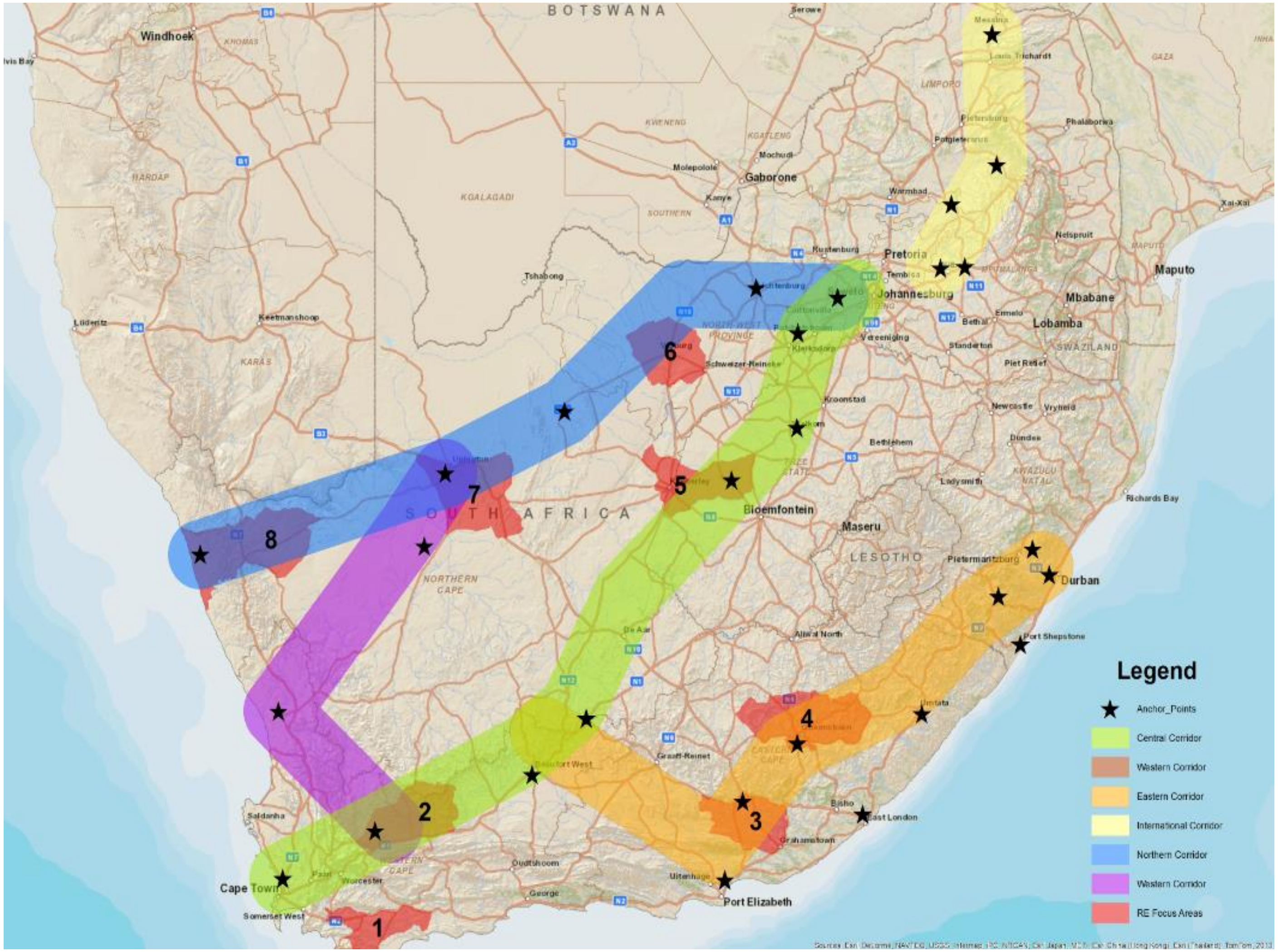


The **"Local"** power corridors were identified to collect new generation and supply load centres within the provinces. (Shown in Grey)

These can then be grouped into or linked to a number of **"National" power corridors** to move the generation around the country to the load centres under various conditions and scenarios. (Shown in Blue)

2040 Strategic Grid Planning – Final SEA Corridors

Eskom

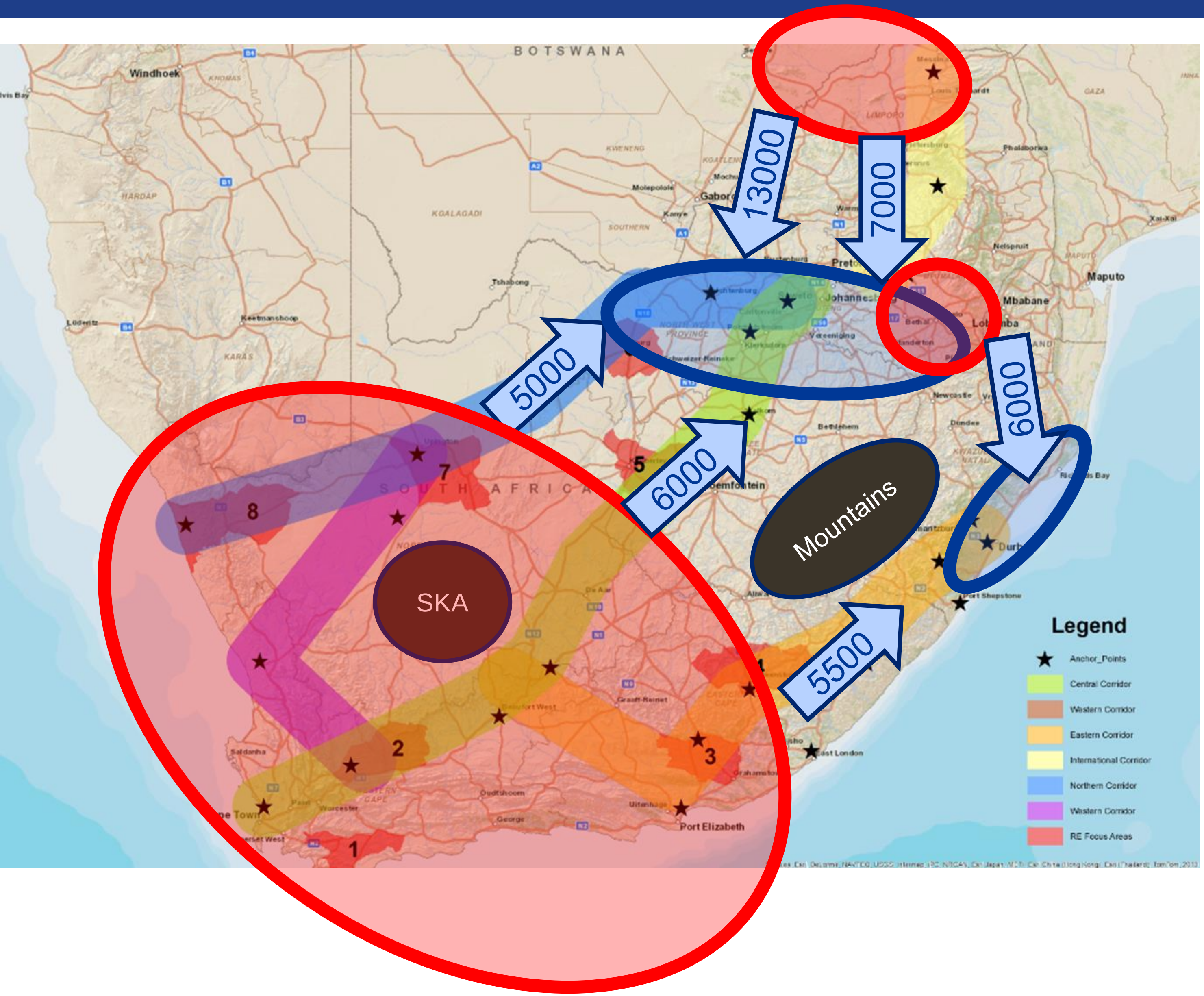


The “National” power corridors were then further refined and consolidated into five Major Transmission power Corridors.

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



Impact of Provincial & Local Govt. Development Plans

- The 5 SEA Corridor Routes based on available information and known expectations.
- Provincial & Local Govt. Development Plans need to recognise these corridors and accommodate them.
- More importantly can your Development Plans be “seen” in the power corridors – i.e. are your needs been addressed?
- Objective of Workshop is to discuss to see how can power corridors support the local development plans and ensure the Transmission & Distribution electrical networks are accounted for into the future.

Thank you

Any Questions?

RE IPP Bid 4 Lessons Learnt

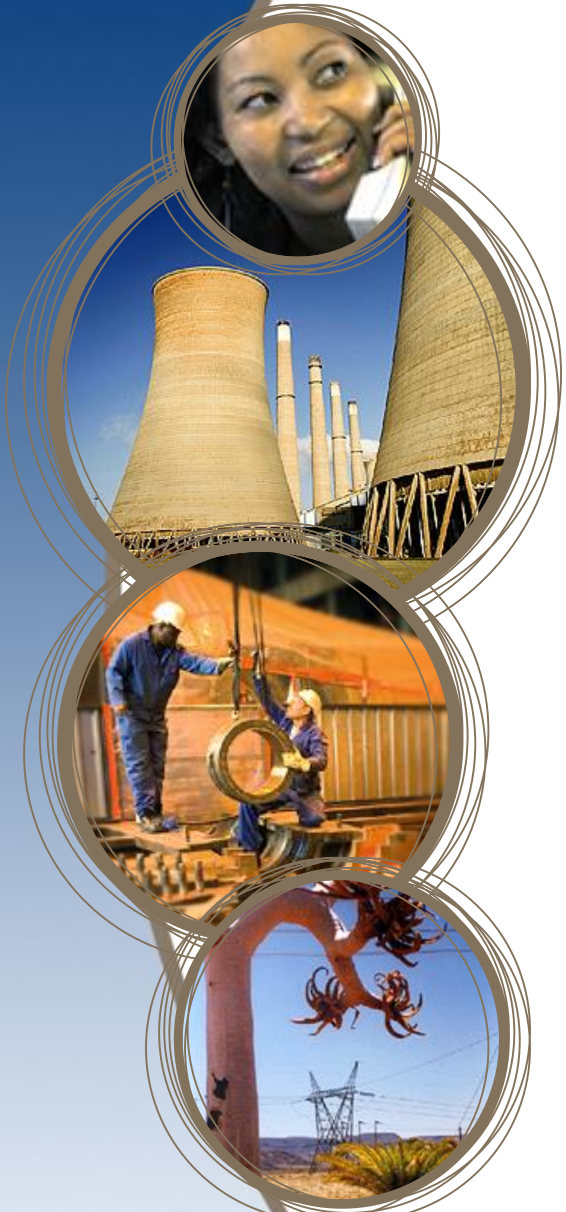
- Eskom Fee to produce Cost Estimate Letter – more serious projects
- Not all applications will have an actual “cheap” practical solution, different expectations from developers after fee payment
- Late applications and payments led to whole process slowed down
- Knowledge of own networks and network studies improving
- Tx GCCA must be made available at earlier stage – currently aim to produce updated information after bid announcement by Jan/Feb 2015 - at risk
- Tx GCCA to be better utilised by Tx and Dx Planners, as well as IPPs
- Non-diversified generation for various technologies – operating experience to influence future capacity studies.
- Focus on network connection topologies, Distribution and Transmission scope requirements – in progress

RE IPP Bid 4 Lessons Learnt

- Environmental Impact Studies to properly consider Eskom network solutions and space requirements
- Land Development exclusion zones
- IPP may need to change solutions form bid to bid to optimise networks within own costs of 2x bids – optimise and less lines
- Need to consider project risk reduction strategy – As capacity is allocated a future CEL may not offer same solution
    - Manage expectations with IPP

RE IPP Bid 4 Lessons Learnt

- IPP submit projects with different timelines than Eskom for project execution, but does not consider full Eskom impact.
  - Timelines critical to project financing – additional interest > higher cost
  - Wrong scope / high costs – impact on capital required / project cost
  - Cannot resubmit to DoE new cost if solutions change
  - Outage management planned a year ahead
- Shared vs Dedicated costs
  - Align Tx and Dx use of who is responsible for what
  - No budget – all costs covered by IPP – for developers, all costs recovered via PPA



Thank you

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