



# energy

Department:  
Energy  
**REPUBLIC OF SOUTH AFRICA**

# IRP Update Assumptions & Base Case

22 November 2016

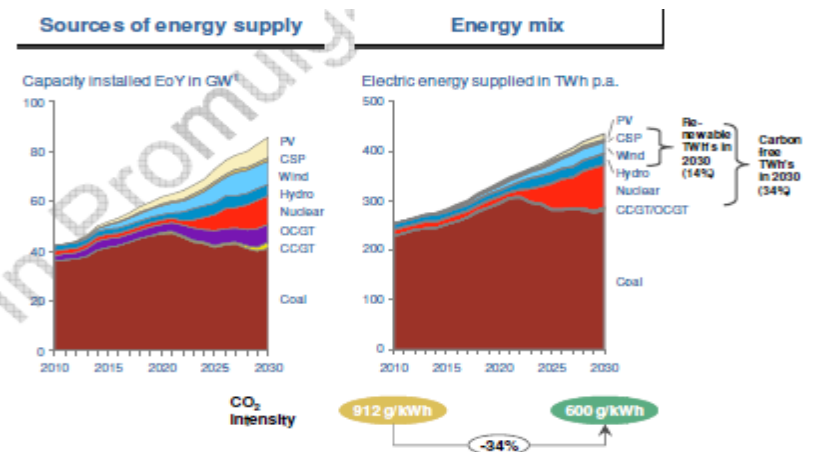
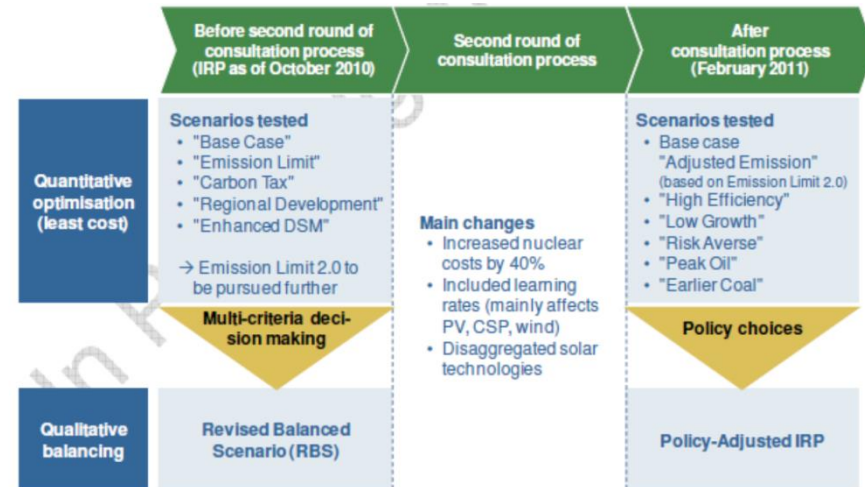


# Purpose

- Purpose of the presentation is:
  - To invite the public to participate in the IRP update consultation process,
  - Apprise the public on the Process and Progress regarding the update of the IRP;
  - Share the key Assumptions used in the IRP update and solicit input on these assumptions;
  - Share the preliminary Base Case observations from the IRP update;
  - Share a list of Scenarios to be analysed and solicit input on what additional scenarios to consider; and
  - Share the information on the planned public consultation forums.

# Background

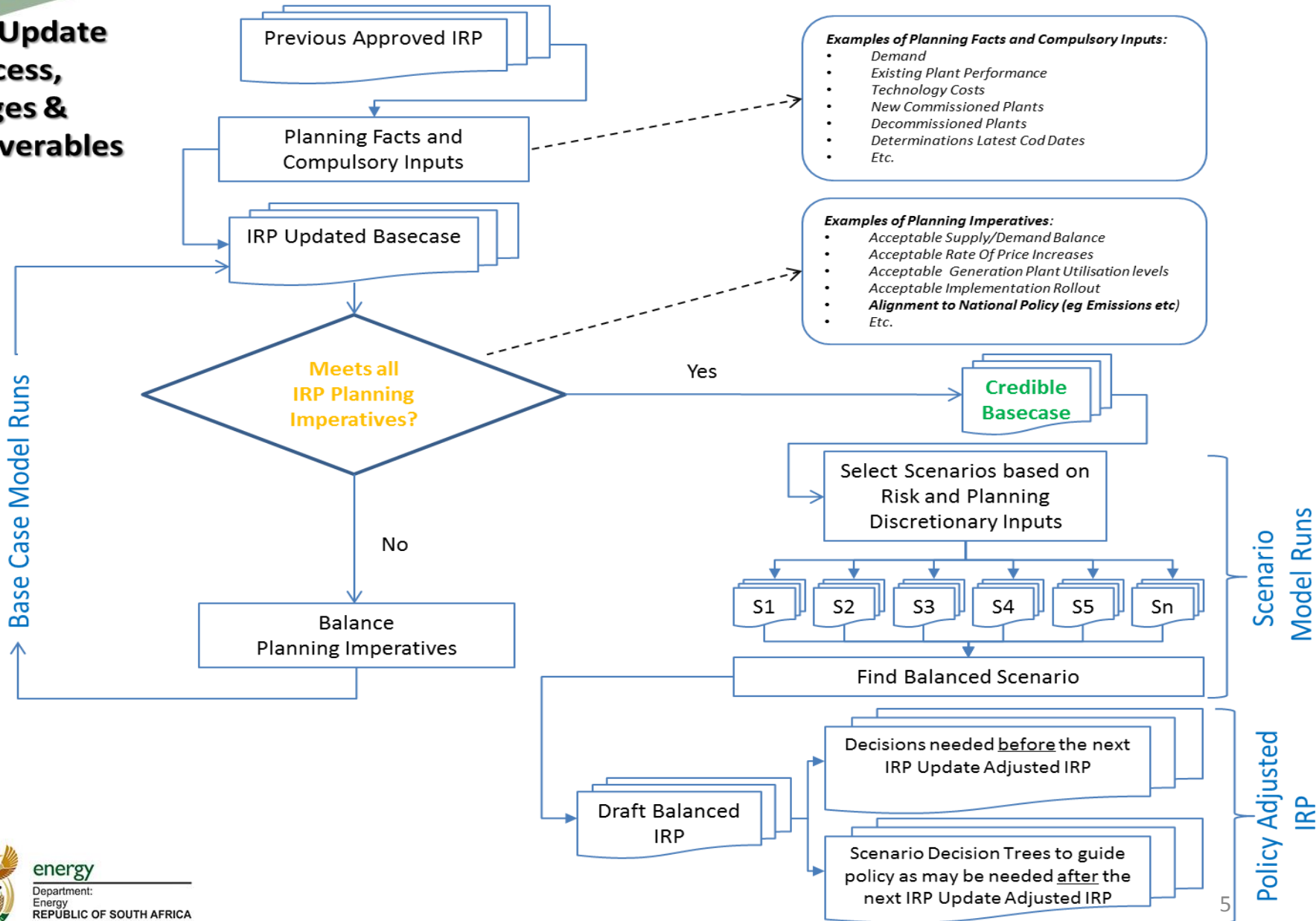
- The Integrated Resource Plan (IRP) 2010-30 was promulgated in March 2011;
- Following public consultation, a number of policy decisions were adopted which resulted in the promulgated policy adjusted IRP 2010-30.
- In line with S34 of the Electricity Act, Minister of Energy use the promulgated IRP to issue Determinations for new capacity;
- IRP update starting point is therefore the promulgated IRP 2010-30



1. Pumped storage capacity of 1,4 GW in 2010 and 2,7 GW in 2030 is not included since it is a net energy user

# IRP Update Process

## IRP Update Process, Stages & Deliverables



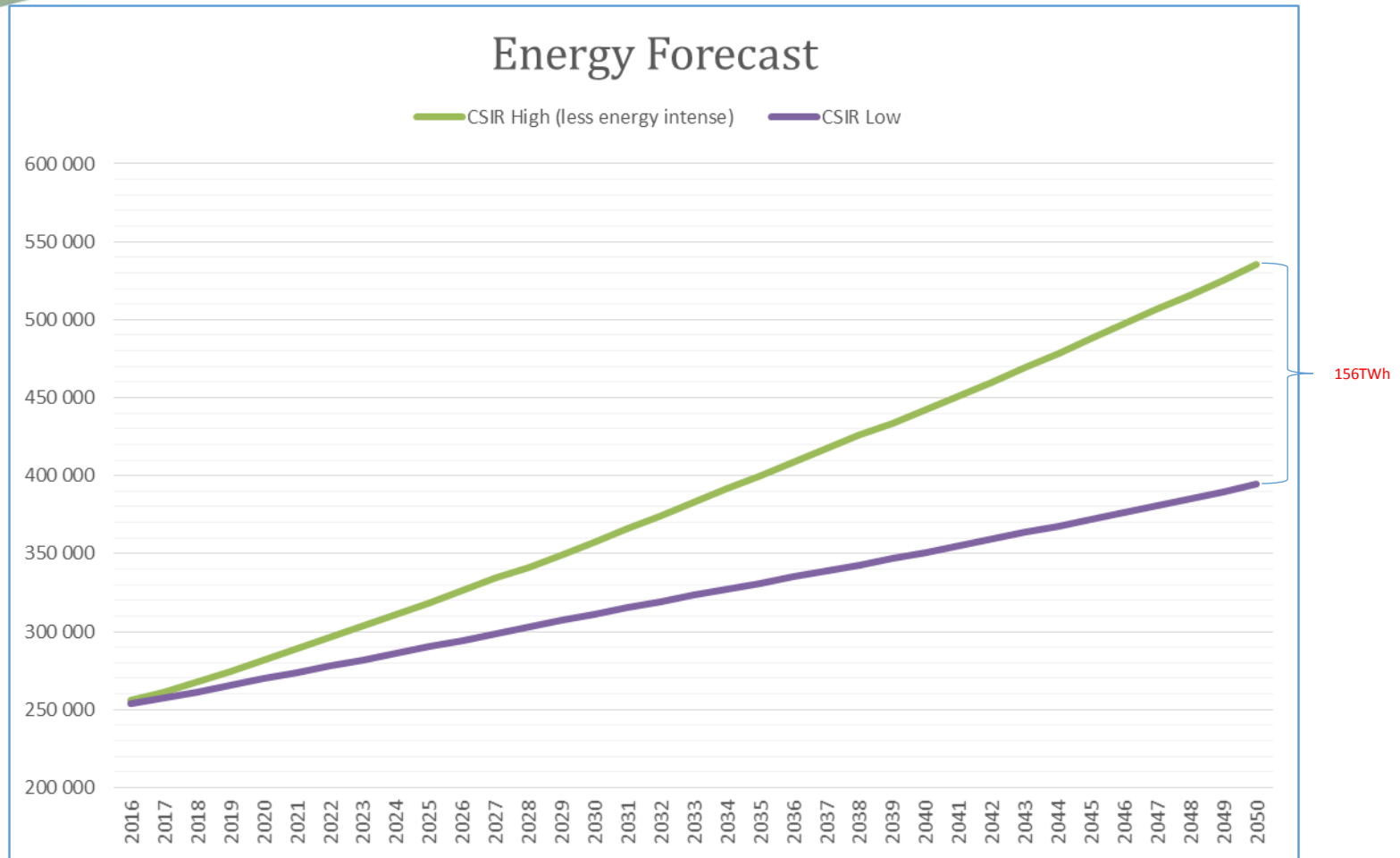
# Assumptions



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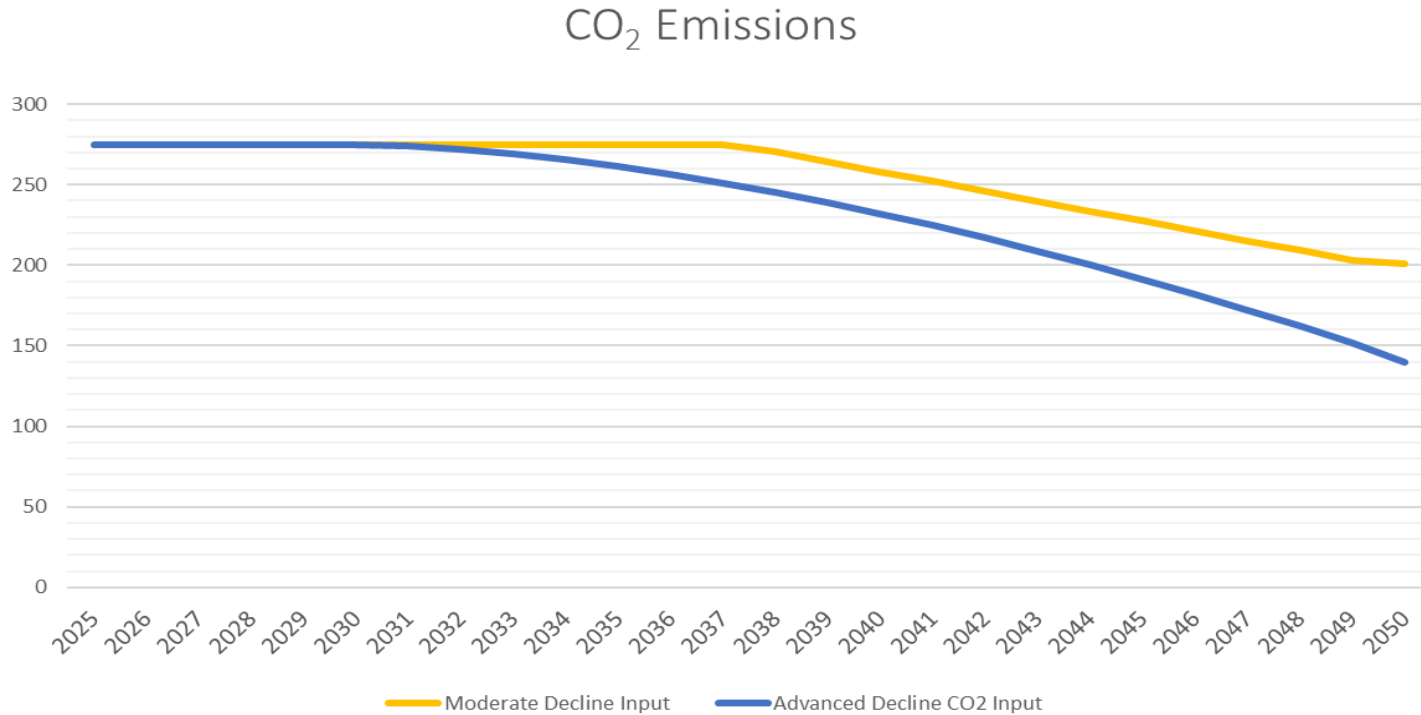
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# Energy Forecast



- CSIR High less energy intensity forecast has an annual average energy growth of 2.17% and was used in the development of the base case.
- The CSIR Low has an energy growth rate of 1.31 % and its energy in 2050 differs from the CSIR High (less energy intense) by 156TWh.

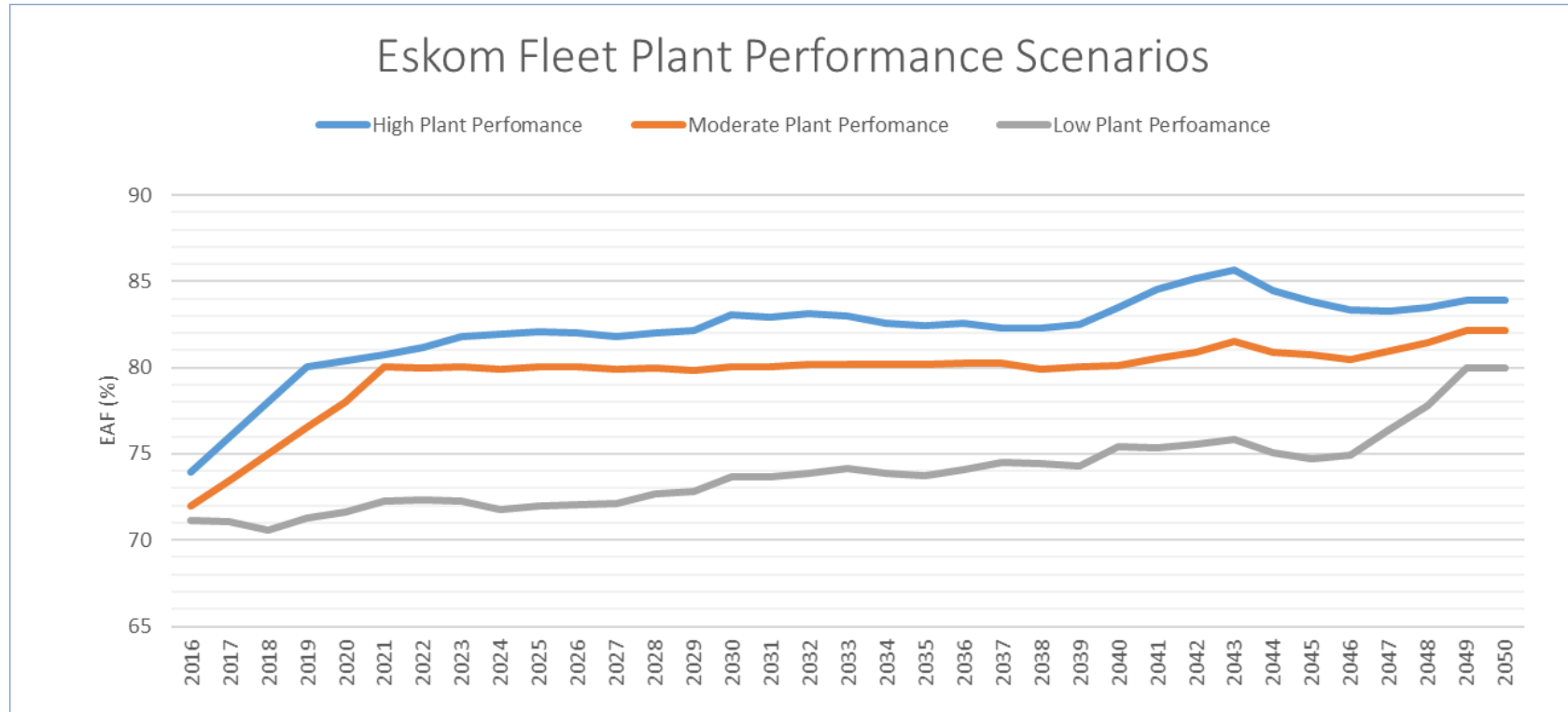
# CO<sub>2</sub> Emission Trajectories



- The Moderate Emissions decline trajectory is used for the IRP Update Base Case



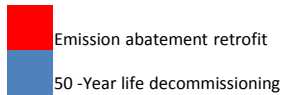
# Eskom Plant Performance Scenarios



- High plant performance depicts the aspirational position that quickly restores the EAF and is aligned to Eskom Design to Cost (DTC) target
- Medium plant performance is based on Eskom's Shareholder Compact and the Corporate Plan target and was used in all the model runs.
- Low plant performance is based on Eskom in-house statistical model

# Eskom Plant 50 Year Life and Air Quality Retrofit Schedule

	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048	2049	2050			
Majuba				LNB																																		
Kendal																																						
Matimba																																						
Lethabo																																						
Tutuka				FFP & LNB																																		
Duvha						FFP																																
Matla					FFP & LNB																																	
Kriel				FFP																																		
Arnot																																						
Hendrina																																						
Camden																																						
Grootvlei	FFP																																					
Komati																																						



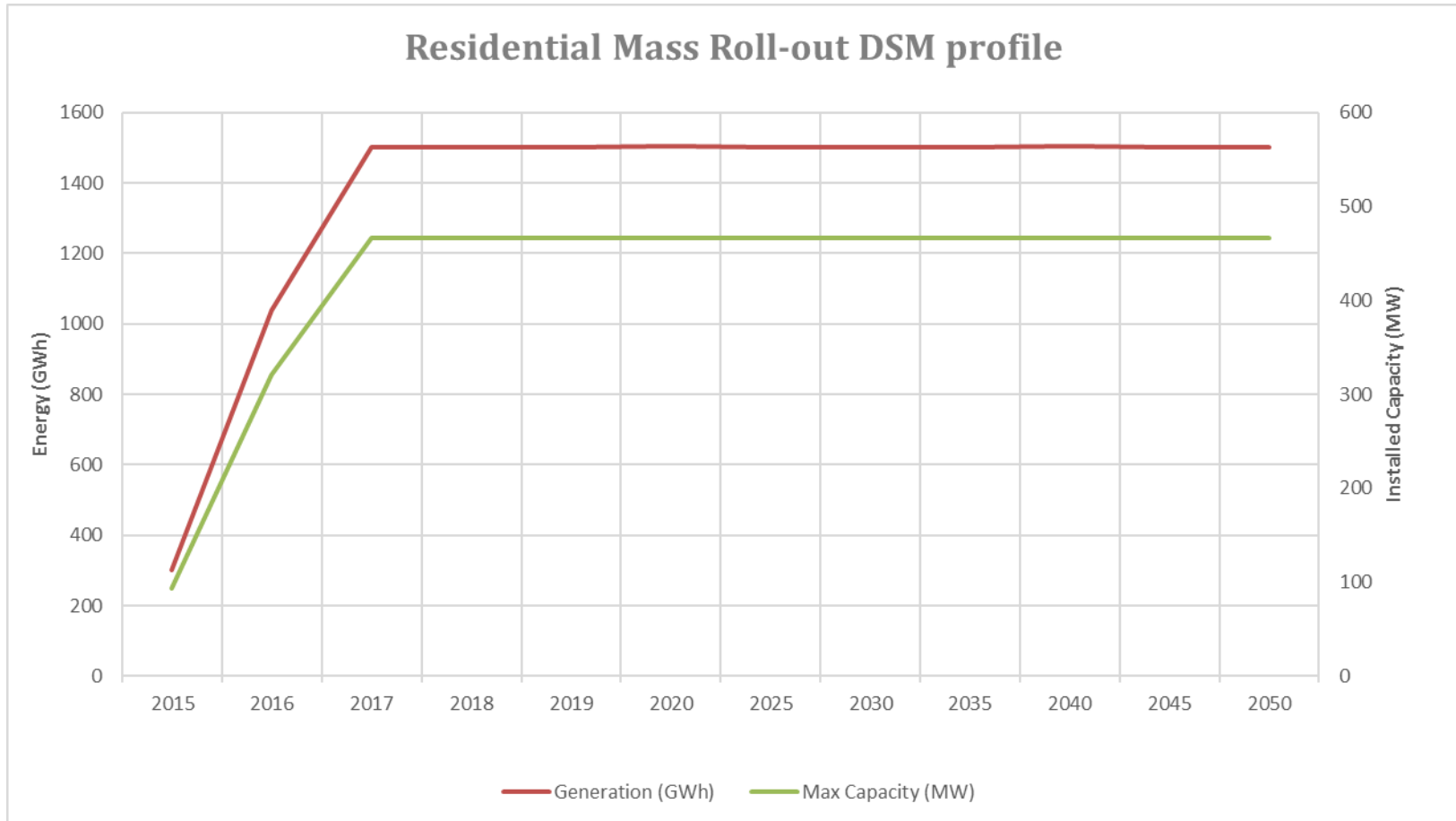
# Eskom Committed Build Dates

Unit	Medupi (P80)	Kusile (P80)	Ingula (P80)
1	Operational	July 2018	Jan 2017
2	Mar 2018	July 2019	March 2017
3	July 2018	Aug 2020	May 2017
4	June 2019	Mar 2021	July 2017
5	Dec 2019	Nov 2021	-
6	May 2020	Sep 2022	-

# Non-Eskom Plant

	Installed Capacity (MW)	Decommissioning Date	Planned Outages (%)	Unplanned Outages (%)
Kelvin	160	Dec 2018	4.8	20
Sasol Infrachem Coal	125	Dec 2018	4.8	15
Sasol Synfuel Coal	600	Post 2050	4.8	15
Other Non-Eskom Coal	18	Dec 2024	4.8	15
Other NonEskom Gas	16	Dec 2019	6.9	11
Sasol Infrachem Gas	175	Post 2050	6.9	11
Sasol Synfuel Gas	250	Post 2050	6.9	11
DOE IPP	1005	July 2045	7	5
Colley Wobbles	65	Post 2050	6.9	11
Other Non-Eskom Hydro	12	Post 2050	6.9	11
Cahora Bassa	1500	Post 2050	4	4
REBID Hydro	19	Post 2050	4	4
Steenbras	180	Post 2050	4	10
Sappi	144	Post 2050	10	10
Mondi	120	Post 2050	10	10

# Demand-Side Management



# Generic Technologies Levelised Cost at 8.2% Discount Rate

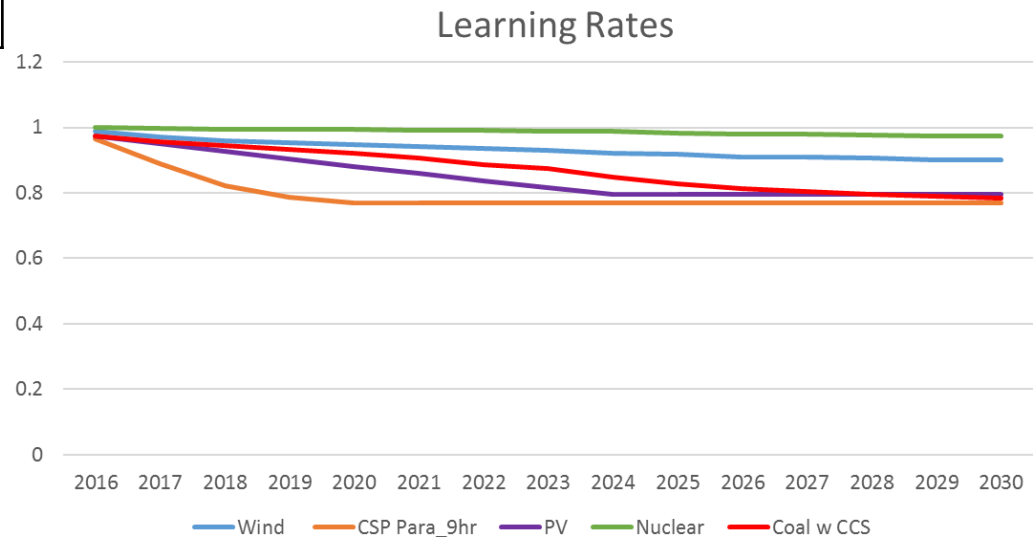
	Base Load					Mid Merit		
	Coal PF	Coal FBC	Coal Pulverized with CCS	Coal IGCC	Nuclear (DoE)	CCGT	Internal Combustion Engine (ICE) 2MW	Internal Combustion Engine (ICE) 10MW
Typical Load Factor (%)	86	86	86	86	90	36	36	36
Levelised Cost (R/MWh)	862.50	888.54	1514.35	1292.85	970.81	1183.22	1615.55	1620.39

	Storage				Peaking	
	Pumped Storage	Lithium-Ion_1hrs Storage	Lithium-Ion_3hrs Storage	CAES_8hrs Storage	OCGT	Demand Response
Typical Load Factor (%)	22	2	6	20	6	1.5
Levelised Cost (R/MWh)	1390.32	8731.11	5615.52	2015.36	2993.97	1362.66

	Renewables															
	Wind	PV, Crystalline Silicon Fixed Tilt	PV, Crystalline Silicon Tracking	Concentrated PV	CSP Trough 3 hours storage	CSP Trough 6 hours storage	CSP Trough 9 hours storage	CSP Tower 3 hours storage	CSP Tower 6 hours storage	CSP Tower 9 hours storage	Biomass Forestry Residue	Biomass MSW	Landfill Gas	Biogas	Bagasse Felixton	Bagasse Gen
Typical Load Factor (%)	36	24	22	22	32	40	44	34	42	48	70	70	80	80	50	50
Levelised Cost (R/MWh)	805.30	931.24	1087.645	2425.812	2887.56	2796.32	3068.50	2585.85	2379.06	2335.93	1835.90	3203.67	732.58	1213.05	2381.23	2210.51

# Technology Learning rate (2016 and 2050)

Technology	2015 (R/kW)	2030 (R/KW)
PV (fixed tilt)	16860.6	13425.03408
PV (tracking)	17860.6	14221.26959
Wind	19208.1	17287.405
Nuclear	55260	53768.80047



# Cumulative Capacity from Procured Determinations

	Renewables							Coal	Gas	Import Hydro	Nuclear	Co-Gen
	PV	Wind	CSP	Landfill	Hydro	Biomass	Biogas					
2016	1328	1373	200	-	14	-	-	-	-	-	-	-
2017	1478	1994	300	13	14	-	-	-	-	-	-	11
2018	1842	2378	600	13	14	17	-	-	-	-	-	-
2019	2412	3188	1050	28	59	142	25	-	-	-	-	-
2020	2811	4006	1050	-	-	-	-	-	-	-	-	-
2021	-	-	-	-	-	-	-	900	-	-	-	-

- The table above shows cumulative installed and procured capacity from Bid-Window 1, 2, 3, 3.5, 4, 4b, Smalls, Cogen, Expedited and Coal that are treated as committed in the Base Case.



# Base Case

("the starting point")



# Base Case Results

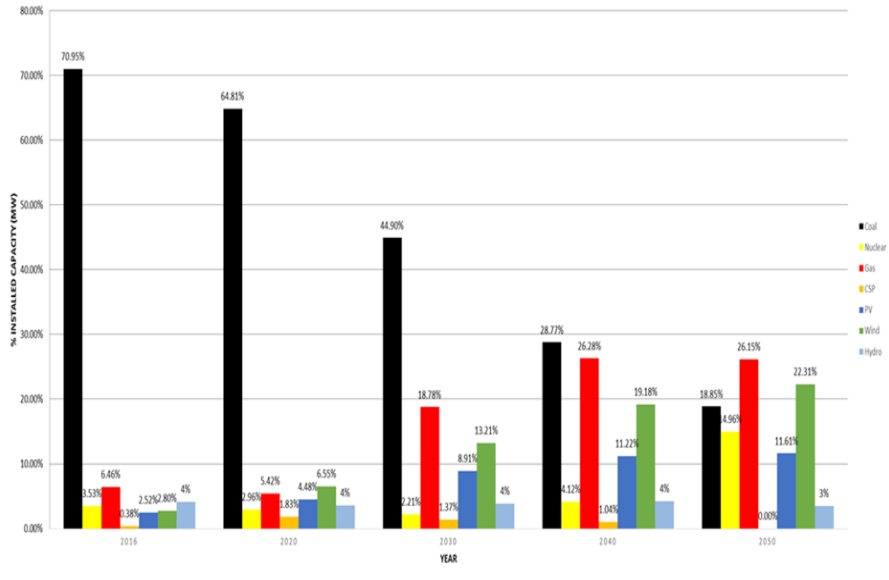
	New Build Options									CO2 Emissions	Peak Demand (MW)	Firm Reserve Margins (%)	Water Consumption (Mill tonne)
	PV	Wind	LandfillGas	DR	Nuclear	OCGT	CCGT	Coal PF w FGD	Inga				
2020										253	44916	24	276873
2021	160									264	46130	28	265765
2022	160									268	47336	23	262350
2023	370	200								272	48547	20	263338
2024	440	500		1000		396				279	49656	18	271908
2025	650	1000	15	1000		2376	732			278	51015	19	275381
2026	580	1000	5	1000		264	1464			278	52307	19	273259
2027	580	1000	230	1000		264	2196			276	53561	19	262760
2028	580	1000		500		396	1464	1500		277	54567	20	254974
2029	580	1100		1000			1464	1500		273	56009	18	226864
2030	580	1200		1000		1716		2250	1000	274	57274	20	205791
2031	580	1200		1000		1584		750		274	58630	20	194160
2032	580	1000		500			732	1500	1000	278	59878	22	181019
2033	580	1200					1464	750	500	276	61388	23	168137
2034	580	1600		1000		1452				278	62799	22	157553
2035	580	1600		500			1464	1500		278	64169	23	136792
2036	580	1600		1000				1500		278	65419	21	123168
2037	580	1400		500	1359		732	2250		277	66993	22	109116
2038	580	1600				1848	1464	750		273	68375	22	102955
2039	650	1500			1359		2928			267	69584	22	93196
2040	650	1600		1000		1056	732			261	70777	20	77738
2041	650	1600		1000	4077	792		750		236	72343	21	73977
2042	650	1600		500			2196			233	73800	21	72668
2043	650	1600		500						232	75245	21	71510
2044	650	1800		500	1359					228	76565	21	71046
2045	770	1600			2718		2196			230	78263	23	71722
2046	790	1600		500	1359	924				225	79716	20	68669
2047	720	1800		1000	1359		732			219	81177	19	65479
2048	720	1600		500	2718	264				211	82509	20	62275
2049	660	1500		500	1359					206	84213	20	58180
2050	720	1400		500	2718					196	85804	20	53605
Total (MW)	17600	37400	250	500	20385	13332	21960	15000	2500				

Learning Rates	PV and Wind	Fuel Prices	Emissions
Moderate	Annual build Constraints	IRP 2015 Fuel Price	Advance Decline
No Learning	No Annual build Constraints	New Policy Prices	Moderate Decline

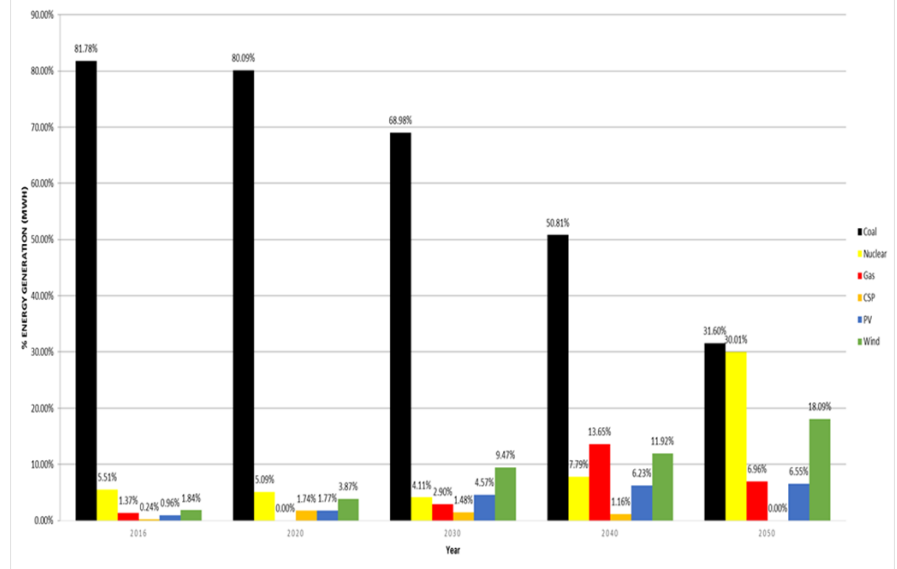
- Ave LF
  - Coal=85%
  - Nuclear=92%
  - CCGT=27%

# Installed Capacity and Energy Mix Contribution Technology

PERCENTAGE SHARE BY INSTALLED CAPACITY (MW)



PERCENTAGE SHARE OF ENERGY MIX



# Base Case Observations

- The system commissions new capacity earliest 2022;
- Initial capacity comes from a combination of PV, Wind and Gas;
- New Base load commissioning is highly linked to Eskom's plant retirement schedule;
  - The system commissions conventional base load (Coal) by 2028;
  - Nuclear is commissioned by 2037;
  - 1000MW of Hydro come in around 2030.
- With regard to energy mix;
  - Gas and Renewables forms the biggest chunk of installed capacity by 2050;
  - There is significant reduction in installed capacity from Coal;
  - While installed capacity from coal has reduced significantly, Coal and Nuclear contribute the most to the volume of (energy mix) energy supplied by 2050.
- Subject to further analysis (scenarios and sensitivity tests), changed assumptions will have an impact on the scale and pace of rolling out of new capacity.

# Scenarios to be Tested



# IRP Scenarios

- Carbon budget as an instrument to reduce GHG emission
- Primary fuel price tipping point (coal, gas and nuclear)
- Low demand trajectory
- Embedded generation (rooftop PV)
- Enhanced energy efficiency
- Low Eskom plant performance
- Regional options (Hydro, Gas)
- Indigenous Gas
- Un-constrained Renewable Energy
- New Technology (Storage)
- Electricity Network Implications
- Additional Sensitivity Analysis



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# Way Forward and Public Consultation Logistics



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# Way Forward

ACTIVITY	WHEN
Continue inter-departmental consultation platform	Ongoing
Public consultation at various platforms including NEDLAC , Provincial road shows etc. in respect of:  a. Assumptions (demand, technology costs)  b. Demand  c. Scenarios	February 2017
Collation and consolidation of public inputs	February 2017
Policy adjustment	March 2017
Promulgation of final IRP	Once Approved by Cabinet



# Documents & Consultation

- Documents will available as follows:
  - Department Website from 22 November 2016  
[www.energy.gov.za](http://www.energy.gov.za)
  - Government Gazette of 25 November 2016
- Consultation Forums
  - Gauteng (PTA/JHB), Western Cape (CPT), Eastern Cape (PE), KwaZulu Natal (DBN), between 7 – 15 December 2016.  
Confirmed Schedule on [www.energy.gov.za](http://www.energy.gov.za) by 25 November.
  - Other Provinces will be covered in January 2017.  
Schedule on [www.energy.gov.za](http://www.energy.gov.za) by 15 December.
  - NEDLAC in February 2017.

Thank You



# Sample Scenario Results



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# Base Case + Carbon Budget+ Annual Constraints on RE

	New Build Options								CO2 Emissions	Peak Demand (MW)	Firm Reserve Margins (%)	Water Consumption (Mil tonne)
	PV	Wind	DR	Nuclear	OCGT	CCGT	Coal PF w FGD	Inga				
2020	580								251	44916	24	272922
2021	650	1000							259	44551	29	257603
2022	790	1000							259	45223	25	252624
2023	930	1500							259	45888	23	250337
2024	930	1400							264	46479	20	256545
2025	1000	1600	1000		1848				261	47286	19	253110
2026	1000	1800	1000	1359	924				251	48009	21	239408
2027	1000	1800	1000		1584				250	48741	19	234044
2028	1000	1800	1000	2718		732			229	49327	21	211141
2029	1000	1800	1000			2928			221	50135	19	191576
2030	1000	1800	1000	1359	2376			2500	194	50803	24	157154
2031	1000	1800	1000	1359		732			187	51495	23	144961
2032	1000	1800	1000			1464			191	52030	22	139793
2033	1000	1800	1000	1359					181	52794	22	125653
2034	1000	1800	1000	1359		732			178	53451	22	120200
2035	1000	1800	1000			2196			167	54113	22	102245
2036	1000	1800	1000	1359		1464			157	54658	22	84559
2037	1000	1800	1000	1359		2196			144	55385	21	67857
2038	1000	1800	1000	1359		2196			131	55990	21	60762
2039	1000	1800	1000	1359	396	2196			127	56682	21	53779
2040	1000	1800	1000		132	2196			123	57239	20	43187
2041	1000	1800	1000	1359	1584	2928			106	58052	20	40609
2042	1000	1800	1000	1359		732			106	58757	20	40259
2043	1000	1800		1359					102	59471	21	39628
2044	1000	1800		1359					98	60026	21	39249
2045	1000	1800	1000			2928			108	60908	20	40520
2046	1000	1800	1000	1359	1452	1464			104	61631	20	37477
2047	1000	1800	1000	1359		1464			98	62344	20	34150
2048	1000	1800	1000	1359		1464			95	62956	20	31135
2049	1000	1800	1000	1359					93	63832	20	28057
2050	930	1800	1000			2928			90	64604	20	25054
<b>Total (MW)</b>	<b>29810</b>	<b>51500</b>	<b>1000</b>	<b>25821</b>	<b>10296</b>	<b>32940</b>	<b>0</b>	<b>2500</b>				

The plan achieved a carbon of 5.03Gt against a target of 5.47Gt from 2021-2050.

Learning Rates	PV and Wind	Fuel Prices	Emissions
Moderate	Annual build Constraints	IRP 2015 Fuel Price	Moderate Decline
No Learning	No Annual build Constraints	New Policy Prices	DEA Lower Carbon Budget

# Base Case + Carbon Budget + No Annual Constraints on RE

	New Build Options								CO2 Emissions	Peak Demand (MW)	Firm Reserve Margins (%)	Water Consumption (Mill tonne)
	PV	Wind	DR	Nuclear	OCGT	CCGT	Coal PF w FGD	Inga				
2020									252	44916	24	276803
2021									264	46130	28	264911
2022									268	47336	23	263291
2023	30								274	48547	20	266630
2024	5580		1000		660				268	49656	18	258366
2025	1020	1800	1000		3300				266	51015	20	256604
2026	2990	1600	1000			1464			260	52307	20	246745
2027	5400	2300	1000			2196			242	53561	20	229042
2028	710	1200	1000			2928			244	54567	20	224277
2029		7400	1000			1464			224	56009	20	193910
2030		7200	1000		1980				199	57274	19	160937
2031			500		396	2928			196	58630	20	152016
2032	4660		1000			2196	2500		195	59878	24	142129
2033		9200	500						185	61388	25	127611
2034	3230		1000			1464			188	62799	24	124447
2035		9000	1000						167	64169	23	104079
2036		1800	1000			2928			166	65419	23	89942
2037	2330	3000	1000	1359		2196			149	66993	24	71541
2038		1000	500			3660			135	68375	23	62959
2039	1590	3300	1000	4077					133	69584	24	58411
2040	5320	600	1000			2928			124	70777	23	45384
2041		6900			3300	732			103	72343	24	42014
2042		100	1000		132	2196			106	73800	23	42463
2043	1370		1000						104	75245	23	41734
2044	4970	7500							98	76565	24	39247
2045	3120	10400	1000						102	78263	22	40290
2046	930	6900	1000		2508				93	79716	22	36783
2047		2200	1000		792				89	81177	19	33515
2048	1430	5000	1000			1464			85	82509	19	30433
2049	120	15000	1000			4392			84	84213	26	27504
2050	5260	2700							81	85804	20	24573
<b>Total (MW)</b>	50060	106100	0	5436	13068	35136	0	2500				

The plan achieved a carbon of 5.09Gt against a target of 5.47Gt from 2021-2050.

Learning Rates	PV and Wind	Fuel Prices	Emissions
Moderate	Annual build Constraints	IRP 2015 Fuel Price	Moderate Decline
No Learning	No Annual build Constraints	New Policy Prices	DEA Lower Carbon Budget