IRP Update Assumptions & Base Case

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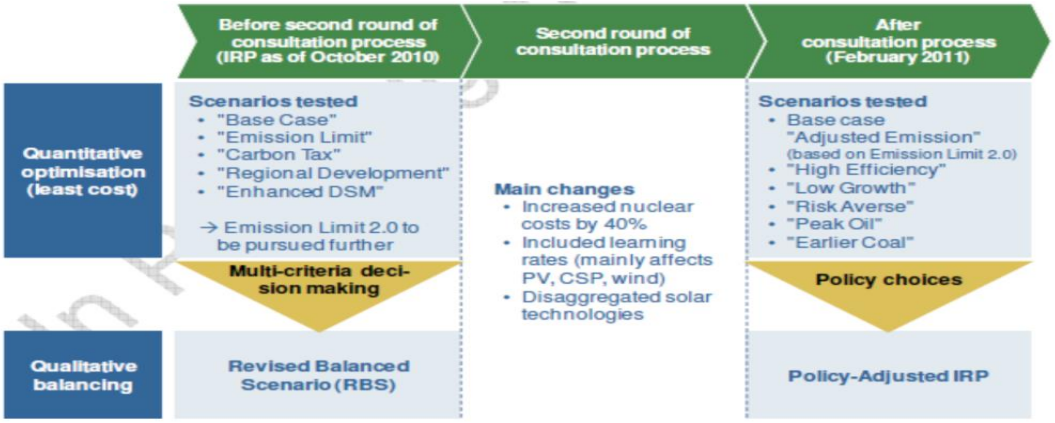
Purpose

- Purpose of the presentation is to:
  - 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

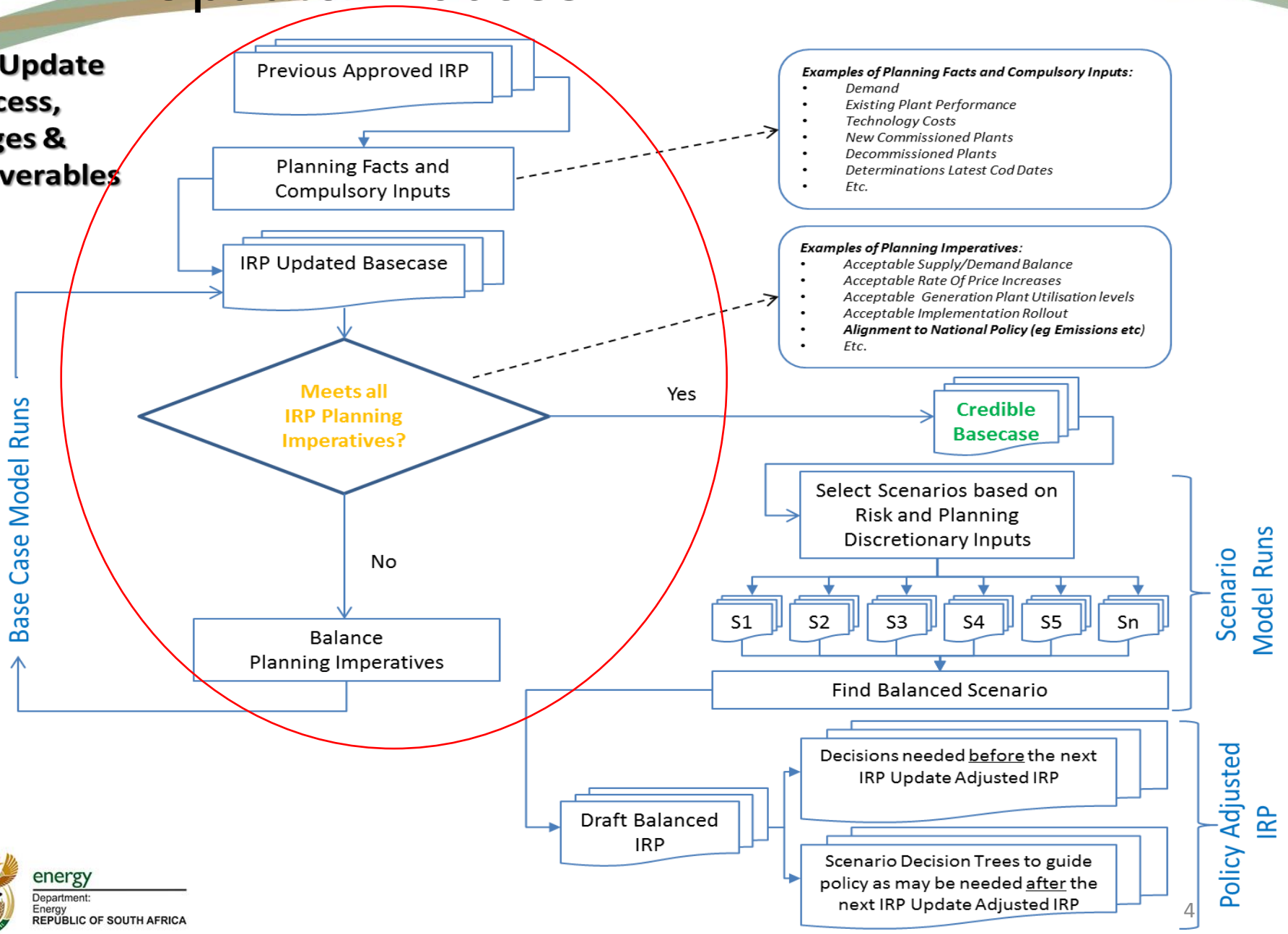
Background

- The Integrated Resource Plan (IRP) 2010-30 was promulgated in March 2011;
- Following public consultations, a number of policy decisions were adopted which resulted in the promulgated policy adjusted IRP 2010-30.



IRP Update Process

IRP Update Process, Stages & Deliverables



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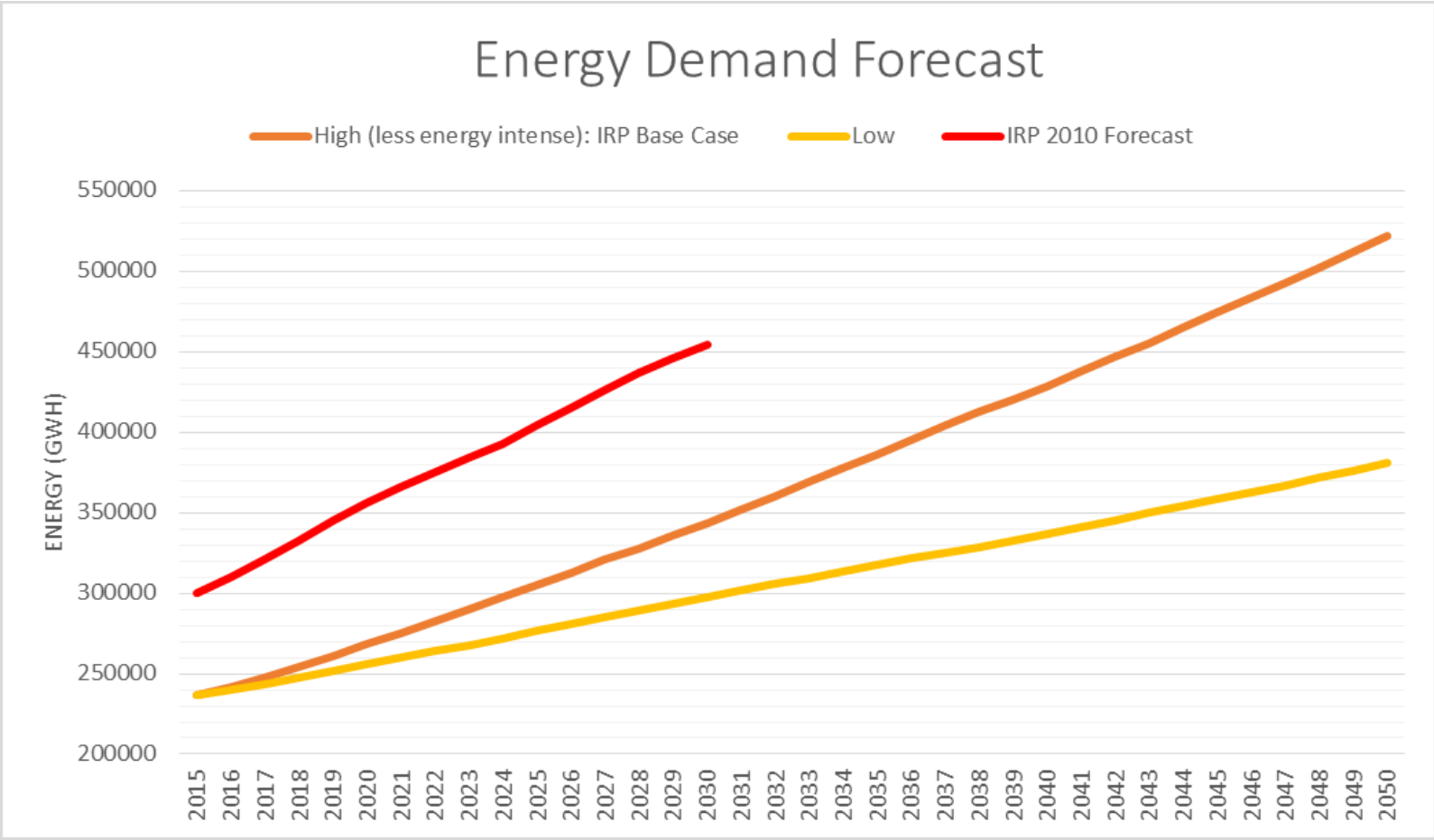
Assumptions

- Demand Forecast
- Economic Parameters
  - Discount Rate
  - Exchange Rate
- Technology and Fuel Costs
- Other Assumptions:
  - CO2 Emissions
  - Existing Plant Life
  - Existing Plant Performance
  - Non Eskom Plant
  - Determinations and New Build

Energy Demand Forecast

Energy Forecast



- The 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 Low forecast has an annual average energy growth rate of 1.31 % and its energy in 2050 differs from the High (less energy intense) by 156TWh.

Demand Forecast Methodology

- Link to CSIR Presentation

Economic Parameters

Economic Parameters

- Exchange Rate January 2015
  - R/$ 11.55
- Social Discount Rate:
  - 8.2% Real post Tax
- Cost of Unserved Energy:
  - R77.30/kWh (NERSA Study)

Technology & Fuel Costs

Technology Overnight Costs (R/KW)

	IRP 2015 (in 2015 rand terms)
Technology	**Overnight Costs of New Plant (R/kW)**
Coal PF	32 420
Coal FBC	39 133
OCGT	7 472
CCGT	8 205
Nuclear	55260
Wind	19 208
PV (tracking)	17860.6
PV (fixed tilt)	16860.6
Import Hydro	41478.8

Generic Technologies Levelised Cost at 8.2%Discount Rate

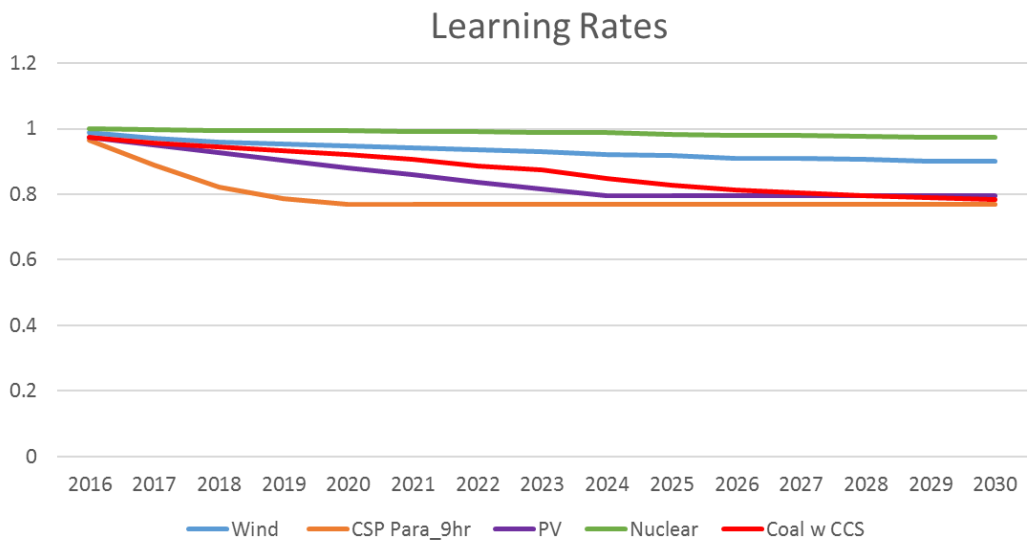
	Base Load					Mid Merit		
	Coal PF	Coal FBC	Coal Pulverized with CCS	Coal IGCC	Nuclear (DoE)	CCGT	Internal Combustion Engine (ICE) 2MW	Internal Combustion Engine (ICE) 10MW
Typical Load Factor (%)	86	86	86	86	90	36	36	36
Levelised Cost (R/MWh)	862.50	888.54	1514.35	1292.85	970.81	1183.22	1615.55	1620.39

	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

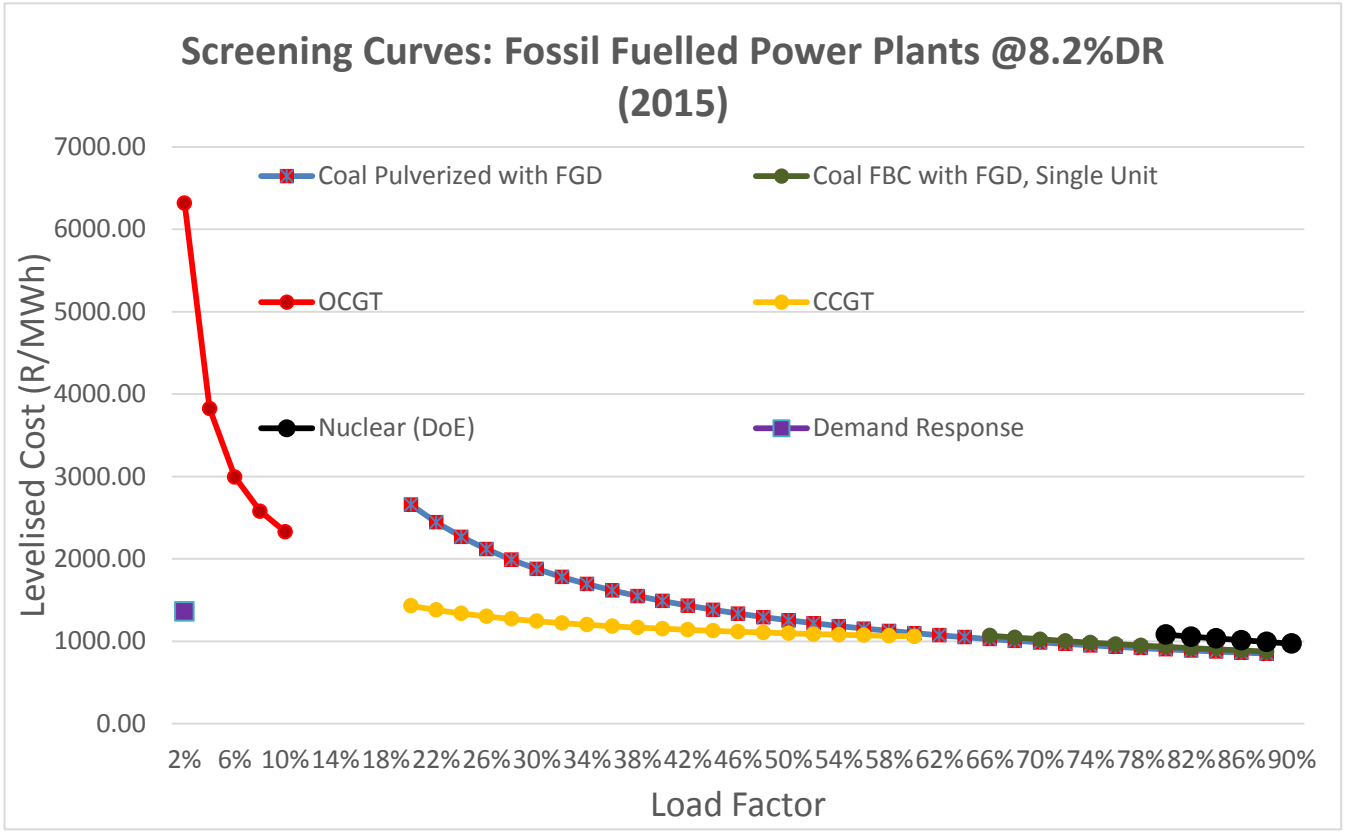
	Renewables															
	Wind	PV, Crystalline Silicon Fixed Tilt	PV, Crystalline Silicon Tracking	Concentrated PV	CSP Trough 3 hours storage	CSP Trough 6 hours storage	CSP Trough 9 hours storage	CSP Tower 3 hours storage	CSP Tower 6 hours storage	CSP Tower 9 hours storage	Biomass Forestry Residue	Biomass 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

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



Fossil Fueled Technology Screening Curves



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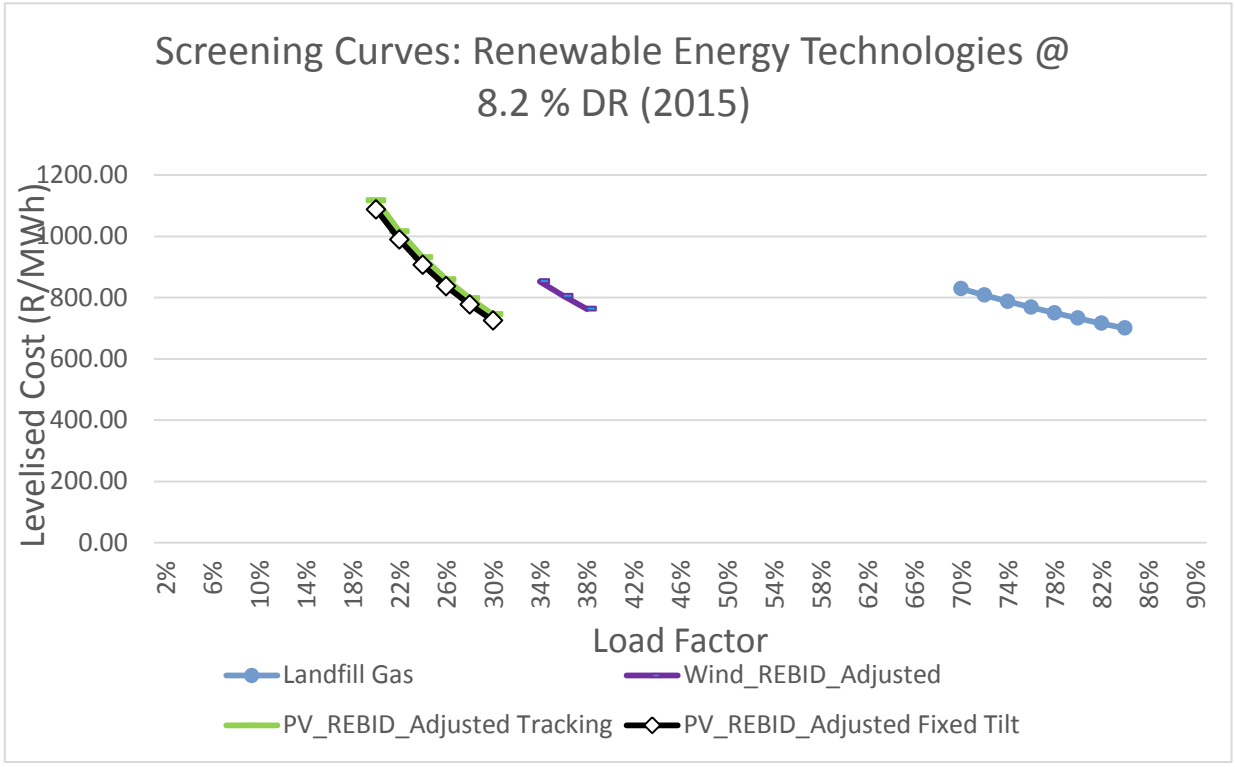
Renewable Energy Technologies Screening Curves



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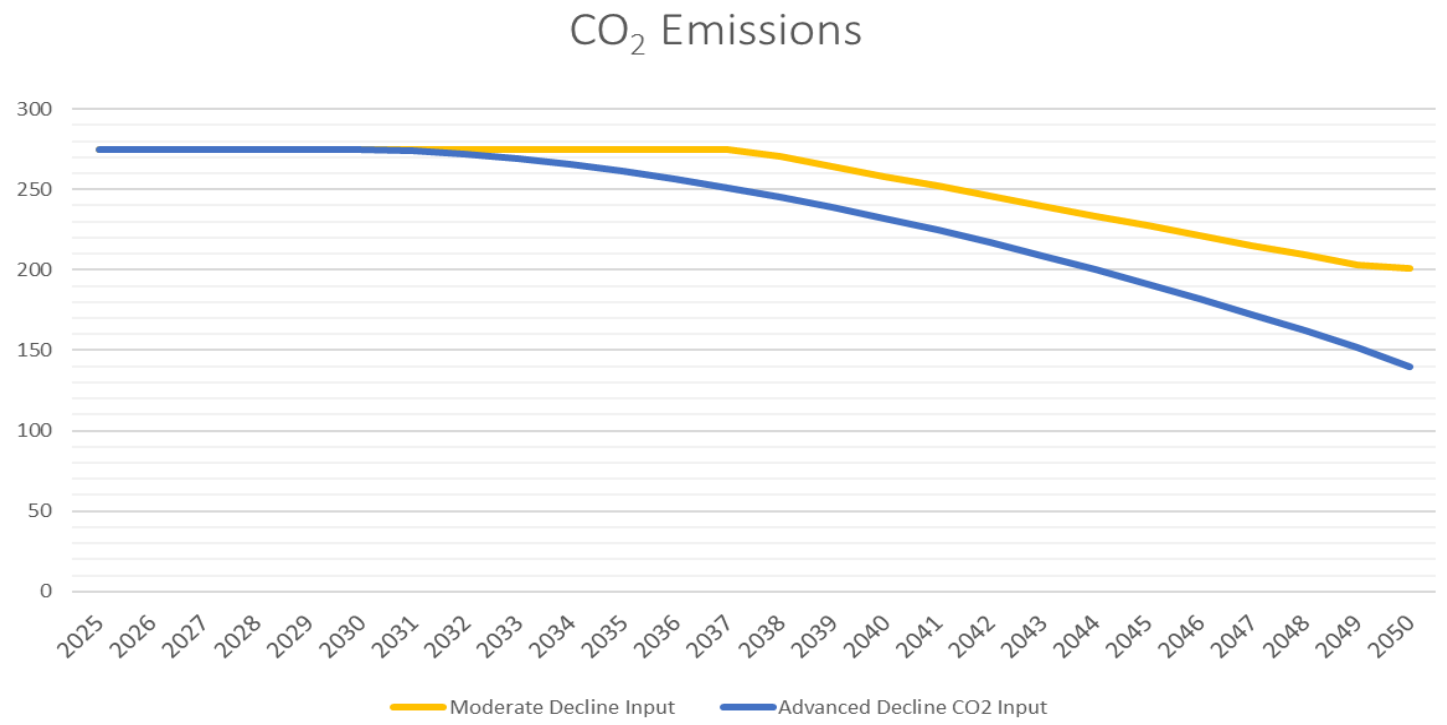
Fuel Costs

Parameter	Value used in model	
Fuel cost in R/GJ (EPRI)	Coal Pulverized with FGD	25 (~R/t 450)
	Coal FBC with FGD	12.5 (~R/t 225)
	Coal Pulverized with CCS	25 (~R/t 450)
	Coal IGCC	25 (~R/t 450)
	Liquefied Natural Gas	115.5
	Nuclear	15.4

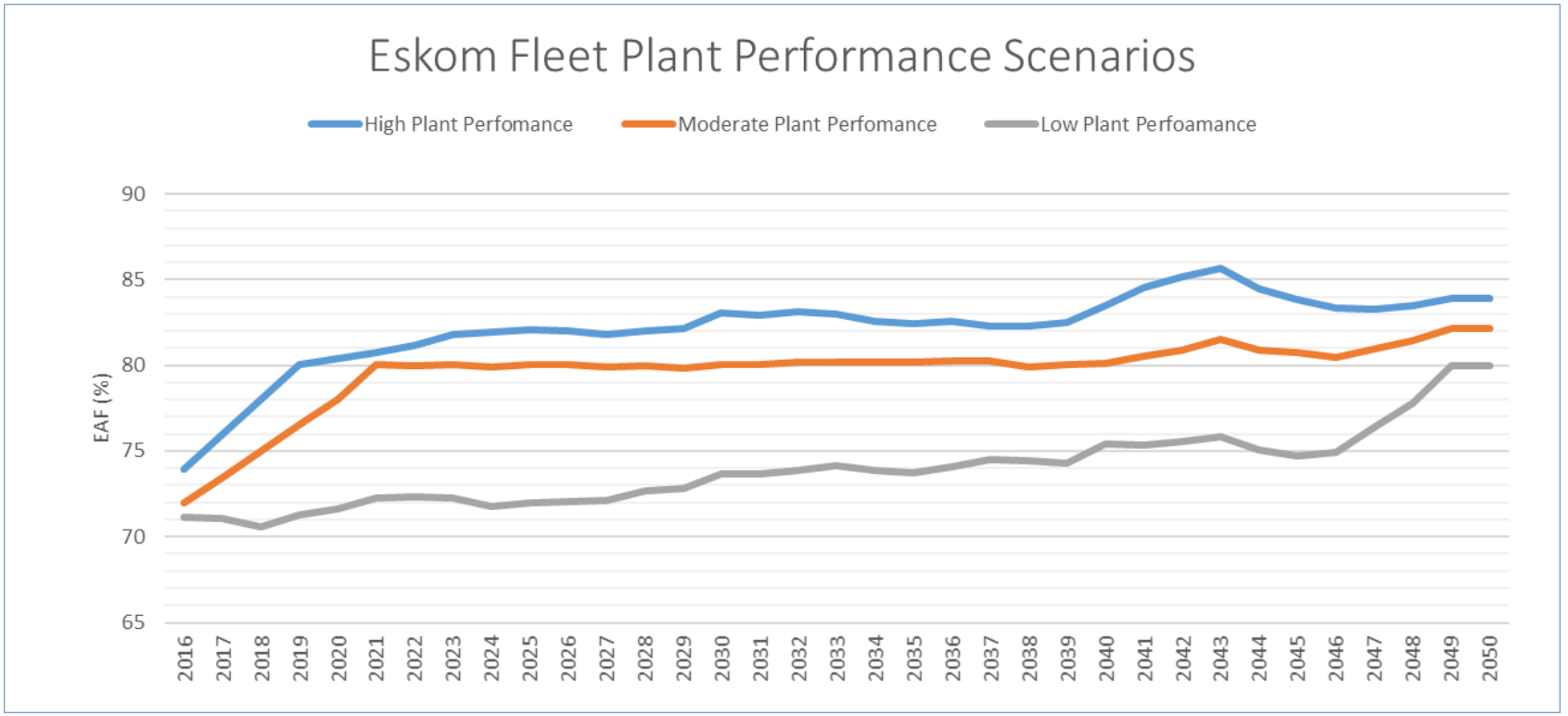
Other Assumptions

CO_2 Emission Trajectories



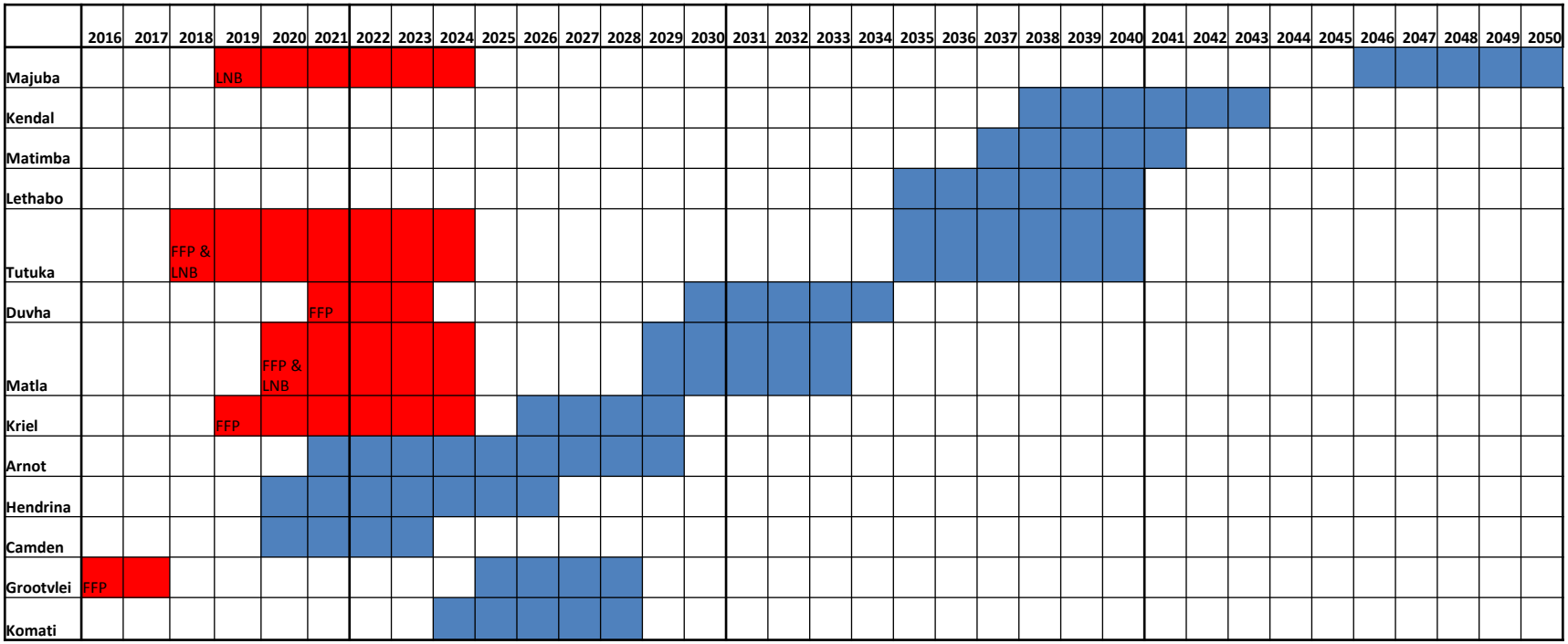
- The Moderate Emissions decline trajectory is used for the IRP Update Base Case

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



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

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	-

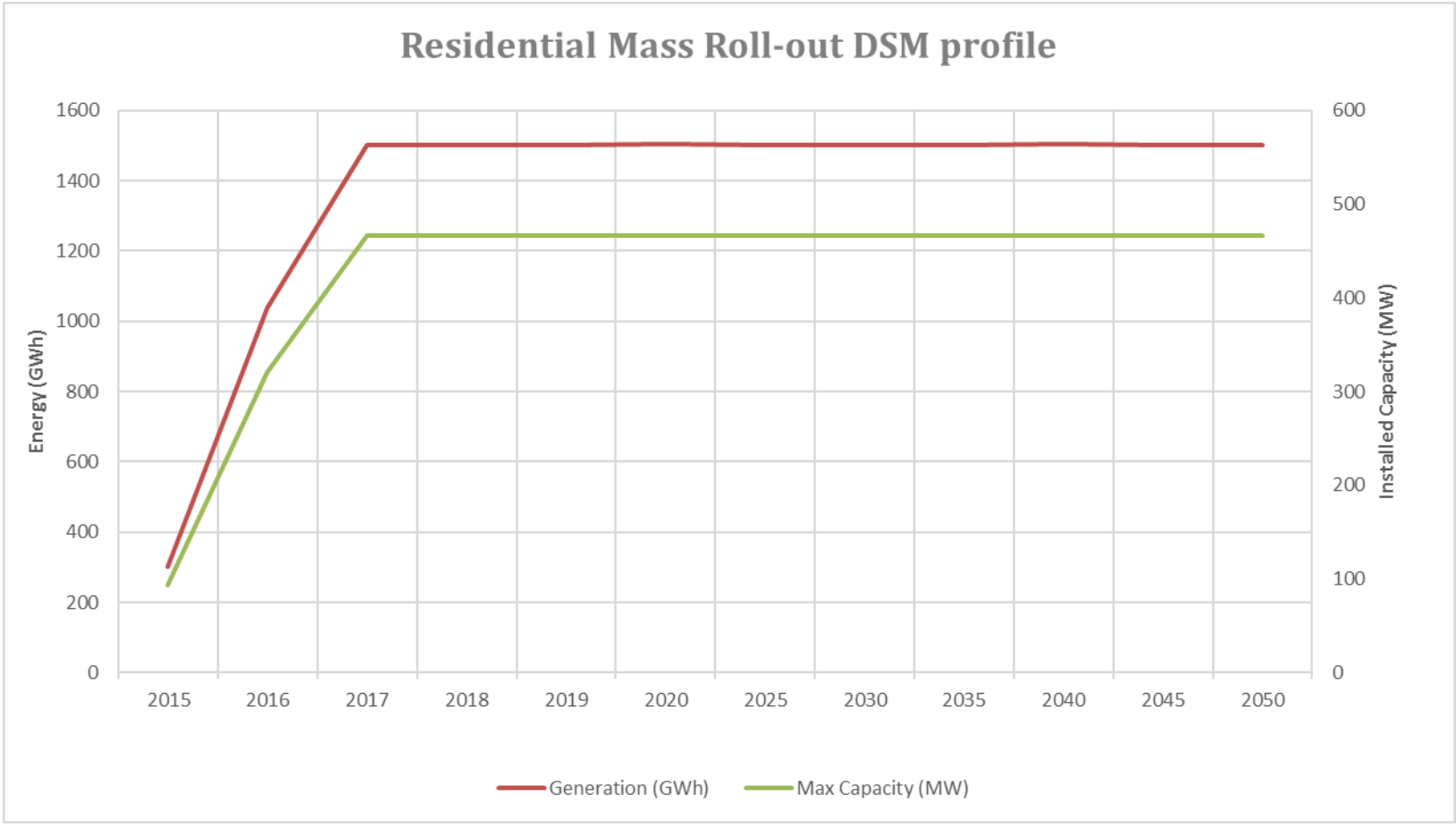
- The second unit of Medupi was synchronized on 08 September 2016
- Three units of Ingula reached COD by end August 2016 and the fourth unit was synchronized to the grid by end October 2016

Cumulative Capacity Procured Under Ministerial 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.

Demand-Side Management



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Base Case

(“the starting point”)

Base Case Results

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

- Demand Response programme of about 1000 MW required om an annual basis for peaking/emergence

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%

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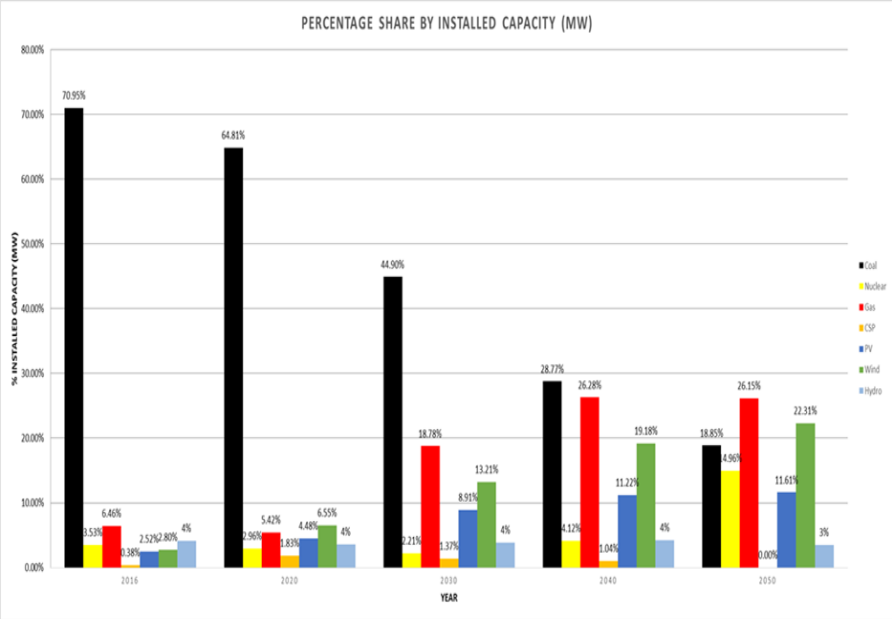
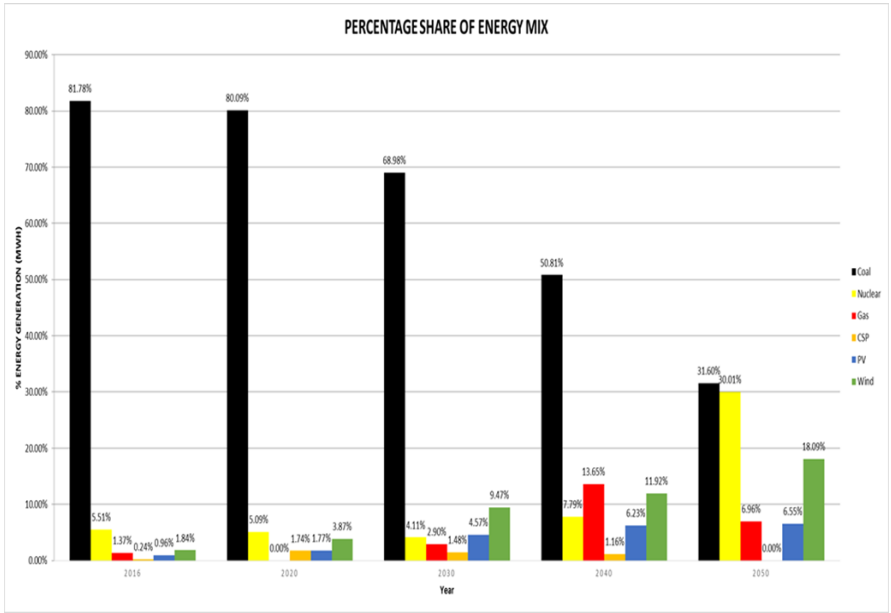
Installed Capacity and Energy Mix Contribution Technology





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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.
  - Observation Coal, Nuclear and Hydro quantity and operation date made above can change significantly based on changes to the assumptions.
- 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.
- **This is not a final plan (cannot be the basis for any decision at this stage) and is subject to further analysis (scenarios and sensitivity tests), following this public consultation process.**

Scenarios to be Tested

IRP Scenarios

Scenario	Source of Assumptions
Carbon budget as an instrument to reduce GHG emission	Department of Environmental Affairs
Primary fuel future price sensitivity (coal, gas and nuclear)	IEA Report
Low demand trajectory	CSIR Forecast
Embedded generation (rooftop PV)	
Enhanced energy efficiency	DoE EE Strategy (draft)
Low Eskom plant performance	Eskom
Regional options (Hydro, Gas etc)	SAPP
Un-constrained Renewable Energy	DoE
New Technology (Storage etc)	Various (DST, CSIR, SANEDI etc)
Electricity Network Implications	Eskom
Additional Sensitivity Analysis	N/A

THANK YOU