Electricity generation technology choice: Costs and considerations

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PARLIAMENT
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- Flexible capacity expansion
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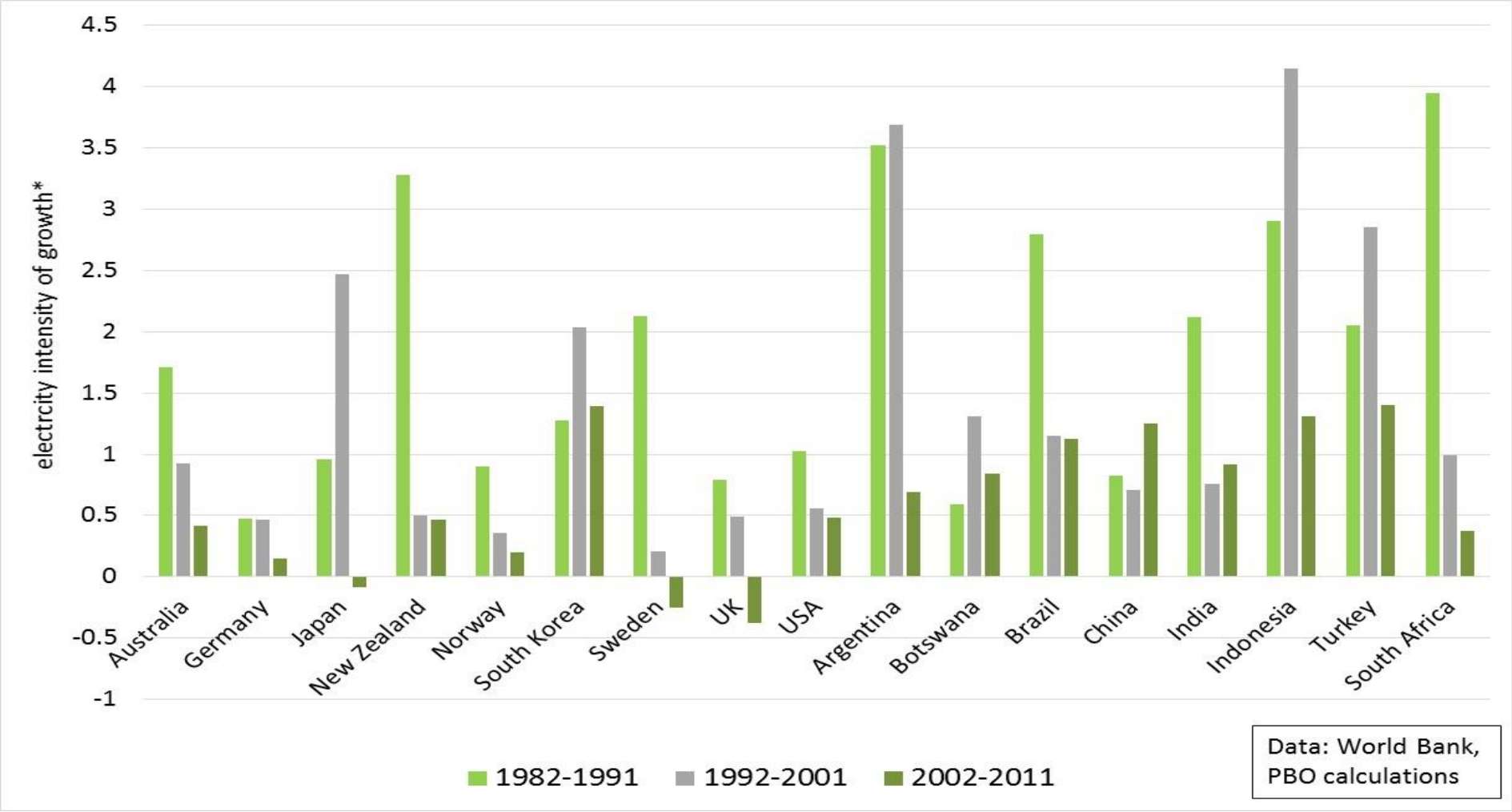
Introduction

- SA to add electricity generation capacity
- Electricity adequacy
- Electricity and growth

Electricity-intensity of economic growth 1982-2015



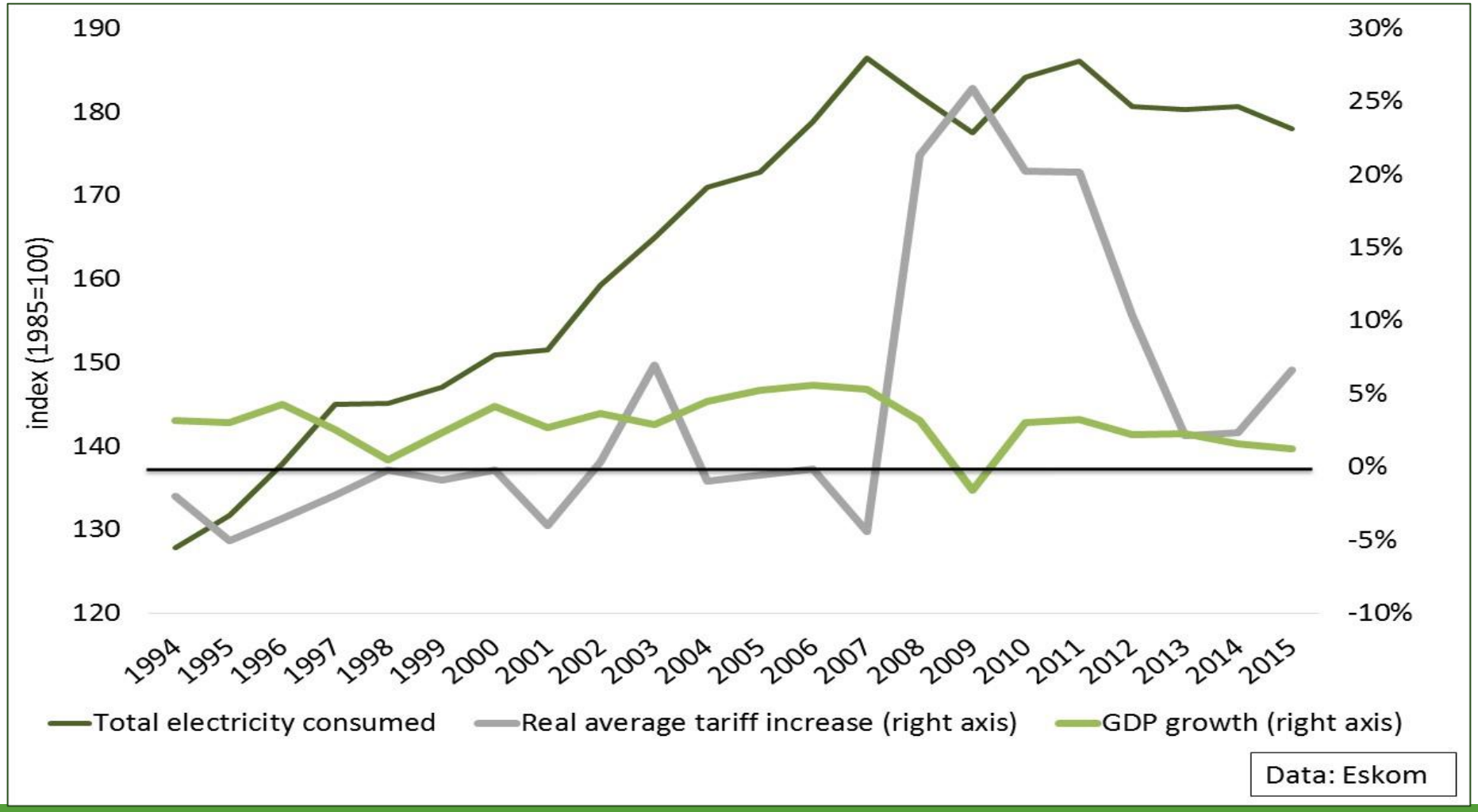
Energy planning

- Energy planning seeks to:
  - Ensure affordability of electricity infrastructure
  - Ensure that electricity is affordable for households and business
  - Maintain a responsive electricity system
  - Meet the country's environmental objectives
  - Meet the country's industrial policy objectives
  - Meet the country's regional development objectives
- Different implications for policy makers and public finance
- Policy-makers have to balance competing considerations

Energy choice in SA

- Over investment before 1994
- Low prices, real price decreases
- Significant increase in demand
- Energy intensive industrial base
- Demand-supply challenges since 2008

Electricity demand, prices and growth 1994-2015



New investment

Plant	Type of station	Project	Total future installed capacity (MW)	Addition to existing installed capacity*	Commenced	Completed
Grootvlei	Coal station	Refurbishing	1180	2.7%	2008	2013
Komati	Coal station	Refurbishing	1000	2.3%	2009	2012
Sere	Wind farm	New build	100	0.2%	2013	2015
Ingula	Pumped storage	New build	1332	3.0%	2005	underway
Medupi	Coal station	New build	4764	10.8%	2007	underway
Kusile	Coal station	New build	4800	10.9%	2007	underway
REIPPP BW1-3	various renewables	New build	3725	8.4%	2012	-
REIPPP BW4	various renewables	New build	1121	2.5%	2015	-
Total			**18022**	**40.9%**		

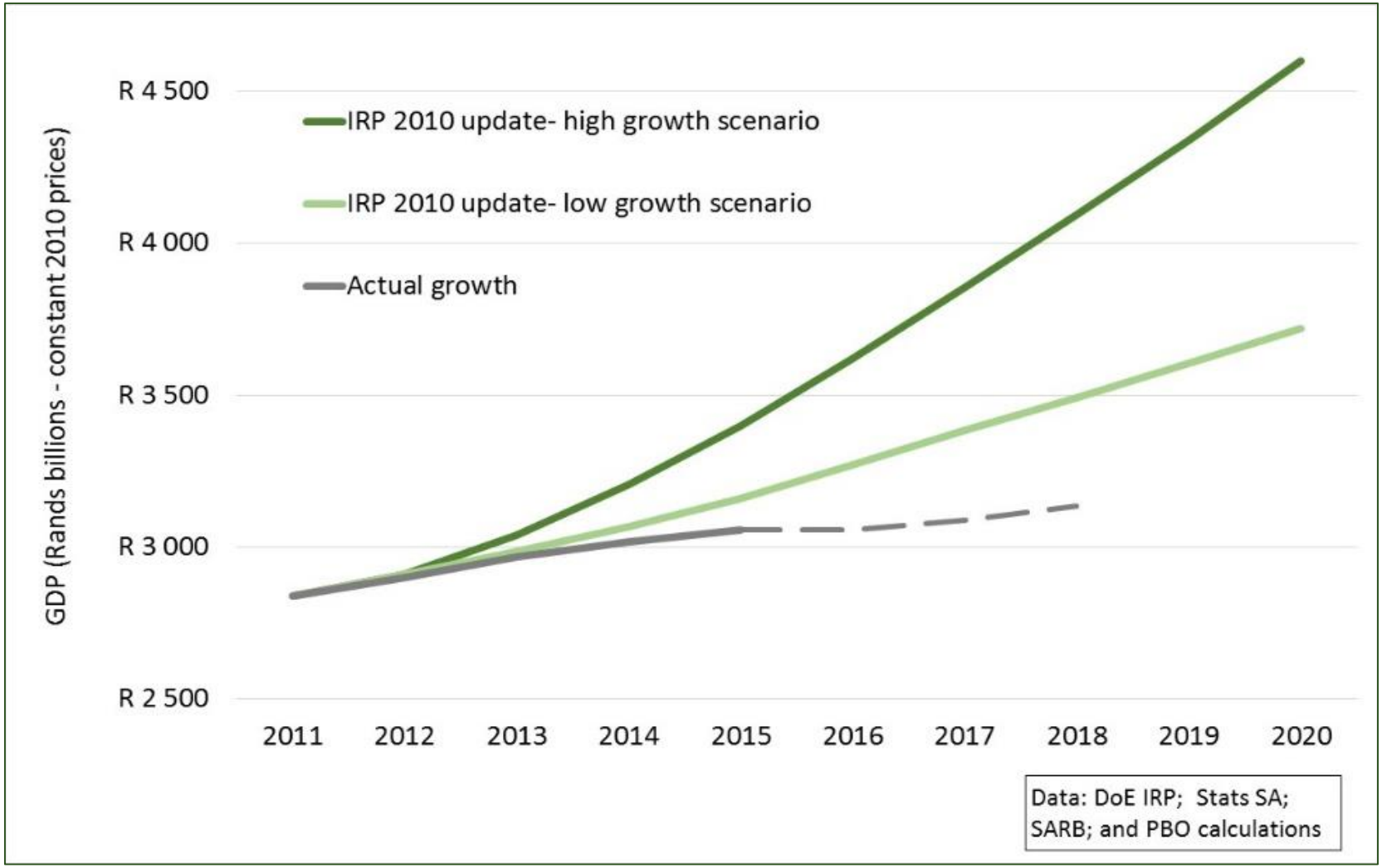
*Existing installed capacity excludes mothballed pla

Data: Eskom and Department of Energy

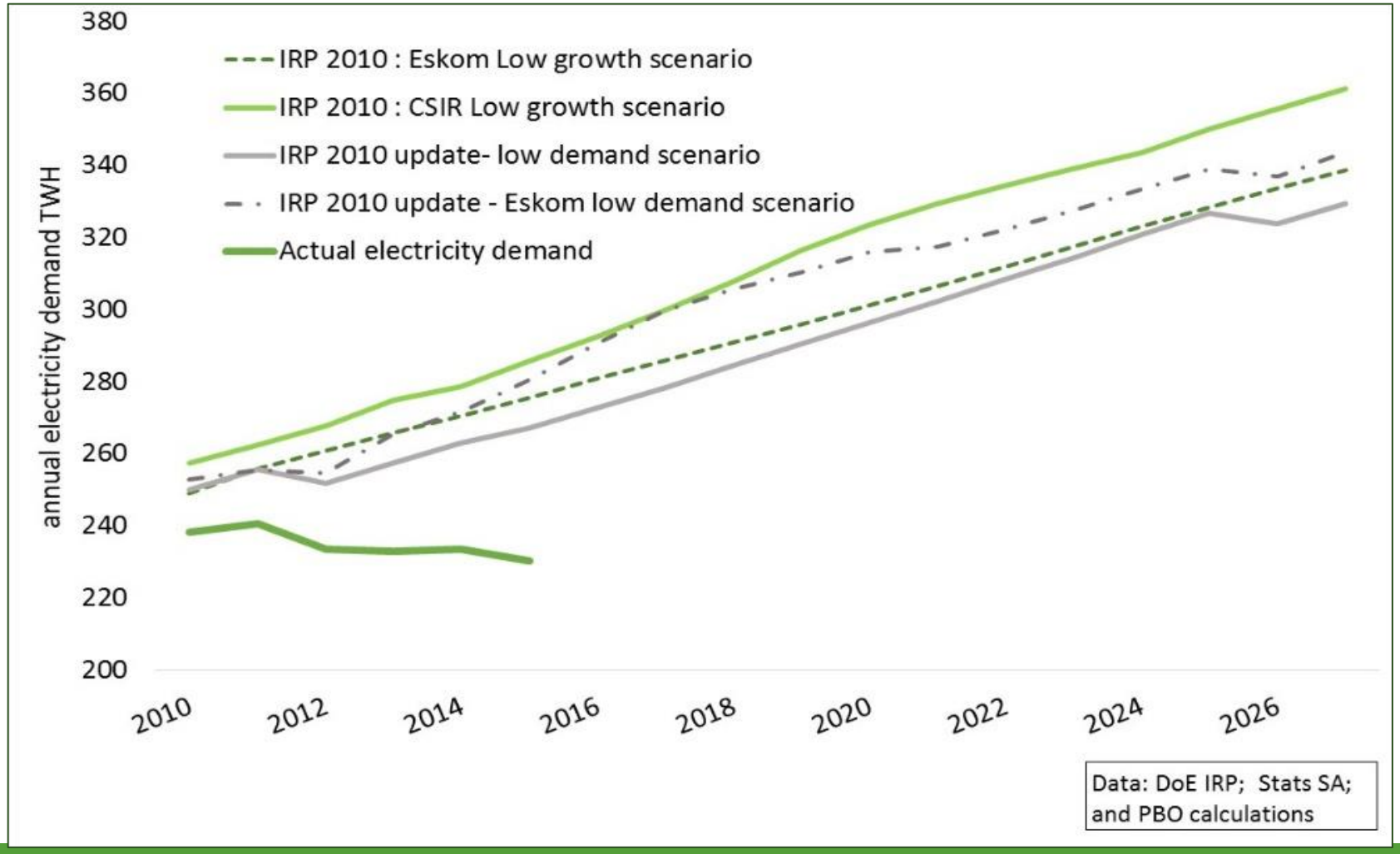
Energy technology choice in SA

- Informed by the Integrated Resources Plan (IRP)
- Current IRP is from 2010
- New IRP is expected soon
- Ministerial determination(s)
- Significant developments since IRP 2010

Expected and actual growth 2011-2020



Expected and actual electricity demand 2010-2026



Developments since 2010 IRP

- Change in technology costs and efficiencies
- Change in the price and availability of fuels
- South Africa's recent experience with large electricity generation projects
- Energy-intensive sectors have reduced their demand
- Eskom's finances have deteriorated
- Slow growth, rising national debt and increased guarantees issued to state owned entities, have reduced the state's room to provide guarantees and direct support to state owned entities.
- The country's credit ratings have deteriorated and its borrowing costs have increased

PBO study - data and limitations

- Several international studies comparing generation technology costs
- Country-specifics affects estimates
- Estimates that are based on local factors are more accurate
- We use cost estimates from
  - Integrated Resources Plan 2010
  - Integrated Resources Plan update (2013)
  - Electric Power Research Estimate 2012 study
  - Electric Power Research Estimate 2015 study
- Technologies considered from the IRP

Technologies considered

	Technology	Type	Rating
conventional technology	Coal 1	Pulverized Coal with FGD	6x750MW
	Coal 2	Pulverized Coal with CCS	6x750MW
	Coal 3	Fluidized Bed Combustion with FGD	1x250MW
	Coal 4	Fluidized Bed Combustion with FGD and CCS	1x250MW
	Coal 5	Integrated Gasification Combined Cycle	2x644MW (IRP 2010: 125MW)
	Coal 6	Integrated Gasification Combined Cycle with CCS	2x644MW
	Nulcear 1	Areva EPR	1X1600MW
	Nuclear fleet	Areva EPR - multiple nuclear units with the same commercial service date	6X1600MW
	Gas 1	Combined Cycle Gas Turbine	711MW (EPRI 2015: 732MW)
	Gas 2	Combined Cycle Gas Turbine with CCS	591MW (EPRI 2015: 635MW)
renewable technology	Wind	Farm	2x50MW (IRP 2010: 200MW)
	Solar 1	Concentrated Solar Power - Parabolic trough - 6 hours storage	125MW
	Solar 2	Concentrated Solar Power - Parabolic trough - 9 hours storage	125MW
	Solar 3	Concentrated Solar Power - Central receiver - 6 hours storage	125MW
	Solar 4	Concentrated Solar Power - Central receiver - 9 hours storage	125MW
	Solar 5	Concentrated photovoltaic (PV)	10MW
	Biomass 1	Forestry residue	25MW
	Biomass 2	Municipal solid waste	25MW
	Hydro 1	Imported hydro - Mozambique	1500MW
	Hydro 2	Imported hydro - Mozambique	850MW
	Hydro 3	Imported hydro - Zambia	250MW
	FGD: Flue Gas Desulfurization, CCS: Carbon Capture and Storage		Data: DoE IRP and EPRI

Costs

- Necessity to ensure healthy public finances and promote economic growth
- Technology-mix should meet electricity needs and efficiently allocate scarce public resources
- Requires lowest-cost technically viable option
- Must compare standardised cost comparison
- Overnight capital costs
- Levelised Cost of Electricity (LCOE)

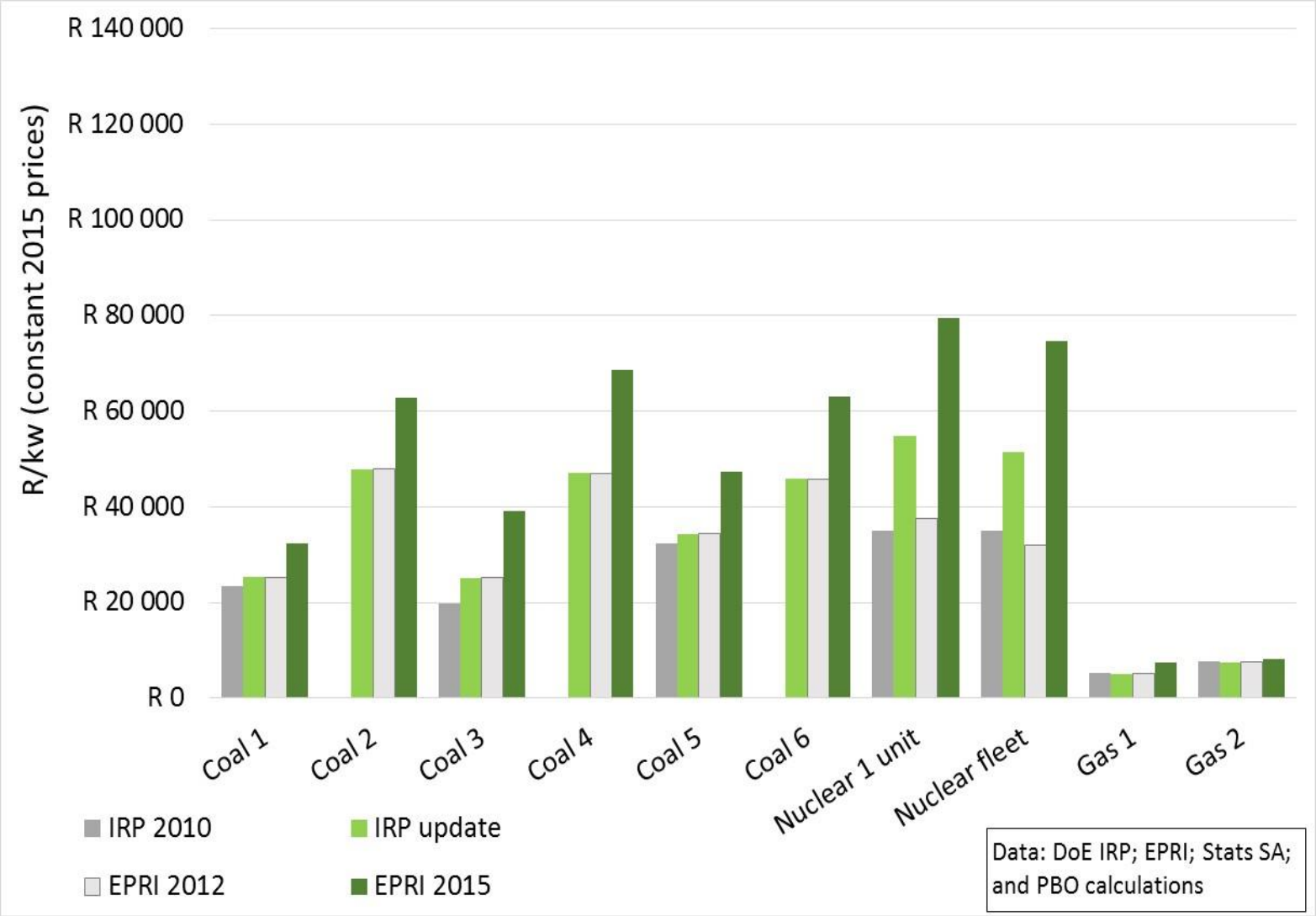
Overnight capital cost

- Overnight capital costs are simple to estimate and understand
- Used internationally to compare options
- Overnight capital costs exclude:
  - Financing costs
  - Plant life
  - Plant load-factor
  - Operation and maintenance costs
  - Fuel costs
- Not reflective of full cost

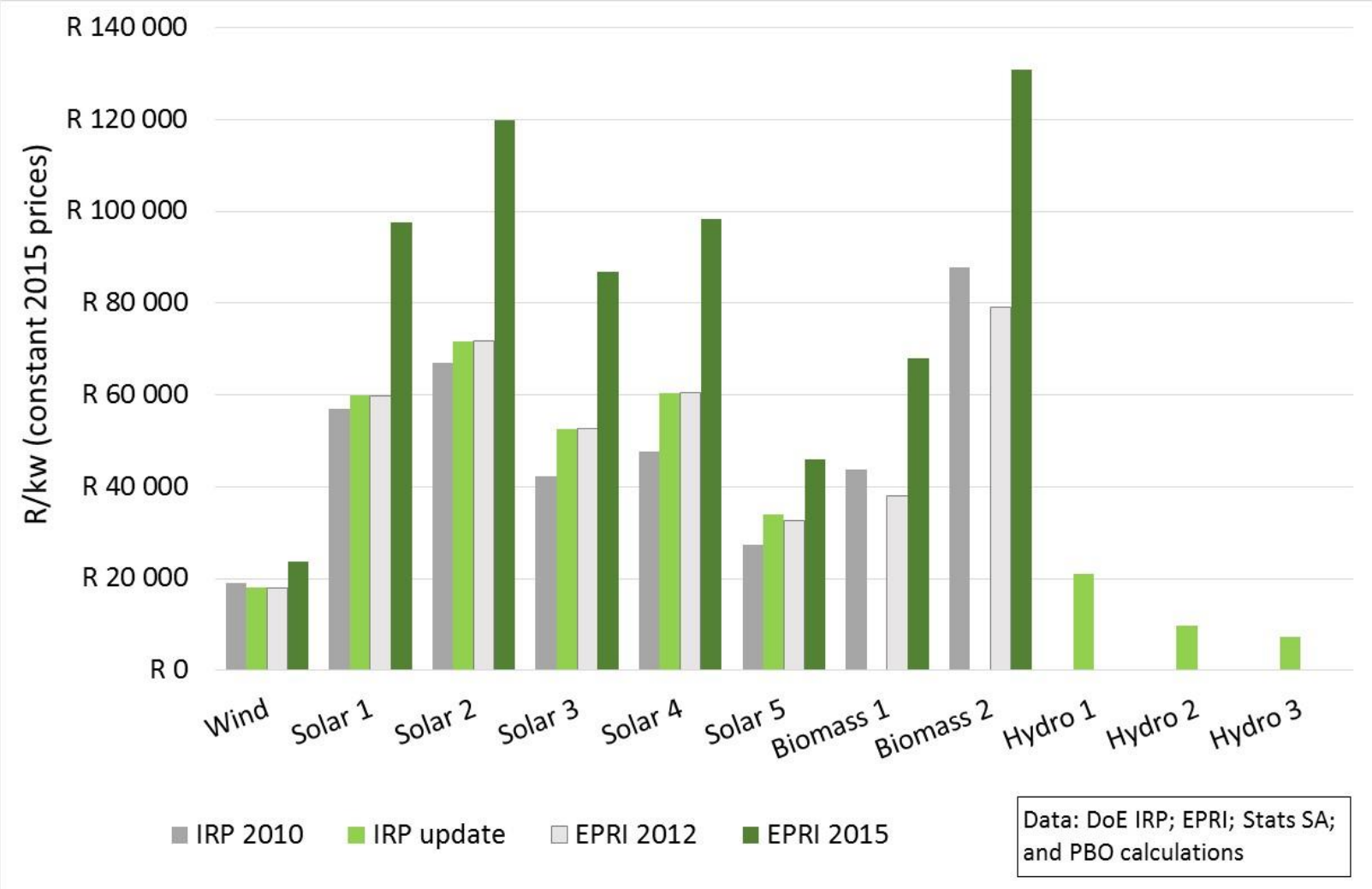
Levelised cost of electricity

- The LCOE is a summary measure that represents the per-kilowatt hour cost of building and operating a generating plant over an assumed financial life. It is intended to be used as a financial tool in comparing the costs of electricity generators.
- Alternate measure of overall competitiveness of different options
- Used internationally to compare options

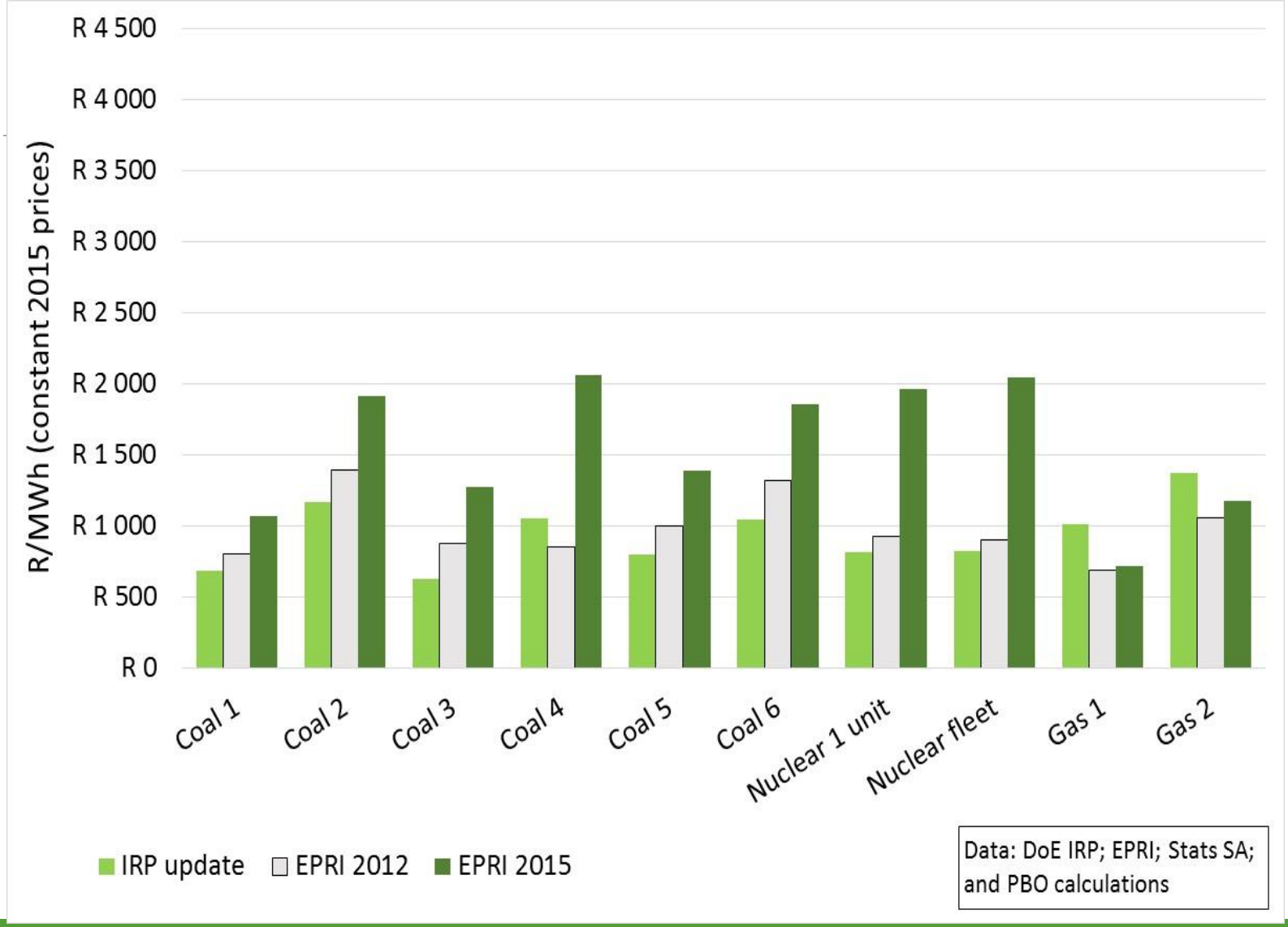
Overnight capital costs – conventional technology (constant 2015 prices)



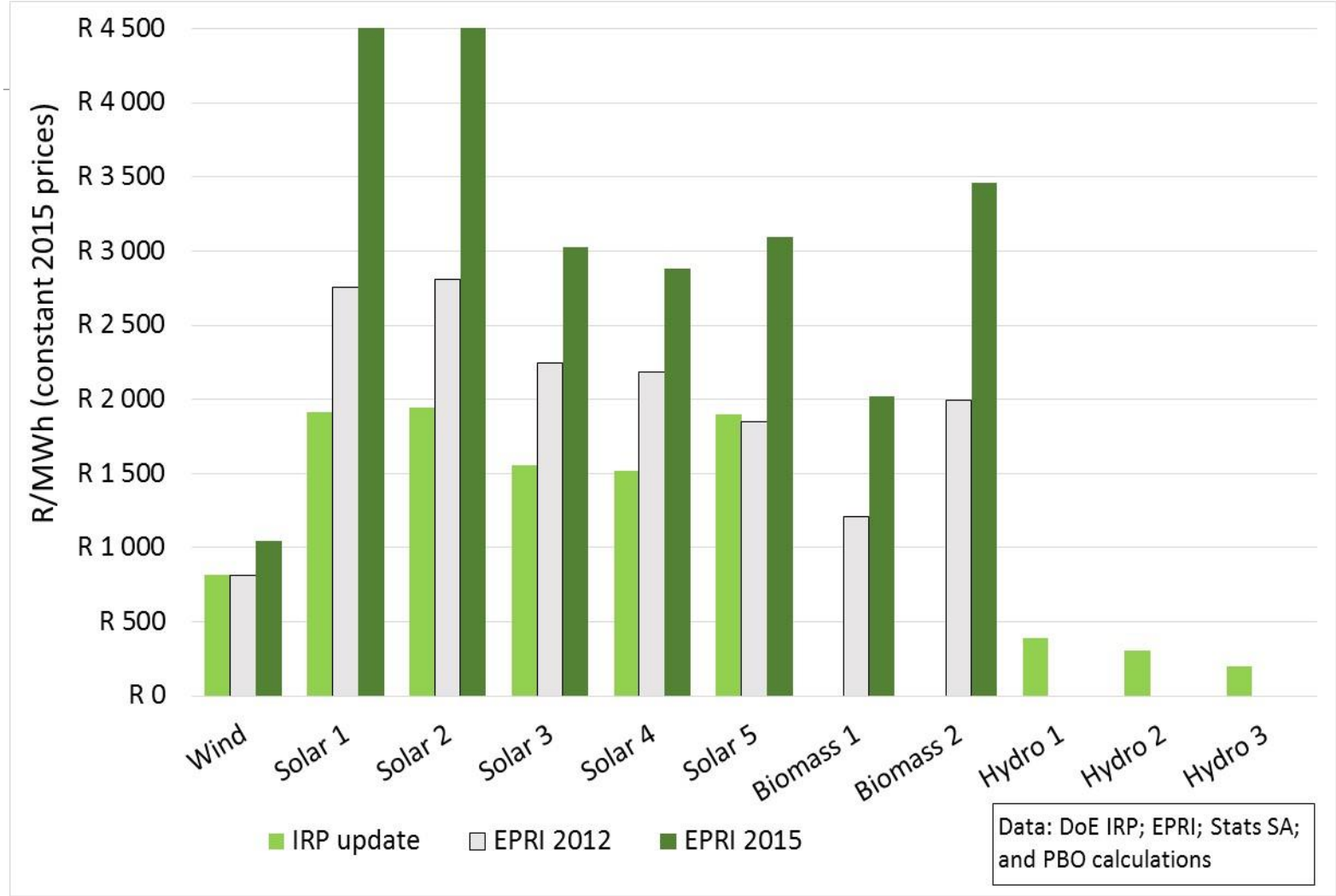
Overnight capital costs – renewable technology (constant 2015 prices)



LCOE - conventional technologies (constant 2015 prices)



LCOE - renewable technologies (constant 2015 prices)



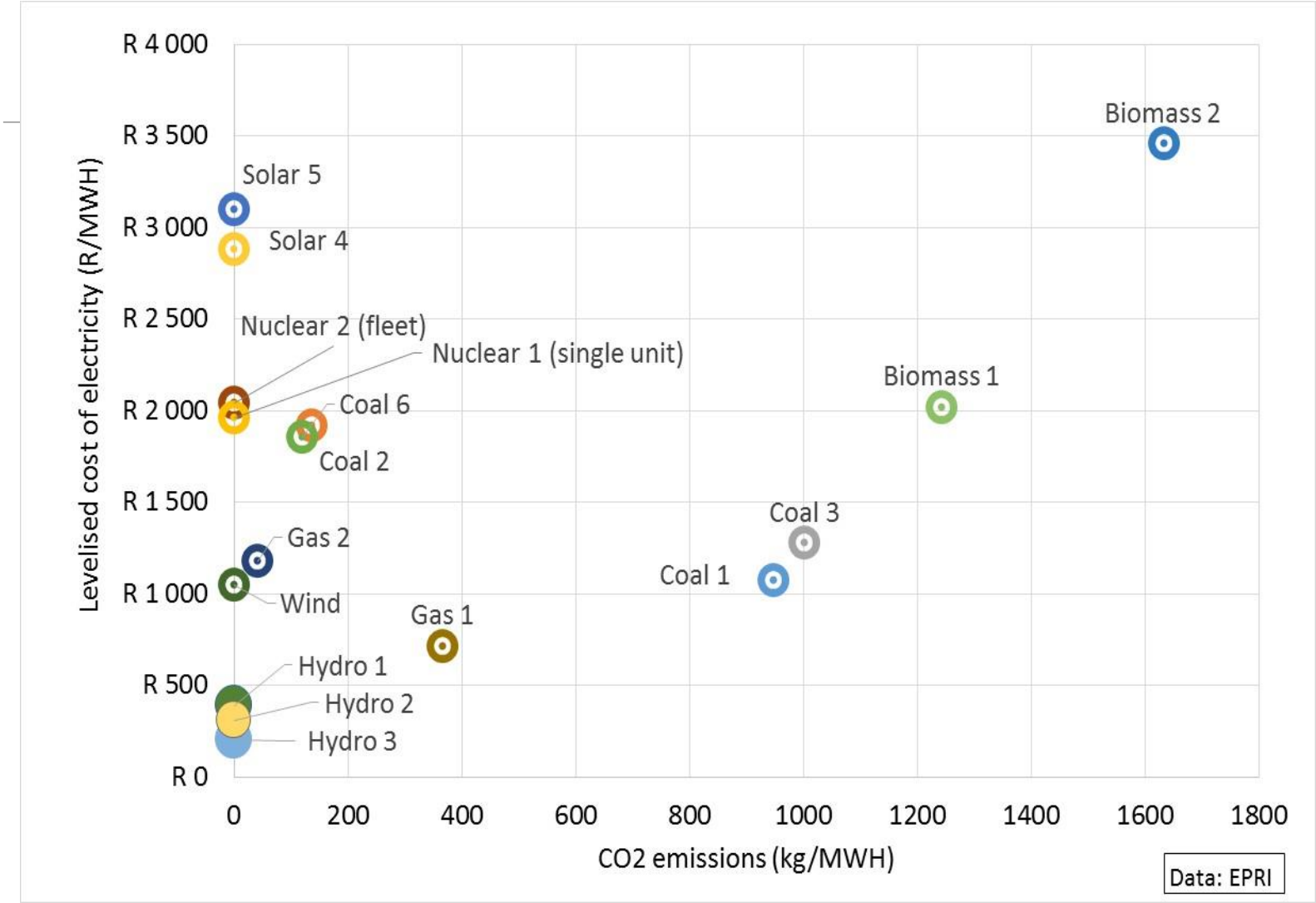
Financial and economic affordability

- Lowest cost option may sacrifice other policy objectives
- The additional financial costs from not choosing the lowest cost option must be compared to the (potential) benefit to the country arising from targeting other policy goal(s).
- More expensive technology affects the country through direct and indirect channels
- Higher overall tariffs
- Higher tariffs affects overall economic activity
- Higher borrowing costs for the state
- In the case of a state owned utility, the utility may require assistance from the state in the form of guarantees, loans and capital injections
- Government has to take account of uncertainty in its investment decisions because of the current difficult economic environment

Carbon emission considerations

- South Africa has made several commitments to reducing its Co2 emissions
- Domestic electricity sector is responsible for significant Co2 emissions
- Important to choose the appropriate policy instruments to reduce Co2 emissions
- National Treasury in 2013 proposed the introduction of a carbon tax
- Electricity generation technology with low carbon emissions will need to increase share of country's total electricity generation-mix
- Carbon emissions of different technologies can be compared based on Co2 emissions per kilowatt-hour of electricity generated
- Reducing Co2 generally entails the allocation of additional resources (higher cost)

Co2 emissions and LCOE across technologies (constant 2015 prices)



Flexible capacity expansion

- Uncertainty over future electricity demand requires an adaptable capacity expansion path
- Over-investing results in higher-than-necessary electricity tariffs
- Risks can be reduced by adopting a more flexible approach to ensuring system adequacy
- A modular approach
  - Requires investment in small plants with shorter construction lead-times
  - Allows for new investment decision to be responsive to changes in energy technology

Localisation

- Adding electricity generation capacity entails significant capital investment
- Opportunity for economy to benefit from increased demand
- Countries have used procurement to develop local capabilities and industries
- Potential benefit of localisation must be compared to the higher cost of procuring electricity generation capacity

Conclusion

- South Africa will add additional electricity generation capacity
- Since the 2010 IRP, economic growth and electricity demand have been much lower than assumed
- Necessitates an adjustment to the country's electricity generation capacity plans, and careful consideration over any new procurement
- Country faces a challenging economic situation
- Critical that the technology-mix chosen is optimal in terms of the effect on public finances and growth
- This study compared overnight capital costs and LCOEs for a range of technologies based on recent cost estimates

Thank you

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