An assessment of new coal plants in South Africa's electricity future

The cost and greenhouse gas emissions implications of the coal IPP procurement programme

ERC
ENERGY RESEARCH CENTRE
University of Cape Town

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NERSA generation license hearings
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Who we are

- Energy systems, economics, and policy (ESEP) group
- Based at the Energy Research Centre, University of Cape Town
- We work at the interface of energy systems analysis, macro-economic modelling, and policy analysis
- National, regional, and city-scale modelling
- Energy-water nexus, integrated energy planning, energy-economic linkages and development pathways, deep decarbonisation, uncertainty analysis, coal transitions, transport modelling… amongst others!
- Maintain the South African Times Model: integrated, full sector energy model
- Undertake multi- and interdisciplinary research

Aim of the current research

- **What are the implications of committing to the coal IPP programme?**

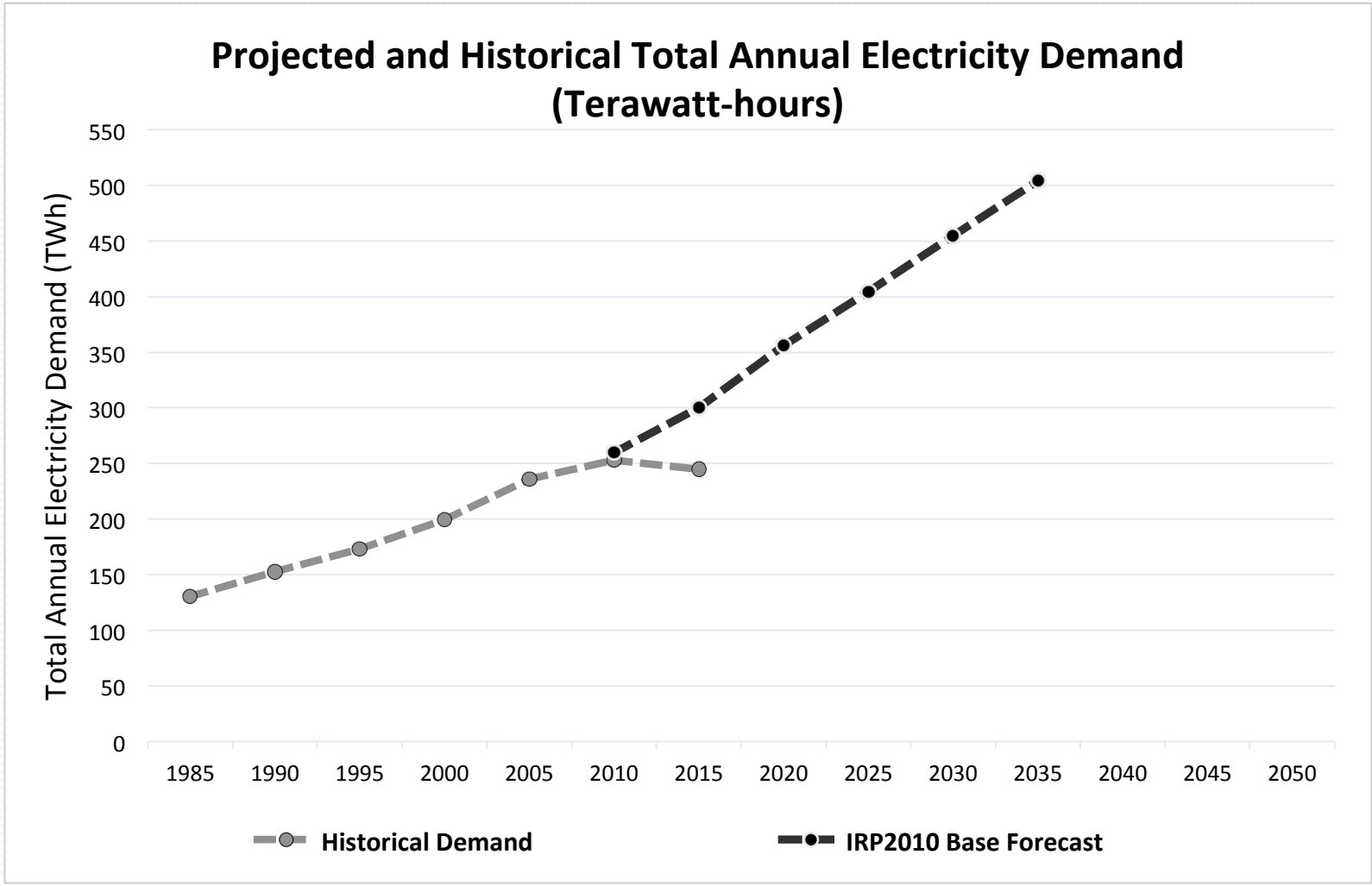
- How: through the comparison of a least-cost electricity build plan against an electricity build plan where the coal IPPs are committed (Coal Plus)
- We assess total discounted system costs, additional annual costs incurred, and emissions, measured as the difference between the least cost reference scenario and the coal plus scenario
- In each case we have assessed the IPPs individually and combined, but will report only the combined results here

Current context

What has changed since IRP 2010?

What does the best available climate science tell us about coal infrastructure?

Substantial oversupply



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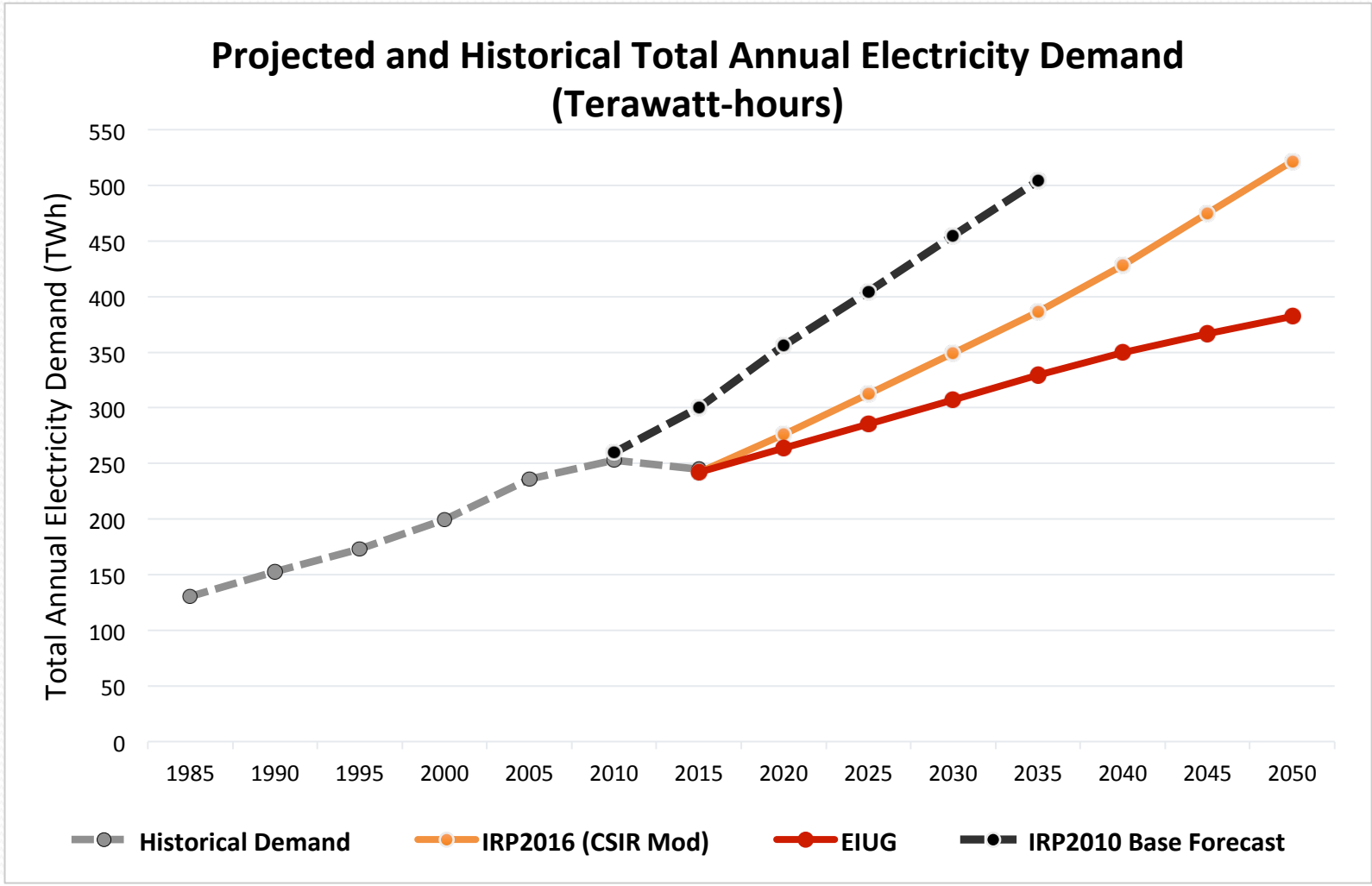
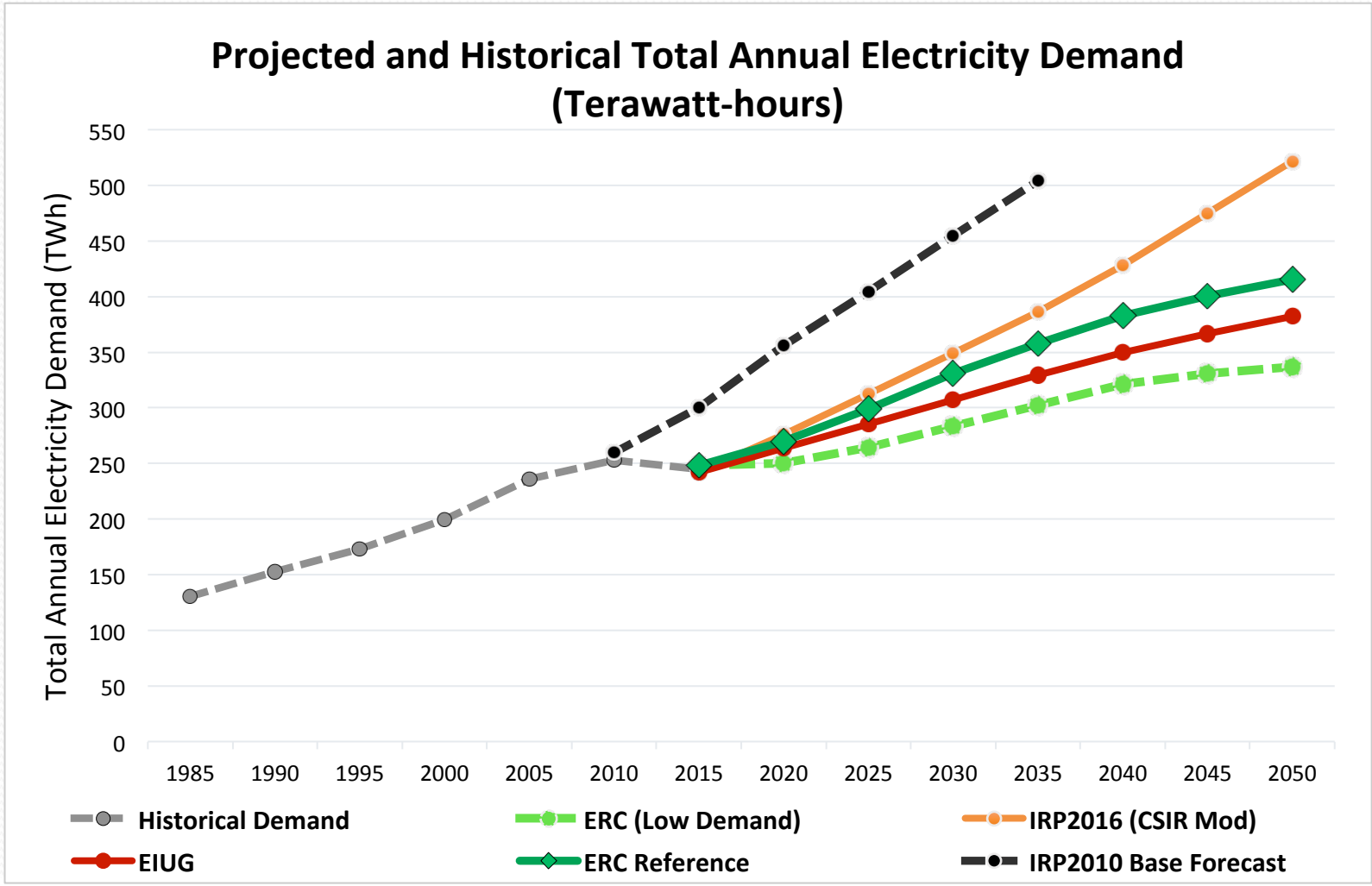
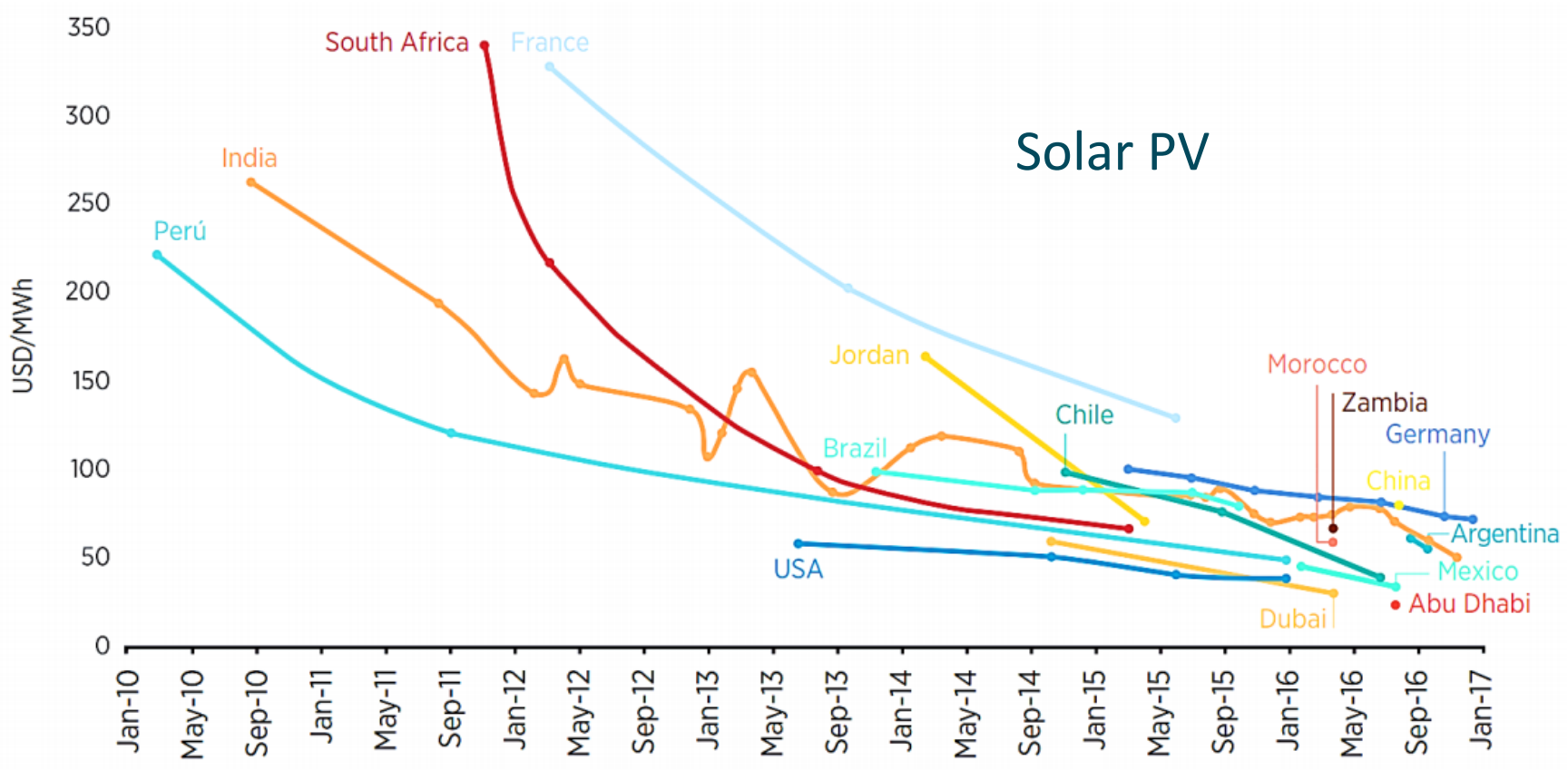


Substantial oversupply

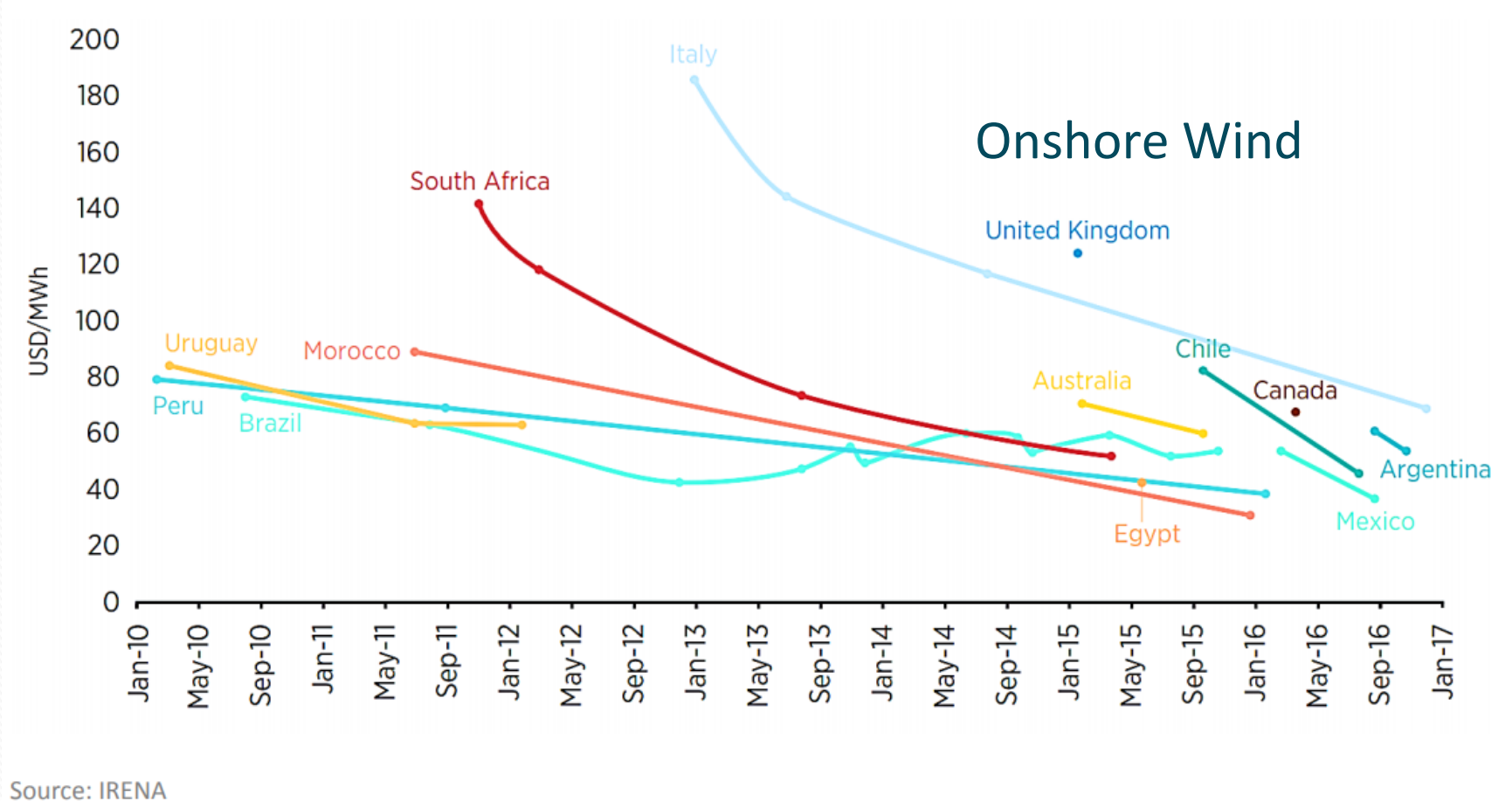


Falling costs of new RE



Source: IRENA

Falling costs of new RE



Source: IRENA

Paris Agreement

- Aims for “well below” 2 degrees
- Net zero emissions in latter half century
- Phase out of unabated coal by 2050 required for 2D
- Current polices still >3D; NDCs 2,8D
- South Africa’s current NDC = “inadequate” (CAT)
- Paris Agreement includes “ratchet mechanism” to increase ambition of nationally determined contributions
- SA can expect to move towards a more ambitious contribution over time
- Stranded assets – 2D requires early phase out of coal. Do we pay for a station we cannot use?

- In Pfeiffer et al. (2016), for example, it is shown that unless the plants later become stranded, no new emitting electricity generation plant can be built from 2017 onwards for 2°C scenarios.
- Many other authors have shown that coal will have to be phased out by 2050 to limit warming to 2°C and even more rapidly to limit warming to 1.5°C
- (Rogelj et al. 2015; Pfeiffer et al. 2016; Johnson et al. 2015; Luderer et al. 2016, Iyer et al. 2015).

Analysis of coal IPPs

Part 1: Reference scenario

Part 2: Coal Plus (committed coal IPPs)

South African Times Model (SATIM)

- Full sector least cost optimisation model
- Aims to meet demand at lowest cost subject to various constraints – implicitly means energy security goals are met, at lowest cost
- Demand derived from a linked energy-economy model (i.e. price effects of investments taken into account, unlike in the IRP)
- Based on the model developed for the DEA-PAMs project (pop, GDP growth, RE costs/learning)
- Has undergone extensive stakeholder consultation incl with industry and Eskom

Reference scenario assumptions

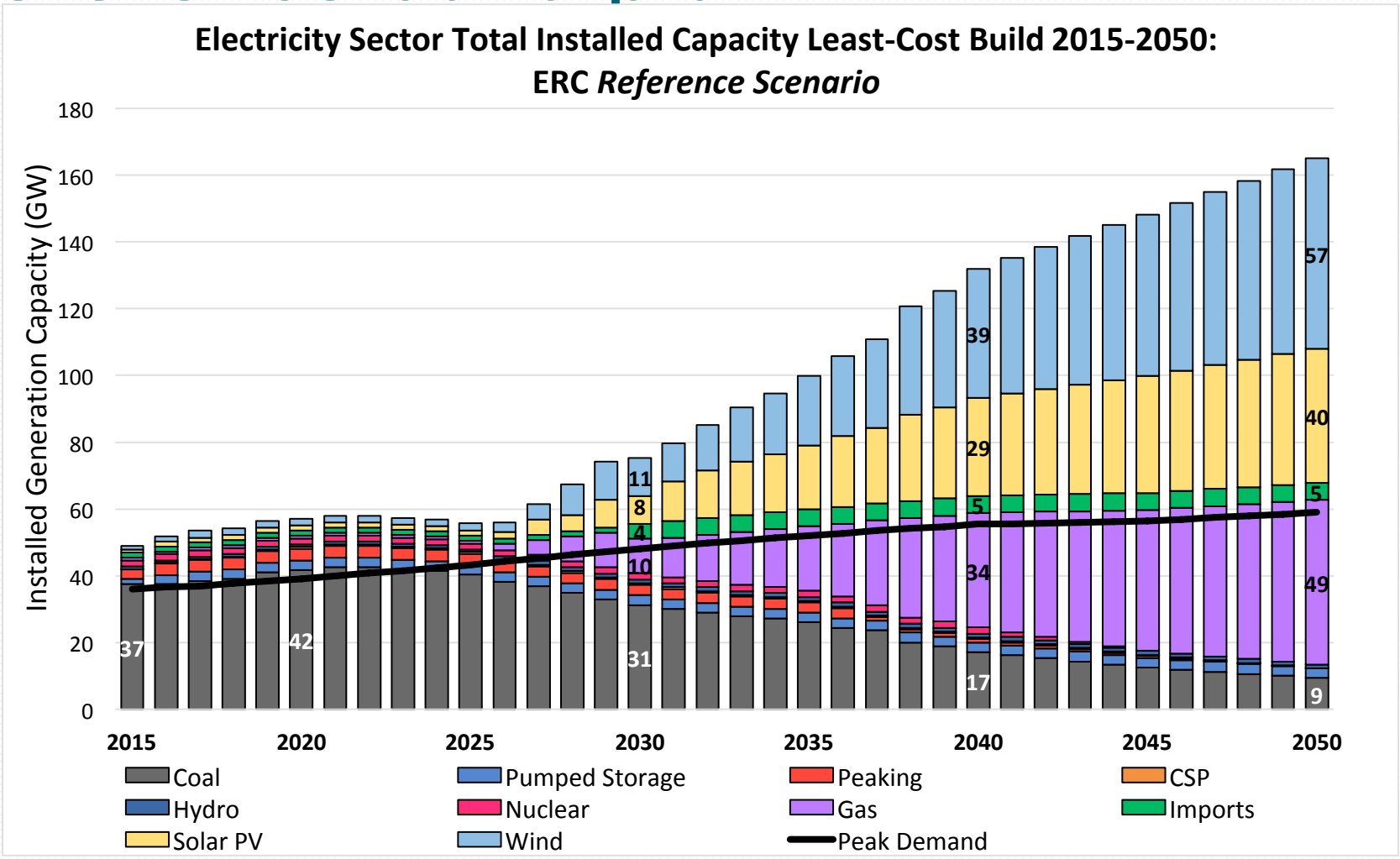
- 3,2% average annual growth 2015 to 2050, high growth in industrial sectors
- Includes EV uptake; no batteries
- Committed build: M&K, REIPPP up to round 3.5 (no later rounds committed)
- Higher demand forecast than EIUG
- The retirement dates of existing plants are aligned to those from IRP 2016 using a 50-year life of plant for Eskom coal plants
- except Arnot and Hendrina which we have not allowed the model to use – cold storage from start 2018 (as per NERSA disallowing in RfD)
- Medupi and Kusile are modelled to come online incrementally according to the October 2017 Eskom Medium Term System Adequacy Outlook)

Further assumptions

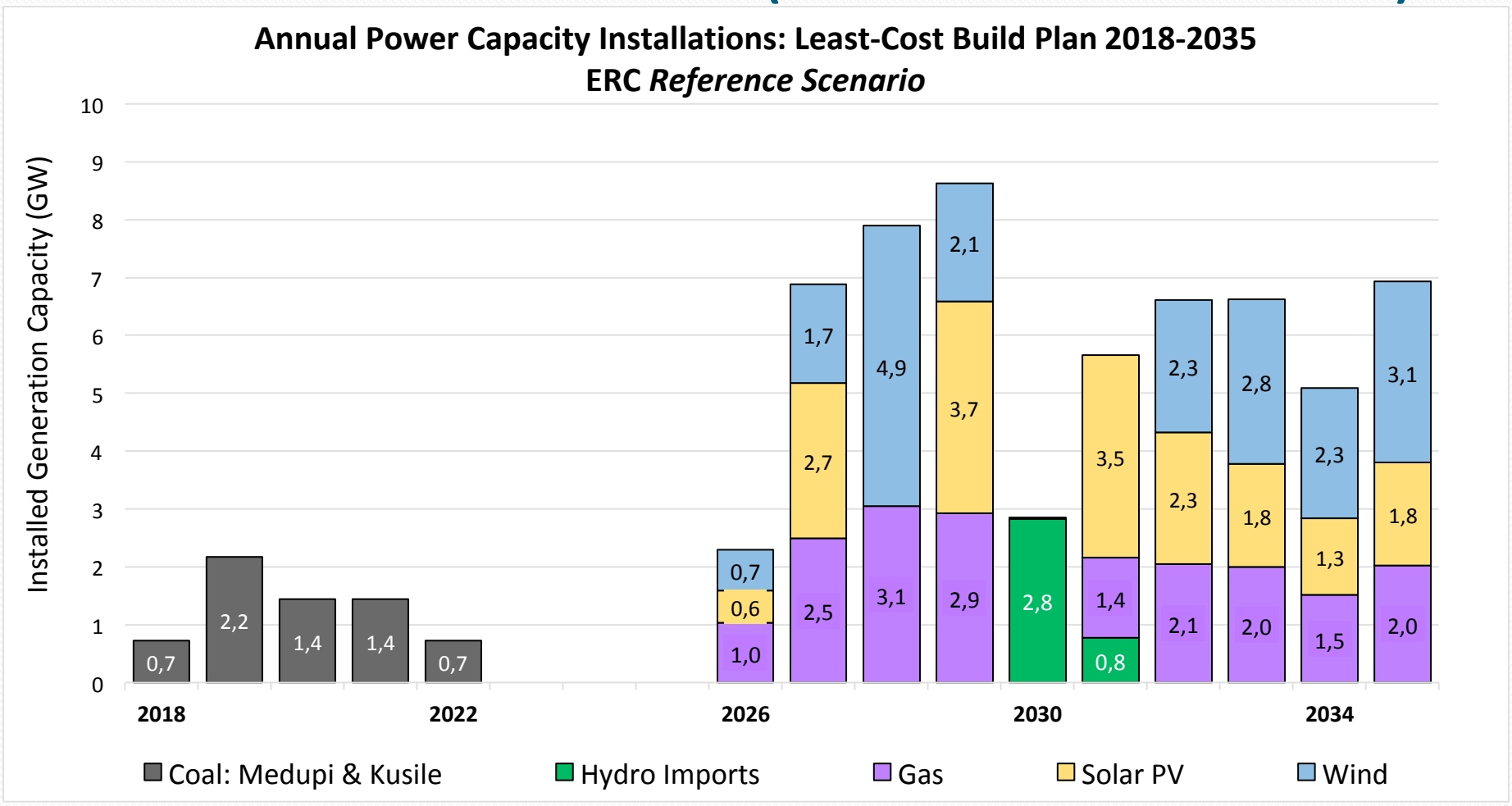
	Thabametsi	Khanyisa
Plant Capacity (sentout)	539.7 MW	306 MW
Efficiency (net)	36.25%	35.5%
PPA Tariff (2016 Rands)	1.03 R/kWh	1.04 R/kWh
GHG Emissions Intensity (CO_2 & N_2O)	1.23 tons CO_2 eq/MWh	
Final Commissioning Date	2022	
Project and PPA Lifetime	30 years	

- GHG emissions intensity:
  - Thabametsi GHG impact assessment (CO_2 & N_2O)
- Costs of IPPs: based on CSIR analysis
  - PPA = Qualification price (+) Shallow grid connection cost
  - PPA = Evaluation price (–) Carbon Tax (120R/t)

Reference build plan



Reference Build Plan (Annual Additions)



Excluded years past 2035 as it throws the scale off and 2045 and 2050 are grouped milestones, not annual… (the data is there though)

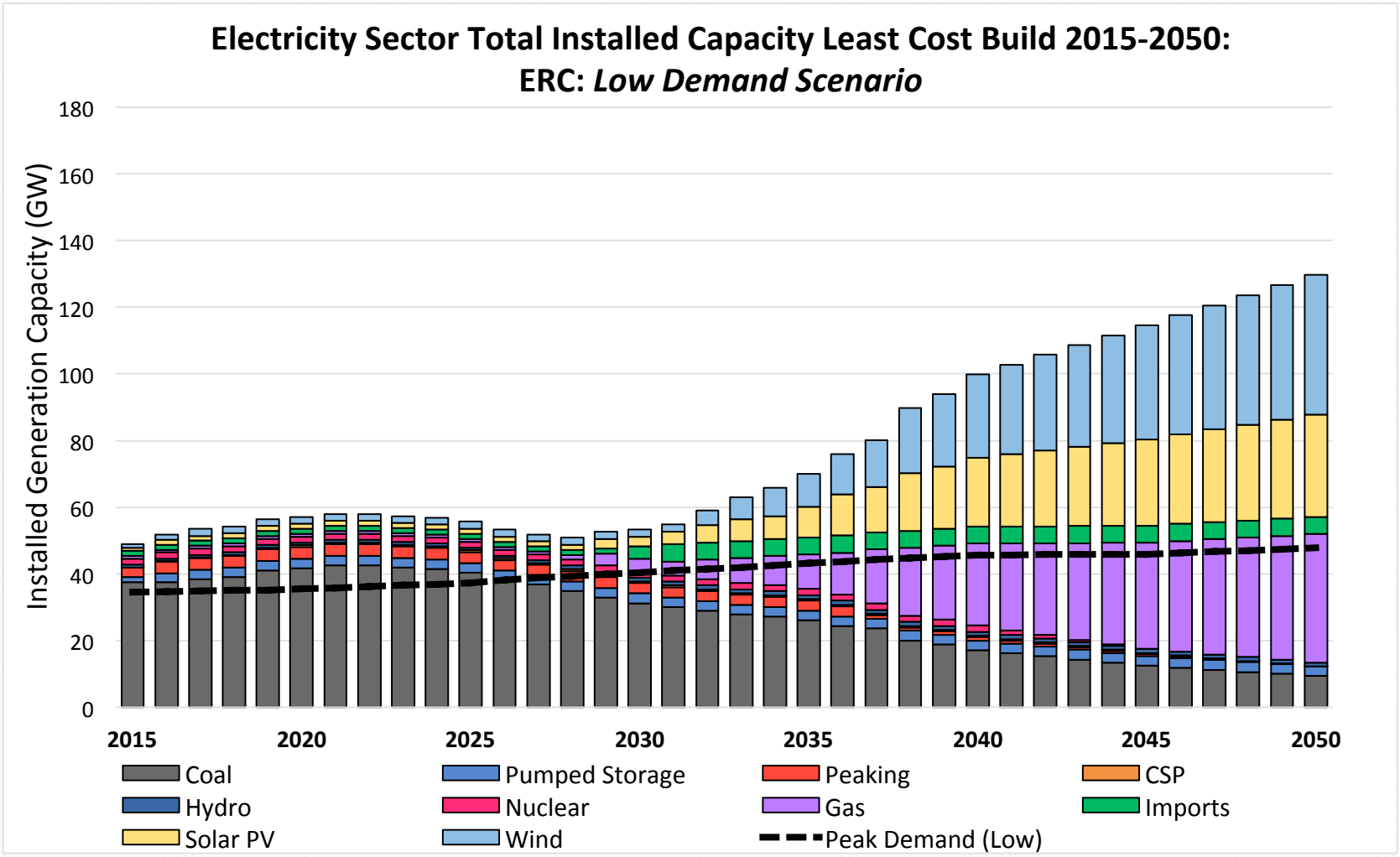
Results: reference case

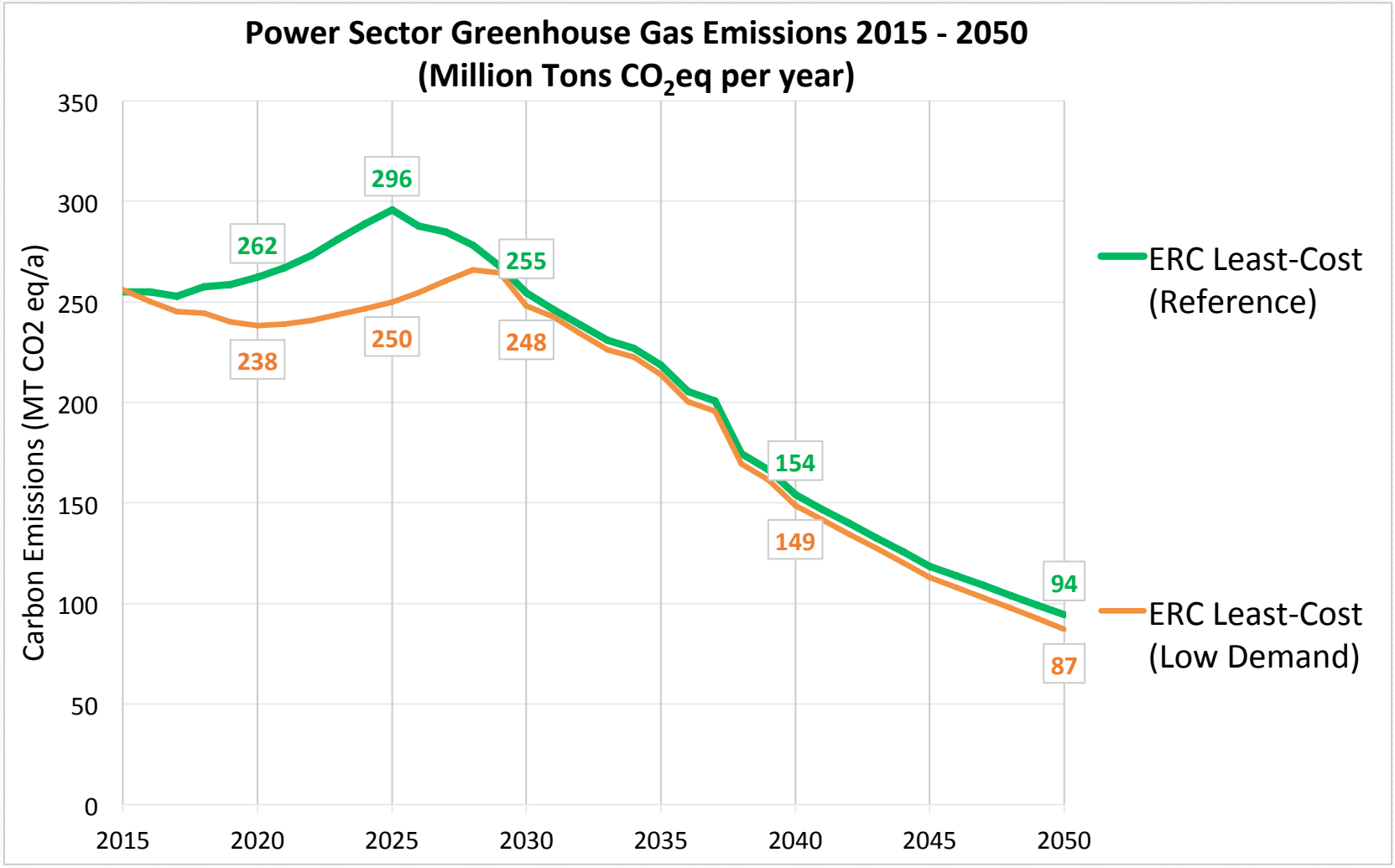
- High penetration of RE plus gas backup
- No new capacity required until 2026 due to previously low demand and M&K coming online
- Emissions are within the Paris Agreement by 2030, and NCCRWP by 2050
- Driven primarily by decarbonisation of the electricity sector (least cost mitigation option)

Sensitivity analysis: demand

- Lower GDP growth (2,4% to 2050)
- Flat demand to 2020
- Still optimistic given that we are at 1.1% GDP rate
- Everything else is equal to reference scenario
- No new capacity needed until 2028

Low demand build plan



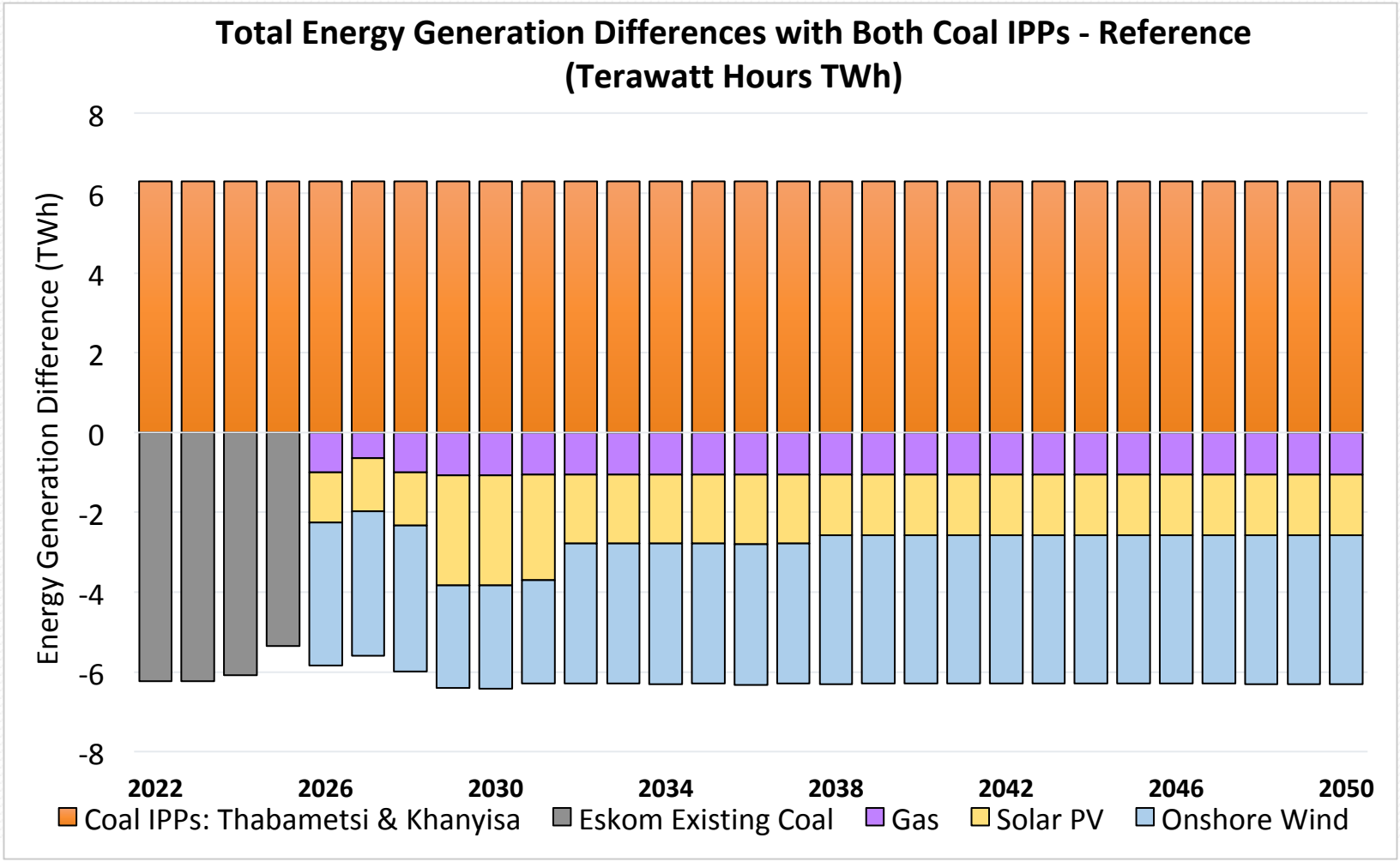

Power Sector Greenhouse Gas Emissions 2015 - 2050
(Million Tons CO_2eq per year)
Carbon Emissions (MT CO2 eq/a)
350
300
250
200
150
100
50
0
2015
2020
2025
2030
2035
2040
2045
2050
296
262
255
238
250
248
154
149
94
87
ERC Least-Cost (Reference)
ERC Least-Cost (Low Demand)

Part 2: committing the IPPs

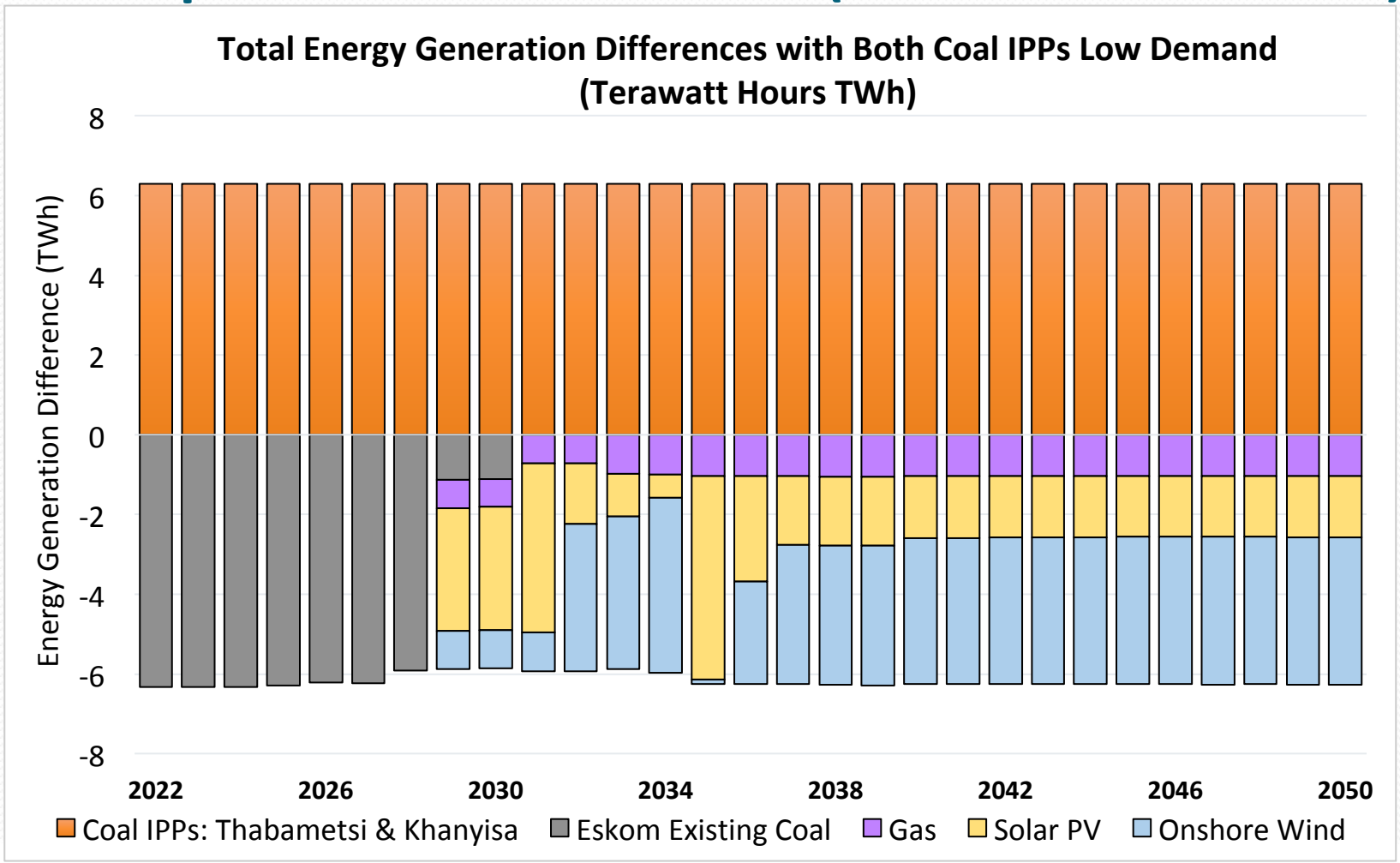
“Coal plus” : committing the coal IPPs

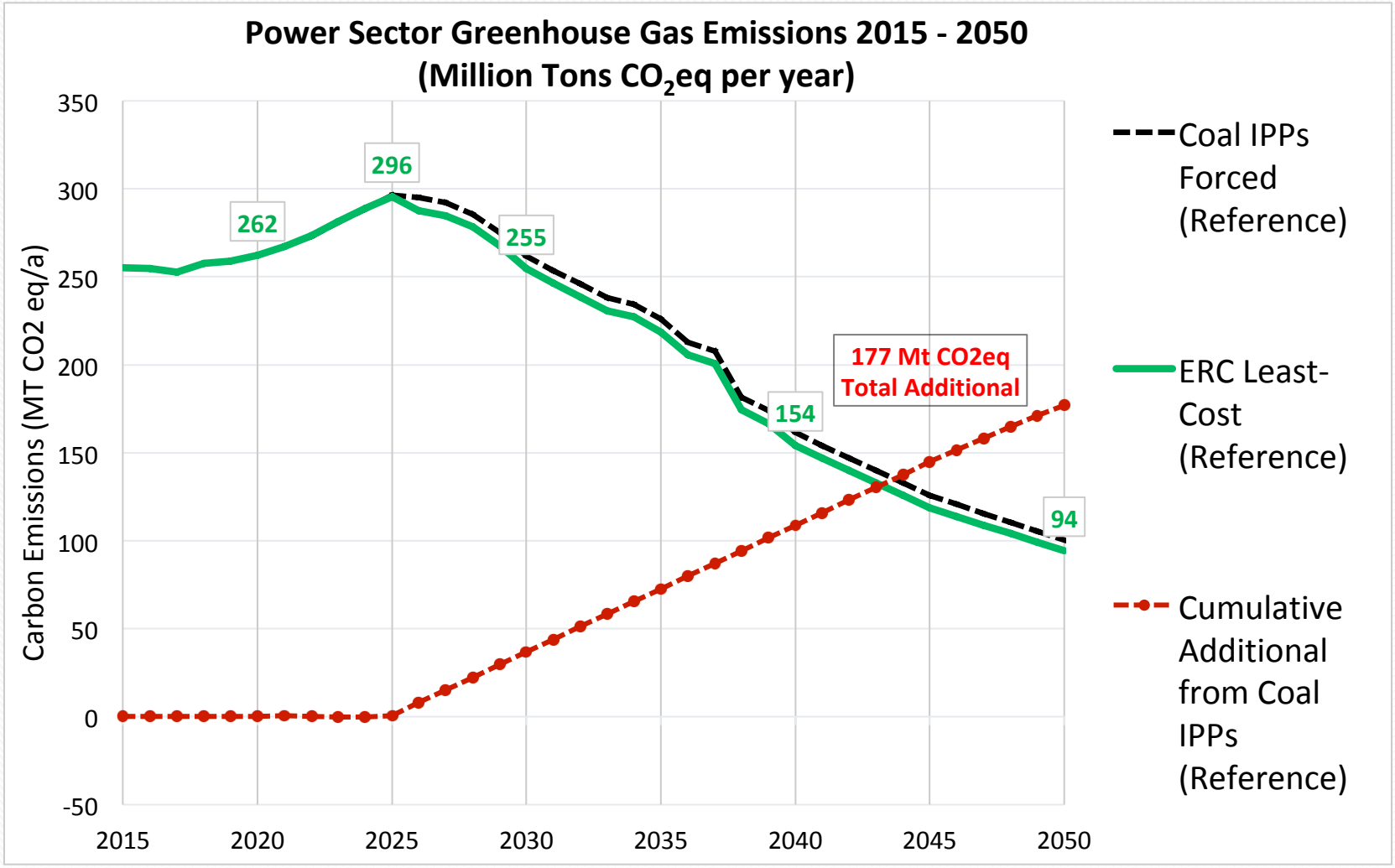
- *The optimised least-cost build plan includes no new coal-fired power plants in the investment horizon to 2050.*
- *testing the system implications of the coal IPPs requires the plant to be “forced-in”, after which the deviation from the reference case can be quantified and analysed*

Build plan difference (Reference)



Build plan difference (Low Demand)

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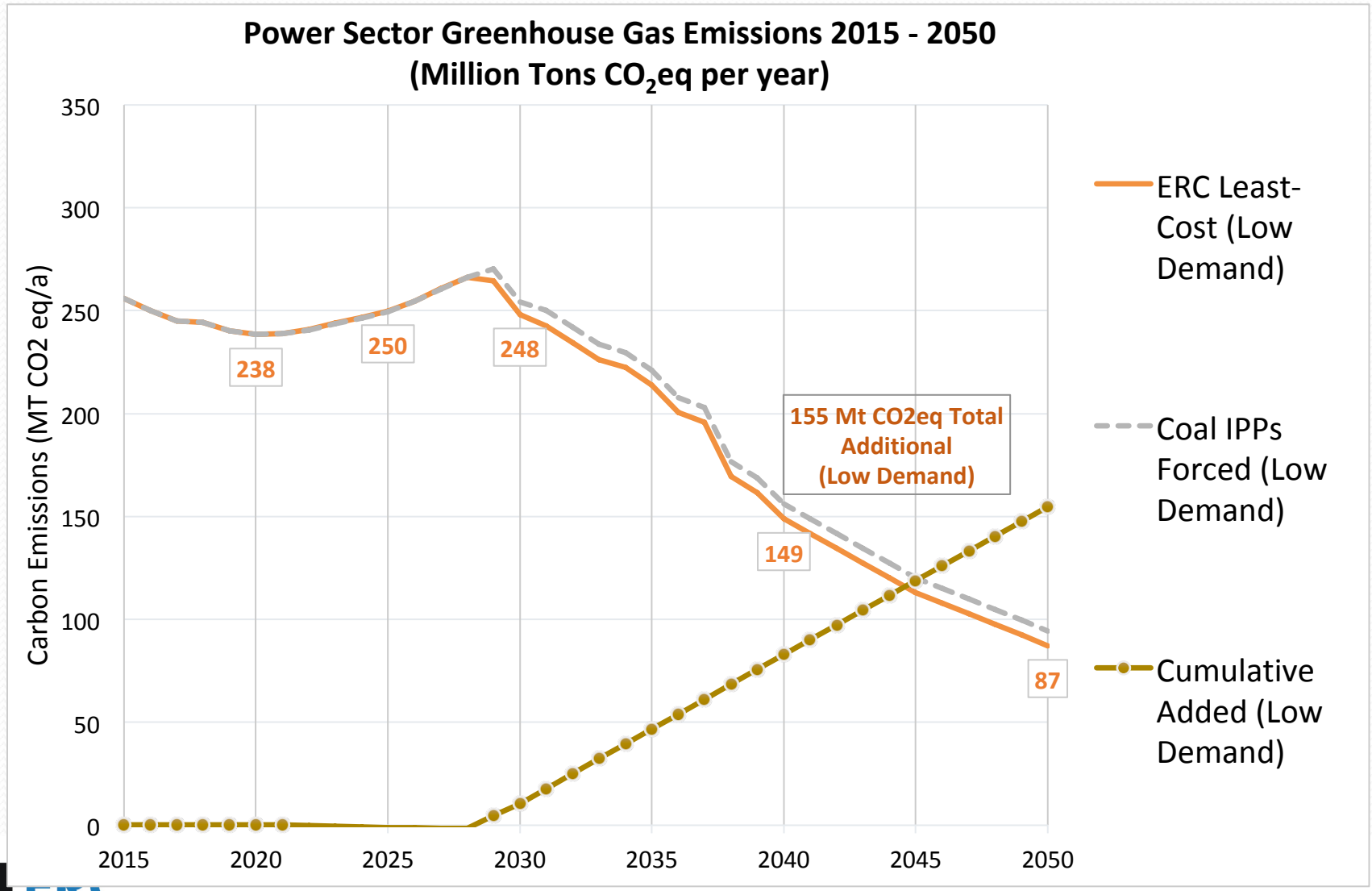
177 Mt CO2eq
Total Additional
Coal IPPs Forced (Reference)
ERC Least-Cost (Reference)
Cumulative Additional from Coal IPPs (Reference)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238
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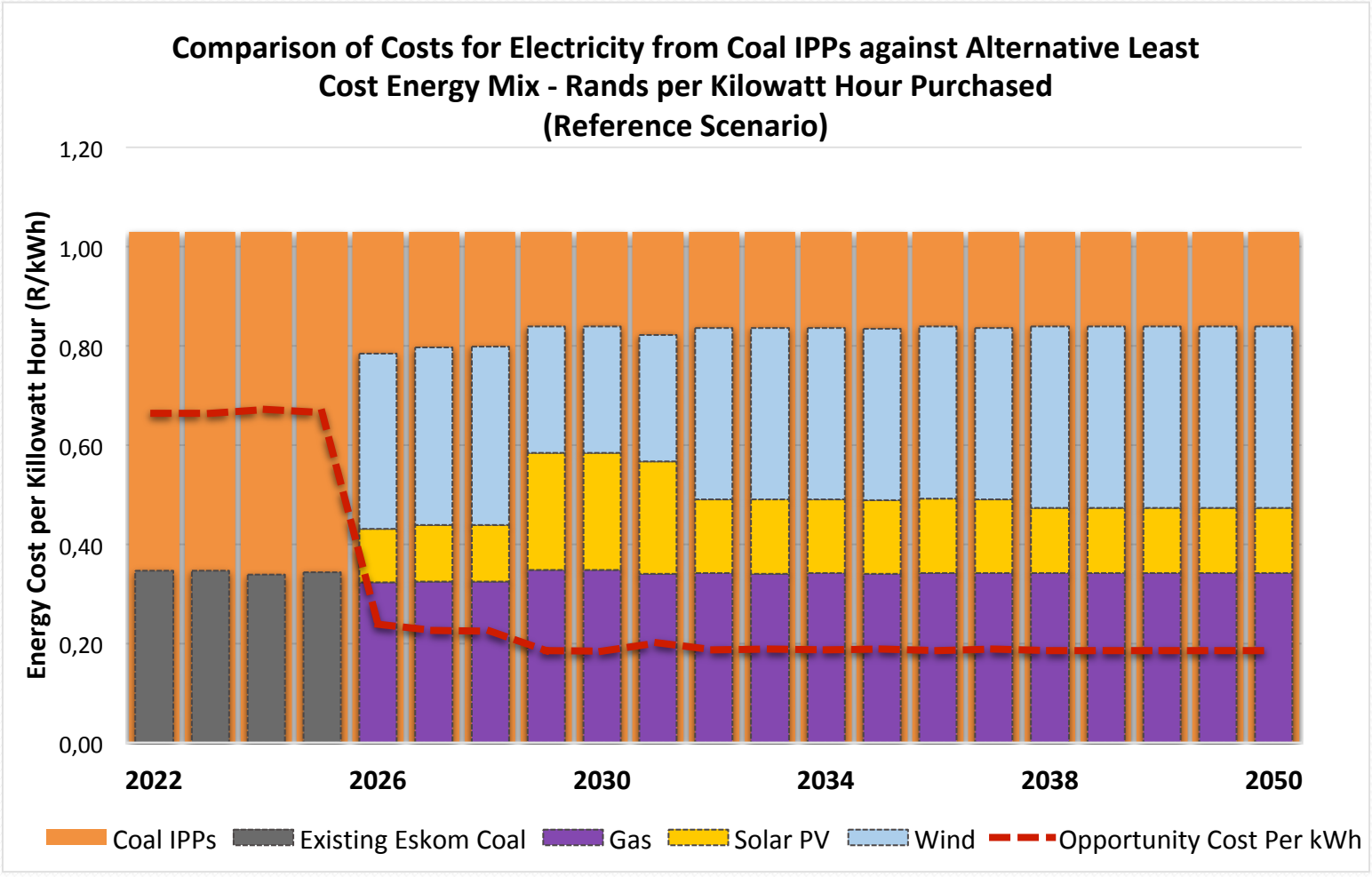
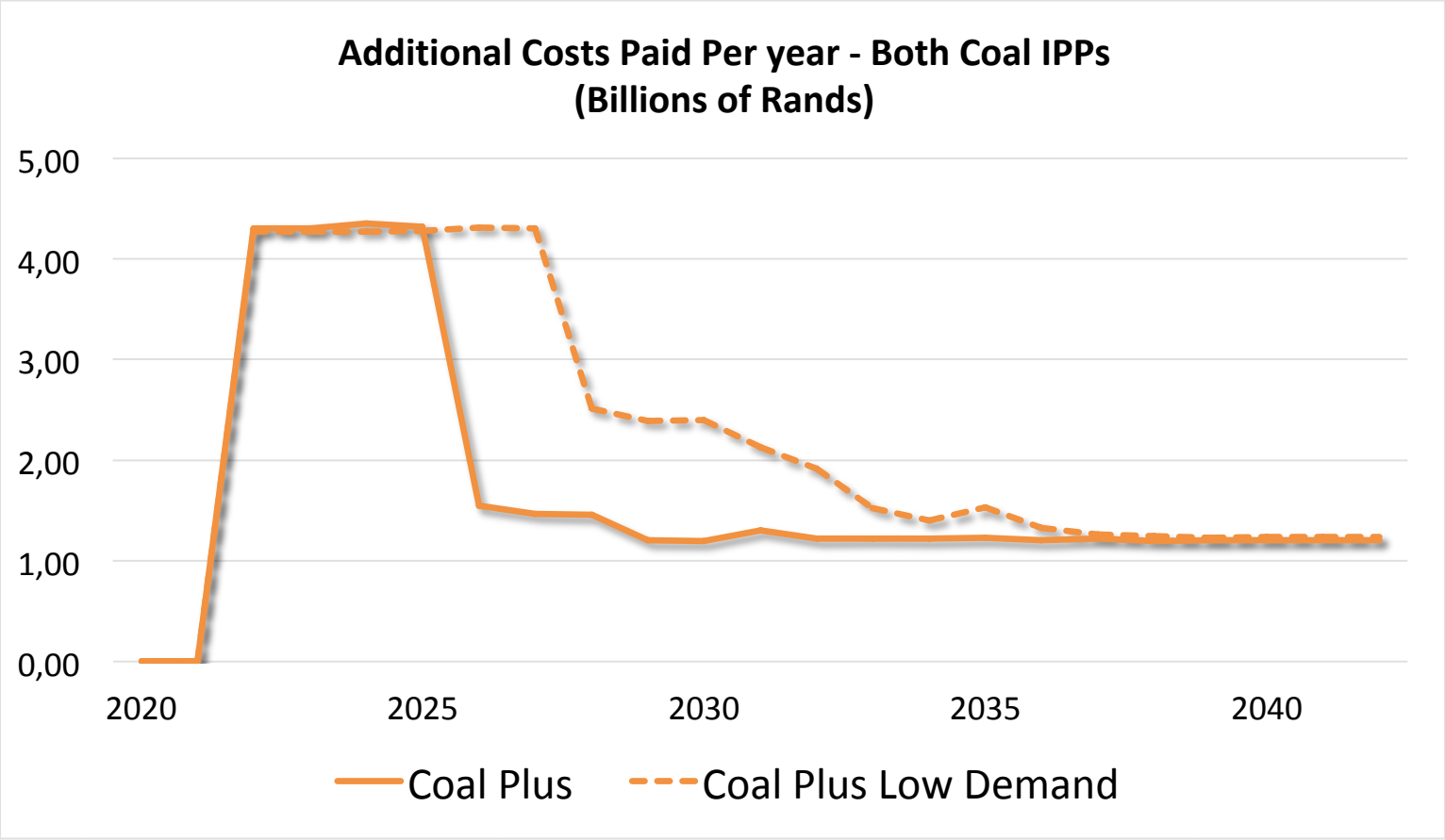
248
149
87
155 Mt CO2eq Total Additional (Low Demand)
ERC Least-Cost (Low Demand)
Coal IPPs Forced (Low Demand)
Cumulative Added (Low Demand)

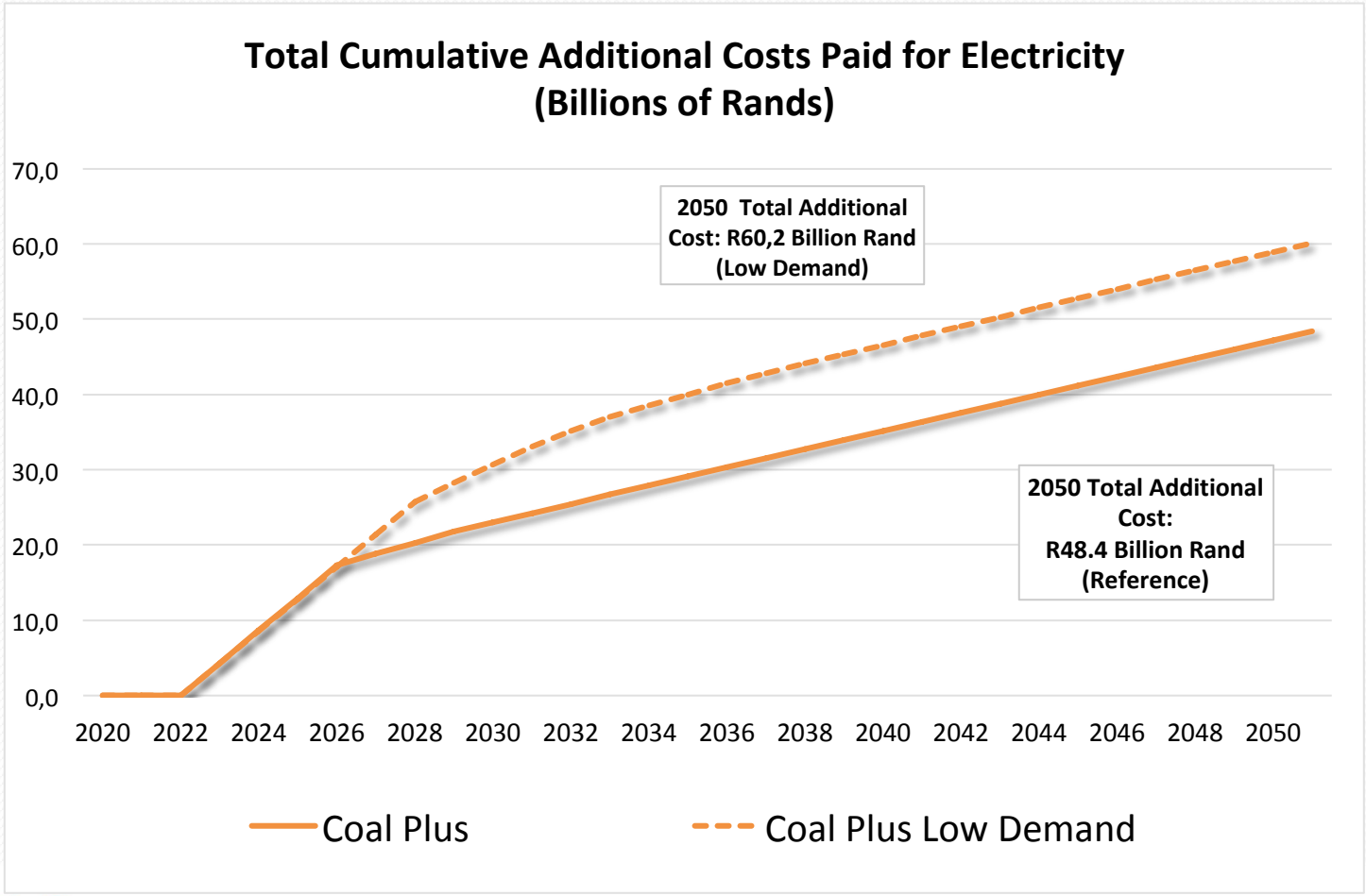
Additional annual costs



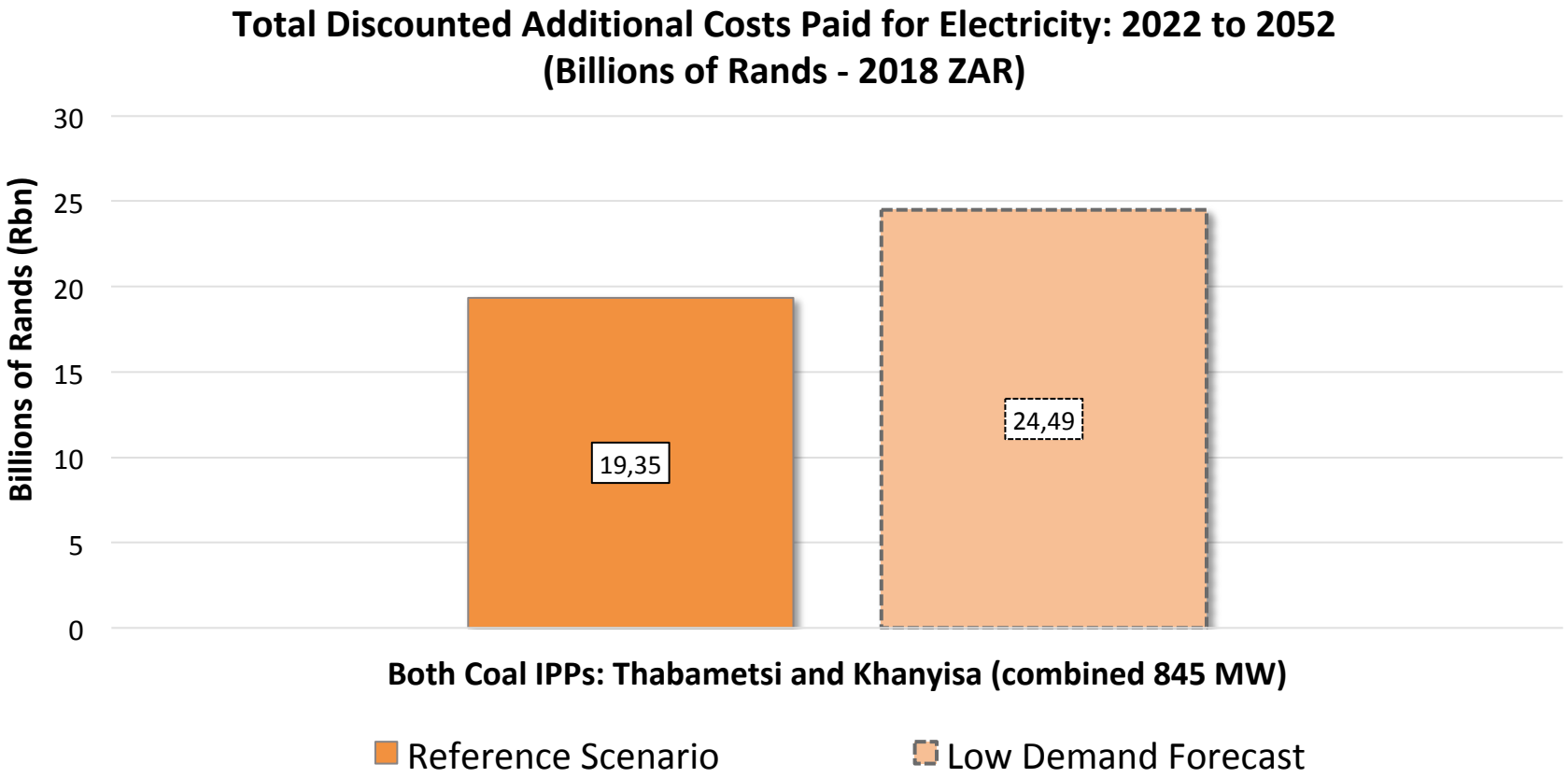
Additional annual costs



Cumulative additional costs



Total Discounted Additional Costs



*Using discount rate of 8.0%

Summary

- Compared to a least cost electricity build plan, the coal IPPs:
- Increase overall emissions by approx 155-177 Mt CO2eq to 2050
- Result in additional costs in the electricity sector every year of up to R4bn to 2025-2027 to be borne by consumers
- Increase the overall system costs by **R19.3 - R24.5 billion** in present value terms
- Makes planned mitigation measures redundant: eg the National Energy Efficiency Strategy saves 214Mt CO2-eq to 2050

ERA and EPP – NERSA's role

- Objective of the ERA is to
- "ensure that the interests and needs of present and future electricity customers and end users are safeguarded and met, having regard to the governance, efficiency, effectiveness and long-term sustainability of the electricity supply industry within the broader context of economic energy regulation in the Republic"
- EPP: to balance affordability and environmental sustainability
- it would be remiss of NERSA to license plants that are both polluting and raise the costs of the electricity sector

Conclusions

- South Africa has a surplus of baseload generation and further new capacity coming online
- Electricity costs have risen and are putting the economy and citizens under increasing pressure
- The IPPs exacerbate the situation of oversupply in the short- and medium term,
- And crowd out cheaper investments later
- The stations lower the load factors at Eskom plants and puts those plants and jobs at risk
- Severe consequences for Eskom: exacerbates the utility death spiral
- This is not in the public interest nor does it meet the objectives of the ERA and EPP
- Demand uncertainty can be ameliorated by flexible options: cheaper and shorter lead times
- If it were Eskom, these stations would be considered imprudent investments

Thank you!

Questions?

Issues arising and further research

- Phase one of our study is this analysis
- Phase 2 will extend the analysis and combine several sensitivities (demand, costs, GHG intensity of the plants); assess costs of meeting our climate change policy with the stations included