Department of Mineral Resources and Energy

DRAFT INTEGRATED RESOURCE PLAN

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Mineral Resources and Energy
REPUBLIC OF SOUTH AFRICA

November 2024

2030 NDP

IRP OBJECTIVES AND METHODOLOGY

IRP OBJECTIVEs

1

Ensuring **security of electricity supply** in South Africa – planning for adequate capacity to satisfy demand and a system which can endure contingencies or disruptions without interrupting supply

2

Minimise the **cost of electricity to the economy** – least cost system planning subject to certain constraints (environmental, lead times etc.)

3

Minimise the **environmental impact of electricity supply** – planning for reduction in global and local emissions while achieving objective 1 and 2

In addition, the IRP also aims to diversify energy resources, improve access, promote localization and regional development, technology transfer and job creation, promote energy efficiency and reduce consumption of scarce resources such as water

IRP PLANNING METHODOLOGY

Projected electricity demand
Informed by economic growth, sectoral trends, electrification and energy efficiency, etc

Expected generating capacity
Existing and committed electricity generating capacity, including availability assumptions

New generating capacity options
Including expected costs and performance characteristics, construction lead times, emission rates etc.

Primary assumptions

Scenarios
Testing variations of assumptions to determine impact on objectives on reference case

Mathematical optimisation model
Simulation of electricity system, to determine optimal utilisation of existing generation resources and construction of new capacity to meet determined objectives at the lowest possible cost

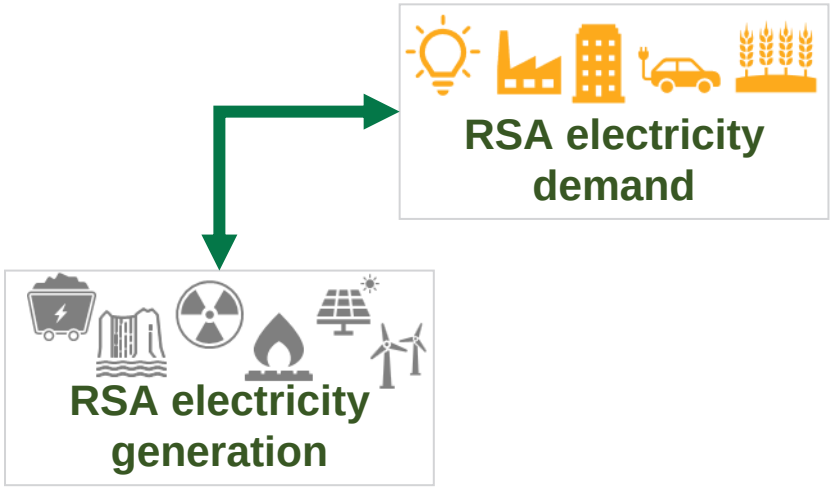
Stakeholder engagements
Private and public sector participation to improve robustness and buy-in of proposed outcomes

IRP report
South Africa's medium- and long-term electricity plan used for section 34 determinations

IRP CO-OPTIMISATION MODEL

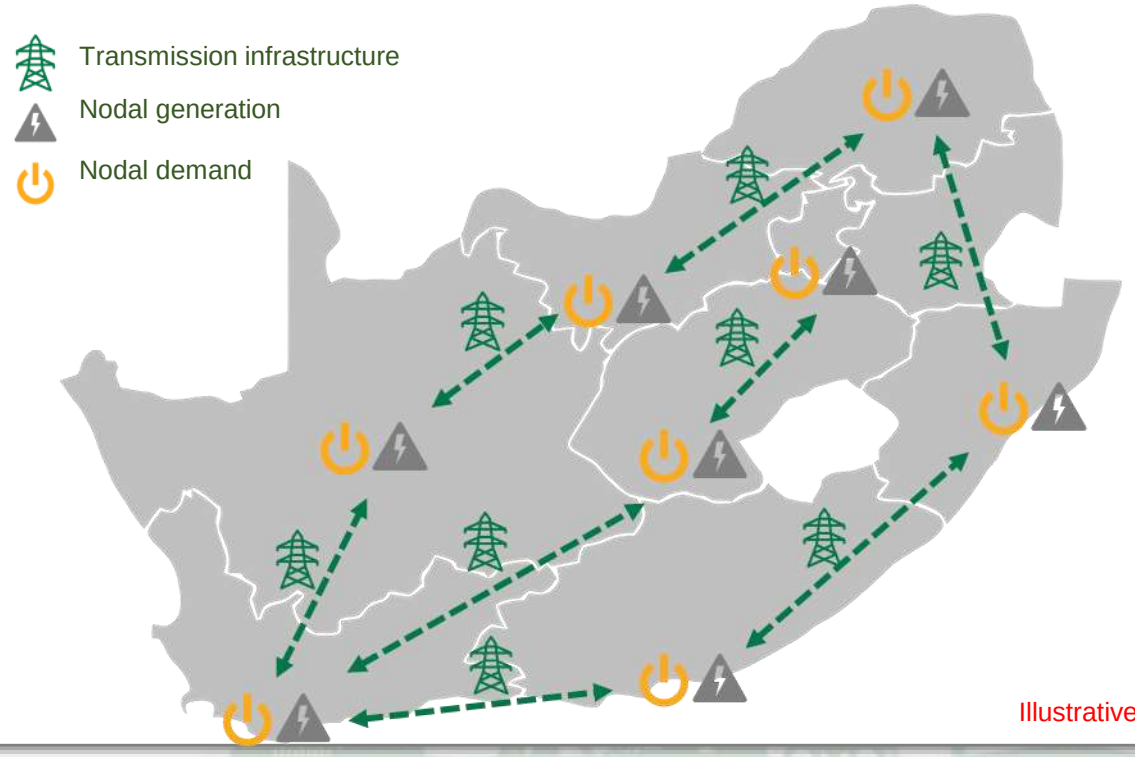
IRP 2010, IRP 2019 & Draft IRP 2023

Previous IRPs were based on a single node model without explicit inclusion of transmission grid constraints and optimisation



IRP 2024

The current IRP simulation is based on a multi-nodal model which seeks to co-optimise generation and transmission infrastructure



Illustrative

SETTING UP Gx and Tx DETAIL IN PLEXOS

Draft IRP 2023

- Emerging Plan 2024-2030
- Generation Pathways 2031-2050

TDP 2024

- Transmission plans 2025-2034

IRP 2024

- **Demand detail** disaggregated to substations
- **Transmission detail**: All Tx voltage level
- **Generation detail** at applicable locations for all technologies (Wind, Solar and BESS; Gas; Pumped storage; Nuclear, Coal)

TECHNICAL TEAM COMPOSITION

Representatives from the following areas:

Energy Planning (Plexos)

- Generation and Transmission Co-optimization
- Electricity supply and demand balance
- Optimisation

Energy Policy Formulation

- Technical and policy research

Transmission Grid Planning (PSSE/DigSilent)

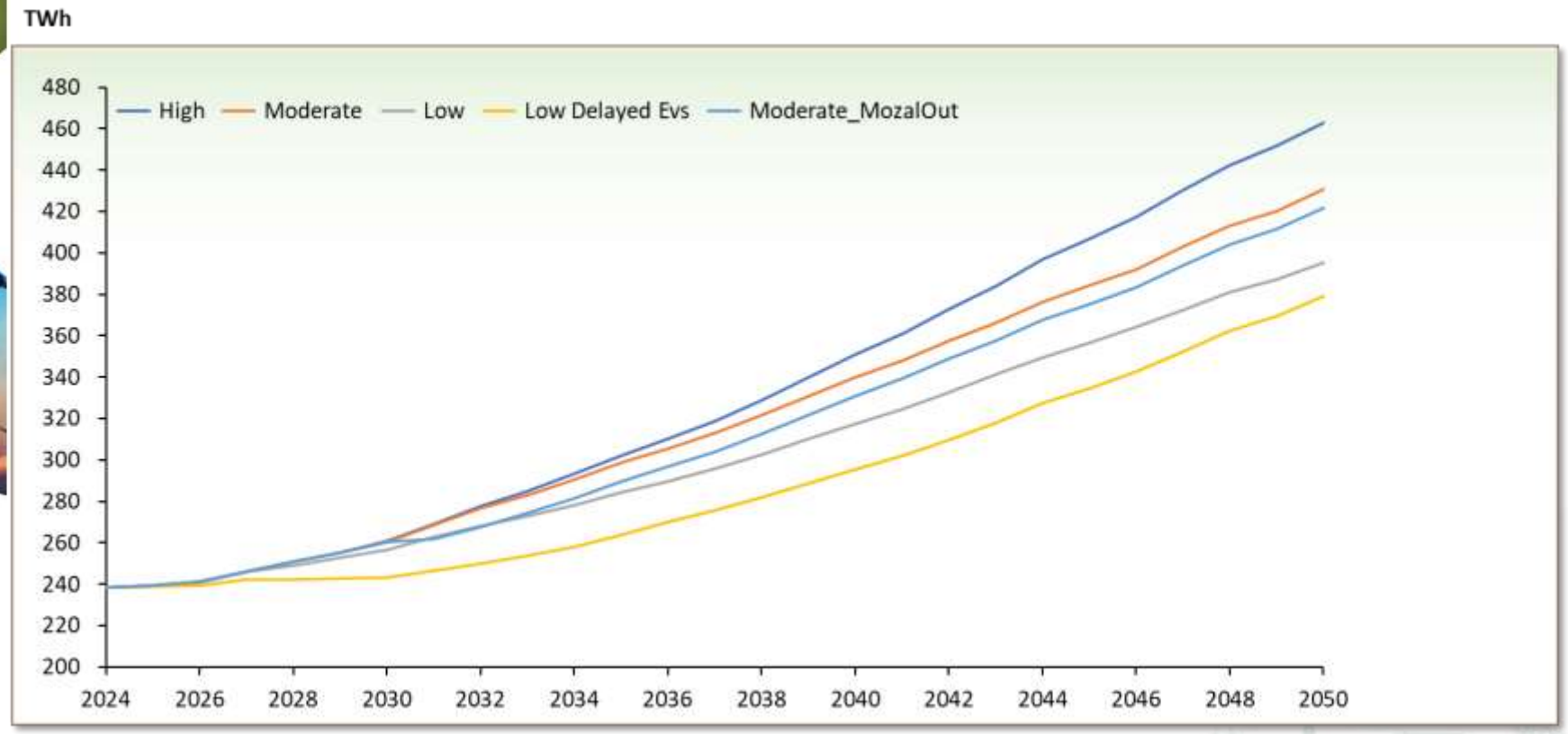
- Transient stability studies/load flow studies
- Transmission expansion and strengthening

System Operations (PSSE/DigSilent)

- Power system operation
- Ancillary services requirements

ASSUMPTIONS

DEMAND FORECAST

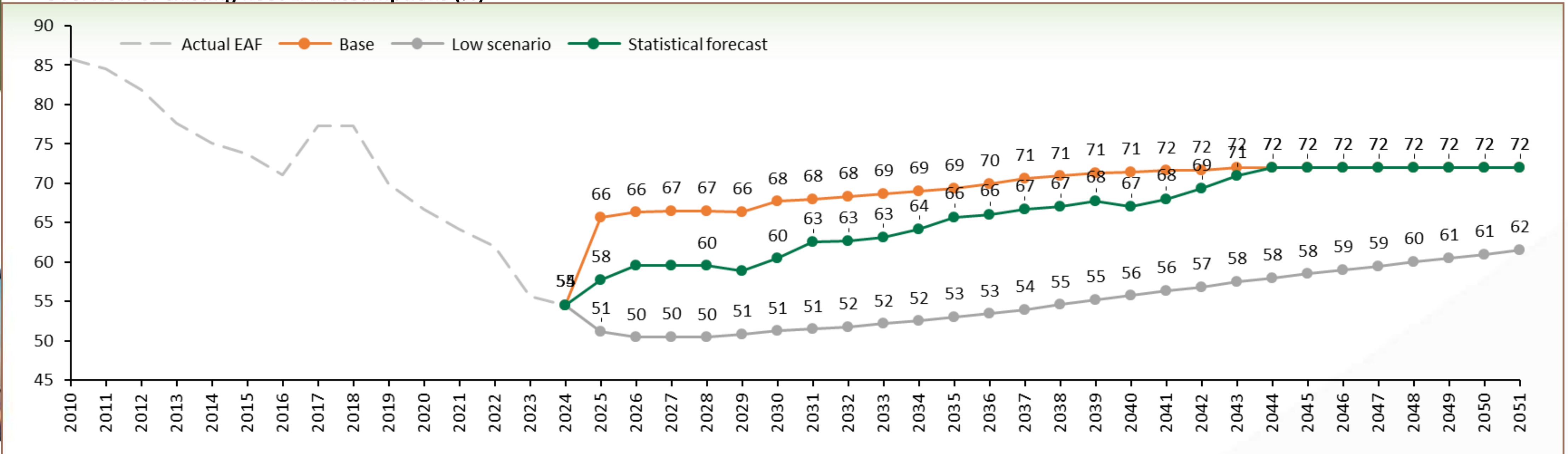


- The High and Moderate demand forecast are identical up to 2032
- Moderate forecast includes the impact of Mozal smelter
- Reference Case is based on the Moderate forecast reflecting a steady growth of 1.5% to 2% in the long term
- Demand forecast has been disaggregated to a spatial level
    - Majority of the demand is concentrated in the northern part of SA

Source: UCT ESRG

ESKOM PLANT PERFOMANCE (EAF)

Overview of existing fleet EAF assumptions (%)



- Peaking EAF reducing from 79% to 72%, Nuclear EAF increasing, Coal EAF increasing from 54% to 63%, PCLF still within 10% on the base, declining UCLF is assumed
- Statistical forecast (developed by the IRP technical team) assumes improvement on certain stations in line with production plan from 2025
  - Kusile improves from 38.2 to 55%
  - Koeberg from 50.4 to 68%
  - Kriel 36 to 42%
- EAF shows a steep improvement from FY25 compared to history. Targeted initiatives will be required to achieve the rate of improvement assumed
- Improvements from 2030 due to stations shutting down from that year
- YTD EAF as of August 2024 is 63.6%

Source: Eskom Generation, Team analysis

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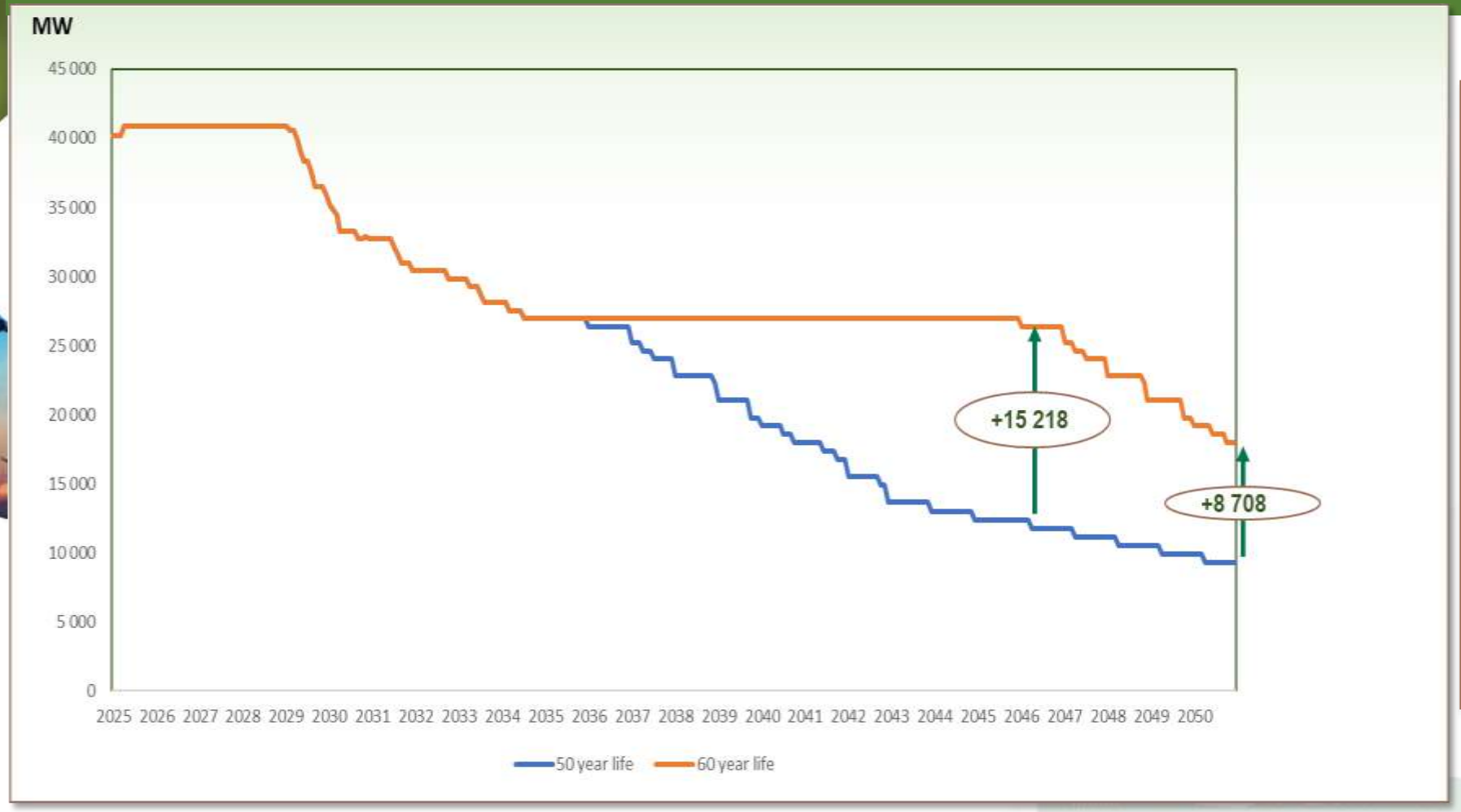
ESKOM COAL FIRED STATION SHUTDOWN PLAN-CAPACITY

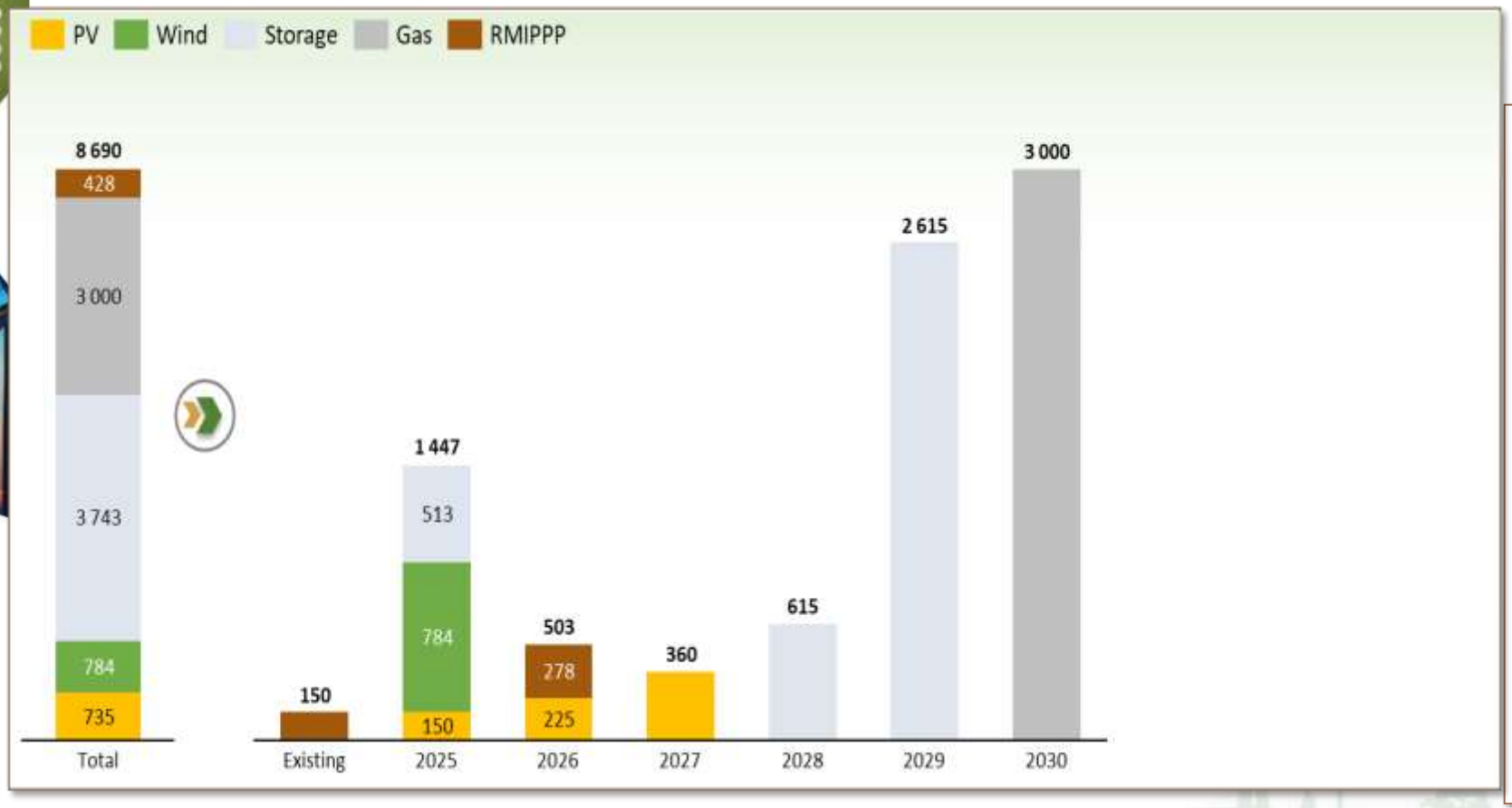


- The 50 year life is based on latest shutdown plan
- Continued operation for Camden, Kriel, Hendrina, Grootvlei and Arnot
- First cliff on the 50 year life from 2030 to 2031 is ~5 GW
- Second cliff on the 50 year life from 2032 to 2042 is ~15 GW
- The 60 year life continues the operation of these stations: Kendal, Majuba, Lethabo, Matimba and Tutuka

Source: Eskom Generation

PUBLIC PROCUREMENT PROJECTS (BEYOND BW1-BW4+)

MW



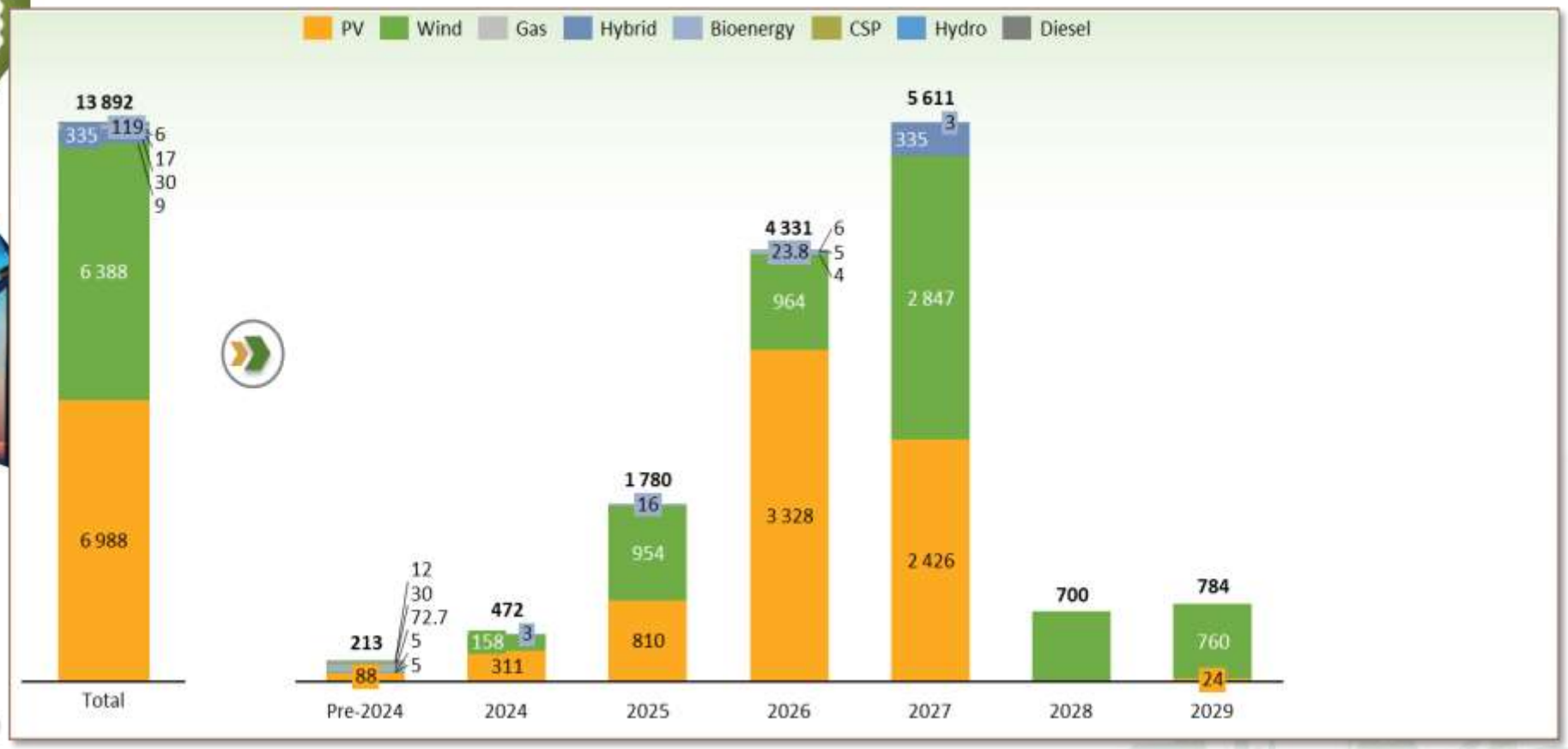
Comments/Insights

- Includes the following Power Producer Procurement Programmes under construction or offered to the market:
  - BW 5 - 1 159 MW
  - BW 6 - 360 MW
  - RMIPPPP - 428 MW
  - GASIPPPP – 3 000 MW
  - ESIPPPP BW 1 to 3 – 1 743 MW
- In addition to ESIPPPP BW 1-3, an additional 2000MW from the Draft IRP 2023 has been provisioned for grid support.
- BW 7 projects have not been included as part of the committed capacity

Source: DMRE

PRIVATE PROJECTS PIPELINE (SCHEDULE 2)

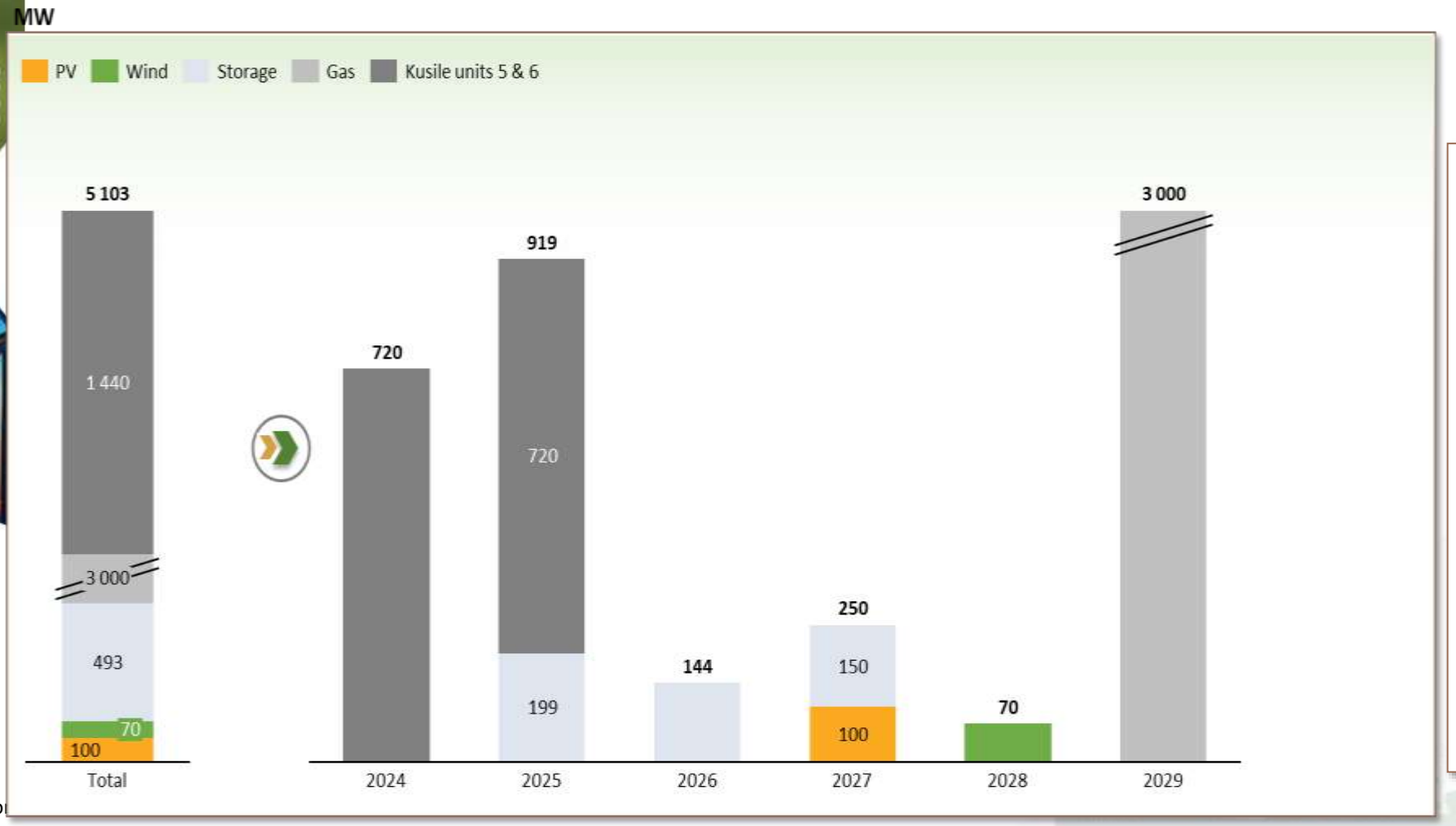
MW



- ~55% worth of projects are either operational, in execution or have budget quotes issued
- The remaining 45% are at Interim Grid Capacity Allocation Rules (IGCAR) stage
- A variation of commited private projects ~7 GW has been studied

Source: Presidency, Eskom Grid Access Unit

ESKOM NEW CAPACITY PROJECTS



- Includes only fully funded projects
- Komati Wind, PV and BESS
- Phase 1 & 2 storage included with the updated dates
- Eskom's aspirations includes a total of ~22 GW from multiple technologies

Source: Eskom Generatio

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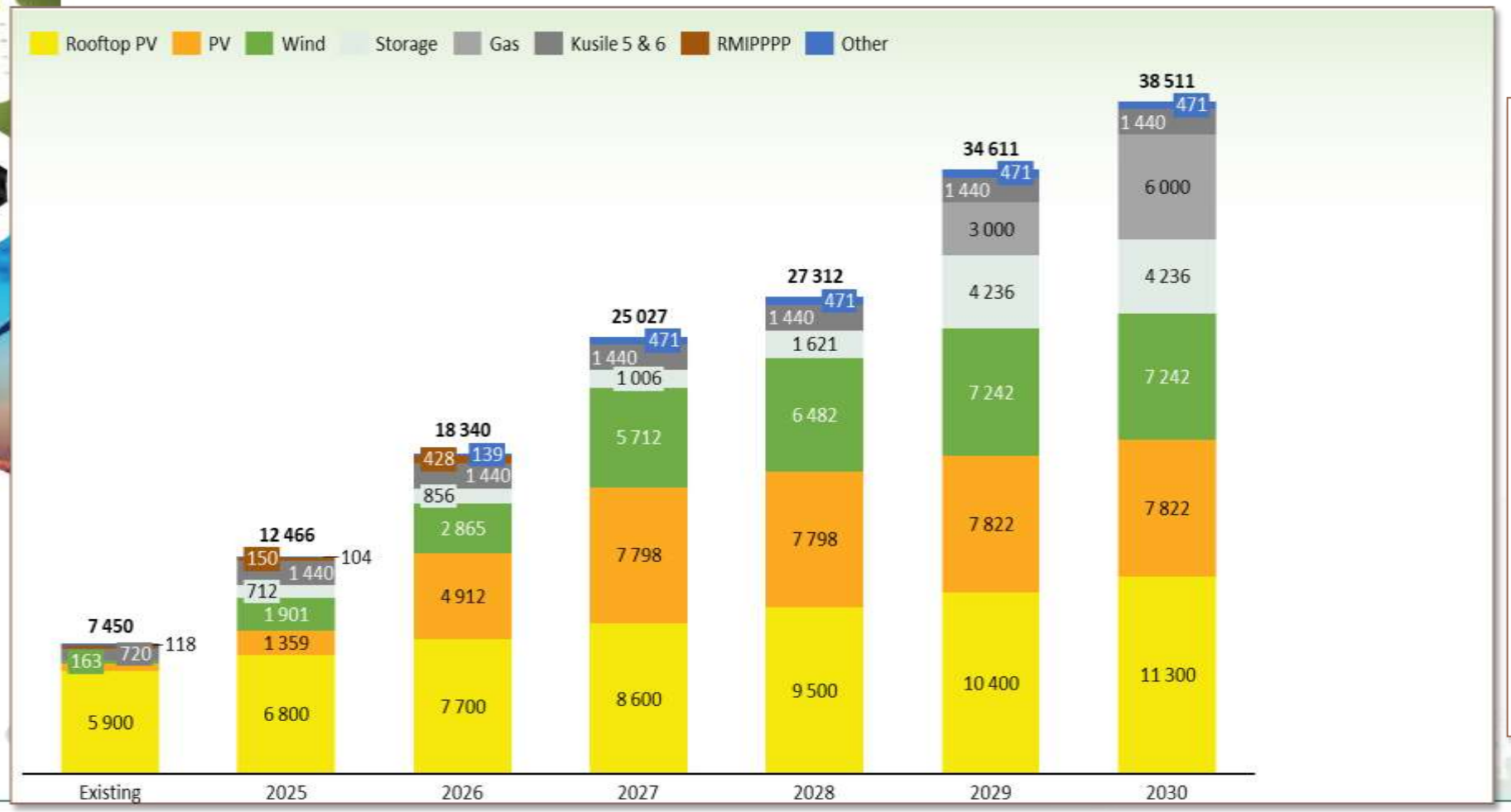
TOTAL COMMIITTED CAPACITY BY 2030



- In addition to public, private and Eskom projects, total committed capacity includes rooftop PV rollout. Actual installations of rooftop capacity is 5952 MW as at August 2024 [1].
- Growth assumes increases of 900 MW per year up to 2035.

Source: x

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Notes:
1 – System Operator publication
2 – as published on Eskom Weekly status

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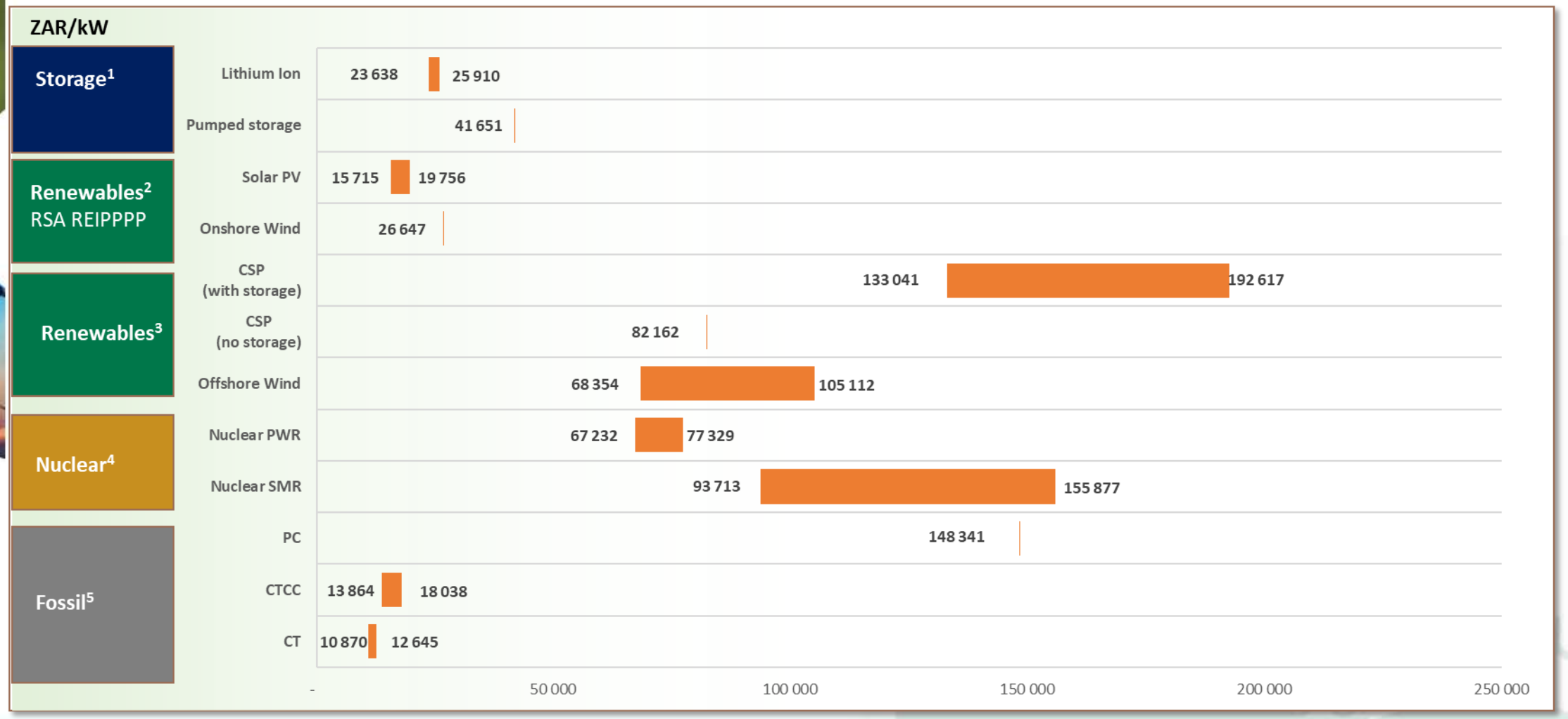
NEW TECHNOLOGY COSTS



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Sources:
1. Lithium ion – EPRI, Pumped storage – Eskom
2. IPPO
3. EPRI
4. DMRE
5. EPRI

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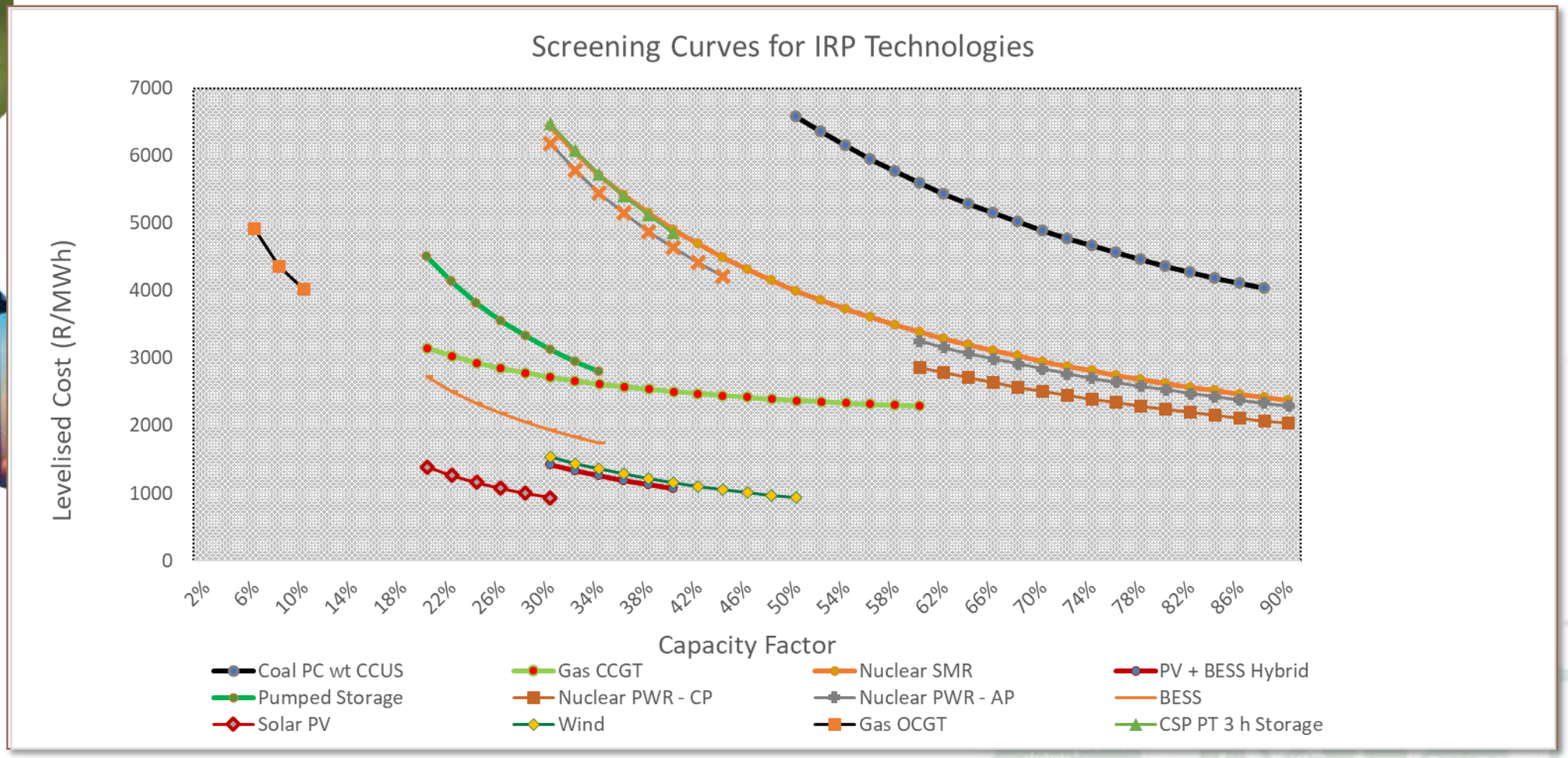
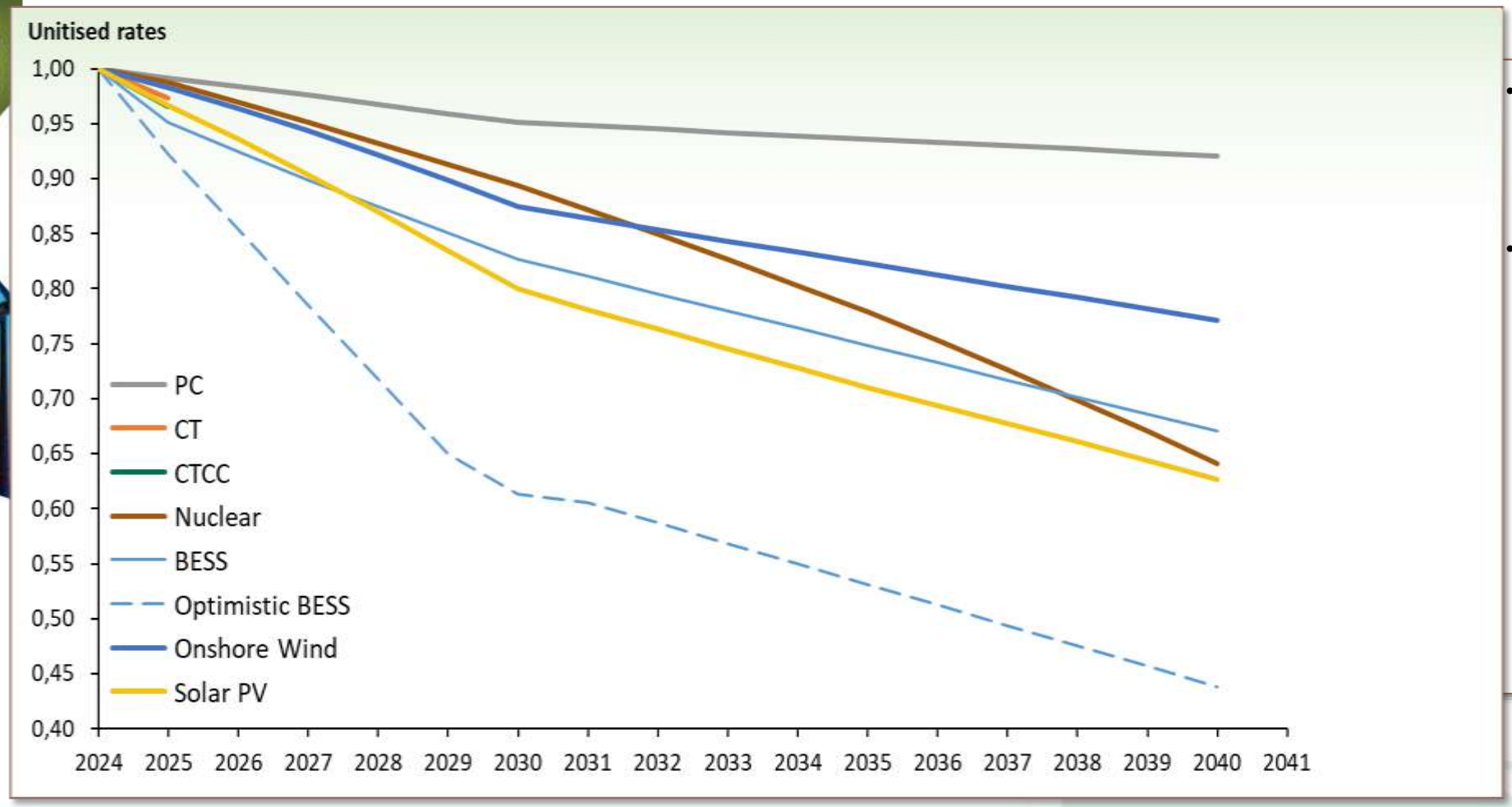
SCREENING CURVES OF NEW TECHNOLOGIES

ZAR/MWh



Source: IRP Technical Team

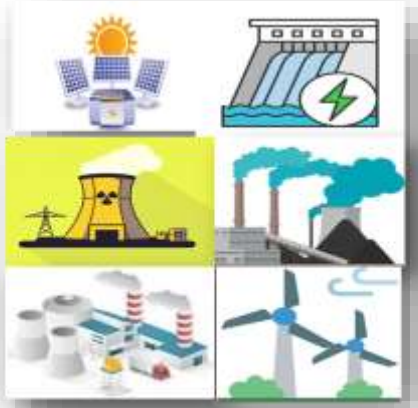
NEW TECHNOLOGY COST-LEARNING RATES



- Starting point for Solar PV and Wind are based on real South African costs, hence no range is considered
- The optimistic and conservative trajectories further include ±5% error bars to capture additional uncertainty at the ends of the projected cost range

Source: EPRI, DMRE

SCENARIOS STUDIED

Reference Case	Reference Case- No Gas Commitment	Nuclear	Aggressive Battery Learning	Delayed Shutdown
				
Model provided with an array of new technology options to choose from. 6 GW of gas CCGT committed in 2030	Similar to the Reference Case but no CCGT has been committed	Commits 2.5 GW nuclear from in 2035 & 2036 and does not allow new gas build from 2030 till 2050	Battery learning based on an - Lazard 2024 base (average of low and high end) cost with optimistic learning rates, which is 20% lower than the EPRI cost in 2024 increasing to 40% by 2040	Operation of coal fired stations by an additional 10 years to 60-year life

RESULTS

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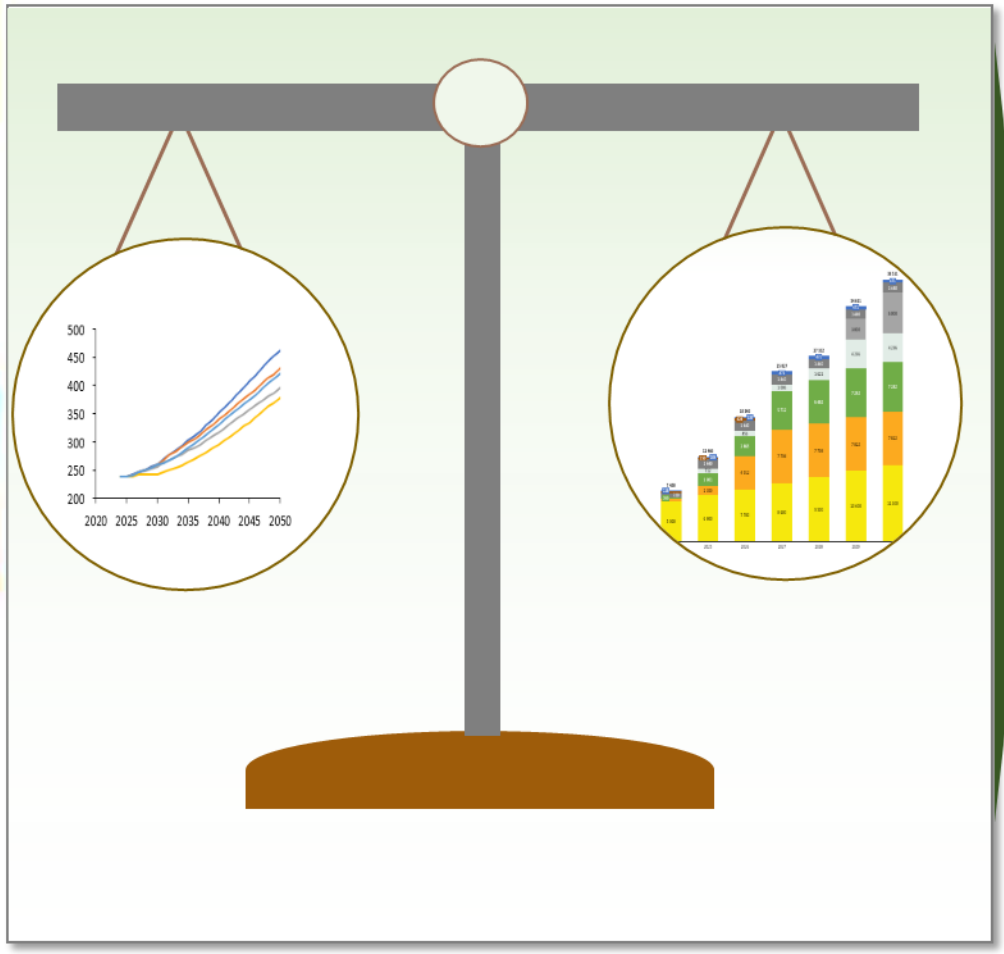
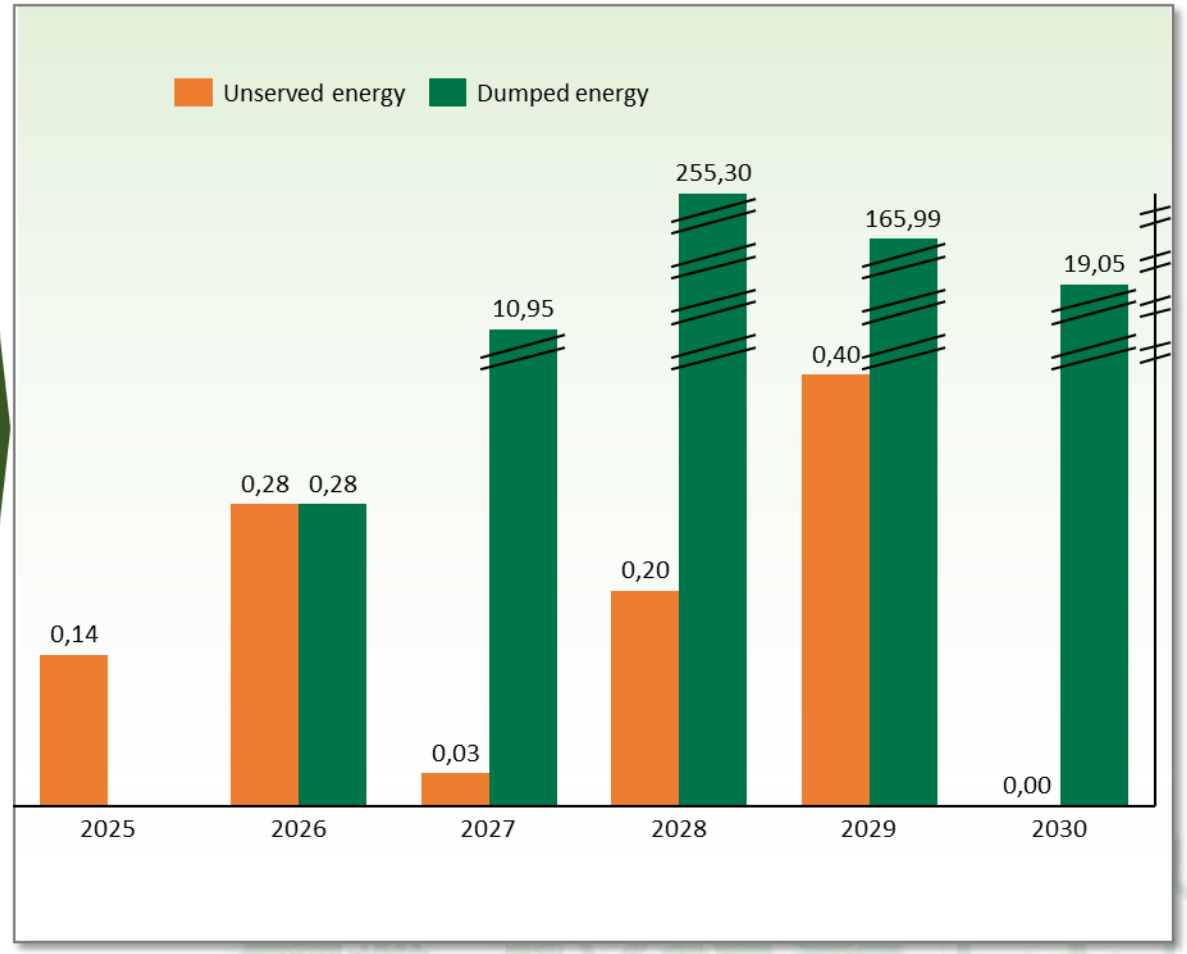
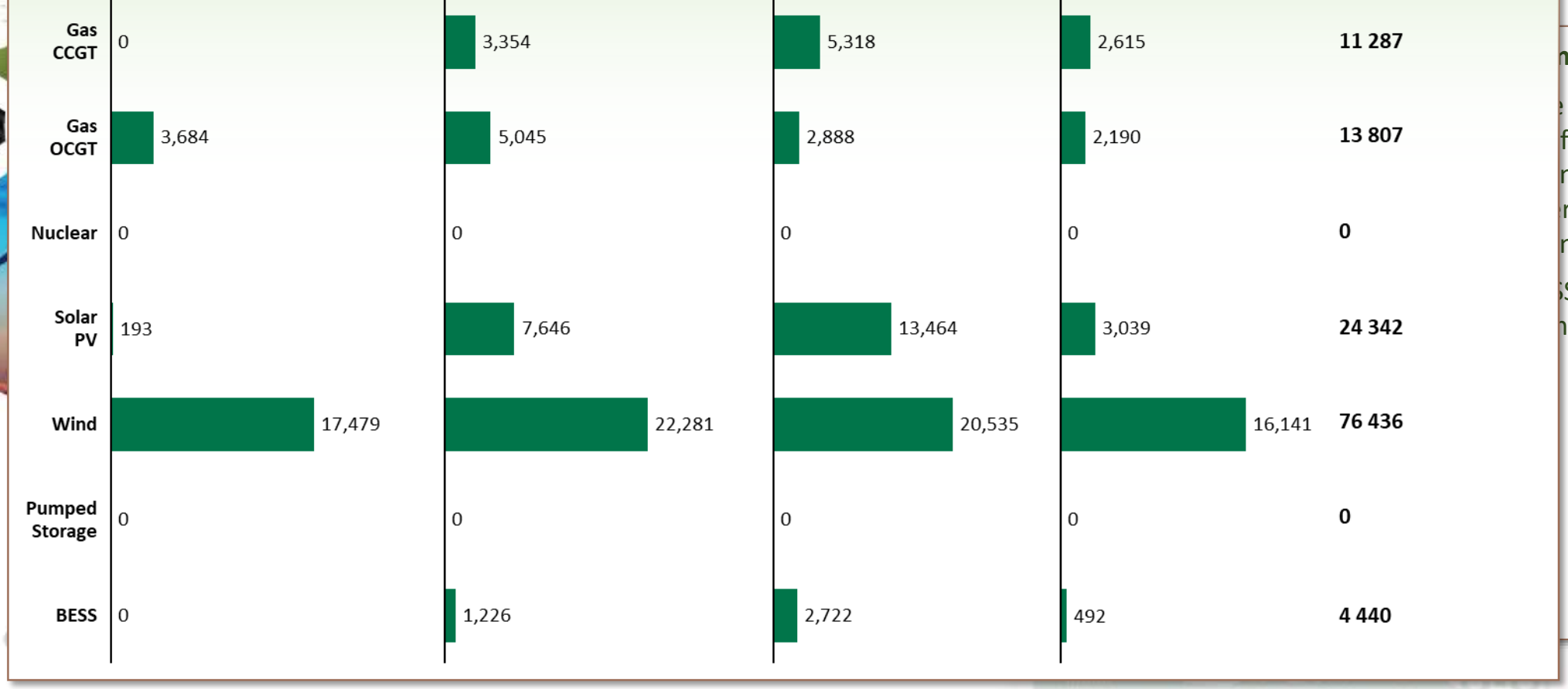
RESULTS OF THE PERIOD BETWEEN 2025 and 2030





REFERENCE CASE BUILD PLAN

Reference case



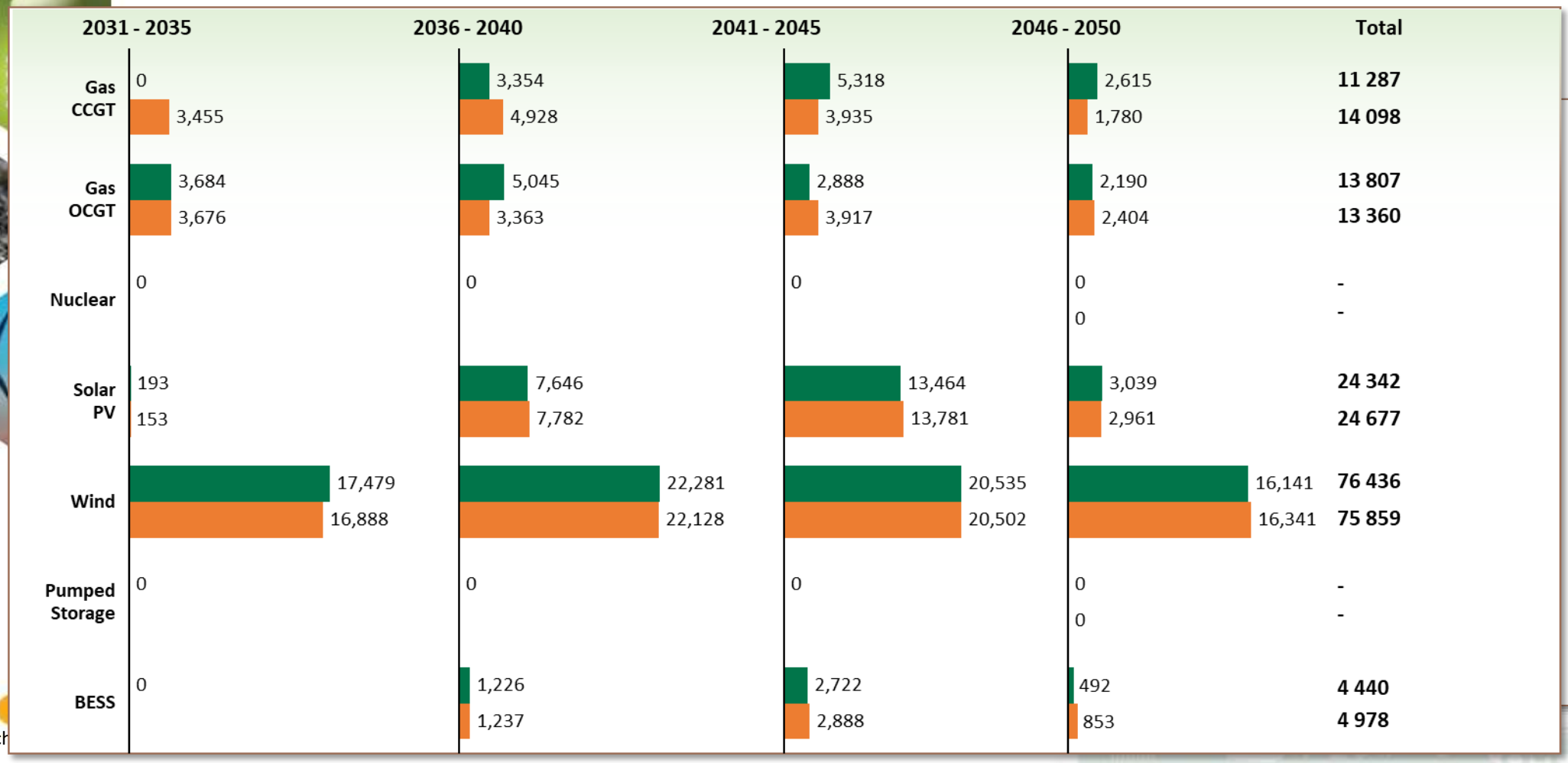
...nents

...e systems
...fers more wind
...n PV by 2040
...raging more
...n 3.5 GW/a

...SS and PV
...main correlated

Source: IRP Technical Team Analysis

REFERENCE CASE WITH NO COMMITTED GAS BUILD PLAN

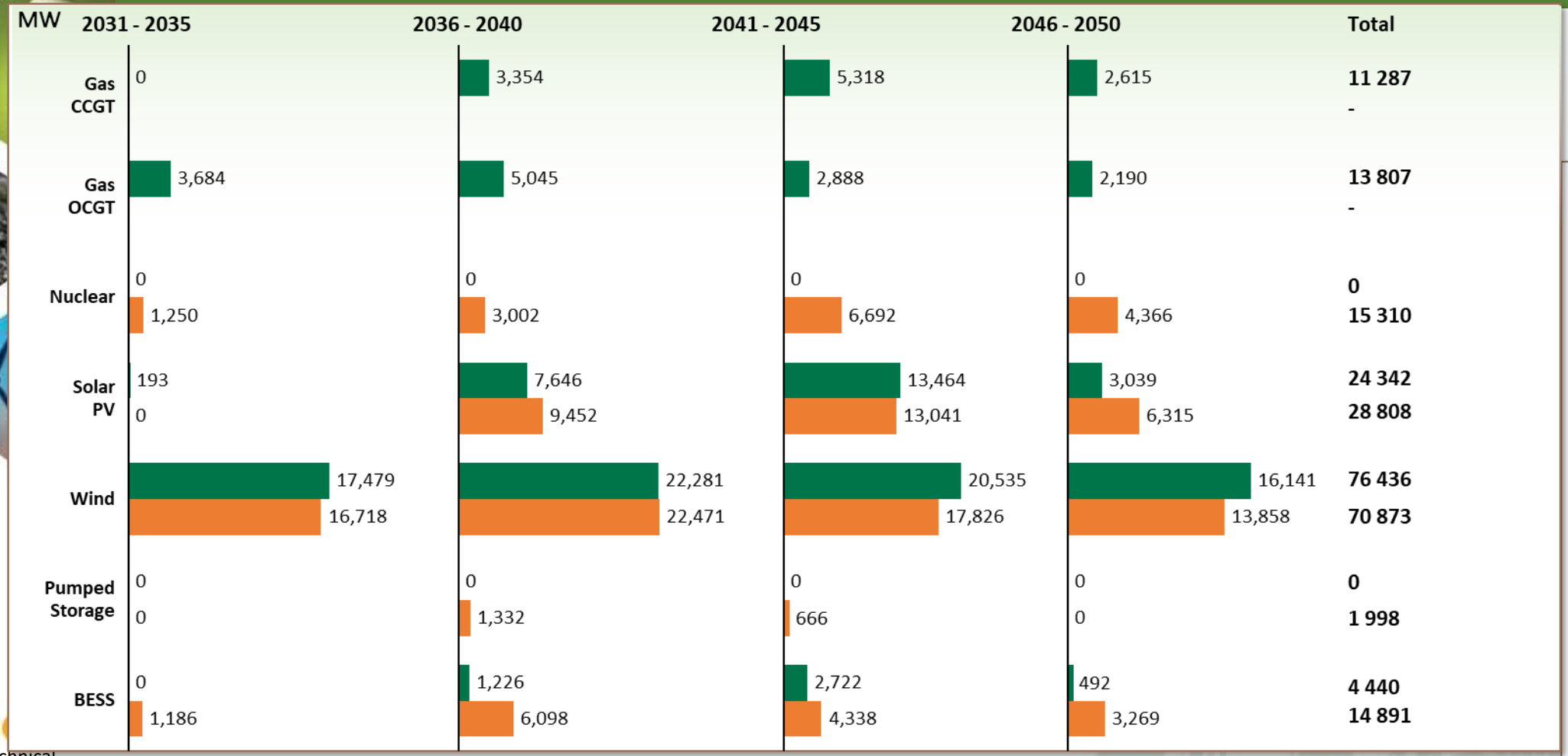


Comments

- More gas dispatchable is required between 2031 and 2040 and overall
- Resembles the by default the least plan

Source: IRP Tech Team Analysis

NUCLEAR SCENARIO BUILD PLAN



Comments

- No new gas was allowed from 2035
- More BESS and WPS is required to make RE dispatchable since gas is not available

Source: IRP Technical Team Analysis

OPTIMISTIC BATTERY LEARNING BUILD PLAN

Comments

- Assumes optimistic learning rate for battery[1]
- The reference case assumes the lithium ion
- ~20% more reduction in cost than the in reference case

Source: IRP Technical Team Analysis

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Notes:
1 Levelized Cost of Energy+ V17.0 (June 2024) - Lazard 2024 base (average of low and high end) cost with the same optimistic learning rates, which is 20% lower than the EPRI cost in 2024 increasing to 40% by 2040

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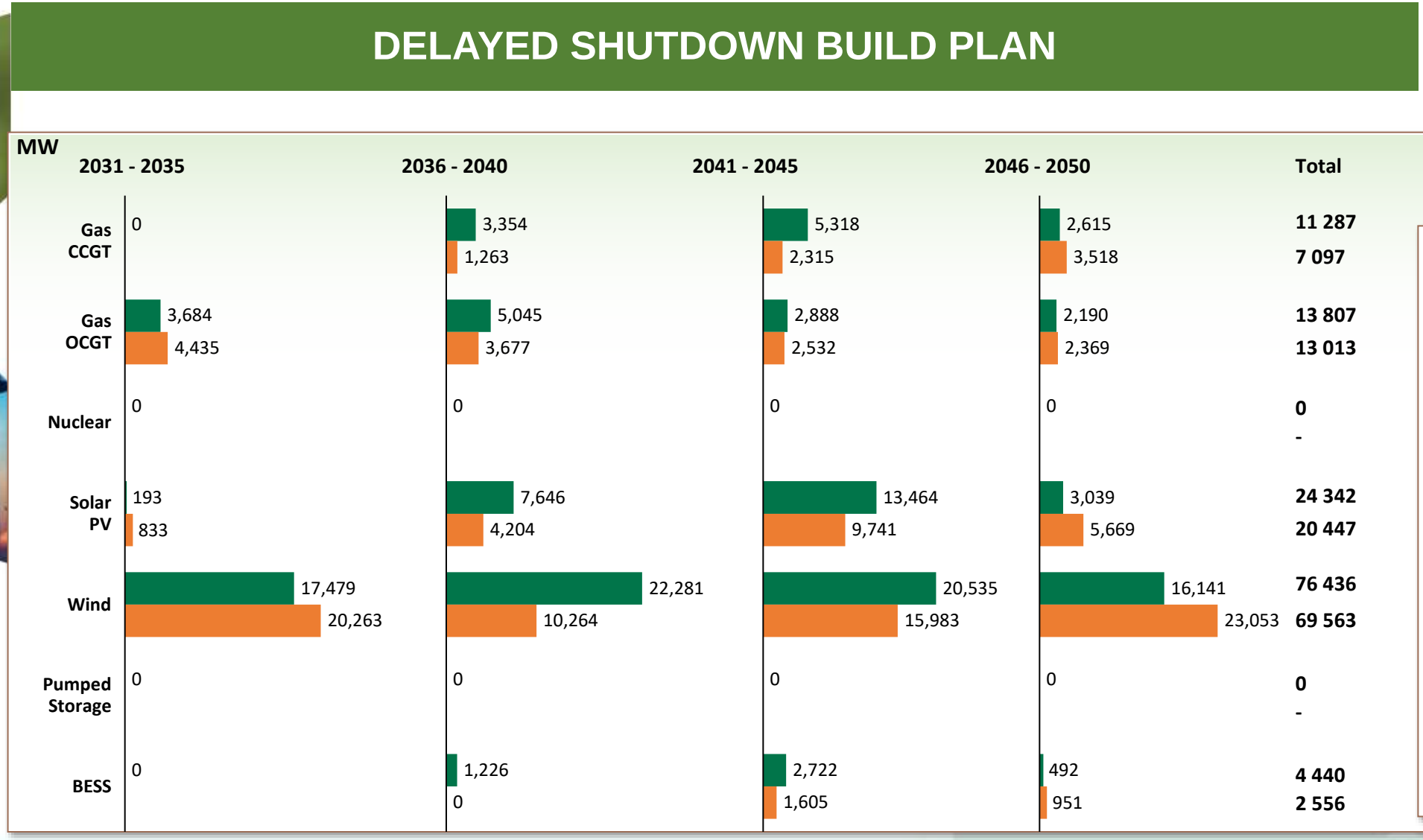
DELAYED SHUTDOWN BUILD PLAN

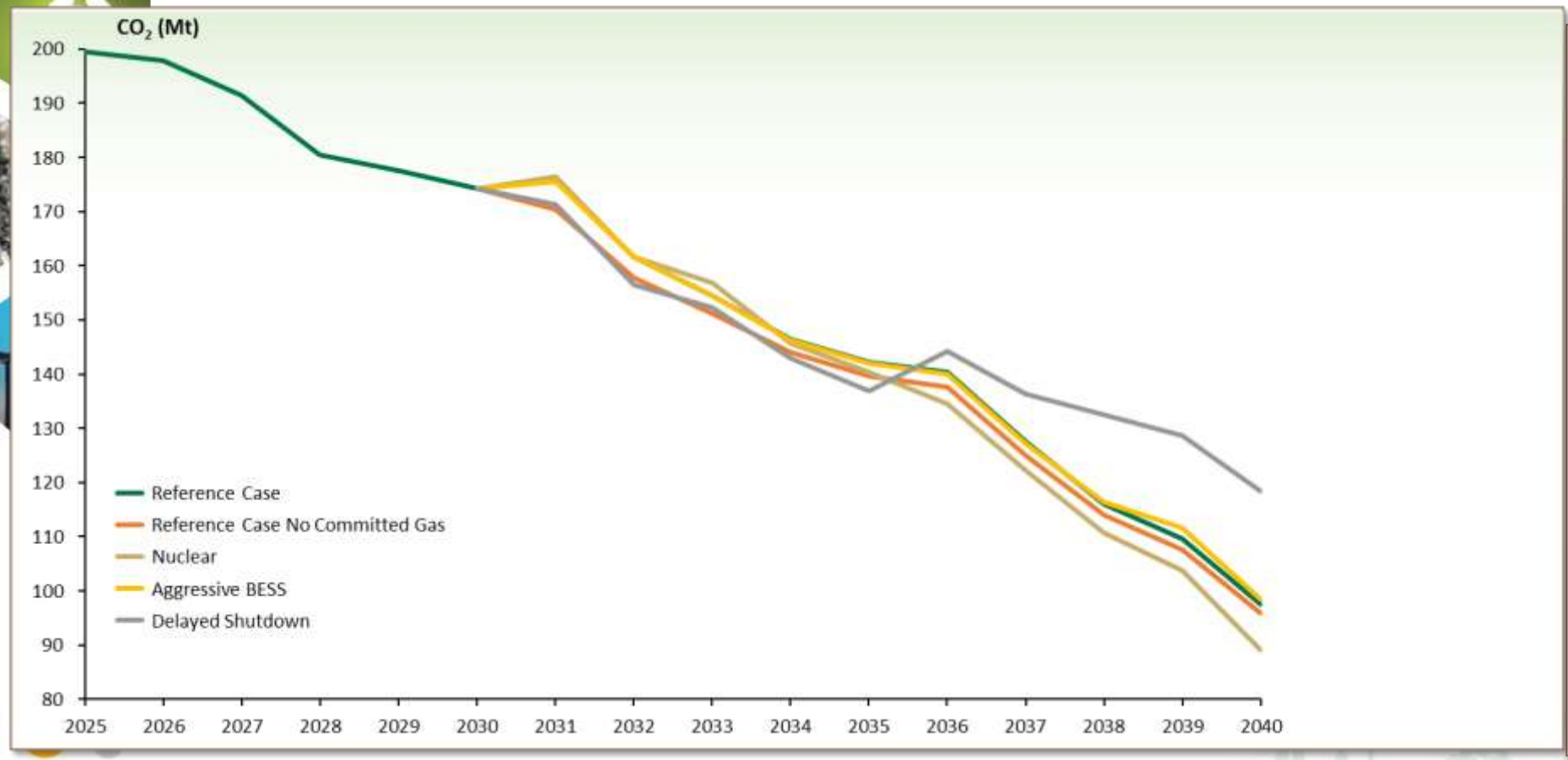


Source: IRP Technical Team Analysis

Comments

- Requires less capacity overall than the reference case
- Due to prolonged outages resuming in 2031 more wind than in reference case in this period

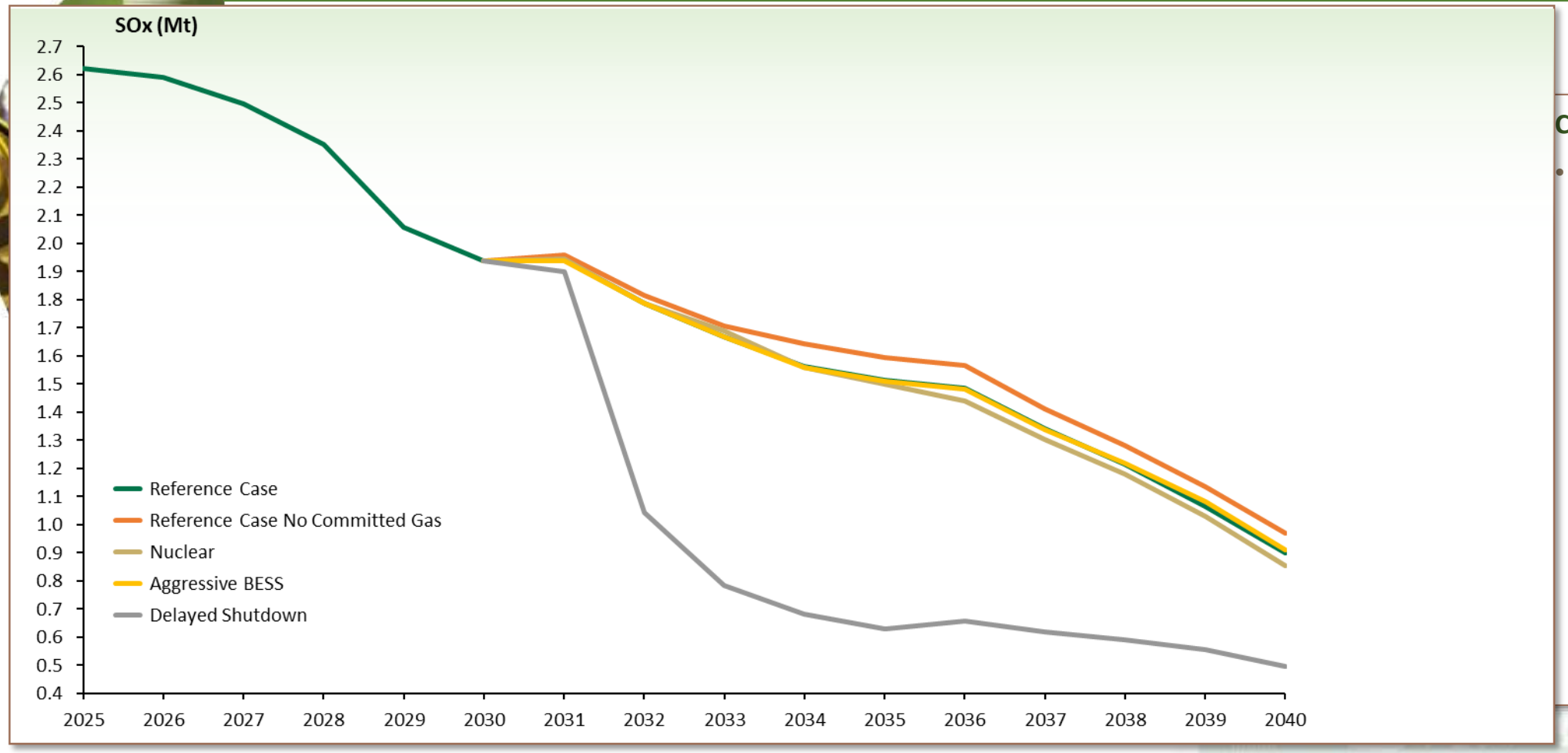
TOTAL CO_2 EMISSIONS FOR ALL SCENARIOS



Comments

- Climate Change Act (no. 22 of 2024) legislates the national emissions trajectory, sector emission targets (SETs) and allocation of carbon budgets
- SETs are key mechanisms to achieve the NDC and implemented through emitting sector policies and measures (PAMs)
- The IRP is considered a policy and measure for achieving SETs in the power sector
- SETs are currently in draft

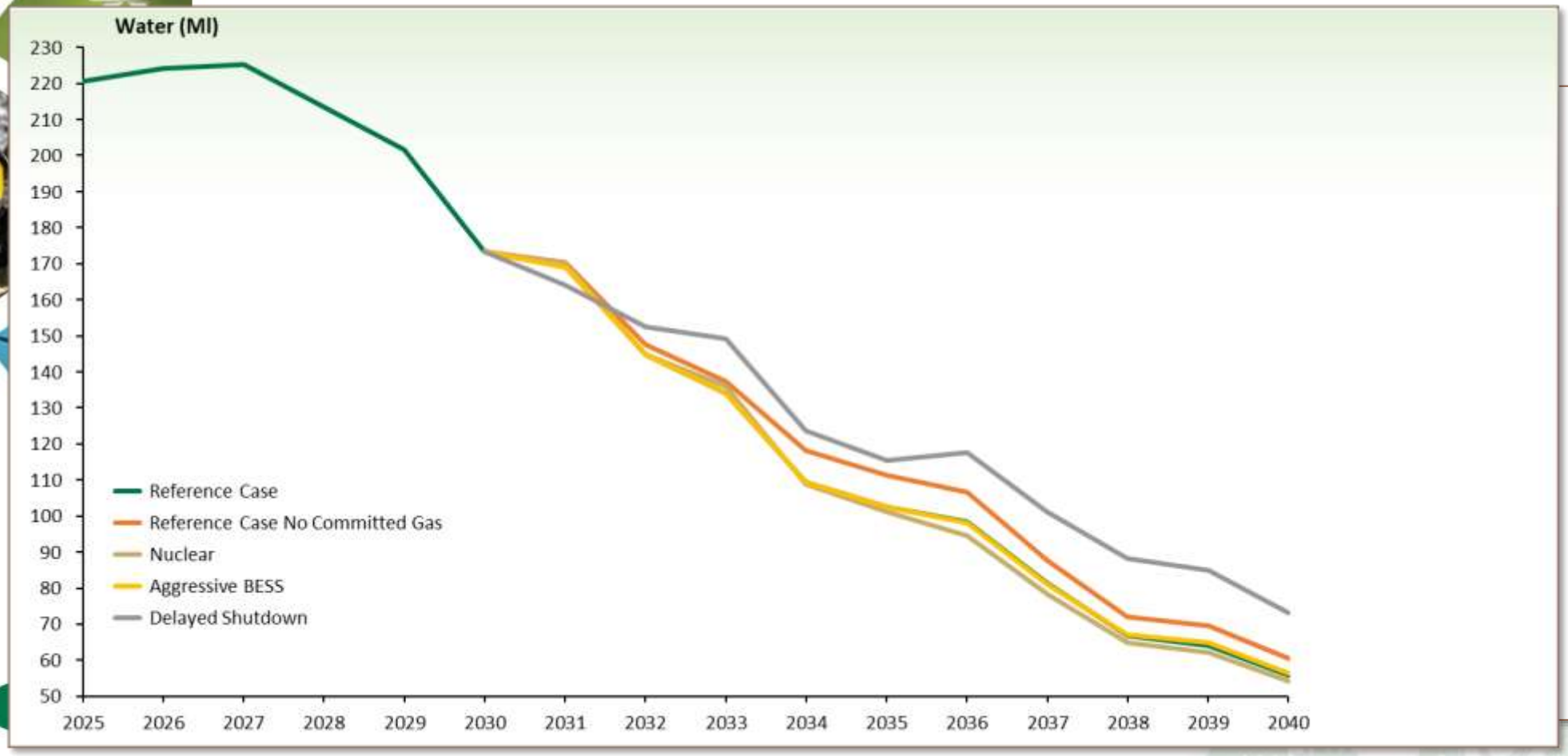
TOTAL SOx EMISSIONS FOR ALL SCENARIOS



Comments

- Impact of FGD abatement noticeable in SO_2 reduction

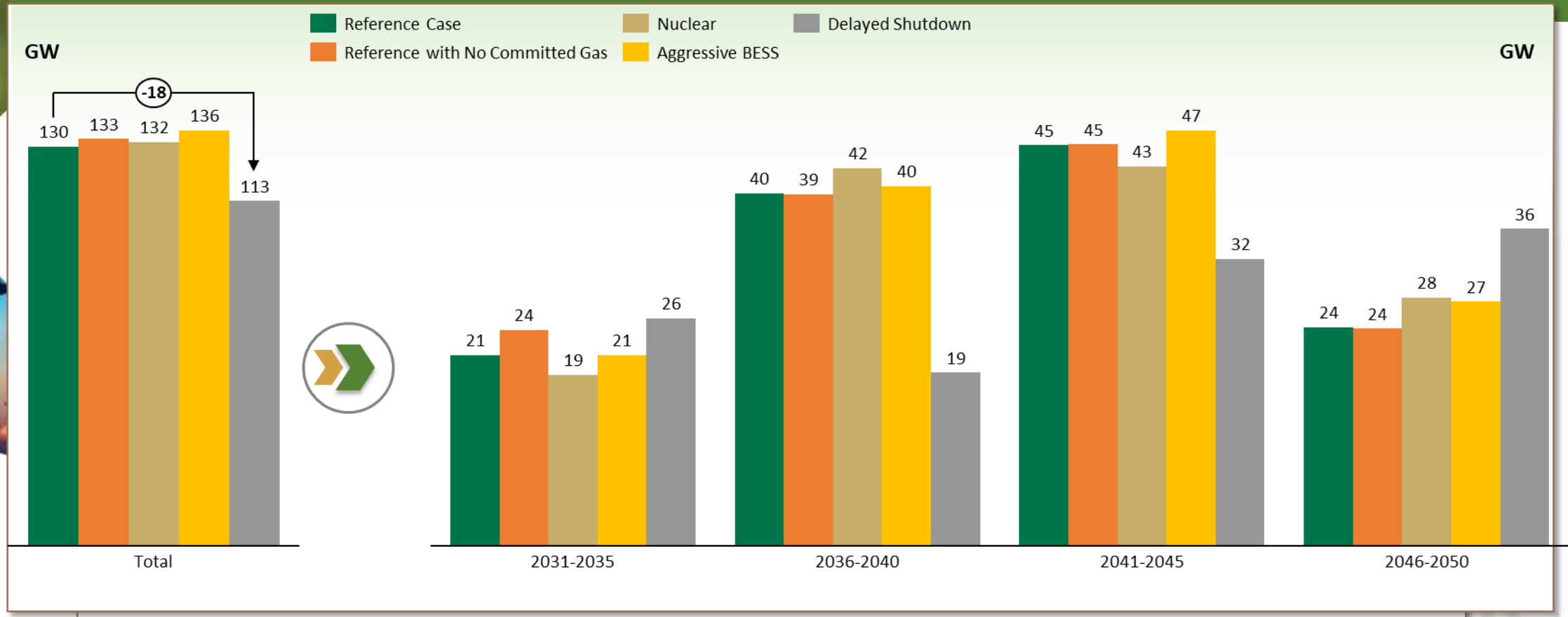
TOTAL WATER REQUIREMENTS FOR ALL SCENARIOS



Comments

- Impact on water consumption visible in the Delayed Shutdown scenario due to FGD retrofits

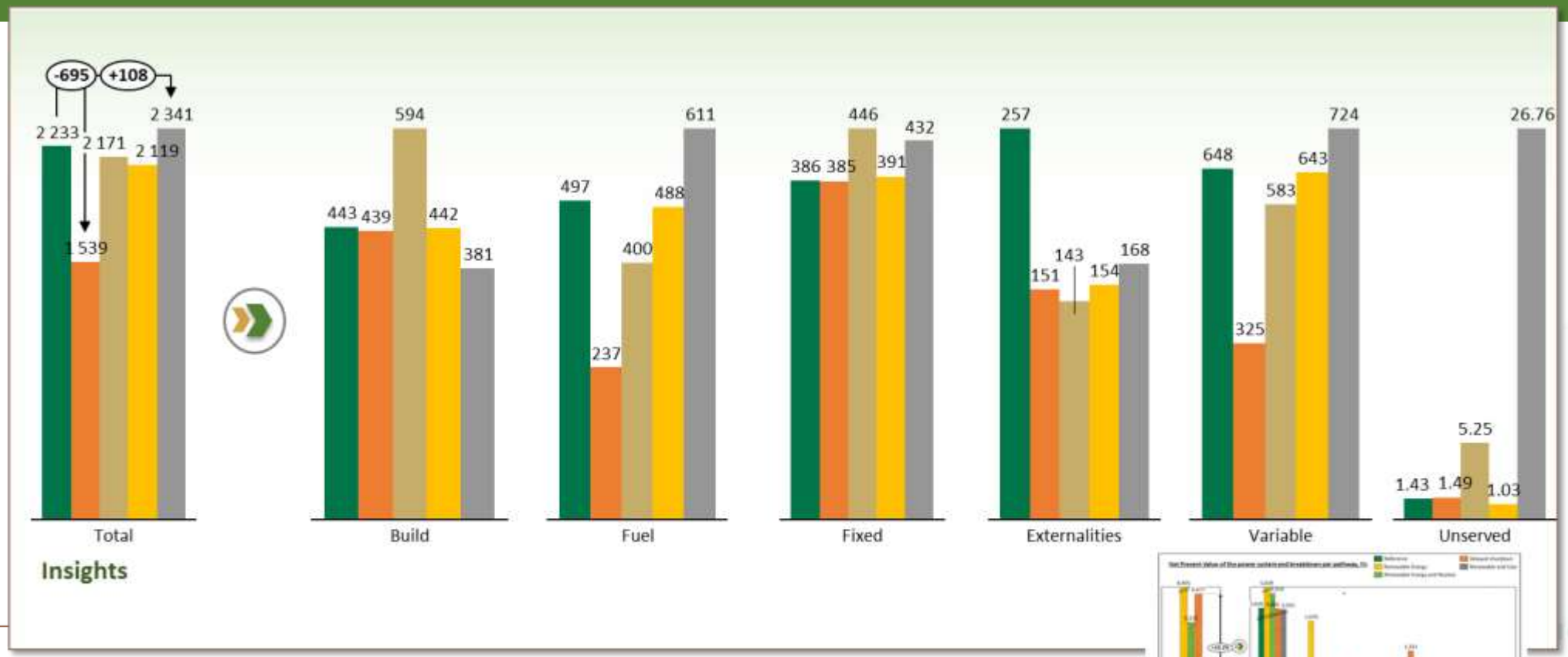
TOTAL SYSTEM BUILD CAPACITY FOR ALL SCENARIOS



- The delayed shutdown scenario builds the least capacity by 2040

Source: IRP Technical Team Analysis

TOTAL SYSTEM COSTS FOR ALL SCENARIOS



Reference Case
Reference with No Committed Gas
Nuclear
Aggressive BESS
Delayed Shutdown

Insights

- The improved security of supply, with elimination of unserved energy has significantly reduced the total system cost for all scenarios
- The system cost for all scenarios are in the same ballpark, except when 6GW of gas is not committed. This is due to reduced operating costs and carbon tax. Delayed shutdown includes SOx abatement.

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Summary of the Analysis

The analysis of the results are linked to the shutdown cliffs spanning 12 years from 2030 to 2042

Case for Gas fired plant

- The case that **commits 6GW of gas by 2030** requires an **additional 1GW of gas per annum** between 2030 and 2040. In the event that 6GW of gas is not committed, approximately 2GW per annum of new gas is required between 2030 and 2040

Case for Nuclear

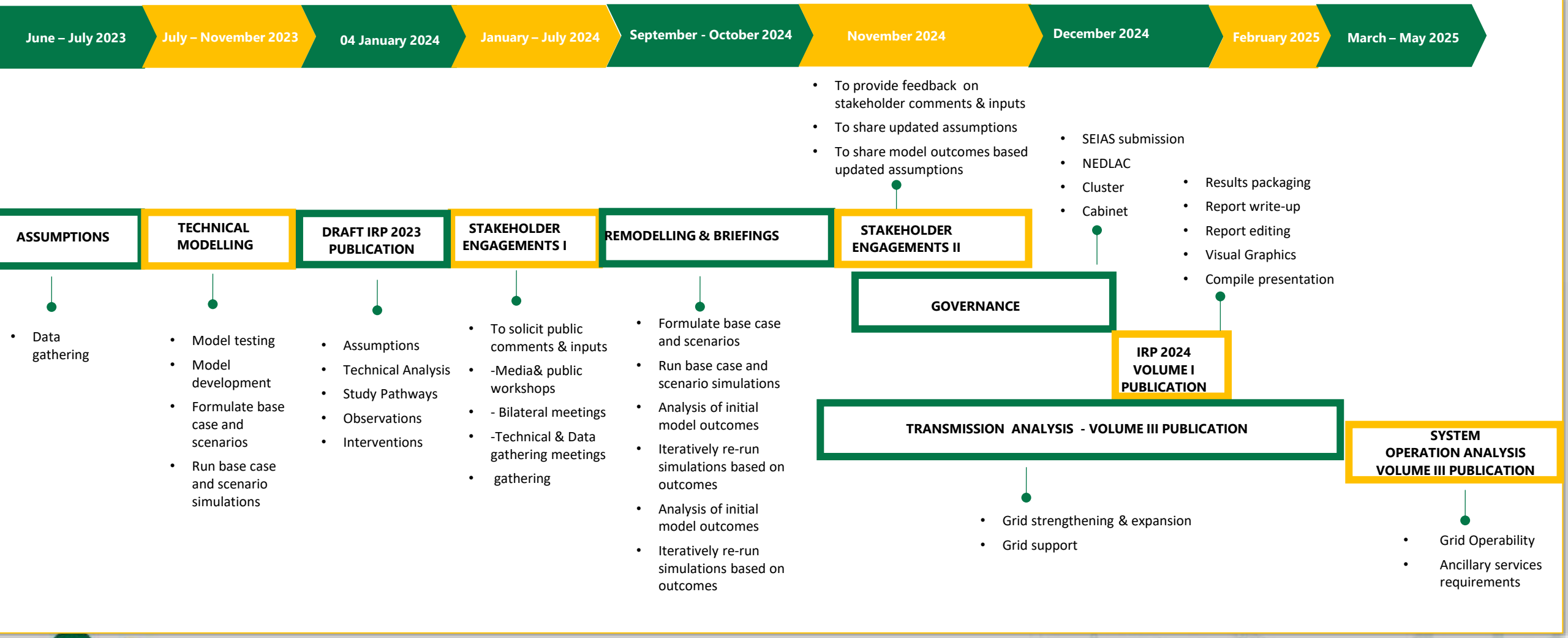
- This case requires that **6 GW of gas** is commissioned **by 2030** to ensure system adequacy **until nuclear is available**, after which a **built rate of 1.5GW** will be **required per annum** between 2035 and 2042. SMR could be a candidate to compete with gas mid merit to base load operation

Case for Continued RE roll-out

- The **26GW of renewable energy** technologies **committed capacity** means at least **4GW per annum of new build** between 2025 and 2030.
- In the period between 2030 to 2042, the renewable energy rollout remains relatively unaffected at **approximately 5.5GW per annum for all studied cases**, except in the delayed shutdown where this reduces to 4.2GW which is still a significant feat!

Case for Storage

- The marginal cost of variable technologies such as solar are not low enough to make storage, even with aggressive learning, a preferred option for flexibility when gas is available. This is reflected in the nuclear case, where gas is limited, **additional 10GW of storage supports variable renewable** and the dispatchable nuclear.



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- End