

Welcome to the 2026 Southern Africa Energy Transition Forum

Johannesburg
Thursday 29th October 2026

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Keynote address

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Scene setting & market environment

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Energy Security : Storage + flexible generation first

IRP 2025 | FIRST SECTION 34 DETERMINATION

A 9,600 MW priority package to reduce curtailment and strengthen dependable electricity supply

4,600 MW

BATTERY STORAGE

Shift curtailed electricity into peak and high-value periods.

5,000 MW

GAS-TO-POWER

Provide dispatchable output when renewable supply falls or demand rises.

WHAT THE SEQUENCE SIGNALS

- No new wind or solar in the first determination; these follow in a subsequent determination, including hybrids and longer-term pumped storage.
- Procurement will emphasise system-operating requirements: BESS location and performance; gas start-up, ramping, minimum load, fuel and infrastructure.
- Delivery is intended to align with transmission expansion, industrial demand, regional trade and measurable local-development commitments.

CORE MESSAGE

"The region cannot afford power shortages. Flexible generation keeps industries operating, businesses growing and communities powered."

Source: Department of Electricity and Energy media statement | 7 October 2026



"This approach... supports dependable supply for industrial production and employment and addresses avoidable costs that place pressure on electricity affordability."

Dr Kgosientsho Ramokgopa
Minister of Electricity and Energy

electricity & energy
Department: Electricity and Energy
REPUBLIC OF SOUTH AFRICA

Enable renewable energy at scale

The next chapter is not renewables versus flexibility. It is renewables enabled by storage and fast, controllable balancing power.

Gas generation does not absorb surplus electricity. Its contribution depends on flexible operation that allows renewable generation to serve demand during high-output periods and supplies the remaining requirement when that output declines

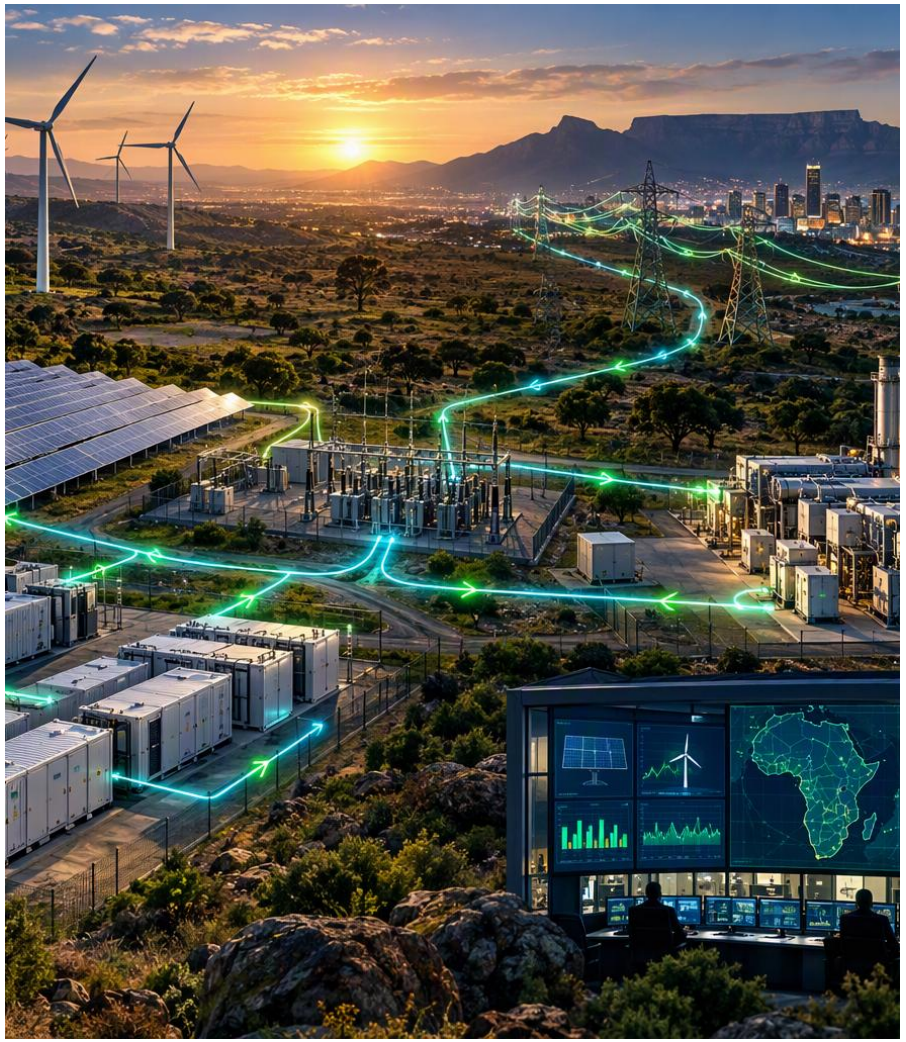
- BESS can absorb electricity that would otherwise be curtailed and shift it into useful periods.
- Flexible engines supply the remaining requirement when renewable output declines.
- Together, storage and engines provide complementary balancing across milliseconds, minutes and longer gaps.

SYSTEM LOGIC

Use surplus renewable electricity first. Add dispatchable generation when the system still needs power.

CORE MESSAGE

"Renewables and flexibility go hand in hand. Gas engines enable more solar and wind to be integrated safely and economically."



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A practical pathway to decarbonisation

A credible transition must combine lower emissions with affordability, fuel security and dependable electricity.

- Natural gas can provide transitional, dispatchable capacity while renewable energy expands.
- Operating flexibility matters: allow renewables to serve demand during high-output periods.
- Future-ready engines preserve a pathway toward sustainable fuels as supply chains mature.

Today
Reliable gas

Transition
Flexible operation

Tomorrow
Sustainable fuels



CORE MESSAGE

"Decarbonisation is a journey, not a single technology choice. Move forward without compromising reliability."

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Modernise the grid, unlock the system

Curtailment and network constraints are now central cost and reliability issues, not secondary technical concerns.

- Locate and operate storage where it can charge from surplus energy and discharge without recreating constraints.
- Coordinate new generation with transmission expansion, industrial demand and regional electricity trade.
- Use digital optimisation to improve dispatch, asset utilisation and measurable system performance.

VALUE TEST **Electricity shifted into useful periods + reliability services delivered**

CORE MESSAGE

"A stronger grid is the foundation of a stronger economy."



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Wärtsilä’s local partnerships for lasting value

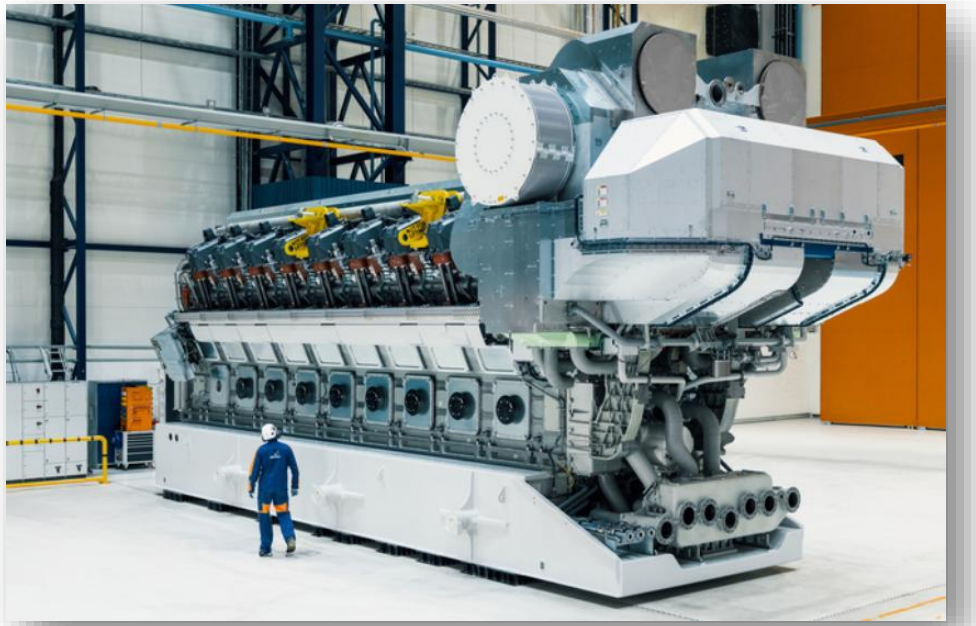
Wärtsilä’s South African presence provides a foundation for local partnerships throughout the life of an energy project.

LOCAL PRESENCE, COMMITMENT AND EXPERIENCE

Cape Town & Johannesburg
Wärtsilä South Africa
(established since 1994 , a BEE level 3 company)

175 MW
Sasolburg reference

Local service
South African service hub



- Engagement with local and international EPCs and suppliers early to identify engineering and construction opportunities.
- Build skills transfer and operator training into partnership discussions to strengthen local capability.
- Align developers, utilities and fuel partners on project delivery and support beyond commissioning.

ENGAGEMENT PRIORITY

Combine Wärtsilä’s technology expertise with local capability to support reliable power and lasting economic value.

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Thank you



Sujen Balakisson
Business Development Manager
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Flexible Gas Technologies and their role & competitiveness in the energy system

Tuomas Paloviita
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Engine Power Plant
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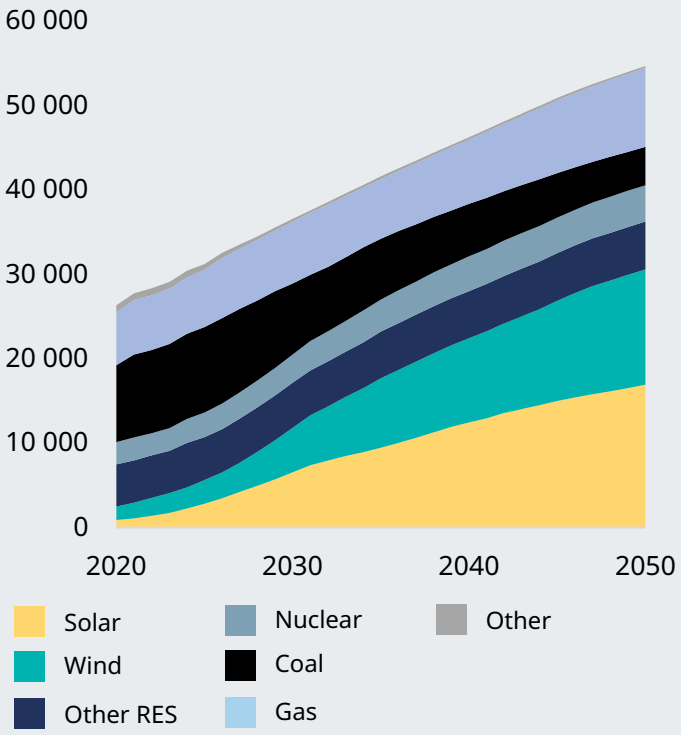
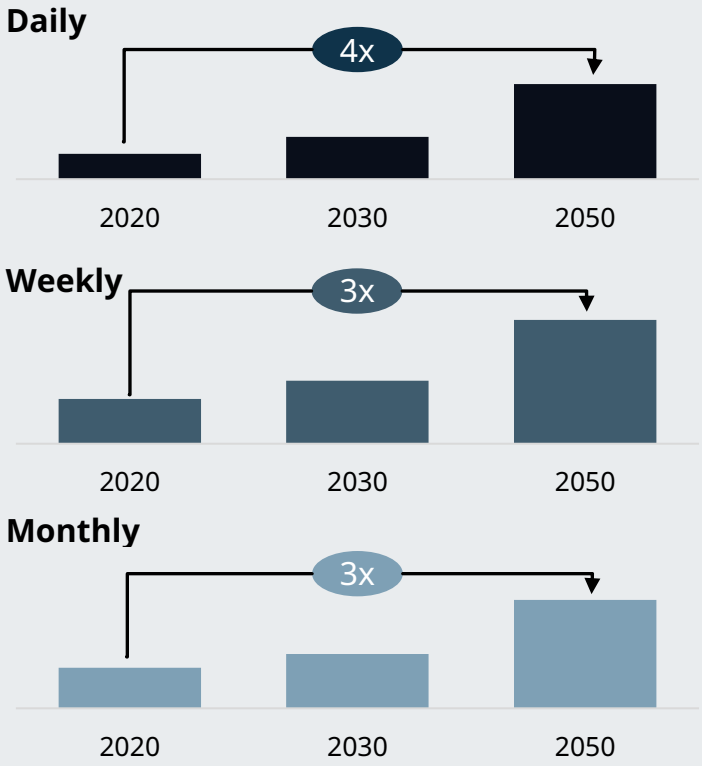
Growing solar and wind raise the need for flexibility on every timescale, from minutes to seasons

The unforeseen electricity demand growth is primarily met by renewables



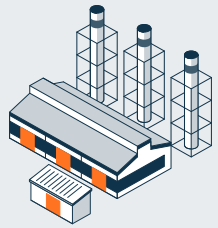
Source: BloombergNEF, BNEF NEO 2026

Power system flexibility need increases on all timescales

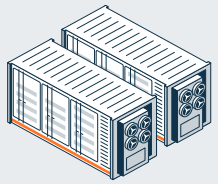


Source: IRENA, 2026

The transition is enabled and supported by flexible power solutions



Balancing power plant



Energy storage

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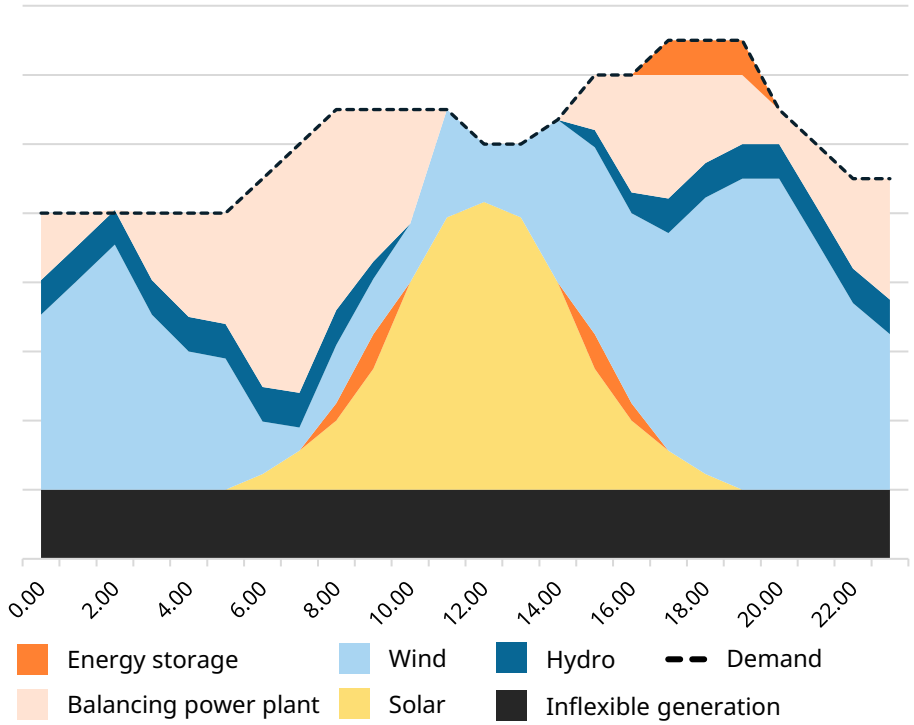
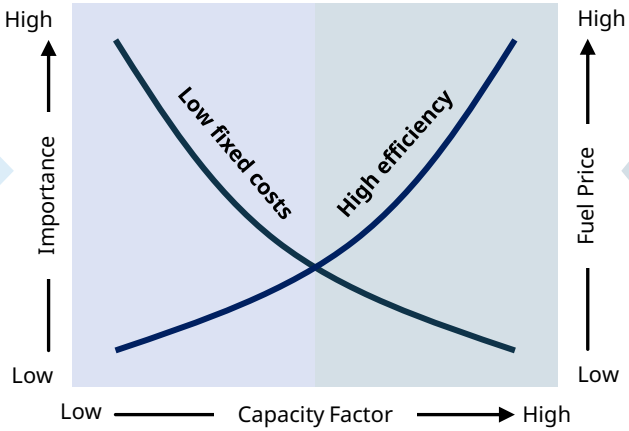
Balancing solutions will provide the power needed to keep the grid stable

As renewables push thermal plants towards lower utilisation, flexibility and starting capabilities matter more than full-load fuel efficiency



As capacity factors decrease

- Importance of low fixed costs increases
- Importance of high full-laod efficiency decreases
- Importance of flexibility capabilities increases



As capacity factors increase

- Importance of low fixed costs decreases
- Importance of high full-load efficiency increases
- Importance of reliability increases

- **Energy storage can provide sub-second and minute-level balancing**
- **Balancing power is needed on minute, daily and seasonal timescales**
- **They work together to ensure a steady power supply**
- **Conventional baseload power prioritises low fuel costs**
- **For balancing, the importance of high full-load efficiency decreases**
- **Flexibility and starting capabilities are key for balancing**

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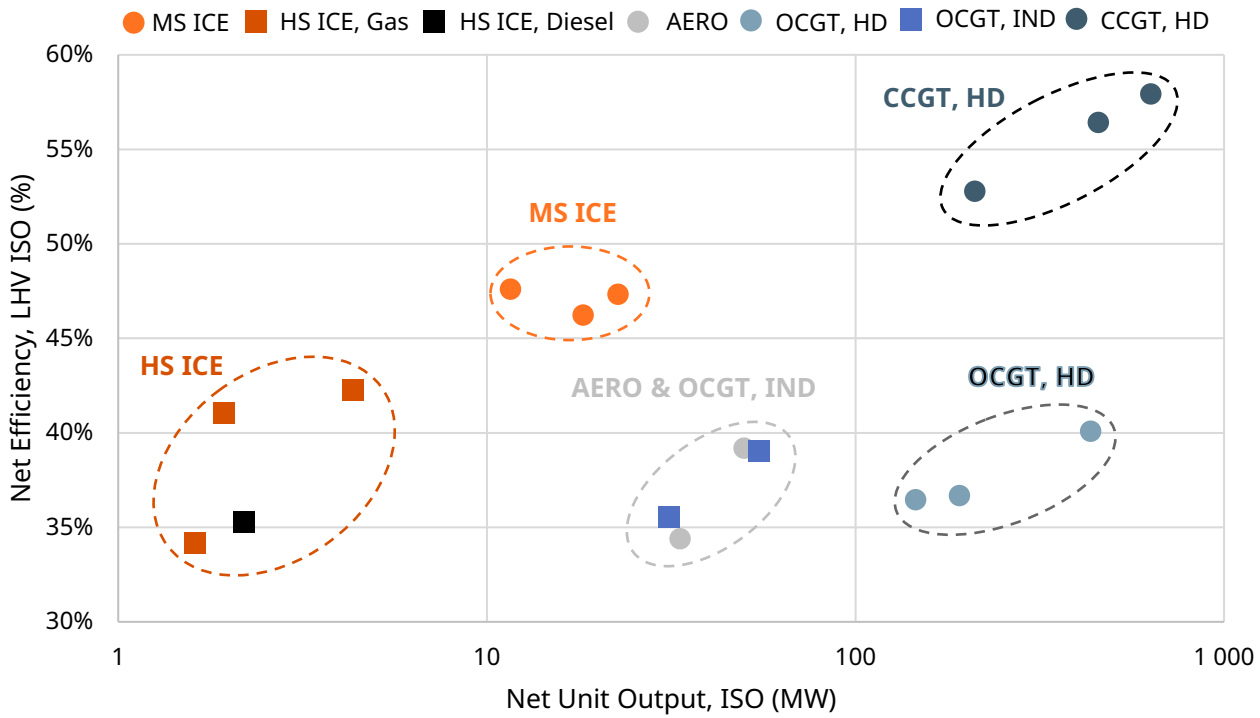
A wide range of generating sets is offered by OEMs, covering different unit sizes and performance characteristics

Medium-speed engines are the engine option designed for continuous, high load operation in large utility and industrial power plants

Generating sets: Medium-speed engines are several times larger than high-speed engines and more efficient than simple cycle turbines many times their size



Note: Net output and net efficiency shown at ISO conditions, LHV basis. Not an exhaustive list of every genset model. Wärtsilä analysis.

Reciprocating internal combustion engine (MS ICE): Medium-speed gas engines that generate electricity by burning fuel inside cylinders to move pistons. They typically have cylinder bores of around 300–500 mm and operate at 500–750 rpm.

High-Speed Engine (HS ICE): Small gas or diesel engines that use the same piston-based combustion process as MS ICE units but operate at higher speeds. They typically have cylinder bores of around 150–240 mm and operate at 1,000–1,800 rpm.

Aeroderivative Gas Turbine (AERO): Gas turbines based on aircraft jet-engine technology and adapted for stationary electricity generation. Hot combustion gases pass through turbine stages connected to an electrical generator.

Industrial Open-Cycle Gas Turbine (OCGT, IND): Stationary gas turbines, typically operating at higher shaft speed and connected to the generator through a gearbox. Exhaust heat is released after power generation.

Heavy-Duty Open-Cycle Gas Turbine (OCGT, HD): Large-frame stationary gas turbines, typically directly coupled to the generator at grid-synchronous speed. Exhaust heat is released after power generation..

Heavy-Duty Combined-Cycle Gas Turbine (CCGT, HD): Large-frame heavy-duty gas turbines combined with heat-recovery equipment and a steam turbine, using exhaust heat to generate additional electricity.

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Modular engine power plants can offer the same total plant capacity as combined cycle power plants

Illustrated using representative plant configurations sized for a hypothetical 500 MW balancing power plant

	MS ICE	CCGT	CCGT	CCGT
Model	**MS ICE**	**CCGT 1**	**CCGT 2**	**CCGT 3**
Plant configuration	24	1-1-1	1-1-1	3-3-1 x 2
Cooling	Closed-loop cooling	Air-cooled condenser	Air-cooled condenser	Air-cooled condenser
Net plant output, ISO (MW)	544	538	500	511
Net full load efficiency, LHV ISO (%)	47.3%	57.5%	57.8%	56.4%

- Engines use closed-loop cooling and need almost no water
- A cooling tower is the preferred industry choice for combined cycle cooling due to its low cost and simplicity
- An air-cooled condenser can reduce water consumption, but it has a negative impact on CAPEX and OPEX

Note: Net performance data sourced from Thermoflow GTPRO33® software.

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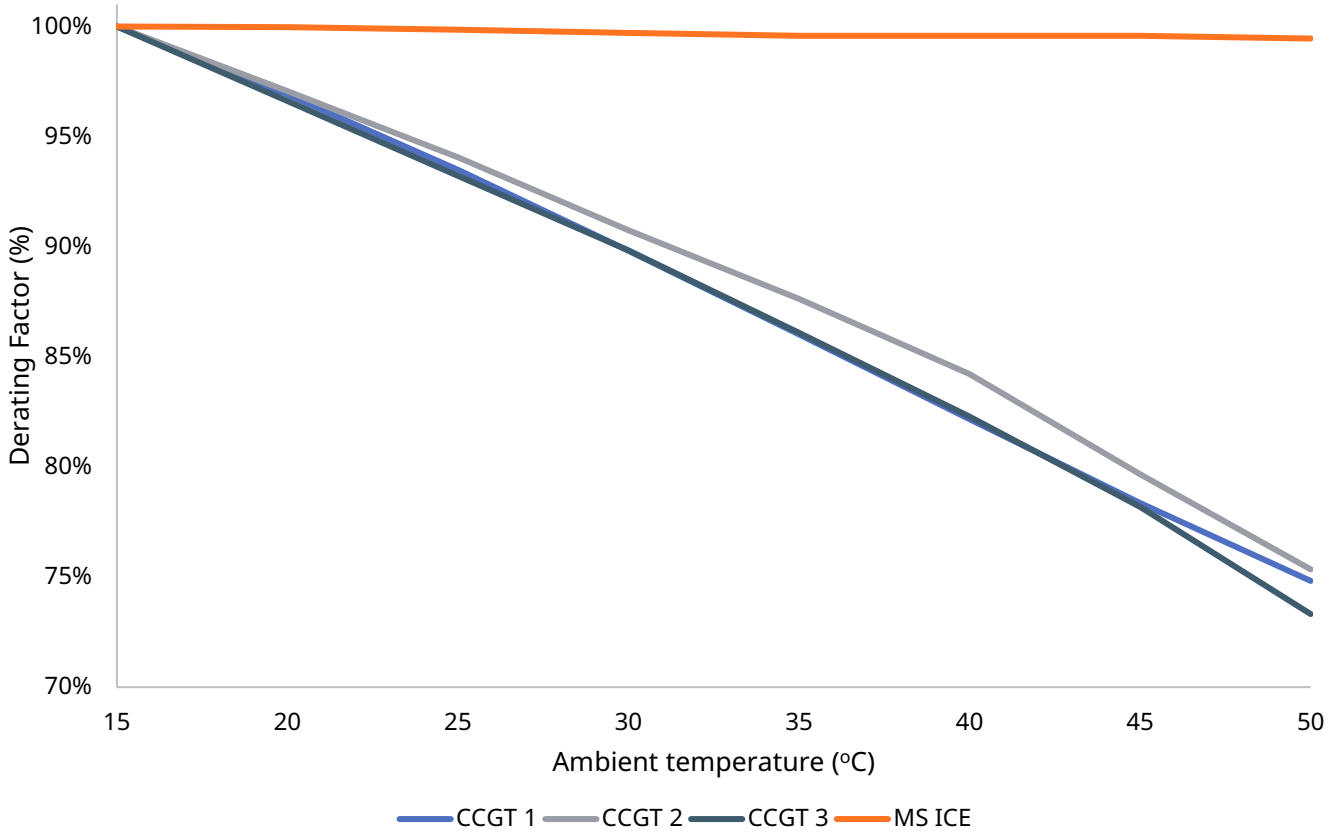
Engines can maintain net output across a wide range of ambient temperatures, while gas turbines derate significantly

Combined cycle gas turbines experience heavy output derating at high ambient temperatures



Note: Derating factors normalised to ISO conditions. Performance data sourced from Thermoflow GTPro33® software.

- Combined cycle gas turbines lose about 25% of net output at 50°C compared with ISO conditions
- Under hot ambient conditions the density of air decreases, and gas turbines require more power to compress the same amount of air, reducing their output and efficiency
- Air-inlet cooling solutions can mitigate the negative impact of temperature, but they cannot solve the issue and increase water demand
- For every 1°C increase above 15°C, combined cycle gas turbines lose roughly 0.8% of output on average, equal to 4 MW reduction for a 500MW power plant
- When a flat MW output is incentivised or must be guaranteed for the hottest summer months and peak demand, gas turbines need additional CAPEX and OPEX

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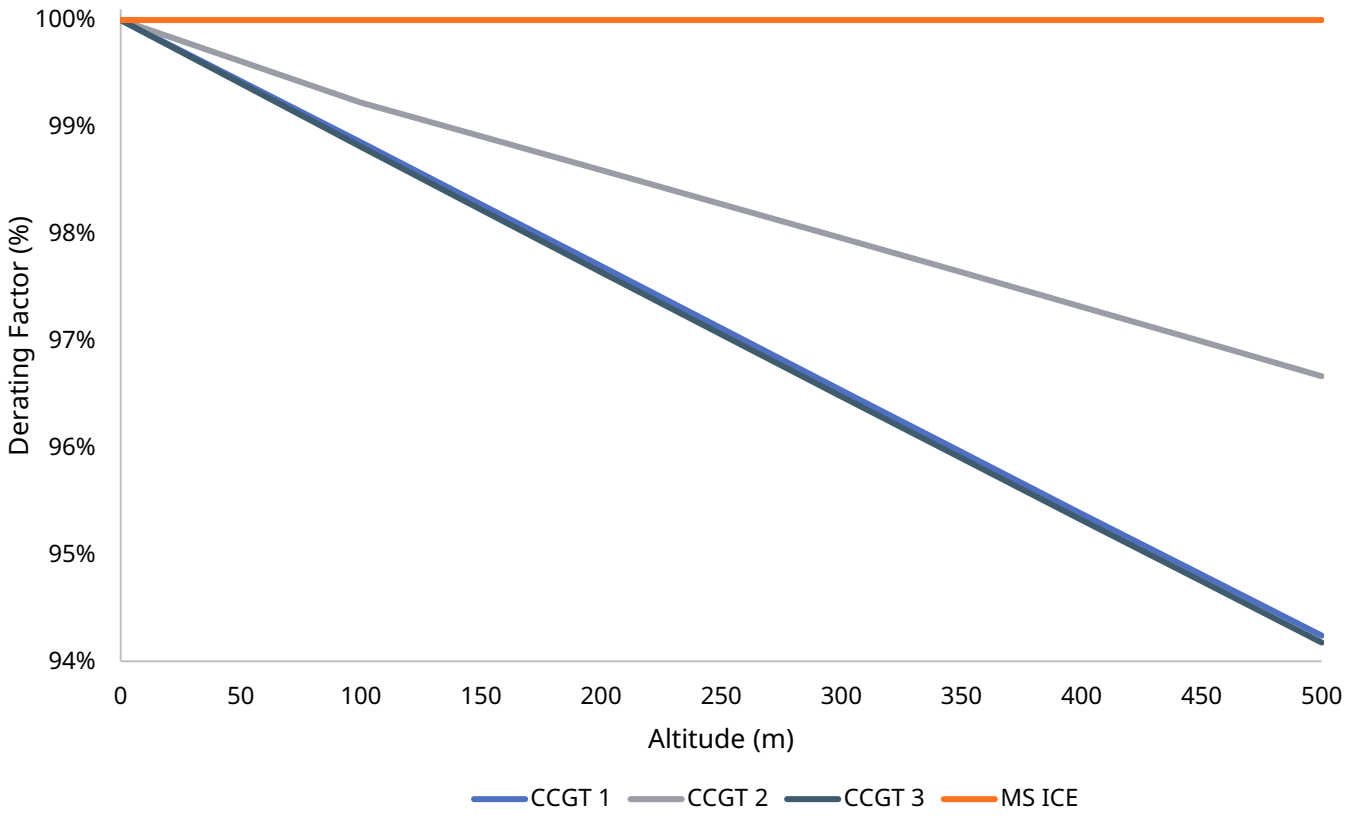
Elevation also affects gas turbine net output, while engines are only marginally affected

Combined cycle gas turbines also experience output derating when site is located above sea level



Note: Derating factors normalised to sea level at ISO conditions. Curves reflect altitude effect only isolated from temperature and humidity. Performance data sourced from Thermoflow GTPro33@ software.

- As with temperature, altitude affects the density of air, reducing gas turbine output
- For every 50 metres of altitude above sea level, gas turbine output falls by up to 0.6%
- Therefore, every 50 metres above sea level costs a 500 MW turbine plant up to about 3 MW of net output
- Sites above sea level must account for reduced output with sea-level performance to meet a certain MW target
- Engines hold their capacity with altitude

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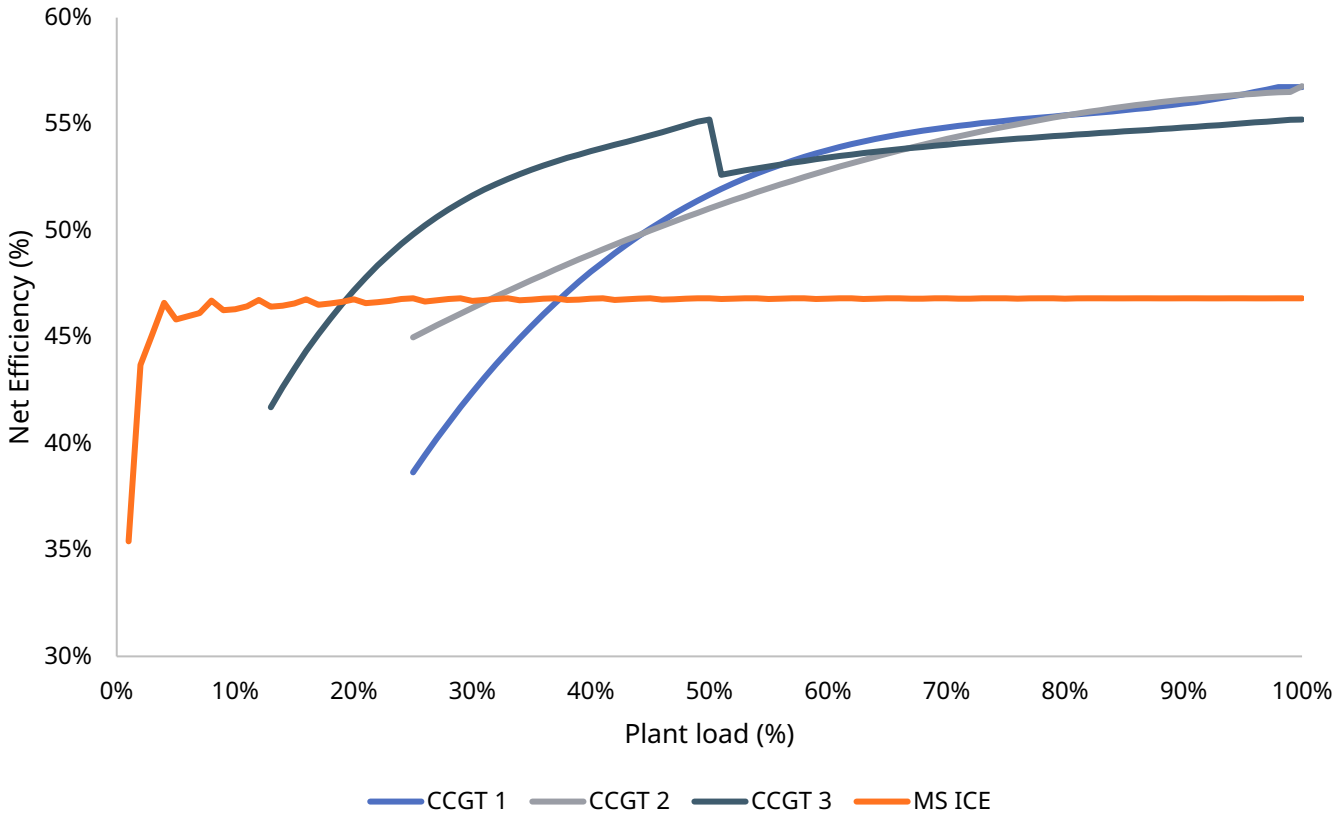
Engines combine high efficiency with flexibility across a wide load range

Balancing power plants typically operate across a wide load range instead of staying at full load all time



Note: Net efficiency shown at site conditions. ICE, AERO, OCGT and CCGT reflect multi-unit plant configurations. Net efficiency data sourced from Thermoflow GTPRO33® software. Wärtsilä analysis.

- Because balancing power plants provide additional power when neither renewables or energy storage are available and when demand is highest, they increasingly operate at part-load
- Due to the modular, multi-unit plant design, engines can run an efficient subset of the full plant capacity
- Engine can operate from 3% to 100% plant load, while maintaining efficiency above 45%
- Multi-unit gas turbine plants can partly offset declining part-load efficiency by switching individual units off rather than derating them
- However, because of long start-up times, start costs and minimum downtime requirements, these efficiency gains come at the expense of fast-response capacity

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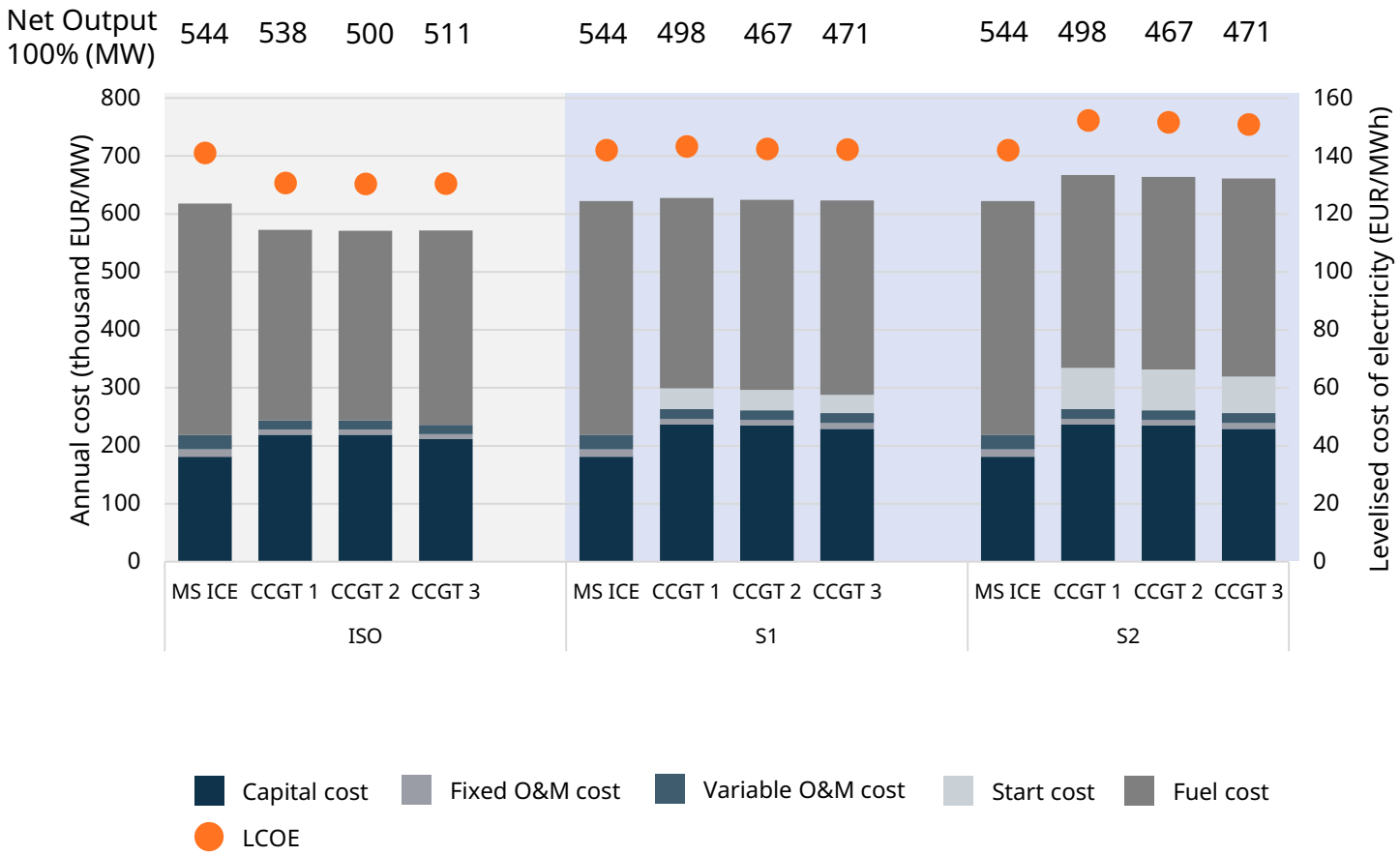
Site 1 (25°C & 60 meters): Engines are the optimal solution for renewable balancing due to modularity and operational flexibility

Annual cost and LCOE of 500 MW balancing power plant

ISO: 15°C temperature, 60% relative humidity, 0 metres altitude, 50% capacity factor, 100% load factor, 0 starts per year
S1: 25°C temperature, 30% relative humidity, 60 metres altitude, 50% capacity factor, 100% load factor, 730 starts per year
S2: 25°C temperature, 30% relative humidity, 60 metres altitude, 50% capacity factor, 70% load factor, 1460 starts per year



- When annual cost and levelised cost of electricity are compared at ISO performance ratings, engines are the most expensive solution
- However, real site conditions in temperature, altitude and relative humidity rarely match ISO standard conditions
- Balancing power also must operate with a highly variable profile, including extended part-load operation and frequent starts
- At site conditions, engines become the lowest-cost solution, with the gap widening in scenario 2
- In scenario 2, the annual cost of the combined cycle gas turbines increases over 18 million EUR compared with scenario 1
- In scenario 2, engine solution would allow an annual saving of 39 000 – 45 000 EUR/MW

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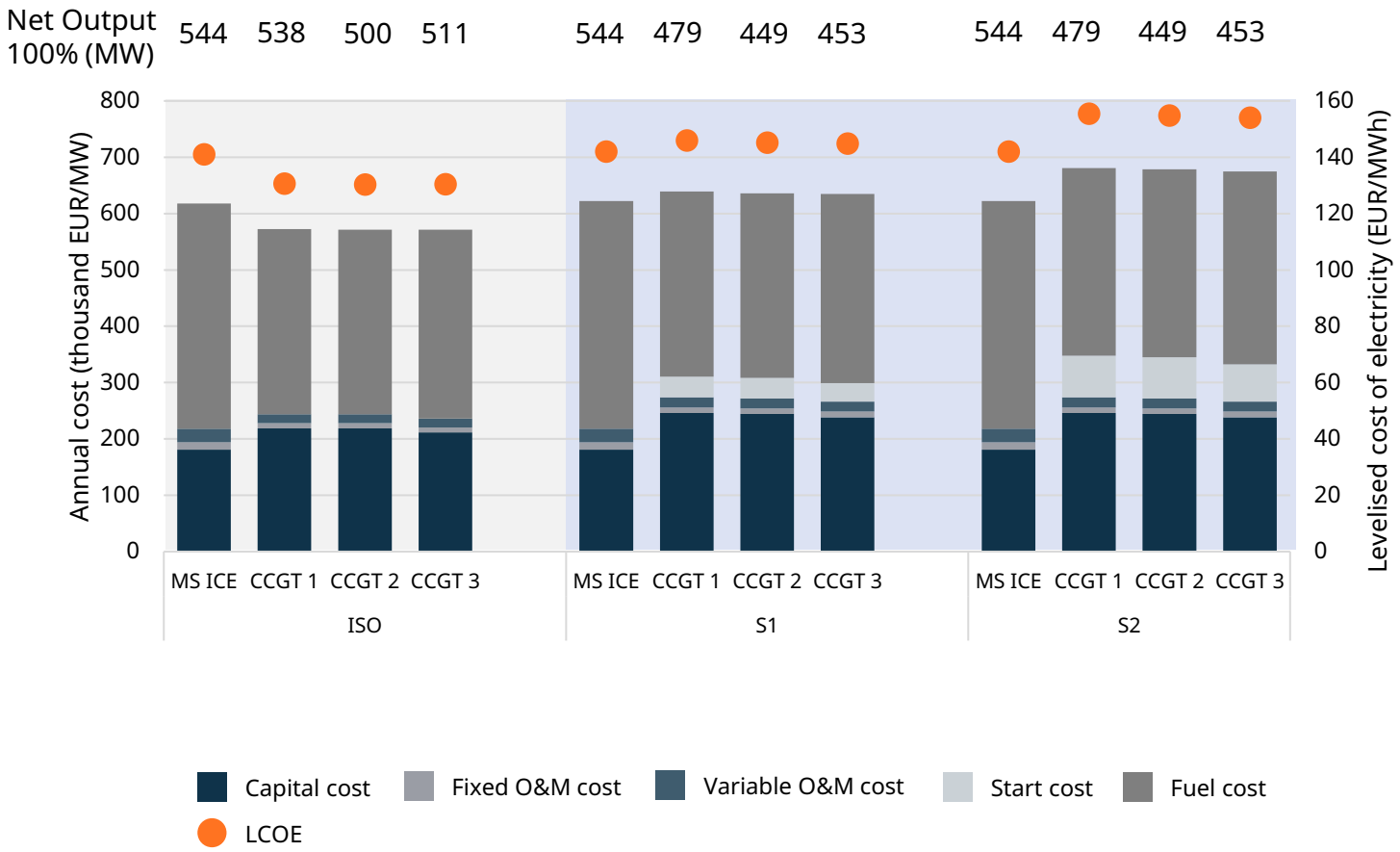
Site 2 (26ºC & 350 meters): Engines are the optimal solution for renewable balancing due to modularity and operational flexibility

Annual cost and LCOE of 500 MW balancing power plant

ISO: 15ºC temperature, 60% relative humidity, 0 metres altitude, 50% capacity factor, 100% load factor, 0 starts per year
S1: 26ºC temperature, 68% relative humidity, 350 metres altitude, 50% capacity factor, 100% load factor, 730 starts per year
S2: 26ºC temperature, 68% relative humidity, 350 metres altitude, 50% capacity factor, 70% load factor, 1460 starts per year



- Similarly to the previous case, engines are the lowest-cost solution in real balancing conditions
- Due to different site location and higher altitude, the engines' cost competitiveness is even larger
- In scenarios 2, engine solution would allow an annual saving of 53 000 – 59 000 EUR/MW
- In scenario 2, the annual cost of the combined cycle gas turbines increases over 19 million EUR compared with scenario 1

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Engines match renewable balancing needs through operational flexibility, modularity and high efficiency across a wide operating range

Frequent start-stop cycles and fast ramping are not a challenge for engines

	MS ICE	CCGT	AERO	OCGT
Start-up time	2 – 5 min	30 – 60 min	5 – 10 min	5 – 15 min
Average ramp rate (% $P_{nom, min}$/min)	>100%	2 – 11%	50%	8 – 15%
Minimum uptime	0 min	4 h	10 min	10 – 30 min
Minimum downtime	0 min	2 h	30 min	30 – 60 min
Unit minimum load (% P_{nom})	10%	25 – 50%	20 – 40%	20 – 50%
Weighted Equivalent Availability Factor (WEAF)	90.81%	83.57%	81.66%	85.28%

- Flexibility capabilities of gas power plants vary significantly by technology
- Engines start in 2 to 5 minutes, with no minimum uptime or downtime
- In addition to high flexibility, engines consist of multiple generating sets that can be started and shut down independently, enabling high total plant efficiency
- Increased flexibility of engines does not come at the expense of availability or reliability

Note: Illustrative. Wärtsilä analysis.
-WEAF measures the percentage of time a power plant is available to produce electricity, accounting for derating and planned maintenance

Source: North American Electric Reliability Corporation (NERC), Generating Unit Statistical Brochure

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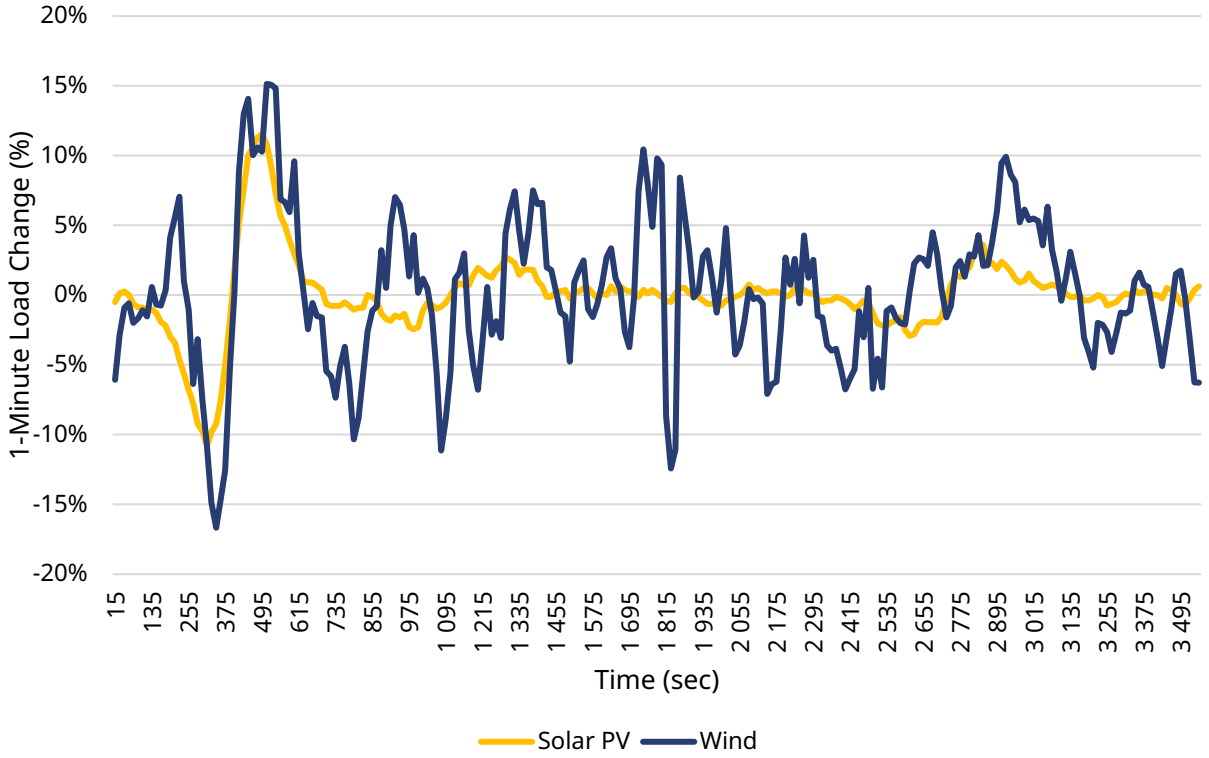
As renewable penetration increases, demand is growing for greater flexibility and more modular, distributed generation to support renewable integration

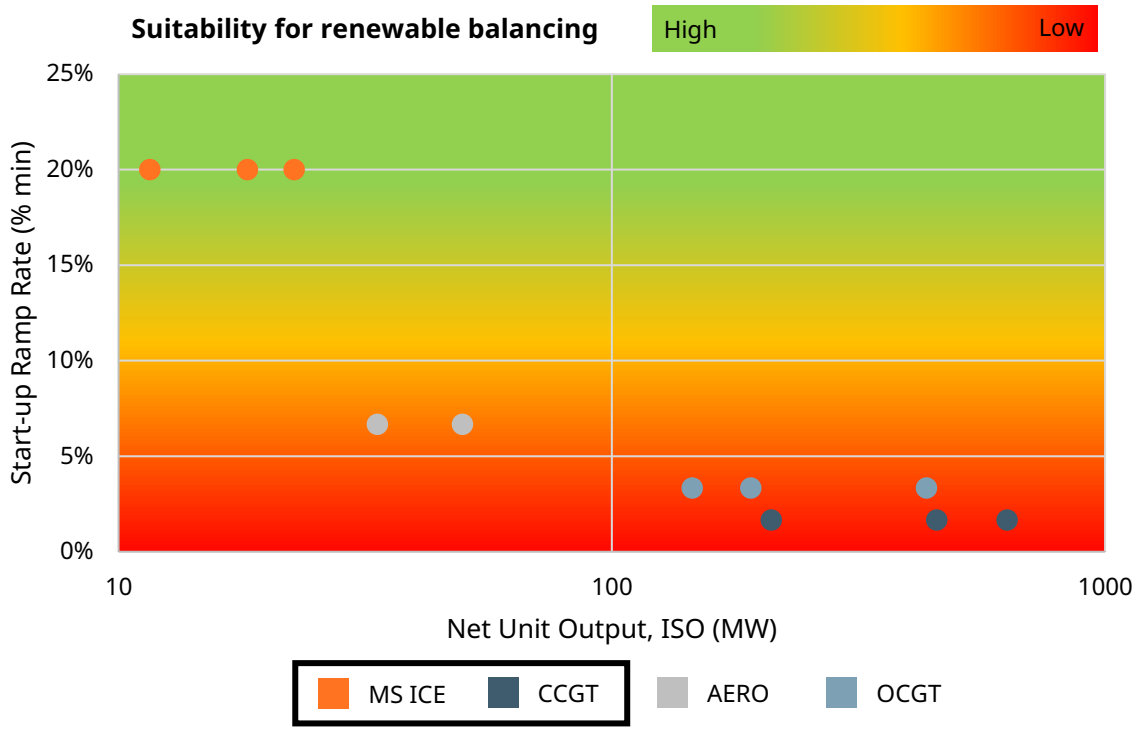
Units combining high flexibility and modularity help offset renewable variability while supporting grid stability through distributed generation

Renewable generation: Solar PV and wind generation introduce great variability to the system as renewable output can swing up to 20% within a few minutes



Note: Illustrative, measurement-calibrated synthetic renewable profiles based on NREL solar and wind data. Short-term variability is calibrated to published high-frequency measurements, while the 60-minute profiles are modelled at 15-second resolution and do not represent a specific historical operating period.

Generating set flexibility: Engines can meet the load change of renewables, while gas turbines cannot keep up with them



Note: Start-up ramp rate shown as cold start,% of net output per minute. Net unit output at ISO conditions. Illustrative. Wärtsilä analysis.

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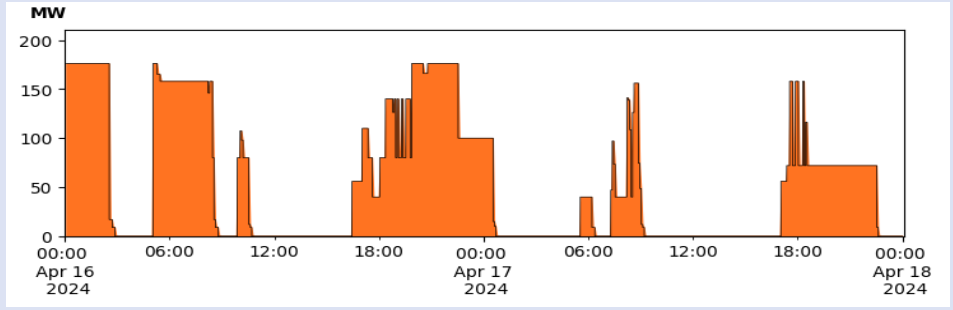
Each technology's real operating pattern reflects its design strengths

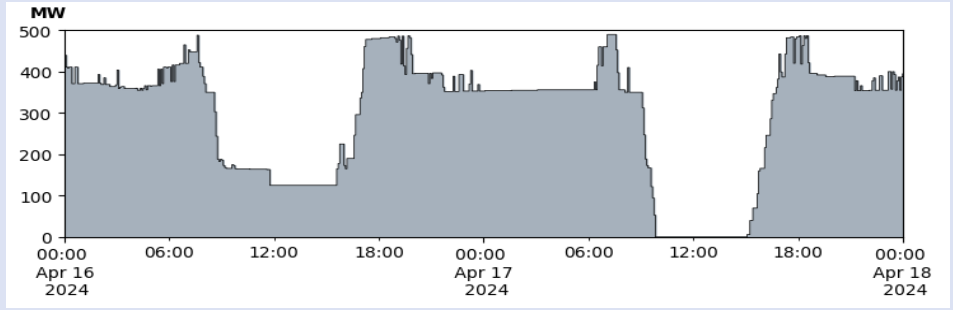
Australian NEM dispatch data confirms that each technology runs as its design intended



MS ICE

Engines combine high full-load and part-load efficiency, very fast start and modular sizing, which shows up as:

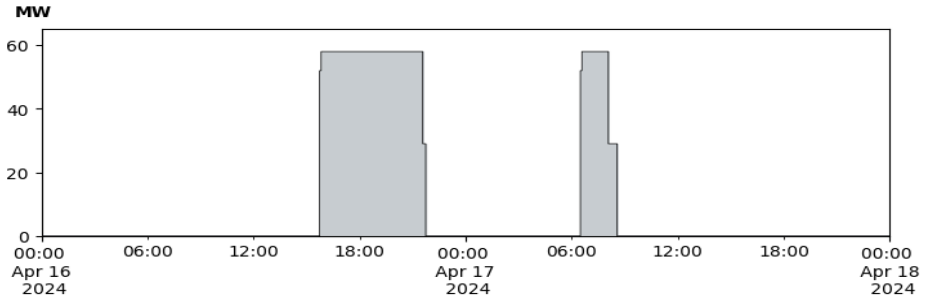
- Rapid start-stop cycles
- Extended part-load operation
- Load-following



CCGT

Combined cycle gas turbines have high full-load efficiency but limited starting capability, which shows up as:

- Continuous operation with limited shutdowns
- Operations constrained by minimum stable load



AERO & OCGT

Aeroderivative gas turbines and **open-cycle gas turbines** have relatively fast start, but they are not designed for multiple daily starts or extended part-load operation, which shows up as:

- An on-off operating pattern with limited daily starts and full-load operation

Source: Australian NEM database

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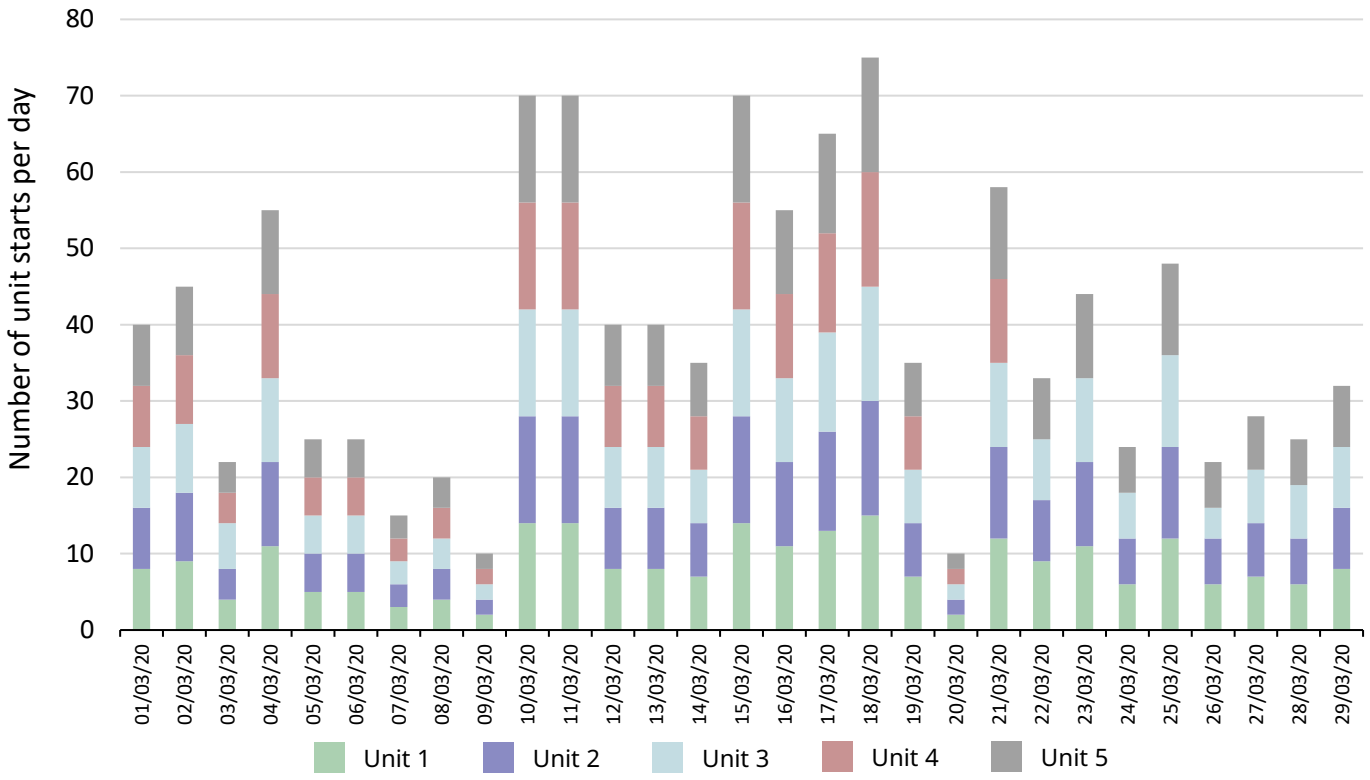
Engines can run exactly when needed for streamlined operations



Wärtsilä engines can be turned on and off multiple times during a day without additional penalty in maintenance cost or wear

No idling needed

No fuel wasted

No CO_2 emitted

© WÄRTSILÄ

Medium-speed engines are increasingly the preferred choice as power systems prioritise flexibility and modularity over unit scale

Leading energy analysts now identify flexibility and modularity as key factors for new capacity

Engines are the cheapest option for data centers, followed by open cycle turbines

BloombergNEF

Thermal Generation: The Importance of Maximizing Flexibility and Availability in the Coming Era of High Capacity Prices and Low Energy Prices

Ascend Analytics

Table 1 shows typical cost and flexibility characteristics for modern Natural Gas Combined Cycle (NGCC), Natural Gas Combustion Turbine (NGCT), NGCT Aeroderivative, and Reciprocating Internal Combustion Engine (RICE) plants.[1] While NGCCs are the most efficient, they are also significantly less flexible than the other resources, requiring longer to start, higher minimum generation levels, longer minimum on-times, and slower ramp rates. This reduced flexibility puts NGCCs at a disadvantage in an era of low and volatile power prices. RICE units have historically been more expensive than CCs and CTs, but turbine supply shortages that extend through the late 2020s have led to significant rises in gas turbine costs without corresponding rises for RICE units, leading to RICE now being cheaper, more efficient, and more flexible than an NGCT.

As seen in **Figure 1**, NGCCs (which are the most efficient) earn the highest net revenue while RICE units have nearly as high revenue, owing to their high flexibility and efficiency. RICE units have the added advantage of modularity, which allows them to operate more frequently in their more efficient range and be less likely to experience total outages during valuable time periods. NGCTs have much lower revenues due to their lower efficiency, with the improved flexibility of aeroderivative turbines driving a small increase in revenue relative to frame NGCTs.

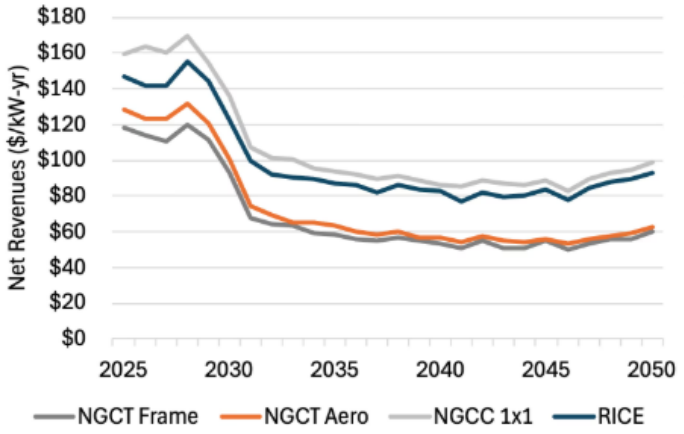


Figure 1. Net revenues by asset type for various gas generators

- Because large unit size and maximised fuel efficiency do not determine every new build project, medium-speed engines are gaining traction alongside gas turbines
- Flexibility and modularity are often highlighted as characteristics that set engines apart from gas turbines
- CCGTs lead at full load and high capacity factors, while engines lead when extended part-load operation, frequent starts and flexibility are required
- Site conditions and operating profile can raise the cost of gas turbine plants significantly

Source: 1) BloombergNEF, 2026, Data Center On-Site Gas Power Costs (behind paywall) 2) Ascend Analytics, 2025, Thermal Generation: The Importance of Maximizing Flexibility and Availability in the Coming Era of High Capacity Prices and Low Energy Prices.

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Eskom Unbundling and the Next Chapter of Power Market Development in Southern Africa

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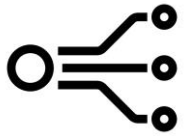
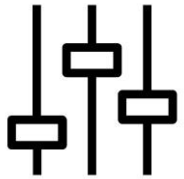
A larger system transformation



Institutional: vertically integrated utility to separate market functions



Generation: a more diversified generation mix



Commercial: Centralized procurement to multiple routes to market



Regional: deeper participation in the Southern African Power Pool

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Where South Africa is today

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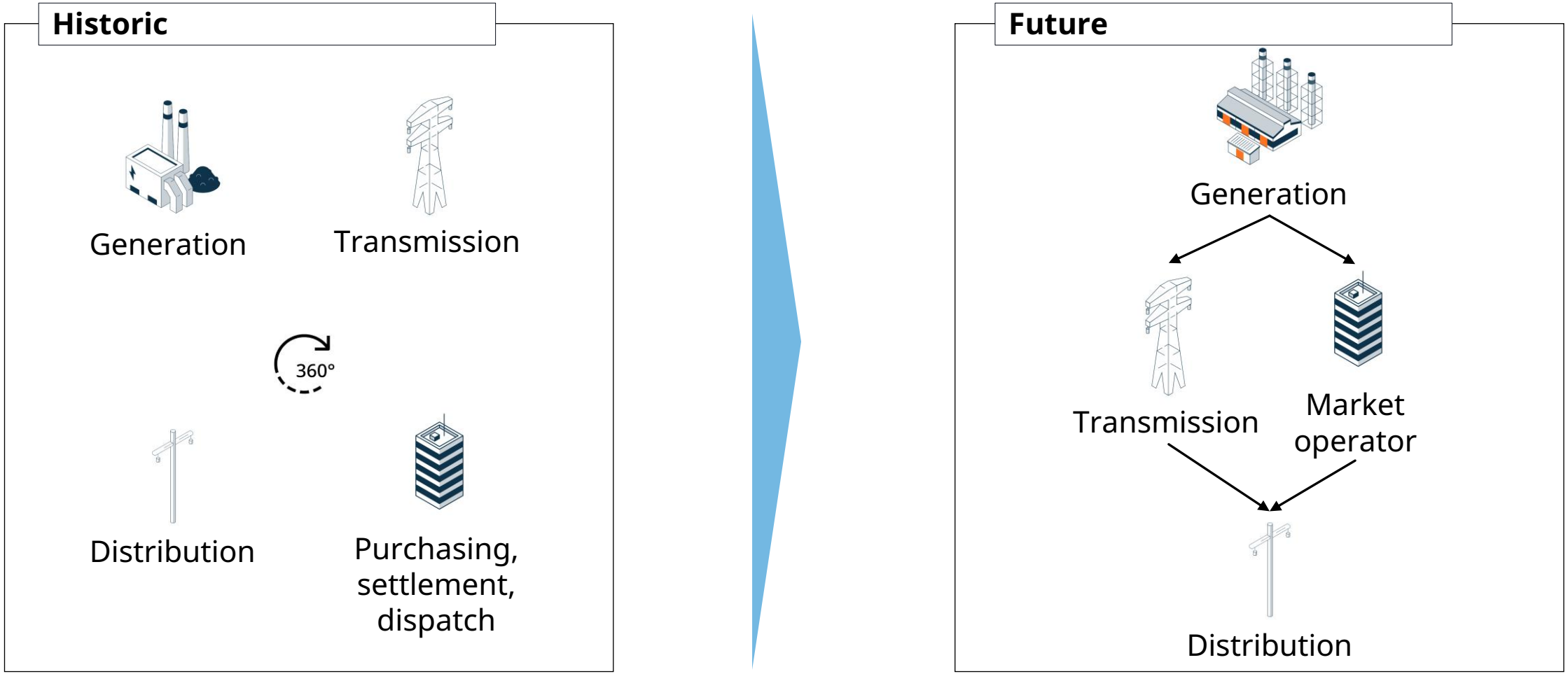
Eskom's unbundling creates new routes to market



This is a change in the operating character of the system, not simply a change in installed capacity.

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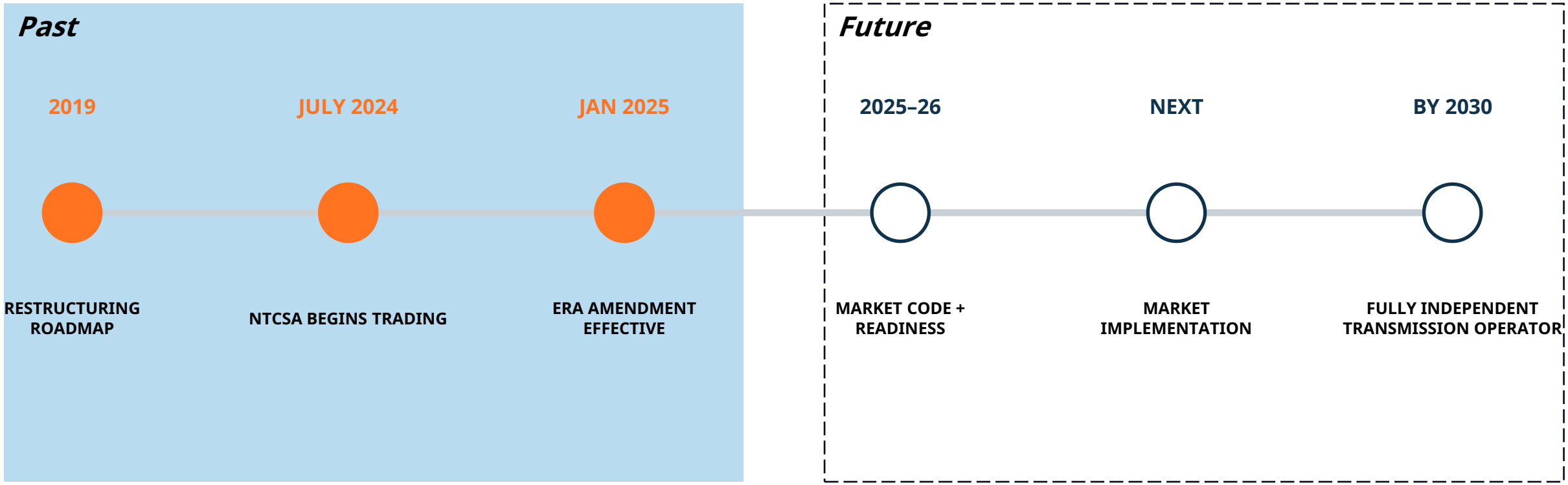
The direction is established, but implementation remains staged



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Where South Africa goes from here

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Unbundling is a catalyst for market reform

Today	Emerging	Target
Single buyer model	Day ahead energy market	Capacity remuneration
Bi-lateral PPAs	Balancing market	Trading
	Ancillary services market	

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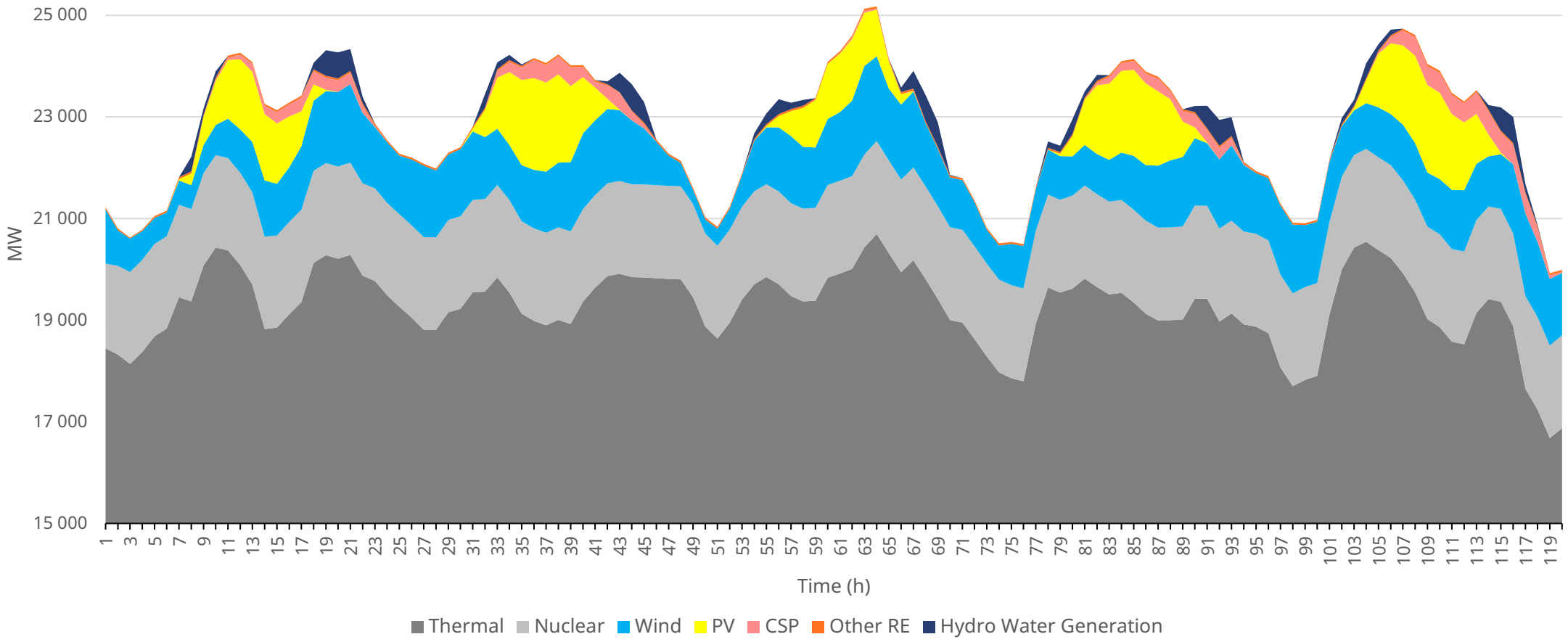
Changing demand and generation mix increases the need for flexibility

Dispatch during 5 days in September 2022



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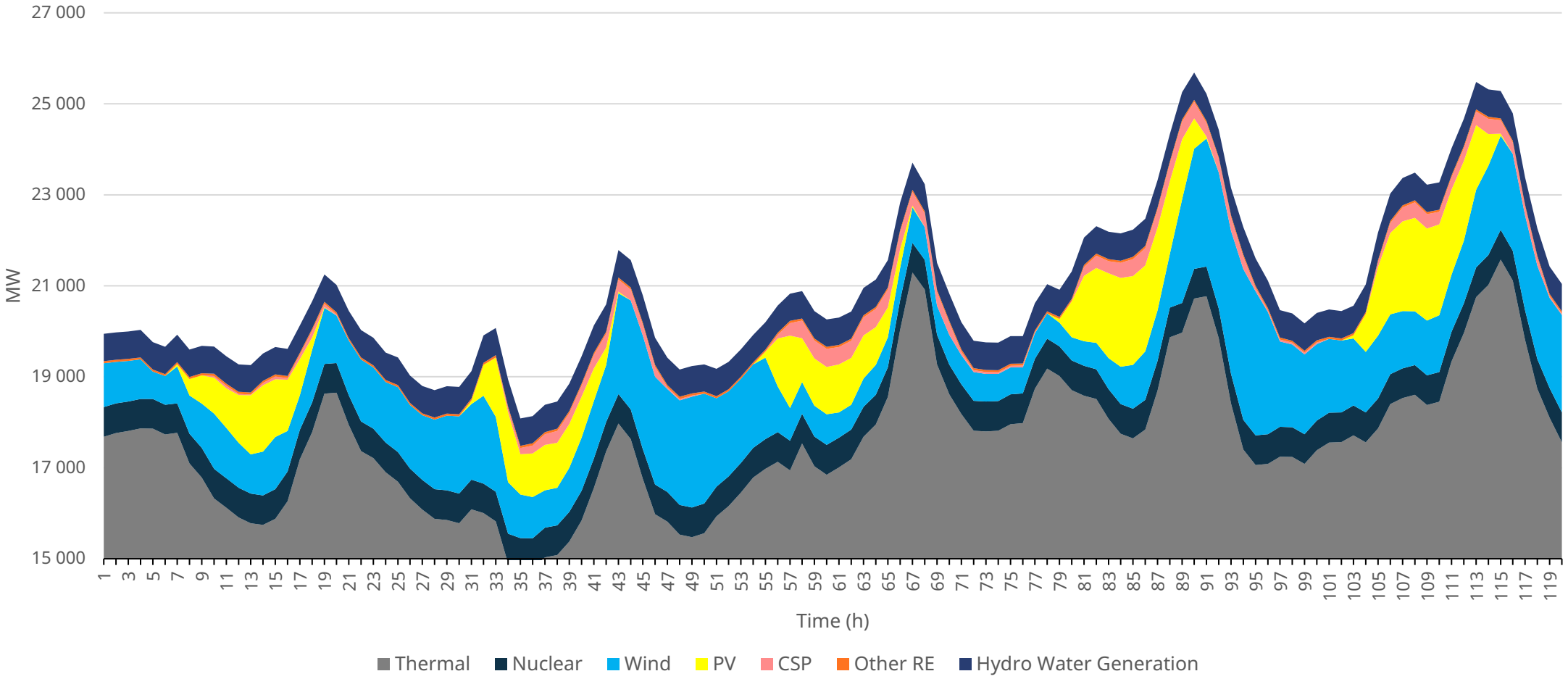
Changing demand and generation mix increases the need for flexibility

Dispatch during 5 days in September 2026



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A changing system required new services

System Challenges

- Variability
- Forecast errors
- Congestion
- Reduced synchronous generation

System needs

- Balancing
- Ramping
- Reserves
- Inertia
- Voltage support

Increasing variability does not eliminate the need for firm capacity, it changes services capacity must provide.

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GASIPPPP BW1 recognized that new capacity must move beyond just energy

Traditional view	GASIPPPP BW1 view
Energy	Energy
	Capacity (MW)
	Ancillary Services

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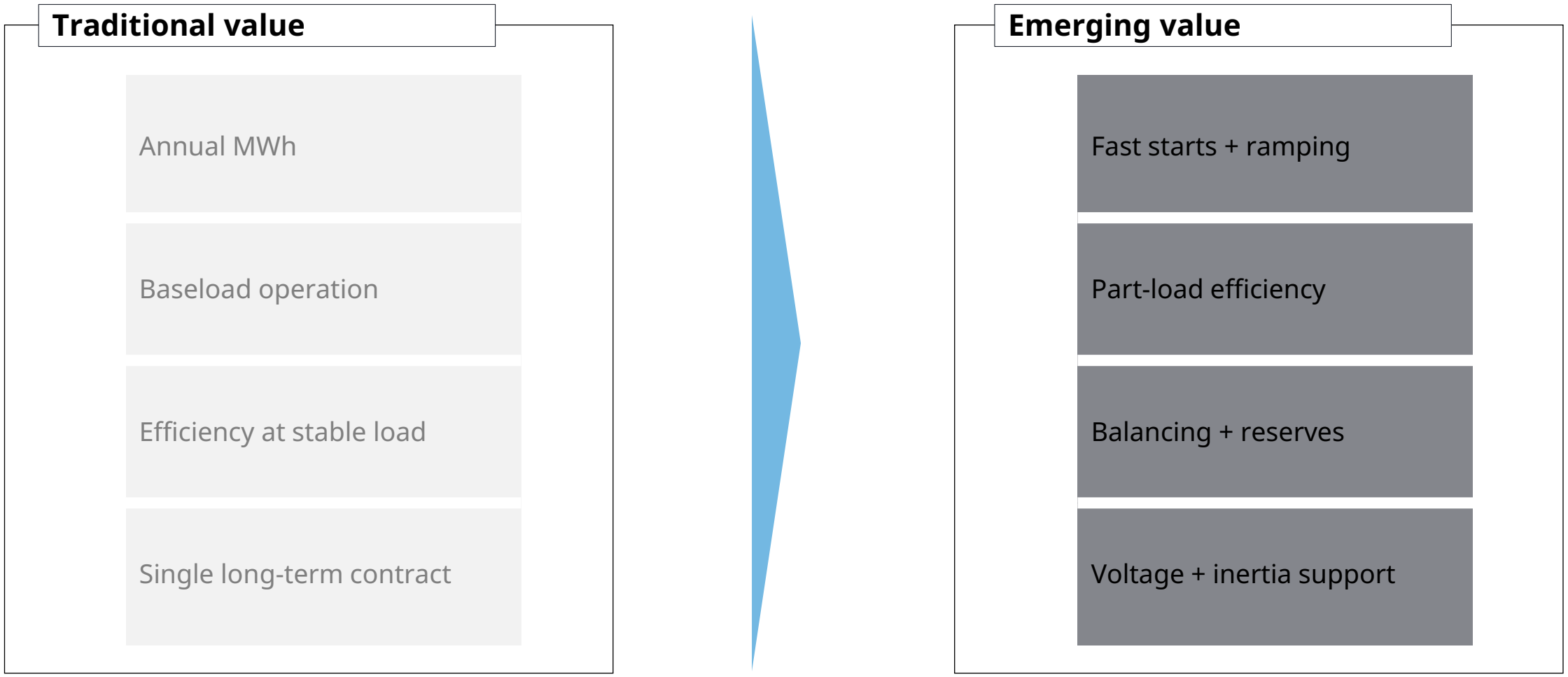
Thermal projects will increasingly need a market role, not only a technology case



The investment case moves from a single revenue stream towards a potential revenue stack.

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Unbundling and the SAPP

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SAPP has a functioning architecture, but limited market depth

Current Market Model

BILATERAL	FORWARD	DAY-AHEAD	INTRADAY	BALANCING

What Exists

- Regional institutions
- Multiple market timeframes
- Cross-border scheduling
- Settlement framework

What Constrains Depth

- Transmission bottlenecks
- National market barriers
- Credit and settlement readiness
- **No balancing trades reported since launch**

191.2 GWh traded in August 2026 | 33% of matched bids blocked by transmission constraints

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South Africa can bring scale and capability to the regional market

Domestic reform	Regional effect
Neutral system operation	More buyers + sellers
Balance responsibility	More short-term liquidity
Forecasting + scheduling	More flexible resources
Settlement + ancillary procurement	**Clearer regional price signals**

Domestic market reform is not SAPP integration, but it builds many of the capabilities deeper regional participation requires.

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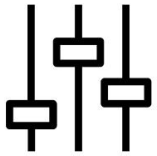
Three takeaways



South Africa: unbundling creates the framework for competition and new services



SAPP: Domestic balancing services can lead to regional balancing services as the market continues to evolve



Developers: Future value will lie in flexibility, not only baseload energy

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Azura Power

Multi-asset Pan-African Power Generation Company

Wärtsilä Energy, Southern Africa Energy Transition Forum: 29 October 2026



STRICTLY PRIVATE AND CONFIDENTIAL

Overview of 752MW Operational Portfolio

Azura is a multi-asset, pan-African power generation company, with controlling interests in IPPs in 3 major markets: Nigeria, Senegal and Mozambique.

IPP	1 Azura-Edo	2 CTRG	3 Tobene
Asset			
Country			
Size	461MW	175MW	116MW
Technology	Gas Open Cycle GT, Siemens	Gas Reciprocating Engines, Wärtsilä	Combined Cycle Thermal Plant *Convertible to run on gas upon supply becoming available*
COD	May 2018	Feb 2015	Mar 2016
Offtaker	NBET NIGERIAN BULK ELECTRICITY TRADING PLC	ELECTRICIDADE DE MOÇAMBIQUE, E.P.	senelec
Enhancement Plans	Conversion to CCGT (+275MW) Potential BESS addition	Conversion to Combined Cycle (c.13MW) Potential BESS addition	Conversion to Gas
Lenders	IFC, DFC and other leading DFIs & commercial lenders	IFC, Proparco and ABSA	IFC, BOAD, FMO and EAIF
Credit Enhancement	Government support, WB PRG, MIGA PRI	Government support, MIGA PRI, LC by EDM	Government support, WB PRG, MIGA PRI

Enpower Trading

Azura has also recently acquired a majority stake in Enpower Trading (Pty) Ltd - **Energy Trader** in RSA, with conditional SAPP license.

Experience in Owning and Operating
CTRG 175 MW Gas Power Plant in Mozambique



Owning and Operating CTRG (1)

- **CTRG operational experience**

Azura completed the acquisition of CTRG in Apr 2022, demonstrating belief in the technology's reliability, modularity and suitability for long-term power generation.

- **Operational advantages**

Ability to maintain 18 individual Wärtsilä gas engines while keeping the remaining units operational, good part-load efficiency and flexibility in dispatch.

- **LTSA relationship**

Wärtsilä's long-term maintenance support is important for equipment reliability, spare parts planning and lifecycle management. Predictability of maintenance costs and OEM responsiveness remain key considerations.

- **Challenges**

Maintenance intensity across numerous (18) engines, ageing equipment, spare parts costs, gas

CTRG
Central Térmica de Ressano Garcia



Owning and Operating CTRG (2)

- **Future opportunities**

Waste heat recovery feasibility work has been completed, with commercial discussions underway with EDM to improve overall plant efficiency and utilisation.

- **Comparison with gas turbines**

Compared with Azura-Edo's Siemens 2000E turbines, Wärtsilä engines offer greater modularity and part-load flexibility, while gas turbines are well suited to large-scale continuous generation. Both technologies have *complementary roles*.

- **South Africa and SAPP**

Gas engines could support renewable energy integration, provide flexible and dispatchable capacity, and potentially contribute to regional electricity trading and balancing services, subject to market and transmission arrangements.

- **Key takeaway**

CTRG provides a proven regional reference for gas-

CTRG
Central Térmica de Ressano Garcia



Views on the Southern Africa Market Environment and Future Opportunities in the Energy Sector



Southern Africa Market Views (1)

Historically, most renewable projects were developed under long-term PPAs with state utilities such as Eskom, ZESCO, EDM or NamPower.

Southern Africa is **evolving beyond a market dominated by utility-scale, single-buyer IPPs** into a more sophisticated electricity ecosystem where generators, aggregators, traders, storage providers and large consumers all play active roles.

Mines, smelters, data centres, manufacturers and agricultural operations are seeking cheaper, greener and more reliable electricity. Rather than relying solely on utilities, they increasingly procure power directly from IPPs through wheeling arrangements and corporate PPAs. This **creates a market** where intermediaries can **aggregate demand** from **multiple buyers**.

Countries across the region are gradually introducing **wheeling frameworks**, **open-access transmission rules** and market **liberalisation**. South Africa's electricity market reforms, planned **SAWEM** and the **SAPP** evolving from a cooperative utility pool into a competitive electricity market with day-ahead, intra-day and forward trading platforms are examples of this broader trend.

As electricity becomes a tradable commodity rather than purely a regulated service, traders can create value by:

- Arbitraging regional price differences
- Optimising generation portfolios
- Selling structured products to customers

Southern Africa Market Views (2)

Enpower Trading

- In Sept 2026, Azura completed the acquisition of a majority stake in Enpower Trading (Pty) Ltd, marking Azura's 1st investment in South Africa.
- Enpower is a licensed South African electricity trader, buying electricity from independent generators and supplying C&I customers across the national grid.
- It holds the 1st new private electricity trading licence granted by the NERSA in more than a decade, together with an import and export licence and conditional market-participant status in the SAPP.
- Enpower is initially wheeling solar PV energy from SolarAfrica's SunCentral 1 project to:
  1. Sappi: 145 GWh/y
  2. Mpact: 30 GWh/y
- Future opportunity in progress: Datacentre and Smelter customer(s) to be supplied with Wind.

AZURA

Enpower fits our strategic growth intent for the evolving Southern Africa energy sector as it:

1. Keeps Azura at the **forefront** of the **power sector evolution**
2. Enhances our **energy transition** credentials
   - Day 1 addition of 85MWp of renewable energy capacity
3. Provides **route to install renewable energy** capacity at a **meaningful scale**
4. Positions Azura in a leading role in **South Africa's rapidly evolving power sector** (with near-term opportunity in SADC countries / SAPP)
5. **Diversifies and broadens** our business model
   - Complementary step-out from our pure Government/ Utility risk profile => to progressive C&I segment
6. Captures **more** of the **generation margin**
   - Pure IPP returns on long-term bilateral PPAs in SA are not overly attractive, relative to thermal

Making Money With Flexibility: featuring global market perspectives and case study from Australia

Tord Johnsson
General Manager, Business Development,
East & Southern Africa
Wärtsilä Energy

tord.johnsson@wartsila.com



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Energía del Pacífico – El Salvador

Providing about one third of the country’s electricity supply

The 378 MW power plant is the largest and most efficient power plant in El Salvador and the first in Central America to use liquefied natural gas (LNG).

FSRU BW Tatiana moored in the bay.

This project produces the cleanest thermal electricity in El Salvador, by producing 30% less carbon emissions and 99% less sulphur dioxide emissions.

EDP is also reducing electricity prices in the country as LNG is cheaper than liquid fuel.

The power plant comprises 19 Wärtsilä 50SG engines and a steam turbine in a highly efficient Flexicycle combined cycle arrangement.

The Dry Flexicycle technology with a closed-loop cooling system has zero water consumption, which is a major environmental benefit.

Wärtsilä Operations & Maintenance solution for 15 years



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4 How can utilities and independent power producers monetise their flexible assets?

5 Case studies from different markets: Australia, Japan and the Philippines

6 Considerations for utilities and independent power producers: What to evaluate in power markets before building a flexibility monetisation business case

7 Appendix

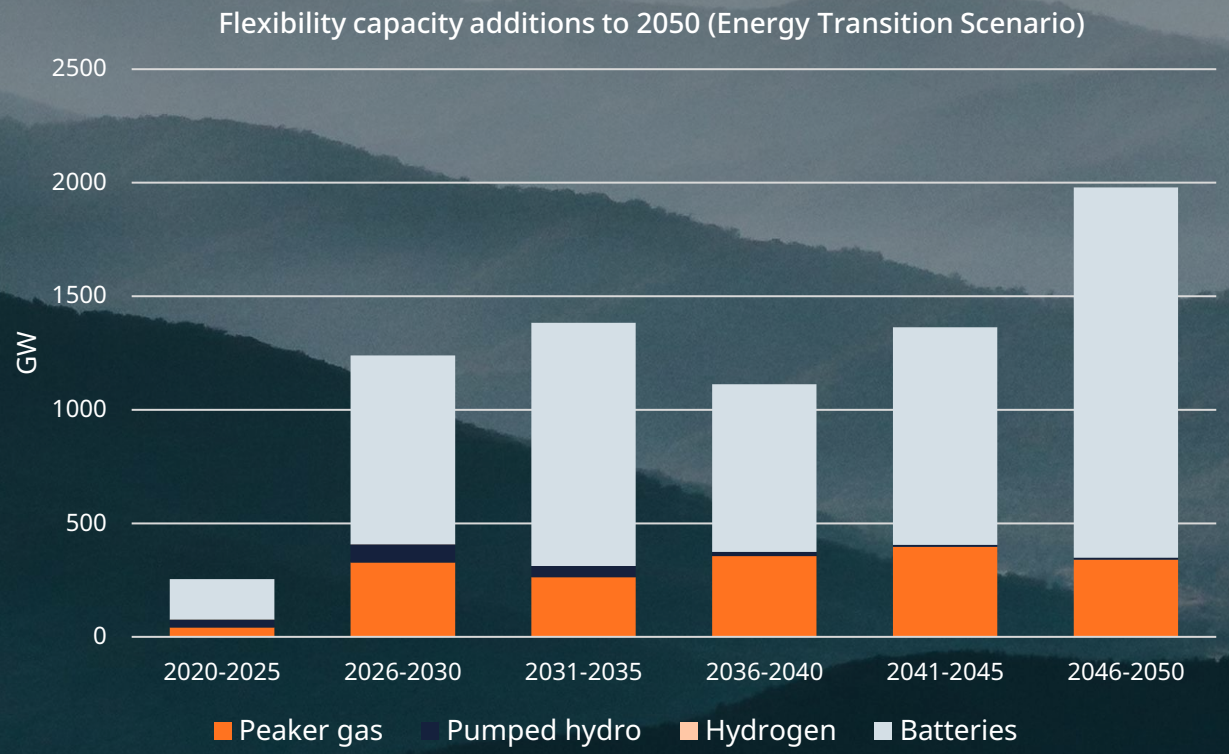
Flexibility in the energy transition

Improving power system stability while maximising value for businesses

In today's rapidly changing energy landscape, flexibility is becoming increasingly crucial for power systems to not only ensure grid stability but also as a strategic opportunity to boost revenue.

The inflexibility of traditional energy systems, combined with the rise of renewables and changing climatic conditions, has led to significant challenges. To accelerate the energy transition and achieve global decarbonisation targets, it is essential to introduce more flexible balancing assets that are capable of rapidly responding to changes and fluctuations that renewables bring to the power system.

According to BloombergNEF, an estimated 6,972 GW of flexible capacity will be added globally by 2050, of which 1,686 GW is peaking gas and 5,286 GW battery storage. Similarly, the International Energy Agency (IEA) predicts that the flexibility requirements will be increased by four times by 2050, compared to 2023, due to higher variability in electricity supply and demand.



Source: BloombergNEF New Energy Outlook 2025

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Adding flexibility to power systems offers numerous benefits and adds substantial value. Flexible assets can adjust their output quickly in response to changing system needs. This ability enables integration of an increasing share of renewables by compensating for their variability (e.g. sudden drops in solar or wind output), thus preventing curtailment and allowing more clean energy into the system.

Adding flexibility also leads to increased system efficiency and reduced fuel consumption as flexible assets only need to run when they are needed, avoiding inefficient must-run operations. Lastly, flexibility enhances power system stability and reliability by maintaining real-time balance between supply and demand, controlling frequency and voltage deviations, and providing fast reserves during unexpected events, therefore reducing the risk of blackouts or system failures.

One area which does not get enough spotlight, is that flexibility also brings substantial monetary value to power generation asset owners, such as utilities and independent power producers (IPPs). With renewables on the rise, volatility is increasing in modern, liberalised electricity markets. In these markets, where renewable intermittency already has a visible effect, flexible assets can register better returns than their less dynamic competitors.

Furthermore, flexible assets create additional value by providing grid services or in certain cases reduce the operation costs of their asset owners. For example, a flexible asset can provide protection against high electricity procurement costs during periods of extreme or unpredicted electricity prices, thus reducing its financial risk.

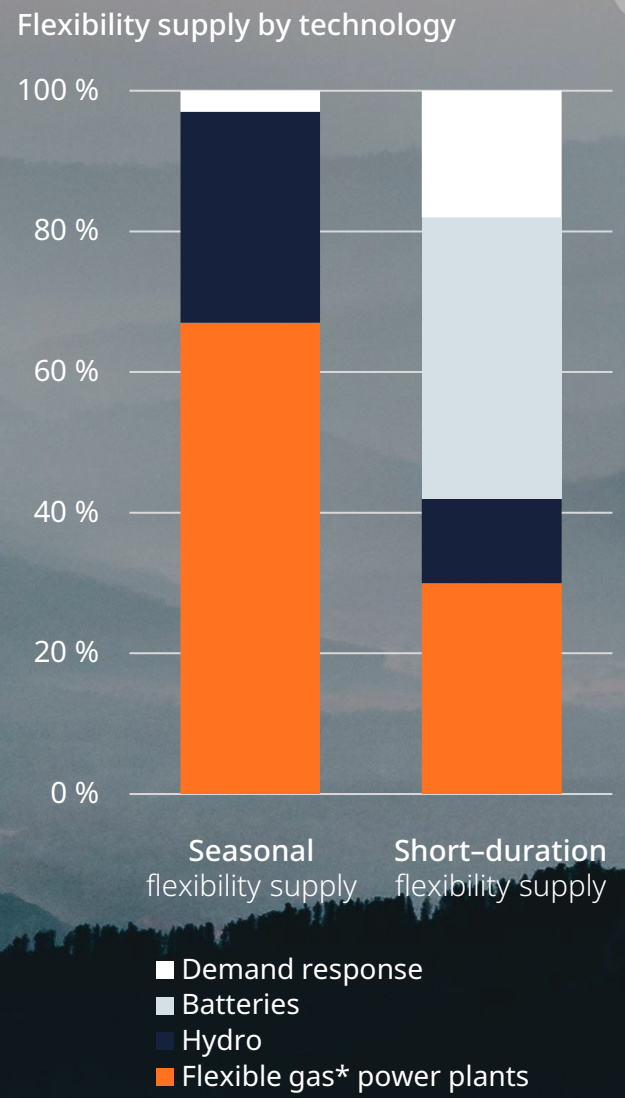

Chart source: International Energy Agency.
*Able to run on hydrogen or other sustainable fuel in the future.

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Understanding flexibility of different technologies

As the energy transition progresses, flexibility is becoming a critical factor for utilities and IPPs to ensure business continuity and profitability. The International Energy Agency (IEA) defines flexibility as “the ability of a power system to reliably and cost effectively manage the variability and uncertainty of supply and demand across all relevant timescales”.

As the share of intermittent renewable energy increases, the ability for power plants and energy storage systems to respond to changes in supply and demand across various timeframes is becoming increasingly important. Understanding the main differences between technologies and the extent to which they are flexible enough to provide services across different timeframes is key for IPPs and utilities to optimally monetise their assets in the electricity market. Defining the intended use case helps to narrow down technology choices.

Examples of how different dispatchable technologies vary in terms of flexibility:



Battery energy storage systems
Energy can be stored or discharged to handle millisecond and minute-level fluctuations and providing support during peak times. Thus, battery energy storage systems are ideal for providing ancillary services, and energy up to 2-4 hours in duration if they are in charged state.



Pumped hydro
Where geographically possible, pumped hydro can provide balancing across multiple timeframes, but its availability is dependent on seasonal water cycles, which can vary considerably year by year.



Flexible thermal generation
Flexible reciprocating internal combustion engine power plants and aeroderivative gas turbine power plants can be dispatched on demand, to fill gaps in renewable energy across minute-level, daily, seasonal and inter-annual variations.



Inflexible thermal generation
Traditional power plant technologies such as coal, nuclear and combined cycle gas turbines are designed to operate at high utilisation rates with minimal starts and stops. Dynamic utilisation is typically technically limited and incurs increased operating costs.

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In order to monetise flexibility, it is essential to have a more nuanced understanding of technical parameters of different technologies within the intended use case. This is especially important as flexibility related value capturing opportunities can be unpredictable and vary in duration. Even technologies within the same category provide trade-offs in their features.

As an example, thermal generation is sometimes mistakenly viewed as having similar technical flexibility parameters. In this category, the key properties used to measure flexibility include:

Start-up time to full load: Shorter start-up times enable rapid response to sudden gaps in renewables or supply-demand changes. Measured in minutes or hours.

Ramp rate: The ability to ramp up and down quickly is essential for providing balancing and firming capacity. Measured as %/minute or MW/minute.

Minimum uptime and downtime: Minimum uptime refers to the minimum operational time after start-up before safe shutdown. Minimum downtime refers to the minimum time after shutdown before safe restart. Measured in minutes or hours.

Plant net efficiency: High efficiency at different load levels helps minimise fuel costs and emissions, maximising operational flexibility as thermal power plants shift from pure baseload to balancing renewables. Measured in percentages or heat rate.

Minimum stable load: The lowest power output at which a power generating unit can operate continuously and in a stable fashion, without time limitations. Measured as % of nameplate capacity.

Understanding flexibility is key to making the most revenue with flexible assets in the evolving energy landscape. Flexibility in power generation is not only a requirement to ensure stability in the grid, but also something businesses can utilise strategically to increase their revenues. By having the right technology to match with available market opportunities, utilities and IPPs can manage their risks and ensure positive returns for their businesses.

	Engines	Aero-GTs	OCGTs	CCGTs	Coal
Start-up time	2 min	8 min	5 – 10 min	30 min – 4 h	75 min – 10 h
Average ramp rate [% Pnom/min]	>100%	50%	8 – 15%	2 – 11%	1 – 6%
Minimum uptime	0 min	10 min	10 – 30 min	4 h	8 – 48 h
Minimum downtime	0 min	30 min	30 – 60 min	2 h	8 – 48 h
Plant minimum load [% Pnom]	10%	20 – 40%	20 – 50%	20 – 50%	10 – 60%
Efficiency (at 100% load)	45 – 48%	36 – 40%	35 – 39%	52 – 57%	40%
Efficiency (at 50% load)	45 – 48%	28 – 33%	27 – 32%	47 – 51%	35%

Sources: IRENA (2019) and Wärtsilä (2024)

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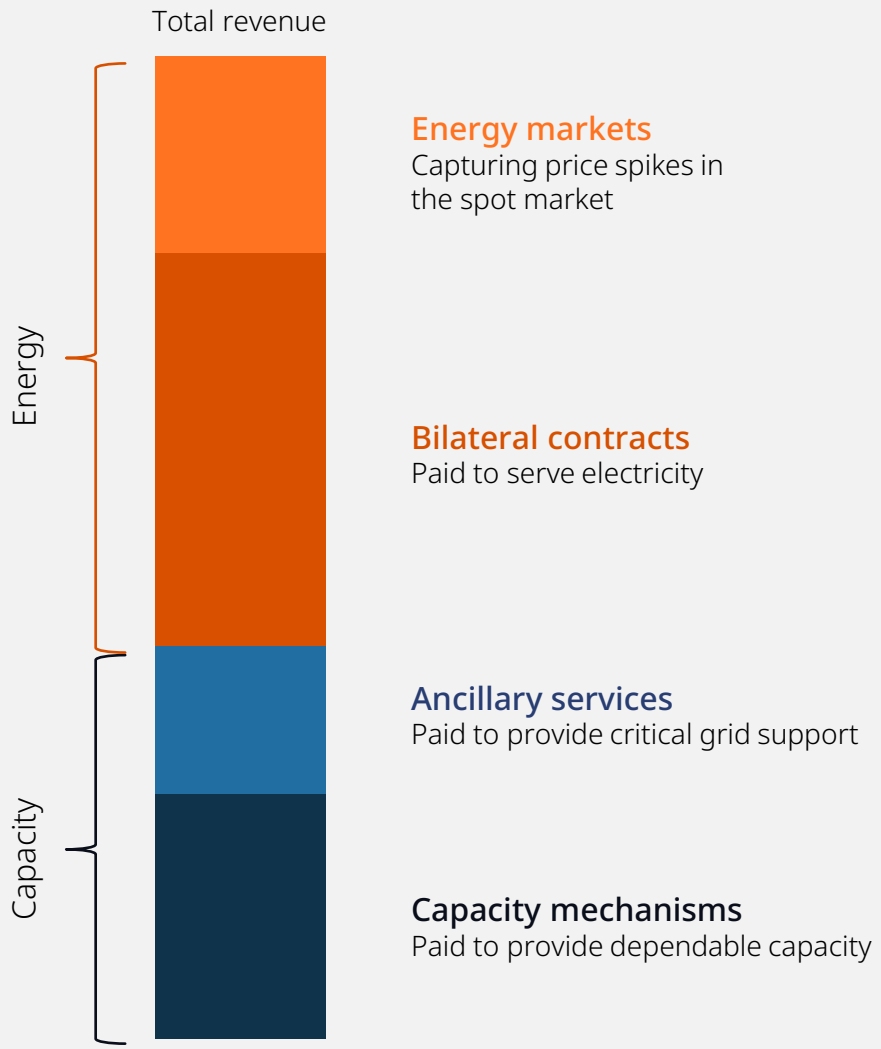
Combining multiple revenue streams, also known as revenue stacking, is key to making flexible assets financially viable. Relying solely on energy sales may not offer sufficient returns so flexible asset owners are optimising returns by offering multiple services simultaneously and/or switching between revenue streams as market opportunities shift throughout the day. Therefore, it is important to understand and capture all available revenues. The next sections will explain the commonly available revenue streams for flexible assets.

Illustrative example of revenue stacking from various streams



Note: Actual revenue from each stream will depend on multiple factors, such as market design, contract terms, asset performance, and regulatory framework, among others.

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South Australia is part of Australia's National Electricity Market

The largest Australian grid, covering 80% of national electricity use



Barker Inlet Power Station is located in Adelaide, South Australia (NEM)



Australian Energy Market Operator (AEMO) runs the NEM

The largest national grid and electricity market the **National Electricity Market** (NEM) covers 80% of national electricity consumption

It is one of the world's longest interconnected electricity systems in the world, connecting eastern and southern states and territories.

In the NEM, energy is generated and used in each region and traded between regions.

Source: AEMO website

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South Australia: The power system of the future

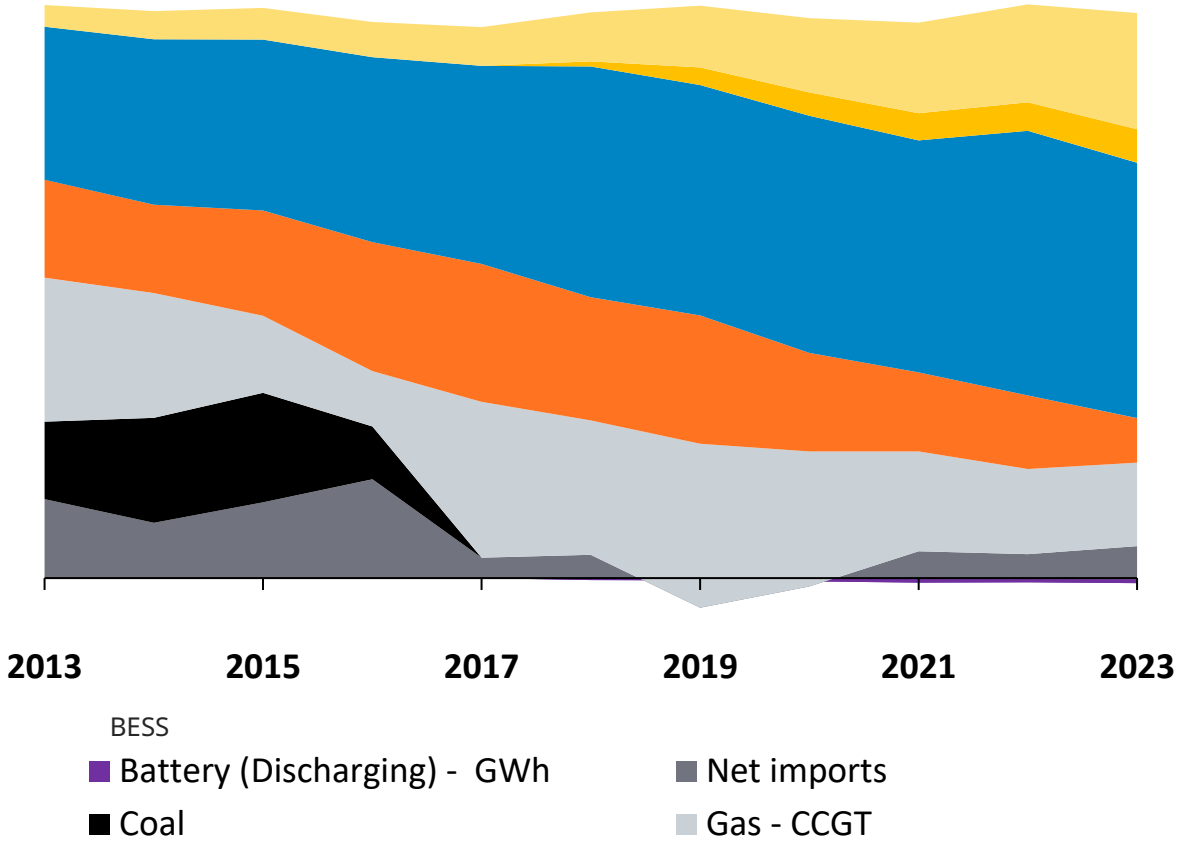
4th largest NEM region with 11 GW capacity (2023)

Most progressive NEM region with 74% variable renewable energy

Coal was phased out in 2016

Firmed by gas, interconnection and battery energy storage systems

1.1GW Gas power retiring by 2030



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Barker Inlet in action

Firming renewables, serving reliable power and stabilising the grid in South Australia

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Barker Inlet Power Station

An integral part of AGL Energy's green transformation

Gensets	12x Wärtsilä 18V50DF
Capacity	211 MW
Fuel	Dual fuel (primarily natural gas, capable of liquid fuel)
COD	December 2019
Scope	EPC with 10-year maintenance services agreement

How does Barker Inlet contribute to AGL's business?

Firm, reliable power alongside renewable generation, particularly wind power.

Cost savings and less GHG emissions. 28% more efficient and 25-50% less unit emissions compared to gas turbines.

Dual-fuel technology. Option of using diesel fuel if gas becomes unavailable or limited in South Australia.

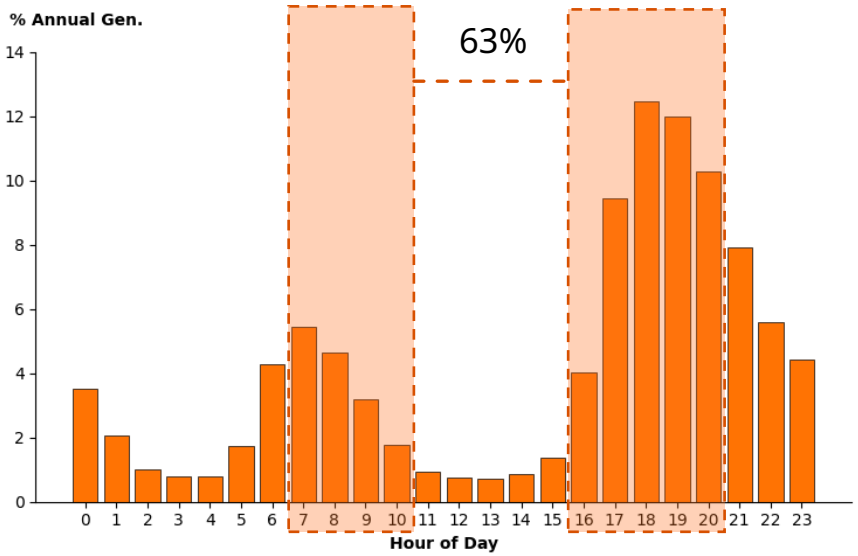
Addresses reliability gaps in South Australia. Dispatchable capacity, inertia, and black start capabilities.



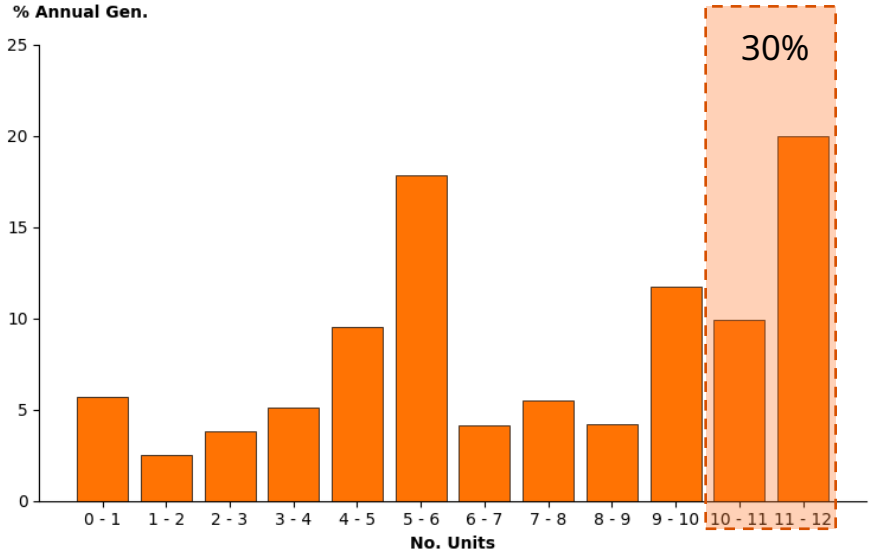
© WÄRTSILÄ

Barker Inlet serves reliable power in times of need

Daily operating profile 5-year average, June 2020 – June 2024



Distribution of operating hours by engine units, June 2020 – June 2024



~2,500 annual running hours

50% more than aeros and
2x heavy-duty OCGTs

More than just a peaker

Only ~63% of all daily hours occur during morning, evening peaks [1]

Part-loading operations

The plant runs more than 10 engines only ~30% of the time.

[1] 7am – 11am, 4pm – 9pm

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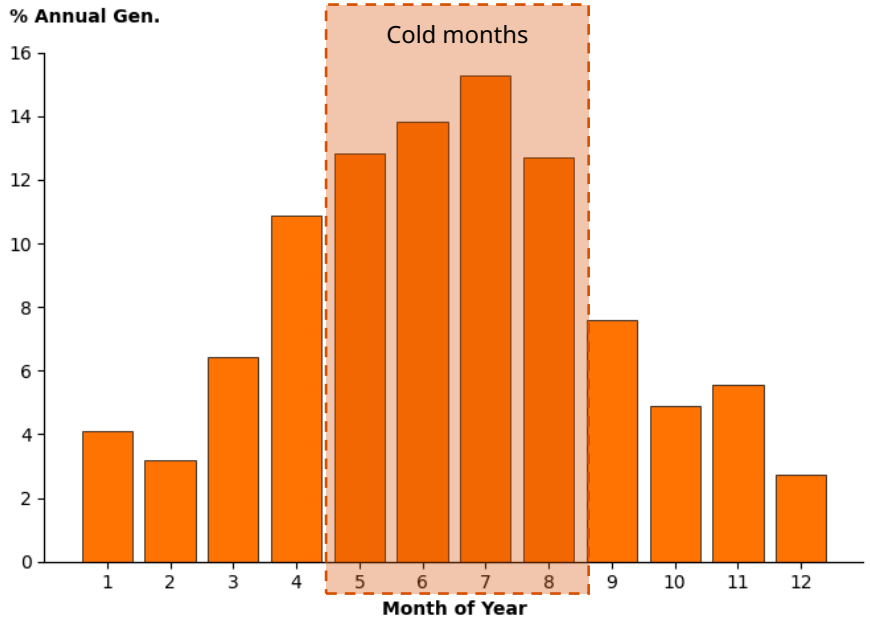
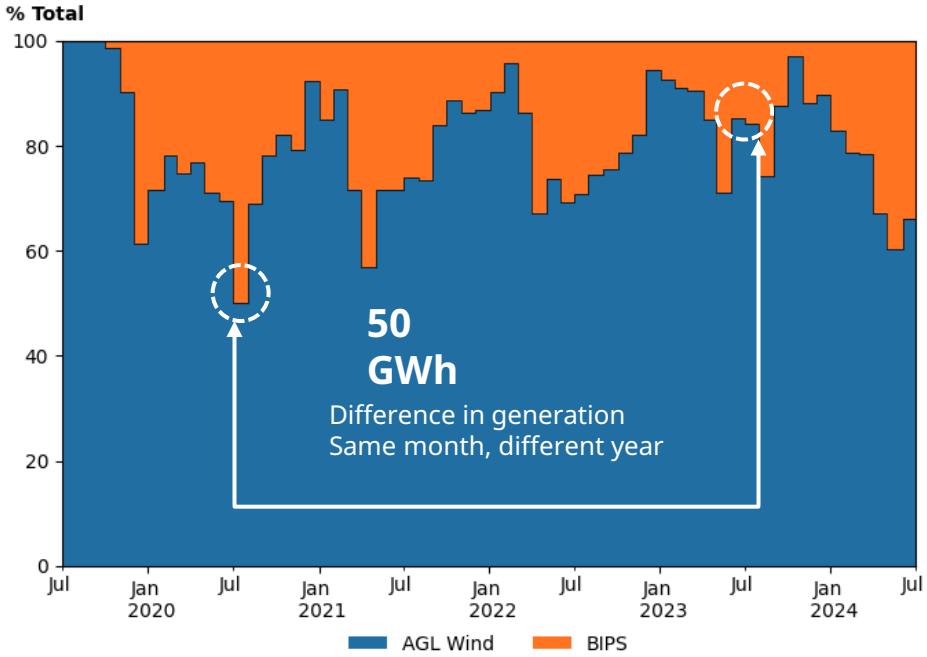
Barker Inlet covers seasonal loads and renewable droughts

BIPS monthly operating profile, 5-year average
June 2020 – June 2024



Seasonal power during cold months.
~55% of all annual hours occur May - August

Monthly wind and BIPS generation over 5 years
June 2020 – June 2024



Barker Inlet serves high demand particularly when renewables are insufficient

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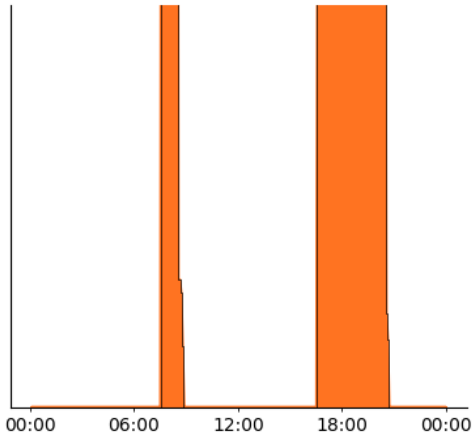
Balancers combines multiple capabilities without constraints

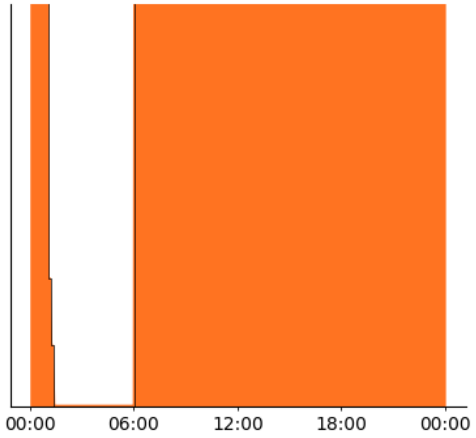
Barker Inlet provides the additional reliability that renewable power systems need

Peaking



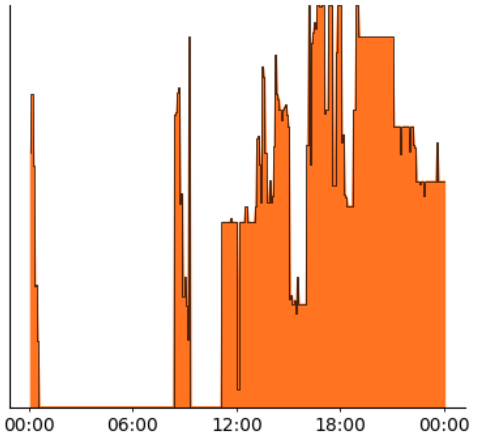
Covering regular morning and evening peaks

Continuous



Providing stable power in times of need

Load-following



Adapting to variable renewable generation and load

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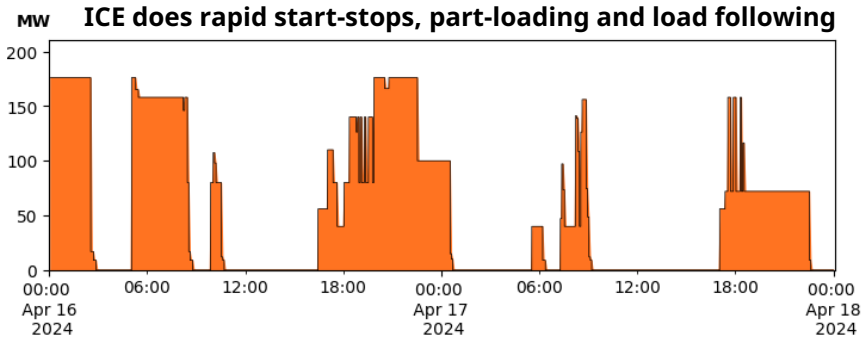
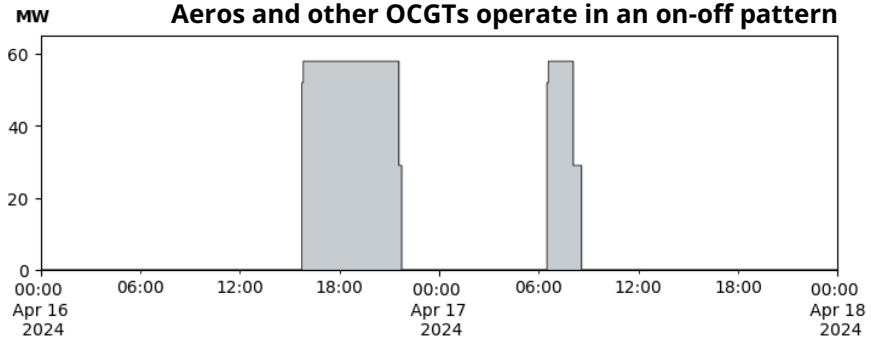
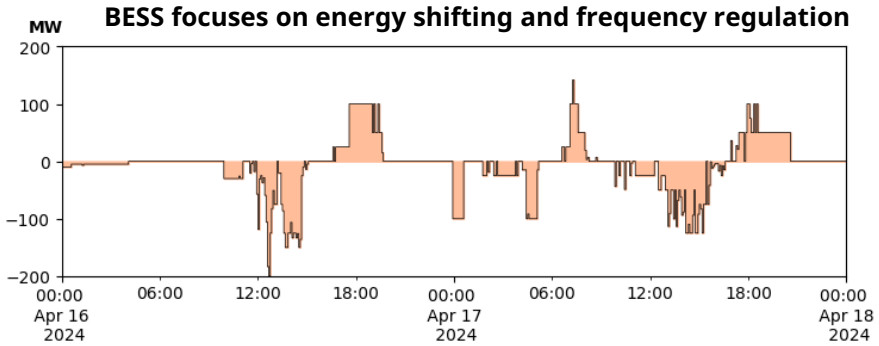
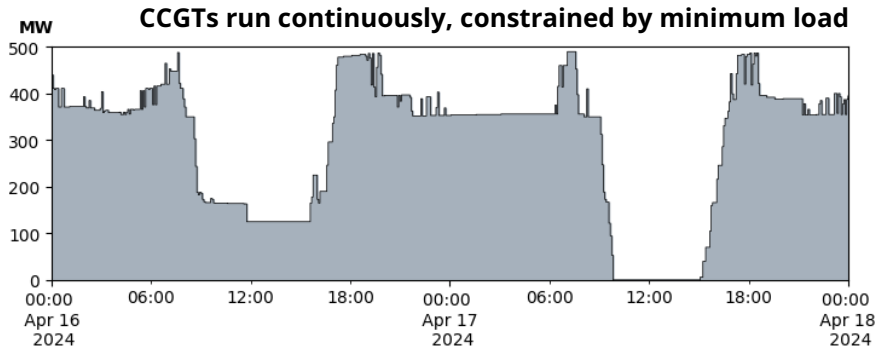
Barker Inlet is a unique asset in the market

Capable of operating like other power plants when needed









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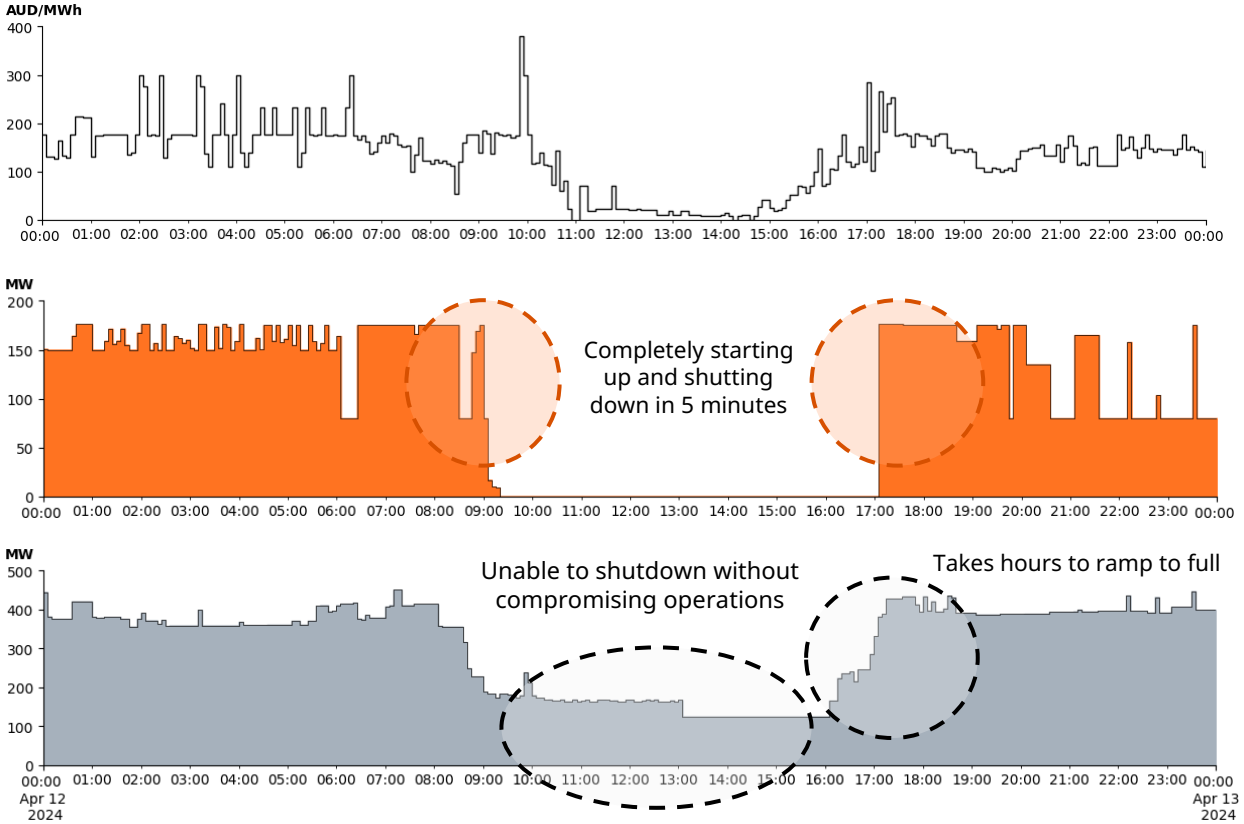
Barker Inlet is able to quickly respond to spot prices and power demand



Spot prices can be very low during periods of high renewable generation and low demand.

Barker Inlet runs during times of need and can quickly turn on and off to respond to prices and demand

Inflexible assets, like CCGTs, have to run at minimum load and ramp and down less quickly.

© WÄRTSILÄ

Revenues from the spot market only is often not sufficient or certain enough to cover the investment cost and deliver the expected returns of investors. Some plant owners prefer to split their generation capacity and allocate a portion of the capacity for fixed contracts, where there is a high degree of payment certainty, and reserve a portion to dispatch on the spot market, which has a bit bigger speculative element. It is up to the lenders and asset owners' risk appetite in what ratios they allocate their capacity for various segments.

Flexibility monetisation check list:

- ✓ Existence of a spot market where price of electricity constantly changes, and is determined by the momentary demand and supply conditions.
- ✓ High share of renewables that introduce high level of price volatility.
- ✓ Short trading periods i.e., 15- or even 5-minute that reflect the fine changes in the system.
- ✓ Shorter gate-closure times allowing market participants to adjust positions closer to real-time, improving forecast accuracy and system responsiveness.
- ✓ Established well-functioning ancillary services markets to support evolving flexibility needs and monetise system flexibility.
- ✓ Low entry barriers so a high number of generators and consumers can participate.
- ✓ Asset owners are penalised if their delivered energy deviates from the scheduled amount.
- ✓ Flexible fuel offtake agreements that allow generating assets to operate in a flexible fashion.



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Making money with flexibility

Unlocking revenue streams through operational flexibility in modern energy markets

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Wärtsilä Energy in brief

Wärtsilä Energy is at the forefront of the transition towards a 100% renewable energy future. We help our customers and the power sector to accelerate their decarbonisation journeys through our market-leading technologies and power system expertise. Our solutions include flexible engine power plants, energy storage and optimisation technology, and services for the whole lifecycle of our installations. Our engines are future-proof and can run on sustainable fuels. Our track record comprises 79 GW of power plant capacity and over 130 energy storage systems in 180 countries around the world. Over 30% of our operating installed base is under service agreements.

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