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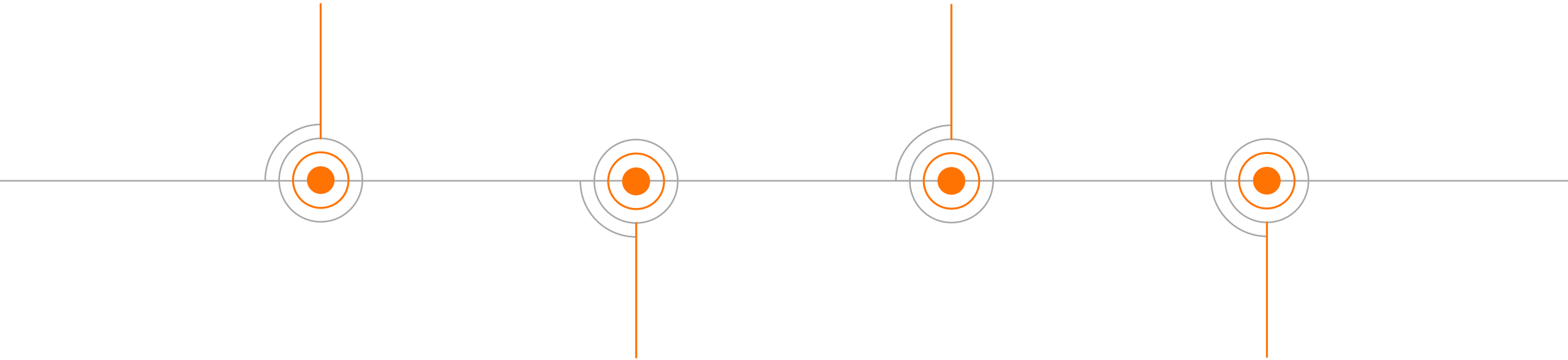
LEADERSHIP IN ENERGY TRANSITION THROUGH FUTURE-PROOF TECHNOLOGIES

MARCO WIRÉN
PRESIDENT, ENERGY & EXECUTIVE VICE PRESIDENT

TOPICS FOR TODAY

Flexible power plants play a key role in future energy systems

Increased focus on agreements and performance based contract models



Providing best value across a wide range of flexibility needs

Geared for energy storage growth

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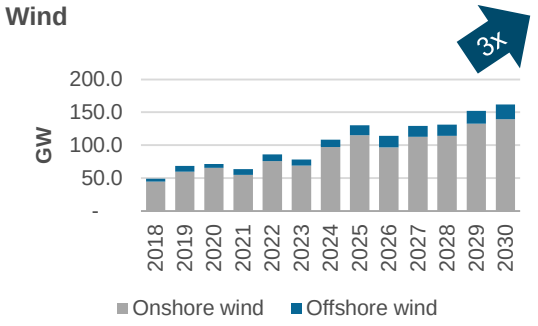
RENEWABLES DRIVING THE TRANSITION, FLEXIBILITY THE HIGHEST GROWING SEGMENT

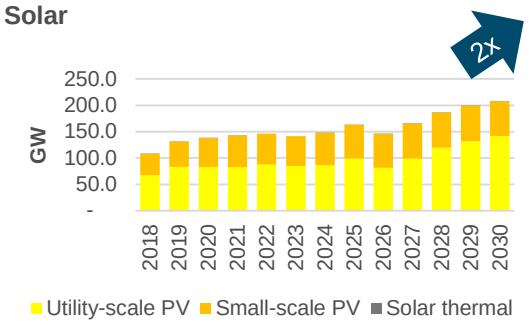
RES

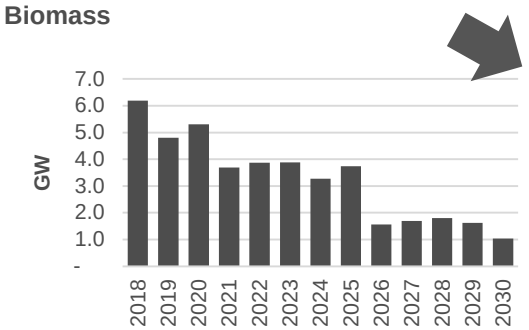
THERMAL

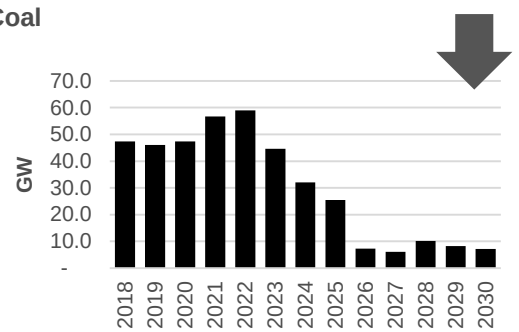
FLEXIBILITY

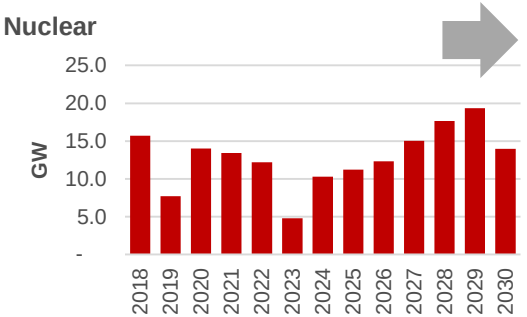
WÄRTSILÄ FOCUS

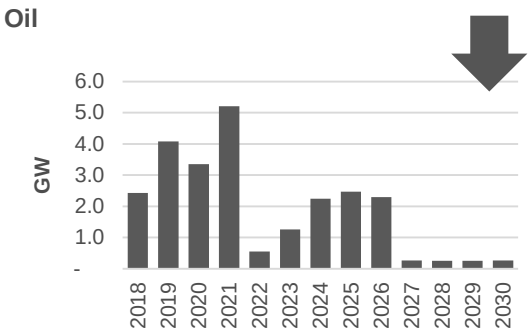


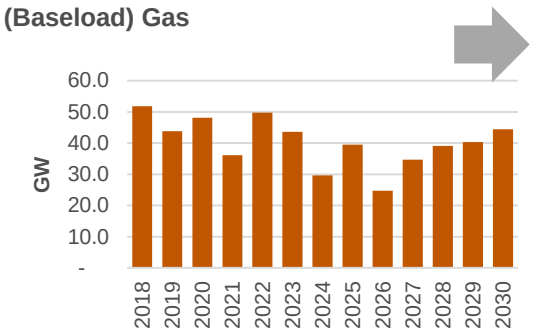


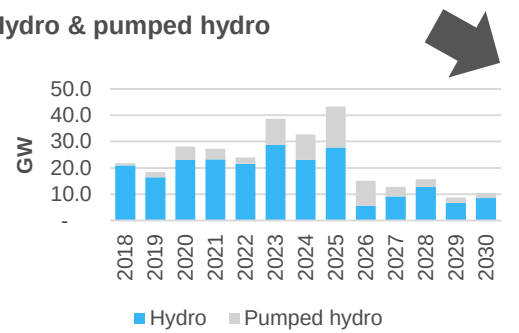


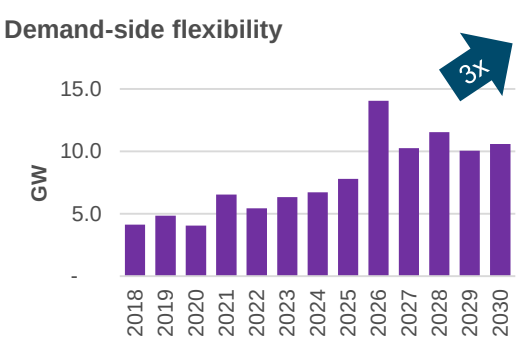


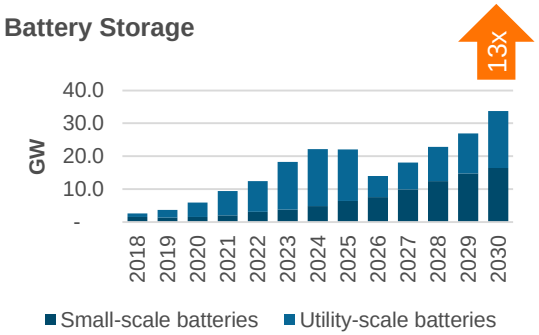


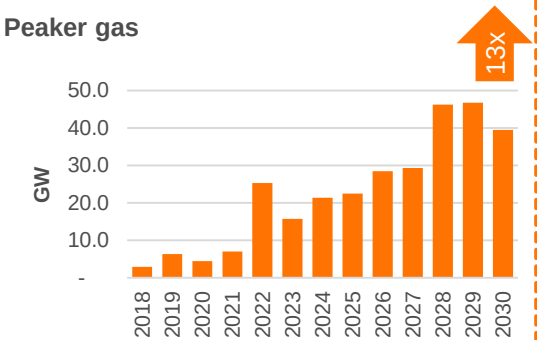












Source: Bloomberg New Energy Outlook 2019

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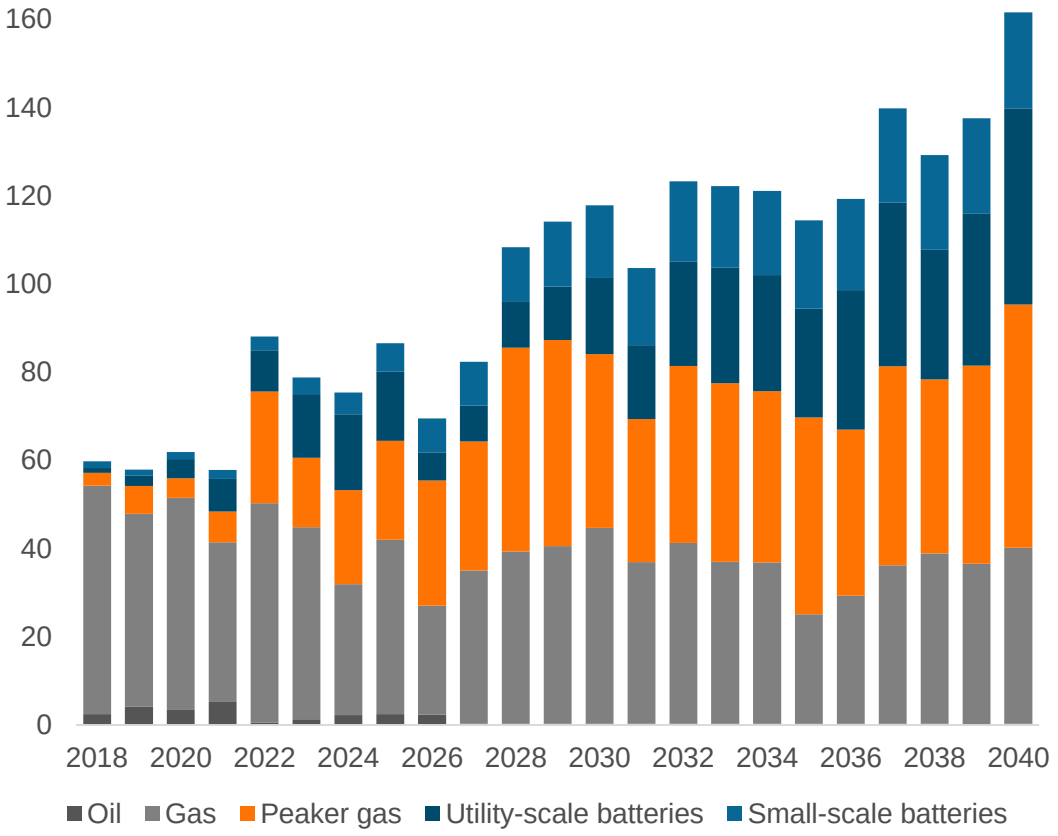
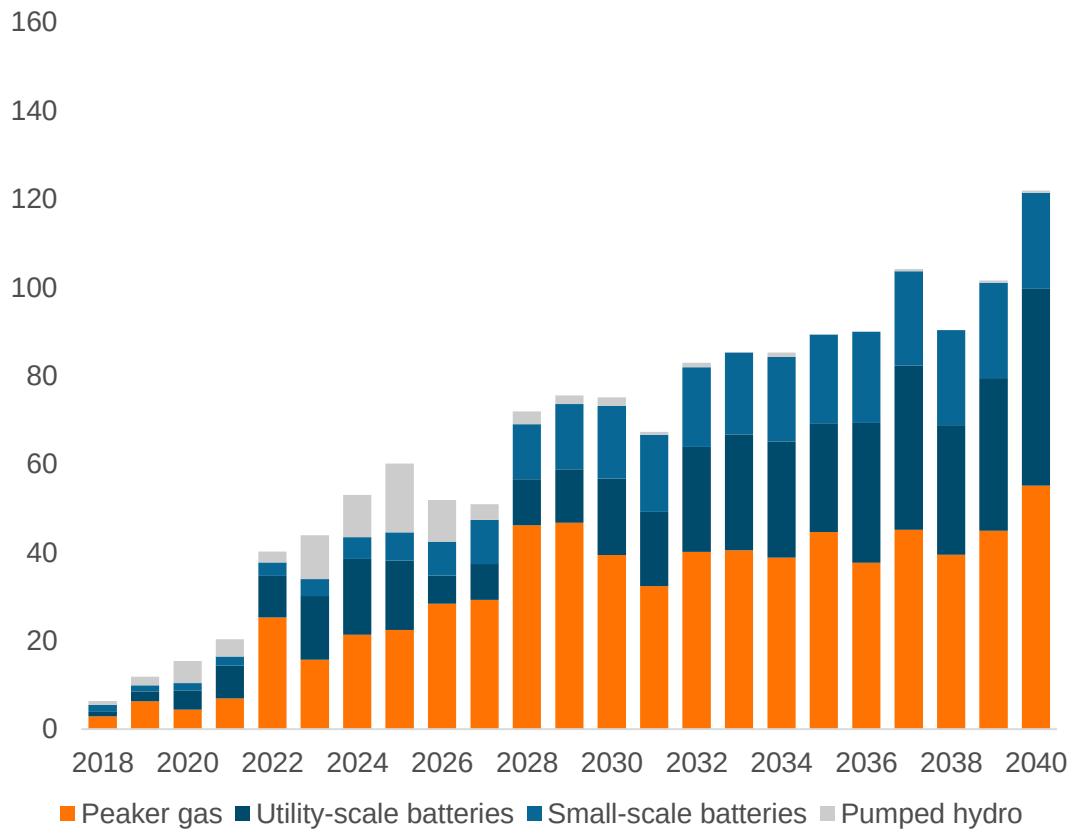
TARGET MARKET ANNUAL CAPACITY ADDITITION 2018-2040 (GW)



ANNUAL FLEXIBLE CAPACITY ADDITIONS 2018–2040 (GW)



Source: Bloomberg New Energy Outlook 2019

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THE RIGHT FLEXIBILITY MIX ENABLES AN OPTIMISED TRANSITION

THERMAL ONLY

99 $/MWh
0% RES

SOLAR, WIND, STORAGE, ENGINES

68 MW | 176 MW | 125 MWh | 75 MW

64 $/MWh
78% RES

SOLAR, WIND, STORAGE, ENGINES
RUNNING ON SYNTHETIC FUEL (P2X)

117 MW | 270 MW | 245 MWh | 66 MW | 59 MW

72 $/MWh
100% RES

SOLAR AND STORAGE ONLY

2 789 MW | 7 276 MWh

394 $/MWh
100% RES

Key technology assumptions in 2030:

Wind:	700 $/kW
Solar:	525 $/kW
Battery storage:	100 $/kWh
Power-to-X:	700 $/kW
Thermal options:	same as today

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PATH TO 100% RENEWABLES WORLD

	RES 0% Good old days	RES 10% Global average today	RES 20% Tipping point	RES 80% Renewables as baseload	RES 100% Final push
RENEWABLE ENERGY	Renewables expensive compared to fossil fuels		Renewables reach grid parity with traditional generation	Renewables become new baseload	Excess renewable energy seen as raw material for other commodities (power to gas, fuel, water, and food)
INFLEXIBLE GENERATION	Majority of energy produced by inflexible plants (coal, natural gas, and nuclear)		Increasing intermittent load profiles increases operating costs and challenges business model	No role for inflexible generation	
FLEXIBLE GENERATION	”Peaking generation” and system balancing, offering inexpensive capacity		Flexible thermal capacity replaces inflexible generation to enable more stable grids	High renewables case requires highly flexible thermal capacity to maintain system reliability	Synthetic gas, biogas, or synthetic liquid fuels used for flexible back-up
ENERGY STORAGE	Limited opportunities for storage to cost effectively address ancillary services		Energy shifting projects start to emerge	Key component in a renewables as baseload grid. Energy shifting and overall grid balancing	Power to gas for seasonal energy shifting, daily energy shifting with energy storage

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Quotes from the Energy Lending Policy document:

- ” Improvement of flexibility of the power system is essential”
- ”...the Bank appreciates the necessary role that gas will continue to play to decarbonise energy systems.”
- ”Natural gas will be progressively replaced by low-carbon gases such as biogas, synthetic gas and hydrogen”
- ”..the Bank will support gas-fired plants which provide credible plan to blend increasing shares of low-carbon gas over the economic lifetime of the project”

Adding EIB’s future carbon price forecast to the Germany example, leads to grid parity between fossil fuels including carbon tax and synthetic fuels during the economic lifetime of today’s flexible gas power plant projects.

2030
Fossil fuels with carbon price of 100 €/ton

114 MW 207 MW 254 MWh 69 MW

73 $/MWh
85% RES

2030
Renewables combined with synthetic fuels

117 MW 270 MW 245 MWh 66 MW 59 MW

72 $/MWh
100% RES

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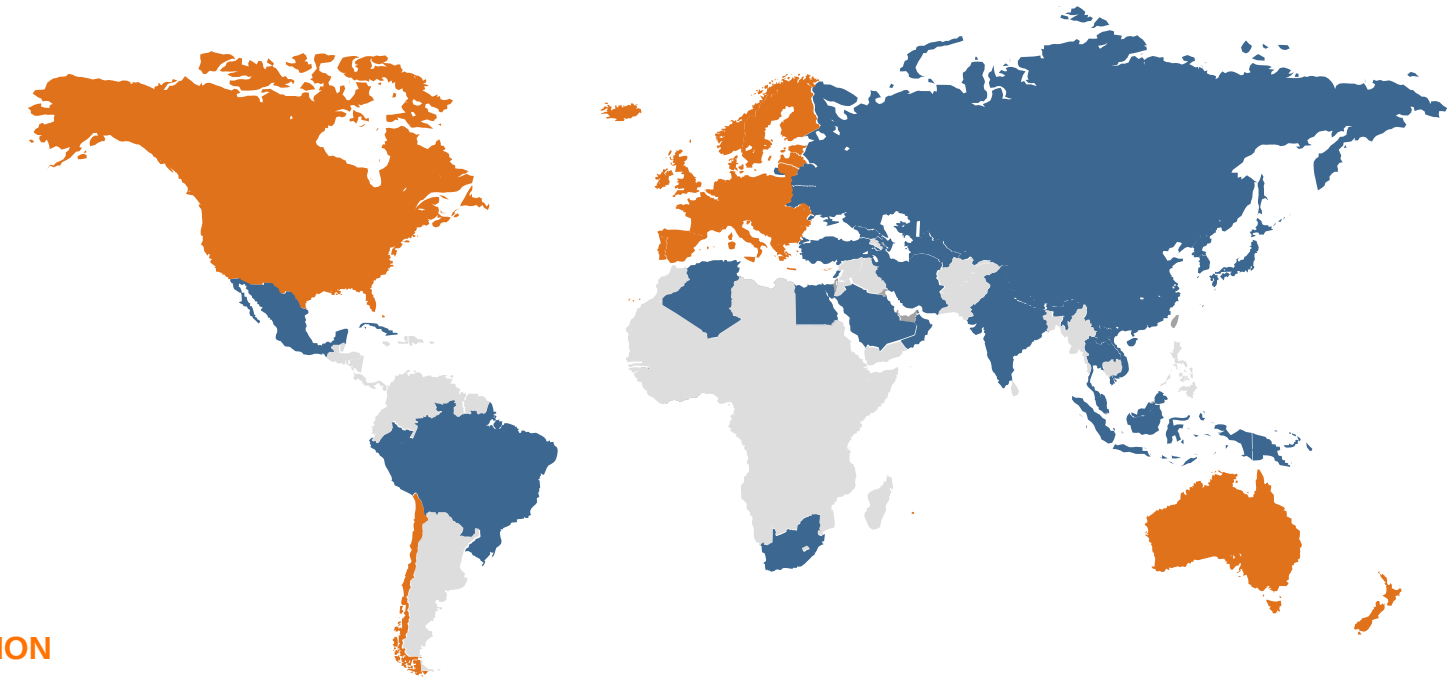
ENERGY TRANSFORMATION PROGRESSING GLOBALLY, BUT THE PACE VARIES COUNTRY BY COUNTRY



ENERGY TRANSITION

Flexible baseload	Transitional baseload	Renewable baseload
Leapfrog	**Capture**	**Develop**
Enabling our customers to leap-frog traditional inflexible thermal baseload technologies (coal, nuclear, CCGTs)	Capture market share from CCGTs by promoting acceleration of energy transition	Capture opportunity in fast growing peaker gas and energy storage markets

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RES 10%	RES 20%	RES 80%	RES 100%
Global average today	Tipping point	Renewables as baseload	Final push
2019	2025	2040	2050

Future-proof **flexible power plants**

Energy storage with industry leading energy management system (GEMS)

Energy services that support customer needs along the energy transition

Constantly seeking **new innovations** for optimised energy transition.

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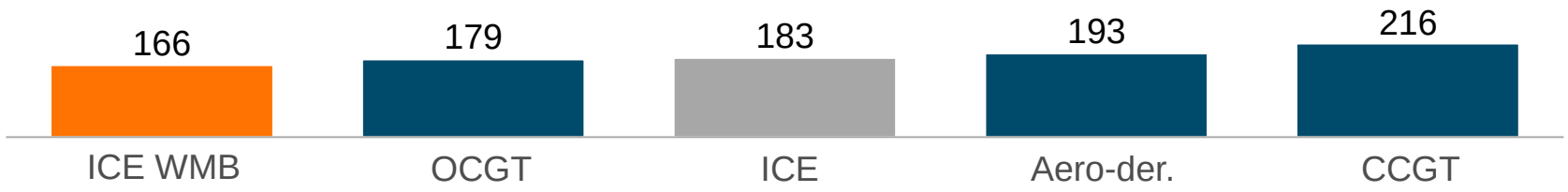
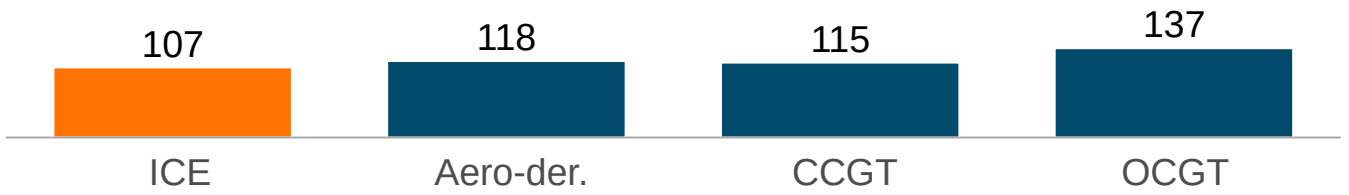
WHEN DO INTERNAL COMBUSTION ENGINES WIN?

Operating profile **LCOE,** $/MWh

"Day after tomorrow: seasonal"
500 hrs/yr
50 starts/yr

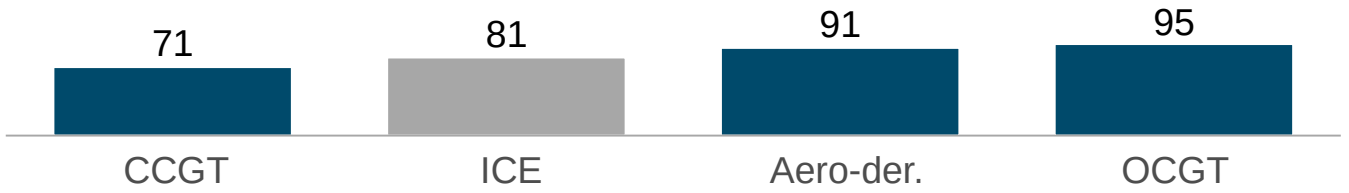


"Tomorrow + batteries"
1500 hrs/yr
250 starts/yr



"Today's wind chaser"
2,500 hrs/yr
1,000 starts/yr

"Baseload"
5,000 hrs/yr
50 starts/yr



CCGT = Combined cycle gas turbine

OCGT = Open cycle gas turbine

Aero-der.= Aeroderivate gas turbine

ICE = Internal combusion engine

WMB = Wärtsilä modular block

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WÄRTSILÄ MODULAR BLOCK – INNOVATIVE WAY TO DELIVER LOW-COST FLEXIBLE POWER

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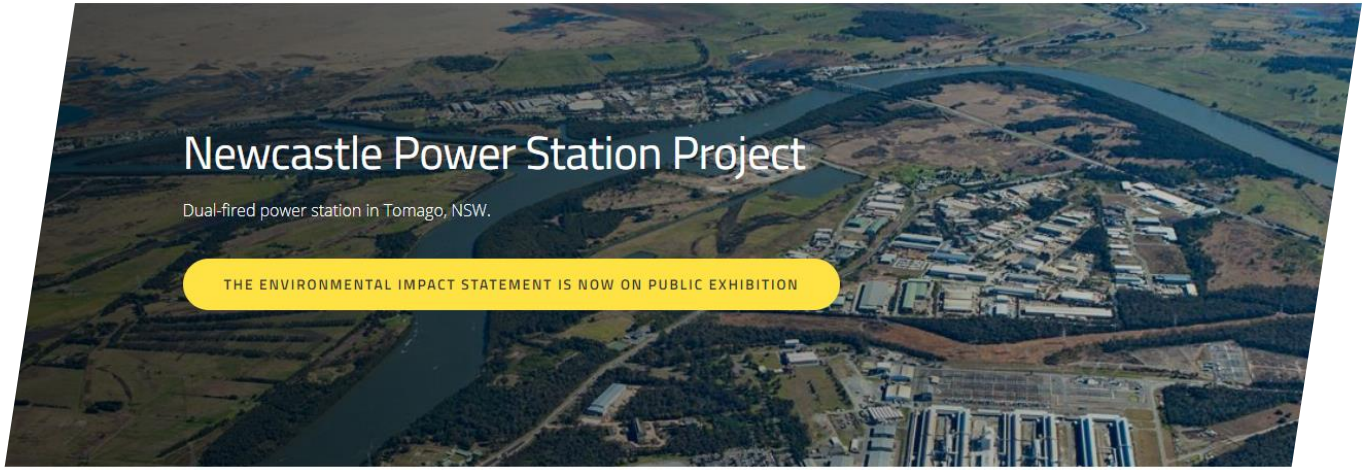
THE FIRST UTILITY-SCALE RECIPROCATING ENGINE POWER PLANT IN AUSTRALIA'S NATIONAL ELECTRICITY MARKET

Australia's Energy Minister visiting the AGL 211MW Wärtsilä Barker Inlet power plant on Nov 4th, 2019

UTILITY MOVING FORWARD WITH THEIR PLAN TO REFORM REST OF THEIR GENERATION PORTFOLIO



A 250 MW power station in Tomago, NSW

The proposed gas-fired power station in Tomago, NSW in the Newcastle region is consistent with our move to a renewable energy mix. Peaking gas power, like the proposed quick-start gas generation plant at Tomago, can be turned on during peak demand periods or whenever renewables aren't available.

AGL's next peaking gas power plant under development

ENERGY STORAGE

Another California City Drops Gas Peaker in Favor of Clean Portfolio

Glendale's municipal utility quickly got comfortable with big batteries, distributed energy, efficiency and a few reciprocating engines.

JULIAN SPECTOR | JULY 30, 2019

Glendale: Fastest energy transition ever?

The Southern California city of Glendale officially dropped a $500 million gas peaker project that it nearly approved last spring, and instead picked up the mantle of clean energy leadership.

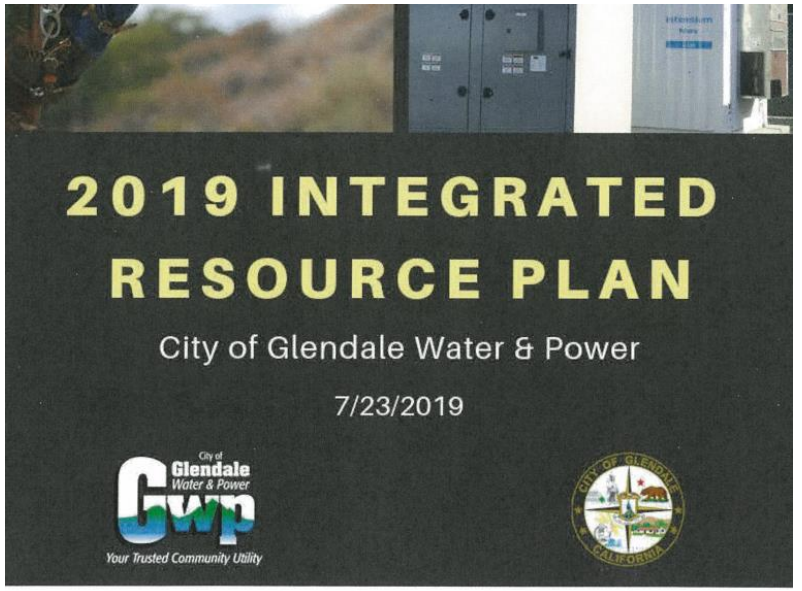


Table 16: Resource EIM Benefits

Resource	Benefit ($/MW-year)
Battery	76,000
Internal Combustion Engine	61,000
Combustion Turbine	7,700
Combined Cycle Combustion Turbine	14,000

Modeled subhourly benefits of resources dispatched against the subhourly market on a five minute time scale.

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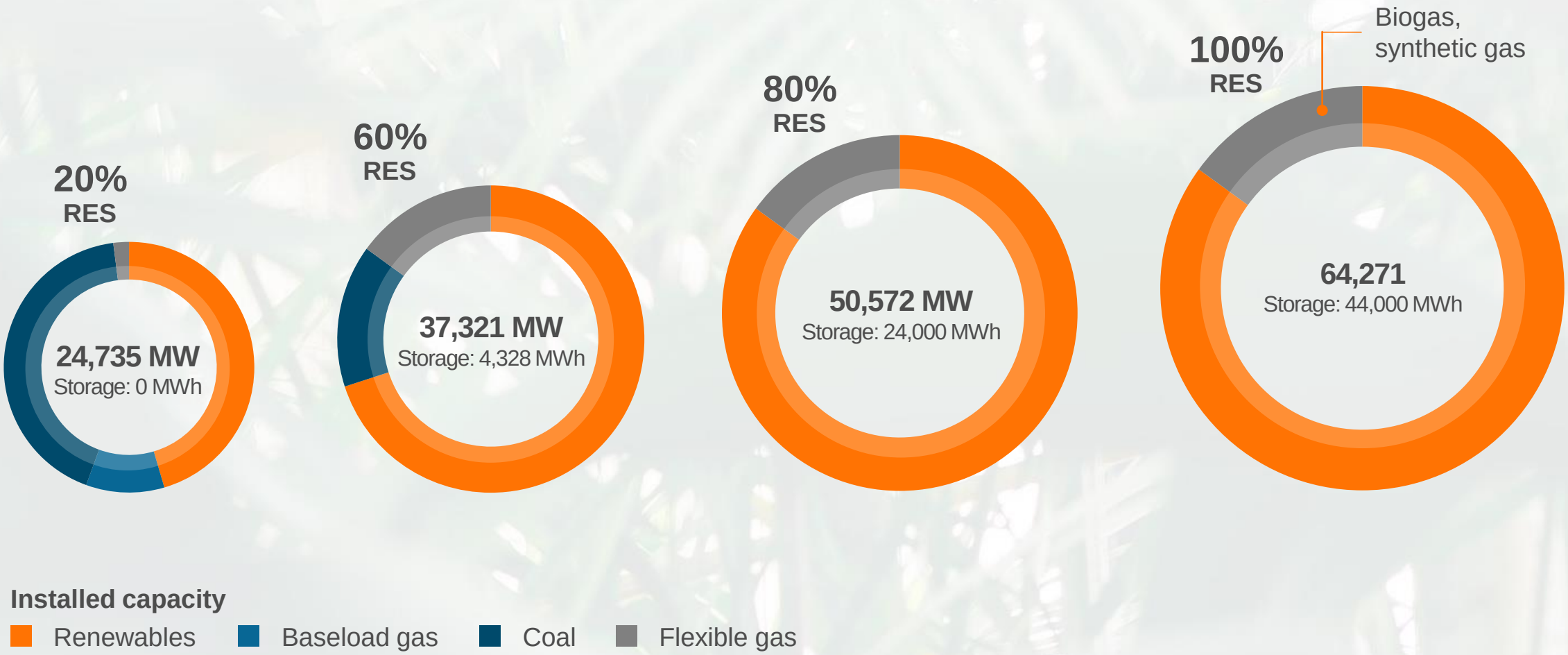
OPTIMAL PATH TOWARDS 100% RENEWABLE ENERGY SYSTEM



Source: Wärtsilä Energy Solutions study

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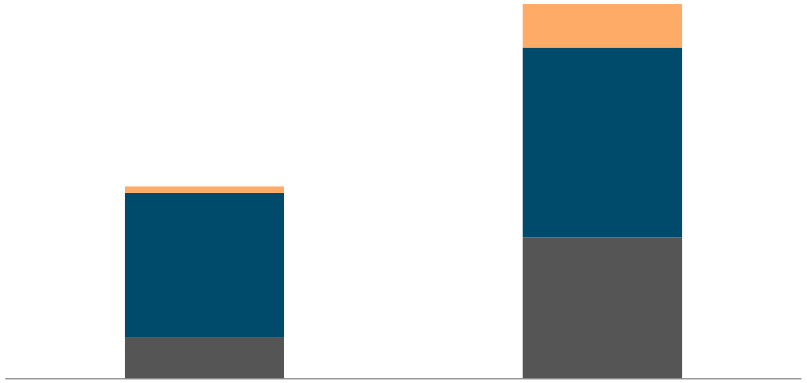
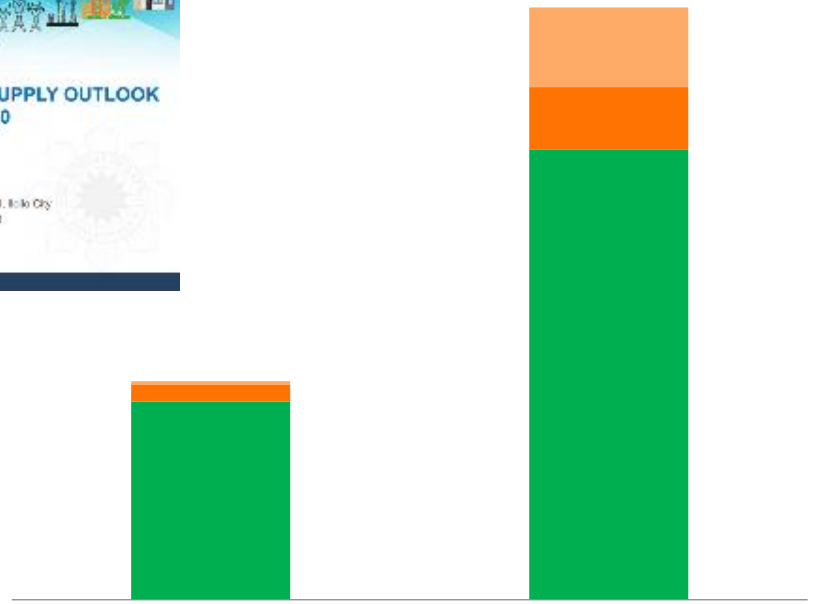
PREVIOUS PDP 2016-2040



	2025	2030
Peaking	165	1170
Flexible	0	0
Variable	0	0
Intermediate	3900	5100
Baseload	1100	3800

NEW PDP 2018-2040 (DRAFT)



	2025	2030
Peaking	85	2140
Flexible	465	1685
Variable	5324	12093
Intermediate	0	0
Baseload	0	0

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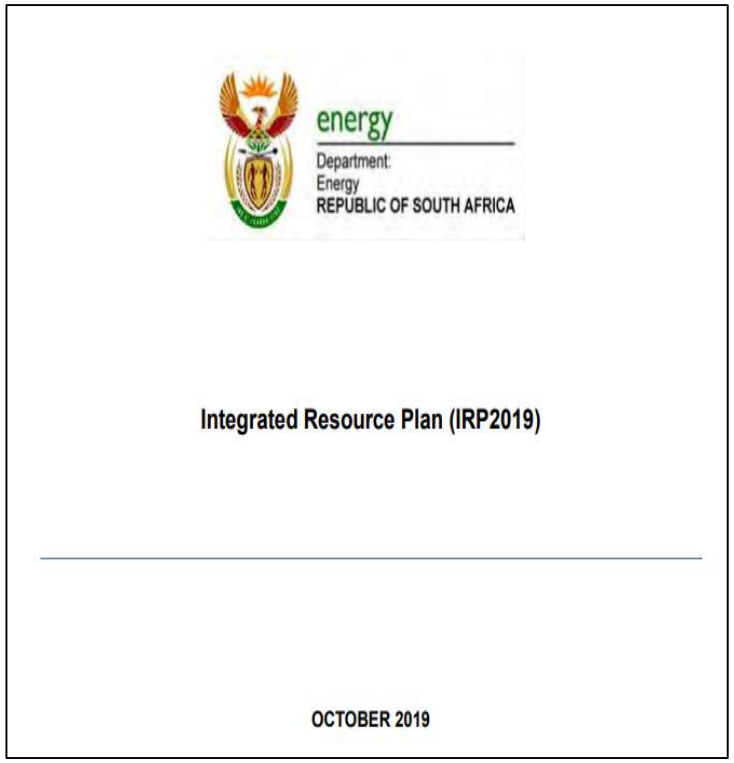
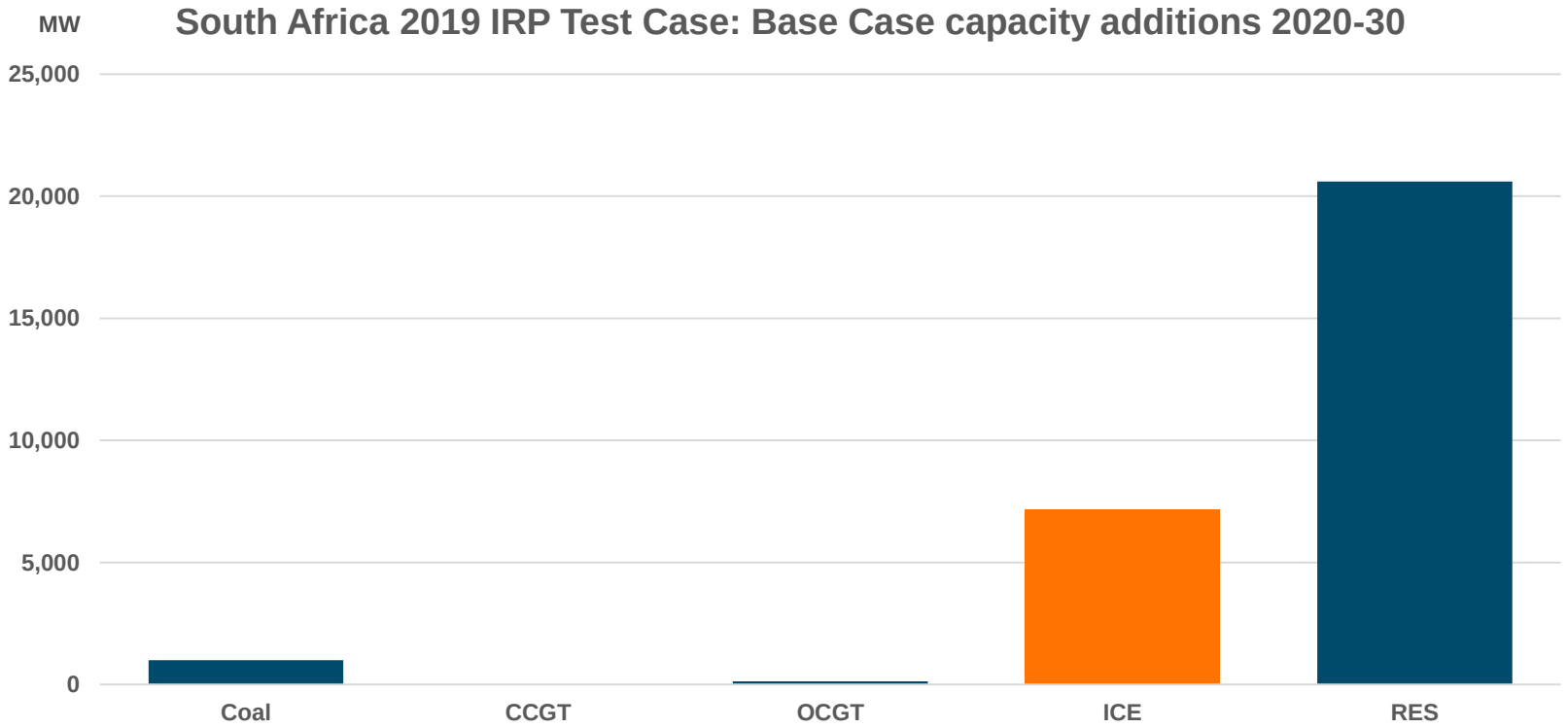
SOUTH AFRICA – NEW IRP MODELING CONFIRMS FLEXIBLE ENGINE PLANTS AS BEST VALUE TO BALANCE RENEWABLES





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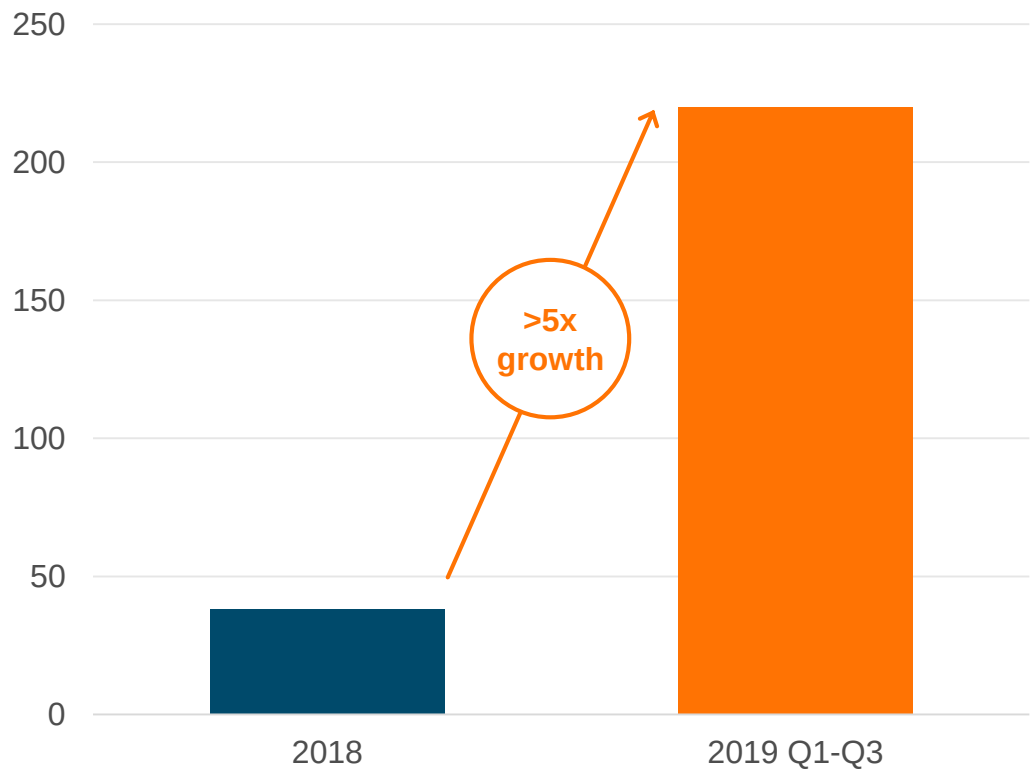
MAJOR BREAKTHROUGH IN ENERGY STORAGE MARKET IN 2019, GEARED UP FOR FUTURE GROWTH

Energy storage market is growing fast and Wärtsilä is well-positioned in the market

- 10+ years of grid-scale energy storage leadership
- Leading energy management software (GEMS Solutions Suite)
- Global sales, delivery, and services footprint
- Strong client base

Energy storage order intake (MW)



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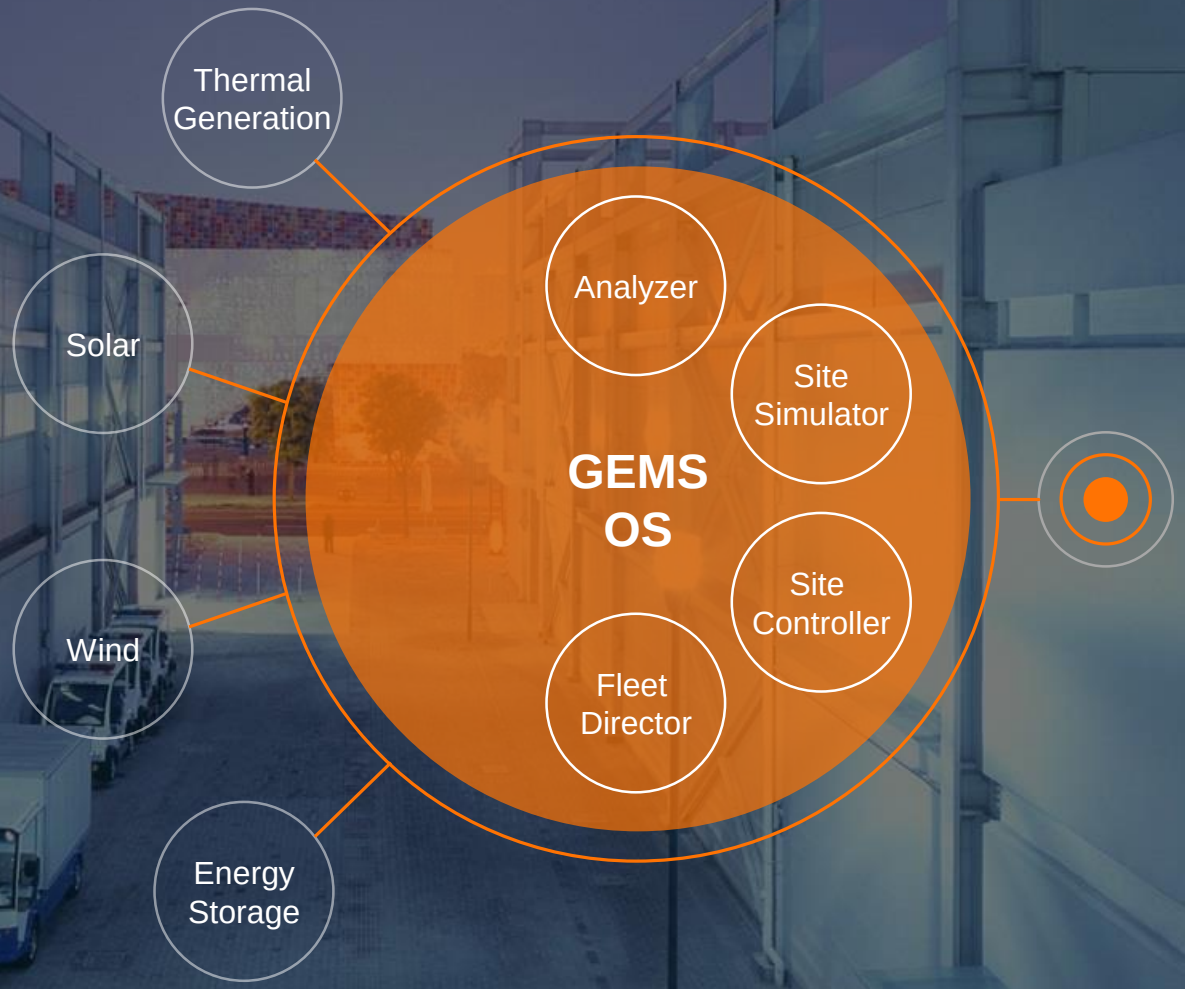
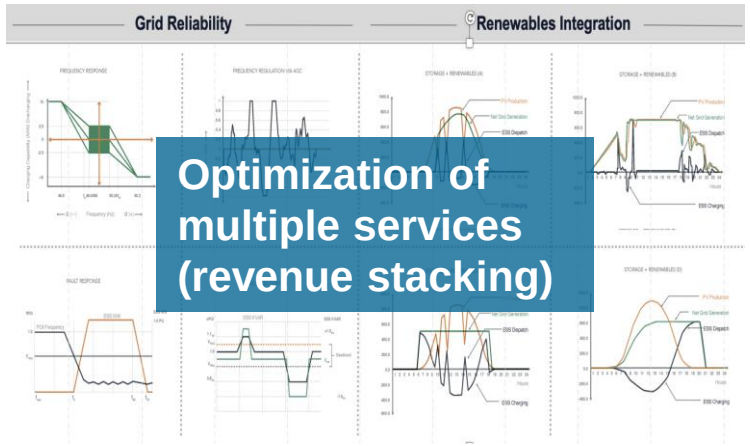
GEMS SOLUTIONS SUITE – LEADING ENERGY SYSTEM MANAGEMENT PLATFORM

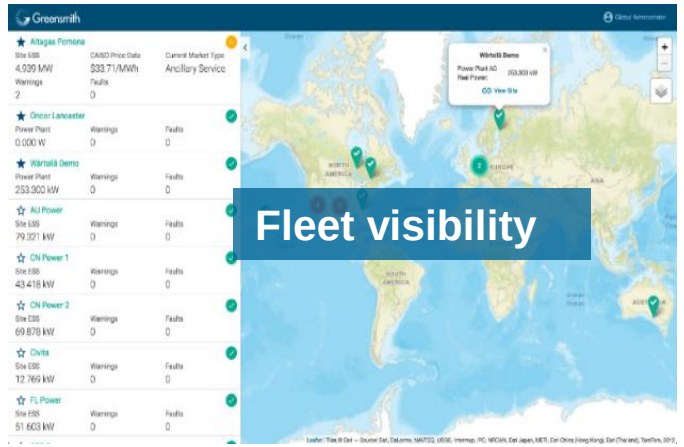
- GEMS: The leading energy system management platform
- A suite of proprietary software products for building, monitoring and intelligently
- Operating power plants and energy resources
- Optimises all generation assets
- Secure, flexible, scalable
- Deployed in over 70 projects around the world



US UTILITY SELECTS WÄRTSILÄ GEMS TO CENTRALLY MANAGE ITS ENERGY STORAGE SITES

- GEMS Solution Suite selected by a Top 5 US-based investor owned utility as the platform to monitor and control all battery storage solar assets across its multi-state service territory
- GEMS selected due to it ability to provide:





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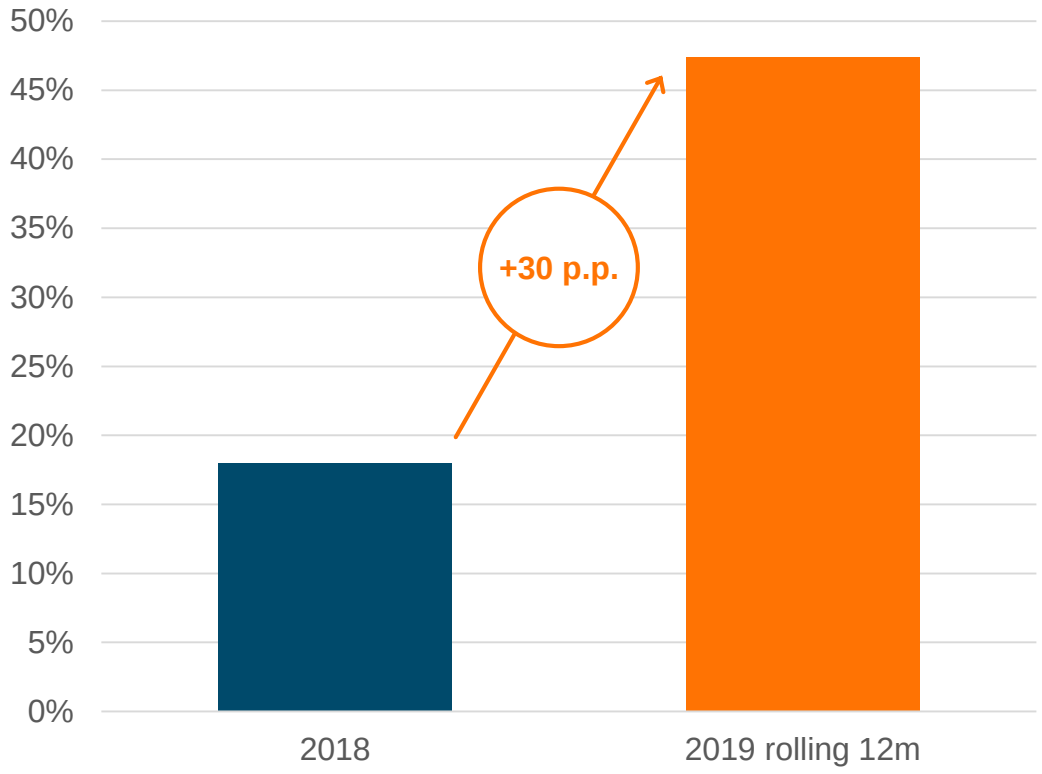
RESULTS FROM NEW CUSTOMER CENTRIC ORGANISATION ALREADY VISIBLE – TARGETING BEST CUSTOMER JOURNEY IN THE INDUSTRY

Growth enablers in lifecycle services:

- Increased share of new installations delivered with service agreements
- Performance-based partnerships
- Value adding services based on data
- Revenue sharing pricing models

Share of new power plant installations with service agreements (MWs)



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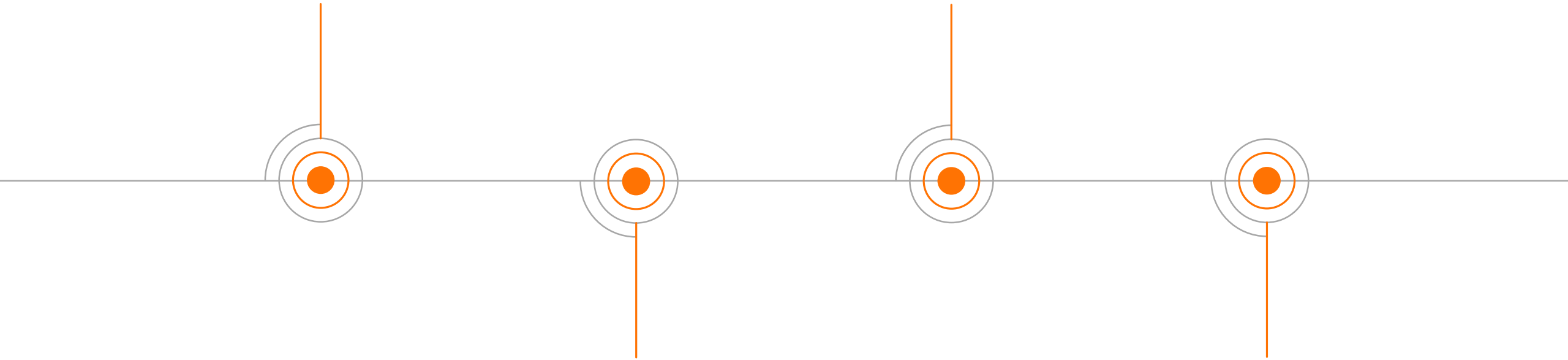

Providing best value across a wide range of flexibility needs

Geared for energy storage growth

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