LEADERSHIP IN ENERGY TRANSITION THROUGH FUTURE-PROOF TECHNOLOGIES

MARCO WIRÉN
PRESIDENT, ENERGY & EXECUTIVE VICE PRESIDENT
Flexible power plants play a key role in future energy systems

Providing best value across a wide range of flexibility needs

Increased focus on agreements and performance based contract models

Geared for energy storage growth
RENWABLES DRIVING THE TRANSITION, FLEXIBILITY THE HIGHEST GROWING SEGMENT

Source: Bloomberg New Energy Outlook 2019
RAPID GROWTH FORECASTED IN WÄRTSILÄ’S TARGET MARKETS

TARGET MARKET ANNUAL CAPACITY ADDITION 2018-2040 (GW)

ANNUAL FLEXIBLE CAPACITY ADDITIONS 2018–2040 (GW)

Source: Bloomberg New Energy Outlook 2019
THE RIGHT FLEXIBILITY MIX ENABLES AN OPTIMISED TRANSITION

- **SOLAR, WIND, STORAGE, ENGINES**
  - 64 $/MWh
  - 78% RES
  - 68 MW, 176 MW, 125 MWh, 75 MW

- **SOLAR, WIND, STORAGE, ENGINES RUNNING ON SYNTHETIC FUEL (P2X)**
  - 72 $/MWh
  - 100% RES
  - 117 MW, 270 MW, 245 MWh, 66 MW, 59 MW

- **SOLAR AND STORAGE ONLY**
  - 394 $/MWh
  - 100% RES
  - 2,789 MW, 7,276 MWh

Key technology assumptions in 2030:
- **Wind:** 700 $/kW
- **Solar:** 525 $/kW
- **Battery storage:** 150 $/kWh
- **Power-to-X:** 700 $/kW
- **Thermal options:** same as today

Capital Markets Day 2019
**Path to 100% Renewables World**

**RES 0%**
- **Good old days**
  - Renewables expensive compared to fossil fuels

**RES 10%**
- **Global average today**
  - Renewables reach grid parity with traditional generation

**RES 20%**
- **Tipping point**
  - Increasing intermittent load profiles increase operating costs and challenges business model
  - Flexible thermal capacity replaces inflexible generation to enable more stable grids

**RES 80%**
- **Renewables as baseload**
  - No role for inflexible generation
  - High renewables case requires highly flexible thermal capacity to maintain system reliability

**RES 100%**
- **Final push**
  - Excess renewable energy seen as raw material for other commodities (power to gas, fuel, water, and food)
  - Synthetic gas, biogas, or synthetic liquid fuels used for flexible back-up

**Renewables Energy**
- **Renewables expensive compared to fossil fuels**

**Inflexible Generation**
- **Majority of energy produced by inflexible plants (coal, natural gas, and nuclear)**

**Flexible Generation**
- **"Peaking generation" and system balancing, offering inexpensive capacity**

**Energy Storage**
- **Limited opportunities for storage to cost effectively address ancillary services**

**Key Components**
- **Energy shifting projects start to emerge**
  - Key component in a renewables as baseload grid. Energy shifting and overall grid balancing

**Conclusion**
- **Power to gas for seasonal energy shifting, daily energy shifting with energy storage**
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.
Global technology leadership applied to local needs

Energy transformation progressing globally, but the pace varies country by country

Marco Wirén

Capture market share from CCGTs by promoting acceleration of energy transition

Develop opportunity in fast growing peaker gas and energy storage markets

Leapfrog traditional inflexible thermal baseload technologies (coal, nuclear, CCGTs)

Flexible baseload

Transitional baseload

Renewable baseload

Energy transition

26 November 2019

© Wärtsilä

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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.
**WHEN DO INTERNAL COMBUSTION ENGINES WIN?**

<table>
<thead>
<tr>
<th>Operating profile</th>
<th>LCOE, $/MWh</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>“Day after tomorrow: seasonal”</strong></td>
<td></td>
</tr>
<tr>
<td>500 hrs/yr</td>
<td>166</td>
</tr>
<tr>
<td>50 starts/yr</td>
<td></td>
</tr>
<tr>
<td>ICE WMB</td>
<td>179</td>
</tr>
<tr>
<td>OCGT</td>
<td>183</td>
</tr>
<tr>
<td>ICE</td>
<td>193</td>
</tr>
<tr>
<td>Aero-der.</td>
<td>216</td>
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<tr>
<td><strong>“Tomorrow + batteries”</strong></td>
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<tr>
<td>1500 hrs/yr</td>
<td>107</td>
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<tr>
<td>250 starts/yr</td>
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<tr>
<td>ICE</td>
<td>118</td>
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<tr>
<td>Aero-der.</td>
<td>115</td>
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<tr>
<td>CCGT</td>
<td>137</td>
</tr>
<tr>
<td>OCGT</td>
<td></td>
</tr>
<tr>
<td><strong>“Today’s wind chaser”</strong></td>
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<tr>
<td>2,500 hrs/yr</td>
<td></td>
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<tr>
<td>1,000 starts/yr</td>
<td>92</td>
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<tr>
<td>ICE</td>
<td>102</td>
</tr>
<tr>
<td>Aero-der.</td>
<td>106</td>
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<tr>
<td>CCGT</td>
<td>162</td>
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<tr>
<td>OCGT</td>
<td></td>
</tr>
<tr>
<td><strong>“Baseload”</strong></td>
<td></td>
</tr>
<tr>
<td>5,000 hrs/yr</td>
<td></td>
</tr>
<tr>
<td>50 starts/yr</td>
<td>71</td>
</tr>
<tr>
<td>CCGT</td>
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<tr>
<td>ICE</td>
<td>81</td>
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<td>Aero-der.</td>
<td></td>
</tr>
<tr>
<td>OCGT</td>
<td></td>
</tr>
</tbody>
</table>

ICE = Internal combustion engine  
CCGT = Combined cycle gas turbine  
OCGT = Open cycle gas turbine  
Aero-der. = Aeroderivate gas turbine  
WMB = Wärtsilä modular block
WÄRTSILÄ MODULAR BLOCK – INNOVATIVE WAY TO DELIVER LOW-COST FLEXIBLE POWER

Marco Wirén
26 November 2019
Australia’s Energy Minister visiting the AGL 211MW Wärtsilä Barker Inlet power plant on Nov 4th, 2019

The first utility-scale reciprocating engine power plant in Australia’s national electricity market

Utility moving forward with their plan to reform rest of their generation portfolio

Newcastle Power Station Project

Dual-fuel power station in Tomago, NSW.

The environmental impact statement is now on public exhibition

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
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 $600 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

<table>
<thead>
<tr>
<th>Resource</th>
<th>Benefit ($/MW-year)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Battery</td>
<td>76,000</td>
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<tr>
<td>Internal Combustion Engine</td>
<td>61,000</td>
</tr>
<tr>
<td>Combustion Turbine</td>
<td>7,700</td>
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<tr>
<td>Combined Cycle Combustion Turbine</td>
<td>14,000</td>
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</tbody>
</table>

Modeled subhourly benefits of resources dispatched against the subhourly market on a five minute time scale.
**OPTIMAL PATH TOWARDS 100% RENEWABLE ENERGY SYSTEM**

- **20% RES**
  - Installed capacity: 24,735 MW
  - Storage: 0 MWh

- **60% RES**
  - Installed capacity: 37,321 MW
  - Storage: 4,328 MWh

- **80% RES**
  - Installed capacity: 50,572 MW
  - Storage: 24,000 MWh

- **100% RES**
  - Installed capacity: 64,271 MW
  - Storage: 44,000 MWh

**Installed capacity**
- Renewables
- Baseload gas
- Coal
- Flexible gas

*Source: Wärtsilä Energy Solutions, 2018*
**PHILIPPINE’S NEW POWER DEVELOPMENT PLAN INCLUDES ONLY RENEWABLES AND FLEXIBILITY**

### PREVIOUS PDP 2016-2040

<table>
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<tr>
<th>Type</th>
<th>2025</th>
<th>2030</th>
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<td>1170</td>
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<tr>
<td>Flexible</td>
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<td>0</td>
</tr>
<tr>
<td>Variable</td>
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<td>0</td>
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<tr>
<td>Intermediate</td>
<td>3900</td>
<td>5100</td>
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<tr>
<td>Baseload</td>
<td>1100</td>
<td>3800</td>
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</table>

### NEW PDP 2018-2040 (DRAFT)

<table>
<thead>
<tr>
<th>Type</th>
<th>2025</th>
<th>2030</th>
</tr>
</thead>
<tbody>
<tr>
<td>Peaking</td>
<td>85</td>
<td>2140</td>
</tr>
<tr>
<td>Flexible</td>
<td>465</td>
<td>1685</td>
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<td>Variable</td>
<td>5324</td>
<td>12093</td>
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<tr>
<td>Intermediate</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Baseload</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>
SOUTH AFRICA – NEW IRP MODELING CONFIRMS FLEXIBLE ENGINE PLANTS AS BEST VALUE TO BALANCE RENEWABLES

South Africa 2019 IRP Test Case: Base Case capacity additions 2020-30

Integrated Resource Plan (IRP2019)
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)

MAJOR BREAKTHROUGH IN ENERGY STORAGE MARKET IN 2019, GEARED UP FOR FUTURE GROWTH
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 its ability to provide:
  - Real-time control and protection
  - Optimization of multiple services (revenue stacking)
  - Fleet visibility
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)

- 2018: 20%
- 2019 rolling 12m: 50%

+30 p.p.
Flexible power plants play a key role in future energy systems

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Providing best value across a wide range of flexibility needs

Geared for energy storage growth