



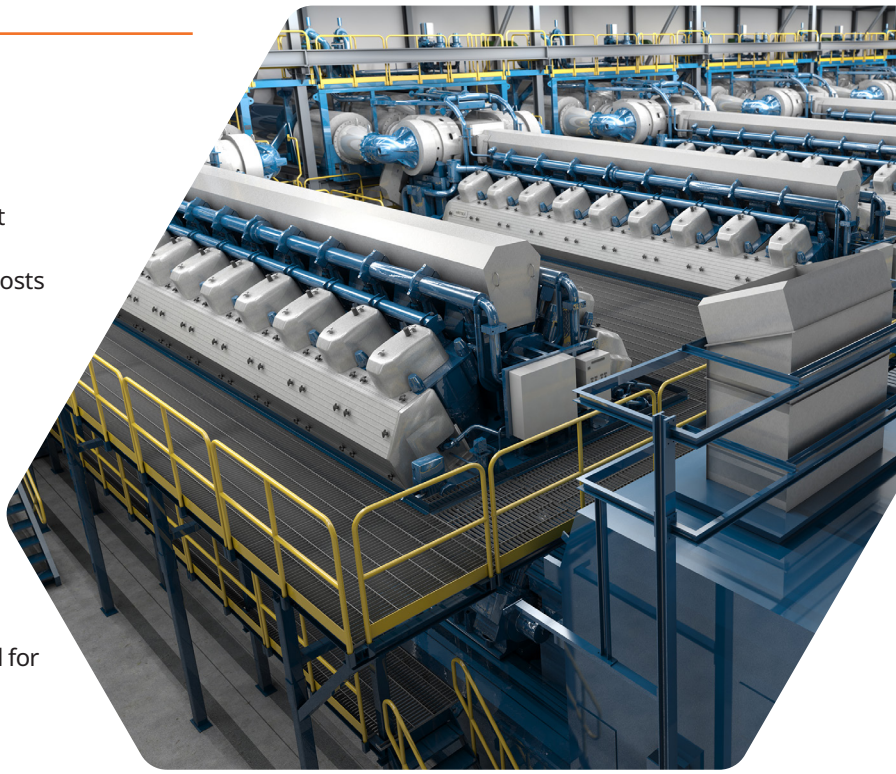
# Balancing a Renewable Grid

The energy grid of the future will require flexible, versatile, efficient energy resources to balance renewable energy intermittency and to constantly meet power demands. Wärtsilä's reciprocating engines offer unlimited cycling with no starting cost and with no minimum up- and down times. The engines' superior efficiency is also reflected at any load.

Wärtsilä reciprocating engine power plants can be located anywhere, because they use no water and do not require high-pressure gas. High altitudes and temperature variations do not affect the performance of reciprocating engines as much as aeroderivative engines either.

Renewable grids require flexible and dispatchable power to maintain security of supply at any weather. Reciprocating internal combustion engines (RICE) offer a mature, scalable, and cost-effective grid-balancing solution with capabilities perfectly suited to integrate high levels of renewables with minimal use of fuels.

Reciprocating Engines: the optimal balancing solution for reliable, sustainable and affordable grids.



## Key Advantages of Reciprocating Engines

### Flexibility

- Power to the grid in less than 30 seconds from start
- 5 minute start to full load, 30 second stop
- Unlimited cycling with no impact on maintenance costs

### Plant Operation

- Insignificant water consumption
- Low gas pressure requirement
- Minimal Temperature and Altitude Derating

### Efficiency

- Lowest simple cycle heat rate at site conditions on full & part-load
- Multiple units provide same low heat rate at any load
- Wide plant load range with 10% minimum stable load for each unit

# Comparing Technologies

## Reciprocating Engines vs. Aeroderivative Gas Turbines

| | Reciprocating Internal Combustion Engine | Aeroderivative Gas Turbines |
|---|---|---|
| **FLEXIBILITY - Dispatchable attributes** | | |
| **Start-Up Time** | 5 minutes | 5 minutes |
| **Synchronization** | < 30 seconds | 3.5 minutes |
| **Minimum Up Time** | 0 | 1 start/hour |
| **Minimum Down Time** | 5 minutes | 10 minutes |
| **Starting Cost (when cycling)** | 0 | 0 |
| **PLANT OPERATION – 200 MW plant** | | |
| **Water Consumption** | 0 gallons | 200 gallons/minute |
| **Gas pressure** | 6 bar // 85 psi | 50 bars // 750 psi |
| **Plant Availability** | 93% | 93% |
| **Plant Reliability** | 97% | 97% |
| **Unit Start Reliability** | 99% | 99% |
| **Fixed maintenance costs** | 5 people | 5 people |
| **EFFICIENCY - 200 MW plant** | | |
| **Heat Rate (HHV)** | 8,100 BTU/kWh ( 46.7%) | 9,400 BTU/kWh (40.2%) |
| **Partial Load Heat Rate (50%)** | 8,900 BTU/kWh (42.5%) | 10,700 BTU/kWh ( 35.3%) |
| **Minimum Stable Load** | 10% | 40% - 50% due to air permits |
| **Plant Load Range** | 2MW - 200MW | 25MW -200MW |
| **Temperature & Altitude Derating (100°F+ at 1 mile sea-level)** | No Derate on Output | 40% Derate on Output |

*Source: Reuters Events and Wärtsilä, March 2023: Uncovering the Hidden Value of Reciprocating Engines in Today's Markets. Available at: https://www.wartsila.com/energy/pages/reuters-white-paper---uncovering-the-hidden-value-of-reciprocating-engines*

# Contact information

Russell Weeks
Manager, Market Development North America
Russell.Weeks@Wartsila.com

Andrew Phillips
Business Development Manager, North America
andrew.phillips@wartsila.com

wartsila.com



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