Wärtsilä provides complete lifecycle power solutions for the marine and energy markets. In 2012, Wärtsilä's net sales totaled US$ 6.5 billion with approx. 18,900 employees. The company is based Finland and has operations 70 countries. Wärtsilä is listed on the NASDAQ OMX Helsinki, Finland.
About Wärtsilä

Wärtsilä USA since 1979. Currently 450 employees

Helsinki, Wärtsilä HQ
Houston, USA HQ
Main Factories
US Service Offices
Marine: We cover all key shipping segments

- 1 out of every 3 ships in the world have Wärtsilä engines
We are the only player in the market able to offer our clients 24/7 support, globally, in the fields of logistics, technical support and field service from a single source.
Wärtsilä North America, Inc. - Flexible Power Plants

(link to video in YouTube)
Global expansion of renewable energy – wind, solar, biomass
• reduced emissions
• high operating variability

**Smart Power Generation is now critical for reliable, affordable and sustainable operation**
• fast start, quick response natural gas-fired generators supplied by pipelines or LNG systems
• distributed generation model to minimize electric transmission upgrades
• selected use of combined heat and power (CHP) or trigeneration at up to 90% efficiency

**What is Smart Power Generation?**
- Energy Efficiency
- Operational Flexibility
- Fuel Flexibility

**Enables**

**Smart Power System**
- Reliable
- Sustainable
- Affordable

© Wärtsilä
A word about our nomenclature...

Typical Wartsila engine name: Wartsila 20V34SG

- How many Cylinders: (4, 6, 8, 9, 12, 16, 18, 20)
- Cylinder configuration: V or L (R)
- Cylinder bore in cm
- Engine type:
  - SG = Spark Gas
  - DF = Dual Fuel
  - GD = Gas Diesel
  (nothing = liquid fuel)
## Generator Set Portfolio

<table>
<thead>
<tr>
<th>W20</th>
<th>W32/W34SG/W34DF/W32 GD</th>
<th>W46 / W50DF / 50SG</th>
</tr>
</thead>
<tbody>
<tr>
<td>HFO, CRO, LBF</td>
<td>LFO, HFO, CRO, GAS, LBF</td>
<td></td>
</tr>
<tr>
<td>LFO, HFO, CRO, GAS, LBF, Emulsified Oils</td>
<td>LFO – Light Fuel Oil</td>
<td></td>
</tr>
<tr>
<td>LFO – Light Fuel Oil</td>
<td>HFO – Heavy Fuel Oil</td>
<td></td>
</tr>
<tr>
<td>HFO – Heavy Fuel Oil</td>
<td>CRO – Crude Oil</td>
<td></td>
</tr>
<tr>
<td>CRO – Crude Oil</td>
<td>GAS – Natural Gas</td>
<td></td>
</tr>
<tr>
<td>GAS – Natural Gas</td>
<td>LBF – Liquid Bio Fuel</td>
<td></td>
</tr>
</tbody>
</table>

**Generator set size [MW]**

<table>
<thead>
<tr>
<th>0</th>
<th>2.5</th>
<th>5</th>
<th>7.5</th>
<th>10</th>
<th>12.5</th>
<th>15</th>
<th>17.5</th>
<th>20</th>
</tr>
</thead>
</table>
## Wärtsilä Gas Engines

<table>
<thead>
<tr>
<th></th>
<th>20V34SG-D</th>
<th>18V50SG</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Output</strong></td>
<td>9,341 kWe</td>
<td>18,759 kWe</td>
</tr>
<tr>
<td><strong>Heat Rate</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(LHV)</em></td>
<td>7,461 Btu/kWh</td>
<td>7,375 Btu/kWh</td>
</tr>
<tr>
<td><em>(HHV)</em></td>
<td>8,271 Btu/kWh</td>
<td>8,176 Btu/kWh</td>
</tr>
<tr>
<td><strong>Speed</strong></td>
<td>720 rpm</td>
<td>514 rpm</td>
</tr>
<tr>
<td><strong>Dimensions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(L/WH)</em></td>
<td>42’ x 11’ x 15’</td>
<td>63’ x 18’ x 21’</td>
</tr>
<tr>
<td></td>
<td>143 US tons</td>
<td>391 US tons</td>
</tr>
</tbody>
</table>

* At generator terminals (pf 0.8, 0% tolerance)
## Wärtsilä Duel Fuel Engines

<table>
<thead>
<tr>
<th></th>
<th>20V34DF</th>
<th>18V50DF</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Output</strong></td>
<td>8,439 kWe</td>
<td>17,076 kWe</td>
</tr>
<tr>
<td><strong>Heat Rate</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(LHV)</em></td>
<td>7,993 Btu/kWh</td>
<td>7,460 Btu/kWh</td>
</tr>
<tr>
<td><em>(HHV)</em></td>
<td>8,439 Btu/kWh</td>
<td>8,271 Btu/kWh</td>
</tr>
<tr>
<td><strong>Speed</strong></td>
<td>720 rpm</td>
<td>514 rpm</td>
</tr>
<tr>
<td><strong>Dimensions</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td><em>(L/WH)</em></td>
<td>42’ x 11’ x 15’</td>
<td>63’ x 18’ x 21’</td>
</tr>
<tr>
<td></td>
<td>143 US tons</td>
<td>391 US tons</td>
</tr>
</tbody>
</table>

*At generator terminals (pf 0.8, 0% tolerance) when operating on natural gas with 1% liquid pilot fuel*
## Wärtsilä liquid fuel engines

<table>
<thead>
<tr>
<th></th>
<th>20V32</th>
<th>18V46</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Output</strong></td>
<td>8.7 MWe</td>
<td>17.1 MWe</td>
</tr>
<tr>
<td><strong>Heat Rate (HHV)</strong>*</td>
<td>8,300 Btu/kWh</td>
<td>8,183 Btu/kWh</td>
</tr>
<tr>
<td><strong>Speed</strong></td>
<td>720 rpm</td>
<td>514 rpm</td>
</tr>
<tr>
<td><strong>Dimensions (L/WH)</strong></td>
<td>42’ x 11’ x 15’</td>
<td>63’ x 18’ x 21’</td>
</tr>
</tbody>
</table>

* At generator terminals (0% tolerance)
Our energy solutions offer a unique combination of:

- **ENERGY EFFICIENCY**
  - Best simple cycle efficiency available in the market.
  - Excellent Partial load efficiency

- **OPERATIONAL FLEXIBILITY**
  - High operational flexibility with multi-engine solution.
  - Quick start and multiple starts/stops with no cost

- **FUEL FLEXIBILITY**
  - Solutions for liquid and gas, fossil and renewable fuels
We offer the **best simple cycle efficiency** available in the market at >46%. Typical **net** plant heat rate of <8400 Btu/kWh HHV at 95 °F

Our power plants achieve high efficiency in a **wide range of ambient conditions**
Multi-engine solution allows for a **good partial load efficiency** with a plant turn down ratio of 30%
No start penalties & No start-up costs

**Unlimited** starts & stops with **no impact** on cost or maintenance schedule.

This is unique, no other competing technology offers the same.

*Dispatcher’s dream plant*
Plains End 227 MW
Colorado
Case Colorado, USA – Grid Stability

Total wind generation drops (green curve) from 700 MW to 350 MW during 1 hour

Screen shot from Colorado Dispatch Center, Xcel Energy, USA

PLAINS END GENERATING FACILITY, COLORADO, USA

Type: Grid stability
Engines: 20 x Wärtsilä 18V34SG
14 x Wärtsilä 20V34SG
Total output: 227 MW
Fuel: Natural gas
Installed: 2002 and 2008
Remote controlled from Colorado Dispatch Center

The Plains End Generation facility is balancing Colorado’s 1000 MW wind power capacity.

Grid stability Power Plants based on gas fired combustion engine gensets are started, providing fast reaction to the change (red and white curves)
W34SG, fast start up and loading

1. Start up conditions maintained continuously
2. Speed acceleration and synchr. 1 min
3. Loading, 4 min
4. Total start up and loading time, 5 min

Engine conditions:
+ HT-water temperature >70°C
W50SG, fast start up and loading

1. Start up preparations, 1 min
2. Speed acceleration and synchronisation, 1 min
3. Loading, 5 min
4. Total start up and loading time, 7 min

Engine conditions:
+ HT-water temperature >70°C
**Quick Start**

Start up and loading of a Gas Engine power plant compared to a GTCC

<table>
<thead>
<tr>
<th>Case Study*</th>
<th>STEC Pearsall</th>
<th>24 x W20V34SG Simple Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>STEC Sam Rayburn</td>
<td>3 x 1 GE LM6000 Combined Cycle</td>
<td></td>
</tr>
<tr>
<td>ERCOT Market at $3,000/MWh</td>
<td>$895,000 per start</td>
<td></td>
</tr>
<tr>
<td>ERCOT Market at $100/MWh</td>
<td>$30,000 per start</td>
<td></td>
</tr>
<tr>
<td>ERCOT Market at $30/MWh</td>
<td>$10,000 per start</td>
<td></td>
</tr>
</tbody>
</table>

* John Packard, STEC, PowerGen 2011 Presentation
Dispatch flexibility

Efficiency and Spinning Reserve Operating Modes

- Efficiency Mode
- Spinning Reserve Mode

Net Plant
Heat Rate (Btu/kWh) (HHV)

Efficiency and Spinning Reserve Operating Modes

- 22 x 20V34SG
- Plant Net Output

© Wärtsilä
Additional Equipment for Combined Cycle

1. Exhaust gas boilers
2. Steam turbine + condenser + auxiliaries
3. Cooling towers + cooling water pumps

Simple Cycle: 450 MW
Combined Cycle: 493 MW
Minimum Area: 680’ X 700’
Minimum Area: 700’ X 750’ (Excluding Switchyard)
Wärtsilä Flexicycle™

100...500 MW combined cycle power plant based on 18.7MW natural gas engine 18V50SG

Simple cycle mode – for flexible power
» 7 minutes to full load, 1 minute to stop
» 48.6% plant efficiency
» Unlimited starting and stopping

Combined cycle mode – for competitive base load power
» 52.1% plant efficiency
» 60 minutes to full efficiency
» Switch back to simple cycle on the run
Flexicycle™ Combined cycle

Engines preheating by steam

6 x 18V50SG + ST

1. Heat Recovery Steam Generator (HRSG)
2. Feed Water Tank
3. Steam Turbine
4. Condenser
5. Condensate preheater
6. Auxiliary Boiler
7. Cooling Tower
8. Engine preheater
Exhaust gas boiler, working principle

**Engine specific equipment**
- **Superheater:** 285°F, 60 psi(g)
  - Increase of the steam temperature
- **Economizer:**
  - Pre-heating of feed water
- **LP-evaporator:**
  - Steam for feed water tank heating and for engine preheating
- **HP-evaporator:**
  - Evaporation of water

**Common equipment**
- **Steam drum:** 395°F, 220 psi(g)
- **Feed water tank:** 285°F, 60 psi(g)
- **Exhaust gas boiler:** working principle

**Typical temperatures & pressures for a 18V50SG combined cycle**
- **Exhaust gas in:** 710°F
- **Exhaust gas out:** 355°F
- **Steam for engine preheating:**
  - 285°F, 105 psi(g)
  - 280 psi(g)

**Wärtsilä Flexicycle™**
240 MW Flexicycle™ indicative performance

All 12 - 18V50SG engines can be started simultaneously within 10 minutes and 240MW is reached within 45 minutes for a plant in hot standby condition.

Output at ISO 3046 conditions, cooling towers for combined cycle system.

© Wärtsilä
Typical reliability data for Wärtsilä gas engines:
• Excellent unit availability
• Excellent unit reliability
• Excellent unit starting reliability
Multi-fuel solutions

We offer solutions for liquid, gas and renewable fuels

Multi-fuel solutions which can flexibly change between fuels (liquid and gas) on-line

Hedge for future, solutions that can easily be upgraded from liquid to gas
Emissions

» Nox - Nitrogen oxides: 5 ppm (0.064 g/kWh) (as NO2) (dry, at 15 vol-% O2) - with SCR

» CO - Carbon monoxide: 15 ppm (0.12 g/kWh) (dry, at 15 vol-% O2) - with CO catalyst

» VOC 25 ppm (0.12 g/kWh) (dry, at 15 vol-% O2)

» Particulates (total) (0.12 g/kWh) (at 15 vol-% O2)
Noise levels

Engine noise at 1 meter: ~ 115 dBA
Power House interior: ~ 110 dBA
Outside: typical design is 65 dBA @ 600 ft
Wärtsilä’ solutions minimize not only fuel but also water consumption thereby providing major environmental benefits. Our power plants use a closed loop cooling system that requires minimum water.

Simple Cycle water consumption = 1 gal/engine/week

Combined Cycle water consumption is 1/3 of GTCC Plant
Wärtsilä power plants use **low pressure** natural gas (75 psig). No need for aux. gas compressor or high pressure gas line.
Modularity

Our modular design allows for **easy capacity additions** and makes it simple for our customers to construct an optimally sized plant.
Engine auxiliary systems
Wärtsilä design makes the project look like a warehouse. No visible smoke, fumes or steam release.
Wärtsilä Smart Power Generation - Texas

- **3 x 20V34SG**
  25 MW – GEUS – Greenville, TX

- **18 x 20V34SG**
  170 MW – GSEC - Abernathy, TX

- **24 x 20V34SG**
  203 MW – STEC - Pearsall, TX
GEUS – Greenville, Texas

3 x 20V34SG
25 MW
The South Texas Electric Cooperative (STEC) Pearsall Power Plant in addition to serving load at member cooperatives, participates in the ERCOT Ancillary Services Market providing quick start reserves, spinning reserves, regulation and other high value products.
Recent Wärtsilä US Flexible Power

- Plains End I / II, Colorado, 227 MW
- Barrick, Nevada, 116 MW
- Midwest Energy, Kansas, 76 MW
- STEC Texas 203 MW
- Greenville, Texas, 25 MW
- Modesto, California, 50 MW
- Golden Spread Texas 170 MW
- Lea County Coop 43 MW
The South Texas Electric Cooperative (STEC) Red Gate Power Project is one Wärtsilä's new flexible power plants with fast start, fast ramping, high efficiency at full and part load with minimal water use. The Equipment Supply Contract was signed in December 2012. Commercial operation is planned for Summer 2014. The plant layout will accommodate future expansion to Flexicycle™ (combined cycle).
Wärtsilä Smart Power Generation - Azerbaijan

21 x 18V50SG
384 MW Boyuk Shor – Baku, Azerbaijan
Pacific Gas & Electric, Humboldt - Eureka, California

10 x 18V50DF - 162 MW
US based Seaboard Corporation

110 MW

6 x 18V50DF Flexicycle™

Heat Rate (LHV / HHV)  7,139 / 7,916

The combined cycle output and performance at 95° F on natural gas. The configuration utilizes once-through cooling
Wärtsilä Flexicycle™ – Dominican Republic

24 x 18V50DF - 430 MW Flexicycle™

Barrick Gold of North America Inc.
Quisqueya I - 12 x 18V50DF Flexicycle™
Now under construction – Fast Track
-Simple cycle in 12 months (8 engines)
-Full combined cycle in 16 months (12 engines)

EGA Haina of Dominican Republic
Quisqueya II - 12 x 18V50DF Flexicycle™
Now under construction NTP Jan 2012
-Full combined cycle in 24 months (12 engines)
Wärtsilä Smart Power Generation – Jordan

IPP4 18 x 18V50DF-> 300 MW
US based AES Corporation

<- IPP3 - 38 x 18V50DF 632 MW

Amman Asia Electric Power, is a special purpose independent power producer, in which Wärtsilä has a minority interest. The other owners of the company are Korea Electric Power Corporation of South Korea (KEPCO) and Mitsubishi Corporation of Japan. The project company will supply electricity to the National Electric Power Company of Jordan (NEPCO).
Smart Power Generation

Dan Shelledy
Business Development Manager, Power Plants
Houston, TX
(281) 233-6216
dan.shelledy@wartsila.com