LPG and Wärtsilä's Power Generation Applications

WLPGA Oceania Regional Summit

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Sales Director (MEA), Wärtsilä - Energy Solutions

LPG as fuel in Wärtsilä Gas Engine Power Plants

Our flexible, efficient and environmentally advanced energy solutions provide superior value to customers and enable a transition to a more sustainable and modern power system.



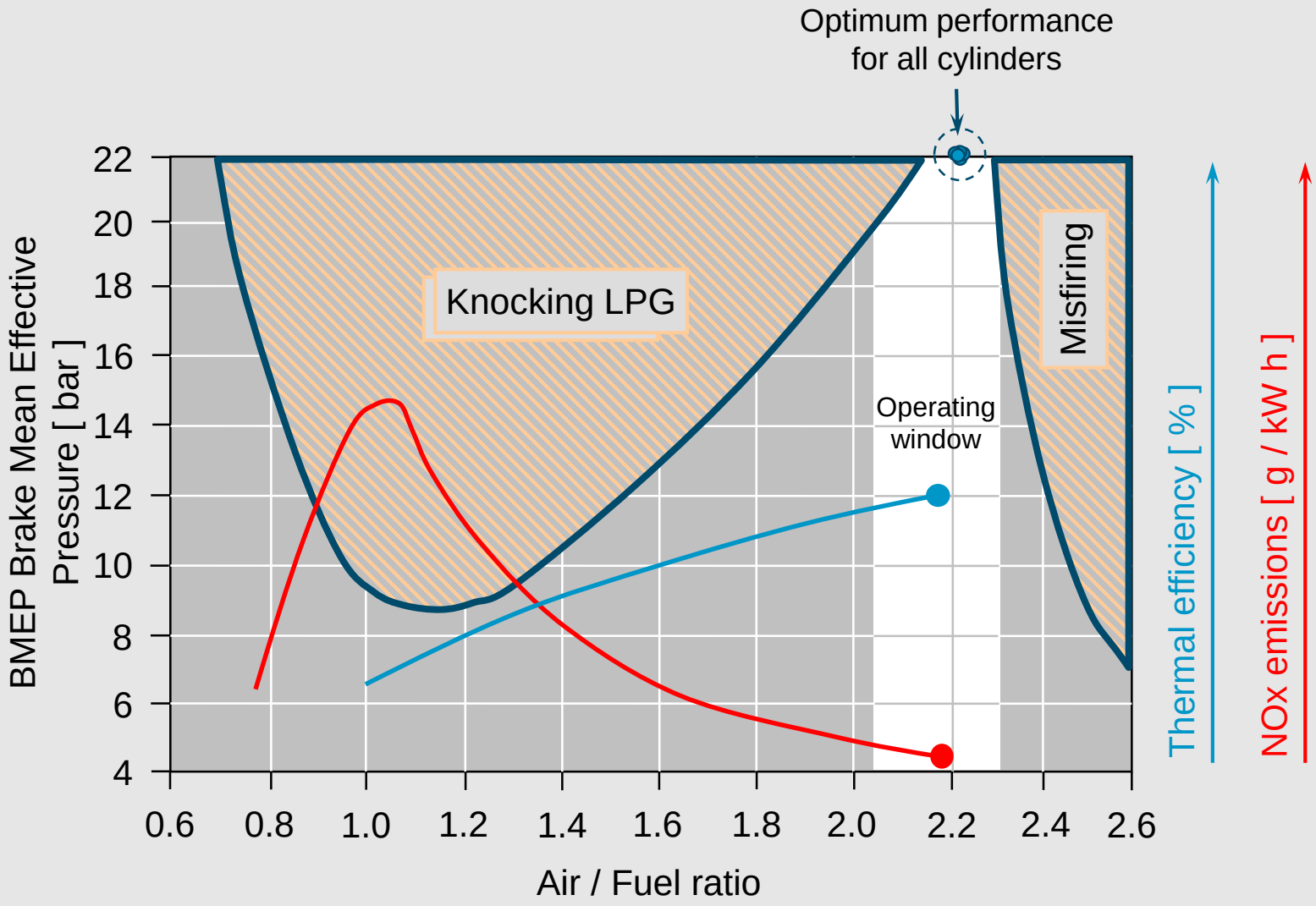
Engine technology as a function of gas quality

Methane Number relation to Gas Composition; Methane number is not the same as methane content!									
Methane	C1	100%	97%	93%	90%	87%	85%	85%	
Ethane	C2		3%	5%	6%	7%	7%	8%	
Propane	C3			2%	3%	3%	4%	3%	97%
Butane	C4				1%	2%	2%	1%	3%
Pentane	C5					1%	1%	1%	
Hexane	C6						1%	1%	
Heptane	C7							1%	
Methane Number		**100**	**90**	**80**	**70**	**60**	**50**	**40**	**…**
SG engines		MN 100 …55				NG			★ LPG

Values presented for guidance only
Exact values to be calculated by Methane Number calculator
If gas content of >C4 exceeds 1 vol-% contact Wärtsilä

WÄRTSILÄ PROPRIETARY INFORMATION

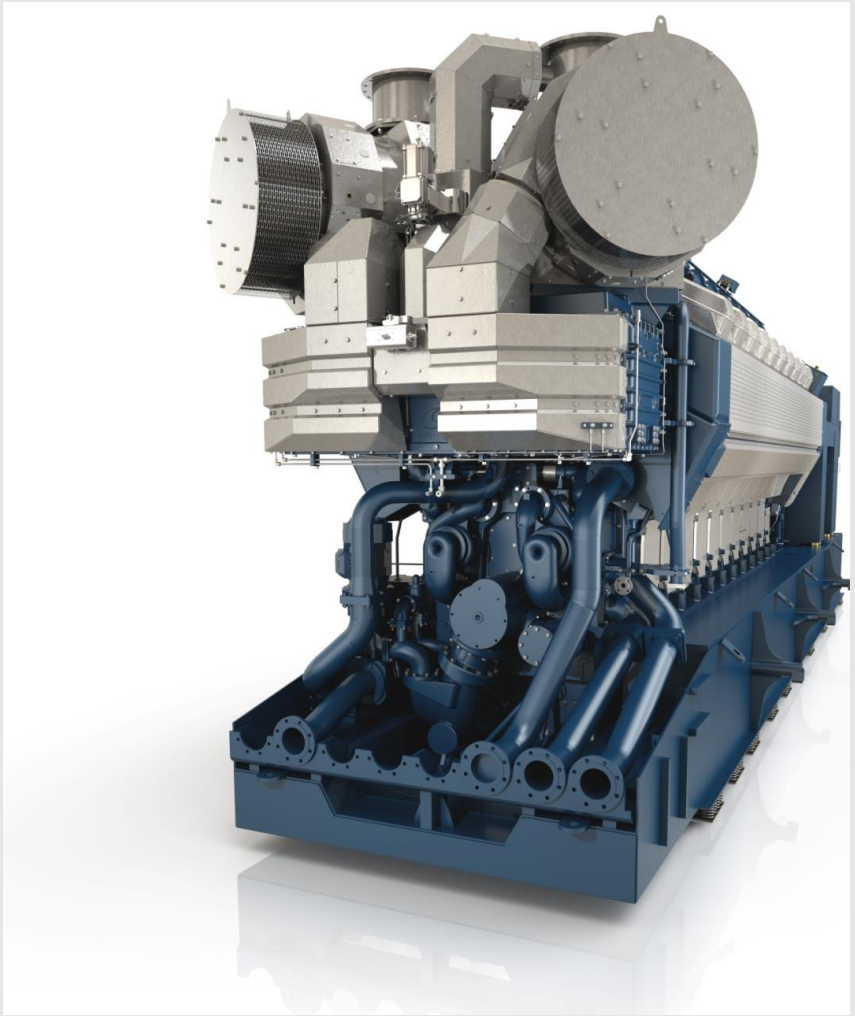
Otto cycle combustion



WÄRTSILÄ PROPRIETARY INFORMATION

WÄRTSILÄ 34LPG ENGINE

1. W9L34LPG, W16V34LPG, W20V34LPG approved for running on propane, efficiency >42% *) [fuel: propane minimum 97%; rest butane]
2. W34LPG can be run full power on natural gas with higher engine efficiency



W34LPG

$Power_{electrical}$ 50 Hz
- 20V34LPG 7300 kW
- 16V34LPG 5840 kW
- 9L34LPG 3280 kW

$Power_{electrical}$ 60 Hz
- 20V34LPG 7000 kW
- 16V34LPG 5600 kW
- 9L34LPG 3150 kW

W34SG

$Power_{electrical}$ 50 Hz
- 20V34SG 9730 kW
- 16V34SG 7740 kW
- 9L34SG 4340 kW

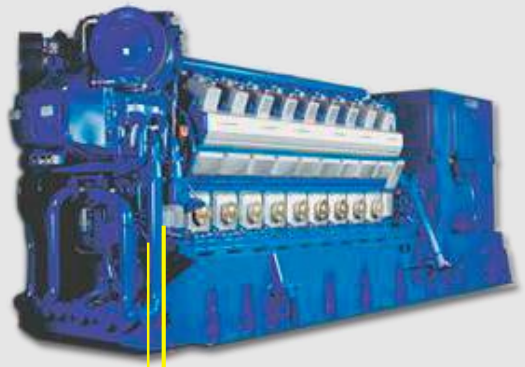
$Power_{electrical}$ 60 Hz
- 20V34SG 9340 kW
- 16V34SG 7430 kW
- 9L34SG 4170 kW

*) efficiency at gen terminals 0% tol

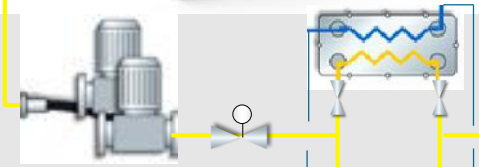
Fuel system - LPG



LPG storage tank
- Pressure vessel without thermal insulation
- Pressure as function of ambient temperature



Gas vents
- New location. Hazardous area to ground level.



LPG pumps and pressure control

HT water

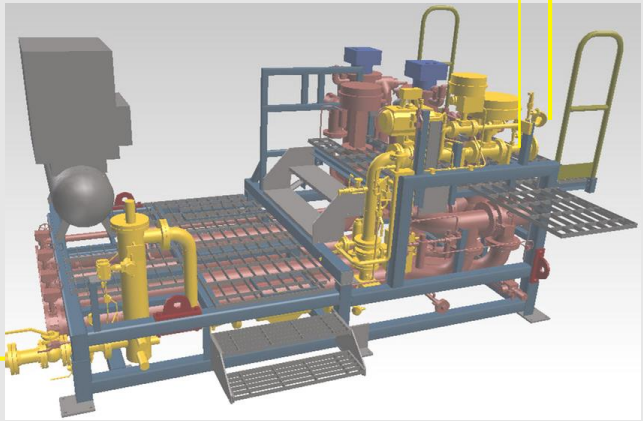
HT water

LPG vaporizers
- Primary heat source HT water

Scope limit

Insulation
- Depending on ambient temp.

Main Shut-off valves



Shut off valves and pipe system
- All materials of Stainless steel

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Proven Technology



211 plants with 874 engines producing 7670 MW



Largest Plants

Aliaga Industrial Park
Aliaga Izmir, Turkey
250.9 MW - 28xW20V34SG

UTE Linhares
Linhares-Espirito Santo, Brazil
204.0 MW - 24xW20V34SG

Pearsall Power Plant
Pearsall, Texas, United States
202.5 MW - 24xW20V34SG

United Ashuganj 200
Ashuganj, Brahmanbaria, Bangladesh
200.0 MW - 20xW20V34SG

PLN Arun
Lhokseumawe, Aceh, Indonesia
190.0 MW - 19xW20V34SG

Sasolburg
Sasolburg, South Africa
175.0 MW - 18xW20V34SG

Central Termica de Ressano Garcia (CTRG)
Ressano Garcia, Mozambique
174.6 MW - 18xW20V34SG

Antelope Station
Abernathy, Texas, United States
168.1 MW - 18xW20V34SG

Pltmg Bangkanai
Karendan Village, Lahai District, Indonesia
160.0 MW - 16xW20V34SG

Dedeli Enerji Afyon
Afyon, Turkey
126.5 MW - 13xW20V34SG

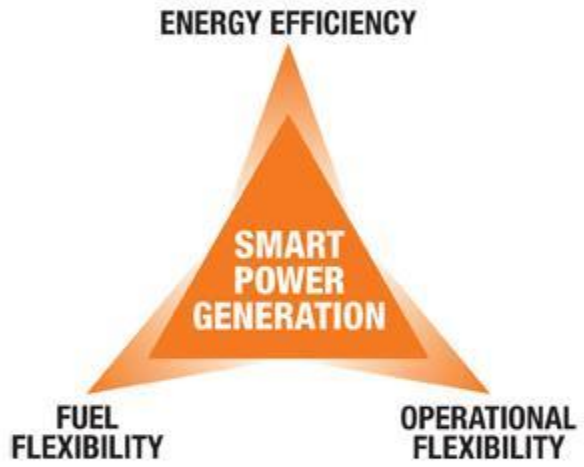
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Press release

Wärtsilä's first propane-fired project using two 20V34SG gas engines in El Salvador

Wärtsilä power plants now capable of running on propane

Wärtsilä Corporation, Trade press release, 6 November 2015 at 9:30 AM E. Europe Standard Time

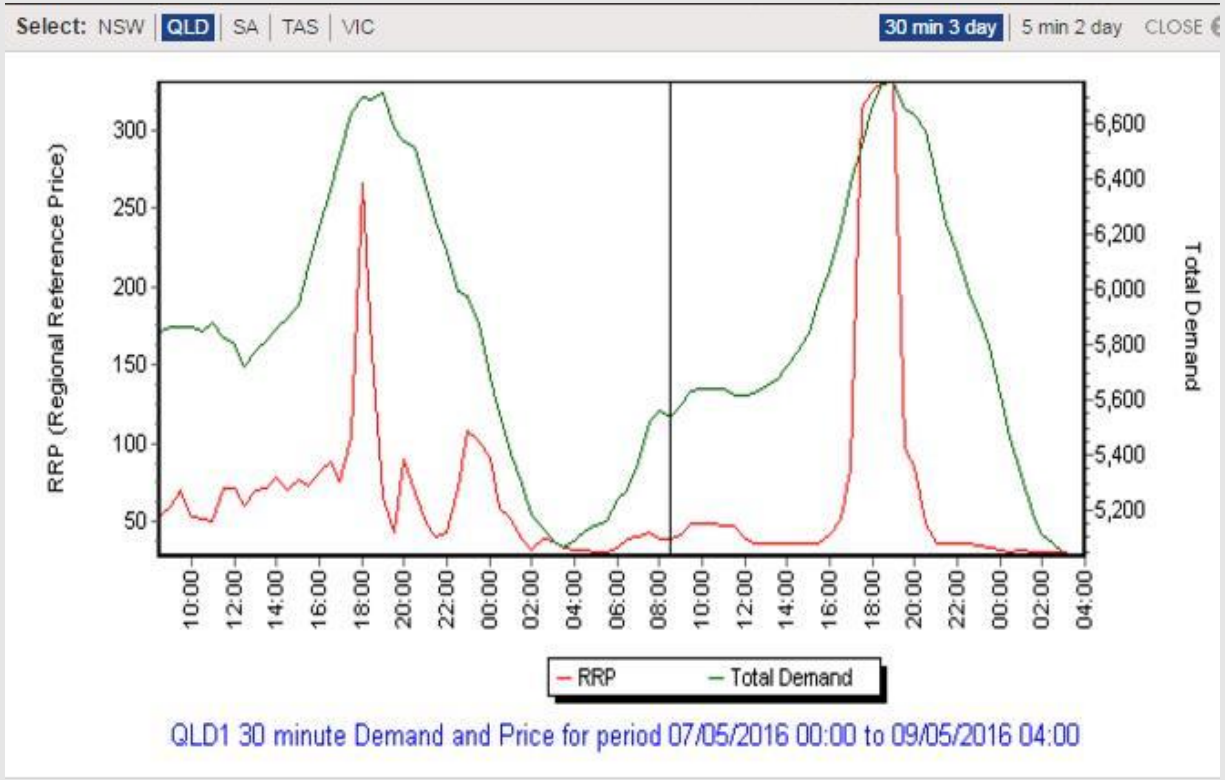


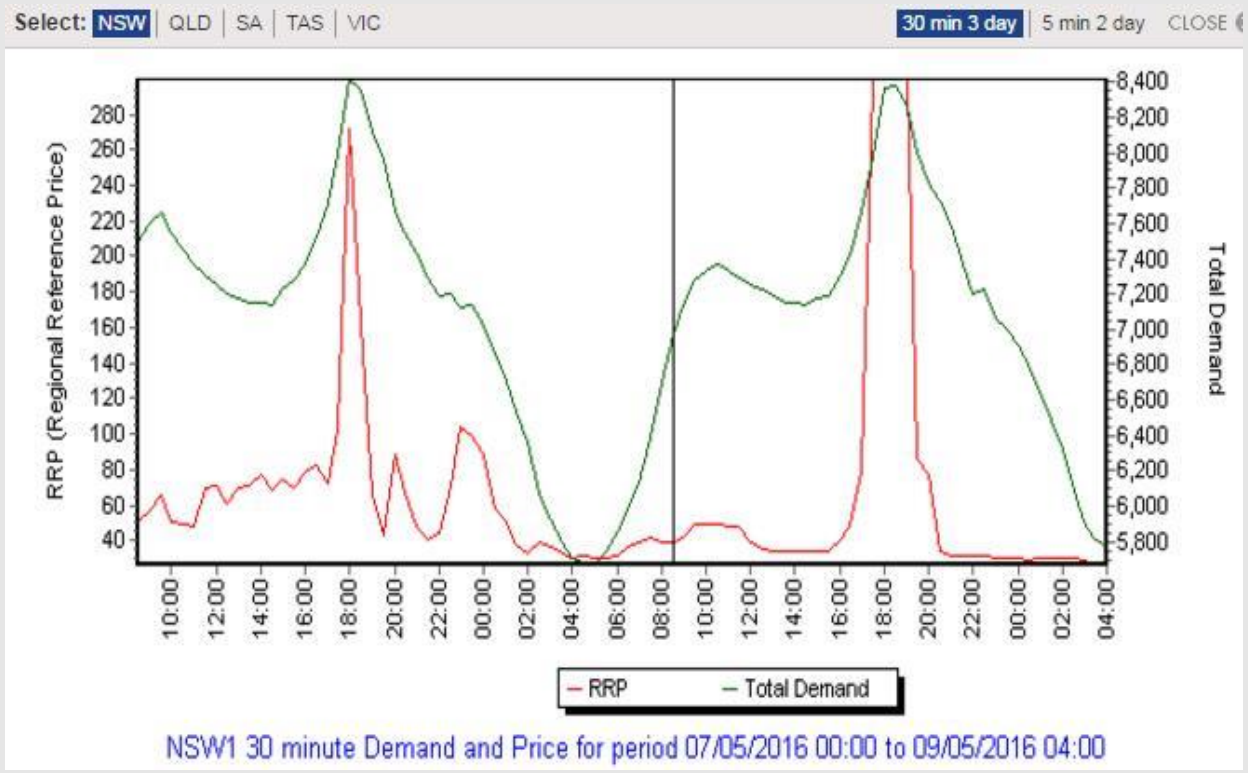
Wärtsilä is expanding its Smart Power Generation portfolio by introducing the capability of using propane as fuel for power generation.

Applications



Typical load profile





- Varying load demand => power plant will have to operate at varying loads; generating units would have to be started and stopped to optimize fuel efficiency.
- **Effect of renewable generation => uncertainty!**

Source: www.aemo.com.au

Characteristics of Smart Power Generation plants

Multimode operations
- Baseload
- Load following, peaking
- Regulation
- Fast reserve

Agility of dispatch
- Megawatts to grid in <1 minute from start
- <5 minutes to full load from start
- Fast shut down <1 minute
- Fast ramp rates up & down
- Unrestricted up/down times
- High starting reliability
- Remote operator access including start & stop
- Black start capability

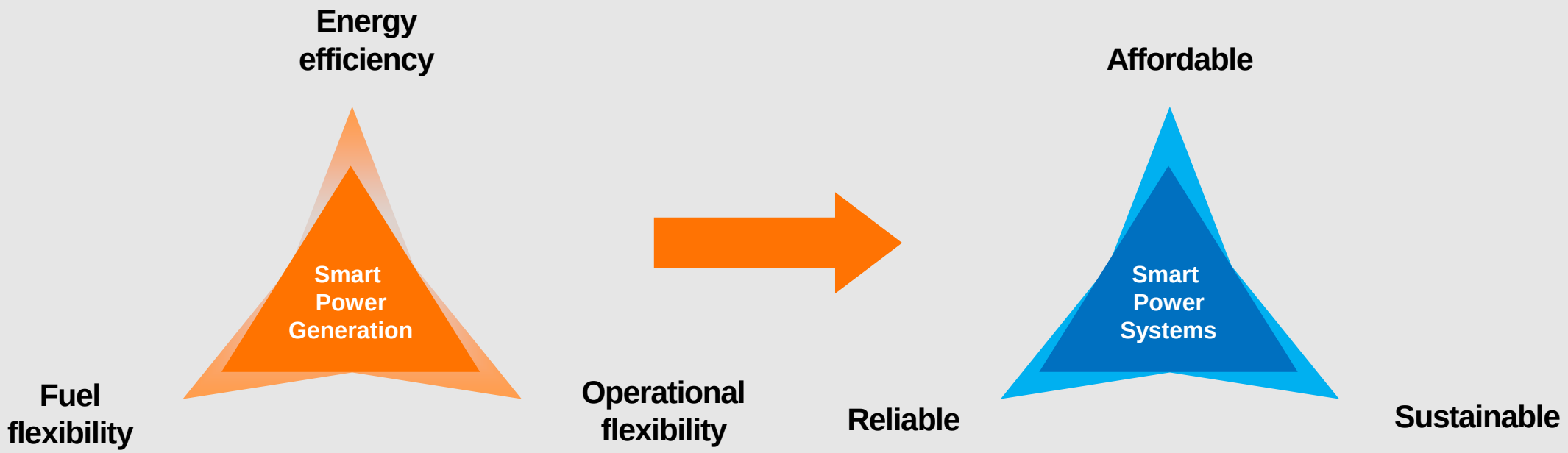
Low generation costs
- High electrical efficiency
  - Quick dispatch with low CO2 emissions
- Wide economic load range
  - Multiple units
  - Any plant output with high efficiency
- No derating – higher dispatch
- Low maintenance costs, not influenced by cyclic operation
- Low/no water consumption

High plant reliability and availability
- Firm n-2 availability (n = no. of units)
- Typical unit availability > 97%
- Typical unit reliability ~ 99%
- Typical unit starting reliability > 99%

Optimum plant location and size
- Industrial outlook to the plant enables location inside load pockets i.e. cities
- Flexible, stepwise expandable plant size
  - Same high performance independent of plant size
- Low pipeline gas pressure requirement (5 bar)

Low environmental impact
- Low CO2 and local emissions even when ramping and on part load
- The best thermal technology to provide sustainable grid stability

Smart Power Generation technology enables transition to a sustainable power system



This is Wärtsilä

A global leader in advanced technologies and complete lifecycle solutions for the marine and energy markets



Our business areas



ENERGY SOLUTIONS



MARINE SOLUTIONS

SERVICES



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A Comprehensive product portfolio



AUTOMATION



BALLAST WATER MANAGEMENT



ENGINES & GENERATING SETS



EXHAUST GAS CLEANING



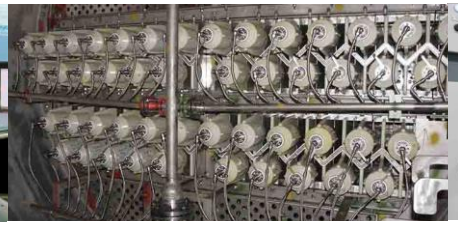
GAS SYSTEMS



INERT GAS SYSTEMS



NAVIGATION



OIL SEPARATION



POWER ELECTRIC SYSTEMS



PROPULSORS & GEARS



PUMPS & VALVES



SEALS, BEARINGS & STERN TUBES



SHIP DESIGN



THRUSTERS



WASTE, OIL & FRESH WATER MANAGEMENT

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Financial highlights

MEUR	2015	2014	2013[2]	2012[3]	2011
Order intake	**4 932**	5 084	4 821	4 940	4 516
Order book at the end of the period	**4 882**	4 530	4 311	4 492	4 007
Net sales	**5 029**	4 779	4 607	4 725	4 209
Operating result [1]	**612**	569	557	517	469
% of net sales [1]	**12.2**	11.9	12.1	10.9	11.1
Earnings/share, EUR	**2.25**	1.76	1.98	1.72	1.44

1) Figures exclude non-recurring items
2) Figures related to the statement of income in the comparison period 2013 have been restated due to the two-stroke business being classified as discontinued operations.
3) The figures in the comparison period 2012 have been restated during year 2013 according to the revised IAS 19.

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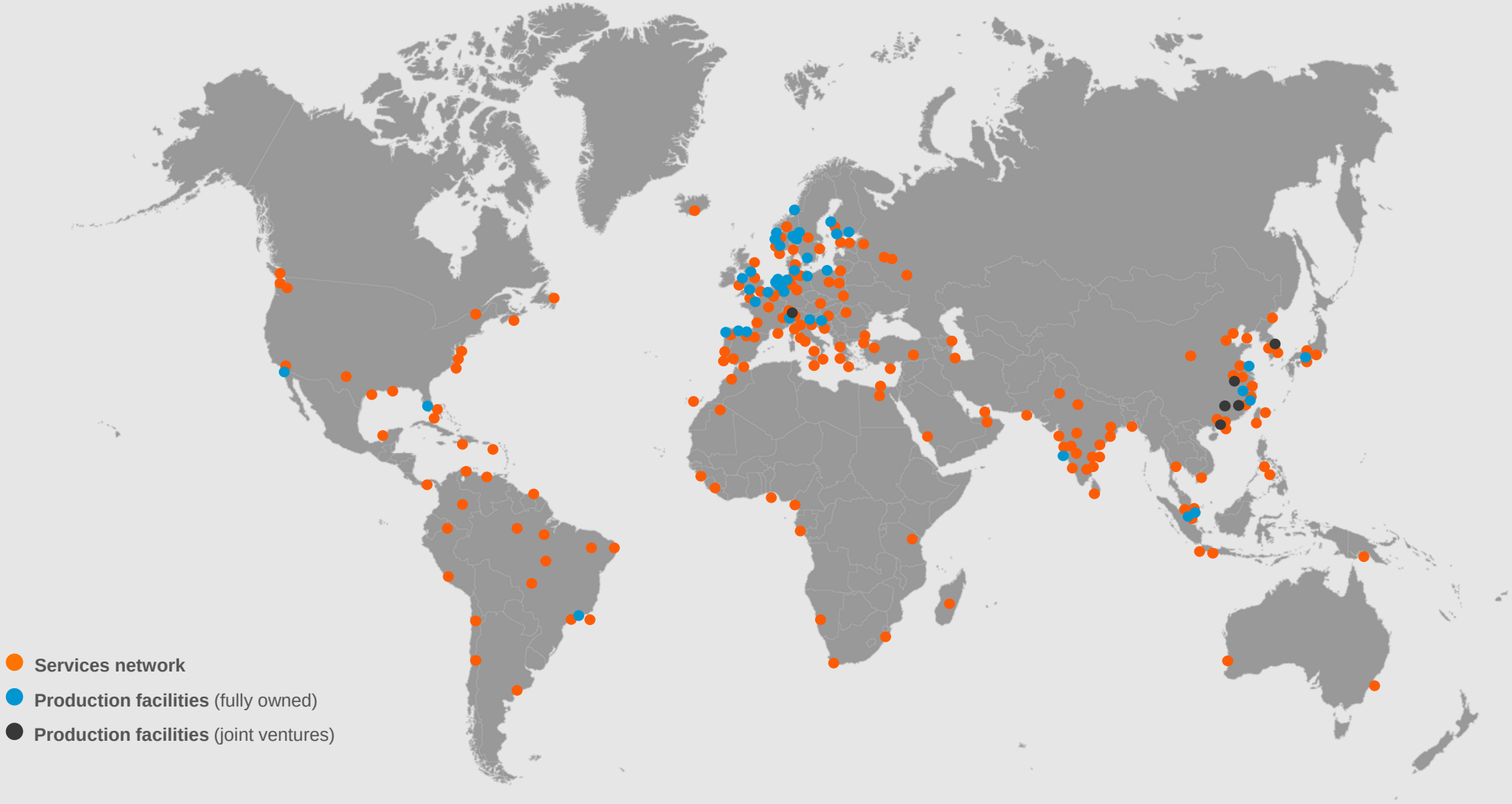
Focus on research and development

- Strong emphasis on product and solution innovation, particularly in the areas of efficiency improvement, fuel flexibility, total cost of ownership, and the reduction of environmental impact
- Long-term co-operation with research institutes and partners
- R&D investments in 2015 EUR 132 million, representing 2.6% of net sales
- In 2015 Wärtsilä made 56 patents for new inventions

“Our market driven investments in R&D and our focus on digitalisation create a strong foundation for securing and strengthening our position at the forefront of technological innovation.”

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Production and services globally



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RECAP

- Wärtsilä’s technology to run on LPG
- Proven references
- Smart Power Generation – high operational flexibility with high efficiency and low lifecycle cost
- Investment in R&D - forefront of technological innovation
- Wärtsilä’s lifecycle power solutions
- Global presence for local support




WÄRTSILÄ