WÄRTSILÄ

Gas and multi-fuel power plants

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Wärtsilä provides contemporary power generation solutions for baseload, intermediate, peaking and standby operations. Wärtsilä's gas and multi-fuel power plants are typically based on modular 4-19 MW internal combustion engine (ICE) units. ICEs can be fuelled by natural gas, or in multi-fuel mode using both gaseous and liquid fuels.

Wärtsilä's gas and multi-fuel power plants offer reliable and high performance; even when the conditions are most challenging. Their energy output and fuel efficiency remains consistent across the entire load range, whether operating in hot deserts, high mountains, city centres or sweltering jungles. The negligible amount of cooling water needed is invaluable in dry locations.

The unique operational flexibility of the ICE technology with ultra-fast starts and stops and quick loading ensures seamless control over load fluctuations. As energy demand grows, the modular design makes it easy to expand the power plant to meet any future needs. Plants can be upgraded at any time without risking operational reliability. Such incremental investment also ensures continual competitiveness in today's volatile market. Moreover, several small units are also always more reliable than a single large one.

Our power plants are backed up by world-wide operations and management services that ensure efficiency and optimise the performance of the equipment throughout its lifecycle.

We offer true flexibility, both in fuel choice and in our ability to respond to operational demand. This makes Wärtsilä gas and multi-fuel power plants the solid choice in today's power market.

ICE-strengths: High efficiency at small scale; modular; rapid start-up; lower capital cost than OCGT; tolerant of different fuel qualities.[1)]

Source: Internal Energy Agency: Energy Technology Perspectives – Harnessing Electricity's Potential, 2014
1) ICE = internal combustion engines, OCGT = open cycle gas turbines

Customer benefits

- Proven technology: Wärtsilä has supplied 176 countries with more than 11,000 engines having a combined capacity of 63 GW
- Plant electrical efficiency up to more than 54%
- Continuous choice of the most feasible fuel
- Fast start-up: only 2-10 minutes from hot standby to full load, regardless of plant size
- Combined heat and power (CHP) as an option
- The multi-unit design guarantees excellent plant availability and reduced need for back-up capacity
- High part-load efficiency
- Low gas pressure requirement
- Maintenance schedule is independent of the number of starts, stops or trips
- Full plant output at high altitudes and in hot and dry ambient conditions
- Closed-circuit radiator cooling with only 0.2 l/MWh water consumption
- Stepwise investment with reduced risks and optimised profit generation

Flexibility in scope

Wärtsilä gas and multi-fuel power plants are designed for optimal performance in a wide variety of decentralised power production applications: baseload, peaking power and CHP plants. The plant can be situated in the midst of a densely populated area, or in a remote location with minimal infrastructural resources.

The modular design simplifies the plant configuration so as to meet the customer's specific needs. Adding features is a matter of adding modules, which are pre-tested for compatibility and reliability. Pre-engineered, integrated solutions make the planning and delivery processes faster, thereby creating savings and additional revenues.

A typical Wärtsilä gas or multi-fuel power plant consignment consists of:

- Generating sets
- Mechanical auxiliary systems including the fuel system, lubrication, air intake, cooling, exhaust processing and sound-proofing
- Electrical systems
- Automation
- Heat recovery system in CHP plants
- Civil works and structures.

The Wärtsilä Flexicycle option includes an additional steam boiler module to drive a steam turbine, powered by the waste heat from the engines. This combined cycle solution increases the power production by almost 10%.

The steam cycle option can either be included in the initial design, or added at a later stage. In CHP applications for hot water production, the total efficiency can reach 95%. This lowers the production cost of electricity and increases the economic attraction of these plants.

The environmental impact of Wärtsilä gas or multi-fuel power stations is low. The NO_X emission levels are low enough to fulfil most current environmental regulatory requirements without need of secondary cleaning methods. To further reduce the environmental impact and to comply with even the strictest regulations, effective oxidation catalysts, NO_X catalysts, and other advanced equipment can be installed.

The engine cooling arrangement using closed-loop radiator cooling reduces the plant process water consumption to a mere 0.2 l/MWh, minimising the effect on local water resources.

The engine hall design and low building profile help the plant to blend in with its surroundings. Effective sound-proofing allows the plant to be operated even in densely populated areas, near the actual loads, which effectively prevents transmission and distribution bottlenecks.

Switchgear room

Control room

The generating set

Selective Catalytic Reduction unit (SCR)

Power plant auxiliary area

Closed-loop cooling system with radiators

- High electrical efficiency
- Minimised consumption of the plant's own electricity
- Simple and reliable technical solutions
- Compact, pre-engineered plant design
- Optimal for EPC deliveries to remote areas with limited infrastructure

The Wärtsilä Power Cubes, GasCube and OilCube, are modular, pre-engineered single-engine power plants. They are produced within a cost framework that justifies turnkey deliveries for small plants while still complying with the needs of different clients and applications.
A Wärtsilä GasCube comprises multiple engine modules designed to meet a total power need of 6-30 MW. A Wärtsilä GasCube based on the Wärtsilä 16V34SG or Wärtsilä 20V34SG engine, with all the auxiliaries and components needed, provides 7-10 MW_e per unit. The Wärtsilä 34SG can operate in a load window of 10-100%. Due to the self-contained design, the GasCube is the optimal solution for agile and exceptionally cost-efficient project execution.

Flexibility in operation

Wärtsilä gas engines operate on a wide selection of gas types. They are also available as multi-fuel versions, capable of operating on both natural gas and liquid fuel (light fuel oil, heavy fuel oil, crude oil or liquid biofuel). When the gas supply is uncertain, or prices are volatile, it is possible to switch from gas to liquid fuel, and vice versa, even during operation. The option to run on liquid fuel as a backup improves reliability remarkably.

In emerging gas markets it is possible to build a fast-track plant, operating initially on liquid fuel and being converted to operate on gas as and when it becomes available. This also works the other way around: existing power plants with gas conversion possibilities create a good base for investments in the gas infrastructure.

Wärtsilä gas engines with modern lean-burn technology reach over 50% electrical efficiency. The heat recovery option does not affect the electrical efficiency of the generating set. High efficiency translates into considerable savings in fuel costs compared to other technologies.

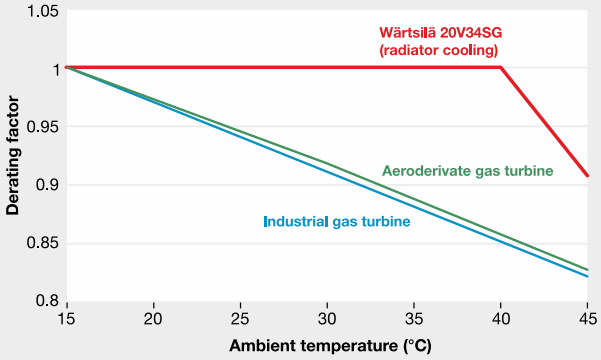
The multi-unit configuration creates a part-load profile that enables the plant's entire output range to be optimised. For any given total plant load, as many individual generating sets as required are operated at their optimal efficiency.

Wärtsilä gas and multi-fuel power plants withstand extreme conditions, with minimal derating of the heat rate and output at high altitudes and in hot temperatures. Furthermore, Wärtsilä power plants can be located anywhere because they run on low gas pressure, and the water consumption of their air cooled system is negligible.

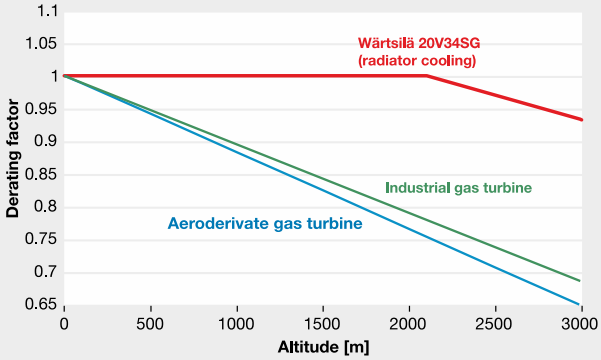
The multiple generating set concept ensures high reliability and availability. All maintenance can be performed on-site, one engine at a time, leaving the remaining units fully available for duty. The use of several identical engines also reduces the cost of the on-site spare parts stock.

The KivuWatt power plant in Rwanda utilizes naturally occurring methane gas from Lake Kivu to generate electricity via Wärtsilä 34SG engines. The tuning possibilities offered by the advanced control system of the Wärtsilä 34SG engines allow the use of pipeline and associated gas with a wide range of gas compositions.

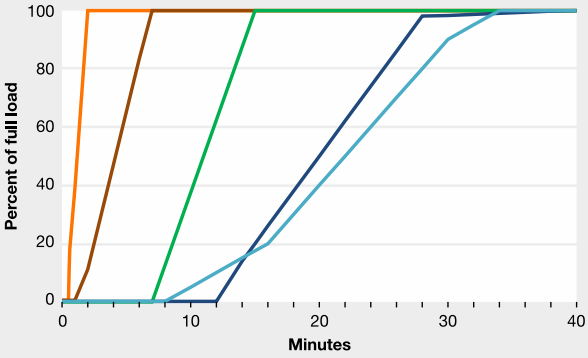
Wärtsilä gas ICEs offer stable output and high performance in hot and dry conditions. No water consumed for plant cooling = arid area suitability!



Wärtsilä gas ICEs offer stable output and high performance at high altitudes as well.



Wärtsilä ICE power plants can start and reach full load in less than 10 minutes.



- Wärtsilä 34SG power plant under hot start conditions: prelubrication of engine and gen bearings
- Wärtsilä 50SG power plant under hot start conditions: prelubrication of engine and gen bearings
- Simple cycle industrial (heavy duty) gas turbine under hot start conditions
- CCGT under hot start conditions: purge credit; rapid response; startup within 8 hours of shutdown
- CCGT under hot start conditions: auxiliary steam, stack dampers maintain HRSG temperature and pressure

A Wärtsilä 50SG multi-unit gas engine power plant has very high part-load efficiency.

Flexibility in fuel choice

Internal combustion engines are today's most efficient means of converting gaseous or liquid fuels into energy. Wärtsilä gas power plants can run on low-pressure gas. The multi-fuel option gives even more flexibility when the gas supply is unreliable.

The engine generating sets used in Wärtsilä power plants are driven by medium-speed four-stroke internal combustion engines. These heavy-duty generating sets consist of an engine connected directly to a generator via a flexible coupling. The generator and engine are mounted on a common base frame.

Lean-burn gas engines (SG)

The Wärtsilä SG is a spark-ignited lean-burn engine. In this process, the gas is mixed with air before the inlet valves. During the intake period, gas is also fed into a small pre-chamber, where the gas mixture is rich compared to the gas in the cylinder. At the end of the compression phase the pre-chamber gas-air mixture is ignited by a spark plug. The flames from the nozzle of the pre-chamber ignite the mixture in the whole cylinder. Combustion is fast. After the working phase the cylinder is emptied of exhaust gas and the process starts again.

Dual-fuel engines (DF)

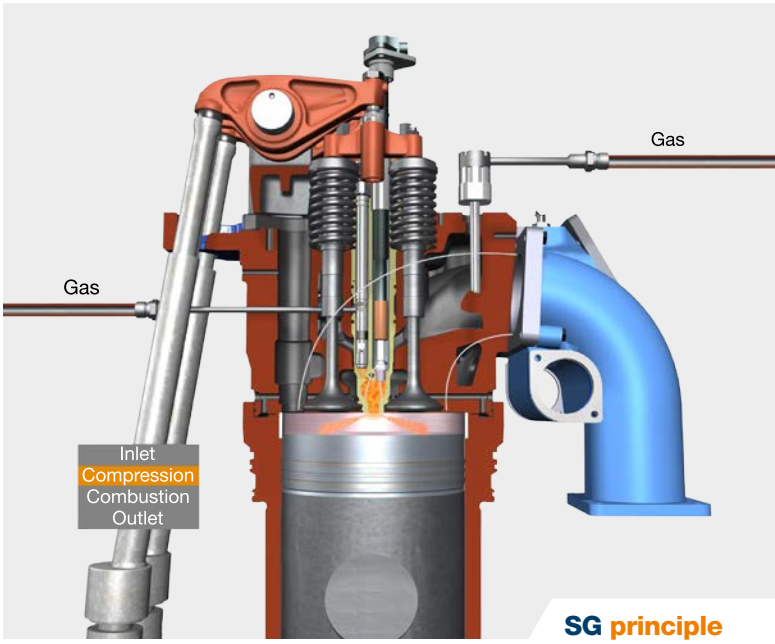
When operating on gas, the dual-fuel engine utilises a lean-burn combustion process. The gas is mixed with air before the intake valves during the air intake period. After the compression phase, the gas-air mixture is ignited by a small amount of liquid pilot fuel. After the working phase the exhaust gas valves open and the cylinder is emptied of exhaust gases. The inlet air valves open when the exhaust gas valves close, and the process starts again. The dual-fuel engine is also equipped with a back-up fuel system. This is a normal diesel process with camshaft-operated liquid fuel pumps, running parallel to the process and working as a stand-by. The engine can switch between diesel and gas mode, even during operation.

Gas-diesel engines (GD)

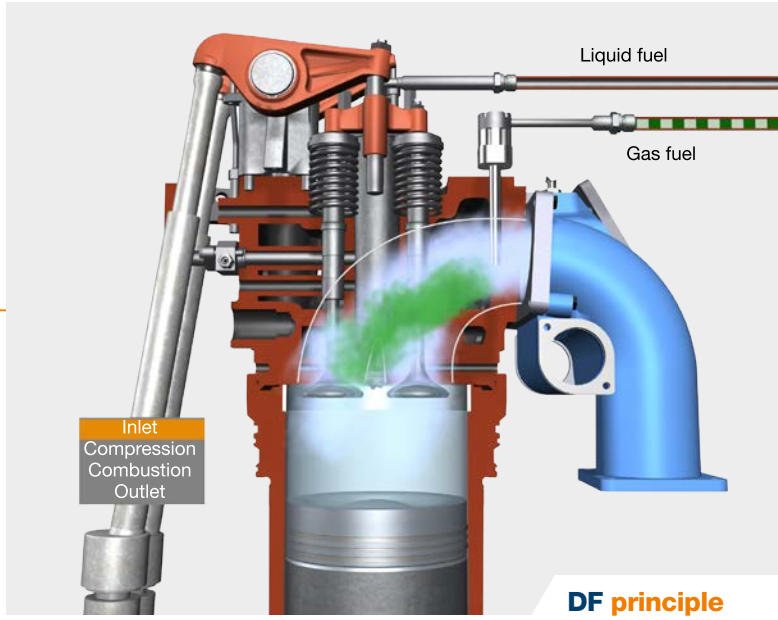
The Wärtsilä GD engine utilises the diesel combustion process in all operational modes. In gas mode, the gas is injected at high pressure after the pilot fuel and is ignited by the subsequent flame. The amount of pilot fuel is equivalent to approximately 5% of the fuel energy input at full engine load.

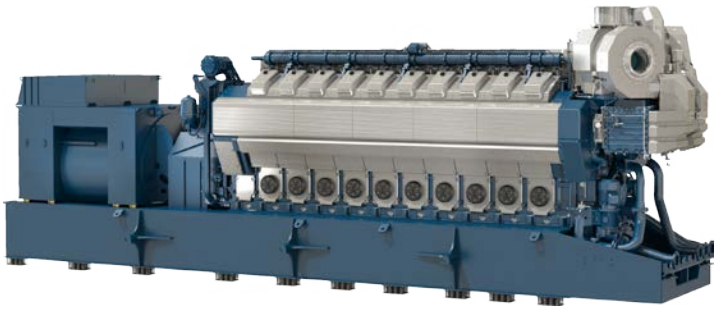
The gas-diesel engine can be switched instantly from gas to liquid fuel mode operation. The liquid fuel can be light fuel oil, heavy fuel oil or crude oil. In this case, the process is the same as the conventional diesel process.

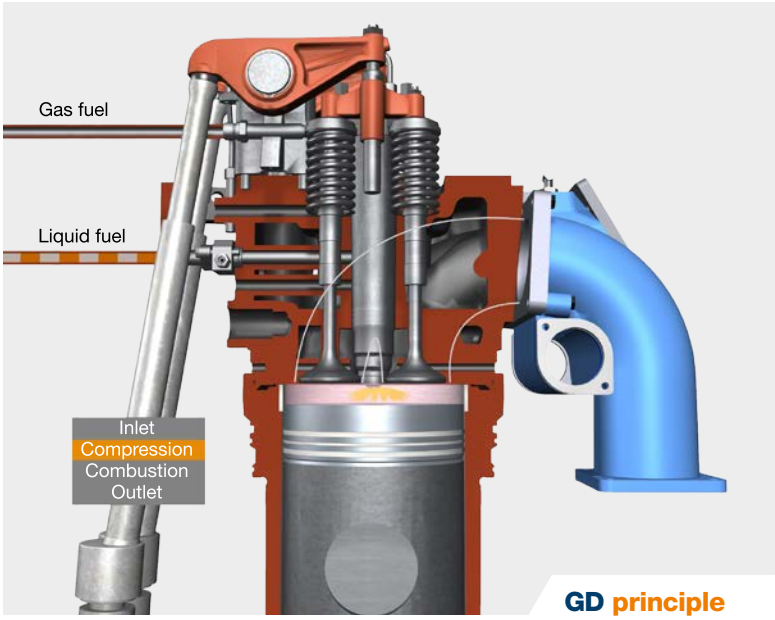
In fuel sharing mode, the ratio between liquid and gas fuel can be controlled and varied during operation. The operating window for the fuel sharing mode is 30-100% load, and the gas/liquid fuel ratio can vary according to the fuel sharing window. This process can tolerate big variations in the gas quality and is especially suitable for low quality gas, such as associated gas in oil fields.



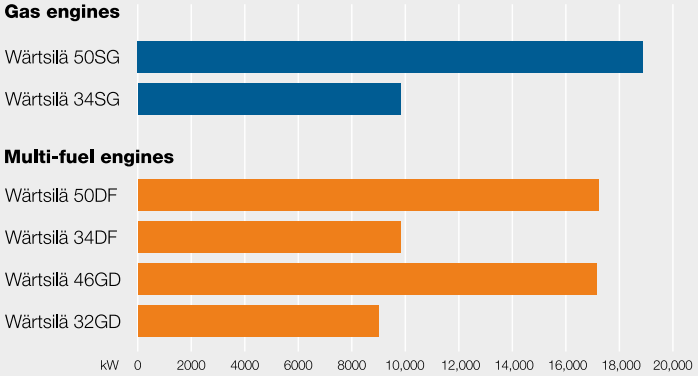
The Wärtsilä 34SG engine can run on a wide range of gases, including liquefied petroleum gas (LPG) and ethane. It is the first medium-speed engine capable of running on LPG.







Electrical power range of Wärtsilä generating sets



Project execution

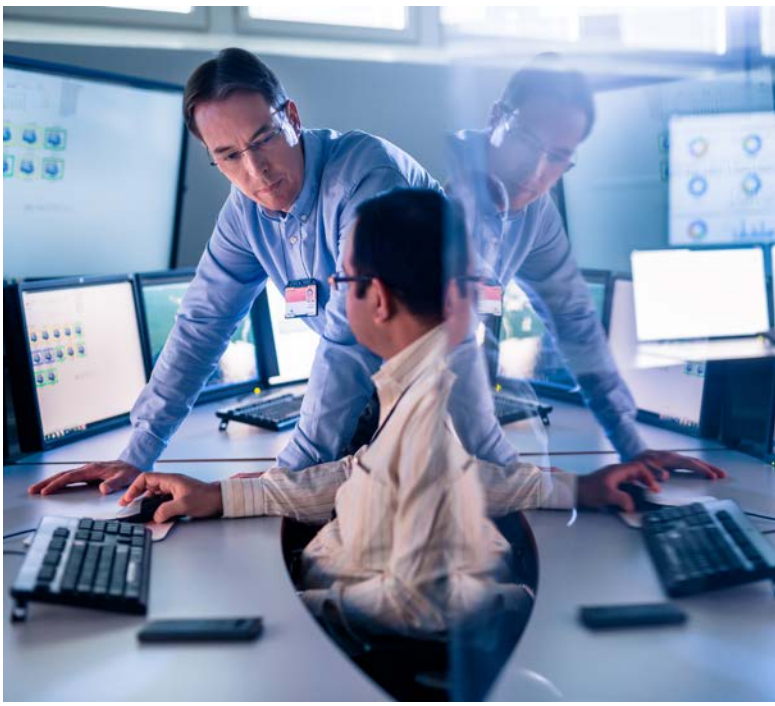
Wärtsilä has the resources and capabilities to fulfil contracts ranging from engineered equipment delivery (EEQ) to complete turnkey projects including engineering, procurement and construction (EPC). We have a proven track record of some 5000 projects in 176 countries.

With experienced and certified project execution personnel, Wärtsilä understands the requirements for power plant projects and is fully capable of handling and managing the complete scope of contracting arrangements.

Capabilities:

- Inter-disciplinary team of more than 200 project managers and project engineers with 100+ PMI-certified professionals
- Certified HSE Management System OHSAS 18001 & ISO 14001. Lost time injury frequency rate ≈ 1.0 (EPC construction sites)
- Quality management system ISO9001
- Efficient sourcing process and well-managed supplier base
- Experienced construction management team of 400+ engineers
- Established network of partners, engineering, manpower etc.
- Sustainable construction strategy utilizing qualified subcontractors, thus providing a positive socio-economic impact locally.

Our dedicated Wärtsilä Development & Financial Services (WDFS) supports clients with advice and assistance in deal structuring and financing. It also develops independent power producer (IPP) projects based on Wärtsilä ICE technology and know-how, with a focus on environmentally responsible power projects with sound financing structures.



Services – lifecycle solutions

Our range of services covers everything from rapid spare parts delivery to complete long-term operation and maintenance solutions. By optimising all aspects of the power plant's operations and minimizing the economic and technological risks involved, we enhance the plant's profitability.

Wärtsilä frequently enters into operation and maintenance (O&M) solutions with customers such as independent power producers (IPP), captive power plant operators, and baseload plant owners. These solutions are also suitable for balancing power plants, peaking/intermediate plants and utilities. They aim to maximise the productive lifetime of the installation and the return on investment. The solution is always tailored to the specific needs of the customer, including performance and lifecycle cost guarantees.

Wärtsilä currently operates more than 600 marine and land-based installations (24 GW of generating capacity) around the world.

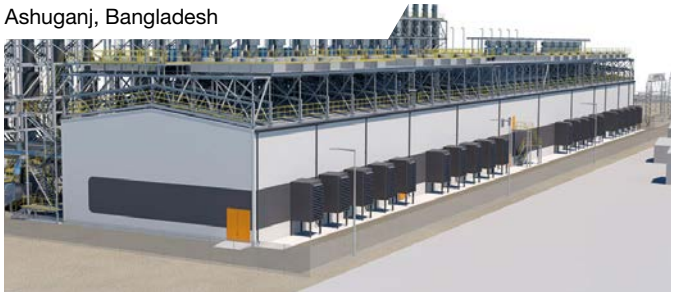
If the customer chooses to operate the asset themselves, the best possible support is available – from training and online support to service packages or plant modernisation and upgrading. Our global services network of 11,000 professionals stands ready to provide support for our customers, anywhere at any time. This ensures that the power station will operate at its highest efficiency and performance levels throughout its lifetime.

Broad experience on a global scale

We have a track record of 63 GW of installed power plant capacity in 176 countries around the world. Here are some examples.

Gas power plants

Ashuganj, Bangladesh



UNITED ASHUGANJ

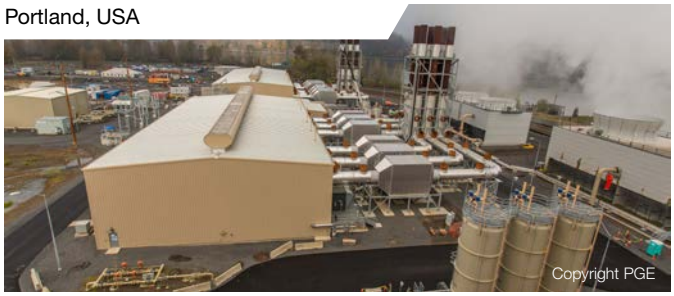
Customer	United Ashuganj Energy Ltd. (IPP)
Type	Wärtsilä 34SG gas power plant
Operating mode	Flexible baseload
Gensets	20 x Wärtsilä 20V34SG
Total output	195 MW
Fuel	Natural gas
Scope	EEQ
Delivery	2015

Sumatra, Indonesia

ARUN

Customer	PT Wijaya Karya Persero Tbk (PT Wika) (Utility)
Type	Wärtsilä 34SG gas power plant
Operating mode	Peak load/stand-by & emergency
Gensets	19 x Wärtsilä 20V34SG
Total output	184 MW
Fuel	LNG (Liquefied natural gas)
Scope	EEQ
Delivery	2015

Portland, USA



PORT WESTWARD UNIT 2

Customer	Portland General Electric (Utility)
Type	Wärtsilä 50SG gas power plant
Operating mode	Peak load/stand-by & emergency
Gensets	12 x Wärtsilä 18V50SG
Total output	224 MW
Fuel	Natural gas
Scope	EEQ
Delivery	2014

Jambi, Indonesia

SEI GELAM

Customer	PT Perusahaan Listrik Negara (Utility)
Type	Wärtsilä 34SG gas power plant
Operating mode	Peak load
Gensets	11 x Wärtsilä 20V34SG
Total output	110 MW
Fuel	Natural gas
Scope	EEQ
Delivery	2013

Sasolburg, South Africa

SASOLBURG

Customer	SNE (IPP)
Type	Wärtsilä 34SG gas power plant
Operating mode	Flexible baseload
Gensets	18 x Wärtsilä 20V34SG
Total output	175 MW
Fuel	Natural gas
Scope	EPC
Delivery	2012

EPC = Engineering, Procurement & Construction
EEQ = Engineered Equipment Delivery
ED = Equipment Delivery

Aliaga, Turkey

ALIAGA

Customer	Çakmaktepe Energy (IPP)
Type	Wärtsilä 34SG gas power plant
Operating mode	Baseload
Gensets	28 x Wärtsilä 20V34SG
Total output	270 MW
Fuel	Natural gas
Scope	EPC & EEQ
Delivery	2007, 2009 & 2011

Linhares-Espirito Santo, Brazil

UTE LORM

Customer	Linhares Geração S.A (IPP)
Type	Wärtsilä 34SG gas grid stability
Operating mode	Peak load
Gensets	24 x Wärtsilä 20V34SG
Total output	204 MW
Fuel	Natural gas
Scope	EPC
Delivery	2010

Texas, USA

PEARSALL POWER PLANT (STEC)

Customer	STEC (Utility)
Type	Wärtsilä 34SG gas grid stability
Operating mode	Peak load/stand-by & emergency
Gensets	24 x Wärtsilä 20V34SG
Total output	203 MW
Fuel	Natural gas
Scope	EEQ
Delivery	2009

Colorado, USA

PLAINS END I & II

Customer	Tyr (IPP)
Type	Wärtsilä 34SG gas grid stability
Operating mode	Peak load/stand-by & emergency
Gensets	20 x Wärtsilä 18V34SG + 14 x Wärtsilä 20V34SG
Total output	231 MW
Fuel	Natural gas
Scope	ED
Delivery	2001 & 2006

Nevada, USA

BARRICK

Customer	Barrick Goldstrike Mines Inc. (Industry – mining)
Type	Wärtsilä 34SG gas power plant
Operating mode	Baseload
Gensets	14 x Wärtsilä 20V34SG
Total output	116 MW
Fuel	Natural gas
Scope	EPC
Delivery	2005

Multi-fuel power plants

Musandam, Oman

MUSANDAM

Customer	Musandam Power Company
Type	Wärtsilä 34DF multi-fuel power plant
Operating mode	Flexible baseload
Gensets	15 x Wärtsilä 20V34DF
Total output	120 MW
Fuel	Natural gas & LFO (back-up)
Scope	EPC
Delivery	2016

Bali, Indonesia

PLTD PESANGGARAN BALI

Customer	PT Indonesia Power (Utility)
Type	Wärtsilä 50DF multi-fuel power plant
Operating mode	Flexible baseload
Gensets	12 x Wärtsilä 18V50DF
Total output	200 MW
Fuel	Natural gas & HFO
Scope	EPC
Delivery	2015

Alaska, USA

EKLUTNA GENERATION STATION

Customer	Matanuska Electric Association (Utility)
Type	Wärtsilä 50DF multi-fuel power plant
Operating mode	Flexible baseload
Gensets	10 x Wärtsilä 18V50DF
Total output	171 MW
Fuel	Natural gas & LFO
Scope	EEQ
Delivery	2015

Amman, Jordan

IPP3

Customer	Amman Asia Electric Power Company (IPP)
Type	Wärtsilä 50DF multi-fuel power plant
Operating mode	Flexible baseload & peak load
Gensets	38 x Wärtsilä 18V50DF
Total output	573 MW
Fuel	Natural gas, HFO & LFO
Scope	EPC in a Consortium
Delivery	2014

Amman, Jordan

IPP4

Customer	AES Jordan
Type	Engine-solar hybrid
Operating mode	Peaking / baseload
Solar PV output	46 MWdc, 40 MWac
Gensets	16 x Wärtsilä 18V50DF
Total output	250 MW (gensets)
Fuel	Natural gas, heavy fuel oil, light fuel oil (tri-fuel plant)
Scope	EPC
Delivery	Engine unit in 2014

EPC = Engineering, Procurement & Construction
EEQ = Engineered Equipment Delivery
ED = Equipment Delivery

Kiisa, Estonia

KIISA ERPP I & II

Customer	Elering (Utility/TSO)
Type	Wärtsilä 34DF multi-fuel grid stability
Operating mode	Peak load/stand-by & emergency
Gensets	27 x Wärtsilä 20V34DF
Total output	250 MW
Fuel	Natural gas & LFO
Scope	EPC
Delivery	2013 & 2014

San Pedro de Macorís, Dominican Republic

QUISQUEYA I & II

Customer	Barrick & EGE Haina (Industrial & utility)
Type	Flexicycle 50DF multi-fuel power plant
Operating mode	Flexible baseload
Gensets	12+12 x Wärtsilä 18V50DF
Total output	430 MW
Fuel	Natural gas & HFO
Scope	EPC
Delivery	2013

Santo Domingo, Dominican Republic

SEABOARD

Customer	Seaboard Corporation (IPP)
Type	Flexicycle 50DF multi-fuel power plant
Operating mode	Flexible baseload
Gensets	6 x Wärtsilä 18V50DF
Total output	110 MW
Fuel	Natural gas, HFO & LFO
Scope	EEQ
Delivery	2012

California, USA

HUMBOLDT

Customer	Pacific Gas & Electric Co (Utility)
Type	Wärtsilä 50DF multi-fuel power plant
Operating mode	Baseload
Gensets	10 x Wärtsilä 18V50DF
Total output	163 MW
Fuel	Natural gas & LFO
Scope	EPC
Delivery	2011

Sangachal, Azerbaijan

SANGACHAL

Customer	AzerEnerji (Utility)
Type	Wärtsilä 50DF multi-fuel power plant
Operating mode	Baseload
Gensets	18 x Wärtsilä 18V50DF
Total output	308 MW
Fuel	Natural gas
Scope	EPC
Delivery	2009

Wärtsilä is a global leader in advanced technologies and complete lifecycle solutions for the marine and energy markets. By emphasising sustainable innovation and total efficiency, Wärtsilä maximises the environmental and economic performance of the vessels, power plants and LNG infrastructure of its customers.

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