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WÃ¤rtsilÃ¤ North America, Inc Response to CEC RFI on Clean Energy Resources for Reliability

Additional submitted attachment is included below.

November 30, 2022

California Energy Commission
Re: Docket No. 21-ESR-01
715 P Street
Sacramento, CA 95814

Re: Wärtsilä North America, Inc.'s Response to the California Energy Commission's Request for Information on Clean Energy Resources for Reliability

Wärtsilä North America, Inc. ("Wärtsilä") submits these comments in response to the Request for Information on Clean Energy Resources for Reliability issued by the California Energy Commission ("CEC") on November 7, 2022. Wärtsilä is leading the transition towards a 100% renewable energy future. Wärtsilä understands, designs, builds, and serves optimal power systems for future generations. Wärtsilä's solutions provide the needed flexibility to integrate renewables and secure power system reliability. Wärtsilä's offerings comprise engine-based flexible power plants (including liquid gas systems) and energy storage and integration solutions. Wärtsilä supports its customers over the lifecycle of their installations with services that enable increased efficiency and guaranteed performance. Wärtsilä has 76 GW of installed power plant capacity in 177 countries around the world. In California, Wärtsilä has delivered over 250 MWs of engine power plants, including the 163 MW Humboldt Bay Generating Station, the 50 MW Woodland 3 Generation Station, and the 44 MW Red Bluff plant, as well as over 420 MWs of battery energy storage systems.

Questions for the Public
<u>List of Resource types and Evaluation Attributes</u>

The RFI seeks feedback on the following questions regarding the list of preliminary resources and qualitative and quantitative attributes by which they will be evaluated:

1) Are the categories (indicated in Tables 1, 2 and 3) appropriately representing how the CEC should be evaluating resources?

Regarding Table 1 on Supply Resources, the CEC should note that Reciprocating Engines possess great flexibility in the fuels they utilize. For example, Wärtsilä's utility-grade reciprocating internal combustion engine ("RICE") power plants can operate on not only natural gas and fuel oil, but also biodiesel and blends of hydrogen and hydrogen-based fuels. Furthermore, Wärtsilä anticipates that 100 percent hydrogen capabilities will be available in 2025. The CEC should recognize such fuel-flexible resources that can convert operations to sustainable fuels because these assets mitigate stranded asset risks associated with fossil fuel generation. Moreover, resources whose operations can be converted from fossil fuels to sustainable fuels in the future can balance emissions and cost constraints, and thereby maximize the benefit of any necessary procurement.

2) Are there resources that should be added to or removed from the preliminary list under each of the categories (shown in Tables 1, 2, and 3)?

As described in response to Question 1, the CEC should add "fuel flexible generation" to the preliminary list of supply resources shown in Table 1.

3) Are there other attributes that should be considered, in addition to the ones listed in Table 4? If so, should those be considered for the qualitative and/or quantitative evaluation?

Although "Dispatchability" is identified as one of the qualitative attributes in Table 4, further clarification should be provided to quantify the degree to which resources can respond to grid needs. Specifically, there are six key elements of dispatchability that should be evaluated quantitatively, defined as follows:

1. Start-up: includes the time (seconds, minutes, hours) for a resource to synchronize to the grid and generate at full output, as well as the associated cost to start the resource. The more quickly a resource can start, and do so while incurring lower costs, the more dispatchable that resource is.

2. Minimum Run Time: the minimum amount of time a resource must operate once it comes online. Longer minimum run times may prevent grid operators from turning the resource off when it is no longer needed (e.g., when renewable resources generate at higher levels than originally anticipated). As such, minimum run time constraints may result in otherwise unnecessary curtailment of zero-marginal cost, renewable resources. The lower a resource's minimum run time, the more dispatchable that resource is.

3. Minimum Down Time: the minimum time a resource must stay turned off once it has been shut down. Real-time fluctuations in supply and demand require resources to respond to minute-by-minute grid needs; when resources cannot turn back on to balance grid needs, they hinder optimal dispatch decisions. The lower a resource's minimum down time, the more dispatchable that resource is.

4. Minimum Operating Level: the lowest output level (MWs) at which a resource can operate. Higher minimum operating levels can constrain economic dispatch decisions

and lead to greater curtailment of renewables in real-time. The lower a resource's minimum operating level, the more dispatchable that resource is.

5. Ramp Speed: the rate at which a resource can change its power output. Large swings in variable wind and solar output, as well as demand, must be complemented by resources whose output can be ramped up and down to maintain a balanced grid. The faster a resource's ramp speed the more dispatchable that resource is.

6. Duration: the length of time a resource can operate at full capacity without interruption. Prolonged renewable energy droughts increase the need for resources that can deliver power regardless of weather conditions. The longer a resource's duration, the more dispatchable that resource is.

The value of these six elements of dispatchability can be quantified by utilizing production cost models at both an hourly (i.e., day-ahead) and 5-minute (i.e., real-time) granularity. Specifically, the dispatchability value of a candidate resource would be calculated as the day-ahead and real-time cost-savings of a system that includes the resource compared to a system without the resource. Importantly, in order to capture the variability of real-time operations the value of the six elements of dispatchability cannot be adequately quantified unless a real-time modeling lens is applied.

Additionally, although the "Cleanliness" criteria is currently listed as a qualitative attribute, efforts should be made to quantitatively measure resource cleanliness from a system-perspective. Similar to the proposed evaluation of dispatchability using day-ahead and real-time production cost models, total system emissions could be compared before and after a candidate resource is added to the system. Such an analysis would quantify the portfolio diversity benefits of resource interactions and highlight the differences in emissions savings associated with different levels of dispatchability.

4) How should the attributes be weighted relative to each other? Should some attributes be weighted more than others?

Given the time-sensitive nature of the state's reliability needs, satisfaction of the criteria related to adequately meeting key deadlines (i.e., the readiness, permitting, interconnection, and supply chain attributes) should be a pre-requisite for any resource considered in the CEC's analysis. In accordance with Senate Bill 846, the CEC must strive for supporting grid reliability while maintaining consistency with the state's greenhouse gas emissions reductions goals. As such, the attributes of dispatchability (as proposed in response to Question 3) and cleanliness must also be prioritized. Furthermore, the greater a resource's dispatchability, the more likely it is to satisfy the attributes of cleanliness, policy alignment, customer acceptance, and equity. However, no single resource can best satisfy all of the desired attributes; a diversified and balanced portfolio of resources will best satisfy the state's clean reliability goals.

5) What data/information sources can help inform characterization and evaluation (both qualitative and quantitative) of the different resources?

The attached specifications sheets provide more information on the dispatchability and cleanliness characteristics of Wärtsilä's reciprocating engines. Please note that the attached specification sheets provide uncontrolled emissions. However, Wartsila will provide emission mitigation equipment that will meet the air permit requirements for a specified site.

Please contact Greg Hall at f.gregory.hall@wartsila.com for more information.

Resource Characterization

The RFI seeks feedback on the following questions for each potential resource.

1) Please provide a general overview of the resource, including the following:

a. Resource category (e.g., supply, demand) and type (e.g., solar) and scale (e.g., utility, distributed)?

Reciprocating Internal Combustion Engines ("RICE") are a supply-side resource that utilize combustion of various fuels, including natural gas, biogas/renewable natural gas, fuel oil, as well as blends of sustainable fuels including hydrogen, ammonia, and methanol. Wärtsilä's utility-grade RICE units range in size from 9.3 MW – 18.8 MW, making them suitable for utility-scale generation, as well as commercial and industrial applications.

2) How does the resource compare to conventional generation in terms of greenhouse gas and priority pollutant emissions?

From a system perspective, the flexibility and dispatchability attributes of RICE power plants enables greater penetration of renewables. Because Wärtsilä's reciprocating engines do not incur start costs, can ramp to full load within 5 minutes, have minimum stable levels as low as 1 – 2 MWs, and do not face constraints related to minimum run times or minimum down times, they only need to run when real-time grid balancing is necessary. With best-in-class open cycle efficiencies of approximately 48% (on an LHV basis, zero tolerance, and power factor 0.8), Wärtsilä's reciprocating engines minimize emissions when they do need to run.

Wärtsilä's reciprocating engines comply with the strictest emissions standards. In California, Wärtsilä has permitted power plants in Humboldt, Red Bluff, and the Modesto Irrigation District.

Please contact Greg Hall at f.gregory.hall@wartsila.com for detailed emissions information.

3) How does the resource support reliability (e.g., supply, permanent load reduction, net peak reduction, or emergency asset?) (List all that apply.)

Generally, reciprocating engines support reliability by providing a highly dispatchable supply of power. Reciprocating engines possess several other attributes that bolster reliability. Because Wärtsilä's reciprocating engines come in modular blocks of 9.3 – 18.8 MW, RICE power plants possess unit redundancy, which maximizes reliability and availability. This modularity also enables RICE plant sizing and siting to be tailored to local needs. Reciprocating engines utilize turbochargers to compress inlet air, thereby minimizing the effects of ambient temperature on capacity and efficiency de-rating. In terms of water consumption, reciprocating engines only require about 1 gallon of water per engine per week because they utilize radiative cooling. Reciprocating engines can operate on gas pressures as low as 80 psi, making them resilient to any sudden fluctuations in gas supply. Reciprocating engines can operate on a variety of fuels, including liquid fuels. This fuel flexibility allows engine plants to seamlessly switch operations if one fuel source becomes unavailable. Wärtsilä's RICE power plants are also black-start capable, meaning they can re-energize the grid in the case of blackouts. Wärtsilä's GEMS software can also be integrated to allow islanded dispatch and operations.

a. How can the resource be used as an incremental on-call resource during emergencies?

Wärtsilä's reciprocating engines can synchronize to the grid within 30 seconds and generate at full output within 5 minutes, making them ideal for responding to emergencies. Additionally, black-start and dual-fuel capabilities also make reciprocating engines ideal for meeting load during emergencies such as public safety power shutoffs.

4) How many new MWs and MWhs can the resource provide per year, taking into account resource characteristics and known barriers between now and 2035?

The MWhs of generation is dependent on the size of the plant and the expected run hours. Wartsila engines have a 99% reliability and a 96% availability. Please contact Greg Hall at f.gregory.hall@wartsila.com for specific inquiries regarding available MWs of reciprocating engines.

a. How is that different if used incrementally as an emergency asset during an extreme heat event?

There is no difference. One engine can be started in full operation in two minutes or five minutes depending on the engine technology selected. The efficiency of each engine is not dependent on each other as well, and heat rates remain consistent during part-load operations.

5) What is the levelized cost for the resource in $/MW-yr. and $/MWh-yr. from 2023 to 2035?

It is important to recognize that levelized cost of electricity calculations of thermal resources vary widely based on several assumptions, such as the plant capacity, fuel prices, and capacity factors. At the same time, these calculations do not consider system-level benefits and synergies between different resources within the system.

Please contact Greg Hall at f.gregory.hall@wartsila.com for indicative pricing information.

6) What is the average length of time from ordering or purchasing the resource to operation? How long does that typically take in today's market? What conditions must be met to deploy the technology rapidly? (e.g., transmission interconnection, building electrification or upgrades, etc.)

Lead times for ex works of Wärtsilä's engines are currently 10 to 12 months. However, typically a contractor has already been engaged in site work and when the engines arrive on site then it is approximately 7 months for commercial operation. A typical overall project schedule is 18 to 24 months depending on the permit(s), labor agreement and site requirements.

7) For an emerging technology, when will it be ready for deployment, and at what scale?

Wärtsilä anticipates reciprocating internal combustion engine power plants capable of operating on 100 percent hydrogen will be available beginning in 2025. Wärtsilä does not foresee any challenges meeting demand at a global scale.

8) Is the target customer primarily residential, commercial, agricultural or industrial?

The primary application for Wärtsilä's reciprocating engine power plants is for utility-scale power generation. Wärtsilä's modular engines have a capacity of 9.3 – 18.8 MWs, making them suitable for agricultural, commercial, and industrial applications. In the USA, Wärtsilä RICE power plants range in size from approximately 9 MW – 225 MW.

9) What are the key non-financial barriers to the development and implementation of this resource (including, but not limited to, permitting, interconnection, supply chain, customer acceptance, and alignment with policy goals)?

Generally, regulatory uncertainty about future decarbonization policies create barriers for any thermal resource. Conversion of these resources to operate on sustainable fuels and associated incentives provided in the Inflation Reduction Act can alleviate such concerns.

10) What are the key financial barriers to the development and implementation of this resource?

Conversion of reciprocating engines to operate on sustainable fuels such as clean hydrogen is primarily hindered by the economics of the fuel (i.e., being able to deliver sustainable fuels at a cost that is competitive with natural gas). Incentives to lower the cost of establishing sustainable fuel supply chains can eliminate these concerns.

11) What types of benefits or impacts is the resource anticipated to have on low income and disadvantaged communities, and tribes, if any in terms of development and deployment?

Thanks to their best-in-class dispatchability and efficiency, reciprocating engines can promote greater integration of renewable resources by shaping the dispatch of thermal resources around the available supply of renewables. Highly dispatchable resources enables the thermal fleet to run only when necessary, which results in minimal curtailment of renewables, and an overall reduction in system costs and emissions.

Wärtsilä appreciates the opportunity to help the CEC identify clean energy resources for reliability. Please do not hesitate to contact Wärtsilä with any questions or requests for additional information.

Respectfully submitted,

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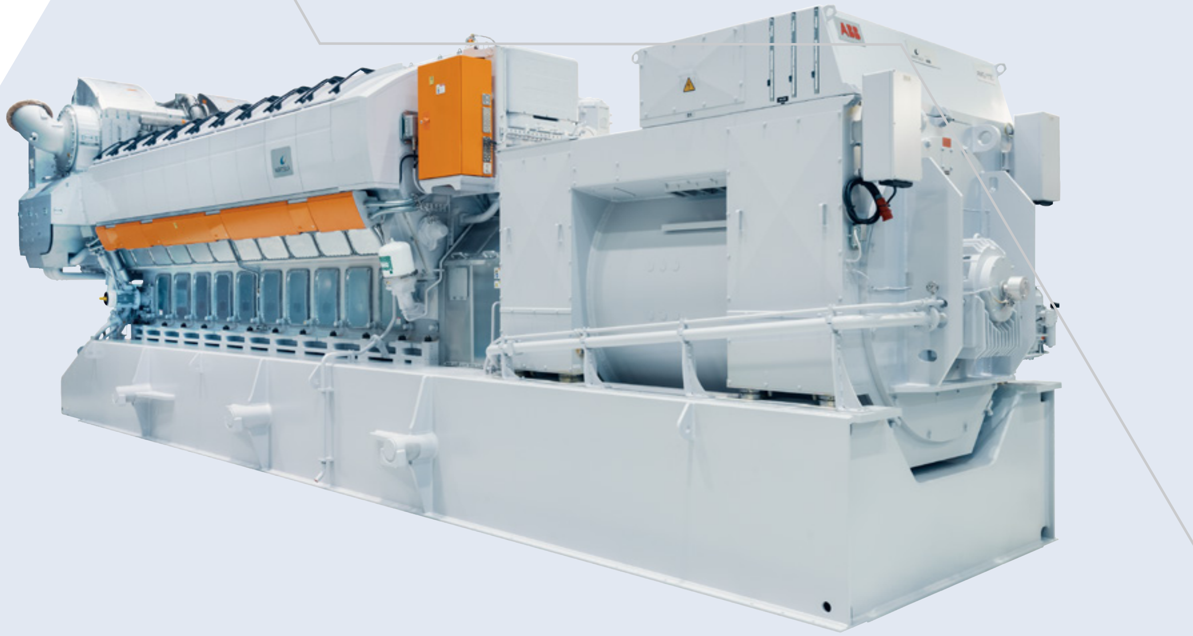


WÄRTSILÄ 31SG

GAS ENGINE GENERATING SET

The most efficient gas engine, Wärtsilä 31SG, is a four-stroke, spark-ignited, lean-burn gas engine generating set. With its world class open-cycle efficiency and unparalleled dynamic capabilities, it reduces environmental footprint and lowers the total cost of ownership.

Wärtsilä 31SG is well suited for baseload production, balancing renewables and industrial applications where reducing carbon emissions while producing reliable power is crucial. Its unlimited capability of fast start and shut-down and ability to run on sustainable fuels secures low emissions and high efficiency. It also meets the specific needs of combined heat and power (CHP) plants, for example steam generation, hot or chilled water or a combination of the above.

We help our customers in decarbonisation by developing market-leading technologies such as flexible power plants that can be delivered as engineering, procurement and construction (EPC). With our full lifecycle support we ensure guaranteed performance of the plant.

Key benefits

- World-class open-cycle efficiency enabled by 2-stage turbocharging system
- Adaptability for various gas qualities
- Capable of hydrogen blending
- Excellent load following capabilities
- Cost efficient maintenance
- Optimised performance and efficiency supported by Wärtsilä Lifecycle solutions

52.3

% Highest possible electrical efficiency

12.8

MW Highest possible electrical power

30

Seconds power to grid

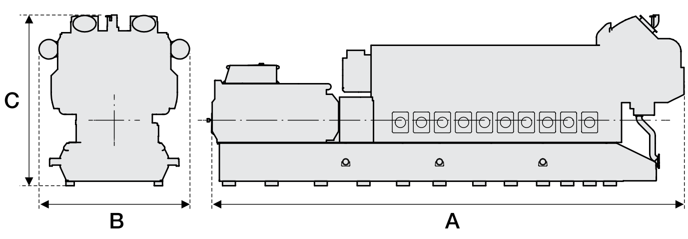
Main technical data

Engine generating set			
Cylinder configurations	20 V		
Cylinder bore	310 mm		
Piston stroke	430 mm		
Engine speed	750 rpm (50 Hz), 720 rpm (60 Hz)		
Performance [1]			
	WÄRTSILÄ 31SG	**WÄRTSILÄ 31SG Efficiency optimised**	**WÄRTSILÄ 31SG Balancer**
Rated electrical power (kW)	11 779 (50 Hz) 11 377 (60 Hz)	10 798 (50 HZ) 10 396 (60 Hz)	12 762 (50Hz) 12 372 (60Hz)
Electrical efficiency (%)	51.5 (50 Hz) 51.6 (60 Hz)	52.2 (50 Hz) 52.3 (60 Hz)	50.2 (50Hz) 50.3 (60Hz)
Loading and unloading			
	Connected to grid	**Full load**	
Regular start time (min:sec)	00:30	< 5:00	
Fast start time (min:sec)	00:30	< 2:30	
Shut-down time (min)	< 2		
Ramp rate (hot, load /min)	> 100%		
Minimum Load			
Unit level	10%		
Plant level	1%		
Minimum up- & down times			
Minimum up-time (time to operate after start, before stopping)	1 min		
Minimum down-time (before re-start is possible)	5 min		

Maximum transportation dimensions (mm) and weights (tonnes) [2]				
Genset type	**Length (A)**	**Width (B)**	**Height (C)**	**Dry weight**
20V31SG	14 412	3 893	5 090	182

1 Rated electrical power and electrical efficiencies are given at generator terminals at 100kPa ambient pressure, 25°C suction air temperature and 30% relative humidity, and without engine driven pumps. Power factor 1.0 (site). NOx emission level 90ppm @15% O_2 dry. Fuel consumption with 5% tolerance according to ISO 3046-1. Gas LHV >28MJ/Nm3. Gas methane number >80. Ambient conditions, fuel and local emission limits are impacting on generating set's performance. Please contact Wärtsilä for project-specifically calculated performance data.

2 There are a number of dismantling options available for transportation of the generator set. These include different options for reduced weight and height. Please contact Wärtsilä for further information.



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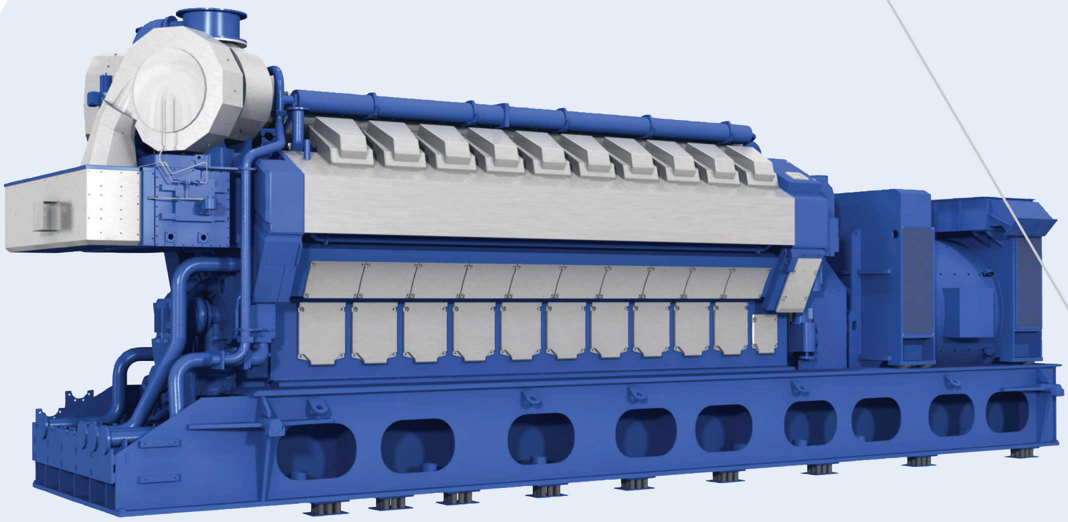


WÄRTSILÄ 34SG

GAS ENGINE GENERATING SET

The Wärtsilä 34SG is a four-stroke, spark-ignited, lean-burn gas engine generating set. Its agility and flexibility make the Wärtsilä 34SG generating set an excellent choice for both flexible baseload and balancing renewables applications. It also offers a unique fast-starting capability, which enables rapid response to fluctuations inherent to renewable generation.

Wärtsilä 34SG helps to provide an efficient, reliable and cost-efficient source of energy for power producers. It also provides enough spinning reserve for balancing whenever needed.

The Wärtsilä 34SG engine generating set is extremely reliable as it is based on the well-proven Wärtsilä 32 engine, that has a track record from the mid-1990s. The Wärtsilä 34SG features a wide power output range from 5.6 to 9.8 MW, as it is available in 12V, 16V and 20V cylinder configurations.

We help our customers in decarbonisation by developing market-leading technologies such as flexible power plants that can be delivered as engineering, procurement and construction (EPC). With our full lifecycle support we ensure guaranteed performance of the plant.

Key benefits

- Runs on natural gas, biogas, synthetic methanol and is capable of hydrogen blending
- No start cost, limitations nor degradation in number of starts
- Compact sizing enables transportation to demanding locations
- Capable of operating in high altitude
- Minimal water consumption
- Longer maintenance intervals
- Optimised performance and efficiency supported by Wärtsilä Lifecycle solutions

2

Minutes to full load

48,9

% Electrical efficiency

1000

Generating sets delivered

Main technical data

Engine generating set	
Cylinder configurations	12, 16, 20V
Cylinder bore	340 mm
Piston stroke	400 mm
Engine speed	750 rpm (50 Hz), 720 rpm (60 Hz)

Performance [1]			
	20V34SG	**16V34SG**	**12V34SG**
Rated electrical power (kW)	9 795 (50 Hz) 9 388 (60 Hz)	7 830 (50 Hz) 7 491 (60 Hz)	5 840 (50 HZ) 5 580 (60 Hz)
Electrical efficiency (%)	48.9 (50 Hz) 48.8 (60 Hz)	48.9 (50 Hz) 48.7 (60 Hz)	48.0 (50 Hz) 47.8 (60 Hz)
Heat rate kJ/kWh	7 363 (50 Hz) 7374 (60 Hz)	7 367 (50 Hz) 7 396 (60 Hz)	7 501 (50 Hz) / 7 538 (60 Hz)

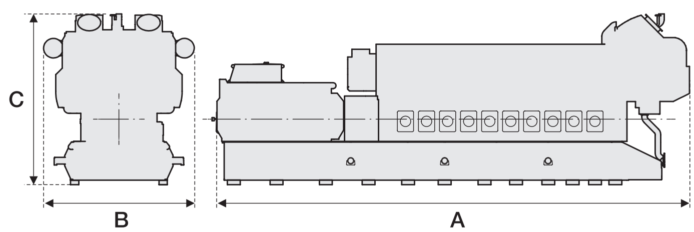
Loading and unloading		
	Connected to grid	**Full load**
Regular start time (min:sec)	00:30	< 5
Fast start time (min:sec)	00:30	< 2
Stop time (min)	1	
Ramp rate (hot, load /min)	> 100%	

Minimum Load	
Unit level	10%
Plant level	1%

Maximum transportation dimensions (mm) and weights (tonnes) [2]				
Genset type	**Length (A)**	**Width (B)**	**Height (C)**	**Dry weight**
12V34SG	10 454	3 350	4 511	102
16V34SG	11 456	3 350	4 511	125
20V34SG	13 142	3 350	4 573	136

1 Rated electrical power and electrical efficiencies are given at generator terminals at 100kPa ambient pressure, 25°C suction air temperature and 30% relative humidity, and without engine driven pumps. Power factor 1.0 (site). NOx emission level 90ppm @15% O2 dry. Electrical efficiency with 5% tolerance. Gas LHV >28MJ/Nm3. Gas methane number >80. Site conditions, fuel and applicable emission limits may have an impact on performance figures. Please contact Wärtsilä for project-specific performance data.

2 There are a number of dismantling options available for transportation of the generator set. These include different options for reduced weight and height. Please contact Wärtsilä for further information.



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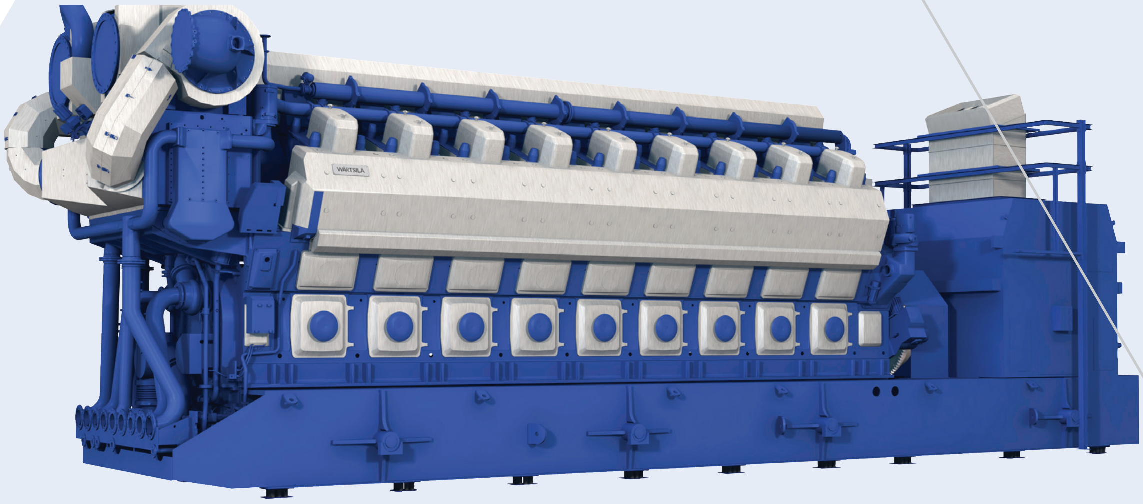

WÄRTSILÄ 50SG

GAS ENGINE GENERATING SET

The Wärtsilä 50SG is a four-stroke, spark-ignited gas engine generating set. High efficiency in a small footprint combined with great reliability and flexibility makes this solution ideal for flexible baseload and balancing applications. It offers unique fast-starting capability, which enables rapid response to fluctuations inherent to renewable generation. Wärtsilä 50SG also supports you towards decarbonisation with its low greenhouse gas emissions and capability of hydrogen blending.

We help our customers in decarbonisation by developing market-leading technologies such as flexible power plants that can be delivered as engineering, procurement and construction (EPC). With our full lifecycle support we ensure guaranteed performance of the plant.

Key benefits

- High power density for balancing and peaking applications
- No start cost, limitations nor degradation in number of starts
- Fast-starting capability which enables rapid response to fluctuations typical to renewable generation
- Minimal water consumption
- Runs on natural gas, biogas, synthetic methanol and is capable of hydrogen blending
- Low greenhouse gas emissions
- Optimised performance and reliability supported by Wärtsilä Lifecycle solutions

2

Minutes to full load

50,2

% Electrical efficiency

More than

4 000

MW Installed capacity

WÄRTSILÄ

Main technical data

Engine generating set		
Cylinder configurations	18V	
Cylinder bore	500 mm	
Piston stroke	580 mm	
Engine speed	500 rpm (50 Hz), 514 rpm (60 Hz)	
Performance [1]		
	18V50SG	
Rated electrical power (kW)	18 434 (50 Hz) 18 875 (60 Hz)	
Electrical efficiency (%)	50.2 (50 Hz) 50.0 (60 Hz)	
Heat rate at generator terminals (kJ/kWh)	7 165 (50 Hz) 7 207 (60 Hz)	
Loading and unloading		
	Connected to grid	**Full load**
Regular start time (min:sec)	00:30	< 5
Fast start time (min:sec)	00:30	< 2
Stop time (min)	1	
Ramp rate (hot, load /min)	> 100%	
Minimum load		
Unit level	10%	
Plant level	1%	

Maximum transportation dimensions (mm) and weights (tonnes) [2]				
Genset type	**Length (A)**	**Width (B)**	**Height (C)**	**Dry weight**
Wärtsilä 50SG	18 747	5 543	6 257	377

1 Rated electrical power and electrical efficiencies are given at generator terminals at 100kPa ambient pressure, 25°C suction air temperature and 30% relative humidity, and without engine driven pumps. Power factor 1.0 (site). NO_x emission level 90ppm @15% O2 dry. Electrical efficiency with 5% tolerance. Gas LHV >28MJ/Nm3. Gas methane number >80. Site conditions, fuel and applicable emission limits may have an impact on performance figures. Please contact Wärtsilä for project-specific performance data.

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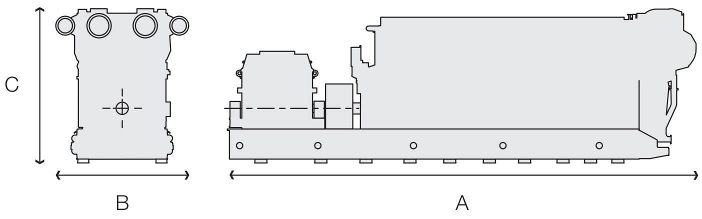

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