European Investment Bank
Consultation Paper

*The European Investment Bank reviews its Energy Sector Lending Policy*

A response from Wärtsilä Corporation

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1 INTRODUCTION

1.1.1 This paper has been prepared by Wärtsilä as a response to the European Investment Bank (EIB) consultation paper published in October 2012. It should be read in conjunction with our responses to the specific consultation questions posed by EIB, which are contained at Section 7. Appendix A contains some general information about Wärtsilä power plants to provide context.

1.1.2 As a major European technology provider, Wärtsilä has proactively participated in the EU energy policy debate with EU institutions in Brussels. Wärtsilä has been especially active in the debate on the 2050 Energy Roadmap, and issues related to the balancing challenges brought about by increasing amount of intermittent renewables on the electricity system. As a contribution to the debate, Wärtsilä has conducted modelling studies on the 2050 Energy Roadmap scenarios using the Spanish system as an example of the need for flexible generation in the future energy mix where renewables are set to make up a major proportion.

1.1.3 We are keen to engage directly on the issues on which we feel most strongly, in particular the demand for and provision of efficient and flexible generation capacity across all timescales. We look forward to continue participation in this debate and support EIB in its review of the Energy Sector Lending Policy.

2 WÄRTSILÄ CORPORATION

2.1.1 Wärtsilä is a global leader in complete lifecycle power solutions for the marine and energy markets. By emphasising technological innovation and total efficiency, Wärtsilä maximises the environmental and economic performance of the vessels and power plants of its customers. In 2011, Wärtsilä’s net sales totalled EUR 4.2 billion with approximately 18,000 employees. The company has operations in 170 locations in 70 countries around the world. Wärtsilä is listed on the NASDAQ OMX Helsinki, Finland.

Ship Power

2.1.2 Wärtsilä enhances the business of its customers by providing solutions for the marine industry that are environmentally sustainable, efficient, flexible, and economically sound. Our solutions are based on our customers’ needs and include products, systems and
services. Being a technology leader in this field and through the experience, know-how and dedication of our personnel, we are able to customise optimised solutions for the benefit of our clients around the world.

Power Plants

2.1.3 Wärtsilä is a leading supplier of modern, environmentally advanced, highly efficient, and dynamic power plants that allow amongst others the maximum integration of intermittent renewable power generation. We offer multi-fuel solutions for power generation markets, from base load generation to peaking and load following, as well as dynamic system balancing and ultra-fast grid reserve for current and future capacity markets. Our fast track deliveries of complete power plants, together with long-term operation and maintenance agreements, offer our customers flexible capacity in both urban areas and the most demanding remote environments.

Services

2.1.4 Wärtsilä supports its customers throughout the lifecycle of their installations by optimising efficiency and performance. We provide the most comprehensive portfolio of services and the broadest service network in the industry, for both the energy and marine markets. We are committed to providing high quality, expert support, and the availability of services wherever our customers are – and in the most environmentally sound way possible.

3 THE NEED FOR INVESTMENTS IN FLEXIBILITY

3.1 The challenge of integrating renewable generation

3.1.1 The EU decarbonisation and renewables agenda will radically change the generation mix, leading in particular to a much greater level of intermittent generation on the system (i.e. wind and solar). Increasing the amount of intermittent renewable generation brings a new aspect to system balancing, in that it causes unpredictable fluctuations in the generation fleet output. These fluctuations have to be balanced – or ’mirrored’ – with other generation units or with some other source of flexibility (e.g. storage, demand side response) to maintain system balance.
3.1.2 The uncertainty of wind and solar generation forecasting increases rapidly when the lead time is prolonged. For example the forecast error for wind production 24 hours ahead can be up to 25-30%. The combined wind and solar forecast error could correspond to around 100GW in the EU power system in 2020. The magnitude of this potential ‘error’ is something totally different to that faced by the system today.

3.1.3 Wind forecasts get more accurate the closer to real-time, however some forecasting error will remain even in very short lead times (minutes). This needs to be taken into consideration when estimating adequate fast reserve levels for system balancing. It is unlikely that today’s short term balancing markets are able to provide the necessary response to decreases in wind production, as such fast capacity does not exist in the quantity necessary on the system (as it has not been needed). Ways must be found to procure more balancing capacity which is available fast enough to react to unpredictable changes in wind generation.

3.1.4 The need for this kind of flexible balancing capacity depends on wind characteristics. In a recent study by Wärtsilä the maximum changes in wind generation output in EU in 2020 were estimated. A large amount of wind data was analyzed, both in North Sea and on-shore, with a total wind generation output estimated at 285GW (of which 40% is estimated to be off-shore). Table 1 presents our estimate of the magnitude of changes in wind output over a 10 minute and 1 hour period.

### Table 1: Maximum EU 2020 wind generation changes over 10 minute and 1 hour period

<table>
<thead>
<tr>
<th></th>
<th>10 min</th>
<th>1 h</th>
</tr>
</thead>
<tbody>
<tr>
<td>Max wind production <strong>negative</strong> change rate GW</td>
<td>-17</td>
<td>-40</td>
</tr>
<tr>
<td>Max wind production <strong>negative</strong> change rate %</td>
<td>-6%</td>
<td>-14%</td>
</tr>
<tr>
<td>Max wind production <strong>positive</strong> change rate GW</td>
<td>37</td>
<td>63</td>
</tr>
<tr>
<td>Max wind production <strong>positive</strong> change rate %</td>
<td>13%</td>
<td>22%</td>
</tr>
</tbody>
</table>

Source: Wärtsilä

3.1.5 As balancing reserves need to ramp in the opposite direction to the wind generation, the numbers in Table 1 represent the necessary quantity of fast reserves of wind balancing. So, for example, we estimate that there could be a drop in wind generation of up to 40GW in the final hour before real-time.
3.1.6 In addition, the amount of solar power in the EU power system will approach 100GW by 2020. Adding the changes in solar output during sunrise and sunset to the wind changes we have presented above expands the dynamic reserve need close to 100GW in total. In other words, the capability to start and stop 100GW of flexible capacity within an hour must be built in the EU power system by 2020. This capacity may be required to start and stop several times per day, without any clear or predictable pattern between days, months or years.

3.2 Finding an efficient flexibility mix

3.2.1 Sufficient flexible resources must be scheduled continuously to meet the flexibility requirements. The most efficient operational resources are those that maximise the amount of flexibility available while minimising cost, emissions and wind curtailment. This balancing capacity will therefore need to have true dynamic characteristics to maintain system frequency levels and to support EU decarbonisation and renewables goals:

- Fast starting and stopping, without impacting on product reliability and operating costs,
- Fast loading: ramp up / down from standstill (matching the speed of change of wind power output, the fastest reserves need to be on-line producing full power in 5 minutes and back at full stop in 1 minute),
- Capability for continuous cyclic operation,
- Wide load range (preferably as close as possible to 0-100%), while maintaining high efficiency,
- Low carbon and other emissions (high efficiency and gas operation where reservoir hydro is not available),
3.2.2 Various solutions are available to meet the challenges of balancing the system as intermittent generation increases. Some of these solutions are already proven and available, whereas others are as yet untested. Different balancing solutions have different characteristics with regard to the time they can be utilized and the amount available. Below is a short summary of some available options.

**Demand response and smart grids**

3.2.3 Power system balancing can to some extent be handled with demand side response, by reducing peak loads or load shifting. The magnitude of the potential depends on the type of load. Demand response is most cost effective for larger loads, such as industrial processes, especially in cases where the process itself includes an intermediate storage or buffer. Naturally there is always cost involved in form of lost revenue, and the duration of the potential response may be somewhat limited (for example due to process reasons).

3.2.4 On a household level, smart meters and smart grids are being promoted across Europe. However the cost of load shifting may be high relative to the potential volumes available. There are also limitations on how long continuous household loads can be switched off (e.g. a refrigerator can switch off for approximately 15 minutes and heating approximately 4 hours), so it will function best as a short term load shifter.

3.2.5 The potential of demand response is though not insignificant. For example, a recent study for ERCOT in Texas shows that 8% of the peak load could be shifted with reasonable costs.\(^1\)

**Storage**

3.2.6 Electric energy is difficult to store. Capacitors have limited capacity and are very expensive, making them unattractive for large scale use. Conventional lead-acid batteries cost about €75,000/MWh and have the restriction that they prefer slow charging and rather fast discharging. Additionally, lead-acid batteries should not be discharged completely since it reduces their lifetime. Lithium based batteries on the other hand can accept fast

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\(^1\) The Brattle Group, ‘ERCOT Investment Incentives and Resource Adequacy’, 2012
charging and discharging, but cost at least €800,000/MWh. As a result, present battery technology does not make much commercial sense in grid size storage applications, and therefore a lot of R&D is going into developing better batteries.

3.2.7 Compressed air energy storage (CAES) is another storage technology. The principle is to compress air to a pressure of about 70 bar using an electrically driven air compressor. At this pressure the energy density of air is 29 MJ/m³, which is not much compared to natural gas that (compressed to the same pressure) contains 2.5 GJ/m³. It is hard to see how compressed air storages would ever make commercial sense.

3.2.8 Hydrogen is another potential electric energy storage medium that is being developed. It can be used as a non-polluting fuel both for transportation or stationary energy generation. Hydrogen would presumably be produced using electrical energy or heat, then compressed or liquefied, stored, and then converted back to electricity using a heat engine or fuel cells. A significant problem with the ‘hydrogen economy’ is the huge conversion losses. The total efficiency of a hydrogen storage system (electricity-hydrogen-electricity), can vary depending on how the electricity has initially been generated, and can in some cases fall below 20%. Obviously the cost of such power would be extremely high.

Pumped hydro

3.2.9 Pumped hydro has the potential to play a role in storing energy from renewable generation. The principle is that surplus electric energy is used to pump water into an elevated reservoir, and later when power is needed the stored water is lead through a turbine generator system. In larger scale, around 500 MW, the cost of a pumped hydro system is approximately 25% of a lead-acid battery based system.

3.2.10 There are some challenges related to pumped hydro. For example, the electricity needed to drive the pumps must be generated with some other power plants, and about 25% of the electrical energy is lost in the process. In addition, depending on the original power source, pumped hydro cannot necessarily be considered renewable energy. If, for example, pumped storage is used during the night to enable coal fired power stations to maintain minimum load (i.e. to avoid stopping them), the power produced later by the pumped hydro is highly carbon intensive. At the same time, if the system contains enough wind power to stop all thermal generation, pumping excess wind power makes more sense. Finally, locations with suitable water storage possibilities are not widely available.
Reservoir hydro

3.2.11 Reservoir hydro power utilises dams that are constructed in mountainous areas, in narrow sections of valleys downstream from a natural basin. The flow of water drives hydro turbines that generate the electricity. Reservoir hydro is dispatchable (it can be totally closed for a period), making it ideal for base load, load following and system balancing. Depending on reservoir size, water can be stored for future needs, making it the perfect carbon-free balancing solution for wind power during low-wind conditions.

3.2.12 Reservoir hydro is currently the most widely integrated renewable energy source, yet most suitable locations that can tolerate the environmental impact have already been utilised. New sites tend to be remote, requiring significant investments in infrastructure, such as new roads and transmission lines, while gaining approval is often very difficult because of the environmental impact. Dams with significantly large capacity take years to plan and construct, and involve remarkably high capital cost.

3.2.13 Reservoir hydro is part of the future balancing solution, but there is not and will not be adequate capacity in the EU system to handle the full balancing task with reservoir hydro. Norway has 30GW producing mainly base load power to Norway and Nordpool area. It also requires a strong grid to be built to connect the remote hydro plants (e.g. in Norway) to the EU main grid.

‘Super grid’

3.2.14 A ‘super grid’ has been marketed as a solution for balancing renewables over large geographical areas. The assumption is that wind conditions over larger areas always differ from each other, which should allow excess wind power to be transferred to areas with zero or low wind. However in Europe the wind conditions are largely determined by Atlantic low pressures, creating similar wind conditions all the way from the North Sea to Spain, as illustrated in Figure 1 below. Transferring excessive wind power from North Sea region to Spain or vice versa does not provide the desired balancing solution as everybody has excess wind power at the same time.
3.2.15 Despite the potential correlation of output, clearly transmission infrastructure must play an important role in integrating renewables across Europe. For example, a super grid will be needed in the North Sea region to bring all the planned offshore wind power to land.

**Flexible Power Generation**

3.2.16 Another potential source for flexibility are highly dynamic power plants, such as the Wärtsilä plant described in Appendix A. Such generation offers high operational flexibility and high generation efficiency. This combination enables the high integration of renewable sources into the power systems at least cost, thus contributing to the transition to a sustainable, reliable and affordable power system. It is the missing piece of the low carbon power system puzzle.

3.2.17 We have undertaken some quantitative analysis to examine the role of flexible power generation in the Spanish system in 2030, using Plexos dispatch modelling software. The software freely dispatches all the plants based on a least cost optimisation, allowing them to operate when their overall cost (including starting and stopping etc.) is lowest from the point of view of total system costs.
3.2.18 The results clearly indicate that flexible power generation (SPG) can play a critical role in the future system with significant volumes of intermittent renewable generation. The optimum quantity (in GW) of flexible power generation varies depending on the capacity mix in question. To reach the optimum cost and system efficiency, CCGT plants are also needed in parallel with SPG. This is illustrated in Figure 2, which presents our modelling results.

**Figure 2: Modelling results for Spanish power system, February 2030**

Source: Wärtsilä

3.2.19 Depending on the scenario modelled, relative to the baseline scenario (without SPG), dispatch of SPG:

- Reduces average system level variable generation costs by between 1% and 5.5%, and;
- Reduces CO2 emissions by between 1% and 12%.

3.2.20 This latter result is quite remarkable taking into account that the Spanish energy has a high penetration of highly efficient CCGTs in the current generation mix.
4 RESPONSES TO INDIVIDUAL CONSULTATION QUESTIONS

4.1.1 Below we provide brief responses to some of the individual consultation questions from the Consultation Paper. We have chosen not to provide answers to all questions raised, but to give inputs to those most relevant for Wärtsilä.

**Chapter 4.2 Renewable Energy**

The Bank’s economic justification for supporting emerging renewable energy technologies, whose cost is significantly above that of conventional and mature renewable energy technologies, is that continued investments in these technologies will eventually lead to cost reductions and will ultimately be the least-cost approach to meeting the EU’s renewable energy targets. Do you agree with this approach? Is there an alternative approach to the economic justification of these technologies which you consider more appropriate?

What evidence is there that the cost of emerging renewable technology is falling?

What level of investment in RE do you expect in the short and medium term?

What are the barriers to investment in renewable energy outside Europe? How might these be overcome?

Do you agree that there is significant scope for investment in renewable heating and cooling?

What are the barriers to investments in this sector and how might these be overcome?

4.1.2 To achieve the EU decarbonisation targets the level of intermittent generation on the system will need to increase radically and therefore significant investments into Renewable Energy Sources are to be expected. Wind and solar capacity will be close to 400 GW by 2020, if EU’s renewable energy and carbon emission reduction targets will be met. As a result, the combined wind and solar forecast error could correspond to around 100GW in the EU power system in 2020. The magnitude of this potential ‘error’ is something totally different to that faced by the system today and sufficient flexible resources must be available to meet these flexibility requirements.

4.1.3 The lack of flexibility within a power system will cause potential barriers for investment in intermittent renewable capacity. Power system flexibility enables maximum utilisation of intermittent renewable generation by adjusting the thermal supply side to meet the remaining demand (so called net demand), when there is no need to curtail the wind or solar output. When the remaining capacity is flexible, there will be more room for wind and solar production, and more room for renewable capacity in general. It can be said that
flexibility provides ‘room’ for more renewable capacity on the system and enables the maximum utilisation of installed intermittent capacity.

4.1.4 In our view, market mechanisms are needed to facilitate market flexibility, ranging from balancing energy markets through to capacity mechanisms (that explicitly procure flexible capacity). In broad terms, in order to integrate significant volumes of renewable generation onto the system, electricity market arrangements must appropriately reward flexibility in balancing resources such that the future value of this flexibility can be realistically and confidently predicted by potential investors.

Chapter 4.4 Security of Supply

Is the traditional model for electricity transmission and distribution changing? What implications does this have for future investments in electricity networks?

What is the future role of smart grids, offshore grids and energy storage solutions?

4.1.5 To meet the security of supply targets, there are three core requirements of economic, efficient and co-ordinated power systems:

- Resource adequacy: ensure there is sufficient reliable capacity on the system to meet peak demand
- Operational security: responsiveness to manage very short term and unpredictable variations in load and generation output
- Market flexibility: ability to vary output / demand in response to ‘predictable’ changes in load and generation output

4.1.6 Resource adequacy is clearly high on the agenda in some member states. For example, the UK Government has decided to implement a ‘market-wide’ capacity mechanism to address resource adequacy issues. In our view, while this form of capacity mechanism may increase the capacity margin and reduce risks to security of supply, it is unlikely to deliver the required market flexibility at least cost to consumers.

4.1.7 Our focus is predominantly on operational security and market flexibility. The requirement for market flexibility is expected to increase dramatically in line with the increased penetration of intermittent Renewable Energy Sources (in particular wind). Our analysis shows that if EU’s renewable energy and carbon emission reduction targets will be met, the combined wind and solar forecast error could correspond to around 100GW in the EU power system in 2020.
4.1.8 We recognize that various solutions are available to meet this flexibility challenge. Such include Demand Response and Smart Grids, Storage and the so-called Super Grid. Some of these solutions are already proven and available, whereas others are as yet untested. Given the size and requirements of the future flexibility requirement, and the limitations in other sources of flexibility, we believe that flexible power generation will play a critical role in achieving the EU’s renewable energy and carbon emission reduction targets.

4.1.9 In our view there is a critical role for market arrangements to attract investments in flexibility. These market arrangements should:

- Provide the right price signals to facilitate the emergence of an efficient mix of flexible technologies, recognising the different technical characteristics provided by different flexibility products.
- Enable wide scale integration of renewable capacity, and to ensure maximum utilisation of this capacity in line with the RES Directive (e.g. by encouraging fast ramp times, high efficiency, avoidance of unnecessary operation).

Chapter 4.5 Fossil Fuel

Gas is an important bridging fuel source in the transition to a low carbon economy: to what extent and under what conditions should gas-fired generation be supported?

What role will coal and lignite fired generation have in the EU power system in the medium term, with or without CCS, and how is this consistent with the EU’s Climate Action goals and its security of supply objectives?

What will be the role of local coal supplies as input for highly efficient CHPs?

What evaluation criteria should the Bank use to assess the economic, environmental and financial viability of coal and lignite fired generation?

What is the scope for the development of shale gas resources in the EU?

Do you expect the share of natural gas in EU primary energy consumption to grow further?

What would be the best approach to increase security of gas supply and reduce import dependency?

Given the large uncertainty on future gas demand, what is the risk that investment in natural gas infrastructure may be stranded?

4.1.10 Sufficient flexible resources are needed to meet the flexibility requirements continuously. The most efficient operational resources are those that maximise the amount of flexibility available while minimising cost, emissions and wind curtailment. This flexible capacity will therefore
need to have true dynamic characteristics to maintain system frequency levels and to support EU decarbonisation and renewable goals.

4.1.11 We believe that generation based on coal and lignite will become very challenging within the EU. This is driven by the EU’s renewable energy and carbon emission reduction targets. Power production based on coal and lignite without CCS is not supporting the EU emission reduction targets. Power production based on coal and lignite with CCS does not provide the flexibility required to enable the full utilisation of renewable energy sources, and therefore does not support EU decarbonisation and renewable goals.

4.1.12 In our view, highly dynamic gas fired generation has the required characteristics and will become an important contributor of flexibility, in addition to other available resources. Such generation can operate in multiple operation modes: from base load power generation to peaking; from load following to ‘wind chasing’; and ultra-fast grid reserve (something important for the TSOs). Such plants can ramp-up rapidly when the wind calms down and the sun sets, and stop in just one minute when the wind starts to blow again. This enables full utilisation of valuable and green wind and solar energy.

Chapter 4.8 EIB external and Cotonou mandates

In a developing market context, where should the balance lie between meeting local energy needs at least cost and reducing global greenhouse gas emissions – the trade-off between affordable energy for all and sustainable energy for all?

What should be the role of the EIB in promoting new technology and helping to transfer existing technologies to new markets?

Where can sources of low-cost finance be more effectively used by the private sector to develop energy projects?

What are the main barriers to developing sustainable energy sources in developing markets?

We will in this section focus on Africa only since we believe that African energy sector offers the most significant opportunity for EIB under the external and Cotonou mandates. The entire generation capacity of Sub-Saharan Africa, excluding South Africa, is only approximately 30 GW which is less than 4% of generation capacity of the EU-27 countries. Furthermore, excluding South Africa’s coal based generation approximately half of the generation capacity in Sub-Saharan Africa is hydropower while the balance is mainly oil and natural gas fired. With these statistics it is easy to conclude that due to its small size the African power generation sector is in the global context quite an insignificant source of greenhouse gas emissions.
4.1.13 The existing generation capacity in Africa is generally unreliable, cost of generation is high and the population in Africa has the lowest electricity access rates in the world. The industries in Africa suffer from insufficient and unreliable supply of energy which is a major limiting factor for industrial development and economic growth across the continent.

4.1.14 For the reasons mentioned above our view is that the main focus of EIB in Africa shall be in improving access to affordable energy for both individuals and industries at the most cost effective fuel and technology, choice of which will depend case-by-case on local conditions and availability of fuel among other things. The forms of support shall not be strictly limited but should include public sector financing to the African utilities in order to enable them to build more reliable and efficient generation and transmission capacity promoting private investments in various sectors which support Africa in taking advantage of their domestic natural resources, as well as participating in privately financed energy projects in order to encourage external investments into Africa.

4.1.15 Due to long distances and underdeveloped electricity grids de-centralized power is the most economical solution in Africa. When building new thermal generation capacity it is important to build fuel flexible plants which can transition to cleaner fuels (e.g. from oil to natural gas) within the life-time of the power plant as new fuel sources are being discovered and utilized.

4.1.16 Due to uneven distribution of natural gas resources among the African countries, it is important to support the development of regional gas infrastructure development. Where natural gas resources are available the development of regional gas transport infrastructure is to be encouraged to minimize grid losses from transporting electricity over long distances at regional level.

4.1.17 While in many occasions building new capacity which can be commissioned relatively quickly yields fastest results in terms of unlocking economic growth potential in many African countries it is also important to build power infrastructure with minimal greenhouse gas emissions. Over time the renewable energy potential such as hydropower, solar, wind and biofuels will play an important role in Africa as well. It is therefore important to build thermal power plants which are flexible and able to operate in multiple operation modes. Such plant can be conveniently used for multiple purposes, initially built for base load generation and over time transitioning to peaking or reserve capacity operation to enable maximal utilization of renewable energy in Africa on the medium/long term.
5 APPENDIX A – OVERVIEW OF WÄRTSILÄ POWER PLANTS

5.1.1 Wärtsilä Power Plants is a leading supplier of flexible power plants. We aim to provide superior value to our customers by offering decentralised, flexible, efficient and environmentally advanced energy solutions. Our technology enables a global transition to a more sustainable and modern energy infrastructure and our solutions are modular, tried and tested power plants.

5.1.2 Our energy solutions offer a unique combination of:

- Energy efficiency
- Fuel flexibility
- Operational flexibility

5.1.3 We offer our customers competitive and reliable solutions that deliver high efficiency. Our power plants engines can run on liquid fuels, a wide range of gases and renewable fuels. Most of our products have multifuel capabilities and all can be converted from one fuel to another. Furthermore, the operational flexibility of our products enables high system efficiency, flexibility in operations with varying loads, low water consumption, as well as the possibility to carry out construction in phases according to the customer's needs. These key features, combined with the full lifecycle support we offer, create the basis for Wärtsilä's strong position within the Power Plants market.

5.1.4 With gas strengthening its potential to be the fuel of the future, our focus is on developing competitive solutions for the gas market. This focus supports our growth ambitions and enables a stronger presence in the broader markets.

5.1.5 Our business is divided into four customer segments

Flexible baseload

5.1.6 Wärtsilä supplies flexible baseload power plants mainly to developing markets, islands, and remote locations. Energy consumption growth in these markets is driving a steadily increasing demand for new power generation solutions. Wärtsilä's customers in this segment are mainly Utilities and Independent Power Producers (IPP). Customer needs typically include competitive lifecycle costs, reliability, world-class product quality and fuel and operational flexibility, as well as operations & management services. Wärtsilä is in a strong position to cater to these needs. Flexible baseload power plants are run on both liquid fuels and gas.
Grid stability and peaking
5.1.7 Wärtsilä’s grid stabilising power plants enable the growth of energy solutions based on wind, solar and hydro power. We offer dynamic solutions used for systems support, reserve power, peaking needs, and in regions with rapidly growing wind power capacity. Customers in this segment are mainly Utilities and IPP’s. The strengths of Wärtsilä’s products include rapid start and ramp up to full speed, the ability to operate at varying loads, competitive electricity generation and capacity costs, as well as 24/7 service. Grid stability and peaking plants are mainly fuelled by gas.

Industrial self-generation
5.1.8 Wärtsilä provides power plant solutions to industrial manufacturers of goods in industries such as cement production, mining, and textiles. Customers are mainly private companies and reliability, reduced energy costs, and independence from the grid are among the key factors in their decision making. Power plants in this segment are run on either gas or liquid fuel, depending on fuel availability.

Solutions for the oil & gas industry
5.1.9 Wärtsilä provides engines for mechanical drive, gas compression stations, and for field power and pumping stations to the oil and gas industry. Typical customer needs include maximum running time, reliability, long term engineering support and 24/7 service. The solutions we offer run on natural gas, associated gas and crude oil.

Power Plants and sustainability
5.1.10 The world is currently seeking more sustainable solutions for energy infrastructure. This development is driven by climate policies, energy security and economics. Carbon intensive energy sources are being replaced by low carbon fuels, such as natural gas and renewable solutions. Energy savings and efficiency improvements are being encouraged, and even legally enforced, at every level.

5.1.11 Wärtsilä’s energy solutions offer a unique combination of flexibility, high efficiency, and low emissions. Many different fuels, including bio-fuels, can be used efficiently, which helps in reducing greenhouse gas emissions. The flexibility of Wärtsilä’s solutions enables the development of a reliable energy infrastructure, wherein most of the sustainable characteristics are already known.
Efficiency development

5.1.12 We continuously seek improvements in the present engine portfolio, and are developing new engine concepts for the future. As a power plant contractor, we develop our power plants in parallel with the engines. This enables us to optimise both the performance and the reliability of our power plant offering. We offer high efficiency, single cycle solutions and focus on improving efficiency even further through the use of e.g. combined cycle solutions. Power plant net efficiency can be further improved by plant design and by optimising internal power consumption. Such solutions minimise not only fuel and water consumption, but also the emissions per unit of energy, thereby providing major environmental benefits.

Flexibility

5.1.13 Flexibility is one of the main features of Wärtsilä’s power plant solutions. The high modularity of our products makes it easy for our customers to construct an optimally sized plant, and to later expand its size to meet future needs. Fuel flexibility has many advantages for our customers, notably the lowering of energy production costs by using low cost fuels, minimising CO2 emissions, and the ability to convert from one fuel to another based on fuel availability.

5.1.14 The unique operational flexibility of our products comprises:

- Very fast plant starts and stops
- High ramp rates
- High part-load efficiency
- A broad load range

5.1.15 Frequent starting and stopping does not affect the operational costs of the plant. This is unique, no other competing technology offers the same

Towards an optimally sustainable power system

5.1.16 The power generation system of the future will contain a significant percentage of wind power capacity. Such capacity is non-dispatchable and intermittent, which creates potential for other power units to balance the system. Wärtsilä is in a good position to meet this need, as the operational flexibility of our products makes them easily adaptable to the needs of the grid.
Reducing emissions

5.1.17 Wärtsilä places high priority on developing diverse and flexible emission reduction techniques. Since emission requirements and the fuels used differ widely, a comprehensive range of products is required in order to offer competitive solutions.

Mitigating the effects of climate change will call for substantial reductions in greenhouse gases (GHG). We believe that the importance of natural gas will increase in the future. Consequently, the multi-fuel capability of our power plant solutions becomes an increasingly significant competitive advantage, as it enables the utilisation of all liquid and gaseous bio-fuels that may become available on a wider scale. Wärtsilä focuses on developing decentralised energy solutions that emit fewer GHG emissions.

Wärtsilä Corporation and Power Plant Business on the African Continent

5.1.18 Wärtsilä is a major provider of flexible baseload and industrial self-generation power plants to the African continent. Wärtsilä’s main customers in Africa are the Local Energy Utilities facing the challenge of providing access to electricity to the fast-growing population and industrial customers in the Oil & Gas, Mining and Cement sector as Africa’s abundant natural resources continue to attract both local and foreign investors to Africa. New industrial projects in remote locations require supporting infrastructure, including a reliable power supply, to be developed for the industrial demand. High efficiency, low emissions and proven long-term reliability make Wärtsilä oil and gas fired power plants suitable for base load applications.

Wärtsilä’s presence in Africa dates back 50 years. The first power projects were delivered to Niger in 1961 by SACM, which has been part of Wärtsilä since 1989. Since then, Wärtsilä has delivered more than 470 power plants to 43 countries in Africa. The individual project sizes have varied from 100kW to 220MW, with a trend towards larger power plant deliveries of more than 30 MW of installed capacity. Wärtsilä’s installed base of power systems in Africa totals today over 5000 MW.

Besides building and supplying power plants on turnkey basis, Wärtsilä also offers Operations and Management (O&M) services for its power plants. Wärtsilä manages all aspects of operating and maintaining an installation, including operation and maintenance planning, day-to-day operations, scheduled and unscheduled maintenance, administration, human resources and training, technical support, logistics management and security. An essential part of the O&M structure is adequate preparation, prior to the operational phase of the installation. This includes the recruitment and training of personnel, the purchase of
inventory and tooling, the establishment of operational infrastructure and maintenance routines, and comprehensive occupational health and safety systems.

In Africa, 932 MW of Wärtsilä’s installed base of power plants are operated, maintained and managed by Wärtsilä under long-term O&M contracts. Currently Wärtsilä employs some 500 people in twelve African countries. The biggest employers are the service organizations in Kenya, Senegal, Nigeria, Uganda, South Africa, and Tanzania.