Business Growth Strategy

Business Growth Opportunities Within Wärtsilä Finland, Services – Sales & Sales Support, Project Sales

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BACHELOR'S THESIS

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Abstract

This thesis will introduce the business and work procedures within a specific department in the Wärtsilä-company. The department's' main responsibility is to make offer documents and sell projects, mostly upgrade packages or fuel conversions, to existing Wärtsilä power plants.

The mission is to research and analyze market, technology and internal procedures for *Wärtsilä Finland, Services, 4-stroke Engine Services, Sales and Sales Support, Project Sales, Energy Applications*. The purpose is to locate the most critical bottlenecks, or finding improvements, where focus should be channelled for maintaining a continuous economic growth and help the departments' actions in the upcoming years.

The Thesis resulted in ideas on how to increase the effectiveness and the value propositions of proposals by adapting according to an environment constantly moving towards fewer emissions and more renewable energy. Also an idea concerning a new type of project is proposed. This would be suited to meet the needs of future electrical grids.

Language: English Key words: growth, strategy, Wärtsilä Services, Sales Projects

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Abstrakt

I detta examensarbete introduceras affärsverksamheten och arbetsprocedurerna inom en specifik avdelning vid Wärtsilä. Avdelningens huvudsakliga ansvarsområde är att göra offertdokument och sälja projekt, mestadels uppgraderingspaket eller bränslekonverteringar till existerande Wärstilä kraftverk.

Uppdraget är att forska och analysera i marknad, teknologi och interna procedurer för *Wärtsilä Finland, Services, 4-stroke Engine Services, Sales and Sales Support, Project Sales, Energy Applications*. Syftet är att lokalisera de mest kritiska flaskhalsarna, eller hitta förbättringar, där fokus läggs för att upprätthålla en fortsatt ekonomisk tillväxt och hjälpa avdelningens verksamhet under de kommande åren.

Examensarbetet resulterade i idéer kring hur slagkraften och mervärdet kan ökas i offerterna genom att anpassas efter en omgivning som konstant strävar mot mindre utsläpp och mer förnybar energi. Även en idé om en ny projekttyp presenteras. Denna skulle vara speciellt anpassad enligt elnätverkets framtida behov.

Språk: engelska Nyckelord: tillväxt, strategi, Wärtsilä Service, Sales Projects

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ABBREVIATIONS

LNG	Liquefied natural gas
DF	Dual fuel[1]
HFO	Heavy fuel oil
LFO	Light fuel oil
SG	Spark-ignited Gas
GD	Gas-Diesel[2]
GDP	Gross Domestic Product
PPP	Purchase Power Parity
CAPEX	Capital Expenditure
OPEX	Operational Expenditure
OEM	Original Engine Manufacturer
PPA	Power Purchase Agreement
EPC	Engineering, Procurement and Construction
CIP	Carriage and Insurance paid "close to destination"

[1] *Engine configuration able to operate on both fuel oil or gas (using oil as igniter in gas mode)*
[2] *Engine configuration operating on gas (of limited quality) with 10% fuel oil as pilot*

PREFACE

Working with finding business growth opportunities for Wärtsilä Services requires interest in technology, energy market and also a deep knowledge about the company itself. I have had a great interest in this subject for many years, as it’s in my field of study and previous work experience. My knowledge and insight in the subject have progressed in the process of the thesis making.

Having finished my thesis I can say that this work nicely concludes my studies in Production- and Mechanical Engineering. I want to thank Tom Lindqvist (Wärtsilä), Christoffer Ek (Wärtsilä), Andreas Gammelgård (Novia UAS) and Holger Sved (Novia UAS) for the opportunity, support and patience in my thesis writing.

1 INTRODUCTION

This Bachelor's thesis is made for the *Wärtsilä Finland, Services* - division. Specifically *Project Sales* - department for *Energy Applications*, which goes under the *4-stroke Engine Services, Sales and Sales Support* hierarchy. The extent of this thesis is wide, but every viewpoint is for improving the departments' business growth and streamlining its way-of-working.

Hereby follows an introduction to the company and the work department. This is followed by the thesis defining, including an explanation of the delimitations made, and a short description of my own relationship to the thesis subject.

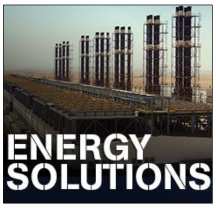
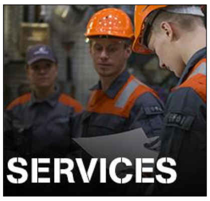
1.1 Wärtsilä

Wärtsilä is an energy-technological company that offers complete lifecycle solutions for power generation across a worldwide market. The company is striving to improve value propositions across this wide front to maintain a leading market position.

Wärtsilä is present in nearly 70 countries in over 200 locations. Installed power generation equipment exist in over 175 countries along with vessels operating worldwide.

The company is divided into three main segments. Energy solutions, Marine solutions and Services. *Energy solutions* offer Wärtsiläs' reciprocating engines along with needed equipment as complete on-land power plants. Also LNG-terminals, nuclear backup generators and maintenance agreements for new-builds go into the portfolio. *Marine Solutions* offer manoeuvring systems for vessels including thrusters, propellers, reciprocating engines, etc., as well as maintenance agreements and designs. *Services'* focus lies upon supporting Wärtsilä's customers within either onshore- and offshore markets with high quality support throughout the installations lifecycle. This includes e.g. part maintenance and system solutions upgrades. (This is Wärtsilä, n.d.)

Table 1: Wärtsilä, Key Figures 2015

	Net Sales [EUR]	Order Intake [EUR]	Personnel
	1.126 million	1.009 million	959
	1.720 million	1.599 million	6 847
	2.184 million	2.324 million	10 592

(This is Wärtsilä, n.d.)

1.2 Department

Sales and Sales Support, *Project Sales* is divided into two segments, E*nergy Applications* and *Marine Applications*. This department's business relies on project sales only. Power Applications focuses on inland installations, whereas marine applications naturally focuses on marine installations. Beneath the General Managers, there are five employees in each of the two segments. Hereby follows an informative list of the typical projects which the department handles today.

Project example	Explanation
Retrofit	An obsolete or broken engine is replaced.
Power upgrade	Plant efficiency and/or output is increased by implementing new technology.
Relocation	A power station not profitable in one location (owners' perspective) is moved to a new location.

Conversion	A power station operating on HFO has received gas connections, and is converted to SG/DF setting.
Rehabilitation	A power station which is obsolete and not in good condition is rehabilitated and overhauled.

The department either receives requests from plant owners or locates potentially interested customers itself and makes proposals for solutions or improvements. Below follows a simplified work process of a project proposal engineer's work.

Table 2 Proposal engineer's workflow example

	Process	Concrete example	Resource example
1.	**Information gathering**	Check plant layouts and assess overall condition. Check engine data and condition. Assess transportation methods, delivery times and fuel prices. Make payback time and feasibility estimations. Check political situation as well as legal and security aspects.	Support departments within Wärtsilä, IDM[1], Customer/ account manager dialogue, news.
2.	**Proposal making**	Make scope of supply list, general terms and conditions, and do cost-, manpower- and performance calculations. Make technical specification, performance standards document, time schedule and proposal document. Review offer. Send to customer.	Wärtsilä document templates, Offer calculation tool, CRM[2] tools, support departments, SAP[3], PerfPro[4], Skype meetings.
3.	**Contract making**	Refine technical documents. Make contract documents. Review contract. Meet with customer. Do business.	Lawyers, templates, support departments, CRM.

A simple early-stage proposal usually contains following documents: Proposal, General Terms and Conditions, Scope of Supply, Performance Guarantee and Technical Specification.

[1] Wärtsilä database for file storage. (IDM)
[2] Online software-tool for managing sales accounts, quotations and templates. (CRM)
[3] Software for data handling. (SAP)
[4] Tool for performance calculations. (PerfPro)

1.3 Thesis

This section is for understanding the shaping of this Bachelor's thesis. This chapter will clarify the content which all work orbits around to finally form a result.

1.3.1 Background

The department's work is not unilateral nor is its business market. The market needs are changing along with new trends and environmental-political decisions. The ongoing development of LNG infrastructure and experiments with alternative fuels in different areas of the world, along with unstable electrical grids as a result of wind and solar energy, all open up potential business opportunities for improving and adapting customers' power generation equipment. The company will have to adjust with better suited technical solutions, new business arguments and a smoother internal process. This is critical for maintaining a strong position on the market and discovering new businesses.

1.3.2 Mission

The mission is to research and analyse market, technology and internal approach within *Wärtsilä Finland, Services, 4-stroke Engine Services, Sales and Sales Support, Project Sales, Energy Applications.* This means locating the most critical bottlenecks and finding where focus should be channelled for maintaining a continuous growth in the upcoming years.

1.3.3 Goal

The goal is to propose a strategy (or improvements) for the department which could enhance its business growth and help the department's way of working. The findings from both theory and research, will be the basis for the development of this strategy.

1.3.4 Delimitation

To delimitate such a wide subject, which could cover almost anything, I have chosen *four main research categories* to focus on. These four categories will be the main topics throughout the thesis.

The first one being *market needs*. This involves mapping out sections worldwide where business potential can be found. This based on available power generation equipment upgrades today. This can be unstable grids (due to much solar and wind energy or countries with still developing infrastructure), where faster start-ups or better grid stabilisation is needed. Alternatively critical fuel price changes or political decisions in different areas which might require a fuel conversion due to economic- or environmental aspects.

The second one being *technical upgrades*. This involves locating obsolete or worn parts (engine-type specific) in installations which could be replaced with new parts (e.g. cooling radiators) and thus enhance performance or reduce derating of the plant. This would only concern Wärtsilä 32 and Wärtsilä 46 engines.

The third one being *customer agreements*. This involves reviewing the possibilities of whether customer agreements can be established or extended after a project is put trough. This would lead to a more secure future for both customer and Wärtsilä in terms of business and plant reliability.

The fourth one being *performance tool improvements*. This would only concern a performance calculation software (called PerfPro) and would be to determine if and what improvements or changes are needed in order to get even more use of it.

1.4 Author

I have worked as a trainee in this department for three summers. This means that I have the basic pre-knowledge about the departments' procedures in order to take on this quite challenging task. After all, this is a big company with professionals working every day of the year to improve business and technology from every detail to the "whole big picture". This means that I have to be innovative and open to information in order to contribute with something of value. One of my strengths is not to have spent much time in the company, meaning that I still have an open mind not restricted by everyday routines.

The mission has very open limits. This gives me room for creativity which motivates me, and the research area is within my area of interest. Therefore I find that I can develop a strategy worth bringing forth to my supervisors.

2 PROCEDURE

This chapter will motivate the choice of method for information gathering and for forming strategies. Chapter *2.1 Theory* describes the procedure and method for finding information concerning the subjects within the thesis delimitations, whilst chapter *2.2 Strategy* will explain the reasoning and method behind the strategy forming and the reliability of the information.

2.1 Theory and information

Most of the research is based on existing quantitative data. Meaning that the theory will be built on research and studies already made. This information can be my own empirical observations and Wärtsilä internal studies and knowledge bases. Also external studies and data will take part in the theory shaping.

Some theory will also be based on qualitative research, meaning that personal communications with colleagues and news reports etc., will affect the decisions made when choosing which fields to research.

2.2 Strategy

The strategical decisions presented in the thesis, are fully qualitative due to lack of models and only relied on observed trends, communications and own judgement. The strategy is based on the research and theory presented in Chapter 3 Theory.

When coming up with a strategy one has to consider so many alternatives. Finding the best path is difficult when so many factors play part. Predictability, confidence and determination towards the goal is very important to be clear about in order to do business.

3 THEORY

This section will explain the basic theory within the frames of the delimitation explained in Chapter 1.3.4. The theory will not go in depth in any subject matter as it easily escalates. Instead the approach will be kept to a reasonable and basic level.

3.1 Market needs

Knowing the *market needs* is of utmost importance when developing new products or services. Most customers will not buy products they do not need nor offer them added value. Hereby follows some very important questions one must know the answer to, to be able to approach a customer in the best way possible.

Needed input	Question
Customer	Which business segment?
	How much energy is needed and how often?
Fuel	What options are available?
	Of what quality is it?
	How much does it cost?
Electricity	How much does the generated power sell for?
	How reliable is the electricity grid?
Political	Is emission control needed?
	What is the situation of renewable energy sources?
	Are there subsidies affecting decision making?
	How safe is the country?
	Are special permits needed?
	May currency fluctuations and taxes affect prices?

Climate	What is the weather like?
	Are there any climate extremes?
	What transportation methods can be utilized?
Environment	Are there alternative energy options?
Competitive	What are the competitors offering?

The following chapters will shortly explain the current situation of the macroeconomic outlook and the meaning of electric grid stability. Also how the political decisions and trends today affect energy markets' needs of tomorrow.

3.1.1 Macroeconomic outlook

Not only political- and environmental drivers affect the market. The economic situation in each and every country affects its companies, and vice versa. This further affects the business of another company in another location and forms an either positive or negative result.

There is a link between electricity availability and wealth. With high electricity availability, factories and services can run steadily which creates a boost in GDP locally. Too high electricity prices on the other hand, reduce this phenomenon. Figure 1 shows an example of the link between GDP (PPP) and electricity availability. There are two exceptions. In this case Finland and The United Arab Emirates, where cold winters require much extra heating and long hot periods require much cooling. Well developed countries in very hot and cold climates often use more electricity compared with the "world wealth per electricity use" trend line.

(Jacob Klimstra, Markus Hotakainen (Wärtsilä), 2013)

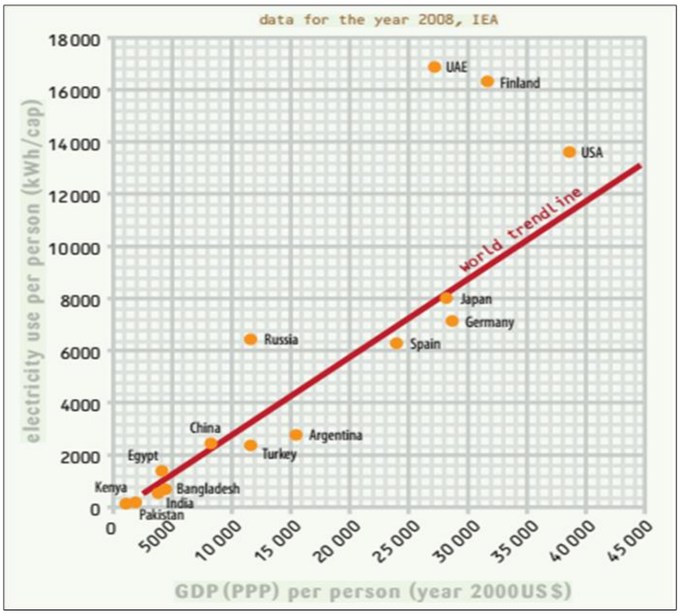


Figure 1 GDP (PPP) in US $ versus electricity use per person

(Jacob Klimstra, Markus Hotakainen (Wärtsilä), 2013)

The macroeconomic start of the year 2016 was an insecure global market with low cash flow. This, along with very low oil prices (due to overproduction), sanctions against Russia and newly lifted sanctions against Iran, makes decision makers insecure on how to invest.

Figure 2 shows the worlds Gross Domestic Product increase in percent. Figure 3 shows an example of the decrease in oil price, for this case West Texas intermediate. In the regions where the GDP has increased most in 2015, many countries are largely dependent on oil and have therefor enjoyed an upswing in production profit thanks to low oil prices.

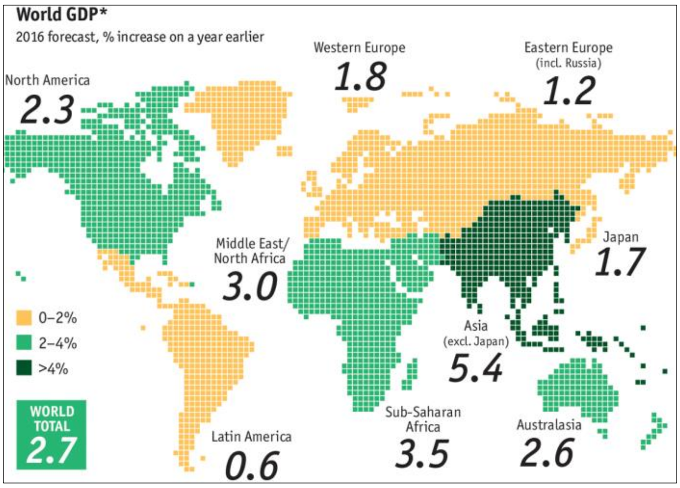


Figure 2 World growth in GDP

(The Economist, 2015)

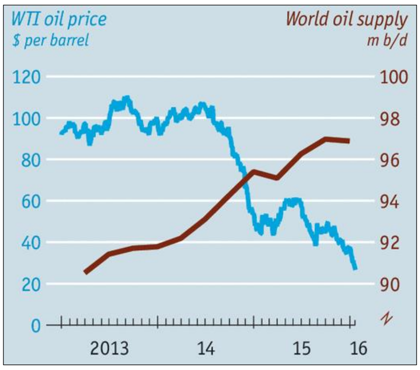


Figure 3 West Texas Intermediate Oil Price curve

(The Economist, 2016)

3.1.2 Grid stability

The renewable power generation is entering the electricity market. This generation is subsidised and has very low operating costs. This is a beautiful trend with many perks for environment and economy in the long haul. In today's situation on the other hand, it is starting to cause problems to backup generation and the still needed baseload carrying plants. These problems are both economic and functional. The economic bit is mostly political and will not be further discussed. The functional problems are different challenges that power producers meet when trying to compensate for unexpected weather changes or peak demands.

Think of a dry season combined with a day without wind. It is also getting late in the evening and people are starting to get home from work to cook food. Having no wind means that the turbines are not producing any electricity. The dry season means you cannot compensate the decreasing grid frequency with the hydro-power station. The battery packs from the solar panels will only be able to compensate a couple of hours. In a situation like this, one can either start cutting of electricity to different regions, or ask the neighbouring power station owner for help, i.e. if he can help. The neighbor did not know of this situation and have to start ramping up his LNG power plant as quick as possible, selling the electricity for a very high price.

This is an example of a situation where renewables can cause unexpected costs and stress to the grid in developed countries. With more renewables even more backup generators might be needed to deal with periods (often a couple of hours long) of this kind. In developing countries the situation is the same. Electric outages occur very often. The reasons are not perhaps because of renewable energy, but because of unpredictable stops and starts of factories and limited grid networks. Also simply lack in power output and cooperation between power suppliers can play a role.

One solution, for maintaining a stable electric grid today, is often called "peaking power plants". These power plants need to be:

- A Fast starting and stopping
- B Fast frequency and voltage balancing
- C Easy accessible for easy and unit-independent maintenance

D Insensitive to environmental stresses

E Efficient in a wide load range

F Black starting capable

Figure 4 indicates roughly where there are frequent problems with the electrical grids on a global basis. A power outage means that money is lost for the distributor.

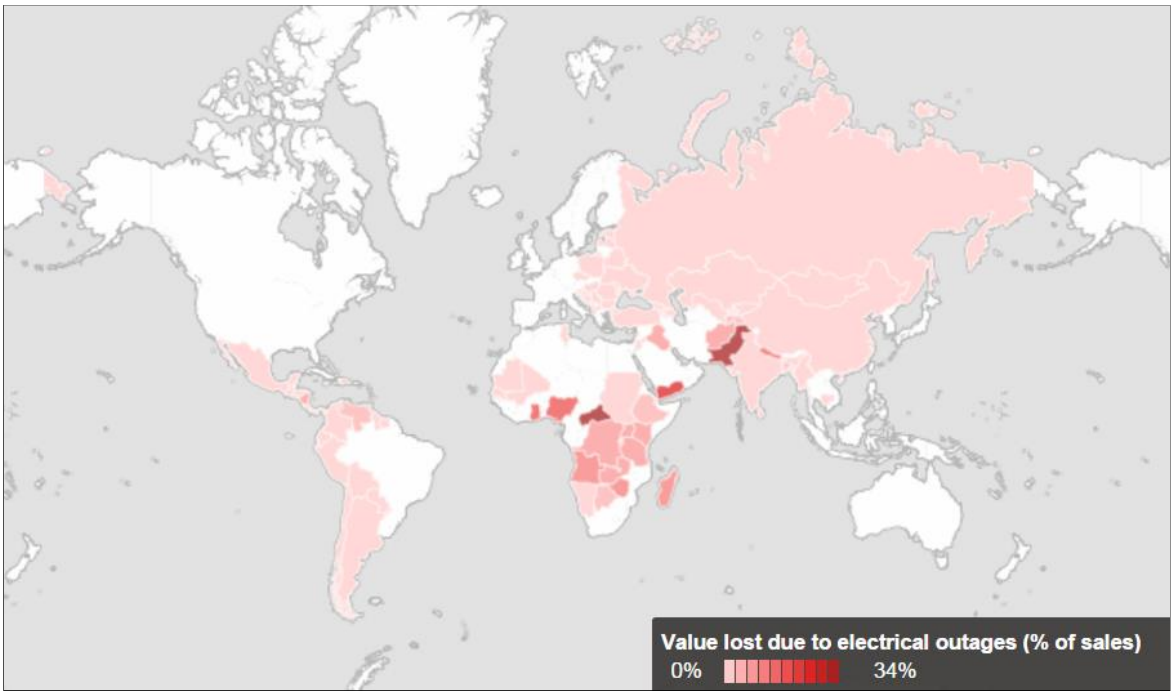


Figure 4 Electrical power outage value loss (2011-2015)
(The World Bank, n.d.)

Figure 5 shows an example of the average hourly demand in Japan. The grid varieties are normal, and following these peaks (or pulses) efficiently is a big challenge. Doing this e.g. with a coal power plant is almost impossible without generating a lot of wasted energy in the downswings. Smaller power sources are often more efficient for “filling” these peaks, when e.g. hydro power is not available.

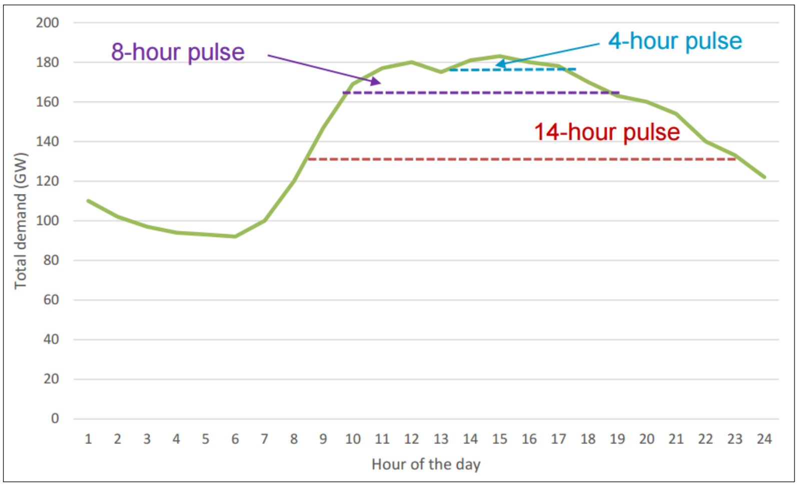


Figure 5 Typical daily demand curve (Japan)

(Christian Hultholm, Jaime López, 2015)

3.1.3 Trends

Hereby follows a description of today's political trends. These trends will have to be adapted to by the energy producers.

3.1.3.1 United Nations Paris climate agreements

United Nations, Framework Convention on Climate Change, held a conference in Paris in November 2015. The result of political leaders worldwide gathering together to discuss actions towards global warming was the so called Paris Agreement. This agreement is a plan to avoid dangerous climate change by limiting long-term global warming to 2°c "in accordance with the best available science". This will be done by continuously improving mainly emission levels and secondly developing warning systems to prevent losses caused by stormy weather. Meetings will be hosted every five years for setting new ambitious targets. The key is to cooperate and support developing countries economically. The agreement will be opened for signature in New York at 22 April 2016. If 55 countries that account for 55% or more of the global emissions sign the agreement, it will enter into force.

Further on, the European Union is the first economy to contribute to the agreement by already taking steps towards reducing emission levels by 40% until the year 2030.

(European Commission, 2016)

3.1.3.2 Climate Change Performance Index

The Germanwatch & CANs´ Climate Change Performance Index is an instrument used to "enhance transparency in international climate politics". The goal is to set pressure on the 58 countries responsible of 90% of the world's energy related CO_2 emissions in order for them to take necessary actions of improvement faster.

The index is based upon input from experts worldwide, forming 5 categories with a specific weighting for each. These categories being: Emissions Level (30% weighting), Emissions Development (30% weighting), Renewable Energy (10% weighting), Efficiency (10% weighting) and Policy (20% weighting).

"Because the energy sector is the most carbon intensive, renewable energy is the key driver for a transition to a sustainable world. Addressing energy production is therefore of paramount importance for climate protection measures. Shifting energy production to renewables also is an important way of decoupling economic development from increasing emissions." (Jan Burck, n.d.)

Figure 6 is a capture from the report showing the CCPI 2015 index rankings for the countries within The Organization for Economic Cooperation and Development (ORCD).

Table 4: Climate Change Performance Index for OECD Member Countries

Rank	Country	Score	Rank	Country	Score	Rank	Country	Score
4	Denmark	77.76	16	Belgium	61.89	36	Austria	55.39
5	Sweden	71.44	17	Italy	61.75	40	Poland	54.36
6	United Kingdom	70.79	18	Mexico	61.30	42	Netherlands	53.27
7	Portugal	67.26	22	Germany	59.60	43	New Zealand	52.56
10	Ireland	65.15	26	Czech Republic	57.99	44	United States	52.33
11	Switzerland	65.05	27	Norway	57.88	51	Turkey	46.95
12	France	64.11	28	Spain	57.34	53	Japan	45.07
13	Iceland	63.07	29	Luxembourg	57.25	55	Korea	44.15
14	Hungary	62.82	32	Finland	56.76	58	Canada	38.81
15	Slovak Republic	62.50	35	Greece	55.89	60	Australia	35.57

Rating
- Very good
- Good
- Moderate
- Poor
- Very poor

Figure 6 CCPI for OECD member countries

(Jan Burck, n.d.)

3.2 Technical improvements

Wärtsilä Services have many experts working on technical improvements and finding solutions to problems that naturally occur to some items working under abnormal and normal circumstances. The main database for accessing information about new solutions and upgrades to this type of issues within Wärtsilä, is the so called Service Offering Catalogue. Alternatively internal conferences, learning lessons or internal news and guideline updates. The information concerning the hereby specifically targeted technical matters is concluded as being the most applicable as business targets on basis of personal communications and information in the Service Offering Catalogue database.

Two of the most common Wärtsilä engines on the market today are the W32's and the W46's. They both exist in many cylinder configurations, as straight- or V-engines, and of different design stages. This chapter will comprehend the most common technical quandaries for these engines.

3.2.1 Derating

Derating in power capacity output can be a problem still today. The phenomenon occurs mainly in hot countries and high altitude locations. The most usual reason why it happens is due to lack in cooling capacity. This is causing a risk of the engines running too hot and the fuel injected is therefore reduced by the automation system resulting in less power output and efficiency.

The lack in cooling capacity is often caused by contamination or corrosion of the radiator flanges caused by time. Causing this is a combination of factors such as dust, moist, salt and of course the temperature itself. The location of the radiators is also important because of differences in airflows. It is getting more common to place the radiator structures on top of the power generation building because of the generally higher airflow and lower air temperature which often comes at higher altitudes above the ground. Most often, in cases where a plant is derating, a rehabilitation project is offered.

3.2.2 Performance

Having better performance increases both fuel savings and output. Improvements for increasing performance are often done by installing a more efficient turbo charger and upgrading the engine control- and automation system. There are also possibilities to upgrade to a newer design stage. These changes can be e.g. camshaft piece changes (miller timing) or fuel injection timing.

3.2.3 Rehabilitation

Engine parts and auxiliary modules get naturally worn over time due to one or another reason. Overhauls should be done periodically in order to keep the power delivery reliability high. However, when a plant comes of age, there might be a need for renewing some parts or systems that are obsolete. The reasons can be of safety regulations, low performance compared with new systems, or service parts being no longer available.

These renewals are often done in power plants “soon to be shut down” or with much derating, in order to get them going for a good couple of years more. Currently most of the potential rehabilitation projects are located in countries of Africa, The Middle East and South Asia.

3.2.4 Fuel conversion

Fuel conversions are very attractive nowadays. Having the opportunity to run a power plant for today’s cheap oil price and later, in the future, convert e.g. to natural gas or biofuel when it become available is a great business possibility. Currently pipelines, export and import terminals are showing up more and more all over the world. Especially the ocean transports are developing, becoming more frequent and the routes extended, giving new opportunities for power generating locations otherwise far from a gas sources.

The following figure shows the LNG bunkering possibilities of the Nordic region. The phenomenon described above is demonstrated as blue dots marked on the map.

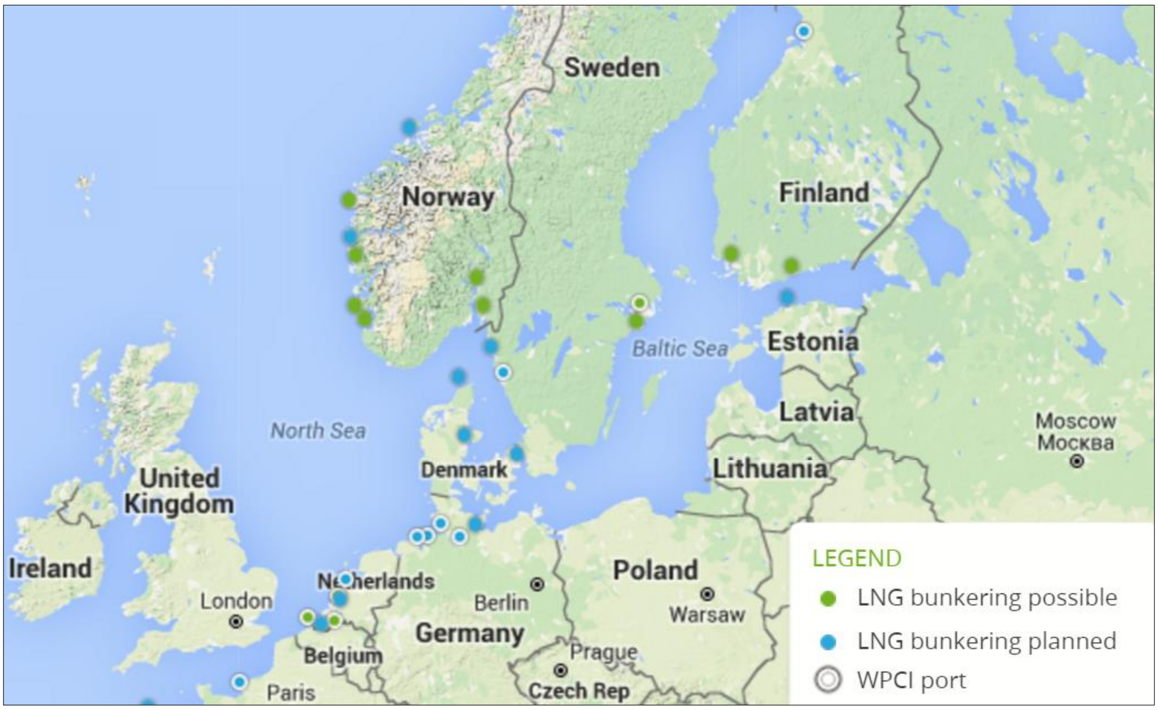


Figure 7 LNG bunkering stations in North Europe

(WPCI LNG Map, n.d.)

When doing a fuel conversion project, a power plants' auxiliary systems play a big role of the changes needed to be made to the plant. Piping, ventilation, electrical consumer cabling, civil constructions and compressed air systems need modifications or extensions. This is mainly due to the changed auxiliary units, but also other reasons. Hereby follows two simplified figures showing the mechanical auxiliary systems. These can be compared with better understand the differences of the systems. Figure 8 shows a layout for the main auxiliary tanks and units needed, for operating an engine on either LFO or HFO (each system shown separate). Figure 9 shows the main auxiliary units for a gas engine, which perhaps could be connected to a pipeline.

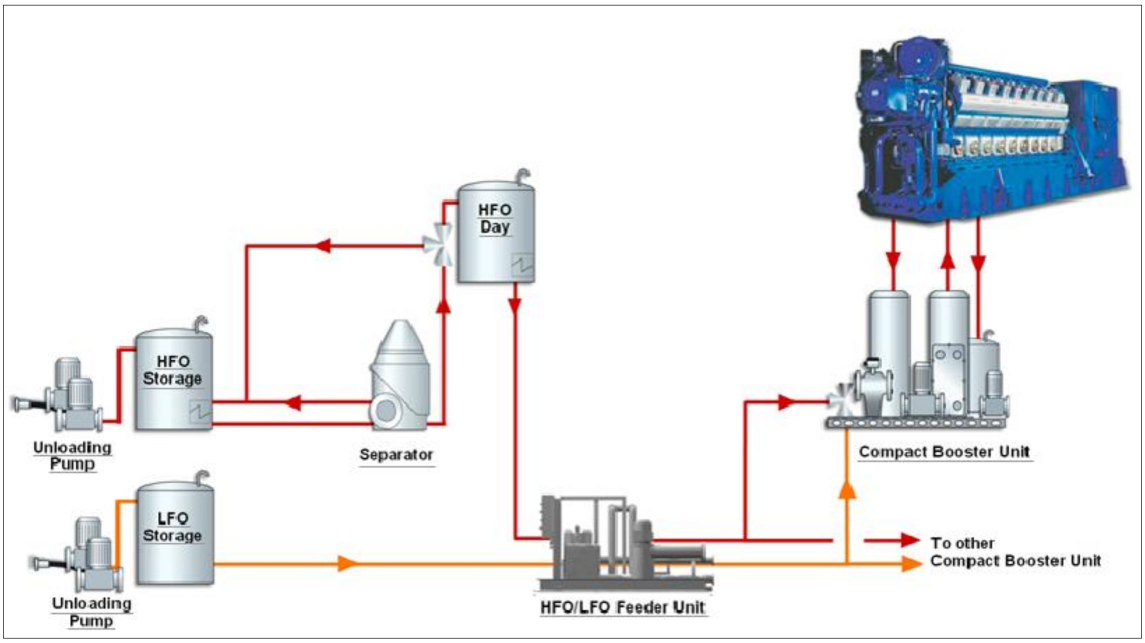


Figure 8 Oil plant auxiliaries

(Citec, n.d.)

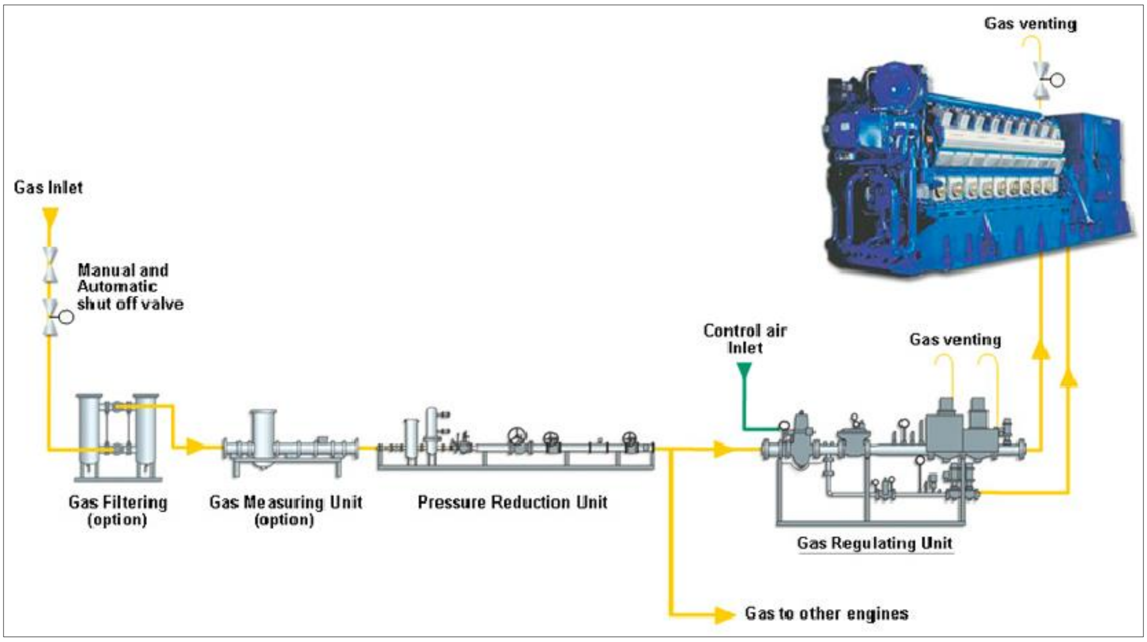


Figure 9 High pressure gas plant auxiliaries

(Citec, n.d.)

Here follows an example of the fuel conversion opportunities available for a W18V32-engine operating on HFO today (and vice versa).

W18V32 HFO	►	W18V34 DF
	►	W18V34 SG
	►	W18V32 LFO
	►	W18V32 GD

The conversions are extensive and require many manpower days. They are not cheap CAPEX-wise but the OPEX-savings (over time) made possible are in many cases much greater. The power output of the engine varies between the different conversions due to fuel specification differences and cylinder dimension variations, e.g. 32 HFO to 34 DF, where the number is the cylinder diameter in centimetres.

For converting a power plant from W32- to 34DF-engines, changes will be made to:

Table 3 Power plant changes

- Cylinder liners	- Pistons	- Connecting rods
- Automation system	- Cylinder heads	- Injection equipment
- Charge air system	- Engine hall ventilation	- Exhaust system
- Low voltage system	- Auxiliary systems	- Operator’s stations
- Civil structures	- Gas detection system	- Tools
- Drawings	- Gas lines	- Fuel storage tanks
- Etc.		

The conversions today are often timed in with a major overhaul, meaning that the engine downtime does not have to be much longer than already accounted for. The engine will be considered as new after the conversion is done. This means that otherwise future planned overhauls are moved forth in the calendar.

3.3 Customer agreements

A customer agreement is an agreement between customer and Wärtsilä to provide OEM (Original Equipment Manufacturer) parts and regular maintenance as well as management services to secure the best possible plant reliability and efficiency. Currently there are mainly three different types of agreements available. Common for these are that they are based on monthly fee charges for on-site personnel, operational support and maintenance management and follows an agreed upon scheme. Scheduled maintenance and parts are paid through a variable fee either per produced MWh or engine running hour.

(Wärtsilä Compass Internal, Agreement types)

3.3.1 Maintenance management and operational advisory

Maintenance management and operational advisory is the lightest of the three agreements. This is an agreement which includes maintenance planning, budgeting support, remote operational support, manpower planning and parts logistics planning.

Each service and part order is delivered based on separate purchase orders from the customer and therefore the customer is not as legally or economically bound as with the more advanced agreements. The customer can also include additional services easily, (such as e.g. emission tests) if desired, in an agreement of this type.

(Wärtsilä Compass Internal, Agreement types)

3.3.2 Maintenance agreement

A *Maintenance agreement* is the “next step” of the agreements and includes revenue based maintenance. Meaning that the services are organized for as little downtime as possible according to dispatch needs. The performance is ensured since Wärtsilä account for manpower, parts, technical support and training whenever needed. The prices for each service-types are fixed and follows a tailored scheme.

(Wärtsilä Compass Internal, Agreement types)

3.3.3 Asset management agreement

An *Asset management agreement* gives Wärtsilä full responsibility for operations and maintenance. This agreements means working towards shared productivity and profitability goals. With this follows ensured performance, lifecycle cost guarantee and information on product development and technical upgrades.

This package includes recruitment and training of personnel, health and safety management, compliance with environmental requirements and performance tracking and reporting.

(Wärtsilä Compass Internal, Agreement types)

3.4 Performance tool

Wärtsilä personnel use a tool to calculate engine and plant performance values. In the tool one can set e.g. parameters for engine settings, site conditions, fuel chemistry and electrical guarantee points. Environmental conditions (such as relative humidity etc.) are normally set to ISO standard and can be modified easily.

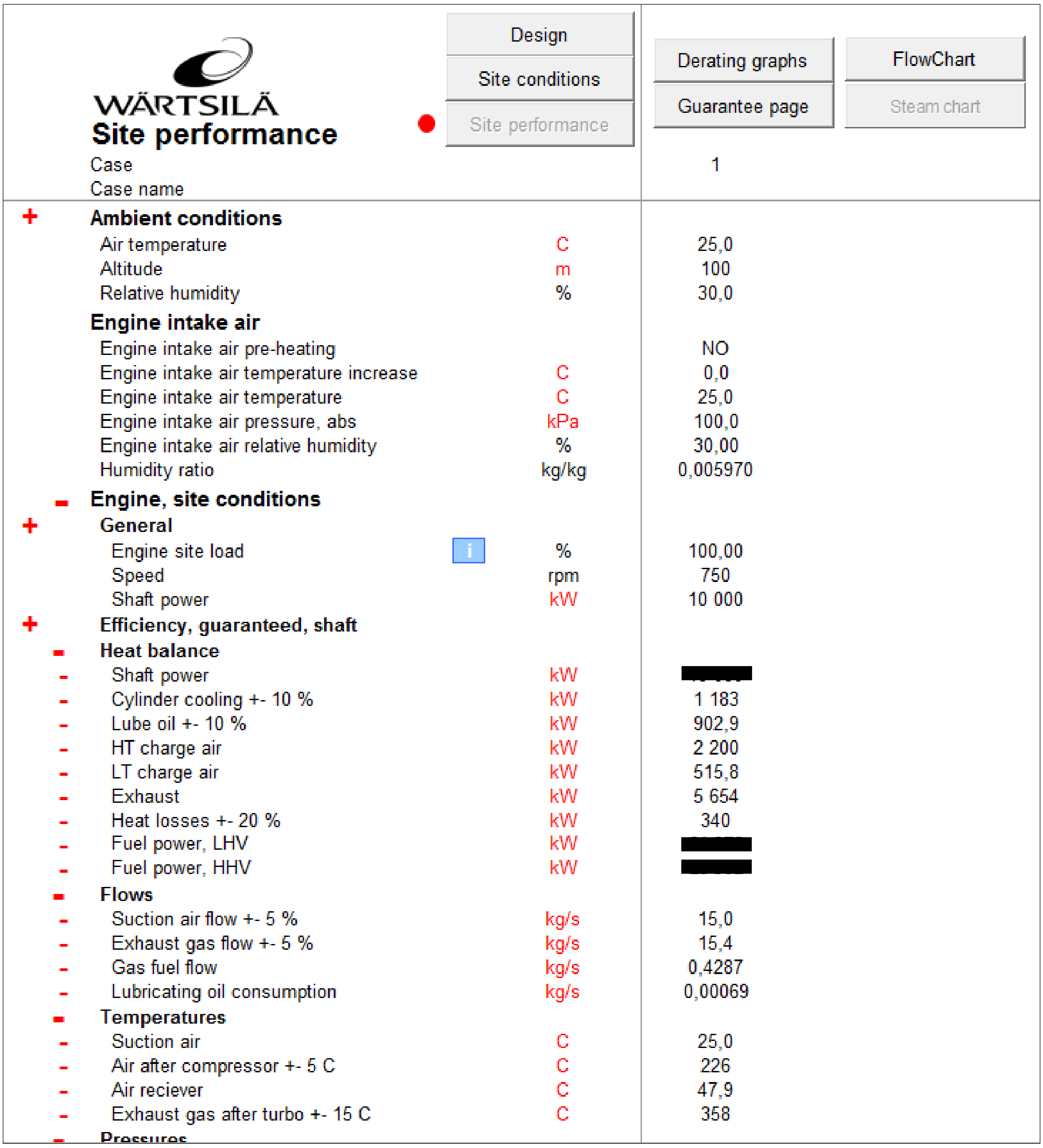
The tool is called PerfPro and is used by sales support, emission experts, process experts and commissioning engineers. The software is only working in Microsoft Excel 2007 and 2011, is programmed in Microsoft Visual Basic language and uses a so called .xlxs workbook as platform for each calculation.

Most engine models and design stages are available from a dropdown list, whilst some have been removed in updated versions to keep it slick. When an engine with the correct specifications is selected (by the basic user), there are two more pages which the calculation formulas will use as input. First a page called “Design” and secondly a page called “Site Conditions”. Walking through these two, specifying the simulated plant as much as possible, will lead to the “Site Performance”-page, where the results will be presented in numbers.

There are three levels of access to the software. Normal user, Specialist and Programmer. In specialist mode comes additional access to emission values and possibilities for more input to customize calculations than in Normal-mode. The Programmer environment is for accessing the code in order to update or modify the software.

(Wärtsilä Compass Internal, PerfPro)

The software is quite simple visually and has no extra features for directly exporting needed values into a text document, except from the so called guarantee page. One can get basic graphs (knocking, derating etc.) quite accessible while the emission basic emission values have to be gathered fully manually. Figure 10 shows a snip from the PerfPro software. Here, a Wärtsilä engine configured with random values, just to show a small teaser of the structure and type of information in the "Site Performance" view.



Case		1
Case name		
+ Ambient conditions		
Air temperature	C	25,0
Altitude	m	100
Relative humidity	%	30,0
Engine intake air		
Engine intake air pre-heating		NO
Engine intake air temperature increase	C	0,0
Engine intake air temperature	C	25,0
Engine intake air pressure, abs	kPa	100,0
Engine intake air relative humidity	%	30,00
Humidity ratio	kg/kg	0,005970
– Engine, site conditions		
+ General		
Engine site load	%	100,00
Speed	rpm	750
Shaft power	kW	10 000
+ Efficiency, guaranteed, shaft		
– Heat balance		
- Shaft power	kW	[redacted]
- Cylinder cooling +- 10 %	kW	1 183
- Lube oil +- 10 %	kW	902,9
- HT charge air	kW	2 200
- LT charge air	kW	515,8
- Exhaust	kW	5 654
- Heat losses +- 20 %	kW	340
- Fuel power, LHV	kW	[redacted]
- Fuel power, HHV	kW	[redacted]
– Flows		
- Suction air flow +- 5 %	kg/s	15,0
- Exhaust gas flow +- 5 %	kg/s	15,4
- Gas fuel flow	kg/s	0,4287
- Lubricating oil consumption	kg/s	0,00069
– Temperatures		
- Suction air	C	25,0
- Air after compressor +- 5 C	C	226
- Air reciever	C	47,9
- Exhaust gas after turbo +- 15 C	C	358
– Pressures		

Figure 10 Snip from PerfPro

4 STRATEGY

Hereby follows the most important findings along with suggested approaches (strategies) for each. These steps might be needed to take action towards in order to maintain and increase sales in the future.

Chapter “4.1. Project offering” will explain extensions to the proposal documents that could be included for increased attractiveness. Chapter “4.2. Project targets” will go through additional value propositions that can be offered to existing power stations. Finally chapter “4.3. Performance tool” will propose improvements on the performance calculation tool.

4.1 Project offering

This chapter will present ideas on how to improve value offering to customers in the future. Offers sent to customers might need more preparation and clarified information in order to awake interest. The process of finishing an offer, however, should not be more complicated nor take more time than before.

Appendix 1 shows a simple feasibility study for an imaginary project case. These values and calculations are only approximates and represents the customers PPA (Power Purchase Agreement), saving to-be-achieved, project price, fuel prices and amount of decreased CO_2 emissions. The purpose is to show the added value in a presentable way. The operating profile of the engine will also be taken into account.

4.1.1 Political preparation

When knowing the political situation of the energy market in the country of a targeted installation, some actions could be taken to increase the attractiveness of the upgrade- or conversion proposal. This could be a document highlighting the grid performance improvements gained with Wärtsilä power generation equipment, showing clear visual calculated effects of the importance of having flexible power generators in the power distribution system. The document would have to be tailored to fit the targeted grid and be explanatory of the positive effect gained in grid stability. I.e. enabling more renewable energy and increased savings from efficiency and the ended need of buying electric power from external sources.

To show annual levels of exhaust emissions could also be beneficial. This in a matter of operating the plant for only a couple of hours a week for grid stabilisation, and showing that the CO_2 emissions will be very low in comparison with baseload generation plants and also enabling more renewables in today’s reality.

A performance upgrade could be called “Security Power Upgrade”, in order to highlight the importance of having backup power. This could wake up politicians’ interests and perhaps even in the future lead to a subsidy for a conversion or upgrade project.

The first step of taking action towards these developments would be to start developing and testing a document template for showing both grid suitability graphs and CO_2 emissions tables with annual operating hours. These based on needed peak shavings in a well-studied grid. This could be attached as an informative appendix also to early-stage proposals.

4.1.2 Service agreement implementation

Maintaining good contact with customers through an installation lifecycle is very beneficial for Wärtsilä. It enables for secure and easy business, better production planning and easier deliveries of both service and manpower. This could be reached by implementing service agreements to a project.

When a service project is in the offering state *Project Sales, Energy Applications* should have an attractive standard service agreement prepared and presentable for customers not having had an agreement before. This agreement should not be too devoted, but could perhaps be of the “Maintenance management and operational advisory”-type and binding e.g. for five years.

Alternatively, an extended Service Agreement for customers already in business, should be prepared with the Service Agreements department and presented along with the project proposal.

Taking action toward this goal would be to have meeting sessions with Service Agreements to form a “standard package solution” which would be easy to calculate upon. This package should be used in an early offering stage without the need for support (or very little) before real interest is awoken. This would require developing a document template for the agreement and an indicative cost graph following the amount of engines and fuel types etc. To make this even more attractive, the planning fees and the spare parts up to a specified amount of engine running hours, should be included in the project price.

4.2 Project targets

Since grid stability will be of increased importance in the future, there will be a need for upgrading systems which improve start-up times and load following capability. This could easily be included for almost all of todays’ projects to extend the content and enhance the added value, and can perhaps in future cases be **the core of the project itself**.

To make this reality, *Services Project Sales, Energy Applications* should in cooperation with Technical Services and Electrical & Automation (Ancillary grid services), develop a Pulse-operation Package which can be sold as such, or included in e.g. a rehabilitation project, to suitable environments.

Practically this Pulse-operation package would be following a standard performance upgrade for the engine plant in demand. Nevertheless it would also include modifications to the Automatic voltage regulator, PLC Software, Power monitoring unit, Operators interface and Engine speed and load controller. This is needed for the additional signals to- and from the control system. Other modifications could be of mechanical nature but needs to be researched further.

Existing installations are of course the target for Services, as always, and these have literally been mapped out (Wärtsilä Power Map) for an easy overview. The most attractive ones, technically, are located in hot areas. Plants that are derating due to lack in cooling capacity should be prioritized. Other very attractive potential projects are in areas near developing LNG or biogas infrastructure, and more energy should be put into following this market.

4.3 Performance tool

PerfPro is the basis when making performance guarantee documents, and can do so for most engine types. In order to improve the internal way-of-working, at least the following improvements should be considered for the PerfPro tool.

Old versions of PerfPro include information of **older engine-types** which are lacking in the new versions. These [*] would be good to still be able to access from *Project Sales, Energy Applications'* point of view, since calculations occasionally are required for older installations. [*W46 A and B stages, 18V34SG A2+ stage.]

Having a possibility to **choose different turbo chargers** (make) would be good in cases where customers are interested in performance upgrades. This would at least concern the two most normally used turbo charger makes by Wärtsilä i.e. ABB and Napier. This to achieve even more accurate calculations.

The tool already calculates exhaust emissions. Therefore it has a good potential to be used as a basis for the earlier mentioned strategical approaches (Chapter 4.1.1). A new input configuration in which one could set parameters for an engine to follow a specified daily grid peak would be a good development. The result would be **emissions based on grid information** (pulse operation). The outputs needed for this extended calculation already exists, but is not in a form easy to use.

Steps towards these improvements would be to first discuss the possibilities of doing these implementations to the software with the programmers. Then *how* they can be made, and to *what extent,* and cooperate from that point.

5 CONCLUSION

The following paragraphs will shortly explain the conclusions made in this thesis. Also, whether the goal has been reached as well as my own lessons learned in the making of this paper.

5.1 Result

These are the practical steps needed in the near future for helping business growth, way-of-working and proposal impact. These are the strategical highlight, in other words the result of the thesis. Here simply divided for easy understanding.

Early-stage offers	Develop an offer attachment containing: - *Grid suitability diagram* - *Yearly CO_2 table* - *Valuable Arguments: "Enabling renewable energy"* - *Service agreement package included in project*
Agreements	Develop a standard agreement package for project sales Cost graph for quick price estimation for project inclusion
Projects	Follow LNG and renewable energy trends in the electricity grids around power plant installations to improve timing of proposals Develop Pulse-operation upgrade package
PerfPro	Improvements to enhance Service projects way-of-work - *annual CO_2 calculations with dispatch needs as input* - *include (or reintroduce) missing engine models* - *add option to choose turbocharger make*

Sales Projects, *Energy Applications* should start to prepare for a future where plants will be requiring less running hours but more flexibility. The project offerings should be adapted accordingly. Also, the benefits of a Wärtsilä power plant must be made clearer, at least for the western world that is currently only focusing on adding renewables to the grid.

In order to increase the project value, service agreements should partially be included in the project price. Otherwise the department should keep up the work, and keep following gas infrastructure development to find new project opportunities.

5.2 Reaching the goal

In my opinion, the goal has been reached. Concrete ideas on how to improve the departments business have been presented along with explanatory theory. This subject has so many branches one could go into depth to, that this thesis only scratch the surface of the subjects. However, when putting together the basic principles and understanding the department's business, one will surely agree that the result is of a nature adapted to match future trends and needs. The results naturally have to be further developed into a more concrete form and tried out before implemented into the reality of the departments business.

5.3 Lessons learned

This thesis has been rewarding to me in terms of gained knowledge about the company and my department. I have increased my skills on how to structure a paper and my knowledge within both how to delimitate a problem and knowledge in the subjects discussed have deepened. I've had both positive and negative experiences with my planned schedule, which will help my future criticism of projects schedules.

All in all I'm satisfied with the thesis and did not meet any too big obstacles. This although the subjects were very wide spread into different research areas. Further delimitations could have been made to focus in depth on one single subject instead. Then again, the diversity of the thesis is what I found most interesting.

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Appendix 1 – Project Feasibility Example

CRM number:	0123456789Abcd0
Revision:	-
Created by:	KBJ
Date:	19 April 2016

*This is an example with fictional values.

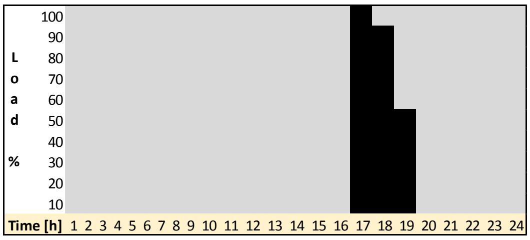
*This layout and information contents is only a sample.

Feasibility study

Gas conversion of peaking power plant

General		
Total daily running time	**3**	**h**
First running hour, load	100	%
Second running hour, load	90	%
Third running hour, load	50	%

Fuel Price	HFO	6	Euro/GJ
	Gas	3,2	Euro/GJ
Lubricating Oil Price		2,5	Euro/kg



*Parasitic load not taken into account, guarantee point is at generator terminals.

*ISO Conditions are used.

	1 x HFO Engine	1 x GAS Engine
Electricity Produced	41,134 MWh	44,088 MWh
CO_2 emissions daily	26,1 ton	19,3 ton
yearly	*9527 ton*	*7060 ton*
Lubricating oil consumption	21,6 kg	14,1 kg
Fuel Consumption (LHV 1atm)	8063,1 kg	7000,6 kg
		9103,5 m^3
	0,331393 TJ	*0,34748 TJ*

Fuel cost per day	1988 Euro	1112 Euro
LO, cost per day	54 Euro	35,25 Euro
Daily total fuel+LO cost	2042 Euro	1147 Euro
Yearly Total fuel+LO cost	745462 Euro	418723 Euro

*Project price is budgetary only (full EPC & CIP Transportation).

Conversion investment price	4,1 milj. Euro	
Electricity sell price	6,7 cent [€] per kWh	
Daily electricity turnover	2756 Euro	2954 Euro
Electricity income	276 Euro	295 Euro
Profit margin	10 %	
Daily savings achieved with SG	564 Euro	

*Engine spare parts are calculated for a ten year period with 1095 running hours yearly.

*No interest rates nor subsidies are taken into account.

Yearly on-engine spare part savings	***22704 Euro***
Yearly fuel and LO savings	***326739 Euro***
Additional electricity output income (if to be sold)	*7224 Euro/year*
Yearly CO_2 emission improvements	***2467 ton***
Efficiency improvement	***2,58 %***
Payback time	***11,5 Years***

**Great lifecycle savings can be achieved if the conversion is timed in with a major overhaul.*

**Plant will be capable of more output, i.e. more electricity could be sold.*

**Peaking prices are often very profitable, which would mean a very much better paybacktime.*