

Wärtsilä Sustainability Report 2002



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NOTES:	
1	Wärtsilä is familiar with the current GRI protocols, but has not adapted the protocols because of their experimental status.
2	Information not available at corporate level.
3	Information not available at corporate level, except fuel consumption.
4	Information not available at corporate level, recycled materials are used in engine and propeller components.
5	Not significant, because companies are mainly located in urban areas.
6	Local practices, not compared to ILO requirements.
7	No separate policy or programme. Part of the occupational health care of employees.
8	No corporate level policy or programme. Some Group companies have policies of their own.
9	No separate policy, procedures or systematic monitoring system available.
10	Reportable evidence not available. Wärtsilä assesses its suppliers as described on page 21 and companies in connection with M&A.
11	Not applicable for Wärtsilä.

Vision and Strategy

Mission

We contribute to solving the global needs of sea transportation and power generation by developing equipment and services that convert fuels into power efficiently and with the lowest possible environmental impact.

Vision

We strive to lead the ship power and distributed power generation markets by providing the most competitive, reliable and environmentally sound solutions.

Our worldwide network of professionals translates these solutions into maximum customer satisfaction and value.

Our mission and vision mean that:

- We take responsibility for the total functionality of our system supplies.
- We maintain and develop a comprehensive service network capable of enhancing value for our customers.
- We develop products that meet the strictest environmental criteria.
- We develop value for our shareholders.

Sustainability Strategy

ECONOMIC

Wärtsilä's target is to improve its financial performance and create added value for its stakeholders and society. Strong financial performance forms a basis for corporate

environmental and social responsibility. Wärtsilä strives to create economic added value for its direct stakeholders and to contribute to wealth creation in the local communities in which it operates.

Operational targets

- The leading global ship power supplier.
- In Power Plants, Wärtsilä's target is to strengthen its global leadership position in large engine-based power plants and to grow in renewable energy solutions. Gas power plant deliveries will be half of Wärtsilä's total engine-based power plant business.
- In the Marine and Power Plants divisions Wärtsilä's target is to grow 4% a year. Further growth will be achieved through acquisitions.
- The annual growth target for the Service division is 10-15%. The service business will represent over one-third of the total net sales of the Power Divisions.

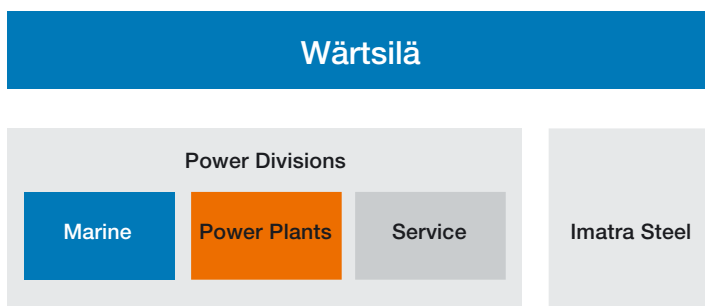
Financial targets

- Wärtsilä's target is to improve the performance of the Power Divisions by raising the operating profit to 7-8% of net sales.
- The solvency ratio target is 40%.

Dividend Policy

Wärtsilä's target is to pay a dividend equivalent to 50% of operational earnings per share.

Group Structure



The Group consists of two industrial business areas – the Power Divisions and Imatra Steel. Power Divisions, which is the core of the Group, is divided into three selling divisions: Marine, Power Plants and Service. Imatra Steel is a Nordic steel company.

ENVIRONMENTAL

Environmentally advanced solutions and services

Wärtsilä's target is to develop and produce environmentally advanced solutions and services for its customers that fulfil all their vital requirements. We require world-class environmental performance of our solutions and services. We put high priority on developing systems and services that have low emissions and high efficiency.

Wärtsilä's targets by the end of 2005 are to:

- Raise the volume of its gas and BioPower plant sales to 1,000 MW.
- Raise the volume of O&M agreements to cover 20% of total new installations.
- Provide a comprehensive gas engine portfolio, for both diesel-electric and main engine installations.
- Be able to offer propulsion systems with 10% higher total efficiency than is standard today.
- Develop a fuel cell solution prototype with ultra-low emissions and provide the first engines able to run on biofuel.

World-class supplier

Wärtsilä's environmental target is to be a world-class supplier of power solutions. Wärtsilä places high priority on achieving sustainable development by means of raw materials, processes, products, wastes and emissions associated with enterprises taking into account the latest technical advances.

Wärtsilä's target by the end of 2005 is to:

- Perform energy analyses and improvement programmes in all factories.
- Perform lifecycle assessments for two Marine and Power Plant applications.

Management systems

Wärtsilä's principle is to apply certified Environmental Management Systems based on ISO 14001 in all Group companies.

SOCIAL

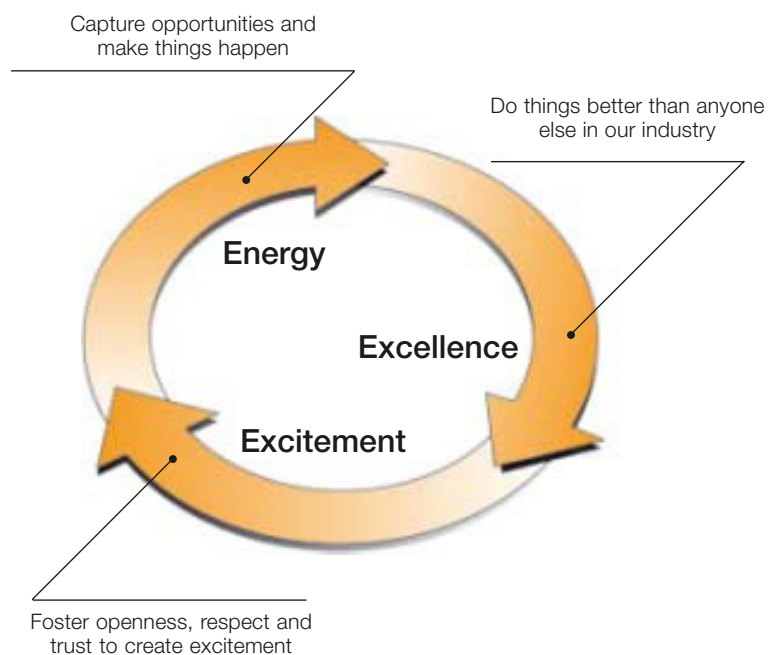
Wärtsilä strives to offer its employees an interesting and exciting workplace where openness, respect, trust and equal opportunities prevail. The company wants to create a learning framework that enables its employees to continuously develop their skills and competences both on the job and through separate in-house and external training programmes.

The company also endeavours to offer hazard-free workplaces to its employees, contractors and others working in different parts of the corporation by applying high standards of occupational health and safety. The Group applies such product development and manufacturing processes as well as such quality assurance methods that minimize health and safety risks related to the use of its products and services.

Suppliers are an important part of the total supply chain of the Group. Therefore Wärtsilä gives considerable attention to the long-term development of common processes with its suppliers. This includes common design activities, development of manufacturing processes and efficient information exchange guided by long-term agreements.

Wärtsilä's intention is to act as a good corporate citizen wherever the company is active. This is accomplished through open communication and good codes of conduct and relationships with its local stakeholders.

Values



Wärtsilä – Power on Land and at Sea



From left: Antti Lagerroos, Göran J. Ehrnrooth, Risto Hautamäki, Jaakko Iloniemi, Bertel Langenskiöld and Paavo Pitkänen

Board of Directors

Mr Antti Lagerroos, LLic, Chairman, born 1945. President & CEO and Member of the Board of Finnlines Plc. Member of the Board of Wärtsilä Corporation since 2002. Member of the Boards of Fortum Oyj and Nordic Aluminium Oyj. Owns 6,500 shares in Wärtsilä.

Mr Göran J. Ehrnrooth, MSc (Econ.), Deputy Chairman, born 1934. Chairman of the Board of Fiskars Corporation. Member of the Board of Wärtsilä Corporation since 1992. Member of the Board of Assa Abloy AB (publ). Owns 6,964 shares in Wärtsilä.

Mr Risto Hautamäki, MSc (Eng.), born 1945. President & CEO of Tamfelt Corporation. Member of the Board of Wärtsilä Corporation since 2003. Chairman of the Board of Teleste Corporation and deputy member of the Board of Alakoski Oy. Owns 1,600 shares in Wärtsilä.

Mr Jaakko Iloniemi, MSc (Pol. Sc.), born 1932. Member of the Board of Wärtsilä Corporation since 1994. Owns 1,597 shares in Wärtsilä.

Mr Bertel Langenskiöld, MSc (Eng.), born 1950. President of Metso Minerals. Member of the Board of Wärtsilä Corporation since 2002. Member of the Supervisory Board of Rautaruukki Corporation. Owns 1,481 shares in Wärtsilä.

Mr Paavo Pitkänen, MA, born 1942. Managing Director of Varma-Sampo Mutual Pension Insurance Company. Member of the Board of Wärtsilä Corporation since 1995. Member of the Boards of Stora Enso Oyj and Sampo plc. Owns 1,597 shares in Wärtsilä.



From left: Ole Johansson, Sven Bertlin, Pekka Ahlqvist, Tage Blomberg, Kari Hietanen, Matti Kleimola, Raimo Lind and Mikael Mäkinen

Board of Management

Mr Ole Johansson, BSc (Econ.), born 1951. President and CEO. Worked for the company 1975-79 and rejoined in 1981. Owns 9,500 shares in Wärtsilä. Warrant 2001 allows subscription of 84,000 Wärtsilä B shares and warrant 2002 allows subscription of 150,000 Wärtsilä B shares.

Mr Sven Bertlin, BSc (Econ.), born 1944. Executive Vice President. Group Vice President, Engine division. Owns 12,472 shares in Wärtsilä. Warrant 2001 allows subscription of 42,000 Wärtsilä B shares and warrant 2002 allows subscription of 40,000 Wärtsilä B shares.

Mr Pekka Ahlqvist, MSc (Eng.), born 1946. Group Vice President, Power Plants division. Joined the company in 1999. Owns 1,500 shares in Wärtsilä. Warrant 2001 allows subscription of 42,000 Wärtsilä B shares and warrant 2002 allows subscription of 40,000 Wärtsilä B shares.

Mr Tage Blomberg, BSc (Eng.), born 1949. Group Vice President, Service division. Joined the company in 1975. Owns 1,350 shares in Wärtsilä. Warrant 2001 allows subscription of 42,000 Wärtsilä B shares and warrant 2002 allows subscription of 40,000 Wärtsilä B shares.

Mr Kari Hietanen, LL.M., born 1963. Group Vice President, Legal Affairs and HR. Company Secretary and Secretary to the Board of Management. Joined the company in 1989. Owns 48 shares in Wärtsilä. Warrant 2001 allows subscription of 42,000 Wärtsilä B shares and warrant 2002 allows subscription of 40,000 Wärtsilä B shares.

Mr Matti Kleimola, LicSc (Tech.), born 1946. Prof., CTO, Group Vice President, Technology and Environment. Employed by the company 1974-84 and rejoined in 2000. Owns 1,000 shares in Wärtsilä. Warrant 2001 allows subscription of 42,000 Wärtsilä B shares and warrant 2002 allows subscription of 40,000 Wärtsilä B shares.

Mr Raimo Lind, MSc (Econ.), born 1953. Group Vice President, CFO. Employed by the company 1976-89 and rejoined in 1998. Owns 1,560 shares in Wärtsilä. Warrant 2001 allows subscription of 42,000 Wärtsilä B shares and warrant 2002 allows subscription of 40,000 Wärtsilä B shares.

Mr Mikael Mäkinen, MSc (Eng.), Naval Architect, born 1956. Group Vice President, Marine division. Joined the company in 1982. Warrant 2001 allows subscription of 42,000 Wärtsilä B shares and warrant 2002 allows subscription of 40,000 Wärtsilä B shares.



Chief Executive's Statement

Dear Reader,

During 2002 the Wärtsilä Group continued to develop its industrial operations in line with the guidelines set earlier. These call for us to strengthen our position as a supplier

of marine propulsion systems and decentralized power generation solutions, and also to increase our presence in the service business. At the same time we continued to disengage ourselves from assets that did not relate directly to these core businesses.

Our strategy

The basis for our strategy and structure is our mission to meet the global needs of sea transportation and power generation by developing equipment and services that convert fuels into power efficiently and with the lowest possible environmental impact.

We strive to lead the ship power and distributed power generation markets by providing the most competitive, reliable and environmentally sound solutions. Our worldwide network of professionals translates these solutions into maximum customer satisfaction and value.

As an important part of our strategy to be a total ship power provider, in spring 2002 Wärtsilä acquired John Crane-Lips, the world's leading supplier of propulsion and manoeuvring solutions for all types of vessels. Now we can take the responsibility for total ship power solutions including engines, gears, propellers and control systems. Wärtsilä's Power Plants division, originally created around diesel engines, is today a recognized global supplier of plants intended for distributed power generation based on oil and gas. The latest step to enlarge the product offering was the acquisition of Sermet, a company specializing in biomass-fuelled power plants.

Our Service division supports our customers throughout the operational lifetime of the products to ensure the efficiency of the customers' systems. To be able to offer the Marine customers a wide range of ship service activities, Wärtsilä has acquired several engine repair and reconditioning companies, now named Ciserv. These Ciserv companies

offer a full portfolio of reconditioning services covering a wide range of engine brands.

Core values – basis for sustainable development

Our three core values – Energy, Excellence and Excitement – form the basis of sustainable development in Wärtsilä. We direct our energy to supporting our sustainability programs. We strive for excellence in our business and achieving our goals creates excitement, which gives us energy to improve further.

Wärtsilä has adopted policies regarding quality, environmental and occupational health and safety management. The purpose of these policies, together with our management systems, is to safeguard the sustainable development of our group, products and services and guarantee a safe working environment for our employees.

Strong financial performance – foundation for sustainability

Wärtsilä's target is to improve its financial performance and create added value for its stakeholders and society. Strong financial performance forms a basis for corporate environmental and social responsibility. The operating profit target is 7-8% of net sales in the Power Divisions.

The downturn in the global economy in 2002 and the ensuing weak markets conditions, especially in the power plant market, have called for restructuring measures in the Group to enable us to reach our targets.

An important step along this path was the termination of engine manufacturing in the Netherlands. The Power Plants division was streamlined and a new functional organization was introduced. Operations have also been streamlined in Switzerland, France and Finland.

In the Marine and Power Plants divisions Wärtsilä's target is to grow 4% a year. Further growth will be achieved through acquisitions.

The annual growth target for the Service division is 10-15%. The service business shall continuously represent over one-third of the total net sales of the Power Divisions.



Environmentally sound solutions – success in the market

During 2002 we revised our environmental strategy and targets. Our whole organization is committed to developing and delivering environmentally sound solutions and service to our customers.

As the ship power supplier, Wärtsilä has identified considerable potential for reducing the environmental impact of ships. In its leading position Wärtsilä also has a significant responsibility to develop products and technologies that impose the smallest possible environmental burden over their lifetime. In this respect our work concentrates on improving the total efficiency of our solutions and reducing emissions by our solutions.

Strong emphasis is being put on reducing carbon dioxide emissions in the world today. The share of renewable power as part of total power production will increase, supported for example by initiatives within the EU. This was the impetus for Wärtsilä's entry into biomass-burning technology.

In the industrialized countries, decentralized power production is gaining ground as the preferred technology today. Wärtsilä's gas- and biofuelled power plants offer an attractive answer to this need. We remain committed to developing our oil- and gas-fired power plants in order to further reduce their operating and construction costs and levels of harmful emissions. At the same time the highest growth potential in our view lies in biopower plants.

Wärtsilä seeks to underpin its leading position and technical competitiveness in the long term through its Technology Forum, a group set up by the company during the year to initiate and co-ordinate research projects important to Wärtsilä. Characteristic of the Forum's activities is tight co-operation with the divisions coupled with closer and long-term collaboration with research institutes. Technology Forum's key focus areas are environmental technology and fuels, new engine and energy technologies, system automation and technologies related to materials, propulsion and manufacturing. Product and system development is the responsibility of the divisions.

Competence development and social dialogue

We have chosen to name this report the sustainability report of Wärtsilä. In addition to economic and environmental performance it also describes more extensively the third pillar of sustainable development, the social dimension.

In this connection I would like especially to mention the large number of in-house programmes we operate for developing our employees' competences and the efforts taken together by management and employees to further enhance occupational health and safety throughout the Group. I also would like to highlight in general the wide co-operation that exists between management and employees in the European and local works councils. Finally I wish to emphasize our policy to promote openness and to create a good dialogue with our stakeholders locally.

Imatra Steel

Wärtsilä's steel business, Imatra Steel, has enhanced its standing as a leading supplier of forged components and springs to the European truck industry. The acquisition of Scottish Stampings in 2001 broadened our product portfolio in this sector and further deepened contacts with customers. The modernization of the basic metallurgical process at the Imatra Steel Works has improved the efficiency of the process and this programme continues during 2003. Imatra Steel is committed to developing its products and operations to meet the requirements of its customers and local communities.

This report is Wärtsilä's second sustainability report and it has been prepared in accordance with the 2002 GRI guidelines. It represents a balanced and reasonable presentation of our organization's economic, environmental and social performance.

Ole Johansson
CEO



Wärtsilä's Sustainability Review

Sustainable development and corporate responsibility are topics that have received much publicity recently. Wärtsilä's vision, mission, strategy and core values cover the basic elements of sustainable development, i.e. the company's economic, environmental and social responsibilities. This report describes Wärtsilä's sustainability performance.

The report is Wärtsilä's second 'Sustainability Report' and it has been created in accordance with the 2002 GRI guidelines. In this report Wärtsilä describes more extensively economic and social issues than in its previous report. However, we have also emphasized the product environmental performance section because of its vital importance.

Sustainability reporting poses a number of challenges. First of all achieving sustainability targets requires a significant on-going contribution from the different Group companies. Wärtsilä is committed to improving its performance, which can be seen for example in Wärtsilä's strategy to provide environmentally sound solutions for its customers. Secondly the guidelines themselves are under continuous development and therefore most of the performance indicators have only recently been defined.

In 2002 Wärtsilä prepared internal reporting guidelines for its Group companies. These guidelines include all the definitions and instructions necessary for collecting and reporting the data. In early 2003 Wärtsilä implemented a special reporting system, called the Wärtsilä CR Profile. The companies report their environmental and social data using this system. All

these measures have improved Wärtsilä's capability to report sustainability issues to stakeholders - customers, investors, personnel, suppliers and society in general. This report is mainly intended for our customers and investors.

ECONOMICS

Sustainable economic performance requires that the company's operations are efficient, profitable and competitive. Wärtsilä has set financial targets for its operations in order to secure its ability to create value for its customers, shareholders, employees, suppliers and local communities. This is the first time that Wärtsilä reports on its economic performance from the sustainability point of view. Our aim is to further develop our capability to present a fair and balanced view of our economic performance.

ENVIRONMENT

Wärtsilä offers its customers safe, reliable and environmentally sound solutions and services that meet the strictest environmental requirements. Reduction of environmental impact is the focus of our R&D activities. We have developed solutions that operate at extremely high efficiency and therefore with low specific carbon dioxide emissions. Carbon dioxide is at the moment the most significant greenhouse gas exhausted as waste.

While global energy consumption is increasing about 2 % yearly, fossil fuels will have a key role for several decades to come. Wärtsilä offers flexibility in power production, because our engines can run on natural gas and biofuels in addition to a very wide range of fossil fuels. We are prepared to meet the structural challenges of power production by



continuing to develop high-efficiency gas engines for marine use and power plants.

Reduction of environmental impact will be an important issue in the future as well. We aim to offer our customers efficient and safe total solutions with the lowest possible environmental impact. For instance, the total efficiency of ships can be improved significantly by designing and optimizing the whole ship power solution concurrently.

The world is now focusing on clean and renewable fuels and for this reason Wärtsilä too is developing products suitable for new fuels. One of the most promising energy technologies of the future is the fuel cell with its high efficiency and low exhaust emissions. Wärtsilä has recently started a development programme for fuel cells – a new future business area for the company.

Over 25 Group companies have a certified environmental system. We also actively follow the performance of our suppliers and we work in close co-operation with our key suppliers in order to reach the sustainable development targets in the whole chain.

SOCIAL

Wärtsilä, with its roots in a society marked by high social responsibility, has always considered socially responsible behaviour to be a self-evident requirement of its activities. Only recently have we started to follow-up a number of key performance indicators in this area in a systematic way, which has given us more information on our performance in issues related to personnel and jobs. Based on job satisfaction studies and personnel turnover figures we have taken measures to improve the intensity

and quality of annual discussions between superiors and subordinates and to enhance communication in our organizations.

In our OpExS and in close co-operation between management and employees we have continued to develop our occupational health and safety system in order to be able to offer hazard-free workplaces to our employees. In cases where we have had to restructure and to reduce our workforce for economic reasons, as was the case in Zwolle in the Netherlands, we have joined forces with the local community and the employee unions to create new job opportunities for the redundant employees.

Matti Kleimola
CTO, Professor
Group Vice President,
Technology & Environment

Organizational Profile - Wärtsilä in brief

Wärtsilä

- ▶ Wärtsilä is the leading global ship power supplier and a major provider of solutions for decentralized power generation and of supporting services.
In addition Wärtsilä operates a Nordic engineering steel company Imatra Steel and manages a substantial shareholding to support the development of its core business.

Wärtsilä's brands:

WÄRTSILÄ®,
SULZER®, LIPS®
JMT, Deep Sea Seals and
Imatra Steel.

Wärtsilä Corporation is listed on the Helsinki Exchanges. The number of shareholders is 25,482, 90% of whom are Finnish.

- ▶ **Breakdown of capitalization: debt & equity^{*)} (MEUR)**



- Total shareholders equity 953.1
- Total liabilities 1 571.5

^{*)} equity incl. convertible subordinated debentures

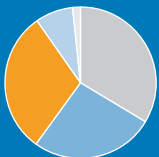
Strategy

- ▶ **Power on Land and at Sea**

Key figures 2002

- ▶ Net sales MEUR 2,519.0
- ▶ Operating profit MEUR 188.9
- ▶ Profit before extraordinary items MEUR 170.4
- ▶ Balance sheet total MEUR 2,685.0
- ▶ Gearing 0.50
- ▶ Personnel at year end 12,459

- ▶ **Net sales by divisions 2002**



- Service 34% (34%)
- Marine 30% (25%)
- Power Plants 26% (32%)
- Imatra Steel 8% (8%)
- Other 2% (1%)

Marine



- ▶ Wärtsilä is the leading supplier of ship machinery, propulsion and manoeuvring solutions for all types of marine vessels and offshore applications.

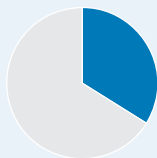
Strategy

- ▶ **The Ship Power Supplier**
Wärtsilä improves the performance and profitability of its customers' businesses by providing reliable and cost-effective total propulsion systems while fully respecting environmental demands.

Key figures 2002

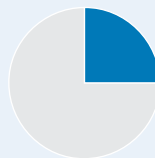
- ▶ Net sales MEUR 763.4
- ▶ Order intake MEUR 506.7
- ▶ Year-end order book MEUR 617.7

- ▶ **Market share of medium- and low-speed main engines**



Medium-speed engines

- Wärtsilä 34 % (37 %)
Orders 6/01-5/02



Low-speed engines

- Wärtsilä 25 % (26 %)
Orders 6/01-5/02

Source: Diesel & Gas Turbine Worldwide

Power Plants



- ▶ Wärtsilä is a leading global provider of power plants for decentralized power generation. Wärtsilä provides power plants for baseload, peaking, and combined heat and power applications. We also supply solutions for gas compression and for oil and gas pumping. The product range comprises gas- and oil-fired power plants with outputs from 1 to 300 MW and biofuelled power plants with outputs from 3 to 25 MW.

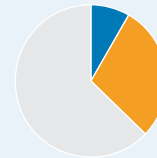
Strategy

- ▶ **Power for a Changing World**
Power solutions for decentralized power generation fast, flexibly and with respect for the environment. The total service and operation concept adds value for the customer at every stage of the plant's lifecycle.

Key figures 2002

- ▶ Net sales MEUR 666.0
- ▶ Order intake MEUR 427.9
- ▶ Year-end order book MEUR 255.2

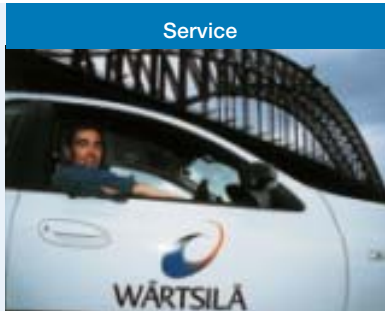
- ▶ **Market share of Wärtsilä power plants**



Wärtsilä 8% (5%)

- Gas turbines 29% (50%)
- Other engine manufacturers 63% (45%)

Engine and gas turbine orders (unit size 1-60 MW) 6/01-5/02



Service

- ▶ Wärtsilä supports its customers throughout the lifecycle of its products by ensuring lifetime efficiency. Wärtsilä's Service business is founded upon the Group's global base of installed engines and power plants. Wärtsilä is close to its customers through subsidiaries in roughly 60 countries.

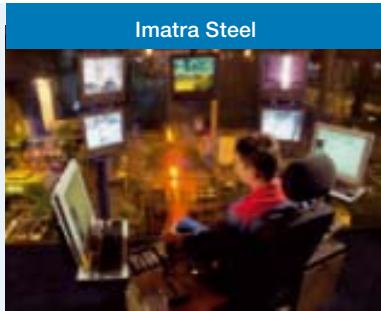
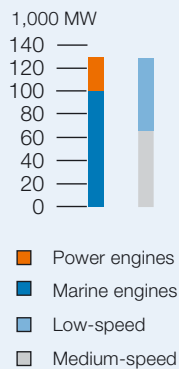
Strategy

- ▶ **The Total Service Provider**
Keeping the customers' investments productive by optimizing their operations throughout the product lifecycle.

Key figures 2002

- ▶ • Net sales MEUR 843.4
- Personnel at year end 5,644
- Long-term service agreements for 9,756 MW
- O&M agreements 2,056 MW

▶ Wärtsilä's engine base



Imatra Steel

- ▶ Imatra Steel is Wärtsilä's special engineering steels company. Imatra Steel produces round, square and flat special steel bars, forged engine and front axle components, leaf springs and tubular stabilizer bars. The company's customers are European automotive and mechanical engineering companies.

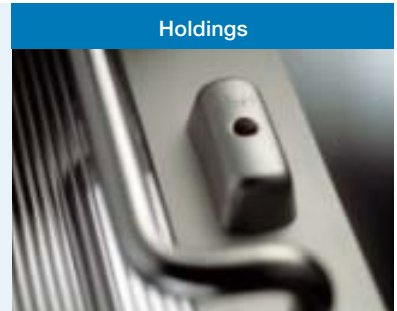
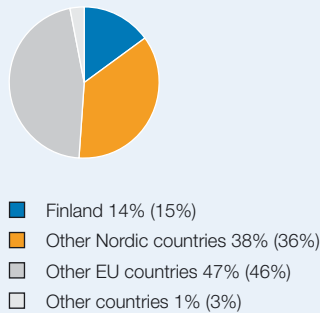
Strategy

- ▶ **A Skilful Niche Player**
Special engineering steels and automotive components

Key figures 2002

- ▶ • Net sales MEUR 200.4
- Operating profit MEUR 3.2
- Profit before extraordinary items MEUR -0.4
- Personnel at year end 1,391

▶ Imatra Steel net sales by market area 2002



Holdings

- ▶ Assa Abloy and Wärtsilä Real Estate are the main holdings.
 - Assa Abloy 7.6%
 - Wärtsilä Real Estate 100%

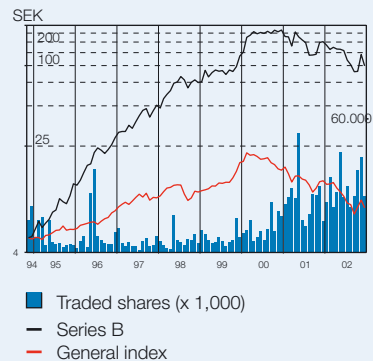
Strategy

- ▶ Holdings create financial resources for developing Wärtsilä's core business, the Power Divisions.

Key figures 2002

- ▶ • Market value of Wärtsilä's holdings on 31 December 2002:
 - Assa Abloy MEUR 302.4
 - Wärtsilä Real Estate, book value MEUR 21.9

▶ Assa Abloy share price development 1998-2002



Report Scope

Wärtsilä's Sustainability Report 2002 is prepared according to the GRI (Global Reporting Initiative) Sustainability Reporting Guidelines 2002, which address economic, environmental and social issues. Wärtsilä has chosen to adopt an incremental approach to developing its sustainability reporting towards wider adoption of the GRI guidelines.

Currently Wärtsilä reports those core indicators which are of most relevance to its operations and stakeholders. Wärtsilä measures the sustainability performance of its products and operations. The product performance section describes the environmental aspects of Wärtsilä's products and the environmentally advanced solutions developed by Wärtsilä. The operational performance section describes Wärtsilä's economic, environmental and social performance. The selected indicators reflect material impacts at the corporate level. This report covers more social and economic information than the previous report published in June 2001.

The GRI contents index on pages 2-3 identifies the location of each element by section and indicator against the GRI guidelines and provides an explanation of any GRI core indicators omitted. The purpose of the index is to enable stakeholders to assess the degree to which Wärtsilä has included the information and indicators contained in the GRI guidelines.

Coverage of the report

This report covers Wärtsilä's main activities: the Power Divisions and Imatra Steel. It does not cover Wärtsilä's holdings and joint ventures.

Wärtsilä Power Divisions comprise the following four businesses: the Marine, Power Plants, Service and Engine divisions. The first three of these generate external net sales; the last is an internal Group function.

The Economic Performance data covers all Group companies unless separately stated. The data on operational, environmental and social performance in Section 11 covers the following companies:

- Wärtsilä companies: Finland including the head office, the Netherlands, Italy, France, Spain, India, the USA, Denmark and Singapore
- Wärtsilä Propulsion companies: the UK, the Netherlands, Norway and Japan
- All units of Imatra Steel Oy Ab.

In addition the social performance in Section 11 covers also the following companies

- Wärtsilä companies: China, Brazil, Switzerland, Sweden, United Kingdom and Operations and Maintenance in Finland.

The environmental data on the Power Divisions and Imatra Steel are presented separately. Not included in the report are network companies which have only sales and service units. Some of these network companies have their own workshops, but their environmental impacts are related mainly to the use of electricity and we consider these to be rather low compared to the reported companies. The reported indicators do not cover the performance of the external supply chain.

Wärtsilä's target is to gather relevant data from all units for the Sustainability Report 2004, to be published in 2005. Wärtsilä publishes its Sustainability Report every second year. However, the sustainability data is gathered annually.

Summary of coverage of operational data

Operational data	% of Group companies	% of personnel	% of product manufacturing
Economics	100	100	100
Environment	35	75	100
Social	45	85	100

The coverage of Wärtsilä's current and forthcoming reports is shown in the following table:

Units	Year of publication	2001	2003 ¹	2005
Power Divisions	Product companies	●	● ²	●
	Network companies: assembly and packing		●	●
	Network companies: sales and service			●
Others	Imatra Steel		●	●

¹The operational data of second-phase companies is reported from 2002.

²The following units have been added to coverage of Product companies: Wärtsilä BioPower, currently part of Wärtsilä Finland Oy, and Wärtsilä Propulsion, which consists of the following Operational Centres of Excellence: Havant in the UK, Rubbestadneset in Norway, Drunen and Heerlen in the Netherlands, Toyama in Japan.

Significant changes in Group structure

Compared to the previous report the following changes have taken place in Wärtsilä's corporate structure which have a material impact on the operational data. Wärtsilä Netherlands, previously a product company, is today considered a network company. The production unit in Zwolle was closed at the end of 2002 and its manufacturing activities moved to Trieste, Italy.

The acquisitions of John Crane-Lips, Sermet and various service companies have broadened Wärtsilä's product portfolio. The new products and services they have added are included in this report in the Product Environmental Performance section.

Report Profile

Data collection

The data on product environmental performance is based on measured test results. Performance data on the environmental and social aspects of sustainability presented in this report has been collected from the Wärtsilä companies using a detailed questionnaire. Economic performance data is mainly based on audited financial accounts.

Wärtsilä has prepared internal reporting guidelines for Group companies. These guidelines include all the definitions and instructions necessary for collecting and reporting the data. The criteria for environmental capital expenditure and operating expenses are defined according to Eurostat instructions.

All the reported companies have nominated individuals responsible for data collection and its accuracy. The management of the companies approve the data before it is reported. The companies report their environmental and social data using Wärtsilä's CR Profile reporting system. The reported data is checked internally before data consolidation.

The content of this report has been reviewed by Wärtsilä's Board of Management and was approved on 23 April 2003.

The completeness, accuracy and consistency of the data has been independently assessed by KPMG. Site audits were carried out at Trieste, Italy, and Imatra, Finland.

Additional information sources

Wärtsilä's Environmental Report 2000 was published in June 2001. The report and other relevant information is available on Wärtsilä's website: www.wartsila.com.

Sustainability Report Project Team

Mr Matti Kleimola; Group Vice President - Technology and Environment

Mr Christian Andersson; Group Vice President - External Relations

Mr Erik Pettersson; Vice President - Production

Mrs Eeva Kainulainen; Vice President - Corporate Communications & IR

Mr Stefan Gros; Vice President - Power Plant Development & Technology

Mr Rolf Vestergren; Vice President - Test and Performance Experts

Mrs Britt-Mari Kullas-Nyman; Manager - Application Technology

Mrs Tuija Lindroos; Publications Manager

Mr Börje Smeds; Quality Manager

Mr Marko Vainikka; Development Manager - Environment

(Contact Person; e-mail: marko.vainikka@wartsila.com)

Definitions:

Network company

A sales and service company, which in some cases may have a service workshop or an assembly/test line.

Product company

A company, which has the functions of Power Divisions: Engine division, Marine, Power Plants and Service.

Structure and Governance

Wärtsilä Corporation adheres to the application guideline on the administration of public listed companies issued by the Central Chamber of Commerce of Finland and the Confederation of Finnish Industry and Employers. Application of this guideline was recommended by the Helsinki Exchanges on 2 October 1997.

Board of Directors

The company's administration and the appropriate organization of its operations is the responsibility of the Board of Directors, which according to the articles of association comprises 5-8 members. The term of office of Board members lasts for one year from their election to the close of the subsequent Annual General Meeting.

The Board elects a chairman and deputy chairman from among its members who serve until the close of the subsequent AGM.

The principles applied by the Board in its regular work are set out in the Rules of Procedure approved by the Board. These also define the main tasks and operating principles to be adopted by the committees which the Board appoints. The committees do not have the authority to make decisions; their purpose is to prepare matters for consideration by the Board at its meetings.

On 12 March 2003 the Annual General Meeting of shareholders decided that the Board would have six members. Mr Göran J. Ehrnrooth, Mr Risto Hautamäki, Mr Jaakko Iloniemi, Mr Antti Lagerroos, Mr Bertel Langenskiöld and Mr Paavo Pitkänen were elected Board members. The Board elected Mr Antti Lagerroos Chairman of the Board, and Göran J. Ehrnrooth Deputy Chairman.

The Board appointed the members of the Audit committee: Antti Lagerroos, Göran J. Ehrnrooth and Paavo Pitkänen.

The Board represents the shareholders. None of the company's management is a member of the Board.

Significant sustainable development issues are reported to the Board of Directors as part of business reporting.

The President and CEO

The company's Board of Directors appoints a President for the Group and, if required, one or more executive vice presidents. The company's president is also its chief executive officer. The company currently has one executive vice president who has also been appointed deputy to the President and CEO.

The Board of Management

The company's Board of Management comprises the President and CEO, the Executive Vice President, the heads of the divisions, the Chief Financial Officer, the Chief Technology Officer and the Group Vice President, legal affairs and personnel. Board of Management members are appointed by the company's Board of Directors, which also approves their remuneration and other terms of employment.

The Board of Management is chaired by the President and CEO. It considers strategic issues, investments, product policy, the Group structure and corporate steering systems, and it oversees the company's operations.

The division heads on the Board of Management are each responsible for the profitability and sales volumes of their respective global businesses, employing the services of the Group's worldwide subsidiaries.

The Corporate Management

The company's Corporate Management includes, in addition to the members of the Board of Management, the directors in charge of corporate functions and the president of Imatra Steel.

Corporate Management meetings are chaired by the President and CEO and their composition varies depending on the issues under consideration. Corporate Management meetings are convened to prepare proposals to the company's Board of Directors, to deal with issues concerning communications, personnel development, quality, information management and other development issues, to handle relations with stakeholders, and to consider issues specific to Imatra Steel.

Division Boards

Each division head is supported by a Division Board. Imatra Steel has its own Board of Directors.

Wärtsilä donated an engine to the Dalian Maritime University for teaching and training purposes. From left: Mikael Mäkinen, Wärtsilä, Wu Zhao Lin, the rector of the university and Jari Vilén, Finnish Minister for Foreign Trade.



Managing Directors of the subsidiaries

The managing directors of the Group's subsidiaries are responsible for ensuring that the local service, sales and manufacturing resources are correctly dimensioned to meet the needs of the divisions; that the subsidiary's personnel development needs are met, that the subsidiary's operations fulfil the requirements stipulated in the Group's quality system; that the subsidiary's human resources are developed appropriately; and that these operations comply with the respective country's legal requirements and with good business practice.

Insiders

Wärtsilä applies the Guidelines for Insiders approved by the Helsinki Exchanges on 28 October 1999. Wärtsilä's permanent insiders comprise the statutory insiders as well as the members of the Board of Management and certain other members of the Corporate Management. Information on the interests and holdings of the company's permanent insiders is available from the SIRE system of the Finnish Central Securities Depository Ltd, Eteläesplanadi 20, FIN-00130 Helsinki, Finland, tel.+358-800-180 500. Information is also available on Wärtsilä's Internet site.

Management incentive schemes

Wärtsilä has two share related incentive schemes for the key personnel of the Wärtsilä Group. In 2001 altogether 1,500,000 warrants were issued entitling holders to subscribe for the same number of Series B shares. The share subscription period began on 1 April 2003 and ends on 31 March 2007. The subscription price is EUR 26.72. The warrant programme covers 74 people.

In 2002 altogether 800,000 were warrants issued allowing subscription of the same number of Wärtsilä Corporation B shares. The warrants were subscribed by 36 key employees. Share subscription will begin provided that the company reaches the minimum profitability target of 4% set by the Board of Directors for 2003. Should this condition be met, the share subscription

period will begin on 1 April 2004 and end on 31 March 2008. The subscription price is EUR 15.92. The amount of any extra dividends that may be distributed will be deducted from the subscription price of both option schemes.

The company also operates a bonus system for senior managers in the parent company, the divisions and the subsidiaries. The bonus is based on the company's earnings per share or division result and cash flow and agreed qualitative personal targets. Approximately 1,500 directors or managers are covered by this bonus scheme.

Shareholders' means of providing recommendations

The Annual General Meeting of shareholders is the main forum for participation by shareholders in the corporate governance of the company and for providing recommendations and guidelines to the Board of Directors. Institutional investors and the largest shareholders regularly meet the top management of the company at information meetings and visits organized for them. Management representatives meet retail investors in Finland at Investment Fairs. Wärtsilä also participates in the road shows organized by the Finnish Foundation for Share Promotion. These road shows and fairs provide retail investors with an opportunity to meet and talk with the top management directly.

Overarching Policies and Management Systems

Wärtsilä Group’s Corporate Manual describes the corporate policies and gives guidelines and instructions regarding the Group’s way of working and decision-making and business control within the corporation.

The manual states that any and all business transactions and other activities conducted by Wärtsilä shall be carried out strictly in compliance with applicable laws and under the requirements of good citizenship in each respective area of jurisdiction where such activities take place. The manual further explicitly states that it is the policy of the corporation to comply with applicable laws and regulations in each country, such as tax, anti-bribery (FCPA, OECD Convention based, etc.) and competition laws.

The policies, instructions and regulations endorsed in the Corporate Manual also apply to human rights and non-discrimination, freedom of association, effective recognition of the right to collective bargaining, bribery and corruption, and the abolition of compulsory labour and child labour. The Corporate Board of Management has established a firm commitment to responsible business conduct and will take action to raise awareness

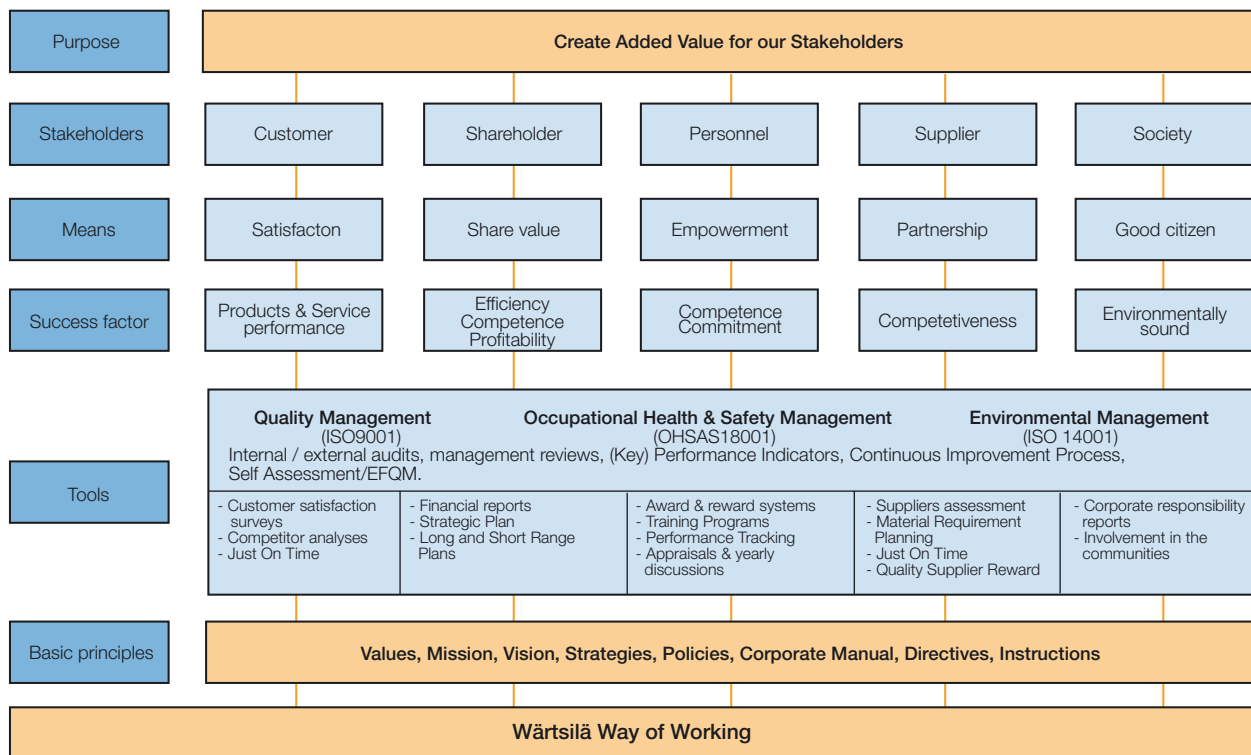
of these issues among the Group’s employees and suppliers.

The corporation also operates Compliance Programmes covering certain of these issues as well as an internal corporate audit system to ensure the availability of reliable information and compliance with its policies, plans and regulations. The corporate social responsibility performance is also monitored through regular management reviews at corporate, division and Board of Management levels within the scope of the Group’s Operative Excellence System.

Wärtsilä Operative Excellence System

Wärtsilä’s Operative Excellence System (OpExS) is intended to create added value for the company’s stakeholders: customers, shareholders, personnel, suppliers and society at large. Wärtsilä OpExS is based on the Corporate Manual, and the policies, directives and strategies approved by corporate management.

Wärtsilä Operative Excellence System



The main principle within the management systems is to continuously improve operational and product performance.



The system itself consists of different kinds of tools, such as management systems covering quality, environmental, and occupational health and safety issues.

The main principle within the management systems is to continuously improve operational and product performance. Each company or business unit sets objectives and targets to improve its performance. In addition separate Key Performance Indicators and targets have been defined for the Power Divisions in order to make improvements at corporate and division level.

Overall responsibility for OpExS lies with Wärtsilä's Board of Management. The Board of Management defines the main strategies and targets and all the corporate-level policies and directives, and it monitors their implementation as well as performance development.

The current status in the implementation of management systems is presented in the following table :

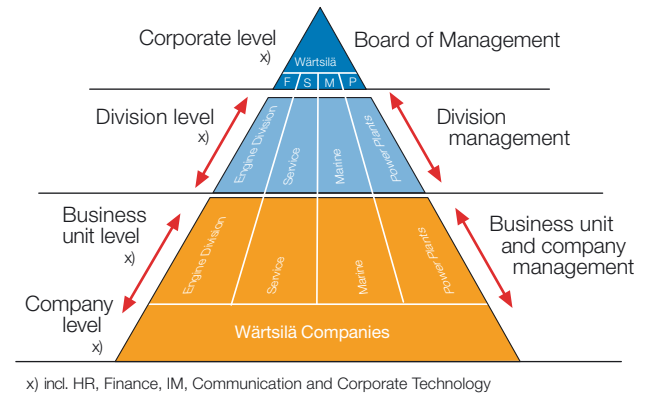
Management system	Environmental ISO 14001	Quality ISO 9000 series
Share of certified Wärtsilä companies (original scope)	65%	93%
New scope including recently acquired companies	42%	81%

In addition 6 Wärtsilä companies have gained OHSAS 18001 certificates.

Our principle is to gain ISO 9001 and ISO 14001 certification for all Wärtsilä companies. The occupational health and safety system based on the OHSAS 18001 standard will also be implemented in the Group companies.

Wärtsilä did not fully reach its original target of certifying its product companies and network companies with workshops according to the ISO 14001 standard by the end of 2001. These companies have nonetheless continued to pursue this aim rigorously and their certification is in progress. In the other Wärtsilä companies work has already started, or is being started, to build up environmental management systems.

The OpExS responsibilities



OpExS responsibilities

The management of Wärtsilä is fully committed to OpExS. Management reviews covering management systems are held at all management levels starting from top management down to the company's business unit management. Wärtsilä management reviews the implementation of the management systems, the functionality of OpExS and the development of performance related to its objectives and targets.

OpExS responsibilities at Wärtsilä are allocated according to line responsibilities. The corporate policies state that all employees are responsible for ensuring that all environmental, quality and occupational health and safety issues are addressed. Each Wärtsilä company has defined responsibilities concerning management systems. The major units have their own environmental, quality and occupational health and safety teams, consisting of representatives from management and the business units. These teams develop operational methods and coordinate their implementation in each business unit.

Environmental, quality and occupational health and safety policies

Wärtsilä's Board of Management (BoM) has approved the following policies concerning the Power Divisions. The table presents the date of approval and persons responsible for the issue in top management.

Policy: Approved by BoM	Quality: 15 February 2002	Environmental: 11 May 1999	Occupational Health and Safety: 19 January 2001
Person responsible	Sven Bertlin, Executive Vice President; Group Vice President, Engine Division	Matti Kleimola, Group Vice President, Technology and Environment	Kari Hietanen, Group Vice President, Legal Affairs and Human Resources

The above-mentioned policies can be found at Wärtsilä's website www.wartsila.com.

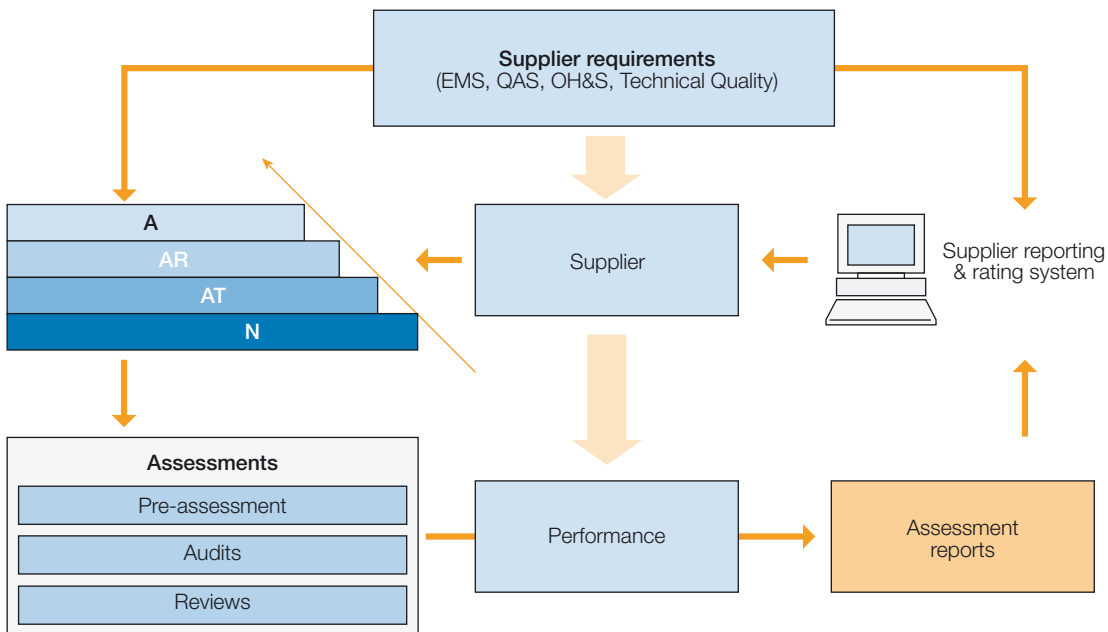
Risk management

Wärtsilä applies an active risk management policy through risk analysis and loss prevention based on the elimination or reduction of risks. The basis for risk management is a systematic, permanent loss prevention work and a continuous effort to enhance the quality of the operations and the products of the Group. Risk management is applied to a wide range of business activities and the tools used in this respect are legal contract reviews and compliance programmes, the OpExS system and internal audits etc.

The Board of Directors and the Board of Management from time to time review the risk profiles, the risk management policy and the relevant insurance coverage. Each Wärtsilä company is responsible for risk management in its own sphere of operation on the basis of directives issued by the Group.

Environmental and social risks are monitored in the same way as other business risks, the main tools being the OpExS guidelines. Also in this respect the risk management is based on a continuous risk assessment and

Supplier assessment system



- A Approved
- AR Approved with remarks, limited volume
- AT Approved for test supply
- N Banned

Vacon Plc was chosen
Wärtsilä's Supplier of the
year 2002.



avoidance of damage, supported by the development of high-quality products and services. Training of the personnel and an active stakeholder dialogue help to identify and reduce environmental and social risks.

Product responsibility

Research and Development in Wärtsilä focuses on reducing the environmental impact of the company's products. Environmentally sound solutions have a major impact on the environmental performance of Wärtsilä's customers due to the long operational lifetime of the products. Wärtsilä supports its customers throughout the operational lifetime by providing environmentally sound solutions also for products which are already in use.

The Service division has introduced several products that improve the product performance of its customers from the environmental point of view. Wärtsilä's service portfolio includes services such as reconditioning of engines and components and modernization of complete installations.

All the Wärtsilä engines are designed to meet the safety requirements of the EC Machinery Directive, SOLAS and other relevant directives. All the Wärtsilä propulsion products are designed to meet the safety requirements of SOLAS and main class requirements, if applicable. All the new Wärtsilä boiler plants are designed to meet the safety requirements of the EC Machine Directive and other

relevant directives like PED, ASME, CE, depending on the national regulations of each country. All the new engine types and boiler plants must comply with the international requirements. Before releasing a new product on the market type approval is obtained from classification societies. Wärtsilä products are delivered with comprehensive user manuals.

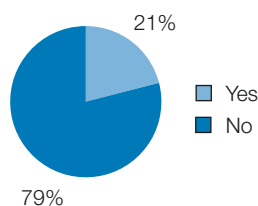
Supply chain management

In recent years Wärtsilä has placed heavier focus on its core competence and this has increased the significance of supply chain management for the company.

Wärtsilä monitors the performance of its suppliers continuously. An annual audit plan is prepared by the sourcing organization based on supplier performance. In 2002, 48 supplier audits were performed in addition to other inspections.

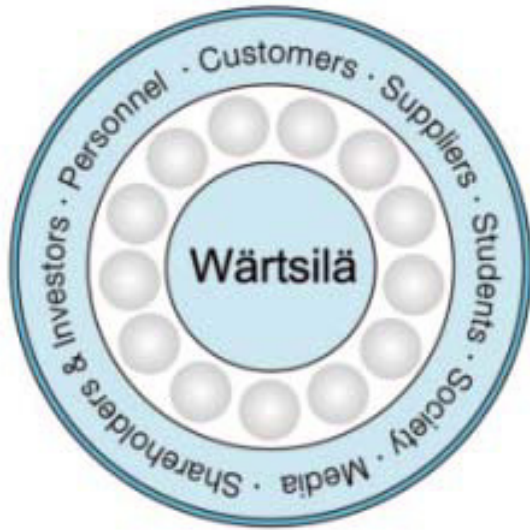
Wärtsilä has updated its requirements for its main suppliers and defined a new harmonized procedure for supplier assessment which will be implemented during 2003. The new requirements consist of General, Quality, Technical Quality, Environmental and Occupational Health and Safety issues. All the main suppliers must comply with Wärtsilä's requirements in order to gain Approved Supplier status.

Certified environmental management systems among 150 major suppliers



Stakeholder Engagement

Wärtsilä and its stakeholders



Wärtsilä's divisions are the interface to its customers. Customer decisions are increasingly influenced by the environmental impacts of the equipment Wärtsilä supplies.

Wärtsilä's subsidiaries focus on production and local sales and service. Their main stakeholders are their local customers, authorities, residents and neighbours, and the local media. The subsidiaries are responsible for ensuring that local environmental and social issues related to production are properly managed.

Environmental and occupational health and safety targets can be made part of everyday life only if every employee is committed to these targets. Training is one important way of ensuring that the company's strategy, including those issues, is internalized and for this reason the report also forms a part of our personnel's competence management.

Co-operation with employees on issues of importance to the entire Group takes place through the company's European Works Council. This forum brings together the personnel representatives of all the main European countries.

Identifying stakeholder requirements

In order to improve communication and serve stakeholders in the optimal way, Wärtsilä co-operates with its stakeholders, conducts its own special surveys and participates in various external surveys.

Feedback from stakeholders and the results of the surveys provide guidance for improvements in business processes. This

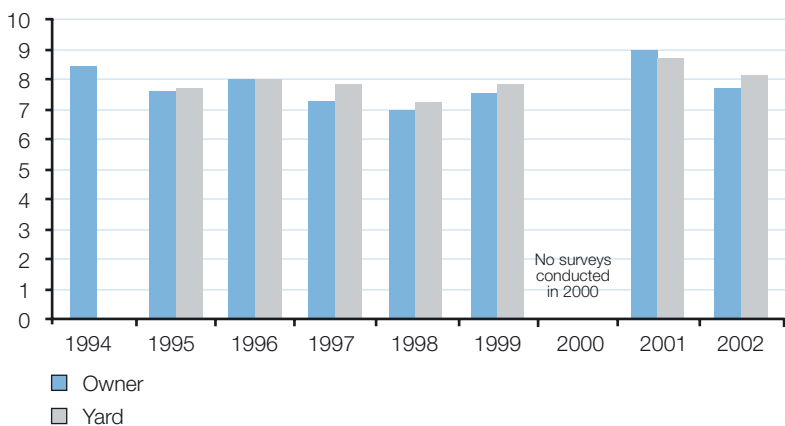
valuable information has been taken into consideration in the business and in the contents of this report.

Customers

Wärtsilä is continuously developing and enhancing long-term relationships with customers in the marine and power markets. Wärtsilä offers support throughout the design, commissioning and operation of its products according to each customer's specific needs and external requirements.

Customer feedback is considered important and used in several ways. Customer information and feedback is collected through several channels such as daily feedback, reports, claims and surveys. Wärtsilä maintains close co-operation with customers in order to develop new technologies and concepts. The latest step in this co-

Total customer satisfaction index 1994-2002, Marine





Marine division held a Wärtsilä 50DF customer event in Vaasa on January 2003.

operation is a project to develop a new low-speed marine diesel engine together with Mitsubishi Heavy Industry. The new engine will be designed to meet the market need for high efficiency, compactness and environmental requirements.

Wärtsilä continuously monitors customer satisfaction through Customer Satisfaction Surveys and phone interviews performed by an external agency. Customer Satisfaction Surveys are performed regularly according to a three-year plan prepared by the Customer Satisfaction Steering Committee. This plan, updated annually, is coordinated between Wärtsilä's various geographical areas based on the location of its customers. The Customer Satisfaction Steering Committee ensures that the surveys are conducted, that corrective action is taken and that the results are communicated both internally and externally. The content of phone interviews is limited compared to the Customer Satisfaction Surveys, but the phone interviews provide wider customer coverage.

Wärtsilä has developed a special Customer Feedback Handling System, the purpose of which is to enable customers to communicate any concerns, complaints and claims to Wärtsilä concerning our products, services and performance. The system ensures that Wärtsilä handles the feedback and replies to the customer in each instance. If the feedback requires any action, this action is agreed together with the customer. A pilot version of the system was launched at the end of 2002. Internal training is underway and the Group-level roll-out of the system will be completed by the end of 2003.

Wärtsilä also arranges Customer Days for its customers all over the world. Customer Days provide both Wärtsilä and its customers with a vital channel for discussing various topics and evaluating future business needs.

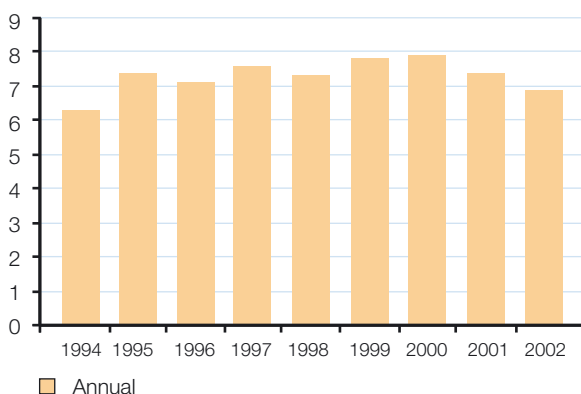
Shareholders and investors

Wärtsilä discloses information on its goals, financial position and business operations to enable stakeholders to form a true and fair view of the company. Wärtsilä has published its communications and IR policy in the annual report.

Wärtsilä regularly informs and meets investors and financial analysts. Financial analysts and major investors receive all stock exchange releases and press releases. The company publishes its financial results four times a year and at the same time holds a conference and teleconference for analysts to discuss the company's performance, business and targets. Road Shows to meet investors are organized in London, Stockholm, Edinburgh, Dublin and New York. Approximately 65 one-on-one meetings and eight group meetings are held a year. Once a year a Capital Markets Day is organized for financial analysts, financiers and investors during which Wärtsilä's top management discusses key strategic issues. All communication material is available on the Internet.

Retail investors are met at Investment Fairs. To identify the information needs of investors and financial analysts Wärtsilä participates in the Investor Relations Barometer, which is conducted every year in Finland and London. This barometer provides an opportunity to benchmark the company against its peers. The same barometer also covers financial journalists' perceptions of the quality and appropriateness of the information Wärtsilä provides.

Total customer satisfaction index 1994-2002, Power Plants



The media

The media is an important stakeholder group of Wärtsilä. Most stakeholders get their information about the company through them.

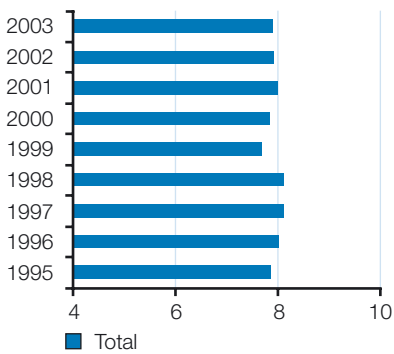
Wärtsilä focuses on the Finnish media, the international financial media and the Marine and Energy trade media. The media are informed through stock exchange releases, press releases, special articles, press conferences or other events and visits to Wärtsilä units.

Wärtsilä publishes approximately 50 press releases a year. Some are general press releases about new orders or other news while the rest are intended for the trade media and therefore contain detailed information on marine or power plant applications or service.

Press conferences are organized to coincide with publication of the company's annual results. The media are also invited to join the teleconferences held four times a year for analysts. Press conferences are held for the trade media in conjunction with large fairs and events. Visits to Wärtsilä factories or sites are organized regularly to give the media a broader picture of the business.

To improve the way it serves the media Wärtsilä participates in the Investor Relations Barometer described above. Special Internet information surveys are also conducted.

Overall grade for Wärtsilä's investor relations
Perceptions by investors, analysts and journalists



Source: Investor Relations Barometer; Införviestintä Oy

Personnel

Every second year Wärtsilä conducts a Group-wide Performance Tracking study to enhance the company culture and identify bottlenecks in communications. These surveys provide guidance for improvements.

Special internal communication measures were taken in 2002 to enhance the corporate culture and values and to improve understanding of the strategy throughout the company. The CEO discussed these issues in training programmes and in his regular teleconference meetings with global management in the Group. Corporate value discussions were in addition conducted by line management in all the divisions. The strategy has also been

discussed between the management and employees in the European Works Council. Corporate Communication prepared tools for internal discussions.

2002 was the first full year of operation of the Wärtsilä Academy. The junior management training programme Lead, one of the Academy's responsibilities, was further developed based on extensive experience from the programme's execution in Finland and India. New Lead programmes were conducted in many countries with a total of close to 200 participants.

Three mid-career Reach programmes were held for altogether 80 participants. The sixth top management Lausanne Leadership programme was delivered in cooperation with IMD and other enterprises. IMD is a university specializing in international executive training. Wärtsilä had 12 participants in the programme.

As a new learning platform, the Wärtsilä Academy offers access to world-class executive training through the IMD weekly web casts. Very favourable feedback from an internal audience of more than 100 attendees is paving the way for increased use of e-learning in the future.

Innovativeness is highly respected in the company. Wärtsilä encourages its employees to be innovative by granting annually Technology Award for individuals or teams. The criteria include innovativeness, positive environmental impact, image strengthening in technological leadership, product/process improvement and cost reduction possibility.

The annual discussion process, one of the cornerstones of Wärtsilä's performance management, was further developed and redesigned in autumn 2002 to ensure full use in the organization. These discussions form the primary tool for cascading Group goals and targets down to the individual and for identifying the competences needed to achieve them.

The goal of the Global HR project initiated in 2001 is to establish a global solution for efficiently managing human resources throughout the Group. The system will give instant and up-to-date information on Group employees, jobs and competences, and will also serve as an effective tool for training and travel management. The project blueprint was completed in spring 2002 and implemented in the form of a pilot project in Wärtsilä Italy in the autumn. The roll-out to other Group companies has started and will continue to mid-2004.

Students

Regular and close contacts with technical and business universities and schools are important with a view to guaranteeing highly qualified personnel in the future.

Wärtsilä co-operates with universities by offering students the opportunity to write their master's theses or diplomas on issues relevant to the company. Wärtsilä also provides training opportunities for students; in Finland approximately 400 students work as trainees mainly



during the summer vacations. Wärtsilä regularly participates in recruitment fairs and seminars organized by student organizations and sponsors their activities.

Students' perceptions and their need for information are assessed through the 'Best Employer' survey, which is conducted among technical and business students in Finland by the Finnish technology and business affairs magazine 'Tekniikka ja Talous'. This survey provides information on students' views concerning salaries and career expectations as well as general perceptions about the companies as employers. In 2002 Wärtsilä was ranked 31st in this survey (33) as a potential employer in Finland.

Suppliers

Wärtsilä maintains an active and open dialogue with its suppliers mainly through the procurement department and supported by relevant divisional organizations. In many cases suppliers' processes and products are developed together with Wärtsilä. The company also chooses a 'Supplier of the Year' from among its suppliers each year. Vacon Plc was chosen as Supplier of the Year in 2002.

Wärtsilä regularly organizes Supplier Days in various locations. In 2002 the Supplier Day was arranged in Trieste, Italy, for the Dutch suppliers who previously delivered components to the product factory in Zwolle, the Netherlands. More than 50 Dutch suppliers were invited to Trieste to get to know the activities of the product factory and to exchange views on any issues related to Wärtsilä's relationships with its suppliers.

The Finnish Association of Logistics (LOGY) chose Wärtsilä as the Purchaser of the Year in 2002. The award was presented to Wärtsilä on 18 September 2002 during the opening ceremony of the Industrial Subcontracting Trade Fair 2002 at the Tampere Exhibition Centre. Summarizing its reasons for making the award, the Finnish Association of Logistics states that Wärtsilä makes excellent use of its Operative Excellence System (OpExS).

One area targeted by OpExS is the company's suppliers. OpExS covers the process of choosing suppliers, planning of material requirements and scheduling of deliveries. Wärtsilä offers its suppliers partnership, which helps to strengthen the competitiveness of both parties.

Wärtsilä also applies partnership thinking in its research and product development activities, working closely with universities and key suppliers. Universities are expected to provide not only basic research but also a vision for new technologies and processes. Suppliers of components and services are integrated into the OpExS quality and environmental management systems.

Society relations

With a view to acting as a good citizen wherever active, the policy of the Group is to promote openness and to create a good dialogue with local stakeholders.

During the past year this has taken the form of 'open doors' events at several factories and through support for community development, arts and sport. A Childrens' Hour campaign was arranged with the International Youth Foundation, in which a large number of employees participated by donating their salary for one hour to different projects to support young people, matched by a similar donation made by Wärtsilä Corporation.

Wärtsilä and its neighbours

Most Wärtsilä factories are located in towns and cities close to residential areas. Information about our operations and their impact on the local environment and people is produced regularly. Some of the product companies regularly organize open house events for local inhabitants.

Co-operation with the authorities

Wärtsilä maintains constructive co-operation with the relevant authorities on environmental and occupational health and safety issues. At the local level, Wärtsilä companies co-operate with their own local regulatory authorities. Open communication with local authorities has ensured that the authorities are well aware of our operations and current environmental and occupational health and safety performance.

Participation in the activities of industrial and international organizations

Wärtsilä is an active member of the working groups of the Confederation of Finnish Industries and Employers, the Chamber of Commerce and the Confederation of the Metal and Engineering Industries in Finland.

Wärtsilä also participates in the work of international organizations like the European Association of Internal Combustion Engine Manufacturers (Euromot), the Conference Board, the International Maritime Organization (IMO), the European Committee for Standardization (CEN), the International Organization for Standardization (ISO), the International Council on Combustion Engines (CIMAC), the International Institute for Management Development (IMD) and the European Foundation for Quality Management (EFQM).

The World Bank environmental guidelines set the trends in many areas of the world where specific regulations for power plants based on reciprocating engines may not yet exist. Wärtsilä reviews these guidelines annually and informs the World Bank about the development of new environmental abatement technologies. Wärtsilä also participates in the following associations dealing with power plant performance and emissions: Cogen Europe, VDMA in Germany and SCSMI in France. Contact with UNECE is organized through ministries of the environment.

Wärtsilä companies take part in the work of industrial and business organizations in their respective areas.

Voluntary agreements

Wärtsilä is committed to the following voluntary agreements:

- Wärtsilä Finland Oy signed the Voluntary Agreement to Promote Systematic Use of Energy in 1998. Since then Wärtsilä Finland Oy has made an Energy Analysis of its premises in order to increase the efficiency of energy utilization.
- Imatra Steel Oy, Imatra, signed the Voluntary agreement to Promote Systematic Use of energy in 1998.
- Wärtsilä Nederland B.V. is committed to the development programmes of the Federation of Metal and Electrical Companies in the Netherlands. The federation sets objectives for example for energy utilization, VOC and waste reduction.
- Wärtsilä Propulsion Nederland B.V. is committed to reducing energy consumption and packing material consumption under separate agreements with the government.
- Wärtsilä North America Inc. signed the Agreement to Voluntarily Participate in the Customs – Trade Partnership Against Terrorism (C-TPAT) on 2 January 2003.

The Viking Energy offshore supply vessel is powered by Wärtsilä 6L32DF dual fuel engines.



Product Environmental Performance

Wärtsilä's strategy is to develop and produce environmentally advanced solutions and services for its customers that fulfil all their vital requirements. For this reason Wärtsilä has long focused the thrust of its R&D activities on minimizing environmental impacts.

Wärtsilä sets high priority on developing systems and services that offer high efficiency with low emissions. The operational lifetime of Wärtsilä's products is relatively long. Therefore every effort made to reduce the environmental impact of Wärtsilä's products benefits both our customers and especially the environment.

In its first Environmental Report published in 2001 Wärtsilä presented the environmental targets related to its products. The first target was to raise the volume of Wärtsilä's gas power plant sales to half of its total power plant business, while the second was to provide an environmental advanced product portfolio by the end of 2003.

Wärtsilä's Board of Management reviewed and approved a revised environmental strategy and targets in October 2002. Management decided to set even more challenging and concrete targets for each division:

Wärtsilä's targets by the end of 2005 are to:

- Raise the volume of its gas and biopower plant sales to 1000 MW.
- Raise the volume of O&M agreements to cover 20% of total new installations.
- Provide a comprehensive gas engine portfolio, for both diesel-electric and main engine installations
- Be able to offer propulsion systems with 10% higher total efficiency than is standard today.
- Develop a fuel cell solution prototype with ultra-low emissions and provide the first engines able to run on biofuel.

Wärtsilä believes that gas and biopower plants will become more attractive alternatives for power generation. Wärtsilä develops and supplies gas and biopower plants to meet the requirements of customers today and in the future. The environmental impact of plants using gas or biofuels is in most cases significantly lower compared to plants running on oils.

Operation and maintenance (O&M) agreements benefit both customers and the environment. The customer can focus on his core business while Wärtsilä takes care of the operation and maintenance of the plant. Wärtsilä has the knowledge to operate and maintain the

plant in a way which ensures the designed operational and environmental performance of the plant.

Wärtsilä has received the first marine orders for its dual-fuel (DF) engines. One is for two offshore supply vessels due to enter service during 2003. Another, to be delivered in 2004, is for installation in an LNG carrier. DF engines utilize the boil-off from the vessel's cargo of liquefied natural gas to produce ship power with high efficiency and low emissions. Wärtsilä's target is thus to provide a comprehensive gas engine portfolio, for both diesel-electric and main engine installations.

As a Ship Power Supplier, Wärtsilä has identified considerable potential for reducing the environmental impact of ships and other marine vessels. Wärtsilä's aim is to develop a propulsion system with 10% higher total efficiency that is the standard today. This can be achieved by designing and optimizing the propulsion systems used in new vessels. Examples of how propulsion efficiency can be improved include the use of contra-rotating propellers or an 'efficiency rudder'. Other theoretical ideas also exist for more efficient propulsion configuration; these ideas have a lot of potential but still await development.

For at least two decades fossil fuels such as oil, natural gas and coal will be the most significant fuels in power generation and the use of natural gas will grow. Wärtsilä believes, however, that alternative fuels like hydrogen and biofuels will become more important in power generation for environmental reasons and owing to the decreasing availability of fossil fuels. Wärtsilä intends to be ready to meet its customers' future requirements by developing fuel cell technology and engines able to operate on environmentally sound biofuels.

Investment in Research and Development

A major part of Wärtsilä's R&D focuses reducing the environmental impacts of its products.

Wärtsilä's R&D expenses

EUR million	1998	1999	2000	2001	2002
R&D expenses	87	87	81	82	88
% of net sales	3.3	3.2	3.0	3.5	3.5



International legislation and initiatives

In Wärtsilä's business, environmental pollution is regulated at the international level mainly by the IMO (International Maritime Organization) and the World Bank. Incremental port charges are also levied at the national level to reduce emissions by shipping.

Wärtsilä's engines fall well below existing environmental restrictions but the company's goal is to reduce emissions still further using new technology. Wärtsilä's environmentally sound product range gives it a clear competitive edge in markets where environmental issues are receiving increasingly high priority.

The enforcement of the Kyoto Protocol will have a significant impact on the power generation business. Wärtsilä supplies decentralized solutions for power generation that provide high efficiency with relatively low carbon dioxide emissions. The modularity of Wärtsilä's solutions enables our customers to optimize the plant size and add additional power whenever needed. Power plants using biofuels offer customers an alternative that generates no additional greenhouse gases into the atmosphere.

The environmental impacts of power generation can also be reduced by promoting combined heat and power (CHP) generation. In CHP generation the utilization of fuel energy is highly efficient since much of the residual heat from the combustion process is also recovered and used; this conserves global fuel resources and reduces

total emissions. The Commission of the European Union released a proposal for a directive in 2002, the purpose of which is to promote CHP generation in the area of the European Union. Wärtsilä provides CHP solutions covering applications such as district heating, district cooling, steam production, hot water generation, and heat for drying processes.

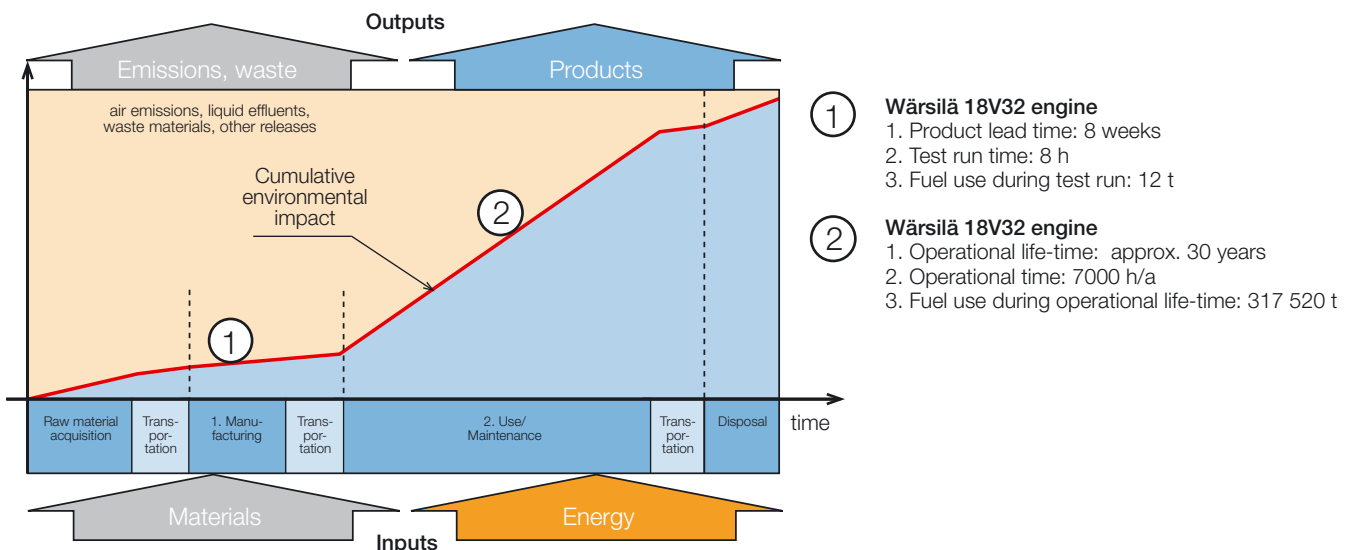
Wärtsilä's products

Wärtsilä's core business is its Power Divisions: these are Marine, Power Plants and Service. Wärtsilä supplies ship machinery, propulsion and manoeuvring solutions for all types of marine vessels and offshore applications. Wärtsilä supplies power plants for decentralized power generation. Its gas- and oil-fired plants range in output from 1 to 300 MW, and its biopower plants from 3 to 25 MW. Wärtsilä provides a comprehensive range of maintenance, repair and operations services to its marine and power plant customers, enabling them to optimize their return on investment.

Imatra Steel provides special engineering steels and automotive components.

Product environmental performance is divided between Marine applications, Power Plants applications, Service and Steel Products. Each section describes the environmental aspects of the products in detail. As the following example shows, most of a product's environmental impact results from its use.

The importance of lifecycle thinking (an example)





Marine applications

The Ship Power Supplier describes Wärtsilä's long-term commitment to providing the marine market with reliable, cost-effective and environmentally sound solutions.

The Ship Power Supplier concept is founded on the need expressed by shipbuilders and shipowners to have the optimal machinery, propulsion and manoeuvring solution installed in their ships in the most competitive manner. The reliability and productivity of the vessels are further ensured by lifetime service support.

Wärtsilä's solutions are customized to specific ship design and operational requirements to ensure maximum efficiency, reliability and environmental performance over the entire lifecycle of the installation.

Wärtsilä's comprehensive product portfolio comprises a wide range of products from engines, via the gearbox, to the ship's propeller and control systems. The product range covers all types of commercial vessel, including containerships, bulk carriers, tankers, ferries, RoRo vessels, cruise ships, car carriers and reefers as well as the specialized marine markets of naval ships, dredgers, tugs, offshore vessels and fishing craft.

Wärtsilä offers main and auxiliary engines with unit outputs from 520 kW to 80,080 kW, generating sets, reduction gears, propulsors, efficiency rudders, control systems, seals and bearings.

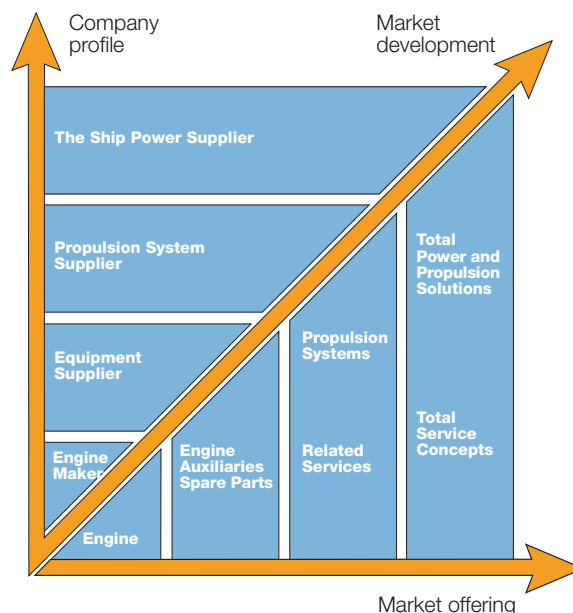
The brand names in Wärtsilä's marine product portfolio are: WÄRTSILÄ®, SULZER®, LIPS®, Deep Sea Seals and JMT.

Environmental aspects of propulsion packages

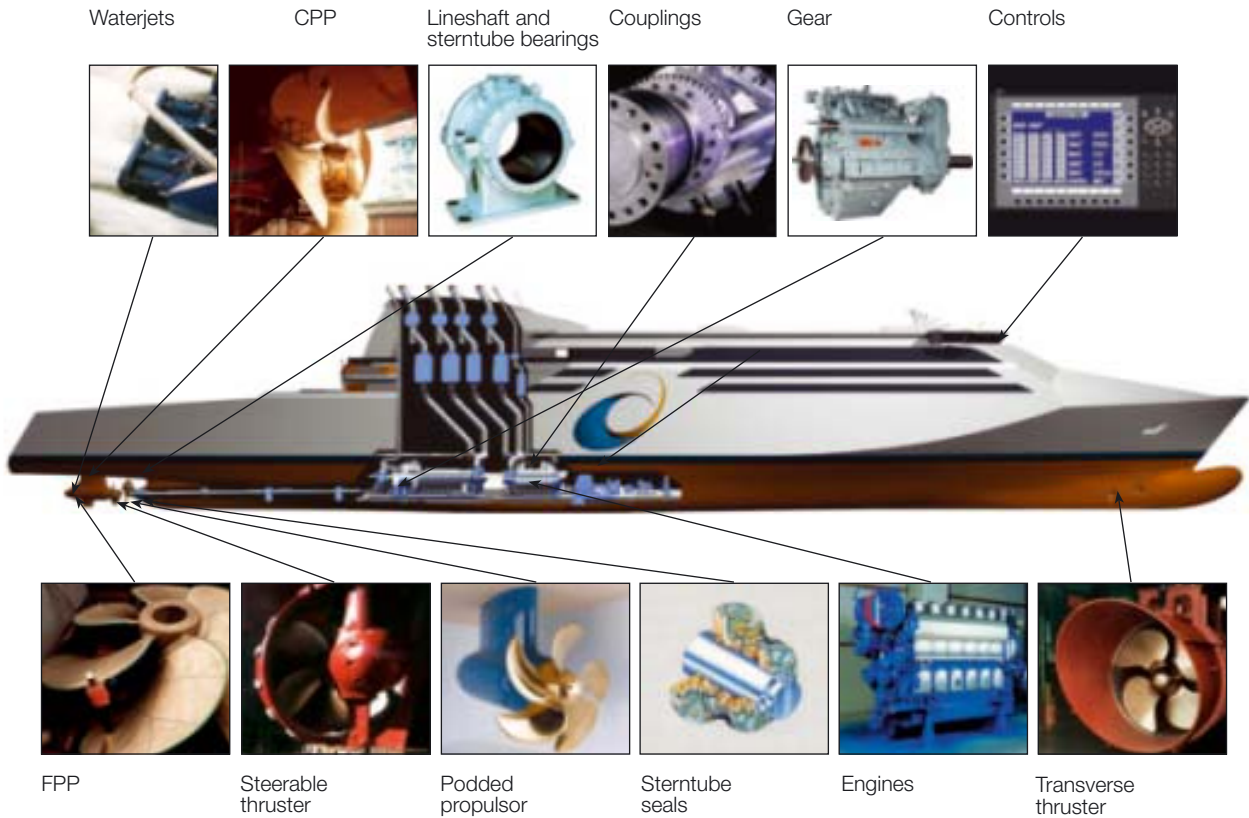
By environmental aspects we refer to those elements of practices, products and services that have an effect on the environment. Environmental impacts can be either positive or negative.

The environmental aspects of a product are mainly related to its use. Wärtsilä engines produce mechanical and thermal energy. The use of fuels and lubricants in engines results in different types of exhaust emissions and

From an engine manufacturer to The Ship Power Supplier



Wärtsilä Marine products



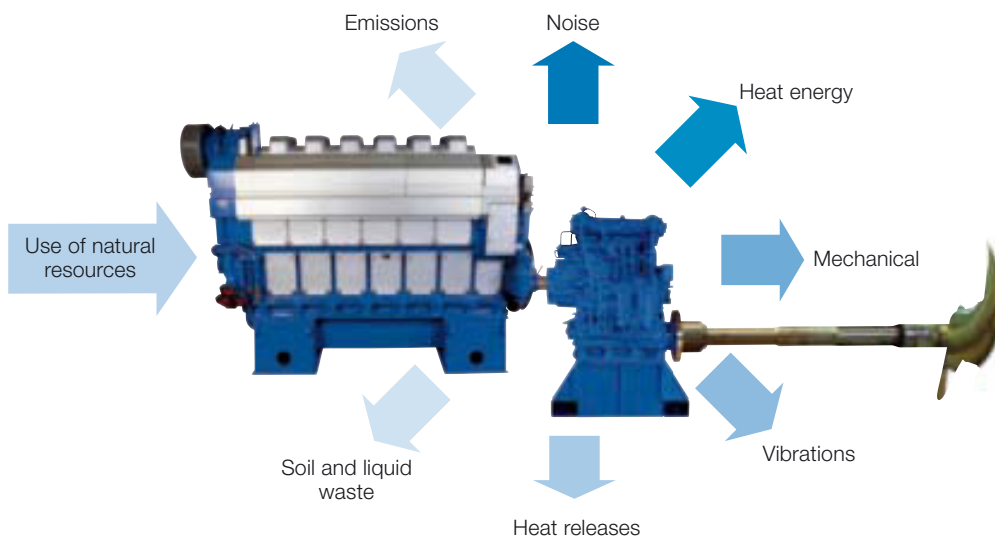
waste. Exhaust gases and engine cooling produce waste heat into the air and water. Part of the thermal energy can be used to produce evaporated water or for other purposes. Engine operation also causes noise emissions.

Wärtsilä is continuously developing environmentally sound solutions for marine vessels and offshore installations. The EnviroEngine technologies, combined with efficient and reliable gears and propellers, enable effective emissions control without compromising overall fuel economy.

Propulsion efficiency is related to the power needed from the engine and thus to the fuel oil consumption and its environmental impact. The 'efficiency rudder'

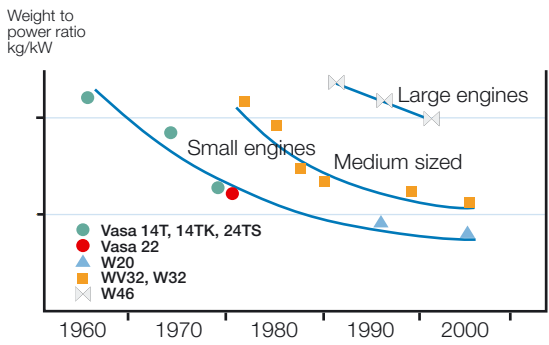
(see page 35), for instance, provides higher propulsion efficiency than conventional rudders, thus conserving engine power and fuel.

Any oil loss to the environment from the ship's sealing system is unacceptable – Wärtsilä's CoastGuard EnviroSeal pollution-free sterntube sealing system offers an environmentally sound alternative and is available in different designs. The CoastGuard sternseal system is a non-polluting option designed in particular for cruise vessels, bulk carriers and RoRo vessels. Similarly the Airguard 3AS antipollution sterntube seal provides an environmentally sound option by preventing the spilling of lube oil from the seal.



Wärtsilä medium-speed diesel engines

Weight of power ratio for 6 cylinder in-line engines



MATERIALS

Engines

Wärtsilä engines have a very long lifetime. The first Wärtsilä Vasa 32 engines were delivered in 1978. In the years since then more than 4,500 such engines have been delivered and almost all of these are still in operation. Older engines are often modernized and modified for better performance. Even after they are ‘scrapped’, the components of the engines are used as spare parts for other engines.

The lifetime of a Wärtsilä diesel or gas engine is normally well over 25 years. During a normal lifetime the engine is run for between 100,000 and 200,000 operating hours. Components like valves, piston rings and bearings are replaced approximately every third year and major overhauls take place two or three times during a lifetime. A major overhaul consists of renewing the pistons, cylinder heads, liners, connecting rods and turbocharger rotor. Old parts are either scrapped or reconditioned depending on their condition. Since scrapped parts consist of various iron or steel alloys, they are reused in the manufacture of new metal products, often with lower quality requirements.

The engine mainly consists of metals, which are fully recyclable. The three main materials are iron 90.8%-w, aluminium 2.7%-w and carbon 2.2%-w.

Materials of propulsion products

All Wärtsilä Propulsion products are made from durable materials. The systems are designed to last the lifetime of the ship, which can be as long as 30 years. Most materials are metals, which are recyclable. Non-ferrous material like bronze is a copper-nickel-aluminium alloy. Scrap material and replaced bronze propellers are used for propeller castings, which reduces the impact on the environment.

Wärtsilä Propulsion systems have the minimum number of wear parts and these are easily replaced. Oil or alternatively environmentally sound products are generally used.

The sealing solutions are optimized to reduce the risk of pollution and the propulsion systems themselves are designed for minimum environmental pollution.

Materials of seals products

Seals are normally manufactured from a centrifugal cast or sand cast material. Most components in a seal are expected to last the lifetime of the ship, and the metal components can be recycled by melting down.

ENERGY

Fuels

Wärtsilä engines are developed to run on very heavy residual fuels with viscosities up to 730 cSt at 50 °C. Wärtsilä engines can also run on crude oil, and on very light distillates such as gas oil and marine diesel oil (MDO).

The trend towards more environmentally sound solutions supports the introduction of liquefied natural gas (LNG) as bunker fuel on ships, especially on LNG carriers and in offshore installations. For these applications: Wärtsilä has developed two kinds of gas engines the gas-diesel (GD) and the dual-fuel engine (DF), both being able to run on either gas or liquid fuel.

The gas-diesel engine is a diesel engine that operates on high-pressure gas (350 bar). It is suitable for installations where there is high-pressure gas available, and offers lower nitrogen oxide (NO_x) emissions than a diesel engine running on heavy fuel.

The dual-fuel engine gives the highest thermal efficiency of any of today’s diesel engines, which means that its carbon dioxide (CO₂) emissions are very low. The level of NO_x emissions is also extremely low, below 2 g/kWh. Combustion is very clean, likewise, and particle emissions are low. This makes the DF engine the most environmentally sound alternative for installations where natural gas is available. The output range for the DF is 2-17 MW, which makes it suitable for many different applications.

The large reserves of natural gas in the world offer great potential for increased usage of gas engines while environmental aspects favour the use of gas over other fossil fuels.

Energy efficiency

Most of the energy produced onboard a ship is used for propulsion power, but a substantial amount is also used as auxiliary power for lighting, pumping and other services like air compression. In both cases high energy efficiency is essential for maximum utilization of the ship’s fuel resources and for minimizing costs and exhaust gas emissions.

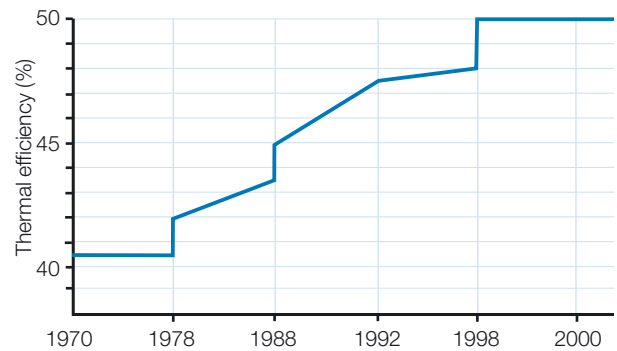
High energy efficiency is the result of efficient and complete combustion. This also minimizes emissions of unburned compounds such as carbon monoxide, hydrocarbons and particulates, the latter being typically evident as black smoke.

Reciprocating engines have the highest energy conversion rate to mechanical output among simple-cycle prime movers, i.e. the lowest fuel consumption and therefore the lowest specific CO₂ and sulphur dioxide (SO₂) emissions for a given fuel quality. Typical energy efficiencies for simple-cycle applications are 40-49%, where smaller units have lower efficiency and large 2-stroke engines have the highest efficiency. Reciprocating internal combustion engines are highly efficient over a broad load range. This is an essential advantage in ships, which typically operate over a load range of 30-100%.

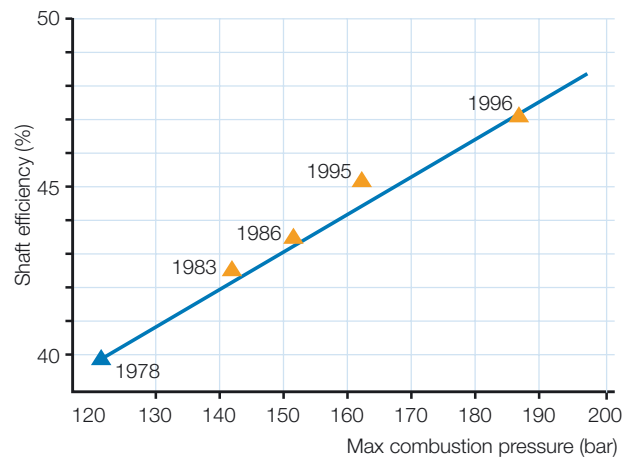
In recent decades the energy efficiencies of Wärtsilä engines have been increased substantially from about 40% two decades ago to a current level of about 49%. This trend reflects both better engine performances and bigger engine sizes. Engine efficiencies have been raised mainly as a result of higher firing pressures, higher compression ratios, shorter fuel injection duration, optimized valve timings and improved combustion processes.

The development of efficiency in Wärtsilä's products has a significant impact on the environment from the lifecycle point of view, since the operative life of a reciprocating internal combustion engine is normally between 25 and 50 years.

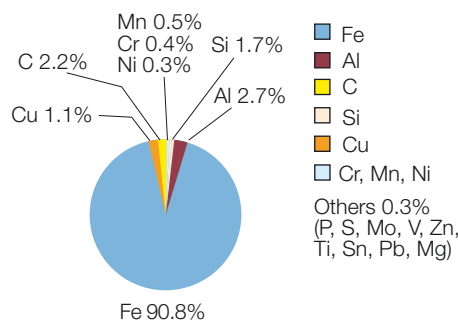
Thermal efficiency development of Wärtsilä engines



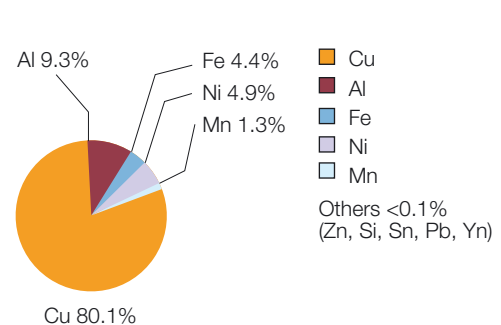
Shaft efficiency of the Wärtsilä 32 engine



Material breakdown of engine



Material breakdown of propulsion products



Desing of propulsion systems

For propellers in general the aim must be the highest possible level of propeller efficiency while keeping cavitation as low as possible to achieve more favourable vibration and noise characteristics. This leads to conflicting conditions: a large blade area ratio is needed for lower cavitation whereas obtaining high propeller efficiency requires the reverse.

Wärtsilä has developed blade sections that combine large cavitation-free operation with good structural characteristics and low drag properties. Application of these features results in a design with optimum efficiency. The propeller design system developed and used by Wärtsilä consists of a series of interactive design and analysis modules as shown in the graph.

Each ship has its own dedicated design propulsion system which guarantees the best operational performance. The design criteria used in Wärtsilä’s propeller design system consist of information on the ship type, the mission profile of the ship and possible limitations regarding propeller diameter, efficiency, ship speed, cavitation behaviour and propeller-generated pressure pulses on the ship’s hull. This ensures that each Lips propeller minimizes environmental impact.

Propulsive efficiency

The total propulsive efficiency of a propeller is determined on the one hand by the open water efficiency of the propeller and, on the other, by the interaction between the hull and the propeller. Hence an increase in propulsive efficiency can be obtained when either the open water efficiency of the propeller or the hull efficiency is increased, or both.

Propeller efficiency has an upper limit, which is the ideal propeller efficiency based on theoretical considerations. In practice the open water propeller efficiency is always lower than the ideal efficiency due to friction and axial and rotational losses. A larger propeller diameter gives a higher ideal efficiency and therefore increasing the propeller diameter will obtain a better open water efficiency.

The propulsive efficiency of a moderately loaded propulsor (a propeller or similar propulsive device such as a waterjet or steerable thruster) is typically 62%. The losses related to this efficiency are:

- Axial kinetic energy losses 20%
- Rotational kinetic energy losses 8%
- Frictional losses 10%

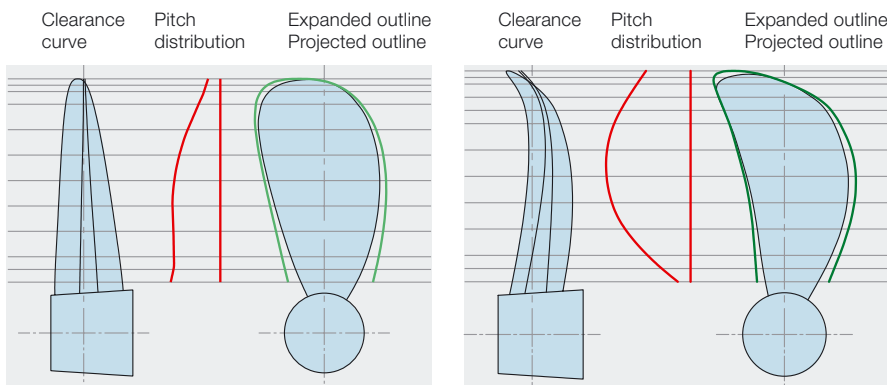
It makes sense therefore to apply large-diameter propulsors to reduce axial kinetic energy losses. This principle is used for the so-called speed adapted propeller or ‘slow runner’, which is often successfully retrofitted to existing ships sailing at reduced power and rpm by fitting a re-designed propeller of larger diameter. Although the hull efficiency in this case is somewhat reduced, substantial gains in propulsive efficiency can be obtained.

Wärtsilä has supplied over 30 speed-adapted propellers and achieved efficiency gains ranging between 5% and 14%.

Propeller replacement

It is sometimes necessary to replace an old design of fixed pitch propeller. A new propeller designed to modern criteria can achieve fuel savings or lower pressure pulses, or both. Propeller efficiency can be improved in several

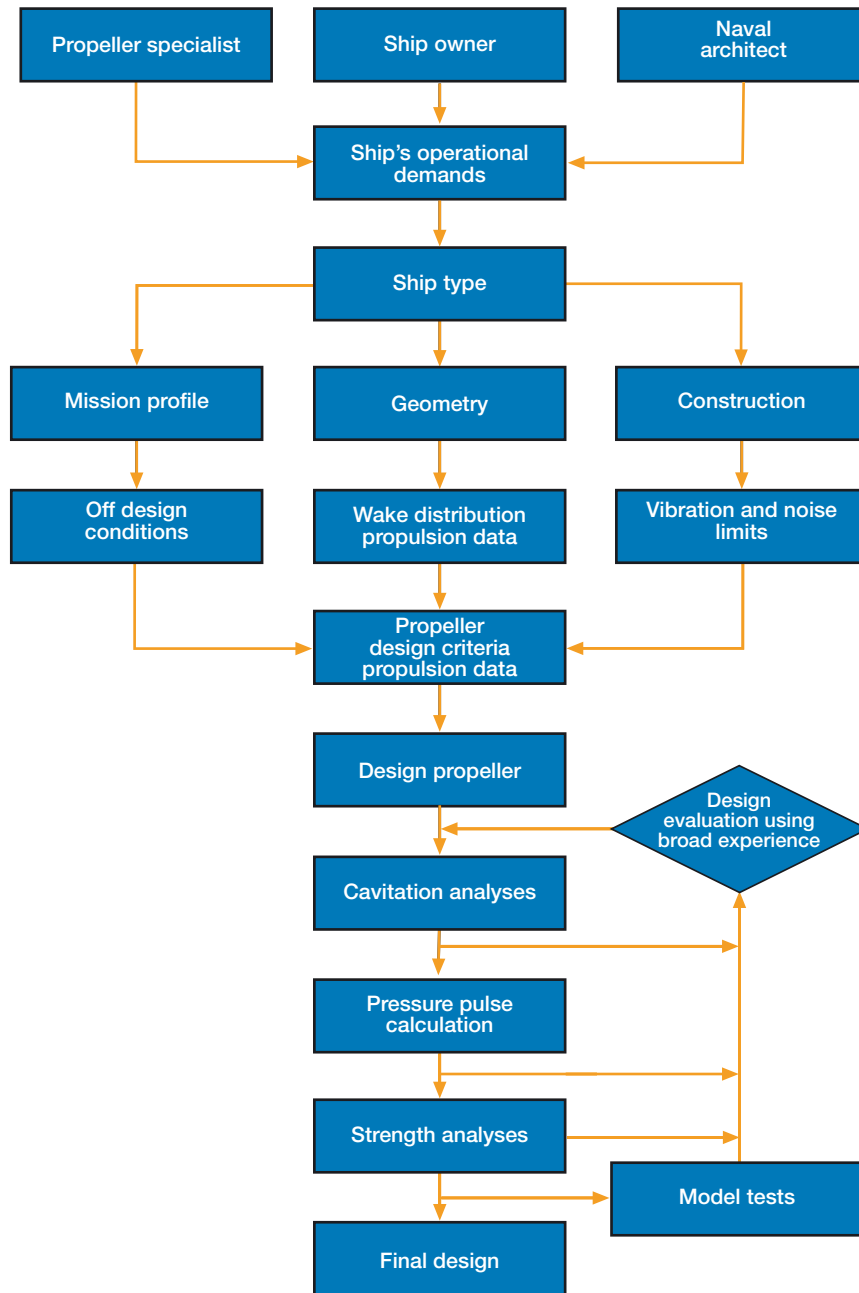
Example of a successful propeller retrofit



Old propeller for the Atlas Sea.

Lips tip-rake propeller for the Atlas Sea.

Propeller design principles



ways, resulting in lower fuel consumption without increasing propeller-induced pressure pulses. For a heavy running propeller a small modification to the existing propeller can help and replacing the propeller is not always necessary.

When considering replacement of the existing propeller, it is worth investigating to what extent a new, state-of-the-art propeller can reduce fuel consumption and/or pressure pulses, thereby increasing crew comfort. In such a case Wärtsilä can advise on how best to proceed. On request Wärtsilä can make a preliminary design for a new, replacement propeller to establish what improvements can be gained.

The efficiency rudder

Vessels can be supplied with an 'efficiency rudder' to increase the propulsion efficiency and to give good steering characteristics. The efficiency rudder features a fixed bulb attached to the rudder horn immediately behind the propeller. The rudder blade can be equipped with a flap at its trailing edge to increase the lift generated by the rudder. The bulb is removable to facilitate withdrawal of the tail shaft.



Efficiency rudder

The efficiency rudder offers at least two substantial benefits:

- Propulsion efficiency is higher than with conventional rudders. Model tests indicate engine power savings of 5-8% for single-screw vessels and 2-5% for twin-screw vessels. Full-scale measurements have confirmed the results of these model tests.
- Pressure impulses on the hull are lower, which reduces vibrations and noise compared to conventional rudder/propeller arrangements. 20-40% reductions in pressure impulses have been confirmed by both model and full-scale tests.

The HR nozzle

The HR (high efficiency) nozzle deviates from the conventional (19A or 37 type) nozzle by a special rounded leading edge and S-shaped outer surface. After introduction with small propellers (less than 3.5 m diameter) several hundred have since been applied to a wide variety of vessels. Full-scale tests on several vessels indicate an improved bollard pull in the order of 7-10%. This means up to 13% improvement in free-running conditions compared to conventional nozzle.

Consequently, Wärtsilä has decided to introduce this nozzle on a wide range of applications such as harbour tugs, offshore vessels, dredgers, semi-submersibles and other applications where nozzles are used.

Remote control system

A remote control system can contribute considerably to reducing operational costs. The remote control system must of course be reliable, safe and available at all times.

Other aspects important for reducing operational costs include:

- Less fuel consumption by optimum scheduling of pitch and shaft speed. The LIPSTRONIC 7000 system easily allows for optimum schedules, one for manoeuvring and one for free-sailing (transit) to ensure environmentally sound operation in different conditions.
- Avoiding over-quick loading and unloading of machinery when decreasing and increasing speed. This greatly reduces maintenance costs and extends the lifetime of the equipment.

Remote control system



These features result in considerable fuel savings and less machinery maintenance due to reduced thermal stresses and lower emissions.

EMISSIONS TO THE AIR AND THEIR REDUCTION

Carbon dioxide and sulphur dioxide

Carbon dioxide contributes the most to the 'greenhouse effect' i.e. potential climate change caused by global warming. Sulphur dioxide, by contrast, contributes regionally both to acid rain and acidification of the soil and also detrimentally to human health.

Emissions of carbon dioxide and sulphur dioxide are directly related to the fuel quality and energy efficiency of the combustion process; in other words, practically all carbon and sulphur entering the engine in the fuel will be emitted as CO₂ and SO₂ through the exhaust duct. CO₂ and SO₂ emissions can be reduced by increasing the total energy efficiency of the plant and by the choice of fuel, i.e.



Installation of SCR in Birka Princess

choosing a fuel quality with lower sulphur and carbon content.

The IMO is currently establishing regulatory regimes with the intention of limiting the sulphur content in marine fuels. The regulation is expected to come into force in mid-2004 (provided that the ratification process among IMO member states is successful).

The cap on fuel sulphur content proposed by the IMO is:

- 4.5% worldwide
- 1.5% in the Baltic Sea, North Sea and English Channel.

The European Union is currently carrying out a number of marine emission studies aimed at introducing regulations on sulphur content in marine fuels. The EU's proposed policy on future marine sulphur regulation is:

- Maximum fuel sulphur content to be used in the North Sea, English Channel and Baltic Sea: 1.5% (in line with the IMO)
- Maximum fuel sulphur content to be used in passenger ships operated regularly to EU ports 1.5% (in force 2007)
- Maximum fuel sulphur content (distillate fuel only) used in ports: 0.2% (0.1% from 2008)

All Wärtsilä engines are already designed and optimized for operation on any sulphur content.

Nitrogen oxides

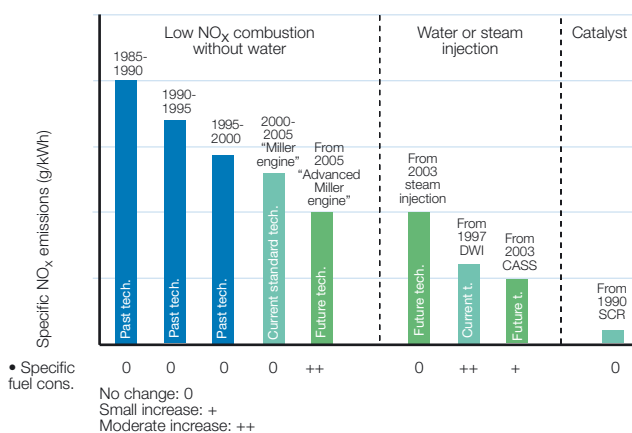
Nitrogen oxides (NO_x) are formed in the combustion process by the oxidation of nitrogen (from the atmosphere and fuel) to nitrogen monoxide (NO) and nitrogen dioxide (NO_2). The rate of NO_x formation is temperature driven and consequently a function of the local high-temperature areas and their duration during combustion. To be able to reduce NO_x emissions it is necessary either to prevent formation in the cylinder (primary method) or to remove the NO_x from the exhaust gases in an after-treatment system (secondary method).

Wärtsilä employs two primary methods for reducing NO_x emissions in diesel engines:

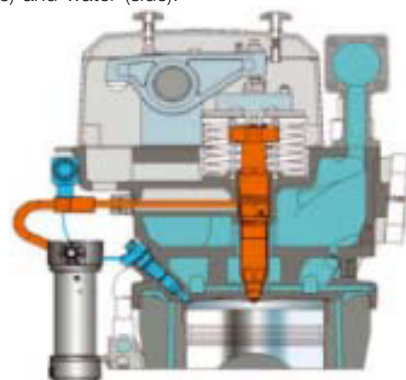
- In-cylinder combustion control measures without water introduction, called Low NO_x combustion
- Introduction of water into the combustion process by either:
 - injecting water directly into the combustion chamber, or
 - humidifying the combustion air.

Low NO_x combustion research at Wärtsilä focuses today on optimizing the closing timing of the inlet valve (this technology is called Miller valve timing); early closing of the inlet valve suppresses the in-cylinder

NO_x emission abatement - historical trend



Wärtsilä 46 with Common Rail and Direct Water Injection – separate injection nozzles for fuel (in the middle) and water (side).



Coral Princess – all diesel engines with Common Rail and Direct Water Injection.



combustion temperatures, which reduces NO_x formation. So far the NO_x reduction achieved using the Low NO_x combustion method has been about 35% (reduction from 1990) with specific fuel consumption either unaffected or even slightly improved. An additional NO_x reduction of about 15% is expected from 2005.

It has long been known that water has a positive influence on reducing NO_x formation by cutting temperature peaks in the combustion process. Various methods of introducing water have been evaluated and tested including water-in-fuel emulsions, humidification of the combustion air in various ways, and direct water injection into the combustion space.

Each alternative has its own merits and drawbacks and accordingly Wärtsilä has chosen to pursue development of the following technologies:

- Humidification of the combustion air by injecting high-pressure water into the air receiver of the engine (technology called Combustion Air, Steam Saturation, CASS) for 50-70% NO_x reduction.
- Injection of water directly into the combustion chamber (technology called Direct Water Injection, DWI) for 50-60% NO_x reduction.

Direct Water Injection

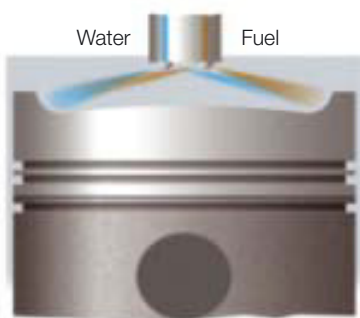
Injecting water into the cylinder reduces the temperature in the cylinder and thereby prevents the formation of NO_x . Direct Water Injection (DWI) can reduce the NO_x level by 50-60% without adversely affecting power output or engine components. The method requires the minimum of space, which makes it applicable for retrofitting at low investment cost.

Water injection takes place before fuel injection, resulting in a cooler combustion space and therefore lower NO_x emissions. Water injection also stops before injection of the fuel into the cylinder so that the ignition and combustion processes are not disturbed.

Water is fed into the cylinder at high pressure, 200-400 bar, depending on the engine type. High-water pressure is generated in a high-pressure water pump module. A low-pressure pump is also necessary to ensure a sufficient stable water flow to the high-pressure pumps. The pumps are built as modules to enable easy installation.

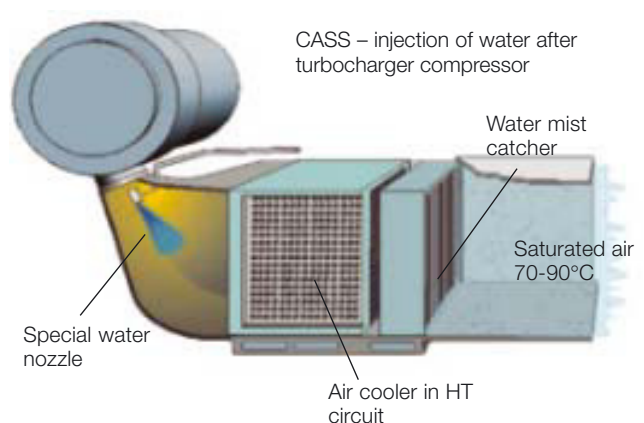
A flow fuse, installed on the side of the cylinder head, acts as a safety device by shutting off the water flow into the cylinder if the water needle gets stuck. Water injection timing and duration is electronically controlled by a control unit, which gets its signal from the engine output. NO_x reduction is most efficient for loads of 40% and higher at nominal engine output.

DWI principle



- Water needle and fuel needle in the same injector
- Water pressure 200-400 bar

Wärtsilä Combustion Air Saturation System CASS



The bulk carrier Gypsum Centennial is propelled by the worlds first low-speed engines with Common Rail fuel injection.



The consumption of water is slightly over half of the fuel oil consumption, and the water used can be evaporated or technical water. DWI is applicable for the Wärtsilä 32, Wärtsilä 38, Wärtsilä 46 and Wärtsilä 64 engines. More than 50 Wärtsilä engines with DWI are already installed or on order.

Combustion Air Steam Saturation system (CASS)

The Combustion Air Steam Saturation system (CASS) is a new technology still under development and, during 2003, is being pilot tested on a Wärtsilä Vasa 32LN engine. Development of CASS for other engine types is also ongoing. CASS technology makes it possible to reach lower NO_x levels than with the DWI system but the water consumption will consequently be higher.

Selective Catalytic Reduction

Selective Catalytic Reduction (SCR) is the only way known today for reducing NO_x by 85-95%. A reducing agent, such as an aqueous solution of urea, is injected into the exhaust gas at a temperature of 290-450 °C. The urea in the exhaust gas decays into ammonia, which is then put through a catalyzing process that converts the NO_x into harmless nitrogen and water.

A typical SCR plant consists of a reactor containing several catalyst layers, a dosing and storage system for the reagent, and a control system. The reactor can also be designed to incorporate the exhaust gas silencer – a solution called Compact SCR. The size of the urea tank depends on the size of the engines, the load profile and how often the ship will be entering ports where urea is available.

The lifetime of the catalyst elements is typically 3-5 years for liquid fuels and slightly longer if the engine is operating on gas. The main running costs of the catalyst come from urea consumption and the replacement of catalyst layers. Urea consumption is 15-25 g/kWh of 40%-w urea.

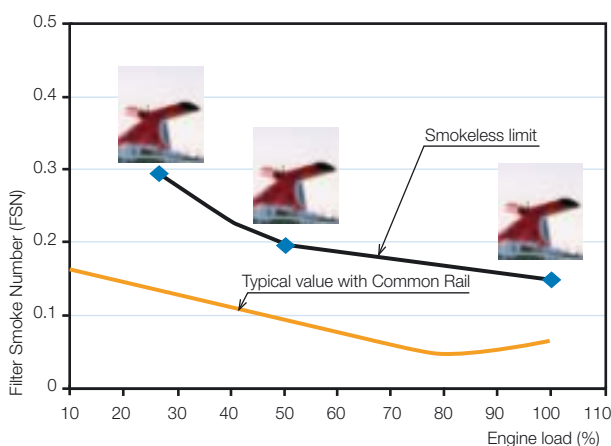
SCR technology can be installed on all Wärtsilä engines, both 2-stroke and 4-stroke. There are already 60 Wärtsilä marine engines fitted with SCR and more are on order. SCR technology is used on many ferries in the Baltic Sea.

The smokeless engine

Visible smoke is an important issue in the marine and also the land-based power plant market. The need for non-visible smoke operation in the power plant market has been obvious for a long time. The need in the marine market has been boosted in recent years especially by the cruise ship industry. Since most harbours visited and routes operated by cruise ships are located close to densely populated or environmentally sensitive areas the demand for non-visible smoke operation is considered to be increasingly important. Wärtsilä has responded to these needs with the introduction of Common Rail fuel injection technology.

In order to avoid visible smoke it is necessary to prevent fuel droplets from coming into contact with metal surfaces around the combustion space. High fuel injection pressures generate small fuel droplet sizes. At low loads, the fuel injection pressure drops when using conventional mechanical injection systems. This results in large fuel droplets, some of which survive until they hit the combustion

Smokeless operation as Filter Smoke Number
460 mm bore engine



space surfaces, generating smoke emissions. The Common Rail fuel injection system, on the other hand, keeps the injection pressure high and constant over the entire load range, thus enabling operation without visible smoke over the whole operation field.

The apparent darkness of a stack plume depends on many parameters including concentration, the size distribution and colour of the particulate matter in the effluent, the gas temperature at the stack exit, the depth of the plume (i.e. the duct diameter), and also natural lighting and background conditions. When establishing the Filter Smoke Number (FSN, an ISO 10054 measurement method) criteria for non-visible smoke conditions, it is necessary to take into account the duct diameter, engine power output and load.

Generally, the Filter Smoke Number values accepted for non-visible smoke operation are lower for bigger duct diameters (bigger engines). For a 460 mm bore engine the upper FSN limit for non-visible smoke operation is typically 0.15 at 100% load and 0.3 at 25% load. The Common Rail engine, in contrast to an engine with a conventional mechanical injection system, can meet this limit and therefore the smoke is non-visible.

Wärtsilä's 2-stroke smokeless engine is called the RT-flex engine. The key feature of the RT-flex system is that it gives complete freedom in the timing and operation of fuel injection and exhaust valve actuation. This flexibility is employed to reduce engine running costs and exhaust emissions, and to ensure steady operation at very low speeds. This is made possible by precise control of the injection together with the higher injection pressures achieved at low speed and sequential shut-off of the injector. Consequently RT-flex engines can run very steadily, and without smoking, at only 10-12% of nominal speed.

Other emissions

Emissions of carbon monoxide (CO) and total hydrocarbons (THC) are typically very low from diesel engines compared to many other industrial and automotive sources. Consequently Wärtsilä has given highest priority to reducing NO_x, SO_x and PM (particulate matter). In recent years, however, particulate size distribution (particulates with diameters between 10 micrometre and 2.5 micrometre) has received increasing attention. Another issue that has been given more attention recently is emissions of hydrocarbons from gas engines since these are also components of greenhouse gases.

Noise

Noise from a diesel engine consists of air-borne noise, structure-borne noise and exhaust noise.

Air-borne noise can cause permanent hearing damage if directly exposed to it, and is therefore regulated by the IMO to a maximum of 110 dB(A) locally in the engine room. Wärtsilä develops its engines with this in mind and has several ongoing projects aimed at reducing engine-radiated noise even further.

Structure-borne noise is transmitted through the hull structure and radiated throughout the ship. Its effects are mainly related to crew comfort. Structure-borne noise is regulated by the IMO, by local (country-specific) regulations, by the ship's comfort class and by the shipowner's specifications. When required, resilient mounting of the engines can be provided, and usually the design is tailored for each installation. Structure-borne noise can typically be reduced by 90%, but in special applications a reduction of more than 99% can be achieved.

Exhaust noise disturbs communication on smaller ships, and is an annoyance factor both onboard and in harbours. Exhaust noise levels are regulated by the IMO, by local regulations, by the ship's comfort class and by the shipowner's specifications. The installation of exhaust gas silencers can reduce exhaust noise levels.

Waste

Most of the lifecycle impact of a Wärtsilä engine on the environment comes from the operation of the engine during its lifetime. With this in mind it is important that Wärtsilä engineers focus during the development process on a design which results in minimal waste during operation. Optimal material utilization, low fuel and lubrication oil consumption, and minimized emissions during the engine's lifetime are crucial for ensuring its low environmental impact.

Minimal waste during operation has been Wärtsilä's aim when designing the lubricating and fuel treatment system. To do this, Wärtsilä has moved away from using exchangeable insert filters, which create hazardous waste, to self-cleaning automatic filters.

The SCR elements.



Low lubricating oil consumption in combination with long change intervals has been achieved by development of the piston – ring – liner combination along with active co-operation with oil companies to reach extended oil drain intervals.

Design for optimal use of materials has been a continuous target, likewise. This is reflected in the development of output density and increased time between overhauls as well as the lifetime of the components.

The cost of fuels can amount to a substantial part of the operating costs of a ship, which makes fuel consumption the most important factor regarding costs and emissions. Engine design based on increased combustion pressure is one way of reducing fuel consumption and thus the amount of waste created.

Neither the DWI nor the CASS systems produce any waste. When an SCR is used, the catalytic elements must be exchanged at certain intervals. These elements are returned to the SCR manufacturer and reused as a base material in the SCR. This environmental impact is very small, and experience has shown that if the SCR is well maintained and good quality fuel is used, the elements will last for many years.

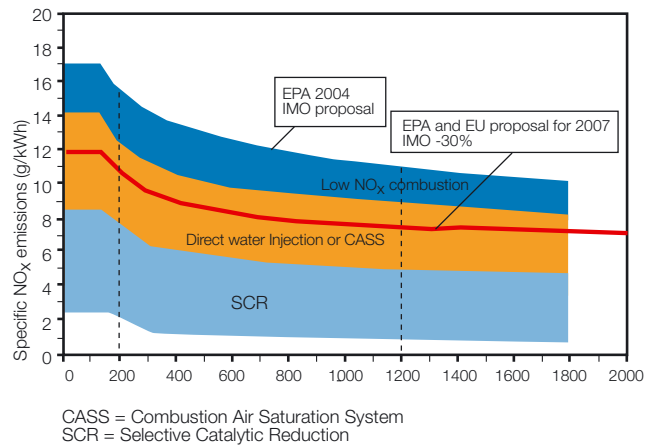
Compliance

Wärtsilä's minimum development requirement for Wärtsilä and Sulzer brand engines for marine use is that these engines comply with the requirements of the IMO. Wärtsilä has developed, and is developing, NO_x reduction technologies that comply with even more stringent national or regional legislation expected in the future. Activity in this field is rapidly increasing around the world.

After a ratification process lasting several years, it appears that the IMO MARPOL 73/78 Annex VI legislation will be ratified by sufficient member states in 2003 and enter into force internationally one year later.

IMO/MEPC is further studying the application of a voluntary Greenhouse Gas Emission Index for ships. A working group is preparing an IMO greenhouse gas strategy resolution for adoption by the IMO Assembly in 2003.

NO_x emission compliance of Wärtsilä engines



Diesel engines - NO_x unit conversion
Approximate scale for 4-stroke engines

g/kWh	ppm, dry, actual O ₂	ppm, dry, 15% O ₂	mg/Nm ³ , dry, 5% O ₂	mg/Nm ³ , dry, 15% O ₂
14	1400	990	5500	2050
11	1130	780	4320	1600
8	820	570	3120	1170
5	510	350	1960	730
2	200	140	780	290

mg/Nm³ refers to milligrams per nominal cubic metre.

The US Environmental Protection Agency (EPA) issued new legislation concerning emissions into the air for US coastal shipping in early 2003. Existing legislation already covers engines with cylinder volumes of 2.5 litres upwards. The new legislation covers C3 category engines, which means new marine compression-ignition engines at or above 30 litres/cylinder, and the limit on NO_x emissions is the same as the IMO's limit. However, the EPA has announced that in 2007 it will review and tighten this legislation.

The European Union is also actively imposing legislation related to NO_x and SO₂ emissions in certain sensitive sea areas and inland waterways. The European Commission is demanding that the IMO agree on more stringent exhaust emission levels for international shipping before the end of 2006 and issue appropriate regulations.

Economic instruments for reducing emissions have been adopted in some countries. A system of environmentally differentiated fairway dues was introduced in Sweden in 1998 and an environmental differentiation of tonnage tax in Norway in 2001. Many Swedish ports, and also the port of Mariehamn in Åland and the port of Hamburg, offer complimentary reductions in port dues to ships that have voluntarily reduced emission levels. Vessels with the Green Award certificate are entitled to a rebate on port fees in 35 ports around the world.

Installations of emissions reduction technologies

Most Wärtsilä installations incorporating emission reduction technologies are found in the Baltic Sea, with some in the Caribbean and in Alaska.

Exhaust gas emission control equipment delivered or currently on order from Wärtsilä (Feb 2003):

Marine	No of engines	Output (MW)
DWI	53	536
SCR	60	340
RT-flex	16	158
CR	29	290



Boulder Park with six Wärtsilä 18V28SG has efficient oxidation catalysts for reduction of VOC emissions and SCR units for reduction of NO_x emissions.

Power plant applications

Wärtsilä provides a wide variety of power plant applications. In this sector, a major part of the company's annual sales comes from baseload power plants for continuous operation utilizing both gas and heavy fuel oil.

Also widely used are peaking plants for more intermittent use such as combined heat and power (CHP) applications during cold seasons, and peak shaving for air conditioning in hot seasons.

The programme also includes standby plants, which often run on light fuel oil, compressor drives for gas pipelines or gas storage systems utilizing the efficient gas engines from the engine portfolio, and liquid pumping stations for e.g. crude pipelines; the latter can use the crude oil directly as fuel, which offers excellent fuel logistics for the oil and gas industry.

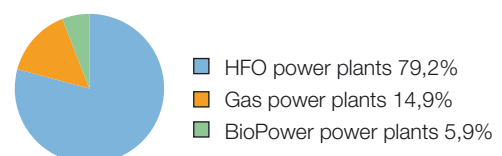
Major customer segments include utility companies and industrial applications where captive power is sometimes essential in order to avoid electricity black-outs. IPP plants are also an important customer segment. For big buildings like hotels and hospitals high-speed engine generator sets can be used both as standby units or for continuous electricity generation.

The latest newcomers to Wärtsilä's power plant portfolio are biopower plants for electricity generation and bioenergy heating plants. Both types deploy BioGrate boilers designed to use wood waste and other biomass as fuel, and are examples of Wärtsilä's increased focus on sustainable energy alternatives.

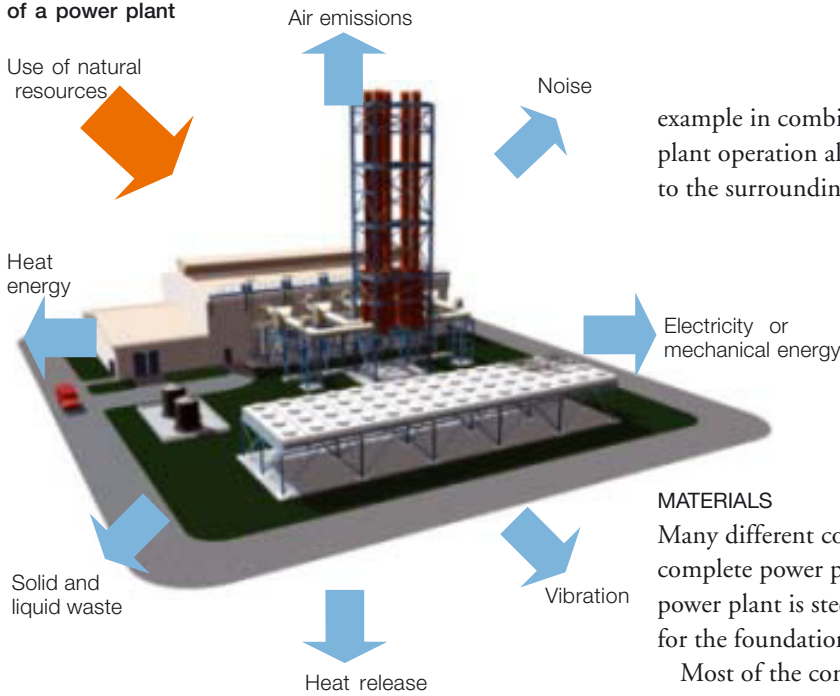
Power plant types based on engines

Applications	Customers	Fuels
Baseload Peaking Standby Pumping Compressor	Utility Industry IPP Oil & Gas	NG, LNG, CNG LFO, HFO Crude Orimulsion Bio-oils

Wärtsilä's power plants by fuel type 2002



Environmental aspects of a power plant



example in combined heat and power production. Power plant operation also causes noise emissions and vibration to the surroundings.

MATERIALS

Many different components are needed to build a complete power plant. The most common material in a power plant is steel but a lot of concrete is also needed for the foundations.

Most of the components, including in many cases even the buildings, are transported as pre-fabricated modules. This helps to optimize delivery efficiency while also contributing to more efficient usage of materials by reducing waste at the construction site.

Another area of optimization is the amount of material used in the power plant owing to its cost impact. This can be done through detailed engineering that takes into account the local conditions, such as noise, the risk of earthquakes and wind conditions.

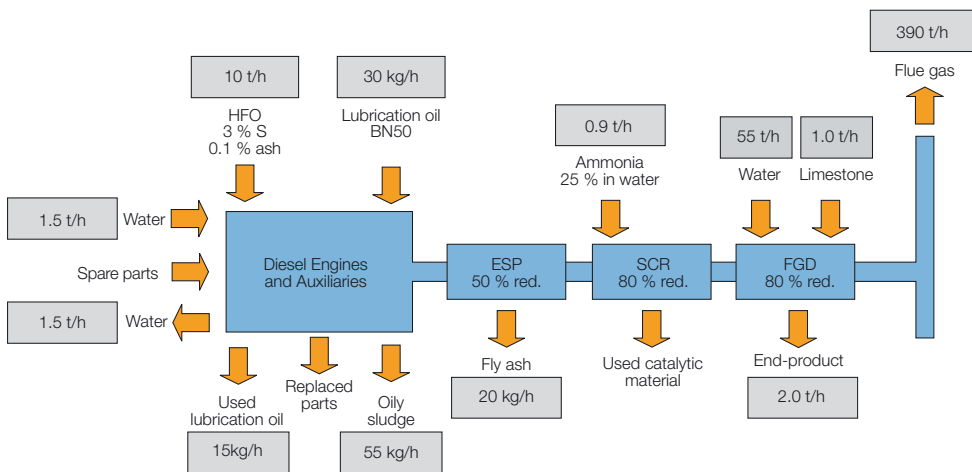
The main materials used in the operation of an engine-driven power plant are fuel and lubrication oil, water and spare parts. The components of an engine and its auxiliaries must be overhauled at intervals. Certain components can be reconditioned while others must be replaced. Most replaced components are made of iron or steel alloys and therefore they can be reused to produce new metal products.

Environmental aspects of a power plant

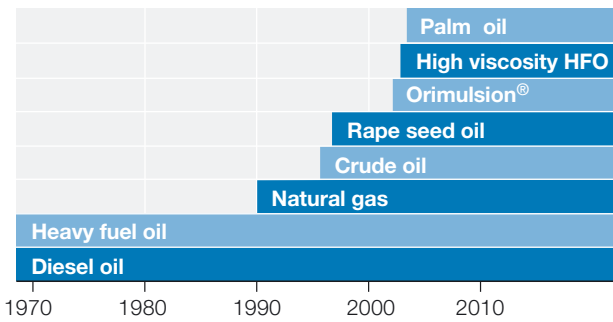
By environmental aspects we refer to those elements of practices, products and services that have an impact on the environment. Environmental impacts can be either positive or negative.

The environmental aspects of a product are mainly related to its use. Wärtsilä engines produce mechanical and thermal energy. In Wärtsilä power plants mechanical energy is used to drive generators for electricity production or alternatively pumps or gas compressors.

The use of fuel and lubricants in engines results in different types of air emissions and waste. Flue gases and engine cooling produce waste heat to the air and water. However, part of this thermal energy can be utilized, for



Typical material balance when operating a 50 MW_e diesel power plant equipped with radiator cooling, consumption boilers and flue gas control system.



Fuel versatility – Wärtsilä engines

If flue gas emission reduction techniques are needed, material flows during power plant operation can include various reagents. In addition to normal spare part replacement, the catalytic material must be gradually replaced in equipment such as Selective Catalytic Reduction (SCR) and oxidation catalysts. The replaced catalytic material is normally sent back to the supplier of the unit for reprocessing into new catalytic material.

ENERGY

Fuels

The world will continue to be dependent on fossil fuels during the decades ahead. The International Energy Agency (IEA) estimates that by 2010-2020 fossil fuels will account for about 80% of the market for global primary energy consumption – the same as today.¹

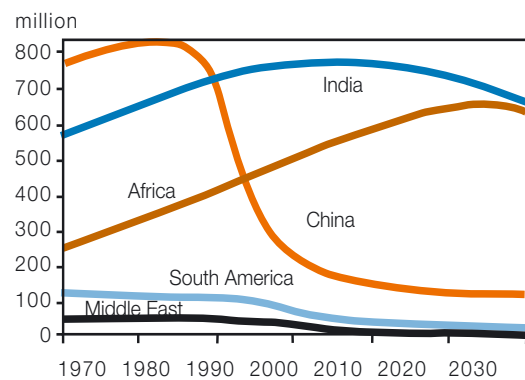
Although oil will still continue to play the most important role in this scenario for a long time to come, we are already seeing a shift to natural gas. The exploitation projects for large gas reserves such as Snow White in northwest Norway will start production by 2010. Natural gas is expected to become an even more important source of energy during the next decades. In the longer term, renewable energy sources will increase their market share as well, due to the need to meet greenhouse gas emission targets.¹

¹Source: International Energy Agency, World Energy Outlook, www.iea.org

Fuel versatility is thus a major issue for the future. Wärtsilä is devoting a substantial part of its R&D efforts to this area. The multi-fuel engine alternatives now offered by Wärtsilä give customers a means of securing low-cost and environmentally sound solutions for the future. The engine alternatives offer the flexibility of burning heavy fuel oils today, gas today and tomorrow, and even renewable fuels in the future.

The possibility to use various kinds of fuels such as light fuel oil, different heavy fuel oils, certain types of bio-oil, crude oil, emulsified fuels and natural gas gives power plant customers a wide choice of fuel. This versatility also secures a reliable fuel supply in case of fuel delivery difficulties.

People without electricity

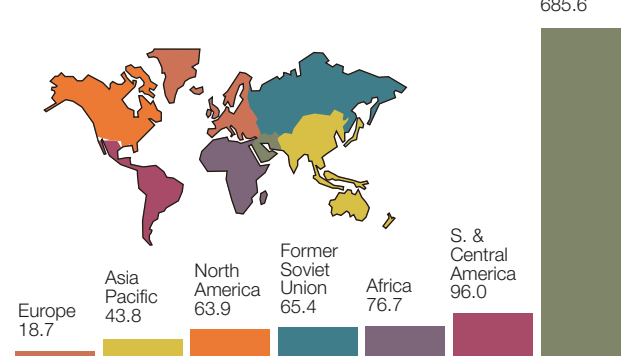


Source IEA

If natural gas is available, this usually is the preferred choice of fuel today. However, many countries and regions lack gas pipelines and natural gas and instead rely on heavy fuel oils and light fuel oils. The Wärtsilä dual-fuel engine can run simultaneously on natural gas and light fuel oil. If the engine needs to run for longer periods on liquid fuel oil, the dual-fuel oil engine can be modified to utilize heavy fuel oil as well.

Map of proved oil reserves at end 2001

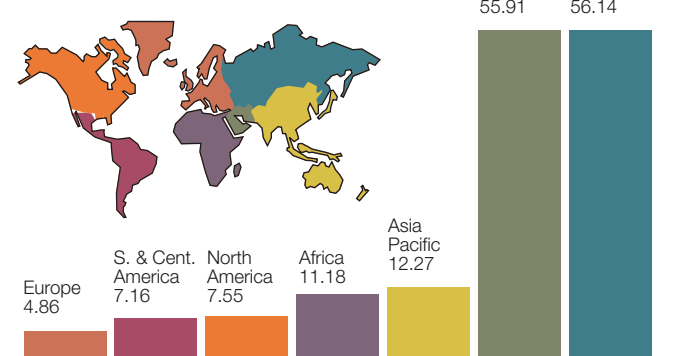
Thousand million barrels



Source: BP statistical review of world energy 2002.

Map of proved gas reserves at end 2001

Trillion cubic metres



Source: BP statistical review of world energy 2002.

At remote sites where crude oil is available, such as crude oil pipelines and crude oil field facilities, crude is often the preferred fuel alternative. Fluctuating heavy fuel oil prices are creating a need for alternative fuels. Orimulsion® and various refinery residuals are suitable possibilities. To reduce the greenhouse effect of power plants considerable efforts have been focused on sustainable fuel alternatives such as bio-oils.

Recent efforts to widen the fuel spectra include:

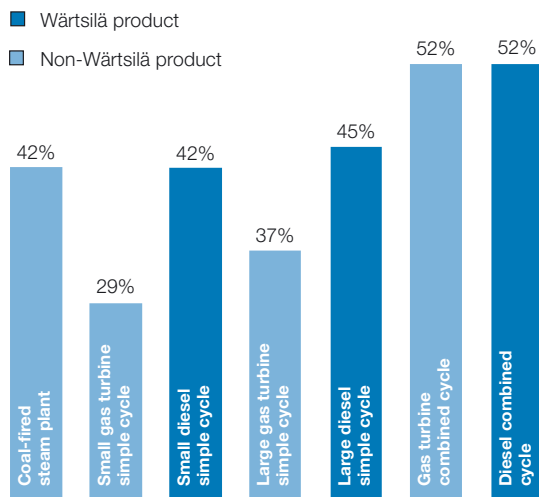
- Testing and approval of high-viscosity heavy fuel oils that exceed normal fuel specifications.
- Further tests and approval of Orimulsion® and emulsified fuels as diesel engine fuel.
- Successful testing of various biofuels to broaden the range of bio-oils available for diesel operation. The first commercial bio-oil diesel engine delivered by Wärtsilä was commissioned in early 2003.

Energy efficiency

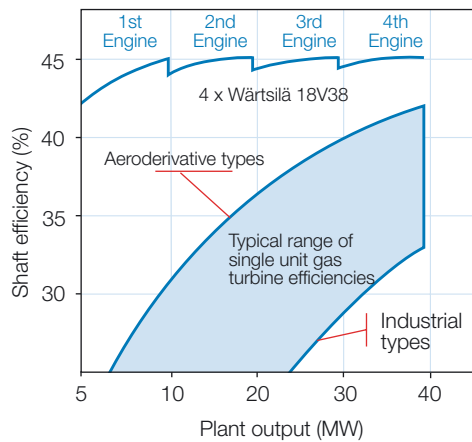
High energy efficiency is essential to ensure optimum use of existing fuel resources and to minimize costs and exhaust gas emissions. Emissions of sulphur and carbon dioxide are directly proportional to specific fuel consumption when comparing operation on the same fuel quality. High energy efficiency is mostly the result of good combustion, which also minimizes emissions of unburned compounds such as carbon monoxide, hydrocarbons and particulates.

Reciprocating engines have the highest energy efficiency among simple-cycle prime movers, i.e. the lowest fuel consumption and therefore the lowest specific CO₂ and SO₂ emissions for a given fuel quality. Typical energy efficiencies (shaft efficiencies) for a simple-cycle application are 40-49% and for a combined-cycle application 45-55%. High efficiency is achieved over a broad load range, typically 30-100%.

Typical plant electrical efficiency



Shaft efficiencies versus power output (ISO 3046 II – Conditions)

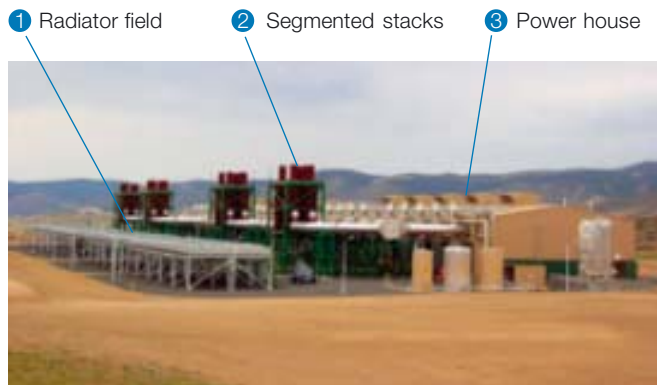


High efficiency at part load together with the consecutive utilization of engines in a multi-engine installation enables highly efficient power production covering a broad load range. This in turn allows very low power plant turndown ratios, to as low as 10%, while maintaining excellent plant efficiency. In multi-engine installations it is also possible to perform service work on part of the plant while the rest continues to produce power and heat.

In recent decades the energy efficiencies of Wärtsilä engines have increased substantially from about 40% two decades ago to a current level of roughly 49%. This trend is the result of both better engine performances and bigger engine sizes. Engine efficiencies have generally increased as a result of increased firing pressures, higher compression ratios, shorter fuel injection durations, optimized valve timings and improved combustion processes. The development of efficiency in Wärtsilä's products has a significant impact on the environment from the lifecycle point of view. We have focused on energy efficiency in our research and development because of the long lifecycle of our products.

The high-efficiency, low-noise radiator system

- Energy savings 20 - 40% of radiator losses
- Noise reduction
- Flexible operation



High efficiency depends not only on the prime mover but also on the complete power plant. Overall efficiency can also be improved by minimizing parasitic losses in electrical equipment such as generators and transformer stations, and losses in cooling water systems. The development and launch of the frequency controlled radiator fan system is an example of technology that combines energy savings, noise reduction and operational improvements. The efficiency of the fan motors and the reduction of unnecessary radiator usage have resulted in a 20- 40% reduction in radiator system energy consumption.

Combined Heat and Power (CHP)

CHP means recovering and using the heat produced as a byproduct of the electrical generation process. The usual method is to use the waste heat from the engine exhaust gases or engine cooling systems, or both, to produce hot water or steam generation. Typical CHP applications include district heating, steam or hot water for various industrial processes, and desalination. The heat can also be used as an energy source in chillers for air conditioning or cooling.

Wärtsilä provides CHP solutions based on engines running on gas or oil with plant electrical efficiencies at the generator terminal in the range of 40-45% and heat efficiencies of 35-45%. This implies total efficiencies from 75% to 90%. Instead of using additional fuel or electricity for heat generation, the plant heat is used. In addition to conserving fossil fuel resources, this results in less fuel-related emissions. The heat emitted into the air and water is reduced likewise, resulting in less disturbance to the ecosystems.

Decentralized energy production

In recent years we have seen a clear trend from large centralized power plants to smaller decentralized solutions. This is the result of a wide variety of factors, the most

important being deregulation and liberalization, fast changing markets and environmental considerations.

One result of liberalization is that smaller communities and local industry can now invest in power production. Large coal-fired, nuclear or hydropower plants are seldom commercially viable options today because of their large size and long delivery and construction times. This clearly favours the use of small- and medium-sized power plants with short lead times.

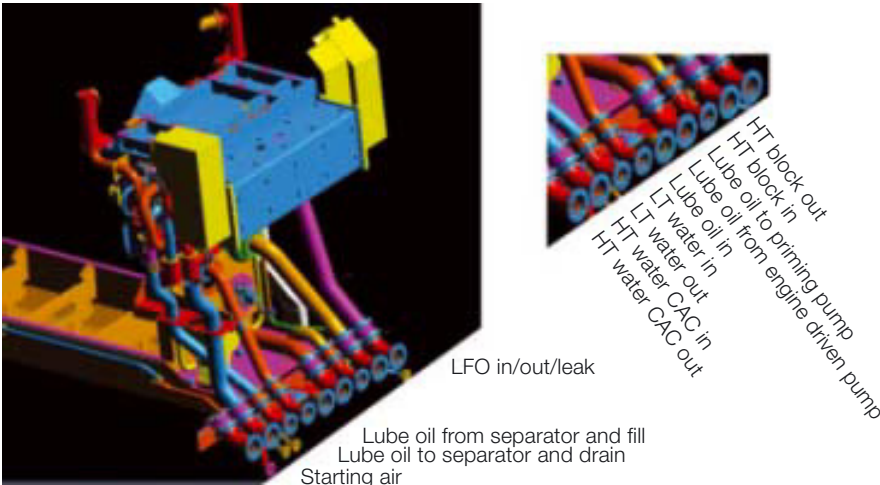
A small plant also makes it easier to apply CHP solutions because it is easier to find local use for the heat production, e.g. district heating, industrial drying processes and steam generation. Big power plants, which produce considerable quantities of surplus heat, require big cities with large district heating systems.

Environmental considerations also favour distributed power solutions. The shift from coal to gas reduces CO₂ emissions and greenhouse effects. For logistical reasons, coal tends to require big power units, while gas makes small CHP units possible. The local environmental impact of a big power plant is more severe because of the elevated concentrations of emissions at ground level. The feasibility of using emission control equipment in big power plants is better, however, owing to economics of scale.

CHP plants suit distributed power solutions. A CHP plant has a total efficiency of typically 75-90% compared to a big coal-fired plant with a typical electrical efficiency of 35-40%. A centralized plant also requires long transmission lines, leading to transmission losses. The construction of long transmission lines, and land reservation for this purpose, is another environmental concern in this context.

The excess heat generated by reciprocating engines from the cooling of cylinder liners, cylinder heads, lubricating oil coolers and charge air coolers is easily utilized in the CHP process. The interconnection to the various heat loads will vary from case to case depending on the CHP applica-

The flexible CHP interconnection system developed for the Wärtsilä 20V34SG/18V50DF engines



tion. A major effort by Wärtsilä to facilitate CHP applications has been the development of flexible CHP interconnections for the new Wärtsilä 20V34SG (gas) and Wärtsilä 18V50DF (dual-fuel) engines. With flexible CHP interconnections the configuration of the various heat exchangers is not predefined in the engine cooling water channels and piping. Instead each heat source can be coupled to any type of outer heat sink, which allows the customer to choose the heat recovery option most suitable for his application.

EMISSIONS TO THE AIR

Carbon dioxide emissions

Carbon dioxide (CO₂) plays a major role in the global warming process as it is considered to be the greenhouse gas that most significantly contributes to the greenhouse effect.

The Kyoto Protocol (December 1997) set a target for reducing greenhouse gases, particularly CO₂. The target is to reduce overall emissions of greenhouse gases by at least 5% below 1990 levels between 2008 and 2012. The procedures related to the Kyoto Protocol will increase trading of greenhouse gas emission allowances, which we expect will have a clear impact on the energy business in the near future.

Carbon dioxide emissions are the result of the complete oxidation of the carbon in the fuel during combustion. The specific emission of carbon dioxide is fuel-related, i.e. it is entirely a function of the carbon content of the fuel and the specific fuel consumption of the energy generation process.

CO₂ emissions can be reduced by increasing the total energy efficiency of the plant, by using oil instead of coal, or natural gas instead of oil or coal, and by further

aiming to use biofuels instead of natural gas. The minor greenhouse gas effect linked to the burning of bio-oils originates from harvesting, processing and transporting bio-oils. No commercially viable technology yet exists for reducing carbon dioxide emissions.

Wärtsilä's product portfolio has for years covered light and heavy fuel oil engines and engines capable of burning natural gas. The latest step has been the development of diesel engines burning bio-oils. Wärtsilä has tested various bio-oils, such as rape seed oil, palm oil and stearine oil in its engines. Bio-oils have largely been found suitable for Wärtsilä medium-speed diesel engines. The first commercial installation with a Wärtsilä diesel engine designed to run on bio-oil started up in early 2003 in Germany.

Sulphur dioxide emissions

The oxides of sulphur are the main reason for acidification of the soil. In high concentrations they are also detrimental to human health and flora and fauna.

Most of the sulphur in a fuel produces sulphur dioxide in the combustion process while the rest takes the form of sulphur trioxide. Emissions of SO₂ are also fuel-dependent as in the case of CO₂ emissions. The lower the sulphur content in the fuel and the lower the specific fuel consumption, the lower will be the level of specific sulphur dioxide emissions.

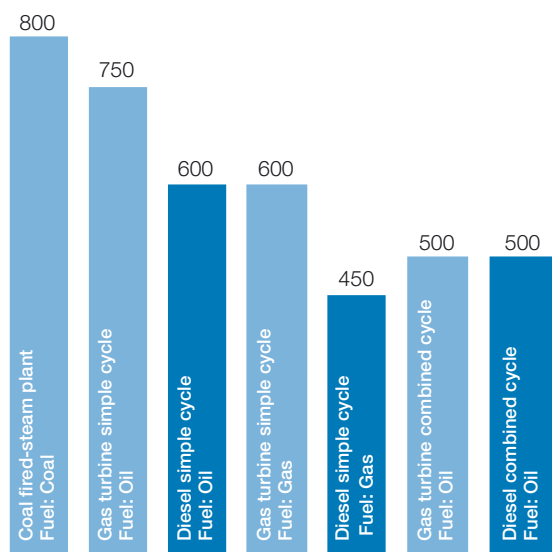
Although Wärtsilä's policy is to promote primary methods for controlling SO₂ emissions, flue gas desulphurization techniques are commercially available for Wärtsilä diesel power plants. The main challenges that arise with FGD techniques are byproduct issues, water consumption, high costs and the complicated operation of such systems.

Nitrogen oxides emissions

Some of the main impacts of nitrogen oxides are considered to be the acidification of soil, their participation in smog and ozone formation in the lower atmosphere, and health risks to the respiratory organs.

The formation of nitrogen oxides in the combustion of fuel oils and natural gas in reciprocating engines typically results from the reaction of oxygen with atmospheric nitrogen at high temperatures, the decomposition of nitrogen molecules in the air at high temperature, followed by the reactions of the nitrogen atoms with oxygen. Therefore a key issue in primary NO_x reduction techniques with Wärtsilä diesel and gas engines is control of the temperature levels during combustion.

CO₂ in g/kWh produced electricity



- Wärtsilä product
- Non-Wärtsilä product

The Wärtsilä Otto-type gas engines operate on a very lean fuel and air mixture (premixed outside the cylinder). This results in a smooth distribution of relatively low temperatures over the entire combustion space, which minimizes NO_x formation. These engines meet the strict German TA-Luft NO_x limit of 500 mg/Nm³, dry, at 5% O₂ (corresponding to about 1.3 g/kWh), while in many cases the half TA-Luft NO_x level of 250 mg/Nm³, dry, 5% O₂ (corresponding to about 0.65 g/kWh) is achievable as well.

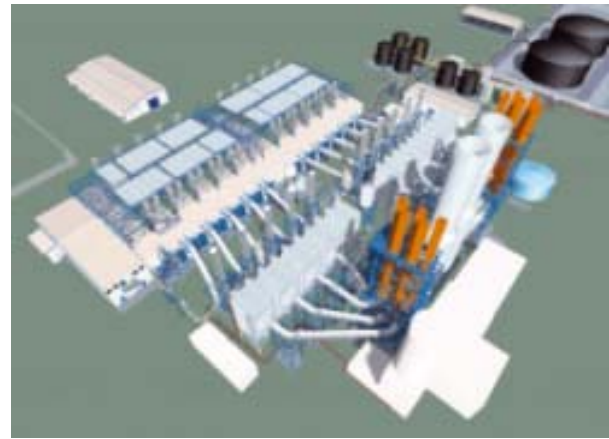
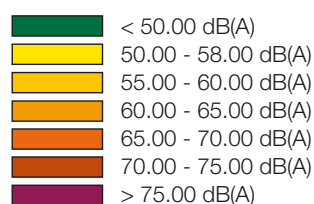
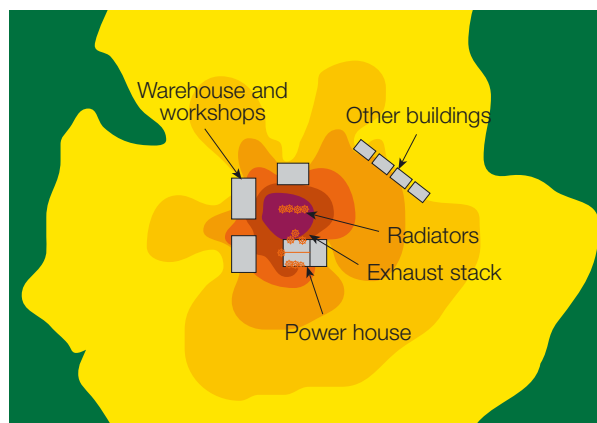
NO_x emissions can be reduced using both primary and secondary methods. The primary methods can be dry or wet. In dry methods the NO_x reduction is achieved by modifying the combustion process, while in wet methods moisture in the form of water or steam is added to the combustion process. The only secondary NO_x emission reduction method used with Wärtsilä gas and diesel engines is selective catalytic reduction (SCR).

Particulate emissions

There has been a lot of discussion about the negative health impacts of fine particulate matter emitted from the combustion of fossil fuels. Man-made fine particulate matter is said to be harmful partly because of the small size of the particles, which allows them to enter and be captured by the respiratory organs, and partly because of their composition. This is especially true of certain hydrocarbons in the context of diesel engines. Studies related to this issue have typically involved PM emissions for small diesel engines used in vehicles.

Particulate emission limits have until now been based on the total volume of emitted particulate matter without regard for particle size. In the future, however,

Example of typical noise contour plot of a power plant



A Wärtsilä power plant with 10 Wärtsilä 18V46 engines (150-160 MWe) equipped with ESP and FGD systems in order to comply with World Bank Guidelines for Thermal Power while burning emulsified fuel oil with high ash and sulphur content. Planta, Arizona, Guatemala.

more attention will be given to fine (PM₁₀) and ultra-fine (PM_{2.5}) particles because these pose a greater hazard to health. The implementation of such new particulate matter emission limits also highlights the need to develop new emission measurement methods. In most cases today PM is defined as dry filterable matter, but in some market areas condensable PM fractions are controlled as well. In the discussion that follows, PM refers to dry filterable fraction.

PM emissions depend on fuel quality. The combustion of fuel oils with high ash and sulphur contents produces a higher level of particulate emissions than in the case of light fuel oil. PM emissions are negligible with gas engines.

Particle emissions can be partly reduced using primary methods. A fraction of the particulate matter emitted from diesel engines is carbon soot and hydrocarbons that originate partly from incomplete combustion and partly from the escape of lubrication oil. PM emissions from diesel engines can be controlled by optimizing the combustion process to minimize soot formation and ensure complete burning of the fuel oil, as well as by using advanced cylinder lining and piston designs to minimize lubrication oil escape.

For medium-size diesel engines the only proven and commercially available secondary PM reduction technology is the electrostatic precipitator (ESP). Other secondary PM reduction techniques have only been used in special applications, such as in parallel with desulphurization. Some methods have been developed for small

diesel engines burning diesel oil that are not suitable for big medium-speed engines especially in heavy fuel oil use.

Other emissions

The efficient combustion process of Wärtsilä diesel engines has kept carbon monoxide (CO) and total hydrocarbon (THC) emissions from these engines low enough to comply with the legal requirements in most market areas without the need for secondary flue gas cleaning methods.

In the case of gas engines, emissions of CO and hydrocarbons, either individual compounds, such as formaldehyde, or a group of them, such as volatile organic compounds (VOC) or polyaromatic hydrocarbons (PAH), are commonly regulated today. The formation of these products of incomplete combustion has been reduced by primary methods such as engine design and adjustments, and by secondary methods, normally catalytic oxidation.

Power plants are designed to meet local and international environmental noise legislation. Wärtsilä applies different technologies and mitigation methods to power plants to fulfil case-specific demands for environmental noise impact. Power plant noise impacts are estimated with special software during the plant design. The overall noise impact can be optimized with minimum cost by selecting the optimal configuration of different components. Optimizing noise impact consists of selecting the correct components in three categories:

- Silencers for the exhaust outlet and charge air intake
- Power plant building design, wall and roof structure
- Engine cooling system.

Detailed noise engineering is a key issue in the delivery of a proper facility for each project. It is not necessary to design power plants that are excessively quiet, however, if the

requirements are not strict, for example in industrial areas where the background noise level is already relatively high. This saves a lot of money, both in materials and in plant construction time.

Emission reduction technologies

Emissions of SO₂, NO_x and PM from power plant applications are regulated. Certain regulations also include limits on CO and non-methane hydrocarbon (NMHC) emissions.

The regulations governing engine-driven plants and especially gas engines are giving increasing focus to VOC emissions as well as to certain individual hydrocarbons or groups of them because of their harmfulness. Some market areas have also seen a trend towards PM10 determination instead of total PM.

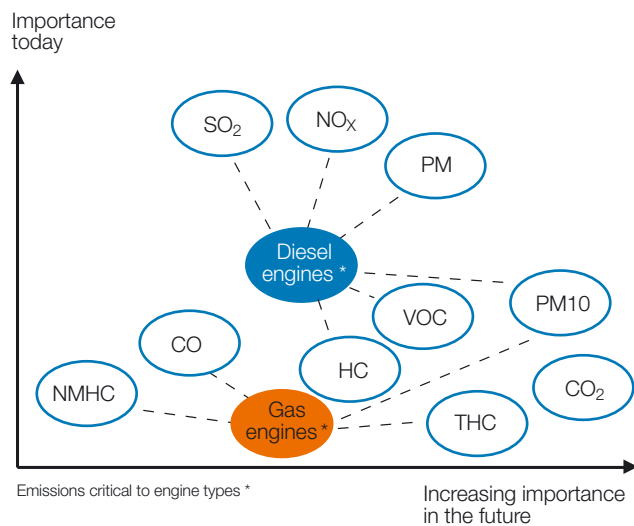
In the near future we expect that the Kyoto Protocol and its reduction targets for greenhouse gas emissions will also affect the regulatory requirements for THC emissions including methane, which is also a component in greenhouse gas emissions. PM emissions will probably lead to definitions of PM less than PM10, such as PM2.5.

Wärtsilä closely follows regulatory developments in the field of air emissions. Wärtsilä's development targets for air emission control will mainly be set based on the general trends taking place in the most important market areas.

Engine development within Wärtsilä is a continuous process towards more complete combustion to produce less CO, HC and PM emissions, by raising efficiency while simultaneously lowering NO_x emissions from the engine.

In the past most development resources were generally devoted to the secondary methods of reducing SO₂, NO_x and PM emissions, especially in the case of diesel engines. Today these techniques have been developed for a wider

Focus on air emissions from engine-driven power plants



Abbreviations:

NO_x = oxides of nitrogen

SO₂ = sulphur dioxide

PM = particulate matter

PM10 = particulate matter with diametres below 10 micrometres; in the future also PM2.5 will probably appear

THC = total hydrocarbons

NMHC = non-methane hydrocarbon

CO = carbon monoxide

VOC = volatile organic compounds, typically means non-methane non-ethane hydrocarbons

HC = individual hydrocarbon compounds (e.g. formaldehyde) or group of hydrocarbons (e.g. PAH)

CO₂ = carbon dioxide



application range and for improved performance. Today more focus is being given to gas engines and especially to oxidation catalysts to promote efficient oxidation of VOC, THC and individual hydrocarbons. An evaluation of new techniques is needed in order to comply with a wider range of stricter emission limits in the near future.

High efficiency ESP

Wärtsilä developed the dry ESP concept for its diesel engines between 1997 and 2000 through the stages of pre-study, pilot testing and comprehensive long-term testing. After the successful completion of the ESP development project, dry ESP has been commercially available for power plants based on Wärtsilä medium-speed engines. The first commercial ESP system is now under construction for a 150-160 MW power plant.

The present dry ESP system is designed to reduce PM emissions from 100-150 mg/Nm³ at 15%-vol O₂ down to 40-50 mg/Nm³ at 15%-vol O₂. Achieving still lower PM levels is a technically challenging task owing to the nature of flue gas and PM emissions. In 2003 Wärtsilä and a sub-supplier will jointly test a boosted ESP unit designed for PM emissions of 30 mg/Nm³ at 15%-vol O₂ also with poor heavy fuel oil qualities.

Wärtsilä intends to continue development of dry ESP in order to achieve PM levels of 20 mg/Nm³ at 15%-vol O₂ within the next three to five years.

Wet limestone FGD

Wet NaOH FGD and dry CaO FGD systems have been developed and released for commercial use with Wärtsilä diesel power plants. The latest step with these systems has been to study the composition and properties of the end-product from a dry CaO FGD system and to verify the results against certain disposal criteria.

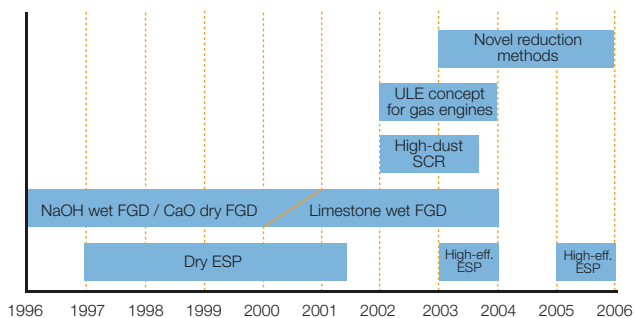
Wet limestone FGD is normally feasible when the fuel oil contains a lot of sulphur. Despite the system's high installation cost, the low price of limestone compared with other reagents often means that the total cost of an FGD system is lower than for other methods. Wet limestone technology has been used in boiler plants for many decades. The transfer of this technology to diesel engine applications involves certain risks. Owing to the variety of flue gas properties, a comprehensive study and follow-up must be performed before the technique can be released for commercial use.

Wärtsilä's first commercial wet limestone FGD system has now been monitored for more than a year. The performance guarantees of the FGD system were achieved at the system's start-up, and its follow-up has continued successfully. A second commercial wet FGD system is under construction at a 150-160 MW power plant in Central America.

High dust SCR

SCR systems have been in use for many years with gas engines and diesel engines burning good quality fuels. The tendency to use poor quality fuel oils in specific applications while adhering to strict NO_x emission requirements has created a dilemma. Wärtsilä has been testing an SCR system with a different catalyst structure and improved

Wärtsilä's development in the past, today and future



Examples of the development of secondary air emission control methods in Wärtsilä.



SCR element (WPPP)

Wasa Pilot Power Plant in Vaasa.



soot blowing equipment at the Wasa Pilot Power Plant (WPPP) in Vaasa, Finland. The test has continued successfully for more than six months and all the problems faced with normal SCR systems are absent. It is expected that this technique will be fully released for commercial use with Wärtsilä diesel engines within the next six months.

The ultra-low emissions concept

In most parts of the world Wärtsilä lean-burn gas engines can manage without secondary air emission control systems or with a small oxidation catalyst if only minor CO reduction is needed. In certain locations, however, pollution is already so high that new plants are subject to extremely low emission limits. In some states in the USA, for example, gas engine plants must be equipped with effective SCR and oxidation catalyst systems. Wärtsilä's ultra-low emissions concept has been developed for this purpose.

In gas engine plants NO_x emission levels as low as 5 ppm (dry, at 15%-vol O₂) can be reached with an SCR system equipped with a sophisticated control system. A test was carried out in Denmark in 2002 in co-operation with an SCR supplier to study the long-term performance of such a system. The NO_x reduction efficiency after a Wärtsilä 18V32DF was found to be excellent both at the beginning and at the end of the test period.

SCR installations with gas engines have already been delivered in the USA, in which NO_x emissions of less than 5-10 ppm (dry, at 15%-vol O₂) have been measured.

Waste

Normal construction waste, such as packing material, is produced during the construction of a power plant. This material is either sent to a local disposal site for disposal or utilized according to local conditions.

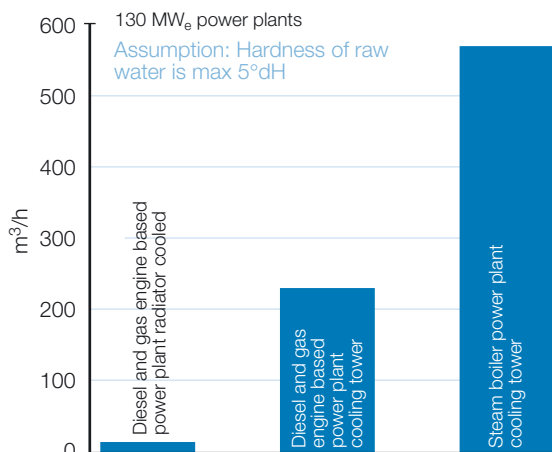
Most of the environmental impact of a Wärtsilä power plant during its lifecycle comes from the operation of the plant. Operation of an engine-driven power plant normally generates only small amounts of waste. The waste fractions from the engine and its auxiliaries consisted of replaced spare parts, used lubrication oil and oily sludge.

The replaced metal parts are normally reprocessed to produce lower quality metal products locally. Exchangeable filters, oily rags and similar waste might be disposed of or incinerated on site according to standards and local regulations or at an external facility.

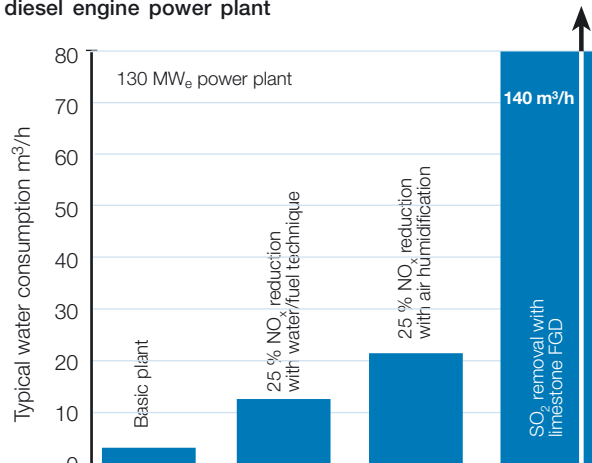
Procedures for oily wastes, including used lubrication oil and oily sludge, vary from case to case from utilization by oil suppliers to produce new oil products, to incineration at the site.

The end-products, liquid or solid, produced by flue gas treatment systems can themselves be problematical from the environmental point of view. The catalyst material of an

Raw water consumption in different power plants



Examples of the effect of flue gas emission reduction techniques on the water consumption for a 130 MWₑ diesel engine power plant



SCR reactor design for the ultra-low emission solution (Grindstedt).



SCR, and the oxidation catalyst that must be changed at intervals, is normally sent back to the supplier of the unit for reprocessing to produce new catalytic material. ESP units produce small amounts of fly ash that contain organic and inorganic compounds. The volume of the FGD end-product depends on the plant size and sulphur content of the fuel oil. Wärtsilä has recently conducted studies of end-products from ESP and FGD systems in order to help customers evaluate such issues in real commercial projects.

Water consumption

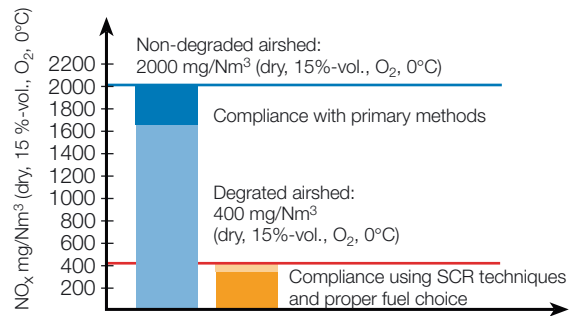
Water is needed in all aspects of life. Water is also crucial for economic and social development, including energy production, agriculture and domestic and industrial water supplies. It is estimated that only 2.5% of all the Earth's water resources is fresh water and only 0.26% of this amount is easily available and renewable, such as in lakes and rivers. In many locations already scarce water resources are limited by water pollution and irregular rainfall patterns.

Given the overall lack of water, there is clearly a demand for power plants with low water consumption. Compared to many competitive methods an engine-driven power plant equipped with closed-loop radiators is very advantageous. Likewise, gas or diesel engines installations with cooling towers use less water than steam boiler installations with cooling towers.

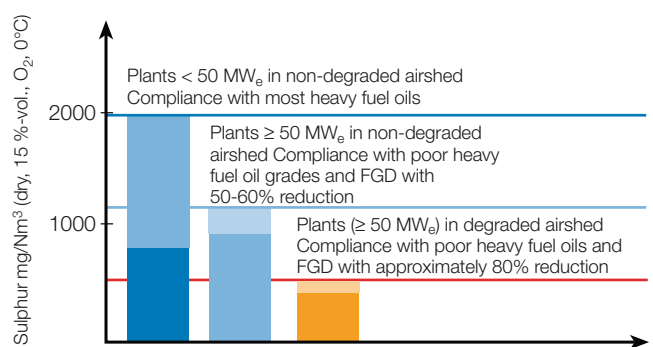
Water consumption is an increasingly important factor when selecting the most feasible plant configuration. Wärtsilä has long considered water consumption to be an important item in the design of its power plants. Unfortunately the use of secondary air emission abatement techniques instead of dry primary methods can dramatically increase water consumption and should be evaluated against the benefits of reduced air emissions. NO_x emissions can be partly reduced using dry primary methods but this results in higher fuel consumption and therefore also higher CO₂ emissions compared to wet primary methods.

Wärtsilä's target for water consumption has been to keep it as low as practicable considering also other limitations. Radiator cooling has become more common instead of cooling towers. The company is continuously developing its dry NO_x primary reduction techniques especially for markets where the availability of fresh water is low.

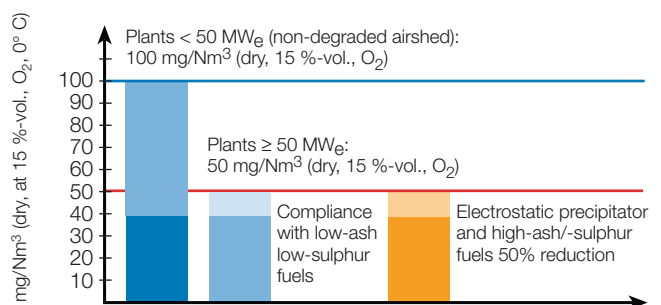
NO_x emissions compliance of Wärtsilä products with World Bank 1998 Guidelines



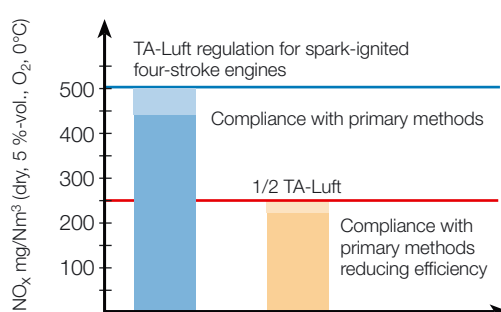
SO_x emissions compliance of Wärtsilä products with World Bank 1998 Guidelines



Particle emissions compliance of Wärtsilä products with World Bank 1998 Guidelines



NO_x emission compliance for gas engine power plant



Indian limits

Parameter		1 July 2003	1 July 2003 – 1 July 2005	1 July 2005
NMHC (as C) (at 15% O ₂) mg/Nm ³		150	100	100
PM (at 15% O ₂) mg/Nm ³	LFO	75	75	75
PM (at 15% O ₂) mg/Nm ³	HFO	150	100	100
CO (at 15% O ₂) mg/Nm ³		150	150	150
Sulphur in fuel	Cities	< 2%	< 2%	< 2%
Sulphur in fuel	Rural areas	< 4%	< 4%	< 4%

Indian limits (2002) for diesel engines in addition to NO_x emission limits (Nm³ is defined at 25 °C and 101 kPa).

Compliance

Wärtsilä's product development strategy for diesel power plants has been to fulfil the World Bank's stack emission guidelines for applications located in a non-degraded airshed by using primary methods and with an appropriate fuel choice. Secondary flue gas treatment methods such as FGD, SCR and ESP are available for applications located in a degraded airshed, subject to more strict national limits or designed for low-cost poor fuel qualities.

The compliance of a power plant with the relevant ambient air quality guidelines or regulations is the responsibility of the plant owner. The resulting ambient air quality is a combination of the effects of various sources, including traffic, natural sources, other industrial plants and households, and it also depends on the local momentary and seasonal weather conditions.

German TA-Luft regulations have been applied widely to gas engine plants in markets other than Germany. The latest TA-Luft 2002, released in 2002, sets stricter limits on dust and CO emissions. Wärtsilä's strategy for lean-burn gas engines, including its dual-fuel engine (DF) in gas mode, is to comply with the TA-Luft regulation using primary techniques as far as practicable. The use of a CO oxidation catalyst is normally required for compliance with the TA-Luft regulations today.

India has long been an important market for Wärtsilä diesel power plants. India has recently launched new regulations for diesel engines in which emission limits are classified for different locations, plant sizes and date of commissioning. There is a clear target to minimize NO_x emissions from diesel engines, putting pressure on the need for developing and adapting more efficient primary methods.

The complete set of parameters in the new Indian regulation contains NMHC, PM, CO and SO₂ emission limits in addition to NO_x emissions. The CO and NMHC emission limits can be fulfilled using primary methods. With most of the fuel oils available in India the PM emissions already meet the limits without the need for secondary particulate removal systems. The SO₂ emission limits are set by the maximum sulphur content in the fuel; if the sulphur content in the fuel oil is higher than the limits, 90% SO₂ reduction is required.

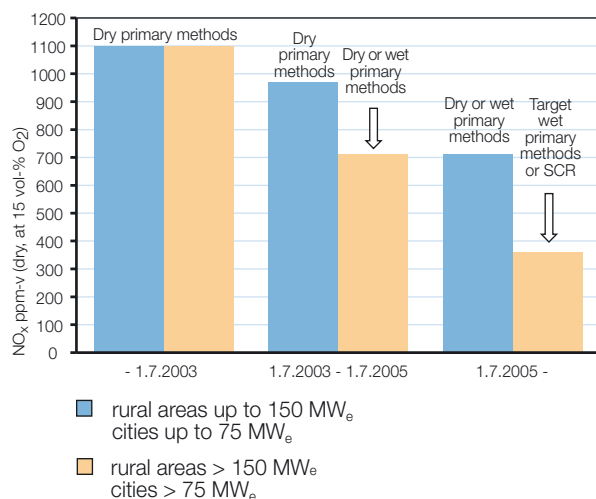
Installations of emissions reduction technologies

SCR units have been installed at both gas and diesel engine installations. The normal levels of NO_x emissions reached with an SCR in diesel engine applications have been about 90-180 ppm-v (dry, at 15%-vol O₂) while in some areas in the USA extremely low NO_x emissions of 5-10 ppm-v (dry, at 15%-vol O₂) have been required with gas engines. Both these levels mean a relative NO_x reduction of 80-90%.

Flue gas emission control equipment delivered or currently on order from Wärtsilä (Feb. 2003) for power plant applications.

	No. of engines	Output (MW)
SCR	115	847
Oxidation catalyst	196	720
ESP	10	160
FGD	52	630

NO_x emission limits in India for diesel engines



The Cerestar (Wärtsilä 16V46) power plant in Germany is equipped with sophisticated heat recovery systems allowing above 90% total efficiency. The plant also has an SCR unit and a wet NaOH FGD making it possible to comply with the strict TA-Luft (1986) limits.



An oxidation catalyst has been used to reduce carbon monoxide (CO) and hydrocarbons (NMHC/VOC) in gas engine installations. However, oxidation catalysts are not normally used with fuel-oil fired diesel engines firstly because these engines can normally fulfil the requirements without the need for secondary flue gas treatment and secondly because the oxidation catalyst is sensitive for toxification by sulphur emissions.

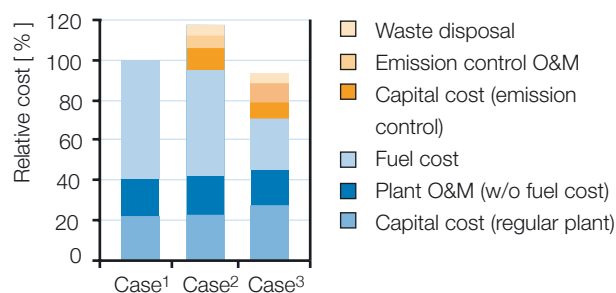
Dry ESP technology is gradually becoming a reality also in commercial diesel engine power plants. After long development and testing, the dry ESP technique has been commercialized and the first installation is now under construction. Dry ESP technology is not feasible with gas engine plants because of their low PM emissions.

There are several different FGD techniques available on the market. Three of these have been successfully used with Wärtsilä diesel engine power plants: namely wet limestone FGD, wet NaOH FGD and dry CaO FGD. There are two trends in the markets concerning the need for desulphurization as a secondary method. The first is the use of cheap high-sulphur fuel oil requiring an FGD system, and in this case the most common selection choice is a wet limestone FGD. The second is that an FGD system is needed for some reason due to a low-sulphur fuel oil, and in many such cases the most feasible system is a wet NaOH scrubber. However, it should be observed that the use of the FGD system requires complicated end-product issues to be solved and that the price of the high-sulphur fuel oil must be low enough compared to low-sulphur oil to make the use of FGD economically feasible.

Fuel quality has a considerable impact on a power plant's exhaust gas emissions and consequently also on the type and degree of cleaning technology required. A poor-quality fuel, high in sulphur and ash, may need flue gas desulphurization (FGD) and particle abatement systems while a low-sulphur, low-ash fuel does not necessarily need any treatment.

A poor-quality fuel may result in lower fuel costs but the cleaning technology on the other hand requires additional capital investments and additional operating costs. The customer will make the investment decision based on the total lifecycle cost corresponding to a certain electricity price. Both capital costs and operating costs are considered overall lifecycle costs. See figure below.

Power plant electricity production costs as a function of fuel quality and cleaning techniques.



Case 1. Good-quality HFO, no emission control

Case 2. Low-cost HFO, particle control with ESP, flue gas desulphurization

Case 3. Low-cost emulsified fuel, particle control with ESP, flue gas desulphurization



Tranås Energy, Sweden.
BioPower, CHP, 15 MW_{th}/1 MW_e.

Boiler applications

Wärtsilä manufactures and supplies boiler plants designed to operate on biofuels, gas and oil. 2002 was the first full year in which Wärtsilä delivered boiler plants to customers outside Finland.

The emphasis in the company's boiler plant business is on boilers and power plants that use renewable energy, or biomass, as fuel. This report focuses on biomass-fired technologies. The total delivered capacity in 2002 was 86.5 MW_{th}.

Typically the same environmental criteria and properties apply to boiler plants as to power plants based on diesel engines.

Oil- and gas-fired boilers

Oil- and gas-fired boilers are fire tube constructions for unit capacities from 1 MW_{th} up to 15 MW_{th} both for water or steam applications. Typical boiler plants consist of several boiler units. The largest boiler plants range to over 70 MW_{th} in output.

The total capacity of oil- and gas-fired boilers sold by Wärtsilä in 2002 was 30 MW_{th}. Most of these were delivered customers in Russia and Finland. Some were backup boilers in biomass-fired boiler plants.

Biomass-based energy production

The main product line is biomass-fired boilers (biofuelled boilers), which are based on a rotating grate combustion process and patented Biograte technology. Heat-only applications are called 'Bioenergy plants' while combined heat and power applications are known as 'BioPower plants'.

The boiler output capacity ranges from 2 to 17 MW_{th}. Smaller boiler plants, from 2 MW_{th} to 5 MW_{th}, are entirely prefabricated including assembly and buildings. Boilers of larger capacities are based on prefabricated modules and assembled on site.

The product range is as follows:

Delivered total capacity of biomass-fired boilers during 2002	
BioEnergy 2 - 5 MW _{th} total capacity	11.5 MW _{th}
BioEnergy 8 - 17 MW _{th} total capacity	45.0 MW _{th}

MATERIALS

Boiler plants consist mainly of steel and masonry materials. The steel is typical construction steel and special steel for higher temperatures and pressures. Some corrosion resistant steel is also used when acidic liquids like water from the flue gas condenser are involved. Building materials are mainly concrete for the foundations, steel and insulation materials. Electrical equipment includes materials for electricity conduction and insulation.

ENERGY

Fuels

Wärtsilä biofuelled boilers are designed to run on wood-based biomass fuels (bark, wood chips, sawdust, wood shavings). These are derived both from various wood treatment processes, such as harvesting, chipping, sawmill processes and other mechanical treatment, and also directly from the forest.

The characteristic features of biomass fuels are

- high moisture content up to 65% (basis)
- low heating value down to 5 MJ/kg as received
- low sulphur content < 0.05% (dry basis)
- low ash content 0.5 - 3% (dry basis)

The typical heat value ranges from 6 to 9 MJ/kg as delivered to the boiler plant. Biomass fuel does not need

predrying before combustion – in fact one of the main advantages of the biomass-fired boiler plant is its ability to burn wet biomasses efficiently.

Large volumes of biomass can contain impurities like metals, soil, sand and stones from the fuel treatment or transporting processes. If not removed from the fuel, impurities can reduce the availability of the boiler plant, for example by requiring manual slag removal from the grate, or by causing corrosion and fouling of the heat transfer surfaces. Impurities are removed using magnetic separators and screens, for example.

Energy efficiency

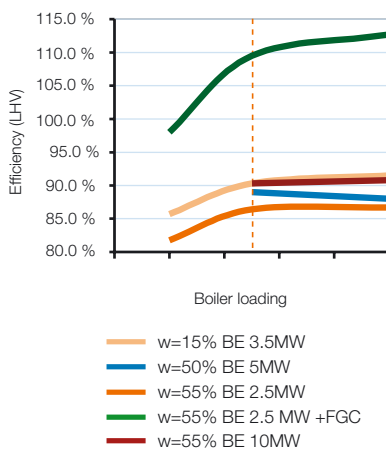
The efficiency of a boiler is mainly determined by the flue gas losses, which are related to the flue gas temperature and the flue gas mass flow: the higher the heat losses, the lower the efficiency and vice versa. Heat losses through heat radiation from the boiler surfaces and unburned compounds in the flue gases have only a minor effect on efficiency, especially when efficient combustion technologies such as the BioGrate method are used.

Clean biomass derived fuels do not contain sulphur or chlorine-bound compounds. This allows applications with a relatively low flue gas temperature, 100-150 °C at full boiler capacity, depending on the temperature of the boiler water, which is typically 110-130 °C in applications where the plant is coupled directly to the network. Higher boiler water temperatures, 140-180 °C, are used in applications where the boiler water pipeline circuit is connected indirectly to the heating network.

Untreated biomass typically contains a lot of water, which lowers the effective heat value of the fuel and increases the flue gas mass flow. Both these properties have a negative impact on the boiler's efficiency. Regardless of the wide variation of the fuel moisture and the corresponding heat value the boiler efficiency level has still been high, 85-90%.

One way of maximizing boiler efficiency is to use an economizer to lower the flue gas temperature and therefore reduce heat losses. When a low water temperature from a heating network is available, another means of raising efficiency is to condense the water vapour in wet flue gases (flue gas condensation, FGC) and to transfer the latent heat from the condensing process to the water used for district heating. Wärtsilä is able to provide all these applications when economical.

The boiler efficiencies of typical Wärtsilä BioEnergy and BioPower boilers.



BE = BioEnergy boiler
FGC = Flue gas condensation included

The results are measured by third-party representatives during delivery.

Typical boiler efficiencies are shown in the figure (page 57) as functions of boiler load (%) and biomass moisture content parameters.

The range of efficiencies is between 85% and 91% at full boiler loads. The highest values are obtained with a fairly dry fuel (15% wet basis). Even with fuels of 55% moisture content, 90% efficiency can be achieved in economizer applications. The increase in fuel moisture from 15% to 60% will reduce boiler efficiency by some 5%. However, when a flue gas condenser is used, efficiency can be raised by as much as 20% or more (based on lower heat value, LHV).

The following figure shows the process efficiencies in a CHP (Combined Heat and Power) application.

In CHP plants electricity is produced using a steam turbine generator and the heat is recovered from the steam condenser and also from the flue gas condenser if installed. The CHP process is typically operated according to heat demand with electricity as a kind of byproduct. The economic performance of biopower plants is optimized by using relatively low steam pressures and temperatures (23-50 bar, 420-450 °C) compared to conventional larger steam power plants. The typical total efficiency of a CHP plant is 85-86% while the electrical efficiency ranges between 13% and 25% depending on the application.

Typical boiler efficiencies for oil-fired boilers fall in range of 85-92% and for natural gas as high as 95%.

Emissions to the air

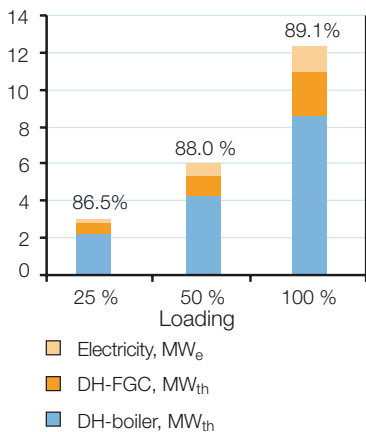
Flue gas emissions from biofuelled boilers mainly consist of NO_x, SO₂, CO, CO₂ and particulates.

Biofuels are renewable fuels; that is, the carbon in the biomasses (e.g. trees) originates from the surrounding air (in the form of CO₂) as the biomasses grow, and is released back into the atmosphere when they are combusted or they decompose naturally. This is the natural ‘lifecycle’ and therefore the amount of carbon (CO₂) in the atmosphere does not change.

This is not the case, however, when fossil fuels are combusted as the carbon in those fuels originates from under the earth and therefore increases the CO₂ content in the atmosphere when released as a byproduct of combustion. Hence the main driver for using biomass fuels today is the need to reduce the environmental impact of CO₂ emissions.

The emissions of oil- and gas-fired boilers are minimized through effective combustion (burner and boiler construction) and the use of accurate lambda control.

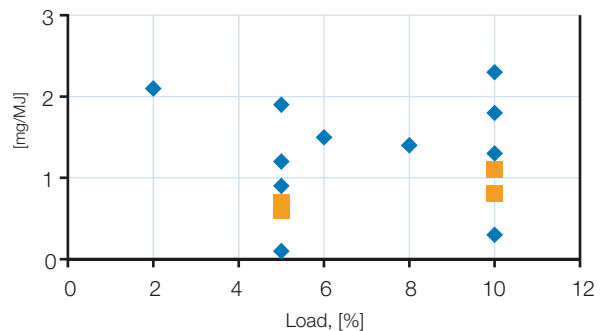
Conversion efficiencies (numbers above the bars) from fuel into electricity and heat.



DH = district heating

The results are measured by third-party representatives during delivery.

Particulate emissions after an ESP in two BioEnergy Plants, 3.5 MW_{th} and 10 MW_{th}



The results are measured by third-party representatives during delivery.



Greenhouse gas emission allowances

Greenhouse gas (GHG) emissions include several gas compounds (e.g. CO₂, CH₄, N₂O) that contribute to atmospheric warming – the ‘greenhouse effect’. The so-called ‘emission allowances’ are determined based on these gases.

Emission allowances are a new form of tradable commodity in the emerging greenhouse gas market and are already traded today in various international, national and inter-company emissions trading schemes. These emission allowances can be an important tool in the financing of biomass-fired energy plants. The European Commission submitted a proposal for an EU directive on this issue in October 2001 and the proposal was approved with various amendments in 2002.

NO_x emissions

NO_x emissions in biomass-fired plants originate mainly from the nitrogen in the fuel. NO_x emissions are reduced by controlling the residence time and local combustion stoichiometry.

The typical NO_x emissions of Wärtsilä’s BioEnergy and Biopower plants are less than 90 mg/MJ (as NO₂, when the nitrogen content of dry fuel is below 0.2%).

CO emissions

CO emissions in Bioenergy and Biopower plants are minimized by keeping the combustion temperature stable and sufficiently high. This is achieved using robust refractory covered combustion chambers and extensive mixing of combustion air and flue gases. The CO emissions are kept below 80-140 mg/MJ, depending on the fuel and application.

Hydrocarbon emissions are not regularly measured but they are typically below 20 mg/MJ.

Sulphur and particulate emissions

Sulphur emissions (SO₂) are also low in biofuelled plants since the sulphur content of wood-based fuels is low. SO₂ emissions are typically below 20 mg/MJ when using clean biomass-derived fuels. No additional removal system is required to meet the emission norms in the EU countries.

The ash content of biomass fuels is often low. Controlling particulate emissions, however, requires special equipment. Different separation techniques will be required depending on the local legislation and the size of the boiler. Particulate levels of 10-50 mg/MJ are typically achieved when using an electrostatic precipitator (ESP). In small BioEnergy plants a particulate level of 200 mg/MJ achievable with multicyclones is normally adequate.

The following figure shows the particulate emission levels of various BioEnergy boiler plants. The results are clearly dependent on boiler loading, based on the drag forces between the gas velocities and particles. Different particle separation properties and variations of fuel ash cause variation at constant boiler loading as well. However, the output particulate emissions can be maintained below the allowed emission limits.

Noise emissions

Noise emissions inside the boiler house are < 85 DB(A) at a distance of 1 m from the noise source (e.g. a fan) and outside < 50 DB(A) at the distance of 50-100 m from the building.

Emission reduction technologies

NO_x and CO are typically minimized by controlling the airflow to the combustion chamber. This is done by feeding air in several stages. Secondary techniques are

The use of oil or gas boilers generates the following emission components: carbon monoxide, hydrocarbons, nitrogen oxides, sulphur dioxide and particulate emissions. The typical values of oil- and gas-fired boilers are presented in the following table:

Emission / fuel	Light fuel oil	Heavy fuel oil	Natural gas	Unit
CO	< 20	< 20	< 20	mg/MJ
C _x H _x	< 7	< 13	< 7	mg/MJ
NO _x	< 60	< 235	< 50	mg/MJ (as NO ₂)
SO ₂	< 10	< 500	-	mg/MJ
Particulates	< 10	< 60	< 5	mg/MJ

normally not needed, since they are not required by current norms, although it is technically possible to reduce NO_x emissions using an ammonia feeding system.

Particulates are removed from the flue gases using either multicyclones or electrostatic filters, which reach much better particulate separation efficiencies than cyclones. Both systems are standard solutions in Wärtsilä's biofuelled boiler plants.

Waste and water consumption

Ash is a typical byproduct of a biofuelled boiler plant. Ash originates from the fuel itself, and the typical ash content of the wood-based fuels burned in Wärtsilä installations is between 1-3%.

The ash is collected using two systems: from below the grate as wet sludge, with a relatively high particulate size range of 50 µm-10 mm when dried; and as fly-ash from the cyclones/electrostatic filter, with a relatively small particulate size range of 1 µm-1 mm.

The ash is reusable. It is typically used as a fertilizer in forests and it is also used as an admixture in concrete by the construction industry.

Biofuelled boiler plants may consume water, depending on the type of application and heat load they are connected to. Water consumption in the bioenergy process (heat production) is around 4 mg/MJ_{fuel} depending on the fuel ash content. Biopower applications (heat and electricity) need new make-up water, typically 15 mg/MJ_{fuel}, if the process fed by the plant requires steam.

Compliance

Regulatory requirements vary from country to country. Wärtsilä Bioenergy and Biopower plants are designed to meet all local emissions limits. The requirements typically cover:

- Combustible gases (CO)
- Nitrogen oxides (such as NO₂)
- Sulphur dioxide (SO₂)
- Particulate emissions.

At present only particulate emissions require an external separator like a multicyclone on its own, an electrostatic precipitator on its own, or a combination (cyclone + ESP, or cyclone + fabric filter). All Wärtsilä biomass-fired boiler plants are equipped with at least a multicyclone.



Service – support during the operational lifetime

Large combustion engines, power plants and propulsion systems are designed and built for a very long operational life. More than 97% of all Vasa 32-type engines delivered since their introduction in the late 1970s are still in operation (taking into account those sunk with their ships or stopped due to weak market conditions). Such high-performance technical systems require systematic maintenance by qualified personnel to keep them operational as needed and their performance levels as close to the designed optimum as possible.

Role of service operations in environmental performance

At Wärtsilä we are committed to honouring our promise to be The Total Service Provider. To us service means more than just providing a prompt supply of parts or sending a maintenance specialist to fix a problem. It means taking responsibility for maintaining or even improving both the operational and the environmental performance of the installations we have delivered, throughout their lifecycle.

Main environmental products in service

We guarantee basic lifecycle support for all equipment supplied by us - parts, field service, workshop service, technical support, operation support and training. Wärtsilä Service Agreements can extend equipment lifetime and optimize the total lifecycle reliability and productivity of an installation.

Wärtsilä produces and provides specific environmentally sustainable products like compact SCRs, chemical-free cooling water treatment, and special cleaning equipment for detergent-free cleaning of coolers, turbochargers and generators (Wärtsilä's eco-friendly chemicals can also be used). Special tools are at hand to

make the performance of maintenance tasks easy and fast to minimize risks during this work.

Reconditioning services restore operational reliability, extend the plant's lifetime, minimize risks and help bring the installation into line with new regulations and environmental targets.

Wärtsilä provides reconditioning at four levels:

- Reconditioning of components or parts
- Complete engine reconditioning
- Exchange service and sales of reconditioned parts and engines, and
- Re-engining or re-powering of the installation.

Reconditioning complete engines can help to meet new environmental requirements, reduce fuel and lubricating oil consumption, and restore operational availability. Propellers are redesigned and modified when needed, and damaged propellers are repaired to keep their hydrodynamical properties and efficiency as high as possible.

Tintrofa



Product liability from Service point of view

In today's business environment where technical development is fast and environmental issues are receiving ever higher priority, Wärtsilä is committed to keeping the investments of its customers productive and profitable throughout the equipment lifecycle.

The overall measure of operating success could be described as 'lifecycle efficiency', which also includes the ability to meet environmental targets. The relative lifecycle efficiency of an application changes over time as technology develops and more efficient solutions become available. Hence a power system installation may need several 're-vitalizing' packages if it is to provide optimum performance throughout its long lifetime.

For this reason Wärtsilä also provides Upgrading & Modernization packages to bring older marine and offshore power systems up to today's technical standards. These cover everything from an initial audit to full modernization of the installation's electrical, mechanical and control/automation systems.

CASE

A recent example of engine conversion and modernization technology in action took place in Portugal.

Tintrofa, a textile company close to Porto, had decided to convert their diesel engine CHP (combined heat and power) plant to run on natural gas. The main incentive for the conversion was to lower emission levels and to raise the plant's efficiency.

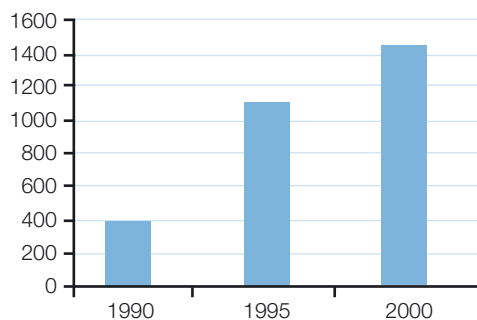
The original plant, built in 1994 and equipped with a Vasa 12V32E genset and exhaust gas heat recovery, had accumulated 48,000 operating hours running on heavy fuel oil (HFO). Full conversion of the plant to run on natural gas required replacing the original engine with a 12V34SG gas engine and the auxiliaries necessary for gas operation, as well making all the other necessary plant changes, commissioning the new plant and providing training for the operating staff.

Steam from the CHP plant is used in the factory for heating and drying. Surplus electricity, up to 60% of the total generated, is sold to the local power grid. In addition, Tintrofa now receives a green gas operation fee for using gas for power generation instead of HFO.

Tintrofa awarded the contract to Wärtsilä in March 2001. Our scope of supply included redesigning the plant, providing the new engine, parts and work for the engine modification, renewing the control system, and providing the gas fuel, alarm, safety and other systems. The conversion project was started in the middle of May and the plant was re-commissioned at the end of June 2001. This fast-track project was made possible by Wärtsilä's ability to convert the power plant in roughly six weeks since all the works were carried out on site.

The plant's performance, as measured in early 2002, is as follows: efficiency (electrical output) 42% and availability over 98%. NO_x emissions were reduced from 5400 mg/Nm³ at 5% O₂ (typical for an HFO-fuelled 12V32E) to

Net sales of modernizations and other environmental products (EUR 1,000)



Environmental products are considered to be products and services which improve the environmental performance of an engine or installation (compared to an engine or installation of similar condition before any such action), or which reduce the environmental risks of an operating engine or installation. The volume of environmental products and their sales are increasing.



around 508 mg/Nm³ (12V32SG NG). Moreover, the periods between maintenance are significantly longer for the converted engine, the degree of automation was considerably raised, space was freed for auxiliary systems, and parasitic loads were eliminated.

Benefits of Service contracts

Any installation performs best, environmentally and operationally, when high-quality fuels and lubricants are used and when it is kept in proper technical condition. This can also mean it is monitored and possibly also operated by the most experienced party – the manufacturer.

Wärtsilä Operations & Service (O&M) agreements are comprehensive in scope and tailored to precise needs, letting customers choose from different levels of partnership agreements, or a day-to-day business relationship. O&M agreements cover all aspects of lifecycle optimization, including parts supply and daily assistance,

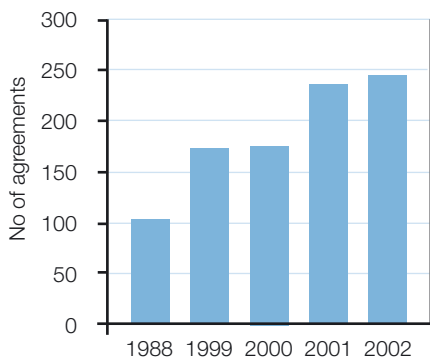
inspection and maintenance. They can include implementation of agreed performance targets and even complete operation & maintenance packages for an installation.

CUSTOMER SERVICE

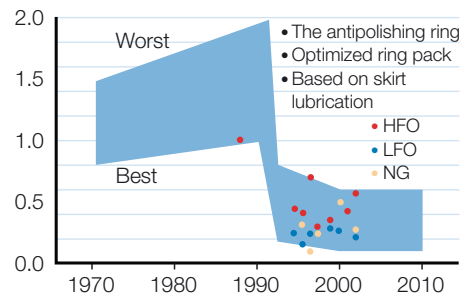
A full in-depth knowledge of every engine, installation, component and system is available to customers through each local Wärtsilä service network company. Product specialists, as well as information and experience on each installation, enable Wärtsilä to provide the best possible lifetime support. This also includes measurement, analysis, investigation and studies of emissions and other environmental properties. Technical and parts support is available by phone 24 hours a day at product companies and major network companies.

Wärtsilä's condition-based maintenance (CBM) service provides remote monitoring and diagnostic support of installations. A combination of manual inspections,

Service agreements in force



Typical lubricating oil consumption of 4-stroke engines (g/kWh)



Measured during field test.



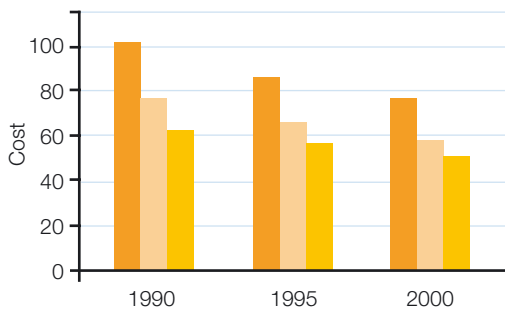
online monitoring of equipment and system efficiency data is used to accurately determine the overall system status and thus predict and optimize maintenance needs.

Wärtsilä is close to its customers through subsidiaries in more than 60 countries. Some 50 workshops worldwide provide the following services: overhaul and repair, reconditioning of equipment, governor and turbocharger services, manufacturing of parts for former engine types, exchange parts service, in-situ machining and propeller blade straightening even under water.

CLOSE TO THE CUSTOMER – BENEFITS FOR ENVIRONMENT

The **Wärtsilä Land & Sea Academy (WLSA)** provides extensive training programmes covering operation, maintenance and safety issues for marine or power plant personnel. With a focused training strategy and qualified teachers, the WLSA provides a thorough understanding of how to optimize the safety, availability, reliability and performance of the installations to meet environmental and financial targets. Training is given in Wärtsilä’s global network of training centres and as on-site training courses. Advanced remote training systems and e-learning enable customers to access an extensive Learning Management System through the Internet.

Maintenance cost development



Maintenance cost development, parts and work during 50 000 operating hours on different fuel qualities (18V32 engine >75% load, year 2000 price level).

- Heavy fuel oil below normal standard quality (sulph.2-5%, ash 0.05-0.2%,van.100-600 mg/kg, sodium 20-50 mg/kg, Al+Si 30-80 mg/kg, CCAI 850-870)
- Heavy fuel oil of normal qty (= low levels prev indic.)
- Diesel oil or light fuel oil



Imatra Steel products

Imatra Steel supplies low-alloy engineering steels and steel products to the automotive industry and other advanced sectors of the mechanical engineering industry. Imatra Steel's operations are founded on full co-operation between its business units, Imatra Steel Works, Imatra Kilsta and Scottish Stampings Forges and Billnäs Spring Works, ranging from product and process development to internal sales.

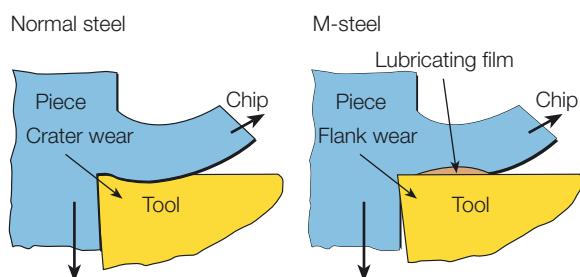
Steelbars

Imatra's steelbars, available as round bars, squares and flats, are predominantly delivered to automotive applications through a diversified supply chain. Typically, long bars supplied by Imatra Steel Works first enter a forging process in which they are forged into a component with roughly the final shape. This is followed by possible heat treatment, machining and finishing in a separate machine shop into a final forged steel component. The component is then delivered to an assembly line for installation into a specific subassembly, e.g. a car or truck engine. This subassembly is then installed in a car or truck.

The automotive supply chain has offered several possibilities for Imatra's R&D to find and maintain environmentally advantageous solutions both for the manufacturing process and through the whole service life of an engineering part.

Direct quenching steel, IMAFORM®, allows the forged component to be quenched in water from the forging temperature without the need for further conventional energy-consuming heat treatment. This decreases environmental hazards and costs.

Lubrication effect of M-steel



Machining of steel forgings requires energy and causes toolbit wear. That is why one of Imatra's main product development targets over the years has been to improve the machinability of the steel it produces. This has led to the product concept called M-steel, where M stands for improved machinability. M-steels offer better machinability than conventional steels without a trade-off with mechanical properties. Better machinability means that the workshop can either use a higher machining speed or alternatively lengthen toolbit life, both of which have a positive impact on machining costs and the environment.

From the standpoint of the steel manufacturer the important environmental aspects in the development of cars and trucks are safety, lightness and recyclability.

Safety requires that the steel components are of high quality and meet strict mechanical requirements, one of the most important of which is fatigue strength. To achieve sufficient fatigue strength properties, the cleanliness and careful inclusion control of the inner structure of the steel play an important role. This is an R&D area that is being given high priority at Imatra Steel Works.

The lightness of a vehicle is a design target that aims for better utilization of the net load of the car or truck. This in turn reduces fuel consumption and hence the risk of pollution over the vehicle's service life. One way this objective can be achieved is to use high-strength steels with advanced properties. Imatra Steel's R&D works in close and intensive co-operation with vehicle designers to extend and further improve the use of high-strength steel grades in customers' products.

Motor vehicles are mainly made of steel or other ferrous materials. At the end of the vehicle's lifecycle it becomes an important source of raw material for steel producers that use scrap steel for raw material, a factor that emphasizes the recyclability of a vehicle. Steel as such can be regarded as 100% recyclable. However, some metallic components manufactured from so-called free cutting steels contain lead to improve machinability, and are therefore not favoured as recyclable materials. Imatra has developed a new steel grade called IMATRA GreenCut[®] to provide customers with an opportunity to replace leaded steel with an unleaded alternative offering equal machining properties.

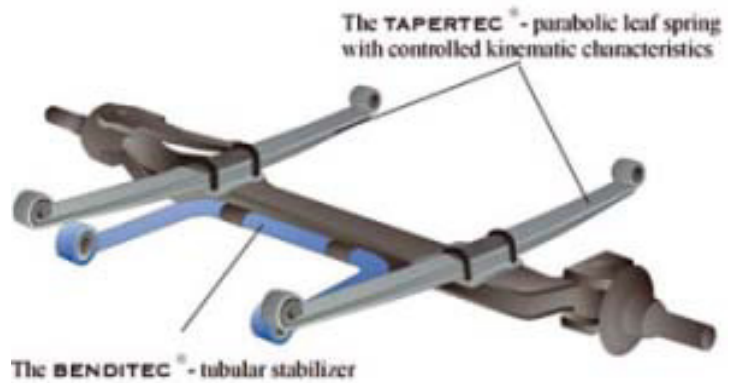


One of the uses of IMAFORM steel is hot forget support arms of cars. Imanite M-steel is used for example for nitrided gears.

The same arguments applied to the automotive industry above also apply to steel deliveries to the mechanical engineering industry although in this case the machinability of steel is even more important.

Tubular stabilizer bars and parabolic springs

The Billnäs Spring Works develops and supplies suspension components to the European heavy truck industry. Its branded products are BENDITEC[®] tubular stabilizer bars and TAPERTEC[®] parabolic springs.



The TAPERTEC[®] - parabolic leaf spring with controlled kinematic characteristics

The BENDITEC[®] - tubular stabilizer

Tubular stabilizers are manufactured from seamless steel tubes. These yield the same mechanical properties that can be achieved using traditional bar-made springs, but with significant weight savings in the final product, i.e. trucks. Consequently this allows reductions in fuel consumption and environmental impacts over the truck's lifecycle. The method used to manufacture the tubular stabilizer itself is pro-environmental if it involves accurate, energy-efficient induction heating to minimize energy losses.

R&D has given strong emphasis to improving the manufacturing process and the materials used for TAPERTEC[®] high-stress parabolic springs in recent years. TAPERTEC[®] springs make it possible to reduce the number of leaves in the final application without losses in suspension properties and service life. The current manufacturing process makes it possible to use lower temperatures and takes advantage of improved material properties. This development work has been so successful that nowadays Billnäs Spring Works is developing and running trials of TAPERTEC[®] springs consisting of only one leaf for a heavy truck application.

Die-forged products

Imatra Kilsta AB is one of the world's leading manufacturers of die-forged products, particularly for the heavy vehicle industry. Imatra Kilsta specializes in heavy crankshafts, front axle beams, steering knuckles and other steering components.

The forge is equipped with the latest technology both in the forging presses and ancillary equipment in order to meet the high demands of the automotive industry with regard to quality, tolerances, drafts and design. Among other equipment, Imatra Kilsta possesses the most powerful and fully computerized forging press in the world. This is used to produce heavy diesel engine crankshafts and front axle beams for trucks and buses.



Imatra Kilsta's subsidiary, Scottish Stampings, is the leading European manufacturer of forged and machined front axle beams for the commercial vehicle industry. Scottish Stampings's dedicated production process includes some of the latest technologies to ensure that

beams of the highest industry standards are supplied to customers. With a product weight range of 30-180 kg Scottish Stampings has the flexibility to supply low-to-high-volume series in a variety of materials, heat-treated and in finished conditions including fully machined.

Imatra Steel's position in the supply chain

Material supplies

The raw material used in Imatra Steel's production chain consists almost entirely of recycled steel.

Imatra Steel Works

The Imatra Steel Works produces low-alloy round, flat and square bars for demanding customers in the automotive and mechanical engineering industries. Deliveries go to the Kilsta Forge and Billnäs Spring Works, and to other automotive and mechanical engineering companies.

Kilsta Forge

The Kilsta Forge specializes in forged engine and front axle components for heavy commercial vehicles. Deliveries are shipped directly to customers' engine and axle factories.

Billnäs Spring Works

The Billnäs Spring Works supplies spring components to the European heavy commercial truck industry. Most deliveries are shipped directly to the assembly lines of vehicle producers.



The recycler

Metal recycling companies recycle disused vehicles and other capital goods for further processing and reuse. The scrap returns to the steel works, completing the circle.

The user

The user purchases a safe, reliable and pleasant-to-drive vehicle that gives efficient service for years. Nonetheless its useful life will one day come to an end.

The OEM manufacturer

Systems and components are assembled into complete vehicles.

The system supplier

Engines and axels are assembled in specific factories into complete systems for final assembly.



Operational Performance

The structure of the Wärtsilä Group changed considerably in 2001-2002. In line with The Ship Power supply concept Wärtsilä acquired the propulsion and marine seals specialist John Crane-Lips in January 2002. Renamed Wärtsilä Propulsion, this company has its main activities in the Netherlands, the UK, Norway, the USA and Japan, with a total workforce of 1,200 persons.

The Power Plants Division of the Group entered the biofuel energy market in 2001 with the acquisition of the Finnish company Sermet, which specializes in boiler plants running mainly on biofuels.

Wärtsilä's Service division has invested considerably in new activities during the past two years with a view to expanding its service offering beyond the scope of Wärtsilä and Sulzer engines. In a drive to become a full service provider the division has acquired a number of marine field service companies in Sweden, Singapore, Canada, Denmark, USA and the Netherlands. These companies, with altogether 338 employees, have all been regrouped under the Ciserv brand.

In order to adapt to market conditions and to reduce capacity costs, Wärtsilä has taken further restructuring measures, mainly within its production operations. Welding workshop in Wärtsilä Italy, in Trieste, was outsourced in 2001 to an Italian company, which took

over the entire staff of 109 persons and continues this activity on the same site. Production at the Zwolle factory of Wärtsilä Netherlands was discontinued in 2002 and production of the Wärtsilä 26 and 38 engines was moved to Trieste. Component manufacturing continues in Zwolle by a company that took over 60 employees from Wärtsilä. Altogether 320 employees will leave Wärtsilä Netherlands in Zwolle between 2002 and 2005 under a social plan agreed with employee representatives and the relevant authorities.

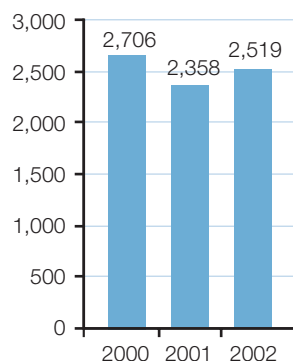
In 2002 the total number of employees in the whole Group increased by 1,337 through acquisitions. Excluding acquisitions, net employment decreased by 70 persons.

Operational performance covers the economic, environmental and social aspects of Wärtsilä's operations. The operational performance data includes all the premises as well as the activities related to these premises such as manufacturing, sales, technology and services.

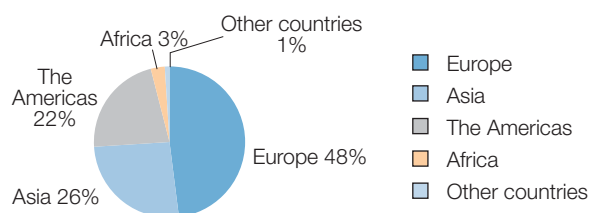


Economic performance

Net sales (MEUR)



Geographical breakdown of markets in 2002



Economic performance involves meeting the expectations of shareholders and contributing towards the wellbeing of society. This requires that the company's operations are efficient, profitable and competitive. Good economic performance establishes a platform for the other aspects of sustainability.

Economic value-added

Wärtsilä's purpose is to create value for its various stakeholders. The focus is on profitability and generating a good long-term investment return for shareholders. Achieving this depends on Wärtsilä's ability to satisfy the expectations of its other stakeholders as well. This includes providing customers with high-quality products, solutions and services, building long-term partnerships with suppliers, offering employees competitive compensation and working conditions, and contributing to the wellbeing of the local communities in which Wärtsilä operates.

Customers

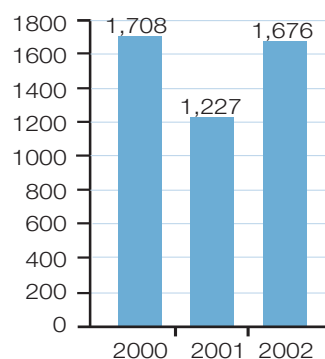
Wärtsilä creates value for its customers by providing products, solutions and services that fulfil their needs and expectations. As the leading global ship power supplier and a major provider of solutions for decentralized power generation and supporting services Wärtsilä is able to provide high-quality, reliable and environmentally sound solutions for its customers.

Wärtsilä's net sales totalled EUR 2,519.0 million in 2002. Europe contributed 48%, Asia 26%, the Americas 22% and Africa 3% to Wärtsilä's overall net sales.

Suppliers

Suppliers play a significant role in Wärtsilä's delivery process. Wärtsilä aims to deepen the partnerships with its suppliers in order to ensure that both parties have a mutual understanding of Wärtsilä's strict process and product requirements. Apart from financial benefits, partnerships create added value for suppliers through the knowledge and development support Wärtsilä offers them.

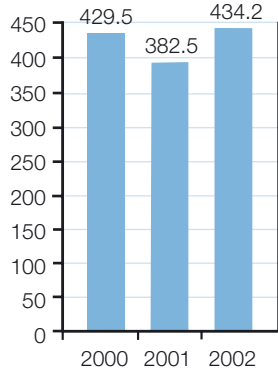
Cost of all goods, materials, and services purchased (MEUR)



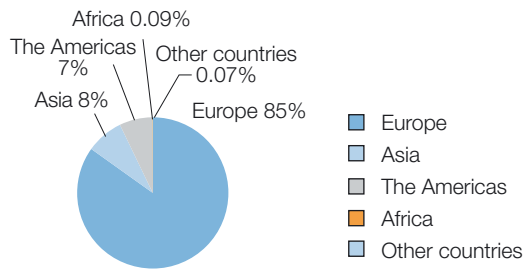
Value-added distributed to Wärtsilä's stakeholders

MEUR		2000	2001	2002
Generation of value-added				
Customers	Net sales	2,706.8	2,358.7	2,519.0
Suppliers	Cost of all goods, materials and services purchased	-1,708.7	-1,227.1	-1,676.7
	Value-added	998.1	1,131.6	842.3
	Distributed to stakeholders	825.4	937.7	719.1
Distribution of value-added				
Employees	Wages and salaries	429.5	382.5	434.2
Public sector	Taxes and social dues	221.3	302.2	162.2
Creditors	Interest on debt and borrowings	31.0	15.2	18.5
Shareholders	Dividends	143.6	237.8	104.1
	Retained in the business	172.6	193.9	123.2

Wages and salaries (MEUR)



Geographical breakdown of salaries in 2002



In 2002 the value of goods, materials and services purchased by Wäertsilä was EUR 1,676.7 million. Wäertsilä has more than 8,000 active suppliers, most of whom are located in Europe where Wäertsilä has its main production units. Wäertsilä also has a significant number of suppliers in Asia.

Employees

At the end of 2002 Wäertsilä had 12,459 employees worldwide. Wäertsilä also employed thousands of people indirectly through its supply chain. In order to be able to recruit competent and motivated people, Wäertsilä strives to be an attractive employer by creating value for its employees. This includes offering of competitive salaries, opportunities for continuous personal development and a good working environment. Developing employee skills and competences is considered to be of critical importance both for Wäertsilä's business performance and for the development of the company's employees.

Salaries totalled EUR 434.2 million in 2002. This sum includes basic salaries as well as payments based on various incentive schemes, which cover about 60% of the total personnel.

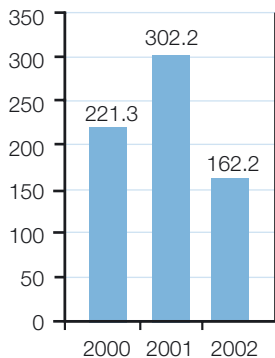
Public sector

Wäertsilä pays various social dues and taxes to the governments of various countries. Income taxes and social dues in the financial period 2002 were EUR 162.2 million. The social costs for employees that Wäertsilä pays in most countries contribute to the funding of pensions, unemployment and other social benefits that provide security and improve the quality of life for the company's employees and their families.

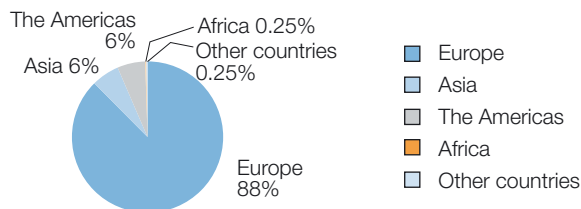
Wäertsilä companies also receive subsidies from the public sector. The value of the subsidies received in 2002 was EUR 2.71 million and they were mainly related to R&D projects¹.

¹The figure includes the subsidies received from 10 major Wäertsilä companies.

Taxes and social dues (MEUR)



Geographical breakdown of taxes and social dues in 2002



Wärtsilä has 12,500 employees worldwide.



Creditors and shareholders

In 2002 Wärtsilä paid EUR 18.5 million in interest to its creditors and EUR 104.1 million in dividends to its shareholders. Wärtsilä's dividend policy is to pay a dividend equivalent to 50% of its operational earnings per share. In recent years the company has distributed an extra dividend based on the sales of certain non-core business interests.

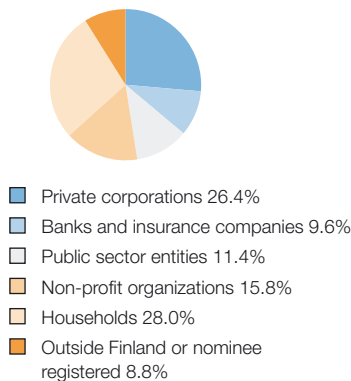
Community support

Wärtsilä provides financial support for a number of cultural, social and sports activities. At the corporate level the Board of Directors decided to reserve the sum of EUR 64,500 for charitable purposes.

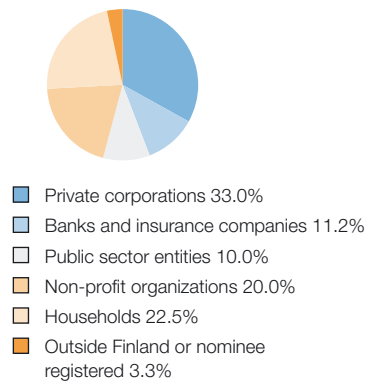
All the individual Group companies also support local community activities. For example the total support provided by Wärtsilä Finland for cultural, educational, sports and similar activities in 2002 was EUR 133,460.

In autumn 2001 and early 2002 Wärtsilä carried out its first 'Childrens' Hour' pilot project in co-operation with the International Youth Foundation in certain Group companies. Under this campaign employees were given the opportunity to donate a sum of money corresponding to one hour's salary for different projects supporting young people and children. The contribution of the employees was matched by a similar contribution by Wärtsilä itself. The participation rate was close to 60% in the Group companies that took part in the campaign.

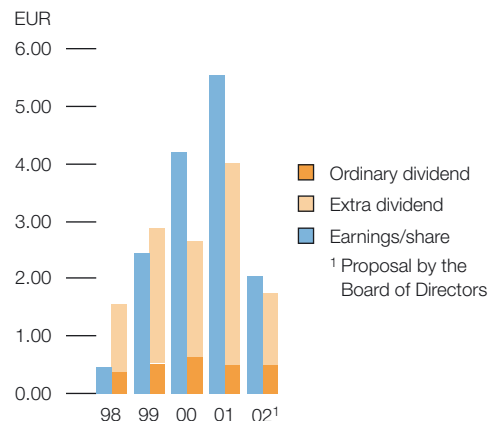
Ownership structure according to shares 31 Dec. 2002



Ownership structure according to votes 31 Dec. 2002

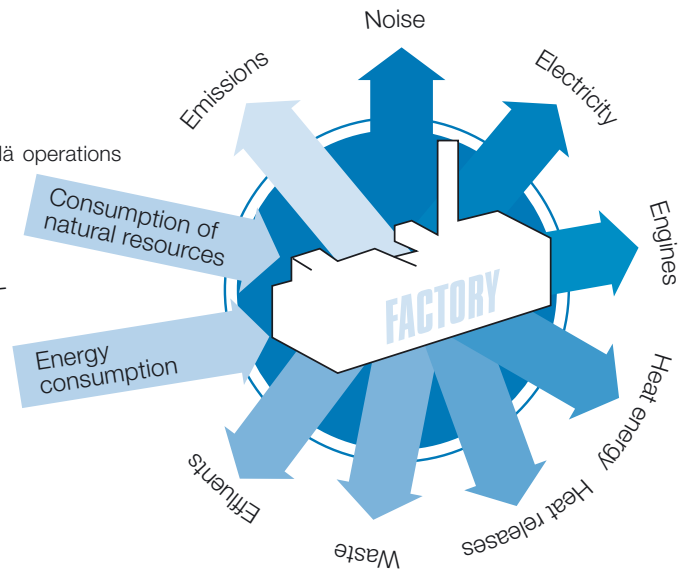


Earnings/share Dividend/share



Environmental performance of the Power Divisions

Environmental aspects of Wärtsilä operations



Good environmental performance means sound management of natural resources and the environment. Protecting the air, soil and water as well as combating climate change and using natural resources in a sustainable way are all important objectives.

Manufacturing is the major element in operational performance related to our premises and for this reason the following eco-balance describes our manufacturing activities. All other Wärtsilä activities are included in our performance data.

Reporting coverage in Wärtsilä changed in 2002, which explains the increased values of certain performance indicators.

ENERGY

Total energy consumption

The total energy consumption (in terajoules) presented below includes the electricity, heat and fuels used in our premises in recent years.

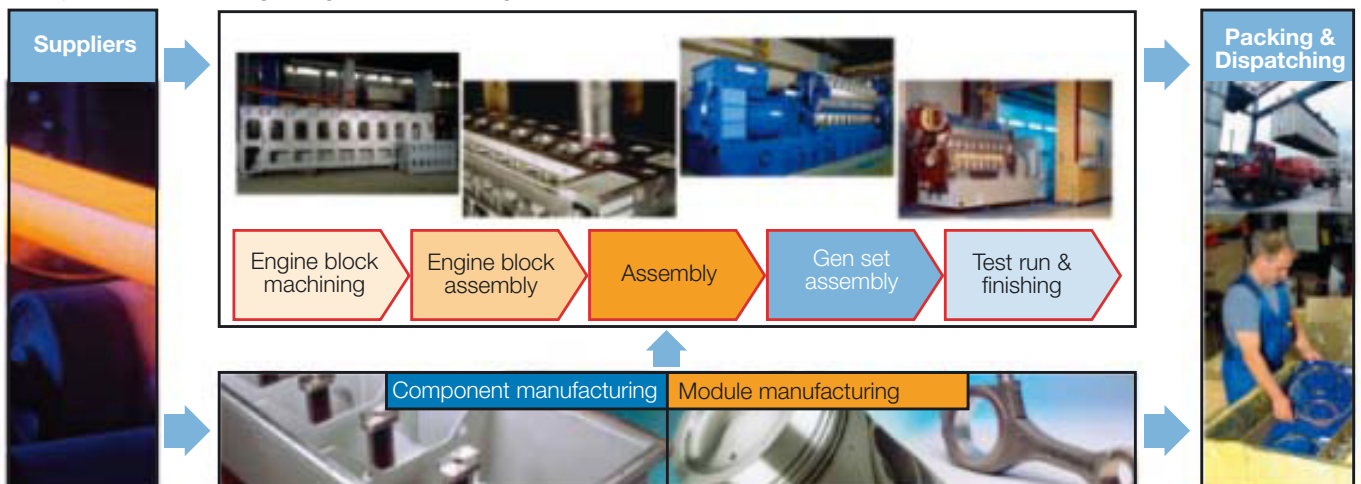
Electricity

The energy generated from engine test runs is increasingly put to further use. Both the electrical and the heat energy generated in our test runs can be utilized. Wärtsilä's aim is to utilize itself the electrical energy generated while also selling part of this electrical energy to a local power company. Due to the nature of engine test runs, the production of electricity and the company's electricity demand are not equivalent; this allows the surplus energy to be sold to a local power company.

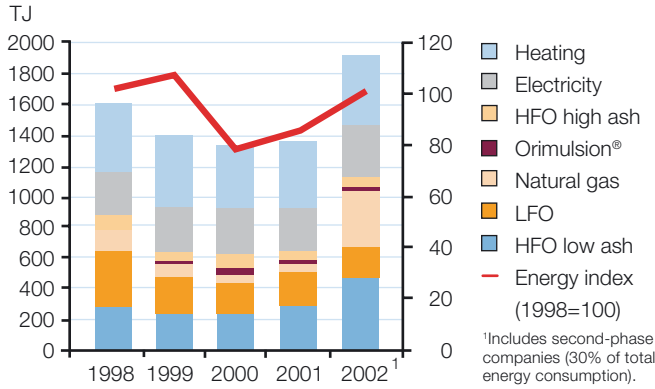
The environmental aspects of manufacturing relate to the use of energy and natural resources and consequently to producing emissions, effluents and solid waste.

Natural resources are used as follows: metal parts and other materials, for engine and propeller raw materials; heavy (HFO) and light fuel oil (LFO) and natural gas (LNG), for engine test runs and LNG in process heating; electrical and heat energy, in buildings and properties and for production equipment maintenance. Noise emissions occur as well. Wärtsilä factories produce not only engines and other Wärtsilä products but in some cases also electricity and heat that can be utilized from the energy consumed when testing engines.

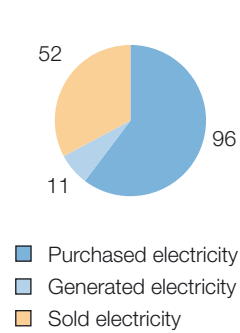
Main processes in diesel/gas engine manufacturing



Annual energy consumption



Electricity balance 2002 in GWh



Heat

In several factories the generated heat in a test run is used for heating. The figure below shows heat consumption in Wärtsilä.

Water

The water consumed by Wärtsilä can be divided into two categories: domestic use and cooling use. Domestic water is used mainly by washing machines and other industrial equipment and by employees, and also to produce moulds in some factories.

Heat emissions from water systems arise from engine cooling and process cooling water. Some Wärtsilä companies use water from the local watercourse for their engine and process cooling needs. In such cases, the cooling water system is kept separate so that only heat is released into the natural water system.

Emissions to the air

The primary source of manufacturing noise is engine test runs and ventilation machinery on the factory floor. This noise is mostly low-frequency and is therefore not easily detected by the human ear. Wärtsilä has specifically

addressed the issue of noise protection using technical means and we have succeeded in lowering noise levels considerably.

Air emissions are mainly caused by test runs and the painting of completed engines or other Wärtsilä products. Test run emissions consist of nitrogen oxides, sulphur dioxide, carbon dioxides and particles, as well as small amounts of other emission components. The painting of engines and other Wärtsilä products generates VOC (volatile organic compounds) emissions.

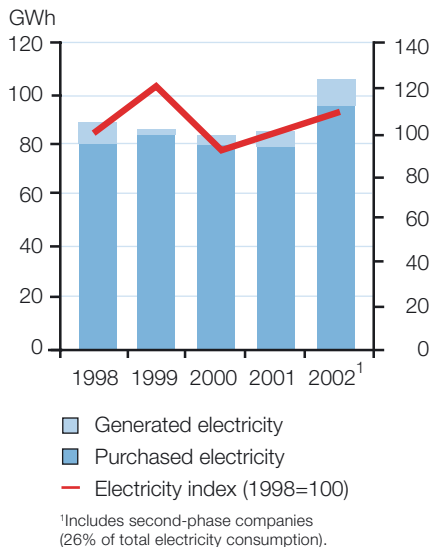
The figures on pages 74-75 shows Wärtsilä's air emissions from engine test runs during recent years and emission trends related to production volumes. All the figures include emissions from engine tests performed in Wärtsilä engine laboratories.

The figure on page 74 shows Wärtsilä VOC emissions from painting activities.

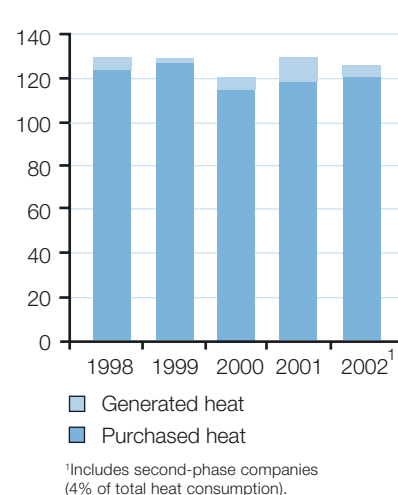
Compliance

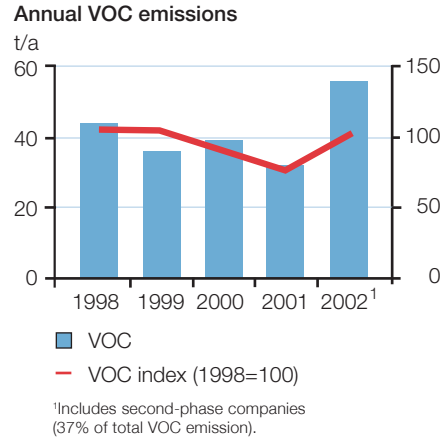
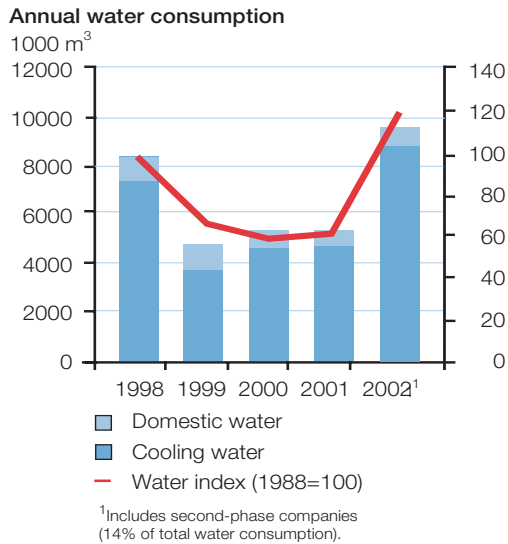
The operations of Wärtsilä's product companies and laboratories require a valid environmental permit. Wärtsilä companies have the required environmental permits, the terms of which are generally met. Incidents of non-compliance are described below.

Annual electricity consumption



Annual heat consumption (GWh)





Monitoring environmental impacts

Within Wärtsilä, environmental impacts caused by operational activities are monitored as follows:

- Participation, for example, in the monitoring of air quality with other local stakeholders
- Measurement of air emissions
- Charting of noise levels
- Periodical effluent analysis
- Soil analysis.

In addition Wärtsilä Finland Oy has participated in making the following surveys: nitrogen fallout patterns, bio-indicator surveys, and NO_x and SO₂ diffusion surveys.

Environmental disturbances and complaints

The number of disturbances, complaints and non-compliances are shown in the figure below. The reported disturbances cover incidents where a Wärtsilä company is usually obliged to report the incident to the authorities.

The following major environmental disturbances occurred at Wärtsilä locations during 2002:

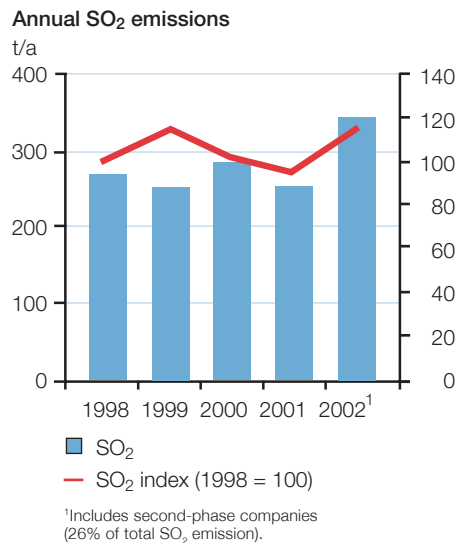
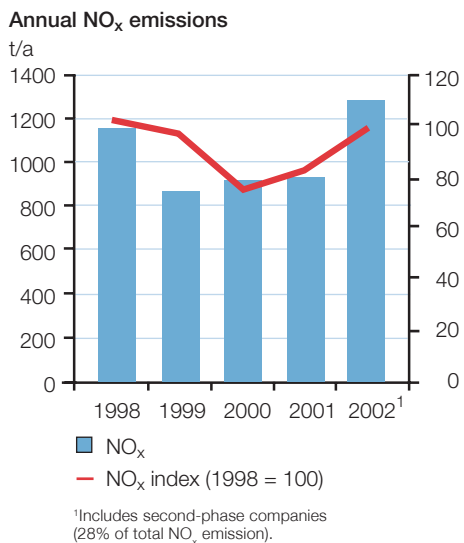
- 6 small fire hazards
- 2 water damages
- Minor oil spillages and leakages.

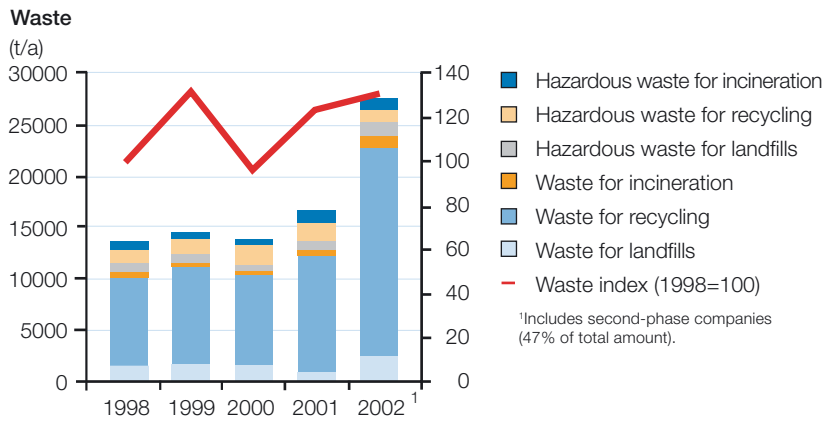
All the above disturbances were inspected and appropriate corrective action was taken.

The major environmental concerns were in most cases voiced by our neighbours. The most common reason for a complaint is noise. All complaints are investigated and the necessary corrective action is taken if needed.

Non-compliance cases

In Norway the non-compliance case is related to efficiency of the oil separator in a spill oil tank. The first corrective has been taken and a permanent solution is being investigated.





In Spain the non-compliance cases are related to:

- Defects in the test bed fuel system
- Defects in the auxiliary boiler
- Delayed periodical inspection of a transformer substation
- Defects in the noise insulation due to insufficient door sealing.

Wärtsilä Spain has taken all the corrective action needed to rectify the non-compliance cases during 2002.

In Wärtsilä France the findings from an internal study resulted in the need for corrective action, most of which has been taken.

The remaining non-compliances are related to:

- Untreated discharges of run-off water to the watercourse
- Hydrants for fire protection
- Cooling system for test bed
- Height of the stacks
- Waste water treatment.

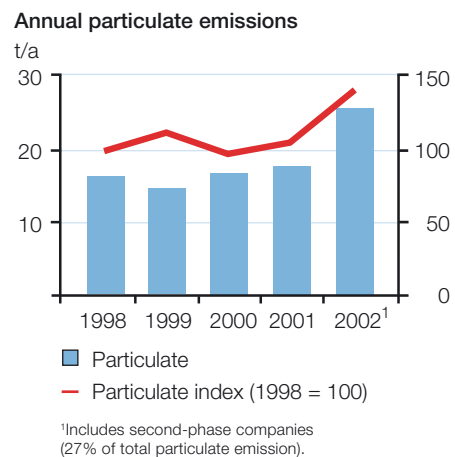
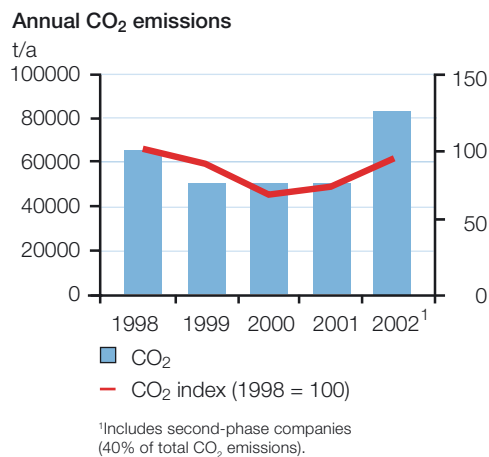
The first three were fixed during 2002, the proposal for solving the fourth has been sent to the authorities, and the last case is under investigation.

Non-compliance cases presented in previous reports

In Wärtsilä Italy the test running of one engine type caused a higher noise level at night-time than was stated in the permit conditions. Wärtsilä installed new silencers during June 2001.

Waste management

Manufacturing activities causes various wastes. These are divided into two main categories: hazardous and non-hazardous. Hazardous wastes include the use of cutting fluids, various types of waste oil, paint and solvent waste, oily wastes and solid wastes, etc. Hazardous wastes are taken to a hazardous waste disposal facility for appropriate treatment.



Environmental capital expenditures and operating expenses					
MEUR	1998	1999	2000	2001	2002
Environmental capital expenditures	0.7	0.7	3.0	5.2	1.8
Environmental operating expenses	2.2	2.2	2.4	2.3	4.0

All Wärtsilä companies sort their waste according to local municipal regulations. However, generally speaking the main sorting categories are: waste to be incinerated, crude waste for landfills, clean cardboard, and waste paper. In addition, waste wood, scrap metal and metal swarf are collected separately. Only coarse waste and in some cases waste wood are removed for landfill disposal, as needed. Other wastes are used either as raw materials or for energy.

Waste management in Wärtsilä has four aims:

- Reduce the amount of the waste generated in Wärtsilä processes
- Utilize the waste as a material
- Utilize the waste as energy
- Dispose of the waste in an environmentally sound way.

The figure on page 75 shows the amount of non-hazardous and hazardous waste generated by Wärtsilä.

ENVIRONMENTAL COSTS

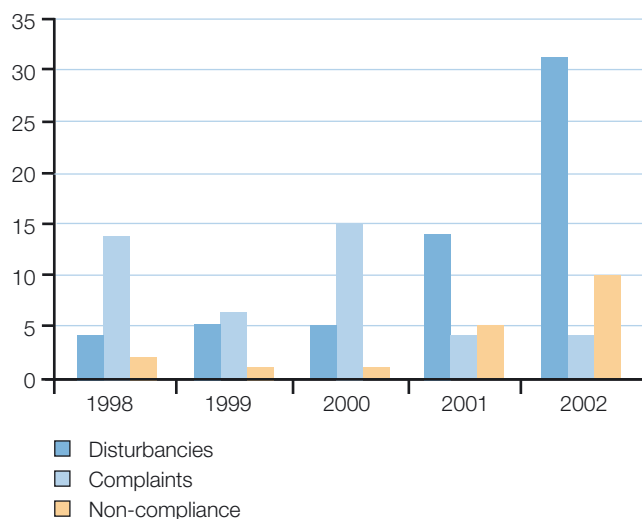
Environmental capital expenditure and operating costs are difficult to separate from normal operating costs in our operating environment. It is equally difficult to define capital expenditure as an exclusively environmental investment or as a machine or equipment investment in the production process.

Concerning Wärtsilä’s operations, we have defined expenditures as environmental expenditures if they are related to soil, water and air pollution control, waste management, environmental management or noise control.

Environmental liabilities

Environmental risks and liabilities are identified and reviewed as a part of overall risk management. In Wärtsilä’s operations, potential liabilities are primarily related to the company’s real estate. Environmental liabilities are systematically scrutinized in conjunction with every acquisition or sale of real estate. Wärtsilä has recognized certain cases where potential environmental liabilities may exist but these are not expected to have a significant financial impact on Wärtsilä.

Disturbances, complaints and non-compliance (pieces/year)



Environmental performance of Imatra Steel

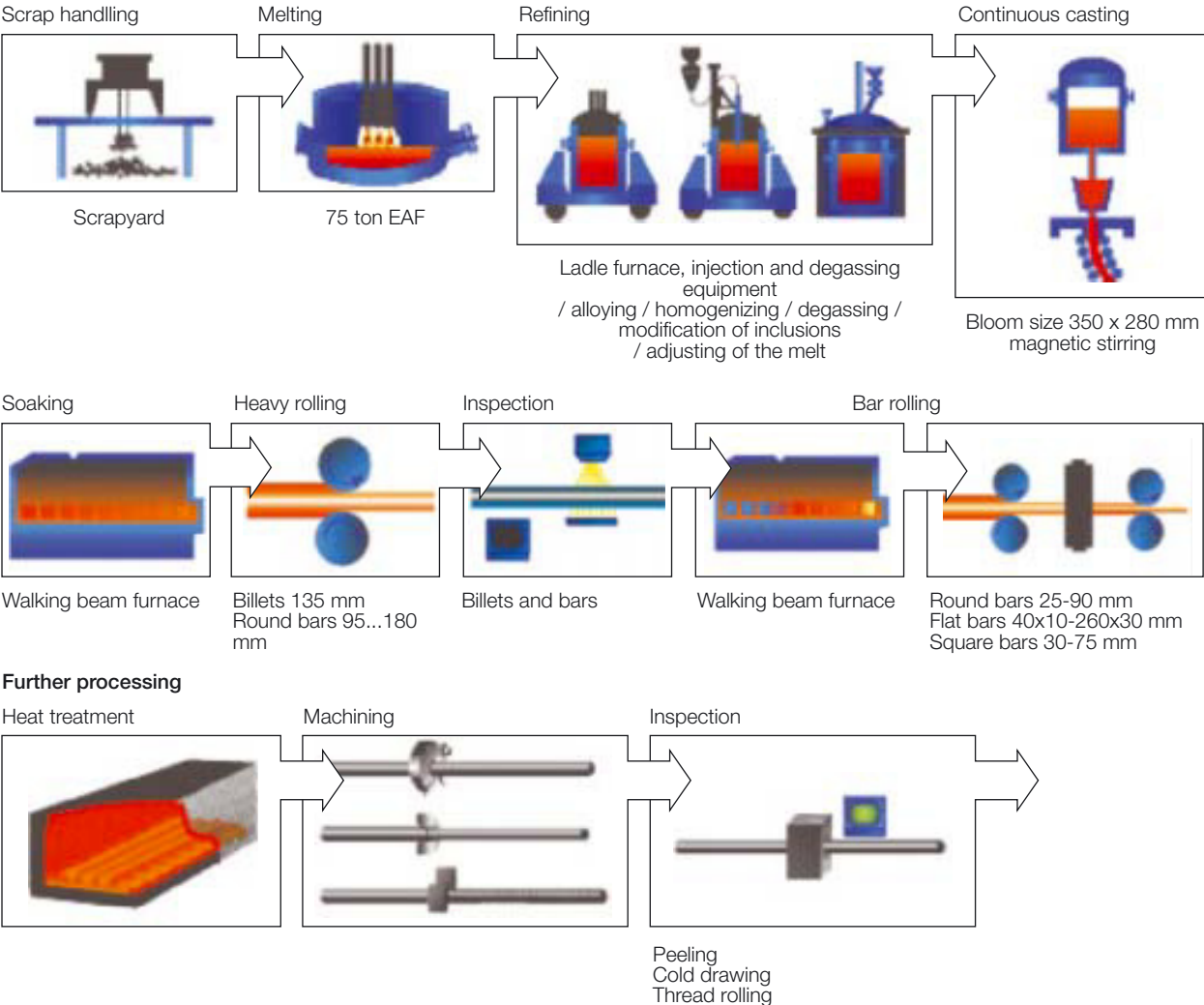
Imatra Steel comprises a Steel Works, a Spring Works, two forging mills and a number of sales offices. The Steel Works is the biggest site at Imatra Steel in terms of both number of employees and production. It also dominates the Group's environmental performance. The data it reports includes environmental information on the manufacturing sites and sales units with warehouse and sawing operations. Scottish Stampings, a subsidiary of Imatra Kilsta since November 2001, has reported its environmental information since 2002. The production units produce steel bars and other steel products. The environmental aspects of production address the use of energy and natural resources and emissions, effluents, noise and solid wastes generated by production.

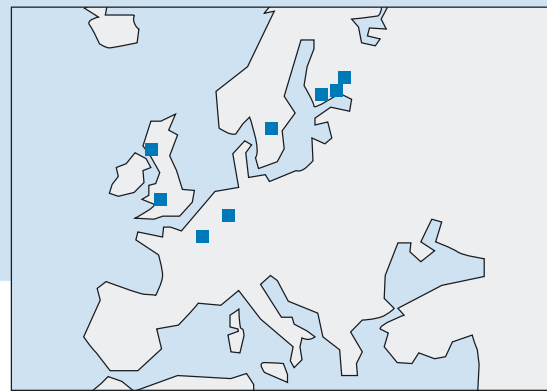
MATERIAL CONSUMPTION

Generally, steel can be produced from iron ore or steel scrap. Despite the effectiveness of scrap recycling, however, not all the steel sold will return to the steelworks.

Imatra Steel Works's raw material is solely scrap, which consists mainly of industrial cutting and machining wastes, steel from demolished buildings and structures, machines, vehicles and other objects rejected in industrial, commercial and private activities.

Using scrap saves large amounts of iron ore, as well as lime and other raw materials. The amount of energy required in the electric arc furnace process is only 25% of that needed in the ore-based process, which in turn means less carbon dioxide emissions to contribute to the greenhouse effect.





Imatra Steel's units

ENERGY CONSUMPTION

Total energy consumption

The production of steel and steel products is highly energy-intensive. Energy consumption is the third highest production cost after raw materials and labour costs. Consequently, the need to use energy effectively pre-dates environmental concerns in the steel industry and has always been an important factor in developing and operating production processes. Imatra Steel Works currently has modern production processes, however, as a result of the large investment program implemented between 1989 and 1996.

Electricity

The electric arc furnace and adjoining processes use roughly 75% of the electricity consumed at Imatra Steel Works to produce raw steel from scrap. The hot rolling of steel bars and various forms of pumping also consume high volumes of electricity. Pumps are used for cooling water and hydraulic fluids, fans for combustion air and flue gases, and compressors to produce compressed air. Other processes play a minor role in terms of electricity consumption.

Fuels

Almost half of the total energy used in Imatra Steel is produced from fossil fuels, mainly natural gas, LPG, and heating oil. Most of this energy is used for direct heating of material to the temperature of 1,200 °C that is

required for hot forming processes, mainly rolling or forging, and to lower temperatures for the heat treatment of steel and steel products in order to give them the mechanical properties that steel parts for machine components need. Other types of processes use fuels for, among other things, heating ladles and producing steam for vacuum pumps. Fossil fuels are also used for heating factory buildings and offices.

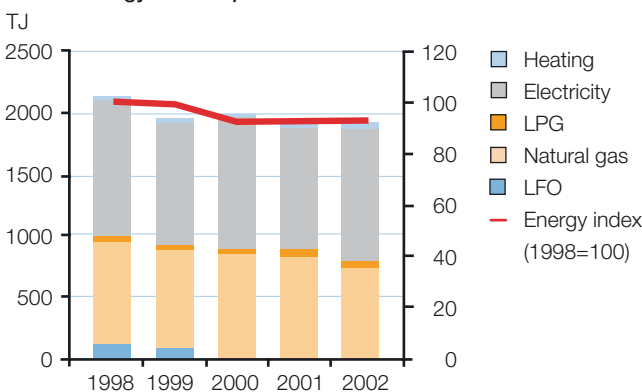
Heat recovery

The main target in designing production equipment for a particular process must be the overall internal efficiency of that process; in other words, the energy output of the process must ideally be re-used in the same process. Thus the hot flue gases from the electric arc furnace at Imatra Steel Works are used to preheat scrap, and the billet reheating furnaces are equipped with recuperators that use the flue gases to preheat the combustion air. Recuperative burners are also used in some smaller units for the same purpose. The heat contained in the cooling water of the bloom reheating furnace, the largest heating unit in Imatra Works, is used externally to heat some factory buildings and office blocks.

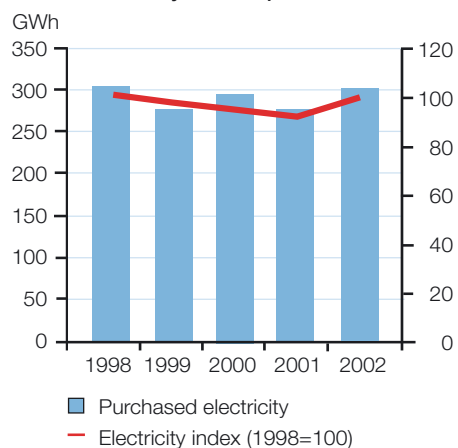
Water consumption

Since steel production involves high temperatures, tools and production equipment require large volumes of cooling water. Most sites obtain cooling water from natural resources, such as rivers and rainwater. Cooling water

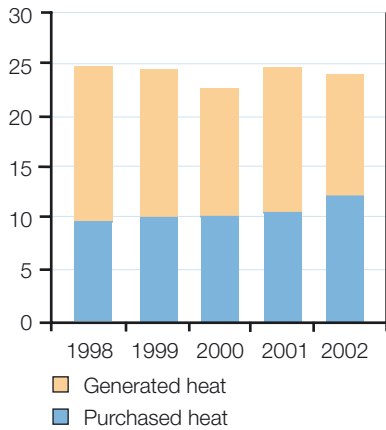
Annual energy consumption



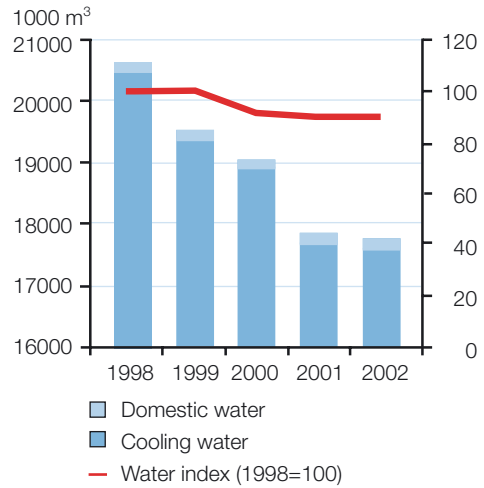
Annual electricity consumption



Annual heat consumption (GWh)



Annual water consumption



that has not been in contact with the steel is returned to its initial watercourse through the site's own sewage treatment plant. Other cooling water is kept separate so that only the heat is released into the natural water system. Some sites at Imatra Steel also use circulating water for cooling operations. The amount of circulation water was over 10 million cubic metres in 2002.

Discharges into water

Imatra Steel Works and Imatra Kilsta have their own sewage treatment plants. The discharged water contains oils, suspended solids and dissolved metals originating from the alloying elements. Most of the suspended material is iron oxide from hot rolling and forging. The oil originates from lubrication used in the bearings of rolls and other machine components as well as occasionally from hydraulic fluid leakage.

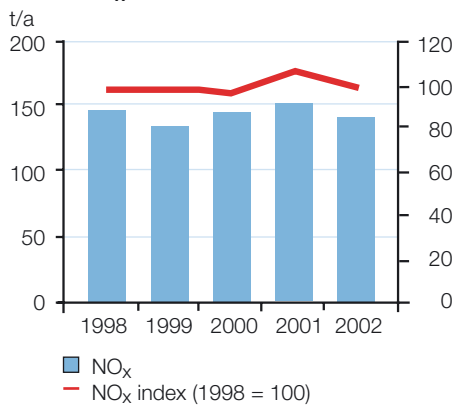
The discharges are limited to comply with permit conditions, so the final environmental impact is small. The discharged water contains dissolved metals originating from the alloying elements. The European Union's policy on the role of metals in water is still under discussion, so the next environmental permits may incorporate new requirements.

All Imatra Steel's factories will need to apply requirements based on laws conforming to the IPPC (Integrated Pollution Prevention and Control) Directive within a couple of years.

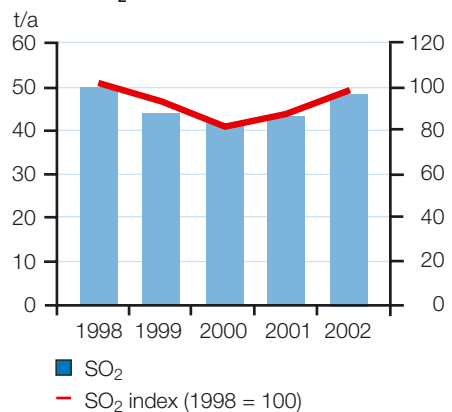
Emissions into the air

Emissions of carbon dioxide are calculated from material balances. Most emissions originate from the burning of fuels, mainly natural gas at Imatra Steel. The electric arc furnace at Imatra Steel Works also produces carbon dioxide emissions. These are determined in the same way, although the calculations are more complicated.

Annual NO_x emissions



Annual SO₂ emissions





Other emissions into the air are estimated using emission factors that are calculated on the basis of measurements or other sources.

Most steps in the production of steel and steel products are performed at high temperatures. Water cannot therefore be used and the processes are dusty. All the main sources of dust are encapsulated and the evaluated process gases are cleaned effectively before evacuation. Thus diffuse emissions – mainly from roof lanterns – are the main source of particulate emissions. Many process steps require very large volumes of ventilation air to maintain acceptable working conditions because of the heat.

Scrap-based heavy metals – lead, zinc and mercury – are evaporated in the high temperature of the electric arc furnace (EAF). Over 99.9% of lead and zinc is found in EAF dust, in contrast to mercury. Almost all mercury, some 30 kg per year, passes through the filter in gaseous form.

Volatile organic compounds

Imatra Steel’s emissions of volatile organic compounds (VOCs) are calculated from the solvents and paints used, and in 2002 amounted to 24 tonnes.

Noise

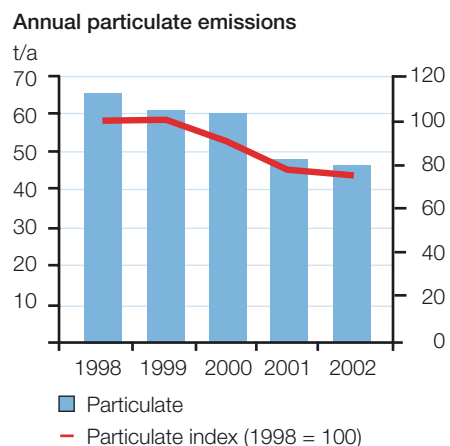
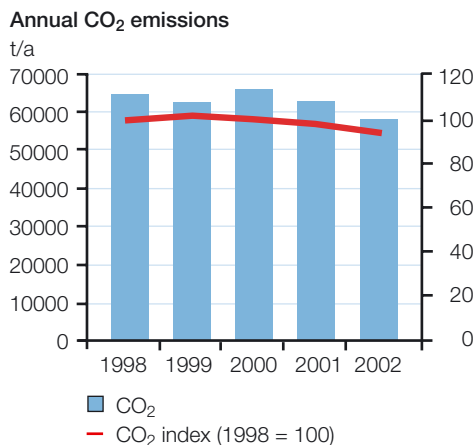
As almost all Imatra Steel’s units are located in proximity to population centres, noise management issues are highly important. Imatra Steel Works conducts a number of continuous studies and measurements to lower the level of noise. Action has included improving the construction of the smelter, installing a noise barrier in the scrap yard and holding educational discussions with the workforce to limit noise emitted by the electric arc furnace and scrap loading.

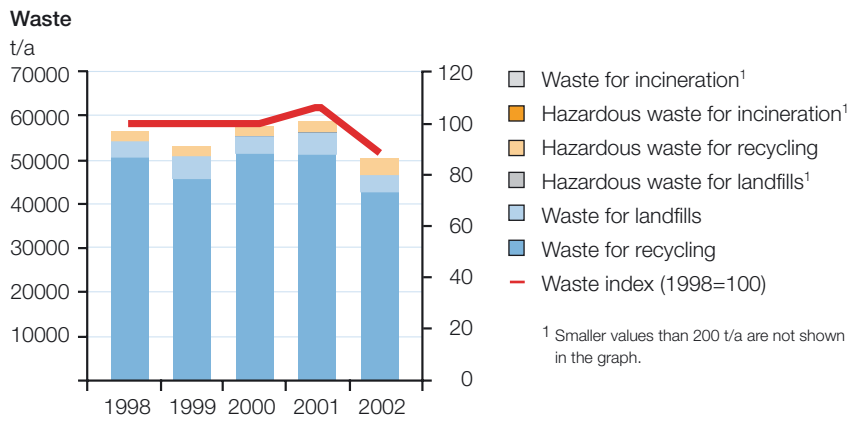
Waste

The European Union has not so far fully addressed the complexity of how to define waste in the steel industry. In this report, Imatra Steel follows the practice of classifying untreated steel slag from the electric arc furnace as waste, and steel scrap as a secondary raw material. The value of scrap and the effective organization of the scrap business guarantee that it is utilized as raw material, if not at Imatra Steel then in other steelworks.

Steel slag, rolling scale (oxidized iron) and used refractory materials constitute most (over 90%) of Imatra Steel’s non-hazardous waste. Steel slag is processed into a byproduct for road construction and most rolling scale is used as raw material in the cement and iron industry.

Development is under way to utilize refractory waste (some 2,500 t/a) in the electric arc furnace process and





the test results are promising. Refractory waste is not reported as recycled in this report since it is stored in expectation of future utilization to replace lime in the electric arc furnace.

There are some 15 designated hazardous wastes that originate mainly from service functions. In terms of weight, these mainly consist of various grades of waste oil and oily solid wastes. The dust separated from the flue gases of the electric arc furnace is also deemed hazardous on account of lead. The dust alone accounts for over 90% of the total amount of hazardous wastes produced by Imatra Steel. Over 35% of the dust is zinc originating from galvanized and electroplated steel scrap. The zinc oxide is separated from the treatment process and sold to the European zinc industry.

Non-compliance on site with environmental permits and agreements

Particulate emissions from sand blasting during billet conditioning at Imatra Steel Works exceeded permits in 2002. Improving the fixing systems of the filter cassettes solved the problem.

Environmental disturbances and accidents on site

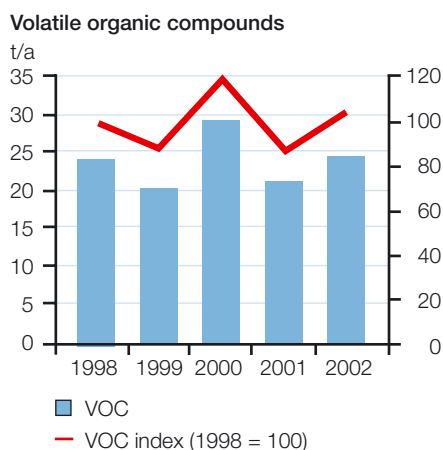
There were no recorded disturbances or accidents at any Imatra Steel sites that needed to be reported to the authorities during 2002.

Recorded complaints

Stakeholders complained about Imatra Steel's environmental performance three times during 2002. One complaint was recorded at Scottish Stampings, where a contractor used solvents on a roof repair that neighbours found a nuisance. Two complaints about excessive oil fumes from sawing operations were received from neighbours of the Wolverhampton sales and sawing unit. This disturbance was resolved by installing filters in the sawing units.

Monitoring of environmental impacts

Imatra Steel Works monitors and reports on discharges into water and emissions into air, as well as on the generation of wastes, in conformance with monitoring programs accepted by the regulatory authorities. The environmental impacts of current discharges into water and emissions into air are monitored mainly in co-operation with local industry and the city of Imatra. Imatra Kilsta and the Spring Factory in Billnäs monitor discharges in cooling water released into the natural water system.



The impacts of past activities are studied in the most suspect areas when evaluating environmental risks. Imatra Steel does not, however, conduct a systematic study of the whole steelworks area.

Imatra Steel Works has conducted a lifecycle assessment (LCA) in co-operation with the Finnish Environment Institute (SYKE) to evaluate the most important targets for environmental protection. The assessment addresses the collection and processing of scrap, production of other raw materials and energy, transports to the factory and production at Imatra Steel Works.

The results show that over 85% of all large-scale environmental impacts from this part of the production chain are caused by emissions of gases causing climate change and acidification. Most of these emissions are related to the use of fossil fuels. Imatra Steel's other units use steel bars as raw material and fossil fuels for heating. Thus the most significant environmental aspects are the same for the whole company: the efficient use of energy and raw materials.

LCA is a good method for evaluating the importance of emissions into air and water. It has some weaknesses concerning the evaluation of wastes and normally the local effects, noise and landfills, are left totally outside the inventory. Therefore, Imatra Steel Works has conducted a survey of its neighbours, most recently in August 2002. They reported that the most irritating environmental harm is noise from the scrapyard during warm summer nights.

The area's rapid implementation of the EU's waste policy was not reflected in the LCA. Reducing the large volumes of wastes generated in the production of steel and steel products requires continuous efforts to minimize waste generation, increase recycling and develop waste treatment methods.

Environmental costs

Environmental capital expenditure and operating costs are difficult to separate from normal operating costs. It is equally difficult to define capital expenditure as an exclusively environmental investment or as a machine or equipment investment in the production process.

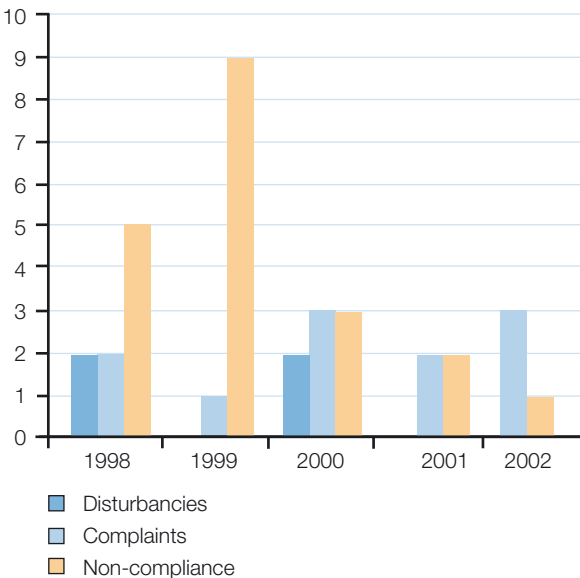
Concerning Imatra Steel's operations expenditures are defined as environmental expenditures if they are related to soil, water and air pollution control, waste management, environmental management or noise control.

In 2002 the environmental capital expenditures of Imatra Steel were EUR 19,000 and the environmental operating expenses EUR 2.02 million.

Environmental liabilities

Some units in Imatra Steel have known environmental liabilities, most of which are related to oily soils. The areas are restricted and their remediation is part of normal operation.

Disturbancies, complaints and non-compliance (pieces/year)



Social performance

Social performance in Wärtsilä Corporation is monitored on the basis of the legislation in force in the countries where the Group operates, and also in accordance with Wärtsilä's OpExS system, including the company's Occupational Health and Safety Policy and Directive, and the key performance indicators applied in the human resources field. As locally applied rules differ widely from country to country, it is difficult to describe in brief the social performance of the Group and its more than 60 subsidiary companies. The descriptions of certain processes in this chapter must therefore be seen as examples representing how certain issues are handled rather than as a complete picture of the situation.

Labour practices

Freedom of association and the effective recognition of the right to collective bargaining belong to the fundamental rights of employees in all member states of the ILO and are also highly respected in the Wärtsilä Group.

In most European subsidiaries the percentage of employees covered by collective bargaining is close to 100%, and excludes only the top management. The percentage of employees represented by independent trade unions is between 70% and 100%. In other countries, such as the USA, the corresponding figures are traditionally very low, although the principles above are fully recognized. The calculation of an average figure for the Group does not therefore give a full picture of the situation.

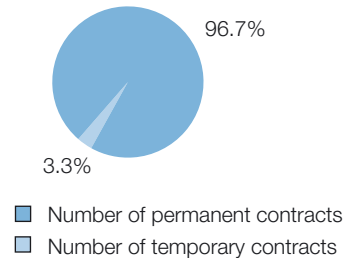
Consultation and communication

Consultation and communication with employees on planned changes to operations takes place in accordance with the local rules and practices in each country. Wärtsilä's policy is to promote a high degree of openness in communication between management and employee representa-

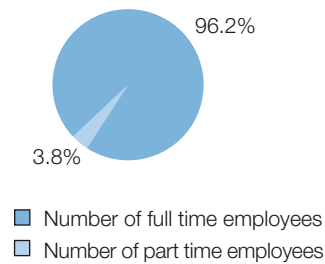
tives in local works councils and to keep employees regularly informed about the Group and local company performance.

The European Works Council and its Working Committee have an active role with regard to cross-border issues in the organization. In several major European companies Wärtsilä employees have their own representative on the company's board of directors.

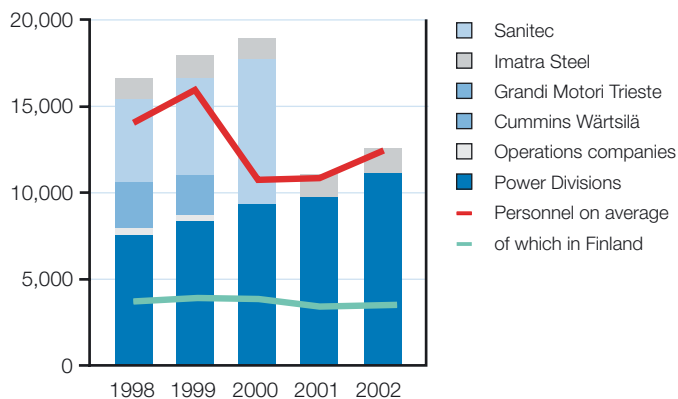
Permanent/temporary employees at the end of 2002



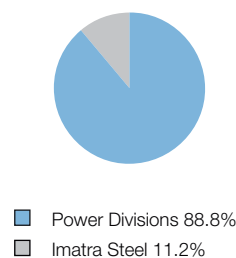
Full time/part time employees at the end of 2002



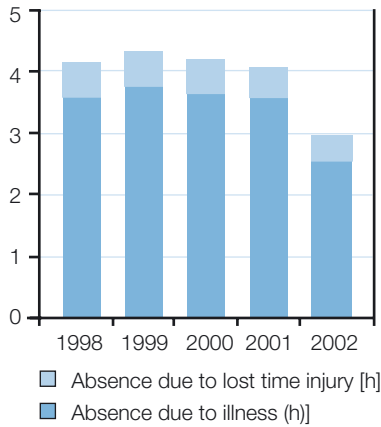
Personnel by division



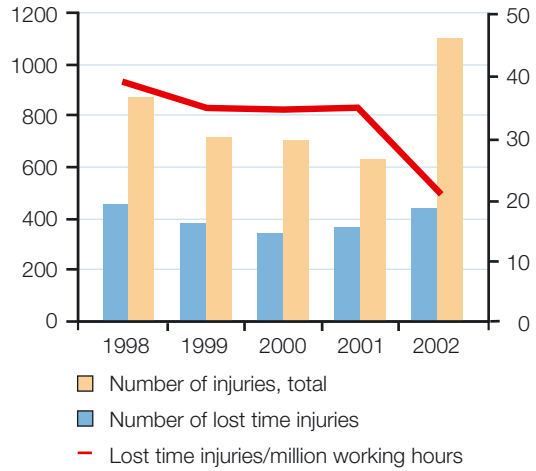
Personnel by division 31 Dec. 2002



Absence rate (%)



Number of injuries



Training and education

Employee training and skills enhancement to meet the demands of the rapidly changing business environment are a central part of the Group’s HR policy. The target of the fastest growing division, Service, is to invest approximately 5% of salary costs in training. Developing professional skills is the responsibility of the divisions. The Group primarily takes care of leadership development while the subsidiary companies direct their efforts mainly to developing the personal skills of their employees.

Training activities in the different parts of the Group are followed up as a part of the HR Key Performance Indicators.

Occupational health and safety

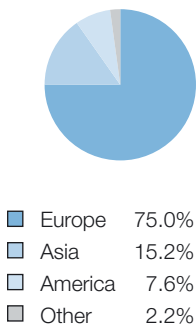
Based on the Occupational Health and Safety Policy and Directive, launched as a part of the Group’s quality system, Wärtsilä’s subsidiaries have been working on the implementation of occupational health and safety management systems in accordance with the OHSAS 18001 standard. At the end of 2002 seven companies complied with this standard.

The target of the policy is to prevent or manage the health and safety risks that concern the personnel and third parties in the corporation. The practical work in this field is largely carried out in co-operation between the management and the employee representatives. Performance indicators have been created to monitor and measure OH&S performance, including accidents and absence from work based on illness.

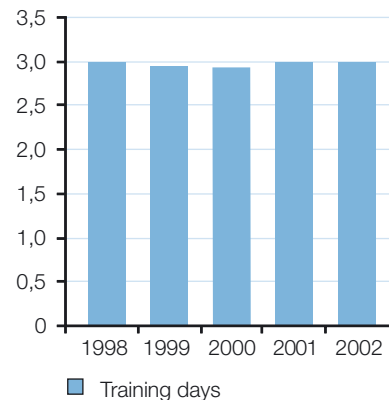
In most of the countries where Wärtsilä is active, the formal joint health and safety committee arrangements are defined by local legislation. The committees are composed of both management and employee representatives and cover essentially all the employees. This is the case in both Europe and North America, and also in a number of other countries.

The Wärtsilä Occupational Health and Safety Policy and Directive as well as the OHSAS 18001 standard (or a comparable locally approved standard) form the basis for occupational health and safety management in all Wärtsilä organizations.

Personnel by market area



Training days (days/employee)



Operational performance data

Performance Indicator ¹	1998	1999	2000	2001	2002
ECONOMIC					
R&D expenses [EUR million]	87	87	81	82	88
Environmental capital expenditure [EUR million]	0.69	0.73	3.02	5.19	1.83
Environmental operating expenses [EUR million]	2.21	2.23	2.45	2.25	6.02
ENVIRONMENTAL: Power Divisions					
Total energy consumption [TJ]	1,605	1,385	1,340	1,348	1,923
• Electricity consumption [MWh]	89,192	86,116	84,315	85,193	106,617
• Heat consumption [MWh]	129,779	129,398	121,746	130,179	126,294
• Light fuel oils [t]	8,395	5,454	4,691	4,872	4,866
• Heavy fuel oils [t]	8,859	7,027	8,353	8,571	13,552
• Natural gas [t]	3,065	1,976	1,366	1,365	7,611
• Fuels, others [t]					242
• Orimulsion [t]	0	392	797	324	232
Total water consumption [1000 m ³]	8,359	4,658	5,357	5,222	9,570
• Domestic water consumption [1000 m ³]	832	790	609	530	727
• Cooling water consumption [1000 m ³]	7527	3,868	4,748	4,692	8,843
Nitrogen oxide emissions [t]	1,147	865	919	947	1,287
Carbon dioxide emissions [t]	66,514	48,389	48,492	49,155	83,232
Sulphur dioxide emissions [t]	269	248	286	252	348
Particulates [t]	16	14	17	18	25
VOC [t]	43	35	39	31	55
Non-hazardous waste [t]	10,714	11,571	10,622	12,921	23,887
Hazardous waste [t]	2,696	2,726	3,320	3,533	3,644
ENVIRONMENTAL: Imatra Steel					
Total energy consumption [TJ]	2,118	1,956	2,001	1,915	1,917
• Electricity consumption [MWh]	304,000	277,000	297,000	279,000	298,000
• Heat consumption [MWh]	24,600	24,200	22,600	24,600	24,000
• Light fuel oils [t]	2,755	1,809	88	100	320
• Natural gas [t]	16,705	16,260	17,083	16,715	15,118
• Liquified petroleum gas [t]	1,041	973	1,080	973	948
Total water consumption [1,000 m ³]	20,654	19,555	19,056	17,853	17,754
• Domestic water consumption [1,000 m ³]	154	155	156	153	154
• Cooling water consumption [1,000 m ³]	20,500	19,400	18,900	17,700	17,600
Nitrogen oxides emissions [t]	145	135	143	150	139
Carbon dioxide emissions [t]	65,200	62,100	66,500	62,900	58,900
Sulphur dioxide emissions [t]	50	44	43	43	48
Particulates [t]	66	62	60	48	46
VOC [t]	24	20	29	21	24
Non-hazardous waste [t]	54,390	50,730	55,260	56,040	46,600
Hazardous waste [t]	2,330	2,340	2,700	2,790	2,960
SOCIAL					
Training days [days/employee]	3.0	2.9	2.9	3.0	3.0
Number of lost time injuries	439	373	348	356	422
Lost time injuries [number/mill. working hours]	39.4	35.3	34.6	35.8	21.4
Absence rate [% of total working hours]	4.19	4.37	4.24	4.14	2.92

¹ The operational performance data in this report have been compiled from economic, environmental and social records of the Wärsilä companies. Whilst every effort has been made to ensure that the information is neither incomplete nor misleading, it cannot be considered as reliable as the financial data published in the Annual Report.

² The R&D Expenses include both the Power Divisions and Imatra Steel.

³ Year 2002 figures include the second-phase companies, see page 14.

Assurance Statement

At the request of Wärtsilä Oyj, we have reviewed the information, systems and methodologies behind the economic, environmental, social performance data and statements presented in the Wärtsilä Sustainability Report 2002. The report is the responsibility of and has been approved by the Board of Management of Wärtsilä Oyj. The inherent limitations of completeness, consistency and the accuracy of the data are set out in the report.

Activities undertaken were performed on a test basis and provide a moderate level of assurance. In the context of assurance we recognize that non-financial data are, in general, subject to more inherent limitations than financial data due to their nature and methods used for determining, calculating or estimating such data.

Our review has consisted of the following procedures:

- making enquiries of management responsible for compiling the report;
- an examination of relevant supporting information;
- an evaluation of accuracy, completeness and consistency of data in the report,
- review in more detail of the systems for gathering and reporting economic, environmental and social performance data at operating level at one site in Finland and one site in Italy, selected by us.

The report has been prepared in accordance with the Global Reporting Initiative's Sustainability Reporting Guidelines. Based on our activities undertaken, nothing has come to our attention that causes us to believe that the presented data and statements in the Wärtsilä Sustainability Report 2002 would not provide a fair and balanced view on the group's sustainability performance.

Helsinki, 23 May 2003

KPMG WIDERI OY AB

Mauri Palvi
Authorized Public Accountant

Mats Hägerström
Sustainability Assurance

Glossary for Wärtsilä Power Divisions

Terms frequently used in publications by Wärtsilä's Power Division.

Airshed = The local area around a power plant whose ambient air quality is directly affected by the emissions of the plant. The size of the relevant local airshed will depend on plant characteristics, such as stack height, as well as on local meteorological conditions and topography. In some cases airsheds are defined in the local legislation or by the relevant environmental authorities.

Baseload = Power plants running for more than 8,000 hours/year, i.e. generating power for continuous use.

Biofuel = Biofuels are a large and relatively unexplored source of energy worldwide. They are derived from forest, swamp and agricultural biomass, and from organic solid, liquid and gaseous biowastes recoverable from municipal, agricultural and industrial processes.

Biopower = Electrical or thermal power, or both, produced by a biofuel-fired plant. Biofuels are considered renewables; therefore biopower is viewed as a "clean" technology.

BioGrate = Combustion technology patented by Wärtsilä and on which Wärtsilä BioPower's small power plant technology is based. BioGrate is especially suitable for burning wood residue, bark and sawdust.

Boiler plant = The plant entity which includes the boiler and all the necessary equipment and auxiliary components needed for operating the plant process.

Bow thruster = A transverse thruster mounted in the bow of a ship to make manoeuvring easier in harbours.

cgt (compensated gross tonnage) = The compensated tonnage of a ship, i.e. the ship's volume adjusted (compensated) by a factor to render the amount of work at the yard equivalent for different types and sizes of ship.

CIPS = Coastal and Inland Propulsion System. A tailor-made propulsion system with small fixed pitch propellers (diameter below 3.5 m) suitable for inland navigation vessels, fishery vessels, coasters and luxury (mega) yachts.

CO₂ = Carbon dioxide. A component in an engine's exhaust gases formed when fossil fuels are burned. The most significant greenhouse gas in the atmosphere; it prevents thermal radiation entering the atmosphere from being reflected back into space.

Cogeneration = The simultaneous generation of electricity and heat. Also called Combined Heat and Power (CHP). This method raises total efficiency to above 90% since the heat produced by power generation is recovered and used, for example, in industrial processes or to supply district heat.

Combined cycle technology = The use of two different power generation processes, e.g. fuel engines and steam turbines, in the same power plant. The second process utilizes the heat recovered from the first.

Combined heat and power = CHP = A means of recovering and using the heat produced as a by-product of the electrical generation process.

Common rail = A method of fuel injection that eliminates the principle of one pump/cylinder. The common rail is constructed from a series of accumulators interconnected by small-bore piping. The injection pressure is adjusted as desired and the injection timing (start and stop) controlled electronically. Wärtsilä has used common rail technology to develop the "smokeless engine", which also reduces NO_x and CO₂ emissions.

Controllable pitch propeller (CPP) = A propeller whose pitch can be controlled (changed) by rotating the blades with a hydraulic or electro-mechanical system in the propeller's hub.

DCC (Diesel Combined Cycle) = Technology utilizing both the shaft output and thermal output of a diesel engine. The thermal output is used to drive a steam turbine, for example.

Decentralized power plant = A small local power plant for small towns, communities or industrial processes.

Deep Sea Seals (DSS) = The trademark for Wärtsilä Propulsion seals.

DeNO_x = Secondary emission reduction technology for emissions of nitrogen oxides. Commonly used technology is Selective Catalytic Reduction (SCR) system.

DWT (dead weight tons) = The difference between the displacement and the light-weight of a ship, i.e. the combined weight of its cargo, passengers, crew, stores, fuel and other liquids.

DWI (Direct Water Injection) = A method in which water is injected into the engine cylinders prior to fuel injection in order to reduce nitrogen oxide emissions. Direct water injection reduces the combustion temperature and therefore the formation of nitrogen oxides.

Economizer = Additional heat recovery equipment that lowers the flue gas temperature, reducing heat losses and improving efficiency.

Efficiency (power generation) = The ratio between the input fuel energy and the power produced. The total efficiency of a power plant means the amount (%) of total fuel energy that can be converted into electricity and heat.

Efficiency rudder = The Efficiency Rudder is a horn rudder that is integrated with the propeller through a fixed streamlined torpedo. This integrated concept reduces fuel consumption, vibration and noise levels compared to a traditional design.

Electrical efficiency (engine) = The amount (%) of total fuel energy that can be converted into electricity.

Electrical efficiency (power plant) = In simple cycle, the ratio between the input fuel energy and the electrical energy produced.

EnviroEngine™ = A smokeless diesel-electric propulsion package developed jointly by Wärtsilä and Carnival Corporation for marine vessels. Combines the use of common rail and DWI technologies. Since both methods are electronically controlled, the EnviroEngine offers an optimized

combination of engine efficiency, smoke emissions and NO_x emissions.

Eutrophication = A process by which pollution from such sources as sewage effluent or leachate from fertilized fields causes a lake, pond or fen to become overrich in organic and mineral nutrients, so that algae grow rapidly and deplete the oxygen supply.

Face seal = A non-polluting seal (e.g. Wärtsilä Coastguard) that eliminates oil loss from a ship's outboard seal, even when this is fouled or badly damaged. The face seal is suitable either for retrofitting to existing vessels or for use on new tonnage, especially cruise vessels, tankers, bulk carriers, RoRo vessels and offshore applications.

FGD = Secondary emission reduction technology for emissions of sulphur oxides. Examples include alkali scrubbing and semidry FGD using quicklime or calcium carbonate scrubbers.

Fixed pitch propeller (FPP) = A monoblock (cast in one piece) propeller optimized for only one operating condition.

Four-stroke engine = An engine in which the pistons complete their power stroke every second crankshaft revolution.

FSN (Filter Smoke Number) = A unit defining the amount of smoke. When measuring, exhaust gas is fed through a special filter element, the colour of which is then analyzed optically.

Fuel cell = Fuel cells are electrochemical devices that convert the energy of a fuel through a chemical reaction directly into electrical energy and heat. The basic physical structure or "building block" of a fuel cell consists of an electrolyte layer in contact with a porous anode and cathode on either side of it.

Fuel cell stack = A fuel cell stack is a multi-layer sandwich of fuel cells and interconnecting plates. The plates function as channels for distributing fuel gas and oxygen to the cells and also as an electrical conductor to couple the repeating cells in series. Piling a sufficient number of cells in series raises the stack voltage and power to the optimum level. See also *Solid oxide fuel cell*.

Gas compression = The raising of gas pressure and density for further processing. This makes it possible to use smaller storage tanks or pipes to transport a given quantity of gas.

Gasification = The production of fuel gas from biofuel for heat and/or power generation. This is a relatively new technology that is currently being developed and commercialized.

GT (gross tonnage) = The gross tonnage of a vessel, i.e. its total enclosed volume.

GTCC (Gas Turbine Combined Cycle) = Technology utilizing the shaft and thermal outputs of a gas turbine.

HFO = Heavy fuel oil

High-powered special vessels = Passenger or naval vessels able to travel at high speeds.

High-speed engine (diesel/gas) = An engine running at speeds over 1,200 rpm (revolutions per minute).

Hot combustion = A method that raises the temperature of the engine exhaust gases by reducing the air intake and isolating the combustion chamber. This increases total efficiency and enhances the engine's suitability for combined cycle technology.

IMO = The International Maritime Organization.

Independent Power Producer (IPP) = A private corporation producing electricity for sale on a national grid. Also an IPP power plant.

JMT (Japan Marine Technologies) = Trademark for lip seals.

Lambda control = Lambda (λ) represents the current air volume divided by the stoichiometric air volume. Lambda control refers to the control of the air volume in the combustion process.

Lean-burn gas engine = A gas-fired engine in which the gas-air mixture in the engine's cylinders contains substantially more air (roughly double) than required for complete combustion of the gas. The over-abundance of air achieves high output and efficiency combined with low nitrogen oxide emissions.

Licensee = A company authorized to manufacture under licence and that pays royalty fees on the products sold. Wärtsilä's low-speed Sulzer engines are mainly manufactured under licence.

Lip seal = Multi barrier type of sealing system (e.g. MKII). Applicable to any size or type of vessel. Highly resistant to wear and fouling.

Load management = Flexible method of meeting varying demand for power, e.g. producing more energy when required.

Low NO_x technology = A method for reducing nitrogen oxide emissions that also raises engine efficiency. Emission levels are reduced by regulating the combustion temperature in the cylinders and the duration of fuel injection.

Low-speed engine = An engine running at speeds below 300 rpm.

Medium-speed engine (diesel/gas) = An engine running at speeds of 300-1,200 rpm.

Multi-fuel engine = A Wärtsilä engine running on both gaseous and liquid fuels. (Engines denoted DF and GD are multi-fuel engines).

Multi-purpose container carrier = A freighter carrying primarily containers but also able to transport other unitized cargo.

NO_x = Nitrogen oxides (NO and NO₂). Products formed during the combustion of nitrogen in both the fuel and combustion air. Nitrogen oxides contribute to local eutrophication and acidification.

NT (net tonnage) = The net tonnage of a vessel, i.e. the volume of its payload spaces.

O&M = Operations and Maintenance.

OEM = Original Equipment Manufacturer.

Offshore = Industrial activity at sea, e.g. drilling and pumping at an oil or gas well.

Operations agreement = Operations & Maintenance (O&M) = Full performance and operational responsibility for the plant, its engines and auxiliary systems.

OpExS (Operative Excellence System) = This system, which covers all Wärtsilä's operations, aims to generate added value for Wärtsilä's various stakeholders. The system addresses issues including quality, the environment, occupational health and safety, continuous improvement process and self-assessment.

Orimulsion® = An emulsion of Orinoco bitumen and water produced in Venezuela.

Panamax vessel = A vessel whose main dimensions (beam/length/draught) are limited to enable the vessel to negotiate the Panama Canal.

Post-panamax vessel = A vessel too large for the Panama Canal. Generally refers to cruise ships and large container ships.

Propulsion package = The propulsion train used to drive a ship (propeller, reduction gear, engine, etc.).

Propulsor = A system used to propel a ship e.g. propeller, thruster.

Pyrolysis = The production of a fuel gas which can be processed as oil and which is combustible in boilers or diesel engines. This is still at the R&D stage although pilot plant projects exist.

Reduction gear = The core function of a reduction gearbox is to reduce the main engine speed to the optimum propeller speed. Wärtsilä gears have been designed to meet the highest standards of operational efficiency and reliability with low noise and vibration.

RoPax vessel = Combined RoRo and passenger ship, a ship equipped with large Roro decks and limited passenger facilities.

RoRo vessel = Roll-On/Roll-Off, a ship designed for carrying vehicles and wheelbased cargo, which are driven onboard and ashore.

Selective Catalytic Reduction (SCR) = A method to reduce NO_x emissions using a catalytic converter fitted after the engine. The catalytic converter requires the addition of an ammonia or a urea solution to the exhaust gases.

Semi-submersible vessel = A vessel designed to be partially submerged to perform a specific task (e.g. semi-submersible oil or gas drilling rigs).

Service agreement = A service agreement covers all aspects of maintenance and service for optimizing a power plant's lifecycle. This can include everything from parts supply and daily assistance, inspection and maintenance to implementation of agreed performance targets and even complete operation & maintenance packages for the installation.

Shaft efficiency = The ratio between the mechanical power measured on the engine shaft and the chemical power of the input fuel.

Shaft output = The power output developed by the engine's crankshaft.

Simple cycle = Power generation using only a thermal power plant.

SO₂ = Sulphur dioxide. Formed by the combustion of sulphur when burning sulphur-containing fuels. Sulphur dioxide contributes to acidification.

SOFC (Solid oxide fuel cell) = The fuel for a SOFC can be hydrogen, natural gas or diesel. Fuel cells offer very low emissions, high electrical efficiency and outstanding reliability. They are very suitable for the production of power in decentralized stationary (CHP) and marine applications. See also *fuel cell*.

Steerable thruster = A 360 degrees rotatable propulsor with FPP or CPP, which applies thrust in any direction and thus achieves superior manoeuvrability. Steerable thrusters can be used for both offshore (dynamic positioning) and seagoing (free-running) applications.

Stoichiometry = Stoichiometry is the branch of chemistry that determines the relative proportions in which atoms or molecules react together to form chemical compounds. Stoichiometric air is the volume of air at standard conditions required to completely combust one unit of fuel with no oxygen left over.

Technical water = Fresh water (not potable), for instance evaporated water.

TEU (Twenty-foot equivalent unit) = 1 TEU is equivalent to the capacity of one 20-ft long container; hence a 12,500 TEU containership can in principle carry 12,500 containers. The TEU takes no account of a container's weight.

Traditional fuel injection = Mechanically controlled fuel injection. Each engine cylinder has its own fuel injection pump and all the pumped fuel is fed directly into the cylinder.

Turbocharging = The pressure of the air fed into the cylinder is raised using the energy in the engine's exhaust gas. This increases the amount of air in the cylinder, allowing injection of a higher quantity of fuel for greater output.

Turnkey power plant = A power plant delivered to the customer ready for operation.

Two-stroke engine = An engine in which the pistons complete their power stroke every crankshaft revolution.

ULCC tanker = Ultra Large Crude Carrier, an ocean-going supertanker designed to carry extremely large amounts of crude oil (>300,000 dwt).

VLCC tanker = Very Large Crude Carrier, an ocean-going supertanker designed to carry large amounts of crude oil (>200,000 dwt).

Waterjet = A propulsor that uses a pump to accelerate waterflow. The momentum generated by the acceleration of the flow results in a force that propels a ship.

WPPP = Wasa Pilot Power Plant. This power plant has been utilized as a test plan for various fuel types and environmental control technologies such as NO_x and particulate abatement as well as flue gas desulphurization.

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