

Wärtsilä Fuel Cell Development

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Our Mission and Vision

Mission

We provide lifecycle power solutions to enhance the business of our customers, whilst creating better technologies that benefit both the customer and the environment.

Vision

We will be the most valued business partner of all our customers.

Financial highlights

MEUR	2008	2007	2006	2005
Order intake	5 573	5 663	4 621	3 491
Order book at the end of the period ^{*)}	6 883	6 308	4 439	2 906
Net sales	4 612	3 763	3 190	2 639
Operating result	525	380	263	225
% of net sales	11.4	10.1	8.2	8.5
Profit before taxes	516	372	255	212
Earnings/share, EUR	3.88 ¹⁾	2.74	2.03	1.80
Cash flow from operating activities	278	431	302	76
Gross capital expenditure	366	231	193	231

1) 3.96 euros before the effect of the combination of Wärtsilä's share series.






*) Cancellations amounting to EUR 333 million and the order book of Bio Power amounting to EUR 116 million have been eliminated from the order book. Additions relating to acquisitions and other adjustments amounted to EUR 158 million.

Wärtsilä has established a new unit

- Wärtsilä has established Wärtsilä Ecotech and entered into emission abatement and efficiency improvement technologies.
- As a centralised unit of environmental and efficiency technology competence Wärtsilä Ecotech provides solutions for our customers during the whole life-cycle of their applications.



Portfolio of Competence

Customer need	ECOTECH Offering	
Emission excellence: ▶ NO _x CO and HC reduction	Catalysts (SCR, Oxicat, etc.)	
Emission excellence: ▶ SO _x and PM reduction	Flue Gas Desulphurisation & Scrubbers	
Emission excellence: ▶ Emission monitoring	Emission Monitoring Systems	
Total economy: ▶ Energy efficiency	Energy Efficiency (WHRS, etc.)	
Emission & efficiency excellence ▶ Energy efficiency	Fuel Cells	

Wärtsilä Fuel Cell Program

- The target of the Wärtsilä fuel cell R&D program is to develop and commercialize **SOFC** based power units for **distributed power generation** and for **marine auxiliary power**.
- We focus on design and engineering of fuel cell systems. **System integration** and application know-how are key areas where Wärtsilä's expertise is utilized.
- Wärtsilä has operated the **WFC20 α -prototype** with NG and **WFC Proto II** with methanol.
- Development of larger units in the **50 - 250 kW** power range are planned to follow 2009 - 2012.



Applications & Customers



Short route ferries, car carriers, cruiser



Biogas from Landfills,
Waste water and farms



Telecom/data centers, Hospitals, Banks



Hotels, malls, offices, industries



Research projects in the frames of EU



METHAPU

WFC20

- Methanol fueled SOFC unit installed on board Wallenius Marine car carrier
- Partners: Wärtsilä, Wallenius Marine, DNV, LR, etc,



Large SOFC

WFC50

- Towards large SOFC power plant, Technology development validation
- Partners: VTT, Wärtsilä, RRFC, TOFC, FZJ, etc.



DEMO SOFC

WFC50

- Development and demonstration of Manufacturing and Operation of SOFC
- Partners: HTAS, TOFC, Wärtsilä



NewEnergy Biogas fuelled SOFC project



- Biogas fuelled fuel cell efficient conversion of CO₂ neutral power
- Biogas can be produced through fermentation process from various feedstock, waste water treatment plants, farms houses and landfills
- Landfill gas brings additional requirements compared to natural gas
 - Fuel is diluted: ~40% CH₄, 34% N₂, 26% CO
 - Impurities such as tars, chlorine compounds and siloxanes, requires additional gas clean-up
 - Fluctuations in gas composition

Fuel Cell Markets

Drivers for Fuel Cells

Energy Security

- Fuel flexibility
- Operational reliability
- Distributed generation

New market potential

- Increased flexibility
- Security of supply
- Increased profitability
- Equipment providers

Sustainable power generation

- Efficiency & Emissions
- Renewable fuels
- CO₂ neutral power

Fuel Cell Markets

EU scenario for fuel cell in Europe 2020

- European Hydrogen and Fuel Cells Technology Platform, Deployment Strategy, August 2005**
<https://www.hfpeurope.org/hfp/keydocs>
- EU cumulative sales: 8-16 GW at 2020**
- Target cost: 1.000-1.500 EUR/kW**

	Stationary FCs Combined Heat and Power (CHP)
<i>EU</i> H ₂ / FC units sold per year projection 2020	100,000 to 200,000 per year (2-4 GW _e)
<i>EU</i> cumulative sales projections until 2020	400,000 to 800,000 (8-16 GW _e)
<i>EU</i> Expected 2020 Market Status	Growth
Average power FC system	<100 kW (Micro HP) >100 kW (industrial CHP)
FC system cost target	2.000 €/kW (Micro) 1.000-1.500 €/kW (industrial CHP)

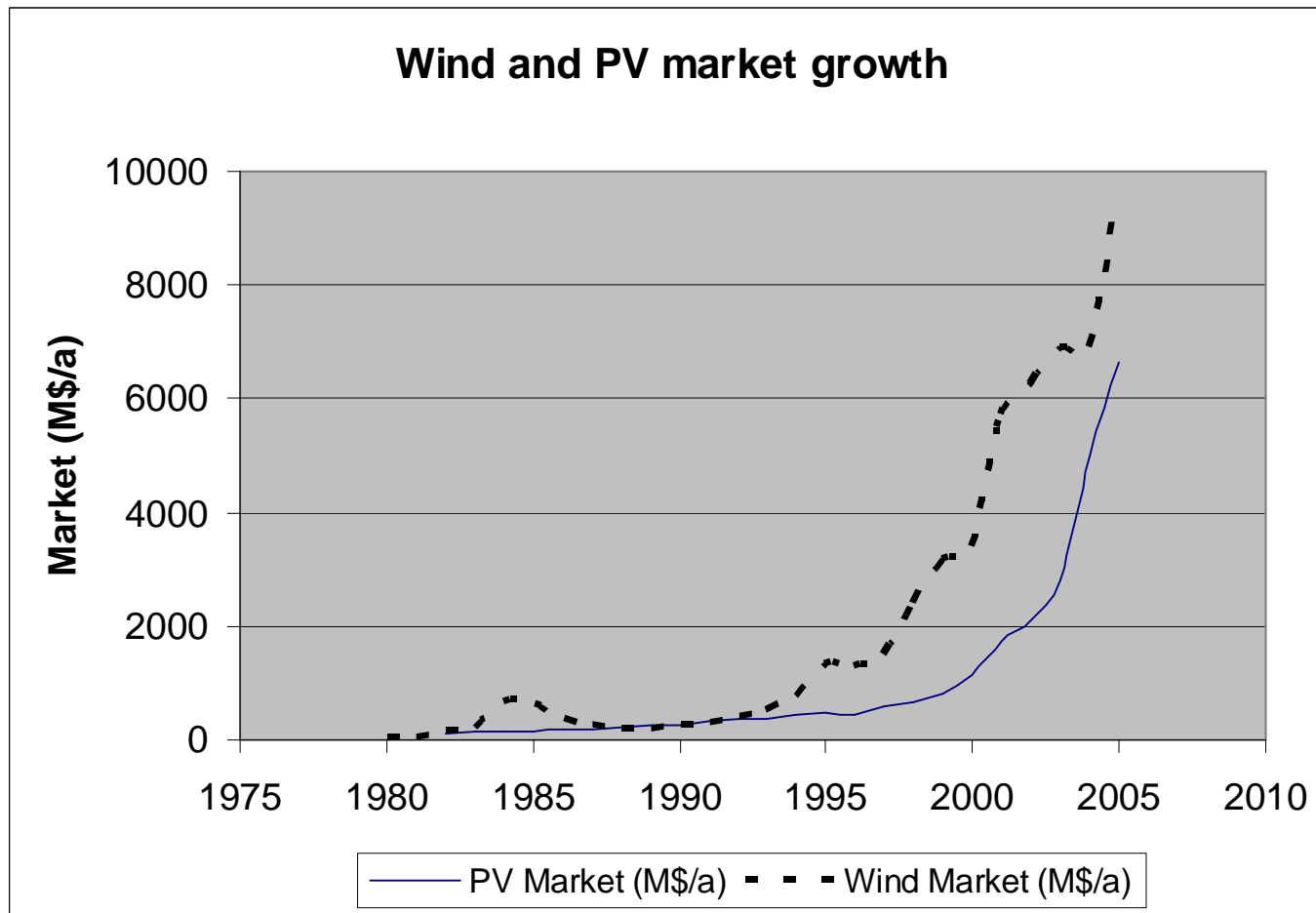
Snapshot 2020. Key assumptions on hydrogen and Fuel Cell Applications for a 2020 scenario.

Source: European Hydrogen and Fuel Cells technology platform (HFP)

Fuel Cell Markets

Market development for photovoltaic and wind power

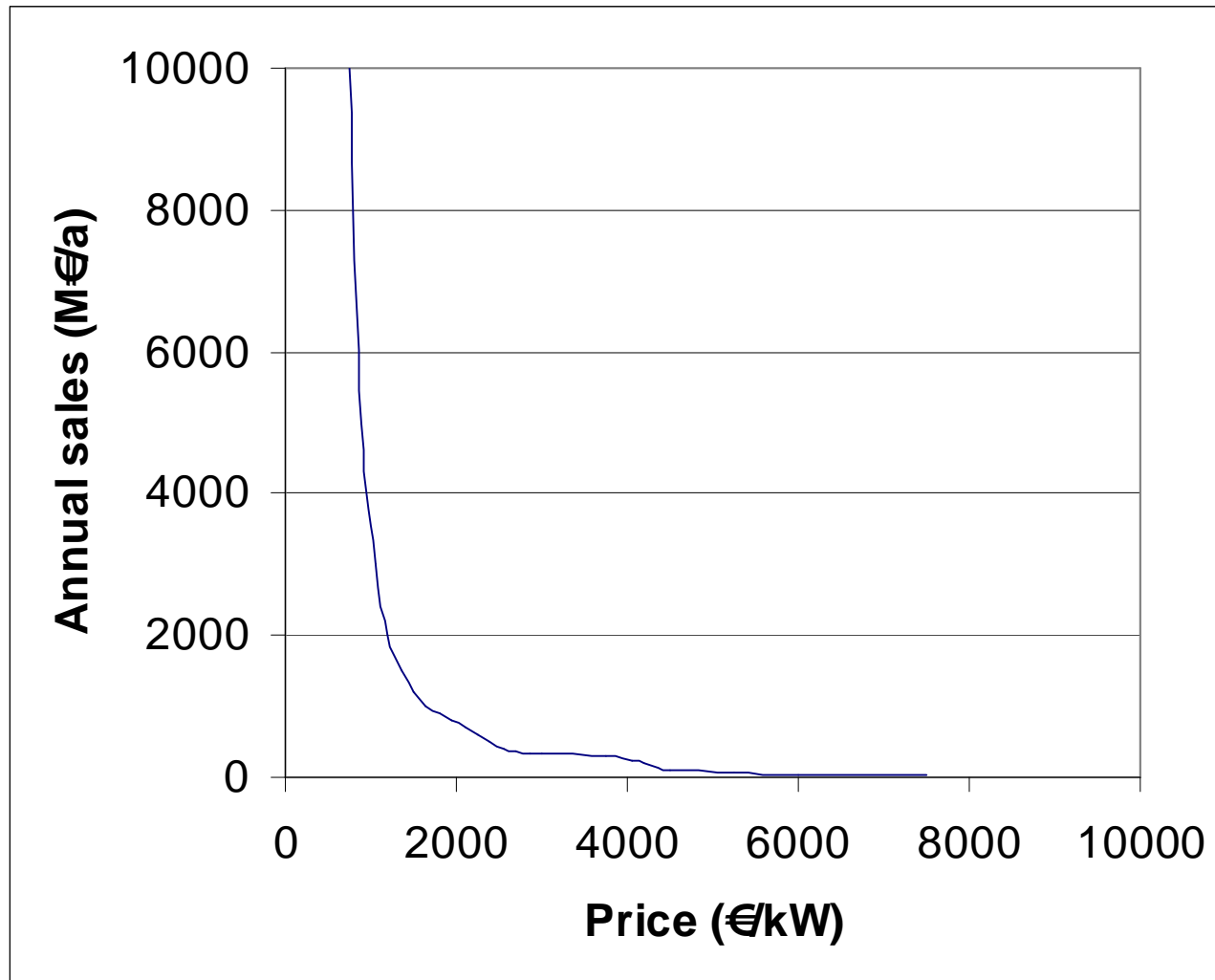
"After 15 – 20 years from first demonstrations the industry enters the growth stage"



Source : Wärtsilä

Fuel cell Markets

Prediction for stationary fuel cell market ; Cost is decisive for the mass market

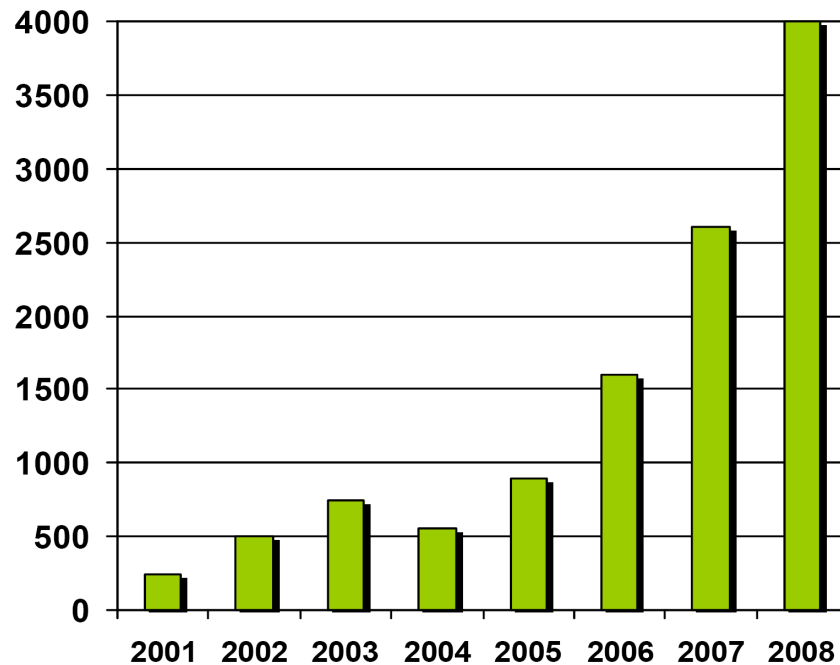


Source : Wärtsilä

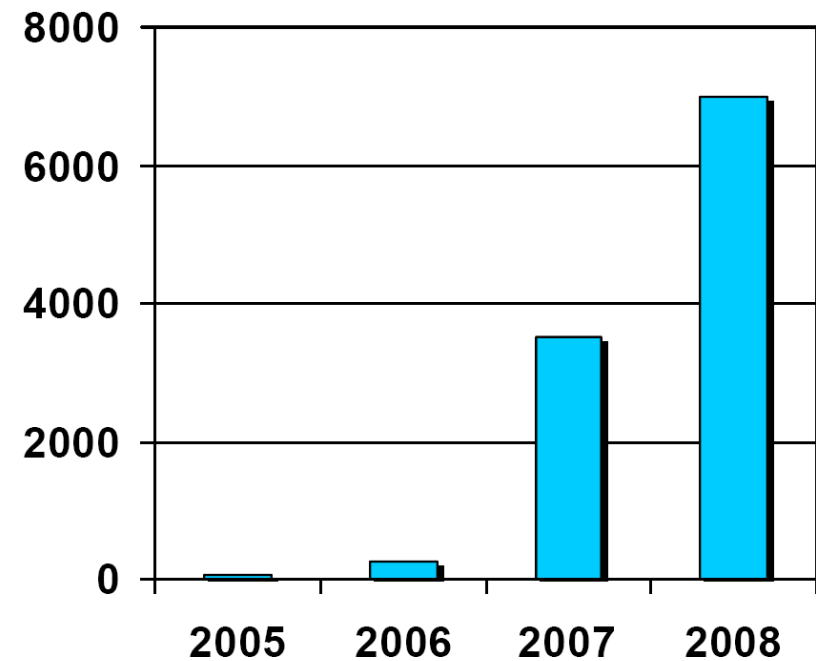
Fuel cell Markets

Small PEM FC are becoming commercial

Small stationary FC delivery (units) < 10kW



Portable FC delivery (units)



Source : Teknologia teollisuus

Fuel cell Markets

How to ensure that competitiveness is reached

Fuel cell system to be simplified

- Simplified and robust process
- Robust fuel cell stack
- Intelligent system control
- Integrated design

Value chain to be further developed

- Cost effective components
- OEM for dedicated development
- Niche applications for initial market volume
- Synergy with existing mass markets

Cost reduction on all levels

- Fuel cell stack largest cost item
- System control
- Materials
- Manufacturing

Cost reduction

1. Cost analysis
 - Create a solid database for optimization
 - Cost of functions and available options
 - Modules and sub-modules structure
 - Technical specifications
 - Cost transparency

2. Process optimization
 - PI-diagram optimization
 - Analysis of control options
 - Feasibility analysis from cost and operational perspectives

3. Supply management
 - Supplier development
 - Component development
 - Value chain analysis and optimization

Conclusions

- Fuel cell technologies have potential to provide ultra clean and efficient power both for marine and distributed generation applications
- Development, integration and operation of 20kW planar SOFC power units have been demonstrated
- The upcoming WFC20 and two WFC50 units will provide extensive experience over SOFC in marine and biogas applications
- Strong focus on R&D and the development of the value chain is needed before commercialization
- Both domestic and international frameworks support long term R&D and commercialization efforts
- System simplicity, cost and durability are the main challenges