



Small Gas Turbine Project

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Dutch Gas Turbine Association VGT
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- **Small Gas Turbine Project**
- **Internal coatings for turbine blades**
- **Emission reduction prediction tool**

Why the interest?

Small Gas Turbine Project

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- Small gt-sector is relatively young
- Below 3 MW only gas engines (or aircraft propulsion, stand by)
- Late 80's situation changed:
 - more stringent emission regulations
 - research on hybrid propulsion
 - turbo charger manufacturing technology
 - high speed generator
 - use of reliable recuperators
- Now micro-turbines available (up to 100 kW) with high efficiency and low price
- Technology will expand in higher power classes



Project outline

Small Gas Turbine Project

- International status
 - Technology
 - Market survey
 - Company & institute visits (24)
- Analyses of international situation
- Applications (focus on Dutch/West European market)
 - potential applications
 - economic feasibility
 - market potential in various areas
- Industrial opportunities
- Government policy issues
- Demonstration projects

COMPANIES VISITED:



Small Gas Turbine Project

- USA:
 - MIT
 - NREC
 - Elliot
 - Capstone
 - Honeywell
 - Private consultants
- Europe:
 - Turbec (ABB-Volvo)
 - Turbomeca
 - Bowman
 - Schelde Heron
 - OPRA
- Japan:
 - Tokyo Gas
 - Japan Cogeneration Ctr
 - MyEnergy
 - NEDO
 - JARI
 - Niigata Engineering
 - Ishikawajima HI
 - Mitsubishi HI
 - Toyota Turbine & Syst.
 - Daihatsu Diesel
 - Kawasaki HI
 - Ebara Corporation
 - Honda
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Applications for small gas turbines

Small Gas Turbine Project

- **Pure electrical power demand**
 - base load power
 - small industries, offices, hotels, apartment buildings, grocery stores, laundries
 - telecom services
 - rural areas (distributed systems)
 - stand-by power (hospitals, offices, UPS-systems)
 - peak shaving
 - mobile power
- **Cogeneration systems**
 - traditional systems
 - absorption cooling
 - mechanical drive of refrigeration systems
 - trigeneration systems
 - direct use of exhaust heat for e.g. combustion air
- **Specific applications, based on fuel capabilities**
 - on-offshore applications
 - landfill gas, sewage gas, biogas,
- **Hybrid propulsion systems (buses, trucks, cars)**
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Final conclusions (1)

Small Gas Turbine Project

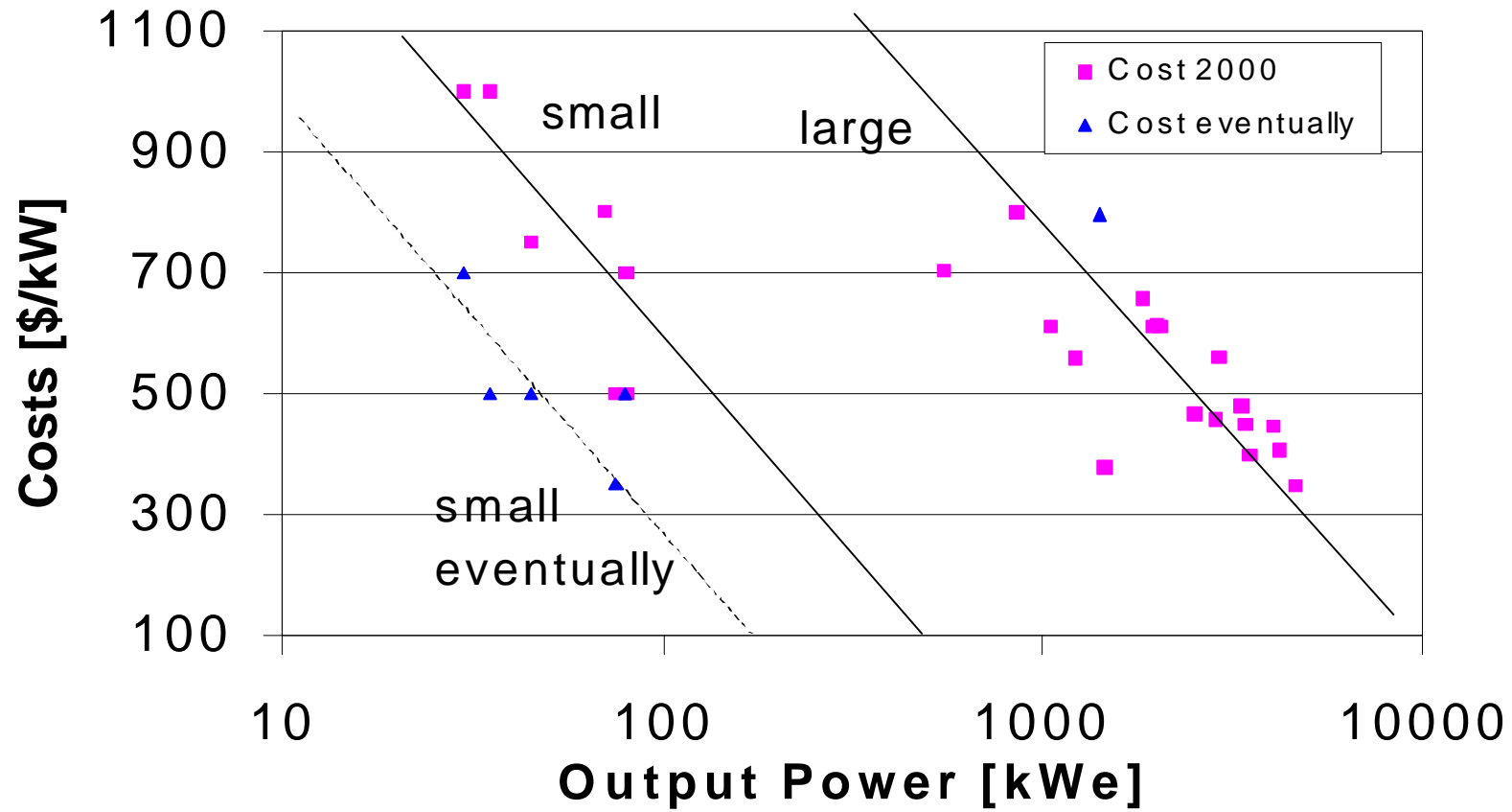
- Technology aspects
 - Small gas turbines will rapidly enter market
 - driving factors: emissions (NO_x, unburned), flexibility, wide applicability, power/size ratio, power/weight ratio, low cost, fills up current power gap
 - efficiencies to be expected of 40% (2010)
- Market & costs
 - Costs eventually between 350 and 700 US\$/kW
 - Growth volume 8000 MW/year for next 10 years
 - In numbers: maximum 80.000 units of 100 kW
 - Worldwide production currently 4000
 - Microturbines follow non-conventional cost line
- Economic feasibility
 - investment costs gas engines and gas turbines comparable
 - maintenance costs of gas turbines lower
 - economic feasibility calculated for 8 different applications
 - SPOT-values cogeneration: 7.7 years (200 kW) and 5.3 years (1000 kW)

Final conclusions (2)

Small Gas Turbine Project

- Netherlands market and potential
 - Application areas
 - Horticulture
 - Utility and residential buildings
 - Industry
 - ICT-networks
 - Oil & Gas Industry
 - Market estimate (numbers and MW):
 - low end 1880 (2350 MW)
 - high end 4860 (5300 MW)
 - Current number of industrial gas turbines: 350
- Market opportunities for Dutch industry
 - Design, manufacturing and packaging
 - Operation, maintenance, overhaul and repair
 - Opportunities related to applications
 - Spin off technologies
- Contribution to Dutch environmental policy goals
 - total greenhouse emissions (CO₂ + CH₄) comparable to gas engines
 - CO₂-savings up to 1 Mton (total emission reduction goal for utility buildings)
 - small gas turbines able to deliver 8.4% of total Dutch NO_x emission reduction goals

Costs vs. Output Power



Demonstration projects

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- Greenhouse CHP and CO₂-fertilization
- Wet natural gas burning on satellite platforms
- Flare gas burning at chemical sites
- Burning of sewage gas/landfill/biomass gas
- CHP/cooling systems in offices/elderly homes
- Preheating of industrial furnaces
- Combination with organic Rankine cycle
- Combination with fuel cells
- Powerpacks for marine cooling application
- Hybrid propulsion system for buses
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