



Wind Power Industry 2.0

Cleanpower '09

Dr Michael Fielding





Wind 2.0

Artemis Intelligent Power

ARTEMIS



INTELLIGENT POWER LTD

Business: Digital Displacement® technology development
(mobile, automotive, renewables)

Location: Edinburgh

Employees: 25

50%
less CO₂
in city driving

30%
less CO₂ combined

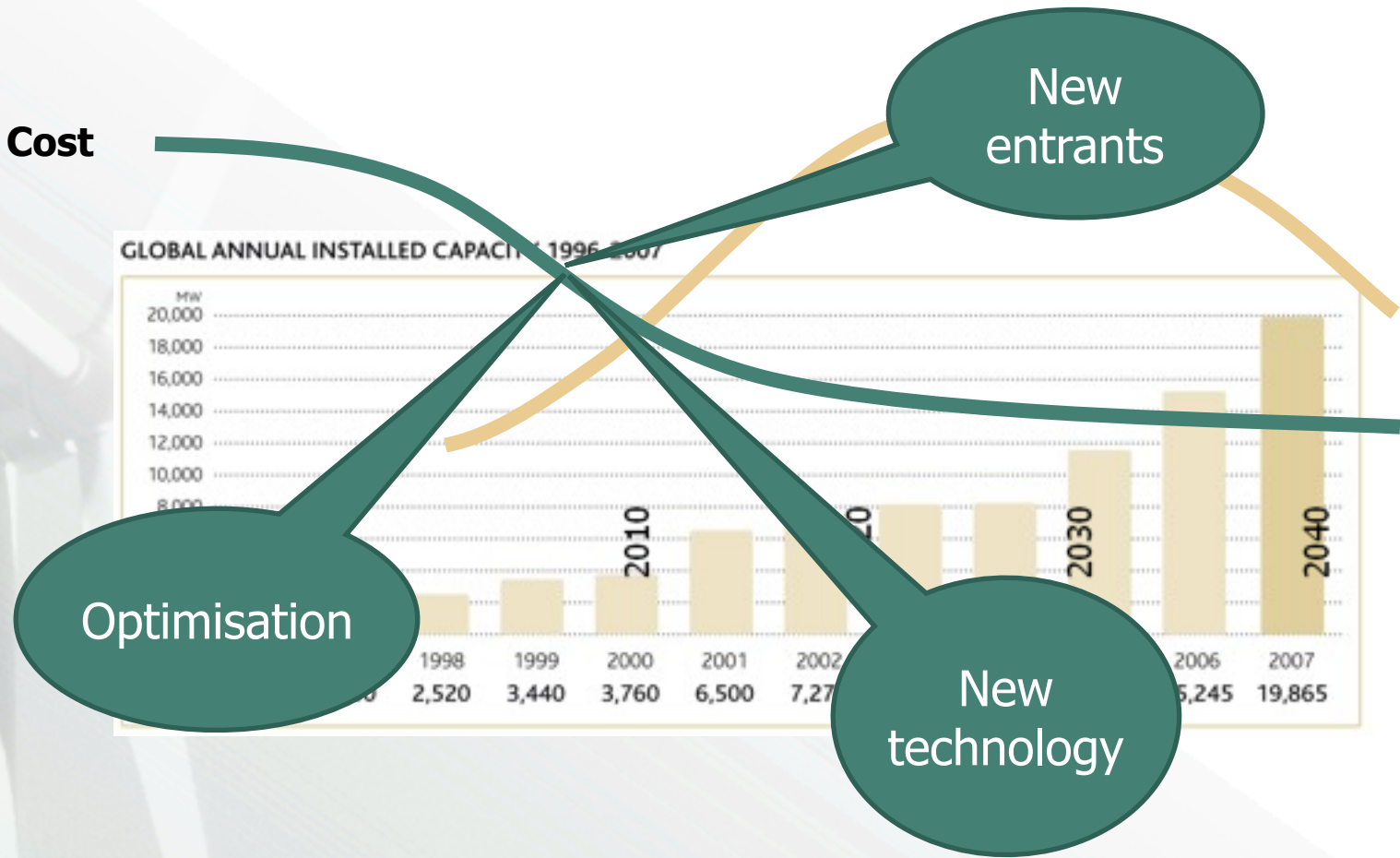


Rexroth
Bosch Group



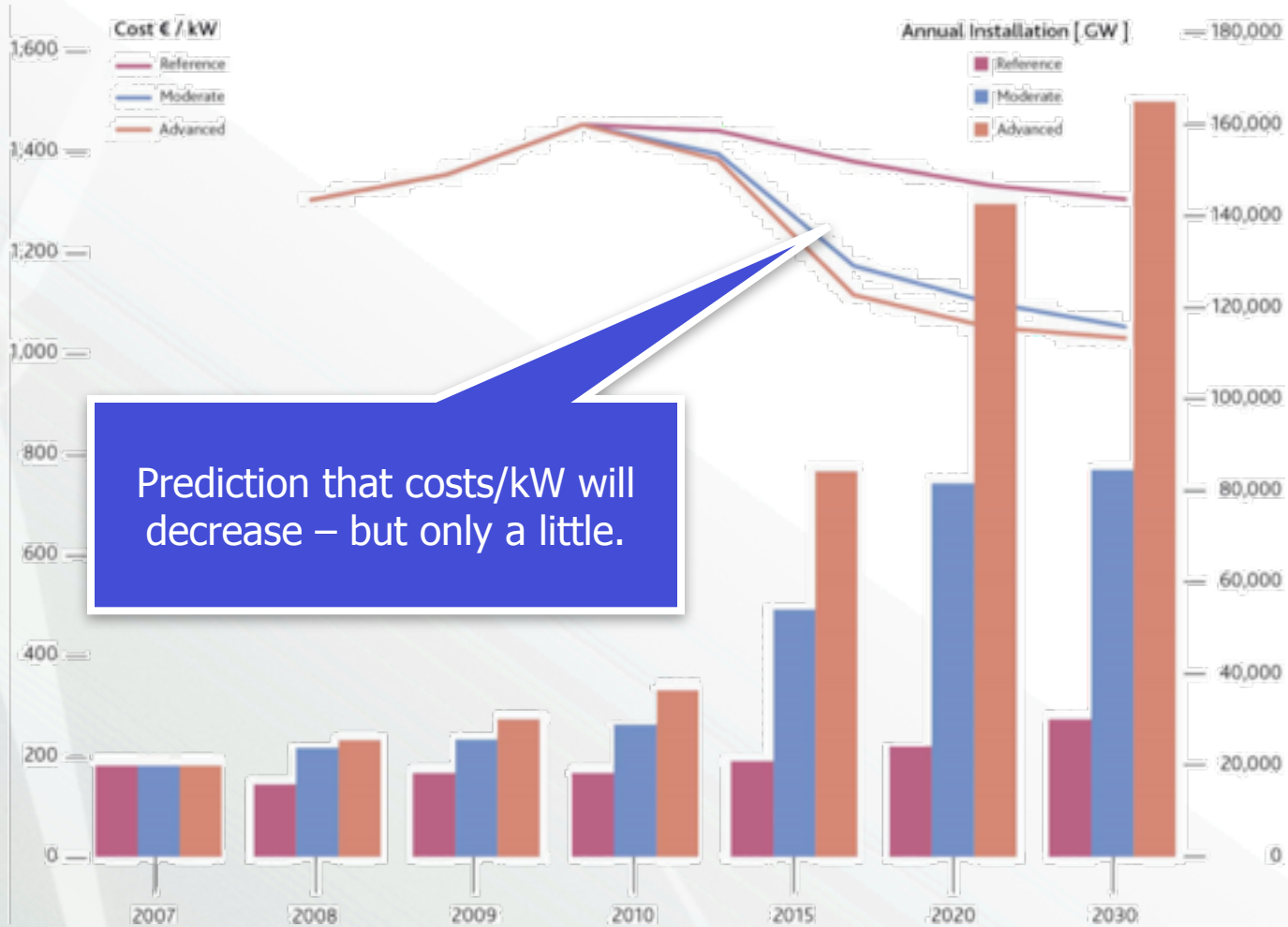


Wind 2.0 Technology lifecycle



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GWEC Perspective



Source: GWEC Global Wind Energy Outlook 2008



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Top targets for cost reduction

How a wind turbine comes together

A typical wind turbine will contain up to 8,000 different components. This guide shows the main parts and their contribution in percentage terms to the overall cost. Figures are based on a REpower MM92 turbine with 45.3 metre length blades and a 100 metre tower.

Drivetrain
25%

Blades
22%

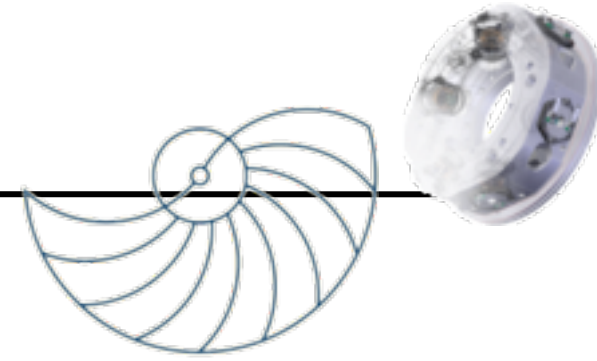
- Tower** 26.3%
Range in height from 60 metres up to more than 300 m. Usually manufactured in sections from rolled steel; a lattice structure or concrete are cheaper options.
- Rotor blades** 22.2%
Varying in length up to more than 60 metres, blades are manufactured in specially designed moulds from composite materials, usually a combination of glass fibre and epoxy resin. Options include polyester instead of epoxy and the addition of carbon fibre to add strength and stiffness.
- Rotor hub** 1.37%
Made from cast iron, the hub holds the blades in position as they turn.
- Rotor bearings** 1.22%
Some of the many different bearings in a turbine, these have to withstand the varying forces and loads generated by the wind.
- Main shaft** 1.91%
Transfers the rotational force of the rotor to the gearbox.
- Main frame** 2.80%
Made from steel, must be strong enough to support the entire turbine drive train, but not too heavy.



- Gearbox** 12.91%
Gears increase the low rotational speed of the rotor shaft in several stages to the high speed needed to drive the generator
- Generator** 3.44%
Converts mechanical energy into electrical energy. Both synchronous and asynchronous generators are used.
- Yaw system** 1.25%
Mechanism that rotates the nacelle to face the changing wind direction.
- Pitch system** 2.66%
Adjusts the angle of the blades to make best use of the prevailing wind.
- Power converter** 5.01%
Converts direct current from the generator into alternating current to be exported to the grid network.
- Transformer** 3.59%
Converts the electricity from the turbine to higher voltage required by the grid.
- Brake system** 1.32%
Disc brakes bring the turbine to a halt when required.
- Nacelle housing** 1.35%
Lightweight glass fibre box covers the turbine's drive train.
- Cables** 0.96%
Link individual turbines in a wind farm to an electricity sub-station.
- Screws** 1.04%
Hold the main components in place, must be designed for extreme loads.

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New entrants



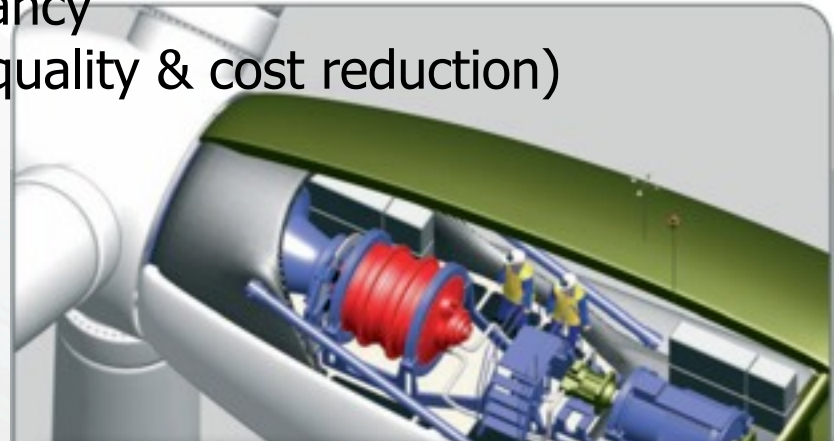
P. E. C O N C E P T S
P R O G R E S S I V E E N G I N E E R I N G

“The combination of lightweight component production and design

Business: automotive consultancy
(powertrain, body, quality & cost reduction)

Location: Europe, USA

Employees: 1,200



Source: RLE Website, June 2009

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New entrants



Business: motion control products
(mobile, aerospace, automotive)

Location: 42 countries

Employees: 62,000

T/O: \$12.1B



Source: Parker website, June 2009

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New disruptive technology



10 MWatt Generator
Size Comparison



Source: StatoilHydro HywindSource: Energy Technologies Institute

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Digital Displacement[®] Wind Transmission



>60% weight reduction

Lower hardware cost
+ no converter nor transformer

= Lower install cost

+ fundamental robustness Lower O&M

+ maintenance from a van Lower €/kWh

1.5MW Digital Displacement[®]
hydraulic motor

1.5MW Digital Displacement[®]
hydraulic pump

Synchronous Generator

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Conclusions



New industry entrants are being attracted by continuing high growth

Industry can't rely on increasing €/kWh

Disruptive cost-reducing technology will destroy some businesses


Investment to get into the technology game is not expensive – especially compared to the cost of being left behind

ARTEMIS

INTELLIGENT POWER LTD



3 Edgefield Industrial Estate
Loanhead
Midlothian EH20 9TB
Scotland
UK

 +44 (0)131 516 8153

Fax +44 (0)131 516 8608

 m.fielding@artemisip.com

 www.artemisip.com

