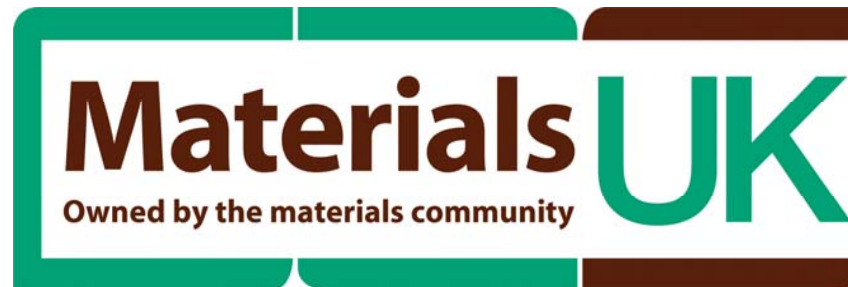


Materials' Supply Chains in the UK's Power Generation Sector

May 2nd 2008

*A Materials UK event, in collaboration with
the Materials KTN and meta⁴*



UK Power Generation Materials Supply Chain Report

- Sponsored by meta⁴ (Materials KTN) and member companies of the Energy Materials Working Group (EMWG) of Materials UK.
- Draft made available for consultation in December 2007.
- Updated following consultation.
- Available today.

The mapping of materials supply chains in the UK's power generation sector



Aims of the Supply Chain Mapping Exercise

- To characterise the markets, strengths and opportunities of the UK's Energy (Power Generation) Materials supply chains.
 - Specifically, the review focused on the application of materials in the generation of electricity by Fossil, Nuclear & Renewable fuels & technologies.
 - ⇒ raw materials suppliers, materials fabricators, OEM's, utilities
 - To highlight significant R&D activities related to materials in UK power generation.
 - ⇒ key organisations and groups
 - ⇒ major, largely publicly funded, programmes
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Summary:

Fossil Fuel-Fired Power Generation

- Electricity generation from fossil fuel combustion constitutes more than 75% of the UK's electricity supply (2006 data).

 - The closure of the coal and few remaining oil fired stations will result from implementation of 'The Large Combustion Plant Directive' (LCPD).
 - ⇒ comes into effect January 2008
 - ⇒ ~11GW of 'opted-out' coal and oil stations to close by 2015.
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Summary:

Fossil Fuel-Fired Power Generation

- Few major power stations have been built over the last 20 years in the UK.
 - ⇒ erosion of supply chains for materials used in the manufacture of power equipment/plant for fossil-fired power generation.
 - ⇒ but, the UK has retained a strong capability in design and manufacture of power equipment and balance of plant.
 - A number of major Energy Companies and materials suppliers retain either headquarters, manufacturing bases and/or R&D facilities within the UK.
 - The UK power equipment and services sector has a turnover of approximately £30 billion and provides employment for approximately 300,000 people in the UK.
 - Exports of power equipment have averaged approximately £1.9 billion a year in recent years.
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Summary:

Fossil Fuel-Fired Power Generation

- Since 1990, the UK has lost ~70% of the supply chain for components/plant into the power generation sector.
 - ⇒ relatively few power stations constructed over the past 10-15 years
 - ⇒ suppliers have sought alternative markets
 - ⇒ UK-based OEMs acquired by mainland European parent companies

- UK-based companies offer an extensive steam turbine service capability (repair, refurbish, upgrade, retrofit, etc.).
 - ⇒ two of the world's four major steam turbine OEMs maintain significant capability in the UK.

- UK-based OEMs for industrial gas turbines serve the requirements for simple cycle & Combined Cycle Gas Turbine (CCGT) applications.

- The materials supply chains for fossil-fired plant are reliant upon 'inputs' from mainland Europe, in particular
 - ⇒ materials are also sourced in Japan and the USA.



Summary:

Fossil Fuel-Fired Power Generation

- However, UK-based companies maintain an extensive capability in the processing and fabrication of precision components for major fossil fuel-fired plant.
- The UK still retains a significant capability to manufacture components such as rotors, blades, discs, rings, casings, etc. for fossil-fired power generation.
 - ⇒ the UK possesses world-class capability in investment casting, with ~50% of Europe's and 10% of the world's investment casting capacity.
 - ⇒ UK also has world-class capability in coatings for aggressive environments
 - ⇒ but, few metals processors (eg, casters, forgers, extruders, rollers, etc.) now have the sector as their major market (20% or more of turnover).
- Gaps in the UK-based materials supply chain include:
 - ⇒ eg, limited capability in seamless stainless & speciality steel tube for boilers, steam generators, et., and large forgings



Summary:

Fossil Fuel-Fired Power Generation

- The capacity of the industrial and academic R&D base in materials for fossil-fired power plant has also decreased.
 - However, many R&D activities in fossil fuel-fired power generation are world-class.
 - ⇒ make an important contribution to the development of materials for high efficiency, low emission power plant
 - Public funding of fossil fuel-fired power generation activities has received a considerable boost recently:
 - ⇒ launch of the Governments 'Strategy for Developing Carbon Abatement Technologies (CAT) for Fossil Use'
 - ⇒ £35M of funding from the TS for Carbon Abatement Technologies.
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SWOT Analysis for Fossil Fuel-Fired Power Generation

Strengths

- Significant capability in design, construction and operation of fossil fuel-fired power plant.
- World leading OEMs in all major fossil fuel-fired plant.
- World-class capability in investment casting (of superalloys) for gas turbine applications.
- World leading fossil fuel-fired plant materials expertise across both the academic and industrial sectors (alloy development and coatings).
- World leading pilot scale test facilities (eg, burner and combustion test rigs).

Opportunities

- Possible that some UK companies would invest to increase their scope and capacity for components .
- Companies could reinstate facilities and skills if the business case justifies.

Weaknesses

- Significant investment will be required to reinstate and / or develop capabilities to supply some critical components.
- No UK-based capability in induction bending of large diameter thick-walled pipes and limited capability in the manufacture of seamless, thin-walled stainless and alloy steel tubing and Ni-base alloy tubing.
- A lack of skilled scientists / engineers with a strong background in materials.

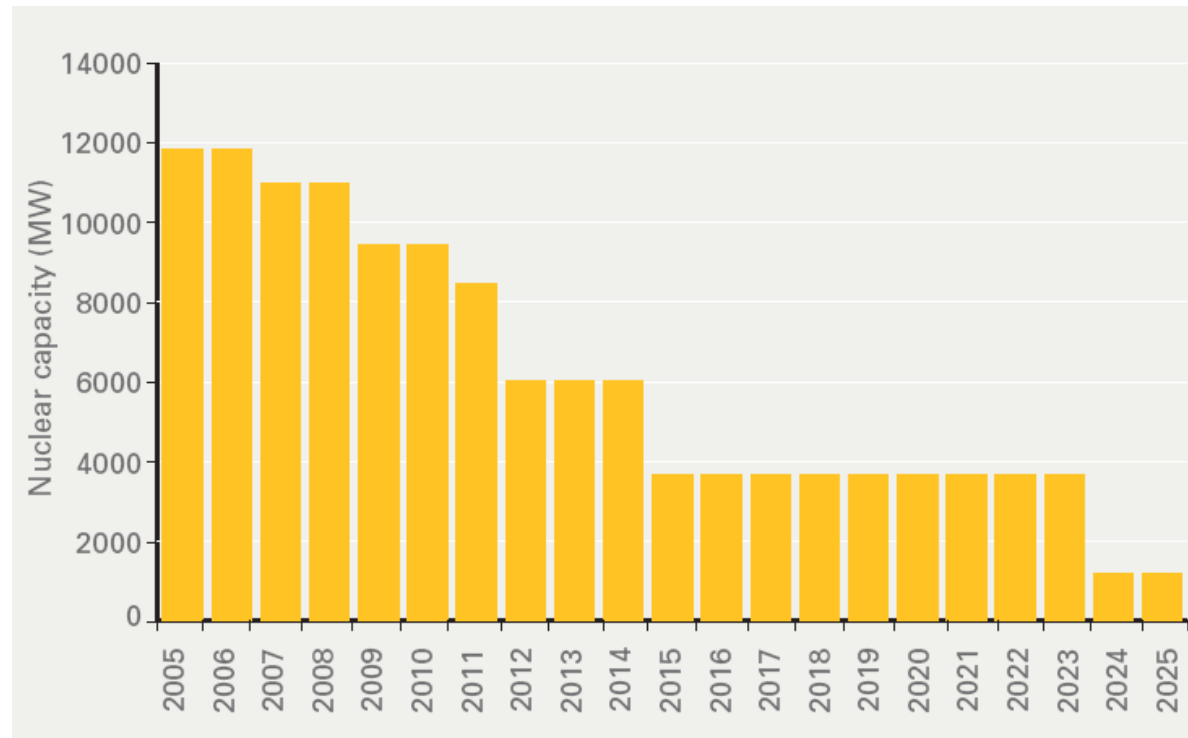
Threats

- Competition from overseas suppliers.
- Lack of investment in manufacturing capabilities; in particular, those associated with the manufacture of large forgings, seamless tube and large diameter pipework bending.
- Very buoyant oil & gas and other sectors resulting in a lack of will of metals processors / fabricators to participate in power generation sector.
- Loss of skills.

Summary:

Nuclear Power Generation

- In 2006, UK nuclear plants generated 18% of UK electricity, compared with 36% from gas and 38% from coal.
 - ⇒ the UK has 12 nuclear power stations and 19 operational reactors, totalling ~11 GW of capacity
 - ⇒ many reactors are reaching the end of their life and are due to be decommissioned.



Summary:

Nuclear Power Generation

- The UK's nuclear industry employs directly and indirectly approximately 80,000 people.
 - ⇒ earns the UK ~ £700M a year from overseas business

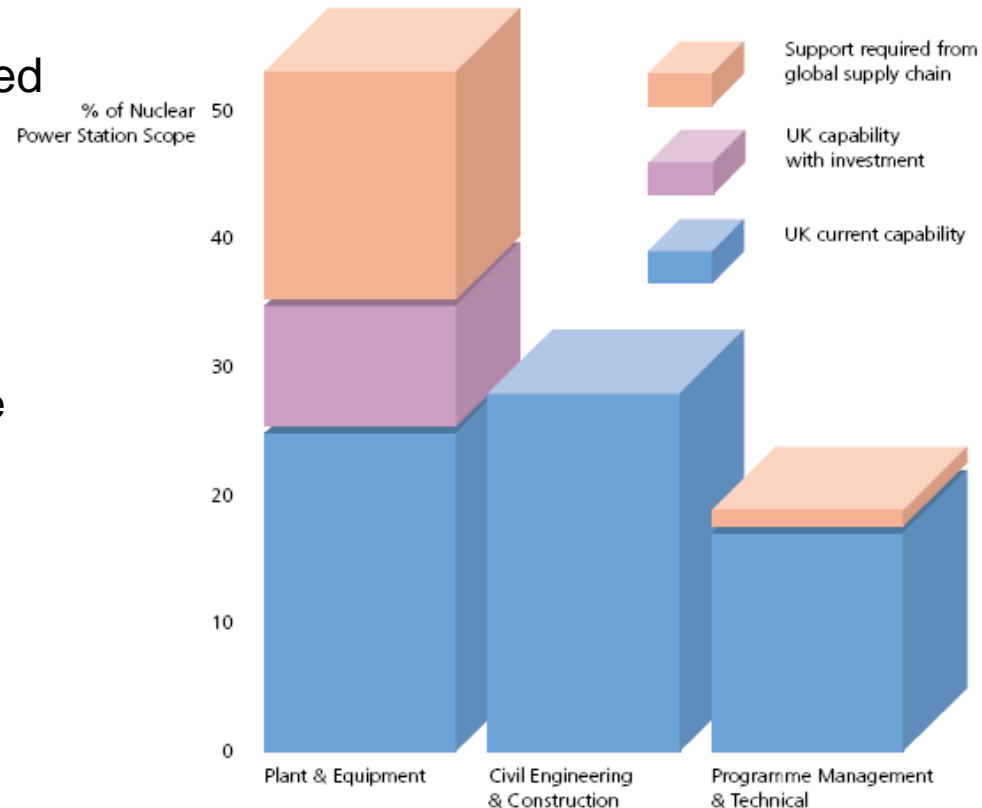
 - The UK maintains a significant capability in the design, construction and operation of nuclear power plant, nuclear plant decommissioning and nuclear waste management.

 - The UK has full fuel cycle facilities:
 - ⇒ conversion, enrichment, fuel fabrication, reprocessing and waste treatment

 - However, the UK's materials supply chain(s) for nuclear power plant has been eroded considerably over the past 15 years or so.
 - ⇒ UK's nuclear power 'fleet' now between 20 and 50 year old
-

Summary: Nuclear Power Generation

- Estimated that the UK supply chain could supply around 70% of the total requirements for such a new nuclear build programme.
 - ⇒ over 80% with some investment and training
- This capability currently being used to support:
 - ⇒ existing nuclear power plants
 - ⇒ new fuel cycle plant
 - ⇒ decommissioning and waste management activities
 - ⇒ non-nuclear projects which utilise similar skills
- All elements of the civil construction could be undertaken by UK companies.
 - ⇒ nuclear and turbine islands, balance of plant, supporting infrastructure



Summary:

Nuclear Power Generation

- Several UK-based companies have facilities and experience capable of supplying a large number of components required for a nuclear power plant.
 - ⇒ world leaders in the supply of equipment to overseas nuclear industries and/or to non-nuclear energy and civil engineering projects.

 - UK companies could supply ~50% of the Plant and Equipment with current facilities and resources.
 - ⇒ with investment, could increase to ~70% or more.

 - With increasing world demand, possible that some UK companies would invest to increase scope and capacity for UK new build and for export.
 - ⇒ companies could reinstate facilities and skills if the business case justifies
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Summary:

Nuclear Power Generation

- Limited world capacity to produce critical components.
 - ⇒ forgings, for Reactor Pressure Vessels (RPVs), steam generator pressure vessels and for primary circuit pipework, large steam turbine and turbine generator rotors

- Currently, no UK companies are set up to produce civil RPVs – forging and subsequent fabrication, and the largest forgings for nuclear Steam Generators.

- Also, no UK-based capability in:
 - ⇒ induction bending of large diameter thick-walled pipes
 - ⇒ limited capability in seamless, thin walled tubing

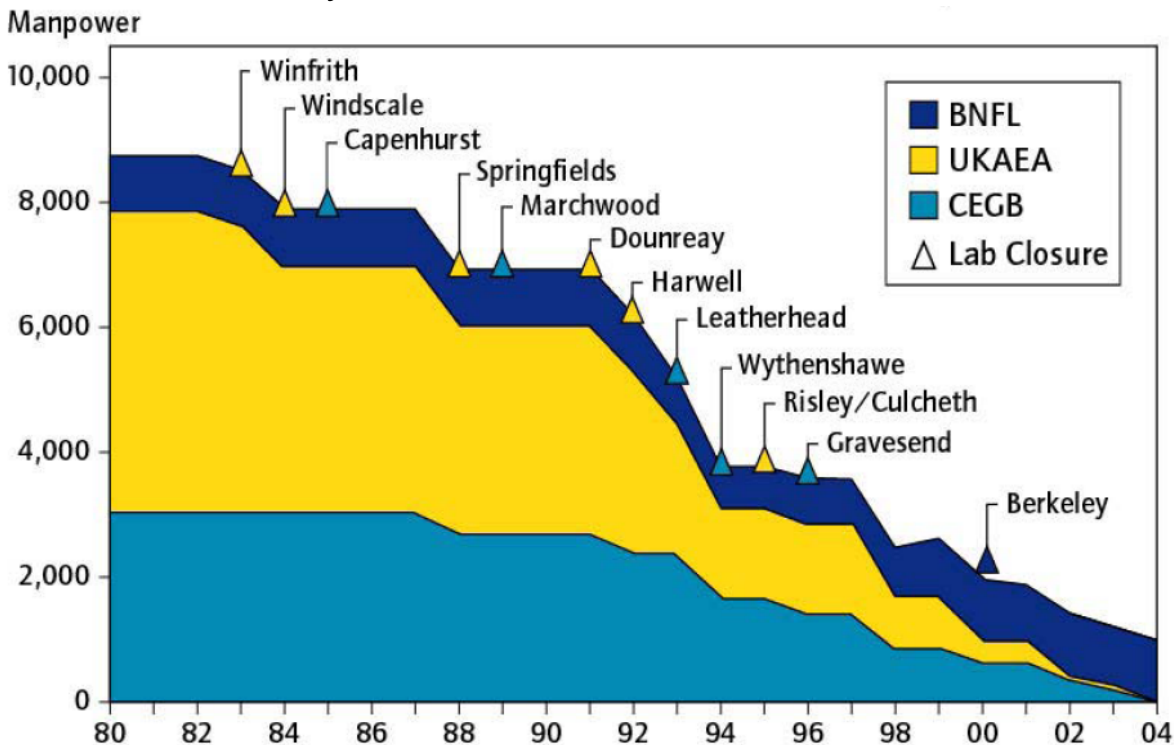


Summary: Nuclear Power Generation

- Nuclear fission related R&D in the UK has declined steadily over the past 20 years - since the 1980's:
 - ⇒ public investment has dropped by more than 95%
 - ⇒ industrial R&D skill base has decreased by more than 90%.

- However, the UK maintains leading nuclear materials expertise across both the academic and industrial sectors.

- Significant effort required to build up the required resources (skills).



SWOT Analysis for Nuclear Power Generation

Strengths

- Significant capability in design, construction and operation of nuclear power plant, and in full fuel cycle facilities, nuclear plant decommissioning and nuclear waste management.
- World leading companies currently supplying to marine nuclear and overseas civil nuclear industries.
- World leading companies currently supplying to sectors such as Oil & Gas, Defence, Chemicals and petrochemicals, which require similar capabilities and skills.
- Companies with experience in supplying to previous nuclear power plant builds.
- World leading nuclear materials expertise across both the academic and industrial sectors.

Opportunities

- The private sector (utilities) appears to have a commitment to nuclear power in their future energy portfolios.
- Possible that some UK companies would invest to increase their scope and capacity for a UK new build programme and for potential export (eg, proposed investment in 15,000 tonne press at Sheffield Forgemasters International Ltd.).
- Companies could reinstate facilities and skills if the business case justifies.

Weaknesses

- No significant nuclear power plant build in the UK since Sizewell B.
- Significant investment will be required to reinstate and / or develop capabilities to supply some critical components.
- No UK companies set up to produce civil RPVs – forging and subsequent fabrication, and the largest forgings for nuclear Steam Generators.
- No UK-based capability in induction bending of large diameter thick-walled pipes and in the manufacture of seamless, thin-walled stainless, alloy steel and Ni-base alloy tubing.
- Steady decline of nuclear fission related R&D.

Threats

- Competition from overseas suppliers already in nuclear power plant supply chains.
- Lack of investment in manufacturing capabilities; in particular, those associated with the manufacture of large forgings, seamless stainless steel and alloy steels, and large diameter pipework bending.
- Significant effort needed to build up the required resources (skills) within the timescale for licensing and contract awards.

Summary: Wind Power Generation

- UK has best offshore wind resources in the world.
- Wind power currently supplying ~1.5% of UK electricity.
 - ⇒ 2,200 MW of installed capacity as of August 2007.
- However, pace at which generating capacity is being installed is increasing rapidly.
 - ⇒ 1,400 MW of new capacity under construction (557 MW offshore).
- Wind energy is the fastest growing energy sector
 - ⇒ 4,000 jobs are sustained by companies working in the sector.



Summary: Wind Power Generation

- Competition within wind industry, particularly in Europe, is fierce.
 - The industry is global.
 - ⇒ global supply chains, and price, quality and delivery are key.
 - No indigenous UK-based wind turbine manufacturers.
 - ⇒ although some manufacturing facilities in the UK.
 - UK has a very limited share of the wind turbine & wind turbine component manufacturing market.
 - There are significant gaps in the UK supply chain for wind turbine manufacture and wind turbine components.
 - The UK has a long tradition of supplying structures and service to the offshore sector.
 - ⇒ should be more than capable of supplying to offshore wind industry.
-

Summary: Wind Power Generation

- There are a number of UK foundries capable of producing large castings for rotor hubs and bedplates.
 - ⇒ demand will increase with increased use of direct drive turbines using permanent magnet and induction generators (' housings).
- Turbine manufacturers are looking to source towers locally.
 - ⇒ ~200 tonnes of steel per tower.
- A major turbine manufacturer produces rotor blades in the UK



SWOT Analysis for Wind Power Generation

Strengths

- Significant capability in services followed by manufacture and supply of electrical and electronics equipment.
- Significant number of UK-based project developers denotes interest in the market and is important because they drive demand. Opportunities for UK depend upon the companies' procurement strategy and the access UK suppliers have to the relevant procurement routes.
- Structures and offshore structures fabrication, in particular.
- Experience exists across a range of industry sectors with similar skills applicable to the wind sector such as oil and gas, aerospace and shipbuilding.
- Presence of rotor blade facility of a major turbine manufacturer (Vestas)
- Some wind tower manufacturing capability, including a Vestas site.
- Suitable manufacturing sites close to points of use - largely linked to offshore capability.

Weaknesses

- Manufacture of wind turbines and specialists components – no major wind turbine manufacturer based in the UK and the majority of wind turbine components are imported.
- UK suppliers have little or no track record in the manufacturing of wind turbine components, and so experience difficulties in becoming preferred suppliers.
- Major turbine manufacturers have established supplier relationships and have undertaken some vertical integration.
- Difficulty in contributing to new turbine design (well established)
- Time is short to demonstrate capability in component manufacture – margins low, quality requirements are high and some investment in new technologies needed.

SWOT Analysis for Wind Power Generation

Opportunities

- The Renewables Obligation and UK Government commitment means that there is a commitment to wind power in the UK.
- There is a very significant market.
- The offshore pedigree of UK companies could mean significant opportunities in offshore wind farm construction.
- Maintenance and service and related equipment linked to offshore skills.
- Manufacture of high mass and size components with high transport costs, such as towers, blades, hubs, rotor shafts
- New technology introduction, such as next generation, direct drive generators.

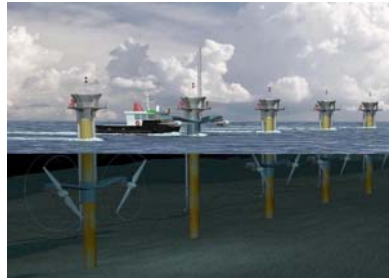
Threats

- Fierce competition from overseas suppliers already supplying to major turbine manufacturers.
- Installation of component manufacturing capacity in lower cost, developing countries, which can supply into the UK.
- Lack of investment in component manufacturing capabilities.
- Planning system delaying approvals for wind farm developments.

Summary:

Marine Power Generation

- UK has established itself as an early market leader in marine renewable energy.
 - ⇒ over 30 technology developers in the UK (~15 in Eu and ~ 20 in RoW).
- UK is very well placed to take a significant portion of the world marine energy market, with strengths such as:
 - ⇒ exceptional wave and tidal resource.
 - ⇒ world leading marine renewable (turbine) technology.
 - ⇒ strong offshore (oil & gas) engineering and fabrication skills.
- The UK has pioneered shared facility testing of wave and tidal devices
 - ⇒ European Marine Energy Centre (EMEC), Scotland, 'Wave Hub' (SW England), NaREC (NE England).



Summary:

Marine Power Generation

- Currently, there are few commercial designs that have been successfully demonstrated.
 - ⇒ no (well) established supply chains and common strategies for procurement and contracting.

 - In general, very few materials related issues or specific materials based development activities.
 - ⇒ technologies lend themselves to adoption of existing offshore (oil and gas), marine and wind power market technologies.

 - There is a high level of research and development activity related to wave and tidal energy ongoing within the UK.
 - ⇒ little activity dedicated to materials development.
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Summary:

Marine Power Generation

- The UK possesses ~ 35% of Europe's wave resource and 50% of Europe's tidal resource.
- In the long-term, marine renewables could meet 15 to 20% of the UK's electricity demand.
 - ⇒ with 3% to 5% from tidal stream
 - ⇒ remainder from wave energy.



European annual average wave power
(kW/m of crest width).

SWOT Analysis for Marine Power Generation

Strengths

- The UK is the world leader in wave and tidal technology development.
- World-class experience in the development and evaluation of wave energy conversion (WEC) devices
- Strong offshore and marine engineering capabilities.
- The UK's tidal and wave energy resource is immense
- The UK has established two major demonstration and test centres which may allow the UK to set the international benchmarks for evaluating marine renewable devices
- There are demonstration projects currently operating in the UK.
- The UK has a large number of companies with experience in the planning, development (fabrication / construction), and operation (including service and maintenance) of offshore structures.
- Some small-scale supply chains have developed around prototyping and demonstration projects.

Weaknesses

- There is no stable design and all designs are unproven, although some front-runner technologies are emerging.
- Technical, economic and performance risks remain.
- The energy supply from marine renewables is intermittent.

SWOT Analysis for Marine Power Generation

Opportunities

- There is a massive resource globally and a potentially large market in the UK and overseas.
- The UK has the opportunity of establishing a 'winning' design and developing a supply base centred in the UK.
- Distinct synergies exist with the offshore industry (including wind). This means that the UK can build on existing strengths and develop wave and tidal service capabilities.
- The UK's offshore industry is looking to diversify from its traditional business, and many within that industry see offshore renewables as an area of opportunity in which they can exploit their existing skills and experience.

Threats

- A non-UK design may become the preferred device (although there may still be significant opportunities for UK-based fabrication, operation, service, etc.).
 - Uncertainty over market volumes can act as a barrier to the investment required to make the transition from a prototype supplier to a commercial supplier.
 - Longer-term, manufacturing may be hosted in countries with low cost labour.
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Summary: Fuel Cells

- The report provides links / references to sources of further information on Fuel Cells.
 - ⇒ large amount of information on UK capability, deployment roadmaps, etc.

 - There are more than one hundred UK-based companies active in the development of fuel cell technologies.
 - ⇒ materials R&D to fuel cell systems integration.

 - Fuel cells are well suited to support distributed power generation or combined heat and power generation (CHP).
 - ⇒ using either natural gas or renewable fuels.

 - Fuel cells are proving competitive in niche applications.
 - ⇒ production scale-up will help accelerate cost reduction necessary for mass commercialisation.
-

Summary: Fuel Cells

- UK has particular strengths in:
 - ⇒ PEM (proton exchange membrane).
 - ⇒ Solid Oxide Fuel Cell (SOFC) materials, components and systems.
 - ⇒ stationary reformer systems.
 - ⇒ fuel delivery and storage systems.
 - ⇒ systems for thermal management relating to 'balance of plant'.

- The UK's fuel cell materials R&D (both industrial and academic) is at the forefront of fuel cell technology.
 - ⇒ UK has an extremely strong academic research base in materials, chemistry and engineering relevant to fuel cell systems.
 - ⇒ more than 35 active university based research groups.



Materials

Knowledge Transfer Network

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