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Triodos Renewables

2011 – 2020: A Decade for Renewables?

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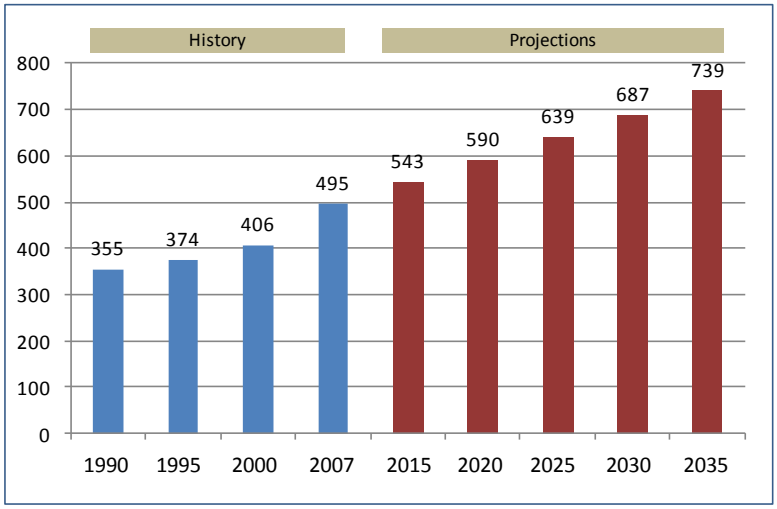
Introduction: Are we in a Global Energy Crisis?

Are we in a global energy crisis? It might not feel like a crisis at the moment, but we should at least feel uncomfortable. Global demand for energy is rising and is forecasted to continue the trend through to 2035. World GDP is forecast to rise by an average of 3.2% over that period, with non-OECD countries, led by India and China, averaging 4.4% per year. With that comes increased demand for energy. The US Energy Information Administration is forecasting a 50% increase in demand for energy in the World by 2035.

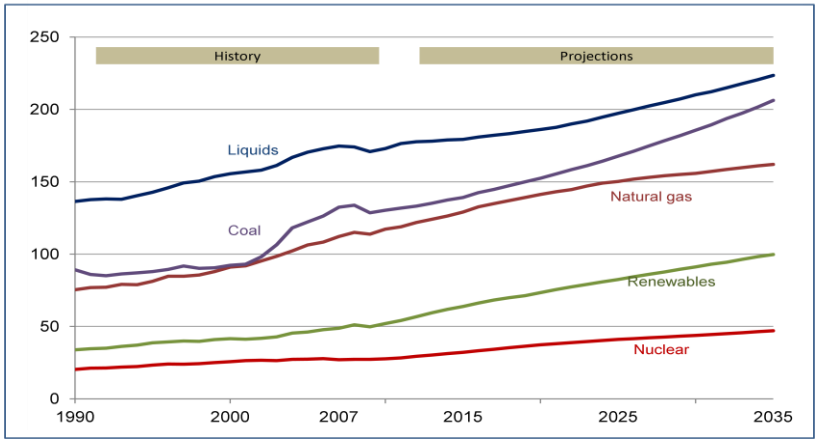
Figure One: Global Energy Demands to 2035, quadrillion Btu



Source: U.S. Energy Information Administration (EIA)

This scenario puts a strain on all types of energy and the associated forecast by source shows no let up on fossil fuel use:

Figure Two: World market Energy Use by Type, quadrillion Btu



Source: U.S. Energy Information Administration (EIA). Note: Liquids includes fuel for vehicles in this analysis – this table plots USE not generation.

The EIA forecast usage of renewable energy will more than double by 2035, as will nuclear off a lower mark, but we shall see far quicker growth of renewable energy than nuclear in the shorter term. There is a popular belief that the World has, or is about, to reach "Peak Oil". This is the point in time when the maximum global petroleum extraction level is reached, after which the rate of production enters terminal decline. Campaigners talk about oil "running out" in 40 years. That is quite a contrast to the picture painted above, but is it right? Certainly reserves are harder to exploit. The European Commission in 2003 concluded that oil discoveries would continue but at a slower rate post 2015 and production would be stable, so the gap between discovery and production post 2015 would indeed begin to close.

Similarly, the rate of gas reserve discoveries was forecast to ease post 2015 but demand will grow so again reserves will decline. The EU forecast was not apocalyptic, but the need for alternatives is plain to see.

Nuclear power capacity is increasing worldwide "*steadily but not dramatically*" (World Nuclear Association). In January 2011 there were 60 reactors under construction in 15 countries. Some countries are reliant on extending plant life to maintain nuclear capacity and today there are 440 nuclear power reactors operating in 30 countries.

The steepest climb on the above chart is however coal. Reserves remain vast, and new technology such as underground coal gasification will gradually exploit much deeper reserves. The World Coal Association states that, at current rate of production the World has 119 years of reserves available. Reserves are widespread, often not so politically controlled for its markets, and therefore relatively secure (security is defined by the United Nations Development Programme as "*the continuous availability of energy in varied forms, in sufficient quantities and at affordable prices*"). If only for this reason, countries will be using coal for energy production for a long time to come.

Figure Three: Coal, oil and gas reserves 2005, (gigatonnes of coal equivalent)

	Coal	Oil	Gas
North America	258	16	11
South America	22	25	11
Western & Southern Europe	97	7	8
Central & Eastern Europe	33	1	1
Middle East	2	179	110
Former Soviet Union	225	21	86
China	115	6	3
India	84	1	1
Asia & Oceania	94	6	17
Africa	55	25	21

Source: World Coal Institute: "Coal: Secure Energy 2009"

The above analysis does not however take into account the impact of shale gas, to the extent that the figures for gas are vastly understated. Extraction of shale gas has been possible since the 1950s but it is only recently that confidence in the technology has permitted full scale commercialisation. And it is a game changer. In the United States, reserve estimates have subsequently exploded and by 2035 shale gas could be contributing 46% of US natural gas production. Of course, "technically recoverable" may not yet mean "commercially recoverable" but the implication of these numbers is clear.

Shale gas reserves have been identified throughout the World. By 2011 6,622 trillion cubic feet had been identified:

Figure Four: Estimated technically recoverable shale gas reserves by region

	2009 Natural gas production (trillion cubic feet, dry basis)	Proved Natural gas reserves (trillion cubic feet)	Technically recoverable shale gas resources (trillion cubic feet)
Europe	10.81	186.21	639.0
North America	28.00	346.5	1931.0
Asia	5.72	174.6	1389.0
Australia	1.67	110.0	396.0
Africa	3.64	217.1	1042.0
South America	3.34	239.2	1225.0
TOTAL	53.1	1273.61	6622.0

Source: EIA 2011 "World Shale Gas Resources", Oil and Gas Journal 2010

This development has implications for the geography of fossil fuel resources. While the biggest reserves are in the United States and China, there are substantial reserves in a diverse range of countries, including Canada, Mexico, Australia, South Africa, Libya, Algeria and Argentina.

Set against this overall picture of increasing resources, and therefore use of fossil fuels, is the compelling argument for the need to respond to climate change. The United Nations Framework Convention on Climate Change (UNFCCC) emphasises the urgency for fundamental change:

"If all current pledges and plans to cut or limit emissions were delivered completely and on time, global emissions would still keep growing in the next 10 years, under present trends. More stringent actions to reduce greenhouse gas emissions, in particular by industrialised nations, cannot be postponed much longer. Otherwise, the window of opportunity to keep the average global temperature rise below 2 degrees C is in danger of closing."

Regular references to the dangers of increased sea levels and glacial melt, the implications that has for as many as a billion people around the world and to as many as 30% of existing plant and animal species, are regularly backed up by reports of analysis around the world. As the June 2011 United Nations Climate Change Conference approaches, Australia added to the argument by stating a one metre sea level rise would reflect stronger global warming than previously thought.

Security of energy supply is a major issue for many countries. The UK, for example, relies heavily on imported gas from Norway and the Netherlands and LNG from Qatar. In the current energy scenario, Europe could expect to see an increasing reliance on fuel imports over the next twenty years, from 55 - 60% in 2010 to 65 – 70% by 2020. For oil, Europe would be almost totally reliant on imports, for

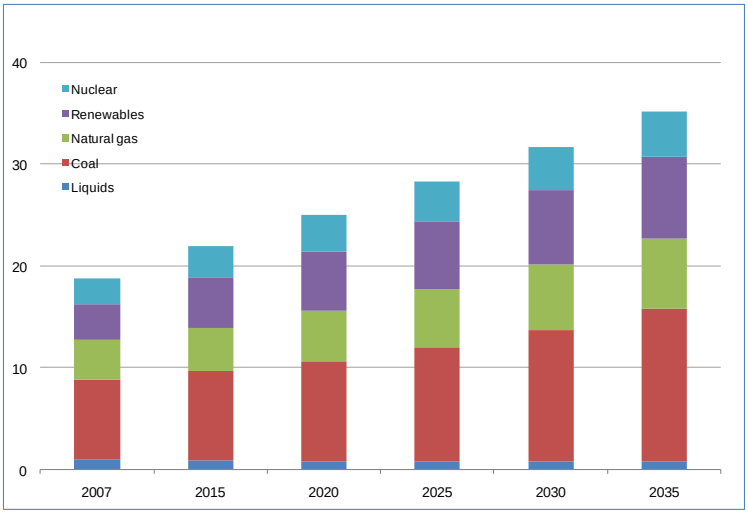
gas it would run at above 80% and for coal it would run at approaching 60% (Source: European Commission). The potential for temporary interruptions in supply therefore increases over time.

Right now, the extent to which there is an energy crisis is different by country. Some are in a much better position to meet their needs, either because usage is declining (as in the United States) or they are reasonably ahead of the game despite increasing energy usage (for example, China). All countries walk a fine line, and as we will see the United Kingdom is closer to crisis than many.

World Energy Generation: Trends and Forecasts for Next Decade

All forecasts are made with the view that energy generation is set to continue rising if it is to meet demand. To 2020, fossil fuels will each lose some share in the scenario below – liquids (oil) will dip from 5% in 2007 to 3.3%, coal from 42.2% to 39.3% and natural gas 20.6% to 19.9%. In contrast, nuclear will grow from 13.8% share in 2007 to 14.3% in 2020, but renewable energy (including hydropower) will grow from 18.4% to 23.3% (with that growth coming mainly from hydro and wind). Post 2020, the EIA are currently forecasting that renewables will do no more than retain the share earned in this decade, but this might be different if over the coming decade legislation for carbon emissions are tightened further, perhaps making coal a less commercially desirable option.

Figure Five: World Energy Generation by Fuel 2007 – 2035 (trillion kilowatt hours)

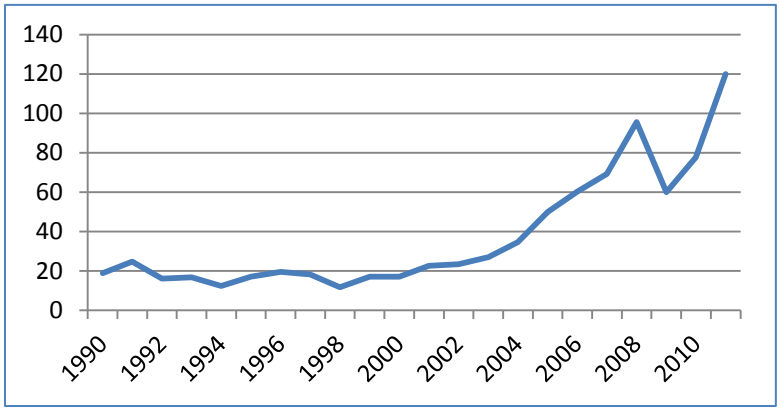


Source: International Energy Statistics Database, EIA. Renewable figure includes hydro.

Accurate forecasts are of course reliant on demand, which fluctuates according to price. Even short term forecasting on oil prices is a challenge. In 2009 the European Commission produced its "EU Energy Trends to 2030" analysis stating that "*oil prices will reach $88/bbl by 2020*". If only. In 2010 Bloomberg was speculating on the likelihood of the $100/bbl. As this report is produced, JP Morgan was increasing its end 2011 forecast by £10/barrel to $120/barrel, and there has been much talk of the $200 barrel as well. The speculation peaked in March 2011 when the "Day of Rage" was called for in Saudi Arabia, a country responsible for one-third of OPEC output (2009) and six times that of Libya (BP Statistical Review of World Energy).

Unrest in Saudi Arabia of the type seen in other Middle Eastern countries would indeed be the catalyst for dramatic escalations in the oil price and its relatively secretive nature causes some unease in oil markets. The uprising in Libya, which removed 700,000 barrels per day from the market, sent crude oil prices up by 15%, demonstrating the sensitivity of oil prices. In 2010 Saudi Arabia produced 8.4 million barrels per day. The Economist wrote in March 2011: "*Two factors determine the price of a barrel of oil: the fundamental laws of supply and demand, and naked fear*."

Figure Six: All Countries Crude Oil Spot Price FOB (Dollars per Barrel), 1990 – May 2011



Source: U.S. Energy Information Administration (EIA)

Figure Seven: Selected long term forecasts for light crude to 2025, dollars per barrel at 2009 prices

	2015	2020	2025
AEO2011 Reference Case (US EIA)*	94.58	108.1	117.54
Deutsche bank	81.06	91.77	99.75
ICF Q4 2010 Integrated Energy Outlook	77.86	77.86	77.86
INFORUM	90.97	102.25	108.91
International Energy Agency	94	110	120
EVA	87.02	91.97	99.71
IHS/Global Insight	90.44	86.15	80.17
MEAN of the 7 scenarios	**88.00**	**95.44**	**100.56**

Source: US DOE/EIA "Annual Energy Outlook 2011" *Middle of three scenarios presented by EIA

Many would think these forecasted growth in oil prices in the longer term are modest, but these represent the mid case scenario. In AEO2011 for example, the EIA also refers to a High Oil Price case which pushes oil up to $175/barrel by 2020, reflecting higher than expected GDP growth in non-OECD countries driving up demand, combined with political decisions that would limit production (access to resources, quotas, fiscal programme, etc.) and OPEC countries reduce production levels. The Low Oil Price Scenario of $55/barrel, reflects a world where GDP growth in non OECD countries is lower than anticipated creating lower demand and OPEC countries encourage development of resources, but the majority of experts would be nearer the High Oil Price Scenario than the lower.

What we should take from this is that the mean price per barrel in 2020 across the 7 forecast sources is $95 (four times the price it was 10 years ago), at the top end of the historical trend and so the step change seen in the "noughties" is clearly unlikely to be reversed. On balance we shall experience upward pressure, driven by declining volumes taken from current reserves and increasing costs of exploiting new reserves (deep water wells, Canada's oil sands, Venezuela's heavy oil deposits, extreme environment locations such as Siberia), potentially combined with reduced investment in exploration by the western oil companies. Extraction technology is developing to increase economically recoverable reserves. This was the cause of the BP Mexico Gulf catastrophe; BP has developed deep drilling expertise beyond any other company.

Short term drops in commodity prices, as in the first week of May 2011 which saw a 13% drop in Brent Crude prices, are fluctuations in an otherwise robust oil price going forward.

The EIA also takes a robust view on coal prices to 2025 suggesting that the likelihood of significant depreciation of coal prices is unlikely:

Figure Eight: Long term forecasts for coal prices (2009 $ per million Btu)

Scenario	Current	2015	2020	2025
High coal cost	2.4	2.4	2.7	3.3
High oil price	2.4	2.4	2.4	2.5
Low coal cost	2.4	2.2	2.0	1.85

Source: International EIA Annual Energy Outlook 2011: Projections to 2035

The nuclear debate has of course been intensified by the Fukushima incident.

China's reaction to Fukushima in halting all progress on nuclear pending a review of safety concerns is unlikely to continue in the longer term given the energy demands of a country of 1.4 billion people.

In Germany, the temporary closure of 7 of its 17 nuclear plants (which supply 25% of Germany's energy) is also likely to be short term as all safety questions are "*due to be answered by June 2011*". In 2010, Germany had actually decided to extend the life of all its reactors by 12 years, but this decision is now in abeyance in the face of public concerns.

The Nuclear Regulatory Commission (NRC) in the United States is reviewing safety on 104 reactors, and will publish within only three months, reflecting the urgency to get on with things. Overall, Power and Policy experts at Harvard are indicating a pause, but ultimately energy demands will bring nuclear back on track despite public concerns.

What was already a slow process will therefore be slower, but the status of nuclear around the world in terms of development is healthy. In 2011 there are 61 nuclear reactors under construction in the World. The focus is on mainland Asia: 27 of these are in China, 10 in Russia, 5 in India, 5 in South Korea.

Figure Nine: Reactors operating, in construction/on order/planned/proposed April 2011: World

	Number	MWe
Reactors operating	440	375,410
Reactors in construction	61	64,074
Reactors on order or planned	158	176,767
Reactors proposed	326	368,995

Source: World Nuclear Association 2011

The 2011 demand for uranium will be 68,971 tonnes. Current known resources are enough to last approximately 80 years at current requirements. Australia (31% of world resources), Kazakhstan (12%), Canada (9%) and Russia (9%) are the key supply countries. Recycled uranium and plutonium and re-enrichment of depleted uranium can increase overall nuclear reserves.

In 2010, of course prior to Fukishima, the International Atomic Agency Authority significantly increased its forecast for world nuclear generating capacity and predicted 73GWe net new capacity by 2020, and a further 546 – 803GWe in place by 2030. The forecast reflects the current speed of development and the time taken to build plants and suggests that capacity increases in the 2020s will be the direct consequence of strategic government decisions today.

In 2009 MIT updated a 2003 report on the future of nuclear, stating: *"Even if all the announced plans for new nuclear power plant construction are realized, the total will be well behind that needed for reaching a thousand gigawatts of new capacity worldwide by 2050."*

Given the rise in energy demand featured in Figure One and apparently little chance of decreases in key fuels, it is reasonable to forecast a good future for renewable energy in order to work towards carbon targets and BP Energy Outlook 2010 suggests strongly that growth in the next ten years will be strong:

Figure Ten: Share of energy production by fuel type 2010 - 2020

Million tonnes oil equivalent	2010	% share	2015	% share	2020	% share
Oil	3906.7	32.9	4109.6	30.7	4258	29.2
Natural gas	2858.9	24.1	3282.6	24.5	3683.6	25.2
Coal	3499	29.5	4032.5	30.2	4310.4	29.5
Nuclear	613.9	5.2	723.8	5.4	823.1	5.6
Hydro	772.8	6.5	855	6.4	958.2	6.6
Biofuels	57.5	0.5	93.7	0.7	133.6	0.9
Renewables	153.8	1.3	274	2.0	432.7	3.0
	11862.6		13371.2		14599.6	

Source: BP Energy Outlook 2010

Renewable energy has experienced substantial growth in recent years and this is set to continue. On a global level, this is much to do with the geographic diversification of renewables. In 2009 over 85 countries had set renewables targets, compared to just 45 in 2005. These include the emerging economies:

- Brazil: 75% of electricity generated to be from renewables by 2030
- China: 15% of final energy to be generated from renewables by 2020, led by wind power
- India: 20GW of solar to be installed by 2020

The Feed In Tariff (FiT) has become one of the key mechanisms, in 2010 more than 50 countries and 25 states or provinces had set FiTs for one or more renewable source. A wide range of additional fiscal stimuli has been adopted around the World – capital investment subsidies, investment tax credits, import duty reductions for equipment and net metering are all increasingly applied.

Some countries have got their calculations wrong; in the shorter term, Spain was too successful in encouraging solar farms and the country now has 10 times the capacity it had originally envisaged. In 2010 the solar industry in Spain received subsidies of €2.6 billion, an amount that is unaffordable. With the country's current economic travails it has recently had to slash the level of subsidies it can offer. The lesson of unforeseen consequences is being learned by the UK as it revises solar FiTs downwards with the prospect of a £40m network of solar farms in Cornwall. Elements of this project went to public consultation in May 2011. As the chairman of one of the Spanish energy majors remarked "*solar is no longer an energy source but a financial instrument*." If other governments concur with this analysis then the regulatory framework for renewables must surely be more

uncertain. It is our firm believe that any doubts as to the long term viability of renewable energy would have a significant impact on willingness for investors to climb aboard.

In a major, 1,000 page report soon to be published by the Intergovernmental Panel on Climate change (IPCC), ratified in May 2011 by 196 countries, the conclusion is that 77% of world demand for energy can be met by renewables by 2050 if the political mechanisms are right.

So which countries currently have the momentum? In 2009 the most active were as follows:

Figure Eleven: Countries Most Active by Renewable Technology, 2009

	#1	#2	#3	#4	#5
New capacity investment	Germany	China	USA	Italy	Spain
Wind power added	China	USA	Spain	Germany	India
Solar PV added (grid connected)	Germany	Italy	Japan	USA	Czech Republic
Solar hot water/heat added	China	Germany	Turkey	Brazil	India
Ethanol production	USA	Brazil	China	Canada	France
Biodiesel production	France/ Germany	France/ Germany	USA	Brazil	Argentina
Hydroelectric	China	Brazil	India	Burma	Russia

Source: Renewable Energy Policy Network (REN21), hydro based on current projects by MW.

Hydro projects are by their very character substantial. The analysis above considers just 23 major projects, 15 of which are in China.

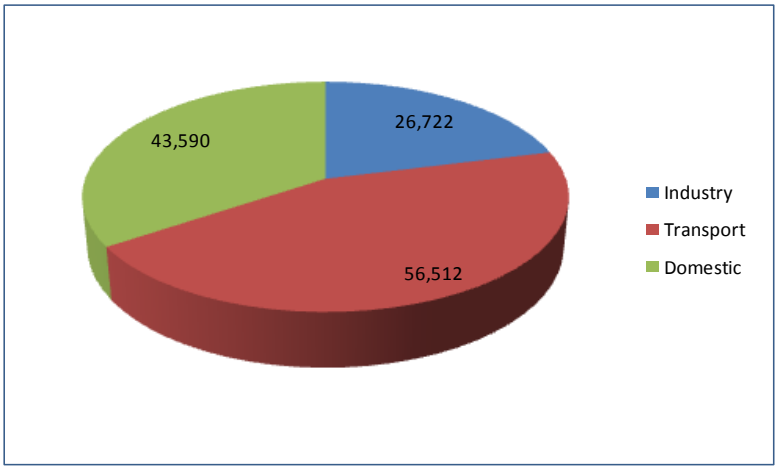
Wave and tidal is difficult to assess in terms of commercial momentum. However, The UK is most definitely among the front runners. A UK government think tank has recently announced that the industry could "be worth £76 billion to the economy and employ 68,000 jobs by 2050". Their study found that total UK marine energy capacity could be 27.5 gigawatts in the UK by 2050, enough to supply more than a fifth of current electricity demand.

What is noticeable in this analysis is the presence of Germany in five of the six categories, and the absence of the UK in any of these critical areas. The significance of this is that, if the UK had developed the same wide portfolio of resource that Germany has done, then it would perhaps not be entering the coming years in such an exposed position, and our contribution to climate change would be somewhat further developed.

UK Energy Production: Trends & Forecasts for Next Decade

Here is the UK "big picture". Currently almost 50% of energy consumption in the UK is transport related. Our focus is on energy generation, but the low carbon future is of course as much about consumption.

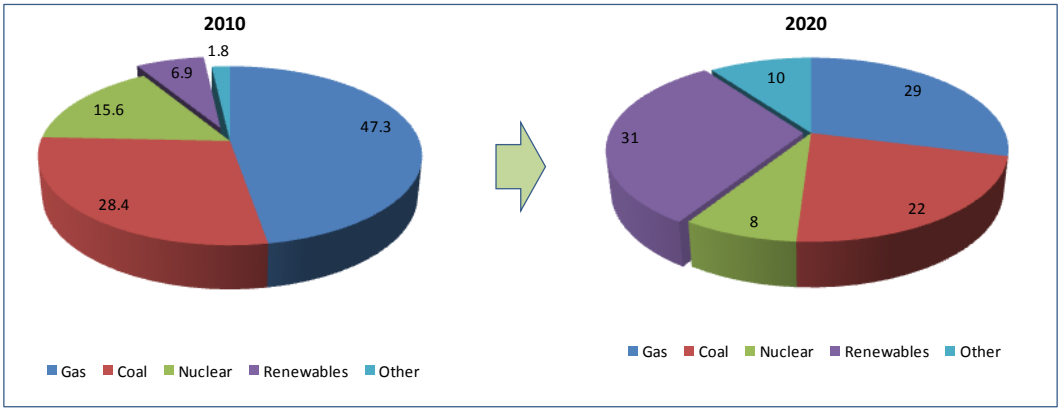
Figure Twelve: How Energy is used in the UK, 2009



Source: DECC

In the UK. electricity generation in 1990 was reliant on coal – it represented two-thirds of total generation. But approaching 100 power stations have been demolished (many small scale), the mining industry collapsed and in 2010 the picture is radically different and in 2020, if government plans are achieved, it will look different again:

Figure Thirteen: The Changing Face of UK Energy Generation: 2010 - 2020



Source: DECC The UK Low Carbon Transition Plan

If this were to happen, it would be a considerable achievement and would perhaps overcome the looming difficulties that the UK might face in the next few years.

Many of the UK's power generation assets are now 50 years old and according to the National Grid one-quarter of these will be retired by 2020. Didcot A, Ferrybridge, Ironbridge, Kingsnorth A and

Tilbury are all to close by 2015, taking 6,000MW out of the system. Without a renewable platform, the country would be more even reliant on imported energy.

The UK programme of nuclear power station closures continues. All but two of the Magnox power stations which started commercial operations from 1959 are now retired. Of the Magnox reactors, only Oldbury and Wylfa remain, the last of the World's first generation reactors, and they are the next to be retired. Of the AGR (Advanced Gas Cooled) reactors that followed, coming on line in the late seventies and eighties, all are due for retirement by 2023. Cost of decommissioning is high, the original estimate of £42 billion easily exceeded and in 2008 the figure had reached £73 billion and still on the rise. The single Pressurised Water Reactor at Sizewell B is scheduled to continue operations until 2035.

In October 2010 the government gave the go-ahead for up to 8 new generation nuclear power stations. On announcing this the government stressed that they would be built without public money and in March 2011 the Secretary of State for Energy and Climate Change implemented a report on the "*implications of the situation [in Fukushima] and the lessons to be learned for the UK nuclear industry*". This will take 6 months to deliver. Meanwhile, the Committee on Climate Change (CCC) has reported in May 2011 that speed of development of new nuclear sites may be the inhibiting factor and added, *"In the medium term, availability of sites may become a binding constraint"*. So while nuclear is anticipated to be a key element of the energy mix in the UK, the challenge is to deliver on a timely fashion, a objective that would have substantially more chance if government money were on the table (as indeed it now looks to be – The Guardian, May 2011).

The recent German experience of shutting down 7 nuclear reactors, taking significant capacity out of the system at short notice, would have interested UK officials. There were no blackouts; nuclear power was replaced by surplus electricity exports, temporarily importing electricity from neighbouring countries and by using the reserve capacity from other fuel sources. The UK, however, imports energy already (mainly from France, which has less surplus than before) and does not have the same reserve capacity.

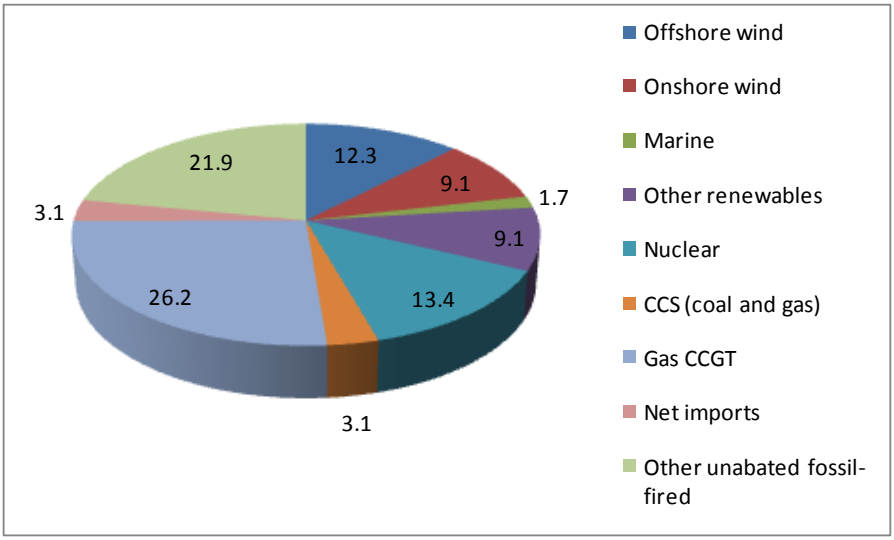
The United Kingdom subscribes to the EU 2009 Renewable Energy Directive which includes a legally binding target of 20% of consumption coming from renewables by 2020. In 2010 each member state presented a Renewable Energy Action Plan (NREAP) to the EU Commission.

The UK also has tough targets relating to reduction in CO2 emissions. By 2020 the target is a 34% reduction on 1990 levels, and by 2050 an 80% reduction.

The UK's plan relies heavily on wind and biomass which between them would represent more than 80% of our stated target of 30% of total consumption. In addition to this, the plan sets out two further objectives; by 2020, 10% of transport energy to come from renewables and 12% of heat generated from renewables.

The 2020 energy mix suggested by the Committee for Climate Change looks like this:

Figure Fourteen: CCC Forecast for the UK Energy Mix in 2020 (percent of total)



Source: CCC, "The Renewable Energy Review" May 2011

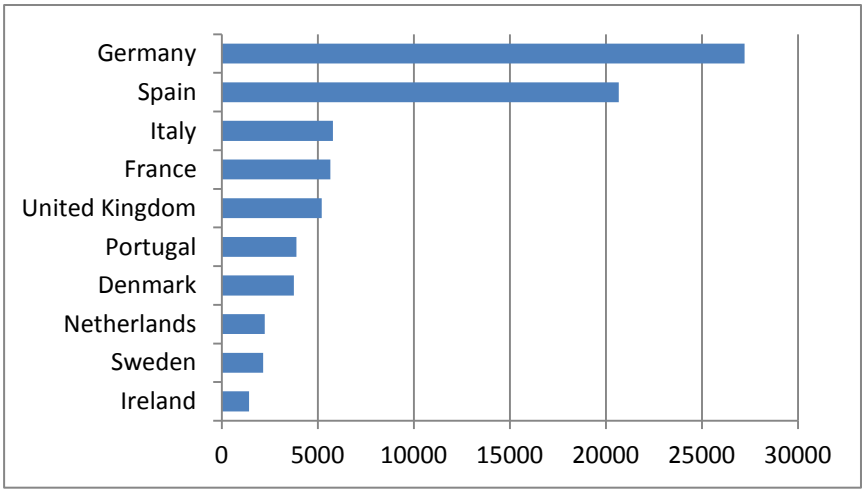
So in the above forecast, renewable energy would account for 32.2% of the total mix, but we would have a long way to go to remove the one-fifth of generation that still came from unabated fossil fuels.

The UK has the best conditions for the generation of energy from wind in the whole of Europe, yet we lag behind some other countries and the potential remains huge. A European Environment Agency 2008 report "Europe's onshore and offshore wind energy potential" mapped average wind speeds between 2000 and 2005 (turbine hub height, metres per second)and concluded:

- In the UK, onshore wind averages at least 6m/s throughout most of the country, compared to, for example, Germany (European leaders in terms of current output), Spain and France where much of the countryside experiences 5m/s or less – that small difference make a substantial difference to the economics of wind energy.
- Offshore, there are many parts of Europe with wind resources comparable to the UK, but we have a long coastline compared to many countries.

Despite this promising scenario, the UK remains behind a number of countries:

Figure Fifteen: Wind Energy in 2010: Top Ten European Countries by Installed Capacity MW



Source: EWEA

The target for energy generation means for wind the UK needs to move from 2010 installed wind capacity of 5,204MW to 27,880MW in 2020, a five-fold increase which would bring the UK up to the level that Germany is now.

In 2010, the United Kingdom accounted for 10% of new installed capacity in Europe (960MW), on a par with Italy, but less than Germany, Spain and France. However, as many other countries step up on wind power, the share of the total EU market held by Spain, Germany and Denmark together is gradually declining (from approximately 84% in 2000 to approximately 37% in 2010). Denmark of course for many years led the wind power revolution where wind energy accounts for 24% of total energy consumption, some way ahead of other leaders (Portugal 14.8%, Spain 14.4%, Ireland 10.1%, Germany 9.4%). By comparison, the UK obtains just 3.2% of its total energy consumption from wind power.

As of May 2011, there are 1,337 turbines under construction (UKWED), representing 3,856MW, enough to power 2.1m homes. Offshore generation is key to reaching the target; of the many wind farms announced, the London Array at 1,000MW is most significant and the first foundations for this were laid in March 2011. This project will easily eclipse the 300MW Thanet Wind Farm which became operational in 2010. However, the Committee for Climate Change has provided a note of caution, stating "*ambition for offshore wind should not be increased unless there is clear evidence of cost reduction.*"

Also important is the role of Scotland. First Minister Alex Salmond announced in August 2010 that the RE target is raised from 50% to 80% of total consumption.

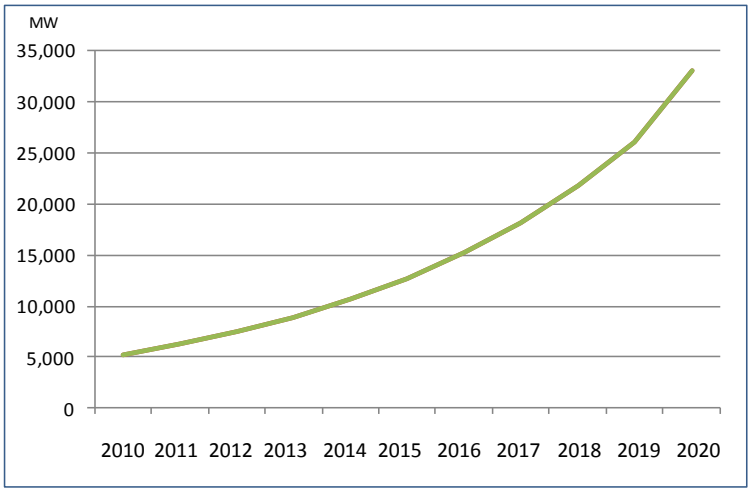
The CCC anticipates that onshore wind will contribute around 15% of renewable energy generation in 2030, not 30% of offshore, but it will comprise many more locations (more manageable projects) than offshore which focuses on relatively few, but very large, wind farms. The importance of onshore wind lies also with the cost of power generated – it is considered to be the cheapest of the new technologies. While site availability may limit growth in the long run, it has much to offer in the shorter term.

The "small wind" sector is worthy of consideration in its own right, and here we have seen a sharp increase in activity in 2010. Small - medium wind power is defined by BWEA as up to 100kW which is capable of generating up to 200,000kWh per year. In 2010, UK capacity increased 65% year on year

to 14.23MW and a market value of £29.3m. These numbers were actually down on expectations, a consequence of delays in government action on General Permitted Development Orders which would free up planning constraints, and on the general economic climate. However, this is also a successful export market for the UK, with 56% of output from UK manufacturers being exported. BWEA is anticipating further strong growth in this segment in 2011 and beyond.

Overall, we can forecast with some confidence that the wind energy target can be reached and exceeded by 2020 given sufficient funding:

Figure Sixteen: Forecasted UK Capacity Growth in Wind Energy 2010 – 2020



Source: Author's own forecasts based on industry commentary

Our forecasts are based on the high likelihood that the Crown Estate will deliver to a reasonable extent on the announced offshore programme. Rounds One and Two, well advanced, will add 8GW, a specific 6.4GW was announced for Scottish territorial waters in 2009 and a further 25GW is planned under the Round Three programme. With approximately 4,000MW of onshore wind under construction (Source: RenewableUK) momentum is certainly there and if the Crown Estate attracts sufficient investment and delivers 100%, the above forecast will be exceeded. As we see in a later section however, there is some doubt as to the extent of government investment over time.

The turbine manufacturers seem to agree with this optimism; May 2010 has seen Vestas announcing their intent to build a plant at Sheerness in Kent which will focus on the UK market specifically. This is not a direct replacement for the recently closed Isle of Wight facility, which focussed on the US market. This follows the announcement of similar plans for from Siemens and GEC.

There are barriers to growth as there are in many markets. Not least of these in the wind energy sector is the speed of administrative procedures to the point of build. Public perception of planning in the UK is that it takes a long time and this is true, but no worse than many other countries. The planning process in the UK takes less time (26 months on average, EWEA WindBarriers Survey 2010) than in some other European markets (for example – Spain 57 months, Germany 30 months) and grid access lead time is considerably shorter than for many other countries (8 months for UK, 33 months for Spain, 22 months for Sweden).

Biomass is the second key element in the UK government's strategy. Many initially think of wood as a key fuel, but there are many different biomass resources. The main resources divide between agricultural residues (by products of food production), forestry products and residues, energy crops

(for example short rotation coppice willow and miscanthus) and recovered materials (for example, from construction). Municipal waste (MSW) is an associated source.

The Renewables Obligation is the main mechanism for supporting biomass energy generation. A key development occurred in April 2010, when support for renewable projects was extended to 2037, or 20 years for new projects. The RO works by placing an obligation on licenced electricity suppliers to source a specified and annually increasing proportion of their electricity sales from renewable sources or pay a fee to opt out.

Supporters of biomass would argue its cost effectiveness compared to other renewable technologies. They would also argue its reliability; biomass energy is available almost all the time (90%, compared to 29% for onshore wind and 35% for offshore wind, Digest of UK Energy Statistics 2009), it can respond to changes in demand in a way that wind cannot guarantee, it can contribute to base load which wind cannot.

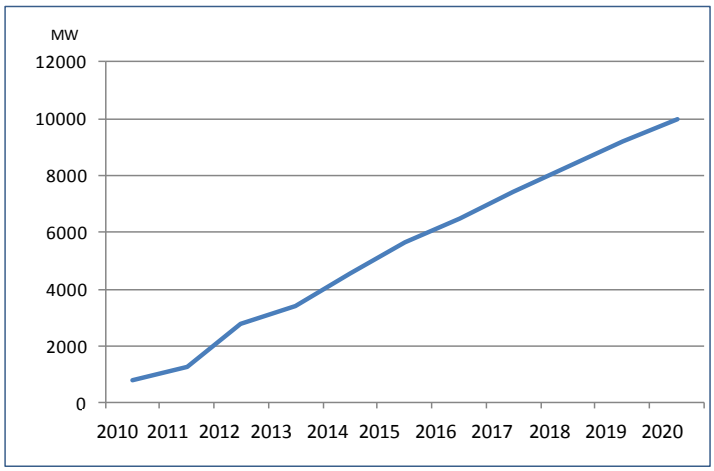
In Europe, it is Germany that is the leader in biomass with France in second place. The UK has been relatively slow at developing biomass but is quickly gathering momentum:

- 10 biomass plants, generating circa 800MW, dominated by the Drax co-firing plant
- A further 15 biomass plants in planning, representing 2300MW
- A further 9 proposed, representing 800MW (source: Biofuelwatch)

The great majority of proposed plants will rely on imported biomass. There is therefore a cost associated with sourcing fuel, and an exposure to variances in the price of fuel.

Based on relatively high likelihoods of success given government support, we predict a steady increase in UK biomass capacity through to 2020:

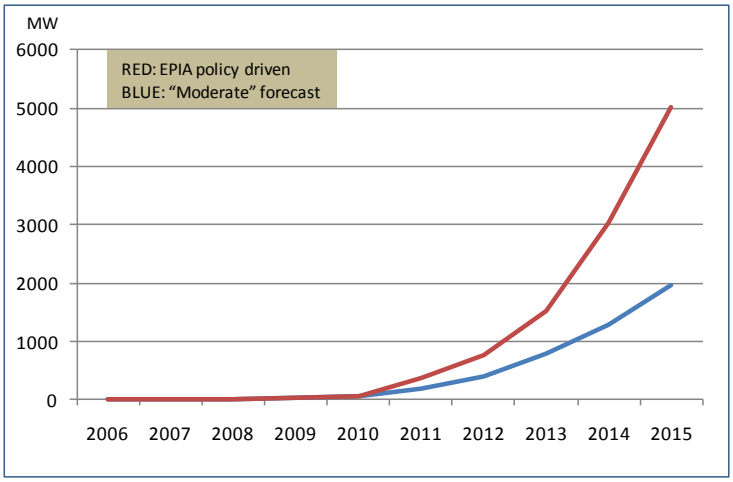
Figure Seventeen: Forecasted Capacity Growth in Biomass Plant Capacity 2010 – 2020



Source: Author's own forecasts, based on announced plans and government projections

The residential rooftop market accounts for 95% of UK solar capacity. The prospect of large scale solar farms in the south west caused the government to take a second look at the Feed in Tariffs introduced in 2010 for installations over 50kW, the stated purpose of this to divert investment into smaller scale projects. Nevertheless. FiTs on small installations remain attractive and we believe that the "moderate" EPIA forecast is achievable.

Figure Eighteen: Solar PV in the UK: EPIA Forecast



Source: European Photovoltaic Association

Clearly, such forecasts would rely heavily on whether a small number of significant solar farms are to be allowed to develop. These numbers are tiny in the global and European contexts. European capacity almost reached 30GW, with Germany representing more than 50% of that figure.

The UK's other great resource, wave and tidal, represents only a very small proportion of the plan as technology continues to develop. By comparison to the figures above, the Crown Estate has recently pre-qualified 4 companies for new wave and tidal projects each with 30MW capacity.

Tidal and wave technology has yet to reach its commercial tipping point. Apart from a 40 year old ocean barrage in France, there are no large scale plants based on energy from the seas but investment in the various technologies is escalating and some prominent projects are well advanced in Korea and China.

UK territorial waters stretch 12 nautical miles from shore. The UK Continental Shelf Area extends further, especially into the Atlantic west of Scotland and in this area the UK claims mineral rights. Taken together, the seas around the UK represent an immense resource.

There are five key opportunities:

- Tidal: by building barrages across estuaries. The Severn Barrage was under consideration for some time, but has recently been dropped by the government
- Wave energy: Modular systems, of which the best known is probably Pelamis
- Marine currents
- Temperature gradients: harnessing the energy due to the temperature differences between the ocean surface and deepwater.
- Salinity gradients: At the mouth of rivers where freshwater and saltwater mix.

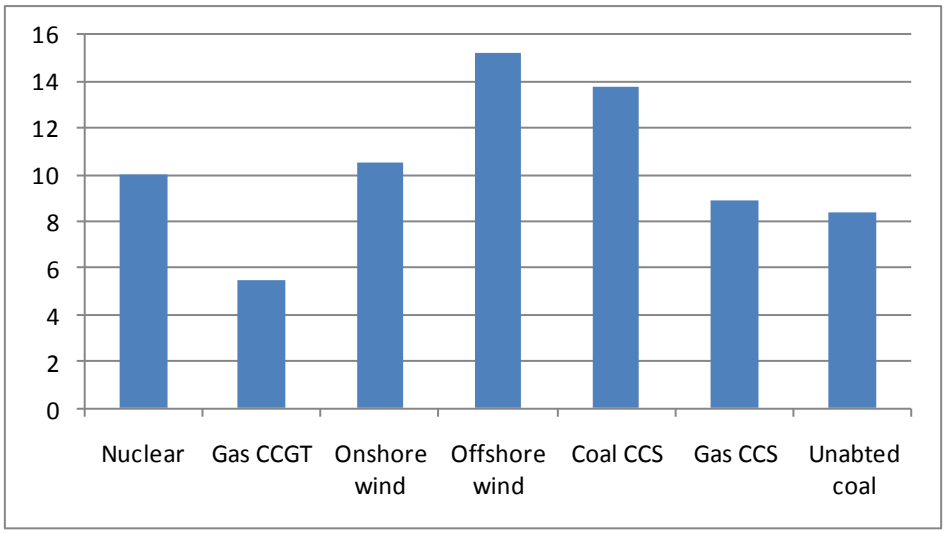
To forecast 10 years forward at this time would not be appropriate, the uncertainties of which technologies will be successful being too great at this stage. However the CCC correctly points out that *"UK companies have significant marine design/engineering experience and already have a sizable share of device developers and patents. UK resource also a large share of the global market."*

Ethanol production is in its early stages in the UK. Much has been written about the Ensus biofuel plant on Teeside, which takes approximately 1 million tonnes of grain, but much of the ethanol sold in the UK is imported and its "green" credentials are less clear cut than, for example, wind energy. In May 2011 Ensus announced the temporary closure of the plant due to slow market development and competition from the US. This is in stark contrast to the global picture which showed a 16% increase in production 2009 – 2010 to 85.9 billion litres (370 billion equivalent barrels of oil) according to Commodities Now. The United States is the World leader in ethanol production accounting for 45 billion litres in 2010.

Cost of Low Carbon Technologies

The cost of low carbon technologies is a significant consideration. Mott McDonald has produced detailed analysis of "levelised" costs of renewable and other low carbon solutions. The levelised cost combines three cost elements – the investment (or capital) costs of bringing an asset to the point of operation, on-going fixed costs of keeping the plant available for generation and the variable costs of operation.

Figure Nineteen: 2010 Estimates of generation costs (levelised cost pence/kWh)



Source: Mott McDonald "2010 UK Electricity Generation Cost Update"

The Climate Change Committee has worked with Mott McDonald calculations in their report "The Renewable Energy Review 2011". The ranges quoted below illustrate low end and high end assumptions:

- Lower price scenario assumes no congestion in the market by 2020 and the most optimistic estimates of cost reduction
- Higher price scenario assumes market congestion is maintained (assets not fully utilised due to imbalances of supply and demand) and cost reductions are modest.

With onshore wind, an established technology, there is considered to be limited scope for innovation and cost reduction. The CCC see potential for a 50% cost reduction for offshore wind, but not until 2040 and it will be as a result of larger turbines, (in Norway, a 10MW turbine is planned which will have a rotor diameter of 144m and already there first design concepts for a 20MW wind turbine have been produced by the technical university of Denmark and the Risø National Laboratory for Sustainable Energy), greater production efficiencies and larger arrays.

Marine technologies come with uncertainties over costs and the CCC considers significant reductions will not be apparent until 2040. Solar PV costs have fallen considerably in recent years and further scope for reductions in the next ten years are likely. Larger dedicated biomass plants are already viable, but exposed to variable costs of fuel which accounts for 40% of total costs.

Some doubt exists with regard to nuclear, in that the costs relating to the first next generation plant in the UK will be higher than for a full programme as the lessons and economies of scale impact.

Carbon capture technology is also at an early stage so the CCC has taken a cautious 10 year view on associated costs.

Figure Twenty: Estimated cost of low carbon technologies, 2011 – 2020: Levelised pence/kWh

Technology	2011	2020
Renewables		
Onshore wind	8.0 – 9.5	7.5 – 9.0
Offshore wind	11.0 – 15.5	10.0 – 15.0
Solar PV	31.5 – 46.0	17.5 – 33.0
Tidal stream	14.5 – 26.5	12.5 – 25.0
Wave	22.5 – 36.5	19.0 – 34.5
Biomass	8.0 – 17.5	Not quoted
Other low carbon		
Nuclear	6.0 – 10.0	5.5 – 10.0
Gas CCS	6.0 – 15.0	6.0 – 15.0
Coal CCS	8.0 – 15.0	7.5 – 15.0
Unabated gas	4.0 – 7.5	5.0 – 11.0

Source: CCC calculations, based on Mott McDonald 2011 Costs of low-carbon generation technologies

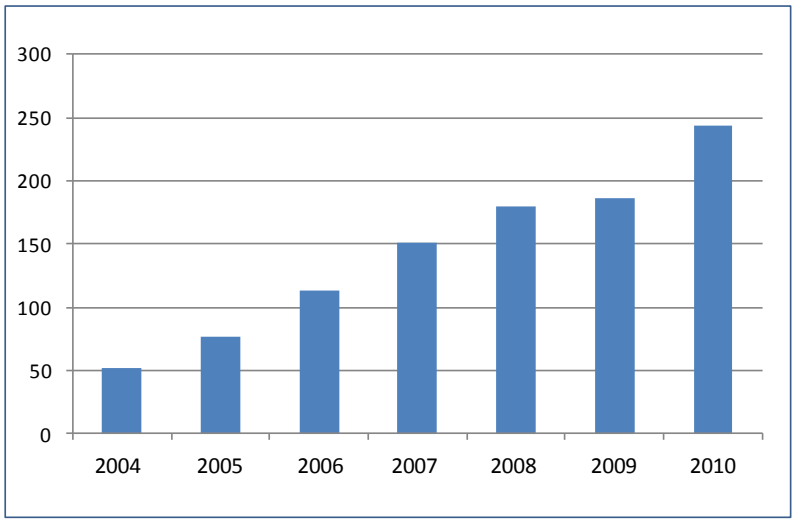
Investment in Renewable Energy

In their analysis "Alternative thinking 2011: A look at 10 of the top issues and trends in renewable energy" Deloitte has produced a succinct analysis of current trends, all of which have implications for investment in renewables in the future:

- Regulatory uncertainty: Government subsidies are the key to providing acceptable returns for investors and they need to be stable over the life of an asset, but some governments are changing the rules as pressure increases on finances and unseen outcomes of existing policies become apparent.
- Government stimuli introduced through 2009 and 2010 has led to increased M&A activity, despite limited access to capital.
- Investment opportunities are opening up in renewables other than wind, solar and biofuels.
- The sustainability credentials of renewable energy companies will come under greater scrutiny, they will need to undertake thorough environmental and social assessments embedding sustainability into their overall corporate strategy.
- Economies of scale is one answer to the huge costs associated with renewable programmes and larger programmes would fit with the challenge of meeting energy demands which many countries will experience. Bigger projects will mean more collaboration between companies to share skills and resource.
- Relevant skills are in short supply and retaining human capital will be a challenge in the future. Training will be critical for future momentum.
- Oil and gas companies will find opportunities in renewables, and renewable energy firms will find skills in the oil and gas sector.
- While the consumer largely recognises the importance of renewables, they have yet to accept that he will be paying his share. Governments and energy companies need to improve their communication of the benefits of renewables given the costs involved.
- Getting energy from its source to its customer will be an increasing challenge. The speed of grid connections will continue to struggle to keep pace with wind development.
- Current supply chains are inadequate to support the 2020 targets of many nations.

Despite these challenges, we have seen steady growth in investment in sustainable energy since 2004 – 2008 and while the recession slowed growth the sector picked up again in 2010:

Figure twenty-One: Global total new investment in clean energy 2004 – 2010, $billion



Source: Bloomberg New Energy Finance

Q1 2011 results however showed a year on year dip: worldwide, the figure in 2011 was $31.1bn, down a third from the $47.1bn fourth quarter 2010 result and 10% down on the Q1 2010 result og $34.5bn.

In the UK, an analysis by the Public Interest Research Centre (PIRC) saw green investment in 2009/2010 totalling £12,620m, 53% came from the public sector in the form of subsidies, Government loans and levies:

Figure Twenty-Two: Estimated UK green investment 2009/2010

	£m
Public subsidy	3035
Government loans	45
Levies	3640
TOTAL PUBLIC INVESTMENT	**6720**
Asset finance	5617
Public markets	60
Venture capital/private equity	223
TOTAL PRIVATE INVESTMENT	**5900**
TOTAL ALL INVESTMENT	**12,620**

Source: PIRC "An audit of green investment" March 2011

PIRC's conclusion is that there is an investment gap if we are to reach 2020 targets. One might argue that the significance of the UK's efforts towards a reduced carbon society is small when pitched against China's headlong rush to power generation, but the outcome of missing the targets the country has agreed goes beyond the arrangement with the EU, and as we state elsewhere, the UK could find itself with an energy shortfall. Their review of various sources shows investment needs to at least double and perhaps even quadruple to achieve the targets:

Figure Twenty-Two: Expert views on required investment in the UK to reach 2020 commitments

Scenario	Scope	Total investment (£bn)	Over what time period?	Annual invest £bn
Ernst & Young 2010	All green investment	450	2010 – 2025	30
GIB Commission 2010	All green investment	550	2010 – 2020	55
Carbon Trust 2010 – High cost scenario	All green investment	334.9	2010 – 2020	33.4
Carbon Trust 2010 – Low cost scenario	All green investment	263.1	2010 – 2020	26.3
Infrastructure UK 2010	All infrastructure	800 – 1000	2010 – 2030	45
E3G 2010 (Role of the GIB in delivering growth, Nov 2010	All green investment	245	2010 – 2020	24.5
E3G (Accelerating the transition to a low carbon economy, March 2010)	All green investment	525	2010 - 2025	35

Source: PIRC "An audit of green investment" March 2011

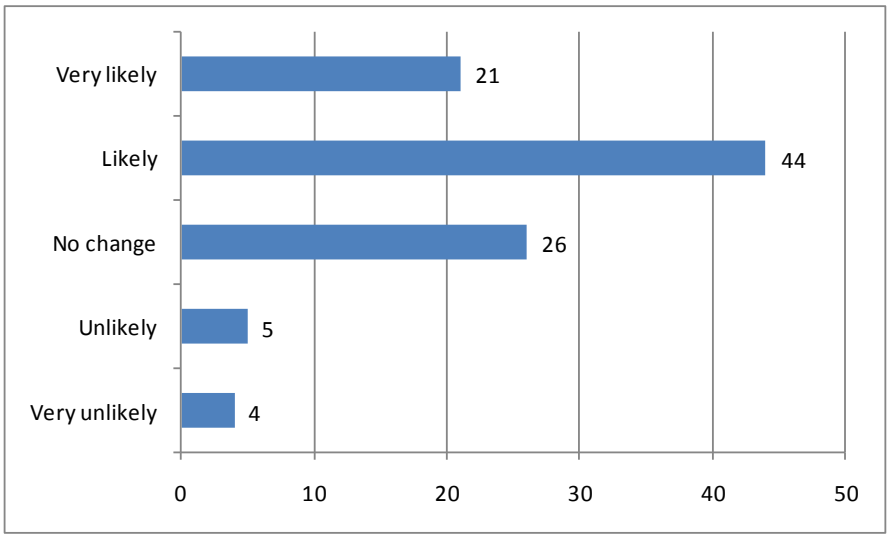
The annual investment figures shown above represent 1.8 – 3.9% of current GDP.

A 2010 Survey of Institutional Investors based around the World by New Energy World Network obtained the views of 110 institutional investors that allocate capital to private equity and venture capital funds and found strong confidence in green investment:

- 90% want at least some exposure to green private equity, driven by expected long term returns, pressure from shareholders, beneficiaries and trustees and contributions to sustainability credentials.
- Interests lie in energy efficiency, energy storage and smart grid which have the most attractive risk-adjusted returns over the next five years.
- Growth equity and expansion capital funds are regarded as most promising, reflecting the appeal of proven technology in a relatively immature sector.
- 72% of their respondents indicated that such funds will generate returns at least as good as generalist private equity and venture capital funds over the next ten years, but only 2% consider that green funds have performed as well historically.

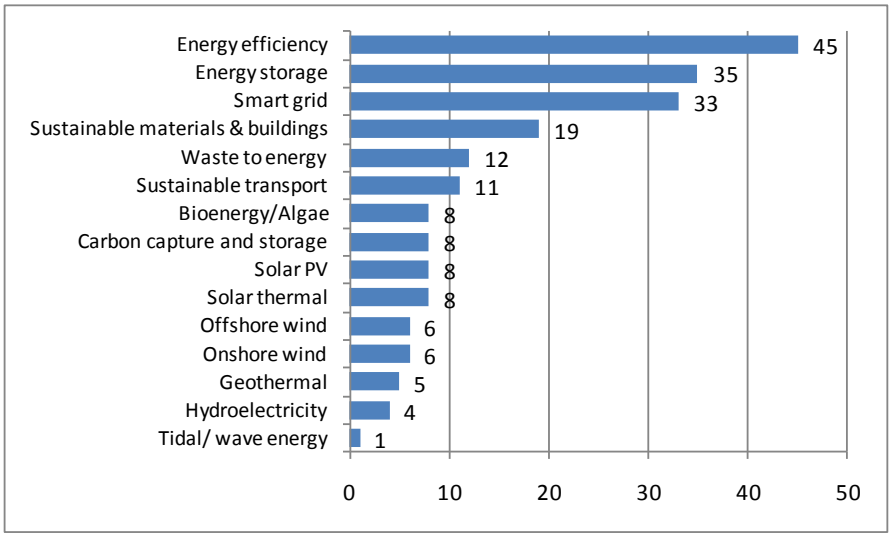
Given this favourable picture, the anticipation is for increased investment in the sector:

Figure Twenty-Three: Likelihood of increasing allocations to green investments over next 5 years (% investors)



Source: New Energy World Network "Survey of Institutional Investors 2010"

Figure Twenty-Four: Sectors viewed as delivering best risk-adjusted returns over next five years (% investors)



Source: New Energy Network "Survey of Institutional Investors 2010"

Energy efficiency can, of course, refer to technologies not necessarily clean, but simply making better use of existing energy sources. This might include, therefore, energy efficient construction products or techniques to make renewable sources more efficient.

In terms of geography, this group of investors consistently consider that Europe will offer the best returns.

A key finding echoes the Deloitte report – 88% of investors consider "improved clarity of regulation" would motivate them to increase commitments to green funds.

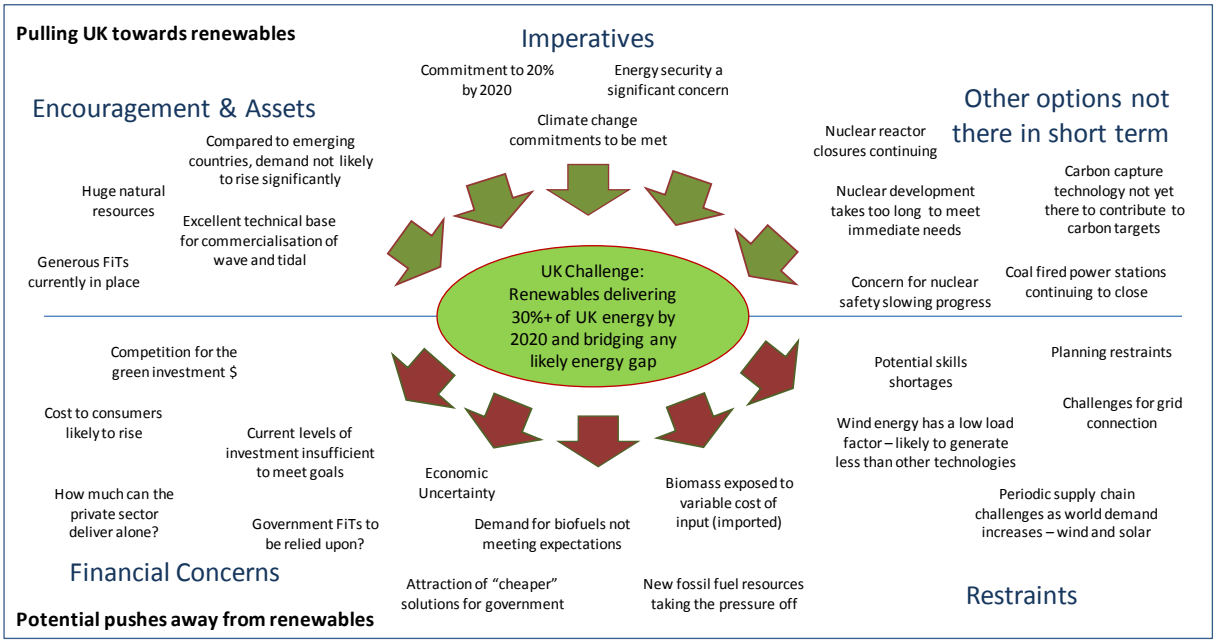
Opportunities for investment in any renewable, whether established or in development, are many and varied. We can take the value chain for wind energy as an example: there are between 16,000 and 20,000 components on a wind turbine installation and many stages of development:

- Raw material and machinery supply: steel, carbon fibre, fibre glass, tooling, etc.
- Design and development services: Engineering, research, automation, assembly
- Component suppliers: Gearbox, bearings, tower, generators, blades, electronics
- Wind turbine companies: OEMs, large utilities, small wind, innovation
- Construction and installation: Engineering & procurement, construction, transport, operation and maintenance
- Wind farm developers: Feasibility analysis, project developers, utilties

On developing technologies, such value chains are still taking shape, but the rewards for involvement can be substantial.

Summary and Conclusions

Renewables as the Key UK Energy Resource by 2020: A Vision or a Dream?



Over the next ten years, the United Kingdom faces an uncertain energy future – perhaps even a crisis. We have discussed in this paper that elements of our energy portfolio are gradually being withdrawn – traditional ("dirty") coal and nuclear closure programmes are well advanced, and the middle of this decade will see further closures leaving a gap that must be filled. The UK does not have the luxury of substantial reserve generating capacity.

And we have also concluded that currently, the United Kingdom is not embracing alternatives sufficiently quickly or with sufficient resource:

- Nuclear development, when it comes, will be funded from the private sector and the planning process is already stretching the target dates for new nuclear power. It will not be here by 2020.
- Despite realistic government sponsorship of renewables, especially wind, experts are concluding that much more investment is required to reach the country's 2020 renewable commitments. Meeting these goals is both economically and socially desirable.
- While the UK may be at or near the forefront of ocean technologies, these are not yet on a commercial scale.
- Biomass is a major part of the renewable obligation, and there is activity here off a low base, but again it is some way short of where the country needs to be.
- Government policy remains exposed to change, and we note contradictions in what the UK government says (renewables are critical to the future in every way) and what it does (funding for many projects being withdrawn). Long term benefit is being lost against short term need.
- Alongside this, carbon capture technology is also in its early stages.

The potential for renewable energy in the UK is vast and the future combination of wind, biomass and water must surely be capable of delivering energy to a level where fossil fuels are a minor component in the energy mix.

Our best bet for renewables delivering capacity to the Grid, by a distance, is wind power and progress with respect to offshore wind in particular is promising. Compared to Germany and Denmark, we were very late to the party, but the UK has momentum (capacity growth in the last four years running at 28.5%, 23.3%, 37,7%, 21.8% and 45.1%) and plans in place (a further 5,500MW has consent and a further 8,700 MW is in planning) would all suggest the UK will make substantial advances.

But beyond wind, the country's energy and carbon commitments require a substantially greater response from the government than is presently the case.

Globally, there is unquestionably a significant place in a portfolio of energy solutions for renewables and there is confidence expressed by many national and international organisations that in the long term, technology and natural resource will combine to create at least a near carbon free environment. But long term could be another 50 years – in time before fossil fuels "run out", but perhaps not in time to forestall fuel inflation as resources become tougher to exploit.

Nevertheless, interest in fossil fuels is not about to die. As we point out in this report, there are still great strides to be made here with technology allowing countries to exploit deeper, broader and more challenging resources. Shale gas is a case in point.

The green challenge is not just about delivery of renewable energy, but also to deliver the technology that makes the exploitation of such fossil fuels as acceptable as possible so that the progress towards the low carbon environment is not slowed.

The renewable industry should recognise that this is likely to be competition for the investment buck and be able to demonstrate the extremely wide scope of opportunities that exist within its reference.

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Triodos Renewables' objective is to exploit opportunities in a growing renewable energy market by taking advantage of projects that generate clean, green electricity from renewable sources. It also works with partners to develop and acquire projects, and invest in innovative companies in the sustainable energy sector. Its portfolio includes seven operating sustainable energy projects with a total capacity of 36.8 MW producing enough clean, green renewable energy for the equivalent of more than 24,500 homes.

Triodos Renewables has financed innovative projects, such as the Haverigg II Wind Farm in Cumbria, a re-powering wind farm project at Caton Moor in Lancashire, a single wind turbine in the Orkney Islands, and the Beochlich Hydro Electric project in Argyll in Scotland.

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banking services are available for businesses and charities. Triodos Bank is an independent bank founded in the Netherlands in 1980. Its principles and independence are protected through a special shareholding trust. The UK office opened in 1995 and is based in Bristol.

Triodos Renewables was established to provide equity finance through direct investment in small to medium-scale renewable energy projects, such as hydro-electric projects and wind farms. The development of the business – and a shareholder base of 4,000 subscribers – provides a mechanism for individuals and institutions to invest directly in renewable energy opportunities.

The Author

David Dower has consulted in industry and utilities, including energy generation, for over 20 years. He has authored or co-authored a number of reports reviewing the global situation for renewables including wind power (onshore and offshore), solar and solar thermal, geothermal, biomass and ocean (wave and tidal) energy. He maintains a watch on all of these sectors.

He has also conducted numerous ad hoc assignments for individual clients, and these have included the nuclear sector, agriculture, transformer manufacturing, power transmission and distribution, power distribution sub stations, metering and UK energy retail markets and players, as well as a substantial amount of work in the water industry over many years.

His company, Closer to Customers, offers market intelligence, research and consultancy services to a wide range of clients located throughout Europe.