Nuclear Free Local Authorities
briefing

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Subject: **Energy Scenarios 2020 – 2030: Alternatives to the UK Government's gas / nuclear / renewable scenarios - a look at the potential of non-wind renewables coming to the fore.**

1. Purpose of briefing

This briefing is the second of the NFLA's early 2013 policy reports considering different aspects of energy policy affecting the UK and Ireland. This briefing is considering in a generic manner the future energy mix and the potential for increasing the development of non-wind renewables within that mix. The briefing has been developed by the NFLA Scotland Policy Advisor Pete Roche with the financial support of the NFLA Scotland Forum. Though it expressly considers UK Government Policy in judging if there are other alternatives to a 'dash for gas' and 'new nuclear build' in addition to a large increase in wind energy, many of the generic energy sources mentioned in the report are relevant for energy policy in Ireland for its Governments and local authorities considering the benefits of non-wind renewables. The report is also of interest to the Scottish and Welsh Governments in their respective development of national energy policy.

2. Introduction

The UK Government's National Policy Statement on Energy foresees a need for 113 gigawatts (GW) of electricity generating capacity in 2025 compared with 85GW now. 59GW would be new capacity, and of this 33GW would be renewable energy, mostly wind, 16GW would be new nuclear, with 26GW left for industry to determine. (1)

In earlier briefings the NFLA has examined why the UK Government foresees a doubling or even tripling of total installed electricity generating capacity by 2050, while the German Government, with the same 2050 objective of an 80% reduction in greenhouse gases, expects electricity demand to be 25% below present levels without using nuclear power. (2) We have looked at how a more ambitious renewable energy strategy, including a local authority led local energy revolution which maximises energy efficiency and the use of small-scale renewables and combined heat and power can not only replace the need for new reactors, but is also much more effective in tackling fuel poverty. (3)

With plans for the first new nuclear power station at Hinkley Point in Somerset now running about two years behind schedule it appears that the Government may be scaling back its nuclear ambitions. It now expects only 3.3GW (the size of Hinkley C) of new nuclear by 2025 and 9.9GW by 2030 (down from 4.8GW and 12GW respectively in the 2011). (4)

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Instead of replacing the nuclear shortfall by planning for more renewables and helping local authorities to implement local energy strategies the Government's focus appears to have shifted to promoting more gas-fired electricity generation. According to the *Financial Times* previous government plans had estimated that 10-20 GW of new gas generating capacity would be required by 2030. But the Department of Energy and Climate Change (DECC) recently raised this to 26-37GW. (5) The chief executive of the Committee on Climate Change, David Kennedy, warned that while the 26GW could prove compatible with the UK's carbon targets the 37GW plan would breach them. (6)

The new scenarios anticipate that total electricity generating capacity will increase from 113GW in 2025 to about 120GW by 2030. The Government says more gas stations are needed, but operating at lower load factors to balance a very significant increase in intermittent renewables by 2030, allowing renewables to become the biggest source of energy generated. Gas capacity is required to meet annual peaks and to cover the eventuality that there is little or no wind at the peak, but this same capacity goes unused when the wind is blowing. For this reason 'capacity payments' are required to make the economics of the gas plants work, because the new stations aren't used very often. (7)

This briefing examines the alternatives to this gas/nuclear/renewable scenario which the Government has mapped out for this decade and next, and we will look at some of the non-wind renewables which are beginning to come to the fore and which could be making an important contribution to our energy supplies in the 2020s.

3. Wind Power Generation in the 2020s

Part of the justification for the UK Government's plans for an expansion in gas generating capacity and its lack of ambition for the wind industry in the 2020s is because of the intermittent nature of wind energy.

The Scottish NGO report "*Power of Scotland Secured*", which is based on research by consultancy Garrad Hassan, says that contrary to popular myth, the variability of renewable power need not pose a risk to the reliability of supply. (8) With improved interconnection to other countries as well as moderate investments in storage and deferrable demand, it is possible to phase out all conventional thermal generation capacity in Scotland by 2030 and still deliver a secure and reliable electricity supply. (9) The same scenario could be scaled-up to the United Kingdom, without the need to rely on such a large expansion in gas-generating capacity.

New Scientist declared in January this year that "*anyone who tells you that renewable energy will never be reliable enough to replace fossil fuels is increasingly telling yesterday's story*." What's needed is a way to store surplus wind and solar energy. That much has been obvious for years, but there are signs that the problem is finally reaching its rightful place - at the very top of the renewables agenda. Technologies are advancing, particularly liquid-air storage. Investment is pouring in. And outdated regulations that have acted as a drag are being swept away. (10) Germany is on the way to ending this debate – base-load will not be required in the new energy future being planned and implemented. By 2030 the 100 per cent renewables electricity grid in Germany may be 40-50 per cent wind, 30-40 per cent solar, with the rest coming from other sources. A smart grid and storage technologies will provide the means to balance this. (11)

Figures from the Department of Energy and Climate Change (DECC) released late last year suggest that the Government expects a sharp slowdown in the increase in renewable energy capacity after 2020. Capacity is expected to reach 35GW in 2020 - a 10-fold increase in capacity between 2012 and 2020, but then only increase to 42GW by 2030. DECC's figures predict that renewables' share of the UK's electricity mix will stabilise at 34 per cent between 2020 and 2030, while the share generated from gas will rise from 29 per cent to 35 per cent, and the share generated from nuclear power will increase from 20 per cent to 24 per cent. In contrast, reliance on coal-fired power will contract from 12 per cent to just three per cent. (12)

DECC says these figures don't represent any kind of Government target or preferred energy mix, but they are hardly going to encourage the establishment of a renewable energy manufacturing base in the United Kingdom if it looks as though the demand for turbines will tail off rapidly after 2020. A report by Cambridge Econometrics for Greenpeace and WWF predicted the UK would be £20bn better off by 2030 if it pursued wind energy rather than gas and would save up to £8bn a year on imports. (13)

4. The Friends of the Earth Scenario

Friends of the Earth, England, Wales and Northern Ireland (FoE-EWNI) has produced an energy scenario using DECC's pathways calculator, in which renewable energy supplies 73% of electricity by 2030, with no new nuclear. (14) Electricity consumption is predicted to rise from 370TWh in 2010 to 470 in 2030, because of the need to switch heating and transport to electricity, but FoE acknowledges that it could have been much more ambitious on energy efficiency measures. Onshore wind supplies 60TWh, and offshore wind 195TWh. But what is interesting about this scenario is that wave, tidal, geothermal and hydro increases from 5TWh in 2010 to 50TWh in 2030 and solar increases from zero to 36TWh in 2030. The balance is provided by the remaining nuclear stations and gas with and without carbon capture and storage.

FoE assumes that the 4GW of interconnection with other countries we have now increases to 30 GW with extra links to Norway, Ireland and Northern Europe. They assume 20 GW of storage and 14 GW of backup plant to help with grid balancing. They say we don't need new nuclear, even given conservative estimates about demand reduction.

5. Wave & Tidal Power

According to the UK Government energy from waves or tides has the potential to generate 27GW of power in the UK alone by 2050 mostly in the two areas now designated Marine Energy Parks – the North of Scotland and South-West England. (15)

DECC's Renewable energy road map indicates that 300MW of marine energy will be installed by 2020, but according to the trade body - Renewable UK - developers expect a more ambitious 1.6 GW (the size of one of EDF's new reactors, or half a Hinkley) which is a significantly more ambitious target. (16) Wave and Tidal Energy have the potential to deliver up 60GW of electricity, 75 per cent of the UK's current needs.

The Forum for Renewable Energy Development in Scotland (FREDS) Marine Energy Group (MEG) Marine Road Map published at the end of 2009 outlined a high scenario of 2 GW of installed capacity by 2020 which could result in 5,300 direct Scottish jobs and £2.4 billion of investment into Scotland. Marine renewables are a growing industry which Scotland is leading. To support this new industry and maintain the global lead to ensure Scotland and the UK reaps the environmental and economic benefits of this industry requires financial and regulatory support. (17)

Approximately 10% of Europe's wave power is off Scotland's coasts, with a potential of around 15 GW. Scotland also boasts about 25% of Europe's tidal stream potential, approximately 18 GW. Wave and tidal power, therefore, have the potential to provide double Scotland's required electricity generating capacity.

The Carbon Trust estimates that the tidal power resource is 29TWh, and wave power is 50TWh. That means together these technologies have the potential to generate about 15% - 20% of the UK's electricity requirement. (18)

6. Geothermal Energy

Deep geothermal energy makes use of water which has been heated deep underground and made its way back to the surface. This hot water may come to the surface naturally, be accessed by drilling wells, or it may be water that has been pumped down to heat and then

pumped back up. This should not be confused with ground source heat pumps which use electricity to circulate a mixture of water and antifreeze around a loop of pipe which is buried near the surface to capture heat in a similar way to the way a fridge works.

Deep geothermal energy could provide 9.5GW of base-load renewable electricity, according to a recent study by engineering consultants, Sinclair, Knight and Merz (SKM). This means geothermal could generate 20% of the UK's current annual electricity consumption. In addition it could provide over 100GW of heat, enough to meet the entire space heating demand of the UK. (19) Up to 4% of this could be readily accessed by 2030. The resulting 4GW capacity would be equivalent to 25% of the UK's 2020 target for renewable energy generation. (20) [For comparison Hinkley Point C and Sizewell C together have a planned total capacity of 6.4GW.]

Geothermal power receives a relatively low level of subsidy - less than that offered to wave and tidal power, and about half of that offered in rival countries such as Germany and Switzerland. As a result of support in Germany, the deep geothermal industry now employs 6,000 people and has attracted €4 billion of investment. Subsidising geothermal technology initially would help to bring down costs rapidly as sites around the UK were developed. There is a danger that the UK will be left out of a global industry which is estimated to be worth £30bn by 2020 if the Government doesn't act. By proving our competence at home we could be at the forefront of a booming global market as well as go a long way to meeting our future energy needs.

7. Solar Photovoltaics

At the end of 2012 the UK Government published its long-awaited update to the Renewable Energy Roadmap. Solar energy has for the first time been included in a list of key technologies that will be required to play a role in the UK's energy mix through to 2020 and beyond. The Roadmap confirmed the cost of solar PV has fallen 50 per cent since the original document was published and that there is now 1.8GW of operational solar capacity. As a result, DECC said it now believes solar technology has the potential to form a "significant part of the renewable energy generation mix" and will play a key role in meeting the 2020 goals. (21) Climate Change Minister Greg Barker believes it has the potential to deliver over 20GW of capacity by 2020, and produce up to 18TWh per year. (22)

The Solar Trade Association is calling for a solar revolution which would deliver around 140,000 jobs by 2015. Under this plan the industry would be able to install around 1GW per year, so would probable meet a 20GW by 2020 target. (23)

8. Small-Scale Hydro Power

The British Hydro Power Association has estimated that the potential for small-scale hydro power ranges between 130 - 185MW capacity for England and 28-63MW for Wales. (24) In Scotland the potential which is financially viable is estimated at 1,204MW. (25)

9. Biomass

The use of Biomass and Biofuels to replace fossil fuels is controversial for a number of reasons. Any support for bioenergy needs to make sure the fuel is from a sustainable source and that burning it is delivering genuine greenhouse gas emission reductions.

Biomass is biological material derived from living, or recently living organisms. In the context of biomass for energy this is often used to mean plant based material, but biomass can equally apply to both animal and vegetable derived material. (26)

Biomass material will have absorbed carbon dioxide (CO_2) from the atmosphere, so if it is burnt to create energy it will release that carbon dioxide back into the atmosphere. If burning biomass is to be of any benefit in tackling climate change, compared with burning fossil fuels, we need to make sure that an equivalent amount of new biomass material is planted to absorb the same or a larger amount of CO_2 from the atmosphere to that released through burning.

Biomass needs to be harvested as part of a constantly replenished crop in order to be sustainable. There needs to be a continuous programme of replanting with the new growth taking up CO_2 from the atmosphere at the same time as it is released by combustion of the previous harvest.

The UK is at the forefront of global plans to expand the use of biomass in electricity generation. According to campaign group Biofuelwatch if the UK's plans are implemented this would result in burning 90 million tonnes of wood a year or nine times as much wood as is produced annually. (27)

Friends of the Earth, Greenpeace and the RSPB question whether the use of biomass to replace coal in large coal-fired power stations such as Eggborough and Drax in Yorkshire will really lead to a reduction in emissions. (28) In Scotland Friends of the Earth has been campaigning against proposals by Forth Energy, a company formed by Scottish and Southern Energy and Forth Ports Limited, to build four huge biomass plants, totalling 600 MW at Rosyth, Dundee, Grangemouth, and Leith. Forth Energy's proposals are primarily intended to generate electricity. Biomass for electricity is incredibly inefficient and requires a lot of wood to produce a small amount of energy. It is estimated that the plants will only be 30% efficient. Initially only 10% of the wood used by Forth Energy would be from the UK, rising to 30% later, the rest would be imported. (29)

There is also a danger that the UK Government's extremely ambitious plans for large scale biomass plants will divert wood fibre southwards, which is currently required by existing wood users or to help meet Scotland's renewable heat target. The Scottish Government's Wood Fuel Taskforce concluded that there is no spare capacity to support the planned large scale electricity generation biomass plants from the domestic wood fibre resource. It would be far better to keep domestic wood supplies to help deliver the 11% renewable heat target by 2020. Supplying this heat would require slightly more wood than is likely to be available. If the heat were to be provided by biomass-fuelled Combined Heat and Power stations this would require more than double the amount of wood available domestically. (30)

The Wood Fuel Taskforce also warns of the danger of excessive dependence on obtaining large volumes in imports from relatively untested markets. Given the likely competition for a sustainable, affordable supply, it is likely that many of the biomass plants proposed will not be built, adding further uncertainty to the projections.

The Biomass Energy Centre says the UK Government has worked extensively with industry and NGOs to develop sustainability criteria for biomass to ensure not just genuine Greenhouse Gas emissions savings, but also to avoid other negative environmental and social impacts. Many countries already have good regulation of their forest sectors but others will need to put robust regulation in place if they are to supply the UK with sustainable wood fuel. Like all energy technologies, biomass can be exploited well or badly. The UK Government says it is working hard to put safeguards in place to ensure that the use of unsustainable biomass is not supported. (31)

The use of locally sourced sustainable timber and wood waste for energy production is still the right thing to do for the climate. The small-scale use of biomass for heat and in combined heat and power stations have an important role to play. But the use of large quantities of biomass in large power stations which burn the material at around 30% efficiency to generate electricity looks unlikely to be sustainable, especially if the fuel is imported. Eggborough alone could consume more than the entire wood production in the UK, whilst in total Government plans for biomass would need about six times UK production. It's hard to believe that the sheer scale of demand could lead to anything other than serious pressure on forests across the world already deeply stressed by deforestation.

10. Biofuels

a) First Generation

Biofuel is a term usually used to refer to substitutes for petrol, diesel or aircraft fuel made from biological material. The EU has a goal to produce 10 per cent of all transport fuels from renewable sources by 2020. Regrettably this target has had some unintended consequences.

While biofuel has the potential to reduce carbon emissions from the transport sector, unfortunately the development of biofuels from food crops such as maize or sugar has been responsible for increases in the price of food as well as for deforestation. Environmentalists claim that some biofuels, particularly those derived from oil crops such as rape and palm, may even contribute more to carbon emissions than the diesel they are intended to replace. (32) Targets to boost biofuel production have encouraged multinational companies to buy up land in the developing world, forcing some of the world's poorest people further into poverty, according to a report by a new coalition of charities and faith groups backed by figures such as Bill Gates, the Microsoft founder, and the South African Nobel Peace Prize winner Desmond Tutu. The group claims that crops burned as biofuels in the UK alone would be enough to feed 10 million people a year. The group wants the EU target scrapped. (33)

If the world wants to ensure better food security for its growing population, then it needs to stop converting food crops into transportation fuel. In Europe, legislators have listened to these arguments with growing concern and last October they decided to take action. Connie Hedegaard, the EU climate change commissioner, announced substantial policy changes that would limit food-based biofuels to just 5 per cent of the renewable energy used by the transport sector.

b) Second Generation: wood waste

But now more advanced products, often referred to as second-generation biofuels, are coming to the fore. Typically produced from agricultural or urban waste or by growing algae, second generation biofuels hope to get over the problems associated with the first generation.

UPM, a Finnish forestry company that manufactures pulp, paper and timber, for example, has been awarded a grant of €170m by the European Commission for the construction of a biorefinery in Strasbourg, France. (34) UPM started the construction of the world's first wood-based biodiesel producing refinery in Lappeenranta, Finland in summer 2012. This will produce renewable diesel out of crude tall oil, a residue of pulp production. The process is based on hydro-treatment and production will start in summer 2014.UPM's biorefinery planned for Strasbourg will produce renewable diesel from energy wood, such as logging residue or bark. The main end product of both biorefineries, one using solid wood and the other using tall oil as raw materials, is second generation wood-based renewable diesel called UPM BioVerno. (35)

c) Second Generation: Algae

Efforts to make biofuel from algae have been under way for more than thirty years. Algae's big advantage is that it wouldn't compete for agricultural land with food crops. It also has the potential to produce as much as 10 times more fuel per hectare. But, according to the US National Research Council (NRC) large-scale production of biofuels from algae is untenable with existing technology, as it would require the use of too much water, energy, and fertilizer. The U.S. Department of Energy (DOE), which supports much of the research in the field, should conduct assessments of proposed technologies that examine sustainability at all stages of fuel production, including growing or collecting algae and harvesting their oil and converting it into transportation fuels.

At the moment the NRC concluded that current technology scaled up to produce just 5% of U.S. transportation fuel needs—would require an unsustainable level of inputs. The good news is that there's still plenty of potential for improvement. The use of water and added nutrients, for example, could drop markedly if engineers come up with ways to efficiently recycle used water and nutrients, perhaps even using nutrient-rich wastewater from agricultural or municipal sources. But for algal biofuels to reach their full potential, researchers will need to integrate

these and other advances and ensure that at each stage algae is converted to fuels in the most sustainable way possible. (36)

The International Energy Agency says there is a considerable potential for the production of second-generation biofuels. Even if only 10% of the global agricultural and forestry residues were available in 2030, these could provide about 5% of the projected total transport fuel demand by that time. (37)

11. Conclusions

Between 2020 and 2030 DECC sees a sudden levelling off in the growth in renewables, and a rapid growth in nuclear and gas. But this is not an inevitable consequence of meeting our climate change objectives. By allowing offshore wind to continue growing at the rate it will have grown in the previous decade, and then looking to bring on a batch of other renewable technologies, including solar, geothermal, hydro and wave and tidal we can move towards a more sustainable renewable energy system which doesn't require new nuclear power or large-scale gas.

Energy System 2030	**UK Government Scenario**	**FoE Scenario**
Unabated Fossil Fuels	150 TWh	60 TWh
Renewables	140 TWh	350 TWh
Nuclear	90 TWh	10 TWh
Carbon Capture & Storage	10 TWh	50 TWh
Total	390 TWh	470 TWh

In the FoE scenario the renewable contribution is made up of 60 TWh from onshore wind; 195 TWh from offshore wind; 50TWh from Hydro, Wave, Tidal and Geothermal and 36TWh from solar. (38) The FoE scenario assumes more switching of transport and heating to electricity than the Government scenario, hence the higher demand, but FoE also note that a massive 155 TWh could be saved through extra efficiency measures – 140 TWh of which would be at a negative cost.

The growth of wind can continue beyond 2020 and it will be possible to cope with variability and intermittency issues. By expanding the use of solar and small-scale hydro and developing newer renewable technologies such as geothermal, wave and tidal it would be possible to decarbonise the UK electricity system without resorting a large expansion of nuclear generation.

UK wood resources would best be used to provide renewable heat or possibly some combined heat and power generation, or there is a danger of moving towards unsustainable use of resources. Biofuels may be able to provide a sustainable fuel for transport, but only if the focus moves away from crops which compete with food for land towards biomass waste. Efforts to produces biofuels from algae appear to require more research to avoid the need for a large input of water and fertiliser.

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