November 2016

Briefing

The renewable energy century

Introduction

Move over fossil fuel dinosaurs – the fleet-footed renewable mammals are taking over.

Renewables are growing at an astonishing rate - up from 7% to 25% of UK electricity in just 6 years. Around the world, from China to Chile, the story is the same: **plummeting renewable energy costs, rocketing deployment**. This, allied to spectacular **technological developments in energy storage, means we can now envisage a fully renewable future**, one that could arrive far faster than most believe. In fact it is probably unstoppable – the only question is if it will happen in time to prevent dangerous climate change.

In contrast, the fossil fuel dinosaurs are starting to fade. They're still powerful, but on their way out. The **Paris Climate Agreement** will be ratified in less than a year – unprecedented for a global treaty – and to meet its goals most fossil fuel reserves will have to stay in the ground. This realization is fuelling fears of a 'carbon bubble' as investors realize that fossil fuel companies may be significantly overvalued. At the same time concerns over the climate and air pollution means coal projects are being slashed all around the world. Utilities are increasingly seeing their centralized business models undermined.

A transition to renewable energy will create winners and losers, but it will protect our climate, our air and our water. It will **create jobs and huge new industries** and has the potential to hand cleaner, cheaper power **directly into the hands of communities** and individuals.

While the direction of travel is clear, the fossil fuel industries won't give up without a fight. Over the years many myths have been put about to argue that the move to renewables need to be held back (see Appendices). These argument now seem weaker than ever, but their influence remains.

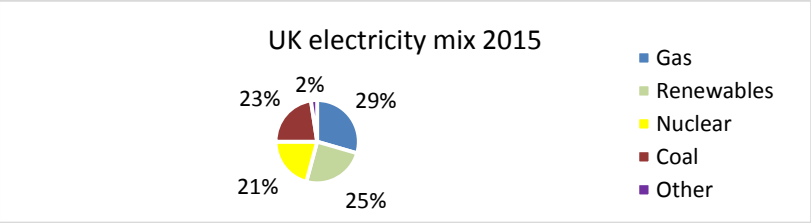
<u>There is still a need for government action</u>

While previous policies have helped renewables to expand rapidly in the UK, since 2015 the Government has slashed support for renewables**, ending several key programmes with no replacement, causing growth to slow**. Cheap onshore wind and solar remain locked out of the market. At the same time they have promoted old, dirty, or expensive technologies - fracking, open cast coal and nuclear power. These are last century's solutions. The Government is in danger of picking losing technologies, and the **UK in danger of losing out on the huge economic prizes** that the renewable transition will bring.

This briefing outlines some key information about the renewables transition in the UK. It will be useful for those fighting fossil fuel projects as well as those concerned about climate change and advocating for more renewable power. It shows how renewables are already on their way to meeting our energy needs, and ends with a series of top line recommendations for government.

The renewables revolution is already happening!

Renewables are growing rapidly. In 2015 they overtook coal as the world's largest source of power. **In the UK a quarter of our electricity already comes from renewables (Fig 1)**.[1] At the same time plummeting costs and exciting new energy storage and smart management technologies mean our energy needs can increasingly be met by safe, reliable renewable energy.



Renewables are cost effective

The cost of renewable energy is falling quickly. In many parts of the world, from California to Chile and South Africa[2], wind and solar are now the cheapest sources of new electricity. In the UK, even the government's conservative estimates show that new **onshore wind is now effectively the cheapest form of new generation available**.[3] Large scale solar in the UK will likely be competitive with new gas generation by around 2020, and cheaper before 2025. Smaller rooftop solar and offshore wind are seeing costs fall quickly (solar down 50% in five years). By 2025 it is estimated that offshore wind too will be cheaper than new nuclear generation and competitive with gas generation soon afterwards (see Table 1).

Table 1. Projected costs of power (£/MWh). Source: BEIS 2016 (note: renewable costs subject to rapid change).

Year of Commissioning	2018	2020	2025	2030	Notes
CCGT Gas	61	66	82	99	
Onshore Wind >5MW	65	63	61	60	
Offshore Wind	114	106	100	96	Likely underestimate of cost reductions. Government targeting £85/MWh by 2026.[4]
Nuclear			95	78	(35-year contract, all others techs are 15 year)
Large Scale Solar	71	67	63	60	Likely underestimate of cost reductions
Rooftop Solar Large	77	73	69	65	
Rooftop Solar Domestic	131	128	121	114	Rooftop solar competes with retail electricity.

Nonetheless government intervention is still needed, as it now is for all new energy generation. **New onshore wind and solar remain locked out of the UK**, as they lack a route to market, while onshore wind also faces a highly negative planning environment. **Offshore wind needs certainty and a market to drive cost reductions.**

Renewables are reliable

Far from causing the lights to go out when the wind doesn't blow, energy systems with lots of variable renewables can be very reliable. Germany and Denmark have the two most reliable energy grids in Europe, with four times fewer outages than the UK, and some of the highest amounts of renewables on the grid[5]. We might get blackouts, but they are unlikely to be caused by renewables.

[1] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/547977/Chapter_6_web.pdf
[2] http://www.climatechangenews.com/2016/10/21/renewables-undercut-new-coal-plants-in-south-africa/
[3] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/566567/BEIS_Electricity_Generation_Cost_Report.pdf
[4] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/572544/Response_to_LCF_Lessons_Learned_FINAL_18-11-16__2_.pdf
[5] https://www.cleanenergywire.org/dossiers/energy-transition-and-germanys-power-grid

Storage is coming

The cost of batteries and other energy storage systems has fallen by around 14% per year since 2007[6]. This will make it cheaper to integrate large amounts of variable renewables onto the grid, slowly reducing the need for fossil fuel back-up. Recent studies by Aurora Research show that building 40 GW solar, and using 8 GW of storage, will reduce the overall cost of balancing the grid compared to business as usual.[7] In the future it should be possible and cost-effective to move to a grid that is almost entirely renewable by a mixture demand side management, energy storage and interconnectors with other countries to take advantage of shifting weather patterns.

Friends of the Earth's vision for the UK's electricity

Friends of the Earth wants a clean, secure and democratic energy future based on exploiting abundant home-grown renewable energy sources. To tackle climate change and decarbonize our electricity supply**, Friends of the Earth believes we need 75% of our electricity to come from renewables by 2030,** moving to a zero carbon grid shortly after. This transition is not only achievable, it is underway. And it will be good for us – improving our health and environment and boosting the economy. **But it is an urgent challenge, requiring immediate, stepped-up action across all sectors of society.** Broadly speaking there are four main steps:

1. Reduce demand for energy

The first step is to reduce the demand for energy - insulating homes, using low energy appliances and shifting energy use to lower energy alternatives (electric vehicles are far more efficient than internal combustion engines). Other measures could include changing planning rules to increase the chances of people working and living in the same location, reducing travel times, and making low-energy alternatives like cycling, walking and public transport safe, affordable and reliable. **Note this will likely increase demand for electricity,** while reducing demand for heat and fuel.

2. Decarbonise electricity

We can make the switch to around 75% renewable electricity within 15 years, made up largely of offshore wind, solar, onshore wind and marine energy sources (we have gone from 7% to 25% in in five years, growing at the same rate would make it possible). Our future electricity grid will likely be a combination of high levels of renewables, with lots of energy storage (batteries, dams, hydrogen etc), interconnectors and smart grids to manage demand and supply, and increasingly small amounts of natural gas as back-up. Biomass and nuclear have significant environmental issues and should be minimized and phased out. Table 2 shows a possible electricity mix in 2030.

Table. 2 Sample UK electricity mix in 2030 (note demand ~50% greater than 2016.) Source: Clean British Energy 2012, FOE

Technology	Percentage	TWh	GWp renewables needed (2030)
Offshore Wind	42%	196	45-50 GWp
Gas	13%	60	na
Onshore wind	13%	61	23 GWp
Gas with CCS	11%	51	na
Solar	10%	45	45-50 GWp
Wave, tidal, geothermal, hydro	9%	45	Variable depending on technology.
Nuclear (residual)	2%	9.32	na
Total	**100%**	**466**	

[6] https://www.sei-international.org/mediamanager/documents/Publications/SEI-Nature-pre-pub-2015-falling-costs-battery-packs-BEVs.pdf.

[7] Intermittancy and the cost of integrating solar in the GB power market, by Aurora Energy Research, September 2016

3. Make the switch to electricity where possible – electric vehicles

We need to make the switch to electric vehicles (EVs) as fast as possible. EVs are also far more energy efficient than diesel/petrol engines, and may be able to provide back-up to the grid by storing electricity until it is needed. Similarly, we can increasingly move to electricity to heat our buildings, possibly alongside a move to other low carbon alternatives for gas central heating – perhaps hydrogen or synthetic gas made using renewable electricity or CCS.

4. Capture and store any remaining emissions

Any large source of emissions (e.g. industrial processes) where electricity or low carbon fuels are unsuitable should capture and store emissions.

RECOMMENDATIONS ON RENEWABLES AND ELECTRICTY

Industrial strategy and devolution

1. Ensure that any **industrial strategy** future-proofs UK industry to operate in a zero-carbon world. **Transition to a zero-carbon economy should be prioritized.**
2. Give greater **autonomy to city-regions and devolved administrations to benefit from and develop local energy assets**, and to stimulate investment in renewable generation, efficiency, energy infrastructure and **skills** and **low carbon transport**.

Renewables

3. Commit to **decarbonizing UK electricity** supply to 50g/C02/kWh by 2030.
4. **Commit to construct 3 GW offshore wind per year** from 2020-2030. First phase 2020-25 would require approximately £1.3bn extra in CfD contracts, on top of £730mn committed.
5. **Restore route to market for more mature renewables like onshore wind and solar** that are currently shut out. (Through auctions in CfD Pot 1, with special measures for communities).
6. Support the **expansion and integration of rooftop solar** and other decentralized renewables. Including **transitional support mechanisms** while costs continue to fall (i.e. FiT or tax breaks).
7. **End the de-facto ban on onshore wind in England** by removing unreasonably restrictive planning guidance; ensure Planning Authorities demonstrate support for the development of appropriate renewable technologies in their areas.

Storage and integration.

8. Implement the recommendations of the National Infrastructure Commission on Smart Energy to make the **UK a world leader in energy storage and smart technology**. Supportive policy, development funding and targets to ensure decentralized energy can thrive.
9. Reform **the capacity market** to ensure it incentivizes low carbon solutions – like energy storage and demand side management.

Energy efficiency

10. Introduce a new national **zero carbon homes** standard for new build.
11. Publicly funded **energy efficiency infrastructure programme** to ensure 20 million homes are insulated to EPC band C or higher by 2030, starting with 4 million by 2020.
12. Support development of **Electric Vehicles**. All new vehicles to be Ultra Low Emission by 2025

APPENDIX 1 - INTERESTING FACTS ABOUT RENEWABLES

Renewables supply is increasing rapidly

- Almost 25% of UK electricity was supplied by renewables in 2015, up from 6.5% in 2010[8].
- Of UK electricity in 2015, onshore wind produced 6.9%, offshore wind 5.6%, hydro 2.2% and solar 1.4%[9] the remainder was generated by bio mass, this has a role to play in a clean energy future it must be sourced in a way that protects nature and guarantees emissions reductions.[10]
- For three months in 2016, solar power produced more electricity than coal, and in fact solar panels alone can already supply up to a fifth of the UK's electricity when the sun is shining!
- A single large 2.5MW wind turbine supplies enough electricity in a year to meet the needs of 1400 households[11]
- More than 50% of electricity In Scotland is from renewables and on certain days has peaked at over 100% ! [12]
- Denmark is over 40% of electricity aiming for 50% by 2020[13]
- Globally renewable energy is growing at its fastest rate ever and accounted for nearly half of all new energy capacity added in 2015[14]. Detailed analysis has shown that 139 countries could reach 80% renewable energy by 2030 and 100% by 2050[15]
- China is building a large wind turbine and a solar PV array the size of a football pitch every hour, on average[16]

Renewables are popular

- Renewable energy is consistently popular, more than 80% of UK public fully support green energy, it is much more popular than the alternatives – fracking and nuclear, only 19% of public think fracking should be pursued in UK[17]

Costs of renewables are falling rapidly:

- Cost of Solar PV has fallen 50% in 5 years and even offshore wind now matches the cost of nuclear power[18].
- The latest wave of wind and solar farms in the UK signed 15-year contracts for £79/MWh, compared to £92.50/MWh index-linked for 35 years for new nuclear power. The most recent offshore wind farms in the UK signed 15-year contracts for £115/MWh.

[8] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/547977/Chapter_6_web.pdf
[9] https://www.gov.uk/government/statistics/energy-trends-june-2016-special-feature-article-renewable-energy-in-2015
[10] https://www.foe.co.uk/sites/default/files/downloads/energy_biomass.pdf
[11] http://www.renewableuk.com/page/WindTurbines
[12] http://www.independent.co.uk/environment/scotland-wind-energy-renewable-power-electricity-wwf-scotland-a7183006.html
[13] http://denmark.dk/en/green-living/wind-energy/
[14] http://www.iea.org/bookshop/708-Medium-Term_Renewable_Energy_Market_Report_201
[15] http://priceofoil.org/2016/09/22/the-skys-limit-report/
[16] http://energydesk.greenpeace.org/2016/09/08/china-six-little-known-facts-countrys-solar-wind-boom/
[17] https://www.gov.uk/government/statistics/public-attitudes-tracking-survey-wave-17
[18] http://energydesk.greenpeace.org/2016/07/27/hinkley-offshore-wind-cost-effective/

- Onshore wind and large solar will likely be the cheapest form of new electricity generation in the UK[19] in just a few years, and are already cheaper than new nuclear, ten years before the first new nuclear power station will come on line.
- Costs of offshore wind have fallen over a fifth in the last few years, and look set to fall further.
- Experts consistently underestimate the pace at which the costs of renewables are falling. In 2011 the Committee on Climate Change estimates for the cost of solar electricity in 2020 and 2030, were beaten in 2013 and 2015 respectively[20].
- Battery prices halved between 2010 and 2016[21] and have fallen at around 14% per year since 2007[22].
- Tesla are building a battery factory in Nevada that will have the same annual production capacity as all the other battery factories in the world[23].

Renewable energy is good for jobs

- Renewable energy projects create more than five times the number of jobs per GWh generated compared to gas projects[24]
- Currently around 100,000 people are employed working in renewable energy in the UK.

Community renewables

- At least 5000 community energy groups are active in the UK[25]
- Community schemes create 12-13 times the community value than privately owned schemes[26]
- Community energy is far more developed in some other countries, 34% of renewable energy generated in Germany is from community schemes[27], in Denmark 70-80% of wind turbines were community owned in 2013[28]

[19] Page 26 https://www.nao.org.uk/report/nuclear-power-in-the-uk/
[20] https://www.theccc.org.uk/archive/aws/Renewables%20Review/RES%20Review%20Technical%20Annex%20FINAL.pdf
[21] https://www.moodys.com/research/Moodys-Declining-battery-prices-could-lead-to-commercial-and-industrial--PR_335274
[22] https://www.sei-international.org/mediamanager/documents/Publications/SEI-Nature-pre-pub-2015-falling-costs-battery-packs-BEVs.pdf.
[23] Pages 177 'the Switch' http://www.carboncommentary.com/switch
[24] http://www.ukerc.ac.uk/support/tiki-download_file.php?fileId=3715
[25] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/275164/20140126_Community_Energy_Strategy_summary.pdf
[26] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/274746/20140108_Community_Energy_Modelling_FinalReportJan.pdf
[27] http://www.communitypower.eu/en/germany.html
[28] http://climatepolicyinfohub.eu/community-energy-projects-europes-pioneering-task

APPENDIX 2 – FREQUENTLY ASKED QUESTIONS / MYTHBUSTER

- Shouldn't we reduce energy use first?
    - Yes absolutely, we need strong action to reduce energy waste, however this will take time even with political will, in the meantime we need to decarbonise our energy supply as fast as possible.

- Is renewable energy popular?
    - Yes! There is vocal opposition to some renewable energy projects (particularly onshore wind) but renewable energy is consistently popular - more than 80% of UK public fully support green energy and it is much more popular than the alternatives – fossil fuels and nuclear, only 19% of public think fracking should be pursued in UK[29].

- How much renewable electricity will we need?
    - To decarbonise electricity supply to 50g/CO2 by 2030 as recommended by Committee on Climate Change will require around 75% of UK electricity to come from renewables. There are lots of ways this could happen, but one pathway would see the need for around 50 GW offshore wind, 23 GW onshore wind, 60 GW solar, 10-20 GW other (tidal, marine, geothermal) by 2030.

- How do we keep the lights on?
    - Germany and Denmark both have very large percentages of variable renewables on their grids, yet both consistently rank as the most reliable in Europe, with four times fewer outages than the UK[30]. We might get blackouts, but they are unlikely to be caused by renewables.

    - Separate studies by Garad Hassan[31], and Poyry for the Committee on Climate Change, have shown that the UK could generate over 80% of electricity demand[32], without jeopardizing security of supply, through the use of storage, interconnectors and demand side management.

    - Moving to 100% renewables will present some challenges, particularly in colder countries like the UK but they are surmountable: Demand side management through variable electricity prices coupled with smart meters, battery storage and interconnectors will deal with short term peaks and troughs and is already being used in industry. Back-up gas power may be needed in the short-medium term to cope with occasional winter demand peaks. In the long term, 'power to gas' technologies and 'green gas' like Hydrogen will mean surplus renewable energy can be stored across the seasons. Even without these new technologies, modelling using real weather data including strings of wind free winter days[33] shows we can virtually decarbonise our electricity supply and keep the lights on.

[29] https://www.gov.uk/government/statistics/public-attitudes-tracking-survey-wave-17
[30] https://www.cleanenergywire.org/dossiers/energy-transition-and-germanys-power-grid
[31] http://assets.wwf.org.uk/downloads/positive_energy_glgh_technical_report.pdf
[32] https://www.theccc.org.uk/publication/the-renewable-energy-review/
[33] http://www.demandenergyequality.org/2030-energy-scenario.html

- Aren't back up gas fired power stations expensive?
  - **The additional cost of having standby gas fired power stations that are used intermittently mainly at peak times has been factored into official analysis of future energy costs, and are modest, around £10/MWh.** Under these scenarios onshore wind and solar PV remain broadly competitive with new gas power stations and cheaper than nuclear.[34]

- Do wind turbines and solar panels ever pay back embedded emissions from construction?
  - Wind turbines recoup their embedded emissions from construction and dismantling in around 5-8 months, they last for 25 years or more[35].
  - Modern solar panels pay back their embedded emissions in around 2.5 years, and have a lifespan of around 25 years[36].
  - All energy projects have some emissions, which is why saving energy should always be the top energy project. But looking across the life-cycle of emissions from mining, use and decommissioning, wind and solar are far lower impact than other technologies.

- What about the impacts of wind turbines?
  - Some people love the appearance of wind turbines, some hate them. Two thirds of the UK public support onshore wind power[37].
  - A Scottish survey found that 6% of people were concerned about noise before a wind development was built but this fell to less than 2% after building[38]. There are strict limits controlling noise
  - Careful siting of wind turbines to avoid impact on birds is essential, this is considered as part of the planning approval process. Some of the most alarming figures for bird mortalities came from early wind farms in the US that were badly sited at mountain passes. The RSPB only objects to around 6% of the wind applications it engages with[39].

[34] https://documents.theccc.org.uk/wp-content/uploads/2015/11/Sectoral-scenarios-for-the-fifth-carbon-budget-Committee-on-Climate-Change.pdf
[35] https://www.sciencedaily.com/releases/2014/06/140616093317.htm
[36] http://pubs.acs.org/doi/pdfplus/10.1021/es071763q
[37] https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/474170/Wave_15_Summary_of_Key_Findings.pdf
[38] p10 http://www.gov.scot/Resource/Doc/47133/0014639.pdf
[39] https://www.rspb.org.uk/forprofessionals/policy/windfarms/

- Why isn't more being made of tidal / wave energy?
    - Tidal energy is already being trialed in the Pentland Firth, Scotland[40] and Strangford Lough, Northern Ireland[41] and investigations are underway at Cardiff and Swansea Bay.
    - Tidal and wave technologies are relatively young, costly technologies, however it is estimated they could theoretically provide 15% of UK electricity by 2030[42].

- What about heating?
    - Decarbonising heat will take longer than electricity, however we already have most of the technologies we need to achieve this
        - UK homes are amongst the least energy efficient in Europe, this must be urgently addressed, the Government estimates we could save equivalent of the output of 22 power stations with cost effective energy efficient measures[43]
        - Many buildings could be heated with efficient electric heat pumps powered by renewable generated electricity. Heat pumps are widely used in some other European countries[44].
        - Many buildings could be heated by Combined Heat and Power (CHP) plants where waste heat from small power stations is used via district heating networks. 'Green gas' from Anaerobic Digestion and in the long term 'power to gas' from renewable electricity could be used to provide zero carbon heat.

- Electric vehicles (EVs) cars will increase our electricity use how will renewable electricity cope?
    - Decarbonising transport will mean electrifying much of our transport system and adding to electricity demand. However, EVs are far more efficient than conventional cars[45] and their batteries will also be a core part of a smart future electricity grid by providing a significant electricity storage. Modelling[46] for Greenpeace shows that we can transition to electric heating and transport while decarbonising our electricity supply. Nonetheless it is important that we minimize the use of vehicles as much as possible, through investments in public transport, urban design, cycling and walking, as well as building lots of renewable energy generation.

    - Taken together the shift to electric heating and EVs will mean shifting energy supply from fossil fuels to electricity, this is another reason why shifting as fast as possible to a renewables powered electricity supply is so important

[40] http://www.johnogroat-journal.co.uk/News/Pentland-Firth-turbines-build-is-underway-22092016.htm
[41] http://www.power-technology.com/projects/strangford-lough/
[42] P48 https://www.theccc.org.uk/publication/the-renewable-energy-review/
[43] P8 https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/65602/6927-energy-efficiency-strategy--the-energy-efficiency.pdf
[44] http://www.ehpa.org/fileadmin/red/07._Market_Data/2014/EHPA_European_Heat_Pump_Market_and_Statistics_Report_2015_-_executive_Summary.pdf
[45] https://www.fueleconomy.gov/feg/evtech.shtml
[46] http://www.demandenergyequality.org/2030-energy-scenario.html

- How can we find the Lithium we'll need for all these batteries?
    - Lithium-Ion is currently the primary battery technology, being used in many electrical appliances, electric cars and increasingly on a large scale for bulk energy storage although there are a very wide range of other new storage technologies being rapidly developed, including other batteries. Currently hardly any Lithium is recycled but there is no reason why it can't be. We need action at UK and EU level to ensure that recycling systems are put in place[47].

[47] https://www.foeeurope.org/sites/default/files/publications/13_factsheet-lithium-gb.pdf