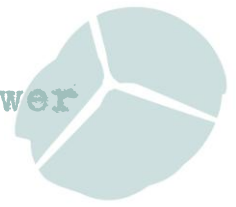


No.96 June 2017

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1. How renewable energy has become unstoppable

What was remarkable about Donald Trump's announcement on 1st June that the US would abandon the Paris climate agreement was not the almost universal condemnation of the move, but the number of stories about how successful renewable energy has become and how its advance has now become unstoppable.

Donald Trump is so wrong to be taking the US out of the Paris accord on climate change, says Jeremy Warner in the *Daily Telegraph*. The renewables train has already left the station and won't now be stopped. Non binding targets for reducing greenhouse gases are no longer relevant and will almost certainly be naturally exceeded of their own accord without any help from inter-government actions. There is therefore absolutely no reason for the US to withdraw. (1)

Although President Donald Trump has presented his energy policy decisions as being focused on creating jobs, the solar and wind industries that could be threatened by leaving the Paris accord employ many more people than the coal industry that is likely to be the principal beneficiary. About 374,000 people spend at least some of their time working in the solar power industry in the US, with 260,000 of those working there more than half the time. A further 102,000 work in wind power. Together that is almost three times the 160,000 people employed in the coal industry, with about 86,000 of those at coal-fired power plants and 74,000 in coal mining and distribution. The number employed in coal mining has dropped from about 89,000 at the start of 2012 to about 50,500 in April, following a slight bump of about 1,000 over the past year. Solar power is so labour-intensive in part because the rapid growth of the industry has created a lot of construction jobs installing systems. About 37% of US solar jobs are in construction, with about 27% in wholesaling. Only about 19% of US solar jobs are in manufacturing, and the industry has been heavily reliant on low-cost imported panels, mostly from China, Malaysia and Korea, to enable it to compete against fossil fuel generation. (2)

The US solar industry alone employs more than twice as many workers as the coal sector. Manhattan has more Tesla charging spots than petrol stations, though many are in fee-paying parking garages. And across the US, where power companies are facing lower wholesale prices thanks to cheaper natural gas, renewables are adding pressure too - even in unlikely spots such as oil-rich Texas. Texas now has more installed wind power capacity than Canada and Australia combined. If it were a country, it would rank as the world's sixth-largest wind power, after China, the US, Germany, India and Spain.

The irony about Mr Trump's inclination to back old industries, says Magnus Linklater in *The Times*, is that the US is an innovator in renewable energy, creating hundreds of thousands of jobs. When you add in all the spin-offs, such as electric forms of transport, employment in renewable energy is starting to outstrip that in the declining oil and gas industries. Now is not the time to slow down. Wind turbines are proving a remarkable success. On some days they produce more electricity than Scotland needs, allowing it to export the remainder. In places like Denmark and Germany, where there has been a massive expansion of wind farms, they



manufacture so much renewable energy that electricity prices have turned negative, with customers paid to use it. Alternative energy is beginning to turn in some remarkable statistics. On 26th May solar energy produced one quarter of Britain's energy needs, more even than nuclear and coal-fired power. There is much more of this to come. (3)

Many U.S. states and private companies announced that despite Trump's decision, they would continue their own existing policies, such as restricting greenhouse gas emissions, as well as pursue new ones to demonstrate urgency in addressing the climate threat. US states accounting for almost 30% of national gross domestic product have pledged to meet the country's climate commitments. California, New York, Washington and five other states have said they are committed to cutting emissions by 26-28% from 2005 levels, which was the reduction proposed for the US by Barack Obama. (4) City leaders of 102 cities across the US have announced they are adopting the Paris Climate Agreement. Mayors who have signed on to the Mayors National Climate Action Agenda represent roughly 50 million Americans in 34 States. (5)

The FT argued that after years of hype and false starts, the shift to clean power has begun to accelerate at a pace that has taken the most experienced experts by surprise. Even leaders in the oil and gas sector have been forced to confront an existential question: will the 21st century be the last one for fossil fuels? Wind and solar parks are being built at unprecedented rates, threatening the business models of established power companies. Electric cars that were hard to even buy eight years ago are selling at an exponential rate, in the process driving down the price of batteries that hold the key to unleashing new levels of green growth.

What is striking is how much of a financial impact this is already having on some companies says Per Lekander, a portfolio manager at London's Lansdowne Partners hedge fund, who has tracked global energy markets for more than 25 years. Government efforts to tackle climate change and smog have driven down costs and spurred huge technical advances.

Global renewable power generation capacity rose by 9% last year - a fourfold increase from the start of this century - buoyed by the growth of solar power that shot up by more than 30%. For the second year in a row, renewable energy accounted for more than half the new power generation capacity added worldwide. These advances have become too significant for the oil and gas industry to ignore. Saudi Aramco talks about a "*global transformation*"; Shell says it's "*unstoppable*". Isabelle Kocher, chief executive of French power and gas group Engie, calls it a new "*industrial revolution*" that will "*bring about a profound change in the way we behave*".

Brian Marrs, director of policy and strategy at NRG, the second-largest US power producer says: "*I think what we're seeing in the US now is the German postcard from the future finally arriving across the Atlantic.*" Yet fast-growing industrialising nations are seeing some of the most profound changes. Towering over them all is smog-choked China, which has become a green energy juggernaut after designating renewables a strategic industry. China has more than a third of the world's wind power capacity; a quarter of its solar power; six of the top 10 solar-panel makers; four of the top 10 wind turbine makers and more battery-only electric car sales last year than the rest of the world combined.

India is eager to follow: it built one of the world's largest solar photovoltaic farms last year; ranks fourth in the world for wind power capacity; and could become the world's third-biggest solar market this year. It also wants to boost its use of electric cars.



The cost of wind turbines fell by nearly a third since 2009 and solar panels by 80%, according to the International Renewable Energy Agency (IRENA). *"It is as if every country in the world woke up one bright morning to find that it had a North Sea at its disposal"*, says London energy analyst Kingsmill Bond. Costs are already lower than widely understood. *"In 2010 we financed a 15 megawatt solar plant in southern California that cost \$55m to build,"* says Jim Long, a partner at Greentech Capital Advisors, a global clean energy advisory firm. *"This year we have done another one the same size in the same area that has cost \$15m and will produce at least 40 per cent more energy."*

Costs are expected to fall further as expensive subsidies guaranteeing set prices are replaced by competitive auctions or tenders. The amount of auctioned renewable electricity tripled last year compared to 2015, according to Bloomberg New Energy Finance, while the average global price of auctioned solar power has plummeted fivefold since 2010. One of the most striking auction results came in Germany in April when Denmark's Dong Energy, the largest builder of costly offshore wind farms, said it would build two new schemes without subsidies, relying instead on market prices alone. Advances in wind technologies - including the prospect of much more powerful turbines - were one reason for Dong's move, a step others are expected to follow. *"Renewables have reached a tipping point globally,"* says Simon Virley, of KPMG. *"A subsidy-free future is now in reach for a number of technologies and geographies."*

Even the experts have been caught out by the pace of the shift. In 2010, IEA projections suggested it could take 14 years before there were 180 gigawatts of installed solar capacity. It took less than seven years for the world to reach more than 290 gigawatts, nearly the entire generating capacity of Japan. *"Fossil fuels have lost,"* says Eddie O'Connor, chief executive of Ireland's Mainstream Renewable Power. *"The rest of the world just doesn't know it yet."* (6)

Craig Bennett, Executive Director of Friends of the Earth said *"it is increasingly clear that the age of fossil fuels is drawing to a close and that the future will be powered by affordable, reliable, renewable energy. Indeed, the speed of this transition has caught many by surprise and may explain why, despite the success of renewables in the UK, too many in the Whitehall bubble remain fixated on old, dirty or expensive technologies, such as fracked gas or Hinkley Point C nuclear power station. As a result the UK risks being left behind. So that the UK remains at the forefront of the renewables revolution, whoever forms the next government should commit to decarbonising the electricity supply by 2030 and fully embrace the move to a low-carbon economy, and the economic, health and environmental benefits it will bring."* (7)

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 2. FT 1st June 2017 <https://www.ft.com/content/6a5fa710-46ea-11e7-8d27-59b4dd6296b8>
 3. Times 29th May 2017 <https://www.thetimes.co.uk/article/trump-must-not-turn-us-off-greener-energy-fq72gzdv6>
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2. 100% Renewables

Over 90 companies have committed to the RE100 campaign. Most simply buy renewable energy certificates but others are taking a more creative approach.

ABInBev - the world's biggest brewer signed up to sourcing 100% of its electricity from renewable sources. The owner of brands such as Budweiser, Corona and Stella Artois – joined a growing number of companies who are part of RE100, the corporate campaign that brings together major businesses who share that goal. So far, over 90 have joined up. As the costs of both solar and wind power continue to fall way beyond expectations, such deals are becoming increasingly attractive.

Four major businesses – Google, DSM, Royal Philips and AkzoNobel – came together to sign a long-term power purchase agreement (PPA) with a Dutch wind farm. This both helped ensure its viability, and helped the companies hit their RE100 targets. Other companies backed by the Climate Group (which spearheads RE100) and NGOs, are lobbying governments to reform power purchase regulations so as to allow direct purchases. Kimmins cites Starbucks, which has persuaded North Carolina to allow it to buy electricity direct from a solar farm: enough to power 600 of its outlets. Meanwhile, a number of companies such as Apple and H&M are encouraging their suppliers to commit to 100% renewable targets as well. With many suppliers being based in Asia, there's growing pressure for governments there to allow direct power purchases from renewables providers. Google has raised the bar by explicitly ruling out locating any of its data centres in a country which fails to do so. (1)

In Britain Premier Inn and Costa Coffee owner Whitbread has agreed a renewable energy tariff with SSE covering all of its purchased electricity. The deal covers all electricity within the UK, with the exception of 15 Whitbread sites where small-scale combined heat and power (CHP) units have been installed. Whilst not a 'renewable' energy source, CHP is regarded as energy-efficient generation, helping to reduce overall carbon emissions through use of the heat from engines within the individual sites. CHP provides less than 1% of electricity consumed by Whitbread. More than 99% of Whitbread's total electricity usage is purchased, with the remainder generated through on-site solar PV systems. The company has completed the installation of solar panels on the rooftops of 88 Premier Inn hotels across the country. (2).

Tesco is aiming to meet all of its electricity requirements from renewable sources by 2030. (3)

LEGO Group has become the latest global brand to announce it has met a 100% renewables goal, with the opening of the Burbo Bank Extension wind farm in Liverpool Bay. LEGO Group's parent company KIRKBI A/S holds a 25% stake in the Burbo Bank Extension project, alongside a 25% stake held by Danish pension fund PKA and a 50% stake held by developer DONG Energy. The company said the project meant LEGO has invested DKK6bn (\$895m) in delivering two offshore wind farms over the past four years and has supported the development of more than 160MW of renewables capacity since 2012. (4)

Coca-Cola European Partners (CCEP) is now sourcing all the power needed for its UK facilities from renewables, helped by a newly built solar farm. The 5MW site was developed by Athos

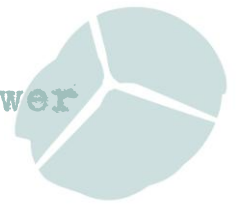


Solar and supplies its generated electricity to CCEP's Wakefield facility under a long-term power purchase agreement. (5)

Unilever has revealed that all of its UK manufacturing sites are 100% powered by electricity generated from certified renewable sources. Electricity is sourced from a Scottish Highlands-based wind farm in Lochluichart. 165GWh – 87% of the farms total output is sold to 15 UK Unilever sites. The new deal builds on Unilever's previous agreement with Eneco in the Netherlands, which has seen a North Sea windfarm generate energy for Unilever since the New Year. Both deals mean Unilever's UK business now sources 100% of its electricity from certified renewable sources. Across its entire global business, Unilever generates 63% of its grid energy from renewable sources. (6)

In 2008, Gregor Robertson campaigned for election as Vancouver's mayor with a promise to make the city the greenest in the world. He was elected in a landslide – 55% of the vote - and speedily began concocting a plan to achieve that promise. In 2011, his Greenest City 2020 Action Plan was published. It's not short on detail - running to 82 pages, and covering every aspect of city life from food and water to transportation and buildings. It has ten goal areas, each with several specific targets for 2020. Under green transportation, for example, the city wants to make more than 50% of trips conducted by foot, bicycle or public transit and reduce the average distance driven per resident by 20% from 2007 levels. A recent pledge to go 100% renewable underlines just how seriously this transformation is being taken. And the indices appear to be moving in the right direction, so as long as Robertson (who was re-elected in 2011 and 2014 with only a slightly decreased majority) can stay the course then there's no reason why Vancouver can't achieve its goal of becoming the greenest city in the world. (7)

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 2. Edie 10th May 2017 <https://www.edie.net/news/10/Whitbread-now-powered-by-100-renewable-energy/>
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 5. Solar Power Portal 18th May 2017 http://www.solarpowerportal.co.uk/news/coca_cola_turns_to_solar_ppas_to_meet_100_renewables_target
 6. Edie 23rd May 2017 <https://www.edie.net/news/10/Unilever-goes-100--renewable-across-all-UK-sites/>
 7. 10:10 (accessed) 23rd May 2017 <https://1010uk.org/articles/how-the-people-of-vancouver-are-making-their-bit-of-canada-greener>



3. Nuclear Power and Jobs

A policy which promotes nuclear power significantly diminishes the prospects of creating new jobs in renewable energy industries – in establishing an offshore wind manufacturing base for instance.

Nuclear power is a capital intensive industry, which means it requires a much higher injection of money to produce its final product – it is not a very efficient way of creating jobs. If there were an alternative way of providing or saving the same amount of electricity, but at the same time creating more jobs, clearly that would be a strategy worth pursuing.

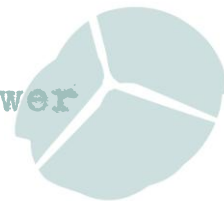
One way of comparing the number of jobs created by different energy sources is to calculate the number of jobs for each Terawatt hour (TWh–1 billion kilowatt hours) generated annually. This, of course, will depend on the performance of the generating station. So a new 1.6GW reactor employing 500 people which operates an average of 80% of the time will be providing 45 jobs per TWh. Goldemberg has estimated the number of jobs created per TWh of power generated and found that nuclear produces around 75 jobs per terawatt hour (TWh), whereas wind power produces 918 – 2,400 per TWh. Solar photovoltaics provides 29,580 – 107,000 jobs/TWh. (1)

According to the Office for National Statistics the number of full-time equivalent (FTE) direct jobs in the nuclear industry had declined to 12,400 by 2015, but about 9,400 of these workers do not produce electricity at all. They are engaged mostly in legacy nuclear waste management. In 2015 ONS reported that the number of FTE direct jobs in the renewable forms of electricity generation had increased to 48,900 – about 16 times the number of jobs in nuclear electricity generation. (2)

In 2015, 338 TWh of electricity was produced in the UK (DECC data). This comprised 70 TWh from nuclear, 85TWh from renewables and the rest from fossil fuels. (3) That amounts to about 43 jobs per TWh for nuclear and about 575 jobs per TWh for renewables. So not only are renewables cheaper than nuclear, but they also create around 13 times more jobs than nuclear power.

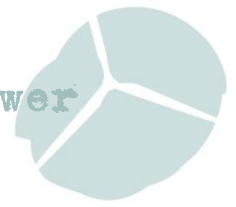
Offshore wind is becoming a double win for policymakers, according to Ray Thompson, Head of Business Development at Siemens Gamesa Renewable Energy. He says offshore wind is coming to represent a major challenge to competing technologies. The new Siemens blade manufacturing facility and project execution harbour in Hull which opened in December 2016 has already created 800 new jobs and the numbers on site will rise to over 1,000 when full production is reached. (4)

Renewable energy jobs could “offset” fossil-fuel job losses by 2030 according to the International Renewable Energy Agency (IRENA). *Renewable Energy and Jobs – Annual Review 2017* presents the status of renewable energy employment, both by technology and in selected countries, over the past year. In this fourth edition, IRENA finds that renewable energy employed 9.8 million people around the world in 2016 – a 1.1% increase over 2015. Jobs in renewables, excluding large hydropower, increased by 2.8% to reach 8.3 million in 2016. China,



Brazil, the United States, India, Japan and Germany accounted for most of the renewable energy jobs. The shift to Asia continued, with 62% of the global total located in the continent. (5)

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1. Goldemberg, J., 2004, The Case for Renewable Energies, International Conference for Renewable Energies, Bonn, <http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.581.7544&rep=rep1&type=pdf>
 2. UK environmental accounts: Low carbon and renewable energy economy survey, final estimates: 2015, ONS, <https://www.ons.gov.uk/economy/environmentalaccounts/bulletins/finalestimates/2015results>
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 4. Clean Technica 11th May 2017 <https://cleantechnica.com/2017/05/11/offshore-wind-represents-major-challenge-competing-technologies/>
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4. Nuclear Power is vanishing as an answer to our energy needs

Government plans flat-lining renewables in 2020s

The Government's November 2015 projection shows that renewable energy production is expected to reach around 125TWh/yr by 2020. After that it virtually levels off. Most of the small renewable expansion permitted in the 2020s is expected to be offshore wind. Apparently the government intends there to be no new PV or onshore wind after 2020.

Electricity demand in 2030 is expected to reach around 350TWh/yr. This would most likely be made up of:

- 110TWh from renewables built by 2020 (including around 45TWh/yr offshore wind and PV)
- 40TWh from gas and non-offshore wind renewables built after 2020;
- 20TWh from Sizewell B – the only current nuclear station expected to be still operating;
- Leaving only 180TWh. This could be supplied by offshore wind and solar PV; (probably about 40GW of offshore wind);
- Or 140 TWh generated by the 18GW of new nuclear capacity supported by current government policy and only 40TWh from offshore wind and PV.

The Government also appears to support the construction of a fleet of Small Modular Reactors after around 2030. (1)

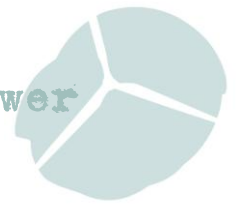
UK Government policy currently envisages only about 10 GW of offshore wind capacity being built in the 2020s. The 18GW nuclear programme would be a significant detriment to both the offshore wind industry and renewables in general because, as simple maths tells you, there would not be much capacity left for the renewables to supply.

Yet the Conservative 2017 manifesto wants to “*maintain our position as a global leader in offshore wind and support the development of wind projects in the remote islands of Scotland, where they will directly benefit local communities.*”

Public Opinion

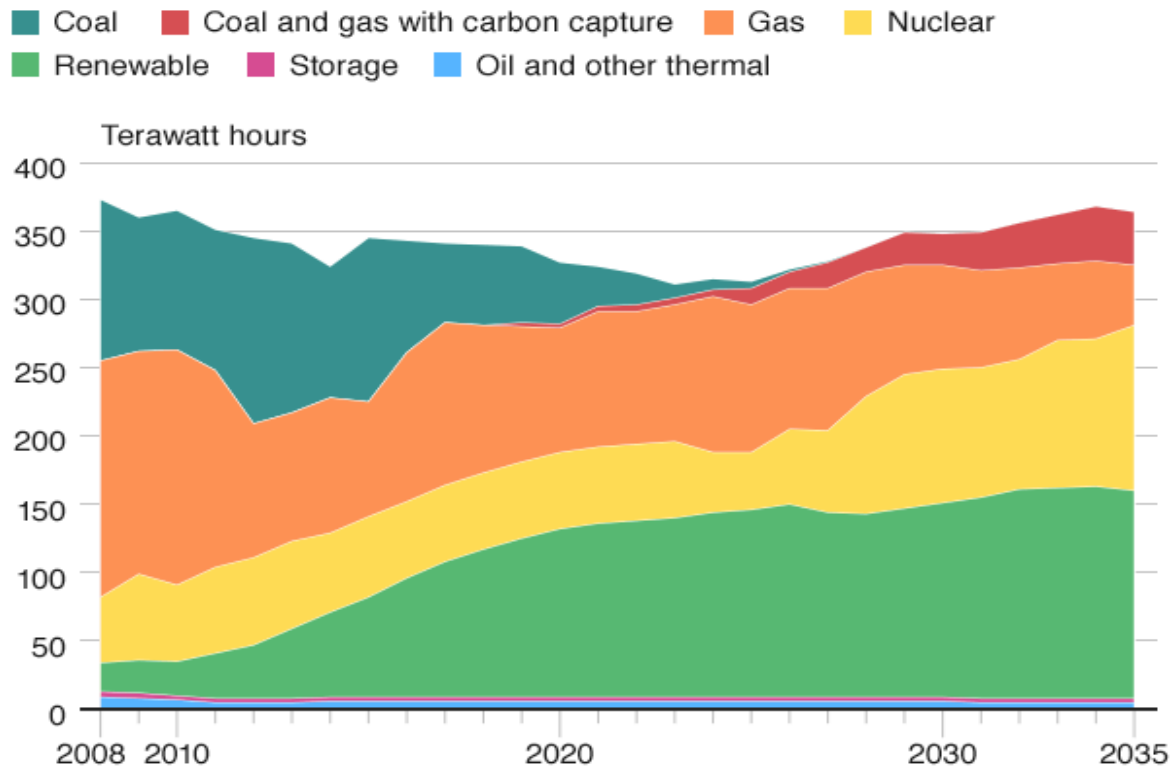
Writing in *The Guardian* Keith Barnham points out that onshore wind has higher public approval than nuclear and fracking, so why are the Tories expanding these unpopular industries with higher carbon footprints. (2)

Public support for onshore wind and solar power are at all-time highs, according to an official survey shows. Almost three-quarters of people (73%) back onshore wind farms and solar has a huge 86% support. Two-thirds (66%) support biomass, 80% are in favour of offshore wind



farms and wave and tidal technologies are backed by 79% of people. The individual technologies all recorded their highest level of support in the quarterly public attitudes tracker from the Business, Energy and Industrial Strategy (BEIS) since it began in March 2012. (3)

Projected sources of energy generation in the UK



Source: Department of Energy & Climate Change (November 2015)

BBC

Labour's Barry Gardiner, the shadow International Trade Secretary, who speaks on climate change issues, said the survey showed "enormous support for renewable energy from the British public. It is just a pity that the Prime Minister and her Cabinet appear to be in the rump 5 per cent who actually oppose renewables," he added. "Why else would they have introduced an eight-fold rise in business rates for companies who put solar panels on their roofs?" (4)

We could have had 100% Renewable Electricity by 2025

Renewable power expanded exponentially under the Tory-Lib Dem coalition elected in 2010 and by 2015 the renewable industries had a turnover of £14.9bn and had reduced wholesale electricity prices. If this expansion had continued a 100% renewable UK electricity supply would have been achievable by 2025. The 2015 Tory manifesto mentioned cuts only to onshore wind, but all renewables have suffered. At least six incentives to highly popular solar photovoltaic (PV) power have been cut. According to the Solar Trade Association, 32% of jobs were lost by summer 2016.

Solar panels produced more electricity than Britain's eight nuclear power stations for the first time on Friday 26th May. Solar power accounted for 24.3% of electricity being generated at 12.30pm and exceeded nuclear output for three hours from 11am to 2pm. (5) As solar power flooded the system wholesale electricity prices fell to around £38/MWh, compared with about



£50/MWh in spring 2013. Friday's peak solar output was almost three times greater than the planned 3.2GW generating capacity of Hinkley Point C. (6)

Why cull such popular and successful industries? The UK has more than 32GW of renewable power, 10 times the power the Hinkley Point C nuclear plant may achieve in 2030. Hinkley's power is not only almost irrelevant; its inflexible nature will make it redundant. Once operating, a nuclear reactor should run with constant output, 24/7, month to month, but power that complements wind and PV has to vary in less than one hour. China, where wind and PV are booming, already has too many nuclear reactors. Its government wants nuclear output varied day to night - an inherently unsafe procedure. The operators at Chernobyl were trying to vary output when the reactor exploded. Renewable expansion has reduced the wholesale price of UK electricity. The rate of fall is consistent with the lower prices in Germany, which has more renewable power.

All the government scenarios assume the wholesale electricity price will increase in the 2020s. This is because they hope the electricity price will rise close to the ridiculously high value guaranteed for nuclear power. If it falls, the nuclear levy on household electricity bills will rise dramatically.

Stop Hinkley spokesperson Roy Pumfrey said: *"It is clear now that the Government's savage cuts to renewable subsidies were made to ensure that the wholesale price of electricity will rise in the future towards the already agreed price for Hinkley Point C - £92.50 per megawatt hour (MWh). In effect the Government is trying to kill off an industry which promises to cut all consumers electricity prices so that it can afford to pay the ridiculously high price it has guaranteed to EDF Energy for Hinkley Point C. If this unproven design ever gets built and produces electricity, the UK consumer will be obliged to pay over twice the current market price for the output. Surely, for the good of electricity consumers, it must be time to scrap Hinkley Point C."* (7)

Keith Barnham says:

"...a Tory government has intervened in two highly successful, exponentially expanding markets, PV and onshore wind, aiming to reduce their expansion to zero by 2020 so as not to threaten their top priorities: higher carbon and more expensive nuclear and natural gas electricity." (8)

An analysis by Good Energy shows that renewables are actually cutting the wholesale price of electricity and lessening the impact of subsidies on bill payers. (9)

One low-carbon renewable technology already provides flexible power to the electricity grid: the anaerobic digestion (AD) of farm and food waste to bio-methane. AD provides extremely low-carbon electricity because it avoids greenhouse gas emission from waste rotting on farms or in landfill. The party that restores renewable subsidies (paid from taxation rather than levies), cancels Hinkley Point C and fracking subsidies while incentivising bio-methane could win a lot more votes. (10)

According to the FT *"Nobody outside the industry now thinks the future of electricity generation is nuclear fission. The cost of building the plants to comply with safety and antiterrorism standards is rising all the time, fears of a runaway price for oil and gas now look silly, while advances in wind and solar technology are destroying those projections of ever-dearer energy ... The UK's energy*



market is in an unholy mess, with attention distracted by the vacuous debate about switching electricity suppliers. The real costs lie with the “green initiatives” at the other end of the wires. Scrapping Hinkley Point would not solve all of them, but it would be a start. Perhaps best to wait until after June 8 for another U-turn from Mrs May, though.” (11)

National Grid

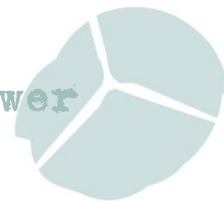
National Grid says the one-way relationship between power producer and power consumer has been skewed by the rise of technology which is handing energy users the power to make their own electricity. From suburban rooftop solar to the scaled-down generation units on site at major factories, Britain’s electricity chain has become more democratic. In the past National Grid was virtually in full control, but today new technology is changing the rules of the game.

“The big challenge that National Grid is facing is that we have 38GW of large thermal plant that are going to be closed by 2025 and they were traditionally what we would use to keep the system stable,” says Tim Rotheray, boss of the UK’s Association for Decentralised Energy. “At the same time we’re seeing a rise of variable, intermittent generation coming on to the system. The traditional tools that National Grid had are falling away so the challenge is to look at the new options which exist.”

The UK is home to about 12GW of solar PV, the equivalent of more than three Hinkley Point C nuclear projects or 24 gas-fired power plants. On a sunny day these panels can generate 9GW of power – much of which cannot be controlled by National Grid’s main control centre because it is connected directly to local grids. The impact is clear: a surge in this “decentralised” power is reflected as a sudden drop in demand on the main grid – and system controllers have seconds in which to react to avoid overpowering the system. Last spring a surge in solar and wind power during an ebb in demand meant power plants were forced to pay to have their generation volumes taken up. Without a redesign of the system negative market prices will increase.

Already National Grid expects to invest £20bn to ensure Britain’s energy system is ready for a low-carbon future, of which £9.5bn will be spent replacing and renewing network equipment. The company is also offering millions of pounds worth of contracts to generators and users who can guarantee to help the operator manage the ebb and flow of demand and generation volumes. This summer the group will launch a scheme which pays companies to use more electricity when wind and solar power surges past demand. This flips the winter-time challenge of securing enough supply to meet demand. During these times National Grid has resorted to paying power plants to remain on standby to ramp up power on demand.

Within the next decade the pipes and wires of the nation will need to accommodate a new generation of electricity generators and users. National Grid plans to harness these changes to overhaul the way it balances the system. By 2030, keeping the lights on will rely as much on bringing together the cumulative impact of small-scale power sources as it will on major power plants, it says. The group’s first task in response to the Government’s industrial strategy Green Paper is for the roll-out of electric vehicles (EVs) to be its top priority in driving affordable energy and clean growth. There are approximately 32 million cars on the road today in the UK. By 2033 National Grid believes half of these could be electric. Already it is exploring the potential of EVs to provide valuable energy storage and demand flexibility for the energy system.



A boom in chargeable cars could mean an increase in electricity demand of 13- 21 TWh. By 2030 this could mean a drain of 1GW, or two large gas-fired power plants, at peak times. But National Grid believes there is the potential for the flow of electricity to go both ways, from the grid to the battery and vice-versa. How EVs affect demand could be shaped by a number of factors: consumers could take up so-called "time-of use-tariffs" which offer cheap deals to charge up when demand is low. This would allow National Grid to make better use of surging wind and solar power on balmy summer Sunday afternoons. Conversely, the energy stored in the vehicle could be used to avoid peak tariffs imposed at times of low demand by flipping the mobile batteries to export power on dark January evenings. (12)

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 12. Telegraph 13th May 2017 <http://www.telegraph.co.uk/business/2017/05/13/inside-national-grids-epic-challenge-keep-lights/>



5. Manifestos look to old energy

As we have seen the Tories are planning for a flat-lining of renewables in the 2020s and the construction of up to 18GW of new nuclear capacity, but what is Labour's alternative?

Jeremy Corbyn has said a Labour government would seek to strengthen ties with China and continue to back plans for a China-funded nuclear power plant at Hinkley Point. "*Labour supports nuclear power as an important part of a low carbon energy mix and would continue to support the construction of Hinkley C.*" (1) Jeremy Corbyn gave his personal backing to the Moorside nuclear plant during the Copeland by-election (2) and Labour's Welsh First Minister, Carwyn Jones, has given his 100% backing to the Wylfa B proposals. (3)

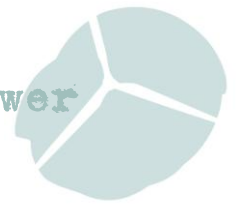
Labour's manifesto says "*nuclear will continue to be part of the energy supply*", and states that the Labour Party will "*support further nuclear projects and protect nuclear workers' jobs and pensions*", and that "*there are considerable opportunities for nuclear power and decommissioning both internationally and domestically*". (4)

This is not very clear, and could just amount to warm words to placate powerful nuclear-supporting trades unions like the GMB and Unite. Many of the existing nuclear power stations will continue operating well into the 2020s and there will be plenty of nuclear jobs in decommissioning and waste management. Fairlie and Tickell argue in the *Ecologist* that none of this adds up to a firm commitment to build a fleet of new nuclear power stations at massive public cost (5)

The manifesto also says a Labour Government would "*ensure that 60 per cent of the UK's energy comes from zero-carbon or renewable sources by 2030*". Some have suggested that the '60% of the UK's energy' 'by 2030' pledge is itself a mistake, and that they really meant 'electricity' rather than 'energy', but of course that's not what the manifesto says. 60% of electricity from renewables by 2030 is a much less radical target, although this in itself is similar to the Liberal Democrat pledge and much better than the Conservatives.

Dave Toke says we can assume they mean renewables because nuclear power is not zero carbon, and zero carbon doesn't exist anyway. There is some confusion on what Labour policy means for nuclear power. There is talk of support for future nuclear projects, but then there is no mention of specifics like Hinkley C and an impression that this just might mean decommissioning projects and a bit of international marketing. There are some laudable promises on energy conservation, insulating 4 million homes (that would be a start, at least), offering home owners interest free loans for energy efficiency. There is an interesting policy on establishing publicly owned 'locally accountable' 'energy companies and cooperatives'. This could in the right form, be highly innovative in various ways, and smacks of the influence of Alan Simpson.

Labour's manifesto is a lot better for green energy than the Tory manifesto whose main preoccupation seems to be to persuade the English Tory shires that they will not be bothered by more wind turbines. Some, however, still think even the 60% of energy by 2030 target is

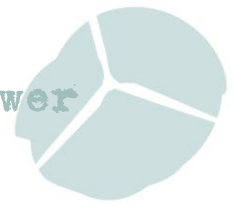


conservative. Keith Barnham, for instance, says offshore wind alone could be supplying all of UK electricity by the early 2020s. (6)

Labour has expressed 'support' for three out of six planned mega projects and no intention has been expressed to get the UK out of the Hinkley-Bradwell deal. That only leaves Oldbury and Sizewell, both projects at an earlier stage of planning and development anyway.

On the other hand a Labour Government could use the next Contract for Difference auction announcement and what could be very low offshore wind strike-prices to rebuff pro-nuclear unions and the Cumbria and Welsh regional party pressure.

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 3. Daily Post 30th May 2017 <http://www.dailypost.co.uk/news/north-wales-news/first-minister-100-committed-new-13097549>
 4. World Nuclear News 19th May 2017 <http://www.world-nuclear-news.org/NP-UK-parties-make-scant-reference-to-nuclear-power-19051701.html>
 5. See Ecologist 18th May 2017 http://www.theecologist.org/News/news_analysis/2988965/conservative_election_manifesto_signals_the_end_of_new_nuclear_power.html
 6. Dave Toke's Blog 1st June 2017 <http://realfeed-intariffs.blogspot.co.uk/2017/06/so-what-would-labour-government-mean.html>



6. Energy Costs

Renewable costs are falling

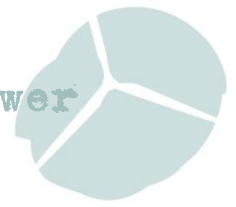
Unsubsidized renewables have become the cheapest source of new power —by far— in more and more countries, according to a new report from the United Nations and Bloomberg New Energy Finance (BNEF). In just one year, the cost of solar generation worldwide dropped on average 17%, the report found. The average costs for onshore wind dropped 18% last year, while those for offshore wind fell a whopping 28%. *“It’s a whole new world,”* explains Michael Liebreich chair of BNEF. *“Instead of having to subsidise renewables, now authorities may have to subsidise natural gas plants to help them provide grid reliability.”* (1)

The World Economic Forum reports that solar and wind are now the same price or cheaper than new fossil fuel capacity in more than 30 countries. As prices for solar and wind power continue their precipitous fall, two-thirds of all nations will reach the point known as “grid parity” within a few years, even without subsidies. (2) Bloomberg reports that solar is now cheaper than coal in some parts of the world and in less than a decade is likely to be cheaper everywhere. (3)

In the UK power produced by onshore wind is now the cheapest source of renewable supply and probably cheap enough to deliver power to consumers without any subsidy. Offshore wind costs have fallen to such an extent that a recent auction in Germany will see one wind farm built without any subsidy at all. The *Financial Times* recently said that *“offshore wind progressively looks cheaper to run, even with all the subsidies, than Hinkley ever will.”* (4)

“We have seen truly dramatic reductions in our costs”, says Ray Thompson, Head of Business Development at Siemens Gamesa Renewable Energy. In 2012, the UK Government set a target for the industry to achieve a levelised cost of £100/MWh for projects reaching financial close in 2020. Incredibly, the industry has managed to achieve this four years ahead of target, with the projects reaching financial close in 2016 at £97/MWh. Some European projects recently won auctions at even lower prices, a Danish near shore project successfully won an auction with a bid of less than €50/MWh and while there are some differences to UK projects – developers in Denmark don’t pay development or grid costs – it still indicates fantastic progress in the right direction. (5)

Sustainability expert, Chris Goodall, author of a book called *“The Switch”* (6), says cheap solar panels and advances in storage technology are about to transform the world. By 2030 or 2040 solar will be the cheapest way to generate electricity, indeed any form of energy EVERYWHERE. At the rate of growth that we are seeing at the moment of 35-45% per year solar will grow from providing 2% of global electricity to at least 50% by 2030. We can see the cost of batteries coming down in price dramatically. Turning surplus solar electricity generated during the summer into something we can put into natural gas networks is what we should be looking at in the UK. Generating hydrogen from water and, using microbes, combining it with carbon dioxide to form methane is the simplest way to do this. The era of fossil fuels, he says, is drawing to a close. (7)



Even the *Daily Telegraph* argues that the old energy order is drawing to a close because a battery storage revolution is taking off. Over the last two years, battery costs have fallen 40%, with further falls to come as economies of scale take hold. Rapid growth in the market for battery storage, forecast by Goldman Sachs to increase by a thousand-fold from \$258m (£210m) last year to \$258bn in 2025, should in turn remove a number of the key economic constraints on renewable forms of energy. Wind and solar are intermittent forms of energy, and hitherto have therefore required complementary back-up generation to ensure there is enough power in the grid at all times to service demand. The great promise of storage is that it should lend renewables the same “always on” characteristics of more conventional forms of power, allowing electricity to be drawn when the wind is blowing, and given out again when it is not.

Paul Massara – a former chief executive of Npower - who now runs his own battery storage business, North Star -says it seems plausible that at least half of all UK households will have installed battery storage facilities within 10 years. In such a world, energy supply ceases to be the linear business of delivering power from the generator to the consumer as and when it is required, and becomes much more about smart grids and data management. There will always be a need for National Grid and the District Network Operator Companies, but they may have to radically change their charging methods from a metered usage basis to a single, all-you-can eat rental charge, to cater for this new, much more diffuse form of power provision. The price of energy storage systems will come down “faster than solar” and “every onshore wind and solar farm will have one in the future.” (8)

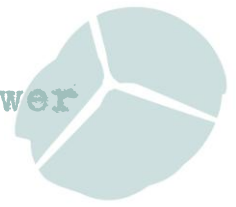
Price Cap

Commenting on the news that Theresa May is to press ahead with her promised cap on energy prices, Stop Hinkley Campaign spokesperson Roy Pumfrey said:

“If Theresa May wants to cut energy prices, the first thing she should do is cancel Hinkley Point C ...The world is moving quickly towards smart flexible energy systems based on wind, solar, energy efficiency, demand side response, storage, and grid interconnections. EDF’s white elephant is trashing this beautiful corner of Somerset for yesterday’s energy system which is going to put up prices for consumers but will fail to deliver the kind of sustainable low carbon energy system we need for the future. If Theresa May really cared about energy prices she would cancel Hinkley right now.” (9)

We wouldn’t need price caps if the Tories hadn’t cut energy-saving schemes, says *The Observer*. Amid all the furore the real solution to cutting energy bills was barely mentioned. Energy efficiency may not be sexy but experts agree that new boilers, better appliances, insulating the solid walls of 100-year-old homes and properly lagged lofts are the only true fix. Government advisers recently found that shifting to A-rated fridge-freezers, ditching incandescent bulbs and switching to condensing boilers reduced the average household energy bill by £290 between 2008 and 2016. Efficiency is a large part of the reason people pay about £115 a year less for energy in real terms than they did nine years ago.

The Conservatives have botched or cut government energy-efficiency programmes that could have reined in the rising energy bills that have made a cap seem so inevitable. The number of insulation measures going into homes will have fallen 88% in a decade by the end of the year, at current rates. The 1 million homes the government promises to insulate this parliament sounds



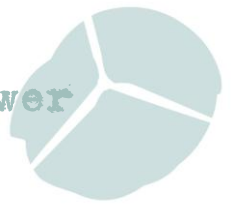
good – until you realise that in 2007, 2.5 million homes were done in a single year. Less than three months after coming to power in 2015, ministers killed the government’s flagship energy efficiency programme, the Green Deal. It was deeply flawed, so few were sad to see it go. But as officials freely admitted, the government had nothing to replace it, and still doesn’t. (10)

Onshore Wind

Scottish Power Renewables CEO Keith Anderson says the UK Government is “allergic” to onshore wind power. The energy price cap addresses the symptoms and not the cause of the issues facing the energy industry. He says the majority of Scottish Power’s 5.4 million retail customers wanted onshore energy: *“Onshore wind is the cheapest form of renewable energy, it’s been hugely successful right across the whole of the UK and particularly in Scotland, yet we appear to have a UK government that is allergic to onshore wind and we don’t really know why and they aren’t very good at explaining their reasons.”* (11)

Britain’s Big Six energy suppliers will cut thousands of jobs in response to the Conservatives’ price cap, says Deepa Venkateswaran, of the broker Bernstein. Theresa May said she expected to save households up to £100 a year. Bernstein estimated the negative impact on the industry would be £1 billion, which was equivalent to average profits since 2014. *“It wipes out the profitability of the industry completely. We expect significant cost reductions across the industry including action on marketing spending and headcount,”* Ms Venkateswaran said. She estimated that between 20,000 and 25,000 people were employed by UK suppliers in call centre and billing operations. *“Even if people took a 10 or 20% cut, you’re talking about 2,000 to 5,000 jobs easily.”* (12)

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7. Local Energy Revolution

With or without Britain's approval, an energy revolution is taking place. The forces that transformed telecommunications are doing the same to energy. Britain's difficulty is that, faced with a host of transformative technologies, the government chose to throw its weight behind the past rather than the future: subsidising non-renewable rather than renewable energies; penalising 'clean' solutions in favour of 'dirty', and propping up a rigged energy market. Former Labour MP for Nottingham South, Alan Simpson says, in this pamphlet, the issues raised by this Transformation Moment touch as much upon 'democracy' as 'technology'. Across the planet, towns, cities, villages and communities are emerging as critical players in the democratisation of energy. They are the key to a different energy politics; one which focusses as much on how we save and share, as on what we produce and consume. Transformation Moment is a narrative journey, not a 'Techies manual'. It will be overtaken by innovations within the emerging clean-technology sector. What it explores is how energy thinking is being turned on its head, where this is happening ... and how Britain can join in. The conflict is not just between the polluting and non-polluting, the national and the local, or between new technologies and old. Ultimately, the most critical issues are rooted more questions of 'power' -democratic power – than 'energy'. Who should own, control and hold to account the energy systems that will define Britain's future? Transformation Moment is an invitation to shape the answer.

If Britain is to become a part of this process it must fundamentally restructure its energy market:-

- Mandating the shift to a more interactive and decentralised grid;
- Introducing a UK right of 'local supply';
- Establishing a national framework of carbon budgeting (including the reduction of grid carbon levels to 50 gCO₂/kWh by 2030), and
- Setting out duties to deliver annual reductions in total energy consumption

For a more convincing strategy, Britain could look at the approach taken by Denmark. By 2050 Denmark aims to have a 100% fossil-free economy. Already, 50% of Danish electricity comes from renewable sources; most of it underpinned by citizen shared ownership. Denmark symbolises today's fundamental shift in energy thinking; from power stations to energy *systems*, and from unlimited consumption towards a more circular economy. It is an approach that makes the links between energy efficiency, clean transport, waste reduction, water management and energy recovery. Nothing captured this better than their '*State of Green*' video, outlining the country's 2050 roadmap towards a fossil-free economy.

The most important aspect of the changes taking place, however, is not to be found in any array of clean technology solutions, nor in the leadership of national governments. It is in the emergence of localities and citizens movements, unwilling to wait for national leadership that sometimes isn't there.



The astonishing level of UK public subsidy demanded by new nuclear almost defies understanding. With the estimated public costs of Hinkley Point now running at over £37bn the whole basis of the UK debate looks drunk, deluded, or both. The real problem for nuclear, however, lies in its claim to be the provider of 'base-load power', when base-load power will not be at the centre of tomorrow's energy systems. Flexibility, transparency, locality and interactivity are already becoming more critical cornerstones. Traditional energy industry assumptions are being torn apart, only to be replaced by markets that are lighter, smarter, more interactive and adaptable than today's. Tomorrow's 'smart energy systems' will need to:

- deliver more, but consume less;
- take clean energy before dirty;
- use smart technologies for localised balancing and storage and;
- be more open, democratic, sustainable and accountable.

The importance of decentralised energy in today's transformations has as much to do with democracy as electricity. The involvement of households and communities is central to its success. (1)

1. Microgen Scotland 12th May 2017
<http://www.microgenscotland.org.uk/uncategorized/transformation-moment/>



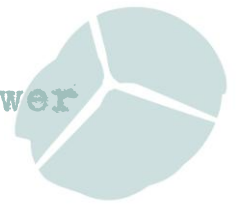
8. The Changing Energy Market

Energy UK - the trade association for the UK energy industry representing over 90 suppliers and generators of electricity and gas for domestic and business consumers – says the next government must embrace the “changing” energy market and extend support for low carbon generation. The association’s 2017 manifesto outlines a series of asks from the country’s political leaders. These asks fall under five key areas, including assurances over the UK’s continued commitment to decarbonisation, establishing energy efficiency as a national priority and ensuring that the government’s industrial strategy is built upon a low carbon economy.

Lawrence Slade, chief executive at Energy UK, said: “*We are witnessing monumental changes right across the sector, as we transition to a digital, decarbonised energy future that better meets consumer’s needs.*” The manifesto laments the withdrawal of routes to market for low cost renewables such as solar and onshore wind. Since the closure of the Renewables Obligation and exclusion from future Contracts for Difference auctions, both technologies have effectively had their deployment prohibited under the current regime. Energy UK says this must change, with the development of a delivery plan for investment in low carbon electricity generation post 2020 – after current Levy Control Framework commitments expire – considered a priority. (1)

1. Solar Power Portal 2nd May 2017

http://www.solarpowerportal.co.uk/news/next_government_must_embrace_monumental_changes_in_the_uk_energy_sector_en



9. New Nuclear: Moorside & Wylfa

The future of Moorside has been thrown into doubt by the financial troubles of Japanese giant Toshiba which owns the company developing the scheme - NuGen. NuGen is undertaking a strategic review of its options following what it calls “*vendor challenges*”, (1) although the company says it is “*110 per cent certain*” it will be built. (2)

According to *The Times* Toshiba is seeking a buyer for NuGen, but bidders are scarce and the sale is fraught with complexity. The source of Toshiba’s malaise is the decision — a decade ago — to transform itself into a global force in nuclear energy. The acquisition of Westinghouse from state-owned British Nuclear Fuels (BNFL) was done amid the feverish climate of the pre-credit crisis boom.

Westinghouse has two contracts to install AP1000 reactors at existing nuclear power stations in Georgia and South Carolina, signed in 2008 — America’s first nuclear reactors in a generation. The plants are years late and an estimated \$10bn (£7.7bn) over budget, with no certainty about completion. After Fukushima, Toshiba was forced to enhance safety procedures at the two plants, at vast expense. The Japanese giant has, in effect, been left on the hook for unlimited costs. It has booked \$6.3bn of write-downs on the Westinghouse subsidiary — and has warned that there is now doubt over Toshiba’s status as a going concern.

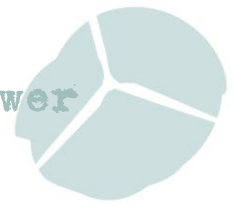
Korean nuclear giant Kepco is the most likely suitor for NuGen, but wants to use its own reactors rather than Westinghouse’s AP1000 design. A sale of the American company would be highly contentious, given its strategic importance. If a buyer cannot be found, or bankruptcy does not sever the liabilities on the American projects, all the uncapped costs could stay with the Japanese company. “*Toshiba could end up as just a holding company for Westinghouse,*” said one industry source. That would be the nightmare scenario for its investors — and a hammer blow to Britain’s nuclear strategy. (3)

The Chinese state-owned State Nuclear Power Technology Corporation (SNPTC) is also reported to be considering investing in NuGen. Eight senior officials from SNPTC are said to have met executives from NuGen and Britain’s atomic power trade body, the Nuclear Industry Association in May. Sources said SNPTC could seek to power NuGen with its own reactor — a derivative of Westinghouse’s AP1000 model, which is planned for the site. (4)

The National Grid has also hit the pause button on Moorside’s 102-mile power line connection. Plans for the “*biggest new power line since electricity network was built*” have been shelved. (5)

The GMB union has demanded that the government “*stop faffing*” and step in to save Moorside. GMB slammed the government for “*continued dithering*” following the latest in a series of setbacks. “*How many kicks in the teeth for the desperately needed new nuclear plant at Moorside will it take to bring politicians of all colours to their senses?*” asked GMB national secretary Justin Bowden. “*Britain must have the reliable zero carbon nuclear power that Moorside will bring as part of the balanced energy mix, alongside renewables and gas.*” (6)

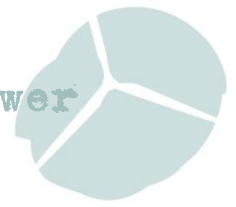
NuGen held a Stage 2 public consultation which finished at the end of July 2016, but now 10 months later, there has been no feedback report despite the fact that it was promised for



'Autumn 2016'. Nor has NuGen indicated that it will hold the further consultation called for by CORE, local authorities and others to make up for the lack of detailed information provided in the Stage 2 consultation documents. (7)

Meanwhile, Horizon Nuclear Power has published new plans for its nuclear power station at Wylfa Newydd, which it states should cut the labour force needed to build the 2.7GW plant. The company, which is owned by Hitachi, has proposed a more compact design in its latest blueprint for the site on the Isle of Anglesey, off the north Wales coast. (8) It has launched a third formal consultation on the latest proposals. (9) The power station's footprint will be reduced by sharing more buildings between the twin reactors, including the facilities for transmitting the electricity generated at the site to the Grid. Off-site support buildings, including a garage and back-up control facilities, will be housed in a single location. Horizon is also investigating making greater use of off-site construction.

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 9. Energy Live News 24th May 2017 <http://www.energylivenews.com/2017/05/24/horizon-seeks-views-on-latest-proposals-for-welsh-nuclear-plant/>



10. SMRs

The UK should focus on developing Small Modular Reactors (SMRs), including at Trawsfynydd in Wales, to secure the country's future nuclear industry post Brexit according to a new report by the Institution of Mechanical Engineers. Following the Business, Energy and Industrial Strategy (BEIS) Select Committee report into the risks to the nuclear industry posed by Brexit, the Institution of Mechanical Engineers has outlined possible pathways the UK Government could take to leaving the European Atomic Energy Community (Euratom) regarding key issues such as safeguarding, Nuclear Co-operation Agreements, Research and Development (R&D) and regulation. The Institution is calling for the UK to develop its own Safeguarding Office, to ensure the country conforms to international rules on safety and non-proliferation, but says the UK should remain an associate member of Euratom for the specific purpose of R&D.

The 'Leaving the EU, the Euratom Treaty Part 2: A Framework for the Future' report also says SMRs could present the UK with key export opportunities and return the country to the international nuclear reactor supply arena. (1)

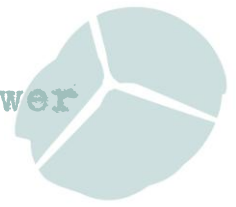
"In the long-term [the UK's plutonium stockpile] is incredibly valuable. It would be crazy to bury it," says Dame Sue Ion. A generation of small modular reactors (SMRs) is on the horizon that promises to use up much of this fissile material "safely" according to the *Daily Telegraph* potentially generating power at a far lower cost than Hinkley Point. No mention, of course of the huge number of armed policeman that might be required to deliver the fuel to reactors around the country. GE Hitachi's PRISM project is a type of Small Modular Reactor SMR - a 600 megawatt sodium-cooled reactor that could be built at Sellafield. "PRISM plants could meet all of the UK energy needs for the next 100 years," says Hitachi.

Britain's Moltex aims to slash costs with a molten-salt design that uses a convection process, cutting corrosion and overcoming the sorts of metallurgy problems that have bedeviled past ventures. It too could in principle use up Sellafield's plutonium. (2)

"It is a fantastic fit for Britain. It solves so many problems, and it is so much cheaper. We think that the levelized cost of electricity would be £40 a megawatt/hour once we get to the second and third reactors," said Dr Scott, founder of Moltex. Hinkley's inflation-linked tariff is already above £100 per MWh. (3)

The nuclear industry is being damaged by government dithering over plans for SMRs. a House of Lords report has warned. The promised competition has suffered "alarming" delays owing to government indecision, the Lords' science and technology committee said. Commercial interest in SMRs will wane unless ministers announce the initial results of the competition soon. More than 30 companies, including Rolls-Royce and Nuscale Power, entered the first phase of the competition last year, with results and a road map setting out proposed next steps expected last autumn, but neither is yet to materialise.

The Lords urged the government to publish *"without delay if industrial interest is to be maintained and if commercial opportunities are not to be missed . . . This has had a negative effect on the nuclear sector."* A spokesman for the business department said: *"The government*



recognises the potential of small modular reactors to help to meet our energy and climate change challenges at a lower cost. We will respond to the select committee's report in due course." (4)

The Government announced an "ambitious" £250m competition in 2015 to identify the SMR reactors offering best value, but the scheme has stalled. "Every deadline has been missed," said Dr Scott. The results of the first phase of the competition should have been published last autumn. Government officials said earlier this year that one of the attractions of SMRs was they fitted with the industrial strategy launched by Theresa May. But Tom Wintle, deputy director at the business department, said they had to provide affordable power. "SMRs will need to deliver energy cost-competitively if they are to play a part in the UK's future energy mix. As well as securing low-carbon energy, government is also committed to keeping down the cost of that energy for consumers, so there is a key challenge there for the nuclear industry as a whole and for SMRs."

There are a number of different SMR designs. Tony Roulstone, course director at Cambridge Nuclear Energy Centre, believes a production line operation could fulfil the promise of continuous improvements, of more efficient designs over the years, and the real prize of being manufactured in the UK. By contrast, the earlier trend for buying renewable systems – wind turbines and solar cells – resulted in a huge import bill with around £3bn alone paid out under David Cameron's administration to big firms such as Siemens and DONG Energy. And renewables are not always as "green" as its promoters claim. Large wind turbine blades made of fibre-reinforced polymer for example are impossible, or simply too expensive, to recycle, according to German research organisation Fraunhofer IWU. (6)

According to an anonymous source quoted in *The Register*, SMRs could ensure that the British government avoids a repetition of the growing fiasco over the cost of Hinkley Point which "could cost the UK as much as £81bn if maximum financing costs are included ... the only reason the British government is going ahead with Hinkley Point is the hook it gives them over the French government during Brexit negotiations. If the French turn nasty, the UK can threaten to scrap Hinkley Point – as it is French contractors who will largely build it."

Yet SMRs face daunting development costs, and mind-boggling technical uncertainties. Like all nuclear sites they inevitably involve high costs, the problems of expensive decommissioning, the risk of accidents and waste disposal.

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1. Process Control & Technology 8th May 2017 <http://www.pandct.com/media/shownews.asp?ID=48509>
 2. See <http://www.moltexenergy.com/>
 3. Telegraph 29th May 2017 <http://www.telegraph.co.uk/business/2017/05/29/brexit-has-forgotten-leaving-europes-nuclear-community-just/>
 4. Times 3rd May 2017 <https://www.thetimes.co.uk/edition/business/delays-over-nuclear-plan-damage-uk-9wvqcp2m9>
 5. Guardian 2nd May 2017 <https://www.theguardian.com/business/2017/may/02/alarm-sounded-over-delays-to-develop-uk-mini-nuclear-reactors>
 6. The Register 24th May 2017 https://www.theregister.co.uk/2017/05/24/mini_nuclear_reactors_for_british_power/