Renew on line 124  Nov-Dec 2016
Technology for a Sustainable Future

A bimonthly roundup of news and views on renewable energy developments and policies

Produced by NATTA, the independent Network for Alternative Technology and Technology Assessment.

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Renew adopts an independent critical approach. It should not be taken to necessarily reflect the views of the Open University

Renew was for many years produced by Prof. Dave Elliott and Tam Dougan, then based at the Open University, as a bimonthly NATTA membership subscription journal, with, after issue 100, a free shortened version, Renew on Line (ROL), also produced for NATTA’s web page. Now run by NATTA independently of the OU, ROL is currently delivered as a Blog, and continues with the same numbering system. It includes a Forum section for commentary and feedback. An expanded version, called Renew, continuing with the old Renew numbering system, is also produced for use by students on relevant courses, on a course linked password protected subscription basis. Course leaders wishing to subscribe on behalf of their students should contact NATTA for details of charges. Students on the OU Renewable energy course T313 have access to it: www3.open.ac.uk/study/undergraduate/course/t313.htm
Send comments/contributions for the Forum section to NATTA at D.A.Elliott@open.ac.uk
Also see Renew Extra which is posted alternate months to the bimonthly Renew On Line at: http://renewextra.blogspot.co.uk For a full guide to NATTA’s various offerings, and access to our free annual end of year review, see: http://renewnatta.wordpress.com Next one out early Dec.

Green Energy Futures  Dave Elliott’s Palgrave book:
www.palgrave.com/page/detail/green-energy-futures-david-elliott?sf1=barcode&st1=9781137584427 Also see www.theecologist.org/blogs_and_comments/Blogs/2987641/renewable_energy_can_keep_the_lights_on_heres_how.html
See summary: www.tandfonline.com/doi/full/10.1080/01430750.2016.1201910

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1. UK Developments

Wind power sites  Dots show capacity scale now

UK Wind

20% by 2020?
The UK now has over 10 gigawatts of offshore wind capacity, either already operating (5.2GW), under construction (0.8 GW) or with FIDs (final investment decisions) taken (4.3GW), so that offshore wind is set to provide 10% of UK electricity needs by 2020. It already delivers 5%. Floating turbines are the next big thing, pushing it higher later on.

Onshore wind stands at over 9GW. Industry projections see a total of 12-14GW installed by 2020, by which point onshore wind will supply over 10% of the UK’s total annual electricity. For updates see: www.renewableuk.com/Page/UKWEDhome

PV solar is at ~12GW. Most of it is in the south. With lower load factors than wind that would only supply ~2% p.a. But the REA says that the industry expect 14 GW by early 2017. 20 GW or more by around 2020 seems possible, especially given the continuing rapid fall in prices: www.all-energy.co.uk/RXUK/RXUK_All-Energy/2016/Presentations 2016 Day 2/Solar/Ray Noble_Solar 1.pdf

Wave & tidal may be headed for around 1 GW by 2022: http://www.all-energy.co.uk/RXUK/RXUK_All-Energy/2016/Presentations 2016/Wave and Tidal Day 1/Tim Cornelius.pdf
And www.renewableenergyfocus.com/view/43898/tidal-developments-power-forward/

Solar PV still booming

**Solar photovoltaics** produced over 40% more power in the UK in the first three months of 2016, when compared to the same period in 2015, helping to ensure the renewables sector provided over a quarter of all UK power during the period, according to statistics from the new Department for Business, Energy & Industrial Strategy (BEIS). Solar generation reached 1.3 TWh in the first quarter of this year, up from 1 TWh in the first quarter of 2015. Renewables capacity overall increased 0.7 GW during the first quarter of the year, with over half the new capacity coming from new, mainly large-scale, solar PV projects. 0.1 GW of the rise in PV capacity was as a result of the Feed-in Tariff scheme, which has now delivered 5 GW across 833,785 installations. The rest, ~5 GW, mostly larger projects, were supported by the RO, now mostly withdrawn, and some may get CfD contracts - one has so far.


Wind power stays on course - and grows at sea

Despite the government support cuts and blocks to onshore wind, and lower than usual wind speeds in the winter, wind power is still doing well. The fall in onshore wind generation in the first quarter of 2016 from 7.2 TWh in 2015 to 6.4 TWh in 2016 was in part compensated for by a 10% rise in offshore wind generation to 5.1 TWh. Subsequently, unseasonal high winds may have boosted annual total wind output: in Scotland in August wind briefly produced the equivalent of all its power needs, and as more onshore projects come on line around the UK, output will rise, and, with more high average-wind offshore projects added, should stabilise: www.theguardian.com/environment/2016/aug/11/scotland-completely-powered-by-wind-turbines-for-a-day

However, DONG, are not to go ahead with the planned base port at the Able Marine Energy Park on the River Humber: www.windpoweroffshore.com/article/1405058/dong-scraps-humber-plans

It said it couldn’t justify the investment. But then it said it will build a repair plant in Grimsby: www.theguardian.com/business/2016/sep/22/dong-energy-windfarm-maintenance-hub-grimsby

So Brexit hasn’t hurt too much. And it will continue with its offshore wind projects off the east coast, including the 1.2 GW Hornsea Project One, 120km out, with work starting in 2018. After that, Hornsea Project 2, now consented, will be 1.8 GW with 300 turbines, 89 km out: www.dongenergy.co.uk/news/press-releases/articles/dong-energy-welcomes-consent-decision-for-hornsea-project-two-offshore-wind-farm

It’s the biggest so far, following on from the 2 x 1.2 GW, Dogger Bank projects, 131km out: www.forewind.co.uk/projects/projects-overview.html Load factors 40%+. The ultimate economically viable offshore wind resource has recently been put at 675GW: www.sciencedirect.com/science/article/pii/S0960148115303001 It’s really all quite astounding: https://theconversation.com/britain-is-only-just-beginning-to-exploit-its-vast-resources-of-offshore-wind-64134

Biomass booms - but imports are still an issue

Electricity generation using plant biomass rose to 5.6 TWh in the first quarter (Q1) of 2016, an increase of 29% on Q1 in 2015 - the largest increase in absolute terms for all renewables. Liquid biofuel use also rose, to 327 million litres, in Q1 2016, up from 314 million litres in Q1 2015, so it now contributes around 3% of the fuel used in road transport. But biomass sourcing problems remain in both areas, though its improving for biofuels. Initially most were imported, but, the REA says, ‘UK biodiesel is now largely made from waste feedstocks, in particular used cooking oil’, with no palm oil now being imported, and UK feedstocks for bioethanol have risen, so overall 26% of biofuels are now UK sourced, up from 8% in 2008:


For solid biomass, the news is less good. The giant Drax plant burns mostly imported wood pellets from North America, raising significant environmental issues, so blocks may be imposed:

www.climatetcentral.org/news/europe-aims-to-close-loophole-on-wood-energy-20591

And to cut costs, it’s decided to cut back on its use of UK biomass:

www.fwi.co.uk/arable/drax-ends-miscanthus-contracts-and-reviews-straw-supply.htm

That’s provocative. So too are the AD biogas cuts - see later.
District heating  Heat networks are beginning to be taken seriously at last:  

Smart heat energy systems, with clever control devices, can reduce waste and costs:  


Even better is E.ON’s Project Sunshine at Cranbrook, near Exeter - a hybrid demonstration project, with the UK’s largest solar thermal array coupled with both heat pump and storage technology for district heating.  
www.renewableenergyfocus.com/view/44671/hybrid-solar-thermal-heat-pump-on-trial/

Frequency response  National Grid got no bids for demand response projects.

The price set may have been too low:  http://theenergyst.com/national-grid-calls-time-on-demand-side-balancing-reserve/  and  www.platts.com/latest-news/electric-power/london/uk1s-national-grid-fails-to-procure-additional-26527072

However, it has awarded enhanced frequency response (EFR) contracts worth £60m to 7 companies. Most of the 201 MW of contracts are for battery storage. EFR is a new frequency response service which requires providers to help balance the national grid in under a second. Demand response is mainly about delaying peak loads for longer periods e.g. by temporary disconnection. Seems it’s still easier to operate on the short-term supply side than on the demand side, though one EFR project is for demand response:  

Local green energy  projects round the UK:  www.microgenscotland.org.uk

And see this  www.microgenergyscotland.org.uk/wp/wp-content/uploads/2016/07/LocalAuthorityEnergy.pdf

But not all may be good: e.g. these diesel backup units planned for a wind project:  

Why not use cleaner bio-diesel, e.g. from chip fat waste? But then these units are just for brief operation while other grid backup ramps up, so their total emissions will be low. There are better options for longer-term balancing, e.g. biomass-fired CHP plants feeding heat networks with heat stores: they can vary their power to heat ratio. While for now gas-fired plants are cheaper, they’re dirtier.

More Mass burn  

Not so hot either: mass waste combustion needs careful emission control: gasification & pyrolysis are better - CHP too.

CfD projects get going

The Contracts for Difference (CfD) system for renewable projects has started to deliver, including a project from the first full round of competitive contract auctions, now generating - Lightsource's Charity Farm 12 MW solar array in Shropshire. In all there were 39 projects backed with contracts worth £315m (that being the LCF price cap that was set) in CfD round one, with 6 GW of on/offshore wind, biomass conversion/ CHP, solar PV, energy from waste and advanced conversion technology. All of them have now passed interim project milestone requirements. CfDs replace the old RO system, and are for large schemes: small ones can still get FiTs. The first full round of competitive CfD auctions was in Feb. 2015, though in 2014 there was a preliminary non-competitive round with 8 projects at 3.2 GW in all, including 5 offshore wind farms.

Next one delayed  
A second full round of what was expected to be an annual CfD competitive round was delayed from earlier this year, but was expected this autumn - though the FT said that it’s now been shifted to ‘early 2017’, as ministers continue to work on merging DECC into BEIS.

Support in the CfD competition is split between Pot 1 ‘developed’ and Pot 2 ‘less established’ projects, but with onshore wind now blocked from Pot 1 and offshore wind still in 2. There are concerns that the competitive auction process might lead to low-price winning bids that would not actually prove viable, as had happened with the old NFFO auction process. Some initially successful low-price CfD round 1 PV projects were withdrawn, leaving just one, but so far, otherwise, the CfD system seems to be functioning acceptably, although still within a tight LCF price cap, limiting expansion significantly.

www.edie.net/news/6/Contracts-for-Difference-What-it-really-means-for-renewables/
Energy policy - all change?

‘Pretty much every major policy design has been geared towards creating a perfect environment for Hinkley Point C […] The CfD subsidy is complemented by a suite of other UK taxpayer subsidies and guarantees designed to mitigate investment risks for the French and Chinese investors & to guarantee costs for dealing with nuclear waste or paying compensation for nuclear accidents. Putting all of these subsidies in place has required the UK government to essentially redesign the electricity market over the past few years in an effort to create a situation where investment in a new plant looked attractive.’ So said Dr Bridget Woodman, from IGov, Exeter University. She saw the governments decision to delay a final decision on Hinkley as offering chance for ‘a real and considered debate about the future shape of the electricity system has loomed into view. Now is the time to start considering the sorts of options being considered widely around the world, with measures to encourage more flexible, smaller-scale, renewable systems incorporating demand-side measures and new technologies such as storage. A system that is the absolute antithesis of what Hinkley Point C represents. Suddenly UK energy policy has become very exciting indeed.’ But it was not to be.

www.energypost.eu/hinkley-point-c-delay-exploit-attack-common-sense-energy-policy

Energy Policy: a consensus?

The Economist: ‘Britain should cancel its nuclear white elephant and spend the billions on making renewables work’:
The Telegraph ran this: ‘Cutting-edge research into cheap and clean forms of electricity storage is moving so fast that we may never again need to build 20th Century power plants in this country, let alone a nuclear white elephant such as Hinkley Point. Nuclear reactors… are useless as a back-up for the decentralized grid of the future, when wind, solar, hydro, and other renewables will dominate.’
www.telegraph.co.uk/business/2016/08/10/holy-grail-of-energy-policy-in-sight-as-battery-technology-smash/

It also ran an unusually positive piece on wind power:
www.telegraph.co.uk/business/2016/08/14/britains-vast-national-gamble-on-wind-power-may-just-pay-off/
That was buttressed by Bloomberg New Energy Finance who claimed offshore wind could supply the same amount of electricity as Hinkley for the same investment, though balancing would cost extra, but doing it with on-shore wind would be cheaper:

The Energy & Climate Intelligence Unit came to similar conclusions: there were ‘cheaper, quicker, simpler’ alternatives including demand management and wind farms:
www.edie.net/news/6/ECIU-report-gives-Hinkley-Point-C-renewable-alternatives

EDF defended its patch: ‘In Britain, onshore wind has a limited capacity to meet our future needs. As well as… intermittency, space is a significant constraint. As for offshore, recent auctions for UK offshore wind projects averaged £137/MWh compared with Hinkley Point’s £92.50. Some pundits suggest battery storage can complement wind and solar generation so that Hinkley is not needed. However, peak electricity demand in Britain is in the winter when there is almost no solar electricity generated. There is no prospect of cost effective battery technology to store electricity for months. Nor is the electricity going into batteries free. Storage is another additional cost for consumers.’

EDF (and HMG) aside, then, a wide consensus. Regardless, the government decided to go ahead with Hinkley. It begsgs belief. In a concession to security concerns, EDF can’t sell it off if there are build problems and the government will take ‘a special share in all future nuclear new build projects’ to maintain some UK control and block any later sell-offs:
Not many loved it, the TUC & Labour’s energy shadow apart. And EDF! See full story later.
65% by 2030: Labour’s renewable target

Labour’s new Environment and Energy policy aims to get 65% of UK electricity from renewables by 2030 and pioneer a ‘democratic, community-led system of energy supply’. Jeremy Corbyn said that ‘over the course of the next parliament, we will use public investment and legislation to promote the creation of over 200 local energy companies, giving towns, cities and localities the powers they need to drive a clean, locally accountable energy system with public, not-for-profit companies. At the heart of this policy will be a new generation of community energy co-operatives. We will create 1,000 of these co-operatives with the support of a network of regional development banks, and legislate to give them the right to sell energy directly to the communities they serve.’ And ‘we will create a National Home Insulation programme to insulate at least 4m homes to energy efficiency standard B or C’. He added ‘As part of our transition to a low-carbon economy, we estimate that we will create 316,000 jobs in wind, solar and wave power. We will use a £500bn national investment programme, with a National Investment Bank and a network of regional development banks, to ensure that these jobs and opportunities are created in places where they are most needed - in coastal towns and areas with high unemployment.’ Also see its Energy R&D Plan below.

Corbyn also said DECC would be reinstated. The ‘1000 co-ops’ promise contrasts with this:


Repower Britain Labour Conference pledge

It will back local power, smart networks and local grids to help ‘take back control in our own homes’ - and it will ban fracking:


The 65% target was ‘ambitious but feasible,’ a Bloomberg New Energy Finance analyst said: the UK was currently on track to reach a 50% share of power from wind and solar in 2030 (see left), which would require about $75 bn of investment. But other technologies might be needed to get to 65%.

Corbyn’s plan uses Poyry’s ‘Very High Renewables’ scenario produced in 2011 for the Climate Change Committee, and also CCC’s data for costs - which in total are put at near £165 bn, on a low CCC estimate. Corbyn says we might aim for 85% renewables ‘as technology improves and diffuses’ later on.

Meanwhile, for balancing it calls for the ‘expensive and polluting’ capacity market to be replaced by a new clean power mechanism to ensure adequate storage & clean backup. In full: https://d3n8a8pro7vhmx.cloudfront.net/corbynstays/pages/425/attachments/original/1473247004/Environment_Energy_Final.pdf?1473247004 Video: www.youtube.com/watch?v=y5t8m1RXG9A&feature=youtu.be Also see: www.theecologist.org/blogs_and_comments/commentators/2988108/jeremy_corbyn_my_plan_for_britains_green_industrial_revolution.html Bold stuff, setting an ambitious target, with nuclear not being mentioned. That could be problematic, as the Labour Shadow Energy spokesman has backed it! But some could fit into the 35% left from the 65% target, though not much if it’s a 15%/85% split. GMB opposed: www.dailymail.co.uk/wires/pa/article-3777018/Jeremy-Corbyn-energy-policy-60-million-not-Big-Six-energy-firms.html
PV: surviving the cuts while we await the next CfD round

PV may be doing well, but the Feed-in Tariff cuts have had a major impacts: see the chart. Though for larger schemes Local Councils are finding ways to compensate for support cuts:

- [www.solarpowerportal.co.uk/blogs/how_solar_acquisitions_present_further_options_for_the_public_sector](http://www.solarpowerportal.co.uk/blogs/how_solar_acquisitions_present_further_options_for_the_public_sector)
- [www.solarpowerportal.co.uk/blogs/sta-publishes_fit_reform_proposal_for_rooftop_sol](http://www.solarpowerportal.co.uk/blogs/sta-publishes_fit_reform_proposal_for_rooftop_sol)

![Rooftop solar PV deployment under Feed-in Tariff](image)

Good Energy may have to sell some sites:


...but there is still PV progress:


Emissions woes mostly due to imports

Figure 1 Greenhouse gas emissions associated with UK consumption 1997 to 2013

Wind curtailment woes

Scottish windfarm operators have been paid a record £3.1m for power not used during a recent high output/low demand day. 46,150 MWh was constrained off. While that’s provocative (it’s paid for by consumers) many generators get constraint payments, not just wind, but it led to some negative press comments. WWF Scotland says it indicated a need for upgraded links & more storage capacity. The SNP agrees.

- [www.express.co.uk/news/uk/700115/Windfarm-storage-off](http://www.express.co.uk/news/uk/700115/Windfarm-storage-off)
- [www.telegraph.co.uk/business/2016/09/14/power-price-surges-to-record-high-on-supply-shortage-fears/](http://www.telegraph.co.uk/business/2016/09/14/power-price-surges-to-record-high-on-supply-shortage-fears/)

Fracking woes

- [www.thenational.scot/news/anti-fracking-academic-in-row-over-losing-online-access.21208](http://www.thenational.scot/news/anti-fracking-academic-in-row-over-losing-online-access.21208)

Meanwhile the Government plans to offer £10,000+ per household to back shale gas fracking:


It didn’t go down well with some:


Climate cost

The Global Warming Policy Foundation says the cost of climate policy for heavy energy-using industry is too high. It puts the ‘electricity network costs brought about by renewable policies but not modeled in government price-impact studies… in the region of £5 bn a year in 2020, almost as much again as the renewables subsidies’: [www.thegwpf.com/content/uploads/2016/08/Industry-1.pdf](http://www.thegwpf.com/content/uploads/2016/08/Industry-1.pdf)


Carbon plan delay? DECCs demise, uncertainties over Brexit, and (see below) the heat plan, could mean a delay:


It will also miss its ‘15% by 2020’ renewables target: [www.carbonbrief.org/uk-to-miss-renewable-energy-targets-mps](http://www.carbonbrief.org/uk-to-miss-renewable-energy-targets-mps)

But UK ratification of the Paris Climate COP21 agreement has not been affected.

Too hot? After the summer heat waves...

Building overheating is widespread. Last year, 83% of Londoners reported ‘unbearable heat’. 2016 was worse. WSP Parsons Brinckerhoff warned that in particular newer flats and offices that have been designed to better insulate heat in winter are not well adapted to high temps, and are damaging UK health & productivity. Inner city areas can be 10C warmer! If run on fossil fuel derived electricity, Aircon will add to CO2 emissions and so, later, to the heat. So try PV? And better building design and shading.

- [www.zeroarbonhub.org/sites/default/files/resources/reports/Understanding Overheating-Where to Start NF44.pdf](http://www.zeroarbonhub.org/sites/default/files/resources/reports/Understanding Overheating-Where to Start NF44.pdf)

*In the September heat wave, demand for air con shot up just at the point when two nuclear plants unexpectedly dropped off the grid and the interconnector link went down: [www.telegraph.co.uk/business/2016/09/14/power-price-surges-to-record-high-on-supply-shortage-fears/](http://www.telegraph.co.uk/business/2016/09/14/power-price-surges-to-record-high-on-supply-shortage-fears/)

Energy Matters is also on the case!

- [http://euanmearns.com/uk/](http://euanmearns.com/uk/)
CSCS defended

The recent report of the Parliamentary Advisory Group on Carbon Capture & Storage addresses ‘the policy disconnect that arises between the previous Government’s cancellation of the carbon capture and storage competition on grounds of cost and the advice it received from a number of independent policy bodies that CCS was an essential technology for least cost decarbonisation of the UK economy to meet international agreements’. It insists that CCS ‘is an essential component in delivering lowest cost decarbonisation across the whole UK economy’. It claims that ‘current CCS technology and its supply chain are fit for purpose. There is no reason to wait for international projects or for technological progress in either the components or overall system of CCS. Because lead times are long - planning, regulatory & construction - early decisions are needed.’ And ‘UK action on CCS now will deliver lowest cost to the consumer. There is no justification for delay. Heavy costs will be imposed on current & future UK consumers by a continued failure to enact an effective CCS policy.’ Convinced? Energy Matters wasn’t: http://euanmearns.com/does-carbon-capture-storage-have-a-future-in-the-UK/

Certainly the Advisory Group note that ‘there is a widespread view that CCS has to be expensive’. But it says ‘the high costs revealed by the earlier UK approaches reflected the design of these competitions, rather than the underlying costs of CCS itself. This poor design led to the lack of true competition and the imposition of risks on the private sector that it cannot take at reasonable cost for early full-chain projects. Previous third party analysis by the CCS Cost Reduction Taskforce and for the Committee on Climate Change as well as analysis performed for this report show full-chain CCS costs at c.£85/MWh under the right circumstances*. This report concludes that, under the right conditions as set out in this report, even the first CCS projects can compete on price with other forms of clean electricity.’ It suggests that a new company be set up to develop it, ‘in the late 2020s’ - initially state owned, but later privatized, and to help ‘a market-style incentive system in the form of a CCS Obligation on all fossil fuel suppliers to store a growing percentage of the emissions resulting from that fuel’. It could ‘guarantee a continued demand for CCS to underpin investor confidence and align demand to achieving the UK’s national and international commitments to decarbonisation’. The focus could be on industrial CO2 emissions as much as those from power plants. And though it admits that, ‘UK industry does not have the incentive, scale or financial capacity to support the development of CCS infrastructure’, it claims that ‘CCS in industry represents some of the cheapest available carbon abatement in the UK economy’. It says ‘another option is to repurpose the recently renovated natural gas distribution network and use it to supply hydrogen to domestic heating and cooking appliances and industrial users’. Certainly CCS would be needed to make hydrogen produced by steam reformation of fossil gas carbon neutral. As that may be an interim option while power-to gas conversion of surplus renewable electricity is developed. It’s also the case that CCS could in theory be used with biomass to make burning it carbon negative. The advisory group are less than convinced: they talk of ‘significant reservations of many about the availability and sustainability of bioenergy at the required scale’. But they note that bioenergy with CCS (BECCS) plays ‘a very significant role in both 2C and 1.5C modelling scenarios for global warming which are consistent with, for instance, the Paris Agreement’. So though the main aim still seems to be to enable the continued use of fossil fuel, some attention to CCS may make sense. The Group says CCS has the potential ‘to be safely storing 15% of current UK CO2 emissions by 2030 and up to 40% by 2050’. Whether that will be achieved remains to be seen. It seems unlikely. https://gallery.mailchimp.com/4ba4a05396f0b7eac512a9b0/files/Parliamentary_Advisory_Group_on_CCS_Final_report_VERSION_TO_PUBLISH.pdf *e.g. assuming the government pays the start-up cost of the pipeline system. But Wind & PV are already cheaper. No direct response from BEIS yet, but it has allocated £8.4m for R&D on ‘negative carbon’…

Timid planning limits for Wales

The St David’s Day agreement on the devolution of energy consents, gave the Welsh Assembly and Welsh Ministers more autonomy to shape devolved energy policy in Wales. Decentralisation of consenting responsibilities for onshore wind projects has already been enacted while consenting responsibility for all other electricity generating projects up to and including 350MW in size is now being debated. That includes wave & tidal projects. But 350MW is very low- it’s just enough for the Swansea lagoon. What about all the other wave and tidal projects that are mooted?
**An insider view**

**Stephen Heidari-Robinson**, former energy and environment advisor to PM David Cameron, has produced an interesting blog outlining his views. He says ‘It’s never been clear to me why green groups and the media spend so much time trashing the government’s record, when they should be celebrating the UK’s achievements and encouraging other countries to follow suit’ e.g. under the UK’s Climate Change Act ‘by the end of 2015, greenhouse gas emissions in the UK had fallen by 38%’. By contrast ‘the EU’s 2020 renewables targets - which only focus on one aspect of decarbonization and ignore ending coal, building nuclear and overall efficiency - have been generally unhelpful, allowing EU countries to build out renewables while carbon emissions fail to fall. For example, between 2010 and 2015, Germany has increased the proportion of renewables by 17% to 33% but its carbon emissions today are the same as they were five years ago, due to the phasing out of nuclear power and an increase in coal and lignite burning’. *Brexit* provides an opportunity to strip away these unhelpful EU renewables targets*. And we should stick to the current UK plan: ‘no new subsidies should be given out for electricity generation (beyond the offshore wind and nuclear contracts already envisaged). Otherwise we would be unduly loading costs onto bill-payers, which is a highly regressive form of taxation.’ But ‘for electricity generation beyond 2025, the question switches to nuclear. What’s at stake here is not some great new nuclear age, but simply replacing the UK’s existing nuclear fleet, which currently accounts for around 20% of our generation capacity, and almost all of which is due to be decommissioned by 2030. We can fill this gap by building three new nuclear plants by the late 2020s.’ *However, if the UK government decides not to go ahead with nuclear at all, carbon emissions will increase, as there is no cheaper, base-load option for electricity generation to take its place: biomass is of questionable carbon benefit and more expensive (£100/MWh) tidal is way more expensive (£170/MWh for 35 years not 15) and only generates electricity 20% of the time (not necessarily when you need it); and onshore wind may be cheaper (£80/MWh) but only produces electricity one third of the time, and Conservative MWh will definitely not sign off on it*. That only leaves gas: ‘This can provide base-load and is cheaper than nuclear (at around £90/MWh) but of course if will cause the UK’s emissions to increase not fall’. But he is no fan of **Carbon Capture and Storage**: ‘As the NAO report makes clear, the two pilot CCS projects required an upfront tax-payer subsidy of £1bn. Between them, they would have required £170 per MW to generate electricity (vs. the £60 for new gas and £90 for new nuclear). The two plants would therefore require annual subsidies from the energy bill-payer of £70m per year for 15 years - that is £8.6bn or £9.6bn including the upfront taxpayer subsidy. On top of that, the government had to cover some of the costs of corrosion & potential CO2 leakage (which could represent quite a sizeable amount).’ He goes on ‘Despite these huge costs, DECC proponents of the projects estimated that there would be little impact on emissions before 2030 and so had not calculated the benefits. Back of the envelope, I estimate the projects would have delivered about 1% of the UK’s generation capacity and saved about 2.6m tons of carbon per annum (equivalent to around 0.6% of current UK emission levels). The cost of the carbon abated would be a monumental £250 per ton, not including the risk of corrosion/leakage. Moreover, with coal being phased out anyway, and gas only running a third of the time due to the success of renewables, we have already delivered most of the benefits of CCS at a fraction of the cost, and there is really no headroom in the system for these projects to operate anyway: you would have to cancel planned renewables projects to create the space for them.’ Or nuclear, though he doesn’t say that - for him it seems to be nuclear all the way.

**What next?**

**The ultimate green policy**

‘Green growth’ was one topic explored at the *Radical Technology 2.0* (RT2) conference in Bristol in September, with the emphasis on how co-ops and community sharing could support sustainable economies using low impact technologies. Clearly many feel that much more than just technical fixes will be needed to tame economic growth and ensure a sustainable future; though tech. can help avoid some resource & impact limits, given a finite planet with limited carrying capacity, no amount of technical fixing could deal with all our eco and social problems, if we stayed in a growth-reliant economy based on yet more expansion of resource use -a view relayed in the *Guardian*: green energy wasn’t enough, we also needed economic system changes: www.theguardian.com/global-development-professionals-network/2016/jul/15/clean-energy-wont-save-us-economic-system-can.

So, a steady-state global economy? www.sciencedirect.com/science/article/pii/S0959652615010471 Not easy. But some at RT2 felt cleaner greener techs could help make it possible- and livable. They could be part of the practical focus for local transitions, enabled by emerging grass roots groups and building up capacity for a more decentralised co-operative society. Radical stuff! Updates on ideas initiatives and ideas explored are promised: www.radicaltechnology.org

It’s a long way from the ‘official’ view - see left. That assumes most things stay the same, with nuclear providing the glue and the UK trading abroad aggressively with whatever we have, to keep the show on the road! Is there no real common ground?! Even for those who don’t think zero or low growth is realistic? Or is this just a clash of cultures? Echoing the late David MacKay, Heidari-Robinson (left) says ‘climate change action is not a matter of opinions: it’s a matter of mathematics’. Yes, the sums are important. But is that all there is to it- just numbers?

*RT2 covered a wide field, not just energy, but on energy nuclear got short shrift, Hinkley especially, while PV solar and wind were strongly backed No surprises there! Though there were some- see below*
CAT shifts policy - small is not the only thing

A mix of scales is needed with social and lifestyles changes only part of the mix

In a paper in the academic journal *Science as Culture*, Peter Harper, one-time AT guru at the Centre of Alternative Technology (CAT) notes that, ‘for entirely pragmatic reasons’ in its ambitious Zero Carbon Britain, the CAT ‘emphasise technical solutions, and try to avoid the need for lifestyle changes’. He goes on ‘There is no doubt that changes of customary practice will be essential, and that the recent historic period of rapid growth is over. Nevertheless the reports’ abandonment of lifestyle change as the key component is a considerable shift. This distances CAT from the ‘deep green’ parts of the environment movement, who usually cleave to the doctrine that Small is (always) Beautiful’. He adds ‘For some it is a betrayal of hard-fought ideals. For others it signifies a welcome return to the real world. Many at CAT would say it implies a recognition that we are running out of time. Had the long slow cultural changes called for in the 1970s taken hold and become widespread, all could have been achieved with ‘alternative’ systems. But of course these changes have not spread, and as various global thresholds loom, the responses have to be more rapid, drastic, infrastructural and ‘one-size-fits-all’, and so now ‘there is much more concern for whether new systems can be generalised and applied on a wider national scale’.

Harper may have overstated the scale of CAT’s shift: for example, Zero Carbon Britain did talk about the need for dietary change and a shift from land intensive meat production to create more space more biomass. [http://zerocarbonbritain.com/en/](http://zerocarbonbritain.com/en/) But it’s certainly true that many deep greens see local projects and social change as much more important and appropriate than what some portray as just technology fixes. Whereas in his *Science as Culture* paper, Harper concluded that though small-scale projects and social change were important, ‘it seems unavoidable that ‘high-tech’ must do the heavy lifting, at least in the short term. Thus two different forms of socio-technical transition need to run in parallel.’ That was also a view that emerged from the *Radical Technology Revisited* (RT 2.0) conference in Bristol in Sept - which looked at CAT’s Zero Carbon Britain scenario as one way forward. That certainly included a mix of technology scales. So, although how much large-scale high technology is needed remains unclear, we’ve moved away from ‘small is (automatically) beautiful’. But then as was pointed out at RT 2.0, Schumacher didn’t ever say that only small was beautiful: it was a question of context. [www.tandfonline.com/doi/full/10.1080/09505431.2016.1164406](http://www.tandfonline.com/doi/full/10.1080/09505431.2016.1164406)


Huhne changes too!

The EUs 15% Renewable target was good for the UK: [https://greenallianceblog.org.uk/2016/09/01/ive-changed-my-mind-on-renewables-targets/](https://greenallianceblog.org.uk/2016/09/01/ive-changed-my-mind-on-renewables-targets/)

Labour’s £300m Energy Research Agency

Labour has pledged to create a £300m US-styled Advanced Research Agency to combat climate change, if it’s elected. It would attract the ‘best minds from the UK & across the world’. Jeremy Corbyn said ‘it is crucial for both energy security and tackling climate change that we give the most serious investment and incentives to high-tech R&D. My pledge to establish a dedicated Advanced Research Agency will help tackle the global social challenge of climate change and make fundamental breakthroughs in energy science. It will put the UK in the best possible place to take advantage of the rapidly growing global renewable energy market, forecast to reach $630 billion worldwide by 2030.’ Corbyn described the Tory cuts to renewable subsidies since 2015 as ‘nonsensical’ and a ‘damaging backwards step in our efforts to decarbonise our energy production’.


Big spend

The UK will need to invest £215 bn in its energy system by 2030 to replace aging assets and decarbonize energy supply/use, says Barclays: [http://utilityweek.co.uk/news/uk-needs-to-invest-215bn-in-energy-by-2030-barclays/1271602-188poleMBYd](http://utilityweek.co.uk/news/uk-needs-to-invest-215bn-in-energy-by-2030-barclays/1271602-188poleMBYd)

Heat plan uncertainties - green gas a better bet

The Energy and Climate Change Select Committee said the UK would fail to reach its legally binding target of providing 15% of its energy from renewables by 2020, due to ‘under-performance’ in heat and transport. It noted that the UK was not even halfway towards achieving the target of getting 12% of energy for heat generation from renewables, while the proportion of renewable energy used in transport had in fact fallen, from 4.9% to 4.2% in the past year. In particular, it criticised the handling of the renewable heat incentive (RHI) scheme, and the cuts in support for smaller AD biogas systems. It said there was a ‘strong case’ against this: ‘Biomethane is crucial to meeting the 2020 target and must remain a funding priority’. The removal of solar heat from the RHI has also raised major concerns:

www.scottishenergynews.com/solar-power-industry-issues-mayday-alert-over-solar-thermal-energy-scheme/

The heat pump-led decarbonisation-by-electrification approach is also getting a bad press:


Green gas (biogas and syngas) looks like a better option: https://policyexchange.org.uk/too-hot-to-handle-how-to-decarbonise-the-way-we-heat-our-homes/

Something a Labour report had already said*. Also see these earlier studies:


New thinking about the new options does seem to be spreading:

www.theecologist.org/News/news_analysis/2988052/the_hydrogen_economy_is_much_nearer_than_we_think.html

All change But then everything, not just heat, is in flux, including energy balancing. Some think that domestic batteries will dominate over larger stores in the storage field:

http://utilityweek.co.uk/news/Domestic-storage-will-dominate-by-2024/1274672 (sub required)

Others look to demand response, with National Grid’s head of commercial operations Cathy McClay saying that the system operator’s 2020 target to achieve up to half of grid balancing from demand-side sources rather than large power stations was ‘totally achievable’:


But see Energyst’s survey which relayed a range of views: http://theenergyst.com/dsr-event-2016/

Looking broadly at all of it, Jeremy Leggett says the current flux of change reflects ‘the speed with which a clean energy insurgency is invading energy markets around the world’ and ‘the speed with which the energy incumbency is unrelavng’:


However, uncertainty still exists over the future due to the vagaries the non-transparent LCF funding cap system:


And while the Institute of Directors was relatively happy with parts of the current approach, it wanted more attention to gas, cost cutting and security of supply:

www.edie.net/news/11/UK-Governments-have-succeeded-on-renewables-but-failed-on-energy-security-say-business-leaders/30745/

.... but no Hinkley rethink

The stakes were high: could the UK afford to antagonise China who had offered to inject £6bn into the project, on the understanding that they would be allowed to build their own plant later at Bradwell - a vital step for them: http://energydesk.greenpeace.org/2016/09/06/hinkley-wont-happen-without-china-say-experts/

At risk were other Chinese inward investments - vital to the UK after Brexit. But if it feared handing over too much control of UK nuclear plants to China, the UK government could step in as an industry insider suggested: ‘£6 bn is loose change to the Government, it would cut the capital expenditure by a third and it’s less of a risk for EDF. That should bring the strike price down, which would be good news for consumers.’ www.thisismoney.co.uk/money/news/article-3772356/Hinkley-new-deal-looms-cost-electricity.html

Other options, as explored by Nick Butler in the FT, were to cut the scheme down to one reactor instead of two and only let it go ahead when and if the Flamanville EPR in France was successfully completed - and with a lower strike price. http://blogs.ft.com/nick-butler/2016/09/05/will-edf-rescue-hinkley-point/

But UK finance minister Philip Hammond didn’t see the need for any of this: the high strike price simply reflected the fact that it was going ahead without any direct UK government cash input and there were penalty protections built in for the UK if it stalled. That view - and China - evidently won!

www.world-nuclear-news.org/NN-Pressure-mounts-for-government-decision-on-Hinkley-09091601.html

See below for the saga story
The Hinkley saga

Although it left it rather late, it was not that surprising that in July the government decided to review the Hinkley project and, by implication, its nuclear policy. The National Audit Office had told them that the cost of electricity from Hinkley could rise significantly: ‘Since 2012, the Department has revised downwards its projections of future wholesale electricity prices, mainly because of a global reduction in the prices of fossil-fuels. While CfDs reduce the risk to consumers of market price volatility, they also mean consumers benefit less from wholesale price falls, which are offset by increased top-up payments. The present value of future top-up payments through existing CfDs has increased by £5.6 bn in the 2015-16 financial year because of lower projected wholesale electricity prices. We estimate that future top-up payments through the HPC CfD have increased from £6.1 bn to £29.7 bn since the Department & EDF agreed the strike price in 2013’: www.nao.org.uk/report/nuclear-power-in-the-uk

Also hardly surprising then that the Welsh Affairs Select Committee (WAC) was worried about the likely cost to consumers of the proposed Hitachi ABWR at Wylfa. Though it backed the project, it suggested that ‘the Government negotiate a strike price for Wylfa Newydd below that agreed for Hinkley Point C [£92.5/MWh] and seek a price that would be competitive with renewable sources, such as on-shore wind. The Government should not continue with the project if the price is too high.’ That’s quite a challenge. Even adding grid balancing costs (maybe ~10% extra), it will be hard for new, untried nuclear to beat the now well established green options. Even more unlikely, WAC bid for a Small Modular Reactor - it said the now closed Trawsfynydd site in Snowdonia was a ‘standout candidate’ for one!


Given that backdrop, new review had a lot to face up to, also including a submission to the government by ‘Together Against Sizewell C’ arguing that energy saving was better: http://tazisewelloc.co.uk/index.php/submissions-and-reports/150-report-from-together-against-sizewell-c-requires-new-secretary-of-state-to-review-nuclear-component-in-energy-policy

Green Hedge says the same for renewables: see Hinkley Point through the looking glass: www.green-hedge.com/news/

And given China’s involvement in Hinkley, and later maybe their own plant at Bradwell, there were also security fears: www.conservativehome.com/parliament/2016/07/the-wit-and-wisdom-of-nick-timothy-19-stop-selling-our-security-to-china.html

Certainly divisions emerged in the Tory ranks: www.solarpowerportal.co.uk/news/conservative_think-tank_turns_back_on_hinkley_c Also see reports above.

However, the government remained committed - with China clearly upset about the wobble! So perhaps it wasn’t surprising that in Sept. the government said Hinkley can go ahead. But it was a close run thing - see Box. And it goes against public opinion: only 25% backed it: www.greenpeace.org.uk/media/press-releases/public-support-hinkley-new-low-20160913

Expect problems! And further updates: www.thecologist.org/News/news_analysis/2988131/hinkley_c_nuclear_goahead_may_caves_in_to_pressure_from_france_and_china.html And up to a £7.2bn cleanup bill!!

Catch up: https://theconversation.com/hinkley-point-c-delay-how-to-exploit-this-attack-of-common-sense-in-energy-policy-63293

Davy www.theguardian.com/uk-news/2016/ Aug/01/ Osborne-rejected-safeguards-over-chinese-role-in-hinkley-point-says-ex-energy-minister


UK Unions for it www.huffingtonpost.co.uk/entry/jeremy-corbyn-facing-backlash-from-unions-momentum-chair-rachel-garrick-and-bill-esterson-over-hinkley-c-nuclear-plant-opposition_uk_579ee74a4b0f42daa4a43c5

But all 6 EDF board union reps voted against it.

France’s Socialists too www.telegraph.co.uk/business/2016/08/09/hinkley-point-near-melt-down-as-french-socialist-party-calls-for/

Some energy practitioner reactions http://euammearns.com/hinkley-point-c-pantomime/


Next: EDF launched a competition to find new ways of inspecting and monitoring its old UK AGRs, offering projects up to £10,000. With its cash tight it needs to keep them going at lower cost: www.world-nuclear-news.org/C-EDF-Energy-seeks-innovative-solutions-for-AGR-fleet-19071601.html

But in its long view, Hinkley ‘will be the best preparation for EDF for the renewal of the French fleet’: www. edenergy.com/content/my-letter-all-edf-energy-employees-regarding-hinkley-point-c-financial-investment-decision
2. Global Developments 147 GW of renewables added in 2015

Global highs

REN21’s latest review puts wind globally at 433 GW at the end of 2015, and PV solar at 227 GW. Solar heating was at over 435 GW(th). CSP reached near 4.8 GW(e). Hydro was at 1064 GW. Biomass supplied 14% of total global energy. Overall, renewables, including hydro (at 16.6%) and biomass, supplied 19.2% of world energy in 2014 and 23.7% of its electricity at end 2015: www.ren21.net/status-of-renewables/global-status-report/

Estimated Renewable Energy Share of Global Electricity Production, End-2015

Based on renewable generating capacity at year-end 2015. Percentages do not add up internally due to rounding.

Jobs boom

More than 8.1 million people worldwide are now employed in green power. The renewable energy industry saw a 5% increase in employment from last year - according to a new report by IRENA. While this increase is smaller than previous years, it is still notable given it stands in contrast to trends across the energy sector; the total number of renewable energy jobs worldwide rose in 2015 while jobs in the broader energy sector fell. In the US for example, renewable energy jobs increased 6% while employment in oil and gas decreased 18%. Countries with the most renewable energy jobs in 2015 included China, Brazil, the USA, India, Japan and Germany. The solar PV sector remains the largest renewable energy employer worldwide with 2.8 million jobs (up from 2.5 at last count): https://irenanewsroom.org/2016/05/25/8-1-million-people-now-work-in-renewables-new-study-finds/

Coal out

The G7 group of countries has set a 2025 deadline for phasing out of fossil fuel subsidies, the first time its set a date.

Coal out

IRENA

Global data

Renewable 2015 global capacity - 3,173GW
Hydro 1,208GW
Wind 417GW
Solar 224GW
Bio 103GW
Geoth. 13GW


Solar PV sells at half coal costs in Chile:

Wind costs will continue to fall says Berkley Lab: www.nature.com/articles/nenergy2016135.epdf
Energy use falls in most countries

Based on 2015 data for G20 countries, Enerdata has analysed trends in world energy. It reports the lowest global economic growth since 2002, with almost no overall growth in energy consumption (see chart above) and a new 3% fall in energy intensity, coupled with stabilization of CO₂ emissions. But it says ‘achieving the goals discussed at the COP21 (1.5 to 2° temperature increase by the end of the century), in fact requires a lasting stagnation of global energy consumption and a strong reduction of emissions. Thus, with a global GDP growth assumption of 3% per year, this would imply an average carbon intensity reduction target of 5 to 6% per year.’

It echoes the International Energy Agency’s view that ‘progress deploying clean energy technologies worldwide is still falling worryingly short of what is needed’ (IEA Energy Technology Perspectives, 2016). The IEA reported flat CO₂ emissions in 2014 and 2015 but BP said it did not take into account numbers that became available later on with regard to Chinese CO₂ output related to the higher grade coal it had been burning. Even so, BP’s latest review of world energy trends says carbon emissions only grew by 0.1% in 2015, the lowest level in 25 years. This was seen as due to 1.8% cut backs on coal, increased efficiency & expansion of new renewables (to 2.8% of world primary energy*), led by China. Wind power capacity grew by 17.4% and solar by 32.6% last year, with China overtaking Germany and the US as the largest solar generator. Overall US renewable capacity increased by 19.7%, Germany’s by 10.9% and Britain’s by 4.8%. BP said global energy intensity, the average amount of energy needed per unit of GDP, fell 2%, while economic growth rose by 3%. It thought these trends would continue, but warned that some of the carbon cuts were due to structural/cyclical economic changes which might not - though China’s growth in energy consumption slowed to just 1.5%. But underlying it all, the global shale revolution increased technically-recoverable oil & gas resources by ‘upwards of 15%’.

Renewable electricity use has grown by over 70% in the G20 in the last 5 years, says BNES: FT 14/8/16

*RENEW’s 2014 figures for final energy consumption are higher - 19.2% for all renewables, 10.3% for new renewables, 6.4% without hydro: it puts nuclear at just 2.5%. BP uses primary energy figures. That links to how much fossil fuel is burnt, but given the large thermal conversion losses, raises the fossil/nuke v renewables share.
PV booms in EU - passing 100 GW

**EU News**

Europe surpassed 100 GW of installed grid-connected solar PV capacity in the second quarter of 2016, up from 3 GW in 2005, mainly as a result of an 80% reduction in costs and a host of supportive regulatory frameworks brought in by countries looking to meet the EU’s Renewable Energy Directive. But with many feed-in tariff subsidies coming to an end across the EU, research firm IHS says there’s a need for suitable electricity market design and long-term investments signals for PV to progress, to enable eventual expansion to maybe 200 GW. Globally it’s already at 227 GW.

**EU emissions rise - but biofuels to be cut**

Energy-related EU carbon dioxide emissions in crept up 0.7% in 2015, compared to 2014. But it is still aiming to cut them overall by 40% by 2030 - so far a 23% cut below 1990 levels has been achieved. However, the EU directive requiring member states to use ‘at least 10%’ renewable energy in transport will be scrapped after 2020, the European Commission confirmed, hoping to set aside the protracted controversy over the eco-impacts of biofuels. The revised version of the current directive already limits the use of biofuels which compete with crops grown on farm land to 7%, and allows member states to set lower national limits. And it set a 0.5% indicative target for 2nd generation biofuels.


**French uncertainties** A recent study by French state energy agency ADEME claimed France could switch to 100% renewables by 2050: [http://mixen.ademe.fr](http://mixen.ademe.fr). However, one of EDF’s top nuclear executives, Dominique Miniere, told reporters in Paris, ‘A certain number of points in that study are not based on technological realities. We do not believe in a 100% renewables mix by the (time) horizon (ADEME) indicates. However, we want to extend the lifespan of our reactors in order to allow a gradual increase of renewables in the mix.’

[www.powereengineeringint.com](http://www.powereengineeringint.com) articles/2016/05/edf-nuclear-chief-says-100-per-cent-renewables-by-2050-unrealistic.html

**German highs** Renewable’s supplied 87% of electricity at one point in May, leading to fossil and nuclear electricity dumping at negative prices - the annual figure is around 36%: [http://qz.com/680661/germany-had-so-much-renewable-energy-on-sunday-that-it-had-to-pay-people-to-use-electricity/](http://qz.com/680661/germany-had-so-much-renewable-energy-on-sunday-that-it-had-to-pay-people-to-use-electricity/)


**PV storage** 41% of new PV has storage: [www.renewableenergy.com](http://www.renewableenergy.com) germany-sets-new-solar-storage-record/ Excellent post


But the 400 MW Horns Rev 3 offshore wind farm is to go ahead at €103/MWh.

**Irish wind** Expanding wind up to a possible 40% share by 2020 will lead to curtailment and balancing problems, even with storage, given the small grid and lack of interconnectors: [http://euanmearns.com](http://euanmearns.com) commercial-measures-to-reduce-the-cost-of-wind-integration-in-the-island-of-ireland/

So why not build more links, and also diversify from just wind? But it may be more costly. [www.independent.ie](http://www.independent.ie) business/personal-finance/latest-news/energy-regulator-seeks-a-32pc-rise-in-levy-on-electricity-bills-34763222.html

**Portugal** runs on 100% renewable power for a while with biofuels, wind, solar, hydropower: [http://electrek.co](http://electrek.co) 2016/05/16/portugal-run-entirely-on-renewable-energy-for-4-consecutive-days-last-week

Energy Matters was bemused: [http://euanmearns.com](http://euanmearns.com) did-portugal-run-for-four-days-on-renewables-alone/

**Swiss** options* [www.swissinfo.ch](http://www.swissinfo.ch) eng/business/renewable-energy_study-pushes-swiss-post-nuclear-power-potential/42430574

*Not in EU
EU Renewable energy league table

Sweden clearly leads, and is aiming to be 100% renewable by 2040, while the UK remains near the bottom in this chart, making it hard to accept the claim that the UK is ‘broadly average’ compared with other EU member states in building a clean energy economy and tackling climate change, made in a report by the Energy and Climate Intelligence Unit. But it has cut coal back. And, though it’s performed badly on renewable energy per-capita compared with other large economies (Germany, Italy, France and Spain) and with the entire EU28, coming 21st overall, it’s now improving. http://renews.biz/102750/uk-average-on-green-economy/ But after Brexit, who knows? The UK will no longer be subject to the EU 15% by 2020 target…

Denmark leads on wind - it supplies over 40% of its power, but Scotland is coming up fast behind. Though this Forbes post says the USA is ahead of all! www.forbes.com/sites/rapier/2016/01/21/the-us-blows-danmark-away-on-wind-power/-471153b254c0 There are some anti-wind posts around on Denmark: www.cfact.org/2016/05/13/denmark-says-wind-energy-too-expensive/

Gross EU electricity generation - GWh Renewables took the lead in 2013 Eurostat 2015/odi
**USA** CO₂ emissions from US energy sector have fallen 12% since 2005. There has been a decline in the use of coal although an increase in the use of natural gas to generate electricity, while renewables are also playing growing role, at near 15%, eclipsing nuclear: [www.eia.gov/totalenergy/data/monthly/pdf/mer.pdf](http://www.eia.gov/totalenergy/data/monthly/pdf/mer.pdf) Wind still leads, heading for 80 GW, including the first US offshore wind farm (with Deepwater’s five 6 MW GE turbines now in place at Block Island, off Rhode Island), but PV solar, nearing 30 GW, is expanding: it already employs more people in the US than oil & gas. It’s been helped by net metering, which helps consumers to expand their use of PV at less cost, by selling any excess to the utilities - paying for the net amount transferred. But the PV boom means they no longer need to buy so much power, so the utilities are expected to lose $2bn in revenue by 2019. Some utilities complain that the ‘prosumers’ also get free use of the grid without paying the full share of its costs and are trying to cut the rate at which they pay for power from them e.g. to 75% in Nevada. This may be an exception - it’s being resisted elsewhere. Meanwhile though, some prosumers are going on the offensive, banding together in local shared ‘community solar’ micro-grid schemes and peer-to-peer trading: [www.smartgridtoday.com/public/Solar-CEO-sees-clout-growing-for-energy-prosumers.cfm](http://www.smartgridtoday.com/public/Solar-CEO-sees-clout-growing-for-energy-prosumers.cfm) And along with many off-grid projects, there are some good municipal micro-grid schemes elsewhere too: [www.renewableenergyworld.com/articles/2016/05/municipal-solar-and-microgrids-a-pv-market-outlook.html](http://www.renewableenergyworld.com/articles/2016/05/municipal-solar-and-microgrids-a-pv-market-outlook.html)

This is all helping to push PV on and cut costs: a review of the DOE Sunshot solar programme says it’s attained ~70% of its 2020 price parity aims so far: [www.smartgridtoday.com/public/DOE-releases-research-on-US-solar-industry-growth.cfm](http://www.smartgridtoday.com/public/DOE-releases-research-on-US-solar-industry-growth.cfm) And the potential benefits are huge: [http://environmentalresearchweb.org/cws/article/yournews/65137](http://environmentalresearchweb.org/cws/article/yournews/65137)


**China** is pushing renewables hard, but has grid integration issues. So it plans to raise its storage capacity by ten-fold to 14.5 GW by 2020 to avoid wasting surplus energy. Some regions are estimated to be losing over 40% of their power from wind due to technical restraints and bottlenecks in the grid leading to regular output curtailment. Nationally its 15%. But despite that, wind is still outpacing nuclear: see chart. PV is > 60 GW. Overall renewables, supply over 10 times nuclear.

**India** Wind has over-taken nuclear output. PV solar and mini grids are also seen as part of the way ahead:


A new energy plan is due soon. Media reports claim that, while Japan will cut reliance on widely-opposed nuclear, it may become more dependent on cheap coal-fired power. But also on renewables: www.dw.com/en/japan-to-cut-emphasis-on-nuclear-in-next-energy-plan/a-19289705

PV & wind are the main renewables focus, but it’s also to test a 2 MW Open Hydro tidal current turbine unit built in France. ISEP 2014 data: www.isep.or.jp/en/library/2982

AEEP: Action on Africa

The Africa-EU Energy Partnership (AEEP) aims to provide an additional 100 million Africans with access to sustainable energy services; double the number of electricity grid interconnection between African countries, and more gas use and exports to enhance energy security; raise the renewable share, with at least 15.5 GW of new hydro, wind & PV; and raised energy efficiency in all sectors. A stakeholder forum in Milan in May, with 500 participants, including Ministers, Commissioners and African Union/ EU officials, looked at the implementation of the 2030 Agenda on Sustainable Development and the Paris Climate Agreement, with a focus on Sustainable Development Goals (SDGs) - number 7 (affordable & clean energy), 13 (climate action) and 11 (sustainable cities and communities). The Forum launched several AEEP reports and initiatives, including the 2016 AEEP Status Report and the Renewable Energy Solutions for Africa (RES4Africa) Initiative. Participants adopted a ‘Call for Action’ and made commitments to help develop a comprehensive portfolio of activities to contribute to the AEEP 2020 Targets.

Summary: www.iisd.ca/download/pdf/sd/enbplus181num15e.pdf

Also worth a look, at the policy level: International climate Policy & energy transitions: evidence from sub-Saharan Africa. www.tandfonline.com/doi/full/10.1080/14693062.2016.1173003

And this: www.ren21.net/status-of-renewables/regional-status-reports/ - EAC

Prime Minister Shinzo Abe’s ruling coalition won a landslide victory in an election in July for parliament’s upper house. That may strengthen his drive to restart at least some more nuclear plants, despite opposition. All but 3 remain shut. Renewables however are also being backed. The aim is to get to 22-24% green power by 2030. Its already at 14%- with over 30 times more output than the 2 nuclear plants running in 2015 (4.3 TWh). And some want a lot more green projects: www.reuters.com/article/us-japan-energy-aEURUSKCN1020XH

Floating solar


Chile changes Free PV!

Cheap PV spreads
www.independent.co.uk/environment/chile-solar-power-panels-free-electricity-five-it-away-a7063131.html

Also Santiago’s subway trains are to run on PV & wind! http://qz.com/691078/santiagos-subway-system-will-soon-be-powered-mostly-by-solar-and-wind-energy/

But see this dour critique: http://euanmearns.com/solar-in-chile/


**BNEF** forecasts investments of **$7.8 trillion** in renewables by 2040, much more than will be invested in fossil fuels, with ‘*a significantly lower trajectory for coal and gas prices*’ than in their 2015 report, putting renewables on track to overtake gas by 2027 and coal by 2038: see Grist’s chart. BNEF says while investment in fossil fuel will continue ‘*cheaper coal and cheaper gas will not derail the transformation and decarbonisation of the world’s power systems. By 2040, zero-emission energy sources will make up 60% of installed capacity. Wind and solar will account for 64% of the 8.6TW of new power generating capacity added worldwide over the next 25 years, and for almost 60% of the $11.4 trillion invested.*’

### Annual electricity output, 2016-40, thousand TWh

Economics will be a major driver. The levelised costs of generation per MWh for onshore wind will fall 41% by 2040, and solar photovoltaics by 60%, making these two technologies the cheapest ways of producing electricity in many countries during the 2020s and in most of the world in the 2030s. PV supplies 15% of world electricity by 2040. However, BNEF warns that the massive projected growth in renewables won’t be enough to keep us under the global goal of 2 degrees Celsius of warming. For that BNEF says, the world will need to see an additional $5.3 trillion in zero-carbon energy. [www.bloomberg.com/company/new-energy-outlook/](http://www.bloomberg.com/company/new-energy-outlook/)

### Round the world

**China** Coal-fired generation will follow weaker trend than previously projected. Changes in the Chinese economy, and a move to renewables, mean that coal-fired generation there in 10 years’ time will be 1,000TWh, or 21% below the figure predicted by BNEF in last year’s NEO.

**India** *It will be the key to the future global emissions trend.* Its electricity demand is forecast to grow 3.8 times between 2016 and 2040. Despite investing $611bn in renewables in the next 24 years, and $115 bn in nuclear, it will continue to rely heavily on coal to meet rising demand. This is forecast to result in a trebling of its annual power sector emissions by 2040.

**EU** *Renewables will dominate* generating 70% of Europe’s power in 2040, up from 32% in 2015.

**USA** *Renewables will overtake gas* Their share will jump from 14% in 2015 to 44% in 2040, as gas slips from 33% to 31%. See national charts at [www.bnef.com/dataview/new-energy-outlook-2016/index.html](http://www.bnef.com/dataview/new-energy-outlook-2016/index.html)

*Storage* Total behind-the-meter battery energy storage rises dramatically from ~400MWh now to nearly 760GWh in 2040, with costs falling, as 35% of light vehicles are EVs by 2040. **Nuclear** stalls.

**IRENA** also says renewable costs will fall- by up to 59% for PV and 35% for offshore wind by 2025: [www.irena.org/menu/index.aspx?mnu=Subcat&PriMenuID=36&CatID=141&SubcatID=2733](http://www.irena.org/menu/index.aspx?mnu=Subcat&PriMenuID=36&CatID=141&SubcatID=2733)

IRENA says PV solar could be supplying 13% of global power by 2030, up from 2% now.

**City power** Here’s a nicely positive view of **urban renewable energy** progress in the EU: [www.nuclearpolicy.info/wp/wp-content/uploads/2016/06/Alan_Simpson_DE_energy_without_illusions.pdf](http://www.nuclearpolicy.info/wp/wp-content/uploads/2016/06/Alan_Simpson_DE_energy_without_illusions.pdf)
Neighbourhood mini-nukes for all?  

Former World Nuclear Association executive Steve Kidd noted earlier this year: ‘The future is likely to repeat the experience of 2015 when 10 new reactors came into operation worldwide but 8 shut down. So as things stand, the industry is essentially running to stand still’.

The latest World Nuclear Industry status report confirmed that: 10 new plants but little net output growth:  [www.worldnuclearreport.org](http://www.worldnuclearreport.org)  However, a leaked draft EU Sustainable Energy Technology Plan argues for more, including Small Modular Reactors (SMRs):

And globally there are still signs of an attempted revival, with mini-nukes being one option. In the US, the Tennessee Valley Authority (TVA) is keen on SMRs, which it says could be part of a cleaner, more diversified fleet that could be deployed in ‘more affordable increments’ and generate faster revenues than large reactors. It claims that SMRs could be put closer to population zones. And, while base-load profiles would maximize plant output, they could also ‘load-follow’ when required. Quite a claim! It’s looking to reduce the risk of issues such as emergency planning evacuation zones slowing operating approval. But given safety upgrades ‘based upon the preliminary information which we’ve received from the four vendors, we are confident that all of them can be supported by a two-mile emergency plan [zone] and at least one has capability of site [only] boundary’ i.e. no safety zoning beyond the plant site. That compares with 10 miles for a large reactor. Will anyone accept that - mini nukes in their backyards? And what about security?

Russia plans 11 new plants by 2030 - two of them liquid sodium cooled fast breeders


US nuclear subsidies  

Nuclear enjoys major up-front incentives in the US. It has access to generous loan guarantees and guaranteed cost recovery from consumers - even in advance of plants generating any electricity: Florida Power & Light has been charging consumers for a plant that has not yet been built and may not be. And it gets worse as the economics crash, with TVA selling off nuclear sites and unbuilt plants for a pitance:  [http://thebulletin.org/delivering-nuclear-promise-tvas-sale-bellefonte-nuclear-power-plant-site9524](http://thebulletin.org/delivering-nuclear-promise-tvas-sale-bellefonte-nuclear-power-plant-site9524)

Its Watts Bar Unit 2 has now started up, but otherwise only two new plants are being built in the US (in S. Carolina and Georgia): despite continued support, nuclear is being squeezed out:  [https://energyathaas.wordpress.com/2016/05/31/is-us-climate-policy-killing-nuclear-power/](https://energythaas.wordpress.com/2016/05/31/is-us-climate-policy-killing-nuclear-power/)

In the latest closures, following the Fort Calhoun plant in Nebraska, Exelon is to shut the Clinton and Quad Cities plants in Illinois, which have lost $800m in the past 7 years. The Nuclear Energy Institute say 15-20 more are at risk of a premature closure in the next decade due to competition from cheap shale gas. Meanwhile there’s this chilling nuclear waste threat:  [www.beyondnuclear.org/on-site-storage/2016/5/26/spent-fuel-fire-on-us-soil-could-dwarf-impact-of-fukushima.html](http://www.beyondnuclear.org/on-site-storage/2016/5/26/spent-fuel-fire-on-us-soil-could-dwarf-impact-of-fukushima.html)

China  


And also with this wild (and old) idea:  [http://thebulletin.org/floating-nuclear-power-plants-china-far-first9522](http://thebulletin.org/floating-nuclear-power-plants-china-far-first9522)

India  

gets ~3% of its power from nuclear, and while more is planned, it’s being opposed:  [www.theguardian.com/global-development/2016/jun/06/lonely-struggle-india-anti-nuclear-protesters-tamil-nadu-kudankulam-idinthakarai - img.1](http://www.theguardian.com/global-development/2016/jun/06/lonely-struggle-india-anti-nuclear-protesters-tamil-nadu-kudankulam-idinthakarai - img.1)

Australia  

A major study says nuclear generation is not on there (yet), but uranium mining still was and waste disposal might be very lucrative - though likely to be opposed:  [http://yoursay.sa.gov.au/pages/nuclear-fuel-cycle-royal-commission-report-release/](http://yoursay.sa.gov.au/pages/nuclear-fuel-cycle-royal-commission-report-release/) (It was opposed - strongly!)

Sweden  

A policy U-turn allows up to 10 new plants to be built to replace closed plants. But there will be no state support for this- and private funding seems unlikely unless costs fall:  [www.world-nuclear-news.org/SP-Sweden-abolishes-nuclear-tax-1006169.html](http://www.world-nuclear-news.org/SP-Sweden-abolishes-nuclear-tax-1006169.html)

Japan  

3. Forum *Odds and ends for you to chew on*  

**Community Energy**

IPPR says more than 5,000 *community energy* groups have sprung up around the UK since 2008, providing over 60 MW of renewable generating capacity. These schemes have benefited localities by reducing energy bills, investing in energy efficiency, providing advice to those in fuel poverty, creating jobs, and contributing over £23m to community benefit funds.

However, the IPPR notes, ‘government’s recent reductions in subsidies for solar and wind power, and changes to other financial support mechanisms, have left the future of community energy highly uncertain’. And although a number of new financing models are beginning to emerge, including peer-to-peer lending, pension fund investment and municipal energy company funding, ‘new community energy projects will need to find business models which don’t depend on subsidy for their profitability’. At the same time there are continuing challenges to ensure that community energy schemes reach the lowest-income groups. IPPRs says the primary goal of the new municipal energy companies has been to provide lower prices for consumers, and thereby tackle fuel poverty. Robin Hood Energy in Nottingham, Bristol Energy and Our Power in Scotland have been able to offer lower tariffs than the ‘big six’ utilities and in this way to stimulate price reductions among their competitors as well. The challenge now is to extend beyond their retail supply role into the provision of energy efficiency services, renewable electricity generation and decentralised heat, and ultimately into demand management. But, IPPR concludes, ‘there remain as-yet unanswered questions about how many municipal energy companies the market can sustain, and how far trust in them will withstand future wholesale price increases. Given the UK’s changing energy system and the opportunities raised by new and more decentralised technologies, a national forum that convenes both local and community ventures could help to develop longer-term strategies to tackle the challenges facing this sector’.


*Sad to see that Cambridge based Solar Cloth Company, that raised £1m from almost 400 individual investors through crowdfunding, has collapsed into insolvency. It aimed to sell a light, flexible solar ‘cloth’ that could be placed on non-load-bearing roofs. The FiT cuts were evidently partly to blame.  
*Good to see this new green jobs initiative: [www.greenerjobsalliance.co.uk](http://www.greenerjobsalliance.co.uk) and Bristol’s heating plan: [www.theguardian.com/environment/2016/jun/09/bristol-mayor-marvin-rees-approves-5m-low-carbon-heating-scheme](http://www.theguardian.com/environment/2016/jun/09/bristol-mayor-marvin-rees-approves-5m-low-carbon-heating-scheme)*

**Wind will put the lights out**

At its annual Congress the GMB Union’s National Secretary, Justin Bowden, said ‘Over the last 12 months there were 46 days when wind was supplying 10% or less of the installed and connected wind capacity to the grid and on 4th November National Grid had to invoke special measures to keep the lights on. Everyone gets that over time sensibly sourced and UK produced renewable energy sources makes sense, but in the real world of the here and now we have to keep the lights turned on, homes heated and the economy functioning. This means that on the days when the wind doesn’t blow and the sun doesn’t shine we need a base load electricity capacity we can rely on. If your heating is turned off, your lights have gone out and your electricity supply has “Gone with the Wind”, the renewable energy suppliers cannot just shrug their shoulders and tell the public “frankly my dear we don’t give a damn”. The public want the lights to stay on, so until there is a scientific breakthrough on carbon capture or solar storage, then nuclear and gas are the only reliable shows in town which those advocating a renewable energy only policy have to accept.’  

[www.gmb.org.uk/newsroom/low-wind-days](http://www.gmb.org.uk/newsroom/low-wind-days)

Sorry, this won’t do! For over half of those 46 low wind days i.e. outside of winter, and for most of the nights, overall energy demand would have been low, so a low wind input would not matter. When it did, existing gas plants ramped up to provide the extra energy needed e.g. to meet daily peaks. But there are many other ways to do this: including using green-gas fired plants, smart grid demand management & storage and interconnector imports. All this exists and can be expanded - and could actually cut costs by avoiding waste/curtailment. Baseload nuclear plants are no use - they can’t vary output quickly. They just get in the way of the flexible supply and demand approach that is needed.
EROEIs for PV solar

The energy return on energy invested ratio can be below 1 in some locations, a recent study claimed, making it a net energy drain: www.sciencedirect.com/science/article/pii/S0301421516301379 See this quite enthusiastic relaying of it: http://euanmearns.com/the-energy-return-of-solar-pv/

But not everyone was convinced. See this comment: http://euanmearns.com/the-energy-return-of-solar-pv/-comment-18997 A lively and wide debate ensued: http://euanmearns.com/eroei-for-beginners/

Clearly EROEI energy output/energy input ratios are hard to calculate (how widely do you draw the boundary) and certainly some of the data, framing and assumption in this study can be challenged. Other studies have put the ‘cradle to grave’ EROEI ratio for good PV systems at up to 20:1 or more - 34:1 in some cases, with new cell materials and manufacturing technology likely to improve that: www.sciencedirect.com/science/article/pii/S136403211500146X

Certainly several studies have put energy or carbon payback time at 10 years at the worst and for many PV systems nearer to 1 year or even less: one anticipates that paybacks can be reduced to below 0.5 years by 2020. http://onlinelibrary.wiley.com/wol1/doi/10.1002/pip.2363/abstract

Christopher Emmott’s ‘Carbon Mitigation Potential of Emerging Photovoltaic Technology’, in a PhD from Imperial College, has PV payback times for greenhouse gas emissions in various countries ranging from 0.5 to 9.4 years. Although it may be that in some locations overall system returns can be lower, its hard to see how it could yield an EROEI of ‘under 1’ unless some very odd assumptions are made - even if major storage projects are assumed as part of the overall system to be assessed. For example, large hydro had a very high EROIE ratio, typically 200: 1 or more, and although pumped hydro storage usage cycles may reduce that, the overall system EROIE surely wont be reduced to below 1!! Some domestic systems with batteries may have low EROEI’s, at present, but that is changing fast as battery tech improves. PV certainly has one of the lower EROIEs of any renewable, and we do need to take note of EROEIs, but this study seems too extreme, with some odd assumptions. Though there was a debate with more aspects raised - PV in the north may have problems due to low capacity factors: http://euanmearns.com/the-energy-return-of-solar-pv-a-response-from-ferroni-and-hopkirk/

But, if so, is that really the case for Spain, as this earlier study argued? http://science-and-energy.org/wp-content/uploads/2016/03/20160307-Des-Houches-Case-Study-for-Solar-PV.pdf

And what about the solar breeder idea: www.azimuthproject.org/azimuth/show/Solar+breeder

German Grid balancing

A critique of the German Energiewende programme says ‘given that biomass and hydro potentials are finite and almost completely in use already, Germany’s energy system is increasingly dependent on intermittent sources of power. Despite all efforts to convert excess electrical power to hydrogen, methane, heat, or other storable commodities, and despite all progress made in battery research, there still is no technology in place at this time that can economically store electricity at a large scale.’ So there were problems: ‘First, the problem of generating electricity on cloudy and windless days could only be managed because utilities were obliged to cover these intermittencies by maintaining and running fossil power plants as backup source, in an uneconomic mode. Second, Germany’s electricity generation on windy and sunny days often exceeds by far the grid’s balancing abilities, forcing the power surplus into the adjacent grids of neighboring countries, and obliging other countries to compensate for German intermittencies. These solutions are neither sustainable nor possible in a carbon-free economy. Moreover, whether bold Energiewende-like concepts will be successful or not essentially depends on our ability to really solve the intermittency problem.’ http://thebulletin.org/germany’s-energiewende-intermittency-problem-remains9469 But see the linked comment by Michael Hogan. And this famed test project: www.kombikraftwerk.de/fileadmin/Kombikraftwerk_2/English/Kombikraftwerk2_Information_Paper_Simulation.pdf

PV stores ‘not economic’
http://instituteforenergyresearch.org/analysist/pavb
ck-on-tesla-powerwall-battery/ But see comments

Seems it can be done. Though that doesn’t mean it will all be easy - e.g. see this on flexible demand and lifestyles: www.ukerc.ac.uk/news/appliances-aren-t-flexible-people-are.html But also this: https://theconversation.com/heres-how-smart-power-could-help-the-uk-reach-100-renewable-energy-59344

That’s with conventional on and offshore turbines. But there’s also the wind kite idea, which would open up a new set of safety issues (e.g. aircraft would have to be kept away). However the high altitude resource is huge e.g. in the jet stream. Though some say it’s not that big: www.mnp.de/4689869/high_wind_low_energy Others disagree: www.kitegen.com/en/2012/03/22/the-max-planck-is-scared-to-fly/ Though no one yet is actually going that high with wind kites.

And down on the ground, some object to RSPB’s support for a wind project at its HQ: www.telegraph.co.uk/news/earth/wildlife/12176938/Controversy build riser turbines/ RSPB say climate change is the single biggest threat to birds… Meanwhile the Mail and GWPF gloat over this: www.thegwpf.com/windfarms-chief-admits-england-is-not-windy-enough-for-more-turbines/ Odd since RSPB says onshore wind could supply up to six times its current level: www.rspb.org.uk/Images/energy_vision_summary_report_tcm9-419580.pdf

And though the best UK on-shore sites are in Scotland, offshore England & Wales are best: www.carbonbrief.org/factcheck-which-parts-of-the-uk-are-windy-enough-for-windfarms

Hydro The debate rumbles on, e.g. on methane emissions. This overview still isn’t bad: www.scientificamerican.com/article/methane-emissions-may-swell-from-behind-dams/

Certainly the huge new 6 GW project in Ethiopia may lead to local problems and conflicts: www.sciady.net/globalenergy/data-visualization/africa-hydropower-future-interactive.html - introduction

The 40 GW Inga project in Central Africa is even more worrying - who benefits, at what cost? wwwinternationalrivers.org/resources/grand-inga-hydroelectric-project-an-overview-3356

Smaller hydro projects are arguably much better, less invasive, meeting local needs.

Solar car breeder Japanese carmaker and electric vehicle producer Nissan has installed a 4.75 MW solar farm in Sunderland - its biggest plant in Europe - which along with other renewable sources will generate enough power to build more than 31,000 cars p.a.

Solar capacity stats can be dodgy - depending on how you measure them and at what stage: www.renewableenergyworld.com/articles/2016/06/what-size-is-the-global-solar-pv-industry-pick-a-size-any-size.html

PV only supplies around 2% of electricity in the UK and 1% in the US: are we overstressing its role?

Solar storage benefits can vary too - utility scale may be best, depending on the tax regime: www.renewableenergyworld.com/uec/blogs/2016/06/storage_instead_ofr.html

Solar co-ops are spreading in the UK - one started up near us recently: www.gawcottsolar.co.uk

Other community-backed green energy project are also proliferating: www.sharenergysolar.co.uk/live/

Smart energy saving A new E2e working paper looks at the importance of the timing of energy saving activities. The value and use of electricity varies a lot over the day - and peak savings are clearly best: http://e2e.haas.berkeley.edu/pdf/workingpapers/WP023.pdf

Biomass DECC is backing waste AD rather than energy crops. But does this go too far? https://theconversation.com/energy-crops-have-been-a-major-flop-with-farmers-heres-why-60017

Here’s the UK state of play as seen by OFGEM: www.all-energy.co.uk/RXUK/RXUK_All-Energy/2016/Presentations 2016/Bioenergy 1/Edmund Ward.pdf?v=635993472226248594

BP stays conservative Renewables only at ‘2.8%’ of global primary energy.

And though they shown ‘a quicker pace of penetration than any other fuel source in modern history’, BP still suggests it will take another 20 years for them to account for 8% of the primary energy production. REN21 says renewables were delivering 6.4% without hydro, on a final energy use basis, in 2014. Methodological issues aside, someone seems to be wrong!

Not just warming & floods: the Gulf stream goes as well www.independent.co.uk/environment/gulf-stream-is-slowing-down-faster-than-ever-scientists-say-10128700.html

www.theguardian.com/environment/2016/jun/13/carbon-dioxide-levels-in-atmosphere-forecast-to-shatter-milestone

To cut CO2, we must switch to green/low energy globally - and fast. And big or small, it all helps: www.theguardian.com/environment/2016/jun/07/solar-sets-british-record-for-may-producing-more-electricity-than-coal

But some say CCS can help too - turning CO2 to stone: www.bbc.co.uk/news/science-environment-36494501

The bigger picture: www.theguardian.com/environment/2016/jun/14/putting-a-price-on-nature-is-wrong

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