Renew 2014
ANNUAL Review Dec 2014

Renewables continue to expand... and develop

With jobs booming, costs falling and new technologies emerging
some good, some maybe too wild...

..while nuclear declines

Running out of roof space for PV?
Go for solar patios, pathways, or even roads

... and for some other renewables-go offshore

500kW Nautricity tidal turbine, for Mull of Kintyre

Offshore Wind powers ahead in UK

After huge demonstrations against a new n-plant in Taiwan, it was abandoned...

NETWORK FOR ALTERNATIVE TECHNOLOGY AND TECHNOLOGY ASSESSMENT
Renew 2014  our end of year overview
ANNUAL Review Dec 2014

What’s new?

2014 saw flooding and air pollution hit the front pages in the UK (and elsewhere!), buttressing, in some peoples view, the attraction of renewables as a way to avoid problems like this. Though, with fears of costs rising, not everyone agreed! See Box below right. However, ‘green crap’ slurs apart, renewables have done quite well in the UK and even better elsewhere, with wind heading for 360 GW (see chart right for global distribution) and PV solar 150 GW globally. This annual review takes a look at progress on green energy supply, new techs and possibilities in the UK and globally. The technological prognosis looks good, but the political prognosis is not so good, at least in the EU. The European Commission has decided to abandon long-term mandatory national renewable energy targets (in favour of just an overall emission target) and also to phase of Feed-In Tariff support systems (in favour of a market based competitive auction/tendering process). That’s what is already being tried in the UK in the form of the CfD auction system. Germany is to do something similar, although it still retains its long-term 80% by 2050 renewables target. And the potential there is vast. For example, the current installed onshore wind capacity in Germany is over 34 GW, but Enercon sees plenty of scope for expansion, up to approx. 80-85 GW. And globally, GWEC predicts that there will be just about 600 GW of installed wind power capacity, by the end of 2018, double where the industry is today. It could be similar for PV solar, with relentless new cell technology innovation as well as module deployment, continuing. And as this annual review show there are many other options that could develop fast, given the chance.

Many see nuclear as getting in the way of renewables, so it’s covered here, as is energy efficiency, a much more compatible option, though we focus on energy supply.

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1. **Renewables 2014 Global Roundup**

Non-hydro renewables (wind power, solar, bioenergy) have grown rapidly to reach 6% of the world’s electricity, on top of about 16% from large hydropower, so nearly a quarter of world electricity already comes from these sources. Overall, renewables account for around 19% of total world primary energy. However, coal and oil each provide nearly one-third of total world energy, and coal is still the source of about 40% of world electricity. So there is a long way yet to go in making a global low-carbon economy. But we are getting there, as the 2014 **REN21** overview shows.

By 2013, more than 1,560 GW of renewables was installed, growing by more than 8% from 2012, with much of it now being in the newly developing world. 10% of the final energy used globally was from modern renewable plants, 9% from traditional biomass, with that share falling. That’s just as well given concerns about biomass use, even with new technology, e.g. in relation to the growth of unsustainable biofuel plantations. But interestingly, in **IRENA’s** 2014 review of renewable jobs globally, PV, at 2.27 million jobs, led by China, had overtaken biofuels at 1.45 million, the grand total for employment in renewables is now over 6.5 million globally, with wind at 0.83 million, and solar heating 0.5 million, mostly in China.

Renewables do seem to be doing well globally. Although, you would hardly know that if you listened to the likes of URENCO, the uranium enrichment company, whose head said, earlier this year, that the challenge for the nuclear industry was to develop mini-nuclear plants that ‘can beat wind power on cost’ for use in developing countries. He added ‘There is evidence that a modular plant can be designed that is every bit as safe as a windmill’. Bring it on!

**Energy Efficiency: the poor relation**

We need to do something quick about energy efficiency. EU states have made a non-binding commitment to improving energy efficiency performances by 20% by 2020 against levels in 2005. But they are not on track to meet this: [www.eceee.org/all-news/news/news_2014/2014-04-08](http://www.eceee.org/all-news/news/news_2014/2014-04-08)

Though there are some good projects [http://energytransition.de/2014/05/the-winner-is-passive-house/](http://energytransition.de/2014/05/the-winner-is-passive-house/)

And the European Commission is taking a slightly more aggressive stance these days, with a proposed 30% savings target for 2030, partly in response to worries about the reliability and cost of oil and gas imports from Russia - investment in energy efficiency offers quick and cheap ways to reduce demand. Germany and France both now have 50% by 2050 energy saving targets. That’s a good goal. [http://ec.europa.eu/energy/efficiency/events/2014_energy_efficiency_communication_en.htm](http://ec.europa.eu/energy/efficiency/events/2014_energy_efficiency_communication_en.htm)
Global developments - technology overview

From: www.worldnuclearreport.org  It notes that PV capacity has overtaken nuclear capacity in China. Globally, wind’s rising output since 1997 overtook nuclear’s small increased output in 2010, PV’s rising output since 1997 overtook nuclear’s in 2012/3.

What next? With oil prices falling, due in part to producer-supplier market policies, who knows what will happen next to energy costs and technology shares - one casualty might be shale gas!
For up in Germany, decentral ownership is challenging the power of the centralised utilities. Clearly contentious, as the talk of prosumer taxes! A opportunities for creative innovations to limit these problems, though the report notes destructive innovation also presents challenges to governments. It can't be all bad then! Though the up new options.

Along with 'green' value orientations, though the report says it has taken the FiT system to kick start it 'Grid defection' is rare in the EU. More common is self... taking control! Although to be fair, there is a need for some regulation to avoid chaos (e.g. to ensure grid balancing) and the policy and regulatory system can perhaps help to extend and support the transition to local green power.

In its RE Prosumer report IEA-RETD provide analyses of the influence of economic, behavioural and technological drivers as well as national conditions for prosumer growth. It aims to provide policy makers ‘with detailed analysis on the potential benefits as well as costs and risks in order to articulate the justification for prosumer-related policies’ and discusses the different forms that PV prosumer policy strategies can take based on the evaluation of drivers and national goals.

Not all the options discussed are attractive. It notes that ‘some PV projects in Germany can now be viably developed without the use of the feed-in tariff under the current policy environment. Developments such as these have led to vigorous debate within Germany about whether additional charges or taxes should be applied to PV prosumers.’ If it moves, tax it! Or slow it: ‘Even if PV LCOE decreased below the retail rate, governments and utilities could still govern (or constrain) the development of prosumers through the use of policy or the removal of enabling regulations (e.g. limiting the amount of PV that can be injected into the grid)’. Though it warns that ‘choosing to constrain the growth of prosumers creates the risk that PV prosumers could emerge suddenly and in a manner that is much more difficult - and costly - to govern in the future’.

The opposite approach is to embrace the revolution fully, though the report focuses more on transitional strategies, ‘incremental adjustments to existing policy and regulation - rather than fundamental or structural changes to the electricity industry or market’. It says ‘there may be opportunities to enable prosumer scaleup while at the same time introducing legal and regulatory reforms that encourage “prosumer friendly” structural shifts in current business models’.

There are of course different types of prosumer, the most radical being those going fully off-grid. ‘Grid defection’ is rare in the EU. More common is self-consumption, backed up by grid top-ups, sometimes coupled with selling excess to the grid. But this is all driven by the falling cost of PV, along with ‘green’ value orientations, though the report says it has taken the FiT system to kick start it - and it’s not yet self-sustaining. Though it may be soon in some places, with storage maybe opening up new options. The report notes that ‘prosumers can challenge incumbents’ business models’ and this destructive innovation also presents challenges to governments. It can’t be all bad then! Though the report notes that the resultant profit erosion makes it harder to invest in grid infrastructure upgrades, which may be even more necessary given the spread of distributed PV! But there are plenty of opportunities for creative innovations to limit these problems, though they will need funding. Hence the talk of prosumer taxes! And a shift from FiTs to systems which charge for connections, contentiously, as now in Spain and Germany.

Clearly it’s a politically charged area: along with the 900 or more local energy co-ops that have sprung up in Germany, decentral ownership is challenging the power of the centralised utilities. However, this thoughtful report tries to stay neutral and provides some helpful insights.


*For a good look at how small businesses have fared in the UK PV market see Green Building Vol.23/No.4
2. Global news - renewables to the fore
IPCC want clean tech to triple
Since 2007 ‘many renewable energy technologies have substantially advanced in terms of performance and cost and a growing number have achieved technical and economic maturity, making renewable energy a fast growing category in energy supply’. So said the Intergovernmental Panel on Climate Change - in volume 3 of its 2014 report. By contrast it said nuclear power ‘has been declining since 1993’ and there were concerns about ‘safety, nuclear weapons proliferation risk, waste management security, as well as financial and regulatory risks’. Overall it saw the renewable sector playing a leading role in boosting the world’s share of low carbon electricity to at least 80% by 2050, and said that policy support for renewables should be maintained. But shale gas might be OK in the interim. Some critics were unhappy with that. And also with nuclear being given any role. And not everyone saw CCS as a viable low carbon clean tech. The inclusion of biomass/waste combustion was also queried by groups like Biofuelwatch. However the IPCC does say ‘Barriers to large-scale deployment of bioenergy include concerns about GHG emissions from land, food security, water resources, biodiversity conservation and livelihoods. The scientific debate about the overall climate impact related to land use competition effects of specific bioenergy pathways remains unresolved.’ There were also concerns expressed about air capture/bio/ground storage of CO₂, and even BECCs: www.trust.org/item/20140409082838-m4pf7/ But on a wider issue, interestingly, IPCC says that the contribution of economic growth to GHG emission growth has been rising steeply over the past 30 years, while that of population growth has stayed static. IPCC report: http://mitigation2014.org/

Meanwhile the nuclear clean-up continues…

After Fukushima: Top soil and biomass is being collected and bagged in the exclusion zone. Moss is even being scraped off stones (see above). http://ccnr.org/Decontamination_Efforts.pdf
The full clean up will take decades to complete and the total costs are huge (£200bn plus). Disasters like this can also have long-term social impacts:
www.theecologist.org/blogs_and_comments/Blogs/2351503/when_life_becomes_a_shadow_after_nuclear_catastrophe.html
Wisely Taiwan has now decided not to press ahead with its new part-ready $10bn nuclear plant, the focus of major demos, with in April nearly 30,000 protestors blocking the capital’s centre - see our front page. The three existing plants are to be phased out by 2025, pending a referendum. In Japan, over 90% of respondents to the public consultation on the Abe administration’s new basic energy policy were opposed to nuclear power, and protests again proposed plant restarts have continued. The government however seems committed to pressing ahead with some restarts, although there is no question of new nuclear plants being built.

Global energy overview

With shale gas booming and money scarce, ‘some think it is the beginning of the end here for renewable energy in the United States’, Adam Umanoff, partner at Akin Gump, told the media last December*. And the International Energy Agency said that, while progress had been made on the deployment of clean energy, the current rate was too slow and ‘will not be enough to limit global warming to two degrees Celsius’ (Energy Technology Perspectives 2012: Pathways to a Clean Energy System). Certainly the advent of cheap shale gas has been seen as potentially slowing renewables growth. So is that a real and continuing threat?

The IEA says only around 15% of global annual investments in energy target renewables, most of the rest, over $1 trillion, is directed at fossil fuels.

Shale Gas- boom or a bust?

2014 was seen as likely to be the year when shale gas fracking would take the world by storm, as it’s allegedly it already had in the USA. ‘Fracking probably won President Obama a second term as cheaper fuel bills pushed household disposable income up by $1,200 a year and kept unemployment below the 8% mark, which has been fatal to presidents seeking re-election’ said David Taylor, in The Times, 19/12/13. Reuters’ map below suggested that many other key regions could also benefit, and despite opposition, the UK government sought to join in the flurry of exploration and development.

Critics say the boom may only be temporary, given that wells only produced for a few years after which there would be diminishing returns, but this potential tail-off has arguably been disguised by the expansion of the fracking programmes around the world. So we still don’t really know whether shale gas is going to have much of a long-term impact. Views differ. Some see it accelerating in net terms, up to 2040 and beyond (see the EIA’s 2013 projection for the US at http://www.eia.gov/pressroom/presentations/sieminski_03012013.pdf). Others think it will fade away long before then. In practice the outcome is likely to be shaped by other factors - e.g., if carbon emissions are taken seriously then shale gas use may be constrained, unless CCS can be deployed on a wide scale. The US EIA suggested that under high carbon costs, renewables and nuclear would boom more, with coal being all but extinguished. In the short term however shale gas does represent a threat to non-fossil fuels. It’s one reason why nuclear has declined in the USA, but its impact on renewables has so far been more muted - as their costs fall, they are still booming in the US and elsewhere, although perhaps not as much as they would if there was no shale boom. Then again there are those that say fossil gas, of whatever sort, is a good partner for renewables. So shale gas represents no real problem. Although try telling that to those having fracking projects imposed on them!

Bloomberg said in Feb. that independent US shale gas producers ‘will spend $1.50 drilling this year for every dollar they get back’. Though maybe they hope it will pay off in time. But what they can get may be limited to 40%: http://www.oxfordenergy.org/2014/03/us-shale-gas-and-tight-oil-industry-performance-challenges-and-opportunities/

What about fossil CCS?

If we are to continue to use fossil fuels, including shale gas, then **Carbon Capture and Storage** will be essential to avoid some of the emissions. Progress so far has been very limited and many argue that the economic costs will be very high. But others say the potential is huge: see the info graphic chart right, which was reproduced by the UK Energy and Climate Change Select Committee in its report on CCS. This seems very optimistic - and can we be at all certain the CO\(_2\) would stay put even if sites for injection were found globally on anything like this scale. Some CCS for biomass fired plants might make sense and carbon capture and use to make synfuels may also be possible, but fossil CCS seem to be a desperate attempt to keep fossil use going - at all cost. Renewables are likely to be cheaper and more sustainable and reliable long-term.

On the ground (or rather under it), the UK’s £1bn programme may at last be getting started, after a long delay, and the US and China have CCS programmes, but key EU player, Sweden’s Vattenfall, has pulled out of CCS research and Australia (a major coal supplier) has now also pulled out of CCS. It does seem a long shot. Though clearly not all agree! Energy and Climate Change Committee Chair, Tim Yeo MP said: ‘Fitting power stations with technology to capture and store carbon is absolutely vital if we are to avoid dangerously destabilizing the climate. After nearly a decade of delay DECC has finally got near to delivering two pilot Carbon Capture and Storage projects in the UK. It must now fast-track these projects and reach final investment decisions before the election to ensure this technology can start delivering carbon savings by the 2020s. These two demonstration projects will not be enough to kick-start the industry or have a significant impact on our carbon budgets, however. Ministers must also ensure that viable CCS projects not involved in the competition are able to apply for guaranteed-price contracts alongside other low-carbon energy schemes.’

The main supporter of CCS is of course the fossil fuel industry, but as the example of Australia illustrates in relation to coal, that only holds if they see carbon emissions as a problem, and in relation to gas, it only holds if they see new options like shale gas expanding. As noted above, there’s some doubt about that. With costs rising and well productivity falling, the shale boom may not be sustained and may in fact be a bit of a myth: [www.bloomberg.com/news/2014-02-27/dream-of-u-s-oil-independence-slams-against-shale-costs.html](http://www.bloomberg.com/news/2014-02-27/dream-of-u-s-oil-independence-slams-against-shale-costs.html)

Even the Select Committee say ‘The higher costs associated with fitting and running CCS means that it is likely to develop only in response to specific policy intervention and will need subsidy’. But who knows, it may get cheaper: [http://www.sciencedaily.com/releases/2014/05/140529142218.html](http://www.sciencedaily.com/releases/2014/05/140529142218.html)


And of course **energy efficiency** can trump all, cutting demand, and making it easier for renewables to meet it. DECC has identified 40% electricity savings as being possible in some sectors, in industry especially, by 2030. Though CHP/DH may be cheaper in some situations.
Renewables Compete despite falling fossil costs

Speculation about peak oil continues. Some say it’s still decades away, and others say it’s here: http://www.theguardian.com/environment/earth-insight/2013/dec/23/british-petroleum-geologist-peak-oil-break-economy-recession Whatever the reality on that, and on shale gas/oil (which some see as postponing peak oil), the negative view of the prospects for renewables portrayed by Umanoff* and others (see above) may have had more to do with the global recession, which slowed nearly everything, and that is now over, at least in the USA and bits of the EU. Although money is still tight, the falling cost of renewables should make them increasingly competitive with all comers - shale gas included. Umanoff said that wind generation (with a good wind resource where capacity factors hover around 50%) costs are now $0.04 -0.05/kWh compared to the mid-eighties when they were $.25/kWh. And in some markets, wind and PV are approaching grid-parity, he said, including wind in Texas and the Midwest and solar in the Southwest: in some markets, PV is coming in around $60-70/MWh range, making utility-scale PV in California, Nevada and Arizona a real success story. As this annual Review shows, it’s a success story that’s spreading.


Green Power- plus Heat, for grid balancing

It’s relatively easy to see how renewables can help to decarbonise electricity supply in developed countries like the UK, with good wind etc. resources, and also possible to see how their grids can be balanced, with a mixture of smart grid DSM/storage, supergrid links and backup plants, increasingly using green gas, not fossil gas, from bio-wastes and from surplus wind-to-gas conversion. Some of the back up plants may have to be fast start up open cycle turbines, but modern Combined Cycle Gas turbines can ramp up quickly to help maintain grid stability:


It’s also argued that biogas-fed Combined Heat and Power (CHP) plants, linked to district heating networks and large heat stores, can play a balancing role, as well as supplying green heat. The ratio of heat to power output can be varied to help balance variations in power or heat demand, and in electricity supply, with any excess heat being stored for later use. Indeed some enthusiasts say that a fully developed green gas fired CHP/DH/storage system, coupled large heat pumps using excess wind, could supply almost all heat and deal with most power balancing needs - the CHP plants would replace simple gas fired balancing plants. That is the sort of thing that might be developed in Denmark, where CHP/DH/ heat storage is quite well established. But in the UK it’s not: most heat is supplied direct by gas, and, perversely, the UK doesn’t have much gas storage.

So the rival view is that, the UK would be better off simply decarbonising the gas supply to domestic users, assuming that is that decarbonising heat by using green electricity is not seen as viable (it is certainly hard to see how the electricity grid could take over the full heating role - the gas grid deals with 3-4 times more energy than the power grid at present). The decarbonising of gas is beginning to happen e.g. in Germany, with green gas (AD biogas from wastes and gas from wind) being fed to the gas grid. While some worry that there wont be enough biogas from wastes and gas-from-wind to replace fossil gas, optimists say that, if so, syngas from fossil fuels can be used - made greener by CCS. That’s debatable - will CCS really work on a large scale? But overall it’s argued that using biomass conversion to biogas for heat supply is far better than burning biomass to make electricity, although the biomass/biogas CHP route does also have attractions, generating heat and power. See this presentation by Dr Ingo Weidlich from Leibniz Universität, which identifies challenges for CHP - District Heating/Cooling in the German context:


For regions without major grid links, like Africa, the story may be different, with PV-fed local mini-grids playing more of a role, alongside locally stored biogas from crop and waste AD.

The situation in rapidly developing countries like India is different again - see case study below. But everywhere PV is on the rise: USA 20 GW, Japan, 25 GW, Germany 37 GW- around 150 GW so far globally. And maybe 100GW longer term in China! CSP is also growing: US 2.5 GW, MENA 2 GW and 400 MW soon in S.Africa. All of this being grid linked.
IRENA looks to 30%+ by 2030

The International Renewable Energy Agency has reviewed likely developments up to 2030. See the summary chart below. It has renewables meeting around 30% of global total final energy consumption (TFEC) by then, and possibly more, depending on access issues and efficiency gains. And the contribution of renewables in the power sector is much higher - 44% of electricity. Denmark leads at ~97% (~66% of TFEC), but Germany gets to just over 60% (~48%) and the UK to nearly 60% (~28%). The US and Japan are put at ~40%, India ~38%, China ~37%. But in terms of absolute energy, the industry and buildings sectors gain most e.g. from green heat.

Table 1. Breakdown of global renewable energy share by sector and total

<table>
<thead>
<tr>
<th>Renewable share of:</th>
<th>as % of:</th>
<th>2010</th>
<th>2030 Reference</th>
<th>REMAP 2030</th>
<th>RE use REMAP 2030 (EJ/yr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Industry</td>
<td>Heat¹</td>
<td>Heat consumption</td>
<td>8%</td>
<td>9%</td>
<td>19%</td>
</tr>
<tr>
<td></td>
<td>Heat &amp; Electricity &amp; DH²</td>
<td>Sector TFEC</td>
<td>11%</td>
<td>15%</td>
<td>26%</td>
</tr>
<tr>
<td>Buildings (excluding traditional biomass)</td>
<td>Heat¹</td>
<td>Heat consumption</td>
<td>12%</td>
<td>16%</td>
<td>35%</td>
</tr>
<tr>
<td></td>
<td>Heat &amp; Electricity &amp; DH²</td>
<td>Sector TFEC</td>
<td>14%</td>
<td>20%</td>
<td>38%</td>
</tr>
<tr>
<td>Transport</td>
<td>Fuels¹</td>
<td>Fuel TFEC</td>
<td>3%</td>
<td>5%</td>
<td>15%</td>
</tr>
<tr>
<td></td>
<td>Fuels &amp; Electricity²</td>
<td>Sector TFEC</td>
<td>3%</td>
<td>6%</td>
<td>17%</td>
</tr>
<tr>
<td>Power¹</td>
<td>Generation</td>
<td>18%</td>
<td>26%</td>
<td>44%</td>
<td>62</td>
</tr>
<tr>
<td>District heat (DH²)³</td>
<td>Generation</td>
<td>4%</td>
<td>14%</td>
<td>27%</td>
<td>5</td>
</tr>
<tr>
<td>Total (as % of TFEC)</td>
<td>Modern + Access</td>
<td>18%</td>
<td>21%</td>
<td>30%</td>
<td>132</td>
</tr>
<tr>
<td></td>
<td>Modern + Access + EE (assumes the implementation of all the 3 SE4ALL objectives)</td>
<td>34%</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Modern + Access + EE + &quot;RE+&quot;</td>
<td>&gt;36%</td>
<td></td>
<td></td>
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</tr>
</tbody>
</table>

As we noted in the Nov-Dec Renew, this progress is driven partly by the continually falling cost of renewables and the percentage could be higher if energy demand can be tamed - as is assumed in the Greenpeace and WWF 2030 scenarios where renewables supply up to 45% of TFEC.

IRENA says that 'strikingly, taking external costs into account, the transition to renewables can be cost-neutral’. And in fact, on this basis, it is the most cost-effective supply option. But IRENA says it will require concerted action to get from the present level, which it puts at 18%, to 30% by 2030 (or higher with more energy efficiency investment). Otherwise, under business as usual policies, it will only reach 21%. IRENA REMAP 2030: www.irena.org/remap/

The US EIA still pretty gloomy

The US Energy Information Administration’s Annual Energy Outlook 2014 says that even taking into account incremental transmission costs and excluding subsidies, wind is cheaper than nuclear and coal new build in 2020. And between 2020 and 2040 it will be cheaper than gas combined cycle plants. See chart right of averaged levelised cost of electricity from different fuel types in US excluding subsidies. But the EIA also offers the chart below, suggesting that, despite wind being cheaper than all other options, by 2040 renewables still only make a relatively small total contribution. This seems to be since there is a lot of sunk costs in conventional energy plants, so their marginal generation cost is relatively low, even if fuel prices continue to rise. So they are kept running until they became obsolete. Fair enough, but since no new plants will be built, you would expect a tailing off and probably not as big a growth in gas as EIA projects. After all shale gas is unlikely to continue to be cheap (assuming it ever is) once the easier sites have been exhausted. Moreover there are likely to be policy changes, for example a carbon tax or cap, like the 30% by 2030 emission reduction EPA rule now imposed in the USA on coal plants. Or, for good or ill, an EU-styled cap and trade system. Or a withdrawal of subsidies for fossil and nuclear power, with the money retargeted on green energy! But there will be strong resistance from vested interests. e.g. in the EU the ETS has not worked well since the cap set was too high proved hard to get agreement politically across the EU e.g. from countries heavily reliant on coal. The US EPA had to include reductions in targets for some states reliant coal. But one way or another it ought to be possible if the political will is there. Long-term everyone gains. Will it happen? The US plan is welcome, but some say it’s full application will be resisted and that anyway it’s not enough: it will only cut US emission by 10% overall by 2030. www.hurriyetdailynews.com/carbon-plan-still-leaves-us-short-of-un-pledge-study.aspx? Though some say it will inspire other to adopt similar moves. China is a key test case and it seem to be moving that way: www.bloomberg.com/news/2014-06-05/china-studying-timeline-for-carbon-cap-to-include-in-next-five-year-plan.html. Australia definitely isn’t, but this nice overview says it could: http://www.businessspectator.com.au/article/2014/6/6/policy-politics/why-renewables-will-fail-without-carbon-price. The EU is trying! But there is a way to go. The IEA says we all have to do much better and invest much more in clean tech, and less in fossil fuel, or else face major crises: www.iea.org/publications/freepublications/publication/name,86205,en.html


*The US has allocated $3bn to the UN Green Climate Fund and the UK is set to donate £650m. It’s meant to provide assistance for developing nations in mitigating their carbon emissions and preparing for the effects of climate change.
**Around the world - a quick global tour**

**Renewables in the USA**

Renewables are supplying about 14% of US electricity, and are still expanding fast. Although there’s been a bit of a slow down for wind, still at around 60 GW, PV is moving up to around 20 GW. Things should accelerate more as and when the EPA’s new 30% by 2030 carbon emission reduction rules bite, although they don’t apply equally to all states: coal-heavy West Virginia has a got a concession, only having to cut by 19%, while some others are expected to do more, like New York State at 44%. And that’s only for coal plants - not for other emitters. So it’s only expected to cut total US CO₂ emissions by just over 6% from 2005 levels by 2020 and then 10% by 2030. But it could enable the US to meet the goal Obama committed to at the 2009 COP talks in Copenhagen: a 17% cut from 2005 levels by 2020. And the new target of a 26-28% emission cut by 2025 announced in November. US energy-related CO₂ emissions already dropped by 13.2% from 2005 to 2012, so its making progress, but some of that was due to the recession and they have gone up slightly since then. Note that none of this involves specific national renewables targets. And of course the EPA’s rules may yet get sidelined, as may the new targets.


It’s also worth noting that, as worded, it seems that EPA rules would encourage ratepayer subsidies to support 6% of a state’s existing nuclear capacity. Will some states opt for that?

http://safeenergy.org/2014/06/02/epas-proposed-carbon-rules/

**and the European Union**

It looks like the EU might just attain its goal of getting 20% of its energy from renewables by 2020, but after that it’s aiming for at quite low 27% by 2030 target. Though that might still be hard, given that the European Commission wants to abandon Feed-In Tariffs: odd since they are the main reason why it has done so well so far with renewables. It’s all no doubt part of the shift to the right, with nuclear and or shale gas seen by some as cheaper options. But the EC has backed better energy saving goals, to reduce fossil energy demand, given the problems with gas imports from Russia. And renewables will also do that: they are getting cheaper, so they are still likely to expand under a more competitive market regime: some EU countries have already surpassed the 2030 target. Renewables are certainly still expanding fast: as REN21 noted, 2013 marked the sixth consecutive year in which renewables had the majority share of new electricity generating capacity, with a 72% share in 2013. And that helped wind power to meet 33.2% of electricity demand in Denmark and 20.9% in Spain, while in Italy, solar PV met 7.8% of total annual electricity demand. But the big success was Germany, with, by 2014, 70 GW of wind and PV, supplying around 27% of power. In all by the end of 2013, REN21 says the EU 28 had over 117 GW of wind, 80 GW of PV and 114 GW of hydro, 360 GW of electricity generating renewables all in. At the end of 2012, renewables were supplying 24% of EU power and contributing to the 14% of EU primary energy renewables were supplying by then, and subsequently it will have moved on - heading for the 20% 2020 EU energy target. www.ren21.net/gsr

**The developing world**

The EU and (though less) the US have historically led. But REN21 notes that the developing world is now the major area of expansion. That’s obvious if you include China, currently pushing ahead very rapidly with renewables, but many other countries are also moving rapidly head, in South America notably. For example Argentina now has over 40% of total energy coming from renewable, El Salvador over 54%, Peru 48%, Venezuela 53%. Africa too is getting on board, if more slowly. But Asia leads - see below. That looks like being the way it will be in future.
Renewables in Asia: China, Japan & India

China gets a lot of coverage, rightly so, given its huge emissions, but also its vast renewables programme, and progress there is quite dramatic: see understandchinanenergy.org That provides a detailed information base looking at the economic, environmental, social and strategic problems of the existing energy options and at the opportunities for the new green options - as well as their potential problems. Looking to the future, see the ambitious proposals for getting 80% of China’s electricity from renewables by 2050, at http://worldwildlife.org/publications/china-s-future-generation-assessing-the-maximum-potential-for-renewable-power-sources-in-china-to-2050 But with its similarly huge population and renewable potential. India is also important, and, given its experience with the horrors of a major nuclear accident, so is Japan. We offer case studies from both below.

Fukushima heads for 100% Renewables

There are ‘100% by 2050’ renewables scenarios for Japan as whole: www.isep.or.jp/en/library/2918 And wind and PV are moving ahead quite well, with national level support programmes. But perhaps of more immediate interest are the local initiatives. For example, Fukushima prefecture wants ‘zero dependency on nuclear energy’ and has a goal to meet 100% of its electricity needs with renewables by 2040. It believes that investing in renewables will spur economic development and create jobs to help its recovery and rebuilding efforts. It aims to have 805 MW of installed capacity by 2016 - equivalent to 24% of the retail electricity demand of the prefecture, with 447 MW of solar PV, rising to 2 GW by 2030. Reporting on this welcome initiative, Renewable Energy World said ‘This goal appears to be easily attainable. As of January 2014, Fukushima already had nearly 1.6 GW of FIT-approved PV capacity.’

There’s already a 1.2 MW PV system at Fukushima airport and a Fukushima Renewable Energy Research and Development Center, with the National Institute of Advanced Industrial Science and Technology, a publicly funded research institution. Community projects are also emerging like a 1 MW PV system ‘of the people, by the people, for the people’ in Iwaki city. All the electricity it produces will be sold to Tohoku Power Electric Co, a regional investor-owned utility, with a 20-year feed-in tariff contract. Some of the revenue will be used for recovery and restoration of the town. In addition, REW says ‘several golf courses were closed due to the physical damage caused by the earthquake and others were closed due to a large reduction in the number of golfers, who stopped the activity due to fear of radiation from the nuclear power plant. As temporary storage sites, some golf courses were filled with bags of radioactive waste, however, others have been turned into solar generation sites filled with solar panels.’ For example, Laforet Shirakawa Golf course at Nishishirakawa town has been converted into a 2 MW solar project. The quake resulted in mudslides and cracks in the ground in the golf course covering over two holes out of the total eighteen holes. The company is planning to develop an 8 MW solar system over the remaining sixteen holes. REW also noted that a 26.2 MW solar project is now under construction at another golf course in Sukagawa city.

REW also reports on a novel project combining PV with farming, at Minamisoma city, 25 km from the nuclear plant. ‘On the city-owned, tsunami-affected land, the city built the Solar Agri Park, which includes a 500 kW solar system and two dome-shaped greenhouses Using hydroponic technology, plants are held in a medium without soil and receive a constant flow of nutrient-rich water at the roots. This method allows farmers to return to farming, eliminates use of possibly contaminated soil and removes consumer’s fear and risk of exposure to radiation.’ The PV panels cover ~ 25% of the roof space so that they don’t affect the growth of the strawberries and tomatoes planted underneath. Some of the electricity they generate is used for the green houses, the rest is sold to the Tohoku Electric Power Co. under a 20 year FIT contract. The park is also used to as an education centre. REW: http://www.renewableenergyworld.com/rea/news/article/2014/05/fukushima-japan-rebuilding-communities-with-solar-commits-to-a-100-percent-renewable-energy-by-2040?
India has been pushing renewables quite hard, with wind in the lead at nearly 20 GW so far, on top of its large 37 GW existing hydro element. But PV is a big new thing in India with 2.2 GW grid linked in place so far. The headline project is the vast Charanka Solar Park in Gujarat, which has so far attracted 21 solar developers. See picture below. The media often says it is 600 MW but actually its only 224 MW so far, though it’s due to expand to 590 GW soon. But land is scarce, so PV ideally should be on rooftops.

Alternatively, an interesting new idea is to use PV to cover areas of water e.g. irrigation canals, reducing evaporation: see picture right. Pictures from CSEs excellent Citizen’s Report on the State of Renewable Energy in India: http://csestore.cse.org.in/usc/books/state-of-renewable-energy-in-india-report.html Also see www.bridgetoindia.com/our-reports/case-studies/ for their free short solar handbook.

India’s target is to have 55 GW of renewable electricity generation by 2017, including solar, wind and biomass. In 2009 the Indian government approved the Jawaharlal Nehru National Solar Mission, which aims to enable 20 GW of solar PV energy to be deployed by 2022. The current Phase II targets installation of 9,000 MW of solar capacity between 2014 and 2017. There is also interest in tidal power, for example in the coastal Indian state of Gujarat, which has green-lighted an initial 50 MW tidal power project. In addition to solar heating/cooking, biomass is a widely used traditional source for heating, and biogas use has been extensively developed.

Funding problems have bedeviled development, as have weak grids, so some say that off-grid or mini grid community projects ought to be the focus. There’s also a slow moving, much opposed nuclear programme. But the overall renewable potential is huge. More at www.renewindians.com/
3. New stuff - some wild ideas, but some sensible ones too

Solar Roads [www.solarroadways.com/intro.shtml]

Why not use ridged toughened glass PV material for road-way surfaces? If it could be done safely and robustly, the potential is vast: e.g. that there is approximately 31,000 square miles of usable road surfaces in the US, and if all of these were covered the Solar Roadways system could produce over three times the electricity that is used by the entire country. The installation costs would be huge, even for partial coverage, but it could be combined with integral heating units to keep roads ice free and also LED lighting for road safety, and it’s argued the net power gain would make the system pay for itself over time. If roads prove too difficult, then pedestrian pathways and forecourts, or car parks, are options: see our cover picture for the US innovators prototype system under test. But what about leaves?!

[www.renewableenergyworld.com/rea/blog/post/2014/05/visualize-solar-powered-roads?]

Tracking PV - for solar car charging too

Tracking the sun to get maximum energy for PV cells and using fresnel lenses to focus the sun are standard practices with Concentrating PV: [www.ecnmag.com/articles/2013/11/cpv-technology-today-and-tomorrow]. But now they are being used for electric vehicle charging. The Ford C-MAX Solar Energi Concept car has 12sq m photovoltaic panel on its roof, which charge its onboard 7.6 kWh lithium-ion battery, at a module efficiency of around 20%, generating up to a peak of 300 watts from normal sun exposure. That won’t give a full typical daily charge, but that can be achieved if the car is sat under a special 12 sq.m solar canopy that is also being offered, which has fresnel lens array to focus sunlight by a factor of around 8, assuming the car is slowly moved (automatically under its own power) so that the lens/PV roof alignment is adjusted to track to suns movement to get optimal energy capture. Clever - pushing it up to 2 kW or more. Though doesn’t that assume the car is at home all day? Or that a canopy is available at work or wherever it is parked most daytime? Mains plug-in charging is available as a back up, which may be just as well (2.5 hours to full charge) since in electric-only power, a 20 mile range has been mentioned, but that’s boosted to 620 miles in petrol hybrid operation. Ford says that up to 75 % of all trips could be powered by the C-MAX Solar Energi Concept’s PV alone, depending on climate: we wonder about UK winters! And presumably not if its run at its top speed of 85mph too much, or with the aircon/heater on!

[www.theregister.co.uk/2014/01/02/ford_unveils_solarpowered_family_car/]

PVT: Next? PV integrated within a solar thermal glass vacuum tube: cooled PV works better.

[www.engineering.com/ElectronicsDesign/ElectronicsDesignArticles/ArticleID/6123/Photovoltaic-Thermal-System-Achieves-86-Efficiency.aspx] and [http://www.nakedenergy.co.uk/product/how-it-works]

The future of PV

Applications like those above may or may not prosper (see also later for more on Concentrating PV/PVT), but new cell technology is likely to change it all - maybe graphene: [www.graphenea.com/pages/graphene-uses-applications#U1voZ4X1vb] One new cell is claimed to have to 15.6% (lab) efficiency: [www.gizmag.com/graphene-solar-cell-record-efficiency/30466/]. That also uses perovskite, a new type of PV material which could well have significant impact, with predictions of up to 50% efficiency and named one of the breakthroughs of 2013. See [www.theguardian.com/sustainable-business/perovskites-future-solar-power] (and our UK section). Or could exotic Infra Red powered devices win? Harvard School of Engineering & Applied Sciences envision a system that would harvest energy from Earth’s infrared emissions, generating power direct in novel optoelectronic devices. Though there’s a way to go yet:


But here is one non-problem: [http://nationalreport.net/solar-panels-drain-suns-energy-experts-say/]


PV window pad - not sure about this: [http://bit.ly/YbOWrR]
Floating and Flying windpower

Floating wind turbines are well on the way to full development in the EU (and also Japan):

Wind kite ideas spread http://www.awec2013.de

Makani power http://www.makanipower.com/

- now run by Google. See left for their novel flying wing.

and cheaper than barrage concepts - a bit like the UK’s Tidal Reef idea. Tidal turbines are mounted in a causeway angled out to sea in such a way that the tidal flows parallel to the shore cause a localised head of water to be created on one side, enhancing the rate of flow through 2-way helical screw type turbines - so it works when the tidal flow reverses four times a day. There would be a T-section at the far end (see pic), but there’s no full barrage enclosing the water - just localised ‘piling up’ against the causeway wall. So it’s less invasive and cheaper than a barrage, though, unlike free standing tidal current turbines, it sill involves a large physical sea wall - expensive infrastructure, with eco impacts. A DTP causeway might even run 30-60 km out, with 8 GW generation capacity. See this video/animation: www.offshorewind.biz/2014/04/07/video-dynamic-tidal-power-concept/

It’s claimed DTP ‘doesn’t require a very high natural tidal range, so more sites are available and the total availability of power is very high in countries with suitable conditions, such as Korea, China, and the UK’. e.g. maybe 80-150 GW in China www.powerdtp.nl/press/default.aspx

*Despite higher costs/impacts some still see a potential for standard tidal barrages in some sites.

But tidal lagoons may be a better tidal range option -they are less invasive. See our UK section- the 240MW Swansea lagoon project looks like it may go ahead.

Micro-turbines for low-speed wind

Nippon Bunri University professor Akira Obata has built a micro wind turbine that works like the distinctive corrugated surface of a dragonfly’s wing and could generate power in very low wind speeds, such as the average in Japan of 2-4 mps. Meanwhile, Italy’s Enel Green Power is testing a 55 kW dragonfly-inspired micro turbine designed by architect Renzo Piano. Obata’s prototypes have generated 4.6 W at 5 mps, while in a 2 month test, Enel’s generated over 1200 kWh in wind speeds of 2 mps.

www.cospp.com/articles/2014/03/from-flotating-wings-to-micro-tidal-wind-turbines.html

Tidal Power

DCNS put the global potential for tidal stream at 90 GW

Conventional tidal turbines continue to proliferate e.g. Kawasaki Heavy Industries have completed a design study for a new tidal stream turbine, but details remain sketchy.


Ireland’s Open Hydro is to install 2 of their 2 MW open centered tidal current units in Canada’s Bay of Fundy next year. And Sweden’s Minesto is to test their Deep Green tidal kite off Florida. But the UK remains in the lead with a range of projects installed or under test - see our UK section (4). There is also interest in very novel ideas e.g. large floating tidal pontoons, with tidal turbines mounted, as well possibly as wave devices and wind turbines. Or the relative tidal movement between a pontoon and a fixed point can be used to generate power: http://social.tidaltoday.com/technology-engineering/tidal-pontoons-what-stalling-commercialisation?

Dynamic Tidal Power  Low-head causeway

The Dynamic Tidal Power (DTP) concept, developed by Dutch companies and now being taken up by China in a joint POWER group: Partners Offering a Water Energy Revolution. It’s a hybrid of tidal current/ barrage concepts - a bit like the UK’s Tidal Reef idea. Tidal turbines are mounted in a causeway angled out to sea in such a way that the tidal flows parallel to the shore cause a localised head of water to be created on one side, enhancing the rate of flow through 2-way helical screw type turbines - so it works when the tidal flow reverses four times a day. There would be a T-section at the far end (see pic), but there’s no full barrage enclosing the water - just localised ‘piling up’ against the causeway wall. So it’s less invasive and cheaper than a barrage, though, unlike free standing tidal current turbines, it sill involves a large physical sea wall - expensive infrastructure, with eco impacts. A DTP causeway might even run 30-60 km out, with 8 GW generation capacity. See this video/animation: www.offshorewind.biz/2014/04/07/video-dynamic-tidal-power-concept/

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*Despite higher costs/impacts some still see a potential for standard tidal barrages in some sites.

But tidal lagoons may be a better tidal range option -they are less invasive. See our UK section- the 240MW Swansea lagoon project looks like it may go ahead.

Solar fuel from CPV/PV-T

In his excellent new book *The Burning Answer*, Prof. Keith Barnham takes us through the options for solar derived fuel, including systems using CO2 from the air and focused lens **concentrated PV solar**, as the energy source. He describes the work of Aldo Steinfeld and his team at the Swiss Institute of Energy Technology at ETH Zurich who have developed a nano-structured gel that will absorb CO2 at ambient temperatures and release it again, with high purity, when the gel is warmed to 90°C (1). Barnham says this idea can be linked with the QuantaSol PV cell that he and his team developed (2): ‘a QuantaSol a version of the triple junction cell can be designed to operate with 40 % efficiency above 90°C in a concentrating (CPV) system. The 40 % efficiency means that 40% of the power in sunlight is converted into electrical power. What happens to the 60% of the power in sunlight that isn’t converted into electricity? It is wasted in most CPV systems. Most of it ends up as thermal energy: the jiggling of the atoms in the solar cell. That is something the manufacturers of CPV systems try to avoid because, as solar cells get hotter, their efficiency falls. One of the clever ways concentrator manufacturers keep the cells cool is to pump water through pipes immediately behind the cells. The cooling of the cells warms the water. If our cells are operated at 110°C (we have tested them at temperatures nearly as high and they work well) then the water should reach 90°C and can be used to release the carbon dioxide from Aldo’s nano-structured gel. The water cooling a concentrator system typically ends up less than 20°C lower than the temperature at which the cells operate.’ 

So-called ‘**PV-T**’ hybrid thermal-PV systems have been tested and give good results (3).

Using the waste heat of a CPV cell is an example of a combined heat and power system (CHP) and Barnham calculates that useful power can be extracted with up to 22% efficiency. So he says ‘from the 60% of the power in sunlight wasted as heat we can hope to extract 22% as useful power. That means we can extract 13% (0.6 times 0.22) of the total power in sunlight as useful power from the waste heat of CPV cells’. And summarising, he says, a rooftop CPV system with QuantaSol cells operating at 40% efficiency at 110°C could produce ‘somewhere between two and three times the electrical power of today’s technology from the same area of roof. In addition there will be useful power from the waste heat which would be equal to the electrical power of today’s rooftop technology. In all, the CPV system will produce nearly four times the power of current PV panels.’

He suggests using the first 13% to power the electrical equipment in the house as today, while the 13% from waste heat ‘could provide the power to extract the carbon dioxide which has been absorbed by Aldo Steinfeld’s nanostructured gels’, and ‘eventually some of the 40% efficient electrical power could be used to turn the carbon dioxide into solar fuels’.

He calculates that while that approach is being developed fully ‘the energy available in the waste heat of a rooftop CPV system is enough to extract the carbon dioxide from the air which the average new car in the UK emits covering the average annual domestic mileage’. 

The final step to a solar fuel may, he says, depend on the development of the ‘artificial leaf’ idea, with one approach being the **photo-electro-chemical cell** (PEC) producing a fuel like methanol directly. But hydrogen from electrolysis using PV electricity could be used to manufacture solar fuels, using captured atmospheric carbon dioxide, by conventional industrial processes.

It’s an intriguing area of development: see Barnham’s book for more on this and many other areas of innovation. [www.guardianbookshop.co.uk/BerteShopWeb/viewProduct.do?ISBN=9780297869634](http://www.guardianbookshop.co.uk/BerteShopWeb/viewProduct.do?ISBN=9780297869634)

**Refs**


And coming soon, a Palgrave book by Jo Abbess on **Renewable gas**, which includes hydrogen.
SolarLeaf - bioreactor façade

The world’s first building façade system to cultivate micro-algae and to generate heat and biomass as renewable energy sources has some structural glass photobioreactors, used as external cladding elements and dynamic shading devices. It’s fully integrated in the house’s building services system to harvest, distribute, store and use the solar thermal heat on site. The integrated system, which is said to be suitable for both new and existing buildings, was developed collaboratively by Strategic Science Consult of Germany, Colt International and Arup.

Arup’s web site explains that ‘The biomass and heat generated by the façade are transported by a closed loop system to the building’s energy management centre, where the biomass is harvested through floatation and the heat by a heat exchanger. The excess heat from the photobioreactors (PBRs) can be used to help supply hot water or heat the building, or stored for later use.’

They say the advantage of biomass is that ‘it can be used flexibly for power and heat generation, and it can be stored with virtually no energy loss. Moreover, cultivating microalgae in flat panel PBRs requires no additional land-use and isn’t unduly affected by weather conditions. In addition, the carbon required to feed the algae can be taken from any nearby combustion process (such as a boiler in a nearby building). This implements a short carbon cycle and prevents carbon emissions entering the atmosphere and contributing to climate change. Because microalgae absorb daylight, bioreactors can also be used as dynamic shading devices. The cell density inside the bioreactors depends on available light and the harvesting regime. When there is more daylight available, more algae grows - providing more shading for the building.’

Arup note that the SolarLeaf façade was installed for the first time on the BIQ house at the IBA in Hamburg in 2013 (pictured above) and add ‘in total, 129 bioreactors measuring 2.5m x 0.7m have been installed on the south-west and south-east faces of the four-storey residential building to form a secondary façade. SolarLeaf provides around one third of the total heat demand of the 15 residential units in the BIQ house.’ [http://www.arup.com/Projects/SolarLeaf.aspx]

Collecting solar energy and using some of it to power photosynthesis boosted by CO2 to make an algal biofuel is certainly clever, and the energy conversion efficiencies seem reasonable: Arup say the efficiency of conversion of light to biomass is currently 10% and light to heat is 38%. For comparison, PV systems have an efficiency of 12-15%, though for solar thermal systems its 60-65%. And the max temperature bioreactors can run at is also limited to about 40°C: higher levels would affect the microalgae.

Solar tower downdraft

US developer Solarwind are moving ahead with their 2,250 ft high concrete tower that will generate electricity by spraying water on hot desert air at the tower’s top. As the saturated air sinks, the down draft creates 50 mile-an-hour winds that are forced into tunnels at the base of the tower to drive wind turbines. Updraft convection ‘solar chimneys’, with wind turbines near the top, seem an easier option (you don’t need to have water, or to pump it up to the top!), but they have to be very tall to get the needed air velocity, up to 1km, with a large solar greenhouse around the base to provide the hot air. This down draft tower is quite tall though, and much fatter! Won’t that mean a lot of energy is embedded in the concrete? The developers nevertheless seem confident and are looking for $1.5 bn to try it out on the US-Mexican border, where they have support from a local town authority: [http://solarwindenergytower.com]

‘Solar Cloth’ to mop up sun’s energy A Cambridge start-up company has a fabric based PV material which it says will be used for canopies across 27,000 car park spaces.
Sahara Forest: desert solar

Sahara Forest, a company established in 2011, is to build a test and demonstration centre after opening a pilot facility in Qatar, the first CSP in Qatari. The 20 hectare test centre will be in Wadi Araba, Jordan. Its CEO says ‘The Sahara Forest project is designed to utilise what we have enough of to produce what we need more of, using deserts, sunlight, saltwater and CO2 to produce food, water and clean energy. By co-locating CSP with a saltwater-based evaporative cooling infrastructure, the thermal cycles of electricity generation or thermal desalination can be completed with ‘wet-cooling’ efficiencies, utilizing saltwater instead of freshwater, without the need for cooling towers. This is very valuable in hot desert environments, where wet cooling with freshwater is usually not possible and dry cooling leads to efficiency losses in electricity production of up to 10%. The combination of technologies also has advantages in addressing social and logistical challenges to project development. The Sahara Forest project creates a much wider range of economic activity and career opportunities than would a ‘single-purpose’ facility. This makes the project better able to secure ‘buy-in’ from a wide range of stakeholders at local, regional and national levels.’

A report based on Sahara Forest’s pilot experience claims that the saltwater cooled greenhouse can deliver at least 75 kilos of produce/sq m, and ‘significantly higher yields could be achieved in a commercial setup’.

CSPtoday notes that Sundrop Farms, one of Sahara Forest’s commercial partners, supplied the small-scale parabolic trough collector and thermal desalination unit used in the Qatar pilot, and has projects in Australia. Both the Sahara Forest and Sundrop Farms schemes represent solar-powered variations of a concept called the Seawater Greenhouse, which has been under investigation by a company of that name since 1991 and has been tested in a number of locations. Sundrop Farms, in fact, took over operation of a Seawater Greenhouse facility as the basis for its Port Augusta pilot. It’s pointed out that while Seawater Greenhouse installations rely on the condensation of water inside the greenhouse for desalination, the integration of CSP into the plant can provide additional energy while taking advantage of saltwater cooling.

Energy Saving in houses  CHP/DH v insulation

Sadly always the Cinderella option, energy efficiency suffers from it not being easy to measure cost effectiveness in wide systems terms. It’s relatively easy for a specific project like a house, but even there it depends on how residents use energy. Claverton Energy Group’s Dave Andrews has been asking for a while, what was the relative cost of retrofitting insulation versus heat supply using CHP/district heating, since his SETIS JRC study showed that CHP/DH had lower capital cost/tCO2 saved than renovation.

He finally got some generic figures for insulation costs as left - it seems that it gets pricey for high levels of energy saving. More maybe than from CHP/DH, which has low marginal costs. But this debate will run and run! Yes CHP/DH heat is free, but pipes are not, and insulation is fast. Though fully airtight buildings can have air quality/damp problems. For a good practice low energy housing guide: www.gbpn.org/reports/best-practice-policies-low-carbon-energy-buildings-based-scenario-analysis TSB’s analysis: www.innovateuk.org/retrofit-analysis Some rehab/retrofit examples: www.lowenergybuildings.org.uk/projectbrowser.php?fmd=0 Meanwhile one-off device plug-in tests continue, like this hydrogen Fuel Cell test in 1000 homes in 12 EU countries: http://dailyfusion.net/2014/04/27804 Wouldn’t CHP/DH be better in most cases? e.g.: www.cospp.com/articles/2014/04/2-fm-central-london-district-heating-contract-awarded.html

Compressed air storage

Energy storage

Not a new idea, but being looked at again in the US: using wind turbines to compress air to store in underground rock strata, then used later to drive a turbine to generate power when needed. In some CAES versions, the turbine burns gas, supercharged by the compressed air. In another CAES is combined with geothermal heat collection: http://dailyfusion.net/2013/05/study-proposes-storing-renewable-energy-in-rocks-9062/

Or use inflatable balloons under water! http://www.renewableenergyworld.com/rea/news/article/?id=1216201409/underwater-compressed-air-storage-fantasy-or-reality

Power to Gas


Organic flow battery

A Harvard team led by Prof Michael Aziz have demonstrated a new metal-free flow battery that relies on the electrochemistry of naturally abundant, cheap, organic (carbon-based) molecules, quinones, similar to the molecules that store energy in plants and animals. So far it’s just a bench test rig, but eventually it could offer low cost large scale storage of power from intermittent renewables: www.seas.harvard.edu/news/2014/01/organic-mega-flow-battery-promises-breakthrough-for-renewable-energy

Solid heat stores

RWE have been working in Germany on ADELE, a CAES compressed-air energy storage system, with heat storage in inert ceramic solids: www.rwe.com/web/cms/en/364260/rwe-power-ag/innovations/adelle/ Desert sand might also be used as a heat store, UAE’s Masdar Institute of Science & Technology has a Sandstock project aiming to develop a sustainable and low-cost system using sand particles as the heat collector, heat transfer and thermal energy storage medium, although it’s not immediately clear that using sand as a heat store will be much better than using molten salt. But it’s cheap! http://social.csp.today.com/technology/sand-csp-energy-storage-solution-future/ and http://social.csp.today.com/technology/two-innovative-technologies-cut-cost-energy-storage

Snow for energy storage: http://advantage-environment.com/byggnader/stored-snow-for-summer-cooling/

Metal hydride solid hydrogen storage: http://www.mcp.com/en/products/solid-hydrogen-

Audi’s A3 g-tron 1.4-liter 81 kW (110 hp) engine can run on petrol, natural gas, or e-gas generated by Audi. In e-gas mode g-tron is CO₂ neutral, Audi says, since they generate the methane from H₂ produced using green electricity www.greenecg.org/2014/02/20140213-audi.html


Li-Battery Power

A 2 MWh lithium-ion NEC battery storage system has been installed by Enel in Calabria Italy, to help manage grid fluctuations, fed by local wind and PV.

The VRB: www.pdeenerg y.com/

Li-S Graphene battery@ Lawrence Berkeley Lab www.theguardian.com/sustainable-business/breakthrough-batteries-lithium-sulphur-graphene

Graphene storage@Manchester University www.manchester.ac.uk/discover/news/article/?id=1216

Super-capacitors may soon have 2-4 times the energy density of the best Li-ion batteries www.idtechex.com/
New Grid systems: demand management

With the rise of renewables, it is becoming vital to develop grid systems that can deal with variable inputs effectively, and not just by back up plants. Demand management is one option, adjusting demand to reduce peaks. One way to do that is by charging more for power at peak times. But there can be problems with this—consumers may compensate for having to avoid doing things during the high charge times but doing more at other times! So, for example, they may run the air con system flat out to stay cool while coating over the peak. The result is that although peak usage may be cut, making system management easier, overall use may rise. It’s the same with systems which offer rebates to users who agree to decouple from the grid at peak times. Indeed in some cases there can be some perverse responses: http://energyathaas.wordpress.com/2014/05/12/money-for-nothing/

There are also some technical problems with demand management, especially if it becomes more interactive, with some loads being remotely or automatically switched off at peak times on the basis of smart grid dynamic management arrangements with consumes or consumer controlled pre-set smart meters, designed to cut use at peak times. At present, grid managers make use of demand forecasting techniques based on historical data to plan ahead, but with interactive systems they will have to use fully real time data on line. This can be done, but it needs a lot of IT!

Storage Another approach is of course energy storage - see above. BBC 4’s Costing the Earth radio show ran a helpful overview in May, which looked at some of the front runners. It covered pumped hydro; lithium-ion and cheaper but so far life-cycle limited lithium sulphur batteries; and power to gas electrolysis, with an input from Graham Cooley of ITM Power. He put the options in perspective: ‘energy storage is segmented in terms of discharge time and scale. So, if you want a very small amount of energy storage almost instantaneously, you’d use a flywheel. If you want two hours of energy storage, you’d use a battery. If you want a few hours, you’d use pumped hydro. But if you want years, or seasons, of energy storage, you use hydrogen, Power to Gas energy storage. And the reason for that is that the gas grid that’s storing that energy, is so large.’ Finally it looked at Gaelelectric’s huge Compressed Air Energy Storage system, with a vast underground cavern being excavated in salt in a hill in Northern Ireland. When completed its claimed it will be able to supply 285 MW for 8 hours: http://www.gaelectric.ie/index.php/energy-storage/energy-storage-team/

There aren’t suitable sites everywhere, but DECC’s Chief Scientist, Prof. David McKay, was keen on the idea. He told the BBC ‘It has absolutely enormous potential because there are places with appropriate geology for making large underground caverns, [Cheshire?] and so it is a technology that could be done at very large scale, in contrast to pumped storage, where we’ve only got one Snowdonia, and one Highlands of Scotland, and so there’s only a limited land area that could conceivably be used for any additional pumped storage’.

Though he added ‘Another technology that’s coming up and looking very promising is an invention that’s being developed by a company called Isentropic and they’re trying to develop an extremely efficient heat pump that could be used to take electricity and use it to pump heat from a cold pile of rock into a hot pile of rock, and then when you want your electricity back, you run the same heat pump in reverse, to turn the heat back into electricity. And a prototype of this is being developed in Southampton at the moment. Now again, this could have really large potential. It would occupy far less land area than pumped storage facilities. So if the costs can be driven down enough, and if it performs as well as hoped, it could be a substitute for pumped storage that could be deployed at much larger scale.’ He was a bit less enthused by power-to-gas: ‘The biggest concern on that side is the risk that the electrolysers will remain expensive, and if you’re only using them say 10% of the time when the sun’s shining, then you’re not getting very good use out of those expensive assets’. But isn’t that true of all storage systems? Offset by the high value of the energy they can supply when it’s needed? www.bbc.co.uk/programmes/b042zsy5
High potential for waste-based biofuels

‘Wasted: Europe’s Untapped Resource’, a study backed by coalition of technology innovators and green NGOs, convened by ECF, suggests that Europe has a significant untapped potential for converting wastes from farming, forestry, industry and households to advanced low-carbon biofuels, but only if it sets a strong sustainability framework and ambitious decarbonisation targets for transport fuels in 2030. The study found that if all the wastes and residues that are sustainably available in the EU were converted only to biofuels, this could supply 16% of road transport fuel in 2030. If advanced biofuels from wastes and residues are sourced sustainably, they can deliver GHG savings of over 60% even when taking a full lifecycle approach. Safeguards would be needed to ensure this resource was developed sustainably, including land management practices that maintain carbon balances and biodiversity, water resources and soil functionality. If this resource were utilized to its full technical potential, up to €15bn of additional revenues would flow into the rural economy annually and up to 300,000 additional jobs would be created by 2030. While some combinations of feedstock and technology will require short-term incentives, others are close to being competitive and require little more than policy certainty.

http://ukerc-news.org.uk/UP4-270L8-7OPMNG-Y4F02-1/c.aspx But see p.39

Seaweed for energy


Sour Gas

There are also more intermediate fossil-fuel based options. Like using the CO2 and H2S that’s in naturally occurring sour gas to make (more) methane. About 40% of global fossil gas reserves are sour gas, and the CO2 etc has to be removed to burn it more effectively - so why not use this, along with other sources of CO2, to make fuel. There are some clever new catalytic conversion ideas. Sour gas is still a fossil source, but processing it is better than venting it, or the CO2, to air. See Bakar et al, Modern Applied Science 2,(3), May 2008, pp42-50

Cost-cutting HVDC wind-to-grid link

GE Power Conversion has completed trials in Leicester of PassiveBoost, a system that allows power networks to use direct current (DC) produced by wind turbines. It could cut the cost of offshore wind energy by 15%, with, instead of the normal alternating current (AC) transformer inside every wind turbine, DC being supplied direct to a high-voltage DC power collection grid. They say DC to AC conversion wastes energy and ‘prices of materials in a conventional transformer are rising’.

Grid balancing

Some clever ideas to help balance variable grid power. Following the nuclear phase out in Germany, Siemens is using grid power to spin up some of the now redundant generator-turbine sets of the 2.5 GW Biblis nuclear plant, so they act as a rotating synchronous condenser/generator to provide grid voltage support. So even bits of old dead nukes can help!

www.energy.siemens.com/hq/pool/hq/automation/power-generation/electrical-engineering/e3000/download/biblis-a-rwe-power-ag-electrical-solutions-generator-synchronous-condenser_sppa-e3000.pdf The same ‘spinning for grid balancing’ idea has been used for the condensers of two old US gas plants at Huntington Beach, but only as an interim measure, given the loss of input from the now closed 2.2 GW San Onofre Nuclear Generating Station (SONGS).

www.powermag.com/aes-uses-synchronous-condensers-for-grid-balancing/

Solar jet fuel

An EU backed project has made the world’s first solar jet fuel from water and CO2, using focused CSP to run a high temp ceria redox process - in the lab. www.solar-jet.aero

Fuel from sea water


*There are also many ways to reduce demand peaks and also to reduce energy waste overall: e.g. www.iea.org/wps/wcm/connect/a87be50044581e9889678dc66d9c728b/IEC+Waste+Heat+Recovery+Report.pdf?MOD=AJPERES

Grid reliability and security issues are growing as renewables expand, but that’s not the only problem: www.peakprosperity.com/blog/86200/electrical-grid-may-well-next-wars-battlefield
Norwegian power company Statkraft has shelved its pressure-retarded osmosis (PRO) project, saying that that the technology could not be sufficiently developed within the current market outlook to become competitive ‘within the foreseeable future’. It had tested a 2-4 kW prototype and there was talk of 1-2 MW units. But they say ‘There are other technologies which have developed enormously in recent years. These are more competitive and relevant investments for us in the future. We are now leaving the process of maturing the technology to others, as several independent public and private enterprises around the world are looking into this already.’

So perhaps someone else will run with it. The PRO process involves creating osmotic pressure across a semi-permeable membrane with seawater one side and freshwater on the other. The freshwater, compelled by osmosis, flows across the membrane, diluting the saltwater and increasing its volume, hence creating pressure which drives a turbine.

www.powermag.com/statkraft-shelves-osmotic-power-project/

.. and some geo-engineering projects may not be sensible

Air capture of atmospheric carbon dioxide (CO2) has been proposed as a somewhat desperate geo-engineering attempt to deal with climate change. The idea is to absorb CO2 by sucking air through vast towers of sodium hydroxide, with the resultant bicarbonate mulch then being stored or recycled. Superficially it sounds attractive - you can capture CO2 anywhere, not just from power plant exhausts. Fill deserts with so called ‘green trees’. But quite apart the need to store or process the huge volumes of residue, the proportion of CO2 in the air is 0.039%, so to capture a ton of CO2 you would have to process over 2500 tons of air. The energy cost would be high. And, done on a wide scale, absorbing CO2 from the air might lead to disruption of natural absorption processes, by plants and the sea, so you may be no better off. One study suggested that mass removal of air CO2 ‘leads to an increase in the ocean-to-air CO2 flux, largely replacing the air CO2 removed’ i.e. in time, the seas would outgas trapped CO2 given the reduced partial pressure. It argued that ‘excess ocean CO2 removal is required for any effective air CO2 capture scheme because removal of air CO2 alone will simply reduce air CO2 concentration relative to that in the ocean’. And it even claims that ‘schemes that consume/remove and sequester excess ocean CO2, therefore effectively address both excess ocean and air CO2, sidestepping the need for direct air CO2 capture’. http://iopscience.iop.org/1748-9326/5/2/024011 Removing CO2 from sea water needs energy, but concentrations are ~ 140 x higher than in air and there are some clever ideas, including for fuel production:

http://www.pnas.org/content/110/25/10095.abstract

There are other options, with perhaps less eco-worries, e.g. biochar production using biomass-trapping CO2 more permanently as charcoal: http://carbon-negative.us/docs/CharcoalVision.pdf and www.biochar.ac.uk/ But see: http://climate-connections.org/2013/07/24/the-problem-with-biochar/

And it doesn’t escape the sea outgassing problem. Neither does BECCS, biomass energy carbon capture and storage. Although, depending on the source, it might be CO2 negative, so some say that, since geological/aquifer CO2 storage space will be limited, BECCS projects should be given priority access to it. Even if no-one can be certain CCS will store CO2 securely long term, from wherever it is captured - and the sea will still outgas slowly to compensate, for a long time ahead.

When it comes to some of the larger scale geo-engineering projects then we enter a realm where there could be major impacts: seeding the sea with ferric compounds to increase bio-productivity, blocking sunlight with aerosol particles, orbital reflecting mirrors and so on. A recent study concluded that, not only could there be local or global side effects, the overall effectiveness was low: even if continuously deployed on a massive scale, the climate engineering methods it evaluated could ‘only sequester an amount of atmospheric CO2 that is small compared with cumulative anthropogenic emissions’ and were ‘unable to prevent the mean surface temperature from increasing to well above 2 °C by the year 2100’. Tragically that also seems to apply to reafforestation, quite apart from the sea outgassing issue - which, over time, also applies to trees: they can help deal with some new emissions, but not all, and, overall, too much CO2 has been released, and trapped partly in the seas, to let us get the planet back even near to how it was.

http://www.nature.com/ncomms/2014/140225/ncomms4304/full/ncomms4304.html
And finally.. some really wild cards

Free Energy! Power from perpetual motion?

For years Free energy websites have been promoting various ideas about how ‘over unity’ energy can be produced. It’s rare to see evidence of examples actually working, but common to hear claims that ideas have been suppressed. Even if we do sometimes tire of endless sealing wax, wire and magnet concepts, you never know someone may come up with something. So we try to keep an open mind. Though, it’s with some trepidation that we relay the following apparent challenge to the Laws of Thermodynamics! Free The World (FTW) have released information on an open source basis on how to build a Quantum Energy Generator (QEG), which they claim can provide 10 kW of power output for less than 1 kW input, which it supplies to itself. FTW says it ‘has never, nor do we ever intend, to own or control the QEG. It is a gift to the world. Now that we have given away the technology, it is up to the people to build, research, promote, prove, demonstrate, innovate and share’. Detailed construction notes, replete with warnings about the hazards of working with high voltages, are downloadable from: http://be-do.com/index.php/en/ This says ‘An effective way to understand the operating principle of the QEG is to think of it as a high-powered, self-resonant oscillator (a power tank circuit), which generates high-voltage AC (15 to 25 kV). These HV oscillations are then transformed into line voltage AC output, at current levels up to approx. 85 A… In the QEG, input power is used only to maintain resonance in the core, which uses a small fraction of the output power (under 1000 watts to produce 10,000 watts), and once running, the QEG provides this power to its own 1 horsepower motor. This is known as over-unity. Once the machine builds up to the resonant frequency, it powers itself (self-running).’ We wait to hear if anyone builds one that works without a mains plug. www.fixtheworldproject.net/qeg-open-source-documents.html For a perhaps not very convincing/motivating photo of one assembly (as above) and more info, see this effusive account: http://www.collective-evolution.com/2014/04/30/free-energy-live-in-action-this-is-breathtaking-as-science-is-being-re-written For a much more critical look see: www.metabunk.org/threads/debunked-quantum-energy-generator-qeg-10kw-out-for-1kw-in.3572/

And defining the context… the climate debate

Many of the technological innovations and policy commitments in the sustainable energy field may be irrelevant or even dangerous if you believe the outpourings from climate skeptic groups. The current view they often put forward is that, while climate change may be happening, it may not be much to do with human activities and in any case will be slow and can be dealt with mainly by adaptation (see Lord Lawson’s views on p. 2), not by massive changes to energy generation and use, although if that is felt to be needed, then nuclear and perhaps shale gas with CCS are the best options, not unreliable and expensive renewables.

The Global Warming Policy Foundation (GWPF), set up by Lord Lawson, is well known for its often strident lobbying on energy/climate issues, backed up by reports from academics evidently sympathetic to its views, overseen by an Advisory Council. In the last year it’s made much of the resignation of one such, who claims to have been subject to peer pressure to distance himself from the GWPF. http://www.thegwpf.org/the-bengtsson-affair-and-the-global-warming-policy-foundation/ The climate debate has certainly been bitter at times, with skeptics alleging that the official IPCC stance is unduly politically shaped. Academics of all types and persuasions can and do align themselves with lobby groups, although they then do risk charges of bias. That’s fair enough - it comes with the territory. But personal attacks are much less justifiable. Although identifying political and institutional affiliations may be valid, in general critics should play the ball, not the man (or woman). While many do not see GWPF as making a helpful contribution, the debate has to continue, with heretical and ‘outlier’ views playing their part. That surely is how good science is done. Though there must be limits! It’s pretty clear that the world is not flat… But we would certainly miss the GWPF’s lively and controversial mailings! Including their wonderful selection of right wing/conservative cartoons. http://www.thegwpf.org
4. The way ahead for the UK

We are already familiar with the wind and solar options, and they have very large potentials, and can and should continue to accelerate (see below), along with energy efficiency, but there are also some new or less familiar possibilities, some of them also quite large, as is explored further below.

Wind power - blowing hard

There are still many opportunities for the expansion of on-land wind, up to and beyond the governments target of 12 GW by 2020. It seems DECC are scaling back offshore wind targets, with just 9-10 GW by 2020 now being talked about, compared to its 2011 Renewables Roadmap assessment of up to 18 GW by 2020 and earlier talk of 30 GW or more. But DECC says that 39 GW might be possible by 2030, and that seems a good target.

Solar power - a bright future

DECC has noted that Government scenarios in the Final EMR Delivery Plan indicate that up to 10-12 GWp of solar PV could be deployed in UK by the end of the decade. But with recent growth, additional capacity already in the pipeline could actually get close to 10 GW much sooner. And as set out in the Solar PV Roadmap, the sector hopes to see PV move towards grid parity over the next few years which would create scope for more ambitious deployment, so 20 GW early in the next decade, if not before, seems possible.

DECC was also keen on industrial applications, like that shown left: JB Wheaton & Sons, a transport and warehouse company, based in Somerset, has installed around 800 kWp on its roofs and another 800 kWp on adjacent waste ground. DECC also noted that the UK has good PV R&D capacity, with new technologies emerging. For example, Oxford PV pioneered the development of perovskite thin film solar cells, which can be printed directly onto architectural glass to produce transparent or opaque coatings. This glass can be integrated into unitised facades for the construction of tall glass buildings. Under laboratory conditions, cell efficiency of 17% has been reported for opaque cells. Longer term, 20% or more might be possible for cells:

www.oxfordpv.com/photovoltaic-cell-technology.html

*Liverpool University’s less toxic cadmium telluride cell uses a cheap magnesium chloride activator: www.independent.co.uk/news/science/breakthrough-in-solar-panel-manufacture-promises-cheap-energy-within-a-decade-9563136.html
Bioenergy - one to watch  But see our Hopes and Fears section

Not everyone thinks biomass conversion of large old GW sized coal-fired plants like Drax is a brilliant idea - far better surely to build new more efficient purpose-designed units and to avoid importing wood chips from North America. For example, Renewable Energy Generation has signed contracts with Finning UK and Caterpillar Financial Services (UK) Ltd for construction, operation and financing of an 18 MW plant at Whitemoor Business Park near Selby, Yorks, using recycled waste cooking oil. It’s expected to cost £6.3m and be operational late 2014. But it’s small, reflecting, amongst other things, local shortages of waste bio-material. That’s why some big municipal waste combusters have to truck in waste from far away to get economies of scale. Then there are the eco/emission issues. Gasification plants are said to be cleaner than mass burn plants: http://www.gasification.org/page_1.asp?a=87 But there are limits. Some see AD biogas production from wastes as a better idea. Maybe 20 TWh p.a. or more. And Imperial College London says propane can be made from glucose using a genetically engineered version of bacterium E coli. http://theconversation.com/how-we-tricked-e-coli-bacteria-into-making-renewable-propane-31209

Overall, by 2050, 44% of the UK’s energy requirements could be met by the increased utilisation of biomass sources, including household waste, agricultural residues and home-grown biofuels, according to the University of Manchester Tyndall Centre for Climate Change in a report in March. It suggests that biomass residue resources from ongoing UK activities, like agriculture, forestry and industrial processes, could potentially contribute up to 6.5% of primary energy by 2050. It says the potential bioenergy generated from agricultural residues, particularly from straws and slurry resources, was one of the biggest opportunities due to their abundance and current under-utilisation. UK waste resources were also found to represent a major potential opportunity for the bioenergy sector. The research highlights that both household and food/plant waste streams represent particular potential for the sector. Better than burning trees! www.tyndall.ac.uk/communication/news-archive/2014/uk-failing-harness-its-bioenergy-potential

Green synfuel for aircraft

US firm Solena Fuels is to build a plant in Essex to process 575,000 tonnes/yr of residual post-recycling municipal solid waste into aviation fuel in partnership with British Airways. The ‘GreenSky London’ plant will be the world’s first to convert waste destined for landfill into jet fuel, at the Thames Enterprise Park, part of the site of the former Coryton oil refinery in Thurrock. Once operational it is should produce 120,000 tonnes/yr of liquid fuels, of which BA has agreed to buy 50k tonnes of aviation grade fuel at market competitive prices. The plant will use Solena’s patented high temperature plasma gasification technology to convert wastes into synthetic gas, which will then be converted into liquid hydrocarbons using a Fischer-Tropsch process and hydrocracking, with electricity as a byproduct. How green is it? That depends on the ratio of biomass to plastics in the waste, on emissions from the process and on how much energy it takes to run. www.waste-management-world.com/articles/2014/04/video-ba-plasma-gasification-waste-to-jet-fuel-facility-set-for-take-off-in-essex.html See also ‘Solar jet fuel’ in our New Stuff section. And for wood waste pyrolysis to make biofuel for ships see: www.theengineer.co.uk/rail-and-marine/news/wood-waste-derived-marine-biofuel-project-under-way/1018654.article

UK-Iceland supergrid link

DECC has supported the plan to import geothermal power to the UK from Iceland via an underwater HVDC connector, with a MOU signed by the countries in May 2012. Now the Atlantic Supergrid Corporation has been getting private funding sorted - £4bn is needed for a 1000 km 1.2 GW link. Still a way to go... www.disruptivecapital.com/content/atlantic-supergrid-corporation-team

A bit nearer home, the geothermal project in Manchester is evidently progressing well:

http://www.renewableenergyfocus.com/view/37556/manchester-geothermal-project-moves-forward/

And heat extraction from one of the old abandoned geothermal hot dry rock wells in Cornwall has been restarted.
Marine Renewables

Wave and tidal power

The Marine Energy Technology Roadmap produced by the UK Energy Research Centre and the Energy Technologies Institute recommends that to move ahead successfully, levelised cost reductions from 20-50p/kWh today to 10-20p/kWh be targeted by 2020 and 5-8p/kWh by 2050. It says a target energy cost of 8-10p/kWh for array-scale schemes must be delivered by the mid-2020s to set ‘a trajectory towards significant marine energy deployment’ in the UK by 2050. The report also identifies 40 technology and deployment issues and prioritises them. It’s a bit odd that wave and tidal stream technologies are treated as one, undifferentiated, when in reality it seems they are developing at different rates (tidal mostly faster) and face different problems, but there are some generic similarities e.g. in terms of offshore access/deployment issues, and grid links.

Wave energy  CETO to test its wave energy device using the Wave Hub.

Australian firm Carnegie Wave Energy plans trials at the Wave Hub, an electrical ‘socket’ in the seabed, 10 miles off Hayle in N. Cornwall, in 2016. Its Ceto Wave Energy UK offshoot said it hoped to install its submerged buoy system there, 3 MW initially, but with the option of a 10 MW upgrade later. Many other wave devices are already under test in the UK, most being UK designs. The most advanced are the Pelamis wave snake and the Oyster hinged flap, tested at EMEC on the Orkneys. It’s taken a while for customers to turn up to use the Wave Hub, but now at last they seem to be - it avoids each project having to install its own connections to land. In addition to Ceto, Finnish company Fortum says it wants to test equipment there, possibly the Penguin, developed by Finnish wave power company Wello. So do Seadrift. Scandinavia’s Fred Olsen and Irish firm Ocean Energy also previously said they would.

Tidal Current turbines

Tidal current turbines development is in many ways easier and so more advanced than that for wave devices (it’s calmer under the sea than on the surface) and the resource is of similar size. MCT’s Seagen still leads, but Open Hydro is also doing well, as are many others: e.g. Nautricity’s 500 kW 2 bladed contra-rotating Cormat is on test at EMEC Orkney, before moving to Mull. See our cover. And the novel Tidal Kite is under test in N. Ireland, while the 400 MW Mygen/Atlantis Pentland project is making progress. Meanwhile Tidal Stream are developing their novel multi-turbine platform system - see concept pic above. And TELs Delta Stream is being tested off Wales.

Tidal Lagoons - trapped lunar power

Three tidal lagoons could be in operation around Britain by 2021 producing large-scale low carbon power at a lower price than offshore wind, according to developer, Tidal Lagoon Power. The company said a report commissioned from consultants Pöyry, confirmed the lagoons, starting with one at Swansea Bay in south Wales, could produce power for about £100/MWh. That compares with recent government calculations for a deep-sea offshore wind farms in 2021 of about £131/MWh. The cheapest of the projects assessed, Lagoon 3, had a cost of about £90/MWh, broadly similar to onshore wind. Lagoons, whether fully off shore or linked to the coast, as these are, should have much lower environmental impacts that cross-estuary barrages, though freestanding fully offshore lagoons might be even better. But shore linked lagoons could offer flood protection in some key areas e.g. a Bridgewater lagoon off Somerset. And lagoons in general could also offer some short-term energy storage/grid balancing capacity, acting as low head pumped hydro plants, especially if subdivided into segments that could be drained and filled in turn.

Sources: Guardian 21/3/14 and www.tidallagoonswanseabay.com
**Water-source heat pumps**

There are already large water-source heat pumps schemes in Scandinavia, feeding heat to district heating networks. About 60% of the total energy input for Stockholm’s Central Network is provided by a district heating plant with six 1180 MW heat pumps (total heat supply 420 MWth) used for base load supply, along with a (mostly) bio fuel-fired backup plant (total heat capacity 200 MW). The heat pumps use the sea (pic. above) as a heat source. Warm surface water is taken in summer, while in winter, the water inlet is in 15m depth where the temperature is at constant +3°C. Helsinki in Finland also has a large heat pump plant producing district heating with 90 MW capacity, as well as cooling, with 60 MW capacity, using heat from the sea and from wastewater led into the sea from a central wastewater treatment plant. Smaller projects are less common. They are seen as less efficient and do not generated sufficiently hot water. But that may change at the medium scale, as indicated by a UK initiative. Mitsubishi have created a system that can generate 45C heat and can be used on a wider scale for mass housing developments. Its Ecodan pump won the award for best new product or technology at the 2014 Climate Week Awards. In the first application of a system of its kind in the UK, backed Mike Spenser-Morris, a local developer and director of the Zero Carbon Partnership, a heat pump in the Thames will provide hot water for radiators, showers and taps in nearly 150 homes and a 140-room hotel and conference centre at Kingston Heights in Richmond Park, cutting heating bills by up to 20%. Water is drawn from two metres below the surface of the Thames, where latent heat from the sun is sustained at around 8°C to 10°C all year round. The water is filtered twice and fed through a pump, where the low-grade heat is harvested by heat exchangers, while the cooler water is pumped back into the river. The heat exchangers transfer the heat to a series of condensers, which boost the 8-10°C heat to 45°C hot water, used to heat water piped into nearby homes. The electricity to power the system is supplied by Ecotricity, which makes it zero carbon. The system is thought to have cost ~ £2.5m, though this is for a ‘first of a kind’ project. The costs of future systems should be lower, and the RHI can offset them.

Energy Secretary Ed Davey told the Independent on Sunday: ‘This is at a really early stage, but it is showing what is possible. You never have to buy any gas - there are upfront costs but relatively low running costs. I think this exemplifies that there are technological answers which will mean our reliance on gas in future decades can be reduced. Here you have over 100 homes, you have a hotel with nearly 200 bedrooms and a conference centre that won't be using gas. It will be using renewable heat from the nearby River Thames. This is a fantastic development. My department is exploring the potential for this sort of water-source heat pump across the UK, so we're going to map the whole of the UK for the potential’.

As the Independent noted, in theory, any body of water, including tidal rivers as well as standing water such as reservoirs and lakes, can be used, as long as they are in the open and heated by the sun. The Government has a target of 4.5 million heat pumps across the UK, though most will be using heat from air or ground and will be small domestic units: Prof. David MacKay, DECC’s chief scientific adviser, described a combination of heat pumps and low carbon electricity as the future of building heating. Small domestic systems may make sense in off gas-grid areas but larger units, feeding district heating networks, are better in urban areas, with COPs well over 3:

*www.energinet.dk/SiteCollectionDocuments/Danske%20dokumenter/Forskning/Technology_data_for_energy_plants.pdf*  Even so, large or small, the current types use electricity, and it’s been argued that shifting to heat pumps instead of gas for home heating on a national scale is impractical since the electricity network could not supply the large amount of power needed - the gas grid carries 4 time more energy than the power grid. It’s worth noting that in the 1950s, Southbank’s Festival Hall was heated by a 7.5 MW gas fired heat pump using the Thames as a heat source, but it seems it was taken out mainly as it produced too much heat: [http://www.architectsjournal.co.uk/home/rolls-royce-performance/181204.article](http://www.architectsjournal.co.uk/home/rolls-royce-performance/181204.article)  The Open University now has a 140 kW gas-fired heat pump. Another way ahead? Though CHP/DH may be best, depending on sites, with COP equivalents of up to 20!  


For slightly different take on it: [http://blog.cat.org.uk/2014/05/22/should-we-all-be-using-heat-pumps/](http://blog.cat.org.uk/2014/05/22/should-we-all-be-using-heat-pumps/)
A DECC overview of UK renewables

In its 2014 review of renewable energy policy, part of its ERM deployment exercise, the UK Department of Energy and Climate Change outlined how it saw each key option. There have certainly been some changes since its 2011 Renewable Roadmap, which selected 8 technologies as likely to be key to meeting the UK’s 2020 renewables targets. PV solar was not amongst them.

http://www.decc.gov.uk/en/content/cms/meeting_energy/renewable_ener/re_roadmap/re_roadmap.aspx But now it’s a front runner. In its new report DECC says, ‘We consider solar PV now to be an established technology in the UK,’ and with ~5 GW now in place that’s clearly true. And they add ‘Solar is anticipated to be the first large-scale renewable technology to be able to deploy without financial support at some point in the mid-to-late 2020s’. Didn’t it do well! Despite the cuts in Feed-In Tariffs. DECC’s main concern now seem to be that PV, especially solar farms, will expand too fast! They note that ‘Solar PV is a technology which can be deployed quickly even at large scale’. But they are worried about the costs and eco-impacts of large ground mounted projects and would prefer Building Integrated schemes, large and small. On costs, they accept that these are falling (which is why take up has grown) and will continue to fall (in part due to the take up) but they say ‘because the UK is a small part of the global market, it is likely that these cost reductions will largely occur independently of what the UK does’. And they have sought to limit the cost pass through to consumers, most notably by entirely cutting Renewables Obligation support for large projects. Otherwise they say they might reach 5 GW by 2020! Nevertheless they still talk of an overall possible 10 GW of PV by 2020 and perhaps even 20 GW.

Wind power featured strongly in the 2011 DECC review, offshore especially. Now, despite being the cheapest of the main new renewables, on land wind has fallen out of favour in some circles (due to vociferous campaigning and some local opposition), although DECC says ‘current installed capacity in the UK is 7.3 GW, with a further 1.5 GW under construction. There is also a large potential pipeline of UK projects with 5.41 GW having received planning consent and a further 6.5 GW currently in the planning system. This means we are well on our way to reaching our ambition for 11-13 GW of onshore wind by 2020.’

By contrast offshore wind is seen the biggie: ‘Offshore wind is the most scalable of the renewable technologies, and it is the renewable technology that has the most potential to make a significant contribution to decarbonisation goals, if required. There is significant long-term potential for cost reduction and it is at an early stage of deployment - DECC’s central estimate is a 25-30% reduction in central costs by 2030, which could be higher depending on the level of deployment between now and then. The UK is the market leader for offshore wind, with the biggest pipeline to 2020, and deployment in the UK is therefore a key driver of cost reduction to 2020.’ DECC has said up to 39 GW is possible by 2030.

Wave and tidal stream also featured in DECC’s 2011 Renewable Energy Roadmap, which suggested that there could be 200-300 MW of marine capacity by 2020. That was much less than the 1-2 GW forecast in the Government’s Marine Energy Action Plan 2010, and, although the UK is still in the lead in this area, the new DECC Review reduces its expectations further: ‘Wave and tidal stream technologies are still at the demonstration stage and are not currently competing in the mainstream market. There are currently around 10 MW of wave and tidal stream capacity deployed in sea trial around the UK - more than the rest of the world combined. We anticipate that by 2020, wave and tidal stream could reach 100-150 MW in the UK alone. This deployment could then increase quickly beyond 2020 to reach GW-levels in the late 2020s - early 2030s.’

Unlike heat pumps, Geothermal wasn’t in DECCs 2011 key options list, but a 2012 SKM study claimed that it could supply 20% of UK electricity from around 9.5 GW of capacity. The new DECC review however relies on 2013 Atkins report on deep geothermal power which suggested a possible best case potential of up to 3-4% of current average UK electricity demand.

By contrast, DECC is still very enamored of biomass, including EfW combustion, advanced gasification/pyrolysis, biomass CHP and AD from farm and other wastes.

The DECC review is just about electricity supplies, so it doesn’t look at solar or biomass heat.

**Putting it all together…**

**UK Wind: operational limits**

A Royal Academy of Engineering study ‘Wind energy: implications of large-scale deployment on the GB electricity system’, notes that integration will be a vital when wind supplies over 20% of UK electricity. But it does not see major problems up to 20%: ‘With a wind fleet of 26 GW (as expected in 2020 or soon thereafter) and using a de-rating factor of 0.17, the equivalent firm capacity would be 4.4 GW. On occasions of negligible output from wind, this would mean a potential shortfall of 4.4 GW which should still be manageable assuming a healthy overall capacity margin. Additional unexpected events such as a generating plant outage could compound the situation but the probability of this happening would be low enough to constitute an acceptable level of risk. The de-rating factor is likely to fall as wind capacity rises, since a de-rating factor of 0.17 and a wind fleet of 50 GW, as suggested for 2030, would produce a potential shortfall of 8.5 GW which would present problems for security of supply on its own.’

It adds ‘in the reverse situation, wind output can still be high when demand is at its lowest. In this situation, there is no security of supply issue in terms of capacity, but other issues do arise such as the proportion of controllable plant that is available. Local network capacity issues can occur, leading to constraint payments to the generator. This is a reasonable approach at low levels of penetration but inefficient and costly as penetration levels rise. Serious problems start to arise when the wind capacity is around the level of minimum demand and displaces base load electricity from the system, as is beginning to occur in Germany.’

It goes on ‘Considering 2020 and a wind fleet of 26 GW, if minimum demand is still around 20 GW it is unlikely, but possible on rare occasions, that wind could be producing almost as much electricity as the system requires. This might therefore be a level of penetration of wind energy when issues could start to occur that could have knock-on effects for other types of generation and overall system security. By 2030 and with a wind fleet of 50 GW, the situation would be much more extreme. Output from wind could easily exceed demand and the system would need to find ways to manage the situation. The easiest is simply to ‘spill’ the excess wind, although this raises the cost per unit actually sold, and the generator may require compensation for the lost production and so would not be desirable. Additional sources of load, particularly electric vehicles, could alleviate the situation by providing additional demand during off-peak times. Energy storage would help alleviate the issues.’ It also looks to smart grids and supergrids helping out. ‘A number of technological innovations are being developed that could alleviate the problems such as demand management, inter-connection and storage. However, most of these have still to be tested at large scale and how they will operate as part of a system is yet to be determined. It is probable that combinations of technologies will be required to deliver a secure and functioning grid. For example, increased wind capacity in conjunction with electric vehicles and a smart grid to manage the demand could provide at least part of a system that could cope with large amounts of variable wind energy and help to decarbonise the transport sector.’

On EU interconnections it says ‘higher levels of interconnection with other systems and the full range of generation that they offer will afford greater levels of flexibility’. However, the RAe says that the geographical and time correlations between wind availability and demand are not that good across the EU. A bit debatable - it depends the footprint. They only look at correlations between the UK, Denmark and Germany. South, East, North and West Europe does not necessarily share the same weather patterns (for sun as well as wind). But it may be true that, as they assert, ‘low wind output in one region is unlikely to ever guarantee high wind output in another’. They conclude ‘the UK system must still be designed to cope with periods of low contribution from wind energy, regardless of where it is from’. Even so ‘in the future, assuming higher degrees of inter-connection, it will be important to consider the UK grid as part of the larger EU grid with a detailed analysis of various mixes of generation required on a European basis’.


**All together**

UK green energy options - overview

As our little summary box above indicates, there are plenty of options, but how realistic are they and which should be pushed hardest? And how? It seems clear that wind on and offshore is the biggie, but **PV solar** is catching up fast, despite the cuts in the FiTs. The CfD system may not be wonderful (not much better than the RO) but it may help wind. However it is no use for wave and tidal power - no projects have so far even considered using it. A quick look at the UK Sankey diagram below will indicate how important it is to look at energy wastage - it’s far larger than delivered energy! Some of this is due the thermodynamic losses in energy conversion in steam raising plants (whether fossil, nuclear or biomass fired) and that can be partly addressed by switching to gas CCGT, as has happened, and crucially to CHP/DH, which is not happening fast enough. Wind, wave, tidal and solar PV of course do not have these thermodynamic losses. But like all the other electricity supply technologies they do have transmission and distribution losses. A shift away from large central plant, sending power long distances, to localised plants will help reduce some of that, but renewable energy based generation introduces the need for grid balancing via local smart grids and long distance supergrids, and that can reintroduce losses. Finally there is actual energy use - we still waste much of what is delivered in poorly insulated buildings and inefficient devices. The scope for energy saving is huge in all sectors. Transport apart, the domestic sector is the worst offender. Transport is outside our frame of reference, although, as we have mentioned in passing, there are some interesting technical developments. Sadly so far the government’s flagship programme for the domestic sector, the Green Deal loan scheme, has been a damp squib - over complicated and not very appealing. And the arguably better ECO scheme has been slowed - to cut costs. We have to do better on energy efficiency. One idea: [http://theconversation.com/heat-is-on-for-new-way-to-sell-green-deal-to-householders-28162](http://theconversation.com/heat-is-on-for-new-way-to-sell-green-deal-to-householders-28162)

One thing we probably don’t need: **Fire Ice** - not for UK?

The battle over shale gas has been bad enough, but there’s more. **Methane Hydrates**, so called fire ice, buried under the deep ocean bed off Britain and Ireland could in theory supply a lot of energy but will be difficult to exploit: the great distance from shore, great depths and harsh environment with major storms, add up to significant technical challenges which could make it hard to mine profitably - much less safely! And burning it still produces CO2. Dr Chris Rochelle, of the British Geological Survey, said: ‘It is exploitable, it is just going to be some way off-shore. Estimates suggest that there is about the same amount of carbon in methane hydrates as there is in every other organic carbon store on the planet,’ but UK reserves are further out than off Japan, where they are being explored. Along with nuclear, and underground coal gasification, it’s arguably something we should avoid…
5. Nuclear Power - still with us

2014 saw the idea that the UK could have 75 GW of nuclear by 2050 resurface. It had initially been floated in a DECC report last year, but caught media attention after a mention by the government advisory Committee on Climate Change. The idea is to follow the 16 GW of currently planned light water reactors (LWRs) i.e. ordinary water cooled plants, with next generation advanced reactors, including fast neutron plutonium breeders. They can breed new fuel from otherwise wasted U238. That’s good news for nuclear since fissile uranium 235 reserves are limited. But you have to have the initial input of plutonium - so you need a fleet of LWRs. DECC said: ‘a future fast reactor fleet has to be preceded by a similar sized LWR fleet and the reprocessing of the LWR spent fuel. Therefore, the ore demand from 2020 to 2100 is dominated by the fuel required for the LWR fleet.’ So we would still be stuck with old LWRs, reprocessing and wastes for the far future. Switching to thorium (see later) does not help much - it’s not fissile, so plutonium (from LWRs) is needed to fire it up, though some see advantages in it, especially if molten fluoride is used, even if that’s a long way off, with unknown costs...

Meanwhile, both the liquid sodium cooled Prism fast reactor and the heavy water moderated Enhanced Canda 6 reactor are ‘credible options’ for managing the UK’s >100 tonne plutonium stockpile, the Nuclear Decommissioning Authority (NDA) says. But the government’s preferred option is reuse as mixed-oxide (MOX) fuel. That would require a new MOX production plant - the old one’s bust. Whichever the route taken, it would be a long-term project, with, the NDA noted, ‘bulk reuse of plutonium likely to commence around 2030-2035 and concluding several decades after that’. While that is being thrashed out, money continues to pour into nuclear projects e.g. the Technology Strategy Board, NDA and DECC launched competitions for ‘Developing the civil nuclear supply chain’ with up to £13 m made available. But dwarfed by the £24bn Hinkley EPR!

Nuclear Contamination *http://fairewinds.org/hottest-particle

The dust has still to settle at Fukushima - or more accurately, the leaks into the sea are still a worry. As are hot particles*. The Embassy of Switzerland in Japan has put together a very insightful briefing sheet, which includes this useful comparison chart of total emissions.

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<td>15-77 Total release</td>
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<td>10-40 Atmospheric deposition to the sea</td>
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<td>3.5-27 Direct discharge</td>
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<td>Sellafield</td>
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<td>41 Total discharge (1951-1992)</td>
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<td>5.2 Maximum annual discharge (1975)</td>
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<td>Chernobyl</td>
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<td>Atmospheric nuclear tests</td>
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<td>948 Total release (1945-1980)</td>
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<td>603 Deposition to the sea</td>
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www.stofficetokyo.ch/reports/201312_Contaminated_Water.pdf

Fukushima - 3 years on and counting The debate on long-term impacts has continued:


Bottom line: most still can’t go home http://ajw.asahi.com/article/0311disaster/recovery/AJ201303110005
Nuclear waste management

The fire and radiation leaks at the Waste Isolation Pilot Plant (WIPP) in New Mexico, USA, illustrates the problems of dealing with nuclear waste. It’s used for military waste, but so far is the only operating deep geologic disposal repository for nuclear waste in the world. Using cat litter! The WISE/NIRS Nuclear Monitor 787 reported that ‘Waste barrels were packed with nitrate salts and organic kitty litter different from the clay-based kitty litter previously used. It is believed the combination of materials set off a heat-generating chemical reaction that caused at least one such barrel inside the WIPP repository to fail, releasing radiation into the environment on February 14 2014 and subjecting 22 workers to internal radiation contamination. That was followed by a second, smaller radiation release on March 11. The Feb. 14 leak came just nine days after a truck hauling salt caught fire at WIPP’. There were no radiological implications with that, but it indicates the problems of operating underground - e.g. fire risks. And overall, there are management issues. High-level waste may be treated more carefully, but if something can go wrong it usually does, eventually, and nuclear waste will be around for a very long time.

Plutonium risks It’s not just waste that’s an issue as WISE/NIRS NM 787 also noted. Contrary to denials, it said reactor grade nuclear fuel can be used to make nuclear weapons. Indeed the US government has admitted that a successful test using ‘reactor grade’ plutonium was carried out at in Nevada in 1962. Spent fuel typically contains about 55% of Pu239. A 1 GW nuclear reactor typically produces 250-300 kg of plutonium p.a., enough for 25–30 bombs. Total global production of plutonium in power reactors is about 70 tonnes p.a. (1 tonne = 1000 kg). Over 2,000 tonnes have been produced globally so far. Of course trapped in spent fuel it’s hard to get at or use for bombs, due to the radioactivity, but, as well as whatever is in weapons, there’s around 270 tonnes of separated Pu 239 in stockpiles around the world. Matthew Bunn, chair of a US National Academy of Sciences’ study of plutonium disposal from weapons, said in 1997: ‘For an unsophisticated proliferator, making a crude bomb with a reliable, assured yield of a kiloton or more - and hence a destructive radius about one-third to one-half that of the Hiroshima bomb - from reactor grade plutonium would require no more sophistication than making a bomb from weapon-grade plutonium’. Is it a good idea to make more? http://www.wiseinternational.org/

Keeping them going - for 50 or even 60 years

With building new plants becoming increasingly expensive, a cheaper option is to keep the old ones going longer. Old designs don’t have the safety features of newer ones, but it’s economically very attractive to pay for some limited upgrades to keep them going, since their main costs have been long since paid off. That’s on the cards in the US and France, who have many old water cooled/moderated PWRs, as do many other countries, for which extended life may be a bit less risky than for the UK’s old UK CO2 gas cooled/graphite moderated AGRs - the graphite crumbles with age and radiation damage. www.no2nuclearpower.org.uk/nuclearnews/NuClearNewsNo63.pdf But the high-pressure pipework and the pressure vessels in the PWRs can also fail with age, so there’s maybe not much in it. EDF is certainly pressing ahead with life extension plans in the UK. It means there will be more waste to deal with. And more risks. There are other options! http://theconversation.com/extension-of-life-ageing-nuclear-reactors-could-help-bridge-the-energy-gap-27617 That web site also plugs yet another Fukushima book: Fukushima: Japan’s Tsunami and the Inside Story of the Nuclear Meltdowns (Pan Macmillan) by Mark Willacy, who once lived and worked locally. Fukushima’s plants were old, 1970s vintage. Let’s hope others won’t have similar disaster stories to tell. It’s possible that new nuclear technologies will emerge, like mini-nukes (www.the-weinberg-foundation.org/2014/05/20/transatomic-power-publishes-details-of-msr-concept) or Thorium (see below) and some say we should wait for that, rather than building more PWR-type plants, and keep the old ones going as a stop gap. That’s a potentially risky strategy: the old plants may fail and so may the new tech. And though new tech may reduce them, there’s still all the same old problems of leaks, waste, proliferation threats. And it would divert money from developing renewables. But so do new ones, and they may incur new risks, especially if it’s imported technology.

http://drdavidlowry.blogspot.co.uk/2013/10/nuclear-safety-concerns-with-chinese.html
Thorium Reactors - an unknown future

The debate over the use of thorium in new breeder reactors rumbles on. Back in March, a headline in the Guardian ran: ‘China working on uranium-free nuclear plants in attempt to combat smog’, and it reported that 'in an effort to reduce the number of coal-fired plants, the Chinese government has brought forward by 15 years the deadline to develop a nuclear power plant using the radioactive element thorium instead of uranium'.

This was met by enthusiasm by pro-nuclear contributors to the linked comments section, some of whom mentioned US advocate Kirk Sorensen’s promotion of the Liquid Fluoride Thorium Reactors (LFTR) e.g http://nucleargreen.blogspot.co.uk/2013/06/kirk-sorensen-global-alternative.html

Some argued that the reason why the early work on thorium had not been followed up was that it didn’t lead to the production of military grade Plutonium. But it was all put in a different perspective by other commentators who seemed to have a clearer, or different, understanding of the technical realities. We’ve taken the liberty of recycling some of the latter points.

Firstly it was pointed out that China’s new project couldn’t be a ‘uranium-free’ reactor. As Peter Palloy explained ‘since Thorium is not a fissile material, it is incorrect to call this technology a Thorium reactor. The Th-232 has to be ‘promoted’ into U-233, which is fissile, so it is still a Uranium reactor, but not the usual U-235 one. Since U-233 does not occur in nature, the U-233 required to get the reactor started is reprocessed out of high-level waste from U-235 reactors. Once the U-233 reactor gets going, it theoretically promotes Th-232, thus breeding its own fuel, but the rate of breeding is crucial, and has not been demonstrated to work at breeding rates of greater than 1. The US abandoned work on this in the 1950s.’

Energyguy then provided more on that project ‘The US Oak Ridge National Laboratory LFTR was an experimental, small-scale partial system only, not a full power plant. It was only 7 MW of thermal output, meaning substantial scale-up would be required to achieve a commercial-size unit. Roughly, 500-to-1 scale-up is required to obtain a 1,000 MWe output reactor. That degree of scale-up is not trivial, nor is it even guaranteed to be successful. Also, the materials used in the Oak Ridge reactor developed serious inter-granular cracking in all metal surfaces exposed to the molten salt. This cracking would seriously limit the life of a commercial-scale reactor. It is questionable if such a reactor could last for 10 years.’ William Ashbless added on that: ‘The main problem isn’t scaling up. Oak Ridge researchers never developed the online reprocessing features they needed. 1) A LFTR will need to extract protactinium-233 from the reactor core or blanket soon after its formed. Pa-233 has a 27 day half-life and a great tendency to capture a 2nd neutron. When removed from the reactor it can beta decay to uranium-233 (which is what we want). 2) To the best of my knowledge, the 2-core reactor design envisioned by Kirk Sorensen is not feasible. No suitable material exists to separate the core from the blanket. Such a material must resist fluoride salt corrosion at high temperatures and be transparent to neutrons. The LFTR is still at the test stage; no chance this will be ready in under 20 years. The 10 year reactor must be the TRISO fueled one. That, however, suffers from the impossibility of Pa-233 online reprocessing.’ That point was reinforced by quokkaZ, who claimed that ‘The initial Chinese plans are actually not for thorium fuel molten salt reactor, but for a uranium fuelled MSR using TRISO fuel that will be available from the HTGR Project (High temperature Gas Cooled Reactor). The HTGR is another Chinese initiative in advanced nuclear power. This could be very useful in its own right, but does carry the disadvantage that TRISO fuel is difficult to recycle. A full LFTR (Liquid Fluoride Thorium Reactor) is significantly more difficult and while the 10 year time frame is commendably ambitious, it may be challenging.’ Mention was also made of the Indian programme, but so far that too isn’t aiming for a LFTR. But no one mentioned the safety risks or the unknown costs of any of this!

The Guardian/article/comments are at: www.theguardian.com/world/2014/mar/19/china-uranium-nuclear-plants-smog-thorium? Also for a more recent overview see: http://thebulletin.org/thorium-wonder-fuel-wasnt7156. But be warned, it’s scary: 96 kilograms of uranium 233 is missing.

Mini-nukes don’t look too good either Babcock & Wilcox is to slash its mPower small modular reactor project, having failed to find customers or investors. MIT’s idea for a 200 MW floating nuke on an oil rig type platform 10 km off shore seems even wilder. So does this idea of combining nukes and renewables e.g. to make synfuels: www.sciencedirect.com/science/article/pii/S0196890413007516#
German phase out - it may come earlier

Nine have gone, the rest of Germany's nuclear plants are to close by 2022 - see above. But energy giant Eon has said it will shut down its Grafenrheinfeld plant in Bavaria in May 2015, 7 months before the originally imposed end of 2015 closure date. It would need to be refueled next spring so it could run until the end of the year, and Eon claims the government tax on nuclear fuel makes its final period of operation uneconomic. It may be uneconomic anyway. Analyst Craig Morris says ‘wholesale prices are now regularly down below the 0.04 euros per kilowatt-hour that RWE’s CEO recently said was necessary for baseload power plants to turn a profit’. And it may be that, even with lots of renewables on the grid, it is not in any case needed for grid stability, though there are evidently disagreements about that. More n-plants may follow this early lead.


Will the Finnish EPR ever be finished?


For a very different view, see the US Breakthrough Institute’s take on it - using German PV data it says PV solar would be 4 times more expensive/kWh than the Olkiluoto nuclear plant: http://thebreakthrough.org/index.php/programs/energy-and-climate/cost-of-german-solar-is-four-times-finnish-nuclear

But it was pointed out (see comments) that this was not a fair comparison: nuclear came with extra costs (e.g. waste disposal) and PV was not meant for baseload power. In any case the cost figures used for new nuclear and PV projects needed updating. The UK Hinkley EPR strike price was £95.5/MWh or 114 €/MWh via CfD support over 35 years index linked to the consumer prices, for a project that might start in the mid 2020s, whereas the German solar FiT level (for up to10 MWp) was 94.7 €/MWh in Jan 2014, for 20 years only FiT. Mind you it has to be said the UK nuke price is high: China is building an EPR much more cheaply. For comparison: http://www.agora-energiewende.org/topics/optimisation-of-the-overall-system/detail-view/article/klimaschutz-wird-mit-erneuerbaren-deutlich-preiswerter-als-mit-atomkraft/

Next With Taiwan’s new plant halted, the plan is to shut the rest by 2025, but it’s not certain. However Japan may restart some, despite objections. For a list of candidates and their status see: www.no2nuclearpower.org.uk/nuclearnews/NuClearNewsNo63.pdf And in the UK, there’s Hinkley.. now with a go ahead for CfD support from the European Commission.
6. Hopes and Fears for the future

IEA: green transition low cost long term

‘Our detailed modeling shows that in the long term a fully transformed power system with 45% of wind and solar in annual electricity generation - that is over ten times more than in most power systems today - that system is only about 15% more expensive than a system with no variable renewable energy at all. And that small cost increase is using today’s technology and assumes a moderate carbon price of 30 USD per tonne. In the future, wind and PV are expected to have lower costs. Combined with increasing prices of CO2, the extra system costs of such high shares of variable renewable energy could be brought down to zero.’ International Energy Agency Exec. Director Maria van der Hoeven, Feb 2014. IEA adds efficiency to the hopes too.

Prosumers & self-generation: a way ahead?

Large scale energy utilities may not be the way forward. Only about 13% of Germany’s 60 GW of renewable power capacity is now owned by big energy companies. The rest is owned by households, communities, development trusts and farmers. The Feed-In Tariff system has allowed many individuals to become ‘prosumers’ of PV projects, and in parallel, there has been a growth in local community run co-operatively-owned renewable energy projects in villages and towns. Around 50% of green energy output being generated by community-based projects. Over 600 energy co-ops have emerged, with more than 100 rural communities becoming 100% renewable energy based, with the number of locally owned energy co-operatives having risen six-fold since 2007. As RENewEconomy noted ‘The big three German utilities have accounted for just 7% of the renewable energy installations that now account for more than one quarter of the country’s generation, and which have transformed the market. Most renewable capacity has been installed by home and industrial consumers, and smaller and smarter energy companies.’

This trend may continue, despite the changes in the German support system, and should spread - similar grass roots development are underway elsewhere in the EU. Soon the bulk of power in many countries may be from local self-generation of various types. Note that its not just consumers and local energy coops that are involved. It’s also industry. New small businesses are also getting into the act, and gradually so are some larger ones - switching over to self-generation. Not content with waiting for the mains grid supply to get greened, they are installing their own green power systems: so-called ‘merchant wind power’ and PV solar, on factory warehouse and office roof tops. It can be cheaper to self-generate than to buy in power. Solar heating is also being adopted to provide not just space heating but also process heat. A UNIDO report said solar thermal (including CSP) could supply 8 EJ of process heat for industry globally in 2050 - nearly 4% of the global total. The UNIDO assessment also concluded that the use of biomass, primarily for process heat, has the potential to increase in the pulp and paper and the wood sectors to reach a global average share of 54% and 67% respectively of the total final energy use in each sector. And it suggested that, by 2050, biomass could constitute 22% of final energy use in the chemical and petrochemical sectors, while alternative fuels could constitute up to 30% of final energy use in the cement sector. Overall, it said that up to 21% of all final energy use and feedstock in manufacturing industry in 2050 can be of renewable origin. Some of these projects would create surplus energy at times, which would be sold to the grid, so helping to green the mains supply, much as the consumer and co-op based projects do. Of course as the grid supply gets greener and grid green energy gets cheaper, the cost advantage of self-generation may diminish, but the distinction between industrial self-generation and grid generation may become academic, with the old utilities transforming themselves into service agencies help decentral projects of various types. That seems to be what RWE in Germany now aims to do. It all sounds very promising.


Will battery storage get cheaper? So PV can boom even more?

http://smartertrends.co.uk/articles/2014-10-14/the-future-of-energy-will-cheap-as-dirt-batteries/-original/
Renewables backlash

This year has seen yet more negativity on wind power from the UK right wing press. Much of this has been about visual intrusion, but economic and strategic arguments have also come to the fore. For example in April in a leader entitled ‘An Ill Wind’, the Times said ‘Britain’s wind power boom is based on assumptions that have proved wrong and subsidies that are unsustainable’. It went on ‘Britain has pledged to produce 30% of its electricity from renewable sources by 2020. Assuming this target is met and all commitments to wind turbine operators are honoured by this and future governments, the cumulative cost to British consumers could reach a staggering £160 bn by 2040’. It concluded ‘Wind power is the most practical form of renewable energy available, but subsidies have allowed the industry to delay technological advances to bring down costs. Wind has a place in the energy supply of any economy in search of a sustainable future, but not on these unsustainable terms.’ [www.thetimes.co.uk/tto/opinion/leaders/article4052663.ece]

Nuclear risk concerns

Alleged dirty dealings at Sellafield, with the privatisation of the £70bn nuclear cleanup operation, worry some: [www.morningstaronline.co.uk/a-c7cb-Disaster-waiting-to-happen.jpg]

Some also worry about nuclear insurance: some UK companies are to be indemnified from nuclear accident liabilities, with DECC claiming that this was reasonable, since there was a ‘low probability’ of a claim against the public purse, despite it being accepted that ‘because of the nature of nuclear activities the maximum figure for the potential liability is impossible to accurately quantify’. But since no commercial insurance is available, the taxpayer has to take the risk. It’s all folded into the cost of nuclear, some of which falls on the public. DECC said: ‘We have a responsibility to clean up the UK’s existing civil nuclear legacy in a safe and cost-effective manner. The taxpayer will not pay any money towards decommissioning of new nuclear, as this will be funded by nuclear operators.’

However, the EDF Hinkley deal explicitly says, ‘protection would be provided for any increases in nuclear insurance costs as a result of withdrawal of HMG cover or in certain circumstances where market cover in the nuclear insurance market is no longer available, with compensation limited to the cost of additional capital required to self-insure’. Meanwhile the fallout from Fukushima continues, with, as well as continuing leaks, the US Navy task force contamination issue still rumbling on: [www.theecologist.org/News/news_analysis/2300846/the_us_navy_knew_fukushima_hard_rain_on_uss_ronald_reagan.html] And there are fears for those returning home to parts of the 20 mile exclusion zone: [http://ccnr.org/Gambling_2014.pdf] There are also worries about the location of new UK plants and nuclear waste stores at or near sea level: [http://www.independent.co.uk/voices/letters/ios-letters-emails--online-postings-02-march-2014-9162676.html]

The sudden closure of the 1.2 GW Dungeness plant in a storm last year was perhaps only a side issue - due it was said to a line loss. More significant was the longer closure due flood risk fears: [www.clickgreen.org.uk/news/national-news/124340-uk-nuclear-power-plant-reactor-forced-to-shut-down-over-flooding-worries.html] But this is a nice ending: [http://www.world-nuclear-news.org/WR-Chimney-work-changes-Sellafield-skyline-1704147.html] Though that site remains a major worry.

Fears

Wind Infrasound?

No worries!

[http://barnardonwind.com/2013/02/20/humans-evolved-with-infrasound-is-there-any-truth-to-health-concerns-about-it/]

Bombs away

About half the electricity from US nuclear plants over the past 15 years has been produced using uranium from the Russian weapons programme under the Megatonnes to Megawatts scheme. Is that good or bad? It’s disarmament, but it’s kept nuclear on line a bit longer and added to the waste mountain [http://thebulletin.org/more-megatons-megawatts]. In a new anti proliferation move, plutonium and highly-enriched uranium research reactor fuel in Japan is be sent to the USA for downblending or disposal. Material from Italy and Belgium is also going to the USA. With nuclear phase-outs, perhaps they don’t need it. But does the USA? The UK meanwhile is also taking in spare material, adding to its waste/plutonium mountain. Is that wise? In any case, in terms of weapons proliferation threats, not everyone is convinced by moves like this: they may disguise, or at least parallel, increased local production of plutonium: [www.publicintegrity.org/2014/03/10/14345/world-awash-nuclear-explosive/] It’s getting to be an even more dangerous world.
Grid balancing cost become too high

It’s clear that using variable renewables does impose extra costs - to integrate them into grid systems, so as to enable grids to balance the variations. A recent study from the German Potsdam Institute for Climate Impact Research and major utility Vattenfall claimed that ‘at wind shares above 20%, marginal integration costs are in the same range as generation costs’ and ‘further increase with growing wind shares’. So it said the standard ‘Levelised Cost of Energy’ figures had to be expanded to what they called ‘System LCOEs’ to include integration costs.

Their claim is thus that this could double the final cost, so making it hard to support wind, unless carbon costs were very high*. See chart left for wind. It’s similar for solar. They may be overstating their case. They admit that the direct short term cost of balancing (incurred by the conventional plants having to vary output) is small, and they focus on longer term ‘profile costs’, incurred since ‘the average utilization of dispatchable power plants is reduced (reflected in decreasing full-load hours)’. This leads to ‘inefficient redundancy in the system and higher specific costs compared to the hypothetic situation if wind and solar would not be variable’.

It’s true that, with a lot of wind and PV on the grid, fossil plants are less used and so are less competitive. To an extent this is because ‘must take’ Feed-In Tariffs favour renewables, but it’s also since the old plants use increasingly expensive fossil fuel. As green plant expand, they are left stranded and lose money. Apart from to their owners (like Vattenfall!!) whose profits fall, that only matters if you need to retain and use them for balancing. In the short term we have to - e.g. with capacity market incentives. But there are other balancing options - including pumped hydro and other storage systems (e.g. H₂, heat), demand management to shift peaks, supergrid imports to deal with supply shortfalls, balanced by export of occasional renewable surpluses.

The paper looks at some of these options, but doesn’t think they can help too much: although demand management may be useful, there is not enough pumped hydro storage capacity in Germany to make a lot of difference (only 7.6 GW). But this is a very static view. Germany is busy on new storage schemes to rectify this, including new pumped hydro projects and, crucially, wind to gas systems, with green gas then being available for balancing (rather than fossil gas), and used, at least initially, in existing (already paid for) gas plants. However, some parts of the new system will add to the cost of energy, though as the paper admits, the grid/balancing part of the overall system cost is relatively low. Even so, it is an extra cost. And it will grow. For the UK, DECC has (maybe optimistically) estimated it will add £2 p.a. to bills by 2030. But then staying with fossil fuels and nuclear would also add costs. And the underlying cost of using renewables will fall - hopefully enough to compensate for the balancing costs: see the IEA’s recent ‘Power of Transformation’ report. Though that’s not certain. But profits may well fall. Maybe it’s that which worries the likes of Vatttenfall:


Even so, there is news that Germany may have to abandon its 40% by 2020 emission cut target, since, as a minister put it: ‘We cannot exit from coal power overnight’. But this will be fought! And some say it can still meet the target…

*A similar view was taken by some UK (Scottish) academics: www.heraldscotland.com/comment/letters/science-should-trump-ideology.24673295

Even so,
Fossil fuels: keep on burning

We ought to be burning less coal, but it seems demand is rising and clever new ways to access reserves are being explored that avoid mining. The UK for example has large coal reserves left after the all but total collapse (or some might say killing off) of the deep mined coal industry. But some of it can be got at using Underground Coal Gasification (UCG) techniques. Basically you set the seams on fire and tap off the resultant gases. It sounds risky: can underground combustion really be controlled, what toxic emissions will escape? Some methane is also emitted by old coal seams and this too can be collected. This Coal Bed Methane approach may be a bit less worrying environmentally than UGC, and it’s wise to stop it leaking into the atmosphere, but, like shale gas, it’s still a fossil fuel and burning it creates CO2 gas. Some say fossil fuel burning can be redeemed with Carbon Capture and Storage, putting the CO2 back underground, but it seems a very long shot, with high costs and risks. Will we ever get to the point when we can leave all the remaining fossil materials in the ground? Wired thinks not: www.wired.com/2014/03/clean-coal/

Burn Biomass instead? Some say it’s the key: http://www.worldbioenergy.org

If you must burn something, why not biomass, with CCS-BECCS. That’s something the IPCC sees as a good option: http://www.eenews.net/stories/1059997251 However there are also worries about that: in a Guardian interview, Dr Rachel Smolker, co-director of Biofuelwatch, said that ‘largely untested’ and ‘very risky’ technologies like bioenergy with carbon capture and sequestration (BECCS), will ‘exacerbate’ climate change, agricultural problems, water scarcity, soil erosion and energy challenges, ‘rather than improving them’. This rather bleak view reflects the debates about the impacts of biomass combustion and about the viability of CCS. On CCS, Dr Smolker warns of ‘the high costs, and associated high added energy demand for capture, transport, compression and injection’. Certainly that makes its use with fossil fuels much less than carbon neutral, so its use with biomass may not give you much by way of carbon negativity. It’s also seems true that, as she claimed, there has been ‘little real world testing’ of whether CO2 pumped into underground cavities ‘will remain in situ’ indefinitely (though ‘indefinitely’ is hard to test!), or be released, which she describes as ‘a dangerous gamble.’ She added, ‘so far much of carbon captured from bioenergy and other processes is ultimately used for Enhanced Oil Recovery - injected into depleted oil wells to create pressure enough to force remaining difficult to access oil out. This can hardly be considered ‘sequestration’ or an effective approach to solving the climate problem’. Fair enough, but in terms of biomass combustion she relayed the more controversial Biofuelwatch view, shared by some other green groups, that ‘burning wood for electricity and heat releases up to 150% as much CO2 per unit of energy generation than does coal’ even excluding emissions from ‘deforestation, harvesting and transportation’. There have been challenges to this view, as we have reported over the last year, some arguing that, while some biomass options are very poor, and few would welcome the use of whole trees, the use of sustainably managed forestry residues can lead to net carbon savings. AD biomass from wastes might be even better. Smolker will have none of this: bioenergy, evidently of almost all types, ‘should be considered a driver’ of emissions from agriculture, forestry and other land use, not a means of mitigation’. She insists that the growing use of bioenergy as a substitute for fossil fuels is encroaching increasingly on land use and that ‘lands and ecosystems cannot at the same time both provide large quantities of biomass for bioenergy, and still securely act as ‘carbon sinks’. It is not possible to have it both ways.’ The large areas of land required for meaningful bioenergy production means it would simultaneously undermine food production while contributing to ‘escalating food prices’. So ‘it can never provide more than a tiny fraction towards the current and projected growth in demand for energy’. If that is true then we do have problems - not only for BECCs, but for biomass use in general.


7. 2015: time to move ahead even faster

In its quarterly Renewable Energy Country Attractiveness Index in the spring, the Ernst and Young consultancy group predicted that in the next 12-18 months the so far dominant EU countries would lose market share to emerging nations. It said that ‘troubled offshore markets’ in the U.K., Germany and the Nordic region would be challenged by China, Japan, Taiwan, South Korea and India, while Brazil was forecast to cement growth not just in its wind sector but also in its nascent solar market. It also thought Ethiopia, Kenya, Indonesia, Malaysia and Uruguay were likely to join the fray. So it’s a new global market and one in which old certainties may not last.

http://www.ey.com/UK/en/Industries/Cleantech/Renewable-Energy-Country-Attractiveness-Index? 2014 was certainly a troubled year for renewables in the EU, with the UK, Spain and Germany all playing around with their support systems, and things elsewhere were not too good either - Australia’s new government took a hard line on all things green and Japan made a partial U-turn of nuclear. But progress continued to be made, led by China and, in competition, the USA. It’s been a long time coming, but, being optimistic, renewables do now seem to be established as a major, if not the major, new energy option globally: www.martinot.info/renewables2050/2014/351

However with an election coming in the UK in 2015, all bets may be off there. The Conservatives look like they will commit to reducing support for on-land wind dramatically - odd since it’s the cheapest option, but maybe a popular move in the shires. But if investors do not lose their nerve, offshore wind could thrive, and PV especially seems likely to thrive. Though it may all depend on what happens about nuclear. The EC’s decision on the Hinkley deal and State Aid is worrying. It’s possible it will be challenged successfully. The proposal for other plants would then no doubt evaporate. If nuclear were off the UK agenda there would be no excuse to limit the expansion of renewables - the potential is there. Germany is already in that situation, although with a smaller resource potential, so we have some idea of what might be ahead - notably squabbles over grids, costs and funding. Japan really ought to be following the same path, but like the UK there are still some with nuclear ambitions, despite both countries, in their different ways, being saddled with huge nuclear debts - notably for cleaning up Sellafield and Fukushima. And there’s Chernobyl too - see below for the $2bn New Safe Confinement structure being built for it. Plenty of worries:

www.independent.co.uk/news/uk/home-news/nuclear-body-rebuked-over-redacted-report-9271478.html
www.theguardian.com/environment/2014/apr/20/choice-cumbria-nuclear-dump-mistake-environment-agency

But let’s look to the more positive future: as REN21’s Chair put it ‘the question is no longer whether renewables have a role to play in the provision of energy services, but rather how we can best increase the current pace to achieve a 100% renewables future with full energy access for all’.

8... and finally RENEW

Renew came out bimonthly on a subscription basis for over 30 years from Natta, an independent info network, but after our 200th issue (end of 2012) we moved to a free web only version, Renew on Line. And soon that will become a Blog version at: http://renew-on-line.blogspot.co.uk alternating bimonthly with the shorter Renew Extra: http://renewextra.blogspot.co.uk At which point our web site www.natta-renew.org will close. This is our fourth annual review, and we hope to continue offering end of year reviews free via various web sites: see http://renewnatta.wordpress.com

We will also offer it via our extended student edition of Renew, which is available to students on subscribing courses, on controlled (password) access.

*And a last word from Renew editor Dave Elliott: a report on one of his many talks over the year - http://www.staffordarea.saveyourenergy.org.uk/how/news/David Elliott talk