A Really Simple Plan To Solve The Climate Emergency

19th May 2019 – updated 12th June 2019

www.carmarthenshireenergy.org/YSG/climate-emergency

Quick Overview

A lot of work has been carried out preparing reports, such as the Institute of Welsh Affairs' "Plan for Wales' renewable energy future"[i], and the Welsh Government's "Low Carbon Wales"[ii] report with its 100 policies and proposals. But they all push the responsibility for solving the Climate Emergency onto businesses, communities and individuals. These policies *might* work in the *very* long term, but they will not be fast enough to stop the tipping point for climate disaster within 10 years[iii].

The only way we can prevent disaster, is for governments to take responsibility now and take direct action.

And there is a really simple way they can do this.

At a Wales level

Welsh Government could invest the £1.4 billion[iv], no longer allocated for the Newport M4 relief road, directly into solar panels and battery backup. Then sell the electricity generated, direct to consumers. The following year, reinvest the profit into additional solar panels and batteries. Repeat each year, building up more income and more panels.

By 2026 the *current electricity* requirement for Wales is generated renewably[v].

By 2047 the *total energy consumption* of Wales including electricity, heating and transport is generated renewably[vi].

And the best bit for Welsh Government is that once the generation capacity has been reached, it will be receiving an additional £12bn per year in revenue from selling electricity. That's an additional ¾ of the current Welsh Government budget[vii].

At a County Council level

Welsh Local Government pensions schemes have collective investments of £15bn, currently invested mostly outside of Wales, including £1bn in fossil fuel companies[viii]. County Councils could invest their funds instead directly into solar panels and batteries which would **enable the total energy consumption of Wales to be generated renewably by 2031**. Additionally, the ongoing income provided would be 107 times more than the current pension fund provides[ix].

At a UK level

We provide £10.5 billion per year in subsidies to fossil fuel companies[x]. In times of Climate Emergency it is criminal for tax payers money to be used in that way. Repeat the same process – investing that amount in solar panels and batteries each year and re-investing the profits.

By 2027 you provide the whole UK *current electricity* supply renewably[xi].

By 2041 you provide the *total energy* supply including heating, transport and aviation[xii].

At a Worldwide level

The subsidies paid to fossil fuel companies are £500 billion a year[xiii]. Invest that amount in solar panels and battery backup each year.

By 2032 you provide the entire world *current electricity* consumption renewably[xiv].

By 2045 you provide the entire world *total energy* consumption renewably, including heating, cooling, transport, shipping and aviation[xv] without having had to invest any new money.

Once all energy is generated renewably, everything else will fall into place with market forces, as fossil fuels will become prohibitively expensive, so people will naturally move towards electricity as their source of energy to save themselves money.

These figures are using already committed funds. So, require no new investment by governments. If we can persuade governments to invest additional real money as-well, the targets can be achieved even sooner[xvi].

There will be challenges, not least that governments selling electricity is not "business as usual", and they will likely be sued by the EU and World Trade Organisation for unfair competition. But as this is a Climate *Emergency*, governments can use Emergency Powers to ensure that sufficient renewable energy generation is available in time. And the Welsh Government has already indicated willingness to tackle "business as usual" by stopping the development of the Newport M4 relief road.

Frequently Asked Questions

I don't believe this is possible. How have you calculated this?

The sources for all figures are quoted in the end notes to this document.

The calculations are included in the spreadsheet at:

http://www.carmarthenshireenergy.org/YSG/PublicFiles/media/ReallySimplePlanToSolveClimateEmergenyCalcs.xlsx

They are broad brush estimates and not intended to be 100% accurate. Even if the assumptions made are more than 50% out, the plan will still work – it will just take a bit longer.

The plan does not take into account other renewable energy schemes by private companies and individuals which will still continue, and these will speed up the process of achieving the 100% renewable energy production sooner.

Assumptions made on the spreadsheet:

1. Fossil fuel subsidies £500bn / year[xiii].

2. Installed cost of 1kW peak solar panels and 1kWh battery backup £1,000[xvii].

3. Average generation per year 1,000kWh for 1kW peak panels – location West Wales[xviii] – panels located in lower latitudes will generate more energy, and in higher latitudes less energy.

4. Profit for per kWh electricity sold 15p. This is based on a major shake up of the energy supply industry. The current model is broken, as evidenced by the large number of new supply companies going bust, including Scotland's own government backed power company Our Power. The structure can easily be simplified, and costs reduced dramatically. Energy suppliers should be able to sell direct to their own customers at the price they set. A prototype of this model has already been developed by Energy Local[xix].

   For many customers, standing charges and availability charges are more than the electricity charges. So, a flat sales rate of 20p per kWh with no standing or availability charges would be reasonable. Leaving 5p per kWh for administration and grid costs. Prices should be kept reasonably high to reflect the true value of energy. Those in fuel poverty need to be able to get support from other means. Remember, this scheme has required no additional investment from governments, so there are still funds available to support those in fuel poverty. Some people may not like the high prices, but the survival of the human civilization is more important than keeping certain groups of people happy, as they will not be happy when civilization collapses and there is no one to support them.

   If the profit per kWh reduces to 10p, the plan still works, but it takes an additional 8 years (2055) to reach the 100% worldwide total energy production.

   If the profit per kWh reduces to 5p, it takes an additional 28 years (2077) to reach the 100% worldwide total energy production which is far too long to prevent climate change tipping points and save civilization.

5. Existing government or public land and building roofs are used, requiring no purchase costs, rent, business rates and no tax on profits. This is an Emergency, so taxing the scheme in any way is a ridiculous waste of time and administrative overhead, as the tax goes back to government anyway.

6. No finance charges are applicable as no new government funding is required.

What happens after we reach full renewable energy production?

Once targets are achieved, there is still $24.5 trillion per year coming into the energy funds per year. If you continue to invest this in further renewable generation, the costs of energy supply to the public can be greatly reduced and you have a large surplus of low-cost energy. This opens up huge potentials for use of energy that would not have been practical before, potentially as transformative as the industrial revolution.

For example, industrial scale farming using 24 hours-a-day grow lights to produce large amounts of food in controlled environments in a fraction of the land, requiring far fewer pesticides and herbicides, and harvests not being subject to inconsistent weather conditions. These can be placed anywhere in the world and grow any type of food any time of year, so there is no need for global transport of food. So, solving the world's food supply problems and freeing up vast areas of mono-culture farming land for re-wilding, regeneration of bio-diversity and carbon capture through growth of trees.

When discussing climate change, many people portray a dystopian future, but this could lead to a truly utopian future.

Can we achieve the global supply without requiring large amounts of backup batteries?

The interesting thing about a global solar power network is that it is always daytime over half the globe, and it is never cloudy over the whole globe at the same time, so we always have bright sunshine over a significant amount of the globe at all times. So, instead of investing in the battery backup, we could invest in a global electricity distribution network.

The net effect of this is perhaps to usher in a new era of world peace and cooperation as each country is reliant on every other country to provide them with power when it's dark on their side of the world. And if one country decides not to cooperate and block off supply, all other countries block off supply to them in return, so no one country is more powerful or has more natural resources than another.

Electricity is already distributed between countries, including through subsea cables of up to 360 miles, with planned cables up to 1,060 miles (Europe to Africa)[xx]. There are losses with distribution networks, but also there are losses when batteries are charged and discharged (at best getting 90% out of what you put in). So, while there are challenges, it is possible with current technologies. Super-conducting materials are also improving and becoming more of a commercial proposition – these would be perfect for long distance distribution networks.

Can other renewable energy generation technologies be used?

A mix of renewable energy technologies is preferable. However, solar panels have been used in this example as they are very simple to implement, they can be placed anywhere rapidly, are a simple fixed cost no matter the location, they are long lasting with no maintenance, and on average produce a known, consistent power over a year, only dependant on global latitude. Other technologies have very variable costs, variable outputs and have long planning cycles to implement, but if they can be brought into plans once a large amount of generation has been installed and is generating income, then they would be ideal.

How can we get to Extinction Rebellion's target for all UK energy including heating, transport and aviation being renewable by 2025?

This requires an investment of 15 times the current fossil fuel subsidies each year: £157bn – that's 21% of all UK government revenue. Which is probably impractical.

A compromise would be to achieve the targets by 2030 which just meet the estimated 10 year tipping point for run-away climate change.

To achieve the UK target by 2030 would require £50bn investment a year, i.e. 5 times the current fossil fuel subsidy or 7% of total UK government revenue. Remember this investment is only for the 10 years – after this point, the government would have an additional revenue of £300bn per year from electricity generation which would enable it to make serious investments into improving the lives of its people. An incredibly good value investment!

To achieve the Wales target by 2030 would require £2.5bn per year investment, or the single one-off investment of the Welsh Local Government Pension Funds of £15bn already discussed.

To achieve the Worldwide target by 2030 would require £6tn per year investment i.e. 12 times the current fossil fuel subsidy or 7% of global GDP.

Can this be achieved by private companies rather than governments?

No. Because you have to introduce finance charges, land rents, and taxes such as business rates on solar panels and batteries. Additionally, most profits must go to paying investors rather than purchasing additional renewable energy generation. So, it becomes impossible to expand the scheme quickly enough.

Can we achieve the targets sooner?

The examples shown are with zero new investment from governments. If we can persuade them to invest a small additional amount – say the same subsidy they were paying to fossil fuel companies, that means we get to the total worldwide electricity supply by 2028 and total worldwide whole energy supply by 2040. More investment clearly brings that target even sooner.

Will the electricity grid cope?

There clearly needs to be investment in the national grids, there has already been work developing "smart grid" infrastructures to help balance the grid. The current companies who run the grids have had no incentive to improve things in a major way, as they keep charging more and more for connecting renewable sources, and are just operating to create a profit for their parent companies e.g. Western Power Distribution is owned by a Pennsylvania coal company, with little incentive for improving renewable energy infrastructure, and making more than 62% of its net profit from UK customers[xxi].

There needs to be blue skies thinking for how to manage the grids appropriately, with, if necessary, the government taking over control and allowing groups with better ideas to run it. A push for commercial production of super conductor technology would open up huge new possibilities, especially for global grid networks capable of distributing solar power from one side of the planet to the other.

How can we power all of our transport electrically?

Prices for electric vehicles are falling rapidly. The only reason it has taken so long is because car companies, like fossil fuel companies have a huge vested interest in the internal combustion engine so have not wanted to produce electric cars. It took new company, Tesla, to disrupt the market to prove that it could be done. Car and lorry fleets are already rapidly changing to electric power as they see the cost savings in both energy and maintenance of vehicles. Bans of polluting cars in cities will also speed uptake. This must go hand in hand with adding to the car charging networks.

Air travel is already turning electric. 100% electric planes are soon to be available e.g. the Eviation Aircraft, a 650 mile range 10 seater plane using a 900kWh battery[xxii].

Currently the trend has been for larger planes as they are more efficient per passenger when burning fossil fuels, but a larger number of small planes that go direct from local airport to local airport is likely to be a far more efficient renewable energy model. After all, very few people actually want to travel from a major airport to another major airport, queuing up with thousands of people hours before a flight – they want to go from their home to their destination. Using small local airports will hugely reduce congestion and make the whole process more efficient. The trend for developing hybrid planes that use a combination of electrical power and aviation fuel should be cautioned against – this model is just like hybrid cars – designed only to prolong the life of the engine manufacturing companies. Legislation to ban any non-100% electrical planes should be implemented by 2035 and companies will soon start making 100% electrical planes.

Electric container ships are already in production[xxiii]. For longer journeys, these should be combined with sails – which are a fantastically efficient way of travelling the seas using no stored energy.

For even more efficient transport, we should be developing evacuated transit tubes. These require tiny amounts of energy as there is very little air resistance, the major loss of energy for vehicles moving at speed. Spending £50bn on HS2 is a ridiculous for an antiquated concept of travelling. An evacuated tube transit system could easily be implemented for this amount of investment. However, even current developers of evacuated tube systems seem to be missing a trick – they are still stuck in the concept of going from a station to a station. People don't want to go from a station to a station – they want to go from their home to work, to visit their friends, to a meeting etc. Evacuated transit tube systems can easily be developed to allow people to get on an off anywhere (see Greg for designs!). This can be extended to allow automated delivery of goods direct from a manufacturer to a customer for negligible energy, so there is no need for storage warehouses or distributions networks or companies like Amazon, as any supplier can very easily deliver direct to a consumer.

Will fossil fuel companies sue governments?

They will try. They have very powerful lobbying forces that have kept governments under their power for too long. This is a Climate *Emergency*, so governments must use emergency powers to implement laws to prevent fossil fuel companies suing them.

Will fossil fuel companies go bust?

Yes, unless they diversify and move to helping installation and maintenance of the new renewable generation.

This is a very good reason for all government bodies to divest their pension funds from all fossil fuel companies and invest instead directly in renewable energy.

Will jobs be lost?

In fossil fuel related industries, yes. But many more jobs will be created in renewable energy industries. Professions naturally change over time e.g. a software developer's job would have been unheard of 100 year's ago but is now one of the major employers, while most people now have never heard of a cooper's job which was so prevalent 100 years ago that it has became a very common surname.

As fossil fuel companies go bust and use of fossil fuels decline there will be less tax revenue and less subsidies

Yes, and that is probably what has paralyzed governments into doing nothing for the last 30 years. Tax will have to be raised from other sources – for example increasing the tax rate on fossil fuels further, gradually making them prohibitively expensive as more renewable energy becomes available. This will make politicians unpopular, but extinction level events triggered by climate change, and costs of repairing damage and migration of billions of people from flooded areas will make politicians even more unpopular. Investments now to reduce climate change will save huge amounts later[xxiv]. This has to be done.

As fossil fuel subsidies are removed will gas, gas powered electricity and oil be more expensive for consumers?

Yes – that's the whole point to encourage consumers to move towards renewable energy.

What about people in fuel poverty?

There are around 6% of households in Wales in severe fuel poverty[xxv]. These will be affected as fossil fuels become more expensive. However, giving unfair subsidies to fossil fuel companies and those who can afford to pay for fuel is not a sensible method of helping these households. There are better targeted measures already in place for helping households in fuel poverty – especially improving energy efficiency[xxvi]. These measures can be extended to ensure more households take up the offers and benefits. The Really Simple Plan has not required any additional government funding, so there should be funds available to help vulnerable people.

Governments running electricity supply companies may be classed as unfair subsidies by the World Trade Organisation and the EU, leading to countries and companies suing them

No doubt. However, as said, this is a Climate *Emergency*, so governments must use emergency powers to implement laws to stop that kind of stupidity.

Not all the countries in the world will agree to implement such a plan

No doubt. However, we cannot wait for total agreement. We must set an example now. The Intergovernmental Panel on Climate Change has been trying to get global agreement for over 30 years and has achieved a lot of good words, but negligible practical action. Once other countries see they are missing out on low cost global energy through a global grid they will soon realise the benefits of joining.

How much land will be taken for the solar panels and batteries?

The land area requirements are calculated in the spreadsheets.

For the whole UK for total energy including transportation and aviation the requirement is a square 31km by 31km (963km^2). This is 0.39% of the land area of the UK (242,500km^2 [xxvii]). As a comparison, the total built area of the UK is 1.4% [xxviii], so it is even possible to fit all the solar panels required on existing buildings. It would be easier and lower cost to place on larger contiguous areas rather than individual buildings.

To ensure the highest profitability, it is vital that very little or no ground rent is payable. Surplus MOD and Council land would be highly suitable, instead of current practice of selling off such land for commercial developers to exploit and make huge profits from. Railway land may also be very suitable – ideally building above lines, although the construction costs will increase to build a structure over a line. Or any other publicly owned land. It is important that emergency planning powers are used to ensure no delays and no additional costs incurred by, for example, extensive environmental impact studies – the overriding benefit outweighs any potential loss of habitat for particular species, as, if they are that sensitive to change they will be wiped out by climate change anyway. So, the overriding priority is to reduce climate change as soon as possible.

For the whole world for total energy including transportation and aviation the requirement is a square 285 x 285km (81,225km^2). This is 0.05% of the total land area of the world (148.94 million km^2 [xxix]).

Will this deter private companies, community groups and individuals investing in renewable energy?

No. The plan should simplify the energy market and improve the distribution grids, making it easier for private companies, community groups and individuals to add their own generation sources. The electricity price charged by the government schemes to consumers will be set at a realistic value to ensure that private companies and individuals will still save money by using their own power over importing from other sources. As part of this, the ridiculous business rates on renewable energy, batteries and car chargers must immediately be scrapped as they make energy production for your own business uses prohibitively expensive. In fact, all business rates should be scrapped as they are a completely unfair, outdated tax based on arbitrary figures set by a rating authority rather than a business' profit. They only account for 4% of UK tax revenue[xxx] and are the largest factor in the death of the high street.

Why didn't the Institute of Welsh Affairs suggest this plan in their document "Re-energising Wales: A plan for Wales' renewable energy future - April 2019" that took 3 years to prepare?

Because they have been limited by what they think the government can do. We now need to step outside of those limitations and realise we are in a Climate Emergency and realise that "business as usual" is not an option.

Will the solar panels produce enough power over the winter?

The calculations have been based on total annual energy requirements and total energy supply capability of the panels over a year. In practice, at latitudes away from the equator, more energy will be suppled by the panels over summer than over winter. So, there will be a surplus over the summer and a shortage over the winter. The ideal answer to this is to use a global distribution grid as it is always summer somewhere in the world (see question *Can we achieve the global supply without requiring large amounts of backup batteries?*). Alternatively, a mix of renewable technologies can be

used in place of purchasing wholly solar panels. Alternatively, additional panels can be purchased to produce sufficient power over the winter. These options will increase the costs and increase the length of time required for 100% renewable power by a few years, unless additional funding is provided for them.

How long do solar panels and batteries last?

The performance of solar panels degrades over time. Most solar panels come with 25-year performance guarantees which guarantee at least 80% of their original performance. Some companies (Sun Power) are now guaranteeing a degradation of no more than 0.4% per year (panels still operate at 90% of their original performance after 25 years, 80% after 50 years, 67% after 100 years). Additionally, real world studies have been going on for over 25 years of use now, and show an average of 0.8% even for older designed panels built 25 years ago[xxxi]. There are no particular components of panels to corrode, all framework and fixings are aluminium, usually not under great stress, so mechanically they can last indefinitely. So, to all intents and purposes, they can last indefinitely. The slight loss of performance can be made up for by installation of new panels over time – it would be wasteful to replace existing panels still producing power.

Lithium Ion backup batteries are guaranteed by manufacturers to still store 80% of their original capacity after 10 years[xxxii]. They are likely to last much longer than this. Even if the capacity falls to 25% of the original capacity they are still performing a good job and should not be replaced. Instead, additional batteries added to make up the shortfall over time.

Are there enough raw materials to build all the panels and batteries?

Solar panels are silicon cells (made from sand), glass (made from sand) and a thin aluminium frame. There is plenty of sand worldwide. 65 million tonnes of aluminium is manufactured per year[xxxiii]. To supply the world's energy requirements needs 50 billion panels. If we say 1kg aluminium per panel this gives 50 million tons over the 27 year build up cycle. Which accounts for 2.8% of the world's aluminium production, which should be no problem.

There has been much discussion about raw materials for batteries, especially lithium, cobalt and nickel[xxxiv]. Estimated 0.25kg lithium per kWh battery = 35 million tonnes of lithium for 141TWh storage. Currently identified reserves of lithium are 39 million tons[xxxv]. Cobalt is a rarer metal with reserves of only 7 million tons[xxxvi], and nickel with 130 million tons[xxxvii]. There are clearly issues with producing enough raw materials, but improving battery technologies will hopefully require fewer or different materials over the next few years. Where larger storage stations are required it may be just as economical to used pumped water storage instead of battery storage, so these should be considered depending on local conditions.

Hydrogen fuel cells may be a viable alternative in some cases but require around 1 g of platinum per kWh capacity[xxxviii]. So would require 141,000 tons for 141TWh storage. Current identified reserves are around 69,000 tons[xxxix] so there would be a shortage using these cells.

The best solution would be to implement the global solar electrical distribution network which would require no batteries as it is always sunny somewhere on the globe and you do not have to over compensate with batteries for winter conditions (see question *Can we achieve the global supply without requiring large amounts of backup batteries?*)

The batteries and panels can be recycled to produce more when they do finally reach the end of their useful lives.

Isn't this too simple - shouldn't we also be encouraging people to change their lifestyles to reduce the Climate Emergency?

There is often a lot bundled into the climate discussion to help improve the planet globally and locally, and make it a better place to live in e.g. cutting down general pollution, reducing consumption, recycling etc. These are all good, but will not reduce the fundamental greenhouse effect generated by greenhouse gases. Even if we all put in huge efforts and reduce our consumption down to 10% of what it is now, too many greenhouse gases will still be produced. The global population has doubled in the last 50 years, which is unsustainable. Fundamentally the best thing we can do in terms of cutting back is to reduce the number of children we have. As people's lifestyles "improve" (in Western consumerism terms), they tend to have fewer children, probably because they see they won't be able to afford such a "good lifestyle" with more children to pay for, so that's an argument for actually supporting the lifestyle that we are saying is damaging…

The only way to bring greenhouse gas emission to zero is to produce all of our energy requirements renewably. If we do this, does it still mean we have to change lifestyles?

The things we are being asked to do are:

Cut down on traveling especially flying – there is no need to do that if all transport is powered by renewable energy.

Cut down on energy use in the house and business – there is no need to do that if we have plenty of low-cost renewable energy.

Cut down on consumerism – there is no need to do that if the energy required to produce and transport the goods is renewable (of course consumerism leads to other forms of pollution, poor working conditions etc. – but those do not produce greenhouse gases).

Cut down on meat & dairy consumption – this is one aspect that will reduce greenhouse gases in cattle farming. More people in Europe are already cutting down and turning away from meat and dairy, not just for climate reasons, but it is growing in Asia. There is already artificial meat grown in the lab - perhaps with unlimited low -cost energy that could be a low carbon source of food long term (if people still really want to eat meat).

Recycling & Reusing – good for the environment and preserves materials long term, but if the goods can be produced and transported again using renewable energy, it doesn't reduce greenhouse emissions.

Are there any other lifestyle changes that would reduce greenhouse gas emission once all energy is produced renewably?

We need to separate out the arguments – "Moving to zero greenhouse gas emissions" – which can easily and quickly be done by governments with a simple plan like the one proposed. And "Improving our Planet" – which involves everyone doing their bit to help.

The problem with combining the arguments into a single discussion is that it makes it too complex and people give up, saying there is nothing they can do, or they tackle one aspect like reducing single use plastic bags, then pat themselves on the back saying they have done wonderful things for the environment, when in fact they have done nothing to reduce climate change.

Any other questions or help moving forward with these plans?

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[i] https://www.iwa.wales/wp-content/uploads/2019/03/IWA_Energy_WP6_Digital-2.pdf

[ii] https://gweddill.gov.wales/docs/desh/publications/190321-prosperity-for-all-a-low-carbon-wales-en.pdf

[iii] https://www.independent.co.uk/voices/climate-change-ipcc-environment-paris-agreement-global-warming-a8573811.html

https://rebellion.earth/the-truth/the-emergency/

https://www.theguardian.com/environment/2019/apr/23/greta-thunberg-full-speech-to-mps-you-did-not-act-in-time

[iv] https://gov.wales/m4-corridor-around-newport

[v] This looks unreasonably rapid considering the tiny investment. The reason it works is because Wales already generates 75% of its electricity requirements renewable (it exports a lot of it, and uses a lot of fossil fuels in return). Total electricity consumption of Wales: 14.9 TWh ("SUB-NATIONAL ELECTRICITY AND GAS CONSUMPTION STATISTICS December 2018" https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/767027/Sub-national-electricity-and-gas-consumptio-summar-report-2017.pdf) less 11 TWh already produced renewably in Wales ("UK Energy Statistics, 2018 & Q4 2018" https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/791297/Press_Notice_March_2019.pdf) = 3.9 TWh balance to generate.

[vi] IWA "A plan for Wales'renewable energy future: Essential actions to re-energise Wales by 2035" https://www.iwa.wales/wp-content/uploads/2019/03/IWA_Energy_WP6_Digital-2.pdf: 14.6 TWh electricity consumption for Wales. 84% of total remaining energy product is non-renewable -> Total 91.2 TWh. Less 11 TWh already produced renewably in Wales ("UK Energy Statistics, 2018 & Q4 2018" https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/791297/Press_Notice_March_2019.pdf) = 80.2 TWh balance to generate.

[vii] https://gov.wales/sites/default/files/publications/2018-12/final-budget-2019-2020-motion.pdf

[viii] https://www.iwa.wales/wp-content/uploads/2019/03/IWA_Energy_WP6_Digital-2.pdf

[ix] "Local Government Pension Scheme Funds" https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/562591/LGPS_Wales_2015-16.pdf
Investment income £175m. Fund Management Costs £63m. Net income £112m.

[x] IWA Institute of Welsh Affairs "A plan for Wales' renewable energy future: Essential actions to re-energise Wales by 2035" https://www.iwa.wales/wp-content/uploads/2019/03/IWA_Energy_WP6_Digital-2.pdf
https://www.theguardian.com/environment/2019/jan/23/uk-has-biggest-fossil-fuel-subsidies-in-the-eu-finds-commission
REPORT FROM THE COMMISSION TO THE EUROPEAN PARLIAMENT, THE COUNCIL, THE EUROPEAN ECONOMIC AND SOCIAL COMMITTEE AND THE COMMITTEE OF THE REGIONS – "Energy prices and costs in Europe SWD(2019) 1 final"
https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=COM:2019:1:FIN&from=EN
https://ec.europa.eu/energy/sites/ener/files/documents/energy_prices_and_costs_-_final_report_-_annexes_v12.3.pdf

[xi] 280 TWh ("SUB-NATIONAL ELECTRICITY AND GAS CONSUMPTION STATISTICS December 2018" https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/767027/Sub-national-electricity-and-gas-consumptio-summar-report-2017.pdf) less 33% electricity already generated by renewables "UK Energy Statistics, 2018 & Q4 2018" https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/791297/Press_Notice_March_2019.pdf = 169 TWh balance to generate.

[xii] 141,175 ktoe = 1,641 TWh "Energy Consumption in the UK July 2018" https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/729317/Energy_Consumption_in_the_UK__ECUK__2018.pdf less 33% electricity already generated by renewables "UK Energy Statistics, 2018 & Q4 2018" https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/791297/Press_Notice_March_2019.pdf = 1,530 TWh balance to generate.
NB. This assumes that all transportation has moved to using electricity as the primary energy supply.

[xiii] Estimates vary from US$302 billion (International Energy Agency https://www.iea.org/weo/energysubsidies/) to $5.3 trillion (International Monetary Fund: How Large Are Global Energy Subsidies? https://www.imf.org/external/pubs/ft/wp/2015/wp15105.pdf). We take a conservative figure of UK£500bn for purposes of illustration.

[xiv] Total Energy Production: 25,592 TWh (Global Energy Statistical Yearbook 2018 https://yearbook.enerdata.net/), of which 24.80% is already renewable, so the remaining renewable required is 19,245 TWh.

[xv] Total Energy Production: 14,080 Mega tonne of oil equivalent (Mtoe) = 163,749 TWh (Global Energy Statistical Yearbook 2018 https://yearbook.enerdata.net/), of which 6,347 TWh is already renewable, so the remaining renewable required is 157,402 TWh.
NB. This assumes that all transportation has moved to using electricity as the primary energy supply.

[xvi] For sooner targets see the question “How can we get to Extinction Rebellion’s target for all UK energy including heating, transport and aviation being renewable by 2025?”

[xvii] Hafod Renewable Energy (https://www.hafodrenewables.co.uk/). 13.4kWh Tesla Powerwall 2 £6,000 = £440 per kWh.
https://www.alibaba.com/showroom/best-price-per-watt-solar-panels.html from US$0.13 per watt = $130 per kWp. Plus inverter https://www.alibaba.com/showroom/solar-inverter.html $80 per kWp.
Total around £604 leaving £396 to allow option for higher quality components and installation per kWp.

[xviii] The Solutions Factory actual generation figures for 150kW peak solar plant in West Wales (www.solutions-factory.co.uk)

[xix] http://www.energylocal.co.uk/

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