From: [redacted]
To: Cleve Hill Solar Park
Subject: Deadline 7 Submission from CPRE Kent
Date: 12 November 2019 13:35:48
Attachments: [redacted]

Dear Cleve Hill Solar Team,

Please find attached a further submission in advance of Deadline 7. This comprises a response to CHSP's submission of EN010085-001607-Cleve Hill Solar Park - AS re: Drax Repower & Energy Storage consultation, and Additional Information.

We expect to make one more additional submission before tomorrow's deadline. As ever, I would be most grateful for acknowledgment of receipt.

Kind regards
Hilary

Dr Hilary Newport
Director
The Kent Branch of CPRE
[redacted]

National Infrastructure Planning
Cleve Hill Solar Park
CPRE Kent (Reference 20022146)

Deadline 7 Submission:
Comments on 'EN010085-001607-Cleve Hill Solar Park - AS Drax power station', and Additional Information for Deadline 7

1 Response to EN010085-001607-Cleve Hill Solar Park - AS Drax power station

1.1 Secretary of State's (SoS) Decision

Cleve Hill Solar Power (CHSP) have submitted EN010085-001607, their commentary on the recent Drax Repower DCO Decision, and its potential relevance to this Examination.

It should be noted that the Secretary of State disagreed with the Examining Authority (ExA) and that Interested Parties, in particular Client Earth, are considering a Judicial Review of this recent Decision.

The Drax Repowering, as its name suggests, is re-powering an existing very large power station, so it is an existing industrial site, not a greenfield site with so many of the environmental constraints that apply to CHSP.

This Examination should consider and draw its own views on the conclusions made by CHSP from that Decision.

1.2 Sustainable Development & Planning

In Paragraph 4.13 of the SoS decision (shown on Page 2 of EN010085-001607), reference is made to the "principles of sustainable development", and these underpin all planning decisions.

The principles depend on three "legs" - economic improvement, social improvement and environmental improvement, and it has long been planning policy that proposals must support all three. In other words a scheme which provides economic benefits but trashes the environment is unacceptable.

Paragraph 4.20 refers to "places where it is acceptable in planning terms" which reinforces the previous point.

Both of these mean that CHSP is unacceptable because of all its adverse impacts.

1.3 Decarbonisation, Security of Supply and Lowering Consumer Costs

CHSP paragraph 2.4, page 5, says: "*CHSP would make meaningful and timely contributions to GB decarbonisation and security of supply, while helping lower bills for consumers*" and

"*submissions by other parties about the contribution made by planned offshore wind farms and other technologies are not relevant. As the Secretary of State says, there is no guarantee those projects will reach completion*"

CHSP's argument about decarbonisation is wrong because CHSP is not zero carbon, as demonstrated in next section.

Likewise "security of supply" is only provided if the battery system is implemented – without the battery it cannot provide security of supply because output depends on light levels, which are not guaranteed. Therefore alternatives which provide greater security of supply to PV supplies on their own (without batteries) would receive economic preference (ie higher prices) by prospective purchasers of CHSP's electricity.

If it is to enable security of supply this Application must include batteries as an integral part of the system for this DCO, and the impacts of the batteries and associated parts must be included in the DCO.

CHSP has also quoted support for more electricity because of potential increases in demand, such as provided by National Grid's Future Energy Scenarios (FES) for 2050. However, like the government's own predictions, such predictions have been proved wrong as previously shown to this Examination, because it is impossible to accurately predict the future 30 years ahead.

Predictions are even more of challenge because of the way consumption and supply can be flexibly managed as shown previously and below, and also the rapidly increasing actions to improve efficiency in use all combining to provide a lower and steadier demand, which existing supplies can easily manage.

Similarly "lower bills for consumers" depends very heavily on the economics of CHSP. As demonstrated below and in other evidence to this Examination, Solar is not the cheapest, and would not provide the potential £600 million from the latest Contract for Differences (see end of 1.5, below).

Therefore consideration of other technologies is very relevant, especially schemes such as offshore windfarms which are supported by both Government policy and funding, and therefore highly likely to be built.

1.4 Decarbonisation - Emissions from Photovoltaic systems

CHSP's Photovoltaic generation claims, in Paragraph 2.9, page 5, to be "without any carbon emissions" which is not true: the processes needed to manufacture, install, operate and ultimately dispose of the system cause emissions.

It is not "Zero Carbon" and, in comparison with other Low Carbon sources, it is certainly not the lowest carbon source.

Where the panels are located on the ground, as in this proposal, they not only adversely affect the area occupied and reduce its ability to sequester and store carbon, but the

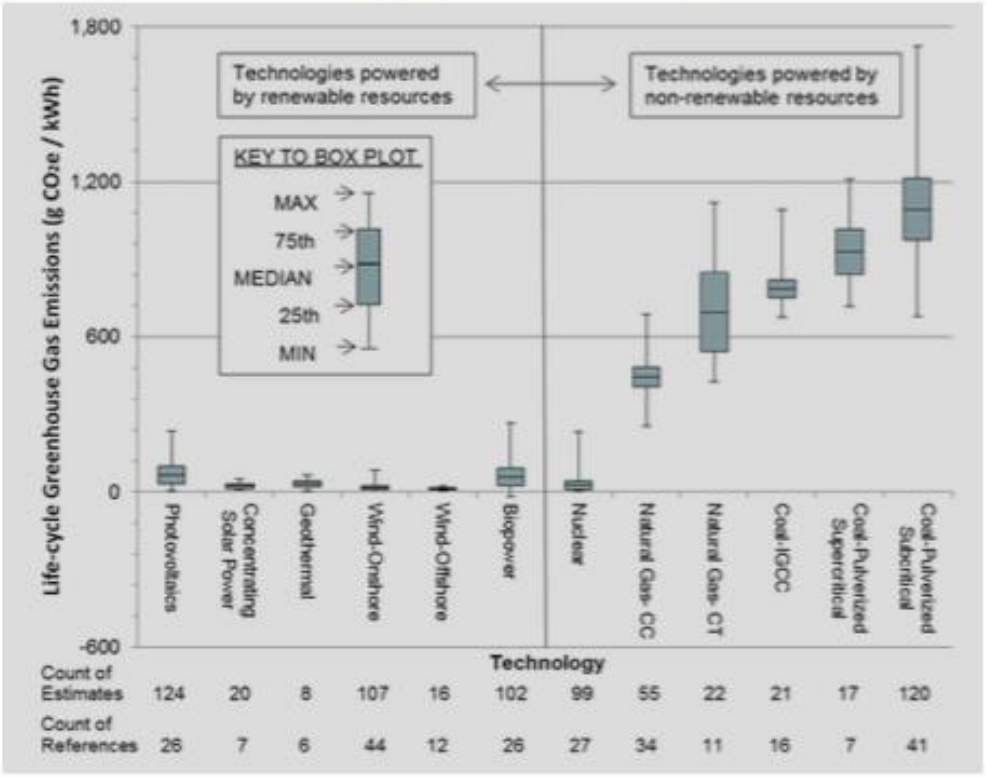
ancillary structures such as roads, bunds, fencing, security lighting etc., all add to emissions.

The Examination has already received evidence on the larger footprint of PV compared to wind, with its associated higher carbon footprint land use, but the actual equipment has a higher carbon impact.

As noted above, to provide security of supply, this proposal must include batteries, and they also have their own significant, carbon footprint, which needs to be added to that of the photovoltaic system, which gives an even higher carbon footprint and cost overall.

The United States Department of Energy publication "An Assessment of Energy Technologies and Research Opportunities"[1] shows in Figure 10.(reproduced below), that the Green House Gas Emissions are comparable to Biopower and are higher than nuclear and several times higher than wind, especially offshore, which has the lowest emissions.[2]

Figure 10.2 Illustrative Comparison of Life-Cycle GHG Emissions of Various Electricity Generation Technologies[2]



Note: Reference has "harmonized" original data to correct for differences in a number of input assumptions, resulting in reduced variance. "Count of estimates" refers to the number of separate sources of data. "Count of references" refers to the number of separate studies used to provide data. Key: **CC** = combined cycle; **CT** = combustion turbine; and **IGCC** = integrated gasification combined cycle.

[1] https://www.energy.gov/sites/prod/files/2017/03/f34/qtr-2015-chapter10.pdf

[2] Data sourced from Mai, T., R. Wiser, D. Sandor, G. Brinkman, G. Heath, P. Denholm, D. J. Hostick, N. Darghouth, A. Schlosser, and K. Strzepek. 2012. Exploration of High-Penetration Renewable Electricity Futures. Vol. 1 of Renewable Electricity Futures Study, NREL/TP-6A20-52409-1. Golden, CO: National Renewable Energy Laboratory.

This means it is not “Zero Carbon” nor is it reducing generation emissions as effectively as wind or nuclear, further diminishing its potential benefits.

1.5 Economic Viability

1.5.1 Solar is still much more expensive than offshore wind

The Applicant claims that the Drax Repower DCO Decision (EN010085-001607) indicates that the issue of need is not relevant.

However the issue of need is entirely relevant since if the Proposals produce expensive electricity relative to other supplies or to demand reductions, then no-one will buy it.

The Marshes are a rare and unique area and therefore it is essential that the Examiners are satisfied that if approval is given then the scheme will go ahead and operate successfully and produce benefits greater than its impacts; otherwise this area would be blighted with all the consequential impacts of that.

Solar is more expensive than wind and the cost of wind is rapidly decreasing. For example, the recent Contract for Difference auction[3] showed that offshore wind is now cheaper than gas powered generation, and the Strike Prices for 2023/24 are £39.62 per MWh, which is some £8 to £9 below the government’s ‘reference price for that year. Since CHSP would be in competition with that, its prices would have to be lower to be competitive.

The new wind schemes are achieving cost reductions because of larger turbines, a host of technical developments in turbine design, manufacture, installation and maintenance, as shown by the Department for Business, Energy & Industrial Strategy (DBEIS).

These factors have also increased the capacity factors with existing offshore windfarms achieving around 47%, but the next generation are expected to achieve 60% - far greater than for solar farms. The higher capacity factor also means cheaper electricity for consumers.

Offshore wind technology has rapidly developed, more than halving costs, and thus undercutting gas powered electricity, the price of which has remained steady and is expected to gradually increase in future, especially as carbon pricing increases.

The impact of lower wind costs has meant that at times the wholesale price of electricity has become negative, further reducing the competitiveness of CHSP.

These results support the expectation of offshore windpower to form the backbone of zero carbon electricity, with the government signing a ’sector deal’ for an increase of 30 GW in

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[3] www.carbonbrief.org/analysis-record-low-uk-offshore-wind-cheaper-than-existing-gas-plants-by-2023?utm_campaign=RevueCBWeeklyBriefing&utm_medium=email&utm_source=Revue

offshore wind, up from the current 9 GW.

The Crown Estate has begun a leasing round for another 7 GW offshore, which is additional to that already planned.

Onshore wind is also cheaper than solar and is expected to continue falling in cost at a faster rate than solar. It also has a smaller footprint per MW than solar, providing further reasons to refuse this application.

These aspects illustrate the greater benefits of wind power compared to solar power, and also show the need to keep the Cleve Hill Grid Connection available for replacing the Kentish Flats wind turbines with upgraded equipment, which would be far cheaper, and deliver more energy than the Application.

Finally, it should be noted that if the market follows the government's reference price expectations, then these schemes will pay some £600 million towards consumer bills by 2027, which would be a much greater public benefit than the Applicant could achieve.

This data shows that it is against the public interest to allow the Proposals to proceed.

1.5.2 Additional New Evidence of Alternatives which compete with CHSP

1.5.2.1 National Grid ESO is encouraging the expansion of resources on the distribution network, rather than on the Grid

It is clear that the National Grid Electricity System Operator (NGESO) is implementing measures to enable ever increasing provision of supply and demand facilities on the distribution networks rather than the traditional Grid connected suppliers and major demands.

Evidence of this is shown on their website and includes using Distributed Energy Resources (DER) for multiple purposes including Black Restart, as shown for example by their Distributed ReStart project[4].

It is also clear that this is the way to maximise carbon reduction, as it increases efficiency of the overall system and therefore reduces energy use.

1.5.2.2 Efficiency and Maximising Low Carbon

As previously stated, the cheapest energy is the energy that you do not use. Improving energy efficiency is far more cost effective and important than new energy resources such as the Applicant's proposals, which merely provide additional energy at huge monetary and environmental cost. Energy efficiency reduces carbon emissions and so should be a priority.

In addition providing 'load' forms of Demand Side Resource is lower carbon than providing new renewable energy resources, because it is making use of available renewable generation, rather than spending resources on creating more generation.

[4] www.nationalgrideso.com/innovation/projects/distributed-restart

Promoting Demand Side Response should therefore be the next priority after improving efficiency. The third priority is then distributed renewable energy. Large renewable schemes which are sited appropriately should only be considered after all of these.

Cleve Hill Solar is therefore both unnecessary and unsuitable.

1.5.2.3 Flexibility and Local Energy Markets in Distribution Network

The two key factors which affect electricity costs are energy efficiency and flexibility in demand.

Energy efficiency is the cheapest way to reduce costs, and flexibility in demand further reduces costs, as shown for example, by Day/Night tariffs which can more than halve costs per unit – Ecotricity currently charge 22.06 p/kWh for daytime use, but only 10.37 p/kWh at night.

Similarly, for energy generators, flexible generation can pay more than inflexible supplies. Modern technologies are now supporting increasing flexibility both in demand and supply, which is completely transforming the market. This includes rapidly increasing developments in local energy markets (LEMs) and in the provision of flexibility by such markets, and examples are provided below.

The key aspects of all these schemes is to provide flexibility for Distribution Network Operators DNOs), but also provide significant direct economic benefits to consumers and generators.

These schemes improve energy efficiency, thereby also reduce energy usage and carbon emissions.

This is in contrast to the Applicant's scheme which provides no direct benefits to local people but merely generates electricity, has significant carbon impacts (specially by reducing carbon absorption of the land) and has numerous other adverse impacts.

Although the Applicant argues that even if other Grid connected sites could be used, their scheme is still needed because there is a need for more low carbon schemes. This argument is only valid if there is a lack of other alternatives, and they do not have to be on the Grid, because it is the total capacity that is important.

As well as the total capacity the demand is equally important because the system now has increasingly flexible demand which can be reduced or increased as required.

The cost of the supply is also vital because no one will buy expensive electricity, so unused generating capacity is a waste of resources.

The key aspect is that demand is falling, with the National Grid's current Winter Prediction, being for a lower demand than last winter. There are so many schemes coming on stream in the distribution system, as well as the major offshore wind schemes quoted above, that Cleve Hill is now unnecessary, even for de-carbonising.

Finally, the Cleve Hill grid connection is currently scheduled for 2024, and many of the other

schemes are being implemented now or before 2024, meaning that Cleve Hill becomes even less viable and unnecessary.

The schemes below would add more than enough low carbon electricity to the existing low carbon supplies to meet the falling electricity demand, and at lower costs than the Applicant's proposals.

An extract from the report "Flexibility and Local Energy Markets in Distribution Network"[5] is appended at annex 1 to this document, and provides more details of the schemes summarised below:

1.5.2.4 Centrica identifies large market for Distributed Energy to reduce carbon, improve resilience and save money

Centrica being a major player in the energy market has the power to influence many energy using organisations, and their commitment to Distributed Energy, means that ever larger amounts of such resources will come into play, as well as their large residential schemes such as the Virtual Power Plant referred to in 1.5.2.5.

1.5.2.5 Centrica's Virtual Power Plant

Centrica are promoting major flexibility scheme of residential hot water tank scheme with Mixergy, providing a 2.5 GW virtual power plant by being able to adjust the demand for heating hot water in line with overall demand, and has already installed 100 systems for this.

As well as benefitting Centrica and the national energy system these tanks will also reduce water and energy by up to 40%, saving consumers money too. - if that had been available for the Grid failure on 9 August 2019, it would have avoided the 3.47 minute grid failure, because the existing Social Energy's distributed load operated within 200 milliseconds of the Grid failure notification, demonstrating that increased flexibility in the distribution system also reduces grid risks.

1.5.2.6 Plan Zero by OVO

OVO Energy has committed to eliminating its customer's household emissions and fit five million homes with flexible, clean energy technologies as part of a wide-ranging carbon-cutting initiative dubbed 'Plan Zero'. This demonstrates that not only can consumers have local clean energy but also reduce energy use.

1.5.2.7 EDF, UKPN to trial residential flexibility in local energy market project

EdF UKPN and Repowering London are providing peer-to-peer energy trading for solar and battery power between residents in Project CommUNITY, and this not only provides low carbon and economic benefits to users but also flexibility to the Distribution Network Operators.

[5] www.centricabusinesssolutions.com/powering-sustainability-report

1.5.2.8 DSR: adding a revenue stream for the water industry

Severn Trent Water provides an example of an industry which currently can provide 15 Megawatts of Demand Side Response, which could increase to 50 MW, which has with very good paybacks of three years, as well as providing other benefits to them.

2 Land and Climate Change

2.1 Land

Land is a scarce and finite resource, because we are not making any more, and in the case of Kent we are facing losing huge areas due to rising seas and flooding. In the face of so many additional competing demands for land, each area must be used for its best use.

We are, as Government and local councils agree, facing a Climate Emergency, and that means Climate Change is our top priority for land.

The Committee on Climate Change (CCC) which has already said we need major land use changes[6]. That will mean ensuring that the Marshes are used for the purpose that will provide the greatest benefits.

As the CCC says in its Executive Summary:
*"**Land is a critical natural asset.** It provides us with the fundamentals of life: clean water, food, timber, and the natural regulation of hazards such as flooding. Key to the effective functioning of these is biodiversity. Land is also an essential resource to mitigate climate change, naturally sequestering and storing carbon. Over the rest of this century and beyond, climate change combined with other social, economic and environmental pressures will present significant risks to the services provided by the land.*
Unless land is managed more effectively over this transition, its essential functions will not be maintained for future generations. "

Clearly the Applicant's Proposals will not provide improved and effective land management.

Support for better management comes from the RSPB who have mapped out protected areas that are providing carbon benefits, and Figure 1 (overleaf) shows the local area:

[6] https://www.theccc.org.uk/wp-content/uploads/2018/11/Land-use-Reducing-emissions-and-preparing-for-climate-change-CCC-2018.pdf

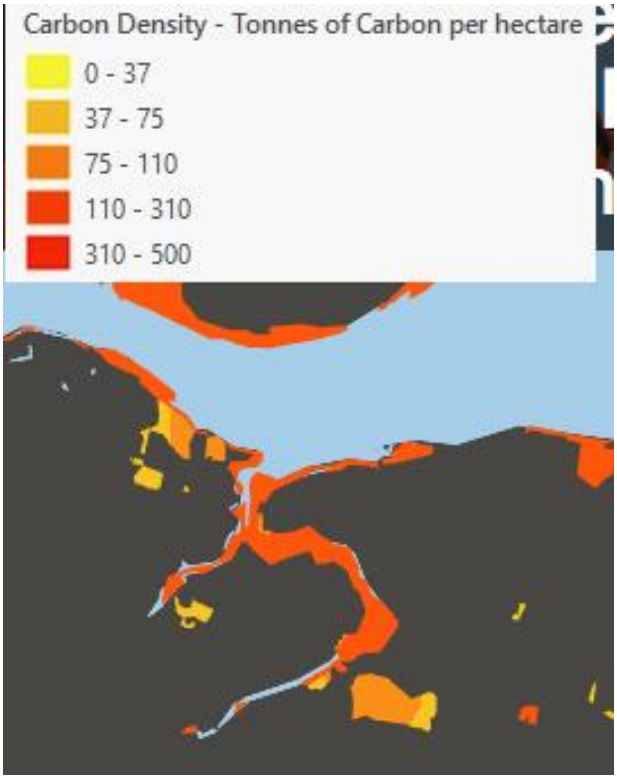

Figure 1 Extract from RSPB Map around Faversham. [7]

Although much of the Application Site is not covered by designations, it is bordered by the high carbon areas, so its management should be improved to provide even greater carbon benefits.

The RSPB conclusions from this mapping are:
"Natural climate solutions are essential to confront the climate change and biodiversity crises. All carbon and nature-rich areas need to be mapped, recognised and integrated into national land plans and initiatives to secure their protection.
Government policies must prioritise and drive a turn-around of the poor ecological condition of the carbon and nature-rich areas across the UK.
Public funding for land management must deliver the restoration and maintenance of these areas to secure long-term benefits for carbon and nature."

RSPB's concerns are just one reason why need to protect this area. Their message is enhanced by the recent declaration by 11,000 scientists around the world[8] that:
"*clearly and unequivocally … planet Earth is facing a climate emergency*."

Their recommended actions include: "*We must protect and restore Earth's ecosystems. Phytoplankton, coral reefs, forests, savannas, grasslands, wetlands, peatlands, soils, mangroves, and sea grasses contribute greatly to sequestration of atmospheric CO_2. Marine and terrestrial plants, animals, and micro- organisms play significant roles in carbon and nutrient cycling and storage. We need to quickly curtail habitat and biodiversity loss*."

[7] https://rspb.maps.arcgis.com/apps/Cascade/index.html?appid=2b383eee459f4de18026002ae648f7b7
[8] https://academic.oup.com/bioscience/advance-article/doi/10.1093/biosci/biz088/5610806

In particular they note: "*Although available land may be limiting in places, up to a third of emissions reductions needed by 2030 for the Paris agreement (less than 2°C) could be obtained with these natural climate solutions"* [9]

In planning terms the marshes are not scheduled for development, and the marshes already provide many benefits for carbon, nature, recreation, mental health, exercise etc., which could be improved. It is far better for them to be protected from the proposed development.

The following section provides additional reasons for protecting these marshes.

2.2 Wetlands

The importance of wetlands, which includes marshes such as Graveney, has not been emphasised enough, and we are very concerned at the inadequate recognition of their importance.

The IET article "Why the World needs wetlands"[10] (appended as Annex 2 to this submission) amplifies how important they are to our world.

Not only are wetlands a scarce and vital habitat, but disturbing them causes large adverse effects, so the Solar proposals would be just about the worst possible thing to do in this area.

To quote some examples from this article:
"*Since 1700, the world has lost 87 per cent of its wetlands according to the Ramsar Convention on Wetlands in its 2018 Global Wetland Outlook (GWO). That's three times the rate of loss of our rainforests. In the technological age, the rate of loss is even greater – 35 per cent since 1970*."
"*What is now increasingly being realised, however, is that wetlands, rather than making human settlements susceptible to floods, provide us with natural protection from fast-rising waters*."
"*When **these environments are modified**, they can lose their capacity to absorb the excess waters*."
"*The Insurance Bureau of Canada announced in September 2018, that wetlands provide flood protection more effectively and more cheaply than dams, levees or other manmade solutions*."
"*Wetland plants take carbon out of the atmosphere and store it as plant tissue and eventually soil, unlike on dry land where plants die, break down and release the carbon back into the air. However, according to a November 2018 Florida International University report, a wetland can only perform this function if it is healthy and intact. '**Draining or disturbing wetlands can actually release the stored carbon into the atmosphere very quickly,**' Lehrter adds.*"

[9] Griscom BW, et al. 2017. Natural climate solutions. Proceedings of the National Academy of Sciences 114: 11645–11650

[10] https://eandt.theiet.org/content/articles/2019/02/why-the-world-needs-wetlands/

"Royal Academy of Engineering report {Referred to in previous evidence], published last September, said restoring wetlands could reduce greenhouse gases and help the UK to be carbon-neutral by 2050"

3 STATE OF NATURE 2019

Our reading of the SoN report is that this update of the previous 2016 report shows continuing losses of wildlife with the majority declining, with no let-up in the losses to all animals, plants and marine life. At least a quarter of UK mammals and nearly half of the birds assessed are at risk of extinction.

However the Report only covers the period since 1970. Major declines of nature have been going on for a long time, so we really need to not only recover what has declined since 1970, but to also try to recover losses from before then.

This means that a scheme such as Cleve Hill cannot go ahead as it would totally alter and damage the environment over a very large area which harbours some of our scarcest nature.

It would also have effects on the aquatic and marine environment which is also at risk.

The website: www.nbn.org.uk/stateofnature2019/ has the Report with a wealth of other information supporting the main report.

REFERENCES

Nature. 2018 Dec;564(7735):249-253. doi: 10.1038/s41586-018-0757-z. Epub 2018 Dec 12.
Assessing the efficiency of changes in land use for mitigating climate change.
Searchinger TD, Wirsenius S, Beringer T, Dumas P.

Abstract
Land-use changes are critical for climate policy because native vegetation and soils store abundant carbon and their losses from agricultural expansion, together with emissions from agricultural production, contribute about 20 to 25 per cent of greenhouse gas emissions1,2. Most climate strategies require maintaining or increasing land-based carbon3 while meeting food demands, which are expected to grow by more than 50 per cent by 20501,2,4. A finite global land area implies that fulfilling these strategies requires increasing global land-use efficiency of both storing carbon and producing food. Yet measuring the efficiency of land-use changes from the perspective of greenhouse gas emissions is challenging, particularly when land outputs change, for example, from one food to another or from food to carbon storage in forests. Intuitively, if a hectare of land produces maize well and forest poorly, maize should be the more efficient use of land, and vice versa. However, quantifying this difference and the yields at which the balance changes requires a common metric that factors in different outputs, emissions from different agricultural inputs (such as fertilizer) and the different productive potentials of land due to physical factors such as rainfall or soils. Here we propose a carbon benefits index that measures how changes in the output types, output quantities and production processes of a hectare of land contribute to the global capacity to store carbon and to reduce total greenhouse gas emissions. This index does not evaluate biodiversity or other ecosystem values, which must be analysed separately. We apply the index to a range of land-use and consumption choices relevant to climate policy, such as reforesting pastures, biofuel production and diet changes. We find that these choices can have much greater implications for the climate than previously understood because standard methods for evaluating the effects of land use on greenhouse gas emissions systematically underestimate the opportunity of land to store carbon if it is not used for agriculture.

Glomalin
www.sciencedirect.com/topics/agricultural-and-biological-sciences/glomalin
Glomalin is a glycoprotein associated with carbohydrates, contains 30–40% (w/w) C (González-Chávez et al., 2004), is assumed to be stable and persistent in soil, and is thought to be produced in copious quantities by arbuscular mycorrhizal fungi (Glomeromycota). This reference source has numerous articles up to 2019, which illustrate the complexities of soil, as well as glomalin benefits.

Carbon sequestration
Royal Society:
https://royalsociety.org/news/2018/09/greenhouse-gas-removal/
The UK 2050 net-zero scenario
GGR technologies suitable for the UK to use to meet net-zero emissions by 2050

- Ready to use GGR methods such as forestation, habitat restoration, soil carbon sequestration, and building with wood or carbonated waste could provide just over a

quarter of the target to reach net zero emissions
- Biochar, enhanced terrestrial weathering in agricultural soils, direct air capture (DACCS), and bioenergy with carbon capture and storage (BECCS) could contribute to the rest of the 2050 target
- Page 33 of this report says: "Storage potential and longevity of storage: Rates for soil carbon sequestration vary considerably, depending on land-management approaches, soil type, and climate region. When scaled globally, the technical potential for soil carbon sequestration is estimated between 1.1 and 11.4 $GtCO_2$ pa, with more conservative estimates suggesting an upper limit of 6.9 $GtCO_2$ pa. Estimates for the UK potential for soil carbon sequestration are 1 to 31 $MtCO_2$ pa. "

Preliminary assessment of the potential for, and limitations to, terrestrial negative emission technologies in the UK. Smith P, Haszeldine RS, Smith SM. Environmental Science: Processes & Impacts. 2016;18(11):1400–5. Available from: http://dx.doi.org/10.1039/C6EM00386A

Carbon sequestration. Rattan Lal.
https://royalsocietypublishing.org/doi/pdf/10.1098/rstb.2007.2185
Published:30 August 2007

Abstract
Developing technologies to reduce the rate of increase of atmospheric concentration of carbon dioxide (CO_2) from annual emissions of 8.6 $Pg\,C\,yr^{-1}$ from energy, process industry, land-use conversion and soil cultivation is an important issue of the twenty-first century. Of the three options of reducing the global energy use, developing low or no-carbon fuel and sequestering emissions, this manuscript describes processes for carbon (CO_2) sequestration and discusses abiotic and biotic technologies. Carbon sequestration implies transfer of atmospheric CO_2 into other long-lived global pools including oceanic, pedologic, biotic and geological strata to reduce the net rate of increase in atmospheric CO_2. Engineering techniques of CO_2 injection in deep ocean, geological strata, old coal mines and oil wells, and saline aquifers along with mineral carbonation of CO_2 constitute abiotic techniques. These techniques have a large potential of thousands of Pg, are expensive, have leakage risks and may be available for routine use by 2025 and beyond.

In comparison, biotic techniques are natural and cost-effective processes, have numerous ancillary benefits, are immediately applicable but have finite sink capacity. Biotic and abiotic C sequestration options have specific niches, are complementary, and have potential to mitigate the climate change risks.

Flexibility and Local Energy Markets in Distribution Network

3.3.1 Centrica identifies large market for Distributed Energy to reduce carbon, improve resilience and save money

The Powering Sustainability Report: A lower carbon future for the UK, a more sustainable future for business

www.centricabusinesssolutions.com/powering-sustainability-report

Centrica Business Solutions' new report, **Distributed Energy: Powering sustainability** reveals the low-carbon ambitions UK businesses and public sector organisations can achieve by committing to a sustainable energy strategy.

The report looks at the carbon challenge facing UK businesses and public organisations, and reveals how new, innovative distributed energy technologies are delivering significant benefits for UK organisations, as well as helping the UK meet its international carbon reduction commitments and Climate Change Act goals.

Read the full report, download our key takeaways, watch our video and learn about how Centrica Business Solutions is already helping organisations in the UK create competitive advantage with a sustainable energy action plan.

The UK is already a global leader in the fight against climate change. This report focusses on the emergence of new distributed energy technologies that can help public bodies, businesses and heavy industry play their part in the UK's low carbon future.

The Powering sustainability report reveals that in the Industry, Health and Hospitality & Leisure sectors alone, distributed energy solutions could deliver cumulative savings of 137MtCO_2e through to 2030; the equivalent to annual emissions of 43 million homes.

Download the Full Report

Partnering with our recent report, , the Powering sustainability report highlights clear ambitions for UK organisations; not just why they need to take action, but also the steps that can be taken to build a more sustainable business.

3.3.2. Centrica's Virtual Power Plant

Centrica is to absorb thousands of residential hot water tanks into its virtual power plant (VPP) to provide flexibility to the grid.

www.current-news.co.uk/news/centrica-to-use-hot-water-tanks-for-frequency-response-in-vpp **30/9/2019**

The energy giant has secured approval from National Grid to use the tanks for firm frequency response (FFR) as part of a 2.5GW VPP it is establishing in the UK.

The tanks will be provided through a partnership with Mixergy, a spin-off company from the University of Oxford which has previously received investment from Centrica Innovations.

The first batch of 100 tanks have already been installed and will be capable of storing energy at times of high renewables, responding at times of stress whilst maintaining efficiency, cost and comfort.

The tanks are set to help balance the grid through storing excess load on the grid and time shifting demand.

Charles Cameron, chairman of Centrica Innovations, said: "The first batch of 100 hot water tanks, which are now in homes in the UK will, at times of stress, be capable of capturing energy at low market prices on sunny or windy days when there is an abundance of renewables on the network, all whilst maintaining efficiency, cost and comfort for our

customers.
It is the first instance of a pool of residential devices being aggregated into a VPP comprising of larger individual industrial assets and used to deliver services to automatically balance the system, Centrica said.
The tanks are also set to reduce heat losses, water and energy usage by up to 40% a year, through a combination of sensory and Internet of Things (IoT) technologies. The hot water levels in the tank are monitored and the household usage habits learned in order to personalise water volumes and heat only what is needed.
Pete Armstrong of Mixergy said the firm is "very excited to be at the heart of Centrica's mission" to add additional flexibility to the energy system.
"Together with Centrica, we are paving the way for smart tariffs which will reduce energy consumption and carbon emissions by storing excess renewable energy on the grid," Armstrong added.
The use of the tanks for FFR has similarities to a trial conducted by Tesco and the University of Lincoln, whereby fridges provided the grid with frequency response services.
Centrica Business Solutions is working with a variety of global residential appliance manufacturers to explore opportunities for providing flexibility services using its demand response technology platform, Flexpond.
In June, Centrica announced its partnership with the Tokyo Electric Power Company for the use of Flexpond in providing demand response services for Japan's grid.

3.3.3 OVO's 'Plan Zero'

Eliminate home carbon emissions and fit five million homes with smart energy tech
20September, 2019
www.current-news.co.uk/news/ovos-plan-zero-eliminate-home-carbon-emissions-and-fit-five-million-homes-with-smart-energy-tech

55. OVO Energy has committed to eliminating its customer's household emissions and fit five million homes with flexible, clean energy technologies as part of a wide-ranging carbon-cutting initiative dubbed 'Plan Zero'.

OVO announced the new initiative at an event held at London's Tate Modern museum, which was previously the Bankside Power Station. The event, attended by Current±, saw chief executive Stephen Fitzpatrick share the stage with carbon academic Mike Berners-Lee.
In establishing its Plan Zero, OVO said it was setting out its vision for the forthcoming decade, ultimately aiming to help customers eliminate their household emissions by 2030.
It sets out six commitments for the supplier to reach by the end of the next decade, namely;

- -Help customers halve their carbon footprint;
- -Achieve net zero carbon operations itself, underpinned through the adoption of science-based targets for its buildings and vehicle fleet;
- -Optimise five million homes in the UK with flexible, low carbon technologies such as smart meters and smart EV chargers;
- -Increase its advocacy operation and campaign more vocally on climate issues;
- -Encourage its staff to adhere to the plan by ranking among the UK's best places to work, and;
- -Becoming one of the UK's most trusted companies, a target to be measured using its net promoter score.

Fitzpatrick said it was clear that government and business need to "lead the way" when it comes to climate action, and Plan Zero was his company's way of ensuring it plays its part.
"Starting now, we're going to be measuring ourselves not by how much energy we sell but

by how much we move the dial on carbon. We're mobilising all our customers to form a zero carbon community and providing them with tools and services they need to help them eliminate the carbon emissions from their homes.
"Putting the needs of customers, employees, community and the planet first undeniably creates a platform for long term commercial success. It is with this knowledge that we begin our next chapter at OVO, continuing our mission to power human progress through clean, affordable energy for everyone."

Inside Plan Zero

Perhaps the most ambitious of OVO's proposals is the intent to optimise five million homes with flexible and low carbon technologies over the forthcoming decade. This plan, OVO said, would enable nearly one-fifth of all the country's homes to "actively participate" in the energy transition.
OVO is counting a number of technologies within this metric. It intends to provide consumers with smart meters – as it is obliged to under the smart meter rollout programme – but also take a hands-on roll in the management of electricity flow for grid balancing where other technologies, such as EV chargers or micro-generation systems, are installed. This also includes the sale of electricity back to the grid on behalf of a consumer, essentially a nod to the looming Smart Export Guarantee requirement.
Internally, this means OVO has embraced low carbon technologies itself. More than 50 solar panels provide 15.12kWp of energy for its new office in West London, and the rest of its energy demand is met using a renewable energy tariff. It's certified to BREEAM Excellent and SKA Gold standards, and all materials used in the refurbishment have used sustainability certifications.
It is also looking to enhance the ways in which it supports new ideas and technologies, both internally and otherwise. OVO Incubate! has been launched as an incubator to develop in-house ideas from the concept stage, while the OVO X Fund is to investment in start-ups aligned to the supplier's vision.

Policy demands

Building on its intent to ramp up its clean energy advocacy, the suppliers has included a list of "next steps" that it has isolated as being pivotal for the transition to take place. It is calling for policies that will better incentivise customers to adopt flexible residential energy technologies, which should include new price signals in the energy market – such as network charges – which will rewards customers for using their energy more flexibly.
Crucially it is calling on the government to ramp up its ambition for electric vehicles. It wants the government to bring forward its planned phase out of ICE vehicle sales to 2030, and measures to promote the installation of an EV charge point on every street.
It has also set its sights on the rollout of half-hourly settlement in order to reduce operational costs and facilitate the transition to a smarter energy system.

3.3.4 EDF, UKPN to trial residential flexibility in local energy market project

www.current-news.co.uk/news/edf-ukpn-to-trial-residential-flexibility-in-local-energy-market-project

A local energy market (LEM) in Brixton is to provide UK Power Networks (UKPN) with flexibility services through residential solar and storage.
Elmore House – a block of flats in South London – is already taking part in Project CommUNITY, a peer-to-peer energy trading trial run by EDF. Project CommUNITY uses blockchain to trade energy generated from solar and stored in batteries between residents. Now it is to go one step further, with an LEM to run out of the flats, testing how residents

can support local power supplies by offering flexible power services to respond to supply and demand. The project, dubbed Urban Energy Club, is being run by EDF, UKPN and Repowering London.
Ian Cameron, head of innovation at UK Power Networks, said residents will be able to "dip their toes into the water" of managing renewable energy.
"The results will really help us design and shape future services. We hope it will ultimately offer more residents the opportunity to run their energy supplies like this," Cameron continued.
A report from the Energy Systems Catapult this week provided guidance on the development of LEMs, citing interoperability, balancing and settlement and conflict management as key considerations for stakeholders.
It warned that developers should take steps to future-proof LEMs in light of a raft of regulatory and market changes.
UKPN has also trialed residential solar and storage for flexibility prior to the Urban Energy Club trial, incorporating the technologies into a virtual power plant in 2018.
The Urban Energy Club project has the potential to enable more people to use renewables and bring new income for individuals and communities otherwise unable to participate in the flexibility market, UKPN said, with residents of apartment blocks and flats traditionally deterred from using low carbon technology.
Maria Brucoli, smart energy systems manager at EDF Energy R&D, said the Urban Energy Club project will hopefully inspire "many more" of its kind.
"Working with UK Power Networks on this new project is the first step to understanding how domestic, local energy markets like this can interact with the grid and flex to match market demands."

3.3.5 DSR: adding a revenue stream for the water industry

September 12, 2019 By Louise Frampton
missioncriticalpower.uk/dsr-adding-a-revenue-stream-for-the-water-industry/
Severn Trent Water has engaged in DSR via two aggregators for the last three years. Now it plans to ramp up its activity – and harness the knowledge to inform battery storage investment…
Demand-side response manager, Rob Wild, says the firm has around 15MW of connected flexibility. About 10MW is generation-based, the remainder load from its treatment processes. Wild thinks there is potential for up to 50MW of flexibility across the estate.
Severn Trent's involvement has largely been STOR the Capacity Market and FFR, but it is eyeing the wholesale market and Balancing Mechanism as value continues to shift.

Good payback

Overall, Wild says DSR has worked well.
"Payback is around three years, which is currently one of the best business cases within the organisation," he says.
"From a technical risk perspective and operationally, we have not had any concerns," says Wild, which has increased management con dence to invest further in exibility.
"Handing over control to a third party was quite a big deal," says Wild, adding that the key to assuaging concern was engaging all stakeholders from the outset.
"The first time we looked at DSR, we put a team together representing all stakeholder groups – particularly the tech and standards team, given we are a standards-heavy industry," he explains.
"They were involved all the way down to choosing which aggregators to work with. We did a

full procurement exercise, which may seem over the top, but it meant we could give stakeholders confidence," says Wild. "If I was starting from scratch [in bringing DSR into a business], that would be a key message: Involve stakeholders all the way, and bring in the right resources – that can be expensive, but if you build it into the business case, you can do it."

Better data, lower bills

Wild says going through the DSR process and connecting up assets has led to a greater understanding of their performance: "It gives you more granular operational data, which has led us to realise that we have good amounts of headroom within processes. That is deliberate, but is has allowed us to get into the nitty gritty and work out if processes are truly optimised from a performance and energy efficiency perspective – which for a company like us that uses £100m of power – is always going to be worth more than DSR."

Market Insight

Severn Trent will also use the knowledge it is building of flexibility markets to shape future investments.

"It means we can have more informed conversations and it's also applicable to other activities, such as storage," says Wild. "It is unlikely that we are not going to be operating dedicated storage in the future, so it is really important to understand the economic case."

Building confidence

Wild says there still much to learn, but that the knowledge acquired to date feeds into Severn Trent's wider environmental programme.

"This year, we've found top-down support on this. We have committed to the triple pledge of net zero carbon, 100 per cent renewables by 2030 and 100 per cent EVs where the vehicles exist, so the work we have done on DSR plays to that quite well," says Wild.

Life after diesel

The possible exception to that is diesel, which Severn Trent has been running in some DSR programmes via back-up generators.

To comply with the Medium Combustion Plant Directive, the company is fitting abatement technology (SCR), though Wild says the biggest challenge is "interpreting the legislation … there is not a huge amount of upfront guidance." He says from a "practical perspective, the Capacity Market [contract] pays for MCPD compliance", though the cost of abatement rules out smaller engines.

Ultimately, the company is looking at technologies that could replace diesel for standby generation. "I am really interested in hydrogen as a storage vector, because we potentially have it available as part of the treatment process," says Wild.

To discover options for new storage, generation and flexibility opportunities, Severn Trent ran a 'soft market test' over summer. It also asked for feedback on its procurement process with a view to enabling smaller companies to provide solutions. Wild says the plan is to use the feedback to go to market "in the near future for batteries, storage and aggregation services."

E&T ENGINEERING AND TECHNOLOGY

By Crispin Andrews
Published Monday, February 18, 2019

We've spent hundreds of years trying to protect ourselves from the Earth's waters. So why, in the 21st century, are wetlands being restored and how can they help us cope with global warming?

The UK's biggest wetlands restoration project was completed last year. It took almost a decade, and now thousands of sea birds and waders congregate on Wallasea Island – avocet, black-headed gulls, golden plovers, teal, redshank and lapwing, and soon, hopefully, rare spoonbills, black-winged stilts and Kentish plover.

Wallasea, situated between the estuaries of the rivers Crouch and Roach in Essex, is Britain's biggest wetland habitat and twice the size of the city of London. Chris Tyas, who led the project for the Royal Society for the Protection of Birds (RSPB), explains that when a sea wall like the one at Wallasea is breached, seawater and silt move inland, over time creating marshes, mudflats, lagoons and other inter-tidal habitats.

"Invertebrates and seeds from the nearby estuary colonise the new habitats," Tyas says. "Within three years, you've got equivalent habitat to the adjacent estuary and all the right saltmarsh plants."

More birds on Wallasea Island is great for bird-watchers, the RSPB and, of course, the birds themselves. The EU directive on the Conservation of Wild Birds says that member nations have to safeguard the habitats of migratory birds and certain threatened birds within designated special protection areas. However, the restoration of Wallasea Island cost £70m. Thinking like a bean counter, that's a lot of money for a few birds.

Similarly, last November, the US National Fish and Wildlife Foundation approved $48m for wetlands conservation and restoration along the Alabama coastline. The recently completed Lost Lake restoration project in Louisiana cost $36m. The Australian government spent $180m to buy the Nimmie-Caira wetlands in New South Wales.

Then there's the ongoing Everglades restoration project, which over 35 years will cost an estimated $10bn. However much they love their cypress trees and alligators down there, for authorities to spend that sort of money they must think that wetland restoration has some serious benefits for human society.

Wetland – swamp, marsh, bog, fen and some peatland – covers 12.1 million square kilometres of the Earth's surface. That's a larger area than Canada, the world's second-largest country, but it's only a fraction of the wetland we used to have, before so much of it was drained and otherwise modified for large-scale urban and agricultural development.

Since 1700, the world has lost 87 per cent of its wetlands according to the Ramsar Convention on Wetlands in its 2018 Global Wetland Outlook (GWO). That's three times the rate of loss of our rainforests. In the technological age, the rate of loss is even greater – 35 per cent since 1970.

The Wetlands Convention also says that wetlands provide food and livelihood for more than one billion people. And that 40 per cent of the world's plant and animal species live and breed in wetlands. Some of the animals are commercially important species like fish, crab and shrimp, which use inter-tidal coastal habitats as nursery areas.

Wetlands are also known to regulate nutrient and trace metal cycles in water systems, filtering out pollutants from human habitation, industry and agriculture before they reach rivers. "Excess phosphorus and nitrogen pollution is a particular problem," says Dr Matthew Simpson, associate director and president of the Society of Wetland Scientists, Europe.

This has all long been known, though, and hasn't stopped authorities around the world from continuing to drain and redirect their wetland habitats. What is now increasingly being realised, however, is that wetlands, rather than making human settlements susceptible to floods, provide us with natural protection from fast-rising waters.

Wetlands can trap, store, regulate and slowly release excess water flows caused by high rainfall and

storm surges. When these environments are modified, they can lose their capacity to absorb the excess waters. This is what many believe happened last August, when floods devastated Kerala in southern India after a particularly intense monsoon. Mountain rivers dumped their excess water into lowland backwaters; over 500 people died and a quarter of a million were evacuated. The Kerala backwaters had previously been modified to create, among other things, paddy fields and tourist lodges.

John Lehrter, a marine scientist from the University of South Alabama, says that in Louisiana funds are being directed towards reconnecting rivers and sediment loads to marshes. Louisiana was designated a Federal Disaster area after floods in 2016 caused more than $10bn of damages. The Mississippi River, he explains, had previously been engineered for transportation purposes with levees and channels so sediments were forced to flow out into the Gulf of Mexico.

As the Earth warms, seas rise and floods affect wider areas and more people, this function of wetlands will become increasingly important. All over the world, authorities will have to think more about what might happen should existing flood defences fail. And some of these defences are very old indeed.

Dutch settlers built the Wallasea sea wall in the 15th century to drain the land for farming. Before that, Wallasea was five separate saltmarsh islands. Parts of the wall needed rebuilding after the infamous North Sea flood in 1953, but when, in the 1990s, the landowner applied for funding to repair the wall, he was turned down. In 2009, the RSPB bought the land.

“We knew that if the sea wall was left, sooner or later it would have failed,” RSPB’s Tyas says. This, he explains, would have caused much of the island, which is below sea-level, to flood, which in turn would have caused problems in the estuary.

In 2015, the RSPB’s engineering contractors breached the sea wall in three places. The aim, according to Tyas, was to allow the tide to spread naturally over the landscape in a controlled way. Paul Eaves, principal geotechnical engineer with Aecom, another Wallasea contractor, adds that to protect the estuary and maintain the tidal prism they had to make sure the right amount of water came on and off during each tidal cycle.

Phil McLoughlin, principal engineer with Wallasea contractor Jacobs, explains that an unmanaged breach in the sea wall would have put flood defences at risk further inland, along the Crouch and the Roach. “All that water is no longer going up and down the estuary, you’d end up getting erosion and sediment where you don’t want it,” he says.

This is why the Society of Wetland Scientists’ Simpson thinks it’s so important to restore a river’s connection to its flood plain in the upper catchment. “To reduce flooding risk downstream, we need to make sure rivers behave in a more natural way in upland areas,” he says.

If left alone, wetland habitats are created naturally over time as water flows on and off the land. The type of habitat created depends on the amount and frequency of flooding and the debris deposited. To create the desired variety of wetland habitats on Wallasea, engineers had to find a way to raise the height of the land above sea level in various places. These areas would flood only when the tide was particularly high, while other parts would flood more often.

To do this, RSPB did a deal with Crossrail. Digging tunnels across London had left Crossrail with a lot of debris. RSPB decided to buy six million tonnes of it. “On average we raised the land by a metre and a half,” Tyas says.

Unfortunately, part of the way through the project, Crossrail discovered that some of their material was too wet to ship out to Wallasea. “The shortfall was about one-third of the material we needed, so we had to adapt our plans with part of the island already built,” says Aecom’s Eaves.

To restore the last part of the island meant switching to a different strategy – regulated tidal exchange; a process by which sluices and other artificial devices restrict the flow of water on and off. The Wallasea engineers also took earth from earlier structures that were above high tide and used it to raise other areas above sea-level.

“We dug ditches and channels planned for aquatic mammals, earlier than anticpated, to free up more material,” Eaves says. “We also set pools below tide level, so the first time the water came in the pools filled up. Then, during subsequent tides, that water doesn’t go in or out.”

Jacobs’ McLoughlin adds that without the pools, more water would come on to the island than could be dissipated, leaving the landscape permanently wet.

And all this just to return Wallasea to something like the state it was in before humans started messing around with it in the first place. It’s the same elsewhere.

Marine scientist Lehrter says that sediment stuck in shipping channels off the Alabama coast could

be used to build up the coastal wetlands. “Before the channels were dug to allow big ships into port, sediment used to deposit naturally on the shoreline,” he says. “Now, the sediment is dumped out into the gulf and, as a result, marshes have sunk and we have erosion problems on the east end of Dauphin Island.”

To do this, however, requires more than just putting the right amount of sediment on the right bit of land. Lehrter explains that marsh is made of very organic, fine silt sediment. “Sand from the shore is too heavy, the marsh soil can’t support the weight,” he says, before suggesting using thin layer sediment dispersal: “If you fluidise fine sediments and spray the material over the marsh, the sediment is then deposited in thin layers, which, over time, build up the right kind of sediments and aren’t going to collapse the marsh.”

Simpson would like to see more land developers make use of natural wetland systems rather than build expensive new flood defences. Lehrter believes that doing this not only protects the local environment, but allows it to be a functioning habitat. He is also in favour of ecologically friendly engineering tools and more scientific research to test out which designs are most beneficial to wetland ecosystems.

Geoff Sweaney, director of UK company Wetland Engineering, adds that in areas where wetlands have historically been drained and used for industry, it is important to remove top soil and, with it, any residual pollutants prior to introducing water. “If not, the water is likely to transport these contaminants over a wider area,” he says.

Wetlands are not static environments; they are prone to change over time, depending on prevailing conditions. Because of this, Lehrter thinks that adaptive engineering approaches would work best, approaches that would enable experts to monitor wetlands over future decades and modify initial designs as needed.

Eaves explains that, for this reason, the new Wallasea flood wall was built 800mm higher than currently needed to allow for sea level rise over the next 50 years. McLoughlin adds that control structures can be adjusted as tide levels change. “If more material became available, the rest of Wallasea Island could be built up to higher levels,” he says.

Despite all this, the Ramsar GWO2018 complains that policymakers in parts of the world still underestimate the value of their wetlands. The report estimates that by 2050, one-third of the global population will likely be exposed to water with excessive nitrogen and phosphorus. It wants more wetlands to be protected under the UN Convention, and additional research conducted, so policymakers might better understand the value of these ecosystems.

The University of Santa Cruz researchers have recommended introducing financial incentives for wetland conservation and restoration.

McLoughlin argues that restoring wetlands on a larger scale, rather than the piecemeal restoration normally favoured, would save money in the long run.

Wetland Engineering’s Sweaney thinks that decisions about what to do with the natural environment should be determined by what’s best for society, not the needs of individual farmers and landowners.

It helps when the Insurance Bureau of Canada announces, as it did in September 2018, that wetlands provide flood protection more effectively and more cheaply than dams, levees or other manmade solutions.

A few months earlier, researchers from Colorado State University had claimed that the global insurance industry could save $52bn a year by increasing protected coastal wetlands. The previous year, a University of Santa Cruz study found that coastal wetlands prevented more than $625m-worth of direct property damage during 2012’s Hurricane Sandy alone. The researchers also found that in some parts of Barnegat Bay, New Jersey, the presence of wetlands reduced flood losses by 70 per cent.

Saving money motivates the authorities, obviously. But there’s another global environmental benefit to restoring wetlands which will become more compelling as the effects of climate change are increasingly felt over the coming decades.

Wetland plants take carbon out of the atmosphere and store it as plant tissue and eventually soil, unlike on dry land where plants die, break down and release the carbon back into the air. However, according to a November 2018 Florida International University report, a wetland can only perform this function if it is healthy and intact. “Draining or disturbing wetlands can actually release the stored carbon into the atmosphere very quickly,” Lehrter adds.

Last year, researchers from Tufts University in the USA went as far as to suggest that without wetlands and forests taking carbon out of the atmosphere, carbon dioxide from human activities would increase by 28 per cent each year.

A Royal Academy of Engineering report, published last September, said restoring wetlands could reduce greenhouse gases and help the UK to be carbon-neutral by 2050, something that decision-makers throughout the world, struggling to meet their climate change targets, will be pleased to hear.

While all this might shift the environmental cost analysis away from building dams and towards restoring wetlands, it must also be remembered that 400 years of human interference and damage to the natural environment is not easily undone.

Facts and figures

■ Global inland and coastal wetlands cover an area of 12.1 million km2, with 54 per cent permanently inundated and 46 per cent seasonally inundated.

■ Regional distribution of wetlands 2018: Asia 31.8 per cent, North America 27.1 per cent, Latin America and Caribbean 15.8 per cent, Europe 12.5 per cent, Africa 9.9 per cent, Oceania 2.9 per cent.

■ Around 93 per cent of wetlands are inland systems, with 7 per cent being marine and coastal.

■ Of the inland wetlands, rivers and streams account for 6 per cent, natural lakes 29 per cent, non-forested peatlands 27 per cent, forested peatlands 6 per cent, marshes and swamps 22 per cent, forested wetlands 10 per cent.

■ Up to 87 per cent of the global wetland resource has been lost since 1700 in places where data exist.

■ Between 1970 and 2015, inland and marine/coastal wetlands both declined by approximately 35 per cent.

■ Natural wetland has been lost at an average of -0.78 per cent a year between 1990 and 2015, according to the Wetland Extent Trends (WET) Index, with the rate increasing since 2000.

■ Human-made wetlands, largely rice paddy (20 per cent) and reservoirs (20 per cent), almost doubled since 1970, now forming 12 per cent of wetlands.

■ Since 1970, 81 per cent of inland wetland species populations and 36 per cent of coastal and marine species have declined.

■ By 2050, one-third of the global population is likely to be exposed to water with excessive nitrogen and phosphorus, leading to rapid algal growth and decay that can kill fish and other species.

■ There are now 2,300 internationally important wetlands designated as Ramsar Sites, which marks them out for conservation.

Source: Ramsar Convention Global World Outlook 2018.