FW: DCCAE Consultation on Offshore Wind

To:OffshoreWind	<offshorewind@dccae.< th=""><th>gov.ie</th><th>>;</th></offshorewind@dccae.<>	gov.ie	>;
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4 attachments

Constable-Brink-of-Darkness.pdf; GWPF_The-Climate-Noose.pdf; GWPF_Vahrenholt-20171- Germany Disaster.pdf; WCD_A4-02-2020.pdf;

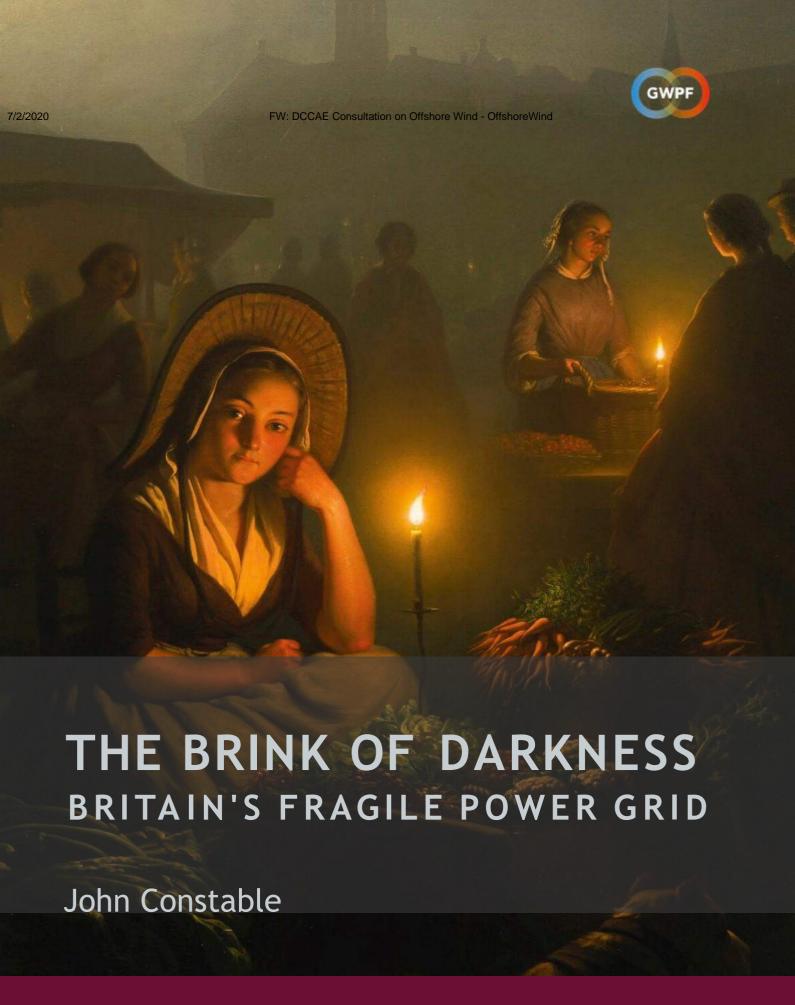
I now wish to submit the attached four documents.

These illustrate very clearly:

- **1.** That, while the climate is changing, there is no climate emergency.
- 2 The intermittency of massive offshore wind creates network instability.
- 3. The intermittency and instability require major back-up by conventional generation.
- 4. The costs of that back-up generation are enormous and unnecessary.
- 5. These issues have not been properly evaluated by the DCCAE or EirGrid.

Kindly acknowledge receipt of my submission.

Best wishes,



The Brink of Darkness: Britain's fragile power grid

John Constable Briefing 47, The Global Warming Policy Foundation

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About the author

John Constable is the energy editor of the Global Warming Policy Foundation. With the exception of the first section, these articles all previously appeared on the GWPF website.

Executive summary

- Steadily rising costs since 2002, and two major events in the last twelve months, one instantaneous and one still ongoing, have exposed the underlying and increasing weakness of the United Kingdom's renewables-dominated electricity supply industry, requiring insupportably large injections of additional resources to patch the system and secure supply.
- Since 2002, when renewables were introduced on a large scale, the cost of balancing the grid has risen from £367 million to £1.5 billion per year. This is largely due to measures to manage the intermittency of renewables, particularly wind and solar. Grid expansions, such as the £1 billion Western Link, to connect up far-flung windfarms, are also adding to consumer bills.
- In spite of this expenditure, in August 2019 a lightning strike on the high voltage grid caused a loss of supply in London and other places affecting 1 million customers for over an hour, with knock-on effects that continued for weeks. Lightning strikes are common events and in a robust system would pass almost unnoticed.
- This spring and summer, low demand resulting from the Covid-19 lockdown has further exposed the fundamental inflexibility and weakness in the UK electricity system. Measures to address the risks arising from the presence of uncontrollable renewables generators at times of low load may cost as much as £700 million over the period April to August alone.
- In response, National Grid has invoked the possibility of compulsory and uncompensated disconnection for smaller generators, and introduced a new scheme to encourage flexibility in the renewables sector, but these measures will save only £200 million, leaving a £500 million bill still to be paid.
- Even this is doubtful. Management costs over the 22-25 May Bank Holiday weekend amounted to over £50 million, including £18.9 million to reduce large-scale wind output, and up to £7 million to switch off smaller, 'embedded' wind and solar generators. It is likely that these costs will have to continue for some time after August.
- These measures are at least doubling the cost of supplying a unit of electrical energy to a consumer.
- Generators and suppliers are unable quickly to increase their prices to recover this cost and they have successfully lobbied Ofgem to defer the bill until 2021-2022. This will further increase prices paid by consumers, who are already burdened by £10 billion per year of renewables subsidies. Post-Covid, these costs are insupportable.
- In order to avoid prolonging and deepening the post-Covid recession, Government should immediately seek to reduce electricity system costs by suspending renewables support and instead should adopt a cost-minimisation policy focused on nuclear and on gas.

The fragility of a renewables-based system

It has been increasingly evident for quite some time, as the papers collected in this monograph demonstrate, that the electricity system of the United Kingdom is becoming weaker as progressively larger volumes of electricity from renewable sources such as wind and solar are forced into the system by regulation. This systemic enfeeblement is happening in spite of substantial increases in the cost of the system, as regulations and measures to support renewables are put in place. These range from more network cables to flexible demand, as well as complex and expensive operational structures such as constraint payments. The purpose of committing these resources is to compensate for the thermodynamic defects of wind and solar, and a corresponding increase in consumer costs is required to fund the reallocation. On a nationally significant scale, resources that consumers would have preferred to use elsewhere are now being swallowed up by the electricity industry. However, in spite of its scale, this reallocation of resources has not been sufficient to produce an electricity system as flexible and resilient to exogenous shock as the conventionally engineered system that preceded it.

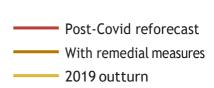
The scale of these additional costs and the resource reallocation can be illustrated by the costs incurred in the Balancing Mechanism. These so-called Balancing Services Use of System (BSUoS) charges are incurred in the first instance by National Grid ESO (Energy System Operator), and are then billed to both generators and suppliers, and ultimately recovered from consumers through higher retail prices. BSUoS costs are not the only additional system costs caused by renewables - transmission network charges are also significant- but they are a large part of that total cost, and a fundamental index of the problem.

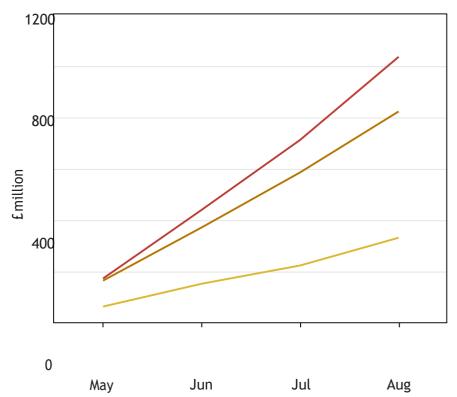
In 2002, before the rapid growth in renewable generation, the annual BSUoS cost stood at £367 million. By 2019 it had risen to £1,482 million, which, even allowing for inflation, is a very large increase. A growing share of asynchronous, uncontrollable generation, such as wind and solar, was the predominant cause of the increase, and yet more increases are expected in the medium and longer term. However, the impact of Covid-19 has brought that medium-term future abruptly into the present.

National Grid ESO's initial BSUoS cost forecast for this coming year, 2020-21, was £1,478 million, but on the 15th of May it revised this figure in the light of difficulties caused by the management of renewables during the period of low demand for electricity caused by the Covid-19 lockdown. The new forecast for 2020-21 was for a BSUoS cost of £2 billion, most of this additional cost being concentrated in the summer months. Figure 1, based on data from National Grid ESO's revised monthly forecast, gives the details of the scale of the additional charges expected from May to August, and also the effect of newly announced special measures, which it hopes will reduce the scale of the cost increase.

Figure 1: Cumulative BSUoS costs for summer.

Outturn 2019, post-Covid forecast for 2020, and with remedial measures. Source: National Grid ESO: BSUoS Forecast Summary: May to August 2020.¹⁰





Without the new services, NG ESO expected the total BSU-oS cost from May to August to amount to just over £1 billion, as compared to £333 million for the same period last year. With the new measures in place, it is hoped that this total can be limited to just over £800 million, an increase of £500 million on the previous year. It is this additional cost that accounts for the ESO's revised estimate that total BSUoS costs in 2020 will amount to £2 billion rather than £1,478 million.

Of many uncertainties affecting this projection, two deserve special attention. Firstly, the estimate seems to assume that the problems caused by the lockdown will continue through to August. This could be wrong; lockdown might be completely lifted before August, with demand rising once again. On the other hand, it might continue, or, even if it is lifted wholly or partially, the economic damage incurred over the spring and summer might reduce demand for electricity substantially for some time to come, being only partially offset by rising demand during the darker and colder winter months. Intuitive pessimism suggests that the latter is more likely, and that the extremely high BSUoS costs noted here for the period up to August are likely to persist after that time. It is notable that the NG ESO forecast does not commit itself to a view on this question.

Secondly, the reduction in additional cost, from £1 billion to £826 million, is dependent on the 'new services' working as intended and at the cost predicted. This is obviously uncertain, and a comprehensive audit will have to wait for the release of full details of deployment and cost.

The uncertainty in cost arises because the root problem ad-

dressed by these services is the presence of uncontrollable and unpredictable wind and solar - particularly embedded solar - which makes the system hard to handle at times of low load, when

renewables make up a large proportion of the generation online. Since the precise scale of the problem is highly uncertain even days in advance - let alone months - the cost of the remedy is also difficult to determine.

A measure of this uncertainty is the rapidity with which large costs can accumulate over a short period at a moment of stress. For example, the management costs over the four days of one Bank Holiday weekend, the 22nd to 25th May, amounted to nearly £51 million. £39 million of that cost was in the Balancing Mechanism, of which £18.9 million was paid to reduce large-scale wind output. Costs that mount at this sort of rate as the result of the conjunction of relatively unpredictable circumstances are inherently hard to foresee.

Although the problem is unpredictable, we can be precise about the character of the remedies proposed, the most important of which the ESO refers to as 'Optional Downward Flexibility Management' or ODFM, a term as notable for its inelegance as for its opacity. This scheme is already costing significant sums, with up to £7 million incurred over the Bank Holiday to reduce embedded renewables, including wind and solar, and a further £4 million to reduce input from the interconnectors, which would otherwise have presented an unacceptably large potential loss.

ODFM can best be understood as Generation *Down* and Demand *Up*; in other words, it is a way of removing some generation, at a cost, and incentivising sources of demand to consume electricity at a time convenient to the system. National Grid's own, hastily written, explanation describes the state of the scheme so far:

[ODFM] is an opt-in service for small scale renewable generators to receive payments from National Grid ESO if we ask them to turn down or turn off their generation of electricity. The service is also open to providers who can increase their demand during the periods when the service is required. It's seen a great take-up so far, with over 2.4 GW of capacity from 170 smaller generators signed-up to respond if we make an instruction from our control room - including 1.5 GW of wind, 700 MW of solar and almost 100 MW of demand turn-up.²

This opt-in scheme is supported by another of the new services, known as 'Last resort disconnection of embedded generation', proposed by National Grid ESO on the 30th of April, and permitted by Ofgem on the 7th May. Last resort disconnection permits the grid to instruct distribution network operators to disconnect embedded generators such as wind and solar without compensation if a system emergency requires it, and only if none of the commercial arrangements is adequate to the task. How well this would work in practice is open to question, but it seems likely that National Grid expects the mere possibility that the measure might be applied to be sufficient to intimidate embedded generators into making themselves voluntarily available through the ODFM scheme.

The average size of the generator already engaged in the ODFMscheme, taking NG ESO's figures above, is 16 MW, but there may be individual units of up to 50 MW, the largest size usual on the distribution network. It is in effect, therefore, a supplement to the constraint payments system, as currently operating in the Balancing Mechanism, which is almost exclusively confined to generators connected to the transmission system, though there are a few exceptions. Constraint payments to reduce wind power output are of course a notorious running sore, and have cost British consumers nearly £800 million since they began in 2010. In 2019, they cost £139 million, a large slice of the BSUoS total, and so far this year have amounted to £123 million, with a new daily record of £9.3 million scored on the 22nd of May.5 The total paid to wind farms over the bank holiday weekend, from the 22nd to the 25th of May, amounted to about £15.7 million. These payments are likely to continue in tandem with the ODFM payments, and will remain significant.

Renewables are not the only plant being paid to cap output. Sizewell B nuclear power station has also been restricted, reducing generation from 1.2 GW to 0.6 GW on the 7th May, and still at the time of writing operating at this reduced level. The cost of this measure is as yet unknown.

There is no public explanation of the reasons behind this capping of Sizewell's output, but the motivation is not difficult to infer, and it is very different from the reasons underlying constraint payments to wind in the Balancing Mechanism, or ODFM payments to wind and solar. At a time of low load and high input from wind, solar and interconnectors, all of which are asynchronous and provide little or no inertia, it is hazardous for the residual synchronised generation fleet, which is guaranteeing the stability of the overall system, to contain a single large unit, such as Sizewell B. Should that unit trip, say because of a frequency disturbance elsewhere in the system, a large further fall in frequency could result, with a cascade trip around the system as a possible consequence, unless sufficient response and reserve generation is being held on hand. For example, transmission system load is currently falling as low as 15 GW or less due to a combination of low lockdown demand and embedded wind and solar input.

In such a situation, Sizewell's 1.2 GW would be 8% of load and, with transmission-connected wind and interconnectors providing about 50% of load, but little or no inertia, it would represent about 15% of the inertia-capable capacity on the system. Providing sufficient response and reserve as an insurance policy against its loss and thus secure the system would be expensive, and we can infer that the ESO has decided that it is cheaper to cap Sizewell B. However, that decision means that the system is now short of 0.6 GW of high-quality inertia-delivering generation. Replacing the inertia lost by capping Sizewell B, probably with combined cycle gas turbines, will also have a cost.

Even from a brief sketch such as this, it should be obvious that

the System Operator is taking extraordinary - and extraordinarily costly-measures in order to secure the system over the summer. These are being presented to the public as a necessary reaction to the unexpected impact of the lockdown required by the viral pandemic. This is a half-truth: a conventional electricity grid would have been readily able to secure the system in the same circumstances, and to do so at low cost. It would even have been able to take advantage of low fossil fuel prices.

Furthermore, while Covid-19 and the lockdown might be accepted as in themselves unforeseeable, an exogenous shock of some kind is not only foreseeable but certain. Accidents and 'events' happen. A robust and flexible conventional electricity system has general versatility, which enables it to address such shocks, no matter what their character. The fragile, renewables-based system that we currently possess can barely deal with the expected; a surprise causes a crisis.

Putting together the experiences of the August blackouts last year, described elsewhere in this document, and the impact of Covid-19 on demand, what we have learned over the last two years is that the UK electricity system is inflexible and fragile. A lightning strike - a minor event - causes a major blackout. Low demand resulting from nationwide public health measures results in a cost spike so large that it causes cash flow and cost-recovery concerns for the industry, even though these costs are usually passed through to the consumer.

Anxiety at system costs in the sector's largest companies is a new development, marking yet another stage in the decline of the UK electricity supply industry, and merits further consideration. On the 20th of May, very shortly after National Grid ESO published its revised BSUoS estimate on the 15th, Scottish and Southern Energy (SSE) submitted a proposal to modify the Connection and Use of System Code (CUSC), entitled CUSC Modification Proposal 345, hereafter CMP345. SSE noted that the increased costs were unexpected, high and would be potentially destabilising to certain industry interests, including presumably themselves. Briefly, they were worried that because BSUoS costs were charged almost immediately, they and others would be faced with high short-term outgoings that they would only be able to recover through increased prices charged to consumers in the longer term, resulting in cash flow problems in the near term. Noting the increase in estimated annual cost from £1.48 billion to £2 billion, SSE wrote:

This 25%+ increase in the quantum to be recovered is further compounded by (i) it being applied, in practical terms, over a third of the 2020/21 year (May-August) rather than the whole year; and (ii) over a smaller charging base, with demand in GB down circa 20% due to Covid-19 lockdown/demand suppression. The combined impact is that BSUoS costs are forecast to increase by around 90% on average from June-August, with a high probability of BSUoS in individual periods effectively doubling the total cost of electricity. ⁶

That is to say, the measures required to stabilise the electricity system in the presence of low conventional and high renewables generation effectively double the cost, a bill that has to be paid to National Grid immediately by both suppliers and generators. This is troubling, as SSE observes:

The effect of recovering the additional costs arising from the unprecedent Covid-19 event from those parties under the status quo arrangements would be profound as they will be unable to fully recover the amounts via retails tariffs (for Suppliers) given fixed price contracting and price caps, or via wholesale prices (for Generators) given that most sales for May to August generation have already been made before indications of these significant BSUoS cost increases over for ecast were given by the ESO.

SSE proposes therefore that payment of the *additional* BSUoS costs from April 2020 to March 2021 be deferred and spread evenly over daily payments in April 2021 to March 2022.

In justifying this truly exceptional request for deferral, SSE identifies both a 'commercial' risk, described above, and a risk to the 'safety and security' of supply, which is still more ominous. SSE writes that:

...significant impact on the safety and security' of electricity arises, in particular for generators in GB, as they are faced with these sudden and substantial additional costs which they are unable to fully recover in the wholesale market given forward trading timescales. This, in turn, could threaten the commercial viability of some of those generators who, in these times of significant system management issues for the ESO (hence the highly abnormal additional BSUoS costs), could cease trading/operating, which could impact on the security of the electricity system. ⁷

The prospect threatened here is that some generators would fail financially and withdraw from the market. A hard heart might suspect theatrical exaggeration, bullying Ofgem into permitting a long deferral of costs, but there is in truth good reason for thinking that companies with longer-term power purchase agreements and many renewables generators have such things as part of their hedging strategies - may indeed find it difficult to fully recover these costs given forward trading timescales. SSE, the owner of a portfolio of 2 GW of onshore wind and 580 MW of offshore wind, will understand this industry-wide difficulty very well.

Similarly, SSE will have a strong understanding of the problems to the supply sector, although it is no longer an electricity supplier, having sold its domestic retail business, comprising about 3.5 million customers, to OVO in January this year. This sale increased OVO's share of the domestic market in Great Britain from 4% to about 16%, making it the country's second biggest electricity supplier, after British Gas. Taking on such a major portfolio is not without growing pains, and indeed OVO has in the last week announced that it will be making 2,600 employees redundant, closing offices in Glasgow, Selkirk, and Reading, with other redundancies in Perth, Cumbernauld and Cardiff. This is a highly contro-

versial decision, and the GMB union has described it as 'amassive betrayal of promises made to workers and politicians that the sale to OVO would not result in job losses'. A very large increase in BSUoS liabilities, all payable in the very short term, can hardly be welcome to OVO.

Fortunately for generators such as SSE and suppliers such as OVO, Ofgem has accepted the request made in CMP345, and in a letter to National Grid of the 22nd of May, recommended that a modification to the BSUoS charging schedule be implemented 'on an urgent basis' to spread the high costs this year over future years. OVO and SSE, and other generators and suppliers, can breathe more easily, perhaps. The increased cost of BSUoS is now the ESO's problem until 2021-2022, but it is a large company with broad financial shoulders and it shouldn't break into a sweat over this burden, although there is clearly a risk that some of the parties with deferred BSUoS obligations may not still be trading when those obligations start to become due in 2021-2022.

For the consumer there is little to celebrate here. The industry has shown complete unwillingness to absorb any of these exceptional costs, and has persuaded Ofgem to agree that they should feed through next year in full to electricity consumers: industrial, commercial and, where the price cap permits, domestic. Because of that price cap, considerable inequality in the distribution of the cost burden is to be expected.

The details of the matter have a grim fascination, but we should not allow ourselves to be distracted by the economic melodrama and the agony of individual companies. There are much larger issues at stake here. The current electricity system crisis is not a one-off event, a singularity the like of which we will never see again. Our electricity system is fragile and unable to respond to the unexpected without requiring a vast injection of new resources, funded by consumers. This time the exogeneous shock was a public health measure, but tomorrow it will be something else.

Any investigation that government undertakes, and one has to hope that the Treasury will review Ofgem's decision as well as National Grid ESO's handing of the BSUoS crisis, should approach these matters as a symptom of an underlying problem, namely systemic weakness in the electricity sector.

Indeed, given the strong possibility that the current problems will continue in some formafter lockdown due to a prolonged and perhaps severe economic downturn, there is a very strong case for immediately acting to suspend other policies, for instance the subsidies that give renewables a guaranteed dispatch, and return to a cost-minimisation strategy over the entire electricity industry. Such a policy would almost certainly have the consequence of driving wind and solar and biomass from the system, and allowing gas and nuclear to deliver a robust and cheap supply. But if there is any hope of an economic recovery after Covid-19 there is really no alternative.



Balancing the grid in times of low electricity demand

As I write this at 8.26 a.m. on the morning of the 8th May, a Friday but anational holiday in the UK, we are waiting to see how National Grid ESO (Electricity System Operator) will cope with the combination anticipated of low demand for electricity and high output from the 12 GW of solar generation capacity connected to the distribution network (as opposed to the transmission network).

Energy from this source reduces transmission system demand at around midday and after, well before the evening peak, resulting in a novel and somewhat bizarre dual peak to the daily demand most days, as can be clearly seen in Figure 2. This data was published by National Grid itself, and describes load for a week at the start of May 2020.

The operator's problem is to keep sufficient conventional rotating plant online to provide stabilising inertia, ¹¹ while at the same time making space for generators granted effective 'mustrun' status, namely wind power and solar power. These do not contribute inertia. In addition, with very low load, that inertia must be provided in chunks small enough to render manageable their sudden absence, as a result of a power station tripping for example. At 1.2 GW, Sizewell B nuclear power station is rather large for the job.

However, National Grid's task today is made that much easier by the fact that combined wind generation, on- and offshore, is expected to be not much more than 1 GW in total, from a nation-wide fleet of about 23 GW. The solar forecast is also lowish, at just over 6 GW in the early afternoon, only 50% of the solar fleet's peak capacity. It will be interesting to discover, as we eventually may, how much of that low output is the result of low winds and cloud cover, and how much has been bought off the system with bilateral trades, and at what cost.

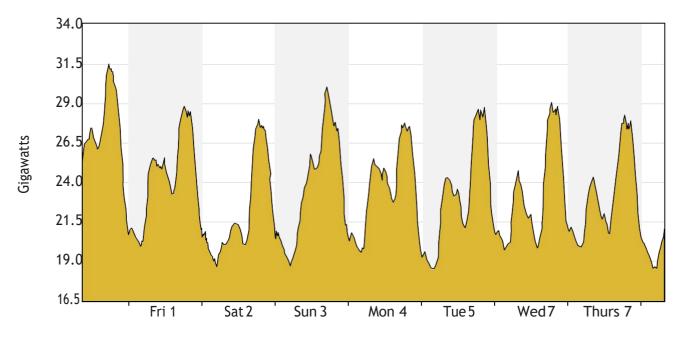


Figure 2: UK transmission system demand, 30 April-8 May 2020.

The trough in demand in the middle of most days is clearly visible. Data: National Grid

The electrical grid and the lockdown

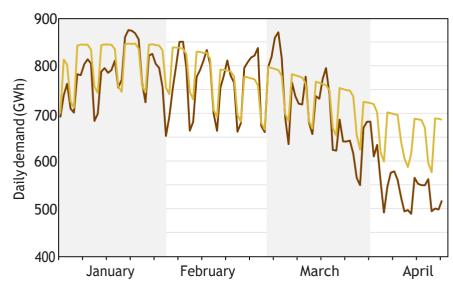
The restrictions on economic and personal activity imposed to address the spread of the coronavirus are reducing electricity demand in the UK to unusually low levels, increasing the difficulties of operating the system, particularly in the presence of embedded solar and wind generation. ¹²

As a result of restrictions on economic activity and personal movement, designed to reduce the rate of transmission of Covid-19, there are striking anomalies in British electricity markets. Figure 3 shows daily electrical energy transmitted over the network, and reveals evidence of a substantial fall in consumption. Domestic use may be rising as a result of the lockdown, but it is nowhere near offsetting the fall in industrial and commercial demand.

Figure 3: Low electricity consumption in 2020.

Daily electrical energy transmitted over the GB grid, 1 January to 23 April, 2020 versus historical average.



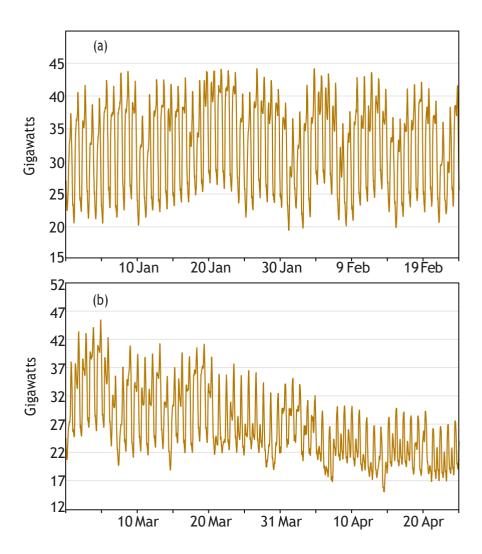


Of course, that decline has to be understood against the background of what is normal for the time of year, and the yellow line shows that demand normally begins to fall from January onwards. The brown line shows that this year was no exception, with the decline beginning well before the first warnings about Covid-19 were given. Furthermore, demand was already low relative to the historical norm for these months because of unusually warm weather. Consequently, some part of the decline seen towards the end of the chart is to be expected. Nevertheless, even when these factors are taken into account, the abrupt nature of the decline in consumption after the 23rd of March is obvious.

Furthermore, there is a clear loss of the familiar structure in the pattern of demand, a feature which is still more evident in the pattern of instantaneous load on the network by half-hourly settlement period. Before the lockdown (Figure 4a), the pattern of load was highly but regularly variable, exhibiting repetitive periodicities on several timescales, all patterns well known to the grid operators. After the lockdown began (Figure 4b), the pattern of electricity demand is temporarily more chaotic, as it moves towards a new and less differentiated equilibrium at a lower level. This is not only new and unfamiliar territory for the system op-

Figure 4: Half-hourly GB electricity demand.

- (a) 1 January to 24 February 2020;
- (b) 1 March to 23 April 2020.



erators, but has also accelerated the arrival of problems produced by large and inflexible renewables fleets, problems the system is probably not quite ready to deal with.

National Grid ESO's Summer Outlook for electricity, published on 15 April 2020, puts a brave face on the matter, but cannot conceal the difficulties. The ESO's principal concern is a combination of low demand and a high proportion of inflexible or relatively inflexible renewable generation, leading to system balancing problems. Assuming that demand cannot be increased on request, the operator must prevent hazardous increases in voltage by reducing generation, while at the same time maintaining sufficient inertia to preserve system stability.

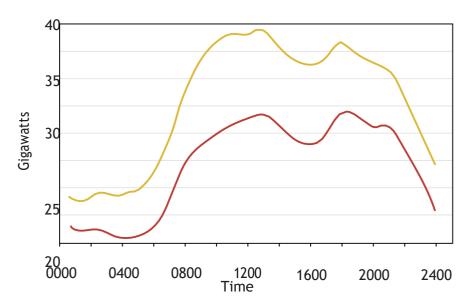
There are already significant reductions in demand, and National Grid ESO's medium-impact scenario envisages these continuing into the summer, with a demand reduction of 7% overnight and 13% during the day. The high-impact scenario involves reductions of 13% overnight and 20% during the day. In fact, reductions approaching the high-impact scenario are already being observed, with National Grid commenting that in April the UK electricity system saw low loads typical of the warm holiday months of July and August.

To illustrate this point, the Summer Outlook provides a graphic comparing actual demand on 14 April 2020 with the demand

that would otherwise have been expected (Figure 5). The largest demand fall in the chart appears to be in the order of 19%, and generally the currently observed reduction is, as NG comments, 'between [the] medium impact and high impact scenarios' considered in the Summer Outlook. One might on that basis suspect that the summer impact scenarios are overly optimistic, but it is probable that National Grid is expecting the lockdown restrictions to be eased, keeping demand suppression within the bounds of its high-impact scenario. If, on the other hand, the restrictions are maintained or even strengthened, then the possibility of demand cuts exceeding 20% are clearly possible.

Figure 5: Pre-Covid forecast and actual demand for 14 April 2020.

Forecast Actual



A reduction approaching 20% on spring and summer demand poses real difficulties for control-room operators, since they are now working with a generation fleet that is, to a large degree, non-dispatchable - 23 GW of wind and 12 GW of solar power for example - and may therefore seek to provide energy to the system even when not required. Table 2 of the Summer Outlook describes a maximum demand of only 25.7 GW in the high-impact scenario, and a minimum demand of 15 GW, a minimum that has already been observed in April. In between these limits, the operator must retain sufficient conventional rotating plant to provide stabilising inertia, but if required also find room for 23 GW of wind and 12 GW of solar power, both uncontrollable.

Of the two, it is the solar fleet that is giving it the most cause for concern. It can afford to be relatively relaxed about wind because, firstly, output tends to be low in the summer months, and, secondly, because they have extensive experience of constraining wind off the system through the Balancing Mechanism (at a cost of £101 million so far this year). That said, it is highly significant that the Summer Outlook refers to the use of an additional instrument, namely 'direct trade' to buy wind farms off the system. ¹³ Bilateral trades of this kind have not been used intensively for quite

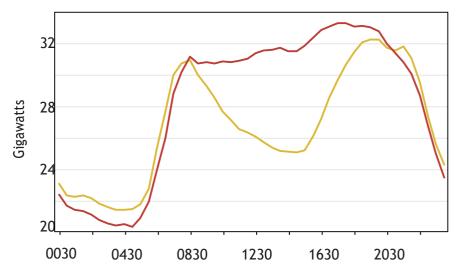
some time, and their return is a sure sign of emergency measures. It's a topic to watch.

Solar, on the other hand, is a looming and novel difficulty, now brought suddenly and alarming close. National Grid presents a chart to illustrate the impact that embedded solar generation can have on transmission demand (Figure 6).

Figure 6: Impact of embedded solar generation on transmission system demand over the day.

The red line is a day with low solar infeed, the yellow line a day with high solar infeed. Source: NG ESO, Summer Outlook (2020), p. 11.

14 May 2019 (high solar) 4 June 2019 (low solar)



The Summer Outlook remarks of the days described in this chart that:

These two dates share similar temperature and embedded wind properties and were both Tuesdays - the only major difference was 7.5GW of embedded solar generation.

Its concern is that if a similar or greater event, up to the 12 GW maximum of solar installed, were to occur with only 15 GW of demand, there would be a real risk to the stability of the system. It sketches out what it will do in this sort of event in three crucial sentences:

...when low demands coincide with high levels of renewable generation that is not synchronised with the grid, system inertia is lower meaning that the impact of any frequency events are greater. This is where our new inertia services are relevant and another reason why synchronous generation may be required to remain on the system. If demand levels fall close to the level of inflexible generation on the system, we may also need to issue a local or national Negative Reserve Active Power Margin (NRAPM). To date a limited number of local NRAPMs have been issued, but none at a national level. 14

An NRAPM is a warning that the ESO may need to give 'Emergency Instructions' to a generator or generators to cut off their supply of electricity, even to the extent of having to trip off the system immediately, and regardless of inconvenience or cost. It is a severe level of warning, and at a national level would indeed be unprecedented. What is not clear from this statement is how embedded solar sites - of which there are quite literally hundreds and thousands - even of the larger size, would be taken promptly off the system by such an Emergency Instruction. The ESO will clearly have, as they say in the control room, a 'difficult day'. It might be awkward for the rest of us, as well as expensive.

Increasing electricity system fragility

The UK's electricity network is likely to become significantly weaker within five years, due to falling short circuit levels (SCLs). These will reduce the reliability of protection systems designed to limit the geographical extent of supply loss during a fault, and also make it more likely that asynchronous sources of electricity, such as wind, solar and high voltage direct current (HVDC) interconnectors, will disconnect during a fault. Ironically, SCLs are falling because of the rising input from asynchronous sources. A remedy for this problem is unlikely to be cheap. Who will pay?

Electricity networks of any size are complex systems, with all the advantages and disadvantages that this implies. The uninitiated believe that the principal threat to such systems is the failure of electricity producers - the generators - to meet the demands of consumers for energy, resulting in a blackout. This is not completely mistaken, but blackouts on a modern and developed electricity system are in fact only rarely directly caused by shortfalls of generation, say as a result of poor system planning, a power-station accident, or unexpectedly high consumer demand. System operators are nearly always able, even at short notice, to call on sufficient additional resources either to increase generation or reduce demand, though of course this remedial action comes at a considerable cost.

Arather more probable cause of a system blackout is a transmission system equipment failure, at a transformer for example, or a sudden external event, such as a storm or a vehicle - a plane or a ship perhaps - damaging a transmission line. In a weak or poorly designed system, such accidents will overload other transmission lines, which then themselves have to shut down to avoid damage, sending a further ripple of overloading through a large part of the network, forcing generators themselves to come offline and resulting in a widespread blackout.

Apart from ensuring a high specification for the components used and a high standard of design and construction, the best protection against such accidents is to ensure that the system is sufficiently stable under stress that it can contain a loss of supply to a small part of the network. This capability is usually automatic, since action must be taken in milliseconds to prevent a cascade of faults. Accidents will happen, but a strong system can prevent a local problem from becoming a regional or even a nationwide disaster.

The strength of the system must be continually monitored to ensure that it will be stable under stress, a precaution that would be necessary at any time, but has particular relevance in the UK at present due to the rapid and dramatic changes in the electricity supply industry being driven by climate change policy. It is therefore only prudent for National Grid ESO (the Electricity System Operator) to be undertaking a review with the aim of ensuring that its System Operability Framework is adequate to the task. The first

results from its Operability Strategy were published in November and December 2018, ¹⁵ with updates being provided in its regular Operational Forums. ¹⁶

National Grid identifies five areas of concern: frequency control, voltage control, restoration (i.e. recovery after a blackout), stability, as discussed above, and thermal (transmission line temperature). All are important, but to judge from the volume of commentary devoted to it, it is stability that is giving most cause for concern. Specifically, SCLs in Great Britain are predicted to fall considerably over the next decade. The SCL is the current that will flow through the system during a fault; an accident affecting a transmission line for example. It is, as National Grid explains, 'a measure of strength', and a 'key parameter for protection systems' in the network itself and also in other equipment attached to it. ¹⁷

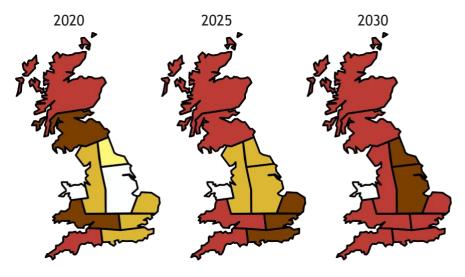
With low SCL the transmission system protection systems, which function to 'isolate faulty equipment...limiting the fault effect on the wider system', ¹⁸ could, in National Grid's own words, 'take longer to operate or not operate as designed', ¹⁹ meaning a loss of supply to a much larger area. Furthermore, some generators, specifically wind and solar farms, and the protection systems of some sources of electricity, such as HVDC interconnectors, may be much more likely to disconnect in the event of a fault if SCLs are low.

As it happens, SCLs are falling in the GB network because of declining input from synchronous, conventional generation, such as coal-fired power stations and combined cycle gas turbines, and rising input from wind, solar, and HVDC links, which are asynchronous and do not provide support to the SCL in their vicinity. Consequently, areas where there is at present a great deal of wind and solar already have low SCL, and this is expected to spread to other areas as synchronous input declines and more asynchronous renewables and interconnectors are built. Figure 7, reproduced from National Grid's publication on the subject, shows predicted regional SCLs in Great Britain in 2020, 2025, and 2030.

Figure 7: Regional short circuitlevels in Great Britain, 2020, 2025, and 2030.

Source: National Grid ESO, System Operability Framework: Impact of Declining Short Circuit Levels (December 2018), p. 2.





Scotland and the West Country already have low SCL, due to high levels of wind and solar respectively, and the analysis projects a falling trend elsewhere, with the largest declines foreseen in the north-east and the east Midlands, probably because of the closure of coal-fired generation in those areas. Only north Wales escapes, since it fortunately has a pumped storage plant, Dinorwig, with unusual design features that make it well equipped to support SCL.

As noted, low SCLs tend to increase the risk that asynchronous generators and HVDC interconnectors will fail to ride through a fault arising from an accident on the system. National Grid explains that this is due to the fact that such equipment uses phased locked loop converters, a technology that relies on voltage waveform to provide it with information about system condition. If SCLs are low, a fault will cause the voltage waveform to become disturbed, with important consequences:

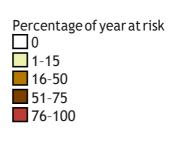
When the phase locked loop measures a more disturbed voltage waveform it might not provide the right information back to the converter and the converter might not respond in the right way to a fault. In this situation there is a risk that the converter will lose connection to the network. 20

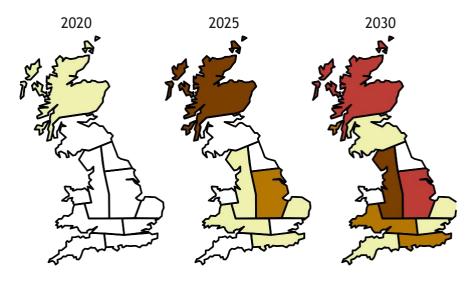
To put that in concrete terms, low SCLs make it more likely that wind and solar and HVDC interconnectors will disconnect during a system fault, just when they are needed most to prevent a blackout.

National Grid provides a simplified map representation of the increasing phase locked loop risk. This is redrawn in Figure 8, which uses colour coding to show the percentage of the year affected by each level of risk in 2020, 2025 and 2030.

Scotland is already at significant though moderate risk, being exposed for about 15% of the year; presumably the winter months when wind input is high. The rest of the country is quite unaffected. By 2025, however, Scotland is at risk for half to three quarters of the year, and other areas are beginning to feel some degree of

Figure 8: Regional Phase Locked Loop (PLL) Risk, 2020, 2025, and 2030.
Source: National Grid ESO, System Operability Framework: Impact of Declining Short Circuit Levels (December 2018), p. 3





exposure. By 2030, only north Wales and the north-east are free of risk, and in Scotland and in the east Midlands it will be an almost year-round fact of life.

Taken together, these two figures show that the GB electricity network is set to become significantly weaker within five years, and much weaker within a decade. Obviously, National Grid's aim in undertaking such assessments is to assist in addressing the problem, and it is to its credit that the matter is being aired so candidly. There is no doubt that this is a serious problem, and that National Grid takes it seriously. However, the documents so far published are longer on diagnosis than remedy. To an extent this is forgivable, since the obvious and economic solution - to run existing synchronous generation such as gas and nuclear much more while running solar and wind much less, and in the future to build more gas and nuclear and less wind and solar - is not compatible with the current politically driven selection of renewables as a means of reducing emissions. With the obvious and economic options ruled out, one is left with speculative and costly alternatives: sophisticated power electronics perhaps, in combination with a requirement for wind and solar and interconnectors to improve their ability to ride through faults. While such things mightbe possible, none would be cheap, and such measures would certainly do nothing to alleviate concern that the United Kingdom's electricity supply industry is greatly reducing its productivity, and making high-cost electricity inevitable. Applying layer after layer of ingenious solutions to problems that have only arisen because of flawed policy-driven distortions of the market and of engineering decisions appears unwise.

Whether the consumer will be shielded from the burden of supporting measures to address falling SCLs, amongst other difficulties, is doubtful. Ofgem, the regulator, is notoriously weak when climate change enters the equation. But some comfort can be taken from remarks elsewhere in the recent Operational Forum presentations. Discussing the cost of balancing the electricity system, which has risen very dramatically over the last decade and now stands at £1.3 billion a year, National Grid very properly expresses the view that more of the costs of measures undertaken to address problems arising in the security and reliability of the system should be met by 'those [generators] exacerbating the issue'. This would at least provide a pricing signal to those generators at present taking a more or less free ride on the system and its consumers, and encourage them to find remedies that are better value for all.

In the longer run, the United Kingdom should obviously be considering whether a large fleet of asynchronous generators, such as wind and solar, is a wise or an affordable choice for an islanded grid that can only secure interconnection with its continental neighbours through HVDC cables that are themselves also asynchronous.

The role of distributed generation in the UK blackout of 9 August 2019

It has been widely claimed that distributed (or embedded) generation, such as solar and wind connected to the low voltage distribution network, reinforces electricity system stability. The final reports into the widespread blackout of the 9 August 2019 show that this is not the case. Distributed generation is now under the spotlight as a leading cause of the severity of the blackout, and as a hazard increasing future risks to security of supply.

Both the UK electricity market regulator, Ofgem, and the Energy Emergencies Executive Committee (E3C) of the Department for Business, Energy and Industrial Strategy have now released their final reports into the blackout on 9 August 2019, which disconnected over 1 million consumers for nearly an hour, with knock-on impacts that persisted for days in many cases, and in one case - an oil refinery - for several weeks.²³

The two studies have different roles. Ofgem's work, which is now almost complete, ²⁴ concentrates on regulatory compliance; that is to say, on whether the relevant parties - National Grid, the distribution network operators, and the generators - breached the terms and conditions of their various licenses. In essence it is a retrospective, forensic and essentially historical study. The E3C work is more forward looking and aims to examine measures that should or are being taken to:

- reduce the likelihood of a recurrence of a similar blackout
- improve the way such a blackout is handled in the event that it cannot be prevented.

The two studies are, as far as I can tell, entirely consistent, but they are complementary, and they need to be studied together.

Those who have been following the blackout story from the outset, as well as more casual readers of press stories on the subject, some of which I have discussed elsewhere, ²⁵ will want to knowwhat new facts and analytic interpretation of the blackout emerge from these two studies.

The answer is that there is a good deal, but it is not initially obvious, and at first glance readers may be disappointed. While there are some new - or at least newish - facts, these are mainly confined to details, and often about the consequences of the blackout rather than its causes. For example we learn that some four hospitals - not just the much-reported case in Ipswich - were disconnected, ²⁶ and that National Grid perhaps over-zealously reconnected Hornsea 1 before it was confident that the 'technical issues' affecting that windfarm, which had without doubt contributed to the problems, had been fully understood. We also learn that a total of 371 rail services were cancelled, and 220 part-cancelled, with three Transport for London tube stations and eight rural signalling stations all disconnected, though without significant effect on services. ²⁷

Many of these details are certainly important in themselves, and Ofgem even singles out for particular criticism National Grid's hasty reconnection of Hornsea, 28 but the principal novelty and value of these two documents is not in such material minutiae pure and simple, but rather in the general and cumulatively damning description of weaknesses in the UK electricity system that emerges when viewed in the context of the event overall. It is proverbial that electricity systems shift from stability to chaos in fractions of a second, while the causes of a blackout take weeks and months to understand, but the mists are beginning to clear and we are beginning to get to grips with what happened on the 9th of August.

With regard to the story of the blackout, the main narrative has not changed much since last year; a lightning strike trigged the disconnection of, firstly, 150 MW of distributed generation, closely followed by the almost instantaneous loss of 737 MW from the Hornsea 1 offshore wind farm. Shortly after that, the steam unit 29 at Little Barford combined cycle gas turbine power station tripped off. All of this occurred within one second of the lightning strike. The consequent drop in frequency triggered further disconnections of distributed generators. Then the first of the two gas turbines at Little Barford also had to disconnect, closely followed by the other one, and yet more distributed generation. 30

Even in this sketch of the summary it will be obvious to those familiar with earlier accounts that, while the main facts remain, the light cast on them has changed significantly, and this results in a somewhat different picture. Attention has switched from the two main transmission-system-connected generators - Hornsea 1 and Little Barford, which have been fined £4.5 million each for failing to ride through the fault - and is now focused on distributed generation; that is to say, on generators connected to, and sometimes said to be 'embedded within', the distribution network. These generators are usually invisible to the system operator, and can range from very small domestic systems, right up to what are, by any standard, large onshore wind and solar installations.

The role of distributed generation in the blackout was, of course, known from quite early on in the post-event analysis, but the scale is only now becoming fully apparent, though even at this late stage it remains, and will remain, uncertain. The E3C report goes so far as to remark that:

There is a significant possibility that the total volume of loss of embedded generation on 9 August is in excess of the transmission connected generation lost during the event.

Since the transmission-connected generation lost comprises Hornsea and Little Barford, and this totals 1,384 MW, we can infer that, over the entire event, somewhere in the region of 1.5 GW of distributed generation disconnected in several closely proximate phases. That is itself a significant quan-

tity, and suggests that, as the E3C report remarks,³¹ the total generation loss during the blackout was a monumental 3 GW.

But it is not simply the quantity of distributed generation that disconnected that is striking. The manner in which it was lost is also important. Ofgem notes that when system frequency fell below 48.8 Hz, the distribution network operators (DNOs), disconnected approximately 5% of load, totalling 892 MW of net demand. However, following a hint in the original National Grid Technical Report, Ofgem comments:

The ESO reported that the net demand reduction seen by the transmission system was only 350 MW. This indicates that approximately 550 MW of additional distributed generation was lost at this point. The reasons for this need to be better understood and addressed to avoid it happening again.

So the DNOs disconnected 892 MW of demand, but the observed benefit to the system at this time of extreme stress was only 350 MW.

The E3C study gives a little further clarity on this point, noting that '550 MW of embedded generation was disconnected, either aspart of the LFDD scheme or via another unidentified mechanism'. 33 The low-frequency demand disconnection (LFDD) scheme is the remedial measure taken during a blackout by the DNOs to bring supply and demand back into balance. Thus much, and perhaps all of that 550 MW of embedded generation, was disconnected by measures taken to address the blackout. In other words, because of the presence of embedded generators, the remedial action taken to address a system disturbance actually made the problem worse, cutting the net benefit of the measure.

Ofgem is quite right to say that this problem should be better understood, but it is difficult to see how it can be prevented in the future, as they hope, except by preventing, whenever possible, the disconnection under LFDD of any area where there is any significant concentration of embedded generation. Of course, that assumes that the system operators are still able to choose which areas will be disconnected, but in a severe system disturbance they may not have that degree of control.

How has this problem with distributed generation crept up and surprised us in this way? Who is to blame? Few if any elements within the UK electricity supply industry come out well from the 9th August blackout. Both Hornsea and Little Barford have been penalised. But neither of them are embedded generators, and they have no role in the management of such generation. National Grid was not fined, and superficially emerges from these studies exonerated: Ofgem puts the point unambiguously:

We have not identified any failures by the ESO to meet its requirements which contributed to the outages.

But this is obviously as much a comment on the licence terms as the performance of National Grid, and both Ofgem and E3C are sharply critical of several aspects of its conduct both before and after the blackout, including the way it handled embedded generation. Ofgem even remarked that:

...the ESO could have been more proactive in understanding and addressing issues with distributed generation and its impact on system security. 34

The implication seems to be that, while National Grid was not in breach of its licence terms as electricity system operator, it has been complacent in its attitude towards emerging and novel problems in the UK electricity system. Many commentators, including Colin Gibson and Capell Aris, both former National Grid employees, have said as much over and over again. ³⁵ It will be interesting to see what comes of the E3C requirement that National Grid review the crucial security and quality of supply standard with the aim of understanding the 'explicit impacts of distributed generation on the required level of security'. ³⁶ If the consumer interest is respected, this could be very interesting.

Taken together, these studies of the 9th August blackout reveal systemic fragility problems in the UK electricity supply industry, but not only within the production side of the industry. National Grid, the generators, the DNOs; none emerge smelling of roses. Moreover, the E3C report also observes that the consumer sector itself is poorly prepared.³⁷ As a matter of fact, they are encouraging consumers of all kinds to develop 'strong business continuity plans' covering 'a range of credible power disruption scenarios'. This is MBA jargon, but is not too hard to put into everyday French: Sauve qui peut!

It seems probable that consumer-side weakness is the outcome of a long period of robust electricity supply, under the CEGB and its inheritors, meaning that consumers never had to test, adapt or even go to the difficulty and expense of developing measures to ensure their lives and businesses were robust in the context of a fragile electricity system. They could rely on the system. That is not the case today.

The costs of a largely decentralised generation portfolio, much of it composed of low-inertia generators such as wind and solar, are not limited to the technical athletics of the system operator, but also involve the need for a forewarned and forearmed consumption market. Thanks to energy and climate policies, British consumers, from households to hospitals, must now ensure that they are able to handle, not only the more extreme grid management measures required by a 'smart', 'clean' system, but also the consequences emerging when those measures prove inadequate. Taking up the slack, which is what 'strong business continuity plans' ultimately means, will not be cost free.

UK energy consumption and weak productivity growth

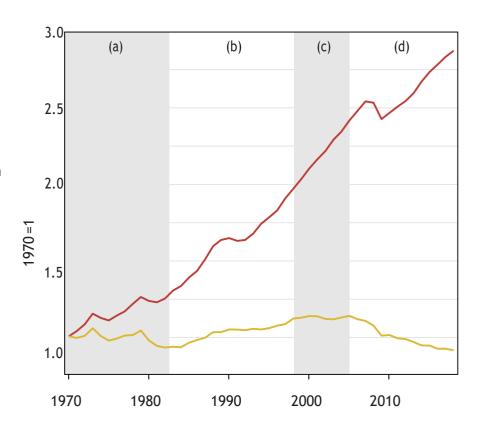
Falling energy consumption in the United Kingdom is not receiving the attention it deserves. While similar to the norm prevailing among the EU 28, the UK pattern is very strongly at variance with global trends, which see significant increases in all sectors. There is a clear possibility that this fundamental difference is revealing a leading causal factor behind the weak productivity growth in the United Kingdom since 2008, yet it is hardly considered by commentators calling, perhaps correctly, for aggressive 'innovation' as the answer to the 'productivity puzzle'. Until they do so, their appeals will be in vain: costly energy makes it rational for innovators to be risk averse.

Figure 9 shows total primary inland energy consumption and UK GDP from 1970 to 2018.

Figure 9: Energy consumption and GDP. 1970-2018.

Energy consumption figures are temperature corrected. GDP on a chained volume measure (black line). Source: DUKES Table 1.1.4.

GDPInland energy consumption



Beginning with the macroscopic pattern, one observes that, while energy consumption over the period has been more or less stable, GDP has exhibited a strong rising trend. This undermines claims that 'de-linkage' of energy consumption and GDP is a recent phenomenon, due, for example, to efficiency measures, the digital economy and dematerialisation. On the contrary, this data shows that de-linkage is a long-standing phenomenon, and probably not to be explained by recent novelties, but rather by factors that are simpler and more fundamental.

Further doubts are cast on the validity of a naïve assertion of de-linkage by examination of the finer structure of the data, in which we observe a varied and subtle relationship between energy consumption and GDP. Firstly, there is an irregular but clear

downward trend in energy consumption from 1970 to the early 1980s (a). After this, we see a moderate but steadily rising trend up to the later 1990s and early 2000s (b), after which there is a flattening off (c) and then a marked decline from 2005 onwards (d), the latter being acute compared both with the previous downward trend in the 1970s and indeed with the preceding upward trend from the early 1980s. In a little over ten years, the increase in consumption evident over the period 1982-2001 has been reversed, and in 2018 the UK consumed around 10% less than it did in 1970. This change would be notable in itself, but is particularly so when we recall that over this period population has risen from about 56 million to 65 million and that GDP has more than doubled.

As already noted, some see evidence in this data that energy consumption and economic growth have been de-linked in the last decade or so (d). There is clearly some ground for this view in the fine structure of the data at the end of the series. But equally there is evidence for an earlier de-linkage, from the 1970s to the early 1980s (a). This can only undermine confidence in any argument suggesting that the current divergent trends result from recent societal and technological modernisation, principally the digital economy. It is at least possible, and in my view probable, that some other explanation accounts for both the divergence in the 1970s and that in recent years. For the time being, the de-linkage case, never theoretically strong, should be regarded as weak in comparison with alternatives.

For example, it might be inferred that the energy consumption required to support the economic growth visible in GDP is taking place elsewhere in the world. On this view, for a short period in the 1970s, the UK economy became more reliant on energy conversion elsewhere in the world for the goods and services it consumed, a trend that has recurred in a stronger form in the present day. If this were correct, the de-linkage of GDP and energy in the UK would be illusory.

Furthermore, the fine structure of the data also reveals that, even in the divergent curves at the beginning and end of the series, there is still some degree of linkage between inland energy consumption and economic activity. For example, in both 1973-1975 and 1979-1981, and again after 2008, falls in energy consumption are paralleled by falls in GDP. Indeed, in the 1970s and the early 2000s the relationship is notable for a subtle but highly suggestive character: GDP and energy are clearly related, rising and falling together over the short term, even as they are exhibiting divergent secular trends over the longer term, with energy consumption falling and GDP rising in both periods.

These two phases at either end of the series contrast sharply with the straightforward correlation visible in the two decades from the early 1980s up to the early 2000s, when GDP and energy consumption rose together. Indeed, one interpretation could be that the Britain of today has more in common with that of the 1970s than with that of the 1980s and 1990s, a rather shocking

conclusion, but one that cannot, I think, be rejected quite out of hand. It is worth asking whether a tendency towards a healthier economic function, with a more reasonable balance between inland production and imported consumption, is represented by the 1980s and 1990s, and a less satisfactorily balanced, or even anomalous operation by the 1970s and the present day.

Analysis along these lines may also shed light on the notorious 'productivity puzzle': the unprecedented and so far inexplicable sluggishness in productivity growth since 2008. Figure 10 charts UK inland energy consumption data (brown line) and output per hour worked (green line).

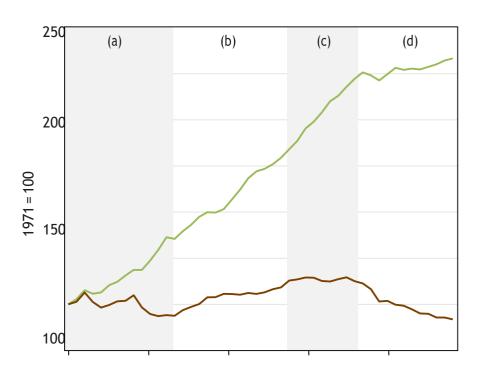
Several of the points made above in relation to GDP can be made again here. Although the 1970s saw productivity growth rise and energy consumption fall (a), there were still signs of a positive correlation in the fine structure of that divergent trend, just as there is in the divergence from around 2008 onwards (d). Furthermore, as with GDP, the central body of the data (b and c) is characterised by the positive correlation of rising energy consumption and rising productivity growth in the period from the early 1980s to the early 2000s.

But there is also a significant difference. While GDP resumes its previous upwards rate of growth quite promptly after 2008, productivity growth does not, and steers closer, as it were, to the downward energy consumption trend. One might infer, therefore, that energy consumption plays a larger part in productivity than in GDP. That is plausible, since a change in the energy consumption of inland economic activities is almost certain to have a significant and direct effect on productivity; if a production system is under-energised it does less; if the throttle is closed, the engine decelerates. On the other hand, any effect that falling energy consumption might have on GDP can readily be offset by other fac-

Figure 10: Energyconsumption and productivity, 1971-2018.

Productivity measured as output per hour, seasonally adjusted. UKinland energy consumption. Source: ONS, DUKES 2019.

ProductivityInlandenergy consumption



1971 1981 1991 2001 2011

tors. For instance, GDP can be enlarged by the spending of borrowed funds on imported goods, goods that are produced with energy consumption in other territories.

It seems, therefore, that there is some ground for concluding that the unprecedented stagnation of productivity growth since 2008 could be explained at least in part by factors depressing energy consumption, such as sustained and significant increases in energy cost, making it difficult to recover from the economic shock of the crash. This is no mere theoretical possibility, and strong candidates can be found, for example, in the loading of climate-policy subsidy costs onto electricity, starting in 2002, and now amounting to about £10 billion per year, and very high, longer-term taxes on transport fuels, totalling £28 billion a year at present. It is important to recall that both these policy impositions were charged on top of fundamental costs that were and still are themselves rising, making an underlying difficulty much worse.

There is a widespread assumption that the productivity puzzle could be addressed by a determined government focus on the enhancement of innovation. For example, a recent paper by Richard Jones, ³⁹ of the Physics and Astronomy Department at the University of Sheffield, has argued exactly this and has received a generally favourable reception, even in right-leaning and Conservative Party circles. ⁴⁰

Jones, in essence following the left-wing economist Mariana Mazzucato's case for an Entrepreneurial State, 41 suggests that major government interventions in low-carbon energy, and in health and social care, are 'key ingredients in turning around the productivity problem'. 42 Strangely, he appears to be unaware of the longterm and exorbitantly costly market coercions already favouring low-carbon energy, and is thus in no position to wonder whether those distorting energy policies may be playing a significant role in creating the productivity problem in the first place. But Jones is by no means unusual in failing to take energy seriously, though discussing it at length; and as a matter of fact, hardly anyone gets beyond conventional and empty gestures towards energy as the lifeblood of the economy. However, the GDP, energy consumption, and productivity data discussed above suggests that such an attempt would be worthwhile, and that a great deal could depend on it. Who would disagree with Jones and others that innovation is essential to prosperity? Why, then, is it so difficult to deliver? Because innovation is the experimental combination and application of inventions to satisfy human requirements and is a very high-risk business indeed; the vast majority of innovations are failures. Cheap energy means that those failures are less expensive, and that innovators can afford to take the risk over and over and over again. When energy is expensive it is rational for innovators to be extremely risk averse, as they generally are at present in the United Kingdom.

The current cost of renewables subsidies

The low and much-publicised offshore wind bids for Feed-in Tariffs with Contracts for Difference (FiTs CfDs) continue to confuse many analysts, even those from whom one might expect clear-eyed caution. A writer for the CapX website, 43 to select an example almost at random, quite correctly takes issue with the Labour Party's reckless plans for major public investment in further offshore wind, but does so on the mistaken ground that 'offshore wind is a big success story...delivering ever more clean energy, at ever lower prices, for a fraction of the price of Labour's plan'.

However, and as a matter of fact, none of the low-bidding wind farms have actually been built, and the 8.5 GW of operational offshore wind capacity that is 'delivering' is, without exception, very heavily subsidised. Indeed, the most recently commissioned offshore wind farm, the giant 588 MW Beatrice, off the north-east coast of Scotland, which only became fully operational in the summer of 2019, has a CfD strike price of £140/MWh, now worth £158.73/MWh, roughly three times the wholesale price, and indeed about three times the almost certainly unrealistic strike prices bid in the most recent CfD auctions. It is obviously premature to say that the observed fall in CfD prices bid is a 'success story'. The CfD contracts are very far from firmly binding, and the penalty for abrogration is trivial. It seems likely, bordering on certain, that they are a sly and low-risk publicity gambit, intended to secure a market position, and inhibit competition, in the hope of obtaining a better price by whatever means at a later date.

And of course the cost of electricity from existing offshore wind power has most certainly not fallen; it continues to be very high, like all the other renewable generators in the UK fleet. Perhaps it is worth reminding ourselves just how much that subsidy currently amounts to, and how much it is costing British households.



	2.7 Env	rironmen	tal levies	;				
	£ billion							
	Outturn	Outturn Forecast						
	2018-19	2019-20	2020-21	2021-22	2022-23	2023-24	2024-25	
CRC Energy Efficiency scheme	0.5	0.4	0.0	0.0	0.0	0.0	0.0	
Renewables obligation	6.0	6.4	6.3	6.4	6.6	6.8	6.9	
Contracts for difference	1.0	1.7	2.2	2.5	2.7	2.9	2.8	
Capacity market ¹	0.0	1.7	1.1	0.9	0.5	0.7	1.0	
Green gas levy	0.0	0.0	0.0	0.0	0.0	0.1	0.1	
Environmental levies	7.5	10.2	9.6	9.9	9.8	10.4	10.8	
Memo: Expenditure on renewable heat incentive (RHI)	0.8	0.9	1.0	1.1	1.1	1.1	1.1	

Note: The 'Environmental levies' line above is consistent with the 'Environmental levies' line in Table 3.3 of the March 2020 Economic and fiscal outlook.

The ONS have yet to include capacity market auctions in their outturn numbers. If they were included, they would have been £0.2bn.

Figure 11: Environmental levies.

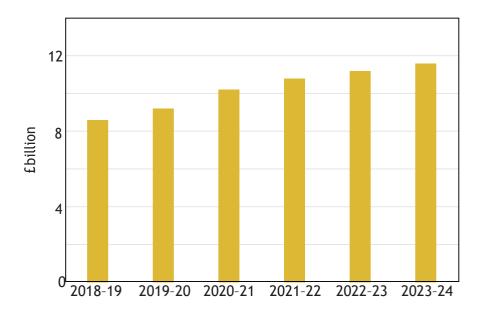
Actual (2017-18) and forecast (2018-2024) consumer cost of environmental levies. Source: Office for Budget Responsibility (OBR), Economic and fiscal outlook - March 2019,45 see "Economic and fiscal outlook - supplementary fiscal tables: receipts and other", Table 2.7.

Apart from the Contracts for Difference (CfDs), there are two other systems of subsidy: the Renewables Obligation (RO), and the Feed-in Tariff (FiT). The costs of these systems are recorded in the Office for Budget Responsibility's Economic and Fiscal Outlook, the most recent issue of which was published March 2019. This reports the current and projected costs of these subsidies amongst other environmental levies (Figure 11).

Note that the Outturn column on the left is incomplete and has to be filled in by reference to Footnote 1, where we learn that the cost of the Feed-in Tariff in 2017-18 was £1.4 billion, which when added to the cost of the RO (£5.4 billion) and the CfD (£0.6 billion) gives a total of £7.4 billion. Adding the FiT the RO and the CfD projections, we can calculate the forecast renewable subsidy costs as shown in Figure 12.

Figure 12: Forecast renewables subsidies to 2023-24.

Source: Office for Budget Responsibility, Economic and Fiscal Outlook - March 2019.



The current annual subsidy will be about £9 billion, and the grand total for the years 2017 to 2024 will come to nearly £70 billion.

These costs are recovered from the prices per unit of electrical energy (kWh) sold and thus the bills paid by all types of consumer: domestic, industrial, commercial and public sector. Consequently, about 30-40% of the total cost is recovered directly from household bills, because retail consumption typically comprises 30-40% of total consumption in a year. In truth, the impact is likely to be slightly higher than the proportions suggest, firstly because industrial and commercial consumers can buy closer to the underlying wholesale price, and secondly because some intensive energy users have partial exemption from these costs, meaning that the burden is transferred to other consumers, including households. It is worth noting also that VAT is charged on these subsidy costs too, and domestic consumers cannot recover that cost. However, for the purpose of a general estimate we can ignore these details.

In 2017, domestic consumers accounted for about 38% of GB electricity consumption, and we can assume that this is approximately correct today. Thus, the direct impact on British household electricity bills is $0.38 \times £9$ billion = £3.4 billion.

There are about 26.5 million households in Great Britain, so the mean annual renewables subsidy impact on a GB household electricity bill is £3.4 billion \div 26.5 million = £129 per household per year.

However, this is not the end of the story. While the other 62% of the renewables subsidies are paid for in the first instance by industrial, commercial, and public sector consumers, these costs are obviously passed through to households in the costs of goods, services and general taxation. If a supermarket is compelled by policy to pay more for electricity to refrigerate milk it must recover that additional cost at the checkout. Of course, those companies withoverseas customers could in theory pass on some part of that extra electricity cost to their consumers abroad but, given the intensity of international competition, that is unlikely to be a strong effect.

Consequently, it is reasonable to assume that the vast bulk of these costs are recovered domestically - in Britain - meaning that we can calculate a total 'cost of living' impact of the renewables subsidies by simply dividing total subsidies by number of households.

Thus, the total annual renewables subsidy impact on household cost of living is £9 billion \div 26.5 million households = £340 per household per year, of which about £129 a year is recovered directly from electricity bills and the remainder, over £200 a year, from increased costs of goods and services.

Given the scale and regressive nature of these impacts it is high time that the Department of Business, Energy and Industrial Strategy resumed publication of its formal estimates of the total impacts of policies - of which the direct subsidies to renewables are only part - on both gas and electricity prices. These figures were last published in 2014, ⁴⁴ but then discontinued, many of us suspect because they were so embarrassing. At that time, the department calculated that in their central scenario for 2020 domestic household electricity prices (prices per unit, not bills) would be some 37% higher than they would have been in the absence of policies, and that prices for a medium-sized business would be some 62% higher. Future projections out to 2030 were equally disconcerting, and it is thus imperative to know whether government attempts to contain the costs of energy and climate policies are having any significant effect. Judging from the OBR forecasts the answer is clearly no. The public needs and has a right to see the details.



Coming clean about electricity prices

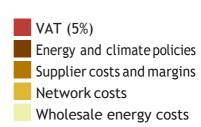
Britain's electricity suppliers are reported to be considering further increases in prices to consumers. Climate policies are largely responsible for such price increases, yet government is more than content to let private energy companies and their shareholders take the blame. Intoxicated with subsidies, the electricity sector has hitherto colluded in this obfuscation of causes, but the introduction of the domestic electricity price cap may change this situation, encouraging energy suppliers and indeed all businesses, to name government as the guilty party.

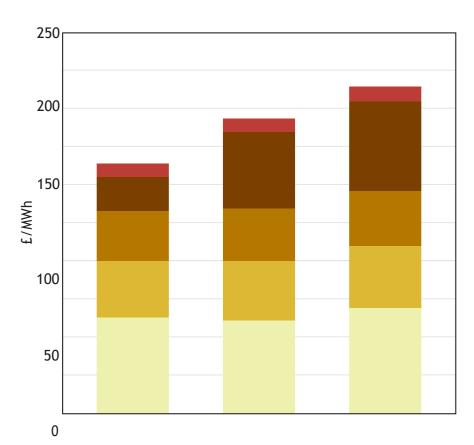
History provides very few clear lessons, but the records are tolerably clear that revenue collectors and tax farmers are always and everywhere loathed without reservation. This may be unfair, but it is a fact, a human universal. Why then did Britain's energy supply companies willingly accept the task of raising the necessary subsidies for renewable energy directly from their customers' bills? This in effect made these private companies covert revenue agents for the state, and so allowed government to hide the costs of energy and climate policies.

Anyone familiar with the industry will know there is no doubt that energy and climate policies are and have been for some time to blame for rising electricity prices, but the point bears repeating. Figure 13 shows the components of electricity prices charged to domestic consumers in 2014, and the projected figures for 2020 and 2030 in the Government's Central Fossil Fuel Price scenario. Energy and climate policy impacts are indicated by the brown section of the stacked bar.

Figure 13: UK electricity price component estimates.

Source data: DECC.⁷⁸





2020 2030

It is obvious that those policies already accounted for a large fraction of the price in 2014, prices being 17% higher than they would otherwise have been. By 2020, policies were predicted to make prices 37% higher, and 41% higher in 2030. In fact, the method of presentation used in the figure somewhat understates the impact since a significant part of network costs are actually due to renewables, because of system balancing actions and grid expansion, and a slice of the VAT element also, of course, results from the policy costs. This is, then, a conservative presentation. Furthermore, the Central Fossil Fuel Price scenario is not necessarily the most probable. In the Low Fossil Fuel Price scenario, which appears to be materialising at present and may very well applyin 2030, energy and climate policies cause prices to be 42% higher in 2020 and 62% higher in 2030.

But even in this understated, conservative central scenario, in which fossil fuel energy costs are actually expected to rise, policies are still the dominant causal factor in the overall price increase up to 2030. Put more precisely, in the absence of policies, electricity prices would have been stable to 2020, rising from about 14p/kWh in 2014 to about 14.1p/kWh. In actual fact, prices stood at 16.4p/kWh in 2014 because of policies, and were expected to rise to about 19.4p/kWh in 2020. We appear to be on track.

While uncontroversial amongst specialists, these facts are sometimes obfuscated even by authoritative sources, such as the Committee on Climate Change (see for example, the *Energy Prices and Bills Report 2017*), and it has been a brave energy company that takes the risk of candour about the in-effect-tax component, as for example Ovo energy was last year. ⁴⁶ Unfortunately, though perfectly correct, they have not been widely believed.

This is ideal for government, and is proving disastrous for electricity suppliers. Indeed, a very large part of the public perception that energy companies are greedy and ruthless results from the industry's short-sighted decision to allow itself to be used as the cat's-paw of climate policy.

The hazards of this situation must have been obvious to the main board directors concerned, but the temptation to collude was certainly extreme. The express-service renewables-target timetable required subsidies so large that the increased turnover and de-risked profit made the danger of bad public relations seem tolerable. The industry may well come to regret this lack of caution. A market sector debauched by subsidies, and already held in contempt by the public, will be in a very weak position to resist nationalisation by a radical socialist government. No one will step forward to protect a persecuted tax farmer, and the expropriators could be expropriated without any resistance, with the only public outcry being one of approval.

However, government may have unwittingly forestalled this outcome, by introducing the domestic electricity price cap, 47 a decision that could force an otherwise anaesthetised and lethargic industry into action. The uncertain, medium-term risks of a toxic

public image and possible nationalisation may be pushed to one side by preoccupied executives, but an immediate crisis in revenue has to be addressed without delay. And the price cap genuinely does present a problem to the electricity supply industry. Having accepted the task of delivering the renewables policies, the industry is now being inhibited from passing the consequent additional costs on to their domestic consumers via rising prices. The sums are not small. The Office for Budget Responsibility estimates that the renewables subsidy costs already amount to about £8.6 billion per year in 2018/19 and will rise to about £11 billion a year by the end of the current price cap period in 2023.

Such steadily increasing policy costs can only be recovered from consumers, and it is therefore probable that, blocked in one direction, suppliers will and must start to increase prices where the cap does not apply, for example prices charged to households choosing fixed term deals, and, much more probably, prices to industrial and commercial consumers.

Since those business consumers will necessarily pass their additional electricity costs on to households in the cost of goods and services, and also in downward pressure on wages and rates of employment, it is debatable whether there will be any net benefit at all from the domestic price cap. What was an electricity cost issue will become another aspect of the general cost of living problem. Indeed, since it is likely that commercial consumers will prefer to pass costs on via those of their products where demand is most inelastic, it is likely that those whom the energy bill price cap sets out to benefit will be worst affected. Basic goods and services, naturally enough, make up a large fraction of the expenditure of a low-income household.

None of this is surprising. The price cap was reluctantly introduced by a weak government and against firm advice from economists, so regressive misfires can hardly be called 'unforeseen consequences'. It was obvious that the price cap would ultimately be bad for consumers in very many ways. However, there is a silver lining to this debacle in that energy companies may now be encouraged to speak out with vigour about the extent to which state policy rather than market fundamentals is responsible for consumer pain.

They might, for example, self-protectively put their weight behind arguments to persuade government to resume the publication of *Estimated Impacts of Energy and Climate Change Policies on Energy Prices and Bills*, the last release of which, in 2014, is still by farthemost informative guide in the public domain. Since the discontinuation of this crucial dataset, government action to reduce energy sector emissions has been flying in a condition of almost complete radio silence in regard to consumer costs. This is unacceptable.

Making do with the information we have, it is obvious from the 2014 data - for example the estimates displayed in the chart above - that consumers should have benefitted over the last few years from electricity prices that were low and stable, whereas in fact prices have increased so much that they have become sufficiently salient to consumers to give specious grounds for a mandatory cap.

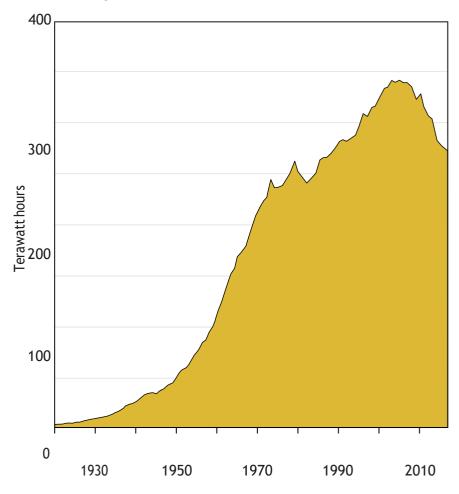
With still larger policy-driven price increases in prospect, energy suppliers were scrambling to raise their tariffs before the price cap came into effect on the 1st of January 2019, and the blame game was already starting. 48 Will the energy companies allow government to get away with this again? Since the price cap clearly shows that they cannot trust their partner in crime, perhaps they will now turn Queen's evidence and speak up on behalf of the public. If they do so, they might find themselves in good company. Industrial and commercial consumers also have an interest in ensuring absolute transparency about energy policy costs. While energy is typically under 10% of the total annual costs of a business, the predicted increase in electricity prices is large even without the burden-shifting probable as the result of the price cap, and such price increases will bite deeply into already very thin profit margins. *Estimated Impacts* reported that, even in the conservative Central Fossil Fuel Price scenario, businesses would see electricity prices rise by 50-60% by 2020 because of policies, while in the Low Fossil Fuel scenario prices are predicted to rise by between 60% and 114%. These striking increases will inevitably be passed through in the costs of goods and services. Unless they are told otherwise, consumers will regard this as yet more evidence of 'Rip-Off Britain'. Private businesses have every reason to make sure this does not happen.

Fuel poverty and electricity policy costs

New analysis from the UK government shows that households are heating their houses less than is required to meet the levels thought necessary to deliver comfort and health. Those on lower incomes are 'under-consuming' by a larger margin than those on higher incomes, with only the top richest decile consuming more than the estimated requirement. It seems probable that increased prices for electricity are rationing the poor out of the heat market.

Electricity demand in the United Kingdom has been falling for about fifteen years, with consumption in 2017 at levels last seen in the 1980s (Figure 14).

Figure 14: UK electricity supplied, 1921-2017.
Source data: BEIS.⁷⁹



The fall is so large and so closely correlated with the introduction of policies increasing electricity prices - note that demand falters in the middle 2000s shortly after the UK introduced its Renewables Obligation subsidies in 2002 - that there is a lurking suspicion that *price rationing* must be at least an element in any plausible explanation, certainly in more recent years. Even if we allow that the early onset of the 2008 crisis is probably responsible for the initial decline in electricity consumption, the lack of a subsequent recovery in demand might well be largely attributable to the rising burden of renewable electricity subsidies (about £9 billion a year at present) and their associated system balancing and grid costs (Balancing Services Use of System costs, are now £1.3

billion per year as compared to about £300 million a year in the early 2000s).

In regard to the non-domestic sector, there is little real disagreement that this decline in electricity consumption can be confidently attributed in large part to deindustrialisation caused by the export of many production processes to jurisdictions - principally China - with lower costs, electricity amongst them. This is an EU-wide effect, with industrial electricity prices in the EU28 being 50% higher than those in the G20. 49

But the domestic correlate of this effect, in relation to household consumption, is more controversial. Apologists for the UK's policies tend to argue that the widespread adoption of efficient conversion devices, such as LEDs and better white goods in areas where demand is not particularly elastic, have cut electricity demand without reducing consumer benefit. But analysis bearing directly on this question is in short supply. Fortunately, as part of its monitoring of fuel poverty, the UK government has recently undertaken an examination of energy consumption at the household level that throws some welcome light on the question.

The March issue of Energy Trends, the statistical bulletin of Department of Business Energy and Industrial Strategy (BEIS), contains an article⁵⁰ that puts actual household energy consumption alongside that predicted by the fuel poverty models as necessary to achieve comfortable and healthy levels of heat.

The government's analysis finds that 69% of households had a theoretical level of consumption that exceeded their actual consumption, the average underspend being about £133 per household per year, or 9.9% of the expected spending. This tendency is stronger in relation to those households classed as 'Fuel Poor', which were underspending by £319 per household per year (19.9%), as opposed to the 'Not-Fuel Poor', who were underspending by £110 (8.6%) per household per year.

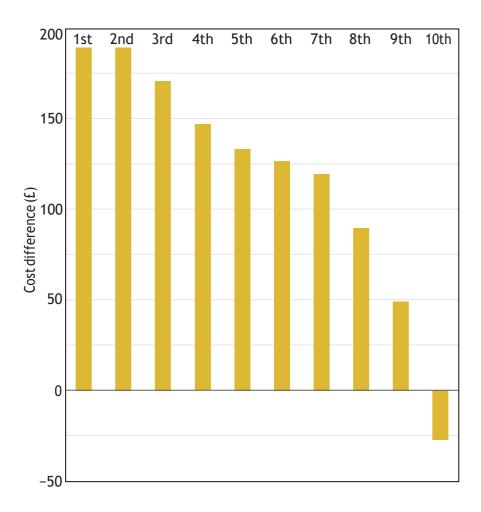
Suspicions that this might result from a known bias in the model, which may overstate requirements, ⁵¹ are to a degree dispelled by the fact that the distribution over income bands is uneven, with those on low incomes much more affected. Indeed, the underspend decreases as household income rises, and those households that spent more on energy than the model predicted also had incomes 21% higher on average than the rest of the sample. Figure 15, redrawn from the study, illustrates the distribution. It is quite clear, as BEIS itself concludes, that the effect of underspending is 'strongly linked to income'. Low-income households underspend on energy to a greater degree than higher income households.

Furthermore, fine-grained analysis reveals that 'households with children had the largest average under-consumption' and that, generally, 'lower income households with dependants are potentially more likely to under-consume than other households',⁵² with this effect particularly marked for fuel-poor households.⁵³

Some would argue that these effects are consistent with the view, which I emphasise is not expressed in BEIS's paper, that such underspending, particularly in the lower deciles, is largely the ef-

Figure 15: Estimated UK household underspend on energy by income decile.

Source: BEIS.80



fect of price-rationing. In other words, energy prices are sufficiently high to force consumers to trade off their wish for heat against competing demands for that income, with evidence of the trade-off being, inevitably, particularly marked in the lower income deciles. However, given the known bias in the model itself, the underspend recorded for the middle- and higher-income deciles is perhaps less significant and our attention should be focused on the causes underlying low energy consumption by the poor. Why are they underspending by so much?

One possibility is that low-income households tend to use electric heating. The regulator, Ofgem, reports that of the 26 million households in Great Britain, about 22 million use natural gas for heating, with 2.2 million of the remainder using electricity. Ofgem also indicates that electrically heated households tend to be of lower income, with around one third of electrically heated households in receipt of an annual income of under £14,500 per year. That is not surprising, since many electrically heated households are flats, and 25% of all flats in Great Britain are electrically heated, as compared to only 4% of houses. The rented sector, of course, is used heavily by those on lower incomes. Indeed, there is some reason for thinking that the proportion of flats using electricity for heating may actually be rising, as non-condensing gas boilers on shared flues reach the end of their lives, and cannot be replaced with the now mandatory higher-efficiency condensing

boilers since the flue gases are too cool to exit the flue safely. In such cases relatively expensive electric heating is the only feasible option.

It follows, therefore, that the 2.2 million electrically heated households are very probably concentrated in the lower-income deciles, precisely where BEIS's study has found greater levels of underspending on energy.

That should be of concern to the Government, since energy and climate policies have a much greater effect on the price of electricity than on the price of natural gas. In 2014, BEIS's predecessor, the Department of Energy and Climate Change, estimated that by 2020, policies would be making electricity prices to households about 36% higher than they would be in the absence of policies, while the effect on gas prices was to increase them by only 6%.⁵⁵

We can consequently conclude that it is very likely that the significant levels of underspending on energy reported for lower-income households are caused in significant part by electricity price increases resulting from energy and climate policy.

With that in mind, I wrote to BEIS asking whether their dataset could identify the electrically heated households and so evaluate the hypothesis that the reported 'under-consumption', particularly of the lower income deciles, was correlated with and in part caused by their use of electric heating. The statistician responsible informed me that the question had indeed been examined, but, unfortunately, the dataset did not distinguish clearly between non-gas households that used electricity only and those that used other fuel types for heating as well. Consequently, the department 'did not have a reliable enough sample to accurately test the difference in theoretical and actual consumption between gas heated and electric heated dwellings.' I see no reason to doubt this explanation, but it is obviously a limitation in the government data that should be rectified promptly.

Even without that information, we can be confident that higher electricity prices, known with certainty to result from energy and climate policies, are very probably making heating unaffordable for those on lower incomes, and that the Government appears to be price rationing the poor out of the heat market in order to reduce emissions. But so far from having second thoughts, the administration is, as the Chancellor told us in his Spring Statement, planning to extend price rationing to still more households, with its Future Homes Standard 'mandating the end of fossil-fuel heating systems in all new houses from 2025'. ⁵⁶ This could well, as Mr Hammond said in his speech, and apparently without irony, deliver 'lower carbon' and 'lower fuel bills too', but only through price-coerced underconsumption.

The decline and fall of Ofgem

The first act of Mr Jonathan Brearley, the new CEO at the UK electricity and gas market regulator, Ofgem, has been to publish a Decarbonisation Programme Action Plan, a document that demonstrates that the regulator is no longer independent and is now an integral part of the climate change policy delivery mechanism and will consequently do nothing, beyond paying lip-service, to protect present consumers from the costs of the 2050 Net Zero target. This confirms concerns that, as a long-term Whitehall policy insider and responsible in part for both the Climate Change Act (2008) and Electricity Market Reform, Mr Brearley was not an appropriate choice to lead the regulator.

In October 2019, Ofgem announced that Jonathan Brearley, its own Executive Director for Systems and Networks, would be succeeding Dermot Nolan as Chief Executive, taking over at the end of February 2020. ⁵⁷ Mr Brearley's Whitehall career is practically a history of modern British climate change policy. From 2002 to 2006 he served as 'Head of Team' in Tony Blair's Prime Minister's Strategy Unit (PMSU). ⁵⁸ The PMSU was at least in part responsible for the *Energy Review* of 2002, and for *The Energy Challenge* study of June 2006, amongst other things. ⁵⁹

From July 2006 until September 2009, Mr Brearley worked as Director of the Office for Climate Change, an offshoot of the Department of Environment (DEFRA) that formed the administrative nexus drawing together six other departments for work on the Climate Change Act (2008).

This experience led to a further appointment in late 2008 in Gordon Brown's new Department of Energy and Climate Change (DECC), where he became Director of Energy Strategy and Futures, and then Director of Electricity Markets and Networks. In this latter position he is said to have 'led the delivery of the Governments' Electricity Market Reform...programme', the programme which introduced Contracts for Difference, the subsidy scheme introduced to replace the Renewables Obligation.

Mr Brearley continued to serve under the Conservative/Liberal Democrat Coalition Government, but in 2013 he resigned visibly and dramatically from DECC, 60 with the *Independent* newspaper reporting a source to the effect that Brearley was 'not happy... DECC is working to improve the investment climate and the Treasury is stopping it'. 61

For a short while after his resignation he ran his own consultancy, Brearley Economics Ltd, the clients of which are not publicly known, which was incorporated in March 2013, just before he left DECC, and was voluntary liquidated in 2016-2019 prior to his return to Whitehall in April 2018 with a position in Ofgem, ⁶² as Executive Director for Systems and Networks, a position he held for only eighteen months before being promoted to the top job of Chief Executive Officer in October 2019.

It must at the least be questionable whether such a person was a suitable choice to act as the CEO of a regulatory body in-

tended to protect the consumer interest. The majority of Mr Brearley's civil service career has been marked by close and committed involvement in the creation of climate policies that impose high costs on consumers, yet he is now entrusted with overseeing the regulation of the markets just as his own policies, now augmented by the Net Zero target, come to maturity. He can surely be neither objective nor independent.

Did no-one on Ofgem's board ask themselves whether this candidate might have a conflict of interest? Did they ask, for example, whether Mr Brearley was in reality likely to side with the consumer against the costs of instruments which he himself had a very prominent role in creating, even, it seems, resigning in protest over Treasury attempts to rein in those costs? If they did so it made no difference to their choice.

From the point of view of the regulator's wider reputation, this appointment is like to prove a mistake, and, until Mr Brearley is replaced, Ofgem will, even in the eyes of only moderately suspicious members of the public, lack any credibility as a sincere and scrupulous guardian of the consumer interest.

Confirmation that these concerns are not merely theoretical can be found in Mr Brearley's first act as CEO, the publication of the *Ofgem Decarbonisation Programme Action Plan*, which was released on the 3rd of February 2020

This document is in substance only a subservient echo of the Climate Change Act and its successor the Net Zero target. Indeed, Mr Brearley's own Foreword tells us as much:

It is vital that as the regulator we are taking the steps to enable and encourage the decarbonisation of energy, playing our part in helping the government achieve its ambition...This action plan is just the start of Ofgem's drive to play our role in achieving net zero by 2050. 63

No independent and consumer-oriented regulator could have written in this way.

Moreover, the lip-service to 'low-cost decarbonisation' is revealed for what it really is by the subtle reference, easily overlooked, to what Mr Brearley refers to as Ofgem's 'principal objective', namely, 'to protect both current and future consumers', 64 a point reiterated in the main text of the document:

In line with Ofgem's principal objective we will balance the benefits to future consumers of greenhouse gas reductions alongside the potential costs to current consumers. 65

Those words will ring an alarm bell for any student of Ofgem's history. As I noted in 2017, the Utilities Act of 2000 had described the overarching principal objective for energy regulation as the protection of the interests of existing and future consumers, wherever appropriate by promoting competition. 66 This was a lucid and unconstricting brief. However, the Energy Act of 2010 amended this principal objective by defining 'interests' thus in two separate paragraphs 68 referring to gas and electricity:

Those interests of existing and future consumers are their interests taken as a whole, including-

- (a) their interests in the reduction of gas-supply/electricity supply emissions of targeted greenhouse gases; and
- (b) their interests in the security of the supply of gas/electricity to them.

This change was of enormous importance, since an increasingly large part of the charges on the consumer were (and still are) the result of climate policy. In effect, the revision to Ofgem's principal purpose made them unable to comment on the imposition of cost increases resulting from measures to mitigate climate change.

Mr Brearley's Ofgem embraces this restriction with vigour. Since present consumers are finite in number, and the nebulous definition implicit in the term 'future consumers' creates an infinite set, no balancing calculation can favour present consumers unless there is a discount rate, and of this there is no mention either in the Act of 2010 or in Ofgem's commentary. But real consumers do discount the future, and this is not necessarily selfish; if parents, for example, failed to discount in order to maintain their own lives, there could be no future generations to be worried about.

The lack of discounting thus puts Ofgemon a collision course with real consumer, real human behaviour. Ofgem's interpretation of the 2010 Act means that they will put only the weakest of brakes on the imposition of climate change cost burdens. Present consumers now have little or no voice.

Anyhopes that Ofgemmight in the future attempt to reverse this weakening of its powers - made of course when Ed Miliband was Secretary of State and Mr Brearley was a senior director in DECC - must now be abandoned since Mr Brearley himself is in charge of Ofgem. Until there is a major overhaul this will be the status quo.

The defence that will be offered, of course, is that immediate high expenditure is simply prudent and precautionary. Ofgem writes in its *Action Plan*:

We are clear...that investing in the short term will save money in the medium and long term.⁶⁹

The misuse of the phrase 'I/we am/are clear' in political declarations is by now a notorious give-away, and it is regrettable to find it in the statement of a regulator. Emphatic assertions of faith may pass with politicians, but are surely impermissible for an objective body entrusted with quasi-judicial oversight. From such an institution the public has every reason to expect careful calculation and argument, not unsupported fervency.

A great deal depends on this, for the short-term investments about which the regulator claims to be so clear are not of a minor order. Mr Brearley's new model Ofgem blithely reports the Committee on Climate Change's estimate that power sector investment:

may need to increase to around £20 billion (in 2019 money) per year by 2050, to cover 'investment in renewables, firm low-carbon power, CCS, peak power and networks (including transmission and distribution).⁷⁰

The cumulative sum, in fact unpublished, will be very large indeed. For comparison, the document itself notes that a mere £10 billion was spent between 2013 and 2017.

Similarly, in regard to heating, Ofgem now reports without concern the CCC's estimate that switching to low-carbon heating 'will require annual investment by 2050 of around £15-20 billion (in 2019 money), up from just £100 million in 2018'. 71

Faced with proposals for such vast expenditure, an objective regulator would require stringent cost-benefit analysis and justification, but under Mr Brearley that not will happen, as the *Action Plan* explains:

'The challenges of net zero are stark and require us to step up our efforts to meet them. As energy regulator, we can create the regulatory framework to enable the appropriate investment, and help direct that investment where it is needed.⁷²

There is only one way in which this can be understood. The ends are taken to justify the means, and Ofgem will collaborate with government to coerce the consumer into delivering a rate of return sufficiently high and secure to motivate investment.

As a supplementary reinforcement for this position, Ofgem claims that the costs of the preferred energy supply, renewables in general and offshore wind in particular, are already very cheap:

The dramatic reduction in offshore wind costs demonstrates that in the long term, low carbon energy can be cheaper than traditional fossil fuels.⁷³

Few commentators anticipated the recent rapid reductions in the cost of wind and solar power.⁷⁴

As a matter of fact, not everyone is convinced that there is significant substance to these apparent cost reductions, with some doubting, for example, that the capital costs of offshore wind, for example, have fallen much if at all. Hughes, Aris and the present author⁷⁵ and Hughes⁷⁶ reviewed offshore wind capital cost data and detected no dramatic fall, a finding that has been replicated by a recent study of audited wind farm company accounts by economists at the Aberdeen Business School of Robert Gordon University.⁷⁷ The authors of the latter paper appear broadly sympathetic to the renewables agenda, but nevertheless write:

The most recent CfDs were awarded at a price (in 2012 terms) of £57.50/MWh, while the analysis here shows that modern wind farms typically have a LCOE of c. £100/MWh. Although... the LCOE and strike price are only the same in a zero-inflation world, it is nonetheless clear that very significant reductions are required to wind farm costs to offer economic projects in the context of current strike prices.

Of this data-grounded concern, Ofgem says not a word, and instead simply repeats the self-serving industry propaganda about falling costs. A truly independent regulator would not have filled up the cry in this way. On the contrary, it would instead have asked if the bids were too good to be true, and whether the CfD system were being exploited to obtain mere options for development, thus gaining market position and inhibiting competition. But Mr Brearley is surely not disengaged in this matter, since he himself oversaw the introduction of Contracts for Difference as part of the EMR package. Being only human, it would be remarkable if he did not have a personal interest in declaring CfDs a success. He may even bequite blind to the possibility that things have gone wrong.

The publication of Ofgem's *Decarbonisation Programme Action Plan* marks the final degradation of the United Kingdom's electricity and gas market regulator. The process begun by the revision of Ofgem's objectives in the Electricity Act of 2010 has been completed in 2020 by the appointment of Mr Jonathan Brearley, a long-term Whitehall climate policy insider who has interests that appear to conflict strongly with those of the consumer. Reform of the Office of Gas and Electricity Markets has long been regarded as needed; it is now essential.



Notes

- 1. https://data.nationalgrideso.com/balancing/bsuos-monthly-forecast?from=0#resources.
- 2. https://www.nationalgrideso.com/news/managing-reduced-demand-electricity-what-our-new-odfm-service-and-why-do-we-need-it.
- 3. https://www.nationalgrideso.com/industry-information/codes/grid-code-old/modifications/gc0143-last-resort-disconnection-embedded.
- 4. https://www.ofgem.gov.uk/system/files/docs/2020/05/gc143_d.pdf.
- 5. https://www.ref.org.uk/constraints/index.php.
- 6. CUSC Modification Proposal Form: CMP345: Mod Title: Defer the additional Covid-19 BSUoS Costs. https://www.nationalgrideso.com/industry-information/codes/connection-and-use-system-code-cusc-old/modifications/cmp345-defer.
- 7. CMP345, p. 8.
- 8. https://www.theguardian.com/business/2020/may/19/ovo-energy-cut-jobs-sse-coronavirus-lockdown.
- 9. https://www.ofgem.gov.uk/ofgem-publications/163442.
- 10. https://data.nationalgrideso.com/balancing/bsuos-monthly-forecast/r/a_note_on_our_bsuos_updates_published_15th_may_2020.
- 11. The large rotating masses of traditional power stations represent a store of energy inertiathat helps slow down the spread of the effects of a system fault, giving managers vital time to bring alternative generation online.
- 12. Embedded generators do not supply the transmission grid, but instead are 'embedded' in the distribution grid, closer to consumers.
- 13. See p. 15.
- 14. Summer Outlook, p. 14.
- 15. https://www.nationalgrideso.com/insights/system-operability-framework-sof.
- 16. https://www.nationalgrideso.com/balancing-services/transmission-operational-forum.
- 17. National Grid, System Operability Framework: Impact of Declining Short Circuit Levels (December 2018), p. 1.
- 18. National Grid, System Operability Framework: Whole System Short Circuit Levels (December 2018), p. 2.
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About the Global Warming Policy Foundation

The Global Warming Policy Foundation is an all-party and non-party think tank and a registered educational charity which, while openminded on the contested science of global warming, is deeply concerned about the costs and other implications of many of the policies currently being advocated.

Our main focus is to analyse global warming policies and their economic and other implications. Our aim is to provide the most robust and reliable economic analysis and advice. Above all we seek to inform the media, politicians and the public, in a newsworthy way, on the subject in general and on the misinformation to which they are all too frequently being subjected at the present time.

The key to the success of the GWPF is the trust and credibility that we have earned in the eyes of a growing number of policy makers, journalists and the interested public. The GWPF is funded overwhelmingly by voluntary donations from a number of private individuals and charitable trusts. In order to make clear its complete independence, it does not accept gifts from either energy companies or anyone with a significant interest in an energy company.

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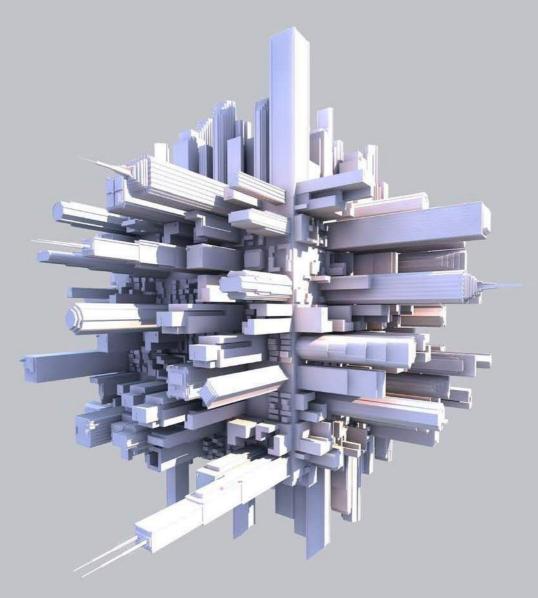




THE CLIMATE NOOSE

BUSINESS, NET ZERO AND THE IPCC'S ANTICAPITALISM

Rupert Darwall



The Climate Noose: Business, Net Zero and the IPCC's Anticapitalism

Rupert Darwall

Report 40, The Global Warming Policy Foundation

ISBN 978-1-9160700-7-3

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'We must stop Tuvalu from sinking and the world from sinking with Tuvalu.'

UN Secretary-General António Guterres, 17 May 2019²

'The IPCC's 1.5-degree special report cites the French Marxist Thomas Piketty's book Capital in the 21st Century, but does not survey the many criticisms of the book.'

Rupert Darwall

'A senior UN environmental official says entire nations could be wiped off the face of the Earth by rising sea levels if the global warming trend is not reversed by the year 2000.'

AP News, 30 June 1989¹

'Shutting down the whole economy is the only way of limiting global warming to 2°C.'

YvodeBoer, former head of the UNFCCC⁵⁶



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Dedication

To the memory of David Henderson (1927-2018)

This paper is, in a sense, a tribute to Professor David Henderson. His interest in, and trenchant critiques of, 'corporate social responsibility'-what today goes under the banner of ESG - was what led him to global warming. On one of the last occasions I saw David, he reminded me of *The Role of Business in the Modern World* (2004). I remembered those words when writing this report and took the copy he gave me from my bookshelf. There I found his case contra CSR expressed with crystal-line clarity. I hope he would approve of my use of it here.

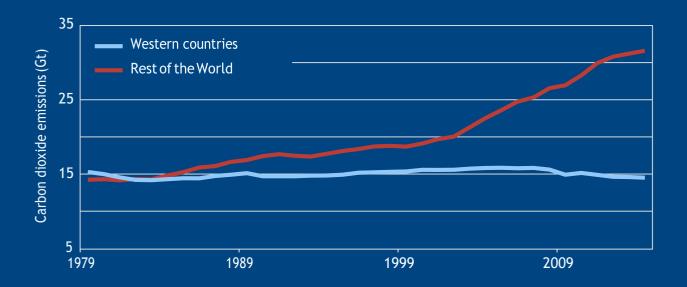
About theauthor

Rupert Darwall is a fellow of the Real Clear Foundation. After reading economics and history at Cambridge University, he worked in the City of London as an investment analyst and in corporate finance before becoming a special adviser to the then Chancellor of the Exchequer, Norman Lamont. He has written extensively for publications on both sides of the Atlantic, and is the author of the widely-praised *The Age of Global Warming: A history* (2013) and *Green Tyranny: Exposing the totalitarian roots of the climate industrial complex* (2017). He has written reports on UK energy policy for Reform (*How to Runa Country: Energy policy and the return of the state*, November 2014) and the Centre for Policy Studies (*Central Planning with Market Features: How renewable subsidies destroyed the UK electricity market*, March 2015) as well as an analysis for the Centre for Policy Studies on reforming tax credits (*A Better Way to Help the Low Paid: US lessons for the UK tax credit system*, 2006) and on energy and industrial policy for Civitas (*Going Through the Motions: The industrial strategy green paper*). This is his third paper for GWPF, the first being *The Anti-Development Bank* (2017) and the second *The Climate Change Act at Ten* (2018).

Two-minute read

- Why 1.5°C? The stated aim of the 1992 UN Framework Convention on Climate Change is to avoid dangerous anthropogenic interference in the climate system. This was defined by European governments as limiting the rise of global temperature to no more than 2°C above preindustrial levels, a definition subsequently written into the UN climate texts. In the run-up to the 2009 Copenhagen climate conference, small island states claimed the 2°C limit risked their homes sinking under the waves. As a result of their lobbying, the 2015 Paris Agreement speaks of 'pursuing efforts' to limit the temperature rise to 1.5°C above pre-industrial levels.
- What was the scientific backing for the claim that 1.5°C was needed to save small islands from drowning? 1.5°C to save small islands is a brilliant soundbite that turns out to be 100% wrong. Nearly two centuries ago, Charles Darwin wrote that coral atolls are formed by the slow subsidence of the seabed. Even though green activists, from the UN Secretary-General down, falsely claim otherwise, modern research finds Darwin was right and that many apparently threatened atolls have increased their land area.
- Why now? The Paris Agreement talked of reaching net zero sometime in the second half of the current century. In 2018, three years after the Paris climate conference, the IPCC published its 1.5° C special report. The IPCC declared that net zero must be reached by around 2050 and that emissions must fall 40% by 2030. The 2030 timeline unleashed the current wave of intensified climate alarm, with talk of '12 years to save the planet', as if a rise in global temperature of around 0.5° C from current levels presages planetary catastrophe.
- On what basis did the IPCC mandate net zero by 2050? In its Fifth Assessment Report, published four years earlier, the IPCC declared a 1.5°C carbon budget that was about to be used up. It therefore had to repackage the 1.5°C budget to avoid the new, lower temperature limit being dead on arrival. The process of revising the carbon budget demonstrates it is more of a smoke and mirrors exercise than hard science, with ample scope for subjective judgment and choices.

The West versus the Rest



Carbon dioxide emissions from energy and cement manufacture

- Why did the IPCC decide to create a climate emergency? The IPCC says net zero provides the opportunity for 'intentional societal transformation'. Indeed, the IPCC does not hide its belief that capitalism and economic growth threaten the future of the planet.
- What does the IPCC want to replace capitalism with? Reaching net zero in 2050 requires top-down coercive central planning on a global scale, encompassing energy, manufacturing, construction, transportation, agriculture and land use.
- **How much will it cost?** The IPCC tries to sweep cost under the carpet, saying cost data on 1.5°C are scarce. The few numbers it provides imply the policy costs of net zero by 2050 are up to 61 times estimated climate benefits, showing that 1.5°C is an arbitrary target requiring massive policy overkill at huge cost to human welfare.
- What is the likely impact on the world's poor? The IPCC concedes that draconian emissions reductions mean higher food and energy prices, the latter delaying the transition to clean cooking, and therefore keeping in place one of the main causes of preventable deaths in developing countries.
- **Is there any chance of reaching net zero in 2050?** Irrespective of what Europe and the US do, there's not a chance. In less than a decade and a half, the *increase* in developing nations' carbon dioxide emissions outstripped the combined *total* of US and EU emissions.
- Why should companies target net zero when the world's governments are going to miss it by a country mile? Unilateral net zero will make companies, their shareholders, employees, customers and local communities poorer. There is no economic, social or ethical justification for self-impoverishment, as it benefits no-one but green rent-seekers and the West's competitors. Capitalism depends on corporations innovating and competing. Investors and boards that force companies to become tools of public policy undermine the motive power of capitalism, the only economic system that generates long-term economic growth. In doing so, they are digging a grave for the West and ceding economic leadership to the rising powers of the East.

The Coronavirus and the 1.5-degree limit

Shutting down the whole global economy is the only way of achieving a two-degree goal, the former UN climate chief Yvo de Boer said in in the run-up to the 2015 Paris Agreement. ⁵⁶ We can now see what a global shutdown looks like. Unlike any economic bounce back from Covid-19 lock-down, decarbonisation permits no let up; it goes on year after year, decade after decade. In a rational world, governments will prioritise economic growth over decarbonisation. Yet adoption of the 1.5 °C target was based on a PR soundbite, not reason or analysis. Two factors, however, doom 1.5 degrees and netzero. The first is the growth of non-Western emissions, as shown on the graph on the previous page:

- From 1979, it took the Rest of the World 33 years to increase carbon dioxide emissions by 63%, a compound average growth rate of 1.6% per year.
- There is a marked inflection point in 2002, after which it took only 12 years for the Rest of the World's emissions to rise by 77% a compound average growth rate of 4.9% per year to a level three times higher than the West's.

The second is the return of geopolitics. In its handling of the pandemic, China - the world's largest emitter of greenhouse gases - has proven itself a bad-faith actor. Great-power rivalry has no place for a multilateral process that undermines participants' economies and their national security. At some point, the penny will drop.

Summary

Business is now on the frontline of the climate wars as never before. Corporations are being told their business strategies must align with the goals of the Paris Agreement. The financial sector is being weaponised to make good that threat. This paper sets these developments in the context of the near certainty that governments, who are the actual parties to the Paris Agreement, have no intention of eliminating net greenhouse gas emissions by mid-century, which the Intergovernmental Panel on Climate Change (IPCC) says is needed to prevent global temperatures rising by more than 1.5°C above pre-industrial levels (Section 1).

Underlying the call that business should go beyond law and regulation to decarbonise is the view that the role of business is to do good; in effect, to be like charities that happen to make a profit. This is a profound misunderstanding of how capitalism works. Individual businesses do not set out to raise living standards; it is the ceaseless effect of competition and the imperative to innovate that have transformed mankind's material condition. Tying corporations in stakeholder fetters and climate shaming them to act against their shareholders' interest threatens to drain the lifeforce out of capitalism. As Joseph Schumpeter argued in the 1940s, the biggest threat to capitalism comes from within capitalism itself (Section 2).

Lowering the target from 2°C to 1.5°C drove the timetable to meet the net zero target. It came about as a result of a sustained campaign by small island states pushing the narrative that their countries were likely to disappear under the waves. Like the iconic polar bear threatened with extinction, this turns out to be false and have no scientific basis at all (Section 3).

The 1.5°C target was included in the Paris Agreement as an aspiration, rather than a hard target. The IPCC was then tasked with providing a scientific and economic justification for it. The IPCC has always been a political body and was conceived as such, but its 1.5°C special report breaks new ground in being overtly ideological, as evidenced by its opinion that the net zero target provides the opportunity for 'intentional societal transformation' (Section 4).

The IPCC had set a 1.5°C carbon budget in its Fifth Assessment Report four years earlier. However, it was about to run out; without a revision to the budget, the 1.5°C target would have been missed virtually the moment it was set, which would have been embarrassing for all concerned. So the IPCC's first order of business was to devise a new carbon budget and push out the





netzero deadline. The way in which the IPCC was able to repackage the 1.5° C budget - the maximum amount of carbon dioxide that can be emitted to stay below 1.5° C - illustrates the amount of discretion it has and the degree of artifice lurking behind ostensibly objective science.

Although it could only muster *medium confidence* on the size of the remaining 1.5°C budget, the IPCC was able to assert *high confidence* that emissions must reach net zero by around 2050 and decline by about 45% from 2010 levels by 2030. It was the 2030 timeline that unleashed the current wave of heightened climate alarm, provoking Congresswoman Alexandria Ocasio-Corteztotalkoftheworldending in twelve years (Section 5).³

The IPCC's treatment of climate science in the special report is full of holes and is far from being a model of scientific objectivity. In keeping with its political mandate, the IPCC avoids any discussion of climate-model tuning strategies being designed to produce politically acceptable results (Section 6).

As an ideological document, IPCC focuses exclusively on the negative consequences of capitalism and economic growth and ignores its benefits: rising standard of living, quality of life and extended longevity. In similar vein, its assessment of the 1.5°C pathway amounts to saying climate impacts are lower than on a 2°C pathway, something a child could have told them. Because the IPCC avoids evaluating the extra costs of the 1.5°C pathway, as a guide to policy, its gloss on 1.5°C is worthless. Comparison with social cost of carbon estimates produced by the Obama White House imply that the costs of the 1.5°C pathway are one to two orders of magnitude greater than the estimated climate benefits from those emissions reductions; that is to say, it represents massive policy overkill and inflicts unwarranted costs on the world economy, especially on the poorest (Section 7).

To cap it all, the IPCC wants to replace free-market capitalism with central planning on a global scale to bring about top-down transformations of the energy, industrial, transportation, construction, land use and agricultural sectors. The IPCC grudgingly concedes that this is likely to mean higher food prices, hitting the poorest hardest. It also expects higher energy costs to delay the move to clean cooking, meaning more indoor pollution and therefore lost lives. When seen in this light, it becomes clear that advocates of 1.5 °C and net zero are behaving like fanatics, with little or no regard for the welfare of the poor and the wider interests of humanity (Section 8).





1. The new battleground in the climate wars

Corporations are being made an offer they can't refuse: align your business strategy with the Paris Agreement's 1.5-degree temperature target or else. According to the We Mean Business (WMB) climate coalition, 550 companies have committed to reducing their greenhouse gas emissions in line with the goal of the Paris Agreement to limit the future rise in global temperature to 1.5°C above pre-industrial levels. If companies don't take steps to becoming Paris-compliant, their access to finance might be curtailed. Sustainability is no longer a matter of taking care of the environment to please millennials. It's now a cost of capital issue', says Peter Bakker, president and CEO of the World Business Council for Sustainable Development.

In September 2019, Mike Bloomberg's Climate Finance Leadership Initiative produced a report for the UN Secretary-General on mobilising capital to meet the Paris target. 'The world requires a significant shift in investments that make financial flows consistent with pathways toward low greenhouse gas emissions', wrote Bloomberg and his seven co-signatories - including the CEOs of Goldman Sachs and HSBC, the world's third largest bank outside China - collectively responsible for \$4.5 trillion in assets under management. 'Capital is not only to be switched to investments deemed socially acceptable; it is to be denied to those deemed unacceptable. A month later, Moody's changed the outlook for Exxon Mobil from stable to negative, citing the threat of 'potential carbon dioxide regulations' as a factor.⁷

Higher energy costs are not popular. Given the chance, voters in the United States reject carbon taxes; in 2018, carbon tax proposals were voted down in Arizona, Colorado and, for a second time, in Washington State. Circumventing voters and the ballot box, climate activists seek to politicise businesses and turn them into tools to achieve public policy ends. 'All businesses - especially those that to date have been silent on the threat of climate change - need to step-up their ambition and actions', the WMB climate coalition says. § In other words, companies are to be bullied and climate-shamed into taking action they judge contrary to their interests.

Climate shaming is being given a huge boost by the greening of Wall Street. The G20 has a task force on climate-related financial disclosures, chaired by Mike Bloomberg. Under the guise of fulfilling their mandate for financial stability, financial regulators and central bankers have formed a so-called 'Network for Greening the Financial System'. Although it doesn't include the Fed or other federal regulators, one member of the Commodities Futures Trading Commission has said the risks posed to financial markets by climate change are on a similar scale to the sub-prime crisis. ⁹ Christine Lagarde, president of the European Central Bank (ECB), wants climate change to be part of the ECB's strategic mission. According to François Villeroy de Galhau, governor of the Banque de France, by increasing energy prices and lowering economic

growth, global warming could cause a 'stagflationary shock'.¹¹ De Galhau missed out a word; what he describes are the likely economic consequences of global warming *policies* rather than the direct effects of warming itself. The more you have, the worse the economic consequences.

All this raises the question of the demarcation between the rightful domains of democratic politics and business. 'We're not going to be the ones to decide society's response. That is for elected officials, not us', Fed Chairman Jerome Powell told the Joint Economic Committee of Congress in November 2019.¹¹ There are 189 parties to the Paris Agreement. All are states, or, in the case of the European Union, a union of member states. None are businesses. And the Paris Agreement requires no ordinary outcome, but a top-to-bottom economic and societal transformation. Limiting global warming to 1.5° C requires 'rapid and far-reaching transitions in energy, land, urban and infrastructure...and industrial systems', the IPCC says. 'There is no documented historic precedent for their scale'.¹²

To state this is to acknowledge the unreality of what is being proposed. To bring it about requires a system of global governance with coercive powers over the allocation of global resources and the ability to dictate lifestyles. With the conceivable exception of EU member states that have already done so, sovereign nations will not willingly cede the necessary authority to a supranational body. In fact, the Paris Agreement gained the acceptance of the major emerging economies precisely because its architecture is designed around *nationally* determined contributions, not top-down targets.

Emission failure

AMartian visiting planet Earth and told about the UNF ramework Convention on Climate Change would assume that the aim of the agreement was to boost carbon dioxide emissions. As shown in Table 1, far from slowing down, during the 22 years since the UNFCCC was signed in 1992, annual emissions rose in absolute and relative terms, the growth rate actually accelerating: from an increase of 50% in the 22 years before the climate pact to 62% over the subsequent 22 years.

Table1: Global CO2 emissions from fossil-fuel burning and cement manufacture.

Source: Carbon Dioxide Information Analysis Center, Oak Ridge National Laboratory (March 2017) https://cdiac.ess-dive.lbl.gov/ftp/ndp030/global.1751_2014.ems

	Annual emissions	22-year change	
	Mt	Mt	%
1970	14,862	_	_
1992	22,288	+7,426	+50.0
2014	36,138	+13,850	+62.1



This is not an accident. The one consistent theme running through nearly three decades of UN climate talks is the refusal of developing nations to be bound by treaty to anything that might appear to oblige them to cut their greenhouse gas emissions. The UNFCCC divides the world into advanced nations (Annex I parties) and the rest. At the COP1 Berlin climate conference in 1995, the parties adopted the Berlin Mandate, which states that the process will not introduce any new commitments for non-Annex I parties. The Berlin Mandate led to the ineffective Kyoto Protocol, which excluded the fastest-growing emitters. The 2009 Copenhagen climate conference (COP15) attempted to remedy this fundamental defect. Article 2 of the draft Copenhagen accord spoke of the requirement for 'deep cuts' in global emissions with a view to halving global emissions by 2050. The Copenhagen treaty was quashed by China, India, Brazil and South Africa.

As originally drafted, the Paris Agreement had a provision for targets and timetables for emissions cuts. Article 3 was drafted with a collective long-term goal of peaking global emissions, aiming to achieve zero global emissions by 2060-80. ¹⁴ The target didn't make the final cut. All numbers and formulae that had been in square brackets in the draft were removed from the final text. Despite a weakened commitment - and much less onerous than climate activists believe (see Box 1) - collectively the parties

Box 1: Relevant provisions of the Paris Agreement

The Paris Agreement has been misinterpreted as limiting the rise in global temperature to no more than 1.5°C above pre-industrial levels and requiring net zero greenhouse gas emissions by 2050. This is a serious misrepresentation of what the agreement states.

Article 2 defines the agreement's objective as:

Holding the increase in the global average temperature to well below 2° C above pre-industrial levels and *pursuing efforts* to limit the temperature increase to 1.5 °C above pre-industrial levels. (Emphasis added; Article 2.1. (a))

Article 4 outlines an emissions trajectory to achieve 'the long-term temperature' goal set out in Article 2.

Parties aim to reach global peaking of greenhouse gas emissions as soon as possible, recognizing that peaking will take longer for developing country Parties and to undertake rapid reductions thereafter in accordance with best available science, so as to achieve a balance between anthropogenic emissions by sources and removals by sinks of greenhouse gases in the *second half of this century* (Emphasis added; Article 4.1.)

Article 4 goes on to differentiate the respective responsibilities of developed and developing Parties:

Developed country Parties should continue taking the lead by undertaking economy-wide absolute emission reduction targets. Developing country Parties should continue enhancing their mitigation efforts, and are encouraged to move over time towards economy-wide emission reduction or limitation targets in the light of different national circumstances (Article 4.4).

The Agreement's recitals provide context on how its provisions should be interpreted. There is one that warns against adopting over-zealous climate policies that lead to self-harm:

Recognizing that Parties may be affected not only by climate change, but also by the impacts of the measures taken in response to it (p. 1).

Source: UNFCCC, Paris Agreement (December 2015) https://unfccc.int/files/meetings/paris_nov_2015/application/pdf/paris_agreement_english_.pdf.

to the Paris Agreement lack the desire or will to meet the agreement's objective of holding the rise in global temperature to 'well below' 2° C above pre-industrial levels. In November 2019, the Obama administration's climate negotiator and one of the agreement's architects, declared that:

...the Paris Agreement is going to rise and fall on the level of political will in constituent countries of the agreement...The fact is that there is a lack of political will in virtually every country, compared to what there needs to be. 15

2. The role of business

Why should business step into the breach to do what governments won't or can't? The enemies of capitalism blame business for the world's ills: inequality, stagnant income growth, poverty in poor countries, environmental degradation and, of course, global warming. Accepting this critique, the reformers of capitalism counter that the ills capitalism caused, business can cure. Corporations can set themselves a wider social purpose; they can make themselves accountable to their stakeholders and the wider community; they can pledge to engage in sustainable business practices and require their supply chains to do likewise and lobby governments to force other companies to do all those things that they claim is in their interests. It is a critique implicitly conceded by the 181 CEOs of American corporations who put their signatures to the Business Roundtable statement of corporate purpose, demoting profit and their accountability to shareholders. ¹⁶

All this misses the reason why capitalism has transformed societies for the better. Businessmen, entrepreneurs and investors didn't set out to make the world a better place, but that is the aggregate result of their individual efforts. The point is beautifully made by Harvard Business School professor Clayton Christensen and his co-authors in *The Prosperity Paradox*.

By investing in market-creating innovations, investors and entrepreneurs inadvertently engage in nation-building...Once these new markets are created, the economy becomes more resilient, as it generates more income to fund schools, roads, hospitals, and even better governance.¹⁷

Contrast Christensen's insight with the dismal and incoherent message of the UN Secretary-General António Guterres banging the drum for fossil fuel divestment and the climate crisis:

People around the world are taking to the streets to protest against rising living costs. A narrow focus on growth, regardless of its true cost and consequences, is leading to climate catastrophe. ¹⁸

Climate policies make energy more expensive, retard development and make poor people poorer. The major emerging economies are going to carbonise before they decarbonise. The growth of global carbon dioxide emissions since 1992 is a conse-

quence of more people being lifted out of poverty than the world has ever seen. It is why the emissions reductions required by the Paris Agreement are an exercise in make-believe.

If collectively the governments who are parties to the Paris Agreement are not going to eliminate net greenhouse gas emissions by mid-century, why should business corporations? External pressure for them to align their business strategy with net zero is evidence that it's against the interests of their shareholders otherwise there would be no need to climate-shame them. But then neither is it in their stakeholders' interests. Carbon dioxide acts as agreenhouse gas on a global scale. Cutting carbon dioxide emissions in one part of the globe makes no difference to the local atmosphere and the local weather where emissions are cut: there is no benefit to employees, whose wages are likely to belower (or there may be fewer of them) or to customers, who will pay more for the same or whose range of consumer choice becomes more restricted, or, indeed, to local communities.

Corporate greenwashing

It is the case that the Paris Agreement invites corporate hypocrisy. The financial sector, for example, is almost totally immune from energy costs. Take Goldman Sachs. Its direct energy costs are a fraction of its office occupancy costs of \$809m in FY2018, which in turn amounted to just 2.2% of FY2018 \$36.6bn net revenue. ¹⁹ Better still, the finance sector can more than hedge its miniscule exposure to rising energy costs by profiting from them. 'At the end of 2018, we reached \$80 billion in our goal to finance or invest \$150 billion in clean energy by 2025', Goldman CEO David Solomon boasts in its 2018 annual report. ²⁰

There is a great deal of self-interest in the greening of Wall Street and the City of London. It helps absolve bankers from their culpability in the 2008 global financial crisis and diverts attention from what UCLA economist Axel Leijonhufvud says are the privileges bankers enjoy, which skew income distribution towards them. And there's hypocrisy too. In a market economy, what matters is consumption emissions, not production emissions. The producer does not decide the purpose of his production, Ludwig von Mises wrote in Socialism: 'Those for whom he works decide it-the consumers. They, not the producer, determine the goal of economic activity'. 22

A growing number of companies boast about going 100% renewable energy. Apple and over 200 others, including Bloomberg, Facebook, Google, Nike, and Starbucks, have committed to go 100% renewable. In the real world, as distinct from the world of corporate PR, no business can depend solely on weather-dependent, intermittent wind and solar electricity. Contrary to its claims, neither does Apple. Rather than 100%, an overwhelming percentage of Apple's energy comes from coal and almost none from wind and solar. Claims of 100% renewable energy rely on an entirely legal accounting fraud that says, in effect, renewable electricity can be stored; corporations such as Apple buy sufficient

renewable energy certificates equal to the electricity they have consumed and pretend that this means they have consumed only electricity from renewables. In reality, they have taken power from whatever generators were connected to the grid at the moment they took it.

The business purpose error

There's a deeper issue than corporations making phoney claims about how they're saving the planet. Demands that corporations should go beyond the letter and spirit of applicable law and regulation when it's not in their interest to do so raise the question of the role of the business corporation in the modern world: What are corporations for? According to the Davos Manifesto 2020 of the World Economic Forum:

A company serves society at large through its activities, supports the communities in which it works, and pays its fair share of taxes...It consciously protects our biosphere and champions a circular, shared and regenerative economy...

Acompany is more than an economic unit generating wealth. It fulfils human and societal aspirations as part of the broader social system. Performance must be measured not only on return to shareholders, but also on how it achieves its environmental, social and governance objectives.²³

Writing on how to reform capitalism, Martin Wolf, the Financial Times' chief economic commentator, quoted approvingly the British Academy's Principles for Purposeful Business: 'the purpose of business is to solve the problems of people and planet profitably, and not profit from causing problems', Wolf adding, 'That is self-evident'. '24 Is it? This views businesses as performing a similar function for society as charities. Their role is to do good - but make money doing so. Just as charities have a charitable purpose, so businesses should have a social purpose. In a tripartite arrangement, governments, businesses and NGOs work together to solve the problems facing society. For matters of global concern and planetary management, their primary governmental partner is the UN.

The desire to harness business to this goal is understandable because of the success of business - more accurately, businesses operating within a capitalist economic system - in transforming humanity's material existence. Nonetheless, it is mistaken. In their critique of the Business Roundtable's demotion of shareholders and their replacement by a raft of stakeholders, George Shultz, Michael Boskin, John Cogan and John Taylor, describe the elevation of multiple stakeholders and the downgrading of shareholder value as wrongheaded and misguided. The Business Roundtable's statement, they write,

^{*} Respectively Secretary of State under President Reagan, Chairman of the President's Council of Economic Advisers under President George HW Bush, Senior Fellow at the Hoover Institution and professor of economics at Stanford University.



lends credence to an incorrect view of the way American businesses operate in today's economy; it fundamentally misunderstands the role that business plays in a free market economy; and it fails to consider the practical, real world, adverse consequences of demoting shareholders' interests...US Corporations have played a central role in improving standards of living in the US and around the globe.²⁵

The economist David Henderson also addressed this issue in his 2004 pamphlet *The Role of Business in the Modern World*.

There is good reason to think that profit-oriented 'capitalist' business enterprises, operating within the framework of competitive market economies, have played, and are continuing to play, a large part in making such achievements possible. From an economy-wide perspective, as distinct from that of the individual firm, this is the primary role of business. ²⁶

The role of government

Henderson goes on to delineate the respective domains of business and government. The effective performance of business requires a framework of laws, institutions and political stability in which a market economy can function.

The main responsibility for creating the necessary framework, which goes beyond norms and rules of conduct for enterprises, rests with governments rather than business. Further, it is for government to decide how far, and in what ways, to enlarge or restrict by law the market opportunities and competitive pressures that bear on both businesses and people in general. Indoing so, they have to take account of other issues, and other aims of policy, than that of improving the performance of enterprises as a means to furthering economic progress. ²⁷

Shultz and his co-authors are similarly critical of businesses taking on public policy roles that belong in the realm of democratically accountable governments. When corporate executives spend corporate funds, they are actually spending their owners' money.

Taking other people's money without their consent and using it to achieve social purposes is properly viewed as a governmental function...A policy of corporate social responsibility, on the other hand, gives corporate executives, or corporate 'stakeholders', the authority to choose which social goals to achieve and how much of other people's money to allocate to them. This policy circumvents the safeguards provided by the governmental system of checks and balances and effectively places the power to tax in the hands of unelected persons.²⁸

The threat to capitalism

Having defined the rightful role of government, Henderson goes on to explain why companies having a business purpose to grow the economy and make the world a better place is, at best, superfluous:

The primary role of business, thus defined, is not one that individual enterprises consciously set out to play: it is not 'internalised', nor could it be. Within it, businesses are cast as agents of market-led change, but this is not because they have chosen to act as such. In any case, internalisation would serve little purpose, since the effective performance of the role does not depend on it...The advances that capitalism has brought did not arise from the resolve of business leaders to make them possible, but from the operation of competitive market economies.

The primary role of business, then, is defined here without reference to either the objectives of enterprises or the motives of those who own, manage and direct them: and its effective performance does not depend on a conscious attempt by business leaders to make the world a better place.²⁹

Henderson cites William Baumol's *The Free-Market Innovation Machine* and the defensive motivation of the modern corporation to innovate, and therefore propel economic growth and rising living standards. In Baumol's words, his book's central contention is that:

what differentiates the prototype capitalist economy most sharply from all other economic systems is free-market pressures that force firms into a continuing process of innovation, because it becomes a matter of life and death for many of them. ³⁰

Innovation accounts for much of capitalism's extraordinary track record and, in key parts of the economy, the primary weapon of competition is innovation, not price. As a result, firms cannot afford to leave innovation to chance. Rather, managements are forced by market pressures to support innovative activity systematically and substantially, and success of any one business firm forces rivals to step up their own efforts. The result is a ferocious arms race among the firms in the most rapidly evolving sectors of the economy, with innovation as the primary weapon.³¹

In their critique of the Business Roundtable's stakeholder doctrine, Shultz and his co-authors warn of the impact on share values and capital flows from sacrificing the primacy of shareholder value. 'The price will be paid by the entire society as economic growth slows and living standards stagnate'.³² Instead of serving as the agent of a single principal, the company's shareholders, corporate executives would simultaneously be agents of multiple stakeholders.

The lack of accountability, the potential for endless legal wrangling and litigation will slow down companies' decisionmaking and lengthen their response times. Ultimately, the dynamism of US companies, which has been so crucial to rising standards of living, will diminish.³³

To these two concerns, a third can be added. Baumol wrote of fear driving innovation; that failure to innovate threatens the firm's survival. Now a new fear stalks the inhabitants of the C-suite, amatter of career life or death - the fear of finding themselves on the wrong side of the Climate Mob. In the past, that mob was composed chiefly of shaggy protestors from groups like Greenpeace

and Friends of the Earth. Now their ranks are swollen by pinstriped climate activists wielding real power: the likes of Mike Bloomberg and his climate-related disclosure task force, and former Bank of England Governor Mark Carney (now UN Special Envoy for Climate Action and Finance and Boris Johnson's chief climate adviser).

Bending the corporate knee at the climate altar comes at a cost to business performance. Corporate affairs executives tell chief executives what they must do to position their corporation as climate friendly. Plans are commissioned to decarbonise supply chains. Promising initiatives are killed for fear of antagonising the climate clerisy. Innovation is chilled. The corporation slows down and starts behaving like a government bureaucracy.

The authors of the IPCC 1.5°C special report are open about viewing climate change as presenting the opportunity for 'intentional societal transformation'.³⁴ They view capitalism and its unprecedented transformation of human welfare as the enemy of the planet. By arguing for draconian emissions cuts that inflict far greater costs than estimates of any corresponding climate benefits, advocates of net zero evince scant regard for the welfare of the poor and the interests of humanity.

The attempt to abolish carbon dioxide emissions requires abolition of the system that gave rise to them. 'Capitalism pays the people that strive to bring it down', Joseph Schumpeter, the greatest economist of capitalism, observed in the 1940s. ³⁵ They won't succeed, but for the efforts of soft anti-capitalists within the capitalist system. To climate-shame corporations without the sanction of law or regulation and bind them in stakeholder fetters, will extinguish the dynamism that justifies capitalism. The moral case for capitalism rests on its prodigious ability to raise living standards and transform the material conditions of mankind for the better. Remove its capacity to do that and we will have quietly entered a post-capitalist era. As we shall see, that is what 1.5 degrees and net zero are all about.

3. The non-disappearing coral atolls

'We are losing the battle', President Macron declared at the One Planet Summit in December 2017 to mark the second anniversary of the Paris Agreement. 'Behind me are the heads of state and governments. In 50, 60, 100 years, there are five, ten, fifteen who won't be there anymore'. 'Be It was the conference's only moment of drama. In the playbook of climate alarmism, the coral atolls of the Pacific and Indian Oceans are the human equivalent of the polar bear; on the front line of global warming and threatened with imminent extinction. Do the facts bear out the climate sound bites?

Disappearing summer Arctic ice threatens polar bears with habitat loss, so the climate trope goes. Despite being put on the IUCN Red List of threatened species in 2011, summer sea ice decline has meant a healthier prey base. From a low of 10,000 or fewer in the 1960s, polar bear populations are thriving and could easily exceed 40,000. Tontrary to the climate narrative, polar bears



have shown themselves to be a highly adaptable species and are a conservation success story.

On 17 October 2009, President Nasheed of the Maldives held the world's first underwater cabinet meeting. 'We are trying to send our message to let the world know what is happening and what will happen to the Maldives if climate change isn't checked', he told reporters after re-surfacing. ³⁸ It was a PR stunt ahead of the December 2009 UN Copenhagen climate conference. 'The reality is that temperature rises above 1.5° C will destroy this island nation from all sides: rising sea levels will swamp the tiny atolls, warmer water will kill its beautiful coral reefs, and an acidic ocean will literally dissolve the islands one by one', Mark Lynas, an environmental activist and adviser to Nasheed, wrote from the conference itself. ³⁹

Lobbying for 1.5°C

A two-degree tipping point is first mentioned in the report commissioned for the 1972 UNStockholm conference on the environment. 'Here we encounter the other facet of our planetary life: the fragility of the balances through which the natural world we know survives', Barbara Ward and René Dubos wrote. ⁴⁰

It may take only a very small percentage of change in the planet's balance of energy to modify average temperatures by 2°C. Downwards, this is another ice age, upwards a return to an ice-free age. In either case, the effects are global and catastrophic.⁴¹

The two-degree 'guard rail' became a fixed part of the environmental furniture until the 2010 Cancún climate conference, the first after the disastrous Copenhagen conference. Following the pattern of UN climate conferences - after a fiasco, there is pressure to keep the show on the road with avowals of heightened ambition-the parties agreed at Cancún to commit to a maximum temperature rise of 2°C above pre-industrial levels and to consider lowering it to 1.5°C in the near future. 42 Note, despite the lack of scientific justification, how the baseline is defined as the temperatures prevailing before industrialisation, even though the early twentieth century warming between 1910 and 1945 occurred before anthropogenic emissions exerted a major influence. 43 Rather than any genuine scientific basis, the pre-industrial baseline reflects the foundational tenet of environmentalist ideology: that the Industrial Revolution constitutes the original sin of modern civilisation.

In the run up to the December 2015 Paris climate conference, the Maldives and the 44-member Alliance of Small Island States (AOSIS) kept the pressure up for the 2-degree 'guard rail' to be lowered to 1.5 degrees. At the end of November, their call was taken up by the Climate Vulnerable Forum. 'It is essential that this target is strengthened towards a below 1.5° C goal', the forum declared. ⁴⁴ In its opening statement at the conference itself, the Maldives, on behalf of the AOSIS, spoke up for the 1.5 degree limit, warning of sea-level rises that 'continue to assault our small states'. ⁴⁵ With NGOs chanting '1.5 to stay alive', the lower limit quickly attracted

the support of over 100 countries. At one point, Todd Stern, the American climate negotiator, was spotted in a '1.5 to stay alive' march, which was wending its way around the pavilions of the conference centre. By then, it was a done deal.

Darwin's coral atoll hypothesis

The sinking low-lying coral atolls thesis that drove adoption of the 1.5°C degree target might seem superficially plausible. It's what Emmanuel Macron appeared to believe when he spoke of island nations literally disappearing. But science has refuted this claim, even as far back as the 1830s, when the 25-year old Charles Darwin, onthe final year of his voyage on HMS Beagle, observed a coral atoll being pounded by waves 'which even exceed in violence those of our temperate regions, and which never cease to rage'.

Yet these low, insignificant coral islets stand and are victorious: for here another power, as antagonist to the former, takes part in the contest. The organic forces separate the atoms of carbonate of lime one by one from the foaming breakers, and unite them into a symmetrical structure. Let the hurricane rear up its thousand huge fragments; yet what will this tell against the accumulated labour of myriads of architects at work night and day, month after month. 46

It led him to hypothesise that coral atolls are formed by subsidence of the ocean bed; that is to say, rising sea levels: 'Let us imagine an island merely fringed by reefs extending to a short distance from the shore'.

Now let this island subside by a series of movements of extreme slowness, the coral at each interval growing up to the surface. Without the aid of sections it is not very easy to follow out the result, but a little reflection will show that a reef encircling the shore at a greater or less distance, according to the amount of subsidence, would be produced. If we suppose the sinking to continue, the encircled island must, by the submergence of the central land but upward growth of the ring of coral, be converted into a lagoon island.⁴⁷

Recent scientific research confirms Darwin's hypothesis. Six years after the submerged Maldivian cabinet meeting, Lynas was tweeting a 2015 study about Funafuti Atoll, in the tropical Pacific Ocean, which had experienced some of the highest rates of sealevel rise over the past 60 years. 'Despite the magnitude of this rise, no islands have been lost, the majority have enlarged, and there has been a 7.3% increase in net island area over the past century', the study found. It tweeted Lynas, saying these findings would not have surprised Darwin, to which he responded: 'Darwin was right - and oddly hurricanes may be a good thing in piling up debris inside islands'. 49

A 2018 study on the Maldives by researchers from Northumbria University found that the atoll was formed when sea levels were up to 0.5 metres higher than today. Large, high-energy waves caused by storms off the coast of South Africa 'broke coral rubble off the reef and transported it onto reef platforms creating the foundations for the reef islands'.⁵⁰

What about Tuvalu, which the UN Secretary-General says the world must save from sinking beneath the waves? A University of Auckland study using aerial photographs and satellite imagery found that between 1971 and 2014, the tiny island had grown by 2.9%, even though sea levels rose at twice the global average.⁵¹ Perhaps, conceivably, coral atolls might even be beneficiaries of global warming and sea-level rise.

Macron versus the IPCC

Climate scientist Judith Curry notes that, for the last three decades, the climate policy cart has been way out in front of the scientific horse. 'There has been tremendous political pressure on scientists to present findings that would support [the] treaties, which has resulted in a drive to manufacture a scientific consensus on the dangers of manmade climate change', Curry says. ⁵² Yet even the IPCC in its 2018 1.5° C special report gave short shrift to the disappearing islands thesis. 'Observations, models and other evidence indicate that unconstrained Pacific atolls have kept pace with [sealevel rise], with little reduction in size or net gain in land', the IPCC said, planing down politically inconvenient evidence that some atolls have actually grown. ⁵³

The small-island sob story takes a further knock from global temperature trends. From around 1980, ocean surface temperatures have risen much more slowly than over land. In the words of the IPCC, 'most land regions are experiencing greater warming than the global average while most ocean regions are warming at a slower rate'.⁵⁴

The impulse for 1.5 degrees had come from the prospect of global warming submerging small island nations. 'As people living on the frontiers and in the epicentres of climate risk and vulnerability', AOSIS said at the conclusion of the 2019 Madrid climate conference, 'we know precisely what ambitious action looks like and how it must be supported. We live with climate impacts daily'. ⁵⁵ This is as ridiculous as listing polar bears as a threatened species. Small island states are not on the forefront of climate change; their claim is without scientific foundation and a scare manufactured for the credulous and gullible.

Speaking two years before the Paris climate conference, Yvo de Boer, the former executive secretary of the UN climate convention, warned of the futility of the two-degree target. 'The only way that a 2015 agreement can achieve a two-degree goal is to shut down the whole global economy', de Boer told Bloomberg News. ⁵⁶ Swallowing the small-island fable hook, line and sinker, the international community then doubled down by committing itself to pursuing efforts to limit the increase in global temperature to 1.5 °C above pre-industrial levels.

Even so, the letter of the deal done in Paris is different from the maximalist interpretation subsequently given to the Paris Agreement to the point of serious misrepresentation (see Box 1, p. 4). Whereas the Paris Agreement spoke of reaching net zero in the second half of the current century, it was the IPCC, three years later, which brought the timetable back to 2050, unleashing the current wave of intense climate alarm.

4. Ideology and the IPCC Special Report

As part of the decision to adopt the 1.5-degree target, the Paris climate conference asked the IPCC to provide a scientific justification for what had already been decided. The IPCC has always been inherently political and aware of the PR implications of its climate messaging. Indeed, the IPCC was conceived with precisely that purpose in mind by Bert Bolin, the Swedish meteorologist who served as its first chair. A highly political scientist and an adviser to two Swedish prime ministers, Bolin was frustrated that scientific reports on climate change 'did not yet stir public opinion'. ⁵⁷ What was needed, Bolin argued, was:

an organ that provided an international meeting place for *scientists and politicians* to take responsibility for assessing the available knowledge concerning global climate change and its possible socio-economic implications. ⁵⁸

In 1995, political control over the IPCC's climate messaging led to the scandal of the Second Assessment Report. The report broke new ground with its claim in the Summary for Policy Makers that the balance of evidence suggested a 'discernible human influence on global climate'. 59 However, the body of the report stated that no study had shown clear evidence that changes in the climate could be attributed to increases in greenhouse gases. The Clinton Administration was on the cusp of a major policy shift in favour of supporting a treaty with mandatory emissions cuts. As the IPCC-supporting scientist Stephen Schneider later wrote, the timing of the Second Assessment Report was 'fraught with political significance'. 60 The offending sentence would have made the politics even more fraught. 'It is essential...that chapter authors be prevailed upon to modify their text in an appropriate manner', an official at the State Department told the IPCC. 61 So out it came. Scientific integrity has limits.

Published in 2018, the IPCC's 1.5-degree special report, goes much further than any of its previous publications in making science the servant of ideology. To the journalist and Hoover Institution fellow Josef Joffe, the report appears 'the very model of scientific enquiry'. But Joffe's attention was drawn to the Summary for Policy Makers:

It is preceded by a motto taken from the beloved French children's book author Antoine de St. Exupéry that gives the game away: the report is about salvation but written in the language of science. The quote reads: 'As for the future, the task is not to foresee, but to enable it'. 62

Evidence of ideological bias is scattered through the report likefly ash. The IPCC cites the French Marxist Thomas Piketty's book

Capital in the 21st Century, 63 which argued that wealth inequalities are heading back to levels not seen since before the First World War, but does not survey the many criticisms of the book, including an investigation by the FT's Chris Giles who found that the data underpinning Piketty's analysis contain a series of errors that skew his findings. 64

In any case, what has Piketty and inequality got to do with climate science? Environmentalism is an ideology, just as Marxism is, and exists in a similar relationship to its scientific base as communism did to the economics of *Das Kapital*. Science and ideology become so deeply entwined that in practice it is difficult to separate the two, the scientist and the environmentalist being one and the same person. It shouldn't, therefore, be a surprise that the IPCC's practice of climate science is far from being a model of methodological integrity and scientific objectivity.

5. Repackaging the carbon budget

Infulfilling its customary role of giving a scientific imprimatur to prior political decisions, the IPCC had a problem with 1.5 degrees. The post-2010 1.5 °C carbon budget in the 2014 Fifth Assessment Report would be used up half way through 2019. For climate alarmists, it would mean the end of the world had already happened. 65 Like some end-of-the-world cult after the clock had passed midnight, it would be more than a little embarrassing. The IPCC's first order of business, then, was to upwardly revise the available carbon budget from that in the Fifth Assessment Report four years earlier to prevent the 1.5-degree limit being dead on arrival.

As luck would have it, the IPCC managed to increase the remaining 2°C budget by 60% (from approximately 1,000GtCO₂ to 1,600GtCO₂) and more than double the 1.5°C budget (from approximately 400 GtCO₂ © 860 GtC ₂). 66 A start had been made in a September 2017 paper co-authored by climatologist Myles Allen and a lead author of the IPCC 1.5 degrees special report. As climate sceptics had been pointing out, Allen found that the world had warmed more slowly than forecast by climate models, noting that a discrepancy in warming between models and observations had opened up since 2000. 67 'We haven't seen the rapid acceleration in warming after 2000 that we see in the models', Professor Allen told *The Times*. Too many of the models 'were on the hot side', meaning they forecast too much warming. 68

The Fifth Assessment Report's 1.5°C carbon budget suggested headroom of less than seven years' current emissions, the paper said. That had led Professor Michael Grubb, another of the paper's authors, to say at the Paris climate conference that 'actually delivering 1.5°C is simply incompatible with democracy'. ⁶⁹ Following the reanalysis, Professor Grubb changed his tune, saying that the changes to deliver the required emissions cuts would merely be

'very difficult'.^{†70} As the paper noted, sustained falls in emissions of 4-6% a year had historically occurred for short periods, for example globally during the 1930s Great Depression and the Second World War, and regionally at the time of the collapse of the Soviet Union. None of these events constitutes an especially reassuring precedent.

In his forensic analysis of the IPCC 1.5 special report, climate scientist Nic Lewis notes that a very large part of the increase is due simply from switching the baseline of past temperatures. The Fifth Assessment Report had used globally-complete near-surface air temperature over land and ocean. The special report uses a blend of near-surface temperature over land and sea-surface temperature over ocean. 'This seems remarkable', Lewis comments, as the special report then inconsistently projects near-surface air temperature (notsea-surface temperature) over the ocean, as well as over land, for future warming.⁷¹

The IPCC also projects lower future warming than it had done four years earlier, despite using the same climate sensitivity assumptions (formally, the Transient Climate Response to Cumulative Emissions or TCRE). Lewis believes this can be explained by the IPCC using simulation runs for the Fifth Assessment Report from a subset of Earth System Models (ESMs) 'biased towards ESMs with a significantly higher TCRE than average', a possibility the IPCC chose not to discuss.

What's the betting the IPCC's latest carbon budgets will also turn out to be unrealistically low?, Lewis asks. The IPCC has left itself plenty of wiggle room. Lewis notes that one of the most sophisticated observationally-constrained TCRE studies cited in the Fifth Assessment Report implies a low TCRE value. 72 One would assume that natural scientists prefer results derived from nature, but not the IPCC. The range adopted by the IPCC in the 1.5 special report has a 22% higher central value and a 25% higher upper bound than the observationally-constrained range from this study.

For this higher range, as it had done in the Fifth Assessment Report, the IPCC uses the 67th percentile of its preferred TCRE range. Excluding the effects of non-CO $_2$ warming, using the 67th percentile implies double the chance of undershooting 1.5°C compared to over-shooting it. Making it an evens chance, as common sense suggests, would allow the IPCC to add a substantial increment to the remaining carbon budget.

The special report is laced with language to give the IPCC plenty of room to re-inflate the remaining carbon budget should that become necessary. It can further revise the historic temperature baseline. 'Future research and ongoing observations over the next years will provide a better indication as to how the 2006-2015

rofessor Grubb also told The Times that the fresh assessment was good news for island states such as Tuvalu, which could be inundated if average temperatures rose by more than 1.5°C, demonstrating that climate experts are also dupes of the sinking island fable.

base period compares with long-term trends and might affect the budget estimates', the IPCC says. 73 As a specific temperature limit is approached, 'relative uncertainties become larger'. 74

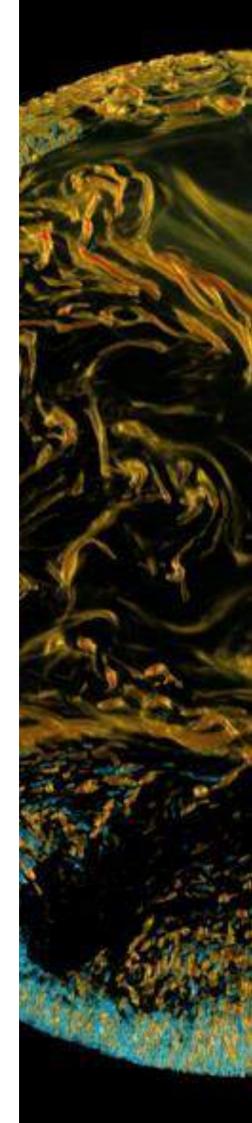
The remaining budget is affected both by uncertainties in past greenhouse gas emissions and estimates of the proportion of warming that is human-induced, the IPCC says. 'As a result, only *medium confidence* can be assigned to the assessed remaining budget values for 1.5°C and 2°C and their uncertainty'. '5 Medium confidence? The whole edifice of the 1.5°C net zero emissions trajectory and timetable has been erected on a foundation in which the IPCC itself expresses only medium confidence.

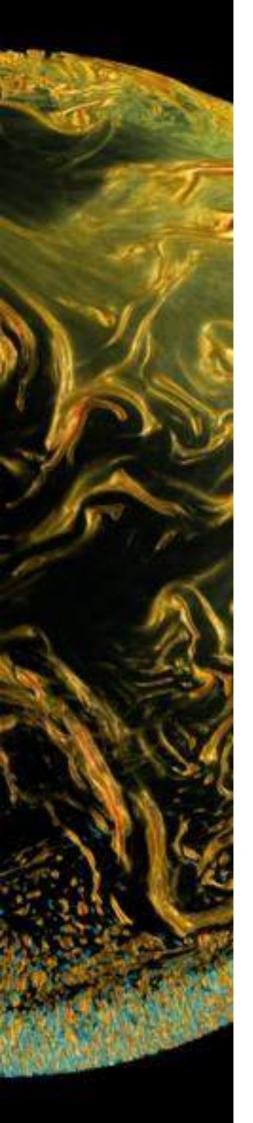
Based on the modest confidence it has in its own data and analysis, the IPCC asserts with *high confidence* that net carbon dioxide emissions must decline by about 45% from the 2010 level of 49 GtCO₂e by 2030, and reach net zero by around 2050. The steep drop to 2030 is now steeper than implied by the IPCC. According to the UN Environment Programme, greenhouse gas emissions (including land-use change) grew at 1.3% a year in the decade to 2018, to 55.3 GtCO₂equivalent. A 45% reduction from 2010 levels would require a reduction of 22 GtCO₂e to 27 GtC ₂e. Emissions growth since then means the 22 GtCO₂e reduction is now a 28 GtCO₂e reduction and a 45% reduction has become a 51% reduction.

6. Holes in IPCC climate science

'The science says...' is a statement oft repeated by politicians and climate activists, as if climate scientists descend from Mount Sinai bearing tablets of stone inscribed with the commandments for our planetary future. As we've just seen, estimates of future warming and remaining carbon budgets are manufactured and involve the subjective choices and judgments of climate scientists. In a critical review of the 1.5 special report for the GWPF, Professor J Ray Bates, adjunct professor of meteorology in the Meteorology and Climate Centre at University College Dublin, raises additional criticisms over and above those made by Nic Lewis:

- The IPCC does not discuss satellite-observed temperature trends, which show a warming trend of only 0.13° C per decade in the period 1979-2018, nor ask why they differ markedly from surface trends. A statistical analysis in which the prominent El Niño signal in the period 2000-16 is removed from the record finds the remaining warming trend is of the order of only 0.04° C per decade.⁷⁸
- From 1900 to 1980, observed land and sea surface temperatures rose and fell at the same rate over multi-decadal periods. From 1980, a strong divergence appears, with land temperatures rising much faster than sea surface temperatures. Why? Though consistent with greenhouse-induced warming, the much weaker rise in sea-surface temperature does not unambiguously exceed the





bounds of natural variability, Bates says. 79

Bates's most powerful criticism is the practice of 'tuning' climate models so they reproduce past temperature trends and not being open about it.

Tunings that have enabled models to successfully reproduce the late 20th century warming have not enabled them to reproduce either the marked early 20th century warming or the recent slow rate of tropospheric warming.⁸⁰

Bates cites a 2017 paper, 'The art and science of climate model tuning', by Frédéric Hourdin and fourteen other climate modellers, which partially lifts the lid on this practice. Although tuning can be characterised as an objective process of estimation, 'there is also subjectivity in climate model tuning'.⁸¹ In theory, tuning should be taken into account in any evaluation, they write. In practice, it isn't.

Why such lack of transparency? This may be because tuning is often seen as an unavoidable but dirty part of climate modelling, more engineering than science, an act of tinkering that does not merit recording in the scientific literature. There may also be some concern that explaining that models are tuned may strengthen the arguments of those claiming to question the validity of climate change projections. Tuning may be seen indeed as an unspeakable way to compensate for model errors. 82

Tuning strategies can also mislead climate scientists, the authors suggest.

Although tuning is an efficient way to reduce the distance between model and selected observations, it can also risk masking fundamental problems and the need for model improvements.⁸³

This danger of climate scientists deceiving themselves is especially acute concerning the values for the equilibrium climate sensitivity of carbon dioxide (ECS), which, in one form or another, drive temperature projections and define remaining carbon budgets for the 1.5 and 2 degrees specified in the Paris Agreement. Rather than use models to test possible values of ECS against observed temperature, the authors strongly imply models are tuned to confirm values that lie within a pre-ordained range. 'One can imagine changing a parameter that is known to affect the sensitivity', they write, 'keeping both this parameter and the ECS in the anticipated acceptable range'. 84 In other words, climate modellers feel constrained to tune climate models in a way that avoids producing results that might challenge the scientific paradigm of potentially dangerous CO₂-driven warming, a paradigm of fossil fuel emissions as the climate 'control knob' which Judith Curry calls a 'simple and seductive idea'. As Curry notes:

this is a misleading oversimplification, since climate can shift naturally in unexpected ways. Apart from uncertainties in future emissions, we are still facing a factor of three or more [of] uncertainty in the sensitivity of the Earth's temperature to increasing carbon dioxide in the atmosphere. 85

The IPCC has form in manipulating climate models to produce politically acceptable results. This scientifically dubious practice was discussed at the American Physical Society's climate workshop in 2014. The moderator, New York University theoretical physicist Steven Koonin, who also served as an undersecretary at the Department of Energy in the Obama administration, read an extract from Chapter 10 of the IPCC Fifth Assessment Report. Model-simulated responses to forcings - including greenhouse gas forcings - 'can be scaled up or down'. Tomatch observations, some of the forcings in some of the models had to be scaled down. But when it came to making the centennial projections, the scaling factors were removed, probably resulting in a 25-30% over-prediction of the 2100 warming, according to Koonin. To

Responding to Koonin was Dr William Collins of the Lawrence Berkeley National Laboratory and a lead author of Chapter 9 of the Fifth Assessment Report on evaluation of climate models. Only the transcript does full justice to the exchange that followed.

Dr. Koonin: But if the model tells you that you got the response to the forcing wrong by 30 percent, you should use that same 30 percent factor when you project out a century.

Dr. Collins: Yes. And one of the reasons we are not doing that is we are not using the models as [a] statistical projection tool.

Dr. Koonin: What are you using them as?

Dr. Collins: Well, we took exactly the same models that got the forcing wrong and which got sort of the projections wrong up to 2100.

Dr. Koonin: So, why do we even show centennial-scale projections?

Dr. Collins: Well, I mean, it is part of the [IPCC] assessment process. 88

'It is part of the assessment process' is not a scientific justification for using assumptions that are known to be empirically wrong to produce projections to give scientific cover to a political narrative of a planet spinning towards a climate catastrophe. Corporations are held to much higher standards. If the IPCC were a publicly traded corporation and its centennial projections formed part of an IPO filing, it would be prosecuted for securities fraud and its directors sent to jail.

7. The IPCC's anti-growth bias

Bias also pervades the IPCC's discussion of economics and the costs and benefits of economic growth; the latter being almost entirely ignored. What is the most important development since the onset of the Industrial Revolution? True to its mission, the IPCC views the past exclusively through the lens of temperature change. 'Temperature rise to date has already resulted in profound alterations to human and natural systems', it says. ⁸⁹ To view the Industrial Revolution as a climate phenomenon is wilfully perverse.

What the IPCC inelegantly calls 'human systems' were profoundly altered by the Industrial Revolution, and not by any indirect effect of temperature changes. These have been so small that few would have taken any notice had they not been constantly pummelled with scare stories about their effect.

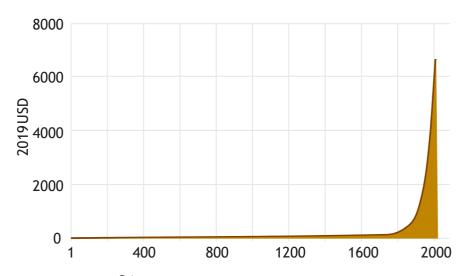
It is the spectacular and historically unprecedented growth rates of industrialised market economies that sets them apart from all alternative economic systems. As economist William Baumol wrote in *The Free-Market Innovation Machine*:

Average growth rates for about one and a half *millennia* before the Industrial Revolution are estimated to have been approximately *zero*, and, although there was undoubtedly some growth starting around the tenth century, it proceeded at a snail's pace by modern standards. Even the most well-off consumers in pre-Industrial Revolution society had virtually no goods at their disposal that had not been available in ancient Rome. In fact, many consumption choices available at least to more-affluent Roman citizens had long since disappeared by the time of the Industrial Revolution. In contrast, in the past 150 years, per capita incomes in a typical free-market economy have risen by amounts ranging from several hundred to several thousand percent. ⁹⁰

The extraordinary and unprecedented transformation in human welfare wrought by the Industrial Revolution is shown in Figure 1. Urbanisation, the intensification of agriculture and a near eight-fold population increase (from 910 million in 1800 to 7.7 billion in 2019)⁹¹ have changed the human environment vastly for the better and inevitably changed the natural environment as well. The idea that the most significant thing about the Industrial Revolution is a 1-degree change in global average temperature is absurd. Neither does the IPCC offer any evidence that humans or, for that matter, the planet would be better off if average global temperatures were 1 degree lower.

In the special report's Framing and Context chapter, the IPCC grudgingly concedes that economic growth unleashed by the In-

Figure 1: World GDP per capita, 1-2000 AD.
Source: Statistics on world population, GDP and per capital GDP, 1-2008AD. Angus Maddison, IMF.



dustrial Revolution has some benefits, before quickly shifting to the negative consequences for the environment.

Global economic growth has been accompanied by [note: a fairer phrase would be 'has caused'] increased life expectancy and income in much of the world; however, in addition to environmental degradation and pollution, many regions remain characterised by significant poverty [i.e. have not industrialised] and severe inequality in income distribution and access to resources...The spread of fossil-fuel-based material consumption and changing lifestyles is a major driver of global resource use [i.e. a bad thing], and the main contributor to rising greenhouse gas (GHG) emissions [a terrible thing]. 92

In other words, the IPCC is implicitly admitting that poverty reduction and rising living standards are the main drivers of global warming. For the IPCC though, the Industrial Revolution imposes costs without benefits, as is clear from the sentence that immediately follows the one just quoted above: 'The overarching context of this report is this: human influence has become a principal agent of change on the planet'. ⁹³ The implication is that humanity's planetary footprint is necessarily a bad thing and should be minimised. This is not science; it is an ideologically-driven value judgment.

In this way, the IPCC ducks the central dilemma of any appraisal of possible policy responses to man-made global warming: What is the impact on growth, living standards and poverty reduction of decarbonisation policies? In the Summary for Policy Makers, the IPCC says risks to economic growth due to climate change impacts are projected to be lower at 1.5 °C than at 2 °C, but that 'this excludes the costs of mitigation'. ⁹⁴ An analysis of climate policy that only counts benefits and excludes policy costs is worthless. One point five rather than 2 °C 'could reduce the number of people both exposed to climate-related risks and susceptible to poverty by up to several hundred million by 2050 (medium confidence)'- if, as the IPCC does, climate policy costs are taken out of the equation. ⁹⁵

Rather than present hard analysis, the IPCC incants sustainable development mumbo jumbo: 'Sustainable development supports, and often enables, the fundamental societal and systems transitions and transformations that help limit global warming to 1.5°C', it says. '6 What on earth does that actually mean? It should disabuse anyone still believing the IPCC is a serious scientific body untainted by ideology or bias.

8. A policy prescription failing every conceivable cost-benefit test

Limiting the rise in temperature to 1.5°C above pre-industrial levels would require 'transformative systemic change' and 'rapid and far-reaching changes in energy, land, urban and infrastructure and industrial systems' that would be unprecedented in scale. 97 These

changes imply 'very ambitious, internationally cooperative policy environments that transform both supply and demand'. 98 This will involve 'unprecedented policy and geopolitical challenges' and requires 'stringent and integrated policy interventions'. 99 Implementing them will require 'enhanced institutional capabilities in all countries, including building the capability to utilise indigenous and local knowledge (medium evidence, high agreement)'. 100

Indigenous and local knowledge? You might be forgiven for thinking the IPCC's policy analysis is driven more by politics and fashion than mathematical rigour. As it turns out, to the limited extent numbers feature in the special report, they show decisively that the 1.5 target does far more harm than good. But it isn't hard to fathom the anti-democratic implications of 'enhanced institutional capabilities' and 'stringent policy interventions' or their incompatibility with free markets and capitalism.

What do these forceful policy interventions look like? 'Energy-demand reduction measures are key to reducing carbon dioxide emissions', the IPCC says, while noting the potential over-estimation of their effectiveness. ¹⁰¹ Reductions in energy demand for space heating and air conditioning are suggested, with a one-third cut in emission from the reference scenario. ¹⁰² Does this mean it wants to limit access to air conditioning for people in emerging economies? The IPCC doesn't say.

It goes on to make the heroic assumption that renewables could supply 70-85% of global electricity by 2050, even though there are no economic grid-scale storage technologies on the horizon capable of storing intermittent wind and solar electricity. The IPCC places a massive bet on 'cheap' renewable electricity, ignoring evidence that countries with the highest proportion of wind and solar capacity also have the highest electricity prices in the world. ¹⁰³ Elsewhere the IPCC concedes that there is 'deep uncertainty' about energy and land use in the current century. ¹⁰⁴ Quite where this leaves the IPCC'scentral planners is not made clear.

More damning is the IPCC's admission that higher energy costs would damage the health of poorer people in developing countries by forcing them to continue to use biomass (wood and animal dung) for cooking. Scenario studies that quantify the interactions between climate mitigation - i.e. emissions cuts - and energy access indicate that stringent climate policy, which would affect energy prices, could significantly slow down the transition to clean cooking fuels, such as liquefied petroleum gas or electricity. ¹⁰⁵ Despite this, the IPCC still supports policies that worsen public health and shorten people's lives in poorer countries.

Transportation is to suffer a similar fate as energy, with a 'mix of additional and stringent policy actions preventing (or reducing) the need for [it]'. ¹⁰⁶ There is, however, no silver bullet to deliver the 60% emissions reduction from transport. 'Every possible measure would be required to achieve this stringent emissions outcome', the IPCC says. ¹⁰⁷

Dietary shifts could contribute one fifth of the emissions cuts

needed to keep warming below 2°C 'by targeting the demand for meat and other livestock products, particularly where consumption is higher than suggested by human health guidelines'. ¹⁰⁸ But then, they might not. 'There, however, remains *limited evidence* of effective policy interventions to achieve such large-scale shifts in dietary choices, and prevailing trends are for increasing rather than decreasing demand for livestock products'. ¹⁰⁹

The IPCC's planned energy transformation and the dietary shift from meat and dairy necessitate massive changes in land use, with bioenergy planned to be a major contributor of primary energy. 110 Agriculture has to cut its emissions too and food production squeezed. According to the IPCC, mitigation efforts that require land are to come mainly 'at the expense of agricultural land for food and feed production'. 111 Thus agricultural land is to be converted to forest, requiring 'distinct policy and government measures'. 112

Overall, the IPCC envisages a 0.5-11 million km² reduction in pastureland. ¹¹³ Toget some idea of the scale of this, the surface area of the United States is 9.8 million km². 'Such large transitions pose profound challenges for sustainable management of the various demands for human settlements, food, livestock feed, fibre, bioenergy, carbon storage, biodiversity and other ecosystem services', the IPCC notes. ¹¹⁴ Yet, the IPCC can't agree on the sign of the required change for some of these huge transitions (e.g. for non-pasture agricultural land and for forestry). ¹¹⁵ In a rare admission that poor people globally will suffer most from IPCC climate policies, the IPCC concedes that deployment of large-scale land use policies could 'compete with food production and hence raise food security concerns (*high confidence*)'. ¹¹⁶

The global industrial sector isn't to be spared either. Industry consumes about one third of final energy and contributes directly and indirectly about one third of global greenhouse gas emissions. To meet the 1.5°C limit, the IPCC reckons the industrial sector will have to cut its emissions by between 67 and 91% by 2050. 117 Quite how this can be achieved, short of a massive contraction in industrial output making the 1930s Great Depression look like a mild recession, the IPCC doesn't say.

What renders the IPCC's analysis worthless as a guide to policy is its refusal to grapple with cost. As previously noted, cost is barely mentioned. In something of an understatement, the IPCC admits that 'knowledge gaps' exist on economy-wide costs of limiting warming to 1.5°C. In the few places where cost is mentioned, it is devastating. Decarbonisation could exacerbate short-term economic and social tensions, the IPCC admits. 'The challenge is therefore how to strengthen climate policies without inducing economic collapse or hardship'.¹¹¹8 It's a challenge that the IPCC then flunks. 'Any comparison between 1.5°C and higher levels of warming implies risk assessments and value judgments and cannot be straightforwardly reduced to a cost-benefit analysis', the IPCC opines.¹¹¹9 Whose values? Whose judgments?

There is a reason for the IPCC jettisoning any pretence of objectivity. The IPCC couldn't perform a cost-benefit analysis because it doesn't know what the additional costs of 1.5°C are. 'Projections of the magnitudes of global economic costs associated with 1.5°C consistent pathways and their sectoral and regional distributions from the currently assessed literature are scant', noting that marginal abatement costs indicated by carbon prices would increase 3-4 times compared to a 2°C pathway. 120 The IPCC didn't even try to put a price tag on 1.5°C. Not only is the IPCC clueless about the cost of eliminating net emissions of carbon dioxide; its view amounts to: 'You must do 1.5°C whatever the cost'.

While the IPCC fails to provide a comparison of total costs and benefits of a 1.5 $^{\circ}$ C target, the failure of benefits to outweigh costs is clearly visible in the IPCC's discussion of marginal costs. This is revealed by the inclusion of implicit or shadow carbon dioxide emission prices of the 1.5 $^{\circ}$ C and 2 $^{\circ}$ C pathways (Table 2). The 'shadow' cost can be thought of as an estimate of the emission tax that would be required to get global emissions down to the required target. The more ambitious the target (i.e. 1.5 $^{\circ}$ C vs. 2 $^{\circ}$ C), the higher the shadow cost. However, the relationship is not linear: The shadow cost rises exponentially as the target becomes more stringent.

For 2030, the 1.5°C pathway implies a shadow price per tonne 9-27 times higher than the 2°C pathway. In other words, the marginal cost per tonne of abated carbon dioxide of choosing a 1.5°C pathway over the 2°C pathway is one to two orders of magnitude higher. In 2030, the marginal abatement cost of a tonne of carbon dioxide ranges from \$135 to \$6,050, rising to \$245 to \$14,300 per tonne in 2050. To anyone with the slightest social conscience, the costs of the 1.5°C pathway are an obscenity. No conceivable amount of welfare redistribution can offset the hit to poorer people for the colossal amount of resources consumed in cutting emissions, raising the direct costs, not only of energy, but also of food, of manufactured goods and of housing. The impact of the

Table 2: Price of carbon dioxide emissions.

	Pathway			Social cost of carbon (SCC)*		
	<1.5°C	> 2°C	1.5°C/ 2°C			1.5°C/SCC
Discount	0%	0%		3%	0%	
	\$	\$		\$	\$	
2030	135-6,050	15-220	9-27.5	52	94	1.4-64
2050	245-14,300	45-1,050	5.4-13.6	72	234	1.0-61
2070	420-19,300	120-1,110	3.5-17.4	_	_	_
2100	690-30,100	175-2,340	3.9-12.9	_	_	

Undiscounted 2010 US Dollars. *As calculated by the Obama administration. Sources: IPCC, Special Report: Global Warming of 1.5°C (2018), p. 152; Interagency Working Group on Social Cost of Greenhouse Gases, USG, Technical Support Document: -Technical Update of the Social Cost of Carbon for Regulatory Impact Analysis (August 2016), Table ES-1.

1.5°C pathway on the world's poor will be devastating and long-lasting.

It is also instructive to compare these marginal costs of emission reduction with estimates of the marginal benefits, which are based on the estimates of the so-called social cost of carbon (SCC). The SCC aims to identify the estimated discounted net damages of each additional tonne of carbon dioxide, which also equates to the benefit of reducing emissions by the same amount. Table 2 therefore includes the Obama White House estimates of the SCC, and specifically the central value of SCC estimates derived from the average, discounted by three percent, inflated by the US GDP deflator, and then undiscounted for consistency.

It shows that in 2030, the undiscounted value of Obama White House estimate of the net damage from the marginal (i.e. the most damaging) tonne of carbon dioxide is \$94 - nearly 30% lower than the low end of the marginal cost of hitting the 1.5 °C pathway, and 98% lower than the high end. Put another way, the IPCC and the Obama Administration numbers show that the marginal cost of achieving the 1.5 °C target would be between 1.4 and 64 times larger than the marginal benefits. The ratio does not improve over time. For 2050, the SCC is still below the bottom of the range of the marginal shadow cost of reaching the 1.5 °C pathway and, at the upper end, the ratio of marginal costs to marginal benefits is 61:1.

Thus, even granting that the IPCC has over-stated the benefits and under-stated the costs of achieving the 1.5°C target, their pathway recommendation still fails to yield benefits remotely commensurate with the costs. On the basis of these numbers, it would be reasonable to infer that net zero is being driven by fanatics and zealots who put little value on human welfare.

Net zero also stands as an indictment of the cravenness and stupidity of governments, especially western governments that should have known better. They signed up to the Paris Agreement goal of 'pursuing efforts' to limit temperature increase to 1.5°C on the basis of the fable of sinking small islands. Then, led by Britain, many of them committed themselves to eliminating net greenhouse gas emissions by 2050, a much more demanding goal than that set out in Article 4 of the Paris Agreement. They did this without having any idea how they could meet it or how much it would cost.

Netzero could only happen if all major emitters in the developing world follow suit, which, to date, they've shown no sign of doing; in fact, quite the opposite. Indeed, the principal merit of the IPCC 1.5°C special report is in setting out why they should not do so: it would crush their economies and immiserate their people. The top-down re-ordering of the global economy, the sacrifices it entails, and the highly intrusive level of global governance it requires all make it both impossible and undesirable.

Net zero by mid-century isn't going to happen because of IPCC-style emissions cuts. If hydrocarbon emissions disappear by mid-century, it will only be because a superior technology - as yet undeveloped - will have made fossil fuels obsolete as civilisation's main source of energy. For those set on net zero, genuine innovation is the only sane and humane option.

9. Conclusion: The coronavirus pandemic and the 1.5 degree limit

Shutting down the whole economy is the only way of limiting global warming to 2°C, the former UN climate chief Yvo de Boer said in 2013. ⁵⁶ To limit global warming to a 1.5°C limit requires industrial emissions to be cut by at least two thirds, says the IPCC, something that implies a huge, decades-long contraction in industrial output.

We can now see what shutting down the world economy looks like. In the wake of the coronavirus pandemic, most governments want a V-shaped recovery. Decarbonisation is different. It's not something economies recover from. With net zero costing many multiples of hypothetical climate benefits, aggressive decarbonisation will act as a brake on any post-pandemic recovery. As the IPCC makes clear, the 1.5°C target requires fundamental restructuring of global supply and demand. The economy would be permanently smaller, people would be poorer and the vast debts incurred during the pandemic would weigh more heavily.

As the virus spreads globally, and in particular into poorer countries, it will become clearer that it is rich countries that can afford prolonged lockdowns. They can pay for expensive health-care systems to treat the sick. They can invest in preparedness for subsequent pandemics. Social distancing is more tolerable for the wealthy and inflicts hardship on the poor. In cities such as New York, Chicago and Los Angeles, minorities suffer disproportionate fatalities from Covid-19. By slowing economic progress, climate policies increase the vulnerability to pandemics of the less well off in rich countries and shrink the options to deal with them in poorer ones.

In a rational world, climate policy would be subordinated to the imperative of economic recovery and repowering the jobs lost during the shutdown. Of course, there will be governments - encouraged by green interests - that put their faith in a low-carbon recovery. It is a rare politician who is honest about the inevitable trade-offs. Emmanuel Macron is one. No one hesitates 'to make very profound, brutal choices when it's a matter of saving lives,' Macron told the Financial Times. 'It's the same for climate risk.' 121 Countries that do will experience weaker growth, and the living standards of their citizens will suffer commensurately. It will accelerate Europe's decline into economic and social senescence as it opts out of the 21st-century economic growth race. This should constitute sufficient reason to dump the 1.5°C target. But, as this report shows, in a rational world, a 1.5°C target would never have been adopted in the first place. When it comes to climate policy, rationality has not prevailed.

There is, however, another factor that will, namely international relations. The Paris Agreement contains a ratchet mechanism. Article Three requires each party's nationally determined contribution to represent a progression beyond its previous one

and reflect 'its highest possible position'. The next UN climate conference will test the effectiveness of the Paris ratchet, and reveal whether Paris is a dead letter like previous climate agreements. Columbia University's Adam Tooze, who is writing a history of international climate politics, has gone so far as to dub COP26, planned for Glasgow, a 'key moment in global history.' 122 It would be the fulcrum to lever up countries' second round of nationally determined contributions and show whether the IPCC's timeline of halving global emissions by 2030 was realistic or little more than a midnight how lat the moon. Thanks to the pandemic, the conference has been postponed.

The agreement itself is a product of a fleeting geopolitical moment that has passed. Its genesis lay in the lesson the Obama administration took away from the fiasco of the 2009 Copenhagen climate conference: that the key to a new global climate pact lay in Beijing. The prospects for an agreement improved when Xi Jinping assumed power in 2012 and signalled that the Communist party recognized that Chinese people wanted cleaner air. 'Our people have an ardent love for life,' Xi said in November 2012. 'They wish to have better education, more stable jobs, more income, greater social security, better medical and health care, improved housing conditions, and a better environment.' ¹²³

At his first meeting as president with Barack Obama in June 2013, Xi laid out his *quid pro quo* -a new model of major-country relations, with China being treated more as an equal to the United States. Intensified dialogue led to the November 2014 Beijing joint announcement on climate change. The two presidents resolved to work closely together and address 'major impediments to reaching a successful global climate agreement in Paris.' As Obama observed at a subsequent meeting with Xi, 'Our cooperation and our joint statements were critical in arriving at the Paris agreement.' ¹²⁵

Any climate pact must include China, if only for appearances' sake. It overtook the US as the world's largest emitter of greenhouse gases over a decade ago. It burns half the world's coal, which supplies it with over two thirds of its energy. However, even before the emergence of the novel coronavirus in Wuhan, there was evidence that China's interest in the Paris process was not all that it was cracked up to be. In a 2018 report for the GWPF, Patricia Adams, a Canadian economist, environmentalist and long-time China analyst, argues that the UN climate process no longer serves the Communist party's two primary domestic needs: securing a share of the promised \$100bn a year of climate finance and securing energy to fuel China's economy. 126

Despite being feted as a climate saviour, China's drive for coal continued unabated. A 2018 plant-by-plant survey by CoalSwarm found that 259 gigawatts (GW) of new capacity are under development in China, comparable to the entire US coal fleet (266 GW). If completed, the new plants



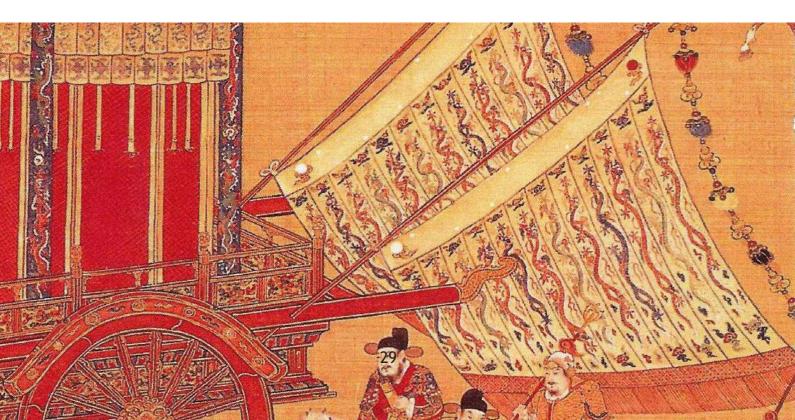
will increase China's current coal fleet of 993 GW by 25%. ¹²⁷ Abroad, China is involved in 240 coal-fired power projects in 25 countries as part of its Belt and Road Initiative. ¹²⁸

And now the pandemic changes everything; its consequences are, as Zhou Enlai reputedly said of the French Revolution, 'too early to say' (Zhou was actually referring to the 1968 French students' revolt). 129 The fact that the coronavirus emerged from China, that the Chinese authorities ruthlessly suppressed news about its spread and transmissibility, that Chinese officials continued to lie by spreading rumours of American involvement in starting the pandemic 130 - all mean that China's communist regime will henceforth be regarded with the deepest suspicion, its *bona fides* as a reliable partner destroyed by the virus it could and should have contained.

Coming out of the pandemic, the twin priorities for China's near neighbours will be to strengthen their economies and their national security. Japan, the world's third largest economy and-based on its climate pledges-acovert climate change agnostic, is not going to imperilits security by embracing net zero. Other countries in the region, such as South Korea, are not regarded as 'developed' by the UN climate process, so escape scrutiny as prime emitters.

Most consequential of all will be the long-term impact on Sino-American relations. Whoever wins the White House in November 2020, Xi's ambition of a new model of major-country relations is dead. For Donald Trump, China's behaviour is vindication of his rejection of the previous bipartisan consensus that engagement with China - something Trump argued was done on terms that disadvantaged the United States economically and strategically - would liberalise the regime. Xi's historic accomplishment is falsifying the globalists' liberalisation thesis.

If Trump is reelected, overt Sino-American rivalry could well define a new paradigm of international relations. This would relegate the UN climate talks from being a chapter heading, to a footnote in history. It is no coincidence that global warming first gained traction as the Cold War came to a close and that the 1992 UN climate change convention came into being after it had ended. Easing of geopolitical tensions was a prerequisite for the UN climate talks to develop momentum. Likewise, their re-emergence would put global warming on the backburner. As with the coronavirus today, the world would have far more important matters to worry about. 1981 was the last year when the West's carbon dioxide emissions exceeded those of the rest of the world. By 1989 and the fall of the Berlin Wall, the West's emissions were 46% of global emissions. Before the pandemic struck, they accounted for around 25%. The tail of the Western decarbonisation isn't going to wag the global dog. Toattempt net zero would indeed be a profound and brutal decision - in favour of extinction on the world stage.



Notes

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GERMANY'S ENERGIEWENDE A disaster in the making

Fritz Vahrenholt

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About the author

Fritz Vahrenholt was one of the founders of the environmental movement in Germany. He holds a PhD in chemistry and is Honorary Professor in the Department of Chemistry at the University of Hamburg. Since 1969 he has been a member of the Social Democratic Party. From 1976 until 1997 he served in several public positions with environmental agencies such as the Federal Environment Agency, the Hessian Ministry of Environment and as Deputy Environment Minister and Senator of the City of Hamburg. From 1998 until 2000 he was a board member of Deutsche Shell, responsible for renewables. In 2001, he founded the wind energy company REpower and was CEO of RWE's renewable energy division, Innogy, one of Europe's largest renewable energy companies. His 2012 book *The Neglected Sun* sparked a broad public discussion in Germany about the dogmatism in climate science. He is the chairman of the German Wildlife Foundation and a member of the GWPF's Academic Advisory Council.

This text is based on a presentation given at the House of Commons on 17 January 2017.

1 Introduction

In 2012, I had the pleasure of delivering the GWPF annual lecture at the Royal Society. I described the *Energiewende* of the German government - its plan to transition to a low-carbon energy supply - in the aftermath of the tsunami catastrophe at Fukushima. At that time, Germany's conservative/liberal government had decided to dismantle 19 nuclear power stations by 2022, despite them supplying nearly 30% of the country's electrical power production. They were to be replaced with renewable energy. This was, for energy experts, a daunting task: to substitute a cheap, reliable, secure electricity supply with expensive, unreliable, intermittent renewable power.

But under the influence of the IPCC circus - Copenhagen, Cancun, Doha, Bali, Lima, Durban, Paris, Marrakech - and the strong demands of German society, media and politicians, Germany's government wanted to be in the vanguard of those combatting man-made climate change. They had set the next target of the *Energiewende*: to get rid of fossil fuels in power, heating and transport as well.

Under its current decarbonization plans, Berlin aims to ultimately increase the share of renewables to between 80 and 95% of total energy supply by 2050 (Figure 1). No other country in the world is following such a radical course. China will grow their carbon dioxide emissions above today's 29% share of the global total until 2035. That is, in essence, their 'deal' with President Obama and their 'commitment' in Paris.

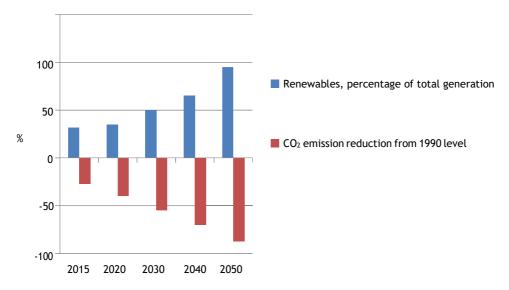


Figure 1: Germany's *Energiewende* target for 2050. Source: Ministry of Economy and Energy, October 2016.

2 Four saving graces

In Germany, we have a proverb that you in the United Kingdom don't have. A literal translation is:

A donkey goes onto the ice until it breaks.

Until now, the reckless policy of the *Energiewende* has avoided disaster. There are four reasons for this.

1. Lack of political opposition Although renewables are already generating an additional cost to energy consumers of the order of **e**25 billion annually, there is no political party in Germany that opposes the policy in the parliament; the majority of the German population support it too, because they think they are saving the world from a climate catastrophe. Today, energy prices in Germany are already the second highest in Europe (after Denmark). The additional levy on power bills for renewables will rise to an astounding 6.88 **e**ct/kWh in 2017, more than double the market price. (Figure 2)

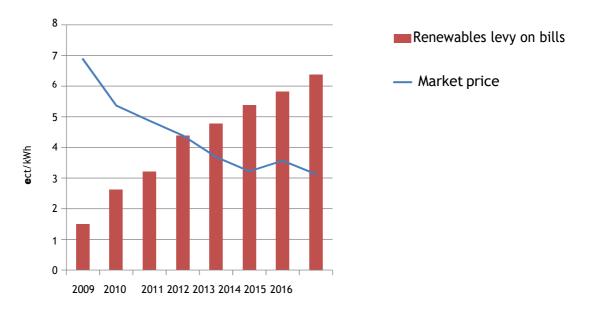


Figure 2: Decreasing power prices, increasing cost of renewables.

Source: BDEW 2016

2. Oversupply means low power prices for some Energy-intensive industries in Germany are profiting from plunging power prices on wholesale markets, the result of growing overcapacity of renewable plants. As energy-intensive industries are partially exempt from the renewables levy, industries such as steel, copper and chemicals are given a remarkable competitive advantage.

- **3. An over-engineered grid is a safety buffer** Until now there have been no blackouts, but the risk *is* growing. The country has benefitted from typical German overengineering of its grid, which was set up with a very wide safety margin. Even if a power line or a power station fails, the power supply remains secure, at least for now.
- **4. The neighbours can help** Germany has nine neighbours with whom power can be exchanged. If the *Energiewende* had happened in the UK, the electricity system would have already imploded, but in Germany, on windy days, surplus power can be dumped onto the neighbours' electricity grids. During the dark doldrums in Germany we call times when there is no wind in winter or at night the *Dunkelflaute* we can be saved by calling on old Austrian oil-fired power stations, Polish hard-coal plants or French and Czech nuclear power.

3 Five looming problems

Nevertheless, a crisis is lurking around the corner.

Problem No 1: Intermittency

To overcome intermittency, green activists and the true believers of the mainstream tell us we have to build more capacity. However, even tripling today's wind-power capacity of 51 GW to a whopping 155 GW would not even satisfy half of Germany's power demand. But it would mean having a 200-m high wind turbine every 2.7 km, right across the country, no matter what the landscape, or what lakes, mountains, towns or cities were there.

But even with this huge capacity, the problem of intermittency is not solved (Figure 3). Such a system would deliver a huge oversupply when the weather was windy, but in lulls it would still deliver nothing: trebling nothing still gives you nothing. That is mathematics, not politics.

The wind not only changes from hour to hour-stronger in winter, lighter in summer - but it also changes from year to year by 25-30%. How can we cope with this silly target of 80-95% for renewables in the light of this huge interannual volatility? We can pay for a second system - a backup system of fossil fuels. That is what we are doing now, with dramatic economic consequences, and as we do the carbon dioxide target is disappearing over the horizon. Another idea is storage. I will come to that later.

Problem No 2: The grid and stability of distribution

Let us look more closely at the problem of overproduction during windy weather. The Christmas period from 24-26 December 2016 was a case in point. Germans consume

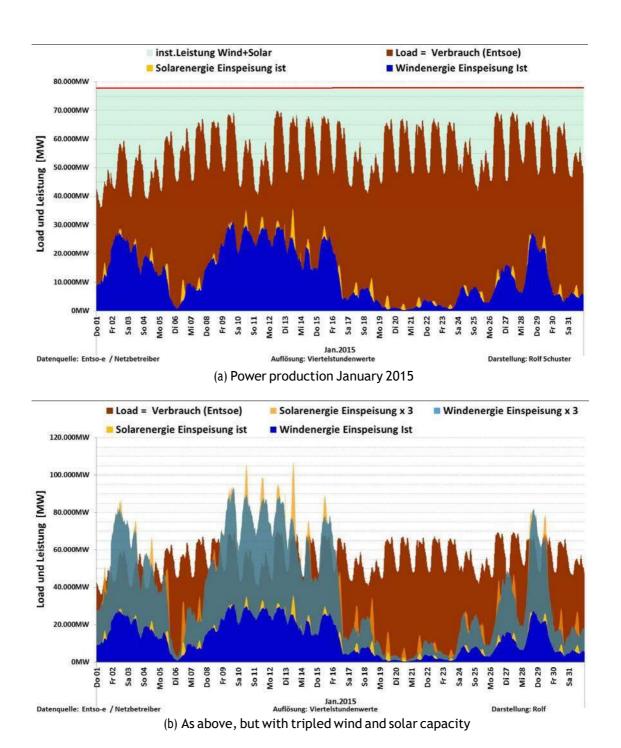


Figure 3: Effect of tripling wind and solar capacity.

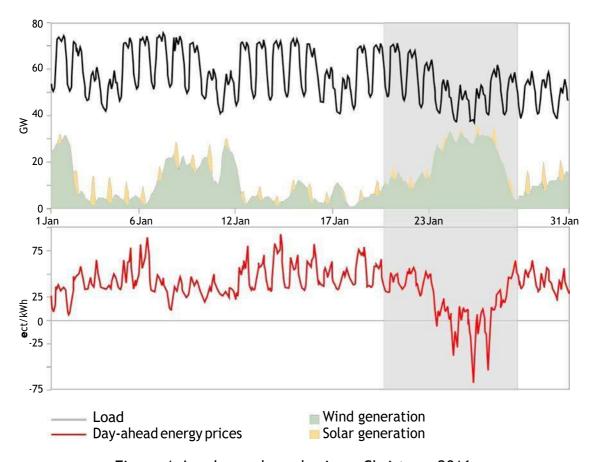


Figure 4: Load, supply and prices, Christmas 2016

Top: Load and renewables supply; bottom, day-ahead prices. In the zone shaded grey, load is falling, but renewables supply is rising, leading to a collapse in prices.

little electricity during holidays and at weekends, so when there were high winds over Christmas, there was a major problem (Figure 4). Because the law requires that renewables get priority, power utilities first throttled down the gas-fired, nuclear and coal-fired power plants. Then the first wind parks were taken offline because of the continuing oversupply to the grid. However, the windpark operators and investors were still paid under the renewables law, even though they produced nothing. The costs of such payments amount to **e**1 billion per year and are still rising (Figure 5). This is something one sees only in a centrally planned economy. When German vice-Chancellor Sigmar Gabriel, Minister for Economic Affairs and Energy, explained this to the Chinese energy minister, he thought it was a translation error by the interpreter. At the end, the Chinese guest stated that it would not be a good idea for China to follow suit and pay for something that had never been produced.

Yet even these payments are not enough to prevent occasional oversupply. When

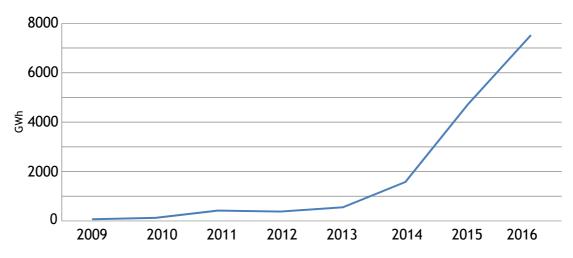


Figure 5: Discarded renewable production.

The cost in 2016 was almost **e**1 billion.

this happens, electricity prices actually become negative and Germany is forced to dump its excess power onto the grids of neighbouring countries. The amount of energy dumped is 50 terawatt hours (TWh) annually, out of a total wind energy generation of 85 TWh, so we are producing wind energy mainly for export.

And are the neighbours enthusiastic about receiving money for Germany's waste power? Poland, the Netherlands, Austria and Switzerland are far from thrilled, because their own power stations have to be shut down, devaluing the investments made in their manufacture. In response, Poland has obtained permission from the European Commission to build phase shifters at their border with Germany, which will repel the current from the German side. The Czech Republic will soon follow suit. Managing transborder energy flows - both of refugees and of people - is becoming a nightmare.

The proponents of renewable energy and their lobbyists, however, are still busily painting a rosy picture, claiming that oversupply incidents are the result of coal-fired power plants being allowed to continue operating. This story sounds implausible though, because wind and solar are given priority on the grid. Why don't the grid operators shut down 15-20 GW of conventional plant?

The answer lies in another problem, the so-called 'secondary reserve'. What is this? When a high-speed train leaves a station, when a steel plant is starting up or the lights goon in a football stadium, it produces a frequency change in the power grid, which automatically activates a power plant to produce more energy. There is no human intervention involved, no controller shifting a slider in a control room. It happens automatically and in just a second. However, solar and wind power cannot reliably provide such a secondary reserve. You can throttle wind down, but you cannot run it up. It is not for the love of coal that the German Grid Agency and the four power-

grid operators are keeping coal-fired power plants on line. They know that without them, the power grid could collapse. The technical reality is that a minimum of 20% of electricity demand must be generated by conventional steam turbines to make the system secure.

In 2012, when the German government decided to close its nuclear plants, which were concentrated in the south of the country, the government also reshaped the grid, building huge DC cables from north to south. The wind is more abundant in the north. So the idea was to transfer wind power to the south.

A total of 6100 km of cable will have to be built by the time the last nuclear power stations shut in 2022. 400 km have been given the go-ahead and 80 km have been built, just 1.3% of the intended total. The government underestimated the opposition that their plans would meet. Building power lines on this scale has brought protests like those against nuclear power in the past. As a result, the plans for all these DC cables have been torn up and the government now plans to build them underground, increasing the cost eightfold. This has never been attempted on such a scale, anywhere in the world, and the project will probably only be completed five years after the last nuclear power station has shut down. This is not a good way to attract investors to build new facilities in the south of Germany. Interventions in the market are piling up. To safeguard a stable 50 Hz frequency in a system where intermittent wind can change the feed by 10 GW within minutes, you have to 'redispatch'. This means that grid operators have to interfere in delivery contracts between power plants and customers, ordering conventional plants to shut down if they are located at the wrong place from a grid-management perspective. Alternatively, they can give cash incentives to generators who are too expensive but are in the right place. In 2011, before

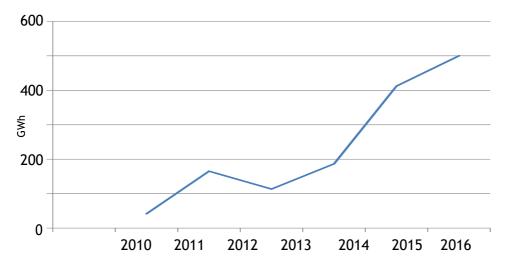


Figure 6: Redispatches in response to grid problems.

The cost in 2016 was around **e**500 million.

the nuclear exit and the renewables boom, grid operators had to intervene on average once a day. By 2016, this had risen to 17 times a day; 6000 interventions per year, at a cost of **e**500 million (Figure 6).

Problem No 3: Market distortion

If you look at power production in Germany over the last decade, you can see a shift from nuclear to renewables, a slight reduction in gas, and lignite stable (Figure 7). What is the consequence if you bring together a fixed-price system for renewables, with a 35% share of supply, and an energy market for the remaining 65%?

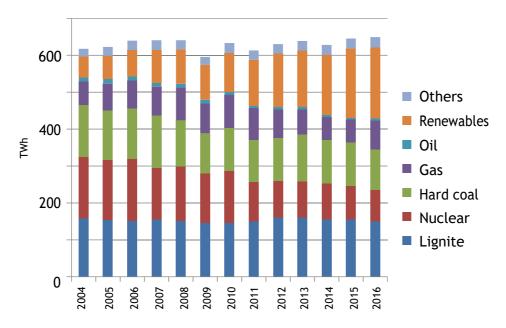
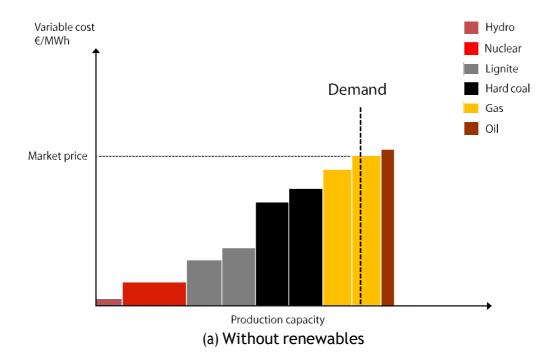


Figure 7: German energy generation mix, 2004-2016.
Source: Ministry of Economy and Energy, 2016

The market price is set by the most expensive power plant that is needed to satisfy demand. You can see the so-called 'merit order' in Figure 8a. If you now introduce renewables that have already been paid for by a fixed feed-in-tariff system and have priority on the grid, then you shift the merit order to the right (Figure 8b) and the most expensive plants are pushed out of the market. Because of this, many flexible gas-fired plants are operating in the red. Even brand new gas-fired plants are being mothballed.

The same fate has been suffered by many hard coal plants. In total, 69 power plants with a capacity of 12 GW are currently running at a loss. Besides the fact that a great deal of national wealth is being destroyed, the government has learned that



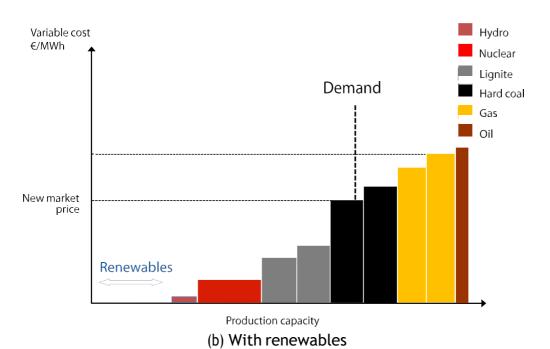


Figure 8: Effect of renewables on market price.

With renewables given a favoured status in the market place by regulators, the equilibrium (a) shifts so that gas is forced out of the market (b), despite it being vital to the functioning of the grid.

closing that chunk of capacity leads to severe supply problems, especially in the south of Germany. In response, a law has been rushed through the German Parliament, requiring that permission be obtained from the federal grid agency before any power plant is closed, with a notice period of a full year also required. Six gigawatts of power stations have been allowed to close and 3 GW has been given a status of 'system relevant'. This means that the owner is required to operate the power station, but receives a price that only covers the operational costs. Capital costs and profit margins are simply ignored, just as they were in the old East Germany. It is like ordering a taxi cab, and then only paying for the fuel on the grounds that the car has already been paid for.

As in all centrally planned economies, the efforts of the planners are proving fruit-less. Carbon dioxide emissions have not reduced substantially since 2011 - in 2016, they even increased - and electricity consumption has not reduced either.

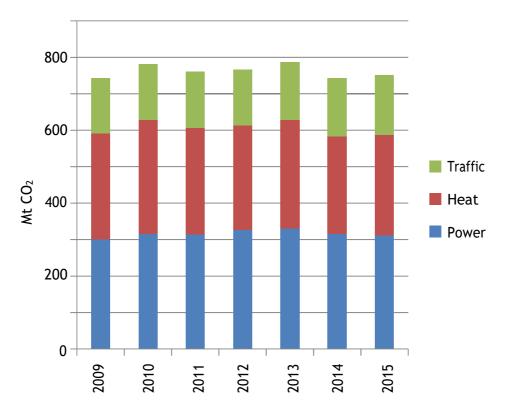


Figure 9: German carbon dioxide emissions, 2009-2015. Source: Ministry of Economy and Energy, 2016

On a European scale, the impact of Berlin's policy is practically nil. The atmosphere has not been spared a single ton of carbon dioxide through German zeal. The system of trading emissions permits means that curbing emissions in one country leads only

to permits being used in other countries. In other words, greenhouse gases are simply coming out of chimneys somewhere else in Europe.

Germany is responsible for 2.5% of global carbon dioxide emissions; China contributes 29% of the total and is adding 40 GW of coal-fired capacity each year. The total carbon dioxide emission reductions planned by the German federal government by 2020 will be wiped out by China in a mere three months. Through the steel, copper, machines, and even solar panels that they import from China, Europeans are in fact importing huge amounts of carbon dioxide emissions.

Problem No 4: Storage and 'sector coupling'

Only a dramatic expansion of a nation's energy storage capacity will resolve these nagging problems, but thus far the technologies involved have been prohibitively expensive. Today's lithium batteries cost more than **e**350/kWh, so with 2000 rechargings of a 50 kWh battery, the cost is 25 **e**ct/kWh. If, in 10 years' time we can reduce this to **e**100/kWh, then the storage cost will reduce to 6 **e**ct/kWh, but we have to bear in mind that the cost is in addition to the burden of paying for expensive solar and wind power. Building 100 GW of volatile generation capacity in the hope that in 10 years' time we will be able to store it economically seems more than a little foolish.

Using intermittent electricity to produce hydrogen by electrolysis and then forming methane (power to gas) in order to generate electricity in a gas-fired power station is an alternative, but is only economic at above 50 **e**ct/kWh.

Using electric cars for storage does not help much either. Even if all 40 million cars in Germany were electric, we could only store 400 GWh. But on lull days, which happen several times a year, we would need 7250 GWh.

It is a dubious strategy, but in Germany the magic words are 'sector coupling', which means that in times of shortage, we have to decide if we want to drive somewhere or have the lights on.

Problem No 5: From Energiewende to a disaster of biodiversity

Renewables are the most land-hungry form of energy generation. To replace the power generated by one typical coal-fired power station with renewable energy requires an area of around 500 km².

But it is not only wind power that needs such huge areas of land. In order to reduce carbon dioxide emissions, green policymakers, supported by the EU, installed a subsidy system for transforming maize into biogas and grain into biofuel. The result has been an ecological disaster. Turning grassland or farmland into maize or corn monocultures has led to an appalling reduction in numbers of 26 of the most important songbird species in Germany. The habitats that supply food to birds of prey have been transformed into deserts of maize. Ornithologists like the famous Dr Flade have

spoken of a 'disaster of biodiversity' and he has observed that while the influence of global warming on biodiversity is hard to detect, the influence of global warming policy on it is a disaster.

Birds of prey are being sacrificed to the green ideology, as wind-farms spread into sensitive, natural areas like forests. In an elaborate field study, researchers from the University of Bielefeld came to the conclusion that the Red Kite and the Common Buzzard were now endangered. The study was commissioned by the German Energy Minister, but policy did not change. On the contrary; conservation laws will be loosened, so as to allow the killing of birds (Table 1).

Table 1: Mortality in birds of prey.

Species	Red Kite		Buzzard
Area	Brandenburg Germany		Germany
Number of turbines (Dec 2014)	3,319	24,867	24,867
Number of casualties (Jun 2015)	65	270	332
Casualties extrapolated	165-508	>1000	11,936

In addition, 240,000 bats have been killed by wind turbines. When they fly too close to wind turbine rotors they are killed by the low pressure behind the rotors, which causes their lungs to burst.



Figure 10: Dead raptor at windfarm.

4 Why are we planning to destroy ourselves?

You know about German *angst*. Climate priests, the media and politicians have created the illusion that carbon dioxide controls the climate. *We* are guilty, but we think that we can save the world if we simply turn the climate control knob - anthropogenic carbon dioxide - to nil.

We have forgotten that in the Medieval Warm Period, temperatures were the same or even higher without elevated levels of carbon dioxide. We have forgotten the Little Ice Age and we have suppressed the fact that the temperature increase over the last 18 years has been much lower than predicted by every climate model. The reason for this failure of the models is that the tuning of the models was based on the period from 1975 to 2000, a period in which natural influences like the Atlantic Multidecadal Oscillation warmed the northern hemisphere.

For all these reasons, resistance to the *Energiewende* has already been surfacing in Germany, although not in the federal parliament, nor in the government. Across the country, no fewer than 800 citizens' initiatives have been filed against further expansion of wind energy facilities. This movement is well organised, well informed, capable of handling conflict and, in due course, taking on the Bundestag. As they have begun to grasp the fundamental problem of the volatility of wind and solar energy, the mood of the citizens has ceased to be complacent. The urban elites' dreams of sustainable power production by wind and biogas have been realised at the cost of the loss of the homeland of the rural population.

Two possible scenarios for the years up to 2020 are conceivable:

Muddling through Policymakers might try to continue on their current course towards economic disaster. A serious move away from the *Energiewende* would amount to an admission of a strategic blunder, with unforeseeable consequences for the current political establishment. Most likely then, there will be endless corrections made to the system and increasingly bold interventions by the state as it attempts to get the flawed electricity system back under control. In the end, some new form of state energy management can be expected - an inefficient arrangement, which will be expensive and detrimental to growth.

Policy correction Over the longer term, a policy correction is feasible, but only if certain conditions are met: a failure of average global temperatures to rise as dramatically as predicted, a sense among the public of a loss of German competitiveness, and the destruction of the Germany landscape becoming a major political issue. The process will accelerate if grid failures become more frequent and supply instability increases.

But in this scenario too, there will be more state and less market in the energy business. After every blackout, the calls for more state control will be come louder. The times of competitive and market-oriented energy management are probably over.

And it will to policy.	ake a long time to rep	oair the serious c	damage caused b	oy a misled ei

GWPF BRIFFINGS

G۱	WPF BRIEFINGS	
1	AndrewTurnbull	The Really Inconvenient Truth or 'It Ain't Necessarily So'
2	Philipp Mueller	The Greening of the Sahel
3	WilliamHapper	The Truth about Greenhouse Gases
4	Gordon Hughes	The Impact of Wind Power on Household Energy Bills
5	Matt Ridley	The Perils of Confirmation Bias
6	Philipp Mueller	The Abundance of Fossil Fuels
7	Indur Goklany	Is Global Warming the Number One Threat to Humanity?
8	Andrew Montford	The Climate Model and the Public Purse
9	Philipp Mueller Philipp Mueller	UK Energy Security: Myth and Reality
10	Andrew Montford	Precipitation, Deluge and Flood
11	Susan Crockford	On the Beach
12	Madhav Khandekar	Floods and Droughts in the Indian Monsoon
13	Indur Goklany	Unhealthy Exaggeration
14	Susan Crockford	Twenty Reasons not to Worry about Polar Bears
15	Various	The Small Print
16	Susan Crockford	The Arctic Fallacy
17	Indur Goklany	The Many Benefits of Carbon Dioxide
18	JudithCurry	The Climate Debate in the USA
19	Indur Goklany	The Papal Academies' Broken Moral Compass
20	Donoughue and Forster	The Papal Encyclical: a Critical Christian Response
21	Andrew Montford	Parched Earth Policy: Drought, Heatwave and Conflict
22	David Campbell	The Paris Agreement and the Fifth Carbon Budget
23	Various	The Stern Review: Ten Years of Harm
24	JudithCurry	Climate Models for the Layman
25	Fritz Vahrenholt	Germany's Energiewende: a Disaster in the Making

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Our main focus is to analyse global warming policies and their economic and other implications. Our aim is to provide the most robust and reliable economic analysis and advice. Above all we seek to inform the media, politicians and the public, in a newsworthy way, on the subject in general and on the misinformation to which they are all too frequently being subjected at the present time.

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World Climate Declaration

THERE IS NO CLIMATE EMERGENCY



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There is no climate emergency

Climate science should be less political, while climate policies should be more scientific. Scientists should openly address uncertainties and exaggerations in their predictions of global warming, while politicians should dispassionately count the real costs as well as the imagined benefits of their policy measures

Natural as well as anthropogenic factors cause warming

The geological archive reveals that Earth's climate has varied as long as the planet has existed, with natural cold and warm phases. The Little Ice Age ended as recently as 1850. Therefore, it is no surprise that we now are experiencing a period of warming.

Warming is far slower than predicted

The world has warmed significantly less than predicted by IPCC on the basis of modeled anthropogenic forcing. The gap between the real world and the modeled world tells us that we are far from understanding climate change.

Climate policy relies on inadequate models

Climate models have many shortcomings and are not remotely plausible as policy tools. They do not only exaggerate the effect of greenhouse gases, they also ignore the fact that enriching the atmosphere with CO_2 is beneficial.

CO₂ is plant food, the basis of all life on Earth

 $\mathrm{CO_2}$ is not a pollutant. It is essential to all life on Earth. More $\mathrm{CO_2}$ is favorable for nature, greening our planet. Additional $\mathrm{CO_2}$ in the air has promoted growth in global plant biomass. It is also profitable for agriculture, increasing the yields of crops worldwide.

Global warming has not increased natural disasters

There is no statistical evidence that global warming is intensifying hurricanes, floods, droughts and suchlike natural disasters, or making them more frequent. However, there is ample evidence that ${\rm CO_2}$ -mitigation measures are as damaging as they are costly.

Climatepolicymustrespectscientificandeconomicrealities

There is no climate emergency. Therefore, there is no cause for panic and alarm. We strongly oppose the harmful and unrealistic net-zero CO_2 policy proposed for 2050. Go for adaptation instead of mitigation; adaptation works whatever the causes are.

OUR ADVICE TO THE EUROPEAN LEADERS IS THAT SCIENCE SHOULD STRIVE FOR A SIGNIFICANTLY BETTER UNDERSTANDING OF THE CLIMATE SYSTEM, WHILE POLITICS SHOULD FOCUS ON MINIMIZING POTENTIAL CLIMATE DAMAGE BY PRIORITIZING ADAPTATION STRATEGIES BASED ON PROVEN AND AFFORDABLE TECHNOLOGIES.

Tobelieve the outcome of a climate model is to believe what the model makers have put in. This is precisely the problem of today's climate discussion to which climate models are central. Climate science has degenerated into a discussion based on beliefs, not on sound self-critical science. Should not we free ourselves from the naïve belief in immature climate models?



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- 28. Arthur Day, Earth Scientist with a specialist background in geochemical modelling of volcanic processes.
- 29. Geoff Derrick, Geologist
- 30. Trish Dewhirst, Retired Geologist, Queensland, Australia
- 31. Aert Driessen, Geologist, Fellow Australian Institute of Geoscientists, Australia
- 32. John A. Earthrowl, retired Geologist, Brisbane Australia
- 33. Mike Elliott, (Adv Dip Ed E&C); Dux of School in Mathematics; Co-Founder of Climate Realists of Five Dock (<2008). Successfully convinced Deputy Premier of the State of Queensland, Australia "to direct local council to remove from its Planning Scheme assumptions of theoretical SLR due to climate change"
- 34. Jeremy K. Ellis, Retired Chairman of BHP, now Chairman of the Saltbush Club, Australia
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- 40. Andrew Gillies, Professional Geologist
- 41. Gavin Gillman, Former Senior Principal Research Scientist with SCIRO Australia; Founding Director of the IITA Ecoregional Research Centre in Cameroon for the International Institute for Tropical Agriculture (IITA)

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- 43. Lindsay Hackett, Founding member of the Saltbush Club in Australia
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- 58. Hugh H. Laird, Retired Tropical Agriculture Executive
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- 60. Brian Levitan, worked for NASA, now Technology Consultant to multinationals
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- 63. Rodney McKellar, Retired Geologist, Queensland, Australia
- 64. John McLean, Author of first major review of HadCRUT 4 climate temperature data, Member of New Zealand Climate Science Coalition
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- 69. John Ross May, Bsc Adip, Cres., 42 in Management of Forests and National parks in Victoria
- 70. Toby McLeay, General Medical Practitioner, AM, MBBS, FRACGP, FACRRM
- 71. Paul Messenger, PhD, Earth Scientist, Australia
- 72. John Michelmore, Retired Industrial Chemist, South Australia
- 73. Alan Moran, Contributor and Editor of the Mark Steyn Compilation: "Climate Change, the Facts", Author of Climate Change: "Treaties and Policies in the Trump Era"
- 74. Des Moore, Former Deputy Secretary of the Federal Treasury, founder and leader of the Institute for Private Enterprise
- 75. Hugh Morgan, prominent Australian mining executive, Fellow of the Australian Academy of Technology, Science and Engineering (FTSE)
- $76. \hspace{0.5cm} \textbf{John Edward Nethery, Consultant Geologist, Bachelor of Science} \\$
- 77. John Nicol, PhD, Retired Senior Lecturer Physics and one time Dean of Science, James Cook University, North Queensland
- 78. C.D. Ollier, Emeritus Professor of Geology and Honorary Research Fellow at the School of Earth and Geographical Sciences, University of Western Australia
- 79. Alistair Pope, psc, CM, Sceptical Scientific Contrarian in the Climate Debate
- 80. Robert Pyper, Geologist and Director of Minnelex Pty Ltd., Australia
- 81. Tom Quirk, Nuclear Physicist, Australia
- 82. Art Raiche, PhD, Mathematical Geophysics, Retired CSIRO Chief Research Scientist
- 83. Campbell Rankine, Barrister and Solicitor, Australia
- 84. Peter Ridd, Oceanographer and Geophysicist, Former Head of Physics at the James Cook University, Queensland
- 85. Tim Riley, Mining Geologist

- 86. John Cameron Robertson, Author of CO2 Feeds the World and The Climate Change Delusion
- 87. Nigel Rowlands, retired from mining and exploration industry
- 88. Judy Ryan, Editor Principia Scientific Institution-Australia
- 89. George (Rob) Ryan, Professional Geologist
- 90. Robert Sambell, PhD Physics, Professional Geophysicist
- 91. Jim Simpson, Retired from Managing Positions in different International Telecommunications Firms, now active in the Australian Climate Community,
- 92. Case Smit, Physicist, Expert in Environmental Protection, Co-founder of the Galileo Movement, Australia
- 93. Lee Smith, University Lecturer in Spatial Technology, Responsible for State Government Precise Monitoring of Sea Level and International Sea Boundaries
- 94. Darren Speirs, Independent Business Owner, Rangeland NRM Consultants, Australia
- 95. Geoffrey Stocker, Professor and Head of Department of Forestry, PNG University of Technology Director of PNG Forest Research Institute
- 96. John Stone, Former Head of the Australian Treasury and Executive Director of both the IMF and the World Bank, Former Senator for Queensland. In the Australian Parliament and Leader of the National Party in the Senate. He is a Principal Founder of The H R Nicholls Society and the Principal Founder of The Samuel Griffith Society.
- 97. Rodney R. Stuart, Retired expert in energy industry, Tasmania, Australia
- 98. R. Symons, Professional Engineer, Expert in Temperature Control of Industrial Buildings
- 99. Rustyn Wesley Thomas, Retired aircraft engineer, Australia
- 100. James Taylor, Electrical, Aerospace and Astrophysics Engineer, Computer Modelling Researcher
- 101. John W. Turner, Science Educator, Noosa Heads, Australia
- 102. Peter Tyrer, Project Controls Engineer in mining industry, Australia
- 103. Terrence Vincent, Security Engineer, Small Business Adviser AIST, ASIAL, SMBE, Australia
- 104. James Walter, Medical doctor, Australia
- 105. John Warnock, Astro Economist, Australia
- 106. Christopher Kenneth Warren, Expert in hydroelectric dam design and construction, Australia
- $107. \ \ Alan\,C.\,Watts, Medical\,Practitioner\,specialized\,in\,Effects\,of\,Infrasound\,on\,Human\,\\ Health$
- 108. Colleen J. Watts, PhD, Retired Environmental Scientist with specialization in aquatic chemistry and environmental consequences of renewable energy
- 109. Neil Wilkins, Retired geologist, Australia
- 110. Lawrence A. Wilson, Professional Chemical Engineer, Melbourne
- 111. P.C. Wilson, Former journalist with the A.B.C. Queensland, Australia
- 112. Philip Wood, Qualified Lawyer in four Jurisdictions (Australia, New York, UK and Hong Kong). Principal focus: International Finance and recently CEO of two ASX-listed companies operating in the mining and minerals processing fields.



SCIENTISTS AND PROFESSIONALS FROM AUSTRIA

. Rudolf Posch, PhD, Retired Software Engineer of a Technical Multinational, Expert in Nonlinearities and Feedbacks



SCIENTISTS AND PROFESSIONALS FROM BANGLADESH

L. Aftab Alam Khan, PhD, Active Professor Geological Oceanography, BSMR Maritime University; Retired Professor of Geology and Geophysics of Dhaka University



SCIENTISTS AND PROFESSIONALS FROM BELGIUM

- Henri A. Masson, Emeritus Professor Dynamic System Analysis and Data Mining, University of Antwerp, WCD Ambassador
- 2. Rob Lemeire, Publicist on Environmental and Climate Issues, WCD Ambassador
- 3. Eric Blondeel, retired Civil Engineer.
- 4. Emiel van Broekhoven, Emeritus Professor of Economics, University of Antwerp

- Christophe de Brouwer, MD, Honorary Professor of Environmental and Industrial Toxicology, Former President of the School of Public Health at the Université Libre de Bruxelles
- 6. Benjamin Damien, Docteur en Biologie et Entrepreneur en Biotechnologie
- 7. Ferdinand Engelbeen, Former chemical process automation engineer, Akzo Nobel Chemicals
- 8. Samuel Furfari, Professor of Energy Geopolitics at the Free University of Brussels
- 9. Georges Geuskens, Emertitus Professor of Chemistry, Free University of Brussels and Expert Publicist on Climate Science
- 10. Drieu Godefridi, PhD in Law, author of several books
- 11. Jan Jacobs, Science Journalist Specializing in Climate and Energy Transition
- 12. Raymond Koch, Retired Research director at Lab. Plasma Physics, RMA Brussels and Fellow Lecturer at UMons.
- 13. Ferdinand Meeus, Retired Research Scientist, IPCC expert Reviewer AR6
- 14. Jean Meeus, Retired Meteorologist, Brussels Airport, Author of the Best Seller Astronomical Algorithms
- 15. Ernest Mund, Honorary Research Director, FNRS, Nuclear Engineering
- 16. Bart Ooghe, Geologist & Geophysicist, Independent Scientist
- 17. Eric Perpète, FNRS Senior Research Associate in Chemical Physics
- 18. Phil Salmon, Computer Tomography Scientist, Kontich, Belgium
- 19. Jozef Verhulst, PhD in Chemistry, Author
- 20. Jean van Vliet, Retired Specialist in Space Weather
- 21. Appo van der Wiel, Senior Development Engineer



SCIENTISTS AND PROFESSIONALS FROM BRAZIL

- 1. Thiago Maia, Nuclear Physicist with PhD in Astrophysics, wrote critical climate letter to Brazilian Government, WCD Ambassador South America
- 2. Luiz Carlos Baldicero Molion, Emeritus Professor of the Federal University of Alagoas (UFAL), Formerly of the National Institute of Space research (INPE)
- 3. José Bueno Conti, Geographer and Professor of Climatology, Full Professor of the Geography Department at the University of Sao Paulo (USP)
- 4. Ricardo Augusto Felicio, Professor of the Department of Geography of the University of Sao Paulo (USP), Member of the Brazilian Society of Meteorology (SBMET)
- 5. Richard Jakubazsko, Executive Editor of Agro DBO Magazine and Co-author of the Book 'CO2, warming and climate change: are you kidding us?'
- 6. José Carlos Parente de Oliveira, Physicist, Professor at the Federal Institute of Education, Science and Technology of Cearà (IFCE), Retired Associate Professor of the Federal University of Cearà (UFC)
- 7. Guilherne Polli Rodrigues, Geographer, Master in Climatology, environmental consultant
- 8. Geraldo Luis Saraiva Lino, Geologist, Author of 'How a natural Phenomenon Was Converted into a False Global Emergency
- 9. Igor Vaz maquieira, Biologist, Specialist in Environmental Management
- Mario de Carvalho Fontes Neto, Agronomist, Editor of "The Great Global Warming Swindle"
- 11. Daniela de Souza Onca, Professor of the Geography Department of the State University of Santa Catarina (UDESC)
- 12. Marcello Silva Sader, graduated in Veterinary Medicine and Computer Sciences and working in project-related IT and Veterinary Medicine to manage data and business



SCIENTISTS AND PROFESSIONALS FROM CANADA

- Jeffrey Ernest Foss, Professor of Philosophy of Science, University of Victoria, English Canada; WCD Ambassador
- 2. Reynald Du Berger, Retired Professor of Geophysics, Université du Québec a Chicoutimi, French Canada, WCD Ambassador
- 3. Steven Ambler, PhD, Full Professor University of Quebec, Dept. of Economics
- 4. John Andersen, BSc. Honours, University of Alberta

- 5. Tim Ball, Emeritus Professor Geography, University of Winnipeg, Canada and Advisor of the International Science Coalition
- 6. Robert Douglas Bebb, Professional Engineer (Mechanical), MBA
- 7. Jacques Brassard, Minister of Recreation (1984), Minister of Environment (1994), Minister of Transport and Intergovernmental Affairs of Canada (1996), Minister of Natural Resources (incl. Hydro-Québec) and House Leader
- 8. Alain Bonnier, Physicist, INRS-Centre de Recherche and Energy Montréal, Canada
- 9. Andrew Bonvicini, Professional Geophysicist, President of Friends of Science Society
- 10. Michel Chapdelaine, MSc Géologie, Montréal
- 11. Edmond (Ted) Clarke, MSc Engineering, Member of Friends on Science Society, Studying Man-caused Global Warming Issue for 25 years
- 12. Henry Clark, Thermal/Power Engineer
- 13. Ian Clark, Professor of Earth and Environmental Sciences, University of Ottawa
- 14. Dr. Paulo N. Correa, Biophysicist and Oncologist, Inventor, author of numerous books and research papers, Director of Research at Aurora Biophysics Research Institute
- 15. Susan Crockford, Zoologist and Polar Bear Expert, Former Adjunct Professor University of Victoria, Canada
- 16. Hortense Côté, Ingénieur Géologue, Goldminds
- 17. Ronald Davison, Professional Chemical Engineer
- 18. Jean Du Berger, Ingénieur Retraité, Bell Canada
- 19. Éric Ducharme, MSc Géologie, Abitibi
- 20. Michel Dumais, Ingénieur Civil Retraité, Université d'Ottawa
- 21. Claude Duplessis, BcSc Géologie, Goldminds
- 22. Ashton Embry, Research Geologist, Embry Holdings
- 23. David Fermor, Anaesthesiologist, B.A., M.D., FRCPC
- 24. Joseph Fournier, PhD, Expert in Physical Chemistry
- 25. Dr. Paul Hamblin, Retired Research Scientist, Environment Canada. Advisor to the Georgian Bay Association
- 26. Paul A. Johnston, Associate Professor, Department of Earth and Environmental Sciences, Mount Royal University, Calgary, Alberta
- 27. E. Craig Jowett, Retired Geologist and Academic Research Scientist
- 28. Klaus L.E. Kaiser, Retired Research Scientist, National Water Research Institute, Author of Numerous Press Articles, Canada
- 29. Madhav Khandekar, Expert Reviewer IPCC 2007 AR4 Cycle, Canada
- 30. Kees van Kooten, Professor of Economics and Canada Research Chair in Environmental Studies and Climate, University of Victoria, Canada
- 31. M.J. Lavigne, M.Sc., Professional Geologist
- 32. Jean Laberge, Professeur Retraité de Philisophie, CEGEP du Vieux Montréal
- 33. Robert Ledoux, PhD, Professeur Retraité en Géologie, Université Laval
- 34. Gerald Machnee, Retired Meteorologist, Environment Canada
- 35. Allan MacRae, retired Engineer, Canada
- 36. Paul MacRae, Independent Climate Researcher, Canada
- 37. Patrick Moore, Ecologist, Chair CO2 Coalition, Co-Founder Green Peace, Canada
- 38. Scott Patterson, Professional Geologist
- $39. \quad \text{Andy Pattullo, Associate Professor of Medicine at the University of Calgary} \\$
- $40. \hspace{0.5cm} \hbox{Joe Postma, Research Analyst, Physics \& Astronomy, University of Calgary} \\$
- $41. \quad Brian\ R.\ Pratt, Professor\ of\ Geological\ Sciences, University\ of\ Saskatchewan$
- 42. Gerald Ratzer, Professor Emeritus, Computer Science McGill University, Montreal
- 43. Norman Reilly, Professor of Mathematics, Simon Fraser University, British Columbia
- 44. Gérald Riverin, PhD Géologie, Géologue Retraité
- 45. Peter Salonius, Retired Research Scientist, Natural Resources, Canada
- 46. Marcelo C. Santos, Professor of Geodesy, University of New Brunswick, Canada
- 47. Ian Semple, Retired Geologist, of McGill University, Canada
- 48. Brian Slack, Distinguished Professor Emeritus, Concordia University Montreal,
 Department of Geography, Planning and Environment
- 49. Marc Vallé, PhD, Geophysicien
- 50. Petr Vaníček, Professor of Geodesy, University of New Brunswick, Canada
- 51. Jean-Joël Vonarburg, PhD Professeur Ingénieur, Université du Québec à Chicoutimi



SCIENTISTS AND PROFESSIONALS FROM CHILE

1. Douglas Pollock, Civil Industrial Engineer, University of Chile



SCIENTISTS AND PROFESSIONALS FROM CHINA AND HONG KONG

- 1. NG Young, Principal Geoscientist, Danxiashan Global Geopark of China
- Wyss Yim, Retired Professor, Department of Earth Sciences, The University of Hong Kong, Hong Kong SAR, China / Deputy Chairman, Climate Change Science Implementation Team, UNESCO International Year for Planet Earth 2007-2009 / Expert Reviewer IPCC AR2



SCIENTISTS AND PROFESSIONALS FROM CZECH REPUBLIC

- 1. Marek Eiderna, Agricultural Engineer and graduated in General Biology
- 2. Vaclav Hubiner, Retired Ambassador, Anthropologist, Freelance Climate Policy Commentator for an internet daily www.forum24.cz
- Pavel Kalenda, PhD, CSc., Coal Expert
- 4. Václav Klaus, Former President of the Czech Republic, Professor of Economics, Founder of the Václav Klaus Institute
- 5. Ivan Spicka, Professor of Internal Medicine at Charles University with speciality in hemato-oncology, Prague
- 6. Gary M. Vasey, PhD Geology, Managing Partner and Analyst in Commodity Technology Advisory Ilc



SCIENTISTS AND PROFESSIONALS FROM DENMARK

- Jens Morton Hansen, PhD, Geology, Professor at Copenhagen University. Former Vicemanaging Director for the Geological Survey of Denmark and Greenland; Former Director General for the Danish National Research Agency and National Research Councils; Former President of the Nordic Research Council under Nordic Council. WCD Ambassador
- 2. Bjarne Andresen, Professor of Physics, Niels Bohr Institute, University of Copenhagen
- 3. Frank Hansen, Emeritus Professor, Department of Mathematics, University of Copenhagen
- 4. Peter Kjær Poulsen, Metering engineer, Denmark
- 5. Sören Kjärsgaard, Professional Chemical Engineer
- 6. Johannes Krüger, Emeritus Professor, dr.scient, Department of Geosciences and Natural Resource Management, University of Copenhagen
- 7. Knud Larsen, PhD in Natural Sciences
- 8. Niels Schrøder, Geophysist/Geologist, Associate Professor Institute of Nature and Environment, Roskilde University, Denmark



SCIENTIIENTISTS AND PROFESSIONALS FROM FINLAND

 Boris Winterhalter, PhD, Retired Marine Geology working at the Geological Survey of Finland.



SCIENTISTS AND PROFESSIONALS FROM FRANCE

- 1. Benoît Rittaud, Assistant professor of Mathematics at University of Paris-Nord, President of the French Association des climato-réalistes. WCDAmbassador
- 2. Jean-Charles Abbé, former research director at CNRS, labs director (Strasbourg, Nantes) in Radiochemistry, expert at NATO and IAEA
- 3. Bertrand Alliot Aliot, Environmentalist
- 4. Charles Aubourg, full professor at the University of Pau, geophysicist.
- 5. Hervé Azoulay, Engineer (CNAM), Specialist of Networks and Systemics, External Speaker at Universities (France, Switzerland, China), CEO and President of several Associations
- 6. Jean-Pierre Bardinet, Ingénieur ENSEM, publicist on climateissues



- 7. Bernard Beauzamy, university professor (ret.), chairman and CEO, Société de Calcul Mathématique SA (Paris).
- 8. Serge Bellotto, PhD in Geology
- 9. Guy Bensimon, Retired Associate Professor of Economics at Institute of Political Studies of Grenoble (Sciences Po Grenoble)
- 10. Jean-Claude Bernier, emeritus professor (university of Strasbourg), former director of the Institute of Chemistry of the CNRS.
- 11. Pierre Beslu, former searcher and head of department in the french Nuclear Energy Commission (CEA).
- 12. Michel Bouillet, PhD Human Geography, Emeritus Professor, Former Associate Researcher at the MMSH (Aix-en-Provence)
- 13. Christian Buson, PhD in agronomy, director of research in a company (impact studies in environmental issues, sewage treatment).
- 14. Sylvie Brunel, full professor at Sorbonne University, geographer and economist, former president of the humanitarian organization Action against Hunger (Action contre la faim).
- 15. Jean-Louis Butré, professional engineer, head of laboratory at Grenoble Nuclear Research Center, Chief executive officer or the Pharmacie Centrale de France, President of Axens, President of the Fédération Environnement Durable and the European Platform Against Windfarms, Knight of the National Order of Merit.
- 16. Bernard Capai, Retired Chemistry Engineer, Specialist of Industrial Processes avoiding the use of carcinogenic solvents
- 17. Patrick de Casanove, Doctor of Medicine, Chairman of the Cercle Frédéric Bastiat
- 18. Philippe Catier, Medical Doctor
- 19. Bruno Chaumontet, Retired Engineer ENSEA, specialized in Feedback Systems
- 20. Pascal Chondroyannis, Forest Engineer, Retired Director of the National Alpine Botanical Conservatory (2008-2013)
- 21. Philippe Colomban, CNRS Research Professor, Former Head of Laboratory at Université Piere-et-Marie Curie, Expert in Hydrogen-based Energy Storage
- 22. Jacques Colombani, Former Research Director retired from ORSTOM-IRD, numerous Studies in Hydrology and Climatology and Specialist in Fluid Mechanics. Member of the Board of ORSTOM for twenty years.
- 23. Christian Coppe, PhD in Organic & Analytical Chemistry, Ten Years' Experience in Gas Analysis and Handling
- 24. Philippe Costa, Energy Engineer at ENSEM Nancy, specialist in industrial process and energy saving
- 25. Vincent Courtillot, geophysicist, member of the French Academy of Sciences, former director of the Institute de Physique du Globe de Paris
- 26. Jean Davy, Engineer (ENSAM), Digital Modeling Software Developer
- 27. Pierre Darriulat, Professor of Physics, Member of the French Academy of Sciences
- 28. Pierre Delarboulas, CEO of a Robotics Company. Former R&D Director at Partnering Robotics. Silver Medal at the 2016 Lépine contest of the Ministry of Foreign Affairs and International Development.
- 29. Jean-Pierre Desmoulins, Retired Professor (agrégé) of Thermal and Energy Engineering at the "Institut Universitaire de Technologie, Université-Grenobles-Alpes"
- 30. Gérard Douet, PhD in Nuclear Physics, Retired Engineer at CERN, Technical Manager on Digital Transmission and Video Encoding
- 31. Hubert Dulieu, Emeritus Professor Applied Ecology, Formerly Senior Researcher in the CNRS, President of the National Scientific Research Committee, Vegetal Biology Section (XXVII)
- 32. Bruno Durieux, economist, former Minister of Health and of Foreign Trade, ancient administrator of the French National Institute of Statistics and Economic Studies (INSFF)
- 33. Max Falque, International Consultant in Environmental Policy
- 34. Serge Ferry, PhD, Retired Teacher-Researcher (MCF), University of Lyon
- 35. Patrick Fischer, Associate Professor in Applied Mathematics, University of Bordeaux
- 36. Michel Frenkiel, Engineer (Arts et Métiers), Former Researcher with NCAR at Boulder

- 37. Francis Le Gaillard, PhD in Natural Sciences and Pharmaceutical Sciences. Emeritus Professor of Biochemistry at the Faculty of Pharmaceutical Sciences of Toulouse
- 38. François Gauchenot, governance specialist, founder of Saint George Institute.
- 39. Jean Gergelé, Engineer graduate from the Ecole Centrale de Lyon, 45 Years in the industry, R&D Director, Freelance Consultant, mainly in the Li-ion battery development.
- 40. Christian Gérondeau, former advisor of several French Prime Ministers. Former responsible for the road traffic safety policy for France and the European Union.
- 41. François Gervais, Emeritus Professor of Physics and Material Sciences, University of Tours.
- 42. Philippe Giraudin, Ecole Polytechnique Paris, Geographic Sciences
- 43. Bernard Grandchamp, Agronomic Engineer and Environment & Plant Defense Expert,
 Managing Director of Famoux Chateaux Viticoles in Bordeaux
- 44. Gilles Granereau, Former meteorologist, currently project manager environment and tourism in a public institution. Worked on coastal risks, marine erosion, sand dune fixation, hydraulics, forest management, botany.
- 45. Maximilian Hasler, Associate Professor in Mathematics, University of French West Indies
- 46. Yvon Jarny, Emeritus Professor in Thermal and Energy Sciences, Nantes University
- 47. Claude Jobin, Retired A&M Engineer Specialized in Microwave Communication
- 48. Alexandre Krivitzki, Psychoanalyst, Member of the International Psychoanalytical Association
- 49. Roger Lainé, Retired Geological Engineer
- 50. Philippe de Larminat, Professor at École Centrale de Nantes, specialist of business process modeling.
- 51. René Laversanne, Former researcher at the CNRS, 16 patents.
- 52. Jean-Marie Longin, Engineer (Saint-Cyr), Chief of the Pole Operations of Security Inventory Management
- 53. Guy Lucazeau, Emeritus Professor (Institut Polytechnique de Grenobel) in Material Sciences and Spectroscopy
- 54. Phlippe Malburet, Emeritus Associated Professor of Mathematics, Founder of the Planetarium of Aix-en-Provence, Member of the Academy of Aix-en-Provence
- 55. Christian Marchal, astronomer and mathematician, former research director at the French National Office for Aerospace Studies and Research, former professor at the Observatory of Paris (1980-93), former assistant professor at Polytechnic School (1981-92).
- 56. Paolo Martinengo, Applied Physicist, Senior Staff Member in the Experimental Physics Department, Detector Technologies Group, CERN
- 57. Patrick Mellett, architect and CEO.
- 58. Marc le Menn, Head of Metrology-Chemistry Oceanography Lab, Brest.
- 59. Jean-Laurent Monnier, Emeritus Research Director, CNRS-Université de Rennes 1, Research worker at the CNRS from 1973 to 2013, Speciality in Pleistocene Geology in Western Europe
- 60. Jacques-Marie Moranne, Retired Engineer (Ecole Centrale de Lille), Specialist in Air and Water Purification, Chemical and Nuclear Engineering
- 61. Serge Morin, Emeritus Professor Geography at Université Michel de Montaigne, Bordeaux, Honorary Mayer of Branne
- 62. Cédric Moro, geographer on natural hazards management, co-founder of Visov, a NGO in Civil defense
- 63. Philippe Morvan, Engineer ENSTA and Génie Maritime, specialist in software development
- 64. Charles Naville, R&D Exploration Geophysicist, IFP Energies Nouvelles
- 65. Michel le Normand, Emeritus Professor of Botany and Plant Pathology and Chairman of Plant Production Department, National Superior School of Agronomy, Rennes (France)
- 66. Rémy Prud'homme, Emeritus Professor in Economics at University of Paris-Est, Former Deputy Director Environment, Directorate of OECD

- 67. Pierre Richard, Engineer ESPCI Paris, Former Research Geochemist at Institut de Physique du Globe de Paris (IPGP)
- 68. Pierre Ripoche, Engineer INSA in Chemistry, Retired Project Manager in R&D, Expert in High Temperature Plasma for Optical Fiber Process
- 69. Isabelle Rivals, Associate professor in Statistics at ESPCI Paris
- 70. Betrand Rouffiange, Doctor of Medicine, Specialized in Radiology
- 71. Jean Rouquerol, Emeritus Research Director at CNRS Marseille, Expert in Gas Adsorption and Calorimetry
- 72. Georges de Sablet, Retired Associate Professor at University of Paris Descartes, formerly in charge of Operating Systems and Networks at IUT Paris
- 73. François Simonet, Former Director for planning and foresight in a State Agency for water and aquatic ecosystems management.
- 74. Marcel Terrier, Engineer ENSAEM in risk management, teacher at École des Mines.
- 75. Étienne Vernaz, former Director of Research of CEA (Commissariat à l'Énergie Atomique) in France, Professor at INSTN (Institut National des Sciences et Techniques Nucléaires).
- 76. Camille Veyres, Retired Engineer at École des Mines, Specialist in Telecommunications and Broadband Networks
- 77. Brigitte Van Vliet-Lanoë, geoscientist, Emeritus Research Director (CNRS, Université de Bretagne Occidentale), stratigraphy and paleoenvironments, Quaternary and Holocene.
- 78. Théa Vogt, retired CNRS searcher, géomorphology, Quaternary palaeoen vironments, soil and desertification remote sensing
- 79. Henri Voron, Retired Civil Chief Engineer, Specialized in Water Managemen

SCIENTISTS AND PROFESSIONALS FROM GERMANY

- Fritz Vahrenholt, Professor (I.R.) am Institut für Technische und Makromolekulare Chemie der Universität Hamburg; WCD Ambassador
- 2. Detlef Ahlborn, PhD, Expert on German Energy Transition (Energiewende)
- 3. H.J. Bandelt, Emeritus Professor of Mathematics, University of Hamburg
- 4. Dietrich Bannert, Professor Honoris Causa, University of Marburg
- 5. Lars Birlenbach, Dr. in Chemistry, University of Siegen
- $6. \hspace{0.5cm} \textit{Michael Bockisch, Emeritus Professor Chemistry at the Technical University of Berlin} \\$
- 7. Thomas Brey, Professor for Functional Ecology at University Bremen, Alfred Wegener Institute. Helmholtz Centre for Polar and Marine Research, Bremerhaven. Helmholtz Institute for Functional Marine Biodiversity at the University Oldenburg (HIFMB)
- 8. Eike-Matthias Bultmann, Geoscientist
- 9. Arthur Chudy, Agricultural Chemist OT Warsaw
- 10. Klaus Döhler, Professor of Pharma sciences, University of Hannover
- 11. Friedrich-Karl Ewert, Emeritus Professor Geology, University of Paderborn
- 12. Ludwig E. Feinendegen, Emeritus Professor Medicine
- 13. Christian Habermann, PhD in Economics, Investment Manager
- 14. Hermann Harde, Emeritus Professor of Experimental Physics and Materials Science, Helmut Schmidt-University, Hamburg
- 15. Manfred Hauptreif, Natural Scientist
- $16. \quad Werner\ Kirstein, Emeritus\ Professor\ of\ Climatology, University\ of\ Leipzig$
- 17. Stefan Kröpelin, Dr. in Geosciences, Free University of Berlin and University of Cologne (retired). Specialized in Climate Change of the Sahara
- 18. Ulrich Kutschera, Professor of Plant Physiology & Evolutionary Biology at the University of Kassel, Germany, and Visiting Scientist in Stanford USA
- 19. Michael Limburg, Vice-President EIKE (Europäisches Institute für Klima und Energie)
- 20. Horst-Joachim Lüdecke, Professor of Operations Research (i.R.) HTW of Saarland, Saarbrücken
- 21. Wolfgang Merbach, Professor Dr. Agrar. Habil. at Institut für Agrar-Ernährungswissenschaften
- 22. Lothar W. Meyer, Emeritus Professor of Material Engineering, Chemnitz University of Technology, Saxony Entrepreneur 'Nordmetall GmbH', Member of the Board of 'Vernunftkraft Niedersachsen'



- 23. Werner Mormann, Emeritus Professor of Macromolecular Chemistry, Universität Siegen
- 24. Hans Penner, PhD, Dipl.-Chem. Dr. rer. nat., Linkenheim-Hochstetten
- 25. Siegfried Reiprich, Dipl.-Ing, Geoscientist and Oceanography.
- 26. W.H. Eugen Schwartz, Emeritus Professor of Theoretical Chemistry, Universitaet Siegen
- 27. Carl-Otto Weiss, Emeritus Professor in Non-linear Physics, Advisor to the European Institute for Climate and Energy, Former President of the German Meteorological Institute, Braunschweig



SCIENTISTS AND PROFESSIONALS FROM GREECE

- . Demetris Koutsoyannis, Professor of Hydrology and Analysis of Hydrosystems at the National Technical University of Athens, WCD Ambassador
- 2. Stavros Alexandris, Associate Professor Agricultural University of Athens, Dept. of Natural Resources and Agricultural Engineering, Sector of Water Resources
- 3. Costas Fasseas, Emeritus Professor of Plant Anatomy & Electron Microscopy,
 Department of Crop Science, Agricultural University of Athens
- 4. Anthony Foscolos, Emeritus Professor of Mineral Resources at the Technical University of Crete, Energy Consultant for the United Nations Development Program (UNDP)
- 5. Sotiris Kamenopoulos, PhD, Independent Researcher in the Field of Sustainable Exploitation of Mineral Resources, Social License to Operate and Risk Management.
- 6. Christos J. Kolovos, PhD, Mining & Metallurgy Engineer, Former Director of Mine Planning & Contractor Works Dept., Public Power Corporation of Greece
- 7. Theodoros Kolydas, Director of the National Meteorological Center of Hellenic National Meteorological Service (HNMS)
- 8. Spyridon Nikiforos, Economist, MBA
- 9. Sonia Perez, PhD Biology/Immunology, Scientific Coordinator Cancer Immunology and Immunotherapy Center, Saint Savas Cancer Hospital, Athens



SCIENTISTS AND PROFESSIONALS FROM HUNGARY

- 1. István Héjjas, PhD, Retired R&D Electrical Engineering
- 2. Király József, Chemical Engineer and one of the authors of the Hungarian site www. klimarealista.hu
- 3. Laszlo Szarka, Geophysicist, O.M., Hungary



SCIENTISTS AND PROFESSIONALS FROM INDIA

1. Sanjeev Sabhlok, Economist with focus on climate and energy policy, India



SCIENTISTS AND PROFESSIONALS FROM IRELAND

- 1. Jim O'Brien, Chair, Irish Climate Science Forum, Expert Reviewer IPCC AR6, WCD ambassador
- 2. Tom Baldwin, Electrical Engineer, Specialist in Power System Security
- 3. Dr Anthony D. Barry, Honorary Fellow, Irish Academy of Engineering
- 4. Tony J. Carey, BA (Natural Sciences), Clare College, Cambridge
- 5. David Horgan, MA (Cambridge), MBA (Harvard), Resource Company Director
- 6. Seamus Hughes, BAgricSc, Specialist in Genetics
- 7. Ultan Murphy, B.Sc(Hons) Chemistry, Industry Science Professional
- 8. Owen O'Brien, Business Founder and Entrepreneur, MBA, DBA
- 9. J. Philip O'Kane, Emeritus Professor, School of Engineering, University College Cork
- 10. Peter O'Neill, Retired, School of Engineering, University College Dublin, Expert Reviewer of IPCC AR6
- 11. Fintan Ryan, Retired Senior Airline Captain, Fellow Royal Aeronautical Society
- 12. Christian Schaffalitzky, FIMMM, Founder Institute of Geologists of Ireland, EurGeol
- 13. Dr. Brian N. Sweeney, Founding Chairman of Science Foundation Ireland
- 14. Sean Tangney, Business Entrepreneur, Former Technical Director, CRH plc
- 15. David Thompson, BAgricSc, MA, Animal Nutritionist

- 16. Dr. Edward Walsh, Former Chairman, Irish Council for Science, Technology and Innovation; Former Director, Energy Research Group, Virginia Tech, USA
- 17. Michael J. Walshe, Agriculture Scientist, Ex-Officer in Charge, Moorepark AFT, Livestock Specialist



SCIENTISTS AND PROFESSIONALS FROM ITALY

- Alberto Prestininzi, Professore di Geologia Applicata, Università di Roma La Sapienza, già Scientific Editor in Chief della rivista internazionale IJEGE e Direttore del Centro di Ricerca Previsione, Prevenzione e Controllo Rischi Geologici (CERI), WCD Ambassador.
- 2. Uberto Crescenti, Professore Emerito di Geologia Applicata, Università di ChietiPescara, già Magnifico Rettore e Presidente della Società Geologica Italiana.
- Giuliano Panza, Professore di Sismologia, Università di Trieste, Accademico dei Lincei e dell'Accademia Nazionale delle Scienze, detta dei XL, vincitore nel 2018 del Premio Internazionale dell'American Geophysical Union.
- 4. Franco Prodi, Professore di Fisica dell'Atmosfera, Università di Ferrara.
- 5. Franco Battaglia, Professore di Chimica Fisica, Università di Modena; Movimento Galileo 2001.
- 6. Mario Giaccio, Professore di Tecnologia ed Economia delle Fonti di Energia, Università di Chieti-Pescara, già Preside della Facoltà di Economia.
- 7. Enrico Miccadei, Professore di Geografia Fisica e Geomorfologia, Università di ChietiPescara.
- 8. Nicola Scafetta, Professore di Fisica dell'Atmosfera e Oceanografia, Università di Napoli.
- 9. Antonino Zichichi, Professore Emerito di Fisica, Università di Bologna, Fondatore e Presidente del Centro di Cultura Scientifica Ettore Majorana di Erice.
- Renato Angelo Ricci, Professore Emerito di Fisica, Università di Padova, già Presidente della Società Italiana di Fisica e della Società Europea di Fisica; Movimento Galileo 2001.
- Aurelio Misiti, Professore di Ingegneria sanitaria-Ambientale, Università di Roma La Sapienza, già Preside della Facoltà di Ingegneria, già Presidente del Consiglio Superiore ai Lavori Pubblici.
- 12. Antonio Brambati, Professore di Sedimentologia, Università di Trieste, Responsabile Progetto Paleoclima-mare del PNRA, già Presidente Commissione Nazionale di Oceanografia.
- 13. Cesare Barbieri, Professore Emerito di Astronomia, Università di Padova.
- 14. Sergio Bartalucci, Fisico, Presidente Associazione Scienziati e Tecnologi per la Ricerca Italiana.
- 15. Antonio Bianchini, Professore di Astronomia, Università di Padova.
- 16. Paolo Bonifazi, Astrofisico, ex Direttore dell'Istituto di Fisica dello Spazio Interplanetario (IFSI) dell'Istituto Nazionale Astrofisica (INAF)
- 17. Francesca Bozzano, Professore di Geologia Applicata, Università di Roma La Sapienza, Direttore del Centro di Ricerca Previsione, Prevenzione e Controllo Rischi 9 European Climate Declaration September 26, 2019 Geologici (CERI).
- 18. Marcello Buccolini, Professore di Geomorfologia, Università di Chieti-Pescara.
- 19. Paolo Budetta, Professore di Geologia Applicata, Università di Napoli.
- 20. Monia Calista, Ricercatore di Geologia Applicata, Università di Chieti-Pescara.
- 21. Giovanni Carboni, Professore di Fisica, Università di Roma Tor Vergata; Movimento Galileo 2001.
- 22. Franco Casali, Professore di Fisica, Università di Bologna e Accademia delle Scienze di Bologna.
- 23. Giuliano Ceradelli, Ingegnere e climatologo, ALDAI.
- 24. Augusta Vittoria Cerutti, membro del Comitato Glaciologico Italiano.
- 25. Domenico Corradini, Professore di Geologia Storica, Università di Modena.
- 26. Fulvio Crisciani, Professore di Fluidodinamica Geofisica, Università di Trieste e Istituto Scienze Marine, Cnr, Trieste.
- 27. Carlo Esposito, Professore di Rischi Geologici, Università di Roma La Sapienza.
- 28. Antonio Mario Federico, Professore di Geotecnica, Politecnico di Bari.
- 29. Mario Floris, Professore di Telerilevamento, Università di Padova.

- 30. Gianni Fochi, Chimico, Scuola Normale Superiore di Pisa; giornalista scientifico.
- 31. Mario Gaeta, Professore di Vulcanologia, Università di Roma La Sapienza.
- 32. Giuseppe Gambolati, Fellow della American Geophysical Union, Professore di Metodi Numerici, Università di Padova.
- 33. Rinaldo Genevois, Professore di Geologia Applicata, Università di Padova.
- 34. Carlo Lombardi, Professore di Impianti nucleari, Politecnico di Milano.
- 35. Luigi Marino, Geologo, Centro Ricerca Previsione, Prevenzione e Controllo Rischi Geologici (CERI), Università di Roma La Sapienza.
- 36. Salvatore Martino, Professore di Microzonazione sismica, Università di Roma La Sapienza.
- 37. Paolo Mazzanti, Professore di Interferometria satellitare, Università di Roma La Sapienza.
- 38. Adriano Mazzarella, Professore di Meteorologia e Climatologia, Università di Napoli.
- 39. Carlo Merli, Professore di Tecnologie Ambientali, Università di Roma La Sapienza.
- 40. Alberto Mirandola, Professore di Energetica Applicata e Presidente Dottorato di Ricerca in Energetica, Università di Padova.
- 41. Renzo Mosetti, Professore di Oceanografia, Università di Trieste, già Direttore del Dipartimento di Oceanografia, Istituto OGS, Trieste.
- 42. Daniela Novembre, Ricercatore in Georisorse Minerarie e Applicazioni Mineralogichepetrografiche, Università di Chieti-Pescara.
- 43. Sergio Ortolani, Professore di Astronomia e Astrofisica, Università di Padova.
- 44. Antonio Pasculli, Ricercatore di Geologia Applicata, Università di Chieti-Pescara.
- 45. Ernesto Pedrocchi, Professore Emerito di Energetica, Politecnico di Milano.
- 46. Tommaso Piacentini, Professore di Geografia Fisica e Geomorfologia, Università di Chieti-Pescara.
- 47. Guido Possa, Ingegnere nucleare, già Viceministro del Ministero dell'Istruzione, Università e Ricerca con delega alla ricerca.
- 48. Mario Luigi Rainone, Professore di Geologia Applicata, Università di Chieti-Pescara.
- 49. Francesca Quercia, Geologo, Dirigente di ricerca, Ispra.
- 50. Giancarlo Ruocco, Professore di Struttura della Materia, Università di Roma La Sapienza.
- 51. Sergio Rusi, Professore di Idrogeologia, Università di Chieti-Pescara.
- 52. Massimo Salleolini, Professore di Idrogeologia Applicata e Idrogeologia Ambientale, Università di Siena.
- 53. Emanuele Scalcione, Responsabile Servizio Agrometeorologico Regionale ALSIA, Basilicata. 10 European Climate Declaration September 26, 2019
- 54. Nicola Sciarra, Professore di Geologia Applicata, Università di Chieti-Pescara.
- 55. Leonello Serva, Geologo, Accademia Europa delle Scienze e delle Arti, Classe V, Scienze Tecnologiche e Ambientali, già Direttore Servizio Geologico d'Italia; Movimento Galileo 2001.
- 56. Luigi Stedile, Geologo, Centro di Ricerca Previsione, Prevenzione e Controllo Rischi Geologici (CERI), Università di Roma La Sapienza.
- 57. Giorgio Trenta, Fisico e Medico, Presidente Emerito dell'Associazione Italiana di Radioprotezione Medica; Movimento Galileo 2001.
- 58. Gianluca Valensise, Dirigente di Ricerca, Istituto Nazionale di Geofisica e Vulcanologia, Roma.
- 59. Corrado Venturini, Professore di Geologia Strutturale, Università di Bologna.
- 60. Franco Zavatti, Ricercatore di Astronomia, Università di Bologna.
- 61. Achille Balduzzi, Geologo, Agip-Eni.
- 62. Pino Cippitelli, Geologo Agip-Eni.
- 63. Franco Di Cesare, Dirigente, Agip-Eni.
- 64. Serena Doria, Ricercatore di Probabilità e Statistica Matematica, Università di
- 65. Enzo Siviero, Professore di Ponti, Università di Venezia, Rettore dell'Università e-Campus.
- 66. Pietro Agostini, Ingegnere, Associazione Scienziati e Tecnologi per la Ricerca Italiana.
- 67. Donato Barone, Ingegnere.
- 68. Roberto Bonucchi, Insegnante in pensione.

- 69. Gianfranco Brignoli, Geologo.
- 70. Alessandro Chiaudani, Ph.D. agronomo, Università di Chieti-Pescara.
- 71. Luigi Fressoia, Architetto urbanista, Perugia.
- 72. Sabino Gallo, Ingegnere nucleare e scrittore scientifico.
- $73. \quad Daniela\,Giannessi, Primo\,Ricercatore, IPCF-CNR, Pisa.$
- 74. Roberto Grassi, Ingegnere, Amministratore G&G, Roma.
- 75. Alberto Lagi, Ingegnere, Presidente di Società Ripristino Impianti Complessi Danneggiati.
- 76. Luciano Lepori, Ricercatore IPCF-CNR, Pisa.
- 77. Roberto Madrigali, Meteorologo.
- 78. Ludovica Manusardi, Fisico nucleare e giornalista scientifico, UGIS.
- 79. Maria Massullo, Tecnologa, ENEA-Casaccia, Roma.
- 80. Enrico Matteoli, Primo Ricercatore, IPCF-CNR, Pisa.
- 81. Gabriella Mincione, Professore di Scienze e Tecniche di Medicina di Laboratorio, Università di Chieti-Pescara.
- 82. Massimo Pallotta, Primo Tecnologo, Istituto Nazionale Fisica Nucleare.
- 83. Enzo Pennetta, Professore di Scienze Naturali e divulgatore scientifico.
- 84. Franco Puglia, Ingegnere, Presidente CCC, Milano.
- 85. Nunzia Radatti, Chimico, Sogin.
- 86. Vincenzo Romanello, Ingegnere nucleare, Ricercatore presso il Centro di Ricerca Nucleare di Rez, Repubblica Ceca.
- 87. Alberto Rota, Ingegnere, Ricercatore presso CISE ed ENEL, esperto di energie rinnovabili.
- 88. Massimo Sepielli, Direttore di Ricerca, ENEA, Roma.
- 89. Ugo Spezia, Ingegnere, Responsabile Sicurezza Industriale, Sogin; Movimento Galileo 2001.
- 90. Emilio Stefani, Professore di Patologia vegetale, Università di Modena.
- 91. Umberto Tirelli, Visiting Senior Scientist, Istituto Tumori d'Aviano; Movimento 11 European Climate Declaration September 26, 2019 Galileo 2001.
- 92. Roberto Vacca, Ingegnere e scrittore scientifico.
- 93. Antonio Ballarin, Responsabile della Ricerca e Laboratorio Digitale di Sogni.
- 94. Flavio Tabanelli, Fisico.
- 95. Giuseppe Basini, Astrofisico, Deputato, Già dirigente di ricerca dell'INFN.
- 96. Marco Benini, Ingegnere idraulico, libero professionista.
- 97. Giorgio Bertucelli, Ingegnere, già Dirigente Industriale, ALDAI.
- 98. Alessandro Bettini, Professore Emerito (Fisica) Università di Padova.
- 99. Luciano Biasini, Professore Emerito, già Docente di Calcoli numerici e grafici,
 Direttore dell'Istituto Matematico e Preside della Facoltà di Scienze Matematiche,
 Fisiche e Naturali dell'Università di Ferrara.
- 100. Paolo Blasi, Professore emerito (Fisica) e già Rettore dell'Università di Firenze; già Presidente della Conferenza dei Rettori delle Università Italiane.
- 101. Giampiero Borrielli, Ingegnere.
- 102. Antonio Maria Calabrò, Ingegnere, Ricercatore, Consulente.
- 103. Cristiano Carabella, Geologo, Borsista presso l'Università di Chieti.
- 104. Edoardo Cicali, membro del C.I.R.N (Comitato Italiano Rilancio del Nucleare) e dell'associazione "Atomi per la pace", ex dipendente di un centro medico radiologico ed attualmente impiegato nel settore dell'informatica.
- 105. Enrico Colombo, Chimico, Dirigente Industriale.
- 106. Vito Comencini, Onorevole, Membro della Camera dei Deputati italiana dal 2018.
- 107. Roberto d'Arielli, Geologo, Borsista presso l'Università di Chieti.
- 108. Stefano De Pieri, Ingegnere energetico e nucleare.
- 109. Benedetto De Vivo, Professore di Geochimica in pensione dall'Università di Napoli; ora Professore Straordinario presso Università Telematica Pegaso, Napoli.
- 110. Carlo Del Corso, Ingegnere Chimico.
- 111. Francesco Dellacasa, Ingegnere, amministratore di società nel settore energetico.
- 112. Alessandro Demontis, Perito Chimico Industriale, Tecnico per la Gestione delle Acque e delle Risorse Ambientali, Pomezia.
- 113. Aureliano Ferri, Vicepresidente Associazione Piceno Tecnologie.

- 114. Gianluca Esposito, Geologo. 116. Sergio Fontanot, Ingegnere.
- 115. Umberto Gentili, Fisico dell'ENEA, Climatologo per il Progetto Antartide, ora in pensione.
- 116. Roberto Graziano, Ricercatore di Geologia stratigrafica e paleoclimatologia/ paleoceanografia, Università di Napoli, già Geologo presso il Servizio Geologico d'Italia.
- 117. Roberto Habel, Professore di Fisica Medica, Università di Cagliari.
- 118. Angelo Maggiora, PhD, INFN Senior Researcher. More that 40 years experience in research at CERN, Saclay, Dubna and Frascati.
- 119. Ettore Malpezzi, Ingegnere.
- 120. Vania Mancinelli, Geologo, Borsista presso l'Università di Chieti.
- 121. Alessandro Martelli, Ingegnere, già Dirigente ENEA.
- 122. Umberto Minopoli, Presidente dell'Associazione Italiana Nucleare.
- 123. Cliff Ollier, Geomorphologist, Emeritus Professor and Honorary research fellow, at the School of Earth and Geographical Sciences University of Western Australia.
- 124. Francesco Oriolo, Professore di Impianti Nucleari, Università di Pisa.
- 125. Paolo Emmanuele Orrù, Professore di Geografia Fisica e Geomorfologia, Università di Cagliari.
- 126. Giorgio Paglia, Geologo, Borsista presso l'Università di Chieti.
- 127. Antonio Panebianco, Ingegnere.
- 128. Davide Peluzzi, Ambasciatore del Parco Nazionale del Gran Sasso e dei Monti della Laga nel Mondo nel 2017. 12 European Climate Declaration September 26, 2019
- 129. Corrado Penna, Docente di Matematica.
- 130. Alessandro Pezzoli, Ricercatore universitario e Professore aggregato in Weather Risk Management, Politecnico di Torino e Università di Torino.
- 131. Andrea Pomozzi, Presidente Associazione Piceno Tecnologie.
- 132. Giorgio Prinzi, Ingegnere, Direttore responsabile della rivista "21mo Secolo Scienza e tecnologia".
- 133. Arnaldo Radovix, Geologo, Risk Manager in derivati finanziari.
- 134. Mario Rampichini, Chimico, Dirigente Industriale in pensione, Consulente.
- 135. Arturo Raspini, Geologo, Ricercatore, Istituto di Geoscienze e Georisorse (IGG), Consiglio Nazionale delle Ricerche, Firenze.
- 136. Marco Ricci, Fisico, Primo Ricercatore, Istituto Nazionale di Fisica Nucleare.
- 137. Renzo Riva, Comitato Italiano Rilancio Nucleare (C.I.R.N.), Buja.
- 138. PierMarco Romagnoli, Ingegnere, Milano.
- 139. Stefano Rosso, Insegnante di Geografia, Storia e Italiano, Scuola Secondaria, Modena.
- 140. Ettore Ruberti, Ricercatore ENEA, Docente di Biologia Generale e Molecolare.
- 141. Francesco Sensi, Generale di Divisione Aerea (R).
- 142. Roberto Simonetti, Geologo, R&D c/o Azienda S.I.I.
- 143. Elio Sindoni, Professore Emerito dell'Università di Milano Bicocca.
- 144. Maria Grazia Tenti, Geologo.
- 145. Andrea Zaccone, Geologo, Dirigente Protezione Civile Regione Lombardia.
- 146. Piero Baldecchi, lettore.
- 147. Eliseo Bertolasi, Dottore di Ricerca in Antropologia Culturale.
- 148. Enrico Bongiovanni, Dottore Commercialista.
- 149. Claudio Ciani, Relazioni Internazionali, Scienza Politica, Università di Roma La Sapienza.
- 150. Luigi Chilin, Dirigente in pensione.
- 151. Alessio Del Gatto, Liceo Scientifico, collaboratore Attivita Solare.it.
- 152. Ferruccio Cornicello, Fotografo e lettore di studi sul clima.
- 153. Maurizio Fiorelli, Sommelier professionale, studioso dell'evoluzione nella coltivazione delle vigne.
- 154. Walter Luini, Geometra.
- 155. Enrico Ghinato, Perito Fisico.
- 156. Alberto Guidorzi, Agronomo.
- 157. Maurizio Montuoro, Medico.
- 158. Gianni Pettinari, Impiegato Amministrativo, Fondatore del gruppo Facebook: "Falsi allarmismi sul riscaldamento globale".



SCIENTISTS AND PROFESSIONALS FROM JAPAN

- 1. Masayuki Hyodo, Professor of Earth Science, Kobe University, Japan
- 2. Mototaka Nakamura, Atmospheric and Oceanic Scientist (ScD in Meteorology, MIT)



SCIENTISTS AND PROFESSIONALS FROM MEXICO

- . Luis Frausto, Chemical Engineer
- 2. Victor Manuel Velasco Herrera, PhD, Space Engineer
- 3. Armando Pàez, PhD in Urganism, Expert in Sustainability and Energy Transitions



SCIENTISTS AND PROFESSIONALS FROM THE NETHERLANDS

- Guus Berkhout, Emeritus Professor of Geophysics, Delft University of Technology, Member of the Royal Netherlands Academy of Arts and Sciences; WCD Ambassador
- 2. Maarten van Andel, Author of the 'Groene Illusie'
- 3. André Bijkerk, Retired Officer Royal Dutch Air Force, now Climate Researcher
- 4. Peter Bloemers, Emeritus Professor of biochemistry, Radbout University, Nijmegen
- 5. Paul M.C. Braat, Emeritus Professor of Pulmonary Physics, University of Amsterdam
- 6. Solke Bruin, Emeritus Professor of Product-driven Process Technology, University of Eindhoven, and Former member Management Committee Unilever Research, Vlaardingen
- 7. Paul Cliteur, Professor of Legal Sciences, Member of the Senate of The Netherlands
- 8. Albert J.H.G. Cloosterman, Retired Chemical Engineer, Publicist on Climate and Cosmological Matters
- 9. Marcel Crok, Climate Researcher and Science Journalist
- 10. David E. Dirkse, Former Computer Engineer and Teacher Mathematics
- 11. Kees de Groot, Former Director Upstream Research Lab. Shell
- 12. Paul de Groot, PhD, Geoscience Manager dGB Earth Sciences
- $13. \quad \text{Rob de Kok, Principal Geophysicist, researching influence of CO2} \ on \ atmospheric temperatures$
- 14. Kees de Lange, Emeritus Professor of Physics, Vrije University Amsterdam and University of Amsterdam
- $15. \quad Louw \, Feenstra, Emeritus \, Professor \, Erasmus \, University \, and \, philosopher, \, Rotterdam$
- $16. \quad \text{Frans H. Gortemaker, Former Vice president Unilever Global R\&D} \\$
- 17. Ton J.T., Grimberg, Research and Operational Petro-physicist
- 18. Leo Halvers, Former Director Billiton Research Arnhem and former Director technology Foundation STW
- 19. Eduard Harinck, Former Logistics Expert, Nedlloyd Group/KPMG consulting; member of the ED support team
- 20. J.R. Hetzler, Forestry Economics and Time Series Modeling
- 21. Jan F. Holtrop, Emeritus Professor of Petroleum Engineering, Delft University of Technology
- 22. Tom Hoornstra, Air-conditioning Engineer
- 23. A. Huijser, Physicist and Former CTO Royal Philips Electronics
- 24. W.J. (Wouter) Keller, Emeritus Professor of Statistical Methods, Former Member Board of Directors, Central Bureau of Statistics (CBS)
- 25. Jacques van Kerchove, Economist and Marketeer, Former CFO Rabobank, now Climate and Environment researcher
- 26. R.W.J. Kouffeld, Emeritus Professor of Energy Conversion, Delft University of Technology
- 27. Hans H.J. Labohm, Former Expert Reviewer IPCC
- 28. Kees le Pair, Physicist, Former Director of Research organisations FOM and Technology & former member of the General Energy Council, The Netherlands
- 29. B.G. Linsen, Former Director Unilever Research Vlaardingen, The Netherlands
- 30. Pieter Lukkes, Emeritus Professor of Economic and Human Geography, University of Groningen
- 31. Hugo Matthijssen, Former Teacher Meteorology, now Publicist on Climate Matters

- 32. J.M. Mulderink, Former General Director Akzo-Nobel
- 33. Rob Nijssen, Radar Engineer and Publicist on Climate Matters
- 34. Leffert Oldenkamp, Expert Forest Management
- 35. Peter Oosterling, Former Scientist E & P Shell, now active as Climate Researcher;
- $36. \quad Kees\, Pieters, Mathematician; Former\, Operational\, Research\, and\, ICT\, manager\, at\, Shell$
- 37. Reynier Pronk, Former IT Manager, Accredited Project Management Consultant and Trainer
- 38. G.T. Robillard, Emeritus Professor of Biochemistry and Biophysics
- 39. Louis, M.P.T. van den Reek, PharmD., Member of 'De Groene Rekenkamer'
- 40. Kees Roos, Emeritus Professor of Optimization Technology, Delft University of Technology
- 41. Arthur Rörsch, Former Member Board of Directors, TNO, The Netherlands
- 42. Don Schäfer, Former Director Shell Exploration & Production and New Business, Shell
- 43. Frans Schrijver, Strategy Consultant and Climate Publicist
- 44. Jos de Smit, Emeritus Professor of Stochastic Operations Research and Former Rector Magnificus of the University of Twente
- 45. Albert Stienstra, Emeritus Professor of Computer Simulation and Micro-Electronics,
 Delft University of Technology
- 46. P.J. Strijkert, Former Member Board of Directors of DSM, Delft, The Netherlands
- 47. Fred Udo, Emeritus Professor of Nuclear Physics, Vrije Universiteit Brussels, Belgium
- 48. J.F. van de Vate, Former Director ECN, Petten, The Netherlands. Former UN Delegate IPCC.
- 49. Frans van den Beemt, Nuclear Physicist, Former Program Director Technology Foundation STW
- 50. Rutger van Santen, Emeritus Professor of Anorganic Chemistry and Catalysis, Former Rector Magnificus, Eindhoven University
- 51. Barend-Jan Smits, Geologist, Former Director of Wintershall Nederland, BASF Group
- 52. Hans van Suijdam, Former Executive Vice President Research and Development DSM, The Netherlands
- 53. Peter van Toorn, Former Research Geophysicist Shell
- 54. Jannes J. Verwer, Former CEO Large Electricity Generation Group and Former Chairman Supervisory Board State Owned Radio Active Waste Storage Facilities, The Netherlands
- 55. Henk van der Vorst, Emeritus Professor of Numerical Mathematics, University of Utrecht
- 56. Rob de Vos, Physical Geography
- 57. Jaap van der Vuurst de Vries, Emeritus Professor of Petroleum Engineering, Former Dean Faculty of Applied Earth Sciences, Delft University of Technology
- 58. Karel Wakker, Emeritus Professor of Astrodynamics & Geodynamics, Delft University of Technology
- 59. Cyril Wentzel, Multi-Physics Engineer and Chairman of Environmental Think Tank 'Groene Rekenkamer'
- 60. Dolf van Wijk, Formerly AkzoNobel Environmental Research Laboratory and Former Executive Director Cefic-Euro Chlor, Brussels
- 61. W.J. Witteman, Professor of Applied Physics and CO2 lasers, University of Twente
- 62. Theo Wolters, Co-founder 'Groene Rekenkamer' and 'Climategate.nl'



SCIENTISTS AND PROFESSIONALS FROM NEW ZEALAND

- 1. Terry Dunleavy MBE, co-founder (2006) and honorary secretary, New Zealand Climate Science Coalition; WCD Ambassador
- 2. Deborah Alexander, Agricultural Scientist, New Zealand
- 3. Jock Allison, retired Agricultural Scientist, Ministry of Agriculture, New-Zealand
- 4. Barry Brill, OBE, Previously Minister of Science and Techology, New Zealand
- 5. Doug Edmeades, Managing Director agKnowledge Ltd., New Zealand
- 6. Roger High Dewhurst, Retired, geologist/hydrogeologist, NewZealand
- 7. Geoffrey G. Duffy, Professor Emeritus, University of Auckland, New Zealand
- 8. Joe Fone, CAD Engineer, Enatel Ltd

- Bryan Leyland, Power Systems Engineer and Experienced Renewable Energy Specialist
- 10. Gerrit J. van der Lingen, Paleoclimatologist, New Zealand, Author of the Book The Fable of Stable Climate
- 11. John Scarry ME (Civil), structural engineer, member of the New Zealand Climate Science Coalition
- 12. John Sexton, Member of the New Zealand Climate Coalition
- 13. David Shelley, Emeritus Associate Professor Geology and latterly Dean of Postgraduate Studies, University of Canterbury, Christchurch, New Zealand
- 14. Philip Strong, Science Research Leader & Member of the New Zealand Climate Coalition
- 15. Richard Treadgold, Executive Member NZ Climate Scienc Coalition, Convenor Climate Conversation Group
- 16. Ian Wright, Professional Geologist



SCIENTISTS AND PROFESSIONALS FROM NORWAY

- Ivar Giaever, Nobel Prize Winner in Physics, Emeritus Professor of the Rensselaer Polytechnic Institute, Chief Technology Officer of Applied Biophysics Inc., Fellow of the American Physical Society, Honorary WCD Ambassador
- 2. Morten Jødal, Biologist, Former Employee of the NMorten Jødal, Biologist, Former Employee of the Norwegian Research Council and the Centre for the Development and Environment at the University of Oslo; WCD Ambassador
- 3. Gunnar Abrahamsen, Professor Emeritus Soil Science, University of Life Sciences, Norway
- 4. Stein Storlie Bergsmark, Phycisist, Former head of renewable Energy Studies Programmes, University of Agder, Norway
- 5. Reidar Borgstrøm, Professor Emeritus in fishbiology and Nature Conservation, University of Life Sciences Norway
- 6. Jon Gulbrandsen, PhD, biologist, Associate Professor NOFIMA and NOAA (USA), Norway
- 7. Rögnvaldur Hannesson, Professor Emeritus, Norwegian School of Economics, Norway
- 8. Geir Hasnes, Adjunct Associate Professor, Institute of applied Cybernetics, Norwegian University of Science and Technology, Norway
- 9. Ole Humlum, Professor Emeritus in Physical Geography, University of Oslo, Norway
- 10. Hans Konrad Johnsen, Dr. Ing., Norway
- $11. \quad Arn finn \, Langeland, Professor \, Emeritus \, Biology, Norwegian \, University \, of \, Science \, and \, \\ Technology$
- 12. Willy Nerdal, professor of Chemistry, University of Bergen
- 13. Ulf Torgny Rock, Master of Chemical Engineering, Norsk Hydro, Norway
- 14. Martin Torvald Hovland, Geophysical and Geological Advisor, Former Lecturer at University of Tromsø
- 15. Elen Roaldset, Emertitus Professor in Geology, University of Oslo, Former Director of Natural History Museum Oslo, Professor at Norwegian University of Science and Technology
- $16. \quad \text{Hakon Gunnar Rueslatten, Geological Researcher, Trondhheim} \\$
- 17. Tom V Segalstad, Associate Professor Emeritus of Geochemistry, University of Oslo, Norway
- 18. Jan-Erik Solheim, Professor Emeritus Astrophysics, University of Tromsø The Arctic University of Norway
- 19. Jørgen Stenersen, Professor Emeritus Eco-Toxicology, University of Oslo



SCIENTISTS AND PROFESSIONALS FROM PARAGUAY

1. Albrecht Glatzle, Retired Director Research of INTTAS (Iniciativa para la Inverstigación y Transferencia de Tecnología Agraria Sostenible)



SCIENTISTS AND PROFESSIONALS FROM THE PHILIPPINES

1. Melanchthon Bernil, Professional Chemical Engineer.



SCIENTISTS AND PROFESSIONALS FROM POLAND

- 1. Marek Boinski, Chairman of the National Section of Energy Workers' Union NSZZ
- 2. Jaroslaw Grzesik, Chairman of the National Secretariat of Mine and Energy Workers' Union NSZZ
- 3. Dominik Kolorz, Chairman of the Slasko-Dabrowski Region of NSZZ



SCIENTISTS AND PROFESSIONALS FROM PORTUGAL

- Demétrio Carlos Alves, Chemical Engineer, specialized in Processes and Systems.
 Postgraduate in Legal Issues of Urban Planning, University of Lisbon.
- 2. Rui Cruz, Pharmaceutical Development Scientist. PhD In Chemical and Biological Engineering (Material Science Focus for Solar Energy Applications)



SCIENTISTS AND PROFESSIONALS FROM RUSSIAN FEDERATION

- Habibullo Abdussamatov, Head of the Space Research Sector of the Sun, Pulkova Observatory RAS and Head of the Lunar Observatory Project on Monitoring of the Climate, Russian Federation
- 2. Henni Ouerdane, Assistant Professor, Manager of the Energy Systems PhD Programme, Skolkovo Institute of Science and Technology. Moscow Region



SCIENTISTS AND PROFESSIONALS FROM SOUTH-AFRICA

- Rosemary Falcon, Emeritus Professor Clean Coal Technology Research Group at the University of Witwatersrand, Director Fossil Fuel Foundation
- 2. Kelvin Kemm, PhD, Nuclear Physicist, CEO Nuclear Africa, Pretoria
- 3. John Ledger, Visiting Professor at the University of the Witwatersrand, Energy and Environmental Consultant
- 4. Don Mingay, Retired Professor of Nuclear Physics, South Africa



SCIENTISTS AND PROFESSIONALS FROM SPAIN

- Maria-Teresa Estevan Bolea, Ingeniero Laureado 2019 Royal Spanish Academy of Engineering. World Award 2018 In Engineering WFEO (World Federation of Engineering Organizations), National Prize in Industrial Engineering 2019.
- 2. Ferran Brunet, Professor on the European Economy, Unniversitat Autònoma de Barcelona
- 3. José Carlos Gonzàlez Hidalgo, Professor of Physical Geography, teaching more that 20 years on climatology and doing research on the topic. University of Zaragoza, Dep. Geografia
- 4. Blanca Parga Landa, PhD, Modelling Expert, Specialist in Environmental Law
- 5. Luis Pomar, Emeritus Professor of the University of the Balearic Islands, Spain.

 Sedimentologist specialized in the study of carbonate rocks which the impact of CO2 and paleoclimate are essential to understand the origin of these rocks



SCIENTISTS AND PROFESSIONALS FROM SWEDEN

- I. Ingemar Nordin, Emeritus Professor Philosophy of Science, Linköping University; WCD Ambassador
- 2. Leif Åsbrink, PhD in Technology at KTH in Molecular Physics, Stockholm
- 3. Sture Åström, Professional in Climate Issues, Secretary of the Swedish Network Klimatsans
- 4. Rolf Bergman, Emeritus Professor of Physical Chemistry, Uppsala University
- 5. Dr. Lars Bern, Retired CEO in Incentive AB
- 6. Magnus Cederlöf, Software Specialist, Stockholm
- 7. Hans Eklund, PhD of Technology, Acting Professor at the Department of Laser-and Electro-optics, Chalmers University of Technology, Gothenburg
- 8. Per-Olof Eriksson, Physicist, Former CEO of Sandvik Group
- 9. Dr. Anders Flodin, PhD Mechanical Engineering, NC, USA
- 10. David D. Gee, Professor Em Orogen Dynamics, Uppsala University, Sweden
- 11. Anders Grufman, MSE, MA Economics, Industrial and Environmental Economics
- 12. Jan Hagberg, PhD Statistics, Stockholm



- 13. Lars Hässler, PhD Rock and Soil Mechanics, B.sc Chemistry and Biology, M.sc. Civil Engineering
- 14. Eilif Hensvold, PhD Mathematics, Associate Professor of Mathematics (retired), Simulation of Large-scale Industrial Systems, Uppsala University, Luleå Technical University
- 15. Gunnar Holmgren, PhD in Space Physics, Retired Head of Dept. of Engineering Sciences, Uppsala University
- 16. Mats Janson, M.Sc Electrical Engineering, KTH Royal Institute of Technology, Stockholm
- 17. Hans Jelbring, Climate researcher
- 18. Göran Johansson, Specialist in Energy Systems
- 19. Claes Johnson, Emeritus Professor of Mathematics at Royal Institute of Technology, Stockholm
- 20. Gunnar Juliusson, Professor of Hematology, Lund University, Senior Consultant, Skåne, University Hospital, Lund
- 21. Sten Kaijser, Emeritus Professor of Mathematics, Uppsala University
- 22. Johnny Kronvall, Emeritus Professor in Building Physics, Malmö University and Lund University
- 23. Lars E. Linder, Associate Professor of Medicine, Gothenburg
- 24. Rune Lundgren, M.Sc at Helsinki University of Technology, Energy System Expert
- 25. Johan Montelius, Associate Professor of Computer Science at the Royal Institute of Technology, Stockholm
- 26. Nils-Axel Mörner, Emeritus Professor Geology, President of the Independent Committee on Geoethics. Former head of Paleogeophysics & Geodynamics at Stockholm University
- 27. Jacob Nordangård, PhD in Technology and Social Change at the University of Linköping, Researcher on Climate Change History
- 28. Gösta Pettersson, Emeritus Professor in Biochemistry, University of Lund
- 29. Marian Radetzki, Emeritus Professor of Economics, Luleå University of Technology
- 30. Peter Stilbs, Emeritus Professor of Physical Chemistry, Royal Institute of Technology (KTH), Stockholm
- 31. Mats Rosengren, Mathematics, Space Flight Trajectory Specialist
- 32. Torsten Sandström, Professor Emeritus, Department of Law, University of Lund
- 33. Rabbe Sjöberg, PhD in Geology, Member of Paleogeophysics & Geodynamics Institute
- 34. Lars H. Thylen, Professor Emeritus, Dept. of Theoretical Chemistry and Biology, Royal Institute of Technology
- 35. Elsa Widding, Consultant, Author on Climate Change, Stockholm
- 36. Lech Wosinski, Researcher emeritus, Associate Professor, Royal Institute of Technology, Stockholm



SCIENTISTS AND PROFESSIONALS FROM SWITZERLAND

- 1. Christian Jacot, Pharmacist
- 2. Thomas Binder, Cardiologist and Internist
- $\label{eq:continuous} 3. \qquad \text{Werner Furrer, MsC in Mathematics and Physics, President of the Climate Realistic} \\ \qquad \text{Group in Switzerland}$
- 4. Jef Ongena, Member of the Permanent Monitoring Panel for World Energy, World Federation of Scientists, Geneva
- 5. Jean-Claude Pont, Dr. Math., Emeritus Professor of The History of Philosophy of Sciences, University of Genève
- Claude Roessiger, Entrepreneur and Author of several Books on Organizational Management and Public Policy, Organiser and Chairman of the Portsmouth Conference 2018 on Climate Policies
- 7. Lars Schernikau, Entrepeneur, Energy Economist, Switzerland



SCIENTISTS AND PROFESSIONALS FROM UNITED KINGDOM

- 1. Christopher Monckton of Brenchley, Peer of the Realm and author of several reviewed papers on climate; WCD Ambassador
- 2. Neils C. Arveschoug, Geophysicist, Private start-up oil E&P Company

- 3. Andrew P. Barker, Biological Chemist
- 4. Paul Binns, Former Research Geoscientist and Climate Researcher
- David Bodecott, Consultant Geophysics and Geology, Fellow of the Geological Society of London
- 6. D. Q. Bowen, Emeritus Professor of Earth and Ocean Sciences, Fellow International Union for Quaternary Research, Cardiff University
- 7. Michael Brown, Expert in large scale thermal fluid dynamic models.
- 8. Brian R. Catt, Physicist, Electrical Engineer, Retired, publishing papers on energy and climate change
- 9. John C. W. Cope, Professor of Geology, National Museum Wales, Cardiff
- 10. Richard Courtney, Retired Material Scientist, Expert Peer Reviewer of the IPCC
- 11. Peter Cunningham, Expert in Mathematical Modelling of Complex Physical Phenoma
- 12. Isabel Davis, Geophysicist and Entrepreneur
- 13. John Dewey, Emeritus Professor of Geology at the University College Oxford, Distinguished Emeritus Professor University of California, Member of the US National Academy of Sciences, Fellow of the Royal Society
- 14. Howard Dewhirst FGS, Geologist, Initiator Open Letter to the Geological Society of London
- 15. Gregor Dixon FGS, Geologist, former member Geological Society of London
- 16. Roderick Paul Eaton, Retired Energy Systems Analyst from the UK Electricity Supply Industry
- 17. Peter Gill, Physicist, Former Chair of the Institute of Physics Energy Group, UK
- 18. Gil Gilchrist, Geophysicist, UK
- 19. Mick Greenway, specialized in research and development of flight control systems for modern civil and military aircraft; Retired Head of Research and Development within a multi-million-dollar company
- 20. Jimmy Haigh, Independent Geological Consultant
- 21. Tim Harper FGS, Geologist, Entrepreneur, Devon
- 22. John Harrison, Former Chartered Physicist and Chartered Engineer
- 23. Bob Heath, retired Geophysicist, Honorary member of the Indian Society of Petroleum Geologists
- 24. Alex Henney, Formerly London Electricity Board, Consultant on Electricity Matters
- 25. Roger Higgs, DPhil (Oxon), Independent Geological Consultant, Geoclastica Ltd.
- 26. Keith H. James, PhD, Consultant Geologist
- 27. David A. L. Jenkins, Geologist, Director Hurricane Energy plc
- 28. Chris Jesshope, Emeritus Professor University of Amsterdam, Director Techne Consulting Ltd. (UK)
- 29. Roger Longstaff, Experimental Space Physicist and Company Director
- 30. Chris Matchatte-Downes, Geologist, fellow of the geological Society of Gt Britain
- 31. Stuart Munro, Exploration Geologist and Geophysicist
- 32. Edward Nealon, Geologist Member of the Australian Institute of Mining & Metallurgy, UK
- 33. Blair Nimmo, Electronic Engineer, working in computer networking and optical surface metrology and fibre optics
- $34. \quad \hbox{Peter Owen FGS, Fellow of the Geological Society of London} \\$
- 35. Dennis Paterson, Geologist, retired
- 36. Clive Randle, Geologist, Fellow of the Geological Society of London
- 37. Michael J. Rath, Professional Forrester
- 38. Ceri Reid, Researcher, Engineer and Manager
- 39. Michael F. Ridd, Geologist, Fellow of the Geological Society of London
- 40. Anthony Robb, PhD, Retired Chemist
- 41. Richard Saumarez, Biomedical Engineer from Imperial College
- 42. Michael Seymour, geologist, Fellow of the Geological Society of London
- 43. Stephen Taylor, PhD, Infra-Red Physicist and Tidal Hydrographer, MD Geomatix Ltd., Member of Inst. of Physics, Member of Inst. of Electrical and Electronic Engineers, Associate Fellow of Royal Institute of Navigation, Member of the Hydrographic Society
- 44. Leslie Thomson, Retired Vice President Operations, BP Exploration, Aberdeen
- 45. Jay Willis, Marine Scientist, Associate of the OxNav Group of Oxford University.

46. Valentina Zharkova, Professor of Mathematics and Astrophysics, Northumbria University, Newcastle upon Tyne



SCIENTISTS AND PROFESSIONALS FROM USA

- Richard Lindzen, Emeritus Professor Atmospheres, Oceans and Climate, MIT, USA; WCD Ambassador
- 2. John Droz jr, Physicist, Founder of AWED Alliance, USA, WCD Ambassador
- 3. Ralph B. Alexander, Emeritus Professor of Physics, Science Writer
- 4. Raphael D'Alonzo, Analytical Chemist, Retired Associate Director, the Proctor & Gamble Company
- 5. Anthony J. Armini, Retired Founder and CEO Implant Sciences Corp.., USA
- 6. Dr. Malgorzata Askanas, Senior R&D Associate at the Aurora Biophysics Research Institute
- 7. Hans-Peter Bär, Emeritus Professor of Pharmacology, Canada and Former Dean of Basic Medical Sciences, American University of Barbados, Barbados
- 8. James R. Barrante, Emeritus Professor of Physical Chemistry, USA
- 9. Charles G. Battig, Climate Adviser, Heartland Institute, USA
- 10. Larry Bell, Endowed Professor of Space Architecture, University of Houston, USA
- 11. David J. Benard, Chemical Physicist & Co-inventor of the Oxygen-iodine Chemical Laser
- 12. Edward Berry, PhD, Atmospheric Physicist, American Meteorological Society, Author, Climate Physics LLC, USA
- 13. Jared L. Black, Numerical Analysis Consultant, Sc.D., USA
- Elliott D. Bloom, Emeritus Professor of Particle Physics and Astrophysics, KIPAC-SLAG, Stanford University
- 15. David Boleneus, Professional Geologist
- 16. Daniel Botkin, Emeritus Professor of Biology, Climate Researcher, Author of the Book: Twenty-five Myths That Are Destroying the Environment, USA
- 17. Robert L. Bradley Jr., CEO and Founder of the Institute for Energy Research
- 18. James W. Buell, PhD, Aquatic Biologist, Consultant
- David Burton, System and Computer Scientist, Expert Reviewer of AR5 and AR6,
 Member of the CO2 Coalition, and Creator of the SeaLevel.info website
- 20. Sharon R. Camp, PhD, Retired Analytical Chemist and Environmental Scientist.
- 21. Nick Capaldi, PhD, Author Books on Logic, the Scientific Method and the Philosophy of Science
- 22. Roy Clark, Climate Researcher, Retired Engineer, California
- 23. Sabin W. Colton, PhD, Biochemist and Marine Biologist
- 24. Martin Cornell, Retired Senior Scientist, Dow Chemical Company, USA
- 25. Joseph S. d'Aleo, Professor of Meteorology and Climatology at Lyndon Stage College, Founder of Icecap.us, First Director of meteorology of the Weather Channel, USA
- 26. George Davey, Physicist, University of Iowa
- 27. Donn Dears, Retired Senior Executive GE Company, BS Engineering from United States Merchant Marine Academy
- 28. James DeMeo, PhD, Retired Expert in Earth and Atmospheric Science, Oregon
- 29. David Deming, Professor of Arts & Sciences, University of Oklahoma, USA
- 30. Harold H. Doiron, Retired NASA Engineer, USA
- 31. Mohan Doss, Professor, Fox Chace Cancer Center, Philadelphia, One of the Founding Members of SARI.
- 32. Jack D. Downing, Geologist and Geophysicist
- 33. Paul Driessen, Senior Policy Advisor, Committee for a Constructive Tomorrow (CFACT) and Congress of Racial Equality (CORE)
- 34. John Dale Dunn, MD, JD, Lecturer Carl R. Darnall Army Medical Center, Fort Hood,
- 35. Freeman Dyson, Emeritus Professor Natural Sciences, Institute of Advanced Study, Princeton University, USA
- 36. Vincent Esposito, Adjunct Professor University of Pittsburg, PA, USA; Doctor of Science in Nuclear Engineering (Un. Fo Viginia), Retired Manager from Westinghouse Electric Company

- 37. Peter Farrell, Fellow of the US National Academy of Engineering, USA
- 38. Rex Fleming, Research Scientist, Author of Book on Carbon Dioxide Fallacy, Retired President Global Aerospace, USA
- 39. Jim Folcik, Geosciences Manager Extraction Oil & Gas
- 40. Patrick Frank, PhD, SLAC National Accelerator Laboratory, Stanford University
- 41. Gordon J. Fulks, Astrophysicist, Board of Directors CO2 Coalition, Co-founder Global Warming Realists
- 42. Terry Gannon, Physicist, Retired Semiconductor Executive, USA
- 43. Nicholas De Gennaro, PhD PE, Coastal Engineer, Southport North Carolina.
- 44. Ulrich H. Gerlach, Professor of Mathematics, Ohio State University, USA
- 45. Ivar Giaever, Nobel Prize Winner in Physics, Emeritus Professor of the Rensselaer Polytechnic Institute, Chief Technology Officer of Applied Biophysics Inc., Fellow of the American Physical Society
- 46. Laurence I. Gould, Professor of Physics, University of Hartford, Past Chair, New England Section of the American Physical Society.
- 47. Steve Goreham, Executive Director, Climate Science Coalition of America, USA
- 48. Mike Gruntman, Professor of Astronautics, University of Southern California
- 49. Lyle W. Hancock, Professional Mathematician
- 50. Bryan Haycock, PhD, Adjunct Faculty at a University in the state of Utah.
- 51. David Heald, Retired Electrical Engineer, USA
- 52. Howard C. Hayden, Emeritus Professor of Physics, University of Connecticut, USA
- 53. Oliver Hemmers, Retired Executive Director of the Harry Reid Center at the University of Nevada, Las Vegas
- 54. Gary L. Hoe, P.E., Retired Colonel USAF; Technical Director of several Nuclear Weapon Effects Tests at the Nevada Test Site; Member Scientists for Accurate Radiation Information (SARI)
- 55. Jim Hollingworth, Social Scientist; Book: 'Climate Change: A Convenient Truth'
- 56. Edward Huff, PhD, Retired NASA Senior Scientist
- 57. Kathryn E. Kelly, President Delta Toxicology, USA
- 58. Hugh Kendrick, PhD, Retired Director Plans and Analysis, Office of Nuclear Reactor Research, US Dept. of Energy, Fellow American Physical Society
- 59. Stephen C. Knowles, Marine Scientist and Geologist, Beacon, New York, USA
- 60. Wayne P. Kraus, Member American Institute of Chemical Engineers (AIChE)
- 61. Jay Lehr, PhD, Senior Policy Analyst for the International Climate Science Coalition. Former Science Director of the Heartland Institute.
- 62. David P. Lentini, Chemist and Patent Attorney, New Hampshire
- Jeffrey Mahn, Retired Nuclear Engineer Sandia National Laboratories (New Mexico, USA); Member Scientists for Accurate Radiation Information (SARI), Member Nuclear Society (ANS)
- 64. M. Malkan, PhD, Distinguished Professor of Physics and Astronomy, UCLA
- 65. James A. Marsh, Emeritus Professor of Immunology, Cornell University, Dept. of Microbiology and Immunology
- 66. Patrick J. Michaels, Competitive Enterprise Institute, Washington DC, USA
- 67. Pamela Matlack-Klein, Member of Portuguese Sea Level Project, USA
- 68. Andy May, Writer and Retired Petrophysicist
- 69. Dr. Gene McCall, Consultant to the Defense Science Board, Former consultant to the Department of Energy on Issues related to Inertial Fusion. Former Member and Chairman of the USAF SAB. Former Member of the Senior Review Group to the Defense Airborne Airborne Reconnaissance Office (DARO) and Former Chairman of the Technology Assistance panel fir DARO
- 70. Craig Mc Cluskey, PhD, Physics
- 71. Richard McFarland, Retired NASA Physicist, USA
- 72. Marc Meier, PhD, Professor of Physics, University of Houston
- 73. Samuel H. Melfi, Emeritus Professor of Physics, UMBC, Retired NASA Scientist, USA
- 74. Kenneth Melvin, MD: retired Professor of Medicine, Portland, Oregon
- 75. Ferenc M. Miskolczi, Retired NASA/AS&M Senior Scientist; Foreign Associate Member of the Hungarian Academy of Sciences

- 76. James Moore, Commercial Fisherman, President Alaska Trawlers Association, Executive Committee Northern Southeast Regional Aquaculture Association, Board member Amstrong Keta Inc.
- 77. Daniel W. Nebert, Professor Emeritus, Department of Environmental Medicine and Center for Environmental Genetics, University of Cincinnati
- 78. Ned Nikolov, Ph.D., Physical Scientist at the USFS Rocky Mountain Research Station in Fort Collins, CO, USA, managing a fire-weather intelligence project
- 79. Thomas O'Connor, Member American Association of Petroleum Geologists, Washington, USA
- 80. Kenton Oma, Retired PE Chemical Engineer, Environmental Engineering, Environmental Consultant, R&D at DOE Nuclear Facility
- 81. Trueman D. Parish, Retired Director of Engineering Research Eastman Chemical Company, USA
- 82. Arvid Pasto, PhD in Ceramics, Retired from the Oak Ridge National Laboratory, TN
- 83. Charles W. Pennington, Senior Vice President of Engineering, NAC International (Retired); Secretary, XLNT Foundation, Board of Directors
- 84. Jeffrey S. Philbin, Retired Nuclear Engineer Sandia National Laboratories (New Mexico, USA); Independent Consultant in Nuclear Facility Design and Safety Analysis, Nuclear Criticality Safety and Weapon Response
- 85. James M. Policelli, Registered Professional Engineer
- 86. Herman A. Pope, retired Aerospace Engineer NASA-JSC, USA
- 87. Willem Post, Independent Researcher regarding Energy and Environment
- 88. Kenneth L. Purdy, Management Consultant, Retired Naval Officer in Operational Intelligence
- 89. Forrest J. Remick, Emeritus Professor of Nuclear Engineering; Emeritus Assoc. VP for Research at The Pennsylvania State University. Retired Commissioner, US Nuclear Regulatory Commission
- 90. Phil Robinson, Retired Chemist in the Aluminium and Steel Industry
- 91. James H. Rust, Emeritus Professor of Nuclear Engineering, Georgia Institute of Technology
- 92. Rick Sanders, M.A. Scientists for Accuracy in Radiation Information (SARI), Associate Editor, 21st Century Science and Technology Magazine
- 93. Charles L. Sanders, Retired Radiobiologist; Author of Radiobiology and Radiation Hormesis: New Evidence and Its Implications for Medicine and Society (Springer)
- 94. Thomas P. Sheahen, PhD, Chairman, Science and Environmental Policy Project
- 95. John Shewchuk, Meteorologist (CCM) and Atmospheric Researcher, USA
- 96. Robert P. Smith, PhD, P.E., Environmental Scientist and Professional Engineer
- 97. Willie Soon, Independent Scientist, USA
- 98. Walter Starck, PhD in Marine Science, Pioneer in Coral Reef Studies, Policy Advisor to The Heartland Institute.
- 99. Jim Steele, Emeritus Director Sierra Nevada Field Campus, San Francisco State University
- 100. Ronald Stein, Professional Engineer, USA
- 101. Gerald M. Sulzer, MS Chemical Engineer, Retired Director of Technology, Albemarle Corporation, USA
- 102. Tomer D. Tamarkin, Physicist, Founder and President/CEO of Energycite Inc., President and Chairman of ClimateCite Inc.
- 103. Paul Taylor, Energy Economist, recipient Rossitor Raymond Award, Golden Colorado, USA
- 104. David E. Thompson, Emeritus Professor Mechanical Engineering and Computer Science, Dean Emeritus College of Engineering, University of Idaho
- 105. Cecil Joe Tomlinson, Retired Boeing Senior Principle Engineer
- 106. Kip Trout, Lecturer in Physics, The Pennsylvania State University York Campus
- 107. Richard Trzupek, Chemist and Air Quality Expert
- 108. Waheed Uddin, Professor of Engineering Science, University of Mississippi, Expert in Climate Modeling, Former Advisor UN
- 109. William B. Walters, Guggenheim Fellow, Professor of Atmospheric, Nuclear and Environmental Chemistry, University of Maryland, USA

- $110. \ \ James \ Wanliss, Professor \ of \ Physics, Presbyterian \ College \ USA$
- 111. Chuck F. Wiese, Professional Meteorologist, USA
- $112. \ \ Steven\ E.\ We is mantel,\ Retired\ Engineer\ and\ Climate\ Researcher,\ USA$
- 113. Gregory R. Wrightstone, Expert Reviewer IPCCC 6th Assessment Report (AR6), USA
- 114. David Wojick, Cognitive Scientist, USA
- 115. Thomas Wysmuller, Retired NASA Executive, USA
- $116. \ \ \, Bob\,Zybach, Program\,Manager, Oregon\,Websites\,and\,Watersheds\,Project\,INC., USA$



The World Climate Declaration was initiated in 2019 by emeritus professor Guus Berkhout, founder of the Dutch Climate Intelligence Foundation (CLINTEL). The list of signatories is a living document that is regularly updated with new additions. The most up-to-date version can be found on www.clintel.org.

 $\textit{Graphic design:} \ \underline{\textit{www.zinontwerpers.nl}}$

