How much global warming would worldwide net zero emissions prevent by 2050, and at what cost?

SOME 70% of new CO_2 emissions arise[1] in Paris-exempt nations – such as China,[2] India[3] and Pakistan[4] – that are greatly expanding their coal-fired capacity so as to power production priced out of Paris-obligated nations by onerous emissions-abatement measures driving high electricity and compliance costs. Output emissions intensity in Paris-exempt nations exceeds that of Paris-obligated nations, whose substantial and growing sacrifices of businesses, jobs and profits thus paradoxically increase global emissions, helping to sustain the near-linear uptrend[5] therein, undiminished since 1990. Here, from mainstream methods and data, it is shown that the uptrend in global temperature[6] since 1990 is well below half the then-predicted[7] midrange rate, so that even worldwide net zero emissions would prevent less than 0.1 C global warming by 2050. Each $1 bn spent would prevent less than one ten-millionth C warming. Paris-obligated nations have accordingly set themselves at a strategic and costly but pointless terms-of-trade disadvantage.

Context

Some 70% of new greenhouse-gas emissions arise in nations exempt from the Paris climate accord.[1] Emissions-abatement legislation in the chiefly Western nations selectively targeted by the accord has greatly increased their electricity and compliance costs, setting them at a severe and deepening terms-of-trade disadvantage against the Paris-exempt nations. Electricity prices[8] in Germany and Denmark, at \$0.80 kWh^{-1} for households and \$0.60 kWh^{-1} for businesses, exceed the \$0.10 kWh^{-1} for households and \$0.08 kWh^{-1} for businesses in India and China by an order of magnitude.

China,[2] India[3] and Pakistan,[4] with more than one-third of global population, are greatly expanding their coal-fired generating capacity, not least so as to accommodate production priced out of Paris-obligated nations by their increasingly costly and intrusive emissions-abatement measures, the chief cause of the large and rapidly-growing disparity between Western and Eastern electricity prices.

Particularly where the manufactures displaced are energy-intensive, Eastward transfer of Western jobs and industries increases global emissions (the opposite of what was intended): for manufacturing in Paris-exempt nations emits more per product than in Paris-obligated nations. Sure enough, since the first (1990) report[7] of the Intergovernmental Panel on Climate Change, anthropogenic greenhouse-gas forcing has increased at an undiminished, near-linear rate[5] of 1.1 Watts per square meter in 33 years, or 1/3rd of a Watt per square meter per decade. Substantial sums spent by Paris-obligated nations on abatement over a third of a century have thus exerted no discernible mitigating effect.

Methods

If – as is likely – the long-run uptrend in anthropogenic greenhouse-gas forcing[5] continues for 27 years to 2050, it will grow by another 0.9 W m^{-2}, of which half, ΔQ_{aba} on **0.45** [0.35 to 0.55] W m^{-2}, would be abated if all nations moved linearly from current emissions to net zero. For **3.93** [3.46 to 4.4] W m^{-2} midrange doubled-CO_2 effective radiative forcing[9, p.925] (**ERF**) and **1.8** [1.2 to 2.4] C transient doubled-CO_2 climate response (**TCR**) thereto,[9, p.93] Monte Carlo distribution **(Fig. 1)** via **Eq. (1)** yields the 2 σ interval **0.19** [0.12 to 0.3] C of global warming ΔT_X that worldwide net zero would prevent by 2050**:**

Global warming ΔT_X that worldwide net zero emissions would prevent by 2050

$$\Delta T_X = \Delta Q_{aba} \frac{TCR}{ERF} = \mathbf{0.19}\ [0.12 \text{ to } 0.30]\ C \qquad (1)$$

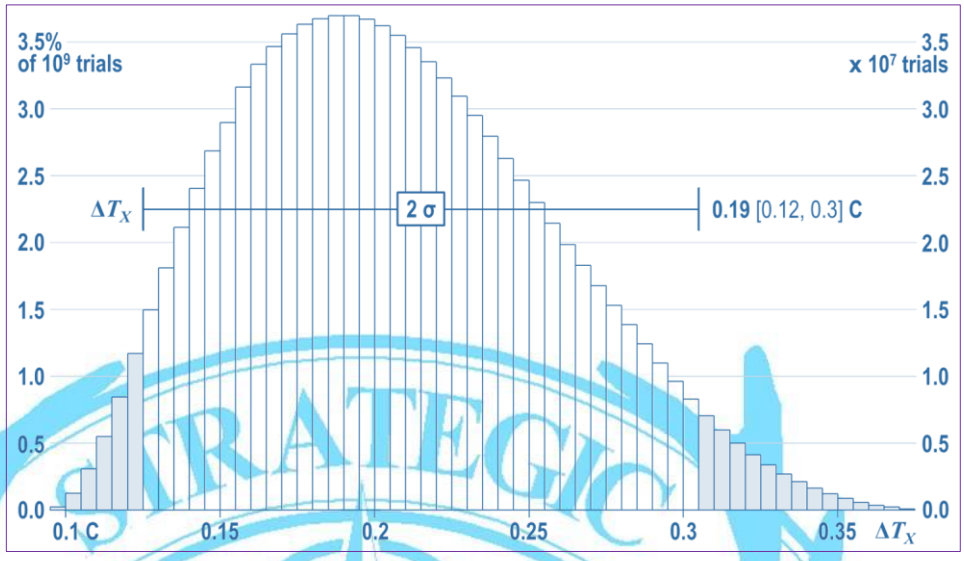


Figure 1.

Global warming ΔT_X that world-wide net zero would prevent by 2050

(Monte Carlo distribution: 1 billion trials)

Results

In the 33 years since 1990, when the global scientific community first[9] predicted the likely evolution of temperature based on four emissions scenarios A-D, emissions have tracked[10] Scenario A (business as usual), which had predicted 0.3 C decade^{-1} midrange transient warming[9, p. xi] ΔT_{prdc}. Yet observed warming[6] ΔT_{obs} was just 0.136 C decade^{-1} (with no trend[6] in the last nine years). **Eq. (2)** gives midrange ΔT_C after allowing for this factor-2 excess of originally-predicted over subsequently-observed warming:

Corrected warming ΔT_C that worldwide net zero emissions would prevent by 2050

$$\Delta T_C = \Delta T_X \frac{\Delta T_{\text{obs}}}{\Delta T_{\text{prdc}}} = \Delta Q_{\text{aba}} \frac{\text{TCR}}{\text{ERF}} \frac{\Delta T_{\text{obs}}}{\Delta T_{\text{prdc}}} < \frac{1}{10} \text{ C} \quad (2)$$

McKinsey Consulting[11] has conservatively estimated that the capex cost alone of worldwide net zero would be $275 trillion, or half of global corporate profits. After allowing for opex, typically at least twice capex, total cost might well approach $1 quadrillion. Then every $1 billion spent on attaining net zero **(Eq. 3)** would prevent only **one 10-millionth of a degree** of warming – poor value for money:

Global warming ΔT_B prevented by each $1 billion spent on emissions abatement

$$\Delta T_B = \Delta T_X \frac{\$1 \text{ billion}}{\$1 \text{ quadrillion}} < \frac{1}{10,000,000} \text{ C} \quad (3)$$

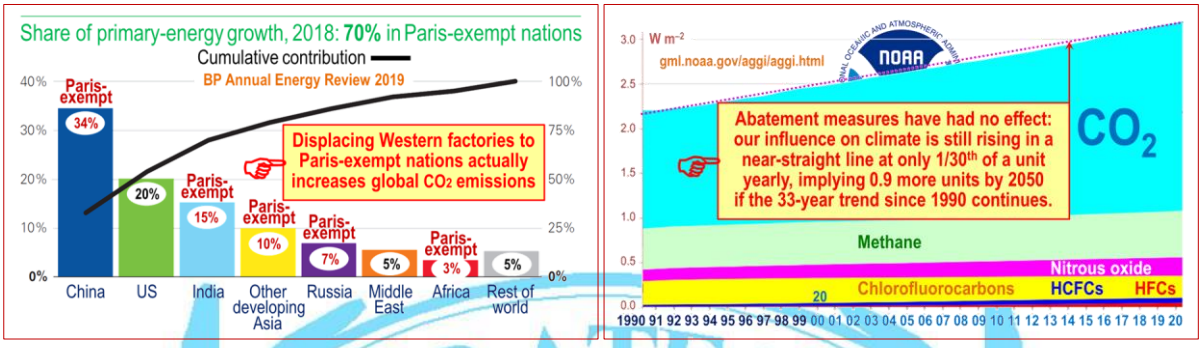
However, the UK's national grid authority estimates[12] the cost of net-zeroing the grid as $3.6 trillion. Since the grid contributes only 23.6% of national emissions.[13] UK net zero might cost $15 trillion – more than six years' annual GDP over 27 years. Since the UK represents 1% of global emissions.[13] UK net zero would prevent only **1/1000th C** of warming by 2050, before accounting for the Eastward transfer of UK jobs, increasing global emissions. On the basis of the probably-underestimated[12] cost of net-zeroing the UK grid, worldwide net zero might cost **$1.5 quadrillion** (100 times the UK cost). Then every $1 bn spent on abatement would prevent only **one 16-millionth of a degree** of warming.

The US represents 15% of global emissions.[14] Even if the US were to attain net zero, its contribution to reduced warming by 2050 would be only **1/70th C**, and less after adjustment for exported emissions.

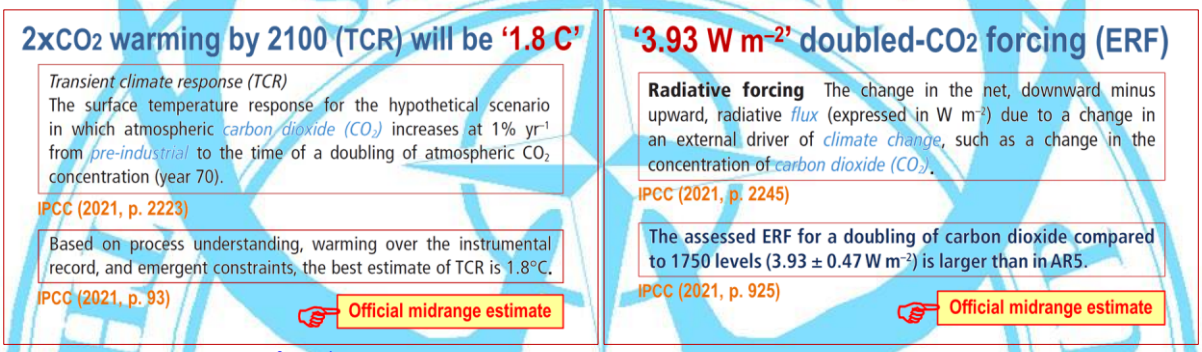
Conclusions

If the present 0.136 C decade^{-1} global-temperature uptrend persists to 2050, by then the world will be less than 0.4 C warmer than now. Even after worldwide net zero it would be less than 0.3 C warmer than now. However, since the most populous Paris-exempt nations are greatly increasing coal-fired capacity, keeping their electricity prices an order of magnitude below Western prices, even the theoretically-achievable 0.1 C reduction will not occur. Instead, exporting Western emissions to the Paris-exempt nations will continue, actually adding to global warming. Thus, net zero would deepen the West's already-worsening terms-of-trade disadvantage without conferring any benefit on the climate. Even worldwide net zero is unachievable, unaffordable and incapable of significantly reducing future global warming, which, on the trend since 1990, will in any event be small, harmless and net-beneficial.

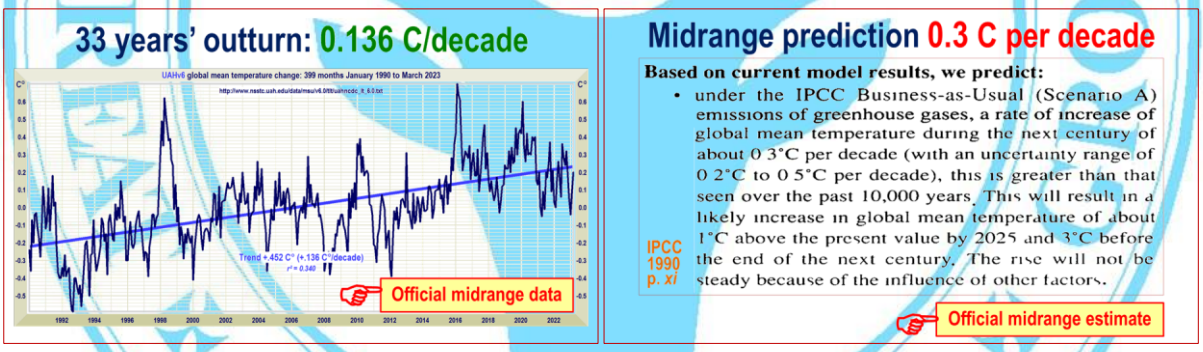
Primary data sources in facsimile



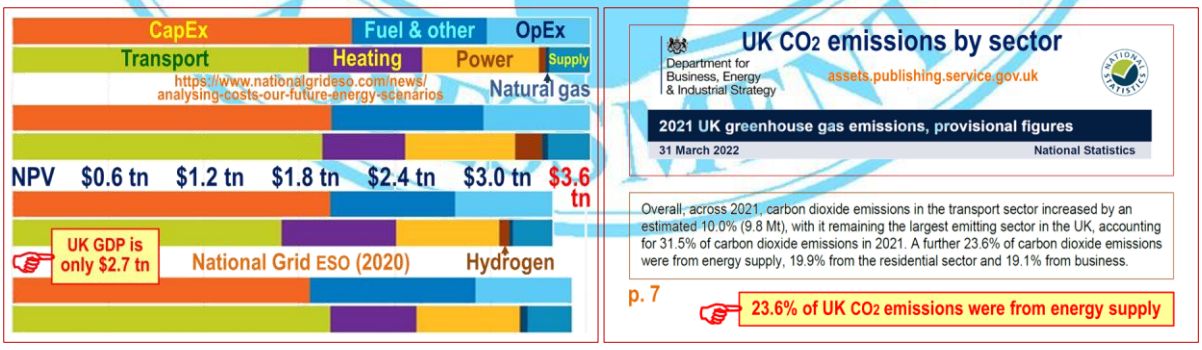
Most new emissions arise in Paris-exempt nations, so abatement measures have had no effect so far. But if the whole world went in a straight line from current emissions to net zero by 2050, half the 0.9 W m^{-2} increase in anthropogenic forcing in the 27 years to 2050 would be prevented: i.e., **0.45 W m^{-2}**.



The ratio **0.46 W m^{-2} K^{-1}** of 2xCO_2 TCR and ERF converts forcing abated to warming prevented.



The ratio **0.45** of observed to predicted decadal warming since 1990 reduces warming prevented.



The ratio of the $3.6 tn cost of net-zeroing the UK grid to the 23.6% of CO_2 emissions represented by energy supply is **$15.25 trillion,** a reasonable first approximation to the true cost of net zero in the UK.

Since the UK represents 1% of global emissions, global net zero might cost **$1.5 quadrillion,** so that each $1 billion spent on emissions abatement would prevent **one 16-millionth C** of warming. But that very large worldwide expenditure would prevent **less than 1/10th C** global warming, of which UK net zero would prevent 1%, or **less than 1/1000th C**, and US net zero 15%, or about **1/70th C.**

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