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Solving the climate crisis: lessons from ozone depletion and COVID-19

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Abstract

The 'climate crisis' describes human-caused global warming and climate change and its consequences. It conveys the sense of urgency surrounding humanity's failure to take sufficient action to slow down, stop and reverse global warming. The leading direct cause of the climate crisis is carbon dioxide (CO_2) released as a by-product of burning fossil fuels,[i] which supply ~87% of the world's energy. The second most important cause of the climate crisis is deforestation to create more land for crops and livestock. The solutions have been stated as simply 'leave the fossil carbon in the ground' and 'end deforestation'. Rather than address fossil fuel supplies, climate policies focus almost exclusively on the demand side, blaming fossil fuel users for greenhouse gas emissions. The fundamental reason that we are not solving the climate crisis is not a lack of green energy solutions. It is that governments continue with energy strategies that prioritize fossil fuels. These entrenched energy policies subsidize the discovery, extraction, transport and sale of fossil fuels, with the aim of ensuring a cheap, plentiful, steady supply of fossil energy into the future. This paper compares the climate crisis to two other environmental crises: ozone depletion and the COVID-19 pandemic. Halting and reversing damage to the ozone layer is one of humanity's greatest environmental success stories. The world's response to COVID-19 demonstrates that it is possible for governments to take decisive action to avert an imminent crisis. The approach to solving both of these crises was the same: (1) identify the precise cause of the problem through expert scientific advice; (2) with support by the public, pass legislation focused on the cause of the problem; and (3) employ a robust feedback mechanism to assess progress and adjust the approach. This is not yet being done to solve the climate crisis, but working within the 2015 Paris Climate Agreement framework, it could be. Every nation can contribute to solving the climate crisis by: (1) changing their energy strategy to green energy sources instead of fossil fuels; and (2) critically reviewing every law, policy and trade agreement (including transport, food production, food sources and land use) that affects the climate crisis.

Social media summary

To solve the climate crisis, governments must end policies that support fossil fuels, not just support renewable energy.

1. Introduction

Humanity is not on track to solve the climate crisis. If unchecked, climate change could lead to global mean temperature increases of several degrees, large uninhabitable regions, melting ice-caps and flooding of coastal cities. The leading cause of warming is CO_2 (see Figures 1 & 2), which is a heat-trapping 'greenhouse' gas[ii] that absorbs and emits radiant energy within the thermal infrared range. If everything else were unchanged, the higher the CO_2 concentration, the warmer Earth becomes. Prior to the Industrial Revolution, CO_2 concentrations were about 280 ppm. Today, mainly as a consequence of human activities, the concentration is more than 410 ppm, and its rise is accelerating. It is the *cumulative emissions* of CO_2 – the total fossil carbon extracted by humans – that determines how much Earth warms (Allen *et al.*, 2009). Humanity has burned ~10% of known fossil fuel reserves and Earth has already warmed by ~1°C. If all known reserves are used, the global temperature rise could exceed 10°C (Tokarska *et al.*, 2016). The science on fossil carbon is clear – we need to 'leave most of the fossil carbon in the ground' (McGlade & Ekins, 2015).

Aside from fossil carbon extraction, the second important aspect to the climate problem is that humanity is damaging and reducing natural carbon stores (e.g., deforestation for timber, cattle, soybeans and palm oil; IPCC, 2019). This has two effects: (1) it releases additional carbon that was stored in trees and soils; and (2) it reduces Earth's capacity to absorb atmospheric CO_2. Even without fossil fuel use, degrading Earth's natural carbon sinks would result in higher CO_2 concentrations, leading to global warming. The science on natural carbon stores

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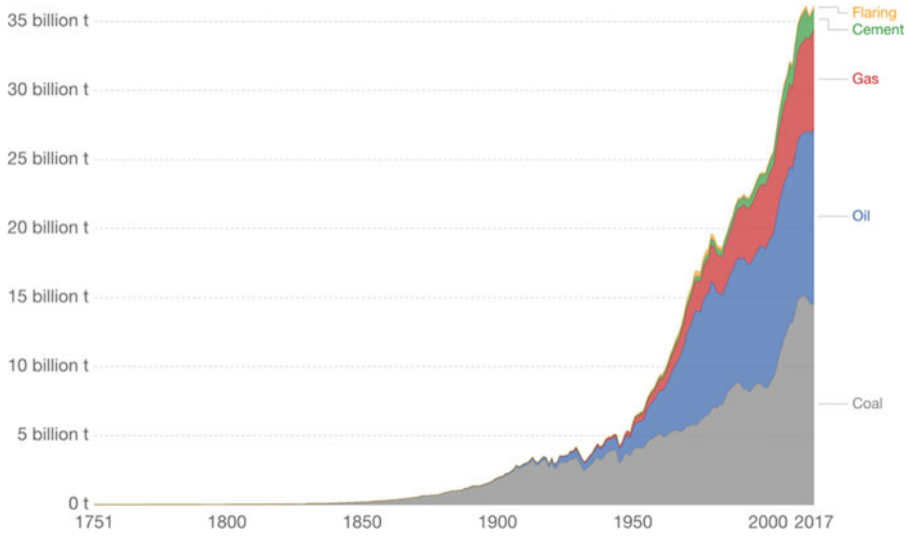

Fig. 1. Global carbon dioxide emissions by fuel type in billions of tonnes per year. Flaring: during oil production, the associated natural gas may be deliberately burned (flared) when barriers to the development of gas markets and gas infrastructure prevent it from being used. Original data sources: Carbon Dioxide Information Analysis Center (CDIAC) and Global Carbon Project (GCP). Graphic reprinted with permission from OurWorldInData.org.

is also clear – we need to stop damaging natural carbon stores and to re-establish them where possible.

A third consideration is that a warming planet may trigger 'tipping points' (Lenton *et al.*, 2019), making climate change greater than the linear response to the cumulative anthropogenic emissions of CO_2. A warming planet will irreversibly melt icecaps and glaciers, causing large rises in sea levels on a timescale of several hundred years and increase heat absorption in ocean water where there once was reflective ice. In addition to CO_2 emissions, thawing permafrost is releasing CO_2 and methane. This will accelerate climate change, adding an estimated 100 billion tonnes of CO_2 to the atmosphere this century even if warming is limited to 1.5–2.0°C (Rogelj *et al.*, 2019). If methane hydrate (a frozen fossil fuel that occurs naturally in cold, deep ocean sediments) is warmed, it reverts to water and natural gas. Over hundreds of years, as the oceans warm, there exists a danger that the release of methane hydrates may accelerate and become catastrophic.

A major impediment to solving the climate crisis is disinformation campaigns and lobbying efforts designed to foster doubt in the minds of the public and politicians about various aspects of the climate crisis (Oreskes, 2011). These campaigns are effective because of the tendency of people to believe false claims that conform to their existing worldviews (Pennycook & Rand, 2020). Disinformation campaigns were used in debates about pollution (Mann & Brockopp, 2019), acid rain, the health effects of smoking, the ozone hole, the meat industry and pesticides (Oreskes, 2011). Today, clever attempts are being made to deflect attention away from reducing fossil fuel extraction towards promoting individual behaviour changes – convincing people that climate change is their fault and that they need to reduce their carbon footprint. If well-meaning people believe that the solution lies with individual behaviour changes, then the fossil fuel industry can continue unimpeded. The key is having an informed public who are not easily swayed by disinformation campaigns or false statements.

The good news is that today we have many technological solutions for green energy and efficiency (e.g., García-Olivares *et al.*, 2018; Hawken, 2017), making green energy sources such as solar and wind power less expensive than fossil fuels. Implementing this transition to a low-carbon global economy could actually be a net financial benefit.

2. Three crises: ozone depletion, COVID-19 and climate

In the 1980s, scientists knew that the ozone layer was being damaged by ozone-depleting substances (ODSs), which were specific manufactured chemicals (e.g., chlorofluorocarbons used in refrigeration, fire suppression and as spray-can propellants). The cause was assessed, free from political influence, and a list of chemicals was given to policymakers. In response, the chemical industry proposed reasonable substitutes. Although negotiations were difficult, there was political will to take action and there was support from the public. The Montreal Protocol on Substances that Deplete the Ozone Layer was ratified by all 197 United Nations members. The Montreal Protocol was guided heavily by science and focused on the actual problem – ODSs – the production of which was banned or severely limited.[iii] The Montreal Protocol specified that progress would be carefully monitored by measuring ODSs, atmospheric chlorine and ozone. The protocol was updated nine times as new information was obtained. The healing of the ozone layer is arguably humanity's greatest success story regarding an environmental problem (Baldwin *et al.*, 2019).

Humanity's approach to solving the COVID-19 pandemic shows similarities to solving the ozone layer crisis. Although the science of the virus is less clear than that of the ozone layer, most governments took action based on the science of virus transmission in pandemics – passing legislation focused directly at the problem and reducing the spread of the virus. Specifically, governments have passed laws to (1) shut businesses and schools and (2) require people to stay at home and social distance when they are in public. Importantly, these policies were evaluated and modified every few weeks, as their effectiveness was judged by new infections, hospital admissions, deaths and other relevant information such as psychological and economic impacts. In most countries, tracking the number of deaths per day kept governments from ignoring scientific advice. As with the ozone layer crisis, (1) the policies were based largely on science and focused on the actual problem, (2) the public was largely supportive and (3) results were constantly monitored for their effectiveness and policies modified as needed.

So far, humanity's approach to solving the climate crisis does not parallel either ozone or COVID-19. Although scientists know that the main causes of climate change are extracting fossil carbon

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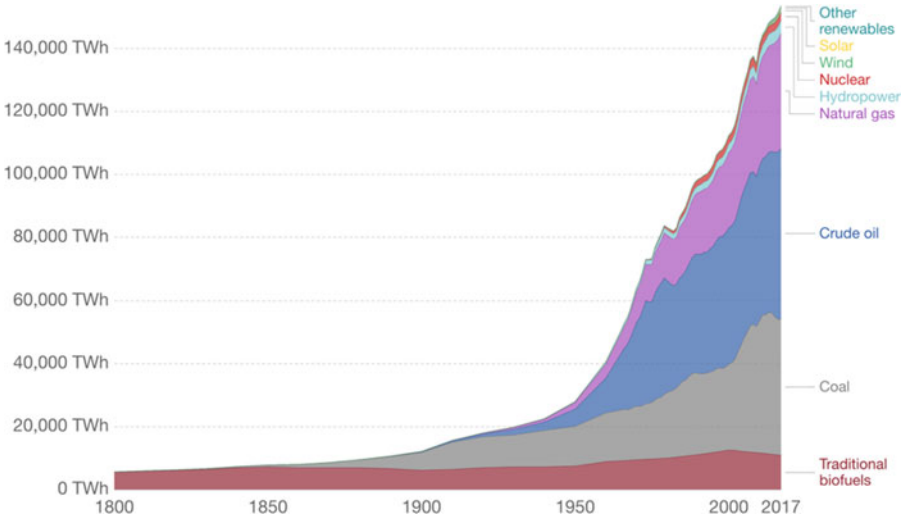

Fig. 2. Global primary energy consumption in terawatt-hours (TWh) per year. Primary energy is calculated based on the 'substitution method', which takes account of the inefficiencies in fossil fuel production by converting non-fossil energy into the energy inputs required if they had the same conversion losses as fossil fuels. 'Other renewables' are renewable technologies other than solar, wind, hydropower and traditional biofuels. Data sources: Smil (2017) and BP Statistical Review of World Energy. Graphic reprinted with permission from OurWorldInData.org.

and deforestation (IPCC, 2019), the problem is typically described in terms of greenhouse gas emissions. This conflates new fossil carbon with carbon already in the biosphere. But the biggest problem is that focusing on greenhouse gas emissions deflects attention from pervasive historical energy strategies based on fossil fuels and deforestation done to produce more and cheaper meat and agricultural products. Neither the Paris Agreement nor the IPCC 1.5°C Report Summary for Policymakers (IPCC, 2018) ever mentions fossil fuels. IPCC assessments are not free from political influence, and the Paris Agreement was negotiated by representatives of governments, not scientists. Finally, there is no specific feedback mechanism to change our approach based on how well we are collectively doing. The net result is that the main drivers of climate change are not being addressed, and they are becoming worse with time.

3. Subsidies to the fossil fuel industry are preventing the transition to green energy

Although fossil fuels are the main cause of the climate crisis, governments continue their historical subsidies to the fossil fuel industry. The total cost of direct and indirect subsidies by governments to the fossil fuel industry has been estimated to be 6.5% of global GDP (Coady *et al.*, 2019). This is more than 2.5 times as large as the total worldwide investment in all types of research and development (Congressional Research Service, 2019). Governments use direct subsidies (e.g., public finance and tax breaks for oil exploration) and indirect subsidies (e.g., granting permits for exploration, not charging for water, ignoring the health effects of pollution, not accounting for the environmental effects of oil spills). Governments also provide 'free' military support for the fossil fuel industry (e.g., Navy warship escorts for oil tankers in the Strait of Hormuz in 2019). The costs of pollution, water use, the military, environmental damage, etc., are economic externalities that far exceed the direct subsidies. These costs are borne by society and are not charged to the fossil fuel industry or to the consumers of fossil fuels.

Energy policies that preferentially subsidize fossil fuels supress the development of alternative energy sources (e.g., solar and wind power) that would be cost-competitive in a subsidy-free world. Subsidies make fossil fuels artificially cheap and make clean energy less competitive. For example, aviation fuel is not taxed in most countries, discouraging investment in solutions such as electric short-haul aircraft. An International Institute for Sustainable Development report (IISD, 2019) found that 10–30% of the fossil fuel subsidies would be sufficient to pay for a global transition to a low-carbon economy. Solar and wind power are becoming cheaper than electricity generated by burning fossil fuels. The biggest impediment to switching to renewables is government energy policies that support the fossil fuel industry.

4. Greenhouse gas emissions and the 2015 Paris Climate Agreement

Framing the climate crisis in terms of greenhouse gas emissions allows policymakers to decouple energy policies from climate policies. It allows governments to subsidize the discovery of new oil or gas reserves, which should, in our opinion, equate in the public's mind with worsening the climate crisis. Though fossil fuels are the central drivers of climate change, they are rarely the subject of international climate policy and negotiations.

Governments' framework to solve the climate crisis is the 2015 Paris Agreement, with a goal of limiting global surface warming to well below 2°C (IPCC, 2018). It shows where we want to go, but not how to get there (Williamson, 2016). The Paris Agreement does not call for leaving the fossil carbon in the ground – it makes no reference to fossil carbon or fossil fuels. It is a first step towards solving the climate crisis, as it raises public awareness because each signatory country has to pledge its Intended Nationally Determined Contribution (INDC) to reduce net greenhouse gas emissions. INDC commitments are flexible, in that each nation decides how to reduce net greenhouse gas emissions (e.g., through reducing fossil fuel use, shifting to green energy sources and through the removal of CO_2 from the atmosphere).

Is the Paris Agreement working? According to the United Nations Environment Programme, even if every nation met their current INDC pledges, the planet would warm by about 3.2°C (UNEP, 2018). There is no independent scientific advice, as there is in the Scientific Assessments of Ozone Depletion (WMO, 2018). The Paris Climate Agreement was negotiated among nations and represents the best solution that nearly all nations could agree to. There is a divergence between the Paris goals and the reality of what is actually done. The clearest example

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of this divergence is that, globally, because nations' energy policies still prioritize fossil fuels, the fossil fuel industry continues business as usual. Fossil fuel production is planned to increase (SEI *et al.*, 2019), even while nations pledge to solve the climate crisis.

However, individual nations can choose their own approach to achieve emissions reductions, so a nation could choose to address fossil fuel production (e.g., New Zealand banned new offshore oil exploration in 2018). Solving the COVID-19 pandemic requires stopping the spread of the virus. Solving the ozone hole crisis required ending the production of ODSs. And solving the climate crisis requires leaving the fossil carbon in the ground. Like the Montreal Protocol, the Paris Agreement will require subsequent changes to solve the climate crisis. In our opinion, if the climate crisis is going to be solved, nations must work within the Paris Agreement to address both fossil fuel extraction and deforestation.

5. The world's shambolic approach to net zero and carbon offsets

There is no agreed-upon definition of net zero, but the basic concept is simple. The Paris Agreement requires that anthropogenic greenhouse gas emission sources and sinks are balanced by 2050. Because some CO_2 emission is unavoidable (e.g., producing lime for cement), this leads to the abstract concept of 'negative emissions' – the removal of CO_2 from the atmosphere through technical means (Anderson & Peters, 2016). It is important that this CO_2 is stored in such a way that it will not leak back into the atmosphere for millions of years (effectively permanent removal of CO_2). Modelling done to inform policymakers (e.g., IPCC, 2018) assumes the massive deployment of negative-emission technologies in order to meet Paris goals – in order to offset continued massive fossil fuel use. Bioenergy combined with carbon capture and storage (BECCS) is the most commonly relied upon negative-emission technology used in climate modelling, but there are many other ideas (Anderson & Peters, 2016). Negative-emission technologies are at an early stage of development (Sanz-Pérez *et al.*, 2016) and may never be practical, especially at the vast scale envisioned. The unproven 'emit now, remove later' strategy is a 'high-stakes gamble' (Anderson & Peters, 2016; Williamson, 2016). The immediate effect of a reliance on future negative-emission technologies is to lessen the perceived need for rapid and immediate mitigation. This licenses the ongoing combustion of fossil fuels while technically fulfilling the Paris commitments.

It is important to keep in mind the magnitude of the problem. At the current rate of fossil fuel use, more than *one million kilograms per second of CO_2* would have to be captured and permanently stored. Using BECCS to offset continued fossil fuel use might require one third of all arable land on the planet to grow biofuels (Gough & Vaughn, 2015). And the underlying reason for this is that the world would continue to make heavy use of fossil fuels. Minimizing the percentage of energy derived from fossil fuels would minimize the need for negative-emission technologies – which are unrealistic at the scale needed to offset continued fossil fuel use.

There is no agreed-upon definition of carbon offsets, but in practice a carbon offset has become any activity that compensates for fossil fuel use by providing for an emission reduction elsewhere. Carbon offset mechanisms effectively amount to paying your neighbour to walk to work in order to justify your continued driving. Typically, a carbon offset is defined as a reduction – *relative to current emissions* – made in order to compensate for emissions made elsewhere. In carbon offset or credit schemes, money is paid to fund a project (e.g., planting trees) to compensate for burning fossil fuel. Planting trees sounds like a good idea because, in theory, the carbon released is absorbed and stored by trees that are growing. Planting more trees to absorb CO_2 is better than not doing so, but trees store carbon only for ~100 years, whereas fossil carbon is stored for ~100 million years. Since carbon offsets do not remove carbon from the atmosphere – and they justify burning fossil fuels – they cannot achieve net zero.

Some carbon credit schemes do not reduce net CO_2 emissions at all. These schemes are like paying your neighbour to walk to work in order to justify your continued driving, but finding out that your neighbour kept the money and is still driving. The UN's Clean Development Mechanism (CDM) scheme allows Western governments and corporations to offset their greenhouse emissions by supporting emission-reduction projects in developing countries. These schemes may not represent actual emission reductions. A study for the European Commission found that '[t]he large majority of the projects registered and [credits] issued under the CDM are not providing real, measurable and additional emission reductions' (Cames *et al.*, 2016). The net result is that we put more fossil carbon into the biosphere, and society incorrectly believes that we are solving the climate crisis.

6. Conclusion

The fundamental cause of all environmental crises, ranging from COVID-19 to species extinction to deforestation to the climate crisis, is that our societies have largely ignored the global-scale environmental impacts of our actions. The first step towards solving the climate crisis is public awareness of the problem. Current and past government policies on energy, land use and food have not addressed the long-term environmental consequences that have led to climate change, deforestation and loss of biodiversity. In our opinion, all government policies and actions must be critically examined, and the public needs to hold governments to account. Today, we have governments engaged in 'climate hypocrisy', publicly supporting the Paris Agreement, but simultaneously opening new coal mines, destroying forests, supporting fracking, subsidizing the fossil fuel industry and supporting fossil fuel projects in the developing world. For example, in 2020, the European Union voted to spend public funds on 50% of the cost of 52 gas infrastructure projects, many of which have been labelled 'unnecessary'. Direct action on this problem is laid out in the *Production Gap* (SEI *et al.*, 2019) – governments must enact 'supply-side' measures that aim to limit fossil fuel production, and they must align fossil fuel plans with climate commitments (Green & Denniss, 2018).

Going beyond fossil fuel use, we also need policy changes to preserve and enhance natural stores of carbon, such as forests and soils. Solving the climate crisis will require that governments change their historical energy and food policies and examine carefully the long-term global impacts of all of their policies. Governments are introducing policies to reduce demand for fossil fuels and shift to green energy sources, but these policies are not enough. Green energy is not yet replacing fossil fuels – it is merely augmenting it. Energy from both fossil fuels and green sources is increasing (Figures 1 & 2). Individual behaviour choices – diets, modes of travel and other personal decisions – are important elements in solving the climate crisis. However, they should be seen as *additional* ways to combat global warming rather than as substitutes for reducing the supply of fossil fuels.

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Paris Agreement commitments by individual nations are only a beginning. They are the equivalent of intending to restore the ozone layer without a plan for eliminating ODSs. They are the equivalent of declaring a global pandemic without a plan for social distancing to reduce the spread of the virus. Restoring the ozone layer and minimizing the COVID-19 pandemic both required governments to enact specific legislation to address the precise causes of these problems. We know that the climate crisis is caused mainly by fossil fuels, so fossil fuels must be the main focus of new regulations and government commitments. In order to solve the climate crisis, all government policies (including energy strategies, tax structures, trade agreements and overseas development activities) must be scrutinized and changed, with the overall goal of minimizing fossil fuel production and maximizing uptake of carbon by natural carbon stores.

We advocate the following immediate actions:

(1) End all government subsidies to the fossil fuel industry.
(2) Ban all exploration for new oil/gas/coal reserves anywhere in the world.
(3) Enforce a policy that no public money can be spent on fossil fuel infrastructure anywhere in the world.
(4) Stop justifying fossil fuel use by employing carbon offset schemes.
(5) Redirect most of the fossil fuel subsidies to targeted programmes for enabling the transition to a green energy economy, especially towards solving major challenges.
(6) Minimize reliance on future negative-emission technologies. They should be the subject of research, development and potentially deployment, but the plan to solve the climate crisis should proceed on the premise that they will not work at scale (Anderson & Peters, 2016).
(7) International trade deals: do not buy products from nations that destroy rainforests in order to produce cheaper, greater quantities of meat and agricultural products for export.

We suggest that the effectiveness of these policies can be judged annually by (1) current emissions from fossil fuel use; (2) current and planned fossil fuel production; and (3) and deforestation. These all must be consistent with Paris goals of limiting warming to 1.5–2.0°C.

Our above recommendations are an immediate step to change the focus of the climate crisis towards changing national energy strategies to focus on green energy and leaving the fossil carbon in the ground. As we have seen from the COVID-19 crisis, focusing directly on the problem does work. A comprehensive global plan to solve the climate crisis will require addressing complex issues involving politics, fake news, human behaviour, government subsidies, taxes, international trade agreements, human rights, lobbying by the fossil fuel industry and disinformation campaigns. Our recommendations could have success not just in democracies, but also in countries with authoritarian governments, because the leaders of those countries need only to impose a decision. In some cases, it will be necessary to use all available tools that are used in international diplomatic and trade negotiations, including tariffs, sanctions and human rights issues.

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Notes

[i] Fossil fuels are composed mainly of coal, oil and natural gas. Adding CO_2 emissions from cement production (converting limestone to lime releases CO_2) would add ~4%, and the term 'fossil carbon extraction' includes all human activities that release fossil carbon into the biosphere.

[ii] The primary naturally occurring greenhouse gases in the atmosphere are CO_2, water vapour, methane and nitrous oxide. Human-made greenhouse gases include the chlorofluorocarbons (CFCs), hydrofluorocarbons (HFCs) and perfluorocarbons (PFCs), as well as sulphur hexafluoride (SF_6).

[iii] Several of these ODSs were also powerful greenhouse gases. Some of their ozone-friendly replacements were also discovered to be powerful greenhouse gases – and these are being phased out under the latest protocol.

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