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WHITHER THE ENERGY TRANSITION?

Humanity is being forced to alter how we use energy sources, to move away from fossil fuels and focus instead on renewable, especially solar energy. This transformation may prove to be the long sought-after “holy grail” of energy.



Fig. 1
The three worst “plagues” faced by humanity at the current stage of civilization, affecting our chances of survival. How can we save the Earth, and thereby ourselves? The choices appear obvious, but are extremely hard to put into effect

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Today, we have enough scientific evidence to take it as a proven fact that the ongoing rapid changes to the Earth’s climate, which pose a danger to our civilization, are in large part due to the high emissions and low efficiency of the energy sector. Both the energy sector and climate neutrality are no longer merely problems for politicians, businesspeople, and scientists, but have become challenges faced by humanity itself. The main message of this article, as encapsulated in these introductory remarks, is that a decisive transition from traditional large-scale fossil fuel-based energy generation to renewable ener-

gy-based, distributed generation is very clearly inevitable in the long run.

Figure 1 lists just some of the factors that threaten human development to the greatest degree. We might describe them as the three major “plagues”: harmful gas emissions, intensive farming, and plastic pollution. The fragile balance of the natural environment may be upset as soon as within the coming decade. This may lead to an increase of over 2°C in global warming and disrupt the climate balance. This is explained visually in Figure 2.

Major barriers

We have listed the three major plagues affecting the planet that may lead to humanity’s downfall: not the demise of life on Earth, but the collapse of our civilization as we know it. But in fact, we have more reasons to worry. In order to answer the question of



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A fragile balance

Natural sources (solar activity, natural geologic cycles, biological processes, and volcanoes) account for ninety-seven percent of CO₂ emissions, and this share can be absorbed by oceans and plants. Thanks to this mechanism, the amount of CO₂ in the air has been stable for thousands of years – but this balance is very fragile. Humanity has been upsetting it by emitting huge amounts of CO₂ that cannot be absorbed by the natural environment. That is the essence of the problem.

An increase of over 2°C in global warming may disrupt the climate balance.

Where does the boundary lie? 2°C, or 4°C?



An illustrative example:

Just a tiny drop of water with a small mass can disrupt the fragile balance of a convex meniscus covering a whole glass.

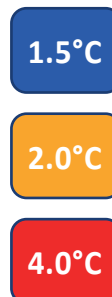


Fig. 2

The fragile balance in the natural environment. Human combustion of fossil fuels emits 37 billion metric tons of CO₂ into the atmosphere each year, and although these amounts account for a very small share of CO₂ in the natural cycle, they remain unsustainable and accumulate. Life on Earth is possible thanks to such natural mechanisms as the carbon cycle and the CO₂ thermostat. The disruption of these mechanisms would turn the Earth into a second Venus or into a snowball. Unfortunately, we are now indeed heading towards such a “Venus scenario”

whether we will survive, we must first identify the most important barriers that prevent us from solving our problems. Attempting to define them, however, leads to some astonishing conclusions.

It turns out that the main obstacles are not posed by the unavailability of relevant technologies, negligence in science, or failure to come up with ideas of how to resolve specific problems. Rather, they turn out to lie in the human mentality and in various geographical/historical factors. These obstacles may be described as people's mindset, climate change denial, and "climate apartheid." Let us take a closer look at each of these in turn.

I. Mindset. We might formulate the most important message for humanity as follows:

If we are to save the Earth, people simply must change their mindset and adopt notions that prioritize sustainable development in harmony with nature, rather than economic development and high consumption at any price.

This is certainly a beautiful idea, but how should we explain to the poorer, developing countries that they should give up their aspirations to attain the standards of living and the level of economic development enjoyed by more developed countries and instead think about the issues of climate change and environmental protection?

A decisive transition from traditional large-scale fossil fuel-based energy generation to renewable energy-based distributed generation is inevitable in the long run.

Across the world, economic development has turned into something of a religion. A key role is played here by the protectionist policies pursued by leaders of some of the world's powers (such as the United States and China) and developing countries (India and Brazil). Also, it is hard to expect that the EU's ambitious climate policy, especially the recent European Green Deal, and the stance promoted by global celebrities (e.g. Al Gore, Bill Gates, Elon Musk, Leonardo DiCaprio) will be enough to inspire all the countries of the world to act.

II. Climate change denial. Why is it so difficult to admit that humans are responsible for progressive climate change? Past fluctuations in the Earth's temperature and CO₂ levels, the relatively low content of

CO₂ in the atmosphere (0.03%) as a whole, and the relatively small impact of anthropogenic factors on the greenhouse effect (0.3%) might lull us into a false sense of security. Consequently, some commentators and even scientists use these facts to promote the opinion that the current rise in temperatures and CO₂ levels is part of the Earth's natural geologic cycle and has little to do with human activity. Indeed, climate change denial has become rampant across the world. Such thinking is clearly a trap (see Fig. 2). How can we win this fight to protect our planet if such an attitude is demonstrated by many members of the public and even by some scientists?

III. "Climate apartheid" is a different aspect of climate injustice. Developed countries (conventionally referred to as the wealthy North) are responsible for most of the emissions and environmental degradation, but it is the inhabitants of the poorest countries (conventionally called the poor South) who will be hardest-hit. This situation is bound to trigger dangerous conflicts, population migrations, and even warfare. It could be resolved through large-scale assistance from the richer countries of the North to the poorer countries of the South, but this appears highly unlikely.

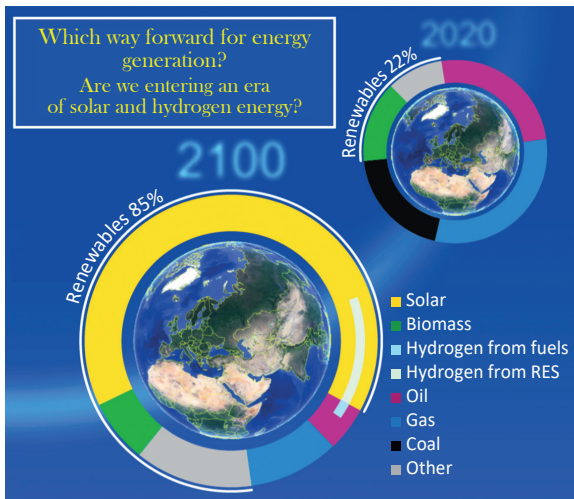
These remarks may lead us to the sad conclusion that as long as the global threats or "plagues" listed above do not directly threaten the very existence of our societies, the support from the global powers and the rest of the world for the EU's climate and environmental efforts will remain moderate or limited only to declarations.

A dawning era of solar and hydrogen energy?

In December 2019, the European Commission unveiled the European Green Deal, an ambitious package of measures meant to bring the EU to climate neutrality in 2050 and enable European citizens and businesses to benefit from a sustainable transition to green energy. In the opinion of many politicians, commentators, and scientists, this is the most ambitious such project ever embarked upon and the most important opportunity and challenge of our era.

Europe has adopted the European Green Deal, but will other countries follow in its footsteps? The questions that arise here are fundamentally important. Do the climate efforts being made by the Old Continent countries actually make sense? Will the costly transition to green energy find allies in other countries of the world? Will Europe not come to be perceived as Don Quixote in this lonely fight?

In answering these questions, we might well quote the statement made by MEP Jerzy Buzek at the last European Economic Congress in Warsaw:



... as Europe, we must show the world – this is the duty of our civilization – that we can move away from fossil fuels, sustain jobs, and remain the most attractive continent for billions of citizens all over the world ... (European Economic Congress Trends, Warsaw, 25 February 2020, <http://www.trends.eecpoland.eu/pl>).

Will this argument be enough? Let us hope so.

Based on an analysis of many research papers, the content published by various companies, and online publications, we may reasonably assume that in the distant future (say, after 2050) we will witness fundamental changes in the structure of the consumption of energy from primary sources (see Fig. 3). In the next century, the dominant source of energy for humans will be solar energy (not nuclear energy, contrary to popular belief). So are we entering an era of solar energy? If so, then technologies related to distributed generation must play a dominant role, and the transition from centralized to distributed energy generation is inevitable.

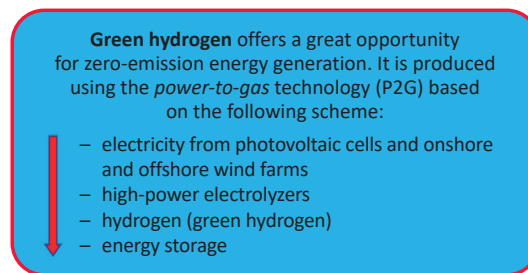
Hydrogen as a fuel of the future

Here, we should stress the role of hydrogen obtained both from renewable energy sources (RES) and from fossil fuels. According to many forecasts, it will come to dominate the structure of primary energy sources at the end of this century, although its exact share is now difficult to estimate.

The production of green hydrogen with the use of renewable electricity is expected to grow rapidly in the coming years. This technology has been relatively well-mastered, but there is still the question of its economic profitability. Today, the unit cost of hydrogen energy is 1.5 to 5 times higher than the cost of energy from natural gas. This will certainly change in the future.

Trends towards producing green hydrogen by electrolysis of water appear promising. Some countries (such as Germany) are already working on high-power electrolyzers. There is no doubt that renewable hydrogen is a technology of the future, although it is currently produced mainly from natural gas and coal (grey hydrogen – approx. 95%).

However, the business models being implemented show that, depending on the location of the electrolyzer and its useful lifespan, e-hydrogen could already be seen as a certain market alternative. However, the future belongs to this technology for reasons related to the expected sharp drop in the cost of producing electrolyzers and the process itself. Thus, e-hydrogen does indeed stand a chance of becoming the fuel of the future (Fig. 4).



Optimistic and pessimistic conclusions

Unfortunately, it is very likely that human societies will mobilize effectively to combat all these “plagues” only when they turn into a direct threat to their existence. At the current stage of human development, it is highly unlikely that all countries of the world will show solidarity in the fight against threats, given the prevalence of the particularistic interests of individual countries and the world of big business.

The situation is somewhat different, however, when it comes to the energy sector itself. The rapid depletion of fossil fuels will simply force us to bring about a profound energy transformation. The only energy source that humanity will never manage to exhaust is the Sun. For this reason, the direction of this transformation is patently evident: away from fossil fuels and towards renewable energy sources. In other words, the next century will be an era of solar and hydrogen energy, resulting from what may be described as a yellow-blue transformation (with “yellow” standing for solar energy, “blue” symbolizing hydrogen).

This puts us in a position to answer the question of “Which way forward for energy generation?” Also, it will open up an even more important question: Have we at long last finally managed to find the necessary “holy grail”? ■

Fig. 3

What will the structure of primary energy consumption be like in 2100? Is the dawn of an era of solar and hydrogen energy upon us? The projected share of energy from renewable sources is anticipated to increase from today’s 22% to 85%, with solar energy accounting for the largest share. This means a profound and revolutionary transformation of the energy landscape

Fig. 4

Green hydrogen (e-hydrogen) obtained from renewable energy sources stands a chance of becoming not only a clean fuel, but also a convenient way to store energy. Solving the problem of storing renewable energy is crucially important for distributed energy generation based on local resources

Further reading:

A New World: The Geopolitics of the Energy Transformation, January 2019, www.geopoliticsofrenewables.org.

Global Energy Transformation: A Roadmap to 2050, 2019 edition, www.irena.org/publications.

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Trisos H.Ch., Merow C., Pigot L.A., The projected timing of abrupt ecological disruption from climate change, *Nature*, 08.04.2020.