

GeoPlanet: Earth and Planetary Sciences

Jan Kiciński
Patryk Chaja

Climate Change, Human Impact and Green Energy Transformation

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GeoPlanet: Earth and Planetary Sciences

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Climate Change, Human Impact and Green Energy Transformation



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***Energy and climate neutrality
are not only political, business and scientific
issues,
but also civilization challenges***



22nd of April—International Earth Day

*“People do not have knowledge, they have
opinions. They do not think, but they think
they know better. Someone has to rectify it”*

Szymon Malinowski

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Thoughts Just a Little Bit Polished

Why is it so difficult to admit that humans are responsible for evolving climate changes?

Previous changes of the Earth's temperature and CO₂, a relatively low content of CO₂ in the atmosphere (0.03%) and small contribution of anthropogenic factors in the greenhouse effect give us a false sense of security. This creates the situation, where some of the publicists or even scientists use these facts for spreading the opinion that current temperature and CO₂ growth is a natural geological earth cycle and humans do not have anything in common with it. **Climate denialism** (rejection of the idea that climate changes are caused by humans) has a strong position in the world.

Such a thinking is a trap. In fact, we are in the state of fragile climate balance. The essence of this problem does not refer to the absolute amount of CO₂, but it refers to the RATE of its growth in the atmosphere due to the large amounts pumped to the atmosphere every year (37 billion tonnes). The nature is not able to balance such a high growth with natural processes that last hundreds or even thousands of years.

The evolving climate changes will not fully destroy the life on Earth, but they can pose a threat to civilization as we know it today with its abundance and quality of life.

Climate “apartheid” is another dimension of climate injustice – i.e., developed countries (conventionally: Rich North) are responsible for most of emissions but it is the citizens of the poorest countries (conventionally: Poor South) that will suffer most of all.

Is the yellow-blue transformation based on sun and hydrogen a **Holy Grail** searched for energy industry and for our civilization?

Community Energy—a beautiful vision, where the citizen is the subject, not the object of the energy market, and has its own virtual advisor on smart grids and data processing technologies in digital cloud.

Some information on global entropy of the world. Comprehensive environmental policy and coherent conservative policy prove to be convergent only at the local level. And, indeed, only at the local level there is a real hope for improvement. There is no evidence that global political institutions have done anything to limit the global entropy. On the contrary, by encouraging global communication and

destroying national sovereignty and legal barriers, they fostered global entropy and weakened real sources of resistance against it.

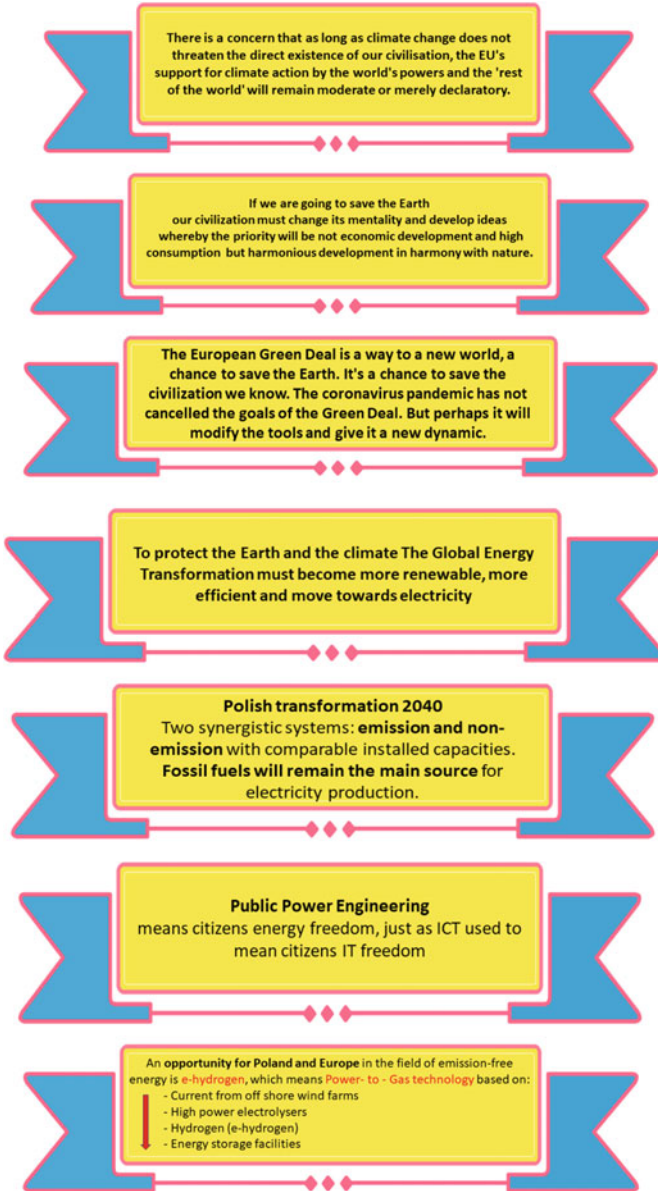
Roger Scruton, Green Philosophy

People will not solve climate problems related to the use of various waste as a fuel until the **phenomenon of energy poverty** is stopped.

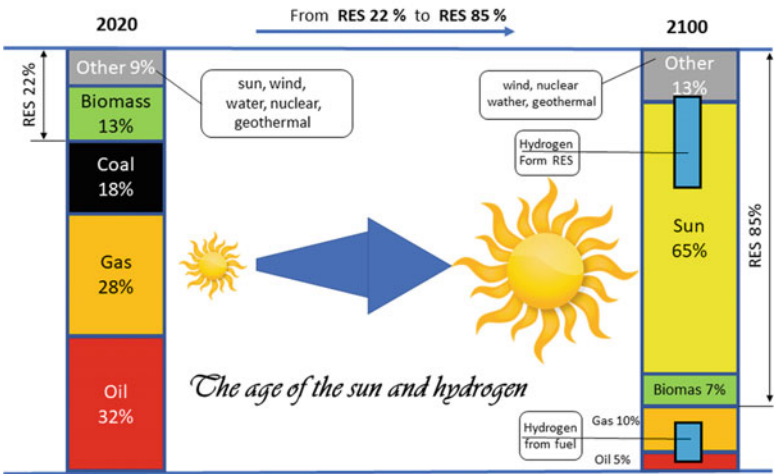
Currently, all governments of the world are faced with a **significant civilization challenge** consisting in taking active measures in the fight with climate.

The Book in a Nutshell

Instead of an Abstract—Something that is Worth Remembering



The yellow - blue transformation based on the sun and hydrogen marks the beginning of a new era for our civilization



The answer to the question: Quo Vadis energetics?

The following topics cannot exist without social commitment:

- Energy Poverty
- Smart Cities
- Industry 4.0

Energy poverty is inherently related to the problem of smog and poor quality air in many parts of the world

Smart Cities of the future do not consist of technology only but also of all the people who use them wisely.

Industry 4.0 is mainly a knowledgeable management of resources using the latest IT solutions closely coupled with changes in human behavior.

The role and the contribution of the Institute



IMP PAN: Projects and recommendations related to the Green Energy Transformation



Our hits. Installations and technologies with high implementation potential

- ▶ **Home Micro CHP.** Project and execution - chapter 15.5
- ▶ **Home electrostatic precipitators** - Project and execution - chapter 15.7
- ▶ **Hybrid energy storage. Heat and cold energy storage.** Project and execution - chapter 15.6
- ▶ **Boilers with low emissions.** Project and execution - chapter 15.7
- ▶ **Microturbines** using waste heat. Project and execution - chapter 15.3, 15.5
- ▶ **Innovative projects** in the field of **small wind energy** - chapter 15.9
- ▶ **Expertises and modernization projects for hydropower** - chapter 15.8
- ▶ **Computer system** for managing energy resources in the commune. **Energy mapping.** Analysis of various scenarios of equipping the **energy system with RES** installations - chapter 15.2
- ▶ **Waste management.** Idea of the **Circular Economy** and its implementation to the tourism industry - chapter 16.4
- ▶ **Projects of large installations:** micro biogas plants, modernization of municipal heating plants - cogeneration, gasification machines, biorefineries - chapter 15.4



Micro CHP

Home electrostatic precipitators



Heat storage

Boilers



Windmill



Hydropower



Microturbines



Computer system Energy mapping



Circular Economy



Biorefineries

About This Book

Smart City or Is the world energy standing at the crossroads? Will the evolving climate changes and rapid development of new areas, such as the Internet, IoT, Smart City or e-mobility not force us to look at the world's energy future from a completely new perspective? What are the real visions and prospects of development related to this? Who is right: big engineering corporations and politicians or ecologists and various types of visionaries?

Is the transformation based on the Sun and hydrogen the Holy Grail of energy industry?

The authors of this book attempts to find answers to these and many other questions.

Nowadays, we can accept as proved the thesis that such rapid climate changes, having a negative impact on our civilization, are related to high-emissive and low-effective energy industry.

Energy industry and climate are not only political, business and scientific issues, but also civilization challenges.

If we are to save the Earth, it is necessary for our civilization to change the mentality and develop the ideas that provide that economic growth and high consumption are not the priorities, but the priority is the harmonious development in accord with nature. In order to do so, we also have to change the way of thinking about the energy industry and global transformation.

The main message of this book is based on the above general comments and clear statement of fact that, in the long term, a major shift from traditional large-scale energy based on fossil fuels to disseminated energy based on renewable sources is inevitable.

The above message is obviously in line with the author's personal views on this issue. However, the authors attempt to present the other, very often controversial opinions in this monograph. It is worth answering the question why it is so difficult for many people to admit that humans are responsible for evolving climate changes.

The aim of the book is also to underline to role of the Polish Academy of Sciences and the Institute of Fluid-Flow Machinery in Gdansk in the process of energy transformation in Poland.

Poland is a powerful example here due to the fact that the Poland's energy system is strongly based on fossil fuels, mainly on coal, which means that challenges related to the climate changes and energy transformation are nowadays vividly discussed here. Both in the context of climate and energy policy of the country and the European Union as a whole, the Institute, as a leader of a dozen high-budget, nationwide and European eco-energy projects, contributed, to some extent, to creating of conditions for development of proconsumer or more civic energy industry in Poland.

Community energy is a beautiful vision, where the citizen is the subject, not the object of the energy market, and has its own virtual advisor on smart grids and data processing technologies in digital cloud. The so-called technological "green hits" in IMP PAN were presented as the evidence of its role in the process on energy transformation in Poland.

The authors of this book do not feel competent or authorized to assess the influence of other research centres on the process of energy transformation in Poland and worldwide. The book is an attempt to gather and systematise information circulating in the world of science and beyond. Every reader is invited to develop his own point of view on the issues contained herein.

The book is addressed both to usual citizens, ecologists, climatologists, and to politicians and experts accounting for shaping country and global climate and energy policies. This book is an attempt to find the most optimal solutions for the problem of our civilization which grows from year to year and relates to accelerating climate changes on our planet.

Note: Some of the information that the reader will find in this book has also been included in the book *Green Energy Transformation* by Jan Kiciński¹. This book was published in 2020 in Polish. Because it was very well received by the Polish scientific community focused on the subject of climate change and energy transformation, those scientists encouraged the authors to expand the book with additional social aspects and disseminate it to a wider audience by publishing it in English.

¹ J Kiciński, *Zielona Transformacja Energetyczna*, ISBN 978-83-88237-96-6, Wydawnictwo IMP PAN, 2020.

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Part I
Some Information on Climate
and Emissions. World Transformation
on the Example of Poland

Chapter 1

Introduction—Some Facts and Opinions



Food, air, water and energy are fundamental needs for humans and for the whole our civilization. It is a trivial statement. In this monograph we will mainly concentrate on energy, its transformation and interrelations.

There are many indications that we are standing at the crossroads. But, are these concerns founded? It is worth considering in which place we are today and what our future is. Let us start from a few points.

At first, please note that we witness the most important demographic event in the world: over the lifetime of a single generation (45 years) the population growth has doubled (from 3 billion in 1960 to 6.5 billion in 2005). It will not happen anymore! For the next 45 years, there will be about 9 billion people and what is worse this growth will be very uneven: the world average +40%, of which in the Eastern Europe – 25%, the USA +33%, Africa +175! It will translate into increased needs on a global scale, also in the energy sector. In the case where it is not possible to satisfy them, it will correlate with the growth of civil unrest. It is estimated that the poverty area will disappear (living for 1 dollar per day), but the huge differences on the standards of living at different continents will remain. It will result in an enormous social and political problems and unknown challenges for the world's energy.

Secondly, the world energy is dramatically low-effective.

Figure 1.1 demonstrates it very clearly. For 100 units of energy contained in primary fuels (coal, oil, gas), we are able to process in a way that is directly useful for us only 9.5 of units.

The rest is lost in power plants through pipes, valves, transmission (pumps, engine) and in the process of distribution through energy lines and locally—Fig. 1.1. Will there be technologies that substantially improve this situation? We will see. NEGAWATTS (saved energy) are always cheaper than MEGAWATTS (generated energy). It gives an impulse for enormous investments in energy efficiency in its wider sense in many countries in the world.

Thirdly, resources of fossil fuels are limited. If we look at them as mean resources for our globe, taking into account the average prognosis of their consumption (with

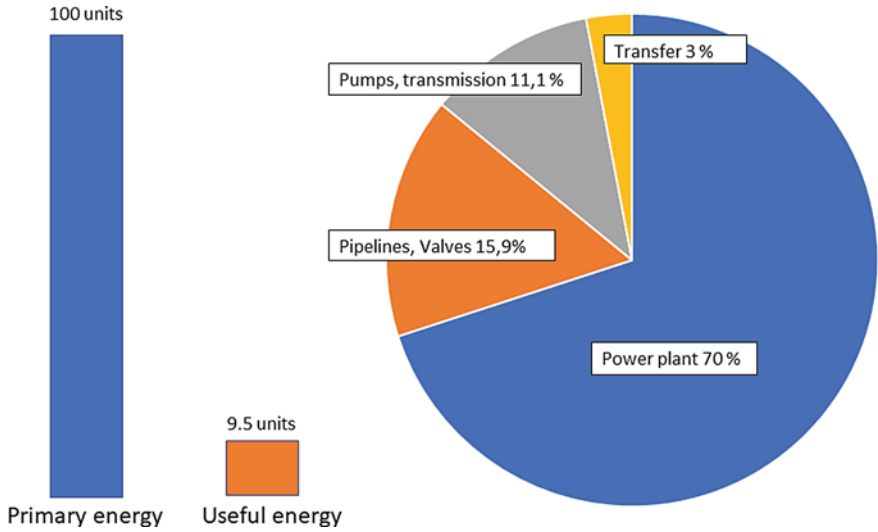


Fig. 1.1 Low efficiency of energy processing at the world scale—for 100 units contained in primary fuels, we are able to use only 9.5 of units. Right side: line of energy losses from power plant to distribution. Author’s own drawing, processing information from other publicly available sources

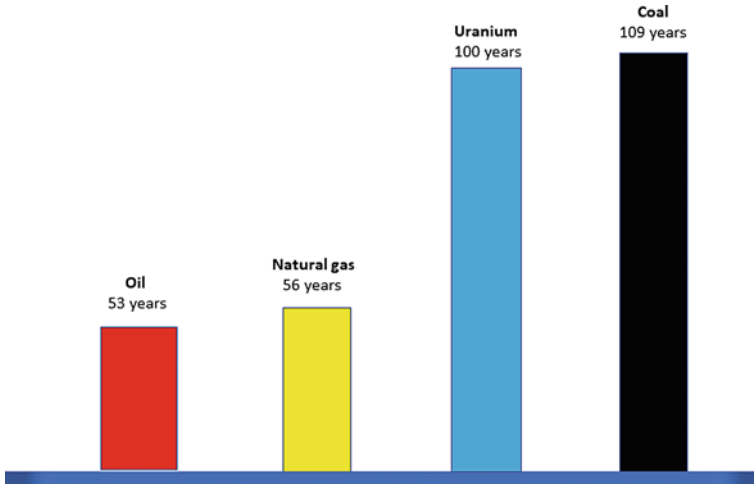


Fig. 1.2 The average world resources of fossil fuels—global sufficiency of resources. Author’s own drawing, processing information from other publicly available sources

differentiation for particular countries or continents), the oil and gas will be sufficient for approximately 50 years and coal and uranium—for approximately 100 years—Fig. 1.2. It is dramatically low!

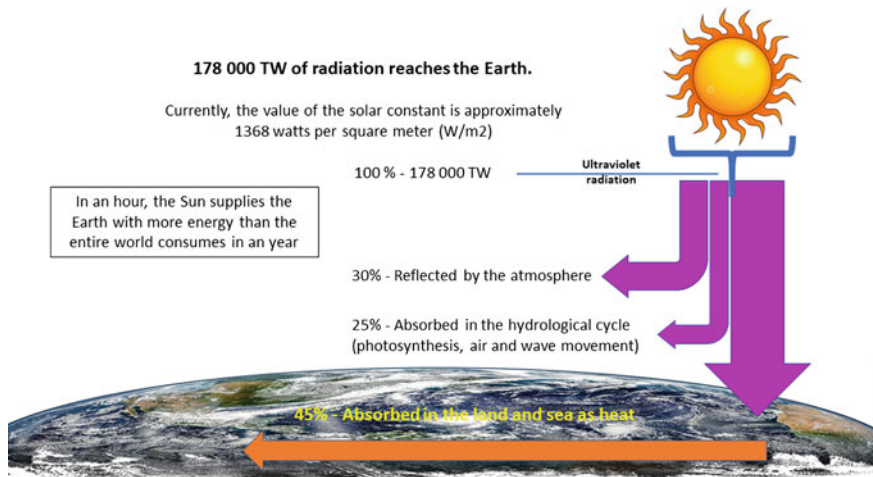


Fig. 1.3 The sun energy—inexhaustible source for our civilization. Original drawing of the author of the monograph

Fourth. Emission capacity of the world economy and climate is changing. This fact poses a real threat for the quality of human’s life or even for human’s existence. We will provide more details in the next chapter.

Fifth. The sun is an inexhaustible source of energy—Fig. 1.3.

A moment of reflection on Figs. 1.2 and 1.3 leads to the conclusion that generally there is only one direction of transformation: from fossil fuels to the sun. What is under discussion is only the time of this transformation and transition periods in various regions of the world. Approximately 45% of the sun energy that reaches Earth we can potentially use both in a direct (e.g., PV cells, collectors), and indirect form in the process of production of other green fuels, such as hydrogen.

Taking the above aspects into account (demographic explosion, low energy efficiency, limited resources of fossil fuels, emissive capacity of the economy and climate changes, as well as inexhaustible source of sun), many fields of human activity, especially including the world energy stands before the necessity of an immediate revision of previous, and traditional ways of development and reassessment of priorities. The alternative is a large-scale crisis. Pessimists say: do not ask IF there will be a crisis, ask WHEN. But it does not have to be like that.

Willing to look at the energy transformation issues more carefully, we need to focus on several key issues, such as climate change and emissions, development of the Internet (Smart City, Industry 4.0, smart management) and electromobility. Widely understood Energy in its wider sense, that is traditional energy industry, transport and heating sector are inextricably linked with these issues.

Chapter 2

Some Information on Climate and Emissions. Where Are We Heading?



In the geological history of Earth, many times we faced enormous changes of the globe's average temperature and CO₂ content in the atmosphere—Fig. 2.1. What is more—the rich life on Earth developed in conditions, where the amount of CO₂ in the atmosphere was much higher than nowadays.

Even in the last 1000 years we had “the Medieval Climate Optimum” (950–1250), when the shores of Greenland became green and the Little Ice Age (1300–1850), when the Baltic Sea was frozen.

Figure 2.2 allows us to reveal that as far as CO₂ is concerned, despite its relatively small amount in the atmosphere (0.03%), its contribution to the greenhouse effect is more than 100 times higher (3.62%). Human contribution to the greenhouse effect is approx. 0.3%—it is an important conclusion illustrating the current state. Wrong interpretation may lead to misleading conclusions. What is more, this amount may change in the nearest future.

Vapour water is the largest contributor to the greenhouse effect, accounting for 95%—Fig. 2.3. It is worth noticing that without natural barrier in a form of greenhouse gases, the average global temperature of Earth would be minus 18 C degrees. Life would not be possible on Earth.

The globe temperature is stabilized by two mechanisms: coal cycle and coal thermostat. Without these two mechanisms, we would have either “**The Snowball Earth**” or “**The Venus Earth**” [1].

Greenhouse effect, coal cycle and coal thermostat are natural mechanisms stabilizing the climate and the atmosphere developed by nature throughout thousands of years.

Previous changes of the Earth's temperature and CO₂, relatively low content of CO₂ in the atmosphere (0.03%) and small contribution of anthropogenic factors to the greenhouse effect give as a false sense of security. This creates a situation where some of the publicists or even scientists use these facts for spreading the opinion that current temperature and CO₂ growth is a natural geological earth cycle and humans do not have anything in common with that. What is the truth?