Global Energy Perspectives

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Global Energy Solutions e.V.

Part 1: Basic elements for avoiding greenhouse gases and generating climate-neutral energy (technical toolbox)

Chapter 1

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1. Introduction

1.1 Introductory remarks

The aim of this study is to develop a reference model for a global energy system that is climate-neutral and at the same time wealth-sustaining - in a global perspective even wealth-enhancing.

In Chapter 2, "Technical Toolbox", all available and relevant technical components will be described in the necessary depth within the framework of a technology-open approach to highlight their relevance in the context of the objectives. The aim is to describe the individual building blocks that can be used in the development of a climate-neutral energy system and that can thus become components of the reference model to be developed.

For the description of the technical toolbox in chapter 2, various existing sources are used, such as current studies, articles in trade journals or publications of relevant companies. These are analysed in terms of content. In addition to reviewing the material available in the literature, expert knowledge was added. Some of the experts were found in our own ranks. Others were approached specifically for this purpose.

Chapter 3 "Consideration of greenhouse gas emitting sectors" deals with the application of the technologies described above in different contexts. The main greenhouse gas emitting sectors are considered, and possible solutions are discussed as to how they can become climate neutral using the tools described above. The focus is on Scope 1 (direct emissions of the company) and Scope 2 (indirect emissions of the company from purchased energy) emissions. Upstream and downstream emissions of the value chain are not considered.

The study of the various greenhouse gas emitting sectors is also based on relevant existing sources. It is also supplemented by case studies. This is where the corporate partners of the Global Energy Perspectives project and their specific circumstances in the conversion to climate-neutral energy production or use come into play.

In particular, the relevance of the individual building blocks for developing and emerging countries is also addressed:

- In what way are developing and emerging countries integrated into corresponding global energy value chains?
- To what extent are there opportunities to use the building blocks and the generated energy oneself and thus to enable value creation in one's own country?
- What possibilities does the technology give for reducing one's own emissions?

- What is the significance of the sector under consideration for further economic development?
- What are the growth expectations?
- To what extent are there particular implementation challenges in the Global South?

The knowledge mapped in the reference model is created in two different ways - by abstracting case-specific information and by incorporating theoretical knowledge. [1]

At the specific request of the client, two topics are not covered by the study:

- Synthetic fuels for individual mobility
- Capture of CO_2 at coal-fired power plants

1.2 Overview greenhouse gases

The shares of the most important climate gases worldwide are shown in CO_2 equivalents Figure 1. CO_2 is the most important, accounting for almost 65 % of the emissions, coming from fossil sources and industrial reaction processes. The importance of CO_2 is increased by a further 11 % from agriculture and forestry, so that in total around 76 % of emissions come directly from CO_2. Methane is in second place with a climate impact of 16 % CO_2 equivalents: Other important gases with a climate-damaging effect are nitrous oxide (NO_x)

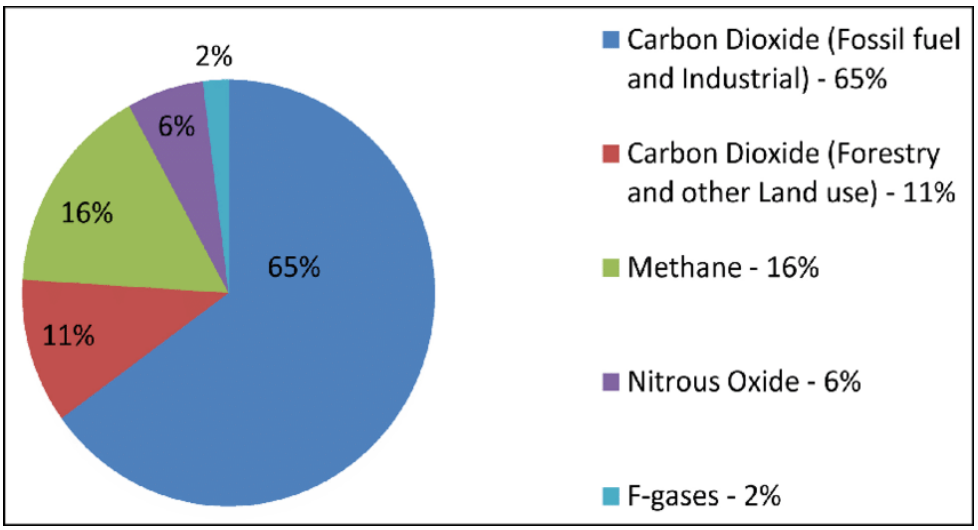

Figure 1: Shares of the most important climate gases in global emissions; Source: IPCC Report (2014)

and fluorine-containing gases. The climate impact of hydrogen is discussed in Chapter 2.12.5.

1.3 Overview of primary and final energy use for energy supply

As part of its work, GES has used data from the IEA data of 2020 to develop Figure 2 which provides an overview of global primary energy use and presents the key baseline data for

energy flows for electricity production and for energy use in the transport, industry and non-energy sectors.

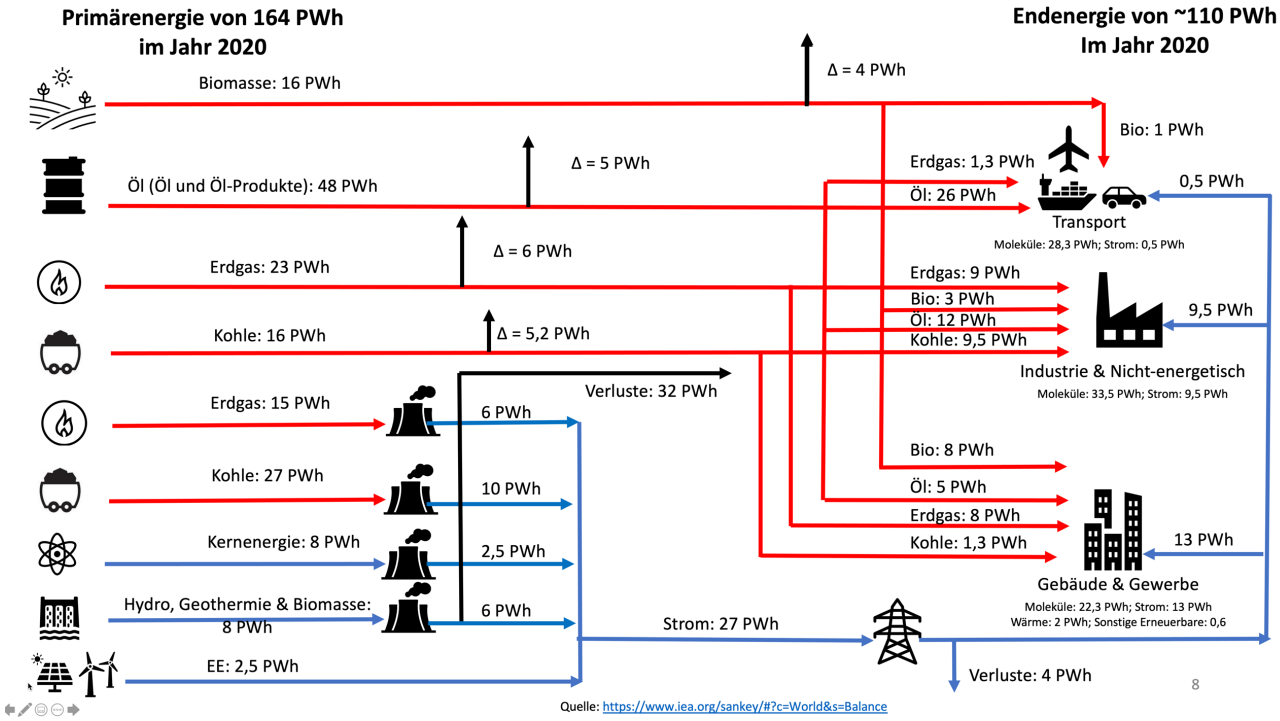

Figure 2: Sankey diagram for primary energy and final energy use 2020

Source: IEA and own representation

This shows that in 2020, 60.5 PWh of primary energy was used to generate 27 PWh of electricity, of which after losses 13 PWh (57 %) was used in the buildings and commercial sector, and 9.5 PWh (41 %) in the industry & non-energy sector. Only 0.5 PWh (< 2 %) of the generated electricity was used in the mobility sector. In view of the objective to increase the direct use of electricity in the various sectors, the question which percentage shares of electrification can be achieved in the individual sectors is particularly relevant. This question will be addressed as part of the development of the reference solution.

The figures from IEA show a direct share of fossil fuels in total primary energy use in 2020 of 79 %. In the transport sector, the share of oil in final energy use is 90 %, in the industry and other sectors it is still 71 %.

GES has used the IEA documentation as basic data for the energy flow correlations for a plausibility check of the development of its reference model. In addition to the emissions caused by energy use, Figure 3 shows other areas in which relevant quantities of emissions are generated. Industrially, these are the chemical industry and the cement sector. Furthermore, waste treatment, landfills and sewage treatment plants are explicitly mentioned. In

addition, agriculture, forestry and land use cause significant emissions. All of these areas must be taken into account in a model development and plausibility checks must be carried out to determine how relevant their influence is.

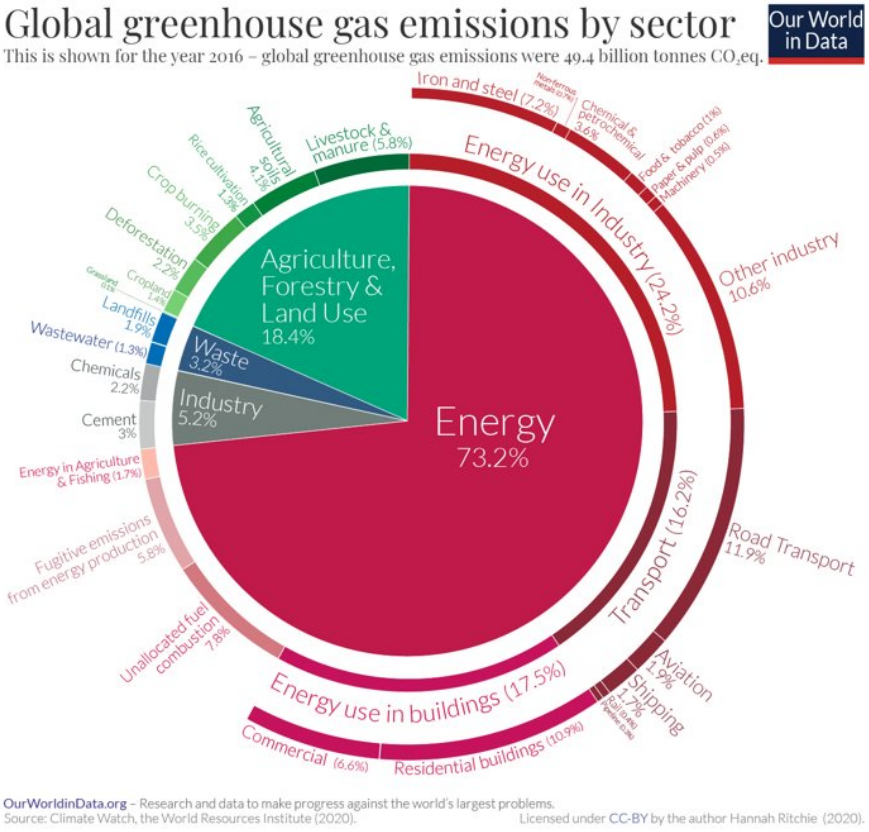

Figure 3: Climate gas-emitting sectors

Source: Our Word in Data (2020d)