



# WHAT IF?

PROJECT BRIEFING #4

## DEFINING THE SCENARIO APPROACH

VERSION #2 | OCTOBER 2021

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### AUTHORS

Sonja Simon, Nadine Mengis, Knut Goerl, Malgorzata Borchers,  
Bettina Steuri, Andreas Oschlies

#### Centres involved:



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## AIM

The aim of this Project Briefing is a clear definition of the various dimensions of our scenario approach in Net-Zero-2050. Starting from the overarching framework, we then describe, how scenarios are applied in the various projects. We define the scope and focus of the energy scenarios and the scenarios for CDR measures, as well as the interface between both approaches.

## FRAMING SCENARIO

Project 1 (P1) defines a joint storyline towards a net-zero emission Germany. The main storyline is to achieve a society, which manages to balance its CO<sub>2</sub> emissions with mitigation measures and carbon sinks by 2050. The project aims for identifying measures, processes and targets, which are consistent and necessary to develop along this storyline. As the project will focus on specific sectors within the various projects, this overall storyline serves as guidance for all specifically analysed sectors. The term “net-zero CO<sub>2</sub> emissions” and the system boundaries are defined within *Project Briefing #1 “P1-Structure”*.

This framing scenario provides the socio-economic background, which serves as a reference for all projects within **Net-Zero-2050**. It requires an explorative approach to further describe a likely development of the society under the agreed premises of “mitigation towards net zero”. In order to quantitatively use this scenario as a background of analysis it needs to be described by a set of quantified framing parameters basically consisting of:

- GDP
- Population
- Carbon budget

The framing parameters describe the overall development of the society, in which the various sectors of CO<sub>2</sub> and GHG emissions will be assessed. The idea is to agree on one socio-economic pathway across all projects. Within this one socio-economic pathway, each project can provide techno/socio-economic analyses as seen appropriate.

We propose to use the National Energy and Climate Plan (BMWi, 2019) as a background/basis for socio-economic parameters such as population and GDP. The specific carbon budget, which will comply with our net zero storyline will be analysed and determined within P1.1 of Net-Zero-2050. The approach is defined in *Project Briefing #2 “Carbon Budget”*. (Responsible: Joint result of P1.1 with input from GERICS, GEOMAR, DLR, UFZ)

## ENERGY SCENARIOS

One special focus of the project is the energy system, which currently is the main emitter of CO<sub>2</sub> in Germany and globally (Teske, 2019; UBA, 2019). Therefore, P 1.2 will describe and quantify this sector specifically, developing scenarios for the energy system (including power, industry, transport and other sectors) within the boundaries of the above described framing scenario. We will quantify several consistent techno-economic energy transition pathways, which achieve different climate protection targets and represent various aspects of technological and regulative options. These scenarios are target driven normative scenarios, describing energy pathways towards an energy system with minimal CO<sub>2</sub> emissions. We apply an integrated approach, based on the assessment of possible energy technologies, their contributions to CO<sub>2</sub> emission mitigation, and their systemic interactions. Thus, we extend the geographical boundary to the grid connected neighbour countries for the power sector. The figure below summarises the approach within the energy scenarios.

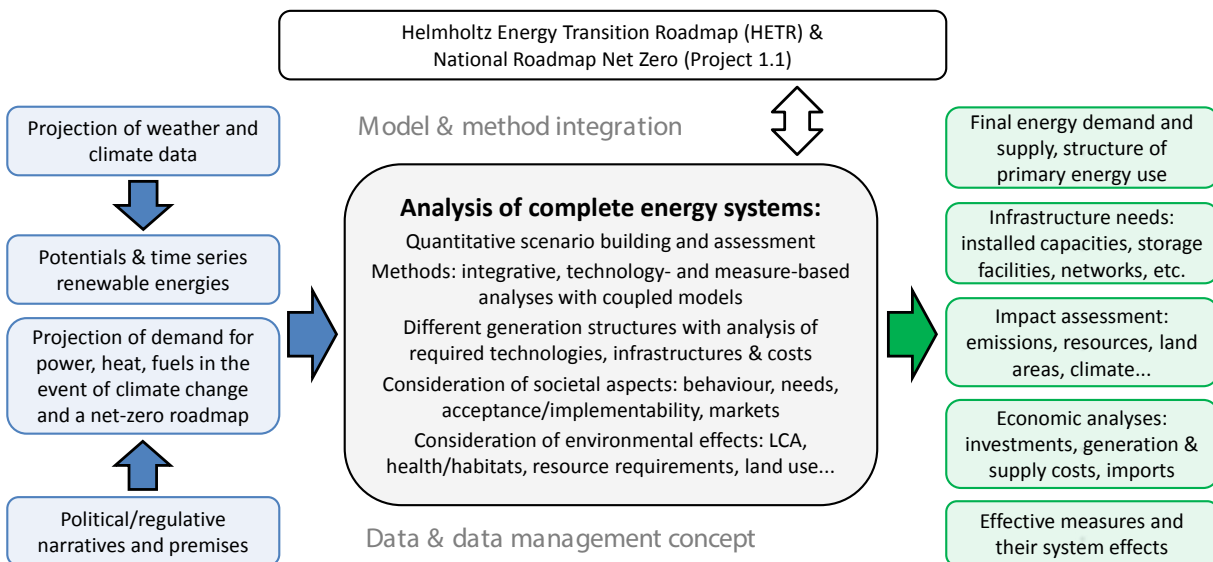


Figure 1: Content and structure of the quantitative energy scenario analysis in Project 1.2

The basic scenario aims for a 100% renewable energy system in 2050. The speed of the development towards this target is defined by the overall carbon budget allocated to the energy sector. However, such a pathway demands an immediate “turn around” regarding all investment priorities in the energy sector. The related decisions of actors, such as investors, cannot be examined in detail in this scenario development process. Suitable regulatory framework conditions and their effects in the form of investment incentives and implementation of new technologies have to be assumed on the basis of plausible assumptions and the available background knowledge. In addition, there exists a high uncertainty on the carbon budget already on global level, moreover for the potential carbon budget of a German energy system (see Project Briefing #2 “Carbon Budget”). We therefore aim for a variety of scenarios as described in Section 4. Additionally, we might address potential time lags in the energy transition in transport or buildings as well as variations in the technical setup of supply and infrastructure.

(Responsible: DLR P1.2 with input from partners and framing scenarios)

## CDR-SCENARIOS

Complementary to the energy system, different transformation pathways are developed and investigated focusing on the mitigation measures (CDR, CCU & CCS) and their specific technologies, as assessed in P2 - P4 and the technology assessment matrix. A large section of **Net-Zero-2050** is dedicated to assessing mitigation measures (see *Project Briefing #1 "P1-Structure"*): P2 - P4 investigate a variety of CDR, CCU & CCS measures with regard to their technical potential to mitigate CO<sub>2</sub>-emissions in Germany (see *Project Briefing #3 "CO<sub>2</sub> (avoided & removed)"*). Additionally, the technology assessment matrix provides an overview and outlook on the feasibility, barriers and chances to apply these measures on the pathway towards net-zero emissions. Interlinkages, i.e. trade-offs and co-benefits, between individual CDR measures are taken into account to comprise possible CDR bundles (based on the results from the assessment matrix).

These CDR bundles will serve as options for CO<sub>2</sub> mitigation, which potentially interact with the energy system. Therefore, they need to provide information on the additional the energy demand, the technical potential and assumptions on the associated cost for applying these CDR bundles, which will be then fed back to the corresponding energy scenarios as described in the next sections.

*(Responsibility: GEOMAR with contributions from other P1 partners, technology assessment matrix and gap analysis)*

## INTERACTION OF THE CDR SCENARIOS WITH THE ENERGY SYSTEM SCENARIOS

To integrate the knowledge from the CDR scenarios, we will quantify 3-4 scenario variants for the basic energy scenario, e.g. considering different carbon budget limits and the deployment of CDR/CCU/CCS measures and their related additional energy demand. The explicit consideration of interactions between climate change and energy potentials and demand as well as an explicit political/societal and regulative framework are also essential inputs to the analysis. These energy scenarios rely specifically on the input from P2 - P4 and the technology assessment matrix with regard to deployment potential, additional energy demand and CO<sub>2</sub> mitigation costs. A specific focus will be laid on the insights from the technology matrix P1.1, and the evaluation of favourable or unfavourable measures for CDR in the near future.

The quantification of this set of 3-4 energy scenarios will be complemented by an extended assessment of the scenarios both on system level (including an ex-post LCA-assessment) and on stakeholder level. Therefore, a set of indicators is prepared and exchanged within the project, to provide consistency in evaluation. One central indicator of the comparative assessment of the scenario variants would be the calculation of system costs and CO<sub>2</sub> mitigation and avoidance costs, which then serve for comparison of alternative options from Project 2-4, which are implemented in the CDR scenarios.

*(Responsible: DLR with input from P1.1, 2 - 4: results from CDR scenarios and technology assessment)*

## BASIC ASSUMPTIONS IN THE SCENARIOS

For the framing scenario, we apply a set of assumptions on the future societal developments in Germany.

- For the carbon budget, our project will rely on detailed analysis as provided in *Project Briefing #2 "Carbon Budget"*. The allocation of the carbon budget to the various sectors will be an outcome of the further discussion in the project.
- For the future development of GDP and population, we will rely on the German National Energy and Climate Plan (NECP) (BMWi, 2019), as provided for the European Commission in 2019. It provides an official outlook for the current development in Germany until 2040. The plan is based on a series of scientific studies, which will also serve as a basis for GDP and population values for 2050. The plan also relies on the official population forecast for Germany.



- For the energy scenarios, the NECP (BMWi, 2019) will also serve as a reference for the overall energy demand. The basic scenario will cover additional efficiency measures, based on literature analysis of the underlying studies.
- Assumptions for energy carrier prices will be defined by a working group within P1.

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## AUTHORS

Sonja Simon<sup>1</sup>, Nadine Mengis<sup>2</sup>, Knut Goerl<sup>3</sup>,  
Malgorzata Borchers<sup>4</sup>, Bettina Steuri<sup>3</sup>, Andreas  
Oschlies<sup>2</sup>

1 Deutsches Zentrum für Luft- und Raumfahrt,  
2 Helmholtz-Zentrum für Ozeanforschung Kiel,  
3 Climate Service Center Germany (GERICS) |  
Helmholtz-Zentrum Hereon,  
4 Helmholtz-Zentrum für Umweltforschung

## CONTACT PERSON

Dr. Sonja Simon | [Sonja.Simon@dlr.de](mailto:Sonja.Simon@dlr.de)

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**More results from the project Net-Zero-2050 are available here:**

[www.netto-null.org](http://www.netto-null.org)

[www.helmholtz-klima.de/en/press/media-library](http://www.helmholtz-klima.de/en/press/media-library)

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## Centres involved:

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