



The development of the German energy market until 2030—A critical survey of selected scenarios

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ABSTRACT

Many scenarios have been generated in the last years analysing the international energy market. The variety of these scenarios is manifold, as they are generated by different institutions using different methodological approaches and different framework assumptions. However, these scenarios can roughly be classified into three main groups: “moderate”, “climate protection” and “resource scarcity and high fossil fuel prices”. Analysing the German energy market makes a fourth scenario group necessary, which considers the possible revision of the decided nuclear energy phase out. Most of the existing scenarios developed by different institutions can be allocated into one of these groups. A representative scenario for each group has been selected to illustrate the development of the energy sector until 2030. Contrary to the worldwide primary energy demand (PED), the German PED decreases in each scenario, even though the drop differs strongly throughout the scenarios. On the other hand the structure of the PED in 2030 varies strongly for each scenario, especially regarding the share of fossil energy sources. However, a common robust result can be observed throughout all scenarios, namely the high increase in the share of the renewable energy resources, although the scenario generation processes are not always robust.

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1. Introduction

The development of the energy sector is affected by several uncertainties and tendencies, especially regarding climate policy and volatile fuel prices. Whereas a (up to now missing) stable legal framework with binding CO₂-emission targets could reduce the uncertainty in this area, the development of fossil fuel prices is likely to remain very volatile and uncertain.¹ It is even expected that they will become more uncertain and volatile, as production capacities of the main fossil energy carrier “oil” have to be moved into less efficient reserve areas. In respect of the German energy market a further uncertainty can be included, i.e. the controversial revision of the nuclear phase out. Opinions about this phase out vary between political parties and the decision about nuclear energy can therefore change in each legislative period. To capture all these uncertainties in the energy sector, an analysis based on several scenarios is necessary to identify robust developments in the different scenario worlds. Thus, this paper gives an overview of selected scenarios illustrating the broad spectrum of possible developments in the German energy market. Thereby, robust developments or trends shall be identified, which are valid within

different scenarios. Additionally, the selected scenarios are evaluated and their main differences are discussed. As all these scenarios have been developed to support policy decision makers, this paper focuses also on their strengths and weaknesses and critically reflects their generation process to gain information about their objectiveness and thus about their validity.

Before the survey of scenarios is presented, the study focuses at first on the historical development of the German energy market to date. Thereby the development of the main parameter of the energy market, i.e. primary energy demand (PED), is described for the last two decades and the share of each primary energy carrier (PEC) is illustrated. The actual power generation is then analysed according to the contribution of each PEC.

The study continues with a description of the future development of the energy sector. Therefore four scenario groups are determined, which cover the main tendencies on the German energy market as expected by different energy experts and institutions. These groups illustrate a broad view of possible developments. These possible developments can be summarized and characterized as the business-as-usual case, the strong climate protection policy case, the high fuel prices case and the revision of the nuclear phase-out case. For each of the cases one representative and well-known scenario is selected.

For example, for the business-as-usual case the oil price scenario of the EWI/Prognos study was selected and indicated as “Moderate Scenario” in the following. The other cases consider

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¹ A detailed analysis of fossil fuel price uncertainties is carried out by (Schmölter (2005)).

Nomenclature

AGEB	Workgroup for Energy Balances	EWI	Institute for Energy Economics at the University of Cologne (German: Energiewirtschaftliches Institut)
ARES	Extention of regenerative energy systems (German: Ausbau regenerativer Energiesysteme);	Fraunhofer ISI	Fraunhofer Institute for Systems and Innovation Research
BDEW	German Federal Energy and Water Association	GDP	Gross Domestic Product
bl	Barrel	GEMS	German Electricity Market Simulation: investment and operation model of the German power plant fleet developed by EWI
BMU	German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety in Germany (German: Bundesministerium für Umwelt, Naturschutz und Reaktorsicherheit)	GermanHy	Study on the future sources of hydrogen published by the Fraunhofer ISI
BMVBS	German Federal Ministry for Transport, Building and Urban Development (German: Bundesministerium für Verkehr, Bau und Stadtentwicklung)	Hydro	Hydroelectric Power
BMWI	German Federal Ministry for Economics and Technology (German: Bundesministerium für Wirtschaft und Technologie)	IEA	International Energy Agency
CCGT	Combined Cycle Power Plants	LBST	Ludwig-Bölkow Systemtechnik
CCS	Carbon Capture and Storage technology	MESSAGE	Model for Energy Supply System Alternatives and their General Environmental Impact
CHP	Combined Heat and Power	NAP II	National Allocation Plan (phase II: 2008–2012)
CO ₂	Carbon dioxide	NEA	Nuclear Energy Agency
DENA	German Energy Agency (German: Deutsche Energie Agentur)	NEMS	National Energy Modelling System
DIME	Dispatch and Investment Model for Europe: Energy system model developed by EWI	OECD	Organisation for Economic Co-operation and Development
DLR	German Space Center (German: Deutsches Zentrum für Luft- und Raumfahrt)	PEC	Primary Energy Carrier
EEFA	Energy Environment Forecast Analysis—a German research institute	PED	primary energy demand
EFOM	Energy Flow Optimisation Model	PP	Powerplant
ETP	Energy Technology Perspectives study published by the IEA	Prognos	Prognos AG—a private Swiss research institute
ETP-Base	Baseline Scenario-Energy Technology Perspectives	REF-TECH	Reference technology database used by the ARES model
ETP-BLUE	MAP Blue Map Scenario-Energy Technology Perspectives	REG	Renewable Energy Technologies
EU	European Union	RES	Renewable Energy Sources
Eurostat	Directorate-General of the European Commission responsible to provide the European Union with statistical information at European level and to promote	VDEW	Former Association of the Electricity Industry in Germany now included in BDEW
		WEO	World Energy Outlook, annual publication of the International Energy Agency (IEA) on global long-term energy market analysis
		WEO-Ref	Reference Scenario-World Energy Outlook
		WETO-CCC	Carbon Constraint Case scenario of the World Energy Technology Outlook study
		WETO-Ref	Reference Scenario-World Energy Technology Outlook

extensive and ambitious climate policies, scarcity of fossil fuels combined with extremely high prices and at last the revision of the act on nuclear phase out in Germany. Renowned scenarios are selected to represent these cases. These scenarios are described in detail with their settings and assumptions (see Section 3).

As the main assumption is the development of primary energy prices, the scenario description and selection focuses on the discussion about fuel prices. However, other key economic assumptions behind the scenarios, such as GDP growth and population development, are also described in Section 3. After the scenario description, the methodology behind the selected scenarios is shortly presented in Section 4.

The analysis continues with the comparison of the scenario results, which are illustrated on the basis of key parameters (PED, electricity generation, etc.) most relevant for energy markets. At first these parameters are displayed for the global energy market considering a baseline and an alternative scenario. Afterwards the future development of the German energy market is described with the help of future PED, gross electricity production and heat generation in the different scenario groups. Besides, the scope of the study is also set on the share of different energy carriers (oil, coal, gas, nuclear and renewable) within the PED and electricity

production. Furthermore, the study covers the development of energy related parameters, e.g. the annual CO₂-emissions, in each representative scenario. Thereby both, total as well as electricity related CO₂-emissions are analysed.

In Section 6 the presented scenarios are critically reflected. Thereby the importance of energy scenarios and prognoses, so-called energy futures, is highlighted, as they are often used to support decisions on energy policies and technologies. As scenarios play an important role for decision making, they should be as objective as possible. Therefore it is discussed, on which type of assumptions the scenarios are carried out and if the scenario generation follows an iterative process. An iterative process raises the quality and objectiveness of the scenario, and thus the validity of their key outcome. However, this analysis shall not end in criticism of the selected scenarios and the methods behind them; rather it will point out the variety of energy scenarios and the difficulties in their development. Therefore this paper will give an impulse to reflect scenarios stronger and thus make them more objective.

Finally, the main aspects of the scenario analysis and the basic results are summarized in the conclusions, while the possible direction of future work is also noted there.

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