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Energy futures: Diversity and the need for assessment

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ABSTRACT

In energy policy and energy research, decisions have to be made about the technologies and infrastructures that may be used to provide and distribute energy in future times, some of which are very distant. Frequently, energy futures such as predictions of the energy demand or energy scenarios are used for decision-support in this field. The diversity of energy futures, however, threatens any possibility for orientation, could lead to disorientation instead of helping more rational decision-making and could be used for ideological purpose. In this paper, we investigate concepts and approaches for scrutinizing, comparing and assessing the various energy futures from an epistemological point of view. Following the analysis of the structure of (energy) futures we will conclude that comparisons and assessments of energy futures should be made through processes of scrutiny and assessment, looking into the *ingredients* which have been used in constructing the respective futures, and into the process of their *composition*. Providing much more insight into the cognitive and normative structure of energy futures is required for allowing a more transparent and deliberative societal debate about future energy systems.

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1. Introduction and guiding questions

Visions and scenarios of future developments exert a strong influence on human thinking, on decision-making in politics and the economy, and on public debate. This is particularly true in the field of energy policy, which is associated with long timescales and high uncertainties [1]. Decisions and policies in this field are explicitly or implicitly governed by images of energy futures, which are often being presented in the form of model-based scenarios that integrate visions and formal analyses [2–5]. Such energy futures inform political actions, enter public debate and influence the main actors in the respective policy arenas. Decisions made today depend, on the one hand, on assumptions about and goals for the future (energy demand, availability of new technologies, greenhouse gas reduction targets, etc.) and, on the other, determine some parts of the energy system for decades to come.[1]

However, due to the enormous number of energy futures (see Section 2) such as scenarios and the huge spread in what they assume about future energy systems, the problem of arbitrariness arises. The diversity of energy futures threatens any possibility for orientation, and could lead to disorientation instead of helping more rational decision-making. This diversity also opens the door for ideologies using energy futures such as scenarios for transporting particular interests, often hidden behind model-based simulations claiming objectivity.

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[1] This paper was written before the Fukushima event. The review process, however, allowed for including hints to some issues of that event relevant to this paper. In particular it can be assumed that specific assumptions about more or less possible, probable or improbable 'futures' entered the decision-making process which led to establishing the nuclear power plants at Fukushima.

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Rationality in this field would require the capability to distinguish between the various energy futures according to their "quality"—where the next question would be for the meaning of "quality" and for criteria for assessing it. It is therefore necessary to develop and provide appropriate approaches and criteria for comparison, weighing and assessment of the energy futures. In this paper we will focus on an analysis of energy futures with regard to their epistemic status. The aim of this assessment process would not be to judge energy scenarios on an individual basis, but to create transparency in comparing them with respect to their premises and presuppositions, and with respect to the consequences of different assumptions and methodological approaches as well. The main theses to be developed in this paper are:

- futures in general and energy futures in particular are social constructs and thus inevitable parts of the respective present time
- the diversity of energy futures cannot be resolved by an optimizing procedure which sometimes is expected to provide the "one best" future scenario
- the popular decision-making mode, that energy futures should enable decision-makers to simply "derive" the adequate decision or at least to give orientation does not work in the naïve sense
- instead, energy futures can contribute to decision-making in a much more sophisticated and complex way via democratic debate and deliberation
- in order to exploit this potential an epistemological scrutiny and enlightenment is needed for uncovering the "ingredients", the premises and presuppositions, the knowledge but also the hopes, assumptions, biases and concerns included in the energy futures as well as possible hidden interests.

The paper is reflective with respect to the usages and roles of energy futures and programmatic with regard to meeting the challenges uncovered by that reflection. Its significance to decision-making in the field of energy is demonstrated by references to papers and studies from that field. Following the diagnosis of the high diversity and heterogeneity of energy futures and corresponding challenges to achieve reliable orientation from them (Section 2) we then will perform a methodological analysis about the very nature of energy futures (Section 3) aiming at giving tentative answers in which direction a comparative epistemological assessment of energy futures might help overcoming the arbitrariness problem. This analysis will be complemented by asking for appropriate methods of scrutiny and assessment of energy futures. The conclusions will address the role of energy futures in democratic debate and the need for epistemological enlightenment there (Section 4).

2. The challenge: energy futures—ideology instead of orientation?

Making energy available and distributing it probably constitute the field in which the most numerous and the most ambitious futures are created (except possibly the field of military), in most cases with very substantial effort. There are masses of energy futures, from the global energy scenarios of large institutions and organizations [3] to futures specific to highly differentiated and modular technologies, industries, and regions [5–7]. Due to the high cost of investments in the technologies employed in energy infrastructure and energy supply and to the fact that large power plants usually have a long service life once they have been put into operation, decisions in the energy field fix or at least strongly influence this aspect of the future for a long term. The long periods involved until new energy technologies are fit for the market and until new infrastructures are built up is another reason that there is a strong need for energy futures, which form the basis for corresponding long-term planning.

2.1. The expectation of deriving orientation from energy futures

In energy policy and energy research, decisions have to be made about the technologies and infrastructures that may be used to provide and convert energy in future times, some of which are very distant. The core issues for energy policy and the orientation of energy research—e.g. statements about the gradual depletion of fossil energy sources and about the perspectives for the competitiveness of renewable energy sources, the formulation of climate goals based on avoiding CO_2, the safeguarding of the supply of energy to the economy in the face of shifts in geopolitics, the potentials and risks of the hydrogen economy, the long-term considerations about the role of fusion technology—are made up in part of far-reaching assumptions about future developments. "Energy futures" in this sense are used as basis of which decisions are made. Fig. 1 illustrates a frequently used mode of decision-making combining forecasting and back-casting [8].

Providing support in form of reflections on the future in order to facilitate presently pending decision-making represents a general mode of preparing decision-making in modern societies [9–11]. Predictions of developments of future society such as demographic change or economic growth, prospective knowledge of consequences, prognoses of technical progress, expectations and fears toward the future, as well as aims and targets are bundled together as "futures", e.g. in the form of complex and model-based energy scenarios [3–7]. Proceeding from *present-day's* problem perceptions and decision-making requirements orientation *for today* is sought via the roundabout route of debates about the *future*.[2]

[2] A central message to be developed in this paper is that the orientation-providing loop (Fig. 2) shows an oversimplified picture which should be replaced by a more complex one (see Section 4).

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