Analysis of energy autarky levels for different system boundaries by using an integrated energy system model approach

Abstract

The different aspects for the utilization of renewable energies, energy savings and emission reduction measures in small municipalities and whole states can be bundled under the keyword “energy-autarky” or energy self-sufficiency. This study examines to which extend self-sufficiency in the energy sector is possible, which storage capacities and technologies are needed and last but not least, how such structures are accepted by the population.

The interdisciplinary project is made possible through the integration of stakeholders and the participation of affected groups as a best estimate of the actual situation and the possible resistances and problems in the course of increasing the energy self-sufficiency. The implementation was inter alia carried out through an intensive public participation processes and public information.

It has been found that the terms "energy self-sufficiency” and "energy autonomy" are used mostly congruent and without a precise definition in both, spoken language as well as in the literature. Therefore, a fundamental discussion and definition of the terms " energy autonomy" and "self-sufficiency" resulted in a definition for "energy self-sufficiency” which has been published in an article.

A variety of technology options, which seems to be of particular importance towards energy selfsufficiency was identified during the reporting year and characterized technically, economically and ecologically. To this end, a systematic analysis of the environmental impacts of a product throughout its entire life cycle was carried out. The key findings of the technical, economic and environmental evaluation of technologies are summarized in technology fact sheets. With the objective to take account of the system perturbation of the medium-voltage level, an exemplary grid was investigated.

The different determinants of energy self-sufficiency rate have been integrated by means of an energy system model, to identify cost-optimal measures to achieve energy self-sufficiency. The Integrative investigation of energy autarky was carried out in a model network between system modelling (direct resource use), network analysis (construction and operation) and an overall ecological model (indirect and upstream resource utilization). The basis for the scenarios to be analysed was formed by a cross-impact analysis which reduces possible measures to plausible combinations of descriptors for the scenario frameworks.