MEASURING REGIONAL IMPACTS OF AN ENERGY SYSTEM TRANSFORMATION – A CONTRIBUTION TO SUSTAINABILITY ANALYSIS

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Overview

The transformation from fossil-fuel based to renewable energy-based energy systems is one of the main challenges for nations' climate change mitigation. As Germany's first political measures in that context were launched comparably early, the assessment of economic effects of this transformation (especially when it comes to renewable energies in the power sector) has been an often-tackled task. Many scenario-based studies come to the conclusion, that the economy can in the long run benefit from investment in renewable-energy facilities and disinvestment in fossil-fuel based capacities in terms of GDP and employment. But positive economic impact is only one of many aspects, if one expends the analysis to different sustainability indicators and broaden the framework to indirect effects of a mix of different technologies in an (optimal) future energy system. Another aspect, which was hardly addressed in an integrated way, are regional effects. One reason might be, that scenarios often are defined on a national level with rather vague assumption about regional distribution of investments and structural changes. Another reason is, that there are no energy economic models on a regional level, which are capable to calculate different scenarios in an integrated manner. This paper introduces an approach to integrate regional distribution aspects both in terms of scenario-definition and model calculation to overcome limitation of previous approaches. The study will be part of an integrated sustainability assessment and optimization of energy systems.

Methods

Among many existing scenarios a base scenario is selected, which has a detailed documentation of assumption regarding economic structural changes. Given those assumptions a framework of regional assumptions is elaborated using detailed data form the energy sector in the regions. The future expansion of renewable energy capacities has to be regionalised. While the base scenario represents a "most likely" distribution of regional pathway of investment and power production, at least two simulations represent alternative regional distribution: One that represents efficiency and at least one that represents sustainability (ecological and/or social). The national macroeconomic analysis is based on simulation results obtained with the environmental macroeconometric model PANTA RHEI (Lutz et al. 2014). Existing regional models, which are fully integrated into the national model framework were already extended and will be further improved to process detailed regional assumptions in the long-term scenarios (up to 2040). The model LAENDER estimates economic structural changes in gross values added and employment for 16 federal states in Germany. It is parameterised with econometrical estimations for 37 industrial sectors. For the energy supply sector specific equation are integrated using detailed data from energy statistics. The results of LAENDER show implications of structural shifts implemented in the national scenarios (Ulrich / Lehr 2018). As macroeconomic impacts of climate change mitigation are strongly driven by the amounts of investment, a model based of analysis of regional multipliers has to be added, for a better assessment of specific effects. An existing model framework (cf. Löckener et al. 2016, Ulrich et al. 2012), which is a representation of a multiregional input-output model, has to be extended to perform this analysis. The baseline and alternative simulations are calculated in the models and indicators are compared.

Results

The national macroeconomic model provides the framework of the regional analysis and projects GDP and employment under the assumption of increasing RES shares in the baseline scenario. Regions show different developments within that framework up to 2040. Regional dynamics already are the result of overall structural shifts and baseline assumptions regarding the changes in the energy market. Regions that already have a high share of renewable energies at the beginning of the projection period are developing more positively in the energy sector than regions with a higher share of fossil fuels. The regional shifts are dependent on the regional structures of energy supply and of the economy in general. Changes in the regional distribution of RE investment in the sensitivity analysis lead to two major redistribution effects. On the one hand the energy sector in the regions either expand or reduce capacities and respective value added. On the other hand, the amount of investment changes and the resulting additional demand.

The calculation of the latter cannot be handled by a system of weights and proportions, as regions only deliver a rather small part of primary input for the installation of new capacities in their region. But other regions can benefit from investment in another. Results from ex-post calculation of gross employment show, that indirect effects of investments are distributed over large areas and that especially regions that have industries corresponding to specific goods can benefit from additional demand from all over the country (Ulrich et al. 2012, Ulrich / Lehr 2018). In the scenario and sensitivity analysis will contribute to a better understanding of implications of alternative regional distribution in the long run. The question whether an investment in weakly structured regions can support sustainability by reducing inequalities is to be discussed.

Conclusions

The sustainability assessment of transformation processes should not only be carried out at the national level. Economic implications and consequences for sustainability can be very different among regions. This perspective does not only imply another dimension in the analysis. Rather, regional equality or inequality is a sustainability aspect in itself. These regional implications must be included in the assessment framework.

References

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