Measuring energy import reductions and monitoring the energy transition in Germany

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Abstract

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1. Background

The energy transition describes the path of the comprehensive transformation from an energy system characterized by the use of fossil fuels, to a system based on renewable energy (RE), in which energy is used more efficiently. In Germany, as a resource-poor country, this is synonymous with a decline in fossil fuel imports. The decline in imports is per se equivalent to an increase in the trade balance. At the same time, energy security may possibly be increased, because imported fossil fuels come in part from politically unstable countries and are subject to considerable price fluctuations. The Impact Assessment on Energy Efficiency (EE) of the EU devotes a subchapter to the topic of energy imports and states as follows. "Although the import of fuels is not an energy security problem in every case, the magnitude and nature of, in particular, oil and gas imports, magnified by the projected reduced domestic production in the next decade, raise specific energy security issues. Energy efficiency policy in total - especially gas and oil imports. (...) In the period 2021 - 2030, the target of 30% would be a cumulative Euro 70 billion saving in fossil fuels. For more ambitious scenarios, the cumulative savings would range from Euro 147 to 288 billion. The savings would be even greater in the period 2031 - 2050."

Import reductions from a shift to renewables are included in the monitoring process of renewable energy deployment and served as an illustration of the benefits of renewables. This is not following the Trumpish argument of “National first”, but putting the large up-front investment necessary for renewables into a better perspective. The message “the shift to green energy actually saves money” was conveyed. Does this also hold true for energy efficiency? The challenge lies in the measurement of energy savings and in the allocation of the respective savings to energy efficiency and renewable energy. Several factors are key: economic growth and energy consumption should be increasingly decoupled, fuel efficiency has to be measured against transport volume and residential energy consumption has to cover increasing areas of living space. This contribution makes a suggestion how to estimate energy savings and import savings based upon publicly available data. It fulfills several of the ten guiding principles that the expert commission has set for good (energy efficiency) monitoring (see Chapter 5 in Löschel et al. 2015). These include, in particular, the principles of "Robust and up-to-date data", and the challenge to the monitoring itself to be "efficient", "transparent" and "neutral".

2. Methodology

If the reduction of energy imports is attributed to a change in the energy system towards domestic energy sources or increasing energy efficiency, a scenario comparison is often used. At the European level, the scenario comparison is applied in the Impact Assessment studies on the expansion of renewable energies or on the effects of climate protection policy, etc.

This contribution takes a different route. Firstly, a reference year is set. Here, the year 2000 is selected, because this is commonly considered as the start of the energy transition in Germany. Secondly, energy consumption (total, by sector, by energy carrier) today is compared to the reference year. However, GDP, number of households, output and value added were much lower in 2000 and the question is if energy efficiency has been growing slower, faster or at the same pace as these drivers. Therefore, we compare energy consumption today to a hypothetical energy consumption, which had occurred, if efficiency had stayed at the level of the reference year. In a third step, we adjust for additional renewable energy since 2000 and let the hypothetical energy demand be covered with an energy mix holding RE amounts constant on their 2000 levels.

Fossil fuel import reduction then follows from:

$$(1)\quad Imp_t = \sum_{i=1}^{30} ip_{i,t} * iq_{i,t} * \left(q_{i,2000}^{c} * \left(\frac{TFEC_{2000}}{GDP_{2000}} * GDP_t - \sum_{j=24}^{26} fec_{j,2000}\right) - fec_{i,t}\right)$$

with

Imp_t	Savings in fossil fuel imports due to energy efficiency and renewable energy increases t
$ip_{i,t}$	Fossil fuel import price of fuel i in year t
$iq_{i,t}$	Import share of fuel i in year t
GDP_t	Real GDP in year t
$TFEC_t$	Total final energy consumption in year t
$fec_{i,t}$	Final energy consumption by fuel and year
$q_{i,t}^{c} = \frac{fec_{i,t}}{TFEC_t - \sum_{j=24}^{26} fec_{j,t}}$	Share of conventional fuels in the conventional mix

Data sources are official or semi-official statistics. GDP and import prices are published by the German Federal Statistical Office, all energy data stem from the German Group on energy balances.

3. Results and Conclusion

Final energy consumption in 2000 was 9.23 EJ; in 2015, it was 8.9 EJ. Primary energy consumption was 14.4 EJ in 2000 and 13.26 EJ in 2015.

If the economic performance of 2015 were achieved with the efficiency of the year 2000, final energy consumption would be just under 23% higher, primary energy consumption and conversion use each just under 29%. In order to estimate the combined effect of energy efficiency and renewable energies, it is also assumed as outlined above that these energy consumptions, which are more than twenty percent higher, will be covered by an energy mix that keeps renewable energy at the 2000 level. Overall, final energy consumption reduced by efficiency and the substitution of fossil fuels by renewable energy sources in the final energy consumption result in savings of € 16.1 billion in 2015. Further, it can be shown that the application of the approach on a sectoral level (households, industry etc.) exhibits slightly higher results and the attribution of the sum to RE and EE depends on the selected sequence.

4. References

Löschel, A., Erdmann, G., Staiß, F., Ziesing, H. (2015): Stellungnahme zum vierten Monitoring-Bericht der Bundesregierung für das Berichtsjahr 2014. Expertenkommission zum Monitoring-Prozess „Energie der Zukunft“. Berlin, Münster, Stuttgart.