# Effects on local value added and employment from transforming energy supply in an urban neighbourhood

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## Overview

To reach the global climate goal to keep the average surface temperature rise well under 2°C, massive changes in the way energy is produced and used are mandatory. In this context, the decentralization of the entire energy system is becoming increasingly important. This transformation requires investments, which in turn influence regional value added and employment positively.

In the city of Heide (Germany) an efficient and integrated energy system that delivers 100% renewable power, heat and mobility solutions is being developed. In our study we analyse the impacts on the regional value added and employment resulting from this comprehensive transformation of the energy system. The core of the system which is being developed in Heide is a local heating and electrical operating grid. PV systems installed on the roofs of the houses supply electricity directly to a large heat pump. The generated heat is temporarily stored in a large-scale heat storage unit. The battery storage buffers the PV electricity when the thermal storage is overloaded. Sector coupling is achieved by means of electrolysis. If no PV electricity is available, the large heat pump is supplied by means of a CHP system. A gas boiler is used for redundancy and to increase the temperature on cold days.

Our approach is a comparatively simple method for estimating regional welfare effects (Kosfeld et al. 2013). Using the example of heat supply in Heide, we come to the conclusion that positive economic effects can arise in the region largely detached from the economic viability of investments in the expansion of a decentralized supply system.

## Method

The study analyzes the impacts on regional value added and employment resulting from the transformation of an urban neighborhood towards renewable energy. The paper uses an additive method to estimate direct and indirect local value added and employs multipliers to derive induced value added and employment effects. We apply this method to a district heating system with a PV-powered heat pump, a CHP plant and thermal and battery storage. We compare two scenarios: business-as-usual (conventional) and future-oriented (renewable) heat supply between 2022 and 2035.

In the literature regional economic effects of investments in renewable energies are estimated based on different approaches (Coon et al. 2012, Jenniches 2018, Rutovitz & Atherton 2009, Wei et al. 2010, Hirschl et al. 2015). The concept of value added is defined and interpreted in many different ways (Bender et al. 2002, Gabler 1988, Haller, 1997, Statistisches Bundesamt 2003). Derived from economic theories, the concept of value added used in this study can be interpreted as an increase in value of means of production, goods and services generated in an enterprise or a region during a certain period of time.

Our method of calculating value added is based on the addition of its individual components. Both, cost-effective-analysis of the production factors used and the income of the various actors involved in the transformation process form the basis (e.g. taxes, interests, profits). In addition to the value added effects resulting directly from economic activities in the transformation process (e.g. plant installation), indirect effects are also taken into account. These result from the demand for intermediate inputs and services by companies in the same or a different economic sector and describe the effects that arise at upstream stages of the value chain. Examples include services in the area of tax consulting or insurance, or the material required to repair a plant. The costs consist of income and material costs. As these two components contribute to the value added to different degrees, the shares of income or material costs for the different cost items (e.g. administration, maintenance and repair, etc.) are estimated. Since not all expenses remain in the region under consideration, their regional shares must be estimated as well.

Finally, the additional value added in the region leads to an expenditure of the additional income generated by the expansion of renewables and thus triggers a multiplier process that stimulates demand in the region over

several rounds and further increases regional value added (induced value added effects). For this purpose, a multiplier is quantified for the region under consideration. This indicates the factor by which the value added generated by the activities in the renewable energy economy is increased after a theoretically infinite number of expenditure rounds (Kosfeld, 2013). The multiplier takes into account the propensity to consume, tax and transfer rates, and outflows from the region.

Employment effects are quantified on the basis of industry-related employment intensities. They reflect the ratio between employees and turnover by describing how many employees are required to generate a certain turnover. Since information about the regionally remaining turnover are available, the employment effects can be derived.

Various scenarios are examined for the sensitivity analysis. Assumptions regarding the degree of regionalization of the individual activities in the transformation process are changed, as well as prices and cost factors.

## Results

Our paper shows that the comprehensive transformation of the energy system leads to positive effects on the regional welfare and employment. Up to the year 2035 the scenario “Renewables” generates more value added than the conventional scenario. The cumulative regional value added resulting from the transformation activities towards a more sustainable heat supply amounts to approx. 14.5 million euros. In the same period, the value added of the "business-as-usual" scenario is around 6.8 million euros.

Overall, the heat pump generates the highest amount of regional value added, since higher costs are generally associated with higher value added. Thus, the consideration of the value added per invested euro allows for more information about the value creation potential of the individual technologies. The heat pump generates in the Renewables scenario a value added of 0.63 euros per euro invested and thus contributes most to the regional value added compared to the other technologies in that scenario (between 0.54 and 0.56 euros). However, with a value added of 0.60 Euros per Euro invested, the boiler plant contributes more to the regional value added than the technologies (except the heat pump) in the Renewables scenario.

During the period under review, 86 people are in total directly and indirectly employed with the installation and operation of the plants and the heating grid. The installation of a conventional heating grid leads to the employment of 29 people. Also in terms of employment effects, the heat pump contributes most to the regional effects. Over 60% of employment is attributable to the installation and operation of the heat pump to supply the neighbourhood with "green" heat by 2035.

For a sensitivity analysis, the amount of non-specific operating costs was increased by 0.5 to 1 percentage points. It is striking that, firstly, positive effects on regional value added can be observed despite rising costs and, secondly, that the scenarios react differently to the variation. Higher costs cause the regional value added in the Renewables scenario to rise from 450-500 k euros to more than 750 k euros annually. In the BAU scenario, the annual regional value added is approximately 50,000 euros higher at the beginning than in the variant with lower costs, but it is also 50,000 euros lower at the end of the period. This development shows that the amount of the profit in the scenarios is decisive for the effect of the variations, e.g. an increase in the non-specific operation costs affects the regional value added only if the regional profit is greater than 0. Higher operating costs can lead to higher value creation.

## Conclusions

The transformation of heat supply from a conventional to a renewable one leads not only to a reduction in $CO_2$ emissions resulting from heat generation but also boasts regional welfare and employment compared to the conventional scenario. Particularly if the transformation of an existing regional energy system is associated with higher costs than the maintenance and continuation of the conventional energy system, the economic effects for the region are positive. The analysis in this paper adds to the notion that investments which are not fully feasible from a business perspective may still lead to considerable positive effects in overall economic terms.

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