Smart strategies for the transition in coal intensive regions

Project No: 836819

Fact Sheet:
Decentralised Electricity Production

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Description

The **transition at coal intensive regions** will minimize the central based electricity production. That's why the whole country needs to support that transition process and should **shift** to decentralised electricity production. There are several ways to achieve that, shown below.

Technological breakthroughs around the world are changing. People are moving from passive receivers of energy from distant terminals to actively controlling their energy requirements including generation on site. Cities can be at the heart of this transition providing the joined up thinking required to deliver **decentralised energy** at a community level.

Rapid falls in the costs of PV panels and battery storage, combined with the roll out of smart meters and the continued development of demand side response (DSR) technologies provide the basis of a very different way of producing and consuming energy in the future.

Installing **PV panels** on the roofs of community and residential buildings, for instance, provides around 40% of a building's electricity needs. In trials, when solar panels were combined with storage and smart water systems generating their own hot water, that figure increased to **80-100%** (KPMG, 2015).

Installing **smart meters** is another step towards using energy in the most efficient way. For example, all households in the **UK** are due to have smart meters by 2020, based on government policy, and this will allow for the creation of more nuanced tariffs that reflect demand at different times of day.

Councils should invest in storage capacity. Developments in lithium-ion batteries mean the cost of storage is likely to fall. **California**, for example, has recently mandated the purchase of 1.3 GW of storage, which should enable economies of scale to kick in for production. The ability to store electricity and then use it when required so as to avoid the higher demand reflective tariffs will increase the value of the electricity generated locally (KPMG, 2015).

There are many different definitions of "**decentralised energy**". The Government takes a broad view using the term "distributed energy" to refer to the wide range of technologies that do not rely on the high-voltage electricity transmission network or the gas grid. This includes:

- All plants connected to a **distribution network** rather than the transmission network;
- **Small-scale plants** that supply electricity to a building, industrial site or community, potentially selling surplus electricity back into a distribution network;
- **"Microgeneration"**, i.e. small installations of PV panels, wind turbines or biomass/waste burners that supply one building or small community, again potentially selling any surplus;
- Combined **Heat and Power (CHP)** plants, including:
    - Large CHP plants (where the electricity output feeds into the transmission network but the heat is used locally);
    - Building or community level CHP plants;
- **"Micro-CHP"** plants that effectively replace domestic boilers, generating both electricity and heat for the home;
- **Non-gas** heat sources such as biomass, wood, solar thermal panels, geothermal energy or heat pumps, where the heat is used in just one household or is piped to a number of users in a building or community (Neil Carson, 2008, p. 7).

Definitions **Power self-consumption** vs. **direct power consumption**:

Besides the feature that self-consumption requires the direct usage of self-produced electricity there are imprecise specifications of its concrete design. Taking a look at the regulatory framework, indicators for power self-consumption are:

1. plant operator and electricity consumer is the same person
2. electricity is consumed in direct spatial context, and
3. the public grid is not used.

The personal identity condition (1) focuses on the plant operation. Therefore, besides possessing the plant also leasing it is in line with this requirement, since then the economic risk is transferred from the owner to the leaseholder. In the household sector, this premise limits self-consumption to homeowners who are able to buy or rent the decentralised energy plant. This is not possible for tenants living in multi-family houses which belong to another party. To differentiate between power self-consumption and circumstances where the personal identity requirement is not fulfilled another term is introduced: direct power consumption.

In contrast to the direct marketing of electricity, this refers to situations where electricity is sold to a consumer in immediate spatial proximity without using the grid. The difference between the terms self-supply and direct supply has to be understood accordingly (Melanie Hillenbrand, 2015, p. 3).

With **shrinking costs** for local production plants and rising retail prices for electricity, the decentralised generation of electricity and its direct consumption is getting increasingly attractive.

At a first glance, the tendency towards **power self-sufficiency** displays a threat to energy companies since it reduces the amount of electricity sold and challenges their traditional business models. Starting from this observation, the overarching research question is how companies can respond to households' power self-sufficiency.

More specifically, the paper explores the relevance of regulatory features, adjustment needs for existing business models, stakeholders' role in implementing these adjustments, and the profitability of the new business models. The findings are based on a review of the extant literature, on interviews with decision makers from eight companies in Germany in 2015, and on net present value (NPV) calculations for the respective business models, including sensitivity analyses for the key factors. Accordingly, the German energy transition has led companies to employ new business models and to become active in the field of residential power self-sufficiency, in particular.

The new business models focus on the two consumer groups: homeowners and tenants. They strongly vary in their extent and complexity. In contrast to the conventional way of making business, this involves rather small-scale and more customized offers (Melanie Hillenbrand, 2015, p. 1).

The **benefits** of electricity self-generation for businesses can be broadly split into two parts. **Firstly**, it can be a way to offset the costs associated with importing power (the traditional flow, where a business draws energy from the grid). **Secondly**, self-generation can be seen as a source of revenue that is gathered by exporting energy to the grid (havenpower, n.d.).

Decentralised energy, also referred to as distributed energy, is seen as having a key role to play in the shift to sustainable consumption and production. Covering a wide range of technologies that do not rely directly on the high-voltage electricity transmission network or gas grid, decentralised energy brings a range of business **benefits** including:

- increased conversion efficiency (capture and use of heat generated, reduced transmission losses)
- increased use of renewable, carbon-neutral and low-carbon sources of fuel
- more flexibility for generation to match local demand patterns for electricity and heat
- greater energy security for businesses that control their own generation

- greater awareness of energy issues through community-based energy systems, driving a change in social attitudes and more efficient use of our energy resource (Neil Carson, 2008, p. 4)

Achievements

The global share of new generation taken by decentralised power in the world market has increased.

Half of **Denmark's** electricity and almost 40% of the Netherlands' is generated by decentralised energy systems. Its use is widespread and mainstream in many other European countries, including Sweden, Germany, Austria, Finland, Italy and Spain. In Denmark, a strategy of decentralised energy focused on district heating and improving efficiency in housing means that while final energy consumption for space heating has fallen by over 15%, the actual floor space heated has increased by over 20%.

The **Netherlands** increased its use of CHP so successfully that in the period from 1985 to 1995 it grew to be the biggest single source of generation in Holland and will continue to grow. According to a review by the Dutch government, CHP also played the most significant role of any policy instrument in reducing CO_2 emissions in the Netherlands in the period 1990-2000 and was also the most cost efficient policy instrument for reducing emissions. (Neil Carson, 2008, p. 15)

Further **best practices** on decentralised electricity production could be found here:

https://greeninclusiveenergy.org/wp-content/uploads/2018/01/Best-Practices-on-Decentralised-Renewable-Energy-1.pdf

Master plan Styria, Austria: http://www.politik.steiermark.at/cms/beitrag/12387873/121400860/ (Padinger, n.d.)

EU-wide solar **PV business models** – guidelines for implementation and financing, including best practices: http://resource-platform.eu/files/knowledge/reports/EU-wide-solar-PV-business-models-PV-Financing.pdf

Challenges

The decentralised energy supply calls for a rethinking in the population and the economy. There is a multitude of power generation systems that need to be built, maintained and funded. Every citizen and every company can contribute to the decentralised energy supply.

One of the biggest challenges is the availability of energy. Because electricity is generated from wind or solar energy, then storages must **compensate for low-performance times**. Furthermore, with this form of energy supply, the dimensions are precisely calculated. For this reason, the number of households to be supplied must be known (Kesselheld, n.d.).

Like already said, a decentralised energy supply is not without its challenges:

- **High costs and recovery issues:** Though costs of renewables are decreasing, the financial expenditure needed to set up a decentralised plant is still high. This would be a problem in poorer regions, if demand is insufficient, or recovery is a problem, since electricity from unsubsidized decentralised systems tends to have high tariffs.
- **No subsidies available:** The cost problem is increased by the fact that grid electricity is often subsidized either through compensation with highly profitable urban areas (cross-subsidization) or through government funds, while decentralised electricity is often not. This is a basic regulatory issue, connected to the fact that grid companies are

well established and often state-owned, while off-grid power is usually provided by smaller and newer enterprises.

- **Skilled manpower:** Skilled manpower to manage and maintain these systems may be lacking in remote rural areas.
- **Seasonal demand supply mismatch:** Seasonal variation of demand and supply needs to be considered in the design of these plants.
- **Daily demand supply mismatch:** Mismatch between the hourly curves of generation (typically solar) and of uptake (load curve), which implies the need for energy storage provided e.g. by batteries.
- **Size:** As of now, mini-systems can only support smaller loads, such as households or limited income generating activities. Scaling up the installed capacity is challenging.
- **Environmental risk:** the inadequate disposal of storage technologies, such as batteries used in off-grid renewable energy solutions, poses significant environmental risks. Thus, take back systems for such technologies must be considered (Surendra, n.d.).

Enabling conditions

Characteristic of products in a **decentralised market** are the combination ranging from technical and commercial services to financing decentralised energy solutions. The important business areas have been recognised but the orientation towards those areas happens hesitantly.

The market players identify several business segments as of great importance in 2025: **"decentralised heat-/local heat concepts"**, **"energy-related support of prosumers"**, **"planning, construction and management of decentralised generating plants"** as well as **"direct marketing"** and **"portfolio management**". However, the actual intention to focus on those relevant business segments is less pronounced by the market players.

The customer and his needs are in the focus of products in the decentralised market. In particular, new participants and non-energy suppliers have a need for different services ranging from:

- the supply and installation of plants,
- technical services (operations and maintenance),
- commercial and energy-related services (energy forecasts, balancing group management, billing etc.) to financing incl. subsidies.

The market players intend to offer total range of technical services as bundle products, whereby in particular larger market players consider also the financing as part of the service package.

The market players assess **CHP, PV, heat-storage, power-to-heat** and **solar thermal systems** as **marketable** technologies without subsidies in 2025. Other technologies like biogas plants, biomass plants and fuel cells will not be marketable without subsidies in the near future. Technologies like the methanisation of hydrogen are still be considered as early stage technologies (Pritsch, 2015, p. 19).

- The use of **photovoltaics** for power generation requires appreciable space. It makes sense to use, for example, the roofs of buildings, instead of building open space systems that require additional space, which can then not be used otherwise. Since the cost degression with increasing size of the plants in the photovoltaic is not too strong, resulting in a high proportion of small decentralised systems, which are usually operated by the respective owners of the building (Paschotta, 2018).
- The use of **wind energy** is also predominantly decentralised. The wind turbines can not be placed too close to each other, otherwise they reduce their yields, and the available contiguous areas are usually limited. Decentralised use also has the advantage that fluctuations in the energy supply of plants in different locations partially offset each other not done at the same time.

- **Biogas** is produced from biomass, which due to its limited energy density is not suitable for transport over long distances. That is why biogas plants are set up decentral - close to the production of biomass.
- So far, **geothermal energy** has been used in rather small facilities that are tied to specific suitable locations. Here, too, of course, results in a decentralised use. (Paschotta, 2018)

Increased energy efficiency of power generation in thermal power plants is possible through combined heat and power. This is possible in principle for both decentralised and centralised power plants. However, it is often difficult for large power plants to use in the vicinity of the resulting huge amounts of heat. District heating pipelines can transport more than a few tens of kilometers, but this also limits the possibilities of use. It is much easier to distribute heat generated in **local, consumer-oriented small systems** via **local heating networks.** (Paschotta, 2018)

Example for a biomass CHP in Austria: The owner of the hotel "Molzbachhof" searched for heat production possibilities for his hotel. The company Fröling offered a new small-scale gasifier CHP technology, which was built close to the hotel. The total investment costs including the district heating grid (~500m pipeline), CHP, building and two additional biomass boilers were about 1.7 million Euro. The input material for the two gasifiers is mainly soft wood from the surrounding forests. Forest owners deliver the wood to the plant. Each CHP (Figure 1) produces about 50 kW_{el} and 106 kW_{th} load. A thermal buffer storage tank helps to decrease the peaks of the grid.

The hotel owner safes up to 150,000 litres of heating oil and 20,000 litres of liquefied gas per year (Molzbachhof, 2019).

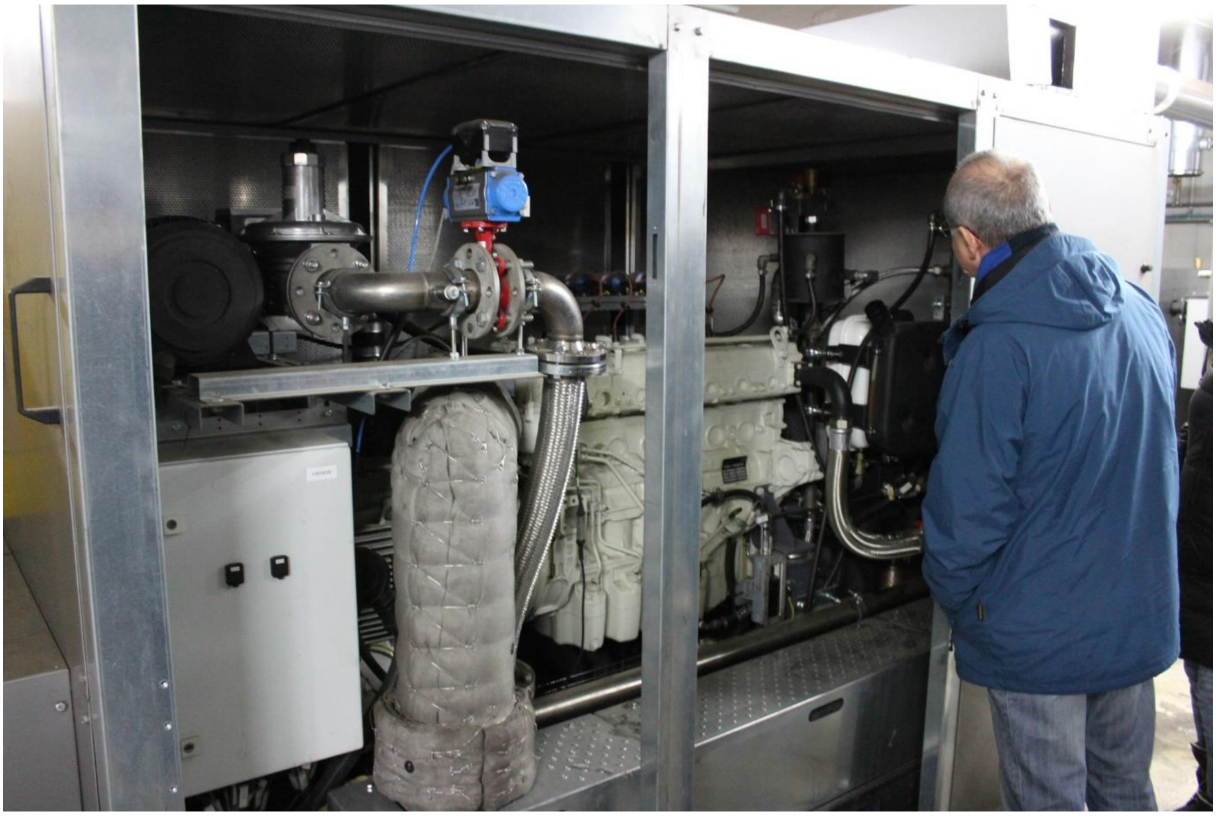

Figure 1: The produced wood gas is generating electricity and heat in this engine (source: Dominik Rutz)

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