

Executive Summary (SI “High Shares of Renewable Energy Sources and Electricity Market Reform”)

## **Regulatory Options for Local Reserve Energy Markets: Implications for Prosumers, Utilities, and other Stakeholders**

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In the near future, the current fixed support mechanisms and incentive schemes, such as the feed-in tariff for solar power, will vanish. At the same time, the guaranteed dispatch of self-produced energy by residential households cannot be sustained forever due to its potentially adverse impact on system stability. Therefore, finding solutions for better integrating decentralized energy generation on a large scale is crucial. Market mechanisms offer a flexible way for further promoting favorable technologies, with an inherent self-regulation that supports the entire system and helps preventing critical failures, such as black-outs. Households, as the owners and operators of distributed generation units, will need to become more active players in the field and emerge as traders in their own markets for self-produced energy.

In this paper, we present and discuss local energy markets as a possible solution. Their concept is based on existing ideas for virtual power plants and microgrids. A microgrid is a small grid within the major electricity grid, which can disconnect and sustain itself in “islanding mode”. In addition to a balanced proportion of energy producers as well as consumers, it employs smart technologies to coordinate production and consumption at any given point in time. On the other hand, a VPP is the aggregation of a fleet of generation devices that are operated to behave like a (synthetic) single large power plant. Given the right signals, the entirety of small electricity-producing units can be controlled to achieve the production goals necessary to fulfill customer demands or targeted trading volumes.

A primary characteristic of a local energy market is its delimitation, which can be virtual or geographical. An important consequence hereof is the composition of market participants, with a dominant share of small-scale generators. This is in sharp contrast to the central markets, where small-scale producers cannot participate individually, and which fosters the need for local energy markets. This definition only refers to the size of the generators, which in turn can be renewably fueled or not. With a high share of intermittent renewable generation, a system also needs controllable generation for balancing. For the local market,

we look at distributed generation which can take the forms of micro-cogeneration (CHP) plants (with or without fossil fuel), solar panels, storage batteries, and many other technologies.

To date, the local energy market is a theoretical construct. Nevertheless, it has some definite characteristics that result from the specific technologies and their users. The predominant attribute is the involvement of households and small businesses, i.e. end customers without professional expertise in the field of energy or trading. Rules need to be very clear-cut and understandable to create something comparable to an “energy-eBay”. This means that since customers are expected to spend some free time on trading their energy, the concept and platform needs to be equally appealing and sufficiently simplified for a large number of bidders. Modern technology, such as smart phone apps, can bring the trading close to the household, enabling to keep its occupants in the loop at all times. Thereby, the household is always informed about the market situation and how its devices are reacting to it, while being able to intervene whenever considered necessary (e.g. for enhancing the comfort of living at a certain point in time). Software agents configured to represent the household’s needs and preferences can then execute the actual bidding, freeing up time for the household occupants to pursue other leisure activities. Concerning the actual auction design, we find that the optimal auction would be a discriminatory first-price auction. In comparison to the uniform-price auction design it also has the advantage of reducing the possibility of collusion, as price manipulation can be more easily detected.

The introduction of local markets would have important consequences for several stakeholders. The main stakeholders are the government, private households, the TSOs, the distribution system operators (DSOs), and utilities or energy service companies.

The most important change would happen to balance groups. With some simple amendments to current regulation, balance groups can be used as the administrative entities for local markets. They can use these markets to procure their own control energy for balancing purposes. This not only reduces grid losses, but also helps to better integrate renewable, decentralized energy generation and thereby, e.g. in Europe, supports the attainment of the ambitious energy policy goals for 2030 put forward by the EU.

Since a local energy market is a relevant component for system stability, future research should look into how (and how much) households can be motivated to accept such a market and engage in trading activities. This also includes an in-depth analysis of the risks that both, households and system operators, face with decentralized energy generation and trading. Another related issue is the identification and development of suitable business models for

these stakeholders.