

Aggregation & Optimization of Behind-the-Meter Loads, Distributed Generation & Storage as Virtual Micro-Grids

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I. TRANSFORMATION OF THE ELECTRIC POWER SECTOR

The electric power sector is undergoing unprecedented transformation at rapid pace driven by the rise of **renewable energy resources** on the supply side and equally dramatic developments on the demand side as **distributed generation, energy efficiency** and other **behind-the-meter (BTM)** service innovations are impacting how energy is produced, delivered, consumed, stored and traded and shared.

While the developments on the supply side are well-known, those on the demand side are not. Yet as BTM technologies evolve and their costs continue to decline, current **consumers** will have new options to become **prosumers** by investing in self-generation and, perhaps, move a step further by becoming **prosumagers** by optimizing when energy is used, generated and – increasingly – stored.

Many of the challenges facing the industry today include realizing, suddenly, that **consumers** are becoming more engaged and more proactive by becoming **prosumers** in large numbers. Australia, for example, has over 2 million solar roofs already, twice as many as California.

As the cost of storage continues to drop, many of these prosumers may become **prosumagers** by investing in distributed storage. And it is not far fetched to think of a future with a sizeable number of communities of “nonsumers” – defined as prosumers who generate and feed into the network as many kWhs as are taken out.

The next step in the story of consumer awakening and empowerment will emerge with the arrival of **intermediaries, aggregators** or **orchestrators** who will enable consumers, prosumers and prosumagers to trade with their peers in **P2P trading** schemes. It is not difficult to envision a future where, for example, one prosumer’s excess generation during the sunny hours of the day can charge the batteries in the **electric vehicle (EV)** of a neighbor across the street, or across the country.

The current distribution network, which was not designed to handle two-way flows will increasingly be utilized in non-conventional ways and this is likely to overwhelm the network during certain times and locations, such as sunny hours of the day in neighborhoods with high concentration of PVs, or in the evening when many EV owners may simultaneously charge their cars.

A myriad of far more exciting and potentially consequential possibilities lies in the power of aggregation. By combining the load, distributed generation and storage capacities of large numbers of participants, an aggregator can optimize the performance of the entire **portfolio of behind-the-meter** assets in ways that is not practical or cost-effective for individuals to do on their own – which explains why there has been so little practical and profitable **demand response (DR)** to date.

This presentation, which is based on a recently published book titled **Consumer, prosumer, prosumager: How service innovations will disrupt the utility business model**, provides an overview of such developments, their implications on the incumbents, new entrants and the many challenges for the regulators and policymakers.

II. THE FUTURE OF ELECTRICITY IN A DECENTRALIZED FUTURE

Looking to the future, more attention must be focused on the developments on the customers including looking at the “behind-the-meter” space.

In this context, two important trends are particularly important:

First, is the stratification of electricity consumers into “prosumers,” “prosumagers” – as already mentioned – leading to opportunities such as Per-to-peer (P2P) trading, virtual power plants (VPPs), increased use of open platforms

and other means of energy transactions, many of which may require new technological solutions such as blockchain.

Second, is the realization that we may be at the cusp of a revolution on the demand-side of the electricity sector where many devices will emerge with capacity to generate, store and consume electricity in essentially stand-alone mode, largely or totally disconnected from the traditional T&D network.

We can see examples of this trend in many stand-alone devices. We also see examples of stand-alone eco-villages

or off-grid communities. In many such cases the needs of the community or micro-grid are locally met with little or minimal interconnection with the macro-grid.

Pairing and co-locating solar-plus-storage, or PVs plus EVs is becoming commonplace. Such hybrid systems are likely to proliferate as the technology improves and the costs continue to decline.

REFERENCE

- [1] <https://www.elsevier.com/books/consumer-prosumer-prosumager/sioshansi/978-0-12-816835-6>