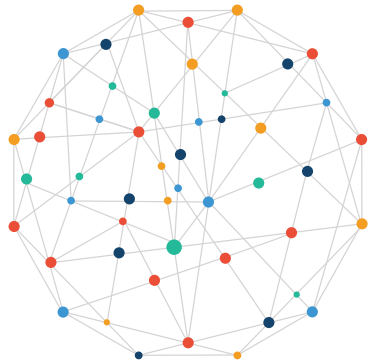


IERE Technology Foresight 2020



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The International Electric Research Exchange (IERE), was established in October 1968. With the leadership of the 4 founding members (EPRI, UNIPED, CEA and Japan IERE Council), IERE has been promoting information exchange on R&D and cooperative activities among the leading electric utilities of the world for mutual benefit. Since 2001, IERE has invited a wide spectrum of members from all around the world, where organizational structures, activities and services have been renewed in order to expedite the progress of electricity technologies and to foster cooperative R&D on a global scale.

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1. Prosumer Technologies

Function

Prosumer technologies are technologies that enable end users to become both consumers and producers of energy. Prosumerism enables consumers to have greater control to choose where, how, and when energy is generated for their consumption. It is not a new concept because this term was first coined in 1980 by Alvin Toffler, the author of *The Third Wave*¹, where he argued that human history started with prosumerism, and with the industrial age, production and consumption activities were separated. When demarketization, including demassification increased, prosumerism gained popularity.

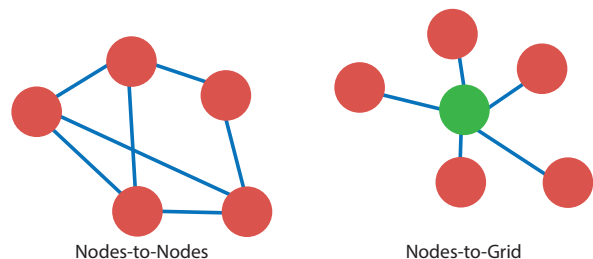
Industry Challenges

Concerns over rising carbon emissions have been a key driver for renewable energy generation. Consequently, surplus power is being generated by distributed generators, typically renewable energy generators. As such, prosumer technologies are intended to enable the uptake of small-scale energy generation (making the energy available for others to consume), while at the same time increasing the financial benefit for such small-scale generators.

End users also increasingly want to take ownership of their own energy supply and demand; this is known as “energy ownership”. This vision of “energy ownership” is being supported by several governments and has led to higher interest in prosumer technologies. This is because prosumer technologies ensure energy autonomy for citizens, enabling self-control of power generation and usage according to one’s needs.

How it Works

Figure 1: Structure for prosumers (Source: Frost & Sullivan)



Prosumers have 2 types of structures -- nodes-to-nodes and nodes-to-grid. In the nodes-to-nodes structure, the nodes might interact independently with another node, or a group of nodes interacts with another group of nodes. Interaction between a group of nodes with another group of nodes will then create a virtual power plant (VPP), which usually utilizes an ad-hoc contractual relation between agents.

¹ Bremdal, B. A. (2011). *Prosumer Oriented Business in the Energy Market*. Narvik University College.

In the nodes-to-grid structure, the nodes interact either with a microgrid or directly with the power grid, typically based on a long-term contractual relationship. In general, prosumerism involves 7 main components, which are 1) distributed energy generation, 2) transmission optimization, 3) distribution automation, 4) advanced metering infrastructure, 5) analytics, such as grid analytics and consumer analytics, 6) energy storage, and 7) monitoring and security automation. Distributed energy generation refers to small-scale power sources that are generated at the point of consumption or on-site. The largest distributed energy generation is from gensets (307.8 GW), followed by photovoltaics (164.1 GW)². Distribution automation refers to automated demand response management that balances the demand and supply of energy within an infrastructure or a city automatically by using software solutions or through software solutions on cloud services. Advanced metering infrastructure (AMI) is an integrated system of smart meters, communications networks, and data management systems, which enables two-way communication between utilities and prosumers. Energy storage systems store the excess energy generated by the prosumer. Analytics will transform big data into utility analytics strategy and grid visualization. Monitoring and security ensures integrity of stakeholders in the ecosystem by guarding the data against improper information modification and data loss.

❗ Requires complex management and system controls capable of handling high loads of bi-directional power processes

❗ Prosumer technologies challenge the traditional business model of power utilities and can potentially impact the long-term sustainability of companies and consequently their employees' future

❗ Opportunities for arbitrage is possible, if the pricing structure is not well-defined



Enablers & Barriers

Enablers

Advances in Technology, Particularly Smart Meters

Advanced metering enables two-way communication between electricity generators, transmission companies, distributors, retailers, and consumers to provide information on how and when to produce and consume power. The wide-scale implementation of smart meters has contributed greatly to the growth of the prosumer business model, as it enables bi-directional power transactions. Using prosumers, surplus energy can easily be sold to a centralized energy producer, based on dynamic pricing systems. Smart meter penetration will double from 2015 levels to 2025³, mainly driven by replacement of first generation meters that have very basic functionalities and a limited lifetime of 10 years especially in Europe and APAC, particularly in China. Time of Use (ToU) of energy in real time can be measured with the help of smart meters, but it is also critical to understand optimization, prediction, and forecasting of the transactional value of data.

Increase in Distributed Energy Generation

Advancements in small-scale energy generation, especially in power conversion efficiency, (lower) cost system and (better) energy resource management has enabled the creation of the prosumer model.



Advantages & Disadvantages

👍 Increases the bargaining power of the end user, thereby reducing the monopolistic features of the power industry

👍 Informed end users can increase overall energy efficiency as they can adjust their energy consumption to obtain maximum financial benefits

👍 Prosumer technologies can help in improving system reliability (reducing congestion) and deferring generation and transmission investments

² Frost & Sullivan. (2016). *Global Distributed Energy Outlook, 2016*. Frost & Sullivan

³ Ibid

Increase in global distributed energy generation with year-on-year growth of 10.3%, which distributed solar PV represents the largest market, contributing 65% of the distributed energy market revenue of \$42.52 billion in 2016. In many developed countries, the focus is on achieving grid parity using PV; however, for countries with weak grids, such as India, PV offers energy security at a rate much cheaper than diesel generators.

Supportive Government Policies

Governments are in favor of consumers taking ownership of their energy needs with supportive tariff policies for distributed energy generation. The European Union (EU), under the Energy Union Framework Strategy, has a vision that states "...with citizens at its core, where citizens take ownership of the energy transition, benefit from new technologies to reduce their bills, participate actively in the market, and where vulnerable consumers are protected"⁴. Besides favorable tariffs, many governments also offer low-interest loans or grants to citizens to install distributed energy, which has driven the growth of the industry.

Barriers

Aging Infrastructure

Aging power infrastructure cannot handle fragmented bi-directional power. Bi-directional processes that do not result in harmonic distortions, voltage spikes, and power output fluctuations are still in development. Furthermore, the success for prosumer technologies depends highly on the degree of integration. Poor integration brings more harm than good for the energy landscape by threatening grid stability and reliability, especially in ad-hoc nodes-to-nodes interactions. For many poor countries, updating the

power infrastructure to incorporate a prosumer model may be less of a priority than ensuring consistent power supply to citizens.

End Users' Concerns

Knowledge among end users regarding the prosumer concept is low, especially regarding costs and consumption, due to a lack of transparency between stakeholders. A few cases regarding the inconsistent statement of accounts between smart meters and power producers have eroded end users' trust in the prosumer concept. Moreover, there is a lack of legislation protecting prosumers from unfair commercial practices. Though there is a best practices procedure (soft law) published by the European Commission⁵, the lack of a legal framework to address prosumer disputes remains a key concern⁶. There are some national policies that discriminate or put prosumers at a disadvantage. Examples include lack of prosumer definition in the consumers' hard law⁷, amount of surplus energy injected into the grid⁸, unfavorable tax or penalty for excessive generation⁹, unrealistic competition law^{10,11}, unrealistic remuneration and lack of bargaining power for prosumers^{12,13}, and ongoing negative changes to the supportive scheme¹⁴. There are also safety concerns among end users regarding data privacy and data security.

This chapter continues to page 23.

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