Microgrid Business Models and Value Chains

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Executive summary

The new energy industry is working to categorize the various types of microgrids and business models.

The primary goal is to minimize microgrid system costs such as project development, system design, commissioning, service, support, and funding. Microgrid categories will help promote standardized designs – which will enable repeatable, modular, and scalable systems.

Typical business models include:

- Customer-owned (capital expense)
- Microgrid as a Service (operational expense)
- Pay as you go (small, remote systems)

Microgrid categories

Microgrid categories are highly structured by their connection mode to the main grid and their type of ownership

The graphic below represents different microgrid categories.

The x axis represents the connection mode of the microgrid. The right side of the graphic represents grid-tied microgrids, i.e., normally connected microgrids with resiliency capability, whereas the left side represents microgrids that are normally disconnected from the main grid.

The y axis represents types of microgrids. Facilities are depicted on the top of the graphic and public on the bottom.

Figure 1

Microgrid categories

Off-grid, facility microgrids

This is the most common type of microgrid today globally, and are typically found in remote areas not reached by the traditional grid. Examples include remote military bases, remote mines or industrial sites, and isolated buildings such as resorts. The main benefits of these microgrids include high reliability energy (avoiding production losses), and integration of low carbon renewable energy to optimize both cost and environment.

Off-grid, community microgrids

Serving multiple consumers and producers, these microgrids are also found where the main grid is out of reach—for example on islands or in remote villages and communities. However, unlike facility microgrids, these initiatives encompass various community assets to guarantee resilient power for vital community services. The main benefits of these microgrids include a high percentage of renewable generation such as biomass, solar PV, and wind power to minimize fuel dependency—minimizing pollution and energy cost. Once they approach a certain size, off-grid, community-led microgrids experience constraints that can be alleviated by microgrid optimization and management technologies.

Grid-connected facility microgrids

Connected to the main grid, these microgrids are created for improved reliability in places where the main grid reliability is not adequate, or when the utility is providing attractive price incentives for shed-able loads. Some examples are high-availability, single commercial buildings, research or business campuses of a corporation, hospitals, data centers, etc. The main benefits of normally connected microgrids are to minimize energy bills, integrate more renewable sources, and ensure resiliency.

Grid-connected community microgrids

These serve multiple consumers and producers, are connected to the main grid, or managed as a dispatchable unit and with optimized power exchanges with the utility's main grid. These microgrids range from business campuses of cities and green villages to eco-districts or even small municipalities. The main benefits of normally connected microgrids are to optimize the cost of energy, ensure resiliency, and integrate more renewable sources.

User values

The user values for the four microgrid categories discussed above are summarized in the following table.

Off-grid facility	Grid-connected facility
Site energy manager, facility manager or IPP (Independent Power Producer)	Site energy manager or facility manager
• Secure access to energy at the site level • Minimize fossil fuel dependence • Monitor decentralized energy resources at the site level • Maximize renewable integration for cost and environmental issues	• Save money by leveraging the flexibility of decentralized energy resources • Maximize self-consumption of locally produced energy for limiting CO2 emissions • Monitor decentralized energy resources at the building level • Secure access to energy at the site level
Off-grid commu-	**Grid-connected commu-**
IPP or public utility	District administrator
• Energy access for community • Minimize fossil fuel dependence • Maximize renewable integration for cost and environmental issues	• Share a view of energy usage within a community • Make local renewables affordable with the help of energy efficiency and self-supply • Monitor and optimize decentralized energy resources at the district or building level • Support smart district specifications

Figure 2

Microgrid values

Microgrid business models

Globally, any microgrid category may use any business model. Sometimes these models are used in combination. Increasingly, microgrid customers are using "financed" or "equity" ownership much like other renewable energy or cogeneration (CHP) projects. Most microgrid assets tend to have an economic useful life of 20 – 25 years or more.

Customer-owned business model: Capital expense

Customer-owned microgrids and Microgrid-as-a-Service (MaaS) yield similar returns – but to different parties. Of course, 10 MW of generation from solar and natural gas, as well as energy storage, the returns for the customer-owned microgrid and MaaS are identical. However, the customer-owned business model places all financial risk on the customer, whereas the MaaS business model offers an opportunity for utilities and third-party financiers to strategically collaborate with customers to diversify from traditional power service opportunities. Further, implementing microgrids is often best managed by developers who specialize in power system design and modeling.

Microgrid-as-a-Service (MaaS) business model: Operational expense

While customer-owned microgrids are common today, a new business model, MaaS [1], offers a flexible ownership structure and presents the best opportunity to capitalize on this growing market. This is essentially a power purchase agreement which may have an equity and debt financing structure. Part of the MaaS structure may be volumetric, and part may be made up of capacity charge.

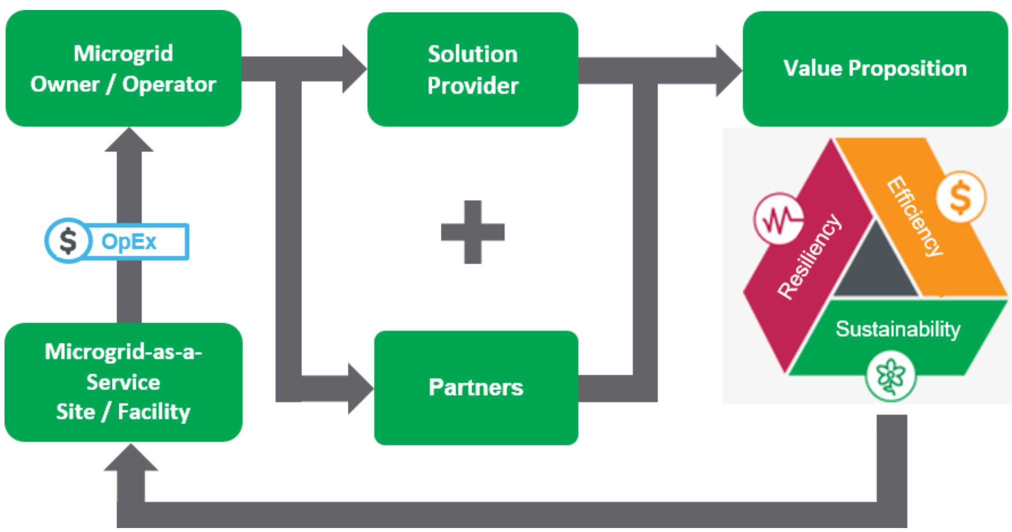

Figure 3

Value chain of Microgrid as a Service

Pay-As-You-Go business model: PAYG expense

The pay-as-you-go (PAYG) model shows promise in developing world. Small-scale PAYG microgrid models can help profitably when serving the 1.3 billion people who lack access to electricity. In India, profitable solar-driven microgrids are serving 25-30 paying customers per microgrid installation.

Spark Spread is the difference between the market price of electricity and its cost of production. Often part of other models, Spark spread describes how electricity and gas prices impact microgrid economics. As the retail rate of electricity increases, microgrids become an obvious investment as every 1 cent per kilowatt-hour increase in the electricity rate translates into a 2% increase in Internal Rate of

Return (IRR). Similarly, gas price fluctuations can drastically swing microgrid economics – a 50% price increase from $4 to $6/mmBTU can completely wipe out any economic benefits of a microgrid implementation [2].

[1] Microgrid business models: by Schneider Electric and parts taken from "Microgrid-as-a-Service Offers a Collaborative Model to the Conventional Macrogrid," Lux Research

[2] Spark Spread Definition | Investopedia

Microgrid value chains

Value chain: Grid-connected facilities

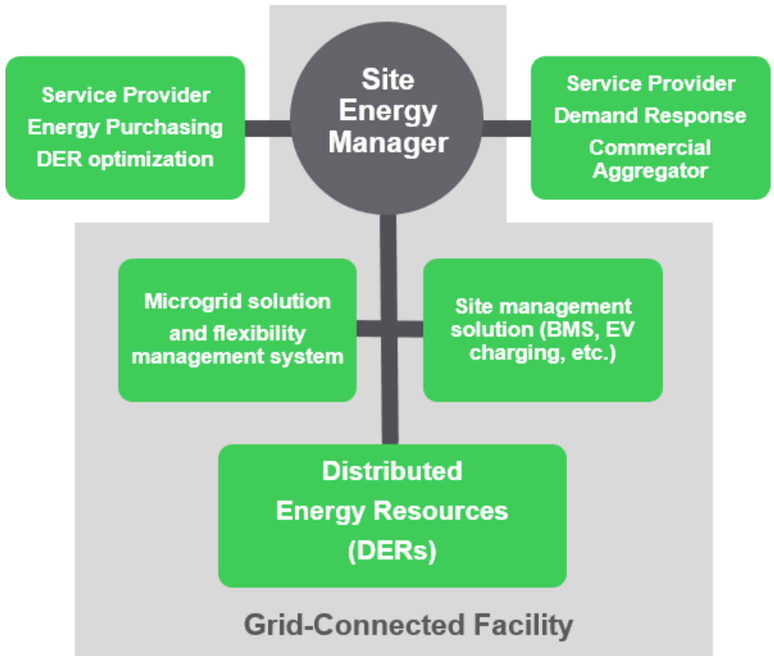

Figure 4

Value chain of grid-connected facilities

The energy policy decision maker for grid-connected facilities is usually the site's energy manager. Supported by analysis tools, this individual typically makes choices that optimize the site's energy usage:

- Energy procurement - purchasing energy and negotiating delivery contracts
- Managing energy consumption priorities for the curtailable non-critical facility loads such as heating, ventilation and air conditioning (HVAC) systems, fleet management of electric vehicle chargers, facility lighting control, etc.

The energy manager's new opportunity is to optimize the microgrid assets with assistance from the microgrid provider and a commercial aggregator to understand the various microgrid strategies that may be implemented:

- Utilize all practical and cost-effective means of local production (distributed energy resources) and optimize self-consumption
- Improve energy flexibility of the facility using a battery energy storage system
- Monetize energy flexibility through a commercial aggregator
- Benefit from advanced microgrid control that manages DER flexibility and reduces energy bills through tariff management optimization

The energy manager has opportunity to prioritize investments and optimize energy efficiency (minimizing kWh consumed) and the kWh price.
The site has the ability to reach a new level of optimization by self-consuming its energy at the right time—when it's available, green, and low-cost.

Value chain: Grid-connected community

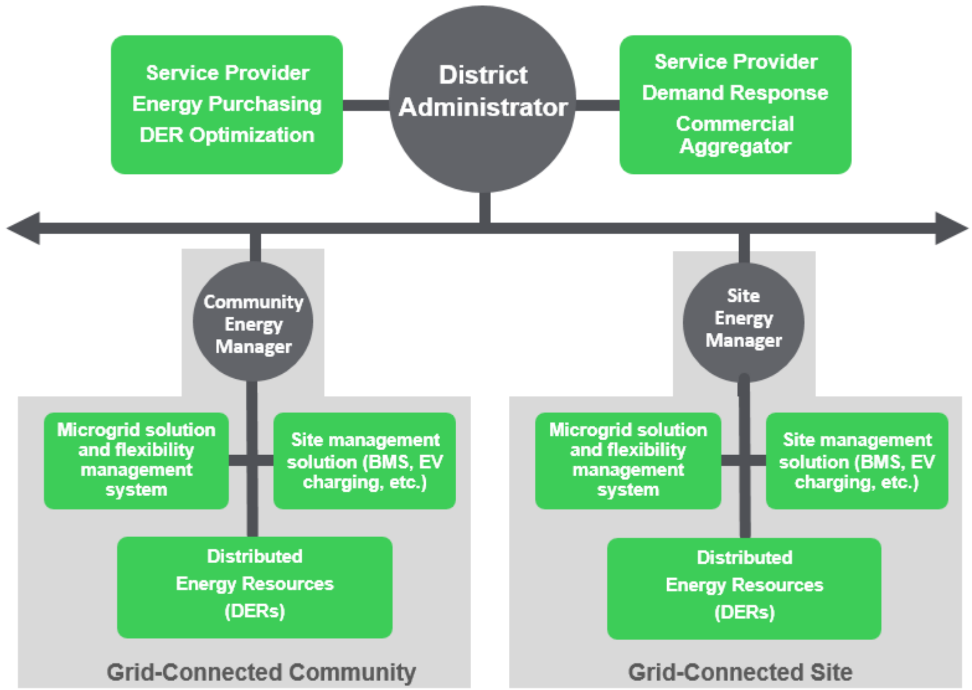

Figure 5

Value chain of grid-connected community

For grid-connected communities, a new actor is necessary: The district administrator. In this case, there are two levels of optimization:

- The district level
- The site, community, or campus level

The grid-connected community is likely to have DER at the site, community, or campus level:

- Local distributed generation (PV, CHP, Biomass, etc.)
- Local energy storage (Li-Ion battery or thermal)
- Some additional loads (public lighting, EV charging stations, etc.)

The district administrator has the opportunity to maximize self-consumption with locally produced energy, and can also purchase energy from the grid, if necessary. Alternatively, when surplus energy is available, the district administrator can sell, store, or distribute it to the sites.

The district administrator also typically determines energy flexibility for the district, and selects participation in attractive curtailment events through a commercial aggregator. This economic optimization at the district level benefits all of the district's sites, the community, and campus owners.

Value chain: Off-grid microgrid

For off-grid microgrids, more public utilities and private entities are calling for tenders from private IPPs (Independent Power Producers). The IPP is an entity that is not a public utility, but which owns facilities to generate electric power for sale to utilities and end users. Private companies are therefore positioned in order to create a consortium and therefore create an IPP.

The consortium comprises:

- EPC (Engineering, Procurement and Construction): EPC is responsible for all the activities from design, procurement, construction, to commissioning
- Solution providers: Microgrid system, decentralized energy resources, energy management system, electrical distribution, etc.
- Business model/funding: Ownership (capital expense), MaaS (operational expense), PAYG (small, remote systems), community (municipal bonds), and Spark Spread (the cost of fuel and generation vs. the cost to buy electricity)

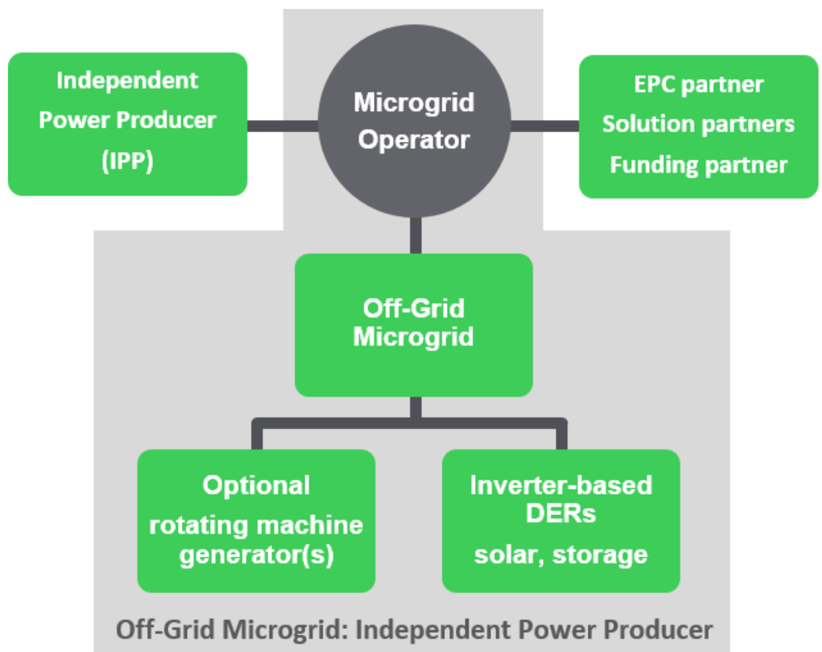

Figure 6

Consortium constituents

Conclusion

The new energy industry is working to categorize the various types of microgrids and business models, with the primary goal of minimizing microgrid system costs such as development, design, commissioning, service, support, and financing.

Microgrid classification will help promote standardized designs – which will enable repeatable, modular, scalable systems. Return on investment (ROI) is improving, due to developments in the microgrid market, technology, and cost effectiveness.

Table 1

Microgrid benefits by type

Off-grid microgrids	Grid-connected microgrids
Secure access to local energy	Secure access to local or grid energy
Minimize fossil fuel dependence	Resiliency from using multiple sources
Maximize integration of renewables	Energy flexibility arbitrage savings
Reduce energy cost and emissions	Reduce energy cost and emissions

There are now a number of new microgrid business models available to allow a choice of funding approaches: Customer-owned (capital expense), Microgrid-as-a-Service (operational expense), and Pay-as-you-go (small, remote systems), each of which can be affected by Spark Spread (the cost of fuel and generation vs. the cost to buy electricity).

In addition to the standards and new business models, there are a number of significant regulations, government incentives, and climate change actions. DERs and microgrid projects may qualify for government grants or production incentives.

- Federal Investment Tax Credits (US)
- State Renewable Portfolio Standards (US)
- COP Conference of the Parties: Climate Conference & Sustainable Innovation Forum (Global)
- The RE100: The world's most influential companies have committed to go 100% Renewable Energy (Global)

About the authors

François Borghese is the global marketing lead for the commercial and industrial energy flexibility management offers of Schneider Electric. He is an expert in the building controls market and has managed numerous projects, acquisitions, and market strategies. He led the definition and launch of the company's cloud-based software platform for optimizing participation in demand response programs and operation of distributed energy assets, including the deployment of successful projects in France and the USA.

Kevin Cunic is the Microgrid Offer Manager for the North American Microgrid Competency Center. He has a 20+ year background with automation systems, advanced real-time metering, power management and energy applications for Industrial, Commercial, Utility, Institutional, Military, and Federal facilities. He is a Certified Energy Manager, Renewable Energy Professional, and Certified Demand Side Manager.

Philip Barton leads Schneider Electric's North American strategy around organizing microgrid projects and solutions, both internally and externally with partner companies. Since 1998, Philip has led Schneider Electric teams in retrofitting entire microgrids or any part of their enabling technology, including distributed generation, power equipment, engineering services, inverters, metering, software, and power controls.