How Product and Service Innovations are Leading to Disruptions of Traditional Distribution Utility Business Models: Implications for Micro-Grids and Isolated Systems

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Introduction

It is an understatement to say that the traditional electric utility business paradigm is undergoing radical change and at a rapid pace.

Among the most pronounced changes are the following:

- **Electricity demand** is flat – hence there will be relatively little investment in traditional thermal generation assets;
- **Generation mix** is shifting to low-carbon options – a trend that will accelerate with significant implications on how electricity will be generated, delivered and used;
- Future will not only be increasingly decarbonized but also **decentralized** and **digitalized** – as further described;
- Product and service innovations will increasingly shift to the ***grid's edge*** – and behind-the-meter;
- The industry's existing **infrastructure** and prevailing **regulations** are increasingly unfit and/or outdated for the future needs of the consumers; and
- **Software** and **intelligence** will increasingly be critical to get the most value out of the **hardware**, the **physical assets**.

These fundamental changes – broadly referred to as the **transformation of the power sector** – are increasingly manifested in other observable outcomes. For example, the fact that ***consumer****s* – who used to be ***passive*** and largely taken for granted – are becoming ***active*** and moving to center-stage as in all other businesses.

Thanks to technological innovations, today's consumers have many more options

than they used to have. In the next few years, they will be increasingly empowered to better manage their consumption – both the quantity and the pattern of consumption. This, they will achieve mostly through **intermediaries** who will

- **Aggregate** distributed loads and storage;
- Add **intelligence**, optimization and improved management; and
- Capture and **monetize value** in the process.

The most important outcome of these changes is that, over time, customers will gradually be **stratified** into several categories, bringing to an end a century of *one-size, one-tariff*, and *one-type-of-service* fits all in the electricity sector.

While virtually all **residential**, most **commercial** and even many **industrial** customers were once "full-service" customers, buying all kWhs from their monopoly distribution utility at "**regulated and bundled tariffs**", many can now exercise choices that were simply not available, practical or affordable in the past.

As **distributed generation** (DG) becomes technically possible and economically viable – sometimes because retail tariffs are not **cost-reflective** and sometimes as a result of the unintended consequences of regulations such as overly-generous **net energy metering** laws – increasing numbers of consumers may become **prosumers**.

The net effect of this migration is lost kWh sales and revenues, potentially resulting in a "**death spiral**" scenario for the incumbent distribution utilities.

If the cost of **distributed storage** plunges, as many experts are now predicting, some prosumers may become **prosumagers** by combining storage and self-generation – resulting in even fewer net kWh purchases from the network.

The implication of the migration of consumers to prosumers and prosumagers, however, is not limited to diminishing net kWh sales.

Far more significant is the changing *relationship* between traditional utilities and the posumers and prosumagers who may increasingly be self-sufficient in net kWhs – only relying on the network for reliability and balancing services.

Assuming that similar schemes become commercially feasible, the **distribution utility**, sometimes called **distribution system operator** (DSO), is virtually cut off from its customers. And since the bulk of the revenues are collected through volumetric tariffs, this is bad news for distribution utilities.

In this context, the key question is who pays, and how much, for the maintenance

of the grid – a highly contentious issue pitting solar and non-solar customers against each other with the regulators caught in the crossfire.

In the mean time, regulators are considering, and in some cases introducing, new retail tariffs that are designed to protect the remaining bundled consumers while not impeding those who wish to migrate to become prosumers or prosumagers. Keeping the proverbial *playing field level*, never easy, is becoming considerably more complicated. This is already the subject of much debate among regulators nearly everywhere.

Moreover, regulators are considering more sophisticated ***granular tariffs*** that reflect variations in the cost/value of generated/stored energy withdrawn from or injected into the grid at different times and locations – recognizing that the days of undifferentiated **postage-stamp electricity pricing** are over.

As further explained, this has led to the realization of a missing component in electricity pricing, namely the need for **price visibility** on the distribution network. A number of start-ups have emerged in the past few years to fill this void, including the likes of **Open Utility**, a London-based start-up.

Granular retail pricing is not only important to the future of DERs, distributed generation and storage but especially critical to further development of **electric vehicles** (EVs) and **charging infrastructure** for obvious reasons. A fast charging station needs the equivalent of an entire neighborhood's capacity and consume enormous amounts of energy. If the price of electricity is not fully cost-reflective of the time and location where charging takes place, it could lead to inefficient investments in the wrong places and could exasperate bottlenecks in the distribution network.

Too many EVs concentrated in certain neighborhoods could also exceed the design capacity of the local distribution network – a likely scenario if many EV drivers come home at the end of the day and plug in their cars more or less simultaneously.

These issues explain the growth of start-ups exclusively or primarily focused on **EV charging solutions** – a major growth opportunity.

But how fast and how far such pricing schemes may go is highly uncertain making it difficult to develop and implement a business plan based on potential changes in existing regulations.

That, however, is not where the transformation story ends.

The biggest upheavals in the electricity business are likely to come *not* from the migration of consumers to prosumers or prosumagers but the emergence of even more exotic business models that involves the **aggregation** of multitudes of

distributed loads and storage spread across a distribution network and/or operating as a semi-autonomous **micro-grid**.

In the future, these sophisticated consumers will play increasingly more important roles, which may include direct **peer-to-peer (P2P) trading** or **transacting** with each other and/or through an intermediary or an open platform. The latter option is on the rise as exemplified by a profusion of investments going into the sub-sector.

The rapid proliferation of **intermediaries**, **aggregators, traders** and **enablers** suggests that – sooner or later – they will master the art of bundling large numbers of consumers, prosumers and prosumagers into ever larger portfolios of assets, which can be remotely **monitored, controlled, managed, dispatched** and **optimized** in real time.

These intermediaries are primarily focused to derive and *monetize* **stacks** or **streams of value** from the aggregated loads and resources under management by invoking sophisticated intelligence – **artificial intelligence**, **machine learning**, **energy management** and **price-responsive demand**.

These business models will thrive with more granular pricing and more price transparency.

The resulting synergies of assembling a portfolio of assets with inherent flexibilities will materialize in the form of powerful **virtual power plants** (VPPs), **integrated energy services** potentially offering **energy-as-a-service** (EaaS) and a myriad of other innovative products and services that are likely to emerge in the coming decade.

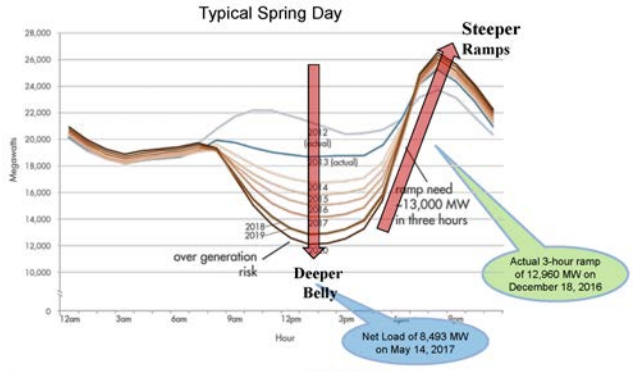
Traditional **energy service companies** or ESCOs, have had limited success since they tend to focus on limited range of products and services and/or narrow business niches such as commercial building lighting retrofits. This leaves a lot of opportunities on the table. By all indications, this space is likely to become one of the **sweetest spots** in the years to follow.

In this context, flexible, price responsive loads and intelligent ESS – especially once aggregated into big blocks and centrally optimized and managed – can play a critical role.

The reasons for stating this should be clear. The continued rise of **variable renewable generation**, and rising concerns about the occurrence of variations of the well-known "**California duck Curve**" (Fig 1) in the coming years will be far more than traditional solutions such as **storage** can handle – at least for a while.

Fig 1
Variations of California duck curve are appearing elsewhere
The growth of mid-day solar generation results in a dip in the observed "net load" on the

California independent system operator's system followed by massive ramping requirements at the end of the day when the sun sets and the peak demand occurs.



Source: CAISO

Grid operators around the world are increasingly confronting limits to their capabilities in integrating ever rising proportion of variable renewable generation in the energy mix – mostly wind and solar – challenging their abilities to maintain the grid's reliability given the daily variations in load and generation.

Currently there is too little storage on most networks to help balance supply and demand, resulting in price pikes, negative prices and other anomalies in the wholesale market.

The increasing frequency of negative prices in California and Texas are caused by the large and growing presence of solar and wind generation.

Another obvious reason is the near total *disconnect* between wholesale and retail prices nearly everywhere – including in areas where both markets are "competitive."

It is widely acknowledged that one way or another **flexible demand** and storage must learn to "tango" with **variable renewable generation** in real time, and prices must play a more prominent role in getting the balance right.

This explains why the business prospects are ripe for **intermediaries, aggregators, VPPs, traders, service integrators** and so on. While nobody is sure what to call the newcomers, few dispute their rising prospects in the years ahead.

Another promising but ill-defined area is **micro-grids**. One way to look at micro-grids, of course, is as aggregated loads, distributed generation and storage with centralized intelligence and management.

It is worth pointing out that broadly speaking, **hardware** – say solar panels, inverters, switchgear, ESS, sensors, etc. – matters today and will continue to matter in the future. However, as time goes on, the key value of the hardware is likely to come from **software**, **intelligence** and schemes that monitor, manage,

modify, control and optimize the interactions among the various parts and components.

Another major driver for change in the energy sector, of course, is the **electrification of the transportation sector**, which explains why new and existing stakeholders – oil companies, distribution companies, auto manufacturers, and others – will be fiercely competing for a share of a shrinking (in case of oil companies) or growing (in the case of distribution utilities) business opportunities.

There are, however, many uncertainties in who will invest in what in the electric charging infrastructure. As will be explained in other parts of this white paper, ultimately regulations and policymakers will determine or largely influence the massive investments in **EV charging infrastructure** that will be needed if the transport sector is to be electrified, and soon.

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