PERSPECTIVES ON TRANSFORMING UTILITY BUSINESS MODELS

# Paper 4 – Business Models that Align with Customer and Policy Drivers: Customer-Driven Models

March 2024

## BACKGROUND

The electricity utility business model has traditionally been based on providing energy to customers through generation, transmission, and distribution of electricity. The implicit assumption underpinning this traditional model has been that customers' requirements can be met simply by providing a reliable supply of electricity at a reasonable cost. In fact, what customers actually require is the facility to perform everyday energy-dependent functions that sustain their residential, leisure, medical, transport, and business needs.

**New factors**: A combination of rising energy costs and technological advances has provided both the incentive and the means to reimagine how energy is provided. While there are factors currently driving high energy costs, which renewables will mitigate in the longer term, the investment costs of low-carbon transition will be reflected in customers' energy bills for many years. The ability to manage electrical energy demand in terms of both volume and daily profile through smart technology has the dual advantage of minimizing consumption while also exploiting time-of-use and dynamic energy tariffs to minimize cost, or even be rewarded for providing flexibility. This in turn has created the platform for new innovative customer-centric business models.

**The emerging service-orientated business model**: It is in recognition of this alternative view of customers' requirements of the electricity system that new customer-centric business models are beginning to emerge to replace the traditional transactional models, with the competitive driver being customer satisfaction rather than volume sales. This is reinforced by the fact that both residential and business customers are increasingly demanding smart systems to perform the functions they require while also managing their energy consumption to control costs. The emerging business model for electricity utilities, whether operating in a regulated or deregulated environment, is one which is evolving from a primarily transactional arrangement with customers to one which is customer-focused and service-based. While utilities have traditionally had a strong public-service ethic resulting in generally high levels of network reliability and customer satisfaction, this is an opportunity for utilities to further enhance their reputation by embracing the new paradigm. Although that may involve some risk, utilities that do so are likely to reap the benefits in terms of business sustainability.

**Deregulation**: Other factors driving business model evolution are deregulation and privatization, a consequence of which is now common for Generators, Transmission System Owners, Energy Suppliers, and Distribution Network Operators to be business-separated entities, with additional stakeholders entering the market, including Energy Storage Operators, Aggregators and Virtual Power Plant Operators (VPPs), Offshore Transmission Owners (OFTOs), Distribution System Operators (DSOs), Independent Distribution Network Operators (IDNOs), Independent (Network) Connection Providers (ICPs), and Smart Metering Communications Service Providers (CSPs). Business separation and increased competition have enabled governments and regulators to benchmark companies more easily in terms of their efficiency and customer service.

**An evolving architecture**: While deregulation and privatization have resulted in a new disaggregated business structure, decentralization (of generation) and decarbonization (of both supply and demand) are resulting in both a new physical architecture and an evolving market architecture. For example, distributed energy resources (DER) and customer energy resources (CER) are providing both grid-connected and behind-the-meter (BtM) supply and demand-side flexibility—the former through onshore wind or solar PV farms with (ideally co-located) battery energy storage systems (BESS) and the latter through decarbonized forms of generation (such as rooftop solar PV panels) and transport (in the form of BEVs and PHEVs). These energy resources and their associated (or inherent) energy storage capabilities can support the operational management of the electricity system, which ultimately confers benefits to customers through lower energy and use-of-system charges. Taken together, the emergence of new technologies, digital platforms, and market evolution is creating both the environment and business opportunity for utilities to differentiate themselves, for customers to make informed choices, and for competition to lower costs.

**A more interactive relationship model**: In addition to deregulation, decentralization, and decarbonization, another driver of electricity utility business model evolution is digitalization and its associated infrastructure. Digitalization enables utility companies to adopt data-driven strategies informed by customer insights and analytics. In conjunction with customer energy resources (CERs) and smart meters, digitalization also creates new opportunities for customers to have a more interactive relationship with utilities. For example, customers now have a wide range of energy tariff product offerings which they can access through their existing Energy Supplier or, if they so choose, by switching to one of the many new Suppliers entering the market. Moreover, notwithstanding the 'supplier hub' principle which broadly established the concept of a single customer interface to the energy system (electricity and gas), customers can also now interact with their Distribution System Operator by providing demand turndown (or demand turn-up[1]) as a network constraint management service, or with the Electricity System Operator[2] to provide reserve and balancing services. Customers are rewarded through energy bill discounts, direct payments, or other schemes such as prize draws.

**Energy democratization**: While the above summarizes how deregulation, decentralization, decarbonization, and digitalization have been drivers for evolution of the utility business model, another factor which is gaining prominence is that of 'democratization' where customers and energy communities are able to shape how they produce and use (or trade) their own energy resources.

**Implications for utilities**: The impact of these developments is that the utility business models which have traditionally

1 A demand turn-up service has been introduced by UK Power Networks in Great Britain, in conjunction with Octopus Energy, to help ease network congestion and reduce the need for curtailment of generation output in parts of UKPN's network dominated by distributed generation. https://industrialnews.co.uk/uk-power-networks-and-octopus-energy-in-programme-to-turn-up-demand/

2 In Great Britain, customers can now be rewarded for providing a Demand Flexibility Service to the Electricity System Operator when supply margins are forecast to be tight – for example, due to low output from wind generators. https://www.nationalgrideso.com/industry-information/balancing-services/demand-flexibility-service-dfs

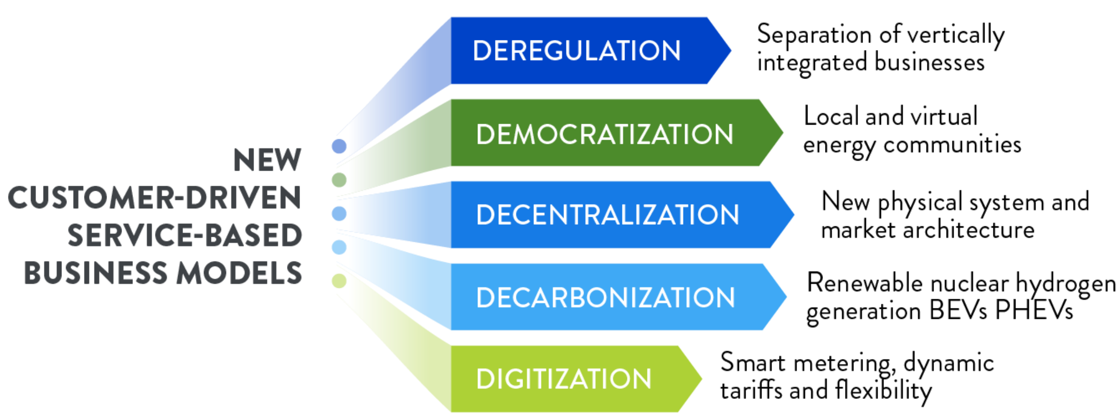


*Figure 1. New customer-driven service-based business model*

been orientated around the linear, generation, transmission, distribution, and supply paradigm are now giving way to a new paradigm where customers and communities are central to the business model (Figure 1).

The message from the above is clear: For utilities to continue to prosper and take advantage of these developments, their business models need to adapt from those which focus purely on delivering energy as a commodity to models which place the customer and customer service at the heart of their business strategies.

## ENERGY COMMUNITIES

A number of energy community models are now emerging. In their most basic form, energy stakeholders form communities which invest in local energy enterprises—for example a wind farm or solar PV farm, or a small hydro scheme—and prioritize the output from their generation assets to supply electricity to the community, thereby offsetting grid imports and hence reducing the community members' electricity bills (Figure 2).


*Figure 2. Local energy enterprises*

The business case for energy communities relies on making sufficient savings in energy bills (and/or sufficient income from exports to the wholesale market) to cover the cost of capital, operating costs, and depreciation incurred in establishing, operating, and maintaining the community's assets over their anticipated operating life. An important secondary benefit of energy communities is that community members generally become more aware of, and engaged with, their energy choices and the environmental benefits of reducing greenhouse gas emissions, including through energy efficiency. They may also benefit psychologically from the 'feel good' factor of belonging to a community which is making a valuable contribution toward net-zero.

**Communitizing assets**: A model which can be applied to either new or existing renewable generation assets is one whereby a consortium agrees to purchase the renewable generation output, which can include existing BtM rooftop solar PV, through power purchase agreements. One such example in the UK is 'Co-op Community Energy' promoted by Octopus Energy in collaboration with Midcounties Co-operative,[3] which so far has secured contracts with over 80 energy communities around the UK. Customers (consumers and prosumers) are offered a 'Community Power' tariff which enables their communities to supply their own renewable power, creating a true peer-to-peer market.

**Funding new energy communities**: Establishing a new energy community with its own dedicated renewable generation assets will generally be beyond the financial/fundraising and technical capability of a typical community of domestic and SME customers. To address this, businesses providing commercial community energy offerings which provide the necessary funding mechanism and technical expertise are now beginning to appear. Again, Octopus Energy in UK has entered this market with its 'Community Energy Kickstart' initiative[4] which provides a £1.5 million-pound revolving fund designed to finance three brand new community-powered projects every two years. A further option is for a business to finance the installation of renewable generation on its own premises—for example a depot or warehouse with sufficient roof space to accommodate a large number of solar PV panels—by selling shares to members of the local community who then benefit from having priority access to the generated electricity. One example in the UK involved the installation of 540 solar PV panels on the roof of the Oxford Bus Company's city center headquarters.[5] The installation was funded by local community shareholders through the Oxfordshire Low Carbon Hub.

## ENERGY AS A SERVICE (EaaS)

The EaaS approach shifts the focus from selling energy as a commodity to providing the energy-related services that customers require. It obliges utilities to consider how they make their products more relevant and understandable to customers. While customers are traditionally charged on a

3 https://octopus.energy/blog/community-energy/
4 https://octopus.energy/blog/community-energy-101/
5 https://oxfordbus.wordpress.com/2013/09/27/solar-panel-roof-ready-to-go/

kWh and/or kVA MD plus fixed-cost transactional basis (for both energy and use-of-system charges), most customers have little concept, and even less interest, in how these measures relate to their needs. In contrast to the commodity model, in its simplest form, EaaS might simply mean guaranteeing a level of service, for example, maintaining in-home comfort levels (by providing warmth and/or air cooling) or a minimum level of charge for an electric vehicle.

**Asset ownership options**: A variant of the EaaS business model is to shift ownership of energy-related assets from the customer to the service provider in exchange for a subscription fee which will cover maintenance, repairs, and ultimately renewal of the installed assets—in other words, broadly analogous to a car leasing arrangement. The benefit to customers of this latter approach is that, as well as having a guarantee of comfort and convenience, it removes the risk of ownership (especially post-warranty) and reduces the need to raise capital which, notwithstanding any upfront financial commitment, might be at a higher cost of capital than the service provider is able to secure. EaaS can be provided by independent organizations such as energy storage providers, heating/cooling system providers, EV charge point operators, or through utilities that might offer a total energy services package which could extend to a guaranteed service level in respect of breakdown cover for both the EaaS and customer's assets.

To explore the concept further, it is helpful to first consider the elements of EaaS individually—that is, heat as a service, air cooling as a service (or, combined together, comfort as a service), and EV charging as a service—and then explore the overall benefits of EaaS for customers and utilities.

## HEAT AS A SERVICE (HaaS)

Adequate domestic space and water heating is essential to maintaining home comfort levels and ultimately sustaining life. It is also a key area of focus for energy decarbonization. However, the capital cost to customers of replacing natural gas or other fossil-fueled heating systems with low-carbon alternatives such as heat pumps or hydrogen boilers (or hybrid systems) can be a major barrier, even with the help of government subsidies. Notwithstanding the capital cost, the impact on energy bills of poorly designed systems or suboptimal operation (for example, overheating rooms which are often unoccupied or failing to take advantage of time-of-use tariffs) can be considerable. Heat as a service provides an opportunity for customers to enjoy optimum levels of warmth while minimizing running costs and, under a leasing arrangement, to also offset much of the upfront capital cost of low-carbon heating.

The following case study describes a trial undertaken by Bristol Energy in the UK in conjunction with the UK Energy Systems Catapult.

### BRISTOL ENERGY (UK) CASE STUDY

In 2019, Bristol Energy in the UK partnered with the UK Energy Systems Catapult to design and trial two 'heat plan' options for space and water heating, with variations on the levels of service and payment terms. Using customers' data, residents were able to compare two heat plan offers through a digital energy services marketplace.

One plan was priced for a fixed number of 'warm hours' based on their existing heating schedule; the other was a 'pay-as-you-go' (PAYG) option with a price per warm hour. Participants who took part in the year-long trial, starting in February 2019, were asked to give their feedback to researchers at the Energy Systems Catapult, helping them to understand how heat plans affected their energy behavior. Part of the trial included a hybrid system with a heat pump installed alongside a gas boiler, designed so that the hybrid system achieved exactly similar temperatures and comfort levels to the gas boiler alone.

Over the trial period, heat pumps delivered between 6% and 63% of the heating demand across the homes involved, depending on how each household used their smart controls. However, the household utilizing the heat pump only 6% of the time increased that figure to 51% following advice on reducing the number of manual overrides to their heating schedule which were forcing the gas boiler to kick in more frequently than necessary. Most participants said they would consider removing their gas boiler and rely entirely on a heat pump if they could buy their heat as a service through a heat plan.

The 'heat plan' model is generating considerable interest since it provides customers with a degree of certainty over both comfort and cost. The concept behind heat plans is to purchase 'warm hours' instead of 'kilowatt hours,' with customers paying a fixed price based on the thermal efficiency of their home and the number of hours of warmth required each week. The price remains fixed, irrespective of external ambient conditions and the heating energy consumed, so customers are protected from the impact of extreme cold weather events, or price shocks due to wholesale market price volatility, while knowing how much it will cost to achieve the comfort levels they require.

## AIR COOLING AS A SERVICE (CaaS)

While heat is generally considered the main decarbonization challenge in Europe and most of the United States, it is estimated that air conditioning currently accounts for around 10 percent of all electricity usage worldwide, and some developing countries could see electricity demand for air conditioning grow by up to five times by 2050. While CaaS is still a relatively nascent business model, global warming and hotter summer ambient temperatures are likely to result in a higher demand for air cooling for businesses and residential properties, even those located in what have hitherto been regarded as relatively temperate climates. Air-conditioned offices, shops, leisure facilities, and vehicles are now common, meaning that the least comfortable internal environment that customers experience is now in their homes. However, in many parts of the world, cooling will not only be required for comfort purposes, but also a means of survival with air cooling and refrigeration becoming increasingly necessary to sustain habitable living conditions, food security, and life-saving healthcare.

From a utility perspective, growth in summer electricity demand requires particular attention since design assumptions regarding cyclic ratings will not necessarily be valid, and spells of extreme ambient temperatures will result in loss of diversity of air-cooling demand and derating of utility plant such as transformers.

Central business districts of major cities are particularly susceptible to increases in summer demand, due to global temperature rise and growth in data centers. The adjacent chart (Figure 3) illustrates a typical seasonal daily demand profile for New York (source: New York ISO). Customer service propositions which reward demand flexibility will become increasingly important for system balancing and electricity network constraint management.

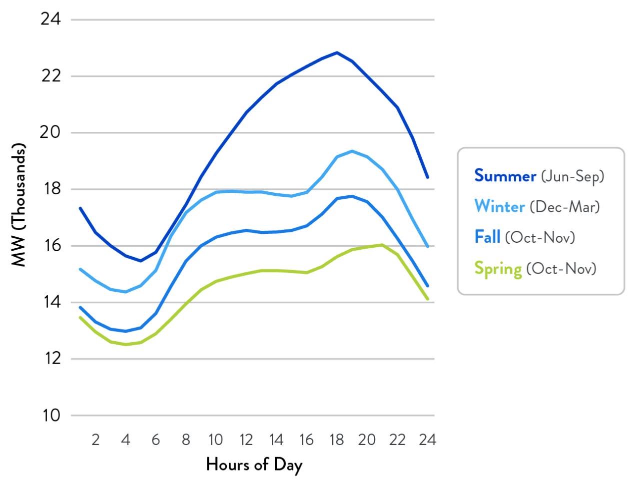


*Figure 3. New York's seasonal daily demand profile*

Given the impact of global warming, access to cooling will become less of a luxury and more of a necessity as global temperatures rise and spells of extreme ambient temperature in summer become more common. As well as providing similar levels of comfort during hot summers to those demanded by customers during cold winters in more developed regions, the availability of CaaS could also help high-risk populations obtain access to more efficient and climate-friendly cooling systems.

## ELECTRIC VEHICLE CHARGING AS A SERVICE

The transition from vehicles powered by internal combustion engines to electric alternatives is a further major focus of national energy decarbonization strategies for both the domestic and business sector. From an energy system perspective, the transition presents both challenges and opportunities: the former in terms of higher electricity demand (especially at times when the system is supplying peak demand), and the latter in terms of the benefits of 'smart' EV charging to shift demand to periods when system demand is relatively low (for example, overnight) and/or when zero carbon generation (especially local generation) output is high, for example, during the daytime when rooftop solar PV panels can provide much of the energy to charge EVs at home or at places of work. Although regulatory approaches and implementation strategies differ across Europe, the UK, and the United States, common requirements for EV charging facilities include:

- Smart EV charging capabilities, including demand response.

- Robust charging network connectivity, enabled by support for communications standards.
- Network-to-grid communications (including bi-directional charging for V2G capabilities).

In the UK, the 'Smart Charging Regulations 2021' requires that all newly installed workplace and home EV chargers have to be 'smart' as a minimum incorporating basic features such as charge scheduling, allowing the times at which an EV begins to automatically charge to be set by the owner.

## RESIDENTIAL EV CHARGING AS A SERVICE

One example of EV charging as a service is a subscription-based EV charging package that provides turnkey EV charging solutions with minimal purchasing costs. Instead of customers having to meet the upfront capital costs associated with smart EV charging, customers instead pay a periodic (monthly) subscription fee over a fixed term. A managed service extends to controlling the timing and/or rate of EV charging to make the best use of low tariff price periods (typically overnight) while ensuring sufficient charge levels to meet the customer's transport needs. For residents with access to off-street EV charging facilities, a managed home EV charging service might be particularly attractive in terms of both avoidance of capital outlay and assurance that their EV is being charged sufficiently to meet their transport needs at the lowest cost of energy.

## COMMERCIAL EV FLEET CHARGING AS A SERVICE

For commercial EV fleet operators, charging as a service can remove the burden of high capital investment through comprehensive project management and amortized costs. The service provider might combine site design, infrastructure deployment, software, maintenance, and breakdown cover in the overall service offering. The service provider might also manage the EV fleet charging rates and times to ensure optimum deployment with respect to time-differentiated energy prices and any network connection capacity constraints. An option that might be considered is the installation of static battery energy storage to smooth out the daily import demand profile to ease any network connection constraints and/or utilize the additional flexibility to secure the lowest energy charges. A further potential benefit of on-site static battery energy storage is to utilize the flexibility to secure a revenue stream through providing ancillary services to the Electricity System Operator and/or the local Distribution Network Operator. On-site static battery energy storage might also be of interest to EV forecourt operators, especially those offering rapid charge facilities.

## V2H/V2G AS A SERVICE

Although relatively nascent, there is considerable interest in (so called) 'bidirectional' EV charging. V2H is an attractive proposition for residents wishing not only to manage the charging of their EV to take advantage of lower (typically) overnight tariff prices but also to reduce peak demand charges incurred during the operation of home electrical appliances. For example, an EV which has been charged at home during the daytime using the output from rooftop solar PV panels could be used to offset grid imports during an early weekday evening when energy and network charges are likely to be relatively high. V2G extends the possibility to also using the EV battery to provide ancillary services such as the Demand Flexibility Service referred to earlier in this paper. Maximizing the potential of V2H/V2G requires additional investment in terms of a V2H/V2G charger (which incorporates an inverter to enable DC-AC conversion) plus a more complex managed charge/discharge operating regime, typically aligned to an EV-specific energy tariff such as the 'Intelligent Octopus Go' Tariff in Britain as demonstrated through the Octopus Powerloop trial.[6]

Integrated with the home's rooftop solar PV panels and inverter, and possibly in-home static battery energy storage (such as a Tesla Powerwall), the overall package could provide a highly flexible 'smart home' solution, enabling customers to manage their overall electricity profile to meet their needs at the lowest energy cost while also providing valuable electricity system services which will ultimately reduce network and balancing services use-of-system charges. However, extracting the highest value from the customer's assets requires an actively managed operating regime which a typical customer may have neither the time nor the inclination to engage with. An attractive proposition is therefore one wherein a service provider installs and maintains the in-home assets and manages the customer's overall electricity profile with a guaranteed level of service in return for a subscription fee.

6 https://octopus.energy/blog/vehicle-to-grid/

## AN INTEGRATED EaaS PACKAGE

Having outlined some of the main components of energy as a service, the ultimate residential, small business customer, or community service offering might be regarded as one which provides all the individual services (heat, cooling, smart EV charging and V2H/V2G) as a complete package, exploiting DER and CER technologies such as local and/or behind-the-meter renewable generation and energy storage. Integrated in this way, EaaS enables customers to enjoy enhanced levels of service while exploiting energy cost-saving opportunities through flexibility, energy arbitrage, and peer-to-peer trading. A typical portfolio of EaaS assets might include:

- Community wind and solar PV generation, and battery energy storage systems (BESS)
- Behind-the-meter generation such as rooftop solar PV panels and static energy storage (electricity and heat batteries)
- Heat pumps – air source or ground source, or water source for community district heating
- Air cooling (domestic and commercial)
- Refrigeration (commercial)
- EV charging – smart charging, V2H, V2G, and V2X (community, domestic, and commercial)

## BENEFITS OF EaaS TO CUSTOMERS

EaaS has the potential to deliver the following benefits to customers:

- **Billing for 'warm hours' or 'cool hours'** (or guaranteed room temperatures) reduces the customer's exposure to energy market price volatility.
- **Guaranteed state of EV battery charge** – sufficient charge to meet the customer's transport needs until the next convenient charging opportunity.
- **Maximizing self-consumption** – using behind-the-meter generation and energy storage to offset energy import while exploiting opportunities for providing remunerated flexibility services.
- **Reduced risk of fuel poverty** – providing adequate warmth at a fixed price might be particularly attractive to lower-income families.
- **Reduced breakdown risk** – including routine maintenance and repairs of a customer's heating system in the heat plan will ensure both dependable and efficient operation of the system.
- **Reduced financial risk** – if the service provider waives much of the installation cost of new heating appliances by recouping the cost through subscription payments over the life of the assets.
- **Property maintenance** – maintaining a minimum ambient temperature can help avoid degradation to the infrastructure of the property, for example, due to condensation and damp.

## BENEFITS OF EaaS TO UTILITIES AND SERVICE PROVIDERS

Notwithstanding advantages for the customer, there are also financial and reputational benefits for service providers in being able to offer a contracted EaaS option for their customers.

- **Commercial incentive** – If an Energy Supplier provides the EaaS service they have a financial incentive to provide the customer's desired level of comfort while purchasing and delivering as little energy as possible, reducing operating expenses, and exploiting flexibility opportunities.
- **Customer loyalty** – If comfort is provided at a predictable price and nominal risk, customers are more likely to trust and remain loyal to their service provider. Indeed, through their contracted EaaS terms, customers may have fewer options to switch their energy or service supplier.
- **Market differentiation** – EaaS has the potential for service providers to differentiate themselves from existing 'energy price-based' services as customers are likely to be attracted by the simplicity of the EaaS model, as well as the attraction of guaranteed comfort levels and pricing.
- **Customer insights** – supported by AI and ML, utilities, service providers, and appliance manufacturers will have access to a new source of valuable data on customer behavior preferences, allowing them to improve their services and products.
- **Green credentials** – EaaS providers offering fixed price/guaranteed room temperature or comfort levels will have an incentive to promote enhanced building thermal efficiency (which might be included in the overall service package). Hence, customers will use less energy while maintaining similar (or higher) levels of comfort. Where gas or other fossil-fueled heating systems remain part of the system (for example, a hybrid heat pump/gas boiler system), this will have a positive

environmental benefit in terms of both reduced carbon emissions and improved air quality.

- **Advancing low-carbon technology** – converting an existing gas (or other fossil-fueled) heating system to a heat pump or hybrid system has significant cost implications for customers, over and above the cost of a replacement boiler, for example, due to having to upgrade wet-system radiators in many cases.[7] By recouping the installation costs from the customer through subscription payments, service providers can offer an attractive low-carbon heating system option.

## BALANCING RISK AND OPPORTUNITY

While there are clearly benefits to both customers and utilities in embracing a customer-centric approach, there is also a need for utilities to balance the risks between adopting an EaaS approach and retaining their existing business model. Risks of not adopting a customer-centric approach are essentially the corollary of the benefits described above, for example:

- Customer alienation and loss of revenue where customers have choice.
- Reduced insights into customer behavior which might lead to missed opportunities for more targeted investment.
- Failing to meet stakeholder expectations in terms of ROI and/or capital growth.
- Loss of reputation in terms of corporate social responsibility (perceived as failing to support national decarbonization and net-zero objectives).

However, there are also business risks in adopting an EaaS model, for example:

- Some financial capital risk in investing in new or upgraded systems, including digitalization and AI.
- Costs of workforce training.
- Liability where installed or leased assets and equipment are on customers' premises.
- Competition from new entrants with more customer-centric products and propositions.
- A higher risk profile than is typical of a regulatory-backed transactional model, which utility investors may be uncomfortable with, resulting in potentially higher costs of debt and equity.

7 More efficient refrigerants are now being trialed which promise higher flow temperatures and a higher overall COP.

## POTENTIAL BARRIERS AND OPTIONS FOR UTILITIES

The opportunity for utilities is to expand their business model by extending their service offering beyond simply providing and delivering energy, to also providing the energy-enabled services that customers actually want or need. However, there may be regulatory constraints which prevent utilities offering these extended services as a regulated business. If that is the case, an option might be to propose an extension or relaxation of their obligations through a regulatory sandbox agreement with the Regulator to evaluate the benefits to customers of utilities having a wider regulatory remit. This would be facilitated if Regulators had a mandate to support governments in their delivery of carbon budgets and their legal obligation toward the achievement of net-zero. Alternatively, a utility may wish to consider establishing a ring-fenced or legally separated arm of their business, or simply form partnerships with energy service providers to ensure that the overall service offering to customers captures the flexibility opportunities that will confer benefits to the wider electricity system in terms of operational efficiency. The approach a utility takes will ultimately depend on its appetite for risk and business model evolution.

## DEVELOPING EaaS MODELS AND TECHNOLOGIES

Fully exploiting the EaaS opportunity requires the development of each of the individual elements of EaaS to a stage where they have reached both technological and commercial maturity as market-ready offerings. In order to develop innovative EaaS applications to commercialization, there is a need to conduct trials in a live environment—in other words, testing the technology with real customers in their homes or business premises. Only through testing and trialing innovative technologies and business models with real customers with varying behavioral characteristics can the business opportunity be confidently evaluated. Recognizing this, The UK Energy Systems Catapult has created a 'living laboratory' which is open to innovators to test products, services, and business models.

The living laboratory is digitally open, interoperable, and scalable, allowing innovations to be tested with, for example, mainstream smart meters, IoT devices, smart heating controls, battery energy storage, solar PV, and EV chargers. It allows innovative businesses to rapidly design, market-test and launch smart energy products, services, and business models. The living laboratory also provides the capability to test and demonstrate market arrangements with real customers. The following are examples of EaaS service case studies trialed with real customers through the living laboratory:

**A new digital air quality platform** – with the aim of reducing indoor or in-vehicle pollution (including carbon dioxide, volatile organic compounds, and particulate matter). The ability to analyze data on air quality within the property or vehicle enables alerts to be generated whenever pollution levels exceed safe limits.

**An intelligent airbrick** – that automatically regulates air flow in homes using sensors to monitor temperature, humidity, and air quality to address current problems arising from poor insulation leading to cold rooms and uncomfortable draughts.

**An autonomous, digital energy assistant** – which helps households reduce their energy costs and carbon intensity through autonomous demand-side-response decisions based on market signals.

**An advanced thermal storage system** – based on a heat battery to provide increased in-home energy storage duration and capacity when paired with household energy systems, thereby helping households avoid high network use-of-system and energy charges at times when the grid is constrained and/or renewable generation output is low.

While development of the required EaaS technologies might be led by independent entrepreneurs, utilities can nevertheless play a pivotal role in collaborating with innovators by supporting field trials and monitoring the impact on local networks and, by extrapolation, the electricity system as a whole.

## SUPPLY SECURITY

Traditionally, customers have had little choice in terms of delivered levels of energy security. Electricity system and network operators will typically have regulatory obligations toward design levels of security (which, for example, might require 'N-1' or greater levels of redundancy above specified group demand thresholds). They may also be subject to guaranteed standards of service and be incentivized in respect of reliability performance (for example, SAIFI, SAIDI, and CAIDI targets). However, notwithstanding regulatory obligations regarding design levels of supply security and regulatory quality of supply incentives, some customers (typically larger industrial or commercial businesses) might require an enhanced level of security due to the criticality of a business process. Such customers might include those with an industrial process that could result in not only loss of production but also damage to manufacturing equipment in the event of a sustained loss of supply. Commercial enterprises such as investment banks might also require a level of security of supply above and beyond the level that network companies are mandated by regulatory security standards to provide.

## INDUSTRIAL AND COMMERCIAL CUSTOMERS

An opportunity for utilities is to engage proactively with large industrial and commercial customers who require an enhanced level of supply security by helping them analyze grid outage (and hence business) risk, offer advice on enhanced security of supply options, or assist with specifications for standby generation and UPS equipment. For example, critical control systems might be individually equipped with UPS or backup supplies, and customers with high power demands and supply-critical applications might benefit from diesel standby generation or DRUPS systems. A more 'carbon-friendly' alternative might be battery energy storage provided that the installed capacity is sufficient to endure a protracted grid outage. As with standby generation, battery energy storage can also be used for reducing maximum demand charges through peak lopping. Subject to regulatory constraints, utilities might offer a turnkey service in terms of procurement, installation, and ongoing inspection and maintenance of backup systems.

## ENHANCED SECURITY

An option for large industrial or commercial customers is to request and pay for a grid connection designed to a higher level of security than mandated by regulation. The case study below (Figure 4) shows a schematic diagram of a network serving a typical large commercial customer in Canary Wharf in East London. The site developer and landlord requested an enhanced level of system security in recognition of the large commercial customers that were expected to occupy the development. Indeed, it was envisaged that providing an enhanced level of security of supply would give the site a competitive advantage over alternative development sites in attracting major customers such as data warehouses and investment banks. The customer in this example is served at 11 kV via a unit-protected ring, effectively giving N-1 security and a no-break supply in the event of a fault on the 11-kV network. In the unlikely event of a double outage on the 11-kV network, the customer is able to perform a manual changeover from the faulted network to a healthy network through the customer's own switchboard, transferring the incoming supply to an alternative unit-protected ring.

The two unit-protected rings are supplied via separate 132/11-kV substations which means that in the very unlikely event of total loss of supply to either of the 132/11-kV substations, the customer would still have access to a live point of supply (albeit some load reduction might be required). It will be evident that the overall supply arrangements required a coordinated approach to the design of the utility network and the customer's electrical infrastructure.

**Community microgrids**: While some industrial and commercial customers might require higher levels of supply security, some energy communities might also value the additional benefits of enhanced security of supply if the local network is able to operate as a microgrid, that is, able to maintain a degree of supply continuity when disconnected from the upstream distribution system, for example, in the event of a loss of incoming supply due to a fault on the local distribution network. Isolated microgrid operation capability will require additional functionality from the energy community assets to maintain voltage within acceptable (if not statutory) limits, and sufficient fault level to maintain acceptable power quality and ensure integrity of protection systems. In practice, this will generally mean that at least some of the wind and/or solar PV farm generation, or grid-connected battery energy storage, will need to be connected to the local network through grid-forming inverters (GFM).

'Off-grid' microgrids might be the only economically viable option for isolated communities or farms which are remote from any public electricity system. However, where connectivity to a public electricity system is economically practi-

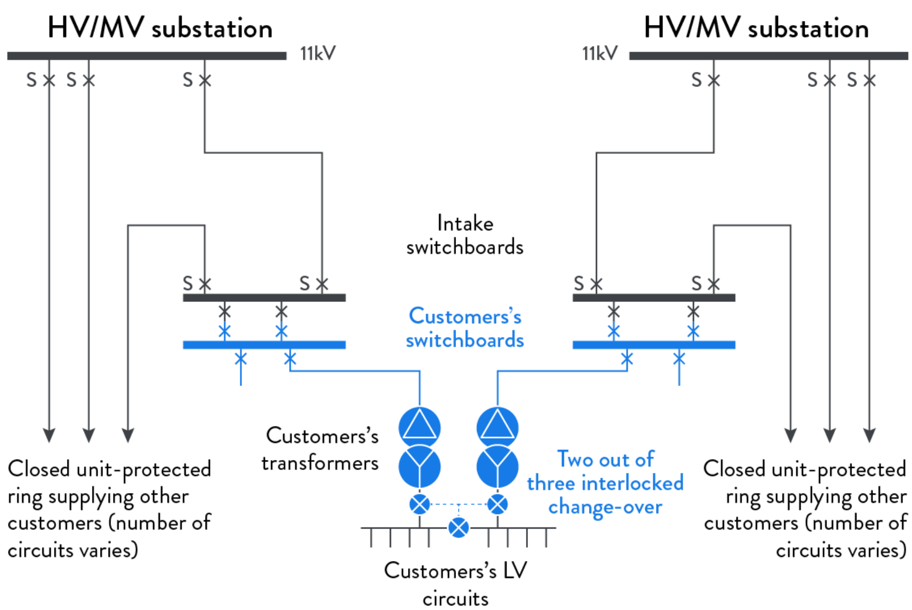


*Figure 4. Schematic diagram of a network serving a typical large commercial customer in Canary Wharf in East London*

cable, the additional cost of islanded microgrid capability will generally be justified only where the ‘value of lost load’ (VoLL) is regarded by the community as exceptionally high and/or where the reliability of the local public distribution system is relatively poor. Nevertheless, where a microgrid is proposed, it will require the utility to engage with the energy community to advise on both the technical and governance requirements of operation, including the means of resynchronizing with the local network once reenergized following an outage.

**Domestic and SME customers**: Since domestic and SME customers are generally served by LV networks from local MV/LV substations, their continuity of electricity supply is susceptible to faults on those networks which will invariably result in a supply interruption for the duration of the repair or in some cases on the time taken to arrange a ‘back-feed’ from an adjacent substation. Similarly, for customers served by MV spurs rather than open rings (typically small rural communities), their continuity of electricity supply is also susceptible to faults which will require repair before supplies can be fully restored. While this design level of security of supply is generally considered acceptable to most domestic and SME customers, there are circumstances where additional security might be considered necessary, for example, vulnerable customers who have a higher dependency on electricity.

**Vulnerable customers**: By the nature of their supply arrangements, generally a single-phase service from an LV distributor, it is generally impracticable to provide an enhanced level of supply security for residential customers. Instead, such customers might be registered by the utility as a priority in the event of a supply failure. By way of example, certain categories of customers in Britain are eligible for inclusion on a Priority Services Register (PSR) which all electricity and gas utility network operators are obliged to maintain. Eligible customers include those who are dependent on electricity for home medical equipment, live with children under age five, or have a disability or chronic medical condition. One of the many priority services available to PSR customers is that in the event of a prolonged supply interruption, or any supply interruption to PSR customers who use medical equipment/aids that rely on electricity, portable generators can be delivered to their homes to restore essential services.

## SUPPLY SECURITY AS A BUSINESS OPPORTUNITY FOR UTILITIES

As the above examples have illustrated, there are customers who, due to their individual circumstances or by the nature of their businesses, require an enhanced level of service in terms of either emergency response or design level of security of supply. Utilities, in particular distribution network operators, are well placed in terms of network design and operational expertise to advise on service level and design security of supply options. An opportunity for utilities is therefore to be more proactive in helping customers, for example, from an operational perspective in offering a more personalized service in terms of emergency response, or, in the case of larger businesses and prospective energy communities, by offering to undertake techno-economic appraisals to evaluate supply options, drawing up an overall design specification, and, in the case of private networks, either supervising or undertaking the actual network installation on a commercial basis. A further option in the case of private networks is to offer a contractual asset management service with guaranteed service levels in terms of quality of supply performance and asset integrity.

## Customer Experience

An essential component of a utility customer-driven model aimed at delivering excellent service is the means by which customers are able to interact with the organization in order to raise queries, request services, and receive information. Done well, this can greatly enhance the customer experience; done badly, it can result in frustration for customers, which in turn is likely to result in poor outcomes from customer satisfaction surveys and, where customer choice is available, the loss of custom (for example, a customer may switch to an alternative Energy Supplier or EaaS service provider).

**Utility customer call centers**: The emergence of utility customer call centers has arisen partly through the desirability of concentrating resources in a dedicated center (physical or virtual) enabled by digitalization of both network asset and customer data. A centralized call center can result in improved productivity as well as more effective team management and service quality control. Digitalized systems allow call-center staff to quickly obtain network and customer data (including customer to network connectivity) and hence more effectively respond to queries or complaints (for example, in the event of a network outage). However, no matter how comprehensive a utility's service offering is in terms of the range of services described in this paper, any shortcoming in its processes and systems for customer engagement will lead to customers becoming dissatisfied. Examples include confusing websites, automated call-handling with multi-layered/multiple-choice menus, and repeated automated reassurances: *We are currently experiencing unusually high call volumes—but your call is important to us, and an agent will be with you shortly.*

**Customer expectations**: Electricity utilities are now under increased public scrutiny in the wake of severe weather events (more frequent and pronounced as a consequence of global warming) that have caused prolonged widespread outages. At such times, the organization's customer service capability is stretched to its limits. It is also at such times that a utility's reputation can be greatly enhanced or severely damaged, the latter particularly if a post-storm performance review by the Regulator finds serious shortcomings in the accessibility of information to customers and/or the accuracy or quality of information provided. The fact is that customers have come to expect the same type of personalized experience from their utility company as they would receive from world-class service providers, including transparent billing, mobile app facilities, digital self-service, real-time communication, proactive notifications (for example, regarding network outages), and not least the ability for customers, if they so wish, to speak to an agent to resolve a query or complaint.

The adjacent chart (Figure 5) shows the results of an annual GB DNO customer satisfaction survey conducted independently on behalf of the Regulator Ofgem. The survey covers customers who have contacted the DNO regarding a planned or unplanned supply interruption, a completed network connection or quotation, or a general inquiry relating to a completed job or service provided.

**Just and inclusive transition**: Notwithstanding difficulties arising from power outages, some aspects of the energy transition might prove particularly difficult for some groups of customers to negotiate, for example, digitalized systems of communication, dynamic tariffs, and smart appliances. Utilities have a societal and moral obligation to ensure a fair and inclusive transition, with no customers being marginalized due to their unfamiliarity with technological and market advances or their uncertainty over how to access the opportunities available to them. It follows that in streamlining their systems to provide a better customer experience, it is important to also ensure inclusivity across all customer demographics.

In that regard, it is important for utilities to understand their overall customer base, for example, in terms of demographics surrounding age profile, socioeconomic groupings, ethnic backgrounds, population density, cultural influences, and so on, as this will not only impact customer perceptions of service standards but also the types of service they will expect utilities to provide. For example, there may be states or regions where English is not the first language of many of the inhabitants and so utilities will need to ensure their communications reflect this, even to the extent of provid-

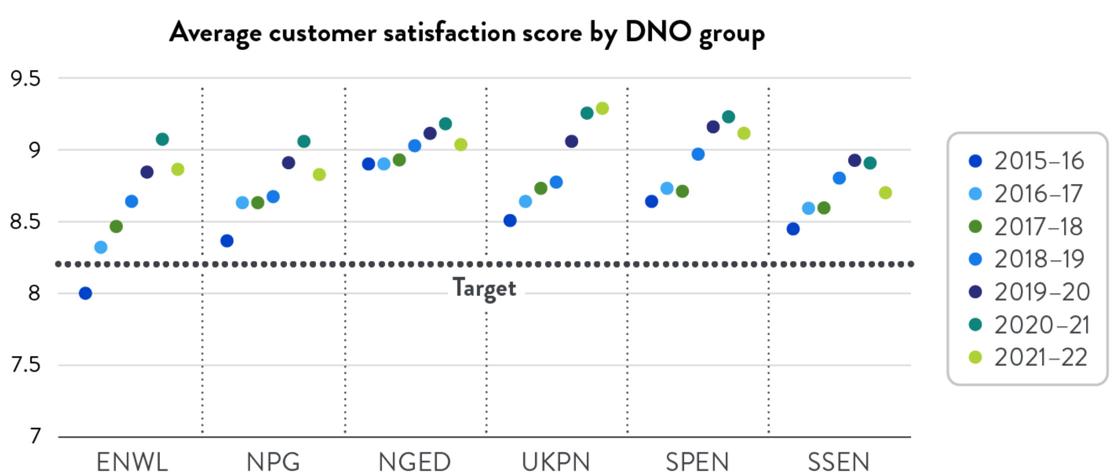


*Figure 5. Annual GB DNO customer satisfaction survey results*

ing information in different languages. There may also be significant differences in geography, climate, and drivers of the regional economy (for example, industry, commerce, agriculture, and tourism).

While these are important differentiators which utilities will need to accommodate in the way that services are delivered, it is also important to acknowledge diversity and recognize that there is no such thing as an 'average' or 'typical customer.' It follows that while utilities will customize their service offerings to reflect the overall characteristics of their customer base, they must not overlook minority groupings that don't necessarily reflect the characteristic demographics of the state or region. In other words, services must be fully inclusive and accessible by all customers. Failure to recognize and accommodate those customers with unique or special needs can easily lead to reputational damage.

**Customer service strategic priorities**: The following are examples of requirements that utilities might consider as priorities for ensuring an excellent customer experience—

- A personalized, consultative, and inclusive approach to customer relationship management.
- Being able to engage proactively with customers of all demographics and abilities.
- Catering for customers of all ethnic backgrounds, including those with a different first language.
- Ensuring access to utility personal across a wide range of specialisms.
- Deploying security systems to ensure customer data are protected from cyber-attacks and fraud.
- The ability to quickly ramp up resources to address call volume surges, for example, during storm conditions and widespread network outages.
- Continuous development and improvement of customer relationship processes and systems, informed by customer feedback.
- A customer call-center personnel training program that can keep pace with customers' continuously evolving expectations.
- Recognizing diversity and ensuring inclusivity in all forms of customer communications.

## CONCLUDING OBSERVATIONS

**Business sustainability**: For utilities to continue to prosper and take advantage of opportunities arising from deregulation, decentralization, decarbonization, digitalization, and democratization, their business model needs to adapt from one which focuses primarily on delivering energy as a commodity to a model which places the customer at the heart of its business strategy and service offering. Not only does this represent a valuable extended service offering to the communities that utilities serve, but also an opportunity for growing the business and enhancing shareholder value. Making the transition is not without risk and will depend on the utility's appetite for business model evolution.

**Customer-centricity**: Placing the customer at the center of the business may seem intuitively logical, but it nevertheless represents a fundamental shift in business philosophy from the essentially supply-centric model that utilities have traditionally adopted. That is not to say that utilities have not been customer-focused; indeed, they have a strong public-service ethic which has resulted in generally high levels of network reliability and customer satisfaction. However, this model relies on the implicit assumption that customers' requirements can be met simply by providing a reliable supply of energy, whereas what customers actually want is the facility to perform everyday energy-dependent functions that sustain their residential, leisure, transport, and business needs.

**Developing EaaS capability**: EaaS and its elements are the subject of many innovative technologies and trials, some examples of which have been highlighted in this paper. While development of the required technology might be led by independent entrepreneurs, utilities nevertheless can play a pivotal role in collaborating with innovators to develop and deploy technologies which enable energy services such as heat, cooling, and EV charging. In particular, utilities can add value by supporting field trials, including by monitoring the impact on local networks and, by extrapolation, the electricity system as a whole. The incentive for utilities is that with sufficient coordination and optimization of operation, EaaS can deliver significant upstream benefits, including reduced need for electricity network reinforcement, wider system reserve and balancing services, and ultimately a reduced requirement for generation capacity through integrating the operational characteristics of CERs within an overall active electricity system management regime.

**Thinking beyond the meter**: An important practical aspect of the transition from a supply-centric to a customer-centric business model for utilities is to embrace the concept that while their regulated asset base might extend only to the point of supply at each customer's premises, the electricity system does not end at customers' meter positions; indeed, a (smart) metering system coupled with digitalized network and customer data should be an enabler for creating a range of energy-related services that customers value and which can also confer wider electricity system benefits. Customer energy resources (CERs)—in the form of micro-generation, flexible smart heating systems, battery energy storage (including EVs and V2H/V2G) and increasingly air cooling and refrigeration systems—have considerable potential in supporting whole electricity (and ultimately whole energy) system management, and hence achieving supply and demand-side energy decarbonization while ensuring both energy security and affordability.

**Larger I&C customers and private networks**: While the EaaS model is traditionally aimed at residential and small commercial customers, there is scope for utilities to also apply greater customer focus to industrial and larger commercial customers, including those operating their own networks. Such customers may require higher levels of security of supply and/or the assurance of a rapid response in the event of an outage. Utilities have an opportunity, potentially beyond their regulated business, to provide a design consultancy service and/or an ongoing emergency response service. A further option in the case of customers operating private networks (such as large industrial complexes, airports, and shipping ports) is to provide a contracted asset management service. I&C customers may also be looking to reduce their carbon footprint through on-site renewable generation and energy storage, which provides a further opportunity for utilities to share their expertise on a commercial basis.

**Monopoly regulatory limitations**: Regulators have traditionally been keen to ensure that the activities of monopoly energy businesses such as electricity and gas network operators are limited to prevent inappropriate incursion into areas of operation that should be open to competition, including, for example, supply of energy. Utilities may therefore be restricted in terms of their ability to directly fund the provision, installation, and operation of CERs, and behind-the-meter assets generally (similar restrictions will also apply to DERs such as distributed generation and battery energy storage). This has led to the 'supplier hub' principle whereby the default point of contact with customers is deemed to be through their chosen Energy Supplier. However, EaaS and the integration of CERs within the overall power system architecture is now beginning to challenge some aspects of that principle. One benefit of monopoly utilities having increased access to customers and their CERs is the ability to deploy those resources in ways which deliver the greatest overall system benefit with customers being rewarded accordingly. Regulatory sandboxes can provide an opportunity for live testing of new energy service offerings in a controlled regulatory environment and a safe means of evaluating the benefits of amending or relaxing some aspects of monopoly utilities' regulatory obligations.

**Other regulatory considerations**: A further secondary benefit of monopoly utilities having increased access to customers is that they generally have access to lower costs of capital and are able to amortize investments over a long period consistent with the nominal weighted average life expectancy of their assets (for example, in Britain, network operators' regulatory asset bases [RABs] are depreciated over 45 years). Regulators may therefore need to review any conditions that are a potential barrier to whole energy system optimization, or which have a perverse impact on investment decisions. One way of empowering energy regulators in this regard is to place a specific mandate on them to meet their principal objective of protecting the interests of existing and future energy customers while also supporting governments in their delivery of carbon budgets and their legal obligation toward the achievement of net-zero.

**Customer relationship management**: No matter how wide and comprehensive a utility's customer service offering is, the organization's reputation can be enhanced or undermined by the quality of engagement customers experience when communicating with the company, for example, through their customer call centers. Digitalization of both the organization's mapping systems (for example, GIS) and customer data (and linking the two through data connectivity) coupled with AI and ML opens up new opportunities for call-center agents to engage more meaningfully with their customers, both proactively and reactively. However, digitalization and AI can also present challenges, for example, ensuring privacy of customer data and adequate cyber-protection, and recognizing that overreliance on websites, chat facilities, and automated call management systems with multi-layered menu options can result in frustration for customers who have difficulty navigating online systems and/or who in any case prefer to sometimes speak to an agent.

**Understanding the customer base**: It is important for utilities to understand the demographics of their overall customer base, for example, in terms of age profile, socioeconomic groupings, ethnic backgrounds, population density, cultural influences, and the underlying economic drivers of the state or regions they serve—for example, industry, commerce, agriculture, and tourism. These are characteristics that will impact how utilities customize and communicate their service offerings while recognizing the overall diversity of their customer base and ensuring that the needs of minority groupings are also accommodated.

**Appetite for change to the utility business model**: Utilities, especially electricity network operators, have an opportunity to develop their business model to become more customer-centric, which would also be complementary to their obligation toward supporting energy decarbonization. Those who have a proactive approach to business innovation and are more open to developing their business environment will be more likely to see the opportunities of adopting a customer-centric approach, offering a wide range of services. Those who are less open to business model evolution or more reactive to innovation, preferring to follow best practice once it has been established or to adopt business transformation more selectively according to their core strengths, might be less likely to fully exploit the opportunities of offering a wider range of customer services, and instead focus on improving their core customer service offerings. Whichever business strategy utilities favor, a transition in philosophy from supplying energy to providing customer services would now seem essential to sustaining the business and maintaining (or increasing) shareholder value.

## About EPRI

Founded in 1972, EPRI is the world's preeminent independent, non-profit energy research and development organization, with offices around the world. EPRI's trusted experts collaborate with more than 450 companies in 45 countries, driving innovation to ensure the public has clean, safe, reliable, affordable, and equitable access to electricity across the globe. Together, we are shaping the future of energy.


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