GEODE FACT SHEET

Flexibility

Introduction – What is Flexibility?

Flexibility has been defined in the joint-European Distribution System Operators (DSOs) report "Flexibility in the energy transition - a toolbox for electricity DSOs"[1] :

Flexibility is the modification of generation injection and/or consumption patterns, on an individual or aggregated level, often in reaction to an external signal, in order to provide a service within the energy system or maintain stable grid operation. The parameters used to characterise flexibility can include: the amount of power modulation, generation forecasts, the duration, the rate of change, the response time and the location. The delivered service should be reliable and contribute to the security of the system.

In other words, flexibility can be thought of as a non-grid solution to relieve electricity network congestion in a safe, secure and efficient manner.

POLICY & REGULATORY REQUIREMENTS

To enable the flexibility that is required to help manage the future electricity system, there are a number of policy and regulatory requirements at both national and European level including:

- Encouraging more flexibility onto the system and removing barriers to entry; with increasing levels of renewables, we will need more flexible DER penetration.
- A dynamic regulatory framework that ensures that the DSO can operate the distribution grid and enables and incentivises a variety of network solutions, including both traditional network build and new (non-build) flexibility services procurement from 3rd parties, to deliver optimal customer outcomes. For flexibility services procurement, financial incentives are key.
- Increasing liquidity in the market: to ensure Electricity Networks deliver best cost to our customers, we will need to increase liquidity in the market by ensuring interoperability of different markets (e.g. flexibility, balancing, wholesale, etc.) to ensure investor confidence and allow stack ability of revenue streams. To do this, we need to ensure exclusivity between markets is minimised as far as practical, and barriers to collaboration and co-ordination (particularly across transmission and distribution) are removed.
- Incentivising innovation and research in flexibility: this is critical for DSOs to understand how to best utilise flexibility to optimize the operation and planning of the grid. It will also enable DSOs to work with industry to understand what best works with respect to market structures and rules, procurement, stackability, etc. All of this will in turn help to increase the competence levels of the industry with respect to flexibility.

[1]Joint DSOs report "Flexibility in the energy transition – a toolbox for electricity DSOs", 2018, https://www.geode-eu.org/uploads/GEODE%20Publications/2018/Flexibility%20in%20the%20energy%20transition%20-%20A%20tool%20for%20electricity%20DSOs%20-%202018.pdf

Why electricity grids need Flexibility

In the energy system, there is currently a fundamental shift towards decarbonisation, decentralisation and digitalisation, which is being driven by the need to transition to a low carbon energy future while maintaining energy security and ensuring affordability for all. Generation is becoming distributed and more variable, consumers are beginning to start monitoring and managing their energy use, and new technologies and business models are emerging.

Many of the new decarbonised energy sources – renewables - are variable in nature, e.g. solar and wind energy, and are connected to a large extent to the distribution network. Similarly, there are new ways in which customers are using and generating electricity; new low carbon technologies such as electric vehicles and heat pumps are creating new demand on the system, and customers are producing and storing energy via solar PV, batteries and vehicle-2-grid systems. This is not how the distribution networks were traditionally designed to operate, and hence they now need to be managed in a more active manner.

This is where flexibility will be critical. Besides technical grid solutions, flexibility is needed both on the generation and on the demand side to help manage distribution grids efficiently in this new electricity system. Flexibility solutions might reduce the need for infrastructure investments in the grid, hence lowering/reducing grid costs.

Who are the main players in Flexibility?

A range of parties need access to flexibility and a range of parties can provide flexibility to support the electricity system, which can be seen in the figure below.

DSOs

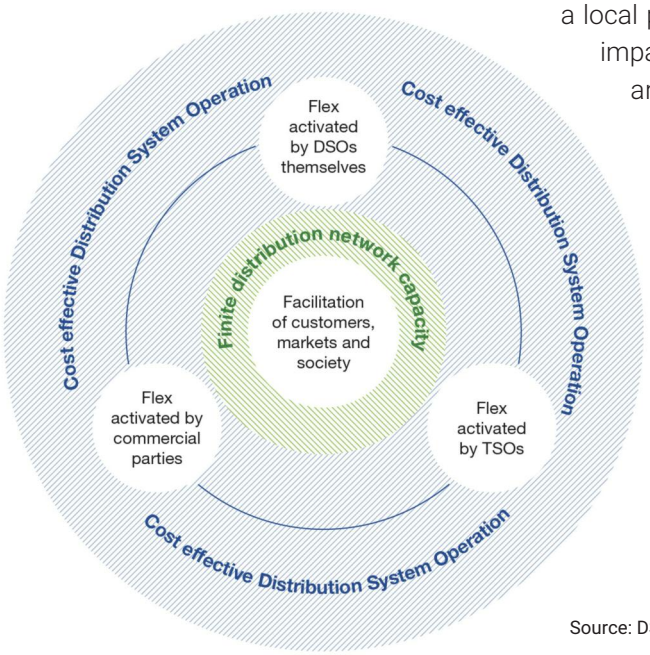
Flexibility is needed by local distribution networks to relieve constraints. DSOs can procure and activate flexibility services from 3rd parties to locally manage the network capacity and voltages. DSOs would traditionally reinforce a network to create more capacity, but by procuring flexibility from 3rd parties cost effectively, this need is reduced. One of the key differences between DSO and TSO flexibility services will be the highly locational nature of the congestion; DSOs will need to know exactly where the flexibility is being provided.

TSOs

TSOs will also need to procure flexibility services from parties connected to the transmission and distribution networks, to help relieve transmission constraints. TSOs will become more dependent on the use of flexibility sources and services connected at the distribution level. TSOs will therefore need to procure and activate such services from DSO customers. TSOs may cause problems in the DSO networks and there is therefore a need for co-ordination and collaboration.

CUSTOMERS AND MARKET PARTIES

Flexibility can be provided by customers and market parties to provide balancing, congestion management and other services to networks, usually as the result of a contract or market signal. These Market Parties may also activate flexibility independently of networks (for example as the result of a local peer-to-peer energy trading market), and this could have an impact on the electricity networks. In these cases, problems may arise and co-ordination is required. Market Parties may own flexibility technologies themselves, or they may provide flexibility services on behalf of other customers via aggregation. This will allow local customers with EVs and batteries in their home to help relieve network constraints. Suppliers and aggregators will be able to combine multiple assets from various locations in an area to provide flexibility services to solve local constraints.



Source: DSO Committee on Flexibility 2017

Enabling Flexibility Solutions in the Distribution Networks

There are a number of ways in which DSOs can activate flexibility solutions to help solve network issues, for example congestion or imbalance. The below list is a summary of techniques available to the networks to activate flexibility[2]:

- Network technical solutions using grid assets: reconfiguration of the grid topology to alter power flows, including but not limited to reactive power flows, and achieve a more desirable system state or inductors for voltage control purposes or in certain circumstances energy storage for grid purposes owned and operate by the DSO.
- Tariff solutions: the use of grid tariffs to trigger implicit flexibility that is able to react to prices and explicit flexibility via a service provider who optimises customers' total costs, not only energy price. These tariffs can take many forms and can include aspects such as time, direction, capacity, power and location.
- Market-based solutions: market-based activation of explicit flexibilities that are able to alter power flows in all directions.
- Connection agreement solutions: connection agreements with certain grid users so that they provide a certain service needed.
- Rule-based solutions: rule-based curtailments as a consequence of the implementation of technical requirements from connection codes that are available in last-resort or emergency situations.

[2]Joint TSO-DSO report "An integrated approach to Active System Management", April 2019
https://www.geode-eu.org/uploads/GEODE%20Publications/2019/TSO-DSO_Report_ASM_2019.pdf

Technology options to provide Flexibility

DSOs need a toolbox of solutions to operate a future electricity grid that is fit for purpose. This will include a range of solutions including storage, tariffs, market flexibility services and traditional reinforcement. There are a wide range of technologies that are available to provide the flexibility required, and these can be owned by various parties. A summary of these technologies can be seen below:

Smart Grids

The Electricity Networks are becoming more active and 'smarter' in the way that they are operating. This includes the physical installation of new intelligent control, automation and adjustable network topology equipment, such as Active Network Management solutions, better monitoring equipment, such as Smart Meters and intelligent sensors, and new business models, such as flexibility markets.

Data is key to the smart grid. Data can facilitate a better understanding of generation, networks and consumption, so that smart grid technologies and new markets can be used to optimise the operation and planning of the electricity networks.

Energy Storage (including paired with solar)

As defined in Article 2.59 of the EU Electricity Directive 2019/944 of 5 June 2019:

Energy storage, in the electricity system, is the act of "deferring the final use of electricity to a moment later than when it was generated, or the conversion of electrical energy into a form of energy which can be stored, the storing of such energy, and the subsequent reconversion of such energy into electrical energy or use as another energy carrier."

There is a wide range of energy storage applications at all levels of the electricity system ranging from generation, transmission, and distribution down to the customer. The use of energy storage for network purposes has vast potential. This will include third parties providing services to the electricity networks such as seasonal storage, congestion management (capacity support), frequency response for grid balancing, voltage and reactive power control, demand side response, fault response, phase balancing, harmonic response, etc. Electric Vehicles (EVs) can also be considered as mobile energy storage that can consume or produce electricity (Vehicle 2 grid).

Combined Heat and Power systems (CHP)

Cogeneration is the simultaneous production of electricity and useful heat ("CHP" systems). CHP systems are currently powered by natural gas, biogas, bio-methane, bio-fuels or gas and power consumption depending on technical or price signals.

Generation/Load Adjustment

Generation can be turned up, down or shifted in time, to provide flexibility to the system. This is usually due to an external signal to indicate that there is stress on the networks, or supply/demand trends. Similarly, demand can be turned up or down (known as Demand Side Response, or DSR), again in response to an external signal to provide flexibility to the system. This will typically be done by the DSOs indicating a price signal to the market, and market parties responding accordingly.

Flexibility Markets

Flexibility can be made available in a number of ways, as described in the previous section. One of the key mechanisms for enabling flexibility will be via flexibility markets. There are a range of options including flexibility markets that regulated networks can use to procure flexibility services, unregulated flexibility markets that are independent of networks (e.g. peer-to-peer energy trading markets) and markets that can be used by both regulated and unregulated entities. These markets could be local, national or even international. Ultimately all flexibility markets will be trading flexibility services that involve energy that is transmitted on the electrical networks, and hence they must be co-ordinated between themselves, but also with other energy markets such as the wholesale and balancing services markets. In the extreme, these markets could all be combined.

The key to making flexibility markets competitive with traditional network solutions such as reinforcement is to increase liquidity in the market(s). There are a range of requirements to increase liquidity in flexibility markets such as increased distributed energy resources (DER) penetration, interoperability between markets and networks, increased visibility from networks to indicate where congestion exists, stackability of revenue streams, etc. For local flexibility markets, these will be constrained to geographic areas corresponding with the local distribution networks, which is very different to TSO markets. This will mean that customers with flexible resources connected in these areas can provide services to help relieve network constraints. Due to the limited geographic nature of these markets, it is essential that liquidity is maximised.