Ofgem

The Future Distribution of Flexibility

Snowflake Response

v3

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SECTION 1

WHAT DO YOU THINK DISTRIBUTED FLEXIBILITY COULD CONTRIBUTE TO THE ENERGY SYSTEM?

The UK's electricity supply is shifting from hundreds of large-scale thermal power plants that could shift up or down at an operator's behest, to fleets of wind turbines and solar parks, the output of which is determined by the weather. This shift necessitates other technologies to ensure demand and supply are in continuous balance. Fortunately, the rise of distributed energy resources (DERs) provides an opportunity, both in shifting electricity demand (such as via controlling electric vehicle charging or water heating) and supply (such as via battery storage).

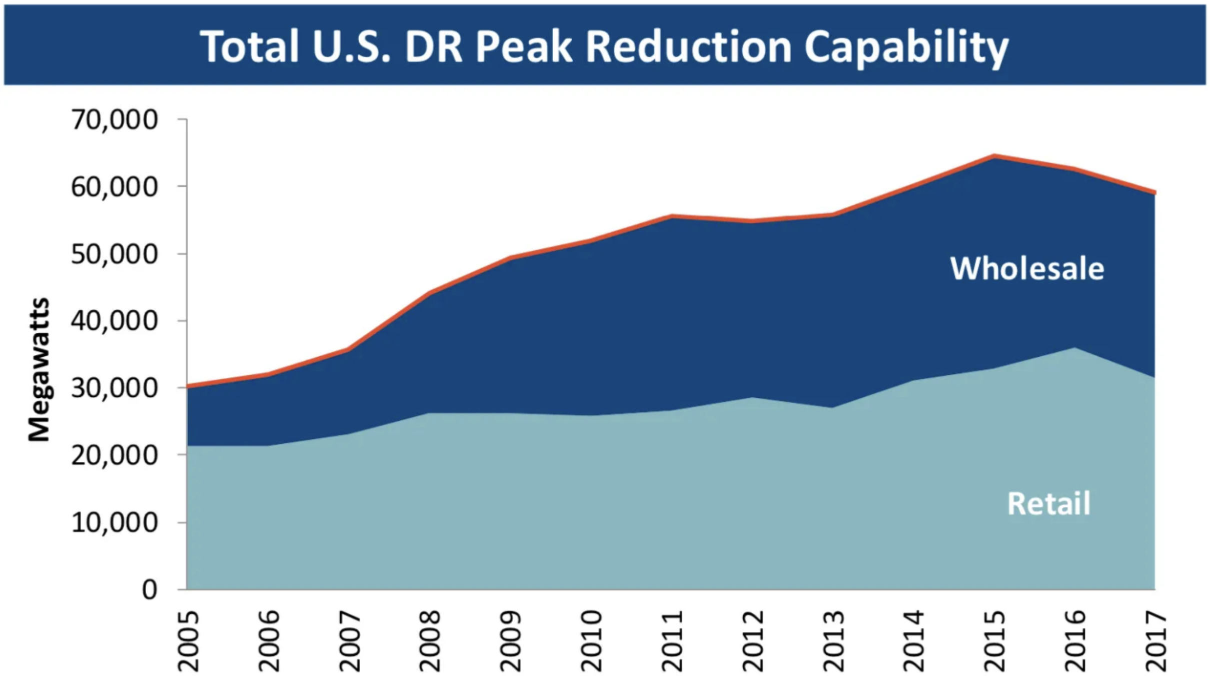
RMI (formerly known as Rocky Mountain Institute)* estimates that grid-integrated aggregations of distributed energy resources could provide 60 GW of flexible capacity in the United States, approximately 5% of the 1,200 GW U.S. grid capacity. The Brattle Group reach a similar conclusion. They estimate this presents an opportunity to reduce annual U.S. power sector expenditure by $17 billion.[1][2]

* This response comes in part from one of the authors on RMI's ground breaking 2017 report "The Economics of Demand Flexibility", in which the term of demand flexibility was first coined. [3]

[1] Virtual Power Plant Insight Brief, RMI, 2023

[2] The National Potential for Load Flexibility, The Brattle Group, 2019

[3] The Economics of Demand Flexibility, RMI, 2017



Distributed flexibility does have the potential to help meet at least some of the dynamic needs of energy consumption, whilst avoiding the need to invest in the building of large-scale power stations, which can take many years to bring online.

Having a distributed network of smaller-scale energy producers that can provide a surplus of energy to the grid as and when required, can help to meet those temporary times of peak demand, which might be caused by local or national events, or even issues with larger-scale production or provision within a geographical area.

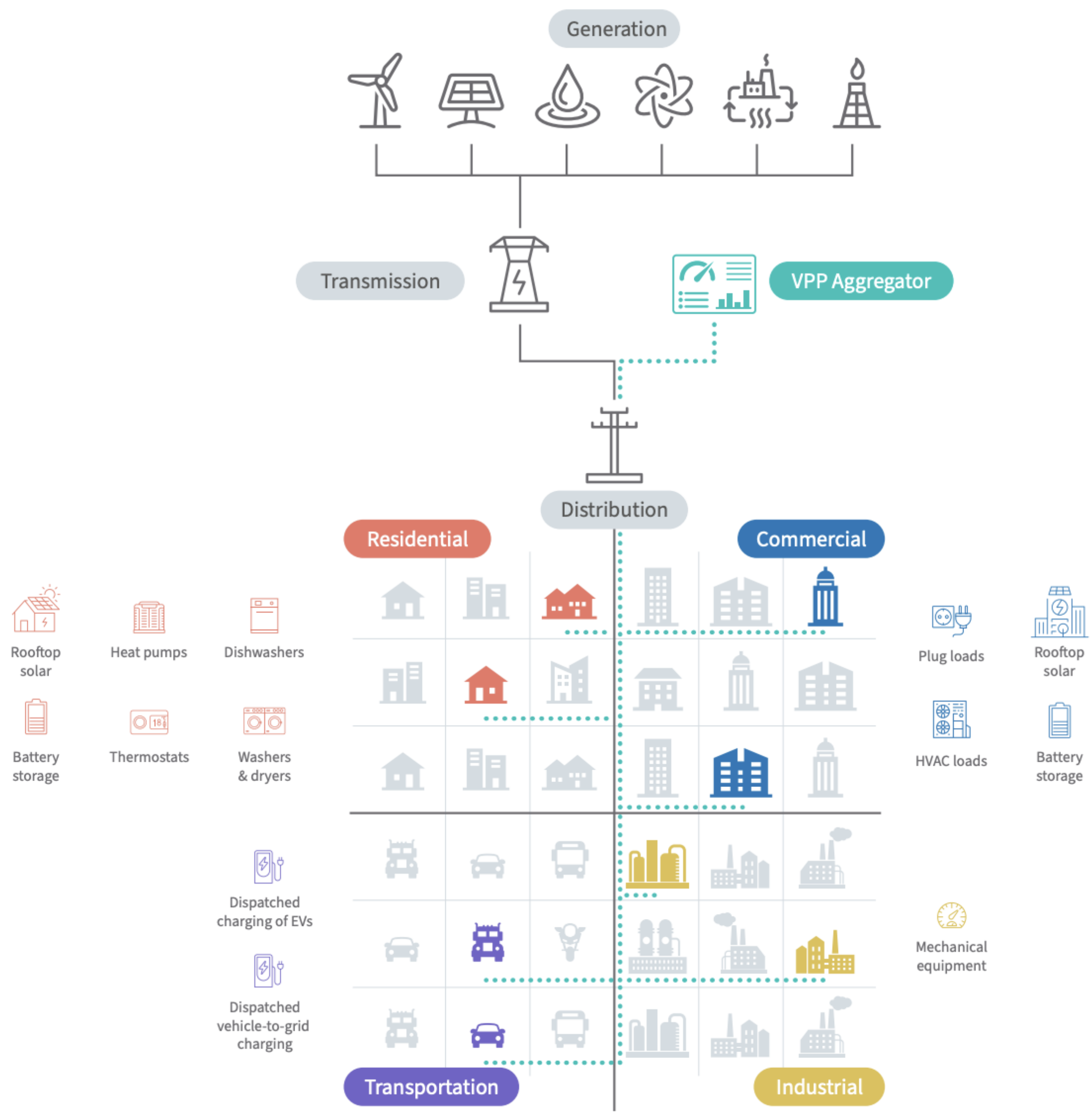
Another consideration for having more available but smaller-scale producers, such as homeowners with solar panels, is that it can reduce the demand on the main grid at peak times. Even if each smaller provider cannot produce excess energy to meet larger-scale needs they should still be able to provide some significant output to support local demand.

One of the key challenges to having this distributed flexibility in energy provision is to know who the smaller-scale producers are, where they are, and what they can produce in terms of meeting the energy requirements of the producer, the local area, and the national grid.

Another key challenge requires us to understand what can be currently achieved, versus what needs to be achieved to meet the needs of today, tomorrow, and the future. This requires access to volumes of accurate and timely data.

WILL A FOCUS ON CER FLEXIBILITY ALSO HELP ENABLE OTHER FORMS OF FLEXIBILITY, ESPECIALLY DISTRIBUTED FLEXIBILITY?

We see Consumer Energy Resources as a subset of the larger distributed flexibility. Distributed flexibility can be divided across four areas: residential, commercial, industrial, and transportation. CERs comprise the first two of these. Ofgem refers to the other types of flexibility as DERs.[4]



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[4] https://www.ofgem.gov.uk/publications/call-input-future-distributed-flexibility, page 16

CER flexibility increases other types of distributed flexibility (i.e. industrial and transportation) in a few ways. First, some of the technologies developed apply to all distributed flexibility. Second, the methods to compensate flexibility, such as market prices or utility- or retailer-provided incentives, can be used across flexibility types.

CERs are different from other types of distributed flexibility because due to their size, resources must be aggregated. This can be a tremendous data challenge.

A focus on CER flexibility could be considered a good agile approach to learning about the problems with distributed flexibility, and how to resolve them. This gives the potential to learn lessons more quickly, to help a wider understanding of what approaches would be required for larger scale energy providers.

One challenge is understanding what additional investments need to be made and where to meet these flexible needs in a reliable and consistent manner. This could include sponsoring more installations of existing production technologies such as solar, wind, and tidal. Future investments should also look at new and experimental technologies that could be suitably installed and maintained.

The focus on CER flexibility will need to be done in parallel with an analysis of the larger distribution and consumption needs, to better understand what can be achieved with just CER, versus what larger investment may be required to build larger-scale critical infrastructure.

To analyse the need and effectiveness of CER flexibility, data will play a key role. Having accurate data to hand across all areas of the CER and a wider flexible distribution network is essential to not only operating and maintaining the network, but to also plan for the flexible distribution of energy actively across that network, to meet current and future requirements. Without this data accuracy there is a very real risk that the flexible distribution network will be over, or under producing energy in a way that doesn't meet the current demands and will lead to destabilising price fluctuations. Overproducing energy unnecessarily or having to ramp up production quickly to meet an unexpected surge in demand will also place additional strain and costs on the equipment and facilities used to generate that energy. This will impact the goals for carbon footprint offset, and increased costs in the production of energy.

The types of data that would be required cover every aspect of the flexible delivery chain. There will be individual devices used to generate, monitor, or control the production of energy, and this data is essential to the operation for the production of the energy.

There will then be the devices, appliances, and installations that will consume the produced energy, whether it's an individual household through to large-scale manufacturers. These devices can provide data that gives valuable insight into how much energy that device uses, and what the consumption patterns are.

In the middle, there is additional data that will be generated on the monitoring of energy production, distribution, and consumption at the local, regional, and national levels. There is also the tracking and setting of prices based on the fluctuating production and availability of energy versus the fluctuating consumption of that energy. This data is likely to differ widely across the local and regional levels, which needs further management.

Each of these data sets will have different types, volumes, and frequencies that need to be efficiently managed across all levels. However, even this very large and rich collection of data is not enough to provide all the insights needed to effectively operate the flexible distribution network. Additional data is required to provide enrichment, further insights, and the potential to infer or predict future trends in production and consumption. These data sets would be external to the flexible distribution network and would need to be combined with your own data, in order to gain additional insights.

These external data sets would include topics such as:

- Location, and geospatial data from organisations like Ordnance Survey. This will help with various insights such as logistics, distances between producers and consumers, understanding of production and consumption zones, whether they are local or regional. Geospatial data is also essential when planning new areas to build additional production facilities, or even electric car charging points
- Demographic data from organisations like the Department for Work and Pensions. This data will help to gain insights around the different consumption patterns based on demographics such as income, and health. As an example, lower income areas are more likely to use public transport and/or diesel/petrol cars, rather than more expensive electric vehicles
- Transport data from organisations such as Transport for Greater Manchester. This will help with various insights around public transportation, and the energy

consumption needs of buses and trains, especially as we are seeing more hybrid and electric passenger vehicles being used. Public transport information can also provide useful insights into trends towards car usage, and types of vehicles, e.g. petrol, diesel, LPG, electric

- Weather and meteorological data from organisations like The Met Office. Weather data can provide excellent insights into both production and consumption patterns. For production this can include data around wind for turbine production, rain and tidal flows for tidal production, UV indexes for solar generation. For consumption, cold and wet weather will result in more consumption, whether it's increased heating, more laundry for muddy clothes, and increased entertainment device usage (TVs, tablets, computers) as people choose to stay indoors
- Retail data can provide trends on what appliances and devices are being purchased. This kind of data would include the energy rating, and which area they are being purchased in. Data like this can help gain insights on likely consumption trends
- Company and organisation data from organisations like Companies House. As part of the flexible distribution model there will be a need to quickly onboard new energy producers, regardless of their scale. Are those new providers being onboarded legitimate businesses registered with Companies House, or is someone trying to commit fraud?

This list of potential data sources is by no means exhaustive, but being able to combine data from disparate organisations like these with your own data will be essential to the effective operation of the flexible distribution network.

Managing all this data will be a challenge. There will be large volumes of many different types of data that need to be processed and shared as quickly and as efficiently as possible. No compromises can be made on what data set is used, and how much of it is used or the accuracy of that data. The data needs to be made available to analysts for all aspects of managing the end-to-end network. In addition, data science models need to be trained, to help with predicting future production and consumption trends so that effective planning can be executed.

The data analytics and science will need to be performed across a mesh of different organisations for different purposes, and this will involve many different technologies such as different cloud infrastructure providers, so a data platform that has strong integrations across a wide eco-system of technology partners is needed. With the different types of access required by all stakeholders, an ability to ensure that only those that are allowed to access data are permitted, so security and governance also needs to be a foundation of your data management. These are some of the principles that are a foundation of the data mesh operating model.

SECTION 2

IS THE REAL CASE FOR CHANGE 'AND A NEED FOR A COMMON VISION FOR DISTRIBUTED FLEXIBILITY?

Yes. If we don't create the proper incentives for distributed energy resources, they could worsen the challenges of operating the grid reliably. For instance, without providing financial incentives to electric vehicle charging, all cars might charge when people return home at the end of the day — exactly at the time when solar production drops.

There is clearly a need for change across several aspects of energy production and distribution, with a non-exhaustive list of examples of how the situation is already changing:

- Move away from fossil fuels such as gas and coal, to more sustainable methods of production
- Increasing desire for households to become more self sufficient to reduce the impact of inflationary price increases for energy
- Lack of investment for larger scale production such as power stations
- A growing list of smaller scale technologies that are improving the accessibility of smaller scale and sustainable energy production
- Increasing use of computerised devices, such as electric vehicles, that are increasing the demand for electricity, and also a need for better battery recycling and disposal
- Increasing use of less main stream technologies such as hydrogen powered vehicles, and the improvement or phasing out and replacement of less energy efficient technologies
- Government's Smart Data Council initiative that will work towards a way for consumers to more easily switch providers to get the best deal (https://www.gov.uk/government/news/new-smart-data-council-to-drive-forward-savings-for-household-bills)

A key challenge to address all of the above and more is providing the necessary legislation, investment, infrastructure, and monitoring to ensure that all of the challenges and goals of the current and future energy demands can be met. This requires a common vision amongst energy consumers, producers (small, medium, large), research institutions and technology developers, and the government to ensure that various environmental and safety laws are adhered to.

WHAT IS YOUR VISION FOR HOW TO ACCELERATE THE DELIVERY OF ACCESSIBLE, COORDINATED AND TRUSTED MARKETS FOR DISTRIBUTED FLEXIBILITY?

As described in earlier answers, there are some key points that the flexible distribution network needs to address, before we can understand what the scale of the problem is, how it can be addressed, and what results can be achieved.:

- It needs to be data driven
- You need to be able to aggregate data and make it accessible and consumable quickly and easily
- Access to the data needs to be secure, and it's use needs to be governed
- It needs to fit in with a large eco-system of technology providers to support everything from extraction from source, through to creating visual dashboards and training machine learning models

By analysing the data across the different areas of consumption and production, we can better understand what can be achieved as a vision, what problems need to be solved to implement the vision, and to monitor on a regular basis how effective the implementation is progressing.

Reaching the objectives of the vision requires us to fully understand where we are, where we need to get to, and the ability to monitor and observe whether the actions being taken are heading in the right direction within the right time frame. With the right data being analysed in the right way it will be easy to see the effectiveness of the various actions that are being implemented and allow for course change if the results are not as expected or required.

Without this data driven approach, there is a very real risk of a lack of direction in trying to achieve an undesirable or unrealistic vision. It also increases the risk that the activities and implementations do not take us in the right direction for realising the vision.

WILL CERTAINTY OF AN END VISION HELP ACCELERATE ENABLING WORK AND MAKE IT COHESIVE?

Using data as evidence to identify what the vision needs to be and how to get there, can further be used to justify why the vision is correct across all the stake holders:

- Business and domestic users can be reassured that energy costs will be affordable over the longer term by a successful implementation of the vision
- Environmental concerns can be addressed by showing how the vision can reduce carbon footprints or pollution, and as programs are implemented, the positive impact it is having on working towards those goals
- Energy providers can be assured on how they will receive a viable return on investment

By backing up a vision with key data points and being able to observe and show how effective the implementation of that vision is will always help to reduce any friction across the various stakeholders and improve motivation to keep the implementation on track.

WHEN SHOULD A COMMON DIGITAL ENERGY INFRASTRUCTURE BE IN PLACE? AND THEREFORE, WHEN SHOULD DEVELOPMENT BEGIN?

The digital energy infrastructure needs to be in place quickly, however rushing in to building out a monolithic program is going to be dangerous, and risks excessive lead times to implement, whilst failing to deliver what is needed. Ideally a series of pilots, and minimum viable products (MVPs) should be implemented in an agile manner to allow for the digital observation, management, and delivery of energy. These smaller projects can be implemented more quickly with less effort, and as lessons are learnt, they will be easier to adapt to provide the desired outcomes. Successful MVPs can act as the foundation for a larger roll out where needed, whilst failed and sub-optimal MVPs can be used as lessons learnt.

As an example, the recent announcement of the government's Smart Data Council that focuses on enabling consumers to change providers more easily, could completely change key requirements for the flexible distribution network and the business models it's designed to support. Taking a monolithic approach would result in these requirements being out of scope, and unsupported. Using an agile approach and implementing smaller projects would allow for initiatives and policy changes like these to be included in the scope.

Start with what you can based on the data you have and use the initial data to gain the insights you need to give you direction and guidance you need. If done correctly, this will lead to more data being made available, which brings the potential for additional insights. This additional data can help guide what changes need to or can be made across the program to deliver better outcomes.

To achieve this across multiple stakeholders there also needs to be a focus around the use of open standards for the interchange of data, so that each party can access and use the data they need. To take this a step further, there is also a potential here to implement a data mesh operating model, to reduce the friction on sharing data across multiple federated domains.

SECTION 3

WHAT SHOULD A COMMON ENERGY DIGITAL INFRASTRUCTURE LOOK LIKE, AND WHY? PLEASE CONSIDER THE ARCHETYPES OR DEVELOP YOUR OWN PROPOSITION.

The initial focus should not be on what the infrastructure should look like, as this is often a design and implementation detail. The initial steps should focus on the desired outcomes across all stakeholders. Only from that point should there be a consideration on how those outcomes will be achieved.

It can be useful to see what's happening elsewhere. In California, for example, CERs are aggregated and have historically received incentives in a way comparable to the "thin" architecture. California's three integrated utilities provided funding to CER aggregators like OhmConnect and Leap via a program called DRAM. California's load serving entities also procured long-term resource adequacy. In both cases, exploration had to be done by flexibility providers individually, and registration happened individually.

In the Netherlands, distribution system operators (DSOs) and TenneT, the transmission system operator (TSO) are creating a market for flexibility. This approach looks more like the "medium" archetype. It might also be useful to look at the approach of Energy Web Foundation, which follows a similar archetype.

The overall infrastructure is going to be complex, and as consumption, policies, business models, resiliency, security, and production technologies change, so must the infrastructure. So, a modular, and adaptable infrastructure is required, but it's too early to say what that will look like.

As an example, early agile projects may take the thin archetype approach, as this could be the easiest and fastest to implement, however it would not be relevant for all required outcomes. For instance, there may be regions where there is a higher number of potential small scale energy products that would be easy to catalogue. This might be suitable for initial observability but may not be sufficient to support desired outcomes around exchange and markets.

To support those additional outcomes moving towards more of a medium archetype may help, but there would still be the need to maintain those thin archetypes, which would be more local in nature.

It would also be essential to have a centralised view, which is where the thick archetype comes into play.

WHAT IS YOUR VIEW ON THE DESIRABILITY AND FEASIBILITY OF THE ARCHETYPES OR YOUR OWN ALTERNATIVE PROPOSITION?

Choosing only one archetype approach is going to be too inflexible to meet all the desired outcomes that have been discussed in the call for input paper, and probably won't be able to accommodate new outcomes and requirements as lessons are learnt, and as the industry evolves over time. So, a mixture of different archetypes is going to be required, with the potential that the definition and implementation of each archetype will probably also evolve over time.

SECTION 4

SHOULD A COMMON DIGITAL ENERGY INFRASTRUCTURE BE NEW-BUILD, OR SHOULD IT BUILD - OUT FROM EXISTING INFRASTRUCTURE?

Before any advice can be given on whether to replace or enhance and full understating of the existing environment would be required. We are happy to work with you and your partners and suppliers to gain this understanding so that we can provide better guidance.

One initial consideration is to keep the lights on, and the business running, so it is worth looking at what existing infrastructure and archetypes are available right now, and whether they can be adapted to meet the current and future requirements of the distributed flexibility program. If a given piece of infrastructure, technology stack, or service isn't fit to serve these requirements, then it will need to be replaced with a new build. It's impossible to say at this point just how much of the existing infrastructure needs to be decommissioned, but there are likely to be at least a small number of cases where a new build is required.

For other infrastructure and systems, there will also be opportunity to re-use, and build out, to meet the required outcomes. These will range from the fairly easy and uncomplex, e.g. where IoT and data analytics capabilities have already been implemented into the infrastructure, to the extremely difficult legacy systems that weren't designed to be changed or integrated with other platforms. Where significant effort is required to adapt existing infrastructure, the balance of the time/cost/risk of evolving existing infrastructure and the potential disruption to the use of that infrastructure while it's evolving needs to be weighed against a new build.

Realistically it will be a combination of new build, and build out, to deliver the desired outcomes. However, there is a major consideration with any new technology investment, whether it's a new build or build out, and that's to ensure that it flexible enough to meet future requirements as well.

Investing in point SaaS applications can result in a flexibility dead end. Although a given SaaS application might meet some current business need, it can often fail to be adapted to meet the changing needs of the business.

Snowflake provides a data platform, which is a single product, and has proven flexibility across multiple industry verticals and data processing workloads. Using Snowflake as your data platform will give you the ability to meet your existing needs, whilst being able to meet those future requirements.

WHAT ARE THE IMPORTANT AREAS FOR CONSIDERATION WHEN DESIGNING INSTITUTIONAL DELIVERY MODELS FOR A COMMON DIGITAL ENERGY INFRASTRUCTURE?

Institutions do tend to be very monolithic in terms of their approach and thinking, which is certainly better geared towards supporting the thick archetype implementation. However, this is too inflexible, and won't meet the requirements of the distributed flexibility program. Such a change in approach does require a cultural transformation within and across the organisation, and without a successful transformation the program will fail through a combination of apathy, ignorance, fear of change, and political infighting.

Some of the key considerations that complex organisations consider, and build into their program, to mitigate the risk of failure are:

- Communicate: It's important to articulate to everyone why change needs to happen, what that change will be, and what role each person in the organisation will play in helping to deliver the desired outcomes. It doesn't have to be a debate, but being reasonably open to feedback from key people can help to identify areas of greater concern, or when things aren't working as they should, or heading in the right direction requiring an alteration.
- Educate: It's essential that stakeholders are also allowed to comprehend the why of the program, not just the what, and this is where education comes in. Different approaches and topics would be required for different teams and departments, but an effective education program will give those stakeholders the agency they need to help deliver the outcomes of the program, or to communicate when things are not working.
- Accountability: There needs to be accountability across the stakeholders, as complex programs like these will need to be delivered at different levels in different ways. Federated accountability and responsibility is required, so that if or when things go wrong with a specific aspect of the program, it should be easier to manage and get back on track
- Flexibility: Things will change and for various reasons. So it's important that the ability to adapt the program to take into account various changes, and to enable the stakeholders to adapt along with the need, is essential. Communication, education, and accountability are a large part of this

Although there are many important areas to consider when designing a delivery model that needs to be both federated and common, when looking at this through a data lens one of the most essential aspects is the ability to easily share data across all parties in a fast and efficient manner. As mentioned in the answer to question 6, this will involve deploying systems that support open standards for data exchange, and deployment of operating models like data mesh to remove the friction of sharing data amongst stakeholders.

Open standards and formats enable different entities to share data and communications more easily, with less friction. Open standards and formats include platform aspects such as file formats, programming/access interfaces, and APIs. Open standards shouldn't be confused with open source, which provides access to underlying source code, but does not necessarily make platforms and systems interoperable.

Data mesh as a data operating model covers both technology and cultural aspects of allowing federated stakeholders to share data quickly and easily amongst each other. The technology focus will need to support open standards as mentioned above, and to enable data sharing with as little friction as possible. Culturally, a data mesh model educates all stakeholders within an organisation to take ownership and responsibility for the data that exists within their domain, and to allow others to access that data in a trusted way.

WHAT ARE THE IMPORTANT AREAS FOR CONSIDERATION WHEN DESIGNING FINANCIAL DELIVERY MODELS FOR A COMMON DIGITAL ENERGY INFRASTRUCTURE?

This is a very complex area that needs to consider the costs to produce energy, costs to deliver the energy to the right place at the right volume, and the price the consumers are willing to pay. Here is a non-exhaustive list of the types of financial questions some of our utility customers ask

- Where is the need based on demand and the ability to produce?
- What investment is needed to meet that demand in the most suitable way?
- Who will be investing in the means of production, and how will they be compensated, and over what period of time?
- What price points are the consumers willing to pay and why?
- What additional parties will need to be involved, either in the charging for consumption, investment in the build and maintenance of the means of production, and the operation of the means of production, exchange, and marketplace?

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