Begonia

USE CASE 1:

ODPs for distribution grids

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Table of Contents

Use case 1: ODPs for distribution grids 2
- Use case identification 2
- The scope and objectives of the use case 2
- Narrative of the use case 3
- Diagram of the use case 5
- Actors of the use case 6
- Scenarios 6
- Policy and digitalisation needs 7

Use case 1: ODPs for distribution grids

Use case identification

Table 1. Identification of the use case 1.

ID	Name of Use Case	Geographical scope	Cross-sector domains			Interoperability layers
			Electric	Mobility	Data	
BEG.01	ODPs for distribution grids	☐ Local ☒ Regional ☒ National ☐Cross-border ☐ Outermost	☒ Customer ☒ DER ☒ Distribution ☐ Transmission ☐ Generation	☐ Customer information ☒ Vehicle ☐ Energy station ☐ Infrastructure ☐ Traffic and logistic	☒ Edge ☒ Fog ☒ Cloud	☒ Component ☒ Communication ☒ Information ☒ Function ☒ Business

The scope and objectives of the use case

Table 2. Scope and objectives of the use case 1.

Scope and Objectives of the Use Case	
Scope	This use case proposes an ODP for distribution grid operation. Every DSO, RES, aggregator, EV charging point, different types of CLs such as heating, ventilation, and air conditioning (HVAC) systems, and even electricity customers can connect to the platform and receive or deliver services. The platform is equipped with a digital twin service that can receive required data from DSOs and generate digital twins of the grid and standard types of assets such as transformers. DSOs can use this service for grid services such as monitoring, forecasting, operation, and planning services. On the other hand, all the abovementioned stakeholders can have access to the platform, connect to their related DSO just by entering their basic information such as address or region, and provide flexibility services. The ODP also allows interaction with end-users via mobile applications for increasing awareness about grid status and contributing to solving grid issues in real time manually.
Objective	The main goals of the use case are as follows: • Developing a cross-border ODP for the operation and planning of distribution grids, • Increase distribution grid observability, • Developing a tool for generating digital twins of the distribution grids and transformers for any DSO that joins the platform, • Benefiting from aggregators, RESs, EVs, HVAC systems, and different types of CLs for providing grid services, • Increasing end-user awareness and engagement in distribution grid management and solving grid issues.
Reference country(ies)	Denmark
Related Business Case	Distribution grid monitor, operation, and planning, grid flexibility services.
Possible stakeholders	DSOs, Aggregators, EV charging points, Facilities with CLs, Electricity customers

Narrative of the use case

Power systems are facing rapid changes. Today, there is a growing investment in RESs and various sectors such as transportation and heating have an increasing tendency for electrification. Installing new capacities of PVs and wind turbines increases the uncertainty in predicting the loading of the lines and the possibility of bidirectional power flow in the girds that are not designed for it. Activating more and more EVs and using heat pumps for heating not only increases the volume of electricity consumption but also puts the system under other stresse such as harmonics and voltage regulation issues. Since most of these changes are happening at the distribution grid level, it is critical to increase the observability of distribution grids, optimally operate the grid, and find the best investment solutions for grid reinforcement.

On the other hand, demand-side flexibility as a grid service is becoming more and more popular. DSOs need a tool to facilitate interaction with different stakeholders that can participate in the flexibility procurement programs.

In this use case, an ODP is proposed to help the DSOs solve grid issues and provide the possibility of interaction between the DSOs and different stakeholders. Since it is important to test any solution in the grid before implementation, the platform should have a tool for generating digital twins of the grids and the main assets such as transformers. This will allow the DSOs to simulate any operational, planning, and flexibility solutions accurately before implementing them in the real system. Data-driven and AI-based methods should be developed in the ODP that receive grid data operate the digital twins. The digital twin tool should be designed in a generic way that can be applied to any distribution grid only by receiving grid and power consumption data. This is an essential point for guaranteeing the scalability of the ODP.

The main requirements of the proposed ODP are presented in Figure . The ODP should provide two types of services: 1) grid services, and 2) flexibility services. Some examples of the main grid services are as below:

- **System Monitoring:** Monitoring the grid using the data received from the smart meters,
- **Estimation:** Developed digital twins can be used to estimate grid parameters in nodes that are not equipped with smart meters,
- **Transformers aging control:** Oil temperature is one of the key parameters that affect the lifetime of the transformers. Transformers digital twin can be used to predict the oil temperature and make the best real-time decisions to manage the temperature in the next time intervals,
- **Transformers dynamic rating:** The static rating of the transformers is calculated in standard temperatures. However, in many cases, the temperature is much less or more than the standard temperature. So, static rating can be replaced by dynamic rating. This requires developing methods for calculating dynamic ratings using load and temperature forecasts,

- **Phase balancing:** Phase unbalances increase power losses in the grid. In addition to the direct costs of losses, they can play a key role in increasing the hot-spot temperature of transformers and reducing their lifetime. The digital twin model can be used to find optimal solutions for mitigating this issue,
- **Grid planning:** Using the grid digital twin, the impacts of different planning strategies for grid reinforcement (installing new lines, transformers, power capacitors, and other equipment) could be evaluated before implementation. The models also provide the possibility of testing solutions at different forecasted scenarios for the behavior of consumers in the future to increase the robustness of solutions.

Figure 1. Requirements of the proposed ODP for use case 1.

Using the ODP for the abovementioned services can decrease the monitoring, operation, maintenance, and investment costs of the DSO. The main flexibility services can be as follows:

- **Flexibility aggregation:** The ODP should be capable of aggregating and classifying the flexibility capacities received from flexibility providers, i.e., aggregators, RESs, EVs, or other loads,
- **Flexibility needs calculation:** Using the grid digital twins, the minimum flexibility that is needed to solve grid issues should be calculated,

- **Flexibility procurement:** The ODP should have a mechanism for procuring the required flexibility, e.g., a market mechanism,
- **Assessment:** A method is needed to assess if the promised flexibility by every flexibility provider in the ODP is procured successfully or not,
- **Settlement:** Procured flexibilities should be financially settled by flexibility providers. Advanced methods should be used to calculate the price for flexibility services that encourage the end-users to participate in the program and support the economical considerations of the DSO,
- **End-user awareness and engagement:** The ODP can give limited access to end-users through a mobile application to observe grid status at an understandable level for the public and react manually and voluntarily. This increases the awareness of the end-users of grid issues and engages them in flexibility provision process without causing additional costs.

Any flexibility provider or end-user should be able to connect to its related DSO by inserting minimum information such as address or region, and several DSOs in one member state or different member states can use the platform at the same time. Additionally, all the processes of providing services should be done automatically. End-users who receive flexibility requests via the mobile application and react manually and voluntarily do not need to meet these requirements.

Diagram of the use case

Figure represents the diagram of the use case 1. The descriptions of actors and scenarios are presented in Table 3 and Table 4., respectively.

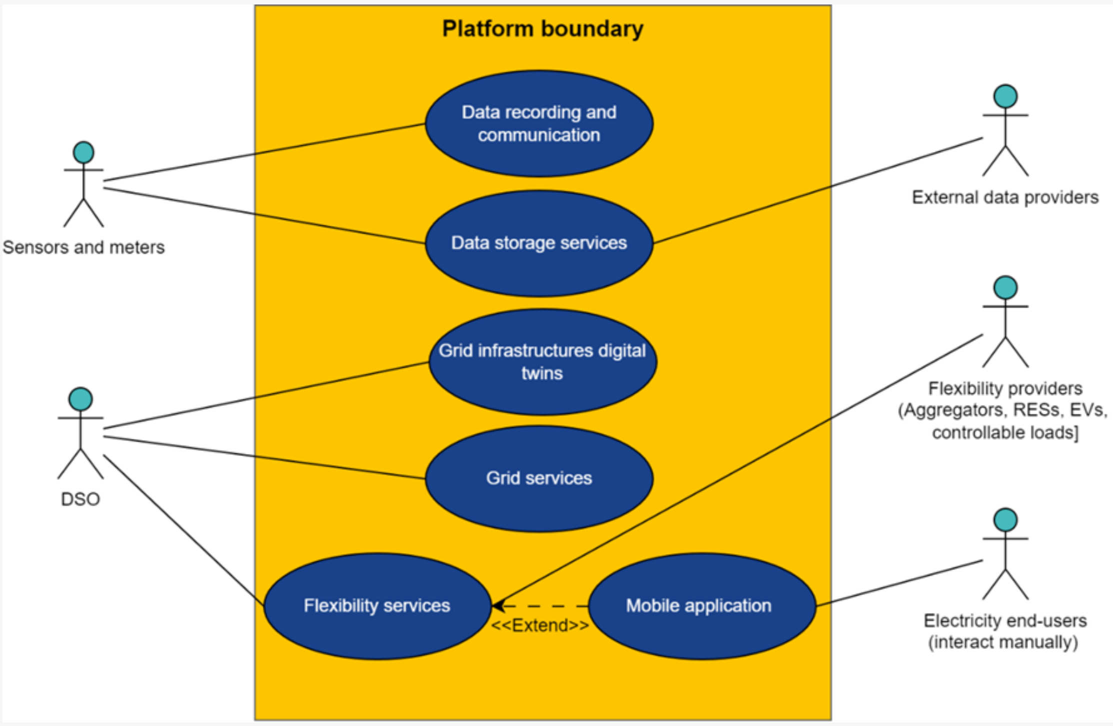

Figure 2. Diagram of the use case 1.

Actors of the use case

Table 3. Description of the actions of use case 1 actors.

Actor Name	Actor Type	Actor description	Actions	Standards
DSO	Role	An entity responsible for operating, ensuring the maintenance of and, if necessary, developing the distribution system in a given area and, where applicable, its interconnections with other systems, and for ensuring the long-term ability of the system to meet reasonable demands for the distribution of electricity.	DSO determines the required services for the ODP and uses the ODP to exploit different grid and flexibility services and ensure efficient operation and planning of the distribution grid.	No
Sensors and meters	System	Sensors are electronic components that respond to physical or chemical stimuli, that is, they detect variations in the environment in which they are inserted. A meter is a system that makes it possible to take measurements of parameters. It is assumed that both sensors and meters are capable of transferring data to the data storage, otherwise, communication devices should be added to them	Sensors measure parameters such as temperature in transformer boxes, while meters record electrical measurements like voltage and current. These devices transfer data to the data storage system. If they lack communication capabilities, they should be equipped with appropriate communication devices.	No
Flexibility providers	Role	Any devices in the grid which the output power or consumed power can be controlled. They can include individual devices or aggregators that manage a group of controllable devices.	Flexibility providers interact with ODP to provide flexibility services. Their interaction must be autonomous using the smart management systems at CL terminals to respond to grid requirements.	No
Electricity end-users	Role	Consumers of electricity	End-users provide flexibility service manually by adjusting their electricity consumption after receiving a notification in the mobile app.	No
External data providers	Role	Data providers are research institutes, industry associations, and sometimes different consultancy companies which are paid by different companies to supply data to eco-invent.	They receive weather, price, etc information, provide forecasts, and send them to the data storage. This data can be used by service providers or digital twin developers.	No

Scenarios

Table 4. Description of use case 1 scenarios.

S.No	Scenario Name	Triggering Event	Scenario Description	Primary Actor

BEG.01.S1	Data recording and communication	Continuous, A new measurement received	Different electrical parameters such as voltage, current, power, and other parameters such as temperature are measured by smart meters and sensors from different locations in the grid and sent to the data storage	Sensors and meters
BEG.01.S2	Data storage services	New data is received	All the data received from smart meters and data providers should be stored in the data centers and can be used by digital twin developers and service providers.	Sensors and meters and external data providers.
BEG.01.S3	Grid infrastructures digital twin	Continuous	Digital twin developers use the data in data centers and the grid data received from DSOs, apply AI-based approaches, and develop digital twins for gird and transformers. They can ask for more metering points and sensors to achieve efficient models.	DSO
BEG.01.S4	Grid services	When the DSO recognizes the need for a grid service	DSO uses the tools in the ODP and the digital twin to simulate any grid solution before implementation using the grid services	DSO
BEG.01.S5	Flexibility services	When the DSO recognizes the need for a flexibility service	DSO uses the tools in the ODP and the digital twin to calculate the required flexibility, procure it from stakeholders, and settle the transactions.	DSO
BEG.01.S5	Mobile application	During the ODP development	The mobile app allows customers to connect the ODP. Receive notifications and provide services manually and voluntarily.	

Policy and digitalisation needs

Table 5. Description of use case 1 policy and digitalisation needs.

Policy needs	• As end-users are one of the core elements in developing the grid's digital twins, end-users should be ensured that the privacy of their data is preserved. Policies should be in place to guarantee that user data is securely stored and only used for its intended purposes. • In case the platform is used by different states, the policies for storing data in different member states should be considered.
Digitalisation needs	• Interoperability between different elements of the platform.