



## **1.5 Joint Product Specification Document**

In Support of the Milestone 3 DEMOCRASI Submission to  
NRCAN

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## Lexicon

AMI	Advanced Metering Infrastructure
API	Application Programming Interface
BESS	Battery Energy Storage System
C&I	Commercial & Industrial
CIM	Common Information Model
DACP	Day-Ahead Commitment Process at the IESO
DER	Distributed Energy Resources
DERMS	Distributed Energy Resource Management
DNO	Distribution Network Operator
EV	Electric Vehicle
HDR	Hourly Demand Response
IESO	Independent Electricity System Operator
IESO CA	IESO Capacity Auction
ISO	Independent System Operator
LDC	Local Distribution Company
MEMS	Microgrid Energy Management Solution
NRCAN	Natural Resources Canada
PV	Photovoltaic
SCADA	Supervisory Control And Data Acquisition

# 1 Joint Product Specification Document

This document serves as a technical specification for the joint product solution developed as a part of the DEMOCRASI project and describes the first deployment of the joint product solution.

This document supports the Milestone 1 Submission to Natural Resources Canada (NRCAN). Collectively, the milestone reports provide a comprehensive description of the project progress to date. This report will reference other Milestone reports including:

- 1.1 Market Adaptation Report
- 1.2 Use Cases Definition Report
- 1.3 User Requirements Definition Report
- 1.4 Solution Architecture Diagrams (also embedded in this report)
- 1.6 Due Diligence Report
- 1.7 Verification Plan

The report is split into two sections as per the above. The first section is focused on the Joint Product Solution (product solution). The product solution is one that is developed for deployment in any context and formalizes the integration between the two software solutions, Opus One's GridOS and Kiwi Power's Kiwi Core. The second section is focused on the first deployment of the product solution in Ontario and outlines the deployment design. In future phases of the DEMOCRASI project, the product solution will be designed for simulation in the United Kingdom (UK).

## 1.1 The DEMOCRASI Project

The goal of the DEMOCRASI project is to demonstrate the viability of a modern approach to asset aggregation where asset dispatch is optimized to meet the demands of the bulk market while also serving local grid needs. The output of the DEMOCRASI project is the design and deployment of a joint product solution that allows distribution-connected distributed energy resources (DER) to participate in both bulk and local flexibility services safely and optimally. Bulk services are those requested by a transmission system operator and local flexibility services are those requested by a distribution utility - in Canada, a Local Distribution Company (LDC) and in the UK, a Distribution Network Operator (DNO). The value proposition and uses cases of the joint product solution are detailed in the 1.2 Use Cases Definition Report.

The core project team, as it is referred to in this report is composed of:

- Opus One Solutions Energy Corporation (Opus One solutions), which owns the software solution GridOS.
- Kiwi Power, which owns the software solution Kiwi Core.
- Bracebridge Generation (Bracebridge), which will serve as the location for the first deployment of the joint product solution.
  - Project DEMOCRASI utilizes Lakeland Power Distribution Ltd. network – Lakeland Power Distribution has full visibility. Bracebridge Generation Ltd. owns and will control the DEMOCRASI assets on Lakeland Power Distribution's network. Bracebridge Generation Ltd. adheres to Lakeland Power Distribution's conditions of service.

This project builds on an existing innovation project at Bracebridge Generation, the SPEEDIER project. This project deploys distributed energy resource management (DERMS) solutions at Bracebridge to

facilitate dispatch of a DER group for local flexibility services. While the SPEEDIER project is not detailed in this report, the project and DER group will be referenced.

## 2 Joint Product Solution

The product solution formalizes the integration between the two software solutions, GridOS and Kiwi Core. GridOS and Kiwi Core are software solutions built and owned by Opus One Solutions and Kiwi Power respectively.

GridOS provides the optimization functionality needed to support the product solution. It performs three-phase unbalanced time-series optimization on distribution and sub-transmission networks.

Kiwi Core provides the bulk system interaction, aggregator functionality and the user interface needed to support the product solution. It offers visibility and control over flexibility assets for effective participation in local and bulk markets.

The product solution is designed such that it can be deployed to any context. In this report, the first deployment is described in section **3 Project Solution**. The specification for the product solution is composed of two key pieces:

- Architecture diagrams that describe the configuration of the two software solutions and how they will communicate between one another
- Data flow diagrams that detail the flow of data within the described architecture

To allow the two software solutions, GridOS and Kiwi Core, to speak to one another, three new components are being developed to facilitate the project use cases:

- The Orchestrator, responsible for integration between the GridOS and Kiwi Core platforms and maintaining the market logic that triggers specific data flows. The logic of the orchestrator is unique for each deployment, but is maintained as a key component of the joint product.
- The Bulk Market Adapter, responsible for sending and retrieving data from bulk market systems. The bulk market systems are unique for each deployment, but the adapter is maintained as a key component of the joint product.
- The LDC Adapter, responsible for retrieving data from local flexibility requests. The LDC and its systems are unique for each deployment, but the adapter is maintained as a key component of the joint product. For the project deployment, no LDC adapter exists. In its place, an existing Distributed Energy Resource Management (DERMS) system on Bracebridge Generation's network will be utilized. This is described in section **3.2.3 Distribution Network Configuration & Asset Participation**

The benefit of developing these three components is that the product can be easily replicated and scaled to be deployed in various contexts and jurisdictions. In a future implementation, this work would be developed and maintained by an in-house IT team or systems integrator.

### 2.1 Product Solution Architecture Diagram

The product solution is composed of the following components:

- Kiwi Core
- GridOS
- Orchestrator
- Bulk Market Adapter
- LDC Adapter

The responsibilities and benefits of each component are detailed below.

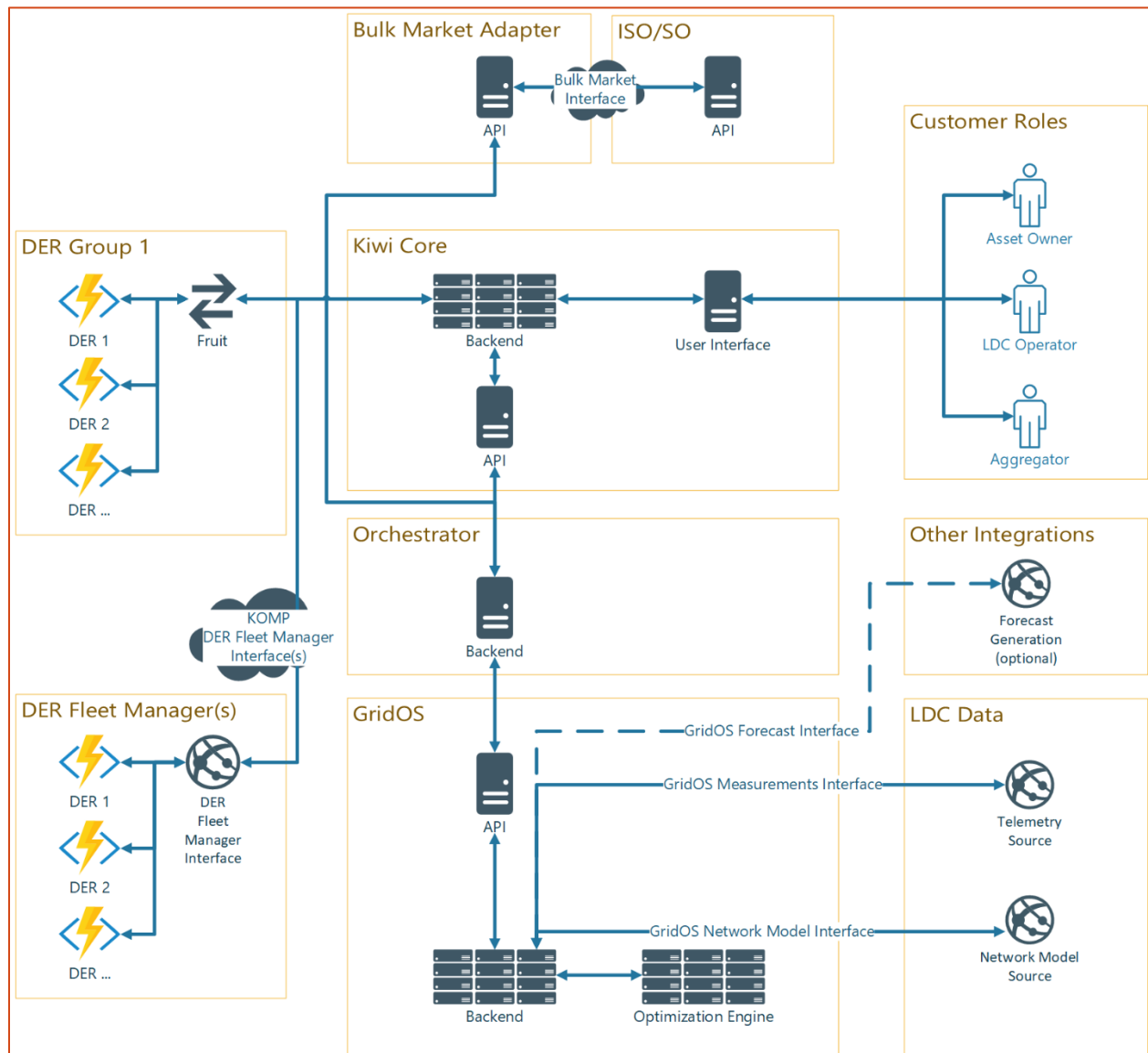


Figure 1: Product Solution Architecture



### 2.1.1 Kiwi Core

Kiwi Core acts as the presentation, high-level monitoring, control, and dispatch layer within the product solution.

On the front end, Kiwi Core will present a user interface to the Asset Owner, LDC Operator and the Aggregator roles; this interface utilizes role-based access controls to present relevant screens to each user role.

On the back end, Kiwi Core will receive high-level commands from the orchestrator. For the project initial deployment, Kiwi Core will also send a dispatch signal directly to GridOS for the SPEEDIER DER group and to the individual assets where necessary (more on this in section 3 Project Solution).

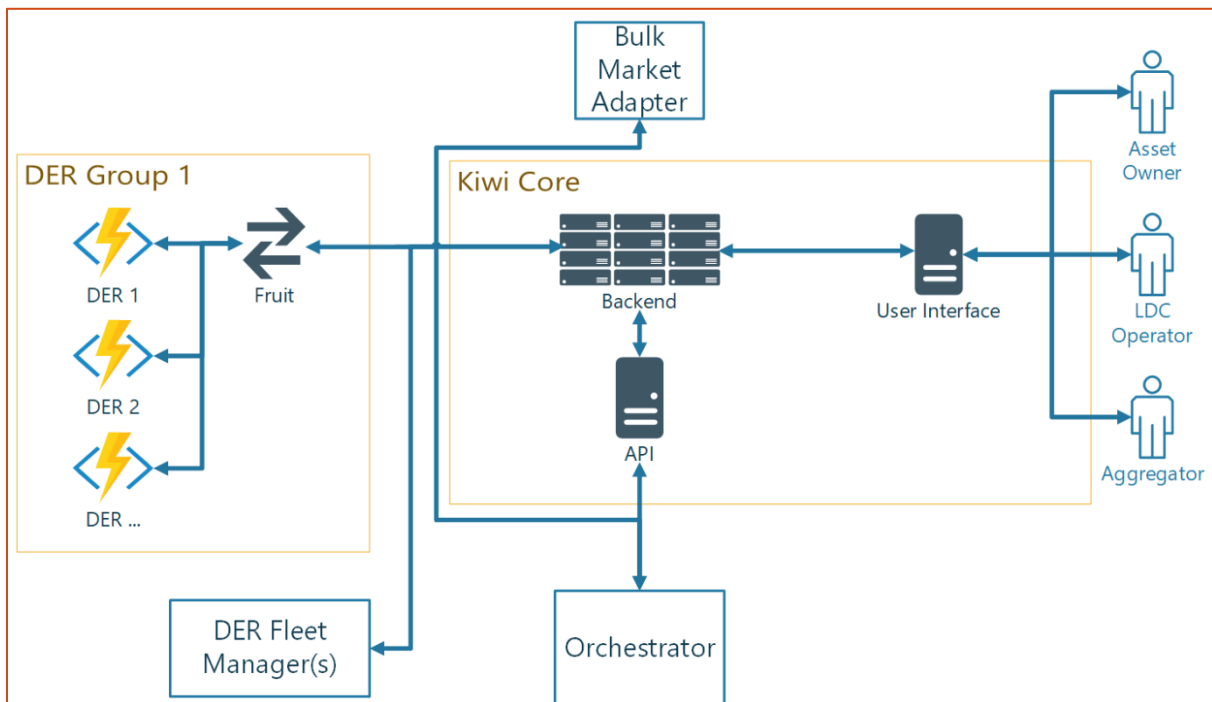


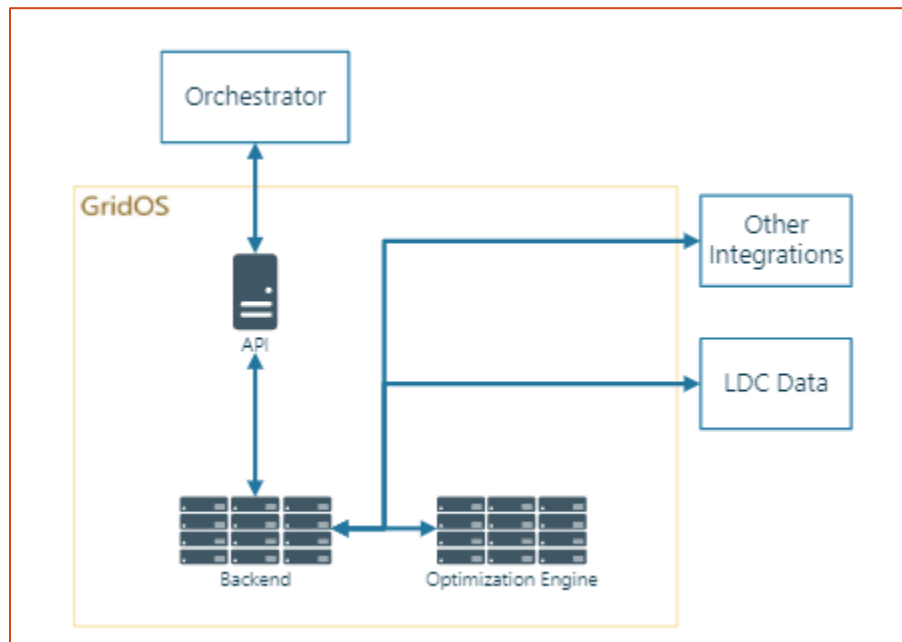
Figure 2: KIWI CORE Product Architecture

### 2.1.2 GridOS

GridOS provides optimization services in the product solution. GridOS receives optimization requests from the Orchestrator and yields optimal schedules, bid recommendations, or other optimization results based on current network conditions.

GridOS integrates with utility data systems such as SCADA.

GridOS integrates with load and generation forecast providers or generates those forecasts internally daily, providing those forecasts to other components in the solution. These forecasts are required to optimize dispatch schedules for future hours.



*Figure 3: GridOS Product Architecture*

### 2.1.3 Orchestrator

The Orchestrator coordinates back end actions between GridOS, Kiwi Core and the Market Adaptor. The Orchestrator holds the logic of the product solution. Architecturally, the Orchestrator contains market driven timing and state components that are used to make decisions throughout the lifecycle of the solution.

The Orchestrator requests optimizations from GridOS and forwards optimization results to Kiwi Core for display to the user and for dispatch to assets.

On a technical level, the Orchestrator will make requests to the APIs exposed by GridOS and Kiwi Core.

The Orchestrator also sends requests to the Bulk Market Adapter to post commitments and receive bulk requests from the bulk market.

#### Future work

For the initial deployment, local flexibility is prioritized when a bulk market request is not available or cannot be fulfilled. To fully optimize DER dispatch between local flexibility and bulk market participation, local flexibility value will need to be quantified; this will enable an apples-to-apples comparison between bulk market and local flexibility requests. This is out of scope of this document and the initial deployment but highlights future scope for the Orchestrator, to be updated in future iterations of the product solution.

Once a valuation approach for local flexibility has been selected, a possible role for the Orchestrator is to fetch local flexibility valuation and send it to GridOS for optimization, then post local flexibility commitments once an optimal bid has been computed.

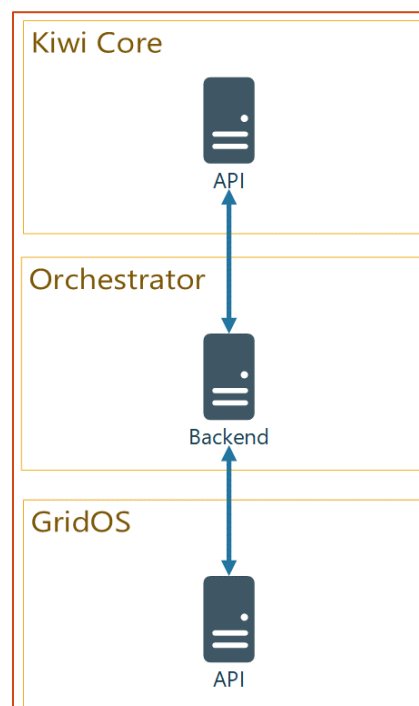


Figure 4: Orchestrator (project specific) Architecture

## 2.1.4 Bulk Market Adapter

The Bulk Market Adapter provides an abstraction over the bulk market, allowing the rest of the product solution to interact with the bulk market using a consistent interface.

At a high level, this component will allow the product solution to retrieve requests from the bulk market and to post commitments to the bulk market.

Each deployment of the solution will require a Bulk Market Adapter. Due to the differences in bulk markets in different regions, this adapter may need significant updates for each new deployment or to be fully built tailored to that deployment. In most situations, a system integrator will handle development of this adapter, conforming to the interface expected by the rest of the solution.

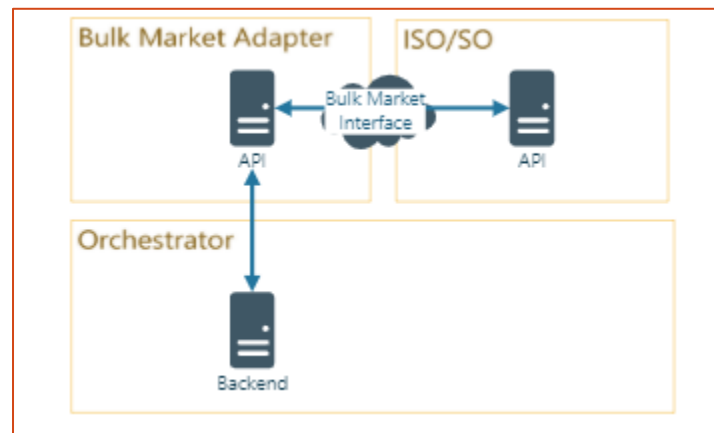


Figure 5: Bulk Market Adapter Product Architecture

## 2.1.5 LDC Adapter

The LDC Adapter is the local flexibility counterpart to the Bulk Market Adapter. In future iterations of the product solution, the LDC Adapter will be used as a source of local flexibility requests.

### NOTE

For the initial deployment, an LDC Adapter will not be deployed. Instead, a logical flowchart is used to choose between bulk market participation and local flexibility. This simplifies the overall project architecture and puts the focus on proving the primary value propositions; those propositions are:

- Optimally dispatch DERs for participation in a bulk market while also serving local grid needs without affecting grid reliability
- Give LDC visibility over participating assets

## 2.2 Product Solution Data Flow Diagrams

Detailed interactions between the components are shown below. Each diagram illustrates the component communications that occur in a single process. These diagrams are read sequentially from top to bottom, with each arrow representing a “request” or “message”; arrows above occur before the arrows below them in the process.

These diagrams are primarily geared towards a technical audience, especially software developers, to assist in software development activities. They are included in this document to provide insight into the detailed design of the product solution.

Each diagram below is named after the process that it illustrates, with a simple code-name paired with each detailed name. These processes are linked to specific sections in the logical flow in the **Project Solution Process** Diagrams section of this document.

For example, see **Figure 6 Demand Response Bid Update (dr-bid-update)**. The name of this process is “dr-bid-update” and “Demand Response Bid Update” is the description. The term “dr-bid-update” is used in the **Project Solution Process** Diagrams section of this document.

Some diagrams include components that are specific to the initial deployment; these elements will be noted for each diagram, where appropriate.

## 2.2.1 Demand Response Bid Update

This flow is entered when a bulk market bid needs be computed. This process is initiated by the Orchestrator. GridOS then computes an optimal bid. The Orchestrator then updates the bulk market with the new bid and sends the updated value to Kiwi Core for display to the user.

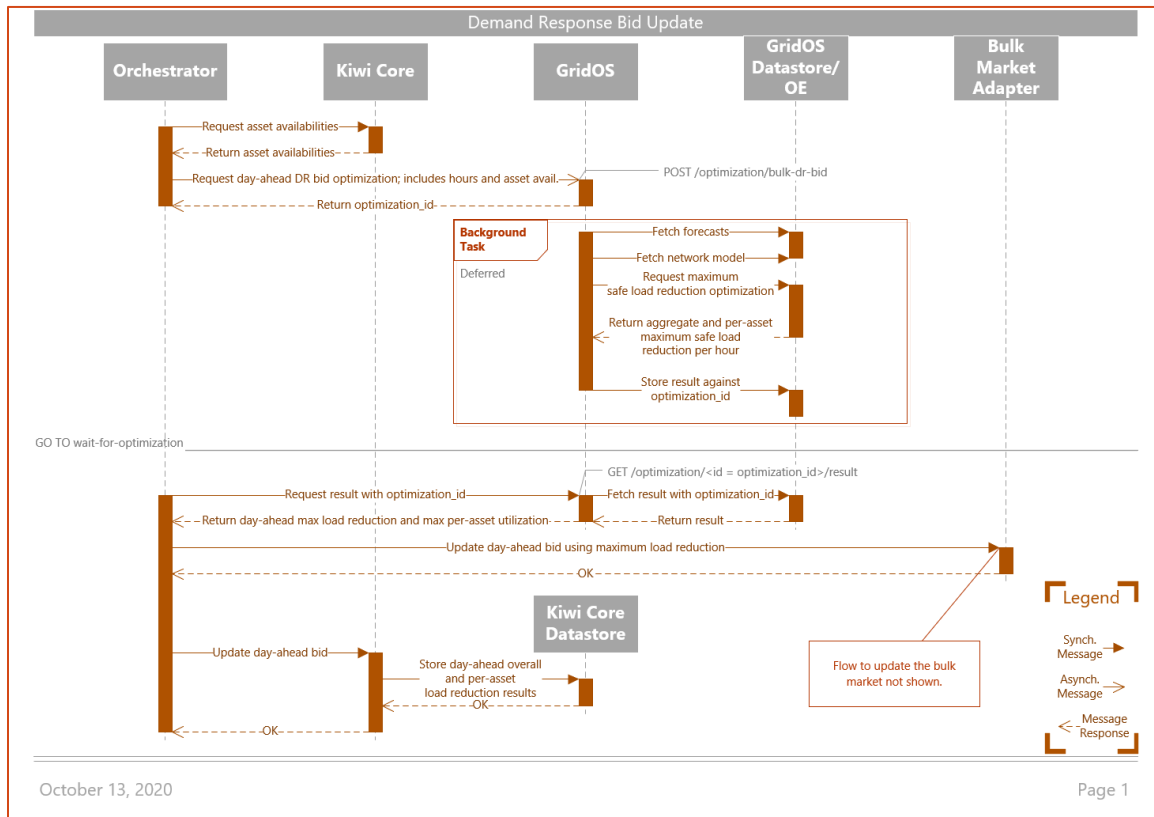


Figure 6 Demand Response Bid Update (dr-bid-update)

## 2.2.2 Demand Response Bid Update Error

This flow is entered if an error is encountered during computation of the bulk market bid. The Orchestrator updates the bulk market to set the bid to 0W, then notify Kiwi Core that this has occurred.

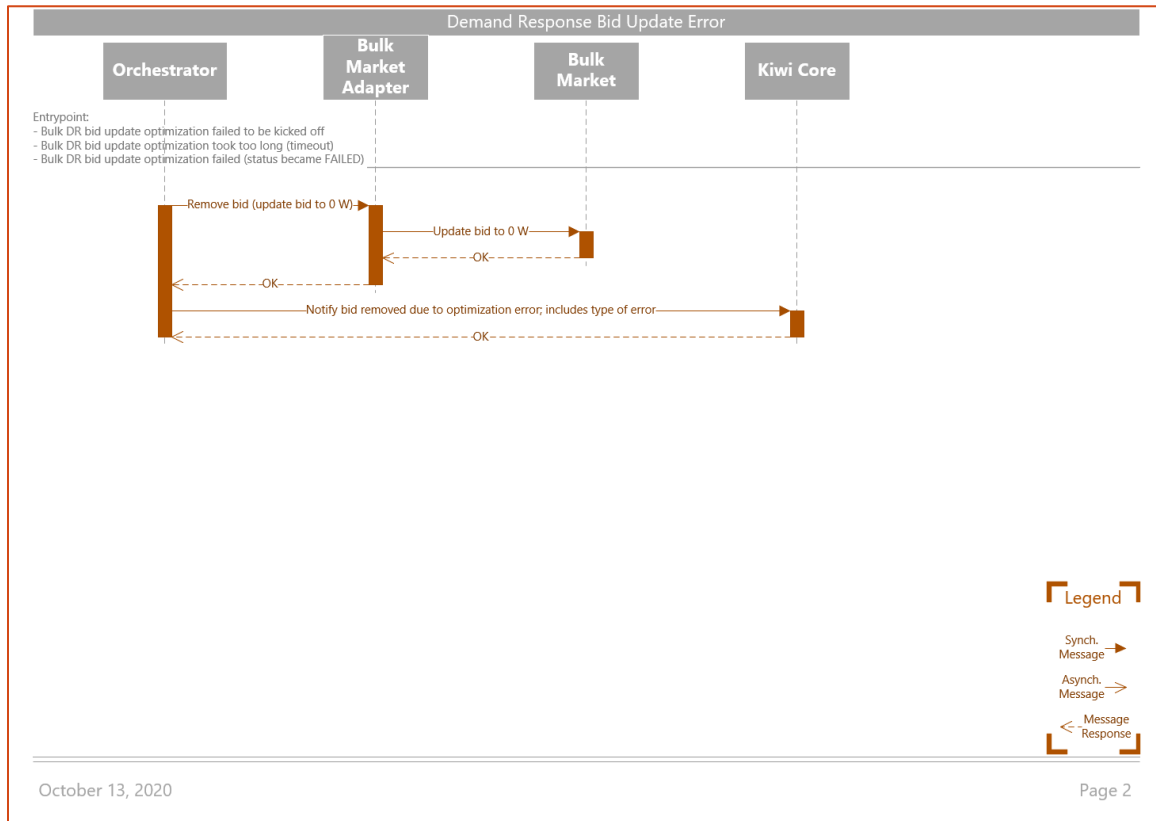


Figure 7 Demand Response Bid Update Error (dr-bid-update-error)

## 2.2.3 Demand Response Activation

This flow is entered when a request for activation is received through the bulk market adapter. The Orchestrator requests that GridOS compute an optimal dispatch schedule for all DERs, in accordance with the received activation parameters. Once GridOS computes the dispatch schedules, the Orchestrator sends them to Kiwi Core for dispatch and for display to the user.

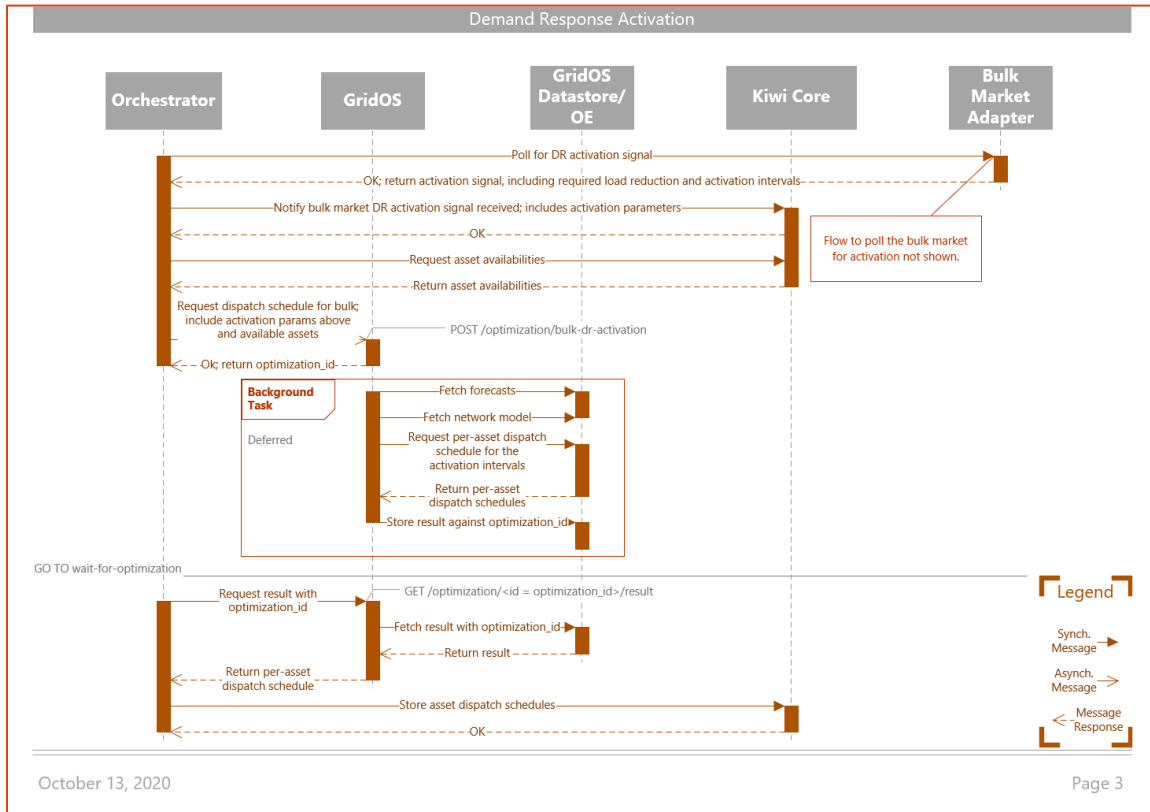


Figure 8 Demand Response Activation (dr-activation)



## 2.2.4 Demand Response Activation Error

This flow is entered if an error is encountered during computation of dispatch schedules when responding to a bulk market activation request. Due to the short timeframe, the goal of this flow is to alert the Operator, who will then follow the steps for “Inability to respond to request” manual process.

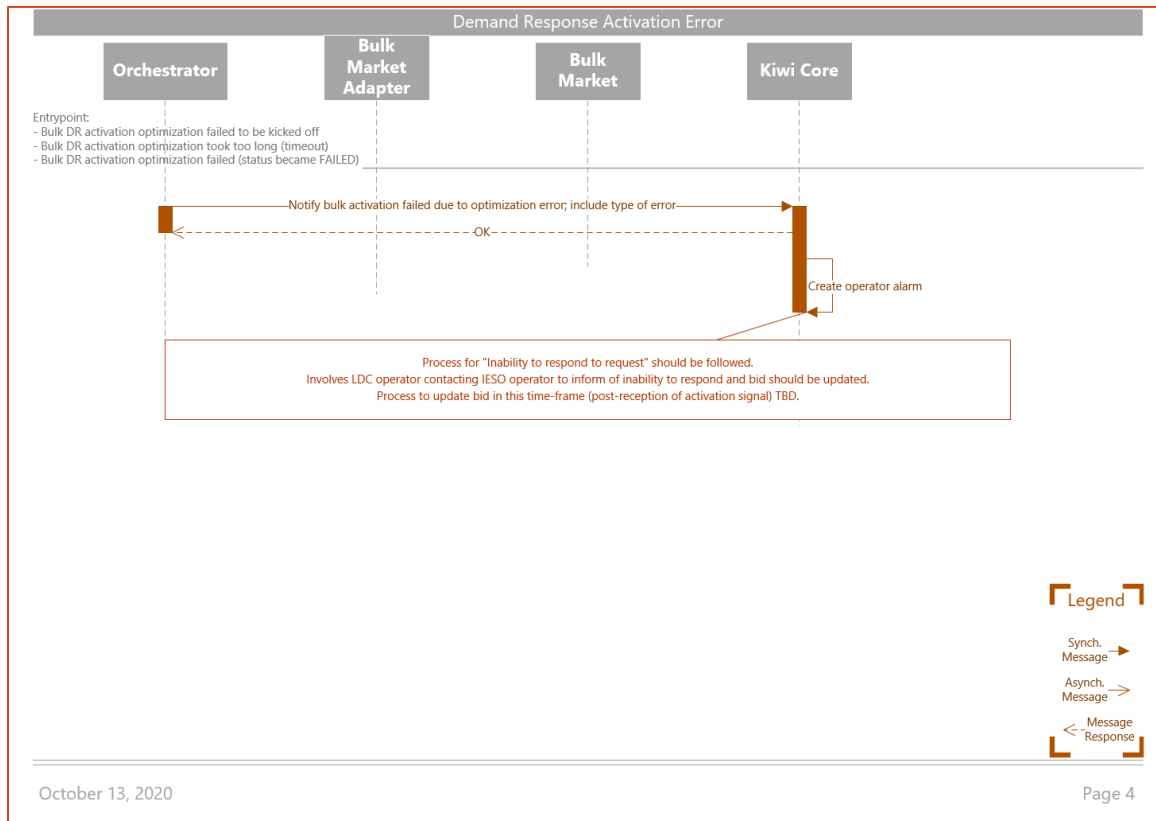


Figure 9 Demand Response Activation Error (dr-activation-error)

## 2.2.5 Local Activation

This flow is entered when a local flexibility request is received. This flow is the local flexibility counterpart to the **Demand Response Activation** flow. In this flow, the LDC Adapter is the local flexibility counterpart to the “Bulk Market Adapter”.

### NOTE

This flow is not applicable to the initial deployment since the initial deployment does not employ an LDC Adapter. In the initial deployment, a logical flow is used to select local flexibility when bulk activation is not received. See **Project Solution Process** Diagrams for more information.

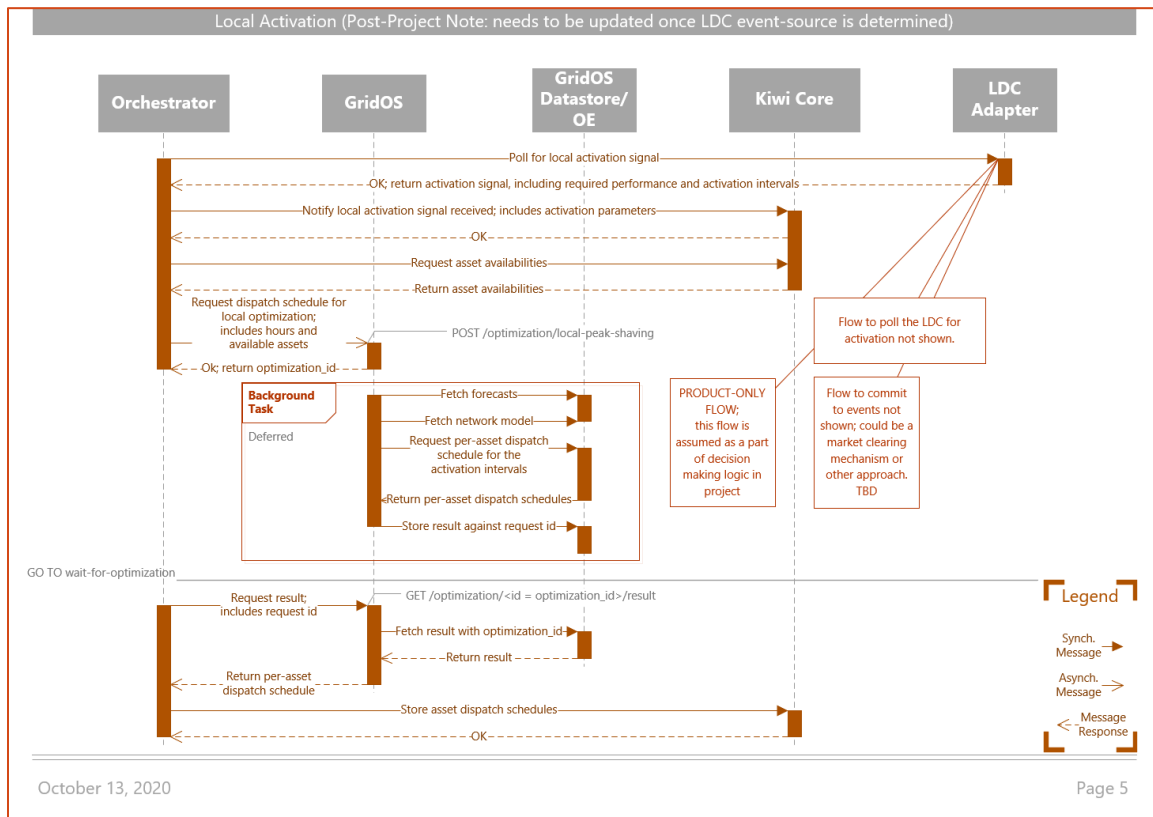


Figure 10 Local Activation (local-activation)

## 2.2.6 Local Activation Error

This flow is entered if an error is encountered during computation of dispatch schedules when responding to a local flexibility activation request.

### NOTE

This flow will be updated once a valuation approach for local flexibility has been selected in future iterations of the product solution; this is out of scope of this document.

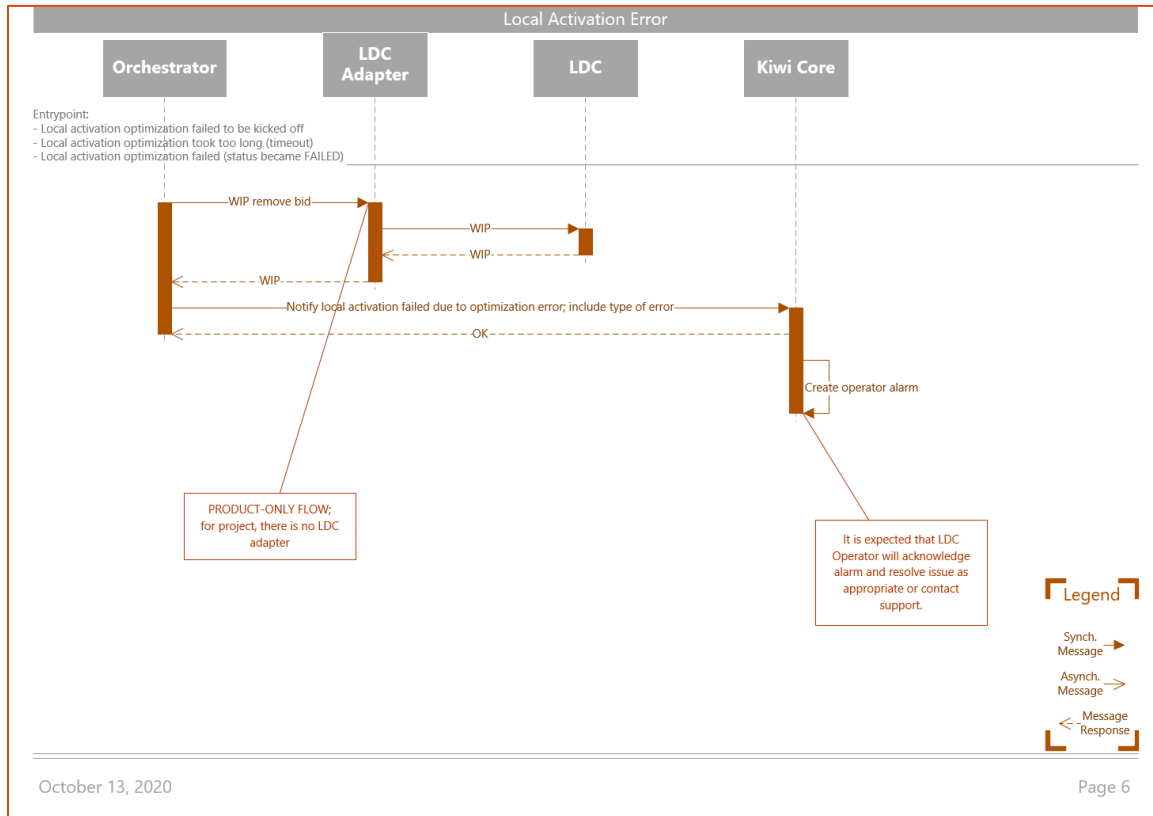


Figure 11 Local Activation Error (local-activation-error)

## 2.2.7 Wait for Optimization

This flow is entered when GridOS begins an optimization. The Orchestrator polls GridOS to check on the status of the optimization, exiting the flow when the optimization completes successfully, fails, or times out.

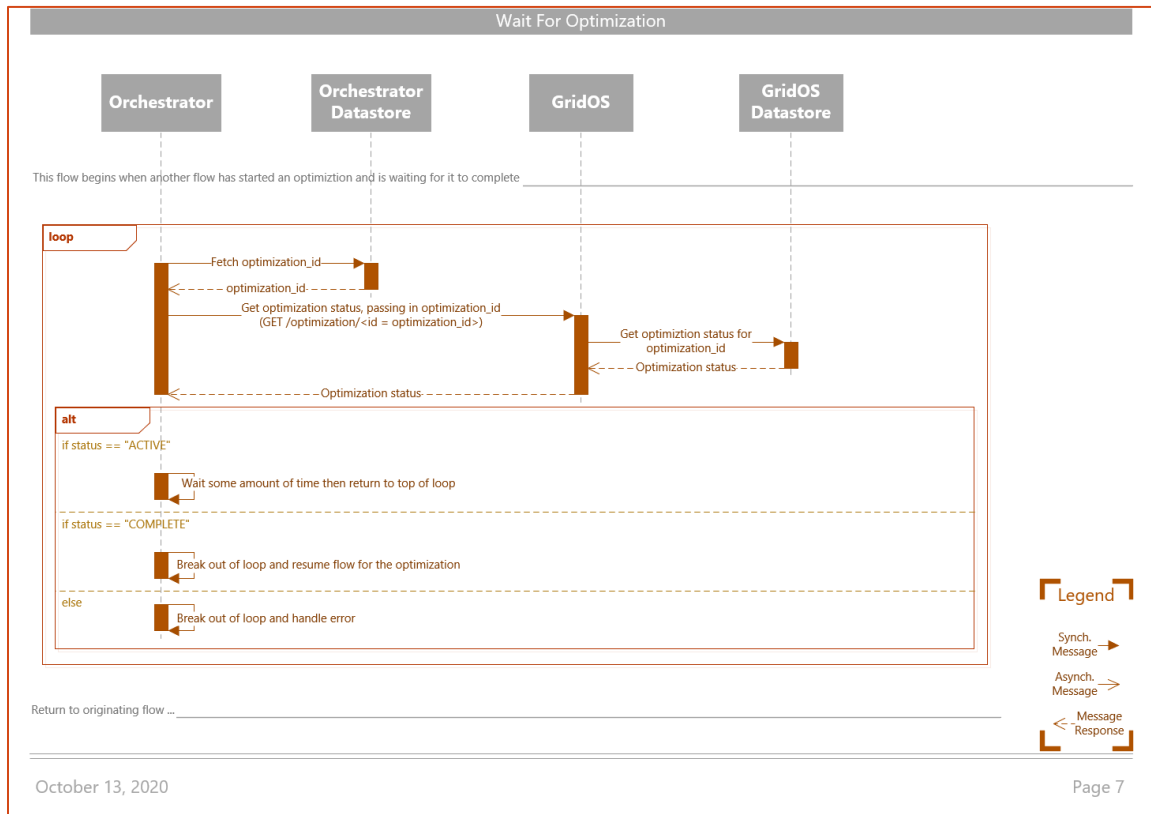


Figure 12 Wait for Optimization (wait-for-optimization)

## 2.2.8 Dispatch

This flow is entered when Kiwi Core dispatches DERs or fleet managers.

### NOTE 1

This flow is only illustrative and may not match the technical reality of the dispatch flow in Kiwi Core exactly.

### NOTE 2

In the initial deployment, GridOS will act as a fleet manager for the SPEEDIER DER group. GridOS only plays this role in the initial deployment; in future iterations of the product solution, GridOS will not act as a fleet manager.

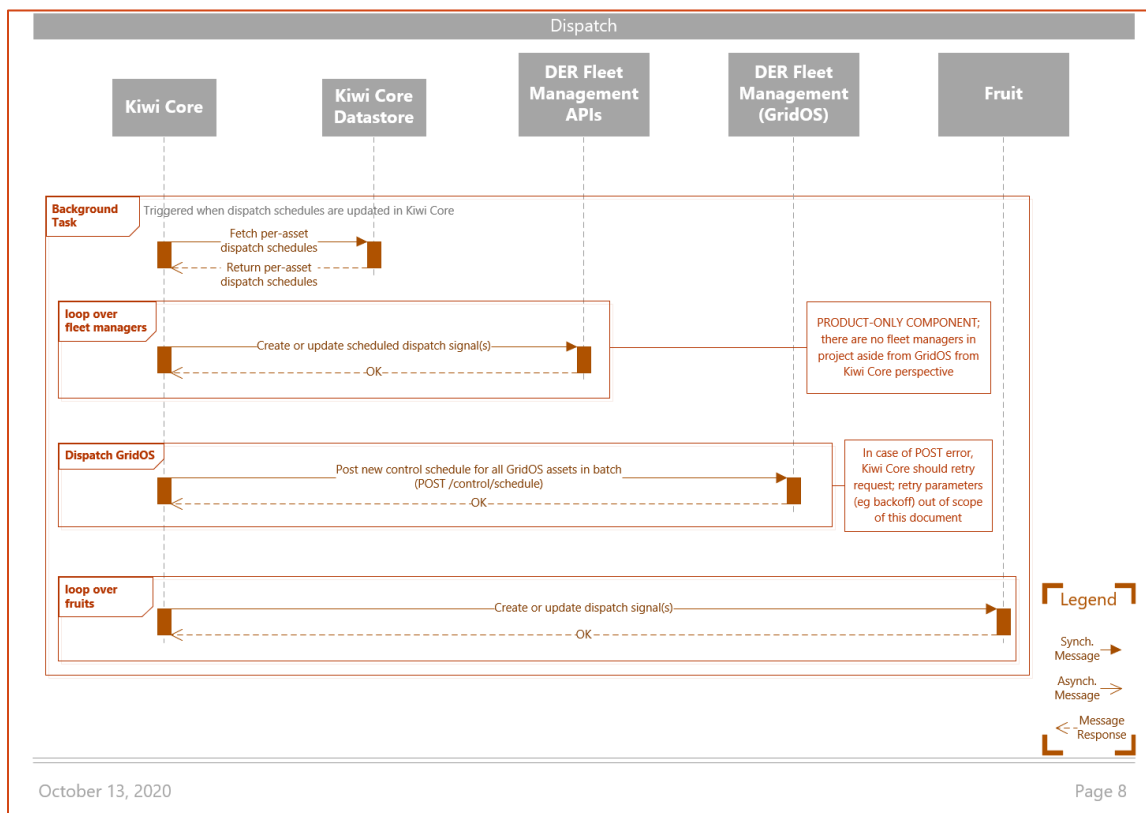


Figure 13 Dispatch (dispatch)

## 2.2.9 Measurements – GridOS

This flow is entered when GridOS collects measurements from the LDC.

### NOTE

For the initial deployment, GridOS will also collect measurements from the SPEEDIER DER group.

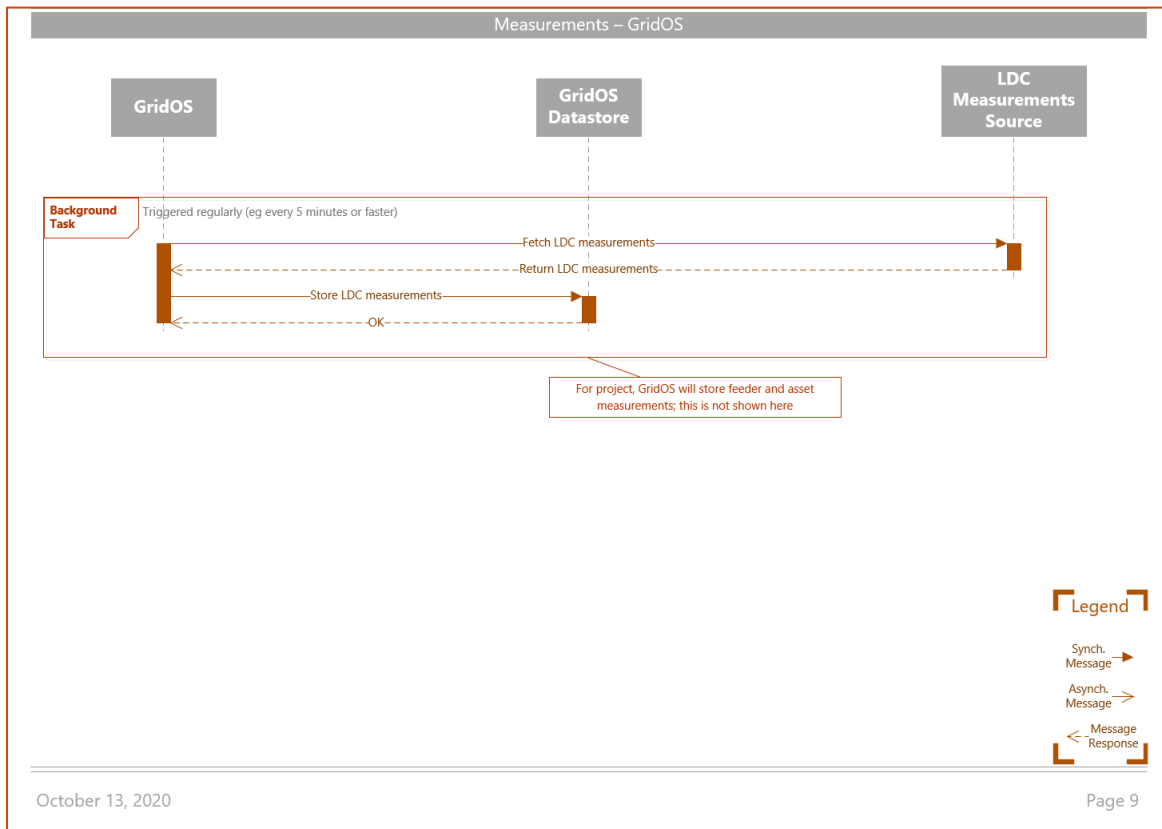


Figure 14 Measurements – GridOS (measurements-gridos)

## 2.2.10 Measurements – Kiwi Core

This flow is entered when measurements are collected and sent to Kiwi Core. The Orchestrator will collect measurements from fleet managers and post them to Kiwi Core. The Orchestrator will also collect LDC measurements from GridOS and post them to Kiwi Core. Kiwi Fruit devices will independently post their measurements to Kiwi Core.

### NOTE

In the initial deployment, the Orchestrator will also collect measurements for the SPEEDIER DER group from GridOS and post them to Kiwi Core.

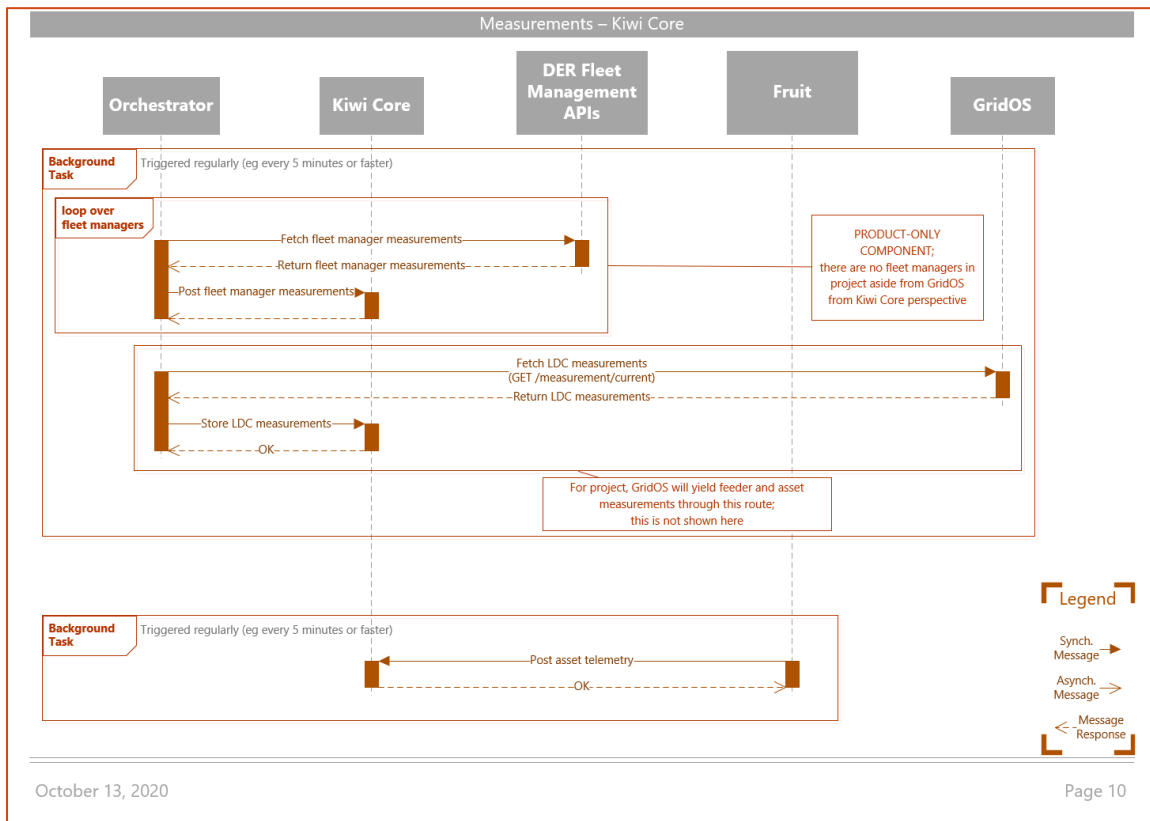


Figure 15 Measurements – Kiwi Core (measurements-kiwi-core)

## 2.2.11 Measurements Submission

This flow is entered when measurement data needs to be submitted to the bulk market for performance reporting and baselining purposes. Due to the bespoke nature of the report format and submission interfaces required by each bulk market, this flow will be revisited for each deployment of the product solution.

### NOTE

In the initial deployment, this flow will be done semi-manually; data will be made available to the user via the Kiwi Core interface for download and manual submission via the bulk market user interface.

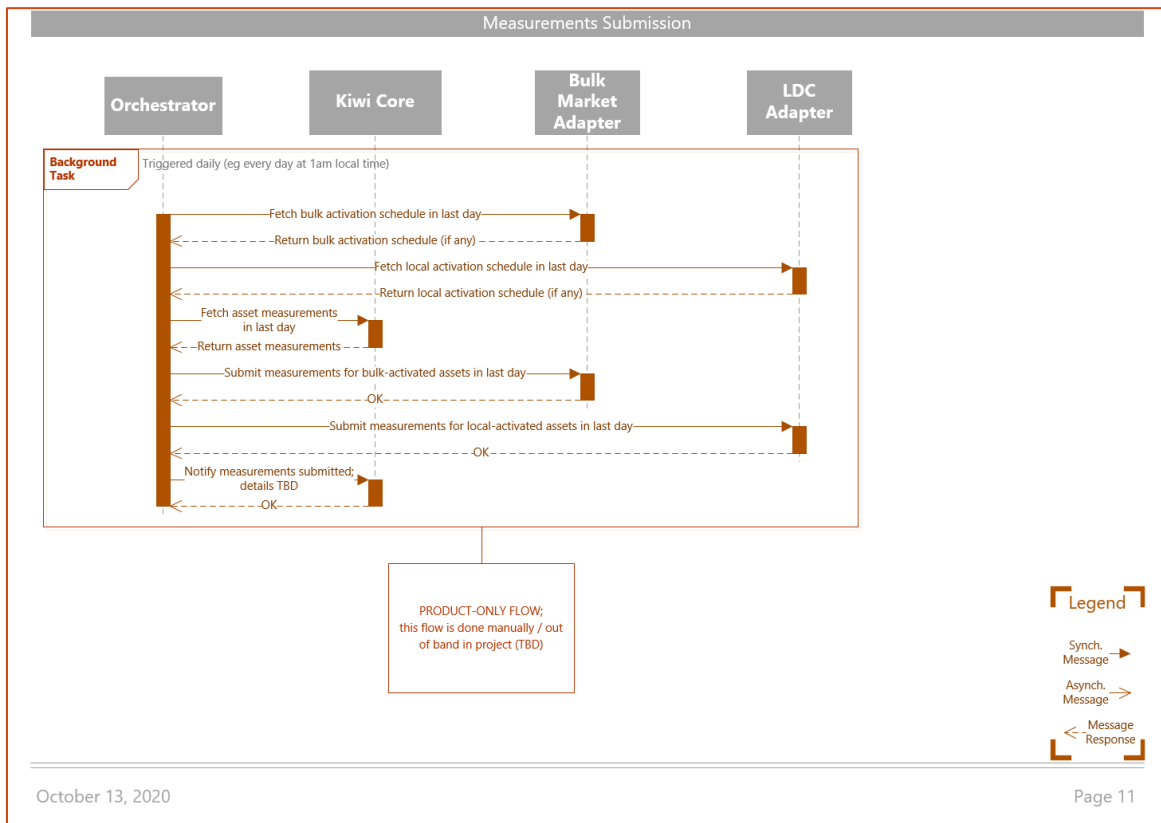


Figure 16 Measurements Submission (measurements-submission)



## 2.2.12 Forecasting – GridOS

This flow is entered when GridOS generates a forecast.

### NOTE 1

GridOS may either generate a forecast internally or collect a forecast from a generator component that is deployed with the solution.

### NOTE 2

For the initial deployment, GridOS will generate forecasts internally.

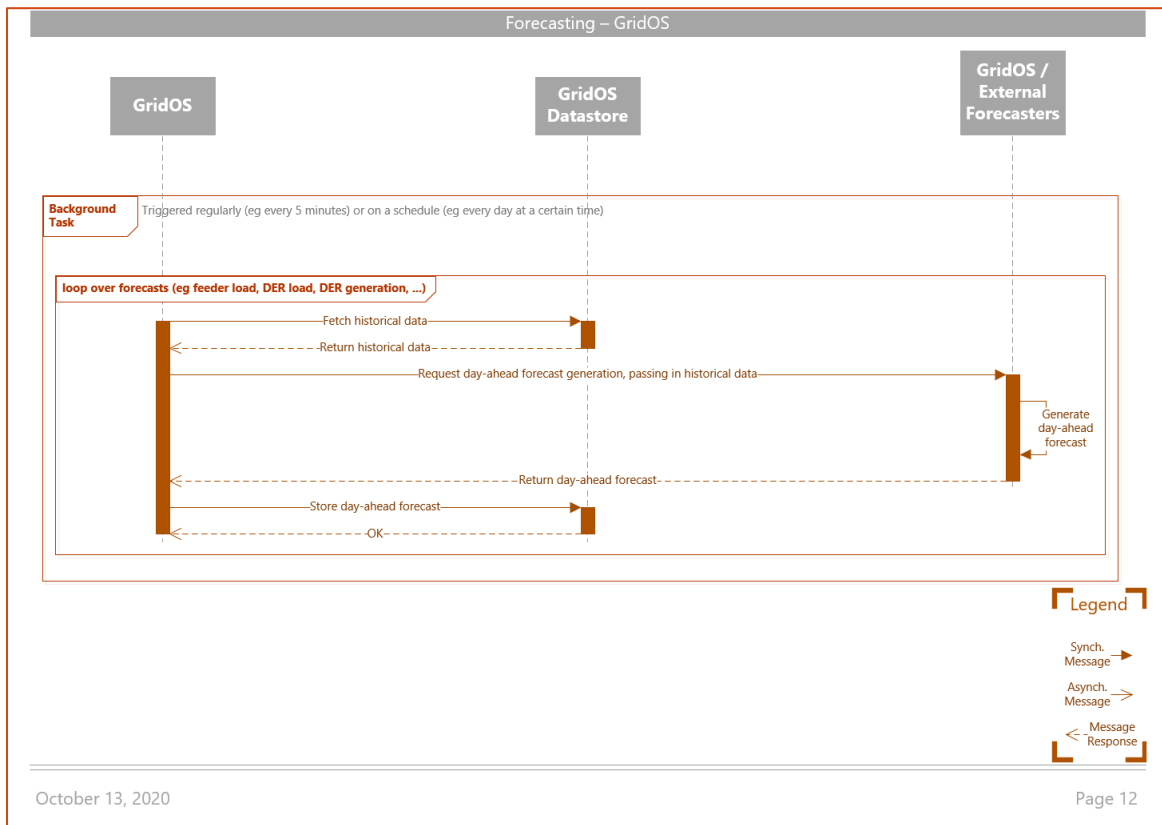


Figure 17 Forecasting – GridOS (forecasting-gridos)

## 2.2.13 Forecasting – Kiwi Core

This flow is entered when forecasts are collected from GridOS and sent to Kiwi Core. The Orchestrator is responsible for ferrying the data from GridOS and to Kiwi Core.

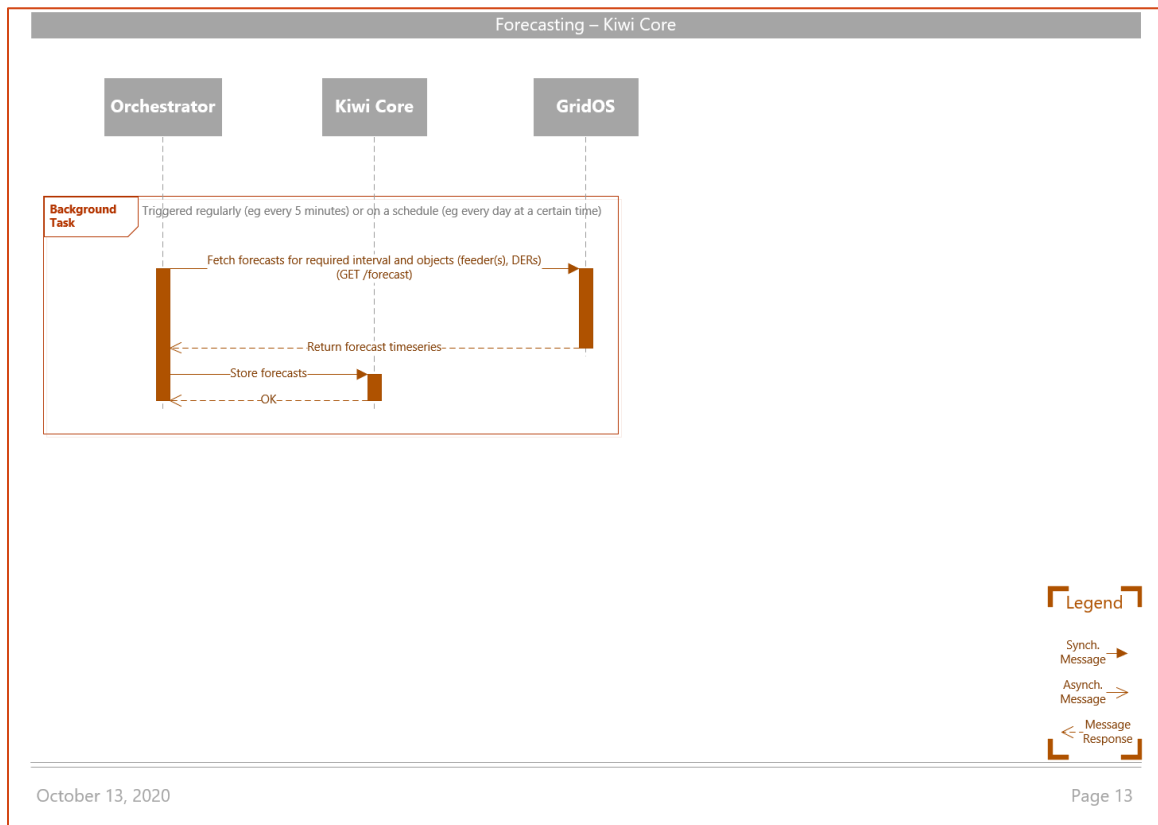


Figure 18 Forecasting – Kiwi Core (forecasting-kiwi-core)

### 3 Project Solution

This project deploys the product solution for Bracebridge Generation in the Town of Parry Sound, on Lakeland Power Distribution's Network. Assets are connected to Lakeland Power's Network under agreement to support Bracebridge in participating in the IESO Capacity Auction (IESO CA) market, which serves as the bulk market, while enabling feeder-head peak shaving, which serves as the local flexibility service. In this deployment, the primary user is an operator at Bracebridge Generation. Operators at Lakeland Power and asset owners at the Town of Parry Sound will also be provided access to the solution deployment. This project will build on the joint product solution to contextualize the offering to support a specific deployment.

This section will identify how the product solution described in section 2 will be borrowed and deployed for this project, with a specific focus on:

- Architecture
- Business rules
- Process and data flows
- Networking

#### 3.1 Project Solution Architecture Diagram

The project solution architecture diagrams are adapted from the product solution architecture diagrams presented in section 2.1 **Product Solution Architecture Diagram**. These describe the configuration of the joint solution deployment and how the software systems and components involved will communicate with one another. Key differences between the product and project architecture are:

- The ISO to be engaged as a part of the project is identified as the IESO. Data from the IESO is accessed through their market participant API.
- The LDC is identified as Bracebridge Generation, under agreement with Lakeland Power Distribution. Bracebridge Generation and the Town of Parry Sound are the asset owners.
- An LDC adapter is not deployed for this project. Instead, a logical flowchart is used to choose between bulk market participation and local flexibility. Refer to section 2.1.5 **LDC Adapter** for more information.
- The SPEEDIER DER group, deployed as a part of another initiative at Bracebridge Generation, is utilized. This includes a combination of both fleet managers and directly controlled assets, all of which are housed within a deployment of GridOS at Bracebridge Generation for this project. The full list of participating assets is included in section 3.2.3 **Distribution Network Configuration & Asset Participation**. This serves in place of an integration between Kiwi Core and DER fleet managers.
- GridOS network model and forecast integration interfaces are not deployed for this project. The network model and feeder forecast have been built and generated for the project; they are stored within GridOS' database as a one-time process.

Figure 19 below presents the overall project solution architecture. Figure 20 and Figure 21 segment this to present the project solution architectures for Kiwi Core and GridOS respectively.

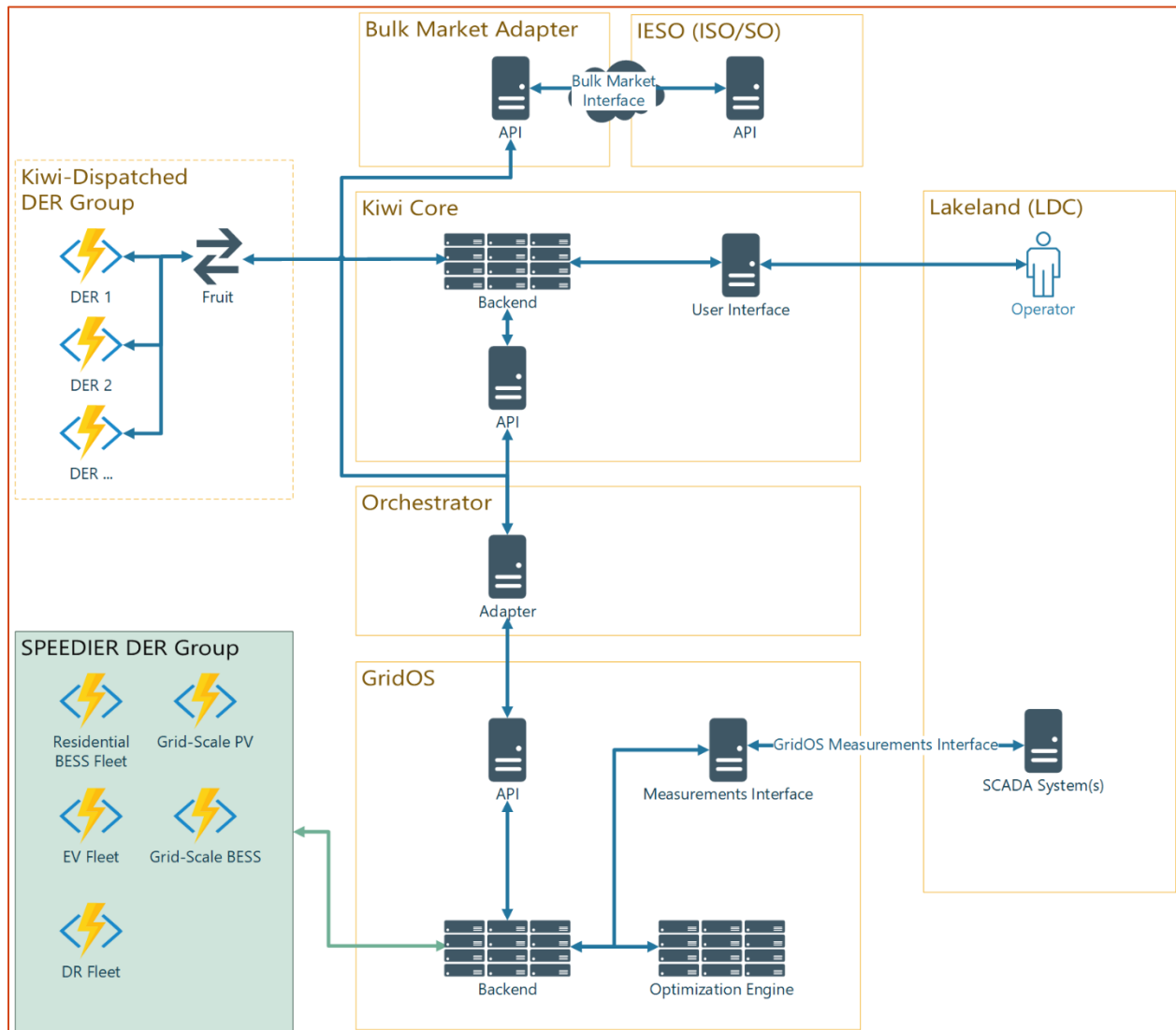


Figure 19: Overall Project Solution Architecture for Deployment at Bracebridge Generation

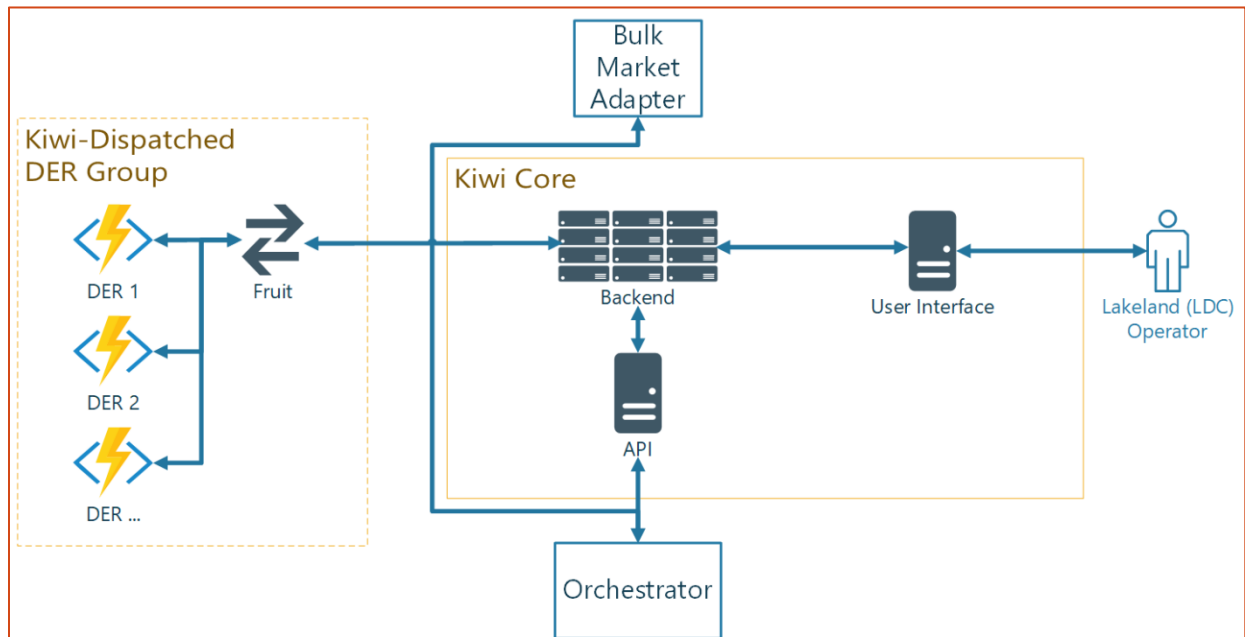


Figure 20: Kiwi Core Project Solution Architecture for Deployment at Bracebridge Generation

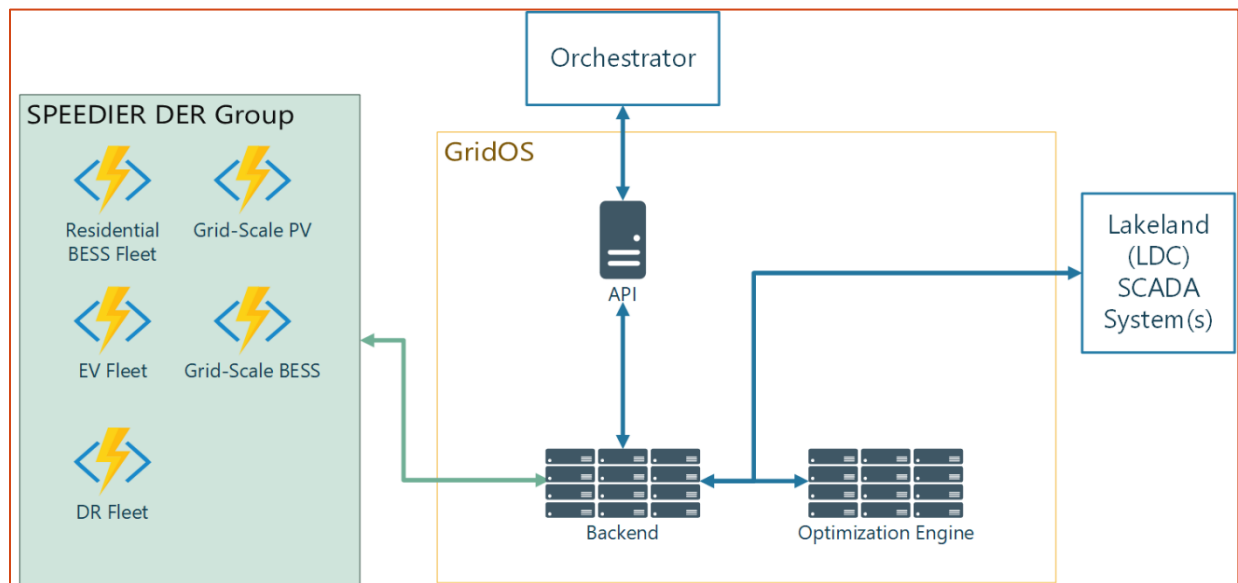


Figure 21: GridOS Project Solution Architecture for Deployment at Bracebridge Generation

## 3.2 Project Business Rules

This section describes the business rules designed for this deployment, which is contextualized to the IESO CA and Bracebridge's system. While the rules of the IESO CA Market are described in the 1.1 Product Adaptation Report, business rules presented here describe the project team's decisions around market participation and how Bracebridge's operator would interact with the joint solution. Business rules outlined are specific to this deployment. These are motivated by a combination of:

1. Bracebridge's business as usual operations
2. Bulk market (IESO CA) rules, and
3. Bracebridge's network and infrastructure

In a future enhancement of the joint solution, or for another deployment, some of these business rules may be accounted for as a part of the deployment.

The joint solution will be deployed on a single distribution feeder within Bracebridge's jurisdiction, the MS3 feeder. This decision was made for the following reasons:

- The feeder has been recently upgraded and reconfigured to allow for the connection of several DERs.
- A microgrid is being designed and built as a part of the feeder and so DER management and control is being deployed on the feeder as a part of another innovation project. This microgrid will not be operational during the DEMOCRASI project but the DER management and control will be functional and utilized. In this way, the microgrid does not impact the DEMOCRASI project.
- The feeder topology and configuration are available in CIM compliant network model format. This is necessary to allow for powerflow based optimization as a part of the joint solution.

### 3.2.1 Bulk Market Participation

Bracebridge Generation must first clear the auction to receive an obligation capacity that enrolls Bracebridge as a market participant. This project simulates Bracebridge participating as a single Commercial & Industrial (C&I) Hourly Demand Response (HDR) resource, as described in the 1.1 Market Adaptation Report.

**Figure 22**, borrowed from the 1.1 Market Adaptation Report, summarizes the IESO CA timeline from a market participant perspective. Business rules for the bulk market participation outline how the project will simulate each of timeline pieces identified.

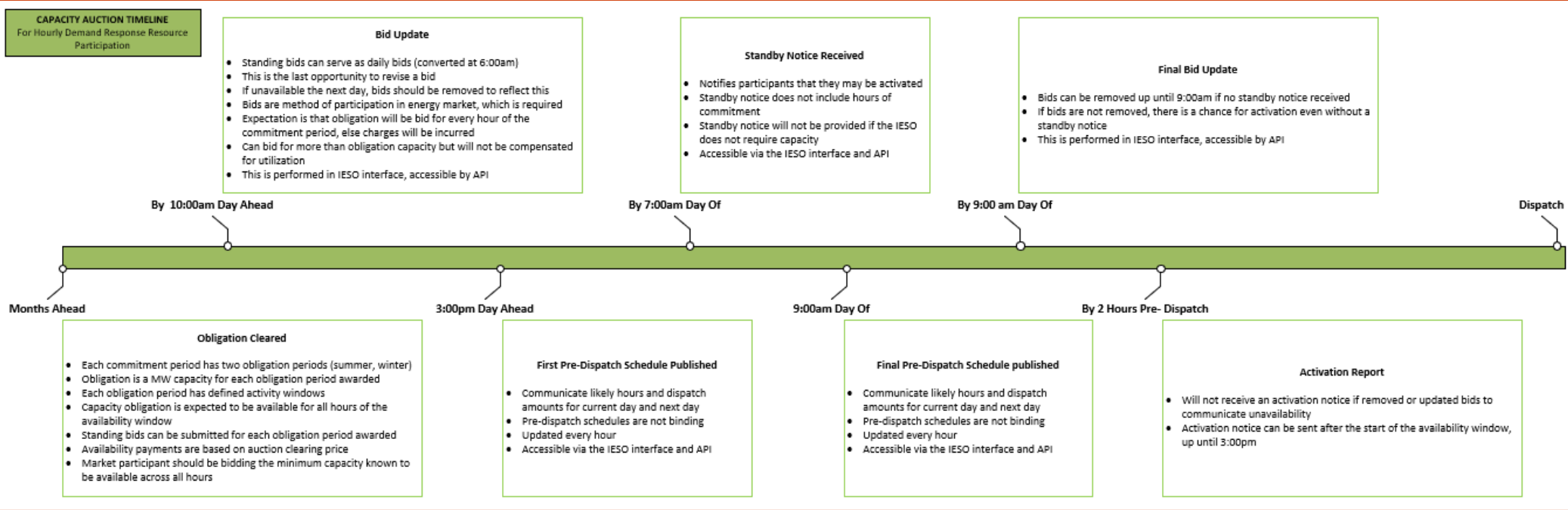


Figure 22: IESO Capacity Auction Timeline Borrowed from 1.1 Market Adaptation Report

### 3.2.1.1 Obligation Cleared

The IESO CA auction phase includes registering and bidding to clear a market obligation. As described in the 1.1. Market Adaptation Report, the capacity obligation indicates the capacity for which the market participant has been enrolled into the market and indicated availability to the IESO CA. At present, Bracebridge does not have a cleared obligation. The next auction period is scheduled for December 2020. This project deployment will simulate Bracebridge's participation in the bulk market and optimization to service local distribution service requests. This will position Bracebridge well to bid in December if the business sees fit and begin participation in the market as early as possible. The project deployment does not include a simulation of the auction clearance process as this occurs once, well in advance of market operational timelines. Instead, a capacity obligation is assumed for the project to simulate Bracebridge having cleared the auction.

The minimum capacity obligation for this project is scaled down to 500kW from 1MW for the purposes of this project. This decision was made to allow the solution to be deployed on the MS3 feeder which does not often experience a load of 1MW. This is in part due to a large generator located on the same feeder, the Cascade Street Generating Station (Cascade), a hydroelectric generation plant. An analysis of the feeder loading, as experienced on the transmission interconnection point of the feeder, concluded that the loading is consistently above 500kW but below 1MW. The minimum capacity allowed to bid for the IESO capacity auction is 1MW. The IESO CA does not allow HDR assets to provide energy services greater than their loading, which would result in reverse powerflow. The reduction of the capacity obligation allows the project to simulate market participation exactly as it would be following market clearance.

When bidding in IESO CA, Bracebridge would need to submit a bid of at least 1MW in capacity size and may meet this capacity by reconfiguring the MS3 feeder to include more loads and resources from another feeder and so reflect a loading of at least 1MW at all times. Additionally, beyond the scope of this project deployment, Bracebridge would need to determine bid pricing for the IESO CA. This would be a business exercise completed at Bracebridge that ensures any asset and operational costs are captured and are accounted for in a bid price submitted to the IESO. As described in the 1.1 Market Adaptation Report, C&I HDR assets are only compensated for availability and do not receive utilization costs for being dispatched as a part of their market participation.

Following, the IESO CA requires that three months of historical load data is provided in advance of market participation. This data serves as the baseline data against which load following activated dispatch is compared. This is intended to be meter data from the meter point at which the load is being reduced. While this data exists, the submission of the historical loading will not be included as a part of the project.

For the purposes of this deployment, asset owners of DER participating in the simulated bulk market requests will not be directly compensated since Bracebridge will not be directly participating and will also not be compensated. Following the deployment, Bracebridge will explore how agreements in place with asset owners will be impacted by aggregated participation in the IESO CA through business and contractual structures. This would need to address DER owner compensation for contribution to bulk requests, local requests or both, as well as the pass-on of any penalties and charges incurred from the IESO CA. This project will serve as a testing ground for the setup of a future local services flexibility market in which distribution-connected assets can be utilized to service Bracebridge's needs.



### 3.2.1.2 Bid Update

Bracebridge, as an IESO CA market participant, is required to submit a day-ahead bid into the energy market to confirm asset capacity commitment. The day-ahead bid submission includes capacity, ramp-rate, and price information. The day-ahead capacity bid is expected to be at least equivalent to the capacity obligation cleared in the market. For this project, the capacity submission will be optimized to ensure safe dispatch.

Market participants can submit a standing bid into the market that would get converted to a day-ahead bid around 6:00am. To demonstrate the full functionality of the joint product solution, a standing bid will not be modeled in this project. Instead, a day-ahead bid will be submitted each day before 10:00am, as required by market timelines. This allows for the project deployment to be as flexible as possible, built to allow bids to be updated as frequently as necessary; each day if required.

Market participants can submit day-ahead bids that exceed capacity obligation but are not compensated for this since C&I HDR resources are only paid for availability and not utilization. For this reason, this project will always simulate submission of a day-ahead bid quantity equivalent to the capacity obligation even if the optimization reports that a capacity greater than the capacity obligation can be delivered. The optimization outputs indicating this availability are outlined in section [3.3 Project Solution Process Diagrams](#).

For HDR resources, ramp up and ramp down values for each HDR resource must be equal to the capacity of the HDR resource. Though these are submitted, HDR resources are expected to be ramped up by the dispatch hour requested. Since HDR assets are notified of activation with ample time to ramp up, these are not accounted for in the optimization. Since the submission of ramp rates is a requirement from the IESO, the project team plans to simulate submission of a static ramp-rate value along with each day-ahead bid update.

Following submission of day-ahead bids, the IESO generates pre-dispatch and dispatch schedules based on an optimization that minimizes cost to the IESO while ensuring all system needs are met. Since C&I HDR resources are not compensated for utilization, these costs are not accounted for in the solution optimization. Instead, the project team will work to determine realistic bid prices that can be simulated in day-ahead bid update.

### 3.2.1.3 Pre-Dispatch Schedule

Pre-dispatch schedules communicate likely or probable dispatch of assets one day-ahead. They are the result of IESO's Day-Ahead Commitment Process (DACP). These will not be captured as a part of the project and will not be utilized in any optimization processes since these dispatch schedules are non-binding. This is because the project solution will prioritize responses to bulk market participation and so will not reallocate DER to local service requests until it is confirmed that no bulk market response will be activated. In a future deployment, if Bracebridge has a greater variety of assets that can be aggregated for bulk market responses, these pre-dispatch schedules can be used to plan asset dispatch further in advance and potentially re-allocate assets to local service requests earlier.

### 3.2.1.4 Standby Notice

Standby notices are received by 7:00am and indicate that a HDR resource may be dispatched during the activation window. These are simulated and captured for this project and serve as a key trigger to the

solution process. Since this deployment prioritizes response to bulk market services, receipt of a standby notice will ensure that all assets are maintained as available to respond to any future activation. The project solution processes flows are detailed in section 3.3 Project Solution Process Diagrams.

#### 3.2.1.5 Activation Report Notice

Activation report notices indicate requested dispatch of a market participant in the IESO CA. They indicate the capacity and times for which an asset is expected to dispatch; IESO CA participants are expected to be able to service their obligation capacity for a period of up to four consecutive hours. These are simulated and captured from this project and are translated into per-asset dispatch schedules that are used to control DER on Bracebridge's network.

#### 3.2.1.6 Measurement Data Submission

The IESO mandates that revenue-grade, Measurement Canada approved LDC or IESO meters be located at contributing DER. This is to measure asset performance during the activation periods of those assets. This data is also used by the IESO to update asset baselines.

For the purposes of this project, this meter will be the Capacity Auction C&I Meter visualized in Figure 23. A physical meter will not be located at this point for this project. As mentioned, to participate in the IESO CA market following the upcoming auction phase, Bracebridge may need to reconfigure its network to add greater load capacity reduction. Given we will be simulating participation in the market, measurement data will not need to be submitted as a part of the project.

Additionally, the IESO requires that CA market participants submit measurement data for months in which the resource is activated. This data is an aggregate of load generated by each of the resource contributors. For the purposes of this project, these contributors are those listed in Table 1. The measurement & controls installed for this project mean that this data is in fact captured and will be used to confirm correct dispatch of assets. Additionally, the equivalent of the baseline loading is calculated as a part of the project based on the feeder-head forecasted load and the generation from Cascade. This information is used to optimize for load reduction as per the bulk market request. The data will not be submitted to the IESO as a part of the project.

#### 3.2.1.7 Outstanding Simulation Business Rules

In addition to the above business rules as they pertain to the IESO CA timeline, the project team will decide on the following prior to the simulation deployment:

- Which of the two obligation periods will be simulated: summer, winter, or both.
  - The summer obligation period provides more potential dispatch hours for market participation.
  - Bracebridge will be better positioned to bid into the auction if both commitment periods were simulated.
- The length of the simulation.
  - Additionally, there will need to be data gathered within the simulation time that represents a baseline dataset that can be used to assess the costs and benefits of the DEMOCRASI project as a part of a future milestone.

- IESO connectivity in the absence of access to the IESO's testing API environments.
- How many direct dispatches will be executed.
  - This corresponds to the number of times an activation notice report will be simulated. Each time an activation notice report is received, assets will be dispatched.
  - It is significant to note that in the IESO CA, participants are not dispatched frequently. There have been less than four activations in the past four years.
- The prices that will be simulated with the day-ahead bids, though not considered in the optimization.
- How publicly available datasets from the previous demand response market can be utilized to design a scenario that mimics previous CA operations.
- How load & generation forecasts for the feeder will be modified to simulate edge case scenarios for the project deployment to test the joint solution's full functionality. This is addressed partly in section [3.4 Project Simulation Scenarios](#).

### 3.2.2 Local Service Requests

This project will allow Bracebridge Generation to utilize network assets to respond to either a bulk market request or a local flexibility market request. At present, there is no local flexibility market at Bracebridge. The local service request selected for this project is feeder-head peak shaving and will be generated from GridOS optimization analyses. The joint product solution as presented in section 2 **Joint Product Solution** features an LDC adapter that would generate and communicate flexibility market requests. GridOS' optimization analyses will serve in place of an LDC adapter.

Feeder-head peak shaving is focused on decreasing peak power demand on a single distribution feeder across 24-hour time intervals.

Feeder-head peak shaving local service is selected for the following reasons:

- Peak demand often corresponds to overburdening of network assets such as transformers and lines. Decreasing peak demand enhances asset health and decreases the probability of asset failure. In the long term, this avoids distribution asset upgrade costs otherwise incurred by Bracebridge.
- Peak demand on Bracebridge's feeder often corresponds to system-level peaks in Ontario, which would price energy higher than non-peak times. Reducing power loading during system peaks would allow Bracebridge to purchase less energy, decreasing overall system costs.
- Bracebridge has already deployed distributed energy resource management solutions that can optimize and dispatch assets to shave distribution network peak as a part of another innovation project. These can be used as a foundation for this project.

For the purposes of this deployment, asset owners of DER participating in the local service market will not be directly compensated. Instead, this project will serve as a testing ground for the setup of a future local services flexibility market in which distribution-connected assets can be utilized to service Bracebridge's needs. Finally, as a part of the project, a voluntary demand response program is being set up with customers who have water heaters installed and are willing to have their water heaters controlled to service Bracebridge's grid.

### 3.2.3 Distribution Network Configuration & Asset Participation

The DER located on the MS3 feeder are:

- A grid-scale battery energy storage system (BESS) of rating 1,257 kW / 2514 kWh
- Fleet of residential BESS composed of ten (10) 5kW TESLA Powerwalls of aggregate rating 50 kW / 135 kWh
  - TESLA is the third-party fleet manager deployed
- Fleet of water heaters participating in a demand response program with aggregate rating 150kW
  - Packetized is the third-party fleet manager deployed
- Fleet of electric vehicle (EV) chargers: three (3) level 2 chargers and one (1) level 3 DC Fast Charger
  - SWTCH is the third-party fleet manager deployed
- A backup generator at the Town of Parry Sound's wastewater treatment facility of rating 938 kVA / 750 kW
  - The backup generator can only displace up to the load of the facility, which is likely less than the generator capacity at any given time
- A backup generator at the Town of Parry Sound's sewage pumping station of rating 438 kVA / 350 kW
  - The backup generator can only displace up to the load of the facility, which is likely less than the generator capacity at any given time
- Solar photovoltaic (PV) units of total rating 500kW alternating current
- Cascade hydroelectric generating station 3.2 MW

The project team has engaged the IESO and various departments at Bracebridge to decide what market participation would look like and where the C&I meter-point, for the purposes of IESO CA participation, would be located. It was decided that the C&I resource would be registered with the IESO as a meter point immediately downstream of Cascade. This is summarized and visualized in [Figure 23](#). This arrangement allows for:

- Cascade generation to be excluded from the IESO CA participant loading. This ensures that the loading is always above the 500kW capacity obligation used for this project. Else, the meter would experience reverse powerflow as the generation from Cascade often exceeds the downstream loading and this would prevent simulation of an IESO CA market participant.
- The grid-connected BESS to serve as a generator that offsets load experienced at the meter point by exporting power.
- The full mix of DER on the MS3 network to serve as contributing assets to the IESO CA bulk market as a single resource. This allows for the joint solution optimization to vary the assets dispatched to service bulk or local requests.

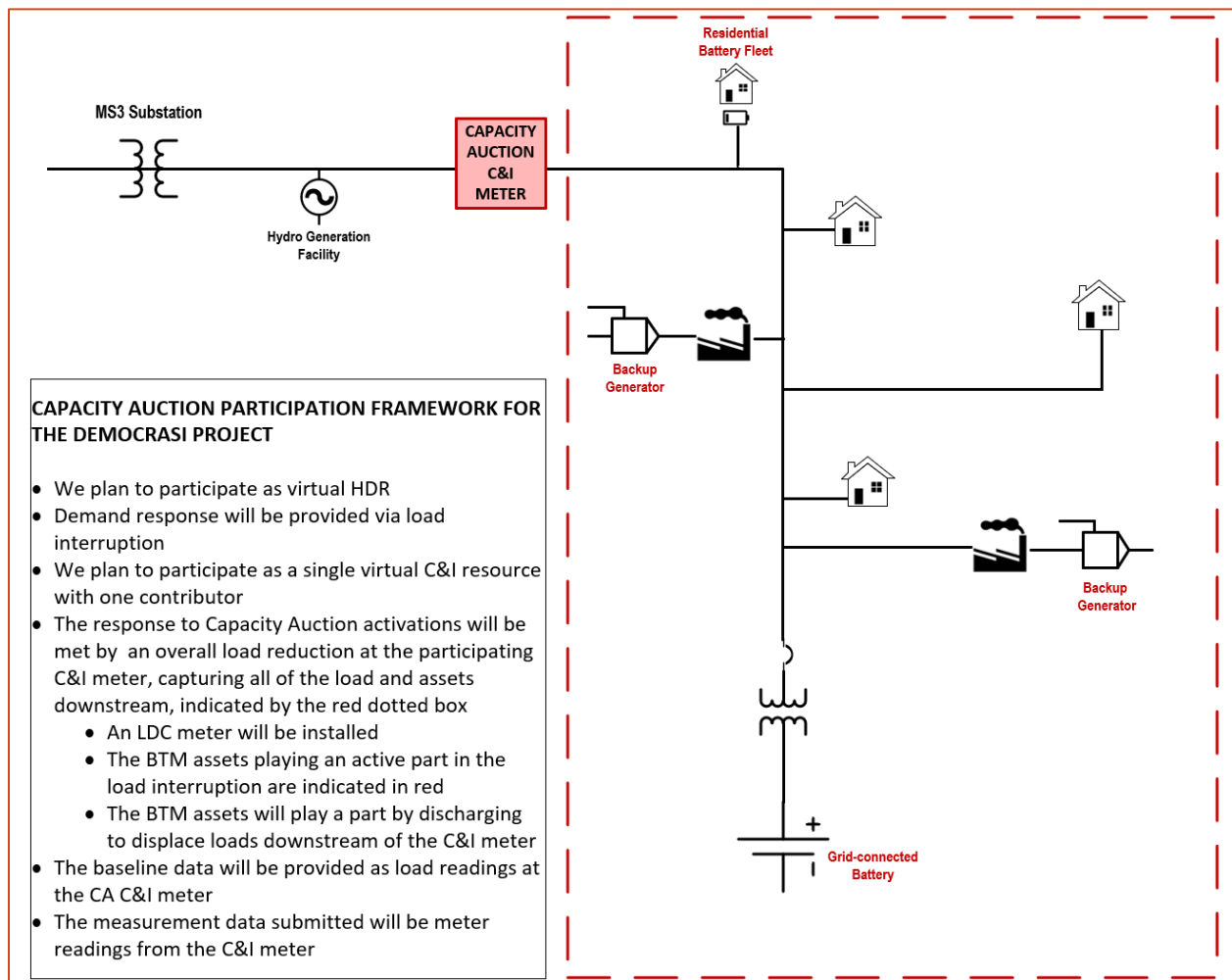


Figure 23: IESO CA Distribution Network Configuration & Asset Participation

The project team has engaged the IESO, asset owners and various departments at Bracebridge to decide which services (bulk market and local peak-shaving) each of the DER would be allowed to participate in and this is documented in [Table 1](#), with justification provided.

Table 1: DER Contribution to Bulk and Local Services

	Asset Owner	Able to contribute to IESO CA load reduction?	Able to service local peak-shaving services?	Automated asset control?
Grid-Scale BESS	Bracebridge Generation	Yes  The C&I participation type will allow the battery to contribute as behind the meter generation	Yes	Yes  A Distributed Energy Resource Management (DERMS) solution is deployed to control the battery and will be utilized for this project
Residential BESS Fleet	Bracebridge Generation	Yes	Yes	Yes  There are 10 residential BESS that are controlled as a fleet as a part of the DERMS solution deployed on the MS3 feeder; each residential BESS cannot be controlled individually, instead a fleet manager aggregates residential BESS fleet operations.  The fleet manager for this deployment is TESLA.

	Asset Owner	Able to contribute to IESO CA load reduction?	Able to service local peak-shaving services?	Automated asset control?
Water Heater Fleet	Homeowners	<p>No</p> <p>The capacity of the water heaters is considered too small to participate in the IESO CA.</p> <p>Additionally, the water heaters will be a part of a demand response program designed and deployed at Bracebridge. This program services local grid needs and not the bulk market.</p> <p>Finally, since the water heaters will be controlled by a fleet manager, the solution cannot ensure that specific water heaters are either on or off. Additionally, the water heaters are displayed as an aggregate asset on the network model which diminishes some of the locational granularity. For these reasons, it was deemed too risky to include water heater participation in the IESO CA response.</p>	Yes	<p>The water heaters are controlled in aggregate by the DERMS solution deployed on the MS3 feeder; each residential BESS cannot be controlled individually, instead a fleet manager aggregates residential water heater fleet operations.</p> <p>The fleet manager for this deployment is Packetized Energy.</p> <p>The demand response program designed will shape limitations around the use of water heater curtailment that ensure that customers water heaters are not disconnected for long periods of time.</p>



	Asset Owner	Able to contribute to IESO CA load reduction?	Able to service local peak-shaving services?	Automated asset control?
Electric Vehicle Charger Fleet	Bracebridge Generation	<p>No</p> <p>EV charging station load is highly dependent on EV traffic and the charging patterns. The loading can at times be highly irregular and unpredictable considering there are only 4 chargers that will be a part of the fleet. Due to the doubtful nature of the load reduction the EV fleet can provide, it was deemed that the chargers will not participate in the IESO market</p> <p>Since the EV chargers will be controlled by a fleet manager, the solution cannot ensure that specific units are either charging or discharging. Additionally, the chargers are displayed as an aggregate asset on the network model which diminishes some of the locational granularity. For these reasons, it was deemed too risky to include EV charger participation in the IESO CA response.</p>	Yes	<p>The EV chargers are controlled in aggregate by the DERMS solution deployed on the MS3 feeder; each charger cannot be controlled individually, instead a fleet manager aggregates EV fleet operations.</p> <p>The fleet manager for this deployment is SWITCH.</p>

	Asset Owner	Able to contribute to IESO CA load reduction?	Able to service local peak-shaving services?	Automated asset control?
Wastewater Treatment Facility Backup Generator	Town of Parry Sound	Yes	No  Since these are backup generators, environmental regulations limit the number of times they can be dispatched. For this reason, they will not be considered for local peak-shaving, which occur more frequently than bulk market requests.	Yes  The backup generators will be controlled by a different DERMS solution than other assets. A Kiwi FRUIT will be deployed to control the backup generators.
Sewage Pumping Facility Backup Generator	Town of Parry Sound	Yes	No  Since these are backup generators, environmental regulations limit the number of times they can be dispatched. For this reason, they will not be considered for local peak-shaving, which occur more frequently than bulk market requests.	Yes  The backup generators will be controlled by a different DERMS solution than other assets. A Kiwi FRUIT will be deployed to control the backup generators.

	Asset Owner	Able to contribute to IESO CA load reduction?	Able to service local peak-shaving services?	Automated asset control?
Cascade Hydroelectric Generation	Bracebridge Generation	<p>No</p> <p>Cascade is already in contract with the IESO to provide generation services and so cannot serve as generation to service any other requests.</p>	<p>No</p> <p>Cascade is already in contract with the IESO to provide generation services and so cannot serve as generation to service any other requests.</p>	No
Solar PV	Bracebridge Generation	<p>No</p> <p>Solar assets are not eligible to serve as generation sources contributing to a C&amp;I HDR resource participation in the IESO CA.</p>	<p>No</p> <p>While solar forecasts will be accounted for in the optimization and powerflow analyses, the solar asset will not be curtailed in response to a local flexibility market as the asset is primarily in place to serve the microgrid that will be operational on the MS3 feeder following the DEMOCRASI project.</p>	<p>Yes</p> <p>The Microgrid Energy Management Solution (MEMS) deployed on the MS3 feeder allows for control and curtailment of the solar PV and can be utilized for this project.</p>

IESO CA activations can be for periods of time between one and four hours. For this reason, the energy managed DER considered for the project are rated at 4-hour power ratings for optimization purposes. The only energy managed assets for which this applies are the grid-scale BESS and the residential BESS fleet (which is treated as a single aggregated asset on the network model). This means that each of these assets can provide their rated capacity for four consecutive hours. All other assets are generation and so no change is made to their ratings.

The Town of Parry Sound has agreed to participate in this project and owns two generators that will be utilized to service bulk market requests. These are behind-the-meter generators and so can only generate energy up to the load of the facility. When the generators are dispatched, the net effect from a distribution network perspective will be a full reduction of facility load. For the purposes of this project, the Town has requested to tie-in any dispatch with existing scheduled testing of the diesel generators, during facility operational hours in order to reduce environmental impact. Beyond this, environmental regulations will not be a consideration since the dispatch for the project will be accounted for in existing test cycles for operations at the facilities. In a future deployment and for actual market participation, the environmental impact of frequent dispatch, if expected, will need to be accounted for.

### 3.2.4 Optimization

This section outlines the business rules that relate to optimization inputs, methodology, and outputs as a part of the project deployment. The optimization is performed by GridOS as a part of the joint product solution and the different optimization analyses are presented in section [2.2 Product Solution Data Flow Diagrams](#).

Inputs into the optimizations for the joint product solution, consistent across all optimization data flows are:

- Asset availability
- Network model
- Load & Generation Forecasts
- Optimization type & schedules

#### 3.2.4.1 Asset Availability

Section [3.2.3 Distribution Network Configuration & Asset Participation](#) addresses the services that each DER can participate in from a technical perspective. An operator can indicate asset availability and identify which of the services each asset is able to participate in through the Kiwi Core interface. The options for asset availability are:

- Participation in only bulk market (IESO CA participation at the meter point)
- Participation in only local market (Bracebridge Feeder-Head Peak Shaving)
- Participation in either bulk or local market

The operator can update each asset's availability through the Kiwi Core interface at any time but for this project deployment, asset availability updated prior to 8:00am the day-ahead will be considered for optimization. This aligns with the day-ahead bid update timeline and allows the same asset availability schedules to be utilized for all optimization runs and dispatches. Since the availability captured at 8:00am is utilized for optimization, any change to asset availability made after this time will not be accounted for in the product solution optimization processes. Emergency situations in which the operator needs to update asset availability and have that impact planned dispatch are described in section [3.3.1 Emergency](#).

Asset availability allows an operator to reallocate assets to certain services and indicate asset unavailability for maintenance. Additionally, an operator can disable the local flexibility market by ensuring no assets are allocated to a local market.

For this project, a Bracebridge operator will be updating asset availability for all participating assets. In future deployments, aggregators and asset owners may be able to update asset availability as well. Finally, since Bracebridge is not participating in the bulk market at present, no agreements are in place with asset owners to limit the number of times they are available. This would be accounted for in contracts and agreements in future market participation.

#### 3.2.4.2 Network Model

For this project, a network model was created for the MS3 distribution feeder. This network model captures and contains connectivity and geographical information on all the network assets and configuration. The network model is created in Common Information Model (CIM) format to serve as an

input to the joint product solution optimization processes. CIM is a standard developed and adopted to standardize the exchange of network models across different systems and solutions.

Distributed demand response assets are modeled as aggregated assets in the network model. For this deployment, these are fleets of: residential BESS, EVs, and water heaters. The network model was enhanced to reflect a meter-point location downstream of Cascade as described in section 3.2.3

**Distribution Network Configuration & Asset Participation.** This meter point is required to perform two of the three optimization objectives analyzed as part of the project

3.2.4.3 Load & Generation Forecasts

The joint product solution’s optimization flows perform powerflow analyses of distribution network feeders. To reflect network conditions correctly, load and generation forecasts for the network and assets need to be allocated to reflect loading and generation at each network node. GridOS allocates load and generation based on connected kVA capacity unless specific load & generation profiles are specified. This data flow is presented in section 2.2 Product Solution Data Flow Diagrams. Table 2 outlines the load & generation datasets that serve as inputs to the optimization processes and how they are captured and generated.

The granularity of historical data captured is hourly and that of measurement data is 5-minute. These datasets will both be stored within the GridOS database.

Table 2: Load & Generation Datasets Serving as Inputs to Optimization Analyses

	Dataset Use	Is Historical Data Captured?	Are Real-Time Measurements Captured?	Dataset Generation Method
Feeder-Head Load Forecast	To allocate load across the network model based on connected kVA	Yes  Since the MS3 feeder has recently been reconfigured, no feeder-head load data is available. Instead, Advanced Metering Infrastructure (AMI) data for all loads currently located on the recently reconfigured feeder has been aggregated for 2019-2020 to generate a historical profile	Yes  With the feeder reconfigured, feeder-head SCADA data from Bracebridge will be captured through the joint product deployment	The historical load data is used and modified based on more recent measurements captured to generate a feeder head forecast each day, for a 48-hour timeframe

	Dataset Use	Is Historical Data Captured?	Are Real-Time Measurements Captured?	Dataset Generation Method
<b>Cascade Generation</b>	To reflect correct network conditions and allow for calculation of meter point loading	No	Yes	The real-time measurement data captured from Supervisory Control And Data Acquisition (SCADA) will be used to generate a short-term forecast (using previous three days)
<b>Solar Generation</b>	To reflect correct network conditions	No  The solar assets will not be in place long enough to have historical dataset to use	Yes	The measurement data captured from SCADA will be used to generate a short-term forecast (using previous three days)
<b>Wastewater Treatment Facility Loading</b>	To determine backup generator generation and load reduction realized at the meter point. The backup generators are only capable of offsetting facility load	Yes	No	Historical load data will be repeated to serve as a forecasted load for the facility
<b>Sewage Pumping Facility Loading</b>	To determine backup generator generation and load reduction realized at the meter point. The backup generators are only capable of offsetting facility load	Yes	No	Historical load data will be repeated to serve as a forecasted load for the facility

#### 3.2.4.4 Optimization objectives & schedules

The three optimization objectives solved for as a part of this deployment are:

- Maximum Meter-Point Load reduction
- Feeder-Head Peak shaving
- Exact Meter Point Load Reduction

For each time an optimization analysis is invoked, an objective type and schedule are identified and provided. This is described in sections **2.2 Product Solution Data Flow** Diagrams and **3.3 Project Solution Process** Diagrams. The schedule outlines the time intervals for which the optimal powerflow analysis will be performed.

##### 3.2.4.4.1 Maximum Meter-Point Load Reduction

The maximum meter-point load reduction objective is used to support the process of day-ahead bid update. This objective function performs a powerflow analysis that optimizes for a maximum load

reduction at the meter point. This optimizes for all available assets to generate power or reduce load to their maximum, while constraining for grid safety and ensuring no constraints are violated on the network. This is a set of snapshot powerflows, each for an hourly interval, that does not need to maintain asset energy since all batteries are modeled as 4-hour batteries as presented in section 3.2.3 **Distribution Network Configuration & Asset Participation**. The output of this optimization analysis, per time interval, are:

- The maximum loading that can safely be reduced at the meter point.
- The reference loading that would have been realized at the meter-point without the optimization of asset dispatch. This serves as the reference loading from which a maximum reduction is achieved.
- The dispatch required of each available asset to achieve the maximum load reduction identified.

#### 3.2.4.4.2 Feeder-Head Peak Shaving

The feeder-head peak shaving optimization objective serves the local flexibility market for this project deployment. This objective function performs a powerflow analysis that reduces peak power load at the feeder-head over time span. This optimizes all available assets to generate power or reduce load to their maximum when the highest power loading is experienced on the feeder, while constraining for grid safety and ensuring no constraints are violated on the network. This optimization requires a schedule and a corresponding load forecast. Battery energy is tracked throughout the optimization. The output of this optimization analysis is the dispatch required of each available asset to achieve feeder-head peak shaving.

#### 3.2.4.4.3 Exact Meter-Point Load Reduction

The exact meter-point load reduction objective is used to respond to IESO CA bulk market activation. This objective function performs a powerflow analysis that reduces load at the meter point by the required amount, as per the activation notice received from the IESO. This optimizes available assets to generate power or reduce load to the extent necessary to ensure that meter-point loading is reduced as required, while constraining for grid safety and ensuring no constraints are violated on the network. This optimization requires a schedule and a corresponding load forecast. Battery energy is tracked throughout the optimization. The output of this optimization is the dispatch schedule required of each available asset to achieve exact meter-point load reduction.



### 3.3 Project Solution Process Diagrams

This project deployment is designed around the IESO CA timelines, explained in the 1.1 Market Adaptation Report. Specifically, there are two key components of the IESO CA participation that serve as triggers for the project solution: the standby notice and the activation notice. This means that these two components are what shape how and when each of the product solution data flows diagrams described in section 2.2 **Product Solution Data Flow Diagrams** are deployed for the project. The high-level process for the project deployment is outlined in **Figure 24**, with interaction flows from section 2.2 **Product Solution Data Flow Diagrams** referenced in red.

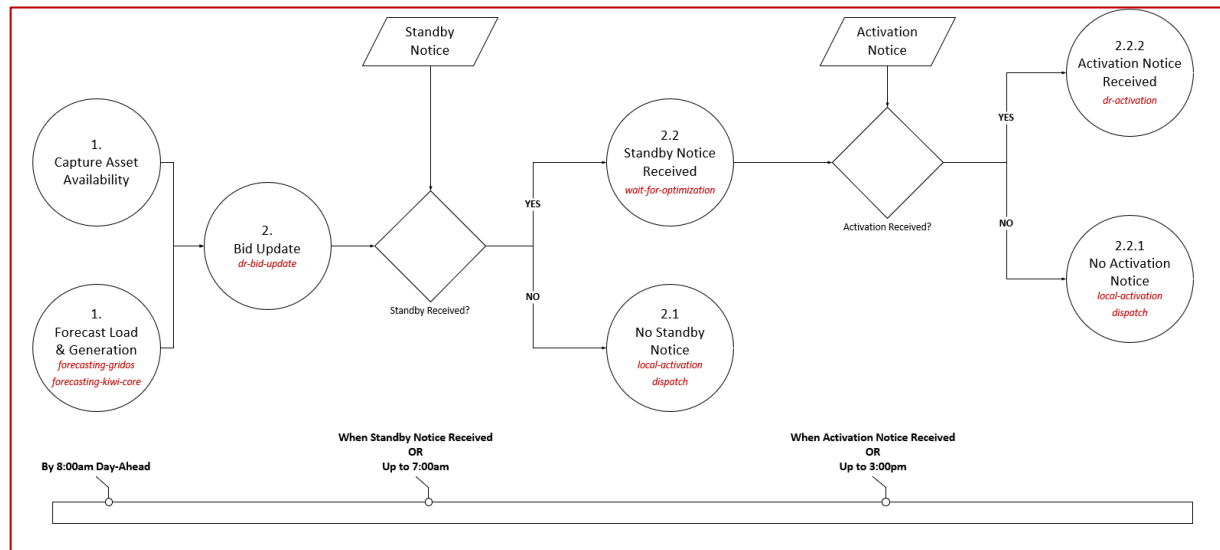


Figure 24: High-Level Project Process

The objective of the high-level project process is to ensure that all participating DER are being dispatched each day to service either a bulk market request or local peak-shaving needs. In this design, bulk market requests are prioritized as penalties incurred by market participants that do not deliver in the IESO CA are significant, as outlined in Report 1.1. The two key triggers in this process are:

**Standby Notice:** The standby notice is received by 7:00am on the day of dispatch. It indicates that the resource may be dispatched during the availability window that day. Following the receipt of a standby notice, the project solution does not dispatch assets for local services and waits for an activation notice if received. If no standby notice is received by 7:05am, the project solution removes bids from the energy market and optimizes assets for local peak-shaving from 10:00am for a 24-hour time period.

**Activation Notice:** The activation notice indicates the hours and capacity for which a resource is to dispatch to service the bulk market and cannot be received if no standby notice was received and resource energy bids were removed. The activation notice is received no less than 2 hours in advance of the first hour of requested dispatch and no later than 3:00pm. Following the receipt of an activation notice, the project solution optimizes available assets for response to the bulk market activation and dispatches assets at the required time. If no activation notice is received by 3:05pm, the project solution optimizes assets for local-peak shaving from 6:00pm for a 16-hour time-period. This ensures that DER available as a part of the project are not left idle for days in which no IESO CA dispatch is activated.

Each of the project solution process flows are broken down and presented further as a part of the 1.4 Solution Architecture Diagrams deliverable accessible below. These diagrams are to be reviewed with a

thorough understanding of the product data flows and project business rules presented in sections [2.2 Product Solution Data Flow Diagrams](#) and [3.2 Project Business Rules](#) respectively.

### 3.3.1 Emergency Processes

Since asset availability updated after 8:00am is not used for optimization, the following emergency processes are in place for this project:

- If an asset that was available for bid is no longer available prior to an activation notice being received, the operator would be expected to wait until a dispatch schedule is generated to confirm whether the asset is planned to dispatch or not
- If an asset that was available for activation is no longer available after the activation optimization has started but prior to an activation optimization completing, the operator would be expected to wait until a dispatch schedule is generated to confirm whether the asset is planned to dispatch or not
- If an asset that was available for activation is no longer available after the activation optimization has completed but prior to dispatch, the operator must take action to pause the dispatch by:
  1. Calling the IESO and agreeing whether to dispatch the remaining assets or none of the assets.
  2. Cancelling the dispatch for that asset In Kiwi Core by removing the asset from the dispatch schedule
  3. Removing the bid in the IESO market through the IESO interface directly
- If an asset that was available for activation optimization is no longer available after dispatch has already started, the operator would cancel the dispatch for that asset In Kiwi Core by removing the asset from the dispatch schedule

### 3.4 Project Simulation Scenarios

To prepare Bracebridge to participate in the IESO CA in future auctions, this project will simulate important normal operation and simulated edge-case scenarios. Successful participation in bulk and local markets will be simulated alongside project simulation scenarios. These remain a work in progress but are shaped heavily by the joint product solution use cases presented in 1.2 Use Cases definition Report. A draft of the simulation scenarios is presented in

**Table 3.**

These scenarios will also be used to ensure that data is captured to support a cost benefit analysis that shows the impact of the joint product solution under various scenarios.

*Table 3: Draft of Scenarios to be Simulated by Varying Input Data*

	Description	Scenario Conditions & Inputs	Value Captured	Corresponding Product Use Case
<b>Scenario 1: Lacking Visibility</b>	Bracebridge does not have full visibility to asset normal operating conditions, or has inaccurate visibility	Asset schedules captured are changed or updated to reflect assets operating with different schedules, ratings, and/or capacities	LDC visibility	UC1
<b>Scenario 2: Unsafe Bulk Market Dispatch</b>	Dispatch of assets to respond to a bulk market request may constrain the network	Network and asset parameters confirmed to showcase dispatch of large generators causing congestion on the network	Security-constrained optimization	
<b>Scenario 3: No Local Flexibility Market</b>	DER are only available to respond to bulk market requests and are otherwise idle	Assets constantly indicated as only available for bulk market participation and are not dispatched to shave MS3 feeder peak	Distribution network benefits of shaving peak power on the network	
<b>Scenario 4: Unsafe Peak Loading Unsafe</b>	Peak loading on the MS3 feeder constraints distribution network assets	Assets constantly indicated as only available for bulk market participation and are not dispatched to shave MS3 feeder peak.  Additionally, a peak loading is forecasted that would hinder asset health on the network	Avoided wear and tear and or degradation of network assets due to decreasing peak loading realized on the feeder.	

Scenario 5: Emergency Process	Individual asset unavailable following bid update	Asset indicated as available and accounted for in optimization has availability updated for in Kiwi Core	Project emergency and failure process flows	
-------------------------------------	---	--	--	--

### 3.5 Project API Specification

The Application programming Interface (API) specification developed as a part of this project describes the software intermediary calls that will be utilized to allow the components of the joint product solution to communicate with GridOS to facilitate data flows and optimization. These flows and the joint solution architecture are detailed in section [2 Joint Product Solution](#).

See appendix A for details.

### 3.6 Project Solution Networking Architecture

As mentioned in the previous sections, the joint solution is comprised of GridOS and Kiwi Core software components. **Figure 25** represents the deployment architecture agreed upon and necessary to securely and safely achieve the project objectives.

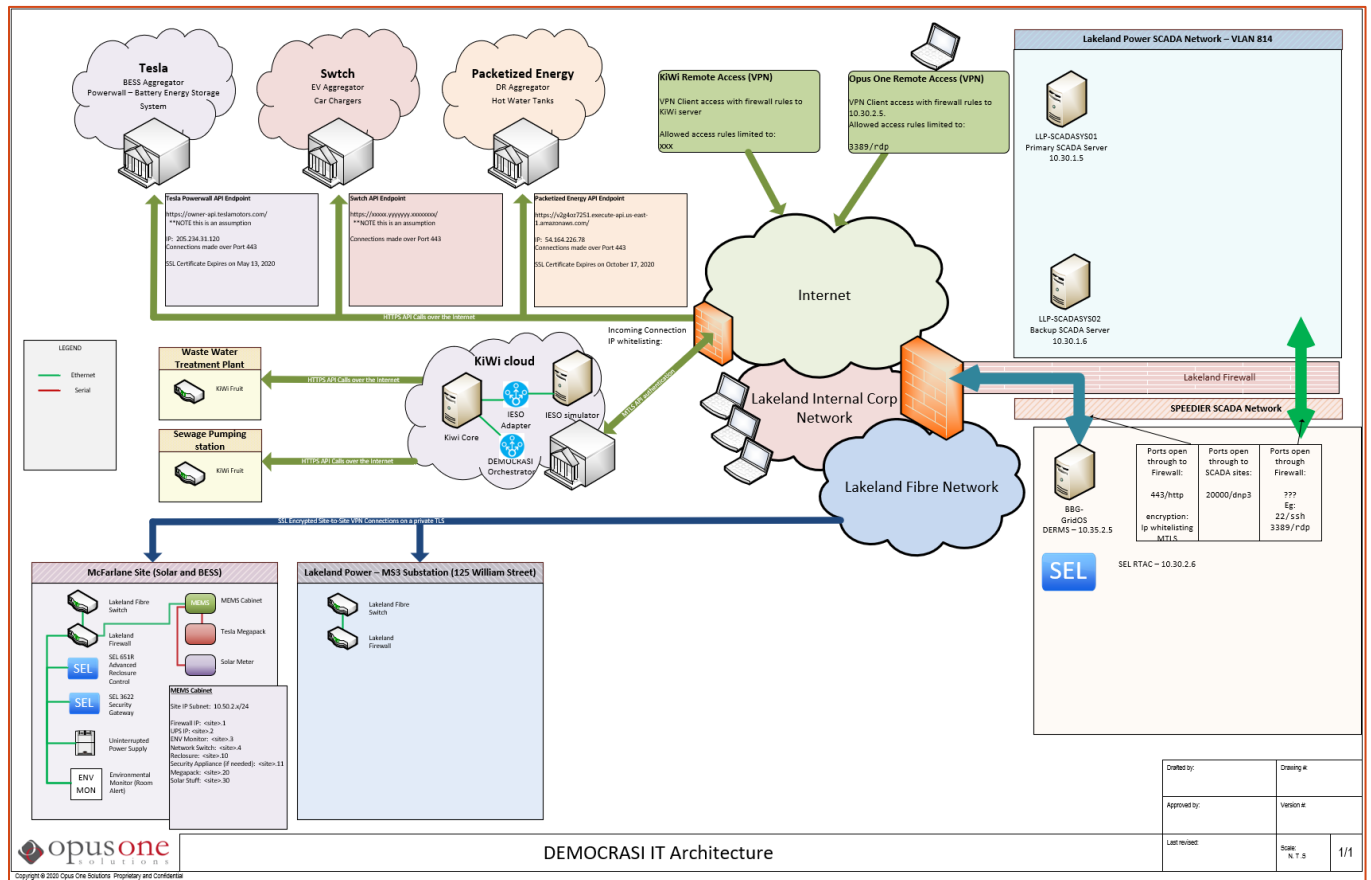


Figure 25: Project Deployment Architecture Diagram

As shown in **Figure 25**, the software components will be physically deployed at separate locations:

1. GridOS (and associated software components) will be deployed on premise, behind the firewalls within the existing network configurations at Lakeland Power
2. Kiwi Core (and associated software components) will be deployed on the AWS cloud

As part of the project, the data flow between Kiwi Core, GridOS and the field devices (including SCADA) can be summarized using the following three components to the network configuration:

1. IoT (aggregated assets)
2. Field devices
3. SCADA

#### 3.6.1 IoT Component of Network Configuration

IoT devices are those participating DERs (as part of SPEEDIER) which will be aggregated for control.

1. Residential BESS Fleet

2. EV fleet
3. DR fleet

Communication to and from these DERs will be facilitated by a third-party fleet management aggregator for each DER type, through internet connection. The communication to each fleet managed end node (DER) will be developed and implemented by the fleet management aggregator and will depend on each DER. Communication hardware needed between end nodes and aggregators will be provided by each fleet management aggregator. Existing connections between GridOS and the DER aggregator will be leveraged to pull telemetry from the DERs and dispatch control signals. The communication between GridOS and the aggregators will be using *https*.

### 3.6.2 Field Devices Component of Network Configuration

Field devices are microgrid DER that make up the non-aggregated participating DERs, their metering equipment, reclosers and relays. The described in the Project Solution section, the project will realize two Groups of field devices:

1. Kiwi Core dispatched DER group
2. GridOS dispatched DER group

#### 3.6.2.1 Kiwi Core Dispatched DER Group:

For the project demonstration, Kiwi Fruit will be deployed at the following sites to facilitate monitoring and control of the equipment:

1. Wastewater treatment backup generators
2. Sewage pumping station backup generators

The Communication to and from field assets will be realized through a private cellular APN on Kiwi's infrastructure. The communication between Kiwi Core and the Fruit will be accomplished through a proprietary RESTful API.

#### 3.6.2.2 GridOS Dispatched DER Group:

This group is comprised of the assets that are a part of the SPEEDIER project:

1. Grid Scale BESS (microgrid Site)

The communication to the Grid Scale BESS (along with meters, relays and the controller) will be accomplished through Lakeland Power's existing fibre network. The microgrid site will be a part of Lakeland Power's operational network and will be configured to follow existing security policies. GridOS communication to the BESS will be accomplished through DNP3.0.

### 3.6.3 SCADA Component of Network Configuration

All the field devices on the MS3-F1 feeder (including those on the MacFarlane section) communicate to Lakeland Power's SCADA system through DNP3 protocol. To gather network level information from SCADA, the information is relayed to GridOS via a network segment through VLAN, from behind a Cisco ASA firewall. GridOS will capture the information sent by SCADA via a Real Time Automation Controller (RTAC), which acts as a protocol translator. The communication between SCADA and RTAC, as well as between the RTAC and GridOS, will be accomplished using DNP3.0.

## 3.6.4 Hardware and Software stack Requirements

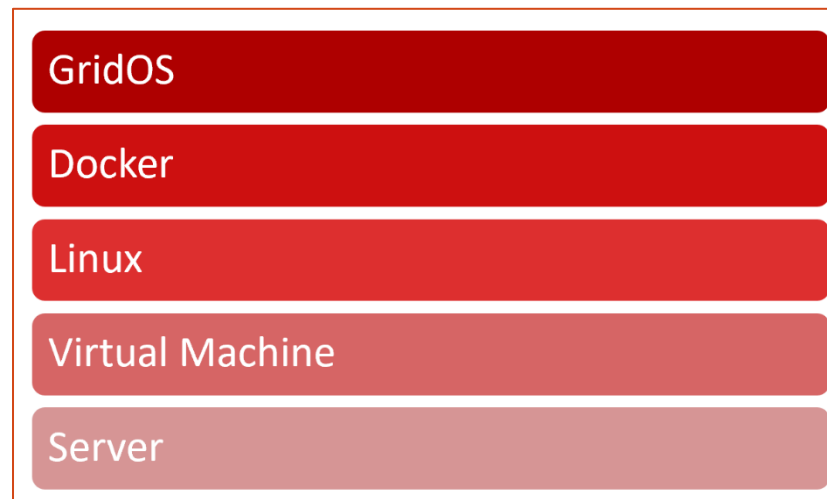
### 3.6.4.1 GridOS:

GridOS will be hosted on servers on-premise at Lakeland Power. The intended and recommended stack is visualized in **Figure 26** and is composed of:

- GridOS software
  - And associated components
- Docker
  - Enterprise Edition – Basic
- Linux operating system

*Table 4: GridOS Server Specification*

Server Count	Role	vCPU	Memory (GB)	Storage
1	Server	8	32	1TB (SSD)
1	Monitoring	4	16 or 32	1TB (SSD)



*Figure 26: Suggested software stack, top components being subsets of components below*

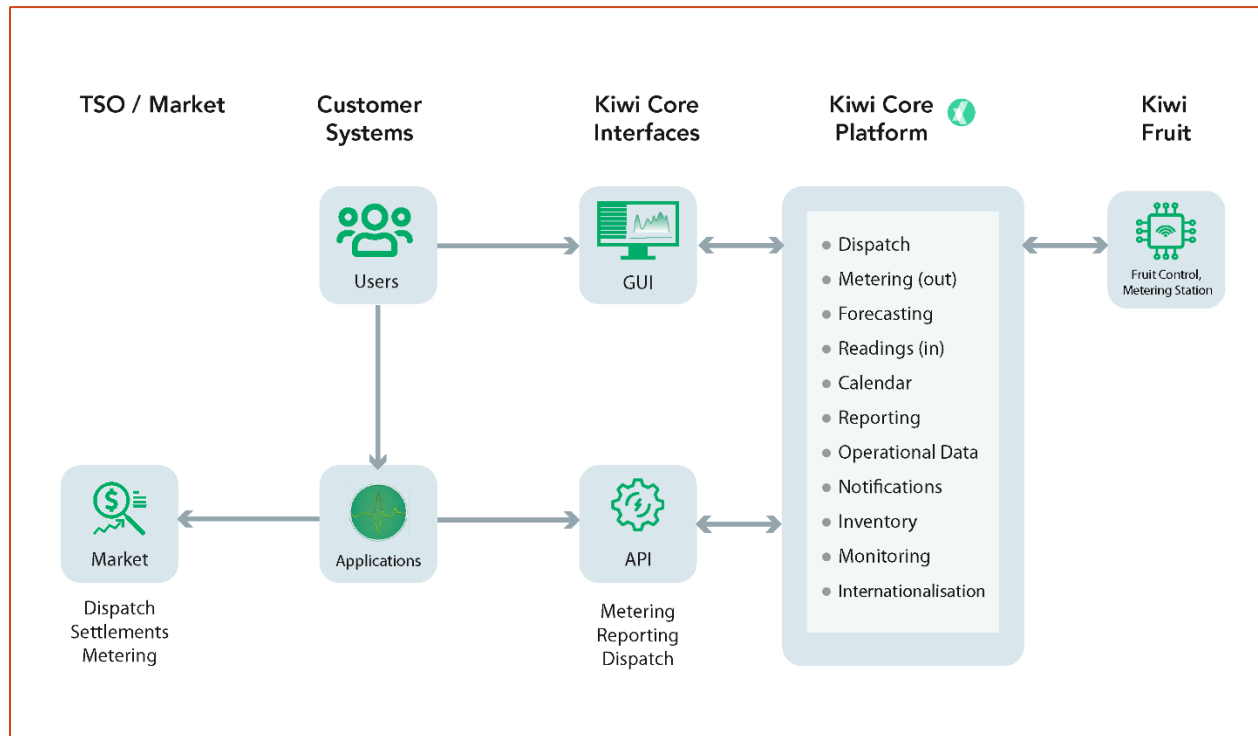
GridOS runs within the Docker software environment. Docker is a platform allowing for applications to be deployed as light-weight containers. This provides a layer of abstraction and sandboxing between the operating system and the deployed software.

The Docker container platform enables GridOS to run on several different operating systems and versions and to be adapted to different hardware builds. This makes the systems efficient, lightweight, and self-contained and it guarantees that GridOS runs consistently and can be easily updated regardless of where it is deployed.



### 3.6.4.2 KIWI CORE:

Networking information for Kiwi Core is presented in **Figure 27**.



*Figure 27: KIWI Core Networking Architecture*

### 3.6.5 Cybersecurity details /Firewall requirements

As part of the communication architecture, the following cybersecurity policies will be enforced as part of the project:

1. Lakeland's Fibre network policies
  - a. Firewall – Existing Lakeland policies
  - b. Communication protocol- DNP3.0
  - c. Ports open through firewall– only pre-determined ports will be whitelisted
2. Lakeland Power VLAN networks (internal communication)
  - a. Firewall – existing Lakeland policies
  - b. Communication protocols enabled – DNP3.0
  - c. Ports open through firewall - only pre-determined ports will be whitelisted (eg: 20000 for DNP3.0)
3. Lakeland Power SPEEDIER VLAN
  - a. Firewall – existing Lakeland policies
    - i. Outbound traffic will be allowed as per existing Lakeland cybersecurity policies
    - ii. Outbound traffic to DER aggregators is allowed only if:
      1. Aggregator IP is whitelisted
      2. And MTLS authentication is used
    - iii. Inbound Traffic from Kiwi Core will be allowed only if
      1. Kiwi Core connection is initiated from a whitelisted IP

2. And the connection is established using an MTLS authentication encryption
  - b. Communication protocols enabled – https
  - c. Ports open through Firewalls – 443 (MTLS encryption)

## Appendix A: Demokrasi API Specifications

### 1. GridOS API Specification

#### 1.1 Optimization

##### 1.1.1 POST /optimization/bulk-dr-bid

Optimize assets for bulk demand response market participation.

**Request Content Type:** application/json

**Request Body Schema:**

```
{
  "hours": <optimization_request_hours>,
  "assets": [
    <asset_id>,
    <asset_id>,
    ...
  ]
}
```

**Request Body Schema Parameters:**

- **optimization\_request\_hours**  
Link: [OptimizationRequestHours](#)
- **asset\_id**  
Link: [AssetId](#)

**Responses:**

**400**

Content Type: application/json

Link: [Error](#)

**200**

Content Type: application/json

Link: [Optimization](#)

##### 1.1.2 POST /optimization/bulk-dr-activation

Optimize assets for an activation signal received from bulk demand response market.

NOTE: for DEMOCRASI project, a successful optimization result will contain dispatch intervals with duration set to 3600 seconds.

**Request Content Type:** application/json

**Request Body Schema:**

```
{
```

```

"load_reduction": <load_reduction>,
"hours": <optimization_request_hours>,
"assets": [
  <asset_id>,
  <asset_id>,
  ...
]
}

```

#### Request Body Schema Parameters:

- **load\_reduction**  
Type: number  
Description: Amount of load to reduce at the meter point in Watts in load-sign convention (positive value is loading); should be greater than or equal to 0
- **optimization\_request\_hours**  
Link: [OptimizationRequestHours](#)

#### Responses:

##### 400

Content Type: application/json

Link: [Error](#)

##### 200

Content Type: application/json

Link: [Optimization](#)

### 1.1.3 POST /optimization/local-peak-shaving

Optimize assets for peak shaving for local flexibility.

NOTE: for DEMOCRASI project, a successful optimization result will contain dispatch intervals with duration set to 3600 seconds.

**Request Content Type:** application/json

#### Request Body Schema:

```

{
  "hours": <optimization_request_hours>,
  "assets": [
    <asset_id>,
    <asset_id>,
    ...
  ]
}

```

#### Request Body Schema Parameters:

- **optimization\_request\_hours**  
Link: [OptimizationRequestHours](#)

**Responses:****400**

Content Type: application/json

Link: [Error](#)

**200**

Content Type: application/json

Link: [Optimization](#)

### 1.1.4 GET /optimization/<id>

Retrieve the status of an ongoing optimization.

**URI Parameters:**

- **id**  
Description: identifier of the optimization

**Responses:****404**

Description: optimization not found

**200**

Content Type: application/json

Link: [Optimization](#)

### 1.1.5 GET /optimization/<id>/result

Retrieve the result of a completed optimization.

**URI Parameters:**

- **id**  
Description: identifier of the optimization

**Responses:****404**

Description: optimization not found

**409**

Description: optimization not in COMPLETED state; error message will be filled

Content Type: application/json

Link: [Error](#)

**200**

Content Type: application/json

Link: [OptimizationResultContainer](#)

## 1.2 Asset

### 1.2.1 GET /asset

Retrieve the list of available assets.

#### Responses:

##### 200

Content Type: application/json

Type: array

Description: List of available assets by Id.

#### Schema:

```
[  
  <asset_id>,  
  <asset_id>,  
  ...  
]
```

#### Schema Parameters:

- **asset\_id**  
Link: [AssetId](#)

### 1.2.2 GET /asset/<id>

Retrieve information and status about a single asset.

#### URI Parameters:

- **id**  
Description: identifier of the asset

#### Responses:

##### 404

Description: asset not found

##### 200

Content Type: application/json

Link: [Asset](#)

## 1.3 Feeder

### 1.3.1 GET /feeder

Retrieve the list of available feeders.

#### Responses:

##### 200

Content Type: application/json

Type: array

Description: List of available feeders by Id.

#### Schema:

```
[  
  <feeder_id>,  
  <feeder_id>,  
  ...  
]
```

#### Schema Parameters:

- **feeder\_id**  
Link: [FeederId](#)

### 1.3.2 GET /feeder/<id>

Retrieve information and status about a single feeder.

#### URI Parameters:

- **id**  
Description: identifier of the feeder

#### Responses:

##### 404

Description: feeder not found

##### 200

Content Type: application/json

Link: [Feeder](#)

## 1.4 Control

### 1.4.1 POST /control/schedule

Update the dispatch schedule of one or more assets, discarding any existing schedule.

**Request Content Type:** application/json

**Request Body Schema:** [AssetsDispatchSchedule](#)

**Responses:**

**400**

Content Type: application/json

Link: [Error](#)

**201**

Description: Success

### 1.4.2 GET /control/schedule

Retrieve the upcoming dispatch schedule of all assets. Includes dispatch intervals that include the current time as well as future dispatch intervals.

**Responses:**

**200**

Content Type: application/json

Link: [AssetsDispatchSchedule](#)



## 1.5 Measurement

### 1.5.1 GET /measurement/current

Retrieve current measurement samples for all currently measured quantities. Includes asset and non-asset measurements. Internally, measurements are sampled at least once every 5 minutes.

#### Responses:

**200**

Content Type: application/json

Link: [Samples](#)

### 1.5.2 GET /measurement/historical

Retrieve historical measurement data. Not supported.

## 1.6 Forecast

### 1.6.1 GET /forecast

Retrieve forecast data in 5-minute intervals.

#### Query Parameters:

- **min\_time**  
Type: string  
Description: (optional) Retrieve forecast samples with time greater than or equal to this value. Must be in ISO8601 notation, with timezone. If not provided, defaults to “now”.
- **max\_time**  
Type: string  
Description: (optional) Retrieve forecast samples with time less than or equal to this value. Must be in ISO8601 notation, with timezone. If not provided, retrieve all forecast samples with time greater than or equal to min\_time.
- **topology\_element\_type**  
Type: string  
Description: (optional) Retrieve forecast samples for topology elements with type matching this value. Array value; provide this parameter multiple times to match additional types. See [TopologyElementType](#).
- **topology\_element\_id**  
Type: string  
Description: (optional) Retrieve forecast intervals for topology elements with id matching this value. Array value; provide this parameter multiple times to match additional ids. See [TopologyElementId](#).

#### Responses:

**200**

Content Type: application/json

Link: [Samples](#)

## 1.7 Type Schemas

### 1.7.1 Error

**Type:** object

**Description:** Describes an error

**Schema:**

```
{
  "message": <error_message>
}
```

**Schema Parameters:**

- **error\_message**  
Type: string  
Description: describes the error that has occurred

### 1.7.2 Asset

**Type:** object

**Description:** Information and status about a single asset.

**Schema:**

```
{
  "id": <asset_id>,
  "type": <asset_type>,
  "feeder_id": <feeder_id>,
  "name": <name>,
  "connection_status": <connection_status>
}
```

**Schema Parameters:**

- **asset\_id**  
Link: [AssetId](#)
- **asset\_type**  
Link: [AssetType](#)
- **feeder\_id**  
Description: Feeder that contains this asset, if applicable. Null if not applicable.  
Link: [FeederId](#)
- **name**  
Type: string  
Description: Friendly name of this asset
- **connection\_status**  
Link: [ConnectionStatus](#)

### 1.7.3 AssetId

**Type:** string

**Description:** The id of the asset; if a physical asset, will be the RDF-ID of the asset as defined in the CIM model; otherwise, will be another unique value

### 1.7.4 AssetType

**Type:** string

**Description:** The type of the asset; can be one of:

- BESS
- PV
- GENERATOR
- RESIDENTIAL\_BESS\_FLEET
- HWT\_FLEET
- EVSE\_FLEET
- METER

### 1.7.5 ConnectionStatus

**Type:** string

**Description:** Status of the communication connection with a physical device or virtual device (eg a fleet API). Value can be one of the following:

- **ONLINE**  
The device has an active connection and is responding normally
- **UNHEALTHY**  
The device is expected to have an active connection but is not responding normally or is unexpectedly disconnected
- **OFFLINE**  
The device is offline; the device has been normally disconnected or normally shut down

### 1.7.6 Feeder

**Type:** object

**Description:** Information about a single feeder.

**Schema:**

```
{
  "id": <feeder_id>,
  "name": <name>
}
```

**Schema Parameters:**

- **feeder\_id**  
Link: [FeederId](#)
- **name**  
Type: string  
Description: Friendly name of this feeder

### 1.7.7 FeederId

**Type:** string

**Description:** Unique identifier for a feeder.

### 1.7.8 TopologyElementId

**Type:** string

**Description:** Unique id used to represent a topology element. If the type of the element is ASSET then this value is the id of the asset (see [AssetId](#)). If the type of the element is FEEDER then this value is the id of the feeder (see [FeederId](#)). Other types may be used in the future. See [TopologyElementType](#).

### 1.7.9 TopologyElementType

**Type:** string

**Description:** The type of a topology element. Can be one of:

- ASSET
- FEEDER

### 1.7.10 DispatchIntervalGenerator

**Type:** object

**Description:** A single dispatch interval for a generator-like device

**Schema:**

```
{
  "start_time": <start_time>,
  "duration_seconds": <duration_seconds>,
  "active_power_total": <active_power_total>
}
```

**Schema Parameters:**

- **start\_time**  
Type: string  
Description: Starting date-time of this dispatch interval in ISO8601 notation, with timezone
- **duration\_seconds**  
Type: number  
Description: Number of seconds between the start and end of this interval

- **active\_power\_total**

Type: number

Description: Active power to be generated by the device during this interval in Watts with load-sign convention (negative is generation)

### 1.7.11 DispatchIntervalDemandResponse

**Type:** object

**Description:** A single dispatch interval for a demand-response device

**Schema:**

```
{
  "start_time": <start_time>,
  "duration_seconds": <duration_seconds>,
  "active_power_load_limit": <active_power_load_limit>
}
```

**Schema Parameters:**

- **start\_time**

Type: string

Description: Starting date-time of this dispatch interval in ISO8601 notation, with timezone

- **duration\_seconds**

Type: number

Description: Number of seconds between the start and end of this interval

- **active\_power\_load\_limit**

Type: number

Description: Maximum loading that this device could exert during this interval in Watts with load-sign convention (positive is loading)

### 1.7.12 OptimizationRequestHours

**Type:** array

**Description:** Hours to be used for the optimization request

**Schema:**

```
[  
  <start_time>,  
  <start_time>,  
  ...  
]
```

**Schema Parameters:**

- **start\_time**  
Type: string  
Description: Starting date-time of an hour in ISO8601 notation, with timezone. Must lie on the starting time of a whole-hour.  
Example: 2020-01-21T03:00:00-05

### 1.7.13 Optimization

**Type:** object

**Description:** A finished or on-going optimization

**Schema:**

```
{  
  "id": <optimization_id>,  
  "status": <status>,  
  "type": <type>,  
  "comment": <comment>  
}
```

**Schema Parameters:**

- **optimization\_id**  
Type: string  
Description: Identifier of the optimization that was created
- **status**  
Type: string  
Description: the current status of the optimization; one of the following values:
  - **ACTIVE**  
Optimization is on-going
  - **COMPLETED**  
Optimization has completed and its result is ready
  - **FAILED**  
Optimization has failed; comment field has been filled with a message explaining the failure

- **type**  
Link: [OptimizationType](#)
- **comment**  
Type: string  
Description: communicates additional context related to the current status

### 1.7.14 OptimizationType

**Type:** string

**Description:** the type of the optimization; one of the following values:

- **BULK\_DR\_BID**  
Bulk market demand response bid optimization
- **BULK\_DR\_ACTIVATION**  
Bulk market demand response activation optimization
- **LOCAL\_PEAK\_SHAVING**  
Local flexibility peak shaving optimization

### 1.7.15 OptimizationResultContainer

**Type:** object

**Description:** contains the result of an optimization, discriminated by the type of the optimization

**Schema:**

```
{
  "type": <type>,
  "data": <data>
}
```

**Schema Parameters:**

- **type**  
Link: [OptimizationType](#)
- **data**  
Description: result data; schema depends on the value in **type**:
  - If **type** is **BULK\_DR\_BID**:  
Link: [DRBid](#)
  - If **type** is **BULK\_DR\_ACTIVATION**:  
Link: [AssetsDispatchSchedule](#)
  - If **type** is **LOCAL\_PEAK\_SHAVING**:  
Link: [AssetsDispatchSchedule](#)

### 1.7.16 DRBid

**Type:** object

**Description:** maximum safe demand response bid

**Schema:**



```

{
  "meter_point_schedule": [
    {
      "start_time": <start_time>,
      "duration_seconds": <duration_seconds>,
      "load_reduction": <maximum_safe_meter_point_load_reduction>,
      "reference_load": <meter_point_reference_load>
    },
    ...
  ],
  "assets": [
    {
      "id": <asset_id>,
      "maximum_dispatch_schedule": [
        {
          "start_time": <start_time>,
          "duration_seconds": <duration_seconds>,
          "maximum_dispatch": <maximum_dispatch>
        },
        ...
      ]
    },
    ...
  ]
}

```

#### Schema Parameters:

- **maximum\_safe\_meter\_point\_load\_reduction**  
Type: number  
Description: maximum safe load reduction in an interval at the meter point in Watts in load-sign convention (positive value is loading); will be greater than or equal to 0
- **meter\_point\_reference\_load**  
Type: number  
Description: forecasted load in an interval at the meter point in Watts that was used for the optimization in load-sign convention (positive value is loading)
- **asset\_id**  
Link: [AssetId](#)
- **start\_time**  
Type: string  
Description: starting date-time of an interval in ISO8601 notation, with timezone. NOTE: for DEMOCRASI project, this value will always be the starting time of a whole hour; for example, 2020-01-21T01:00:00-05
- **duration\_seconds**  
Type: number  
Description: number of seconds from the start to the end of this interval. NOTE: for DEMOCRASI project, this value will always be 3600

- **maximum\_dispatch**

Type: number

Description: maximum generation that this asset could be dispatched when contributing to bulk demand response in Watts in generator-sign convention (positive value is generation)

### 1.7.17 AssetsDispatchSchedule

**Type:** object

**Description:** Dispatch schedule for multiple assets

**Schema:**

```
{
  "assets": [
    {
      "id": <asset_id>,
      "dispatch_schedule": [
        <dispatch_interval>,
        <dispatch_interval>,
        ...
      ]
    },
    ...
  ]
}
```

**Schema Parameters:**

- **asset\_id**

Link: [AssetId](#)

- **dispatch\_interval**

Type: object

Description: a single dispatch interval for the asset; schema depends on the type of the underlying asset (see [AssetType](#)):

- If type of asset is

**BESS, RESIDENTIAL\_BESS\_FLEET, or GENERATOR:**

Link: [DispatchIntervalGenerator](#)

- If type of asset is **HWT\_FLEET** or **EVSE\_FLEET**:

Link: [DispatchIntervalDemandResponse](#)

### 1.7.18 Samples

**Type:** array

**Description:** Zero or more samples of measured or forecasted quantities. For listing of available sample types, see [Sample Types](#).

**Schema:**

```
[
  {
```

```
"topology_element_id": <topology_element_id>,  
"topology_element_type": <topology_element_type>,  
"sample_type": <measurement_type>,  
"sample_time": <sample_time>,  
"value": <value>  
},  
...  
]
```

#### Schema Parameters:

- **topology\_element\_id**  
Link: [TopologyElementId](#)
- **topology\_element\_type**  
Link: [TopologyElementType](#)
- **sample\_type**  
Type: string  
Description: The type of the sample. See [Sample Types](#).
- **sample\_time**  
Type: string  
Description: Sampling date-time in ISO8601 notation, with timezone.
- **value**  
Type: number  
Description: Sampled value. Unit depends on sample\_type. See [Sample Types](#).

## 1.8 Sample Types

Available measurement and forecast types.

### 1.8.1 TopologyElementType: ASSET

#### 1.8.1.1 AssetType: BESS, RESIDENTIAL\_BESS\_FLEET

Name	Description	Unit
energy_remaining	Remaining energy in the battery or battery fleet.	Wh
energy_capacity	Total energy capacity of the battery or battery fleet.	Wh
active_power_total	Instantaneous 3-phase active power; positive = import, negative = export	W
reactive_power_total	Instantaneous 3-phase reactive power; positive = import, negative = export	VAr
active_power_max	3-phase active power rating; always positive	W
reactive_power_max	3-phase reactive power rating; always positive	W
energy_imported	Total energy imported into the asset from the grid. This value may reset to 0 occasionally. May not be available for all assets of this type.	Wh
energy_exported	Total energy exported to the grid from this asset. This value may reset to 0 occasionally. May not be available for all assets of this type.	Wh

#### 1.8.1.2 AssetType: PV, GENERATOR

Name	Description	Unit
active_power_total	Instantaneous 3-phase active power; positive = import, negative = export	W
reactive_power_total	Instantaneous 3-phase reactive power; positive = import, negative = export	VAr
active_power_max	3-phase active power rating; always positive	W
reactive_power_max	3-phase reactive power rating; always positive	W
energy_exported	Total energy exported to the grid from this asset. This value may reset to 0 occasionally. May not be available for all assets of this type.	Wh

#### 1.8.1.3 AssetType: HWT\_FLEET, EVSE\_FLEET

Name	Description	Unit
active_power_total	Instantaneous 3-phase active power; positive = import, negative = export	W
active_power_max	3-phase active power rating; always positive	W
active_power_load_limit	Maximum allowed active power load; always positive	W

#### 1.8.1.4 AssetType: METER

Name	Description	Unit
active_power_total	Instantaneous 3-phase active power; positive = import, negative = export	W
reactive_power_total	Instantaneous 3-phase reactive power; positive = import, negative = export	VA <sub>r</sub>
energy_imported	Total energy imported into the asset from the grid. This value may reset to 0 occasionally. May not be available for all assets of this type.	Wh
energy_exported	Total energy exported to the grid from this asset. This value may reset to 0 occasionally. May not be available for all assets of this type.	Wh

#### 1.8.2 TopologyElementType: FEEDER

Name	Description	Unit
active_power_total	Instantaneous 3-phase active power; positive = import, negative = export	W
reactive_power_total	Instantaneous 3-phase reactive power; positive = import, negative = export	VA <sub>r</sub>
energy_imported	Total energy imported into the feeder from upstream. This value may reset to 0 occasionally.	Wh
energy_exported	Total energy exported to upstream from this feeder. This value may reset to 0 occasionally.	Wh