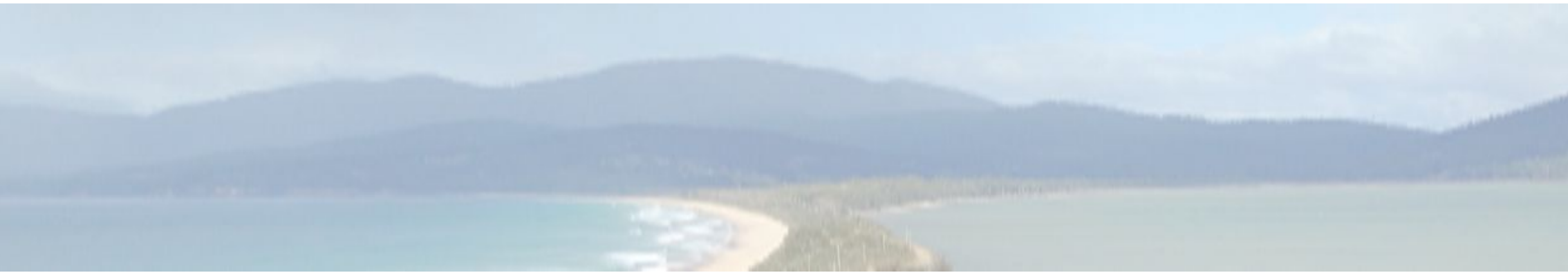
CONSORT Project
submission to the AEMO-ENA consultation paper
Open Energy Networks



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About the authors and the CONSORT project

*The authors of this submission are involved in the **CONSORT Project**, also known as the **Bruny Island Battery Trial**. The CONSORT project team is made up of industrial partners Reposit Power and TasNetworks, and researchers from the Australian National University, The University of Sydney and the University of Tasmania. The Australian Government, through the Australian Renewable Energy Agency (ARENA), is providing $2.9m towards the $8m CONSORT project under its Research and Development Programme.*

The CONSORT project and field trial is addressing how batteries can be used by householders to manage their energy while simultaneously being used to help manage the network. During the trial, up to 40 battery systems are being installed in homes on Bruny Island in Tasmania's south-east. Working in conjunction with rooftop solar generation, these batteries are being coordinated to alleviate congestion on Bruny's undersea power supply cable and to reduce the reliance on costly and polluting diesel generation during peak season.

More on the CONSORT project can be found at: http://brunybatterytrial.org/

NOTE: This submission is additional to other submissions made by the respective partner organisations. It provides additional insight gathered by the CONSORT trial.

1 Introduction

The CONSORT Project partners - Australian National University (ANU), The University of Sydney (USyd), University of Tasmania (UTas), TasNetworks and Reposit Power - welcome the opportunity to contribute to the Australian Energy Market Operator (AEMO) and Energy Networks Australia (ENA) consultation paper on Open Energy Networks (OEN), and thank the AEMO and ENA for initiating this program of work.

We feel this is a timely and important opportunity for stakeholders to contribute to the the ongoing work of facilitating the uptake of distributed energy resources (DER), particularly those embedded in distribution networks and "behind the meter." We believe that continued efforts to harness the full potential of DER will contribute towards the long-term interests of consumers in the NEM.

In particular, we agree with the premise of the report that current NEM arrangements (and those of almost all electricity industries around the world) do not provide economically efficient means for consumers to actively participate in distribution network management to reduce costs, be that their own private energy costs or electricity system-wide costs. More generally, the role that a wide range of DER - such as local generation, storage and flexible loads - might play in delivering network services, while understood in theory, is only just being realised in practise. Given the continued evolution of technological developments in this space, it comes as little surprise that designs for the institutions and market arrangements that enable and facilitate the delivery of these services, and their integration into existing energy market and frameworks, are not settled.

In our view, the requirement for effective coordination of DER, at distribution network level and at power system level, is absolutely critical, and hence we welcome the consultation paper's clear position on this. Lack of coordination of DER will in future result in, at best, sub-optimal outcomes which result in inefficient use of resources and ultimately a relatively higher cost of delivery of energy and services, to inefficient investment in assets by customers and/or network service providers, to, at worst, significant problems within local networks and at whole of system level which may result in loss of service for customers. We suggest therefore that enabling optimal use of resources (DER and centralised resources) is an important objective when designing the new framework.

Against this background, the CONSORT project represents a world-first in bringing such DER-harnessing technology to deployment in order to provide a solution to the technical problems on distribution networks of thermal and voltage constraints. As such, we believe that our experience gained during the CONSORT project gives us a unique set of insights to share with respect to the design and operation of a future DNSP or DSO role within an OEN architecture or other future distribution network arrangements and regulation. In this submission, we aim to share these learnings with other stakeholders in order to contribute to the design of an OEN architecture that provides good outcomes for all.

The structure of this submission is as follows: In section 2 we provide detailed responses to the consultation questions posed in the approach paper. Section 3 then considers alternative ways mathematical models can be constructed for distribution markets. This section focuses on the methods employed in the CONSORT project, as a way of explaining what is possible and what has already been achieved.

2 Responses to Consultation Questions

2. Path-ways for DER to provide value

2.1. Are these sources of value [self consumption, passive exports, NEM participation and bilateral agreements] comprehensive and do they represent a suitable set of key use-cases to test potential value release mechanisms?

In the CONSORT project's experience, customers highly value backup services in addition to the sources of value listed above. Backup services are generally only a subset of the customer's own load with current generation inverters, and a few sources of backup value include direct economic value (fridge/freezer losses, business operations), comfort or perception of comfort, and bushfire risk for sprinkler use. It is our view, noting that we are still engaging in the process of evaluating this more closely via battery owner interviews and focus groups within the project, that the value attributed by customers to back-up is both difficult to quantify and compare against other value streams, and is also highly variable between customers. Almost certainly, the importance placed on back-up by customers in rural locations where outages are more frequent is high compared to that for the urban setting. Thus, it is essential that an OEN architecture allow for significant variation in customer backup value when balancing this against the value of services at the network and/or system-level.

Generally, from a customer point of view, value extends beyond simply the monetary value of energy or power services. For many customers, each use case for their systems provides a different inherent value. For instance, a customer may prefer to supply their own needs before the network or market's needs, as they inherently value their own usage more. Similarly, customers may value the remaining energy in their battery as the state of charge reduces. This may be for backup purposes or as a risk mitigation measure against peak consumption charges.

Moreover, we recommend that closer attention is paid to the willingness and interest on the part of householders to be closely involved in, and engaged with, new energy technologies and tariffs (or other changes to pricing and payments/rebates). Our social research within CONSORT has revealed a reasonably high proportion of households were:

- stressed by new information and practices brought about by the solar-battery installation and operation,
- time-poor, and therefore not engaged.

The ENA-AEMO paper assumes that householders' are willing to be tightly involved in the energy market. This is starting point is largely taken for granted and left unsaid, but it may well be a false premise from which to begin the discussion of an OEN architecture design.

2.2. Are stakeholders willing to share work they have undertaken, and may not yet be in the public domain, which would help to quantify and prioritise these value streams now and into the future?

The CONSORT Bruny Battery trial is testing many of the functions required by a DNSP to implement a OEN architecture now. The project team includes all parts of the value chain. It also includes world-leading research on main aspects of the distributed energy future. Including:

- Technical tools that could form the basis of a distribution dispatch engine underpinning an OEN architecture (regardless of which entity operates it);
- Research on the payments structures that may be appropriate to reimburse customers for services provided; and
- Social science research to determine what customers think, feel, and do when actively participating in a distributed energy market.

The CONSORT Bruny trial is ready and willing to share its project learnings, and information, messages and slides have already been shared at the Tasmanian stakeholders forum.

As far as quantifying the value of various potential value streams that DER can generate goes, the project is now building valuable experience regarding the ‘costs’ of procuring network support from DER that would otherwise be serving local retail arbitrage objectives. We do of course note that the value of network support is highly variable with location and is almost entirely dependant upon local network asset and demand status and upon the network planning process, and that to assess this really requires deep engagement from the relevant DNSP in each region.

We make the point also that the potential value of wholesale NEM participation is both highly variable between NEM regions and between years and seasons. It could be argued, therefore, that the realisable value associated with retail arbitrage (bill reduction) is the lowest risk and most predictable, and therefore may possibly be weighted accordingly by many prosumers (in the absence of contracted positions for services).

3. Maximising passive DER potential

3.1. Are there additional key challenges presented by passive DER beyond those identified here [voltage management, local network capacity]?

3.2. Is this [Network modelling, advanced planning, advance operations, and active DER (e.g. promoting load shifting, promoting the use decentralised storage, transition of rooftop PV systems from passive to active capabilities to facilitate coordinated feed-in management] an appropriate list of new capabilities and actions required to maximise network hosting potential for passive DER?

3.3. What other actions might need to be taken to maximise passive DER potential?

CONSORT focuses on active DER. It has generated several learnings about the relative benefits of active DER over passive DER. Nonetheless, the findings of the trial show that **passive DER does not provide significant benefit to the network** in many circumstances. This is particularly true if the customer is not on a ‘cost reflective’ tariff. There are many cases which the battery is operated to the customer’s benefits that result in perverse outcomes for the network. These findings are corroborated by simulation studies undertaken by the University of Sydney over a range of different DER integration path-ways, including an array of tariff structures and simple (network-oblivious) peer-to-peer energy trading mechanisms. Together, these results highlight the desirability of moving rapidly to active management of DERs on power networks, as exemplified by the CONSORT project.

Detailed response to 3.1:
Several additional challenges should be incorporated into a DSO design from the outset, including:

- Interaction with protection scheme design and operation.
- Interaction with emergency control schemes (UFLS etc)
- Short-term fluctuations in power that occur at time-scales shorter than those traditionally considered by DNSPs, but which are more regularly being actively managed, and at magnitudes below current protection set-points, but which in aggregate may have higher-level network and system-level effects (i.e. dispatch and frequency regulation service effects, MV and HV reactive power support requirements, etc; e.g. STATCOM deployments that incorporate Fast Frequency Response). Many projections for high penetration DER suggest that the system will possibly see 'instantaneous' power capacity changes far in excess of the largest NEM generator (which is currently used predominantly for security constrained dispatch optimisation). This presents a very large change from current system-level operating requirements, and unless coordinated well poses as a significant potential threat to system security. However, if coordinated appropriately it may instead be viewed as an opportunity (for the power system, and for DER owners).
- Pickup load effects after outages.

Detailed response to 3.3:
Other actions that would improve the value of passive DER include:

- Better access to real-time network data via existing metering infrastructure. At present, the data custodians are the electricity retailers, who only have an obligation to share market settlement data. This excludes valuable real-time network state data, such as connection point voltages, which presents a barrier to DNSPs visualising their networks and improving their operations.
- Incentives, financing or long-term contracts to invest in the equipment that add passive DER flexibility may be considered, as individual customers may not have the financing or risk appetite to take on this investment when faced with an uncertain value stream. Over and above this, however, such efforts should also focus on turning passive DER into active DER. For example, currently only 10% of DER installed is done so with a smart gateway or smart control system, even though it is more cost-effective to install this functionality at same time as the DER, and the benefits, or potential future benefits, to networks are large.

4. Maximising active DER potential

4.1. Are these [unmanaged or independent VPP actions, defining and demarking new services and the markets for them, interaction of distribution-level services with transmission network and system services and markets, understanding network constraints and the permission structures enforcing them] the key challenges presented by active DER?

We see the issues associated with uncoordinated DER actions (uncoordinated between individual DER, aggregator fleets, VPPs and networks and the power system operator) and also with misaligned objectives of DER owners, retailers, networks and the power system as being among the biggest challenges for integration of large amounts of active DER.

Additional challenges posed by active DER include:

- Interaction with emergency and protection schemes.
- Communications network interoperability, constraints and vulnerabilities.
- Competing / counterproductive demand on DER services from DER owners, retailers, network and system operator.

4.2. Would resolution of the key impediments listed be sufficient to release the additional value available from active DER?

Although this would likely release additional value, it might not maximise additional value, as it is the way the system operates at critical times that defines whether it is successful or not. This is especially the case with the premium placed on the value of unserved load, and the fact that faults occur on distribution networks much more regularly than on other parts of the power system.

4.3. What other actions might need to be taken to maximise active DER potential?

- As discussed in detail in Section 3, DER needs appropriate coordination or optimisation to maximise its potential. The is a key finding of the CONSORT project to date.
- Forecasting constraints and forecasting or scheduling DER availability is key; and just as for wind and residential solar, this is a thoroughly empirical problem that will only be resolved with more experience.
- In order for DER in future to support power systems operation (regulation, contingency services, inertia-like functions), they will need to incorporate real-time system frequency responsiveness which is consistent with requirements of system operator

4.4. What are the challenges in managing the new and emerging markets for DER?

- A first challenge is defining the services and assigning an entity to be responsible for managing them.
- Second, market designs must be cognisant of the risk appetite of DER owners, their preferences, and their ability to commit to scheduled actions.
- Third, the role that power network service providers play as facilitators or gatekeepers for demand-side participation in power systems markets needs to be clearly defined. Specifically, there is a need to manage the potentially overlapping obligations that DERs may sell to network and system services operators, and to automate this process. The

responsibility for managing such cases of overlapping obligations needs to be vested in an appropriate entity.

- Finally, new roles and developing new technical competencies - and doing this fast - is a major challenge in the system transformation, as we have experienced in CONSORT (e.g. with different installers, facing a range of different devices, trying creating a process). The early phases of rolling out DER and services more widely, we are seeing that the technicians that interact directly with the householders are pivotal to an 'orderly transition.' As such, “good” battery installers, and other technicians that interact directly with the consumer/prosumer, are required to move from being innovative and troubleshooting a new technology, to becoming fully competent in a stable setting as soon as possible if an ad-hoc transition is to be avoided. To achieve this requires policy and regulatory support in terms of more in-depth training for the installers (for example, CEC training currently, and extended to trusted labels or ticks for consumer confidence). In other words, in addition to the safety compliance and basic performance requirements under current draft standards, we would encourage a support mechanism for both (residential) energy consumers and DER technicians/installers. This support mechanism should describe a communications strategy and education for both new entrants (PV/battery installers) and consumers.

4.5. At what point is coordination of the Wholesale, FCAS and new markets for DER required?

The longer we wait for active DER integration and management, the more we rely on later DER to “carry the load.” It is better for everyone if the capability becomes standard ASAP, even if we don’t use it often to start with. CONSORT has shown a small number of customers (34/~600) can make a big difference in the right area with active coordination. In other words, it is better to have active DER enabled before constraints become binding or before DER penetrations begin adversely affecting the system.

With emerging market opportunities for DER, a significant challenge will be to ensure that DER that is already installed or available to be installed will be market-ready in advance of the value of market warranting participation and that coordination systems are in place to manage those resources within markets. The alternative, waiting until a market of sufficient value emerges to signal to DER suppliers the need to develop that functionality creates a risk of inadequate response capability being in place, given the experienced and expected rate of uptake of DER.

5. Frameworks for DER optimisation within distribution network limits

5.1. How do aggregators best see themselves interfacing with the market?

In the CONSORT model, online negotiation (every 5 minutes) is used operationally to clear the network services markets. In its current instantiation, each Reposit controller box communicates independently with the NAC algorithm to negotiate an outcome that is best for the customer it represents. This approach can be used to jointly coordinate multiple aggregators operating on the same network.

While it is possible to optimise at the level of aggregated blocks of customers or VPPs, knowing where individual customers connect into the network and coordinating their operations with this knowledge can provide much better overall outcomes. It enables targeted response for particular parts of the network accounting for voltage and thermal constraints, network losses, and customer phasing, which is important under unbalanced network conditions.

Note that it this approach leaves open the possibility for aggregators to virtually implement coordinated or strategic policies across the assets it manages, as viewed from its side; because such coordinated efforts would be irrelevant to the operation of the NAC (although they would likely affect dispatch schedules and prices).

5.2. Have the advantages and disadvantages of each model been appropriately described? [Three options: A. Single Integrated Platform; AEMO central platform and optimising dispatch taking into account transmission and distribution network constraints B. Two Step Tiered Platform; DNSPs optimising distribution level dispatch. C. Independent DSO]

One of the common challenges mentioned in the report that we would like to emphasise is around the co-optimisation of wholesale and distribution network activities. As indicated in the report, all three approaches will face this challenge, with even the SIP approach likely requiring a multi-stage optimisation to remain tractable and flexible. The lower distribution stage or tier needs to be able to operate not at the level of aggregate bids, but to consider where the DER that make up the aggregate bids connect into the distribution network, in order to provide targeted distribution network support and constraint management.

The CONSORT approach could work under any of these high-level model designs. From a technical perspective (ignoring regulation and social issues), the only major difference between them is in what data gets transferred to whom and when. As explained above, the finer details of how the tiered or hierarchical platform is designed and their interface with aggregators and customers will be critical for determining the quality of the outcomes that can be achieved.

5.3. Are there other reasons why any of these (or alternative) models should be preferred?

Our experience in the CONSORT project has resulted in a strong preference for one underlying coordination approach per network or network segment. There is, understandably, a desire to make networks very open, so that multiple aggregators and multiple VPPs can cohabitate on a single piece of network and compete in the various markets available. However, at some point, the network itself couples everything together under a single constraint, which can't be 'allocated' between service providers, etc. This is immutable, and drives the argument for one coordination approach per network. We feel it is important to explicitly state this point of view, as it has been left largely implicit in the consultation paper’s discussion and could lead to ambiguity.

That said, whatever model is ultimately adopted, it should also be uniform in its interface with aggregators and VPPs across the NEM. If this is not the case, extra development and transaction costs are put on these service providers/aggregators, with a loss in overall system efficiency. This perspective does not preclude different approaches being trialled or tested during the development of the open energy networks architecture.

6. Immediate actions to improve DER coordination
6.1. Are these the right actions for the AEMO and Energy Networks Australia to consider to improve the coordination of DER?

- We have shown a collaborative, cross organisation project can work to test technology and demonstrate some very interesting outcomes.
- The point on “Sharing information relating to bilaterally provided DER services” is particularly important. The permission structures required to safely pass DER response to wholesale market condition though the distribution and transmission networks at operational timescales requires considerable development, and would benefit immensely from automation.
- Support technology development projects and trials which will provide DER capabilities and coordination capabilities capable of tackling emerging issues and addressing emerging market opportunities.

6.2. Are there other immediate actions that could be undertaken to aid the coordination of DER?

Support (from networks, as well as retailers, technology providers, funding agencies) for deployment trials within proposed model frameworks. Of particular concern based on the CONSORT experience are trials that supporting scaling up of technologies, as the computational, communication and organisational burdens can become unwieldy.

3 CONSORT approach

The CONSORT Bruny Island Battery trial is a ground breaking project that combines people power to solve real network problems. In a world-first, the trial is demonstrating how to optimise a network with large amounts of energy storage, solar, diesel and a nearly 70 year old cable with the capacity for customers to maximise their own energy usage.

3.1 Background

The core technology underlying the CONSORT project is the *Network-Aware Coordination* (NAC) software. The NAC software is a model-based optimisation tools that implements a dispatch engine-like service for distribution network operators. The NAC does this by coordinating individual battery systems and hot water storage that are located in people's homes, and can be extended to a range of other DER including other flexible loads. More technical details of the approach are given in the Section 3.3.

For Bruny, the NAC is interfaced to TasNetworks distribution networks operation centre, which is tasked with dispatching Bruny Island's diesel generator in the event of peak loads, and Reposit's *GridCredits* platform, which is tasked with optimising power flows at the customers residence. By providing network support via battery discharge, the network no longer needs to rely so much on diesel generation for peak periods.

Beyond this, the solution provided by CONSORT can be applied not only to edge of grid locations, but importantly to any distribution network requiring stabilisation related to high penetration of renewables and DER.

This project is delivered through a partnership between industry and researchers. To meet the challenge of solving such a complex problem, the team is made up of a unique breadth of expertise covering economics, power systems, computing, and social science. This has allowed the project team to learn about the whole path from the network and software provider right down to customer experience. Customers are central to the delivery of this project and contribute key learnings to enable us to understand real life barriers to rolling out the technology at scale. The Australian Government, through the Australian Renewable Energy Agency (ARENA), is providing $2.9m towards the $8m CONSORT project under its Research and Development Programme.

3.2 Challenges addressed by CONSORT

The key question posed by the discussion paper is:

> *"What new capabilities, functions and roles will be required to coordinate and optimise the value of customers' DER investments whilst maintaining security and reliability across the NEM and WEM?"*

The Bruny trial is a complex project involving a range of stakeholders. The broad spectrum of stakeholders included researchers, utilities, a technology start-up, and the installers and customers who are participating.

Specifically, the trial is demonstrating how to:

1. optimise a network with large amounts of energy storage, solar, and an aging cable, while
2. allowing customers to maximise their own energy usage, and also
3. opening new revenue streams to customers for using their DER to provide network support.

The key challenges that have been tackled in the CONSORT project are:

- Detailed network modelling,
- Device-level DER modelling,
- Renewable generation and load forecasting,
- Integrating a distributed optimisation framework with the network and device models and forecasting tools,
- Network support pricing,
- Assessing customer engagement activities and efforts to building trust and acceptance of energy technology in use.

Our responses to the consultation question above are guided by our experience in the Bruny Island trial. More detail of the technical solution developed by CONSORT - the modeling framework and NAC algorithms - are provided below.

3.3 Technical details

NAC is fundamentally designed with DSO operations in mind. It enables the DNSP to ensure the safety and reliability of the network is maintained while allowing customers to optimise the use of their own DER. It does this through an automated negotiation process. The NAC negotiates battery operations with the household via the Reposit controller box, which acts as the customer's agent in the negotiation, to reach an optimal consensus on battery discharge schedules. In these negotiations, computer algorithms request battery assistance at a price that reflects the value to the network, and the Reposit controllers accept a price that reflects value to the individual. The NAC arrives at an optimal solution that both benefits the network and the consumer, with the potential to avoid costly upgrades and drive down electricity prices for customers.

In particular, the novel and groundbreaking aspects of the CONSORT approach are:

- Customers have ultimate freedom to decide how they respond;
- It explicitly allows several price signals to coexist as alternative offers to the DER controller agent, and be co-optimised by the NAC system;
- The NAC does not issue a direct control signal, but rather negotiates a price (and target consumption) with customers. This means that customers still have ultimate say over what happens (constraint oversight requirements notwithstanding), and;
- NAC comes to an optimal dispatch at a market clearing price within the network's operating constraints.

To understand how this process benefits both customers and the DNSP, we now provide more detail on the approach underpinning the NAC technology developed in the CONSORT project. To start, we take the perspective that detailed mathematical models of the distribution network (DN) and customer DERs are essential to both the design and operation of any open energy networks (OEN) architecture. Given that this is a large system with many independent actors, a useful approach is to break the model up into distinct agents with their own individual objectives and constraint. In distribution networks, the most important agents are typically (i) the DNSP and (ii) electricity customers, with retailers and/or aggregators also playing an essential part if the goals of the DMM extends beyond local network management issues to wider wholesale market considerations. Building on this, when modeling the behaviour of an agent it is useful to think in terms of their actions, constraints and their objectives. Within this context, an OEN architecture specifies how agents interact with one another and the payments that are exchanged between them, it therefore influences the agents' models, for example, by adding a new revenue stream for providing network support, which the agents need to consider in their objective.

3.3.1 DNSPs

The primary objective of a DNSP is to provide their customers with safe and reliable access to electricity, and to do this within a limited operating budget. With customer adoption of DER, this objective is shifted towards not just providing customers with access to electricity supply, but also with the opportunity to provide energy and power services back to the network and system. Putting faults to one side, the key physical constraints that limit a DNSP's ability to achieve these outcomes in a high DER future are (i) the current carrying capacity of equipment (e.g., conductors and transformers) and (ii) their rated voltage limits. In addition, regulated limits on voltage at the point of customer supply must also be considered.

A good starting point for an OEN architecture for day-to-day operations of a distribution network is a model of the physical network itself. In the CONSORT project, this is used to simulate the voltages and currents on the network, and incorporates line limits and well as an objective that takes into consideration any variable operating costs. These costs may be those known to the DSO, such as the operating costs of a diesel generator or the degradation cost on a substation transformer, or they may be those negotiated with assets owned by other parties, such as customer-owned batteries.

3.3.2 Customer-owned DER

Like a DNSPs assets, the operation of customer-owned DER are also governed by physical constraints and operational costs. For batteries, physical constraints include charge and discharge power ratings, charge capacity and the current state of charge. Flexible loads have their own physical characteristics, which have to be appropriately modeled.

Regarding costs, in the specific case of batteries, the most relevant costs are often opportunity costs, representing situations where energy can either be put to a valuable private use or sold to a DNSP or aggregator (at a profit, if the customer is acting rationally). Of course, the operation of DER affects the distribution network state - injecting real power from a DER has effects on the power network - so having good visibility and/or control of DER has many benefits from the DNSP’s point of view. It is the NAC algorithms that bring these two sides together - more below.

However, before discussing NAC, one challenge that arises when trying to coordinate the actions of many independent DER owners to implement any form of control is eliciting the cost and resource availability parameters of those assets truthfully, or at least close-to truthfully. The economic principles underlying this have a straightforward intuition: truthful elicitation of costs leads to optimal or efficient outcomes, because the cost-minimising optimisation problem cay be correctly formed; while misreported costs can lead to economically inefficient outcomes.

In the CONSORT project, this elicitation is facilitated by Reposit's controllers, which take the role of the customer's agent, and interact via automated negotiation. Reposit's systems act in the interests of customers and only offer services at a profit to DER owners. Specifically, the Reposit controllers hold the private cost and resource availability information of consumers and use this to make offers, via the NAC, to the DNSP (or procurer of other services). In this way, cost information and resource availability needs to be only incrementally revealed by the customer (or their agent), which has an additional benefit of keeping much of this information private.

3.3.3 NAC algorithm

The NAC algorithm is the bridge that links these two sides. Armed with a network model, the NAC makes decisions about how to operate the available assets on the network. Effectively, this makes the NAC a distribution dispatch engine, itself informed by negotiation-based elicitation of costs from customers' agents, which ensures that the solutions produced meet the operating constraints of the network at lowest cost.

The negotiation process itself is conducted using tools from the cutting-edge of mathematical programming and distributed optimisation research. The finer details of these methods are omitted, but many are available in publications by the CONSORT academic partners.