INTELLIHUB

Intellihub

Demand Flexibility Platform

Knowledge Sharing Report 1 | July 2023

Purpose

The purpose of this document is to provide an initial update to the Australian Renewable Energy Agency (ARENA) and the industry regarding lessons learned to date on the Intellihub Demand Flexibility Platform Project.

Acknowledgements and Disclaimers

This project received funding from the ARENA as part of ARENA's Advancing Renewables Program.

Contents

Acronyms

Acronym	Description
AFLC	Audio Frequency Load Control
AMI	Advanced Metering Infrastructure
API	Application Programming Interface
CER	Consumer Energy Resources
CSIP-Aus	Common Smart Inverter Profile – Australia
DERMS	Distributed Energy Resources Management System
DNSP	Distribution Network Service Provider
EV	Electric Vehicles
LTE-Cat M	Long-Term Evolution Machine Type Communication
NEM	National Electricity Market
OEM	Origin Equipment Manufacturer
V2G	Vehicle-to-grid
VPP	Virtual Power Plant
Wi-SUN	Wireless Smart Utility Network

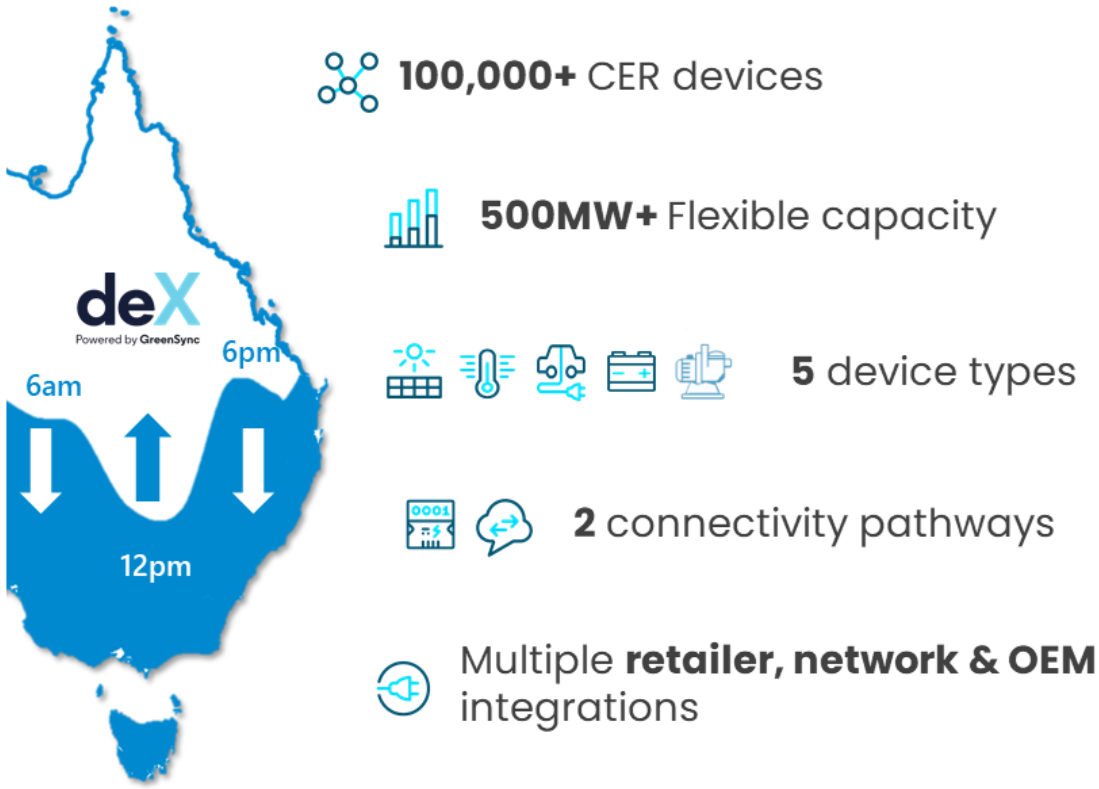
1 | Background

1.1 | Project Overview

Intellihub has launched a Demand Flexibility Platform (the Platform) targeting over 500 MW of aggregated load under control with over 100,000 customer devices enrolled (the Project). The Platform builds on the deX platform developed by GreenSync, and will target registration of hot water systems, solar inverters, batteries, electric vehicle (EV) chargers, and pool pumps over a two-year period.

The Project will allow Virtual Power Plant (VPP) operators, such as retailers, and networks, and aggregators to enable flexible operations of Consumer Energy Resources (CER or Devices). VPP operators can integrate their VPP with multiple device types and manufacturers through a single integration, avoiding the costly development of systems, multiple device integrations, installation and additional communication systems.

Figure 1 Overview of the Intellihub Demand Flexibility Platform



1.2 | The Flexible CER Opportunity

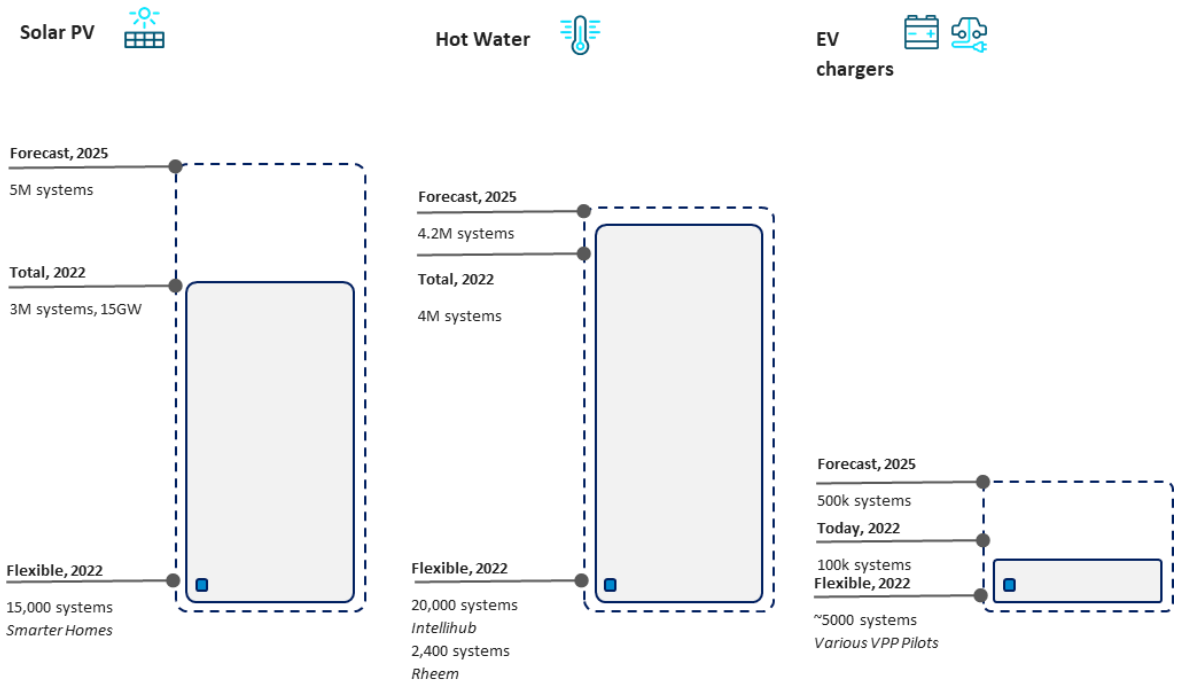
The recent growth in CER such as hot water systems, rooftop solar, battery storage, pool pumps, and electric vehicles (EV) present the energy industry with both a significant challenge and an exciting opportunity. Uncoordinated, these CER contribute to stability and reliability challenges for the grid. However, when aggregated at sufficient volume through VPPs CER can provide much needed demand flexibility, unlocking benefits for retailers, networks and consumers.

Table 1 Benefits to retailers, networks and consumers

Retailers	Networks	Consumers
✓ Reduction in wholesale energy costs ✓ Reduction in network costs ✓ Improved customer engagement	✓ Greater utilisation of network during off-peak hours ✓ Reduces voltage issues on network from excessive solar exports ✓ Defers costly network upgrades	✓ Financial benefits from participating in VPPs ✓ Smaller carbon footprint by maximising off-peak or rooftop solar consumption ✓ Highly automated device operations with minimal customer involvement

The vast majority of CER is at present 'inflexible', meaning it's not possible to harness the benefits of flexibility from the gigawatts of energy that they generate or consume. To date, the industry has not been able to efficiently aggregate these resources into VPPs at scale due to the cost and complexities of integrating multiple device types and device manufacturers. Scalable CER connectivity and interoperability between customer, grid and market systems are critical to realising the full potential of CER and mitigating their adverse impacts. Figure 2 below illustrates the untapped opportunity of operating CER in a flexible manner.

Figure 2 Opportunity sizing of flexible CER



2 | Solution Overview

The Intellihub Demand Flexibility Platform solves the challenge of integrating and managing multiple Original Equipment Manufacturers (OEMs) across a range of device type, enabling rapid scaling of VPP platforms. This platform integrates Intellihub's smart meter technology with GreenSync's CER registration and control software, deX to enable the realisation of a scalable CER registration and connectivity platform.

This platform will allow VPP operators, such as retailers, networks, and aggregators to integrate with multiple devices and device types through a single integration with one platform.

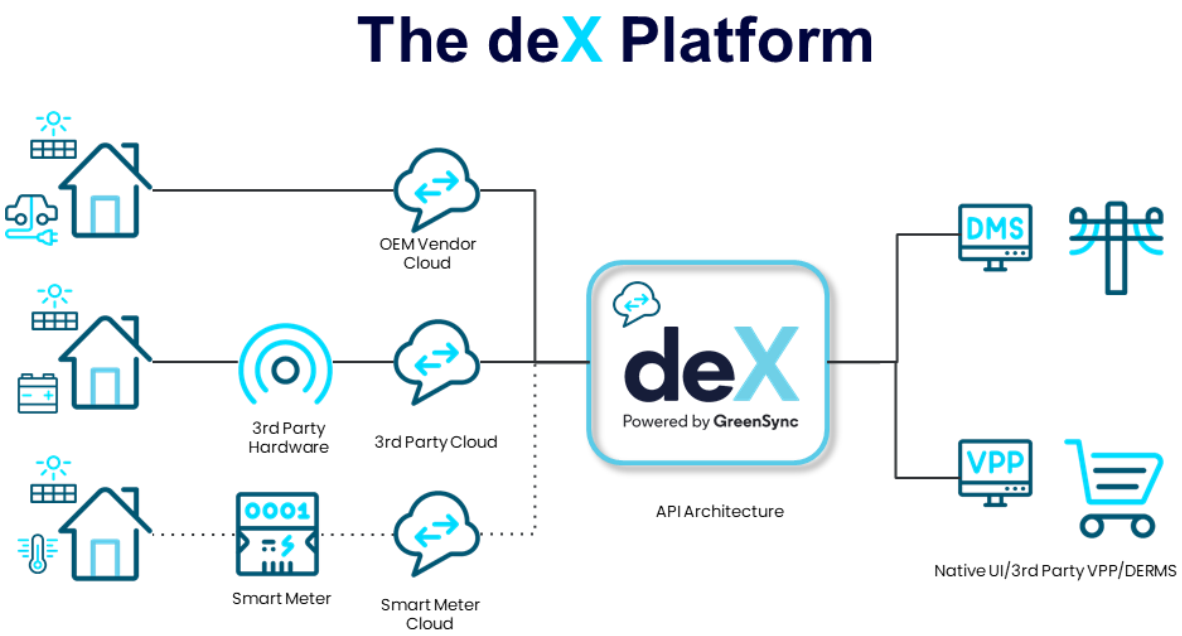
2.1 | deX

The deX platform has been developed by our technology partner GreenSync, and is the foundation of the Demand Flexibility Platform. deX is an Application Programming Interface (API) based platform that facilitates communication of CER instructions and CER data from multiple parties, reducing the costs and management overheads of integration, churn management and compliance.

The deX platform is complementary to other demand management solutions and is agnostic to technologies and vendors. Additionally, the platform is agnostic to CER type, brand and applications, which guarantees a universal technology pathway for connecting 'behind the meter' CER to any utility northbound platform used for CER orchestration and control.

With deX acting as a central integration point for OEMS, VPP aggregators, ADMS and DERMS it solves the 'many to many' problem for CER by reducing the number of point-to-point integrations, as illustrated in Figure 3 below.

Figure 3 The deX platform



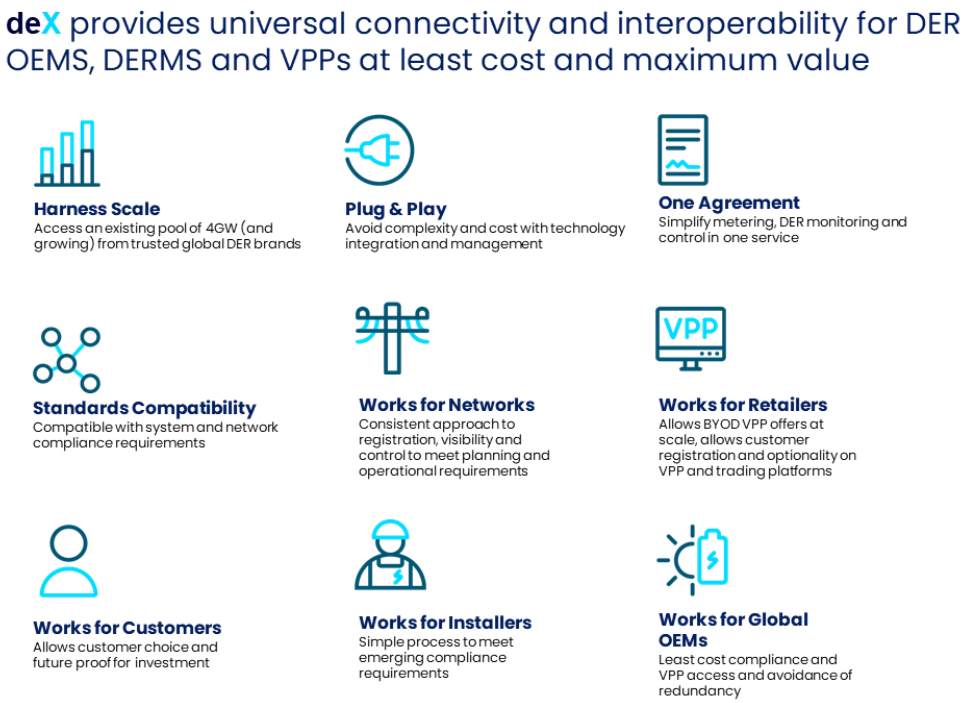
To achieve the above outcomes, a number of core capabilities have been implemented within the deX platform and APIs, including:

1. Registration and contracting CER (with a clear distinction between the two)
2. Non-exclusive interaction between a party (e.g. a retailer and network) and a CER, with visibility and coordination between parties
3. CER provision of both control and data information services
4. Enactment of dynamic/flexible export limits on CER by a network/system operator
5. A robust approach to control of CER
6. A complete solution for near real time telemetry provision
7. A system of record for all CER activity/behaviour to enable retrieval for reporting and analysis.

Compared to direct integrations with individual demand management providers or device manufacturers, the following benefits are realised when integrated with the deX platform:

- **Immediate access to registered CER -** Provides immediate access to an existing pool of thousands CER from trusted global brands without additional hardware.
- **Reduces integration complexity -** De-risks project delivery and reduces ongoing API maintenance by reducing the number of point-to-point integrations between OEMs, VPP platforms and DERMS systems.
- **Designed for scale -** deX has been designed to scale for millions of registered CER, with the platform already controlling hundreds of thousands of CER in real time.
- **Universal CER Connect -** Allows all CER to register in a standard format via customer Wi-Fi or via Intellihub's metering solution pathway. This also allows OEMs to maintain global approach to functions and avoid jurisdiction specific changes.
- **CER registration and contracting -** deX presents heterogeneous CER across device types and OEMs as homogeneous, enabling low friction customer authorisation for registration and contracting.
- **Standardised control and telemetry -** deX provides a unified and consistent approach for CER control and telemetry across multiple devices types and OEMs.
- **Network friendly -** Enables functionality for CER to operate with consideration for network defined limits. Provides future proofing of solution with respect to any future regulatory changes that enforces safe operation of CER (e.g. South Australia Smarter Homes and Flexible Exports regulations).

Figure 4 deX platform benefits



2.2 | Device integration and connectivity

The Intellihub Demand Flexibility Platform offers multiple ways to connect multiple device types and manufacturers to retailer VPP Platforms or network Demand Management Platforms, as shown in Figure 5. The two connectivity pathways are through the OEMs APIs via the cloud, and via Intellihub meters. More details on both pathways are provided below and illustrated in Figure 6.

2.2.1 | Integration via OEM Cloud

Integrations via the OEM cloud are enabled through partnership with OEMs and the establishment of APIs that connect the Platform with the OEM's own cloud-based monitoring and control system. This cloud solution is considered low cost and scalable as it can utilise a devices' existing cloud connectivity via the consumers existing home internet connection. Majority of devices on the Platform are expected to integrate via this pathway.

2.2.2 | Integration via Intellihub meters

This pathway involves establishing a connection to devices through Intellihub's smart meters and its onboard communications capability to monitor and control devices. The communications modem linked to the smart meter also contains multiple technologies for connectivity including LTE-Cat M, as well as Wi-SUN and Wi-Fi which provide connectivity to local devices. Device monitoring and control via this pathway is supported through a secure cellular 4G network.

For devices that are not able to communicate directly with the meter, a communications bridge known as the 'Intelli-Bee' can be installed to enable communications. Through this pathway, devices can connect directly to the smart meter and participate in VPPs.

Figure 5 Conceptual Solution Overview

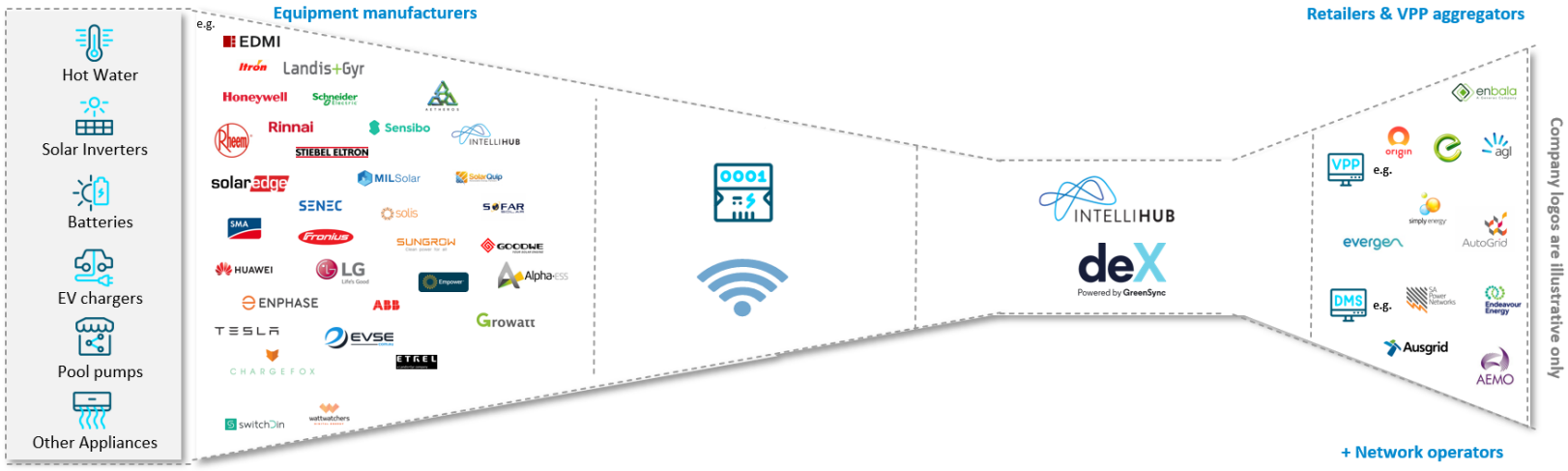
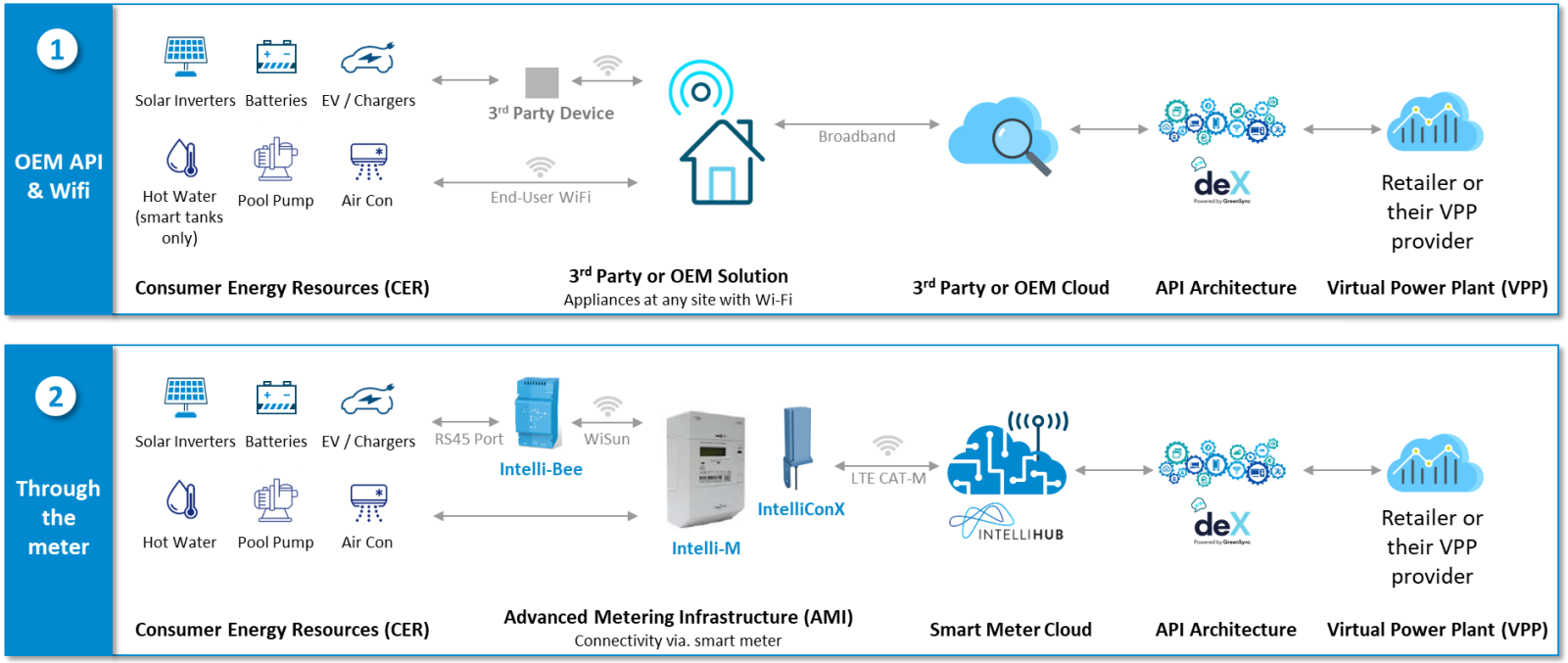


Figure 6 CER connectivity pathways to deX



2.3 | Device Registration

Both connectivity pathways converge to the deX platform. deX is not a VPP management platform itself and not provide any optimisation or orchestration of devices. It acts as the registration and connectivity layer that enables retailers and networks to register and control customer devices in their VPP.

VPP managers, such as electricity retailers, will integrate their own VPP management platforms with deX as a means of accessing devices. This means that VPP managers avoid the cost and complexity of multiple OEM integrations which presents a significant barrier to scaling. It also allows for an OEM and technology agnostic model that lets the customer choose which devices they install. This is similar to 'bring your own battery' models but with a more extensive range of compatible devices and OEMs.

2.4 | Customer Acquisition

The target customers of Intellihub's flexible load platform are VPP operators such as electricity retailers, distribution networks, as well as CER aggregators. The end consumer is an indirect customer, with the retailer, network or aggregator responsible for managing the relationship with the consumer.

Operating under a business-to-business model, Intellihub is not directly responsible for developing the exact products and services that are offered to consumers. The platform provides the underlying infrastructure and capability and that allows VPP operators to come up with innovative offers and propositions for their customers.

2.5 | Targeted Devices

The Demand Flexibility Platform will be offered to VPP operators to enable flexibility across multiple device types. An overview is provided below for each device.

Hot water

Electric hot water units can be enabled through dual element smart meters to turn on during low demand periods to soak up excess renewable energy such as rooftop solar generation.

Solar Inverters

Solar inverter exports can be managed during low demand periods to take advantage of negative wholesale prices and be responsive to system security. The solution can be combined with increased load from other devices such as hot water and EV charging.

Batteries

Battery systems have a range of services being able to charge and discharge. Providing both demand and ancillary services.

EV Chargers

Similar to stationary battery systems, EVs have a range of services being able to charge and discharge. Providing both demand and ancillary services. As EV take up grows there is an important role to coordinate charging profiles and unlock V2G at scale.

Pool Pumps

Pool pumps use a large amount of energy in a residential homes with swimming pools. This project will trial flexible operations of pool pumps. If successful, it will enable the integration of another device class into VPPs.

2.5.1 | Hot water

There is a significant amount of domestic electric immersion hot water systems in Australia today, and because they have a relatively high electricity demand they can store material amounts of energy in the form of hot water for use at a later time. The timing for activating hot water systems to consume load from the grid can be quite flexible without impacting customer experience. This makes it an ideal flexible load to help manage the electricity grid.

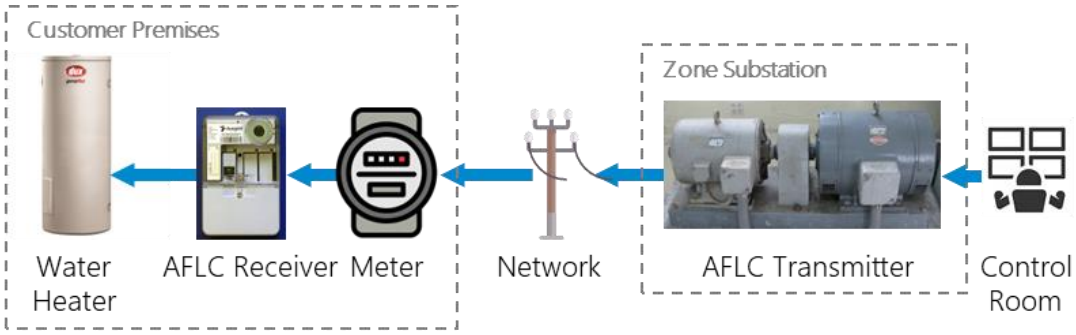
Current state

Today most of these hot water systems are typically controlled by a Distribution Network Service Provider (DNSP) using Audio Frequency Load Control (AFLC) technology. More details on AFLC are provided below:

- AFLC, also known as 'ripple' control is a legacy technology used by electricity networks to remotely turn on and off electrical equipment, including electric hot water heating for 'controlled load' tariffs.
- AFLC requires a signal transmitter, which is installed at the substation, and a signal receiver, installed in the meter board.

Hot water systems controlled through this technology are operated without reference to wholesale market conditions, and require the maintenance and replacement of aging AFLC transmitters in zone substations. Figure 7 below illustrates this technology.

Figure 7 Control of hot water systems through Audio Frequency Load Control

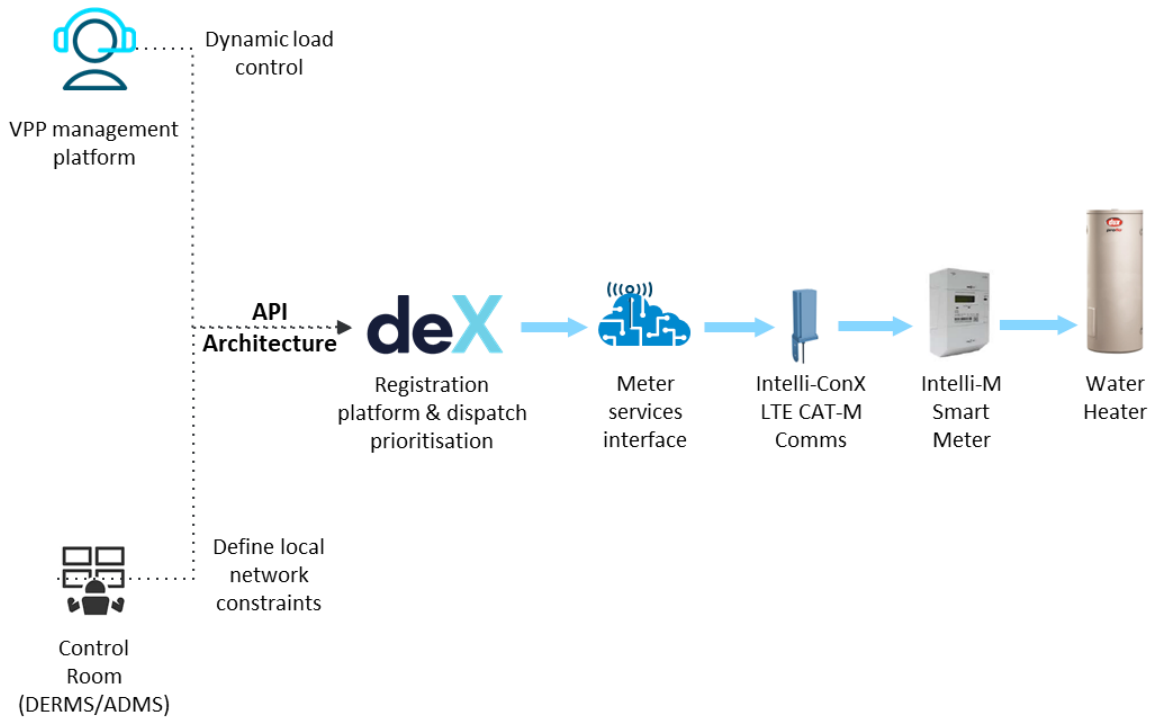


Future state

The rollout of smart meters with the capability to switch load on and off based on a time-schedule or remote commands presents a lower cost way of controlling hot water systems. Controlling hot water systems through a smart meter also permits more granular load control as individual premises can be controlled, rather than the whole zone as a single group. It also removes the need for the AFLC receiver and associated costs.

Today, Intellihub removes AFLC receivers, and provides the load control functionality with the smart meter as a business-as-usual activity. Integrating the smart meter head-end systems with the deX platform allows both retailers and networks to dynamically control these hot water systems, as illustrated in Figure 8 below.

Figure 8 Control of hot water systems through Intellihub smart meters and deX



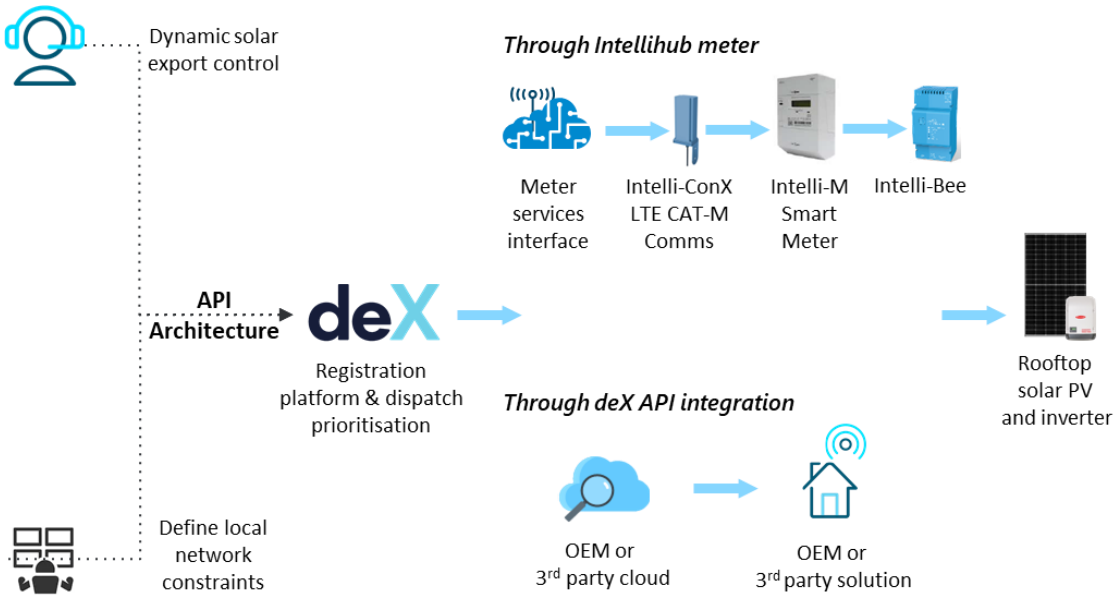
2.5.2 | Solar Inverters

Solar inverters are a form of flexible supply rather than flexible load, however they can still play an important role in VPPs by dynamically curtailing exports when surplus solar is creating grid stability issues or negative wholesale electricity prices.

The penetration of rooftop solar inverters is expected to continue to increase, and the average system size is also expected to increase as the cost of panels decreases. Intellihub will offer retailers and networks a control functionality to dynamically adjust the settings of solar inverters enrolled in their VPP. In return, they can offer their customers incentives to participate in the dynamic solar export program.

Connectivity from the solar inverter to deX can either be through an API integration to the manufacturers cloud, or through Intellhub's meter backhaul. Retailers and networks would integrate with the deX platform to register these devices in their VPP, as shown below in Figure 9.

Figure 9 Control of solar inverters through Intellihub smart meters and deX



2.5.3 | Battery inverters and EV charging

The benefits of integrating home batteries into flexible load platforms like retailer VPPs are well understood and provide both the retailer and the consumer a benefit by shifting load away to off-peak times (or when solar is available) and exporting during peak times. Many retailers currently operate battery based VPP products, either via the 'bring your own' model, or via a direct sale and installation model.

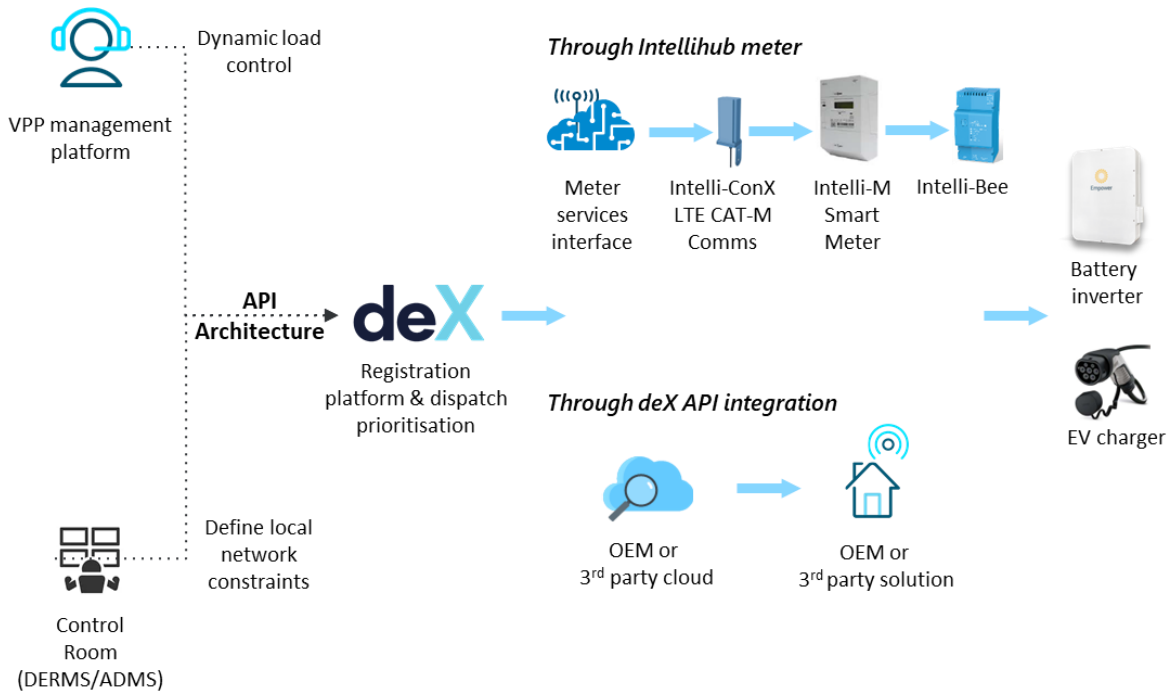
Batteries are the most flexible resource available to the Platform, given they can be charged and discharged very flexibly. However, they are limited in volumes given the relatively high cost of a battery for consumers and relatively slow payback period.

In the medium to long term, EV charging presents a big opportunity given that the typically EV battery has 3-10 times more energy than a typical home battery. Coupled with the long term expected uptake of EVs which will far exceed the uptake of batteries, the flexible capacity available via EVs will likely exceed stationary home batteries.

There are two key applications of managing EV charging, one is a smart charging capability that ensures customer EV charging is shifted away from peak times. This form of managed charging will be crucial to minimise peak load on the grid. The other is vehicle-to-grid (V2G) technology, which involves the vehicle battery exporting back to the grid. The use of V2G is currently limited to early adopters of the technology, but it may play a key role in future grid operations if there is significant consumer uptake.

The conceptual control architecture of battery inverters and EV chargers through deX is illustrated below in Figure 10.

Figure 10 Control of residential batteries and EV chargers through Intellihub smart meters and deX



3 | Milestone 1 Knowledge Outcomes

This is the projects first Milestone and 'Lessons Learnt' provided in this section are preliminary. Further insights are expected to be provided over the course of the project.

Activities in this milestone include:

1. Project mobilisation and establishment of project working groups.
2. The development of functionality in deX to enable remote management of schedules for hot water systems connected to controlled load circuits.
3. Successful integration between deX and Intellihub systems, making over 150k residential hot water systems available for registration in VPPs.
4. Engagement with the industry on the Platform, including consultation on Platform design and technical support for customers and potential customers of the Platform

3.1 | Lessons learnt 1 – Close engagement with the industry is crucial to ensure the Platform is fit-for-purpose

The CER landscape is still nascent, with rapidly evolving technologies, regulations, and business models. Across the industry, retailers are increasingly making investments to develop VPPs to engage customers, and access additional value streams in wholesale or ancillary services markets. Networks are also in the process of building out their Demand Management Platforms to manage CER to avoid or defer network upgrades, or to improve grid stability and utilisation.

Retailers and networks are still early in their journey when it comes to CER management, they are also trialling different approaches to register, connect and control devices. Due to the above factors each retailer and network are at different levels of readiness and have different requirements for the Platform. To ensure the Platform meets the requirements of the industry, it is critical that Intellihub continues to actively engage with retailers and networks to ensure that the Platform is fit for purpose, and that our product roadmap is aligned with the most pressing needs of our customers.

3.2 | Lessons learnt 2 – The value of flexibility varies across device type

The project focuses on the device registration and connectivity of residential hot water systems, solar inverters, EV chargers, residential batteries and pool pumps. The value of flexibility for each device to a retailer varies according to a few factors, including:

- The typical load or generation profile.
- The maximum load or generation output.
- The extent that the device can be operated flexibly without impacting consumer experience.

To provide retailers with an initial indication of the value of flexible device operations, Intellihub performed high level analysis to estimate savings in wholesale energy cost from shifting the baseline load profile of hot water systems, pool pumps and EV chargers. The assumed max load, average daily usage, timing of when the device is typically used, and optimised timing is shown below:

Table 2 Device max load, daily use and operational timing assumptions

Device	Max load (kW)	Av. daily use (hrs)	Operation timing – baseline	Operation timing – optimised
Hot water	3.00	2	12am	12pm
EV charger (charged once a day)	7.60	1	6pm	2am
EV charger (charged once a week)	7.60	7	6pm	2am
Pool pump	1.50	10	9am	7am

The estimated annual savings in wholesale energy costs are shown in Table 3 below. The extent of savings varies by device, the assumed baseline profile and by state. Managing daily EV charging was found to have the most value, as charging is deferred to avoid the evening peak period. Shifting hot water and pool pump load was also found to have material benefits, providing annualised savings of over $100 in most NEM regions.

Table 3 Savings in wholesale energy cost from shifting device consumption profiles

Device	NSW	QLD	SA	TAS	VIC	NEM
Hot water	$120	$166	$203	$35	$125	$130
EV charger (charged once a day)	$560	$1,242	$584	$304	$467	$631
EV charger (charged once a week)	$142	$273	$79	$49	$151	$139
Pool pump	$200	$388	$27	$16	$125	$151

The above figures represent savings from a basic VPP strategy of changing the daily operating schedules of hot water, EV chargers and pool pumps. Advanced optimisation from reducing consumption during high wholesale price intervals, or increasing consumption during low or negative price intervals will yield additional savings. Future reports will provide further analysis of this and also explore the value of curtailing solar generation during negative price periods.

Estimation methodology

Savings in wholesale energy cost was estimated by calculating the difference in average wholesale energy cost from shifting a devices baseline load or generation profile to an optimized profile. The key steps are outlined below:

1. A baseline daily load profile for hot water, EVC and pool pumps were developed.
2. An optimised load profile was determined by minimising wholesale energy prices by adjusting the timing of grid imports.
3. The yearly wholesale energy cost was calculated for the baseline profile and optimised profile, using average hourly wholesale energy pricing.
4. The arbitrage revenue was then calculated as the difference in wholesale energy cost between the baseline profile and the optimised profile.

Assumptions

- Each reference device was assumed to have a daily profile, following the same load or generation, usage timing and duration.
- Wholesale pricing based on 2022 Regional Reference Price for NEM each region.
- Assumes neutral impact from network tariffs (to be explored in future reports).

Appendix A - Company Overview

Intellihub

The Intellihub Group is a leading Australian and New Zealand based utility services company that delivers innovative metering and data solutions that maximise digital and new energy services. It is an experienced and leading provider of multi-utility services across electricity, gas and water networks for residential, commercial & industrial, embedded network and solar metering customers. It specialises in asset management, installation, financing, and the day-to-day operations of smart meter. Intellihub is the only independent smart metering provider across Australia and New Zealand, supplying smart meters to all leading retailers. Since February 2022, Intellihub is also the exclusive distributor of GreenSync's deX services across the Australian and New Zealand market.

CrescoNet

CrescoNet was spun out of Intellihub in 2020 as a separate technology arm to focus on digital metering and CER services complimenting Intellihub's metering infrastructure services. CrescoNet Group, with its headquarters in Sydney, Australia, runs and operates a number of businesses worldwide delivering integrated digital utility IoT solutions and services for smart water, gas, electricity and CER management.

GreenSync

In late 2021 Intellihub acquired GreenSync and their Decentralised Energy Exchange (deX) platform, a proven CER registration and verification platform that is deployed across the world; from remote solar curtailment in South Australia, EV partnerships with Wellington Electricity in New Zealand, to providing a digital marketplace for distributed renewable energy as part of the world's most advanced network control system in the United Kingdom. GreenSync's deX platform is designed as a CER registration and verification service that can then be controlled by a regulatory authority, retailer and/or network. Intellihub can provide this registration and verification service independently of our smart metering platform.

GreenSync Pty Ltd was founded in 2010 to enable CER such as rooftop solar PV, batteries, load control and EVs to connect to the grid and provide renewable energy services. Its deX platform has been designed and built to meet the growing challenges of high penetration CER in grids using Application Programming Interface (API) cloud technology. While deX is rapidly scaling in Australia to meet the exponential growth in rooftop solar PV, deX is also being piloted in New Zealand, Japan and the UK to manage EVs, heat pumps and energy storage.

GreenSync has partnerships with over 95% of the global solar PV and energy storage inverter manufacturers and is actively expanding its services to a range of other technology providers to support grid connection requirements including EV smart charging. In February 2022 GreenSync was 100% acquired by CrescoNet, a technology arm spun out of metering services provider Intellihub.