ARENA INSIGHTS SPOTLIGHT: RHEEM SMART NETWORK PROJECT

AN INTERVIEW WITH COMBINED ENERGY TECHNOLOGIES

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Australian Government
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ARENA

INTRODUCTION

The Rheem Smart Network[1] project is demonstrating innovative approaches to flexible orchestration of behind-the-meter (BTM) distributed energy resource (DER) devices, such as rooftop solar, residential batteries, pool pumps and smart hot water systems.

In collaboration with Combined Energy Technologies (CET), SA Power Networks and a number of interested retailers, the Smart Network project is developing low-cost and scalable technologies that rewards customer participation for supporting the local network through the use of Home Energy Management Systems (HEMS).

INTERVIEW WITH:

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ARENA: WHAT ARE HOME ENERGY MANAGEMENT SYSTEMS (HEMS)?

CET: HEMS control major electrical loads and energy storage devices to minimise the total cost of energy used by a home or business. They are designed so that there is little or no interaction required by the homeowner as they coordinate devices around the home.

HEMS choose the ideal times for specific devices to consume or supply energy based on criteria such as the cost of energy, historical usage, and expected production from the building's solar PV system. To maximise savings, HEMS focuses on devices which consume the most energy in the home, such as water heaters, batteries, air conditioning systems, Electric Vehicle (EV) chargers, pool pumps and resistive heaters.

HEMS is not to be confused with Home Automation (HA), which provides technologies to monitor and directly interact with devices around the home. HA encompasses a range of applications including security, lighting, music, video and other systems. Some devices fall into both the HA and HEMS category, such as Electric Vehicle chargers and air-conditioning systems. Where this overlap exists, the HEMS will automatically manage the device on a day to day basis to minimise the cost of energy by scheduling power for the device, but the HA system may take over control based on immediate user inputs. Over time HEMS will embrace features of the HA and visa versa.

Some solutions in the market purporting to be HEMS are simple, monitoring-only systems that do not perform any active optimisation. A common feature of HEMS systems that do perform control is to focus on a single appliance or device category (e.g. battery-only HEMS), or perform rudimentary load control using relays in the meter box that is detrimental to some appliances like heat pumps.

ARENA: WHAT ARE THE CHALLENGES FACING UPTAKE OF HEMS AND DER?

CET: For DERs to become a useful tool for grid management they need to be cost effective, scalable, reliable and secure. Many networks have an immediate need for significant DERs to be available now, or in the very near term, to address stability and peak demand issues. So the challenge is to find the most cost effective way to get load and storage devices deployed as DER as quickly as possible.

1 https://arena.gov.au/projects/rheem-active-hot-water-control/

Most modern DERs (solar PV, batteries, EV chargers) are easy to integrate into HEMS as they have inbuilt networking capabilities. The main issue is that the capital cost of these DERs is quite high, resulting in a relatively low penetration. On the other hand there is a large number of installed assets, such as water heaters, air conditioners, pool pumps and heaters, that don't have native networking capabilities and as such cannot be easily leveraged as DERs.

CET, in conjunction with Rheem, has developed technology that solves this problem for water heaters, and we have recently extended this to include pool heating, pool pumps and air-conditioning.

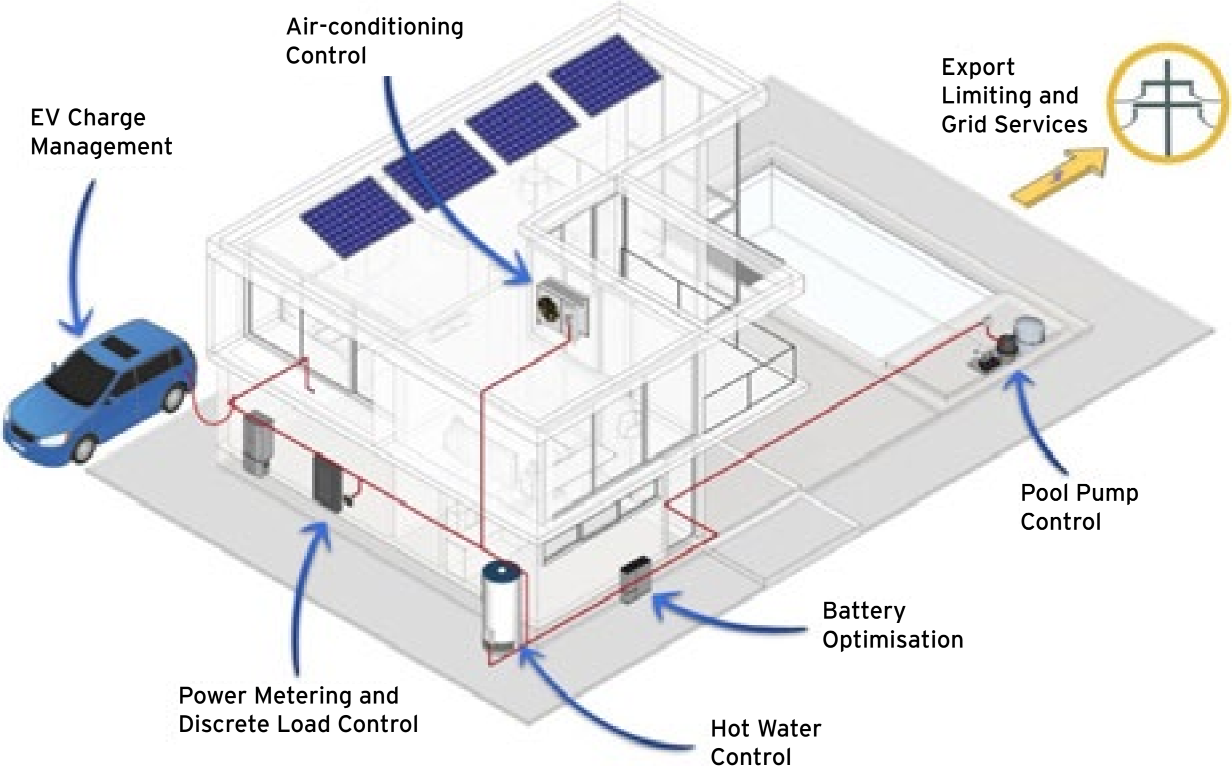

Figure: CET's Home Energy Management System (HEMS) currently being trialled as part of the Rheem Smart Networks project.

CET's HEMS technology uses the existing building wiring to communicate with load control adapters that can be retrofitted to existing appliances, removing the requirement for additional communication cabling. An added benefit of this approach is that existing plumbing and electrical trades can install new devices using existing procedures in conjunction with load control adapters to convert devices into DERs.

There is a tendency to focus exclusively on the capital cost of hardware rather than the total cost of installation and maintenance, but our objective has always been to minimise the total lifetime cost. Where possible we have designed customer installable products to remove the need for costly installations entirely, such as in the case of the EMU, air-conditioning adapter and pool controller.

ARENA: WHAT IS THE RELATIONSHIP BETWEEN HEMS, DER ASSETS AND THE AGGREGATION OF DER?

CET: Devices under the control of a HEMS can be considered a Distributed Energy Resource (DER). We believe that the natural point of management for DERs is at the National Meter Identifier (NMI) or Whole of Home (WoH) level. Encapsulating the complexity of the home behind a single resource simplifies the process of managing large fleets of DERs without compromising the ability of HEMS to optimise the home for the customer. WoH DER provides a simpler and more scalable solution that reduces cost and provides benefits for securing the required communications backhaul.

Figure: Combined Energy Technologies' EMU (Energy Management Unit)

CET's deployment model is to have an edge computing device that can manage all of the devices in the home. CET has a customer installable gateway that we call the EMU (Energy Management Unit) that will support IEEE 2030.5 EMS/ CSIP-AUS in early 2022. We also provide services to aggregate, monitor and control fleets of WoH DERs into unified resources.

ARENA: WHAT ARE THE CHALLENGES IN ORCHESTRATING DER BEHIND THE METER (BTM)?

CET: Ideally all devices would support a standards-based Application Programming Interface (API), but in reality DERs implement a wide variety of standard and proprietary protocols. To-date we have successfully integrated devices using CAN bus, Modbus, SunSpec, ECHONET, OCPP, and a number of proprietary User Datagram Protocol (UDP) and Transmission Control Protocol (TCP) protocols.

There are a few battery and EV chargers brands that do not provide APIs to their systems, and when these devices are deployed at a site with HEMS the customer is usually disadvantaged. For example, uncontrolled batteries will discharge into storage devices (such as water heaters and EV chargers) during off-peak tariff periods whereas the HEMS would normally have deferred the discharge of the battery to the evening peak tariff period. The inability to control batteries also disadvantages homeowners who are registered in a virtual power plant (VPP), as exporting power from the battery may be interpreted by other devices as an opportunity to charge, negating the expected benefit to the grid.

The distribution network service providers (DNSPs) are progressing a model of setting dynamic operating envelopes for individual NMI or parts of the network which naturally fits with HEMS and (WoH) management. The majority of the DER that has been deployed to-date has been based around a single DER type (i.e. solar or solar/battery system) as such there is little difference between single device and WoH management. As more DER is installed in a home then it will become very difficult or impossible to meet the requirements of the dynamic operation envelopes if each of the DER is independently controlled.

The challenge is to ensure that WoH architecture is deployed early in the DER deployments as retrofitting the technology will add unnecessary costs.

ARENA: WHAT BENEFITS CAN EVERYDAY CUSTOMERS EXPECT TO RECEIVE FROM HEMS NOW AND IN THE FUTURE?

CET: As retailers continue to reduce feed-in tariffs the economic case for customers using HEMS to maximise solar self-consumption will only improve. Cost-reflective tariffs such as Time of Use (TOU) and demand tariffs amplify the potential of HEMS to reduce the overall cost of energy.

The great advantage of HEMS is that it is an automatic 'price signal follower', coordinating devices in the home to minimise the total cost of energy no matter the complexity of the price signal – as tariff structures grow more sophisticated, customers can use HEMS to insulate themselves from bill shock.

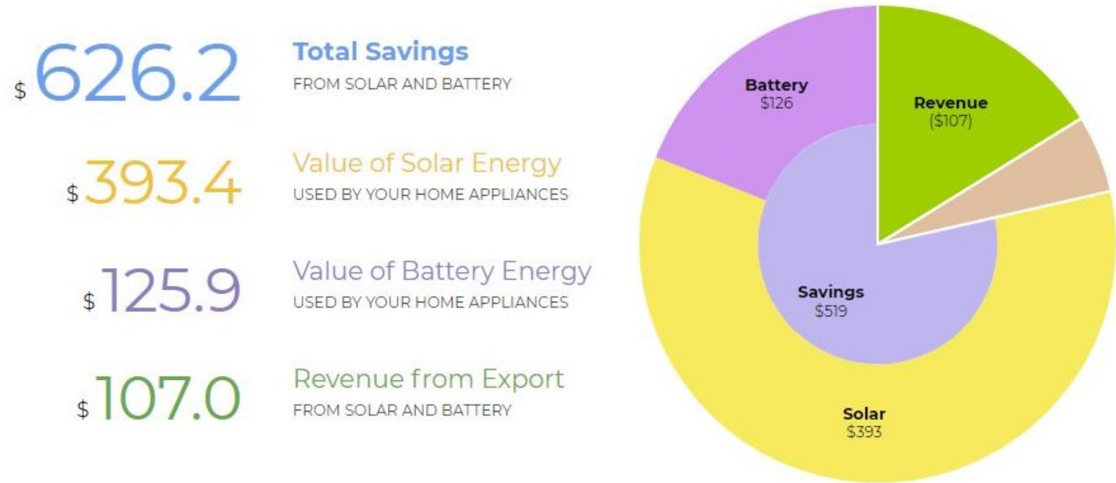

Figure: Screenshot of the CET Home Energy Management System (HEMS) coordinating residential controllable loads to deliver value for customers.

As the industry settles on IEEE 2030.5 and DNSPs implement DER management systems (DERMS) based on IEEE 2030.5 you will see a number of Australian and overseas vendors enter the market with energy management systems (EMS) products. This will drive the prices down as volumes increase and as interoperability is ensured, the homeowner will be able to easily churn between DER aggregators as new innovative market offers are created and refined.

Regardless of innovation in generation and storage, it is essential that load management be implemented as the highest priority as uncontrolled loads translate into larger ranges in the minimum and maximum grid loads. The larger the problems the more costly it will be to solve.

ARENA: WHAT DO YOU FORESEE AS THE FUTURE OF HEMS AND DER?

CET: There are many incremental gains yet to be realised in existing HEMS technologies. Better modelling of energy flows within the home can increase the value of HEMS significantly by enabling the use of air-conditioning as an 'energy storage' device. Tighter integration of HEMS and HA systems will lead to coordination of traditional energy consumers (e.g., air-conditioning) with less conventional systems (e.g. automatic blinds).

We think there will be a trend towards reduced centralisation of the energy system in the form of neighbourhood-scale energy systems and microgrids, and both HEMS and DER will be key enabling technologies for these systems. The principles of real-time optimisation performed by HEMS at the level of an individual house can be applied to an entire community, and can incorporate shared resources such as community batteries.

Further information is available at
arena.gov.au

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