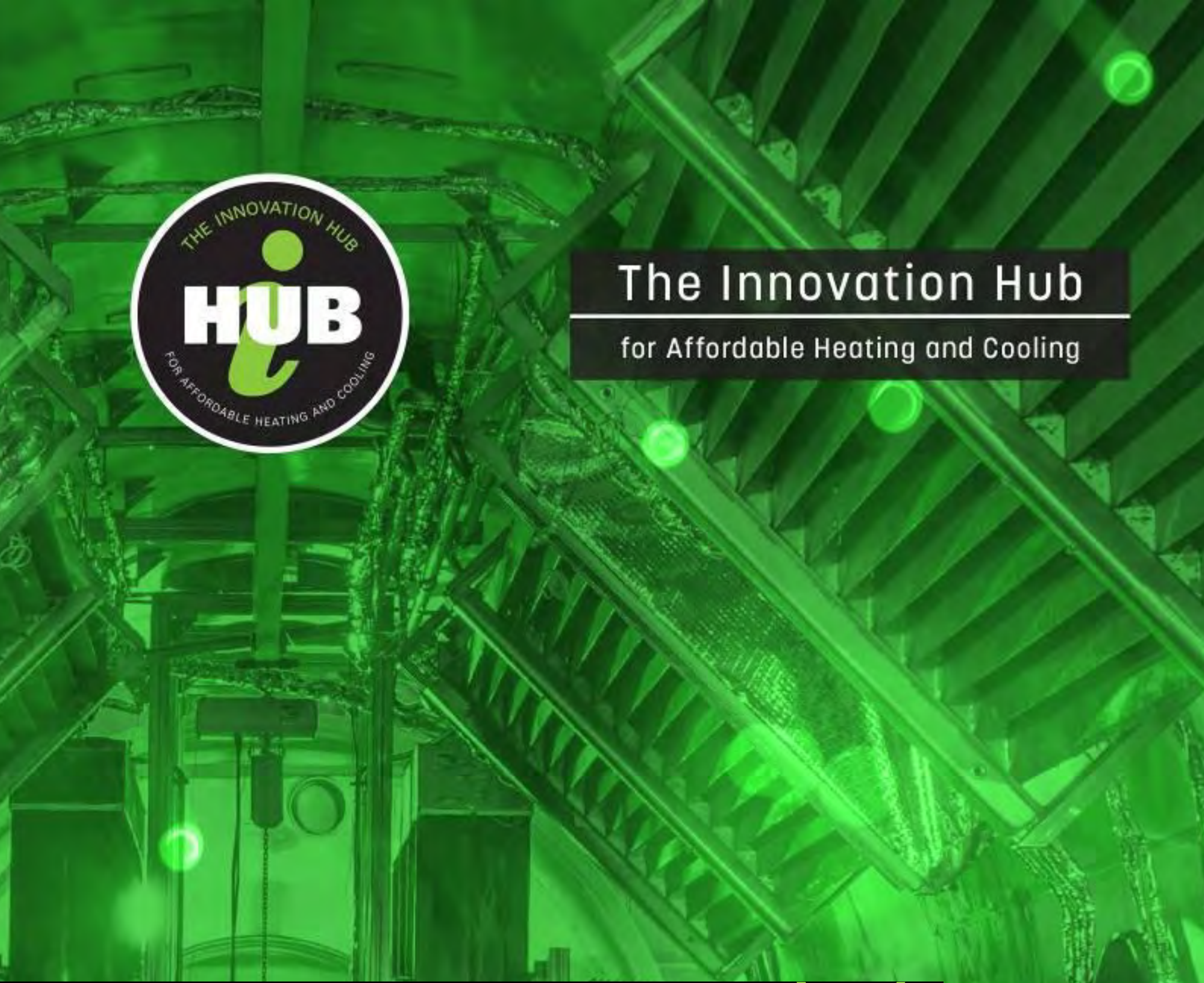

The Innovation Hub

for Affordable Heating and Cooling

Lesson Learnt Report

Precinct energy integration for accessing the wholesale demand response mechanism

DCH 3

May, 2022

DeltaQ Pty Ltd, Walker Assets Pty Ltd, CSIRO

About i-Hub

The Innovation Hub for Affordable Heating and Cooling (i-Hub) is an initiative led by the Australian Institute of Refrigeration, Air Conditioning and Heating (AIRAH) in conjunction with CSIRO, Queensland University of Technology (QUT), the University of Melbourne and the University of Wollongong and supported by Australian Renewable Energy Agency (ARENA) to facilitate the heating, ventilation, air conditioning and refrigeration (HVAC&R) industry's transition to a low emissions future, stimulate jobs growth, and showcase HVAC&R innovation in buildings.

The objective of i-Hub is to support the broader HVAC&R industry with knowledge dissemination, skills-development and capacity-building. By facilitating a collaborative approach to innovation, i-Hub brings together leading universities, researchers, consultants, building owners and equipment manufacturers to create a connected research and development community in Australia.

This Project received funding from ARENA as part of ARENA's Advancing Renewables Program.
The views expressed herein are not necessarily the views of the Australian Government, and the Australian Government does not accept responsibility for any information or advice contained herein.

i-Hub Lessons Learnt Report

Guidance notes for completion of the Lessons Learnt Report:

- This report is intended to be made public.
- Please use plain English, minimise jargon or unnecessary technical terms.
- Please use your organisation's branding for the report.
- The report should meet your organisation's publishing standards.
- Please use one template per each major lesson learnt and include as many as are relevant for your sub-Project. If what you learnt is more technical, this is the section to include technical information.
- The content of these Lessons Learnt Reports can be compiled (and updated, where necessary) for inclusion in the (public) Project Knowledge Sharing Report, for submission at the completion of your sub-Project.

Lead organisation	Precinct Energy Integration for Accessing the Wholesale Demand Response Mechanism		
Sub-Project number	i-Hub DCH3		
Sub-Project commencement date	January 2022	Completion date	May 2022
Report date	27 May 2022		
Contact name	Caoimhin Ardren		
Position in organisation	Managing Director, DeltaQ Pty Ltd		
Phone	0422 004 392	Email	Caoimhin.Ardren@dqcs.com.au

Lessons learnt

Lesson learnt #1	Operation of gas generators for demand management is best considered in terms of generators that are not operated for underlying site demand					
Category	Technical/commercial					
Choose from:	*Technical*	*Commercial*	*Social*	*Regulatory*	*Logistical*	*Other (specify)*

Describe what you learnt about this aspect of the Project.

Our review of available gas generator capacity identified that many of the cogeneration and trigeneration systems in buildings have been switched off, and indeed many have been decommissioned or even removed. This is mainly because the cost of gas and O&M far exceeds the benefit in terms of avoided electricity cost. Thus, where the opportunity exists, it would by turning these systems on purely based on the demand events rather than modulating output of a continuously running machine, as such machines are rare.

Furthermore, where a system is currently in regular operation as a cogeneration or trigeneration system, the incremental load available to respond to a demand event is a fraction of system capacity and thus often below the threshold for useful outcomes.

Please describe what you would do differently next time and how this would help. What are the implications for future Projects?

If it is intended to make use of these gas generators in demand response, there is a need to act quickly, the availability of such generators in operable condition is declining rapidly. In some ways it felt like this project was several years too late, as the raising of gas prices resulting from Australia's conversion to a gas exporter in 2015 drove most of this decline.

If your Project learnings have identified any knowledge gaps that need to be filled, please state it below.

The extent of existing, operable gas generators in the market is not well documented.

Lesson learnt #2	Slow thermal response times means that heat recovery systems are not a relevant consideration in relation to the economics and operation of gas generators for demand management

Category	Technical/commercial					
Choose from:	*Technical*	*Commercial*	*Social*	*Regulatory*	*Logistical*	*Other (specify)*

Describe what you learnt about this aspect of the Project.
Our assessment of data from Collins Square indicated that the time constant from gas input to the generator to cooling output from the absorption chiller at start-up is of the order of 50 minutes. Furthermore, part-load COP figures for the absorption chiller were very poor. As a result, in the context of the operation of gas generators to meet short term demand management events, the heat recovery/absorption chiller systems are largely irrelevant. We attempted to assess the extent to which the generator efficiency is affected by ramp rate, but the time definition of gas metering was inadequate for this task. Our first order analysis based on available data indicates that such effects are likely to be of second order.
Please describe what you would do differently next time and how this would help. What are the implications for future Projects?
Some of our analysis was hindered by the non-availability of short time-base gas consumption data to enable full characterisation of the dynamic response of generators and their attached thermal systems. Future projects would need to consider the introduction of dedicated high-frequency or continuous (rather than pulse) metering for gas consumption. However, this type of metering is not used in normal practice for buildings and so is a significant hurdle.
If your Project learnings have identified any knowledge gaps that need to be filled, please state it below.
The extent to which ramp rate affects the gas use and cost associated with demand management operation is a second order factor, but it would be useful to know. It would also be useful from a broader perspective to have further corroboration of the very low efficiency figures found for the absorption chiller at low load.

Lesson learnt #3	Achievement of a positive financial return from operation of gas generators requires capture of essentially all demand management revenue streams due to the high O&M costs for generators					
Category	Technical/commercial					
Choose from:	*Technical*	*Commercial*	*Social*	*Regulatory*	*Logistical*	*Other (specify)*

Describe what you learnt about this aspect of the Project.

O&M Costs for gas generators can be high (up to $113 per KWe). Most importantly though, these costs are largely fixed and thus a (significant) minimum level of financial return is required to justify keeping a generator operational. This in itself indicates that the maximum capture of revenue streams is desirable, and indeed no single mechanism appeared sufficient by itself to offset the O&M costs reliably. A further factor is that there is a high level of variability in the value of each mechanism in a given year, so participation in multiple mechanisms provides the best method of risk management for revenue.

Helpfully, one of the other significant findings in this area is that retailer activity in this area has grown substantially and there are numerous options for working with retailers, and dedicated demand management aggregators, to access multiple demand management revenue streams without the needs to become a market participant.

Please describe what you would do differently next time and how this would help. What are the implications for future Projects?

The project did not evaluate FCAS participation on the basis that we were unclear whether the generator plant could respond quickly enough or consistently enough to service FCAS. However, we are aware now that some demand management aggregators can manage such issues within a portfolio of other flexible loads, and thus facilitate participation in FCAS at a level that may be able to be tailored to the limitations of the gas generators.

If your Project learnings have identified any knowledge gaps that need to be filled, please state it below.

More resolution on the O&M costs of gas generators – separately from the associated cogeneration and trigeneration plant – would assist in improving understanding of the financial case.

Lesson learnt #4	The net real-time environmental impact of gas generator operation is generally negative. However, the impact on NABERS ratings is more generally positive.					
Category	Technical/commercial					
Choose from:	*Technical*	*Commercial*	*Social*	*Regulatory*	*Logistical*	*Other (specify)*

Describe what you learnt about this aspect of the Project.

In general, the average real-time emissions of the grid during demand management events are lower than average. This reduces the probability that operation of a gas generator generates electricity at a lower emissions intensity than the grid during such events. In general, we found that gas generator operation is likely to be detrimental in terms of real-time emissions. Exceptions to this are for generators in NSW, QLD and VIC, where the generators have an efficiency less than 30%, 26% and 22% respectively.

From a site perspective, on the other hand, the emissions intensity is judged from the perspective of average annual emissions factors which, being higher than the event-specific factors, are generally favourable for the use of the generator. This effect is amplified for NABERS ratings, which are based on lagging indicators of annual emissions intensity.

In terms of total emissions from the use of gas generators used for demand management, it has to be noted that the impact of generator gas use in response to short term demand events is insignificant on an annual grid-level scale.

Please describe what you would do differently next time and how this would help. What are the implications for future Projects?

As the efficiency of generation is critical in determining the emissions balance, more detailed information on the impact of ramp rate on gas consumption has an impact on determining the detail of this calculation. However, as noted above, existing gas metering data is inadequate to provide this level of resolution in the data and the effect appears to be second-order.

If your Project learnings have identified any knowledge gaps that need to be filled, please state it below.

While the real-time emissions impact of gas generator use may be detrimental, this ignores the bigger picture question of the extent to which the availability of demand-side resources enables the market to have a higher proportion of gas use. Given the low frequency and short duration of such events against the year-round emissions reduction of any incremental addition to renewable generation capacity enabled by the demand management services provided, it would seem likely that the net result is strongly in favour of the use of the generator capacity. However, it would be useful to be able to quantify this high-level balance in order to (presumably) counter any focus on the real-time emissions balance.

Lesson learnt #5	The implementation of gas generator driven demand response does not require the full functionality offered by a platform such as DCH. However, opportunities for additional flexible demand may need a DCH-level functionality to be enabled.

Category	Technical/commercial					
Choose from:	*Technical*	*Commercial*	*Social*	*Regulatory*	*Logistical*	*Other (specify)*

Describe what you learnt about this aspect of the Project.

Given that the opportunity was reduced to that of turning generator(s) on in response to well defined events while essentially ignoring the thermal side of the problem, the result is that such operation is not significantly integrated with the buildings operation in general. This means that a building-wide data systems as offered by DCH is not needed to inform operation; indeed, the use of diesel gensets in a similar manner is already a well-established component of market-enabled demand response.

In discussions with demand response aggregators, though, we found that broader flexible demand in commercial buildings, arising from the manipulation of HVAC equipment power draw during demand response events, is significantly underdeveloped. The main reason for this appears to be the uncertainty of outcome combined with concerns at site level about the loss of occupant comfort during a demand event. Given these factors, a full picture of HVAC operation, including comfort levels, is needed to obtain characterisation and access to the significant flexible load that may be available by this route.

Please describe what you would do differently next time and how this would help. What are the implications for future Projects?

Future projects need to consider the use of flexible HVAC loads for demand response, with emphasis on how to characterise the extent (kW) timing/availability and duration of those loads to enable them to be offered to the market.

If your Project learnings have identified any knowledge gaps that need to be filled, please state it below.

Future projects need to consider the use of flexible HVAC loads for demand response, with emphasis on how to characterise the extent (kW) timing/availability and duration of those loads to enable them to be offered to the market.

Lesson learnt #6	When developing building models in DCH, model development can be assisted with building model data in Kaizen (CopperTree), and to ensure model integrity, equipment and points not required in the project scope still need to be included in the DCH building model.

Category	Technical/commercial					
Choose from:	*Technical*	*Commercial*	*Social*	*Regulatory*	*Logistical*	*Other (specify)*

Describe what you learnt about this aspect of the Project.

Two aspects of DCH building models were learnt:

- Although the primary role of CopperTree in this project was to use the DCH API to send already-available BMS and EMS data to DCH, the ability to leverage the metadata of the building model in CopperTree to build the building model in DCH was attempted. A "model translator" to convert the building model metadata from CopperTree into a partial BRICK model for DCH was attempted. Here, CopperTree metadata assisted with generating the lower-level sections of the building model (details of equipment's points), leading to the population of 80% of the point classifications. However, equipment and Location classifications and relationships still required manually work to analysing and verify the onboarded points with technical documents such as Meter hierarchy charts, BMS screens etc.

- The initial approach for developing the building models for this project was to only include points and equipment required for the analysis model in the BRICK building model. However, further analysis indicated that a complete model of the building, based on all the resources available and regardless of whether those equipment and points were being onboarded, was required. A complete model ensures that gaps in the BRICK relationships are avoided. It also assists in easier querying after the model is deployed to DCH. The initial approach increased the chances of gaps in the model, which would make application development for DCH difficult and at times, impossible. The presence of these gaps would counteract the goal of DCH, which is building data standardisation.

Please describe what you would do differently next time and how this would help. What are the implications for future Projects?

Any future client using Kaizen or CopperTree can use the developed translator to fast-track the DCH model generation. As only limited parts of the model can be standardised automatically using programs and applications, manual intervention will still be required.

Even if the equipment and points are not required for the project scope, they should be included and are necessary for model integrity. The approach for building modelling needs to be a top-to-bottom method starting with defining the relationship between locations-to-equipment and equipment-to-equipment relationships. This is followed by relationships between equipment and their associated points.

If your Project learnings have identified any knowledge gaps that need to be filled, please state it below.

The extent to which similar findings might occur for other systems competing with CopperTree was not established. Such additional information may assist in the roll-out of the DCH platform.

There is an opportunity for a process/method to be developed in DCH, whereby the challenges associated with a model that gas gaps can be overcome. The ability to deploy/develop a simplified BRICK model for the purpose of a specific analysis is beneficial for projects with a limited timeline. It can also be beneficial to users who would like to explore the benefits of DCH without needing to wait for a complete building model to be developed.