The Innovation Hub

for Affordable Heating and Cooling

DCH7 Knowledge Sharing Report #005
Project Completion Report

Improving the accuracy of PV analytics and energy analytics in buildings using open asset standards and data platform integration

27 May 2022

VBIS, CSIRO, PrediQ

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.

Primary Project Partner

Improving the accuracy of PV analytics and energy analytics in buildings using open asset standards and data platform integration

Large scale adoption of technology in buildings has resulted in availability of large volume of data on the performance of HVAC and renewable generation assets. This data can be used for predicting availability of onsite generation, effectively manage HVAC operations and support decarbonisation of buildings.

While operational data exists, application of data driven analytics for accurate predictions will still require customisation of methods/models to specific systems and assets.

This project proposes the utilisation of the VBIS asset classification open standard and link them with Data Clearing House (DCH) based semantic models to demonstrate the benefits of integrated asset and building tagging systems to be used by PrediQ's analytics solutions.

Lead organisation

Virtual Buildings Information System (VBIS)

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1. SUMMARY

This report provides as summary of the DCH 7 project journey. For additional detail refer to the previous Knowledge Share and Lessons Learnt Reports listed in Section 6 of this report.

DCH 7 sub-project set out with several objectives aimed at demonstrating the value of having an integrated semantic data model which can be used in portable mass redeployable applications. With significant costs incurred for new applications, the concept of retrieving building information from an open data model (Data Clearing House) supported by asset information (VBIS Asset Classification) has the ability to substantially reduce adoption or implementation barriers for organisations.

The project team was able to successfully achieve the outcomes set at project inception by connecting to 5 City of Melbourne buildings, associating 1,100 VBIS asset classification tags to equipment, modelling the building and developing energy analytic applications to make use of the building model and data. While site limitations meant the project team was not able to have the recommendations implemented in a timely manner to validate for this report simulation and modelling showed savings in the order of 5% to 20% is achievable with the 20+ applications developed (of which 8 applications are fully mass redeployable utilising building and point information solely from the DCH environment).

This report provides a summary of the project journey, how DCH 7 has contributed to the overall i-HUB objectives, as well as providing suggested next development steps. For details, please refer to the relevant technical knowledge sharing report and lessons learnt reports.

2. PROJECT BACKGROUND

2.1 Overview

Large scale adoption of IoT technology in buildings has resulted in availability of a large volume of data on the performance of HVAC and renewable generation assets in buildings. These data can be used for predicting availability of onsite generation, effectively manage HVAC operations and support decarbonisation of buildings.

While operational data exists, application of data driven analytics for accurate predictions will still require customisation of methods/models to specific systems and assets. For example, data cleaning, energy analytics process can be significantly improved by grouping assets of similar types. Tuning of parameters can be easily achieved through group of assets and linking their operational data.

This project proposes the utilisation of the VBIS open standard linked with DCH based semantic models to demonstrate the benefits of integrated asset and building tagging systems. Application development partner PrediQ incorporated the tagging and semantic modelling approaches to support delivery of their PV analytics and energy analytics applications. These methods were implemented on 5 buildings and their assets.

This project resulted in the successful deployment of two applications in DCH that focus on better utilisation of (i) onsite energy generation and (ii) HVAC equipment maintenance, resulting in operational performance improvements leading to reduction in site energy use. Deployment of these applications will lead to better management of supply (renewable energy generation) and demand (reduction in HVAC energy use) in buildings.

These project outputs will lead to implementation of measures that will improve availability of onsite generation and reduce carbon footprint of buildings. It will also allow the development of the proposed analytics applications to follow a standardised approach which enhances the capabilities to accurately mass deploy across large portfolios.

The 5 City of Melbourne buildings connected to Data Clearing House are as follows:

1. Library at the Dock
2. East Melbourne Library
3. Boyd Community Centre
4. Lady Huntingfield Early Learning and Family Services Centre
5. Fitzroy Gardens Visitors Centre

These buildings represent 3 building types (Library, Community Centres and Public Space / Visitor Centres), which all have different usage characteristics and building designs.

2.2 Objectives

Three key objectives were defined for this project.

1. Improve the reliability of onsite PV generation through deployed and validated PV system analytics applications linked with DCH and offering browser based and mobile app-based interfaces.
2. Validated PV system operational efficiencies via applications that can be mass deployable for repeatable results. A SaaS based energy analytics application and PV analytics application that utilises the integrated schema deployed into DCH will be implemented through this project.
3. Demonstrate the value of integrated asset classification and semantic modelling for delivery of PV analytics, energy analytics applications and asset performance optimisation.

2.3 Importance to Market and Industry

Business cases to implement new analytics platforms often have challenges in quantifying the return on investment of the platform. This is often due the cost of implementation outweighing any potential or expected savings. To get the expected savings, large scale deployments are often required limiting the ability to try new analytics offerings.

It has been said by analytics providers that if providers have to configure their own data, costs are measured in dollars per point whereas if data can be provided that is already structured, costs to implement becomes cents per point.

Through developing an integrated schema that bridges the gap in the current siloed approaches to asset meta data models used in the built environment by integrating VBIS asset classification and existing DCH semantic modelling/schema, this project aims to remove the cost barriers for analytic application deployments. Proving the feasibility of mass redeployable applications will further reduce the initial on-boarding costs of applications for organisations. In doing so, this should allow organisations additional opportunity to adopt and implement new analytic applications which will have a positive impact to energy reduction and decarbonisation efforts.

3. PROJECT LESSONS LEARNT

A number of lessons learnt reports have been provided for this project. At a high level this can grouped into Data On-boarding, Data Maintenance, and Data Use. These summaries are provided in the following sections of this report.

For additional detail, please refer to the following reports:

- DCH 7 – M6 Lessons Learnt
- DCH 7 – M7 Lessons Learnt

3.1 Data On Boarding

One of the key challenges faced by DCH 7 was obtaining sufficient building information data to on board onto the DCH platform and allow for the subsequent building of the data models. This is often due to incomplete or out of date information available from each site. Due to the complexity of organisations and the level of reliance on specialist contractors, effort was required to locate the correct stakeholder or contractor who could provide additional information or resolve identified issues. An example of this was at Boyd Community Centre where the PV system had lost communications and it was only after thorough investigation by the project team whereby it was identified the issue was not with the PV system but with a network configuration change used by the PV system for internet access.

These issues, while not difficult to resolve, means the effort required to on-board new buildings will often take longer than expected. This further reenforces the value of the Data Clearing House and the integrated semantic modelling being used as this effort would only need to be spent once before the data can be used by multiple vendors and suppliers, without the need for each vendor/supplier having to incur costs to locate the same information.

3.2 Data Maintenance

As buildings become smarter with more devices connected, data sources will become richer. How these data sources are managed and their impact on other systems that have a reliance on them will also need to be considered. These issues have started to become evident throughout the DCH 7 project, with the project team retrieving data from multiple platforms. It was observed that while each contractor/vendor was able to ensure their platform was operational, the same could not be observed when information/data points was used across platforms. An example of this again could be seen with PV inverters. When the project team initially on-boarded and modelled the micro inverters used at Boyd Community Hub, mapping was provided to individual micro inverter addresses. When an inverter was later noticed to be offline in the DCH platform, it was discovered that the inverter had been replaced with a new address allocated. The PV system was operational and had registered the inverter however the downstream impact of the change was not noticed until the project team noticed a loss of data.

Moving forward, new processes will need to be developed to take into account how systems which operate independently impact potential down stream systems to ensure changes are tracked and changes which have a potential impact to downstream applications are planned for as well.

3.3 Data Use

Obtaining data point and building information though querying and data models is a new concept for industry. Throughout this project, the team was still learning how the model should be constructed to provide the maximum flexibility to application providers while in developing the applications, the team was also learning how to best structure queries to ensure repeatable results. It was said that this was akin to building the plane whilst flying it.

To ensure other application developers (as well as organisations wishing to on board and make use of data within the DCH environment) can make use of the DCH platform, detailed documentation is required. Application developers need to know about the norms and conventions as they need to write queries to find things that are modelled using the norms, and clearly modellers need to know the norms to generate models that will yield correct responses to well-formed application queries. While it is envisioned that the DCH platform will be self-service, on-going support will also need to be required to assist with debugging and fault rectification.

4. EVALUATION OF IMPACT AND TECHNOLOGY

This project was able to successfully demonstrate and prove the feasibility of redeployable applications that make use of integrated semantic models. Given the market and industry challenges faced with initial implementation costs for analytics applications, the lessons learnt, and the methodologies developed will have a significant impact on how these applications can be procured in the future. Analytic applications can have a large impact on organisations with energy and carbon reduction goals. By reducing the investment hurdles, this should encourage more organisations to adopt technology platforms to support net zero initiatives.

5. PROJECT OUTCOMES

5.1 Project Outcomes and KPIs

An evaluation of DCH 7's project outcomes and KPIs is provided below.

Outcomes	Evaluation
Create an integrated schema that bridges the gap in the current siloed approaches to asset meta data models used in the built environment by integrating VBIS asset classification and existing DCH semantic modelling/schema.	**Achieved** This project has successfully incorporated VBIS asset classification tags into BRICK schema which can be used by different applications to enhance the outputs available from BRICK. This has allowed additional functionality to be provided within redeployable applications. Refer to Knowledge Share Reports 1 – Building of Data Models for 2 Buildings and Knowledge Share Reports 3 – Application Development in Trial Buildings for further details.
Validated PV system operational efficiencies via applications that can be mass deployable for repeatable results. A SaaS based energy analytics application and PV analytics application that utilises the integrated schema deployed into DCH. Deployment will be across 5 buildings. Improved management of building assets including onsite PV generation due to integrated asset classification and semantic modelling.	**Achieved** PrediQ have provided applications to assist with PV generation that utilises integrated asset classification and semantic modelling which is now redeployable. Applications deployed are off platform which can query information located within DCH model. Modelling (utilising historical building performance data available) shows proposed savings of 5% to 20%. Refer to Knowledge Share Report 2 – PV and Energy Analytics Development and Knowledge Share Report 4 – Application Use Case for further details.
A 3D/BIM Model (if BIM available) will be deployed that will showcase attributed from the two applications. This enables an intuitive way for building operators to interact and interrogate with the applications and building to learn critical information about the facility they have been tasked with operating.	**Achieved** Although no BIM model was available, PrediQ have been able to construct a portfolio wide 3D building model that been made available via "City Observer" module within the user interface. City Observer provides a base 3D model of the city highlighting building status and KPI interaction. Refer to Knowledge Share Report 4 – Application Use Case for further details.

Outcomes	Evaluation
Demonstrate the value of integrated asset classification and semantic modelling for delivery of PV analytics, energy analytics applications and asset performance optimisation. Operational efficiency improvements in service delivery achieved by the application developer due to availability of portable, mass deployable PV analytics and energy analytics applications.	**Achieved** Value of integrated asset classification and semantic modelling demonstrated through redeployable apps that provide sufficient detail for software vendors to utilise in applications. Applications make use of additional functionality provided through a fully integrated building model enhanced by VBIS The estimated savings from redeployable applications is between 20% and 90% when compared to a typical implementation cost. Refer to Knowledge Share Reports 3 – Application Development in Trial Buildings and Knowledge Share Report 4 – Application Use Case for further details.
Global recognition for Australian asset classification system VBIS due to integration with ASHRAE (American Society of Heating, Refrigerating and Air-Conditioning Engineers) supported semantic modelling framework Brick schema.	**Achieved** VBIS asset detail is being incorporated into the BRICK model being developed by CSIRO. VBIS already has an MoU with BRICK for alignment, have published in the US based IFMA journal FMJ and is referenced in IEA Annex 81 document - Survey of metadata schemas for data-driven buildings

KPIs	Evaluation
Deployment of PV Analytics and Energy Analytics Applications across 5 buildings in the City of Melbourne portfolio with all buildings signed up and connected to DCH.	**Achieved** 5 City of Melbourne Buildings connected as follows: 1. Library at the Dock 2. East Melbourne Library 3. Boyd Community Centre 4. Lady Huntingfield Early Learning and Family Services Centre 5. Fitzroy Gardens Visitors Centre
Development and deployment of 2 applications (PV Analytics and Energy Analytics Applications) in DCH that provide the functionality outlined before	**Achieved** In total 20+ applications have been developed, with 8 fully redeployable using building model and VBIS asset information within the DCH platform. Refer to Knowledge Share Reports 3 – Application Development in Trial Buildings for further details.

KPIs	Evaluation
VBIS classification tagging for all applicable assets in the 5 buildings and integration of VBIS with the Brick Schema in DCH	**Achieved** In total 1100 VBIS tags have been added to the DCH building model for the 5 connected buildings. Refer to Knowledge Share Reports 3 – Application Development in Trial Buildings for further details.
Access to building data through DCH and the PV Analytics and Energy Analytics Applications made available for use by City of Melbourne till the completion of the project.	**Achieved** A user interface developed to communicate the outputs of the applications have been provided to City of Melbourne for review and feedback. Refer to Knowledge Share Report 4 – Application Use Case for further details.
Reporting on the mass deployable nature of the PV Analytics and Energy Analytics Applications through the standardization offered by the VBIS integrated DCH to support wider application of developed technology beyond this project.	Achieved DCH 7 have provided the following reports which can be used to support additional organisations and applications: Refer to Knowledge Share Report 3 – Application Development in Trial Buildings, and Knowledge Share Report 4 – Application Use Case for further details.

5.2 Financial and Engineering Outcomes

Financially, this project was delivered largely to planned budget. While there has been movement of costs with certain tasks (such as building on boarding) taking longer than expected the ability to reuse application building blocks across multiple applications has meant net costs was still in line with expectations without significant impact to project deliverables and engineering outcomes.

5.3 Contribution to i-HUB Outcomes

Through the deployed applications and the demonstration proving the use of integrated schematic modelling to build mass deployable applications, DCH 7 was able to contribute to the following i-HUB outcomes and KPIs

- Improve the control of HVAC&R compared to business as usual by demonstrating the capability within a selection of building types to reduce onsite energy use a forecast of between 5% and 20% across 3 building types (Library, Community Centres and Public Space / Visitor Centres).
- Modelling to show a reduction of peak demand and demand charges as well as increase the hosting capacity of solar through load control combined with onsite renewable energy. While site energy use was more than generation available, PrediQ have been able to demonstrate use of how Virtual Energy Storage Systems to balance the energy of an electrical system by utilizing power distribution strategies and existing HVAC equipment. Through demand management along with real-time control interaction with electricity market prices, VESS not only optimises the energy balance of microgrid systems but also improves both the economy and environment while retaining stable operation.
- By developing an integrated schematic model and building portable applications, DCH 7 has been able to demonstrate an increase of value of open data platforms that deliver innovation in the built environment to deliver energy savings by reducing the initial implementation time and cost by between 20% and 90% from current methods.

- The user interface developed by PrediQ will improve decision making capabilities by proving actionable insights that are supported by non-monetary benefits of energy productivity measures, such as occupant energy use habits.

6. REPORTS AND KNOWLEDGE SHARING

The following reports have been compiled for DCH 7 which detail the project journey as well as lessons learnt.

- DCH 7 – M6 Lessons Learnt Report
- DCH 7 – M7 Lessons Learnt Report
- DCH 7 – Knowledge Sharing Report # 1 – Building of Data Models for 2 Buildings
- DCH 7 – Knowledge Sharing Report # 2 – PV and Energy Analytics Development
- DCH 7 – Knowledge Sharing Report # 3 – Application Development In Trial Buildings
- DCH 7 – Knowledge Sharing Report # 4 – Application Use Case
- DCH 7 – Knowledge Sharing Report # 5 – Project Completion

7. NEXT STEPS

Whilst the DCH7 project demonstrated that the DCH platform is ready for early adopters to use there are several areas where functionality can be improved to give a better customer experience. Should additional opportunities become available, the following further development enhances could be considered:

- Partial VBIS asset classification search capability within DCH platform to support wider application development functionality.
- Alignment of DCH with the wider BRICK community as a number of BRICK extensions were developed for the DCH platform.
- Develop an online platform for BRICK model construction.
- Improve the validation and tools available to support the DCH environment.
- Develop documentation to inform modellers and developers of the norms and best practices for using the DCH platform. Specifically, this should include BRIQL query and modelling conventions.
- Further enhance the M&V application to support multiple instances of a building.