The Innovation Hub

for Affordable Heating and Cooling

Report #001

Final DCH2 Knowledge Sharing Report

15 December 2020

SWITCH AUTOMATION

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.
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i-Hub Switch Data Clearing House

The Open Data Clearing House project is to develop and deliver a proof of concept that demonstrates how technology infrastructure can underpin an open data clearing house for all Australian buildings. The solution will be tested on three CSIRO campuses by integrating their building data, and showcasing how that data can be collected in a consistent format, normalized, then used to benchmark buildings and ultimately hasten the transition to more renewable power sources and a net zero future.

Lead organisation

Switch Automation Pty Ltd

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1. SUMMARY

1.1 Executive summary

The purpose of this report is to publicly share the technical content, the lessons learned and the final results and findings for i-Hub DCH2 – Data Clearing House sub-project.

The Data Clearing House 2 is an open data platform for hosting of building data, built using IP from the Switch market-tested Digital Layer. The premise of the project is that easy, quick access to building data will help grow the industry, accelerate innovation and encourage building owners and operators to adopt technologies that can improve the performance of buildings.

This is a public facing report and outlines:

- Sub-Project overview, objectives and importance to market/industry
- Challenges experienced and how these were overcome
- Summary of Sub-Project Lessons Learnt
- List and links to all public reports listed in Annex A relevant to the Sub-Project
- Evaluation of the Sub-Project impact and technology
- What comes next in terms of applicability beyond the current contract

1.2 DCH2 Overview

The Smart Buildings Data Clearing House Platform (DCH2) is a visionary initiative which fits perfectly with the industry vision of a future of smart and connected buildings. By exposing building data to service providers, entrepreneurs, software developers, research scientists, students, and organisations owning and operating buildings, the door is opened to a never-before-seen ecosystem rooted in connectivity.

The DCH has the potential to create and support an entire eco-system of world-class Australian-born smart building technologies, creating thousands of new jobs and upskilling of the existing workforce such as trades involved in building services and maintenance. This industry growth can grow skills and revenue for Australia and, at the same time, transition our buildings to be the most advanced smart, sustainable buildings, reducing our carbon footprint and leaving a measurable, positive impact on the planet.

1.3 Deliverables of DCH2 Project

The project is divided into three distinct phases two of which are covered by funding and one is future state.

The first phase is to build a dedicated instance of the Switch Platform for the DCH and to license that into a CSIRO instance of Microsoft Azure cloud within one of the Australian Data Centres.

The second phase is to prove the functionality across a sample of CSIRO buildings and the third phase is future state (not covered in the DCH2 scope), expanding the DCH for a Marketplace.

1.3.1 Phase 1: Build a Data Clearing House

- Build an **open infrastructure (DCH)** that can host building data for an ecosystem of stakeholders including building owners and operators, application providers, service companies and researchers

1.3.2 Phase 2: Proof of Concept Project Across 3 CSIRO Campus

- Demonstrate value of **DCH** on three CSIRO campus by collecting data and applying fault detection and diagnostics (FDD) to identify energy and other opportunities

- Objective is to demonstrate **Fault Detection and Diagnostics (FDD), visualization, work orders and analytics** to provide value from building data to stakeholders

1.3.3 Phase 3 Deliver a Marketplace and Create an Ecosystem

- **Provide a marketplace** where an industry can thrive
- Positively **impact energy use** by buildings
- Demonstrate that **visibility to building data** can improve the way buildings are managed

1.4 Importance to Market/Industry

The i-Hub Data Clearing House, open data platform is a visionary initiative and fits perfectly into the vision of smart and connected buildings. By exposing building data to service providers, entrepreneurs, software developers, research scientists, students, and organisations owning and operating buildings, the DCH could open the door to a never-before-seen ecosystem rooted in connectivity. This could be an initiative that creates and supports an entire eco-system of world-class Australian-born smart building technologies, creating thousands of new clever jobs and upskilling of existing jobs such as trades involved in building services and maintenance. This industry growth can grow skills and revenue for Australia and at the same time, transition our buildings to the most advanced smart, sustainable buildings, reducing our carbon footprint and leaving a measurable, positive impact on the planet.

CSIRO and AIRAH have a vision to build an open access data sharing platform to assist in overcoming the barriers to provisioning of energy services in Australian buildings by:

- Providing visibility into building performance at national, regional, site, system, equipment and sensor point levels via a range of supporting data
- Facilitating transparency around key performance metrics, industry benchmarks and sustainability goals
- Benchmarking performance and clearly defining minimum standards that align with long term goals such as net zero emissions
- Establishing a foundation for education to inform consumers and providers around best practices for energy management, service delivery, etc.
- Allow for development of incentives programs to motivate building operators and energy providers to meet mandated energy efficiency and delivery requirements
- Foster commercialisation and distribution of innovative, new technologies

2. CHALLENGES

2.1 Challenges Experienced

2.1.1 Complexity

Building a Data Clearing House as described by this sub-project is highly complex and there have been numerous attempts globally by large companies ranging from traditional building technology companies like Johnson Controls and Schneider all the way to large IT companies like IBM, Google and Microsoft. It is a complex problem to solve and to date there has been limited and piece-meal success because building a technology platform for collection and hosting of building data requires not just software expertise but a deep domain knowledge across a range of disciplines specific to buildings.

Additional complexity is in the types of data that comes out of buildings, the format of that data, the resolution and the various standards and protocols required to communicate with the building systems. Ingestion of all this various data into a single standard that allows like-for-like comparison and for end users to access it and consume it in different ways is so much harder that most people imagine.

Furthermore, there are very few companies, globally that have the unique blend of skills required to build an enterprise IT platform for building performance data. These skills include, big data, cyber-security, machine to machine communications, embedded computing as well as extensive building science expertise across mechanical, energy and lighting engineering, controls and all the protocols and standards in the industry.

2.1.2 Competitive Landscape

The competitive landscape is noisy and confusing. There are thousands of companies that provide energy management solutions, dashboards and analytics into the market. There are literally a handful that could be classified as data platforms and provide the type of functionality requested by the DCH2. That is a confusing environment for the various stakeholders and differentiation with their skills is not easy.

2.1.3 Customer Understanding

On the customer side there is little to no understanding of why this problem is so complex and how the owner or operator can foster or accelerate their own digital transition. They also lack the digital experience to recognize the benefit of open data and how this could add value to their organisation. And to exacerbate this even further is the lack of budget for technology or experimentation.

2.1.4 Commercial Model

Switch and CSIRO worked on a number of theoretical pricing models for the DCH for the various stakeholders and services that would be involved. The key to success is that any pricing model must support market adoption, DCH profitability, partner profitability and return value and benefit to the customer.

2.2 How Challenges Were Overcome

2.2.1 Complexity

Switch has a lot of experience in the provision of data platforms to companies using Switch Automation Platform as infrastructure. The complexity was reduced by reprovisioning the Switch Platform in its entirety to reduce the amount of new software development. The DCH is a white-labelled version of Switch launched into its own instance of Microsoft Azure. The amount of new development was limited to the MQTT driver required to consume CSIRO data and the APIs that support third party consumption of DCH data.

2.2.2 Competitive Landscape

This problem was not overcome, and the competitive landscape is as noisy and confusing at the end of the project as it was in the beginning. There was a lot of education and knowledge sharing between stakeholders and potential customers, but more is needed.

As more and more IT skills enter the smart buildings market the problem is slowly resolving itself.

2.2.3 Customer Understanding

The head of this project, Stephen White participated in a vast amount of market analysis and education. This included speaking at events, talking to potential customers and industry groups.

The results speak for themselves when potential projects are referring to and requesting the DCH in their RFPs.

2.2.4 Commercial Model

Several real projects emerged during the course of the DCH project and those real-life examples of how the DCH might be used, provide sample projects that can be used to refine the commercial model. Switch have submitted an example of a project and the commercial model as part of the final DCH2 submission.

3. SUMMARY OF LESSONS LEARNED

3.1 Commercial – Working with Building Data

Building owners and operators already believe their buildings are digital-ready. Owners, operators and most people who are not deeply involved in building systems assume that in 2020, building systems are in situ and already smart, connected, digital with a dearth of readily available and quality data. They are led to believe they have BACnet or Modbus, or open systems, or IP connected systems.

The reality is most operators and owners do not know or understand how badly commissioned building systems are. This is one of the outcomes of the DCH – to shine a light on these poor standards of professionalism and to raise the bar. The industry and i-Hub should run a series of educational pieces to help people understand this and why it is so exasperating and difficult.

3.2 Commercial – Operational teams are threatened by transparency

The operational teams managing buildings have often been in the field on the same assets for many years and introducing open data and transparency is not always well received by incumbent staff who may perceive their role threatened by visibility into building performance.

Smart building technologies need a lot of education across the entire organisation and all stakeholders. There is a lot of change management involved and this is not always factored in.

3.3 Commercial – Size of opportunity

Smart buildings as an industry has been identified for economic recovery as the entire world of real estate needs to transition to a digital model over the next 3-5 years. Growth predictions of 50%, year-on-year are supported by several mega-trends:

- Digitization of enterprise – the enterprise is twenty years behind the consumer in the adoption of technology. Real estate operations is one of the more languid areas of enterprise and well overdue for an acceleration of technology adoption. COVID caught the industry out with no visibility or remote capability for monitoring or controls.
- Climate Change has become a climate emergency – most nations and corporates are adopting much more aggressive and aspirational ESG goals to address reduction of carbon emissions. Buildings use 40% of the worlds energy so there is significant impact that can be achieved by understanding energy consumption and identifying opportunities to reduce that. We know from experience that 50% of a building's energy goes into heating and cooling and that 30% of that can be saved with no impact on comfort or operations. The DCH and platforms like it have the potential to lower the worlds energy use by 6%.
- Post COVID stimulus – governments all around the world are looking for industries that can create jobs and are investing e.g.: Victoria $59M for greening govt buildings, South Australia $60M for energy projects in government buildings. The Biden campaign has 2T dollars budgeted to move into smart buildings and upgrading of infrastructure.

Business as Usual is not the business model of tomorrow and there are customers who recognize the benefit of this project. Real projects emerged from this DCH exercise including a potential 700-site project with Property NSW with a $10M total contract value.

4. EVALUATION OF DCH IMPACT AND TECHNOLOGY IN CSIRO BUILDINGS

4.1 Project summary

The DCH2 project required a real-world demonstration of how the DCH would be implemented and the potential benefits that the DCH will bring to both clients who own and operate buildings but also to the various participants in the industry.

Three sites were provided with MQTT capability and that data feed was provided to Switch.

a. B001 Newcastle Energy Centre
b. B801 Black Mountain
c. B307 Clayton

Tasks completed:

1. Switch developed and tested the MQTT driver.

2. Connected to the three sites and integrated with more than 14 thousand data points, ingesting the data

3. Over 14,000 data points were mapped and data flowing to Switch data management layer had analytics applied via more than 40 fault rules.

4. Following successful integration and flow of data, the DCH data mapping, and data tagging was completed. This allowed the building engineers to apply analytics for alerts, reports and dashboards.

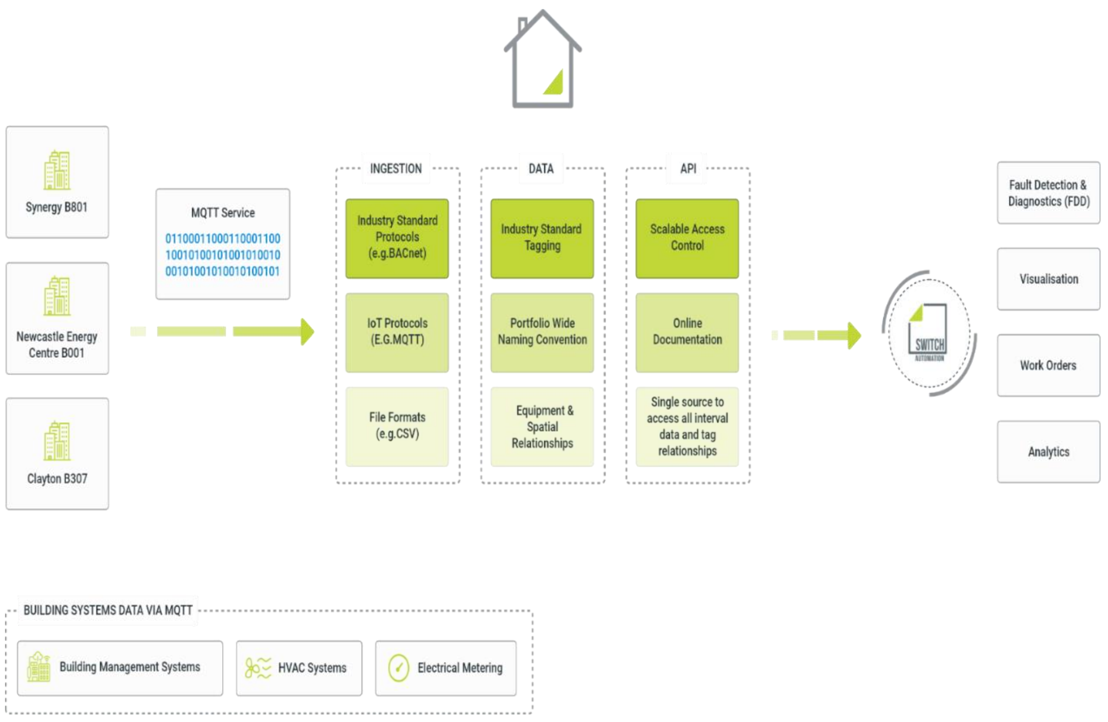

Figure 4.1 DCH data mapping, tagging and analytics

4.2 Results

The Switch engineers spent two months studying the outcome of the CSIRO analytics to determine if there were opportunities for improving building performance at one of the three campus or could make recommendations to the way buildings were commissioned to increase equipment performance.

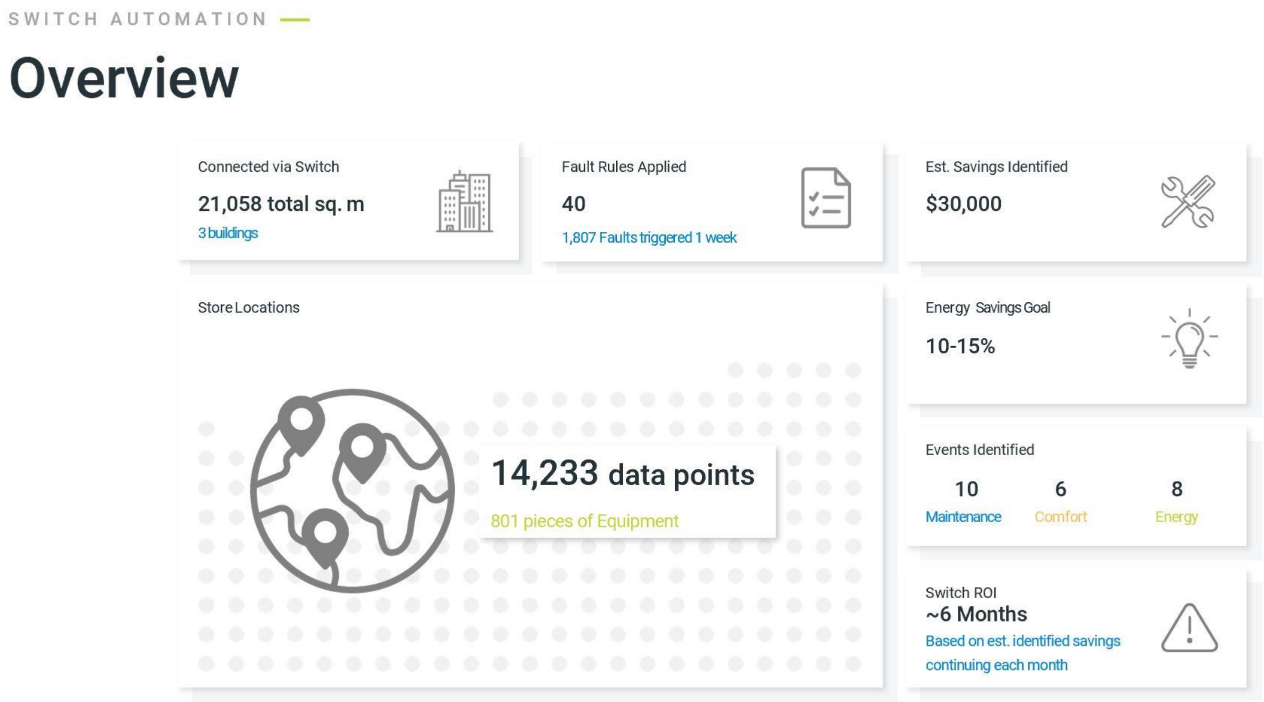

Figure 4.2 SWITCH DCH data analytics

The engineers found eight major opportunities that have the potential to save more than $30,000 of energy per annum, 6 opportunities to improve comfort and 10 opportunities to improve the performance and maintenance outcomes of equipment.

4.3 Major opportunities

1. **Data commissioning issues:**
   Problem: CO2 Sensors indicate poor calibration or faulty sensors
   Identified by: Many of the sensors are reporting below 400ppm which is not possible. Outside air is more than 400ppm. The Switch Platform applies similar FDD analytics across all sensor types, as well, in order to assess if values are reading within expected operating ranges.

   Opportunity:
   - Automated & centralised digital audit of sensors to improve accuracy and integrity of data
   - Energy savings through accurate equipment control
   - Improvement of occupant comfort (and productivity) by accurately measuring Indoor Air Quality and addressing ventilation issues

2. **Low Power Factor:**

Problem: Power factor for M42 DB-1 meter is reading 0.5

Identified by: Multiple meters identified with a power factor of less than 0.6. Low power factor will generally use more power through higher current draw. This can significantly reduce the lifespan of the equipment. A low power factor can damage voltage sensitive equipment too. If the Synergy building is on kVA rates from the utility, you could be paying up to double the utility rate. These meters particularly:

- DBB.2
- GOODSLIFT
- LIFTI
- MCC.04.03.E

Opportunity:

- Energy savings by reducing line losses
- Improved equipment service life (reduce overheating, overloading)
- Reduced utility bill (and penalties) through reduction of reactive power

3. **Chiller – excessive cycling and cycling out of hours :**

Problem: Chiller 1 has excessive cycling which reduces the overall COP of the plant during operation, and as a result will yield increased energy consumption. The chiller is also cycling out of hours when it should probably not be on at all.

Identified by: real time alerting on chiller reading via BMS

Opportunity:

- Reduced energy costs through:
  - Fewer chiller hours
  - Temperature stabilisation
- Improved equipment service life (reduce cycling, lubrication issues)

Energy savings of roughly $5k per year

4. **Chilled Water Plant Differential Pressure Reset Strategy**

Problem: The differential pressure reset setpoint for the chilled water system is currently set to a single value while the plant is operating, independent of downstream valve control. Through analytics, it was discovered that the pressure setpoint is too high for average operation and valves are quite throttled back, resulting in higher pressure and pump power in the system.

Identified by: real time alerting on chilled water plant operating parameters reading via BMS

Opportunity:

- A chilled water reset could be implemented, and lower average chilled water pump power could be realized, if rogue zones are accounted for.
- Energy savings of over $13K per year

5. **AHU Outdoor Air Dampers Open Above Minimum While Heating:**

Problem: A fault detection Alert detected that outdoor air dampers were open above minimum set point during heating, which unnecessarily increases heating load and increases energy consumption of the facility.
Identified by: fault detection Alert running on AHU control
Opportunity:

- Change control such that outdoor air damper remains at minimum position while the AHU is in heating mode.
- Energy savings of roughly $7k per year

6. **AHU Damper Control May Limit Economizer Capability**

Problem: The return air dampers on AHUs remain open while units are in economizer mode. This dilutes the thermally advantageous outdoor air stream with warmer return air and thus increases overall cooling load

Identified by: energy analytics of AHU control data in the platform

Opportunity:

- Improve economizer performance of AHUs by controlling return air dampers closed during full economizer mode.
- Energy savings of roughly $10k per year.

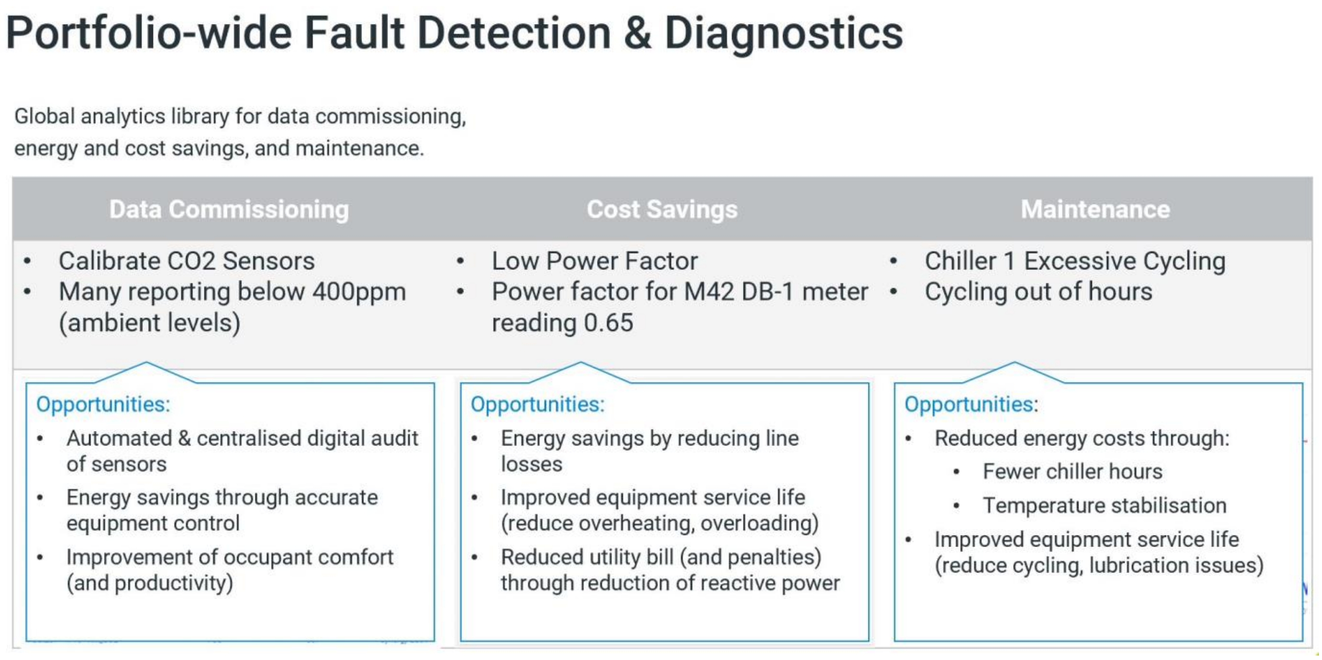

Figure 4.3 SWITCH DCH FDD summary

5. WHAT COMES NEXT

5.1 Platform launch

The work conducted in this project provided a ‘learn by doing’ opportunity to better understand the issues involved in deploying a data platform and demonstrating the value of data to industry stakeholders.

Combining this knowledge with stakeholder feedback from interviews across the industry, and results from each of the i-Hub Data Clearing House Activity sub-projects, the i-Hub must now prepare to launch a self-supporting data-service for the industry. Amongst other commercial and governance decisions, the i-Hub will need to access a suitable software platform for hosting and managing data, on acceptable terms. The Switch platform described here is one of a number of candidate software platforms under active consideration.

5.2 DCH Marketplace – future state

The DCH requires a marketplace to support the emerging ecosystem:

1. Research scientists and students: raw or anonymised data sets and queries which will be able to be used for various forms of analysis including machine learning scenarios and predictive models.
2. Service providers leveraging the Marketplace to build and re-sell applications including dashboards and presentation layers.
3. External providers. These third-party suppliers will use the data via APIs to access data from the platform, and building applications, such as
    - Weather normalised benchmarking.
    - Use of Artificial Intelligence (AI) technologies to optimise building equipment.
    - Ability for Building Owners to leverage fault rules which can be used as a mechanism of tuning a building.

The Marketplace is an enabler of engagement and growth for the industry. Hopefully by seeding the Marketplace with example services and applications, and by publishing the required SDKs and documentation, the DCH can encourage other service providers to follow.