The Innovation Hub

for Affordable Heating and Cooling

Report

DCH4: Data integration, standardisation and energy baselining report

Authors: Will Borghei, Giles Browne, Mark Goldsworthy

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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.

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Project title: Sustainability monitoring and energy innovation in 5 NSW Govt Buildings (DCH4)

This project aims to evaluate the suitability of DCH as a data platform for Property NSW (PNSW) operations. This project aims to ingest data from 5 buildings into the DCH, and evaluate the ability of the DCH to store, organise and structure the data in a standardised framework, such that anyone can query the information with high level of confidence, in order to generate business insights and actions that help optimise building performance, manage energy consumption and solar PV generation, and reduce R&M costs.

Lead organisation

PNSW

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Contact name

Will Borghei

Email

Will.borghei@csiro.au

Project website

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DCH integration and standardisation

As part of managing data from five PNSW buildings, these buildings were onboarded to DCH platform. Onboarding is the process of linking data sources from buildings/sites to the DCH cloud data platform, including building structure and layout information and buildings operations data from building energy systems, equipment, sensors, and actuators.

Onboarding enables the DCH to federate data from a range of disparate building data sources and exploit the value-add features of the DCH4, such as the Building Services Layer that facilitates discovery and searchability of data, and end-use applications enabled by the DCH.

Onboarding the DCH4 buildings involves four stages as shown in Figure 1:

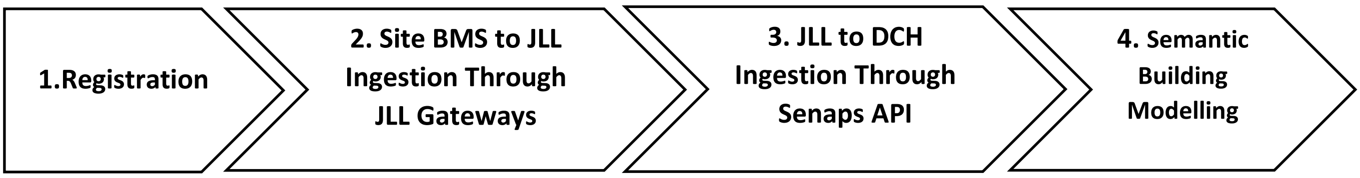

Figure 1 DCH4 Onboarding Steps

Registration: The DCH4 registration consists of three steps:

1. Create PNSW organisation instance on DCH named "pnsw".
2. Create roles based on the permissions intended for all individuals and organisations involved in the sub-project. (read-only access, admin access, delete permission etc.)
3. Send out invitations to all parties involved giving them access based on roles created for them.

For example, PNSW members involved would be assigned admin access enabling them to create new streams, invite new users and giving them relevant access and permissions (only for "pnsw" organisation instance), access and edit building models. In contrast, JLL individuals would only have permission to create new streams and read the information about the data groups in Senaps.

At the moment, PNSW Sustainability Manager, JLL's API Engineer and Buildings Alive API team have access to DCH.

1.1 Data Ingestion

The table below shows a summary of data and data sources available from the five PNSW sites. Figure 2 illustrates the data ingestion methods and dataflow for DCH4.

Site Name	Lithgow	Sydney (Prince Albert)	Cootamundra	Wagga Wagga	Griffith
Utility Meters	Electrical Solar Gas Water	Electrical Gas Water Private Submetering (included in BMS points)	Electrical Solar Gas Water	Electrical Solar Gas Water	Electrical Solar Gas Water
IoT Sensors	Temperature Humidity Occupancy Status Luminosity CO_2 levels Particulate Matter (PM_{10} and $PM_{2.5}$) Total Volatile Organic compounds (TVOC)	Temperature Humidity Occupancy Status Luminosity CO_2 levels Particulate Matter (PM_{10} and $PM_{2.5}$) Total Volatile Organic compounds (TVOC) People Counters	Temperature Humidity Occupancy Status Luminosity CO_2 levels Particulate Matter (PM_{10} and $PM_{2.5}$) Total Volatile Organic compounds (TVOC)	Temperature Humidity Occupancy Status Luminosity CO_2 levels Particulate Matter (PM_{10} and $PM_{2.5}$) Total Volatile Organic compounds (TVOC)	Temperature Humidity Occupancy Status Luminosity CO_2 levels Particulate Matter (PM_{10} and $PM_{2.5}$) Total Volatile Organic compounds (TVOC)
BMS Data	Yes	Yes	No	No	No
Control Algorithms	N/A	Demand and Response Strategy Points (PlantPro)	N/A	N/A	N/A
Total Number of Points (Last updated 8th of Nov 2021)	1810	1730	283	185	250

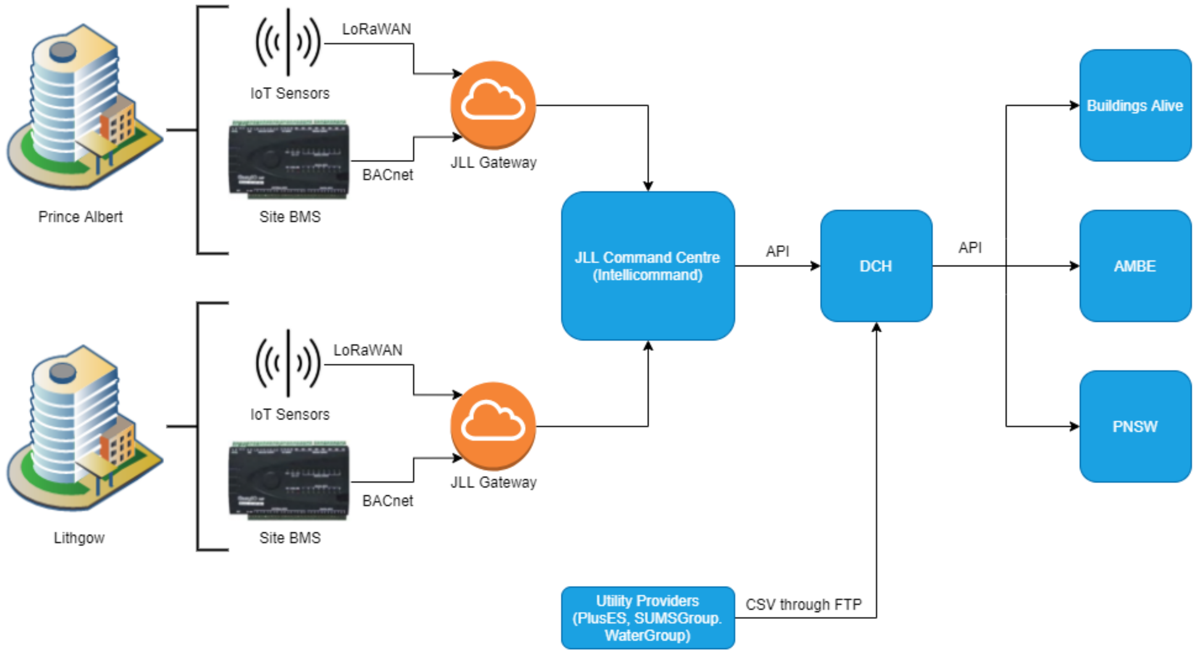

Figure 2 Data ingestion breakdown for DCH4

Site BMS to JLL Ingestion Through JLL Gateways: The official IoT provider for PNSW, JLL, installed their gateways in the 5 sites included in this project. Gateways are the standard method for ingesting IoT data to cloud services. The BMS data available on the BACnet networks on sites was then exported and ingested to JLL's cloud platform Intellicommand (Command Centre). Additionally, JLL installed LoRa PIR (Passive Infrared) sensors for monitoring occupancy (motion), temperature, humidity, and light. Each point, location, equipment, and site are then assigned a Unique Identifier (UID) for each data stream.

JLL to DCH Ingestion Through Senaps API: Working closely with the JLL software team in the U.S., a bot was programmed on the Intellicommand servers to package the data and metadata for each point and send them to DCH using the Senaps API. A bot is a software application that runs automated tasks, can adapt and can handle more complex operations than a workflow. Communication from DCH to Intellicommand is also possible, but would require setting up a workflow on DCH which follows the Intellicommand API specifications. The bot would acquire all JLL specific data and metadata from Intellicommand and use the publicly available dch-bms JSON schema (https://bitbucket.csiro.au/projects/SBDCH/repos/bms-json/browse) to send the packets to DCH. The bot acquires any point on Intellicommand with timeseries data available and automatically sends it to DCH. This means if new points are onboarded to JLL, they are automatically onboarded to DCH, and no additional work is required. The reason for choosing API rather than an IoT protocol like MQTT was to avoid adding unnecessary complexities to the dataflow from DCH to site and vice versa. Typically, MQTT is used to transfer data from the physical hardware to the cloud. Once the data is available somewhere on the internet, using MQTT becomes unnecessary. In this context, if we would use MQTT to ingest data to Senaps, we would have two MQTT brokers, Intellicommand broker and Senaps broker. This creates two stages of MQTT which introduces unnecessary complexities to the dataflow.

Sites in Sydney (Prince Albert) and Lithgow are fully onboarded. Wagga Wagga, Cootamundra and Griffith have been under BMS and equipment upgrade and JLL has been unable to onboard their BMS points so far. IoT Sensors and meter data has been onboarded for all 5 sites.

Utility data to DCH:

Aside from the data ingested by JLL, authority letters were issued by PNSW to request utility metering data ingestion from utility providers. Without exception, all providers ingested their CSV data through unsecured FTP protocol. In total, 28 datastreams were onboarded by 3 providers for 10 meters (See appendix A for more info). This data was also onboarded by JLL through the BMS points available from these meters. Further letters of authority are required to ingest other data from the utility providers.

1.2 Semantic Model Creation

Building semantic data models enable the description of various entities in a building and their relationships in a machine-readable format. 2 out of 5 PNSW building models are complete while the other 3 are under renovation and only meters and IoT sensors are onboarded on Senaps. Once the BMS points are onboarded to JLL Command Centre, they are automatically ingested to Senaps.

Using a combination of tools/templates that simplify the process of converting existing building information as inputs for a building data model and using an expert to support further building model development and verification. In DCH4, screenshots of the BMS and various technical documents were provided by PNSW and JLL to support the development of the model.

A technical decision made during our collaboration with JLL was to include the Intellicommand UIDs in the stream ID names. This was to accomplish two goals:

- Avoid namespace collision in Senaps (duplication of stream IDs)
- Enable bi-directional communication between DCH and Intellicommand

The example below shows the datastreams' metadata (Figure 2) and the outputs of the script:


```
{
  "dchjson": {
    "$schema": "http://csiro.au/dch/bms-json/schema-draft-06.json",
    "point": {
      "parentName": "1_Prince_Albert_Rd_Sydney_Blr1",
      "pointName": "QS_LB2R_HW_Plant_1_Blr1_Status"
    },
    "tags": {
      "jll:BMSPointName": "QS_LB2R_HW_Plant_1_Blr1_Status",
      "jll:ConnRef": "28678a93-b33191dc",
      "jll:EquipName": "1_Prince_Albert_Rd_Sydney_Blr1",
      "jll:PointId": "2889a794-18694ec1",
      "jll:PointName": "1_Prince_Albert_Rd_Sydney_Blr1_STS",
      "jll:SiteId": "283b3e4a-d87897ec",
      "jll:TimeZone": "Sydney"
    }
  }
}
```


Figure 3 Example JLL Metadata Fields

OUTPUTS:

Stream ID: dch.pnsw.point.2889c34a-42c579f4.QS_LB2R_HW_Plant_3_Blr3_Cont_Status

Skeleton Instance: Blr3

Skeleton Instance Class: Boiler

Point Expression: 2889c34a-42c579f4

Description in Point Name: 2889c34a-42c579f4.QS_LB2R_HW_Plant_3_Blr3_Cont_Status

BRICK Class: Status

Another script (written in Python) that generates semantic data models based on the Brick schema was used to generate the building model. This script uses available building information (e.g. BACnet data points lists, Modbus power meter data point lists and building layout information) to create semantic data models for each building, including the type of each data point and the relationships between data points, equipment, systems and building location.

The Table below provides a summary of Brick relationships currently available in these models. These models can be easily visualised using RDF viewers available at the Brick website (https://brickschema.github.io/brick-studio/) or open-source tools such as Protege (https://protege.stanford.edu/)

Site Details	Lithgow	Sydney (Prince Albert)	Cootamundra	Wagga Wagga	Griffith
Number of locations in the Brick model	30	63	N/A	N/A	N/A
Number of BMS points, IoT sensor and energy meter points in the Brick model	1258	1425	564	370	495
Number of equipment points	71	162	N/A	N/A	N/A
Total nodes in the Brick model	2704	3159	N/A	N/A	N/A

1.3 Data and model usage

Currently, two applications are utilising the DCH models and the data: i) Measurement and Verification (M&V) application; ii) Buildings Alive (PNSW service provider) custom external application. These applications query the building model for the necessary input data points using the query functionality available via DCH API (BRIQL or SPARQL). The query results return the DCH stream IDs and the timeseries data is then requested from DCH for analysis through DCH API.

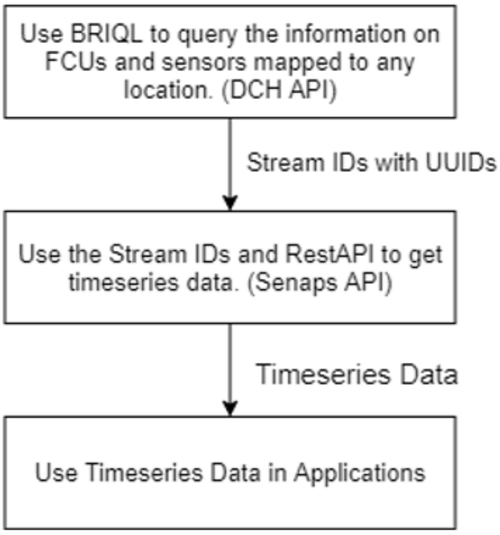

Figure 4 DCH Data Usage Flow

For example, the M&V app queries the Prince Albert building model for Energy consumption point, Active (Real) Power Sensor point, and Outside Air Temperature Sensor point. For further information on the M&V application and the detailed results, please refer to the “Energy Baselining” document.

Buildings Alive application is used to acquire required datastreams from the DCH using the query functionality and also by looking at the metadata fields for each point.

For example, in Figure 3, note the pointName field text contains Status which indicates that it is an On/Off point OR inside tags PointName which ends with _STS, which indicates it is a Status point. Figure 4 shows one of the BRIQL queries used by Buildings Alive to map the motion sensors to the room they are located in.

```json
{
  "dchjson": {
    "$schema": "http://csiro.au/dch/bms-json/schema-draft-06.json",
    "point": {
      "parentName": "61_Railway_Pde_Lithgow_HWP-1",
      "pointName": "DDC1_Boiler_HWP_1_Status_BI30"
    },
    "tags": {
      "jll:BMSPointName": "DDC1_Boiler_HWP_1_Status_BI30",
      "jll:ConnRef": "28678a93-b33191dc",
      "jll:EquipName": "61_Railway_Pde_Lithgow_HWP-1",
      "jll:PointId": "288ad8ac-9f6048e8",
      "jll:PointName": "61_Railway_Pde_Lithgow_HWP-1_STS",
      "jll:SiteId": "283b3e4a-eb81ab87",
      "jll:TimeZone": "Sydney"
    }
  }
}
```


Figure 5 Metadata extraction for Buildings Alive

```
briql_query = {
  "models": [
    {
      "org_id": "pnsw",
      "site_id": "Lithgow",
      "building_id": "61RailwayPde"
    }
  ],
  "query_def": {
    "comment": "Map Motion Sensors to Rooms.",
    "mode": "select",
    "variables": [
      {
        "var_type": "node",
        "name": "room",
        "output": True,
        "fetch": [
          "id"
        ],
        "brick_types": [
          {
          "match":"isa", "type":"Room"
          }
        ]
      },

      {
        "var_type": "node",
        "name": "ms",
        "output": True,
        "fetch": [
          "id"
        ],
        "brick_types": [
          {
          "match":"isa", "type":"Motion_Sensor"
          }
        ]
      }
    ],
    "query":{
        "paths":[
          {
            "from_ref":"room",
            "to_ref":"ms",
            "properties":[{"property":"hasPoint"}]
          }
        ]
    }
  }
}
```

Figure 6 BRIQL query to map motion sensors to rooms.

1.4 Learnings from the exercise

1. As previously mentioned, JLL assigns a UID to each point, equipment, location etc. and to maintain the consistency between our platforms and to enable bi-directional communications if needed, that UID was retained in the stream IDs on Senaps. This resulted in the stream IDs being vague during the BRICK model development of the buildings. Previously, the model development solely used stream IDs to identify what equipment that stream belongs to (e.g. AHU, FCU, VAV) and what the point is responsible for (e.g. Return Air Temperature Sensor, VSD Speed, Outside Air Temperature Sensor). In this case, JLL provided an extensive metadata field in the json-bms schema outlining the equipment and point name to be used by model developers instead. This meant that model developers required additional time to write a script for analyzing the metadata fields and associate the results with the stream IDs and UIDs.

   Furthermore, the Prince Albert site required a BMS and Gateway reset to update some missing BACnet points. This reset generated new UIDs for existing points which then duplicated the streams on Senaps. Working closely with the JLL team, we swapped the old UIDs in the model with the new UIDs, added the new points to the model and retained the historic data.
   When the duplication of points occurred, if the streams were not assigned UIDs, distinguishing between the old and the new streams would have been a difficult task. The UIDs may have added extra time in model development timeline, but they proved to be essential in doing damage control.

2. Although the preferred method of data ingestion to DCH is through IoT protocols such as MQTT or AMQP, since the data was being onboarded to Intellicommand before DCH, API proved to be the fastest, easiest, and most reliable method for this project. Having a variety of data ingestion methods is essential in accommodating the onboarding for all clients. Additionally, since JLL has not disclosed the protocol used for ingesting data from their gateways to Intellicommand, if MQTT was used for communication between DCH and Intellicommand, a translator system would be required interpret signals sent from DCH to JLL command centre. Evidently, this would be unnecessary and therefore, API was preferred by both JLL and DCH.

Energy baselining study

Historic and ongoing data collection from two sites (Prince Albert st, Lithgow) have been used to study the electrical energy use behaviour of these sites. Only site level energy use data has been used for this study. Further study with more fine grained data will be carried out during the next milestone period.

Details of data streams used for the study :

1 Prince Albert St, Sydney DCH Stream: dch.pnsw.point.28c58223-d8e05b2c.NCCCZ00638_kW 15 minutely electricity demand in kW spanning 1 May 2020 to present	61, Railway Pde, Lithgow DCH Stream: dch.pnsw.point.28c3e7d7-8b64e027.4310857063_kW 15 minutely electricity demand in kW spanning 1 May 2020 to present.

- KMeans clustering to the data to create representative profiles for the sites. Outlier detection and removal has been applied, with observations having a pattern frequency of less than 0.3% being set aside for further investigation.
- Heatmaps have been created to allow for relative comparison of site energy use on different days.
- Box plots and bar plots are used to visualise typical site energy use patterns during various seasons and to capture typical daily variations.

An interactive map has been created to support further exploration of the results. However, static plots are provided here for discussion purposes. Interactive plots can be made available on request. These plots are shown in Figures 7 and 8. A summary of observations from these results are provided below.

Prince Albert site :

- This site has a baseline energy use of about 60 kW. A discussion with the site facility manager indicated the site has a dedicated AHU for an archive room in the basement that operates continually. Prince Albert site HVAC systems are started at around 6am and the chiller start at 7am. These two starting times show a blip in the energy use. Some of the outliers observed in the box plot for these two time periods (6 and 7am) correspond to hot summer days.
- This site has not been impacted by Covid lockdowns. Hence the energy use of the site is typical of normal operations. The site manager observed that some of the changes in monthly energy use could be attributed to change in tenancies.
- The site uses gas for heating (not captured in this analysis). Days belonging to cluster 2 are primarily from July and August months.

Lithgow site :

- Lithgow site has onsite solar generation that is influencing the daily demand profiles. It can be observed that unlike the Prince Albert site, Lithgow does not have a constant, baseload type cluster, but rather three clusters have a similar shape but different magnitude, with Cluster 3 being 20-40 kW higher than Cluster 1. High demand cluster (cluster 3) represents typical warmer months of November – March and accounts for nearly 74% of days in January and February. Cluster 1, the low demand profile, is more evident in the cooler months, and occurs infrequently over summer. Cluster 2, the medium profile, occurs on weekends.

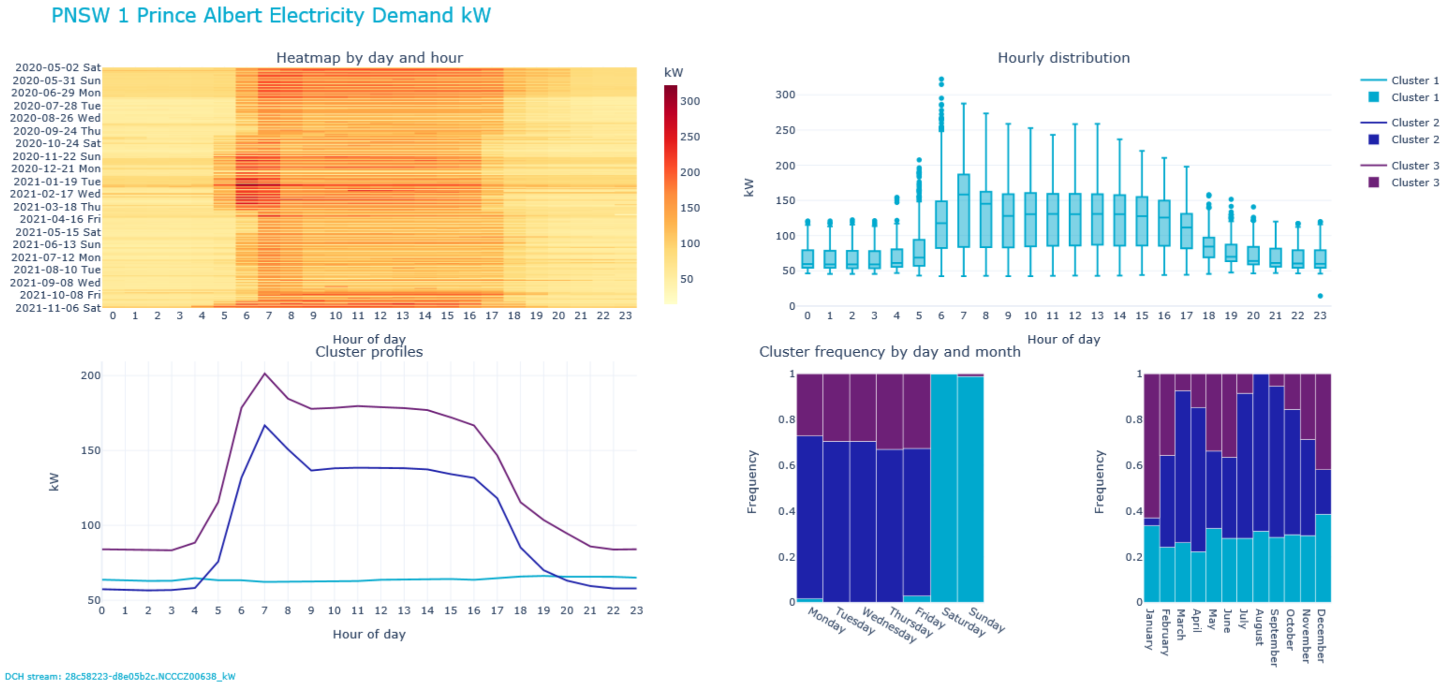

Figure 7 Energy use patterns for 1 Prince Albert site

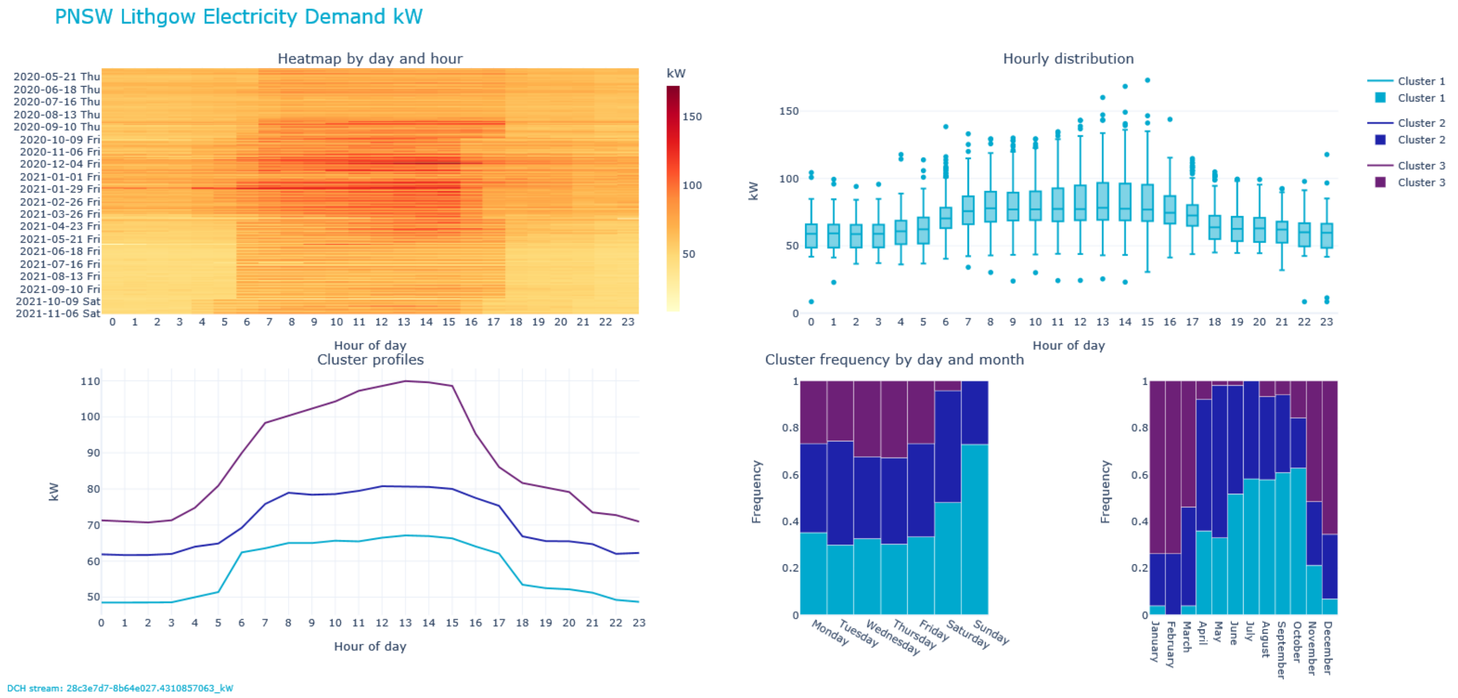

Figure 8 Energy use patterns for Lithgow site

Measurement and Verification (M&V) for two sites :

M&V results are summarised for the two sites in Figures 9 and 10.

1 Prince Albert St, Sydney DCH Stream: dch.pnsw.point.28c58223-d8e05b2c.NCCCZ00638_kW Ambient temperature: dch.pnsw.point.28a05f4f-8bd97e70.Global_OAT Data period for both data streams: 1-Oct 2020 to 30-Sep-2021 Baseline period: 10-Oct-2020 to 13-Apr-2021 Analysis period: 14-Apr-2021 to 29-Sep-2021	61, Railway Pde, Lithgow DCH Stream: dch.pnsw.point.28c3e7d7-8b64e027.4310857063_kW Solar generation stream id: dch.pnsw.point.28c3e7d7-7b0e5292.ZZZZ035367_Solar_Energy_Generated Ambient temperature stream id: dch.pnsw.point.288ad7b6-de684f55.DDC5_Chiller_O_A_Temperature_Output_AI12 Baseline period: 22-July-2021 to 22-Sep-2021 Analysis period: 23-Sep-2021 to 09-Nov-2021

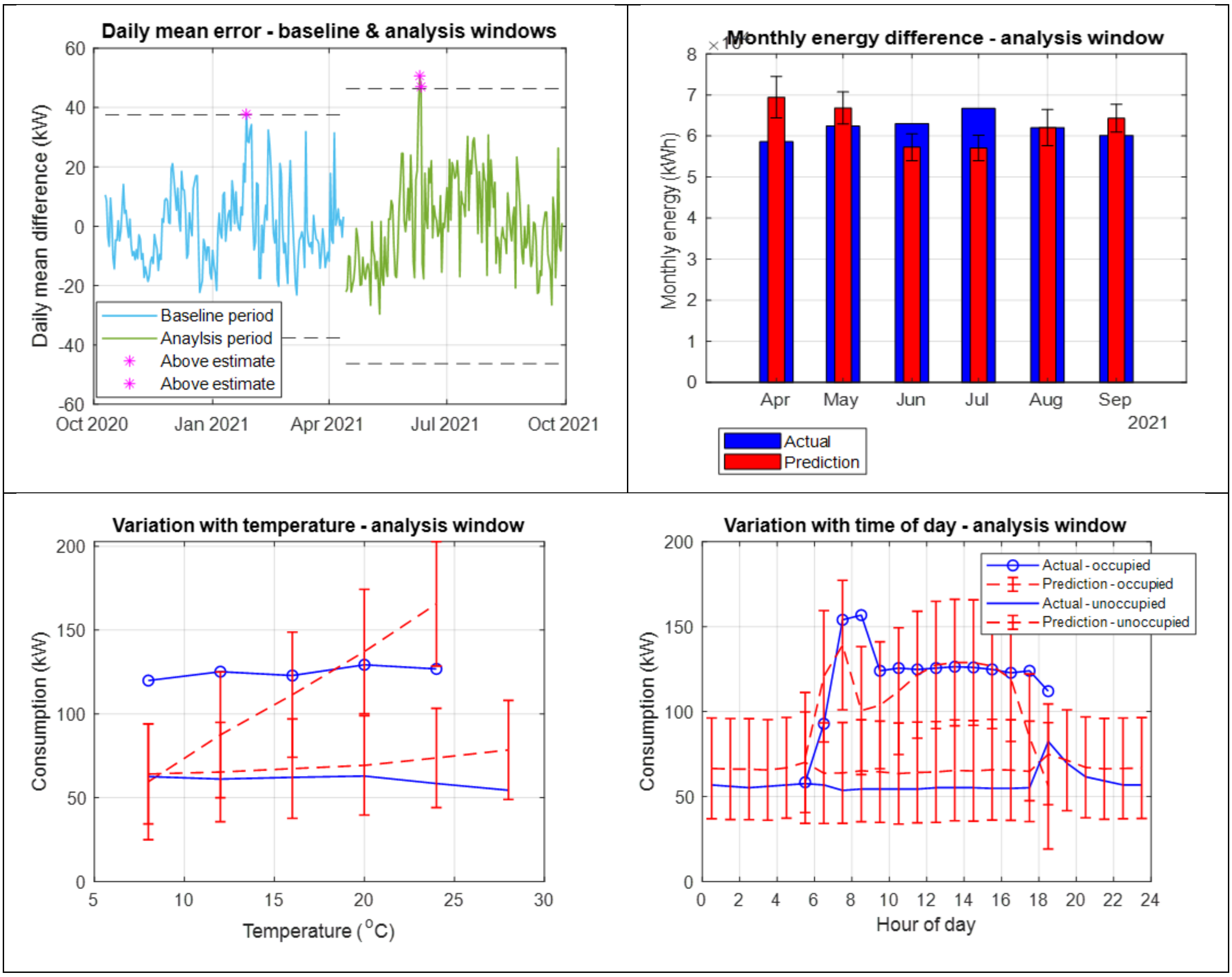

Figure 9 M&V results summary for Prince Albert site

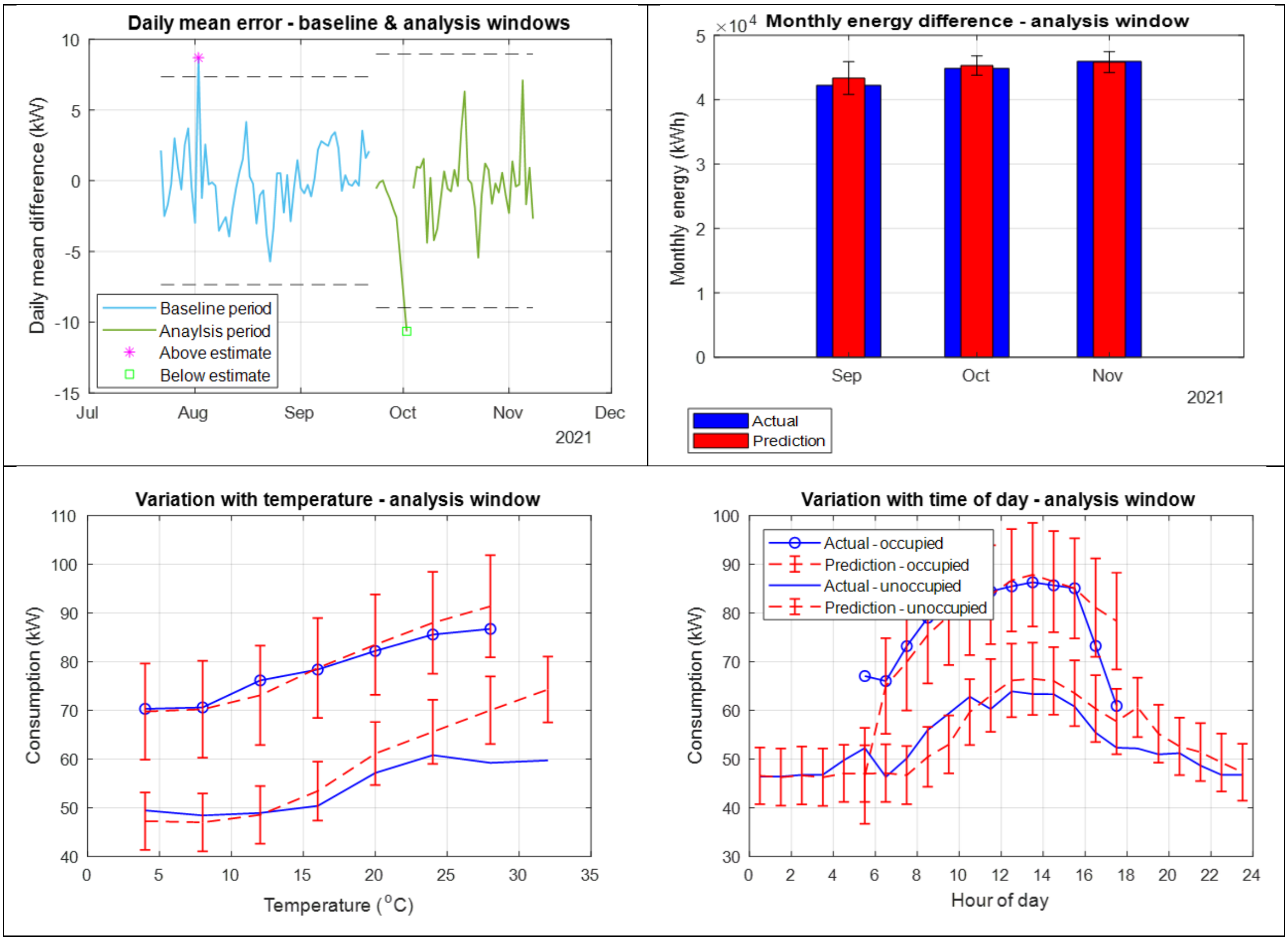

Figure 10 M&V results summary for Lithgow site

Summary of results for Prince Albert site:

- A good fit of the model to the baseline data was obtained (CVRMSE=17.1, NBME=-0.11). Figure 1 indicates that there was only 1 day in the baseline period where the mean error was significant.
- The site has a baseline consumption of approximately 60kW that is largely independent of temperature. The typical workday daily pattern has a peak of approximately 150kW in the morning between 7 and 9am followed by a relatively steady ~120kW consumption throughout the day dropping back to the baseline consumption level after 6pm.
- Overall energy use increased by 2.3% (+-2.6%) over the analysis period compared to expected. However, the variation was not uniform with decreases in April and May followed by increases in June and July and a decrease again in September (Figure 2).
- The most striking feature is the change in variation of energy use with temperature for periods where the site is likely to be occupied (Figure 3 left). Over the analysis period the actual energy use was almost independent of temperature, as compared to the baseline period where the energy use increased uniformly with increasing temperature.

Summary of results for Lithgow site:

- A very good fit of the model to the baseline data was obtained (CVRMSE=6.9, NBME=0.13). Figure 1 indicates that there was only 1 day in the baseline period where the mean error was significant.
- The site has a varying baseline consumption that changes between approximately 45kW and 65kW depending on the time of day and temperature. The typical workday pattern increases gradually from about 6am to a peak consumption of approximately 85kW in the middle of the day before decreasing again from approximately 4pm.
- Overall energy use decreased by 1.6% (+-1.3%) over the analysis period compared to expected. The variation between months was not substantially different (Figure 2).
- The variation in energy use with time of day over the analysis period was very close to expected (Figure 3 right) but with a slight decrease in consumption between 4pm and 6pm during occupied days. The variation in energy use with temperature was also similar for occupied periods. However, for unoccupied periods there was a decrease in consumption at times of higher ambient temperature (Figure 3 left).

Appendices

A. Utility Meter Providers (CSV through FTP)

- PlusES (Electrical and Solar) NMIs:
  - NDDD00GH59 (Wagga Wagg)
  - NDDD00GM81 (Cootamundra)
  - NCCCZ00638 (Sydney Prince Albert)
  - NDDD00GH58 (Griffith)
  - ZZZZ035406 (Griffith)
  - ZZZZ035367 (Lithgow)
  - 4310857063 (Lithgow)
- SUMSGroup:
  - 03HB06947 (Lithgow)
  - 17E000154 (Griffith)
- WaterGroup:
  - 12610004RW (Wagga Wagga)

B. Site Data Breakdown

61 RAILWAY PDE LITHGOW

Building General

Data Name	Value
Address	61 Railway Pde, Lithgow NSW
Postcode	2790
Building Zones	Tenant, Area, Type
Total Floor Area	Calculated - Total of Building Zones
Total Occupied Floor Area	Calculated - Total of Occupied Building Zones

Energy and Utility Sources

Net Electrical Energy Consumed / Exported

Data name	Units	NMI / Meter ID	Data Method
Grid Energy Consumed	kWh	4310857063	PlusES – FTP CSV
Net Energy Exported	kWh	4310857063	PlusES – FTP CSV
Building Power	kW	4310857063	PlusES – FTP CSV
Demand	kVA	4310857063	PlusES – FTP CSV

Solar Energy Generated On Site

Data name	Units	NMI / Meter ID	Data Method
Solar Energy Generated	kWh	ZZZZ03567	PlusES – FTP CSV
Solar Power Generated	kW	ZZZZ03567	PlusES – FTP CSV

Gas Purchased

Data name	Units	Meter ID	Data Method
Gas Energy Consumed	MJ	52470063518	TBA (require letters of authority from PNSW)

Water Purchased

Data name	Units	Meter ID	Data Method
Water Consumed	ML	19HB00832	FTP / CSV / MQTT (require letters of authority from PNSW)

Building Zones

Zone Descriptor	Tenant	Zone Type	Occupied Status	Floor Area NLA (m^2)	Data Method
LG.01	Office of State Revenue – Meeting & Training Rooms	Tenant – Meeting	Occupied	161	API - IOT Provider
LG.02	Office of State Revenue – Server Room	Tenant – Office Support	Occupied	24	API - IOT Provider
LG.03	Police Force NSW	Tenant - Office	Occupied	655	API - IOT Provider
L1.01	Office of State Revenue – Offices	Tenant - Office	Occupied	1012	API - IOT Provider
L2.01	Office of State Revenue – Offices	Tenant - Office	Occupied	1014	API - IOT Provider

Zone Thermal Comfort, Lighting and Occupancy Data

1 off point per 250m2 of Tenant-Office area.

Data Point Name	Units	Data Method
Space Temperature	Deg C	API - IOT Provider
Space Relative Humidity	%RH	API - IOT Provider
Occupancy Status (PIR)	Boolean	API - IOT Provider
Light Level	Lux	API - IOT Provider

Floor Indoor Environment Quality Data

1 off data point per occupied floor placed in return air path, total of three sensing points.

Data Point Name	Units	Data Method
CO2 (Carbon Dioxide Level)	ppm	API - IOT Provider
Particulate matter (PM_{10})	mg/m3	API - IOT Provider

Particulate matter ($PM_{2.5}$)	mg/m3	API - IOT Provider
TVOC	ppb	API - IOT Provider

BMS Data

Detailed BMS Data is integrated to the IOT System and ingested to DCH via API.

1 PRINCE ALBERT RD, SYDNEY

Building General

Data Point Name	Value
Address	1 Prince Albert Rd, Sydney
Postcode	2000
Building Zones	Tenant, Area, Type
Total Floor Area	Calculated - Total of Building Zones
Total Occupied Floor Area	Calculated - Total of Occupied Building Zones

Energy and Utility Sources

Net Electrical Energy Consumed / Exported

Data Point Name	Units	NMI / Meter ID	Data Method
Grid Energy Consumed	kWh	NCCCZ00638	PlusES – FTP CSV
Building Power	kW	NCCCZ00638	PlusES – FTP CSV
Demand	kVA	NCCCZ00638	PlusES – FTP CSV

Gas Purchased

Data Point Name	Units	Meter ID	Data Method
Gas Energy Consumed	MJ	52471918072	TBA (require letters of authority from PNSW)

Water Purchased

Data Point Name	Units	Meter ID	Data Method
Potable Water Consumed	kL	N/A	TBA (require letters of authority from PNSW)

Private Sub-Metering

Data Point Name	Units	Data Method	Data Provider Contact Details	Notes
Energy Consumed	kWh	API	IOT Provider	Private metering via BMS to IOT Gateway. Approximately 32 off meters.
Power	kW	API	IOT Provider	Private metering via BMS to IOT Gateway. Approximately 32 off meters.

Demand	kVA	API	IOT Provider	Private metering via BMS to IOT Gateway. Approximately 32 off meters.

Building Zones

Zone Descriptor	Tenant	Zone Type	Occupied Status	Floor Area NLA (m^2)	Data Method
L1.01	Corridor	Base Building	Occupied	292	API - IOT Provider
L1.02		Tenant - Office	Unoccupied	11	API - IOT Provider
GF-South	Office of The Children's Guardian	Tenant - Office	Occupied	TBA	API - IOT Provider
GF-East	Office of The Children's Guardian	Tenant - Office	Occupied	TBA	API - IOT Provider

Zone Thermal Comfort, Lighting and Occupancy Data

1 off point per 250m2 of Tenant-Office area.

Data Point Name	Units	Data Method
Space Temperature	Deg C	API - IOT Provider
Space Relative Humidity	%RH	API - IOT Provider
Occupancy Status (PIR)	Boolean	API - IOT Provider
Light Level	Lux	API - IOT Provider

Floor Indoor Environment Quality Data

1 off data point per occupied floor placed in return air path, total of four off sensing points.

Data Point Name	Units	Data Method
CO2 (Carbon Dioxide Level)	ppm	API - IOT Provider
Particulate matter (PM_{10})	mg/m3	API - IOT Provider

Data Point Name	Units	Data Method
Particulate matter ($PM_{2.5}$)	mg/m3	API - IOT Provider
TVOC	ppb	API - IOT Provider

People Count

People count provided for each Office of The Children's Guardian building zones.

Data Point Name	Units	Data Method
People Count	Integer	API - IOT Provider

Demand Response Strategy

Data Point Name	Units	Data Method
DRS Enable	On / Off	API - IOT Provider
Chilled Water Conditions (Supply / Return Water Temps)	Deg C	API - IOT Provider

Data Point Name	Units	Data Method
Thermal Comfort Conditions throughout building	Deg C	API - IOT Provider
Total Building Demand (kW & kVA)	Deg C	API - IOT Provider
Chiller Plant Demand (kW and kVA	Deg C	API - IOT Provider

BMS Data

Detailed BMS Data is integrated to the IOT System and ingested to DCH via API.

87 COOPER STREET, COOTAMUNDRA

Building General

Data Point Name	Value
Address	87 Cooper Street, Cootamundra
Postcode	2590
Building Zones	Tenant, Area, Type
Total Floor Area	Calculated - Total of Building Zones
Total Occupied Floor Area	Calculated - Total of Occupied Building Zones

Energy and Utility Sources

Net Electrical Energy Consumed / Exported

Data Point Name	Units	NMI / Meter ID	Data Method
Grid Energy Consumed	kWh	NDDD0GM81	PlusES – FTP CSV
Net Energy Exported	kWh	NDDD0GM81	PlusES – FTP CSV
Building Power	kW	NDDD0GM81	PlusES – FTP CSV
Demand	kVA	NDDD0GM81	PlusES – FTP CSV

Solar Energy Generated On Site

Data Point Name	Units	NMI / Meter ID	Data Method
Solar Energy Generated	kWh	NDDD0GM81	PlusES – FTP CSV
Solar Power Generated	kW	NDDD0GM81	PlusES – FTP CSV

Gas Purchased

Data Point Name	Units	Meter ID	Data Method
Gas Energy Consumed	MJ	6459072	TBA (require letters of authority from PNSW)

Water Purchased

Data Point Name	Units	Meter ID	Data Method
Potable Water Consumed	kL	98774	TBA (require letters of authority from PNSW)

Building Zones

Zone Descriptor	Tenant	Zone Type	Occupied Status	Floor Area NLA (m^2)	Data Method
1.03	Vacant	Tenant - Office	Unoccupied	1.03	API - IOT Provider
1.04	Vacant	Tenant - Office	Unoccupied	1.04	API - IOT Provider
1.05	Vacant	Tenant - Office	Unoccupied	1.05	API - IOT Provider
1.06	Department of Primary Industries	Tenant - Office	Occupied	1.06	API - IOT Provider
1.07	Department of Primary Industries	Tenant - Office	Occupied	1.07	API - IOT Provider
1.08	Department of Primary Industries	Tenant - Office	Occupied	1.08	API - IOT Provider
1.09	Department of Primary Industries	Tenant - Office	Occupied	1.09	API - IOT Provider
1.10	Vacant	Tenant - Office	Unoccupied	1.10	API - IOT Provider
1.12	Building Manager	Base Building	Occupied	1.12	API - IOT Provider
1.13	Store	Base Building	Occupied	1.13	API - IOT Provider
1.15	Local Land Services	Tenant - Office	Occupied	1.15	API - IOT Provider
1.16	Vacant	Tenant - Office	Unoccupied	1.16	API - IOT Provider
1.18	AWEX	Tenant - Office	Occupied	1.18	API - IOT Provider
2.02	Vacant	Tenant - Office	Unoccupied	2.02	API - IOT Provider
2.04	Vacant	Tenant - Office	Unoccupied	2.04	API - IOT Provider
2.05	NSW Police	Tenant - Office	Occupied	2.05	API - IOT Provider
2.07	NSW Police	Tenant - Office	Occupied	2.07	API - IOT Provider

2.08	NSW Police	Tenant - Office	Occupied	2.08	API - IOT Provider
2.10	NSW Police	Tenant - Office	Occupied	2.10	API - IOT Provider
2.11	Vacant	Tenant - Office	Unoccupied	2.11	API - IOT Provider
2.12	NSW Police	Tenant - Office	Occupied	2.12	API - IOT Provider
2.13	Vacant	Tenant - Office	Unoccupied	2.13	API - IOT Provider
2.14	Vacant	Tenant - Office	Unoccupied	2.14	API - IOT Provider

Zone Thermal Comfort, Lighting and Occupancy Data

1 off point per 250m2 of Tenant-Office area.

Data Point Name	Units	Data Method
Space Temperature	Deg C	API - IOT Provider
Space Relative Humidity	%RH	API - IOT Provider
Occupancy Status (PIR)	Boolean	API - IOT Provider
Light Level	Lux	API - IOT Provider

Floor Indoor Environment Quality Data

1 off data point per occupied floor placed in return air path, total of two sensing points.

Data Point Name	Units	Data Method
CO2 (Carbon Dioxide Level)	ppm	API - IOT Provider
Particulate matter (PM_{10})	mg/m3	API - IOT Provider
Particulate matter ($PM_{2.5}$)	mg/m3	API - IOT Provider
TVOC	ppb	API - IOT Provider

HVAC Monitoring

Limited status monitoring via IOT Provider, points as follows

Data Point Name	Units	Data Method
Condenser Water Pump 1	Status / Fault	API - IOT Provider

Condenser Water Pump 2	Status / Fault	API - IOT Provider
Cooling Tower Fan Low Speed	Status / Fault	API - IOT Provider
Cooling Tower Fan High Speed	Status / Fault	API - IOT Provider
Heating Water Pump 1	Status / Fault	API - IOT Provider
Heating Water Pump 2	Status / Fault	API - IOT Provider

BMS Data

Not Applicable

43-45 JOHNSTON ST, WAGGA WAGGA

Building General

Data Point Name	Value
Address	43-45 Johnston St, Wagga Wagga
Postcode	2650
Building Zones	Tenant, Area, Type
Total Floor Area	Calculated - Total of Building Zones
Total Occupied Floor Area	Calculated - Total of Occupied Building Zones

Energy and Utility Sources

Net Electrical Energy Consumed / Exported

Data Point Name	Units	NMI / Meter ID	Data Method
Grid Energy Consumed	kWh	NDDD00GH59	PlusES – FTP CSV
Net Energy Exported	kWh	NDDD00GH59	PlusES – FTP CSV
Building Power	kW	NDDD00GH59	PlusES – FTP CSV
Demand	kVA	NDDD00GH59	PlusES – FTP CSV

Solar Energy Generated On Site

Data Point Name	Units	NMI / Meter ID	Data Method
Solar Energy Generated	kWh	NDDD00GH59	PlusES – FTP CSV
Solar Power Generated	kW	NDDD00GH59	PlusES – FTP CSV

Gas Purchased

Data Point Name	Units	Meter ID	Data Method
Gas Energy Consumed	MJ	6459072	API – IOT Provider

Water Purchased

Data Point Name	Units	Meter ID	Data Method
Potable Water Consumed	kL	TBA	TBA

Building Zones

Zone Descriptor	Tenant	Zone Type	Occupied Status	Floor Area NLA (m^2)	Data Method
LG.01		Tenant - Office	Unoccupied	47	API - IOT Provider
LG.02		Tenant - Office	Unoccupied	16	API - IOT Provider
LG.03		Tenant - Office	Unoccupied	71	API - IOT Provider
LG.04	NSW Fire & Rescue	Tenant - Office	Occupied	208	API - IOT Provider
LG.05	NSW Fire & Rescue	Tenant - Office	Occupied	19	API - IOT Provider
LG.06	NSW Education Standards Authority	Tenant - Office	Occupied	148	API - IOT Provider
L1.01		Tenant - Office	Unoccupied	47	API - IOT Provider
L2.01		Tenant - Office	Unoccupied	16	API - IOT Provider
L3.01	Lobby	Base Building	Occupied	9	API - IOT Provider
L3.02	NSW Dept of Public Prosecutions	Tenant - Office	Occupied	537	API - IOT Provider

Zone Thermal Comfort, Lighting and Occupancy Data

1 off point per 250m2 of Tenant-Office area.

Data Point Name	Units	Data Method
Space Temperature	Deg C	API - IOT Provider
Space Relative Humidity	%RH	API - IOT Provider
Occupancy Status (PIR)	Boolean	API - IOT Provider
Light Level	Lux	API - IOT Provider

Floor Indoor Environment Quality Data

1 off data point per occupied floor placed in return air path, total of four sensing points.

Data Point Name	Units	Data Method
CO_2 (Carbon Dioxide Level)	ppm	API - IOT Provider
Particulate matter (PM_{10})	mg/m3	API - IOT Provider
Particulate matter ($PM_{2.5}$)	mg/m3	API - IOT Provider
TVOC	ppb	API - IOT Provider

HVAC Monitoring

Limited status monitoring via IOT Provider, points to be monitored subject to final confirmation due to upgrade works being undertaken July – November 2021:

Data Point Name	Units	Data Method
TBA	TBA	API - IOT Provider
TBA	TBA	API - IOT Provider
TBA	TBA	API - IOT Provider
TBA	TBA	API - IOT Provider
TBA	TBA	API - IOT Provider
TBA	TBA	API - IOT Provider
TBA	TBA	API - IOT Provider
TBA	TBA	API - IOT Provider
TBA	TBA	API - IOT Provider

BMS Data

Not applicable

104-110 BANNA AVE, GRIFFITH

Building General

Data Point Name	Value
Address	104-110 Banna Ave, Griffith
Postcode	2680
Building Zones	Tenant, Area, Type
Total Floor Area	Calculated - Total of Building Zones
Total Occupied Floor Area	Calculated - Total of Occupied Building Zones

Energy and Utility Sources

Net Electrical Energy Consumed / Exported

Data Point Name	Units	NMI / Meter ID	Data Method
Grid Energy Consumed	kWh	NDDD00GH58	PlusES – FTP CSV
Net Energy Exported	kWh	NDDD00GH58	PlusES – FTP CSV
Building Power	kW	NDDD00GH58	PlusES – FTP CSV
Demand	kVA	NDDD00GH58	PlusES – FTP CSV

Solar Energy Generated On Site

Data Point Name	Units	NMI / Meter ID	Data Method
Solar Energy Generated	kWh	ZZZZ03540	PlusES – FTP CSV
Solar Power Generated	kW	ZZZZ03540	PlusES – FTP CSV

Gas Purchased

Data Point Name	Units	Meter ID	Data Method
Gas Energy Consumed	MJ	52471918072	TBA (require letters of authority from PNSW)

Water Purchased

Data Point Name	Units	Meter ID	Data Method
Potable Water Consumed	kL	17E000154	SUMS Group – FTP CSV

Building Zones

Zone Descriptor	Tenant	Zone Type	Occupied Status	Floor Area NLA (m^2)	Data Method
L1.01	Corridor	Base Building	Occupied	292	API - IOT Provider
L1.02		Tenant - Office	Unoccupied	11	API - IOT Provider
L1.03	NSW Dept of Education	Tenant - Office	Occupied	396	API - IOT Provider
L1.04		Tenant - Office		31	API - IOT Provider
L1.05	Dept of Communities and Justice	Tenant - Office	Occupied	360	API - IOT Provider
L1.06		Tenant - Office	Unoccupied	144	API - IOT Provider
L1.07		Tenant - Office	Unoccupied	13	API - IOT Provider
L1.08		Tenant - Office	Unoccupied	29	API - IOT Provider
L1.09		Tenant - Office	Unoccupied	15	API - IOT Provider
L1.10	Conference Room	Tenant - Office	Occupied	30	API - IOT Provider
L1.11		Tenant - Office	Unoccupied	33	API - IOT Provider
L1.12	Dept of Communities and Justice	Tenant - Office	Occupied	20	API - IOT Provider
L1.13	Dept of Communities and Justice	Tenant - Office	Occupied	20	API - IOT Provider
L1.14	Dept of Communities and Justice	Tenant - Office	Occupied	20	API - IOT Provider
L1.15		Tenant - Office		28	API - IOT Provider
L1.16	Member for Murray (Legislative Assembly)	Tenant - Office	Occupied	123	API - IOT Provider
L1.17		Tenant - Office		150	API - IOT Provider

Zone Thermal Comfort, Lighting and Occupancy Data

1 off point per 250m2 of Tenant-Office area.

Data Point Name	Units	Data Method
Space Temperature	Deg C	API - IOT Provider
Space Relative Humidity	%RH	API - IOT Provider

Occupancy Status (PIR)	Boolean	API - IOT Provider
Light Level	Lux	API - IOT Provider

Floor Indoor Environment Quality Data

1 off data point per occupied floor placed in return air path, total of six off sensing points.

Data Point Name	Units	Data Method
CO2 (Carbon Dioxide Level)	ppm	API - IOT Provider
Particulate matter (PM_{10})	mg/m3	API - IOT Provider
Particulate matter ($PM_{2.5}$)	mg/m3	API - IOT Provider
TVOC	ppb	API - IOT Provider

HVAC Monitoring

Limited status monitoring via IOT Provider, points to be monitored subject to final confirmation due to upgrade works being undertaken July – November 2021:

Data Point Name	Units	Data Method
TBA	TBA	API - IOT Provider
TBA	TBA	API - IOT Provider
TBA	TBA	API - IOT Provider
TBA	TBA	API - IOT Provider
TBA	TBA	API - IOT Provider
TBA	TBA	API - IOT Provider
TBA	TBA	API - IOT Provider
TBA	TBA	API - IOT Provider
TBA	TBA	API - IOT Provider

BMS Data

Not applicable