Australia’s National
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Industry 4.0 Opportunities in White Certificate Schemes

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Contents

Figures

Tables

EXECUTIVE SUMMARY

The RACE White Certificates Project examined two Industry 4.0 opportunities for enhancing Australia's existing State-based white certificate schemes. The project's work for these opportunities was (1) to define a dedicated **Energy Management Information System (EMIS) Activity** that could enable Industry 4.0 technologies to be eligible for certificates (for the energy savings that they deliver) and (2) to develop a **streamlined measurement and verification (M&V)** tool that could reduce the cost and administrative burden of generating certificates.

Results of this research are:

Industry 4.0 Opportunity #1: EMIS Activity

An Energy Management Information Systems (EMIS) is a family of digitalisation tools that save energy by some combination of monitoring, analysing and controlling building energy use. Research showed that the hypothesised EMIS Activity would be best established as two distinct EMIS Activities: a Foundational EMIS and an Advanced EMIS.

The proposed <u>Foundational EMIS</u> covers the implementation of EMIS software-as-a-service (SaaS) digital infrastructure, that is necessary for (i) deploying energy analytics, (ii) communicating relevant information to decision makers, and (iii) measuring energy saving outcomes. Detailed requirements for the Foundational EMIS were developed. These requirements have been provided to the Australian Building Codes Board (ABCB) for possible inclusion as optional requirements in the National Construction Code (NCC). It is proposed that certificates for the Foundational EMIS be deemed at rate equivalent to 3% of site energy consumption over 5 years.

The proposed <u>Advanced EMIS</u> Activity is for deploying energy saving software applications (Apps) such as fault detection and diagnosis (FDD), and advanced energy saving controls. It is proposed that certificates from this Activity be generated using a performance-based measurement and verification methodology. While the certificate creation potential of the Advanced EMIS would be significantly higher than that of the Foundational EMIS, a streamlined M&V methodology would likely be needed to make certificate creation viable.

EMIS providers, consulted in the project, were supportive of the approach to separate EMIS technology into the proposed two EMIS Activities, and indicated that they would be likely to use such an Activity (if it were implemented in the Schemes).

Based on (i) identified strong industry support and (ii) the potential to attract additional energy savings from the hard to reach low/mid-tier property sector - this project recommends that the proposed Foundational and Advanced EMIS Activities be implemented in the relevant national certificate schemes. This could use the suggested eligibility criteria and savings calculation methods described in Section 2 of this report.

Industry 4.0 Opportunity 2: Streamlined M&V

A 'human centred design' process, run with relevant NSW Energy Savings Scheme (ESS) industry participants in 2021, recommended developing a streamlined 'low administration' M&V process for the NSW ESS Scheme. The aim of the streamlined process would be to automate and standardise the M&V calculations, to reduce cost and improve calculation integrity.

Automation can be achieved both in (i) the collection of data and (ii) in the deployment of M&V analytics. Given the lack of existing automated tools, that match the needs of Australia's certificate schemes, CSIRO developed a minimum-viable-product streamlined M&V software tool, hosted on CSIRO's Data Clearing House (DCH) data management platform.

Subject to obtaining a data agreement with AEMO, the tool expects to automate NMI meter data collection, by directly accessing data from AEMO in a similar way to the Energy Made Easy website (https://www.energymadeeasy.gov.au/).

CSIRO's M&V software also automates much of the M&V analytics, including detection and removal (where possible) of solar PV from net-meter data. The M&V algorithms calculate statistical metrics and conduct additional tests to evaluate the quality of the fit of the delivered baseline model. These tests incorporate existing requirements of the NSW Energy Savings Scheme. Collectively a given model must pass all the criteria to achieve an overall 'good' rating. A failure of one or more criteria results in a 'poor' rating.

The M&V analytics algorithms were benchmarked against other international M&V tools using a portal provided by the International Efficiency Valuation Organisation (EVO). The CSIRO M&V analytics were found to be in the top performing 5% of all international models.

Across both the EVO buildings data set and 12 Australian pilot buildings, CSIRO's M&V software would have passed between 40 and 50% of the buildings (for the purpose of creating a valid baseline for certificate creation). Investigating the underlying causes, for buildings that did not get a 'good' baseline, it appears that the CSIRO automated M&V tool does a good job of identifying those sites that are unsuited to (and should not be used for) calculating energy savings through automated analysis. It also showed that the automated approach is more likely to be suited to office-based applications as opposed to sites with potentially bespoke high energy consuming equipment.

The sensitivity of the M&V calculation results to various alternative M&V analytics settings (each being broadly acceptable under the current scheme M&V guidelines), was examined in an industrial retrofit case-study. The case-study highlights the ability to judiciously select baseline model settings and data exclusions (legitimately within the existing scheme rules) to achieve quite different energy saving results. This suggests that a Scheme Administered M&V Tool could be beneficial for the integrity of certificate schemes.

Rather than relying on industry to interpret detailed technical rules and assumptions, provided in written form, a scheme administrator could provide the streamlined M&V analytics as an API plug-in. This would help industry to apply the intended rules appropriately and consistently. This approach is sometimes called "Rules as Code".

Around 40 potential users of the streamlined M&V tool were consulted on the potential efficacy of the proposed streamlined M&V tool. Users included both existing scheme Accredited Certificate Providers (ACPs) and NABERS assessors, who are a highly qualified cohort of users that are well suited to delivering certificate calculation services. Despite potential impacts on ACPs, stakeholders were very supportive of the streamlined M&V approach. The general feeling was that the tool fills a gap (eg low/mid-tier buildings) where existing ACPs would not be able to provide cost-effective services anyway. Various questions, tool improvements and use-case opportunities were identified during the stakeholder consultation.

Sustainability managers were separately surveyed and stressed the importance/value of avoiding duplication of effort by integrating the certificate schemes with the NABERS rating scheme.

The project recommends that further research and tool development be undertaken to enable the streamlined M&V approach to be implemented in relevant national certificate schemes. This recommendation is based on:

(i) identified strong industry support

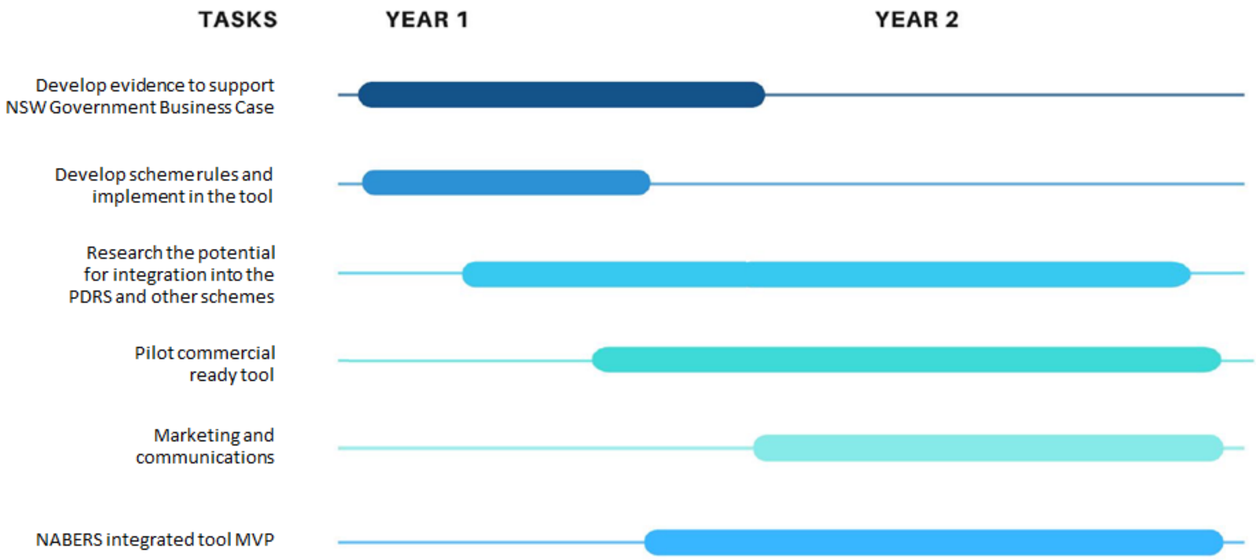
(ii) the potential to expand the range of projects and buildings that can cost-effectively access the schemes,

(iii) the potential to reduce unnecessary transaction costs associated with certificate creation,

(iv) the potential to improve the integrity of the existing project-based certificate generation methods; and

(v) the potential to strategically support the future evolution of certificate schemes towards time-of-use based energy management objectives (eg building on the NSW Peak Demand Reduction Scheme (PDRS)).

A facilitated workshop was held to identify additional research and development needs. The identified needs are illustrated in the high-level work plan below.



The proposed project would complete the tool, within 2 years, ready for implementation in certificate schemes. It would also create appropriate rules and guidelines for overseeing tool use (to maintain scheme integrity). The impact of implementing the tool would also be assessed, in terms of both new certificate creation potential and administrative cost reduction potential.

While delivering a deployable tool and framework for measurement and verification of energy savings, the proposed project would also begin to exploit additional opportunities – including opportunities in the PDRS and potentially in the wholesale demand response mechanism (WDRM).

1 Introduction

1.1 White Certificate Schemes

White certificate schemes (also known as Energy Efficiency Obligation (EEO) schemes) are an energy efficiency policy instrument that aims to incentivise investment in energy saving activities. There are more than 50 such schemes operating worldwide (Lees and Bayer, 2016).

White certificate schemes set specific targets for obligated parties to achieve energy savings. Such savings are obtained by implementing energy efficiency measures. Certificates are issued when these measures, and their concomitant savings, are verified. In various schemes, obligated parties can purchase these certificates from 3rd parties in order to satisfy their obligated savings targets. In this way, white certificate schemes can fall into the category of being a market-based instrument.

White certificate schemes have generally proved highly cost effective. In Great Britain, they produced 7.41 euro in benefits for each euro spent, excluding CO_2 savings (Giraudet and Finon, 2014). The ENEA (2015) claim that an Italian white certificate scheme is seven times more cost effective (in terms of the ratio of the scheme's annual cost and the energy savings achieved) than an alternative tax deductions approach also available in Italy.

There are many possible variants in the detailed implementation of a white certificate scheme. In general, the key actors in the schemes are:

- The Energy Saver: The consumer of energy who invests in the energy efficiency measure (i.e. implements an energy saving 'Activity'). The energy saver reduces energy consumption and reduces their energy bill. They also earn certificates from the scheme. These certificates can then be purchased by the obligated party to provide a further financial incentive for the energy saver to act.
- The Accredited Certificate Provider (ACP): An entity that utilises the approved calculation methods to create Energy Savings Certificates for implementing the eligible 'Activity'. The ACP is trained in the use of the calculation methods, to ensure a level of assurance in the certificate generation process.
- The Obligated Party: The entity that must acquire and surrender a certain number of certificates each year. This may be an electricity retailer.
- The Scheme Administrator: The governing body that (i) sets the rules as to what energy efficiency measures are recognised, and how energy savings can be calculated and (ii) oversees the operation of the scheme. This is typically a role of government in the relevant jurisdiction.

In order to generate certificates, the ACP will typically need to demonstrate:

- Proof that an energy efficiency measure ('Activity') has been implemented. This can be in the form of evidence that recognised energy saving equipment has been purchased and installed.
- An evidence-based calculation of the energy savings achieved. Some typical approaches, for this calculation include:

- Upfront Deemed Savings, based on predetermined deeming factors for retrofit of various pre-qualified energy saving products. This is the simplest and most favoured method for creating certificates.
- Engineering Assessment where expert engineering design consultants calculate savings using established engineering modelling tools.
- Metered Baseline where site/equipment energy consumption is logged before and after the intervention. A baseline model is created to predict how the old site/equipment would have been expected to consume energy. Energy savings can then be calculated as the difference between the actual energy consumption and the predicted baseline (counterfactual of what would have been consumed if the intervention had not been implemented).

1.2 Possible Roles for Digitalisation in these Schemes

Access to data, use of advanced analytics algorithms, and the ability to connect and distribute information between actors (Data, Analytics, Connectivity) are the three core attributes of digitalisation. Using emerging IT technologies, these attributes can be combined in innovative ways to drive new energy productivity outcomes.

Digitalisation can be an ***engineering tool***: for automating and optimising equipment operations to reduce energy consumption, and to match energy demand with the availability of variable renewable energy resources.

Digitalisation can also be an ***administrative enabler***: for operationalising Government policies that either (i) support energy-users with incentives to save energy (eg rating schemes and certificate schemes) and/or (ii) impose relevant regulatory requirements.

In almost all use-cases, digitalisation plays a key role as an ***information sharing tool***: distributing information to where it is needed. Information/data-sharing can involve either one-way or two-way communication. Information/data-sharing can be machine to human (providing decision support for manual interventions), or machine to machine (automating dynamic processes).

In the RACE for 2030 'Industry 4.0 Opportunities in White Certificate Schemes' project, two digitalisation opportunities are investigated:

1. Creating an Energy Management Information System (EMIS) 'Activity' as an eligible technology class for earning certificates. This work focusses on rewarding consumers who utilise digitalisation as an engineering tool for optimising energy consumption in their operations.
2. Creating a streamlined measurement and verification tool, to simplify calculation of the number of certificates that an energy saver should earn when implementing energy saving Activities. This work focusses on using digitalisation to reduce the administrative burden of compliance with scheme requirements.

These digitalisation opportunities were investigated as work packages (WP1 and WP2 respectively). The findings of these two work packages are detailed in the following chapters.

2 WP1: Opportunity for an EMIS 'Activity'

2.1 Why an EMIS Activity?

Kramer et. al. (2020) claim that Energy Management Information Systems (EMIS) are a *"family of tools that monitor, analyze and control building energy use and system performance. The data generated from EMIS tools enable building owners to operate their buildings more efficiently and with improved occupant comfort by providing visibility into - and analysis of - the energy consumed by lighting, space conditioning and ventilation, and other end uses. EMIS tools are used in the monitoring-based commissioning process to organise, visualise and analyze the data"*.

An EMIS typically includes a cloud platform. The cloud platform is the data infrastructure of an EMIS. Importantly, an EMIS is more than just smart metering. It organises (federates) meter data with other relevant building data and other data sources residing in the cloud (e.g. weather data, electricity market data). This enables data to be consumed by energy productivity applications (Apps). Some of these EMIS end-use Apps are illustrated in Figure 2.1.

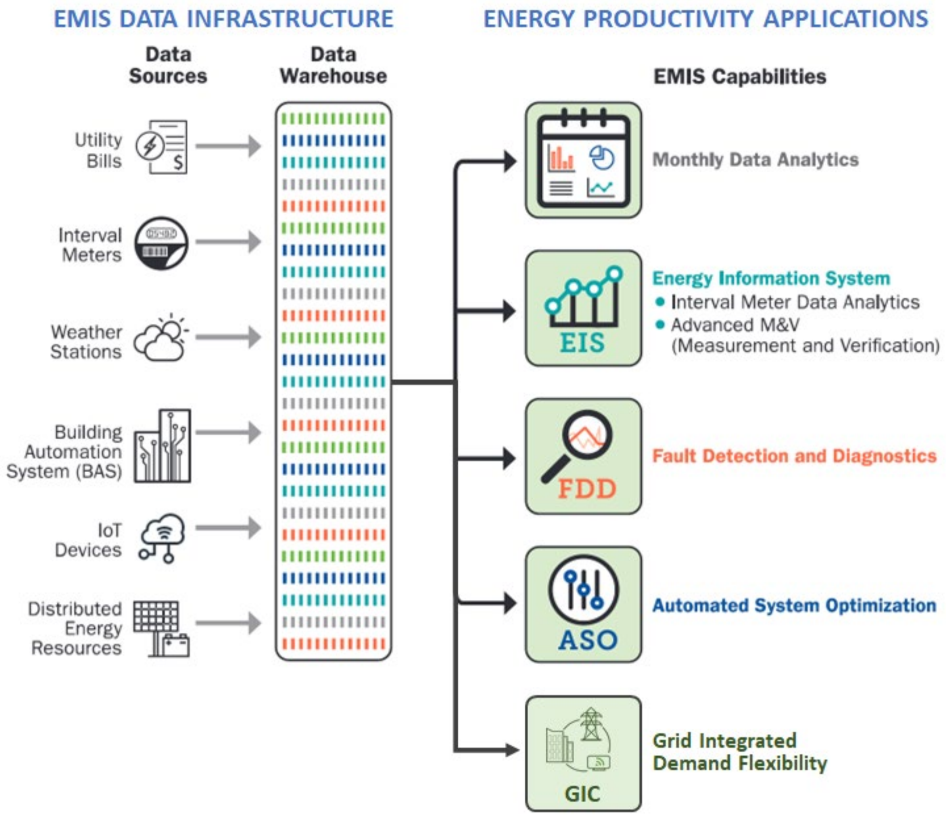


Figure 2.1: Data inputs and key capabilities of an EMIS (adapted from Kramer et. al., 2020)

Energy savings of up to 40% are possible from an EMIS (Serale et al, 2018). An EMIS is also a critical capability required to unlock controllable (dispatchable) resources for the electricity system, as part of the clean energy transition.

An initial coarse-level assessment was made of the size of the energy productivity opportunity that could be obtained by implementing EMIS technology across the national non-residential building stock (White et. al., 2023). It identified the following 10-year benefits of digitalisation in the non-residential buildings sector (Figure 2.2: Impact (technical potential) of implementing EMIS technology in the Australian non-residential buildings sector (White et. al., 2023)

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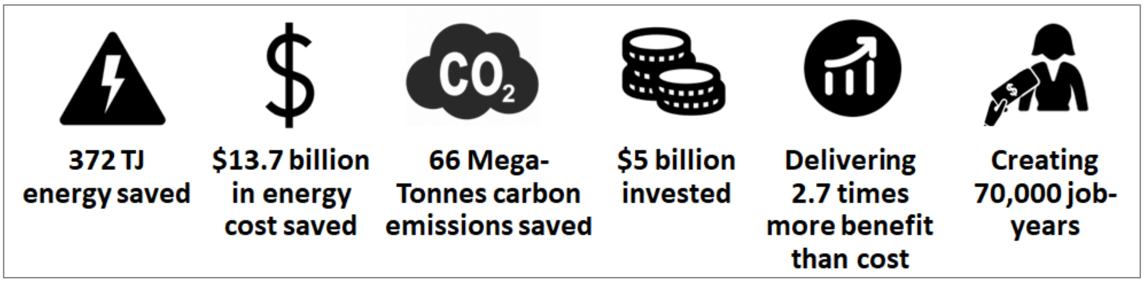

Figure 2.2: Impact (technical potential) of implementing EMIS technology in the Australian non-residential buildings sector (White et. al., 2023)

These benefits suggest that an EMIS Activity is an attractive target for inclusion in Australian certificate schemes.

2.2 The Challenge

While EMIS technology is widely known to save energy, the exact amount of the energy savings is very difficult to know prior to implementing the technology. This makes it difficult to access certificates via traditional upfront 'deemed savings' method. Other more complex methods are required, which typically incur higher cost and administrative burden.

An additional challenge is that, while EMIS analytics technology is good at detecting and diagnosing equipment operational issues, there is generally a further supply chain step involved in getting mechanical and electrical contractors to (i) implement revised control tune-up settings and/or (ii) perform problem-rectification (in response to advice from the data analytics) – all before energy savings are realised. Often this rectification work occurs progressively over a period of a year or more, being more akin to a continuous improvement process than a capex efficiency investment. In this way, the full impact of the energy efficiency measure can evolve over a significant period of time and the relevant start date for the energy efficiency measure may be unclear.

In response to these challenges, the aim of work package 1 (WP1) research was to:

- Identify/define what an EMIS is – in a way that could provide criteria for assessing eligibility to generate certificates from an EMIS Activity.
- Identify/define when and how the energy savings of an EMIS could be derived – in a way that could be used for calculating the number of certificates that should be generated from an EMIS Activity.
- Assess whether there is industry appetite for an EMIS Activity in Australia's existing white certificate schemes.

WP1 research involved:

- Review of EMIS stakeholder roles, EMIS products and costs, and potential financial returns from a hypothetical EMIS Activity.
- An EMIS product/vendor survey.
- A consultation workshop with EMIS providers and M&V consultants.

- Synthesis of findings into strategic recommendations for an EMIS Activity(s).

The research is based on the premise of previously published Victorian EMIS consultation papers (Victorian Government, 2021). However, the research published here should ***not*** be taken as official government policy or advice.

2.3 EMIS products and stakeholders

White (2024) identified various possible providers of EMIS products and/or services. These include:

- Software as a Service (SaaS) vendors: who provide cloud-based analytics software. The software is typically offered as a subscription service to continuously monitor equipment operation and to identify areas where equipment performance could be improved.
- OEM controls hardware providers: with embedded energy optimisation features and algorithms in their controls hardware products.
- Heating Ventilation and Airconditioning (HVAC) controls contractors: who install, commission and maintain HVAC equipment. These contractors may use their own analytics tools bundled up inside their recurring maintenance contracts.

Even if an independent SaaS platform is used to identify energy saving opportunities, the HVAC controls contractor would typically still be required to implement SaaS platform recommendations (i.e. implement rectification works).

EMIS product and service providers were surveyed with the aim of better understanding (i) the important characteristics of EMIS products and services and (ii) what industry would like recognised in Australian certificate schemes. Seven responses were received. The survey found that:

1. An EMIS should not be just a data visualisation tool. Furthermore, you can't just install EMIS technology and expect that the operational problems of a building will then solve themselves. There is a need to provide HVAC domain-specific expertise to drive outcomes from EMIS technology (i.e. An effective EMIS requires both a product/technology investment and an ongoing expert monitoring/maintenance service).
2. It is difficult for industry EMIS providers to communicate the key features of an effective EMIS and to differentiate on quality. This tends to lead to a 'race to the bottom', with purchasing based on lowest cost alone. Requirements schedules, and other guidance material incorporated into a certificate scheme Activity, could be a useful way of supporting energy consumers to understand and invest in better quality EMIS solutions.

Synthesising this information, the proposed deemed 'Foundational EMIS Activity' (see Section 2.5.1) focusses mainly on deploying a Software-as-a-Service (SaaS) platform – rather than OEM controls hardware or HVAC controls contractor services. This has been chosen to avoid incentivising business-as-usual services that are not directly related to energy savings.

However, an 'Advanced EMIS Activity' (see Section 2.5.2) has also been recommended as a means of incentivising energy savings from other EMIS products and services. The 'Advanced EMIS Activity' would use annual measured savings (using the metered baseline method) to determine the number of eligible certificates that can be generated. This ensures that energy savings claims are performance-based, rather than linked solely to hardware/software investment decisions.

2.4 Indicative impact of white certificates on EMIS financial return

The cost of EMIS products and services was reviewed with input from both literature sources and from the product survey responses of industry providers.

The US Smart Energy Analytics Campaign (Kramer et al, 2020) provides a statistically representative estimate of the cost of establishing an EMIS for two energy productivity use-cases. The Nexus Labs FDD Buyers Guide (2023), gives the following budget cost range for fault detection and diagnosis (FDD) SaaS solutions.

- US$0.32 - $1.08/m^2 for installation and configuration implementation/setup cost
- US$0.22 - $1.29/m^{2}yr for annual recurring software cost

Supplier survey responses confirmed that these costs are fairly representative of a SaaS platform. Extra costs are involved in fixing identified issues. Implementing FDD often reveals a backlog of maintenance and repair needs. As a result, there is often a temporary increase in repair costs as deferred maintenance is addressed. Across 1,500 buildings/373 million ft^2 of floor area in North America, Crowe et al. (2020) found that rectification costs averaged US$0.22/ft^2 (~AUD$3.16/m^2).

Combining the cost of the EMIS software and subsequent rectification works, Kramer et al (2020) found that payback times were less than two years in favourable buildings.

An example financial scenario was analysed, as a means of illustrating the indicative impact that white certificates could have on the economics of implementing a fault detection and diagnostics (FDD) SaaS EMIS service.

Assumptions are detailed in Table 2.1 and the resulting financial outcome of investing in an EMIS is compared, with and without certificates, in Figure 2.3: Financial position after implementing an EMIS product/service, with and without certificates in Victoria

(based on certificate prices representative of the Victorian Energy Upgrades scheme). The assumptions reflect a continuous improvement/ continuous maintenance approach (rather than simple invest and forget).

Table 2.1: Base case assumptions for EMIS financial analysis

ITEM	ASSUMED VALUE	SOURCE
Building size	30,000 m^2	Indicative medium to large building
Annual energy consumption	178 kWh/m^2	Commercial Building Baseline Study, 2023
Installation and configuration cost	$1/m^2	FDD Buyers Guide, 2023
Annual recurring software cost	$1.08/m^{2}yr	FDD Buyers Guide, 2023
Annual inhouse labour	8 hr/month	Kramer et al (2020)
Labour cost	$95/hr	www.glassdoor.com.au
Cost of rectification works	$2/m^2 (year 1) $1.50/m^2 (year 2) $1/m^2 (year 3) $0.5/m^2 (>year 3)	Industry experience, and with reference to Crowe et al (2020) - $3.16/m^2 - considering the cost to be spread across multiple years
Energy savings	6% (year 1) 9% (year 2)	Kramer et al (2020), average savings from FDD in campaign cohort

	13% (year 3) 13% (>year 3)	
Electricity tariff	15c/kWh	Indicative commercial tariff
Certificate price	$30/MWh NSW ESC $85/T Vic VEEC	Indicative spot price https://www.demandmanager.com.au/
Emissions factors	0.76 T/MWh in 2023, decreasing to 0.37 T/MWh in 2034	DCCEEW (2022)
Certificate allocation	100% on measured savings	

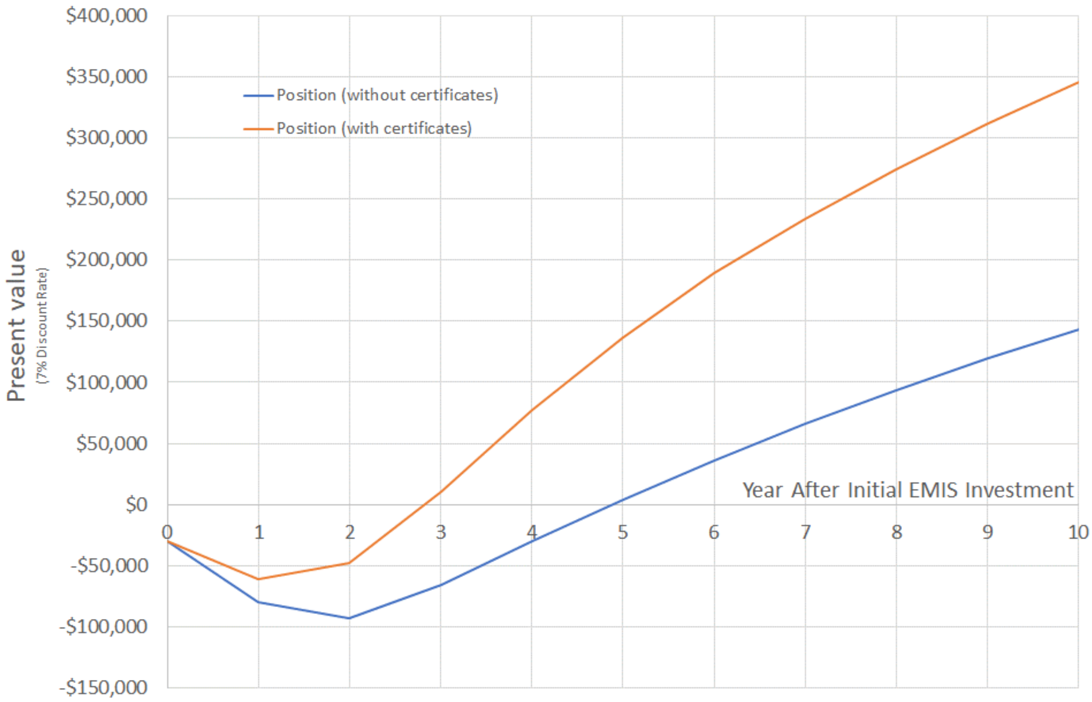

Figure 2.3: Financial position after implementing an EMIS product/service, with and without certificates in Victoria

Under these assumptions, the 10-year IRR with and without certificates is 64% and 28.5% respectively.

It is understood that industry has a strong preference for 'forward-creation' of certificates (i.e. upfront certificate creation/ financial incentive), rather than annual performance-based certificate creation. This provides the energy saver with greater certainty in the business case to invest.

The financials of an EMIS Activity were rerun, using the same assumptions as detailed in Table 2.1, but with different levels of forward-creation (deeming) of the 10-year whole of life energy savings. It appears that around 10% forward creation would deliver a scenario where investment in a software as a service (SaaS) EMIS platform could be essentially free of charge. This would still leave incentive to continue to invest in rectification works (to generate certificates from the remaining 90% of expected energy savings).

2.5 Suggested approach for an EMIS Activity.

It is already possible to attract certificates for investing in EMIS products and services, as a 'Project Based Activity' (PBA) under the Victorian Energy Efficiency Target (Project-Based Activities) Regulations (2017). However, greater certainty would be provided to investors if a dedicated EMIS

Activity was created that provided clarity on (i) what EMIS technology is/isn't eligible and (ii) how a claim for certificates could be proved without excessive administrative burden.

To this end, information from Sections 2.3 and 2.4 was synthesised, along with information on barriers relevant to EMIS investments (Trianni et al, 2022), and used to devise a possible strategic approach for incentivising EMIS technology through the Australian certificate schemes.

Two EMIS Activities are recommended (rather than one). These are a Foundational EMIS and an Advanced EMIS. The principles of the proposed two Activities are listed in Table 2.2.

Table 2.2: Summary of Proposed EMIS Activities

	FOUNDATIONAL EMIS	ADVANCED EMIS
Scope	EMIS infrastructure investment • Energy metering and equipment monitoring • Cloud data access, visualisation, normalisation and reporting • Consumer data right style data sovereignty and 3rd party provider enablement • An oversight process for actioning findings from analytics	EMIS software applications (Apps) • Fault detection and diagnostics • System optimisation advice • BMS equipment operational scheduling • Supervisory (SaaS) control optimisation • Grid integrated control (flexible demand)
Eligibility Constraints	• Office, shopping centre and healthcare buildings that are >500 m^2 but <5000 m^2 floor area • All other buildings (excluding NCC class 1 and 2) that are over 500 m^2 floor area • Qualified EMIS product	• Must have a Foundational EMIS
Certificate Creation Method	Deemed at a rate of 3% of energy consumption for 5 years (~$1/$m^2$)	Annual IPMVP Option B or C measurement and verification
Comments	Provides infrastructure for deploying EMIS Apps and capability to implement meaurement and verification (M&V)	Performance based creation of certificates

2.5.1 Foundational EMIS

The Foundational EMIS could be conceived as being similar to the existing 'in-home display unit' Activity (Part 30 of regulation 10 in the Victorian Energy Upgrades Scheme) – focussing on infrastructure for information provision and interpretation – but, in this case, for use in non-residential (rather than residential) buildings.

Proposed requirements for the Foundational EMIS are presented in the breakout box below.

Deeming of savings (i.e. up-front certificate creation) is proposed for the Foundational EMIS. This is because the extent of the energy saving opportunities (that the EMIS analytics will subsequently discover) can't be predicted up-front at point of investment. This creates a catch 22 situation, where it's impossible for the energy saver to perform a business-case analysis prior to committing to investment in the initial EMIS data infrastructure. Hence, deeming has great potential to overcome one of the main identified barriers to uptake of EMIS technology.

The proposed rate of deeming (i.e. certificates awarded for expected energy savings from the Foundational EMIS) assumes that 3% of site energy consumption is saved each year for 5 years[1]. This rate is based on the savings reported by Kramer et al (2020) for metering only services. Conveniently, the value of these deemed certificates, in the Victorian Energy Upgrades scheme, would be similar to the initial installation cost of a SaaS platform (while not neutralising investment costs for implementing rectification works). This value would help enable energy savers to defer investment costs to the point where they can realistically assess the business case for further action.

[1] (Note: It is purely coincidental that this 3% reduction in energy consumption in a building for 5 years (= 5*0.03*E = 0.15E in this Section 2.5.1), is roughly the same as bringing forward 10% of expected whole-of-life (10 years) energy savings from a fault detection and diagnosis application that reduces building energy consumption by 13% (= 10*0.1*0.13E = 0.13E in Section 2.4))

Foundational EMIS Requirements

A qualifying Foundational EMIS shall have features that include advanced metering, data integration, data visualisation, M&V application readiness, and a demonstrated plan for a reporting service to highlight operational issues; as described further below:

Advanced metering

The building shall have energy sub-metering that is sufficient to meet the requirements of the National Construction Code (2022) - Section J Energy efficiency - J9D3 Facilities for energy monitoring.

Data integration

The building shall be provided with facilities that include the following functionality:

1. *Provision of a data integration process or platform that can connect to onsite systems and transfer data/information to a separate EMIS platform with no cost for additional users to access the data*
2. *Data uploaded to the platform, that shall be normally available for analysis no later than:*
   a) *For BMCS systems: upload daily as a minimum*
   b) *For metering systems: 5 minutes after the point is generated;*
   c) *For all systems: as fast as required to support applications in use.*
3. *The data uploaded shall include all relevant analogue and digital points from monitoring and control systems relating to, as a minimum:*
   a) *Energy metering,*
   b) *Heating, ventilation and air-conditioning system control, setpoints and operation*
   c) *Outside air conditions (temperature humidity) from local and/or external sources*
   d) *Solar PV system generation monitoring.*

Data Visualisation

The data integration platform shall be configured with the following minimum functionality:

1. *A user interface that enables authorised users to visualise system data and operational status.*
2. *Visualisation of data in a graphical format including the ability to compare individual data streams integrated over time periods and in time series.*
3. *Able to provide bulk downloads of data to the authorised users for external analysis at no additional cost per user.*

M&V application

The EMIS shall include or incorporate access to a monitoring and verification engine/app that meets the following criteria:

1. *The measurement and verification app shall be able to operate on utility and sub-metered data, using the data transferred by the data integration process.*
2. *The app functionality shall include the ability to monitor and verify energy savings and performance metrics. The system shall be configured and available for use and have the ability to:*
   a) *Provide monitoring and verification of energy savings in accordance with IPMVP Options B and C.*
   b) *Accept a user-defined baseline/ benchmark, or automatically determine a baseline from historical building data and weather data.*
   c) *Compare current building performance against the baseline, both numerically and graphically.*
   d) *Provide forecasts of solar PV production (if relevant).*

Energy management process*.*

The applicant shall provide evidence that a reporting process is planned to be undertaken. The evidence shall include, at a minimum, the following details:

1. *Nomination of*
   a) *A reporting manager responsible for overseeing the reporting process.*
   b) *Members of the energy management committee responsible for reviewing data and discussing/approving actions in response to data*
   c) *1, 3 and 5 year energy and emissions performance targets*
   d) *Energy management meeting frequency (not less frequent than monthly in year 1 and quarterly thereafter), with a standard agenda*
2. *Identification of key stakeholders and recipients of the reporting insights, as well as summary reports and stakeholder distribution*
3. *Documentation of an effective chain of command for authorisation of energy efficiency expenditure, including limits of delegation*

The proposed eligibility criteria for the Foundational EMIS are intended to focus the Activity on buildings that are large enough to create a useful saving (i.e. minimum 500 m^2 floor area) while excluding larger office buildings (those greater than 5,000 m^2 floor area) on the grounds that larger buildings in this sector should have a Foundational EMIS as business as usual (i.e. the limitation is based on considerations of additionality).

Given that the proposed deeming rate may end up providing zero upfront cost SaaS services, it would seem sensible to restrict eligibility to vendor EMIS products that have been pre-qualified. This would help to prevent low quality products and services being dumped on energy savers who have limited capability to assess product quality. Pre-qualification would require the scheme administrator to maintain a register of these pre-qualified products.

2.5.2 Advanced EMIS

The Advanced EMIS involves deploying energy saving software services such as fault detection and diagnosis (FDD), HVAC controls tuning and automated system optimisation. Amongst many other things, it could potentially include aspects of space management and/or occupant behaviour change support services. With such diverse solutions available, it would be difficult to codify the proposed Advanced EMIS into a set of technical requirements.

Consequently, the proposed Advanced EMIS Activity leaves the exact application software/technology somewhat undefined and relies on measuring actual savings (using the metered-baseline-method) to justify award of certificates. In this way, the proposed Activity is performance based.

The Advanced EMIS is intended to be additional to (and built upon) the Foundational EMIS - rather than be seen as an alternative EMIS Activity with alternative functionality. Hence, certificates are expected to be generated from both Activities, at a given site where eligibility criteria are met. However, certificate calculations should allow for deemed Foundational EMIS energy savings to be deducted from the measured M&V-based Advanced EMIS energy savings, to avoid double counting.

Data from Kramer et. al. (2020) suggests that energy savings from an Advanced EMIS would typically be around 13% of site energy consumption. Noting the proposed 3% deemed savings for the Foundational EMIS (see Section 2.5.1), there should be many more certificates generated from this Advanced EMIS Activity compared with that from the Foundational EMIS.

Back-of-the-envelope calculations of certificate value, suggest that the administrative burden of certificate generation will need to be low, potentially achieved by streamlining the metered baseline method (as discussed in Section 3 of this report).

The approach taken, in the proposed Advanced EMIS Activity, implies that measured energy savings (detected using the metered-baseline-method) is the primary evidence to demonstrate that an Advanced EMIS has been deployed. Of course, many other factors could be contributing to measured energy savings.

This uncertainty, regarding the precision of where the energy savings may be coming from, is not seen as an insurmountable problem - given that the core objective of the certificate schemes (to save energy/emissions) is being achieved. However, to demonstrate that the Advanced EMIS is causing at least some portion of the energy savings, eligibility is proposed to be restricted to those buildings that have a Foundational EMIS (see Section 2.5.1), whether or not deemed certificates were generated from the Foundational EMIS's original installation.

2.6 Appetite for an EMIS Activity

A consultation workshop was held to discuss the merits of introducing an EMIS Activity into Australian certificate schemes, and to gather perspectives on industry preferences relating to its implementation. The workshop included various Slido poll questions (Figure 2.4: Significance of a deemed Foundational EMIS Activity that attracts an incentive of around $\$1/m^2$

, Figure 2.5: Usefulness of maintaining a product register for a Foundational EMIS

and Figure 2.6: Expectation to use the proposed EMIS Activities, if made available).

The workshop was attended by 28 people: comprising 7 from the delivery team, ~8 measurement and verification (M&V) professionals, ~10 product providers, 1 facilities manager, 1 consultant, and 1 industry association representative.

Key findings from the workshop were

1. Participants agreed that an EMIS Activity would be a good inclusion for certificate schemes. In particular, they felt that it could play an important role in helping to stimulate energy savings in difficult-to-reach smaller low/mid-tier buildings.
2. Participants liked the idea of separating out a Foundational EMIS Activity that attracts deemed certificates for installing EMIS data infrastructure. They felt that deeming the Foundational EMIS Activity, at a rate of 3% of baseline energy consumption over 5 years, was appropriately conservative but sufficient to incentivise the desired outcomes (Figure 2.4: Significance of a deemed Foundational EMIS Activity that attracts an incentive of around $\$1/m^2$
3.)

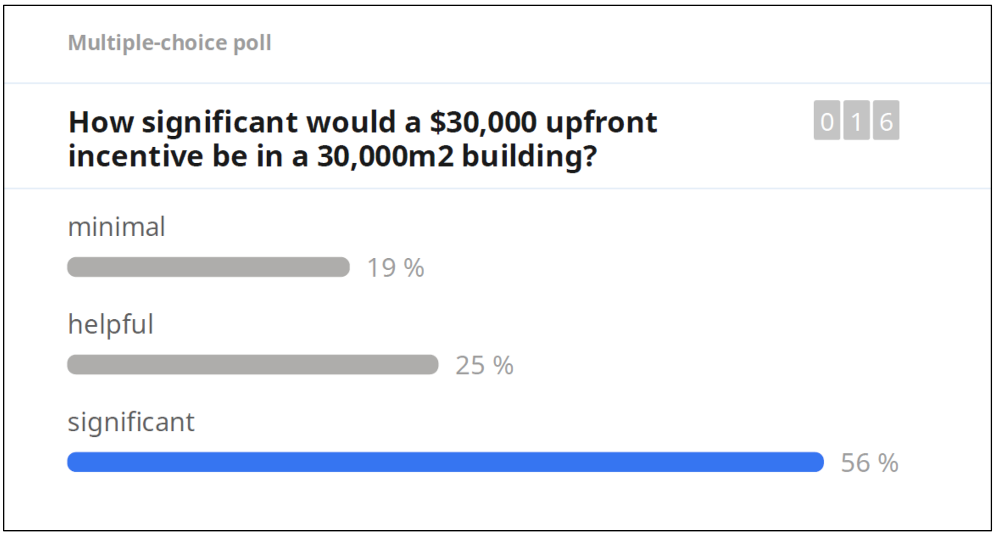

Figure 2.4: Significance of a deemed Foundational EMIS Activity that attracts an incentive of around $\$1/m^2$

4. Participants liked the idea of enabling the creation of additional certificates, through a separate performance-based Advanced EMIS Activity. It was noted that care should be taken to avoid double-counting.
5. Participants emphasised that deploying EMIS technology does not necessarily lead to savings without ongoing implementation of rectification works. Consequently, a requirement for generating certificates should be establishment of an ‘energy management committee’.

Such a committee should meet regularly (at least quarterly) to consider opportunities to action the advice from the EMIS technology.

6. Participants liked the idea of maintaining a register of qualified products/services, in a similar manner to that implemented by the NYSERDA RTEM program (Figure 2.5: Usefulness of maintaining a product register for a Foundational EMIS
7.).

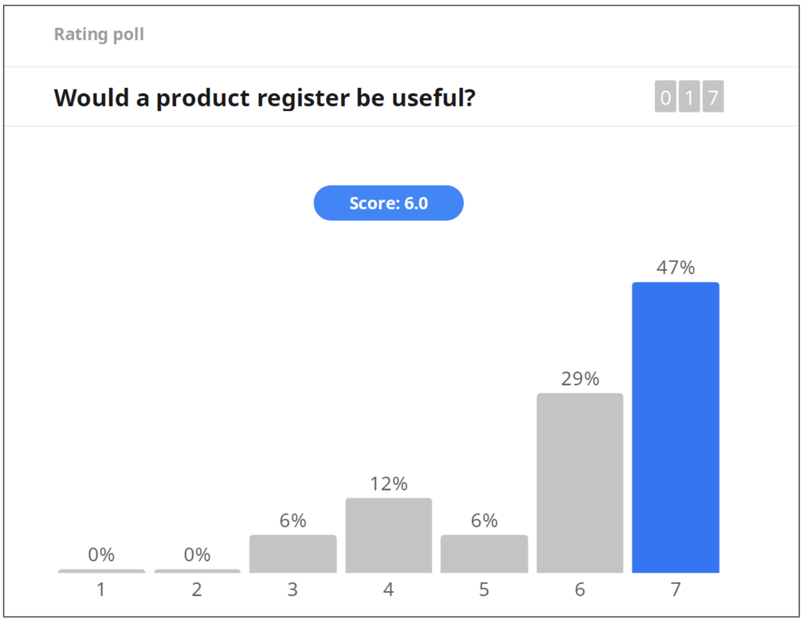

Figure 2.5: Usefulness of maintaining a product register for a Foundational EMIS

8. Participants were comfortable with EMIS providers being allowed to gain accreditation (i.e. become an Accredited Certificate Provider (ACP)), for the purpose of creating certificates when deploying their own products and services. However, if creating certificates for their own products, EMIS providers should be required to generate certificates through an independent, authorised, automated measurement and verification (M&V) tool.
9. Participants felt that government should provide such an authorised automated measurement and verification (M&V) tool as it would help to (i) reduce the upfront investment cost for building owners, (ii) reduce the compliance risk and transaction cost for service providers, and (iii) maintain the integrity of the scheme.

Overall, there was significant enthusiasm for the proposed EMIS Activities and strong expectation that they would be utilised (Figure 2.6: Expectation to use the proposed EMIS Activities, if made available).

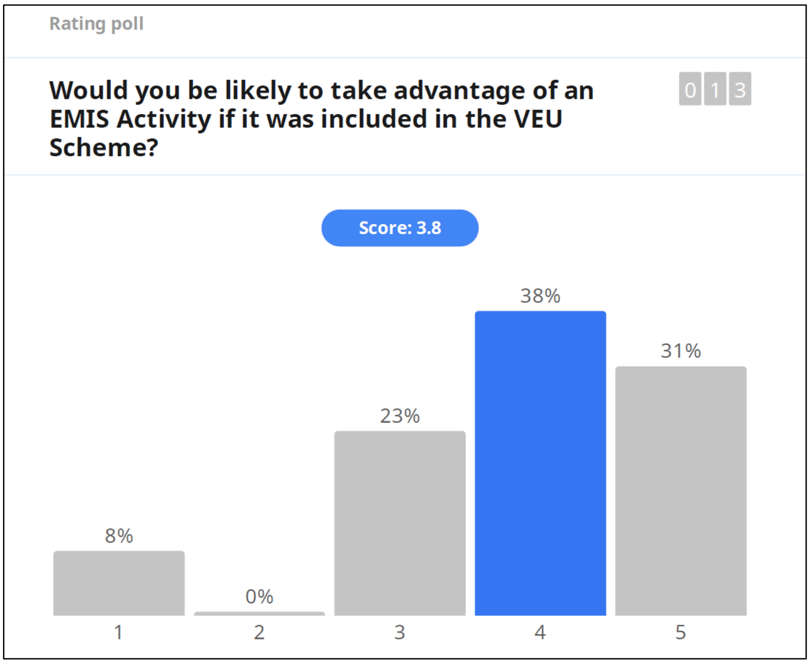

Figure 2.6: Expectation to use the proposed EMIS Activities, if made available

3 WP2: Opportunity for Streamlining Measurement and Verification

3.1 Why Streamline Measurement and Verification?

Measurement and Verification (M&V) is the formal process of measuring energy consumption - both before and after an energy saving Activity is implemented - for the purposes of determining energy savings.

Energy consumption measurements before the Activity are used to create a baseline energy consumption model that can predict how the old site/equipment would have been expected to consume energy. The energy savings (after the Activity is implemented) are then calculated as the difference between the actual energy consumption and the predicted baseline (counterfactual of what would have been consumed if the Activity had not been implemented).

The NSW Metered Baseline Method Guide (IPART, 2023a) and Project Impact Assessment with M&V (PIA M&V) guide (IPART, 2023b) provide detailed information on the methodology that must be followed to be eligible for certificates under the NSW Energy Savings Scheme (NSW ESS). Victoria (Essential Services Commission, 2024) and South Australia (Government of South Australia) also provide guidance on their own M&V based methods. Internationally, the Efficiency Valuation Organisation (EVO) (EVO, 2022) has published several guidelines and, in the USA, ASHRAE Guideline 14 (ASHRAE, 2014) relates to M&V methods.

Importantly, M&V calculation methods attempt to measure actual energy savings, after they have been achieved. In this way, they are performance-based and can be used to track progress on a site's energy savings journey. They are also agnostic to the energy saving Activity deployed.

In contrast the 'deemed savings' and the 'engineering assessment' calculation methods predict expected energy savings. These energy savings may or may not occur in reality and are, therefore, only suitable for a limited range of energy saving Activities. Furthermore, once the expected savings are calculated and certificates generated, there is limited incentive to track outcomes and ensure that the energy saving Activity is maintained and performs to plan.

As a performance-based method, M&V has the potential to be a more rigorous certificate generation method, that both enhances the integrity of white certificate schemes, and better supports energy users achieve energy savings outcomes. It could also enable new technologies and services to become eligible energy saving Activities (eg the proposed EMIS Activity in Section 2).

Unfortunately, however, there has been relatively limited uptake. This is due to the cost, complexity and time-consuming nature of the existing methods. By 2020, in the NSW ESS Scheme, only 3.6% and 1.4% of certificates had been generated using the relevant (i) Project Impact and Assessment with M&V (PIA M&V) and (ii) Metered Baseline calculation methods respectively.

In 2020, the NSW Government used a 'human centred design' process to consult with NSW ESS participants and explore ways to improve the PIA M&V method. The process involved a series of steps to (i) identify the problems faced by ESS participants, (ii) brainstorm solutions, (iii) develop concepts and (iv) test the viability of these concepts with ESS participants.

One of the solutions tested and validated with ESS participants was the desire for a proposed Low Administration Pathway (Figure 3.1) for implementing M&V based certificate calculation methods.

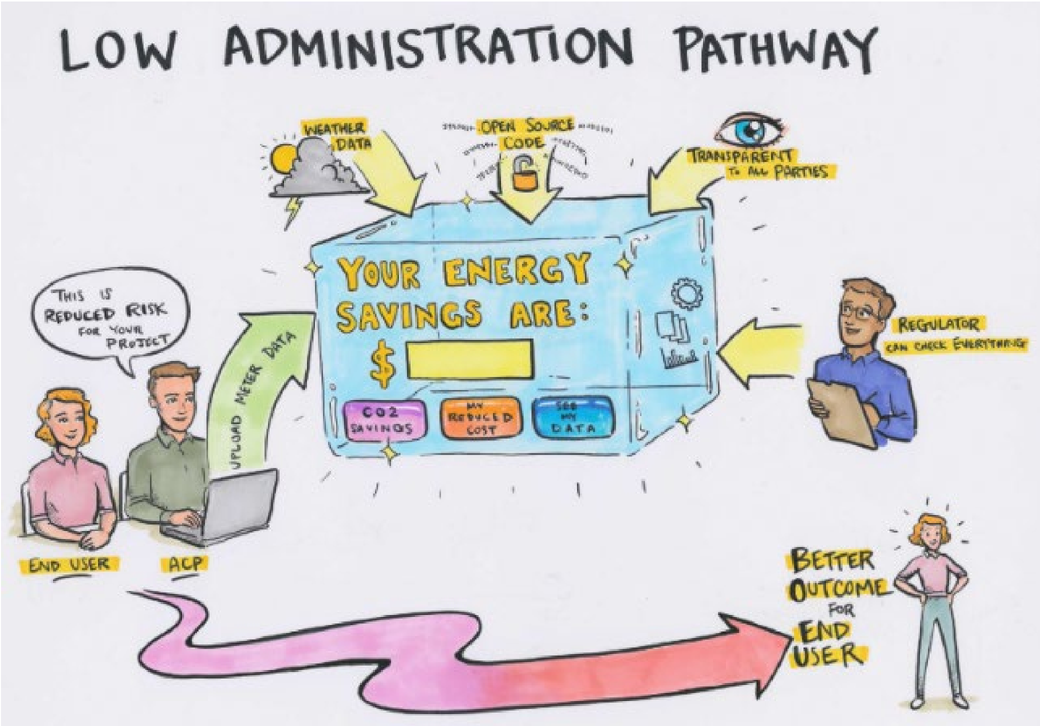

Figure 3.1 Proposed Low Administration Pathway for M&V in the NSW ESS (Source: NSW Government's Energy Security Safeguard Team)

The proposed pathway involves uploading meter data into a Scheme administered web-portal which performs standardised M&V calculations for the site and manages record keeping on behalf of users. The aim of the new approach is to

- Simplify, automate, and accelerate the process of baselining historic energy consumption
- Standardise calculations with transparent, trustworthy M&V algorithms and prevent potential rule-stretching with bespoke M&V implementations.

This Section explores the feasibility of this approach, with particular focus on using CSIRO developed M&V software, hosted on the Data Clearing House (DCH) data management platform.

3.1.1 Use-Cases for M&V

While M&V is an important tool for certificate generation in the various Australian State-based certificate schemes, the built-in ability to learn time-of-use based energy consumption rates and be able to predict site performance, enables various other use cases, such as:

I. Continuously benchmark site energy consumption, track improvements in site energy use and hold energy efficiency suppliers to account.
II. Make projections of future energy, cost & emissions for sustainability reporting/compliance.
III. Identify anomalies in operations, with some fault-finding diagnostic capability.
IV. Support advanced controls, including (i) demand response services in energy markets such as the Wholesale Demand Response Mechanism, and (ii) matching demand with local or grid-based renewables.

In this way, M&V should be seen as part of the minimum capability suite of all sites.

3.2 Automating Measurement and Verification (M&V 2.0)

Advanced M&V (M&V2.0) involves the use of automated data feeds and semi or fully automated analysis, to streamline processes and reduce the overall transaction cost of energy savings assessments. A fully automated tool would automate both:

1. the form and method of supplying input data to the M&V analysis, including the meta-data that provides the linkage between data and relevant site equipment features; and
2. the M&V analysis itself and the extent to which an expert user (for example the tool vendor, the tool user, or a 3rd party) is required to choose analysis options, interpret results and to ensure that the analysis is valid/accurate.

Some of the difficulties with automating the M&V analysis include:

- Automating processes for dealing with non-routine events (periods where the site is operating in an atypical way, eg plant maintenance, Christmas shutdown etc),
- Quantification and benchmarking of model uncertainty & accuracy, and
- Adjusting for difficult to model buildings/sites (eg where energy consumption depends on erratic changes in use, or sites that only have net metering of onsite solar generation).

Table 3.1 identifies different levels of automation across the two dimensions of *data* automation and *analysis* automation.

Table 3.1: Summary of M&V2.0 levels of autonomation

Automation level	Data Automation (**D**)	Analysis Automation (**A**)
Level 1	Input data must be supplied pre-processed (cleaned, synchronised and/or filled). User must upload data file(s) and specify all configuration options.	M&V specialist user must interpret model validity & results as well as design & initiate new analysis if required. Minimal model diagnostics and checks (for example standard metrics such as R2, CVRMSE only)
Level 2	Raw input data can be supplied. User must upload data file(s) and specify most configuration options.	Detailed model diagnostics are provided with limited suggested changes to analysis options based on default model performance. M&V specialist required to initiate (configure) and run new analysis.
Level 3	Data is obtained from an automated service (e.g., data-base, API, cloud service). All processing is done by the application. Minimal configuration options required (for example specify data linkages & site location).	Natural language processing of outputs & application diagnostics are reported & interpretable by a non-specialist. Suggested analysis changes provided to user for review. Analysis automatically reruns based on user selection.
Level 4	Data is obtained from an automated service. Semantic models are used to provide data interpretation & linkage. Analysis across multiple sites can be done with no specific user setup.	Application automatically self-diagnosis model performance. (e.g., non-routine events are automatically identified and accounted for. Different model options are automatically trialled if the initial model does not meet specifications.) Invalid model results cannot be provided as final outputs.

Based on the literature reviewed in this project, no existing M&V applications were identified that provide full automation (D4A4). The vast majority of applications described in the review by Granderson and Fernandes (2017) use D2 level data automation or less and A1 or A2 analysis automation. The current CSIRO DCH-M&V application is around D3A3 level of automation.

3.3 Development of CSIRO’s DCH Hosted M&V2.0 Tool

CSIRO’s Measurement and Verification tool aims to automate the task of calculating the number of certificates that an eligible Activity should be able to generate. This includes both (i) automating the task of obtaining and managing the necessary meter data and (ii) automating the task of analysing the data.

An objective is to make the M&V tool essentially ‘self-service’. That is, the process of performing the M&V task is sufficiently simple, structured and guided (by the software), that a site owner can perform the M&V task themselves.

3.3.1 Automating the M&V Analysis

The core CSIRO Measurement and Verification analytics algorithms are bundled up in a hosted application ‘MVApp’. It contains all the core code for data ingestion, processing, calculating baselines, evaluating savings, and generating outputs.

An overview of the M&V analytics stages is shown in Figure 3.2. A significant amount of code is dedicated to the initialisation and data-preparation stages prior to running the actual M&V analysis (i.e. fitting the baseline model and estimating analysis period consumption). This includes automating the processes of reading and cross-checking configuration parameters, setting and calculating default options and derived parameters, cleaning and processing individual data streams, calculating derived data streams, and performing checks on the processed data. Detailed descriptions of these steps are provided in Goldsworthy (2024).

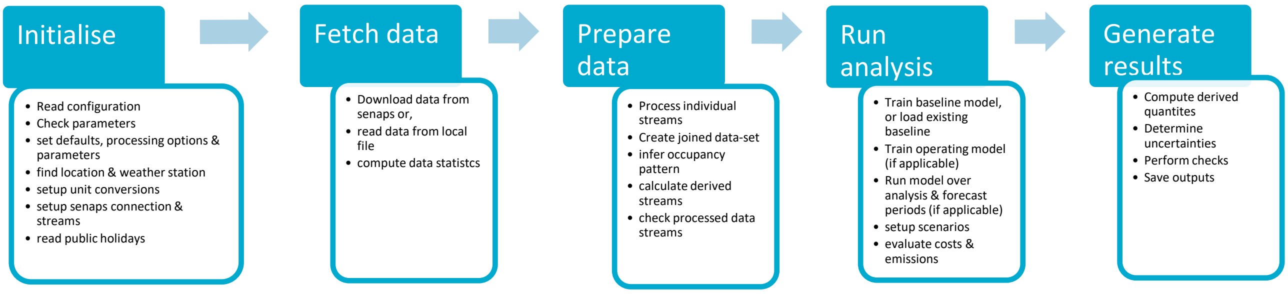

Figure 3.2: Overview of MVApp algorithm key stages

MVApp (applied to the cleaned data streams) uses a weighted piecewise continuous multi-linear regression for modelling the overall site consumption, as a function of ambient temperature, for each half hour time of the day.

Daily, weekly or monthly energy consumption models are also inbuilt, fitting consumption as a function of Cooling Degree days (CDD) and Heating Degree days (HDD).

MVApp automatically calls up Bureau of Meteorology weather data. The algorithms automatically distinguish between week-days and weekends/public holidays, and they detect building occupancy.

MVApp can further use solar irradiance data to automatically detect if solar PV generation is occurring on site and is present in the meter data (net metering). Daily, weekly or monthly models are strongly recommended when solar PV is present in the meter data. The algorithms can account for solar generation up to approximately 20-30% of site underlying energy consumption. Above this, additional meters will be required on the generation plant.

MVapp automatically calculates statistical metrics and conducts additional tests to evaluate the quality of the fit of the delivered baseline model. Each test is compared to a criterion or threshold to determine a binary pass/fail. These checks include the requirements of the NSW Metered Baseline Method Guide (IPART, 2023a) and Project Impact Assessment with M&V (PIA M&V) guide (IPART, 2023b). Collectively a given model must pass all the criteria that are included in the overall rating to achieve an overall 'good' rating. A failure of one or more criteria results in a 'poor' rating.

MVApp was benchmarked against other international M&V tools using the portal provided by the International Efficiency Valuation Organisation (EVO) (https://mvportal.evo-world.org).

The EVO portal contains whole of building half-hourly interval electrical power consumption data and ambient temperature data from 367 real-world commercial buildings, spread across the United States. For each building, 1 year of data is available to construct a baseline model. An additional year of temperature only data is provided for blind validation. Users (who are interested in benchmarking their algorithms) can upload the predictions from their M&V model and the portal evaluates model performance against the unseen data set.

At the time of running, 93 models had been submitted to the EVO portal with summary performance results as shown in Figure 3.3. CSIRO's MVApp achieved a median 'Coefficient of Variation of the Root Mean Square Error' (CVRMSE) score of 33.75% and 'Net Mean Bias Error' (NMBE) score of 0.04% placing it in the top 5% of all models and very close to the top performing model.

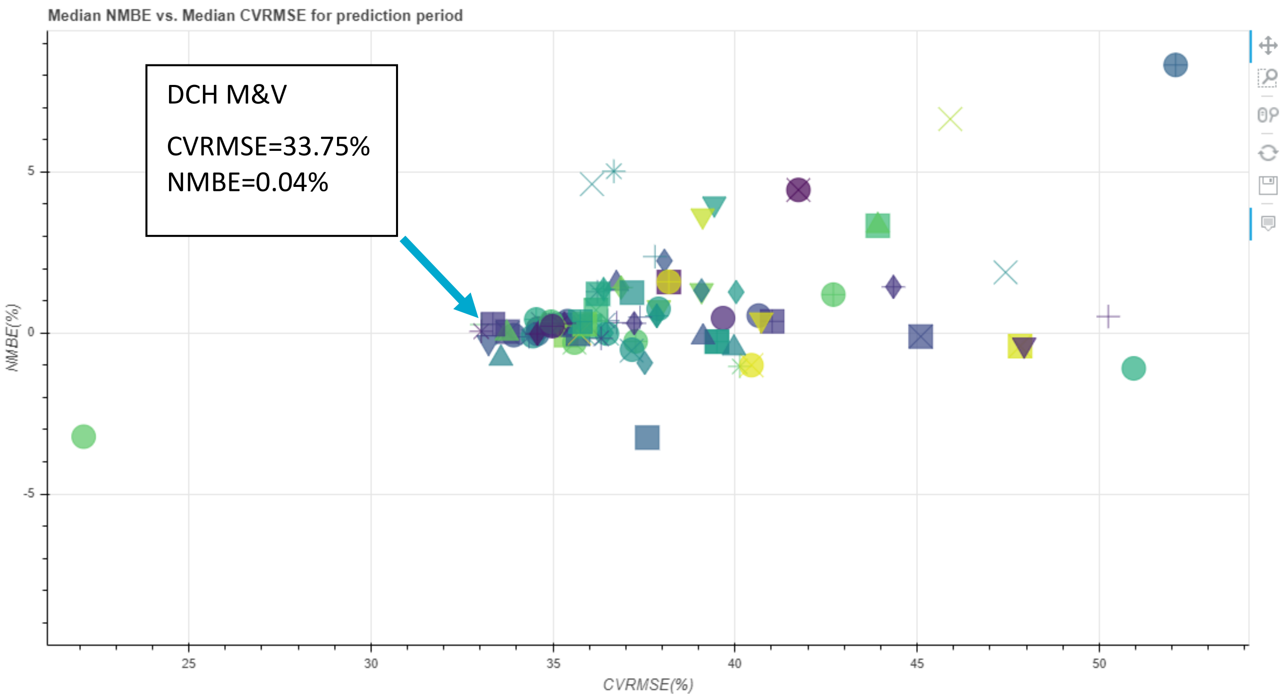

Figure 3.3 Illustration of how semantic sufficiency guides the creation of metadata models

Daily and interval baseline models were fit to the EVO portal buildings and the number of buildings where the models satisfied each of the baseline rules and checks was assessed. Results are summarised in Table 3.2. Just below half of the buildings met all of the baseline criteria with the number slightly higher (48.5%) for the interval model than for the daily model (42.8%).

Table 3.2: Summary of percentage of EVO building baseline models that passed each baseline rule/checks

BASELINE RULE /CHECK	PERCENT PASSED (%)	
	Daily Model	Interval Model
R^2	67.9	97.0
CVRMSE	64.0	78.2
NMBE	81.5	97.8
Residual auto-correlation	83.7	82.0
Seasonal trend	100	100
Time trend	85.0	94.3
Over & under-estimated months	66.2	73.0
Missing data	98.6	98.1
Excluded data	Not applicable (no excluded data)	
Outliers	64.9	74.1
PV	Not applicable (no irradiation data)	
Passed all included checks	**42.8**	**48.5**

These results suggest that CSIRO's MVApp would be able to establish a baseline, suitable for generating energy saving certificates, in around half of the building stock. As expected, complicated buildings with erratic energy usage patterns would be unsuitable for this approach and would need to use other existing certificate generation methods.

3.3.2 Automating Data Collection and M&V Application Hosting

CSIRO's MVApp is hosted on the Data Clearing House (DCH) data platform (https://research.csiro.au/dch/). The DCH is a cloud-based digital platform for ingesting, storing and managing access to sensor data (eg meter data) and other time-series data-sources (eg weather data). The DCH also allocates cloud compute resources for running analytics that generate valuable insights from the data.

The DCH has a granular permissioning system to enable data to be held confidentially and securely, giving the user full control over who gains access to their data. The DCH database structure supports the ability to self-configure (automate) deployment of Apps, analogous to the downloading of Apps on a mobile device.

For the proposed streamlined certificate calculation M&V tool, a website has been developed that provides a user interface to enable users to (i) input setup information into relevant fields and (ii) view results from the calculations. The website calls the DCH hosted MVApp to acquire the required data and to process the calculations.

The streamlined M&V tool uses National Meter Identifier (NMI) data. This was chosen because it is the most reliable and ubiquitous source of energy consumption truth, and it avoids the need for additional metering to be installed. Subject to obtaining a data agreement with AEMO, the goal is to access this meter data directly from AEMO, via an API, in a similar way to the Energy Made Easy website (https://www.energymadeeasy.gov.au/).

This level of data collection automation overcomes substantial friction accessing relevant meter data. It also avoids any concern over potential tampering with the data. The raw meter data would be stored by the M&V tool, for calculation and audit purposes, but would not itself be visible to the user.

The current version of the streamlined calculation tool allows for one NMI meter. Future developments of the platform will incorporate the potential to include multiple meters and gas consumption data. Also, the Web Portal does not currently include a post-retrofit analysis dashboard.

3.3.3 Using the Streamlined M&V Tool

The minimum viable product (MVP) web-portal is accessed through a browser by navigating to:

https://dataclearinghouse.org/whitecertificate/dashboard

The description below is based on the MVP product as of May 2024. Given the web-portal is undergoing continuous development It is expected that some of these details may change. Using the tool requires the user to be a member of an 'Organisation' (as discussed below). The reader can contact CSIRO at contact.dch@csiro.au to join an Organisation and get started.

After logging in, the main dashboard appears (Figure 3.4). This allows the user to select the site owner's Organisation from a drop-down list of those they have access to. The user can then add a new site to the Organisation, and can see existing sites in the Organisation that M&V has previously been installed on.

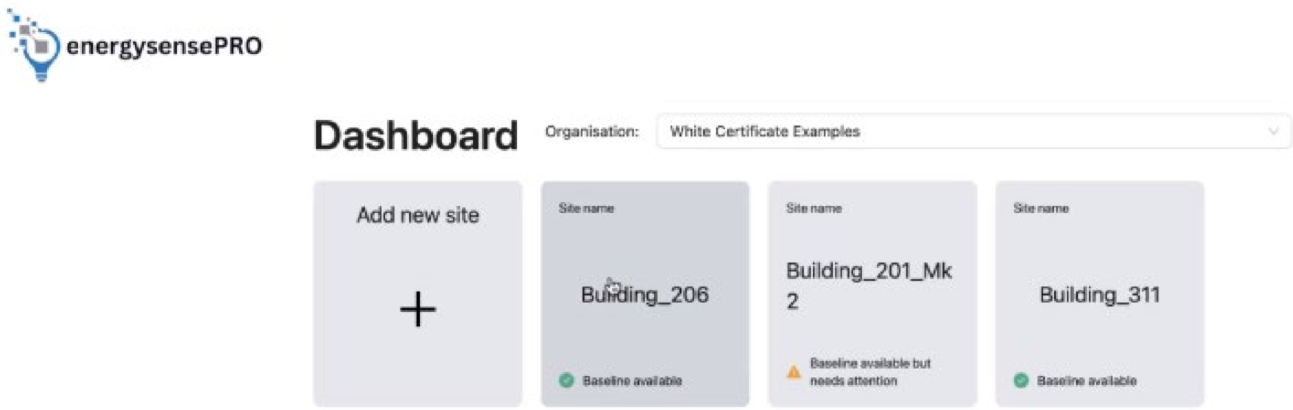

Figure 3.4: Screenshot of the main buildings dashboard in the MVP Web Portal

Selecting the 'Add a new site' button prompts the user to enter a site name, postcode, electricity retailer and NMI number.

Accepting the terms and conditions, initiates a sequence of steps in the DCH app hosting layer to create the site, find and ingest the NMI meter data and to configure and run MVApp on the DCH platform to generate a baseline. This process can take several minutes depending on the system load and other factors. The user is returned to the main dashboard and the new site appears almost instantly. An indicator is provided next to each site showing the status of the baseline creation and, if ready, whether the baseline meets all the eligibility criteria.

Once a building has been installed on the main Dashboard, the user can click on the building's tile to get information on the baseline fit and the analytics results.

Baseline model quality is primarily visualised through a graph of the daily energy 'delta' as shown in Figure 3.5. This is the difference between the model estimated daily energy consumption and the actual daily energy consumption for the baseline period. The blue line plots the daily values and the solid black line the monthly average of the daily values.

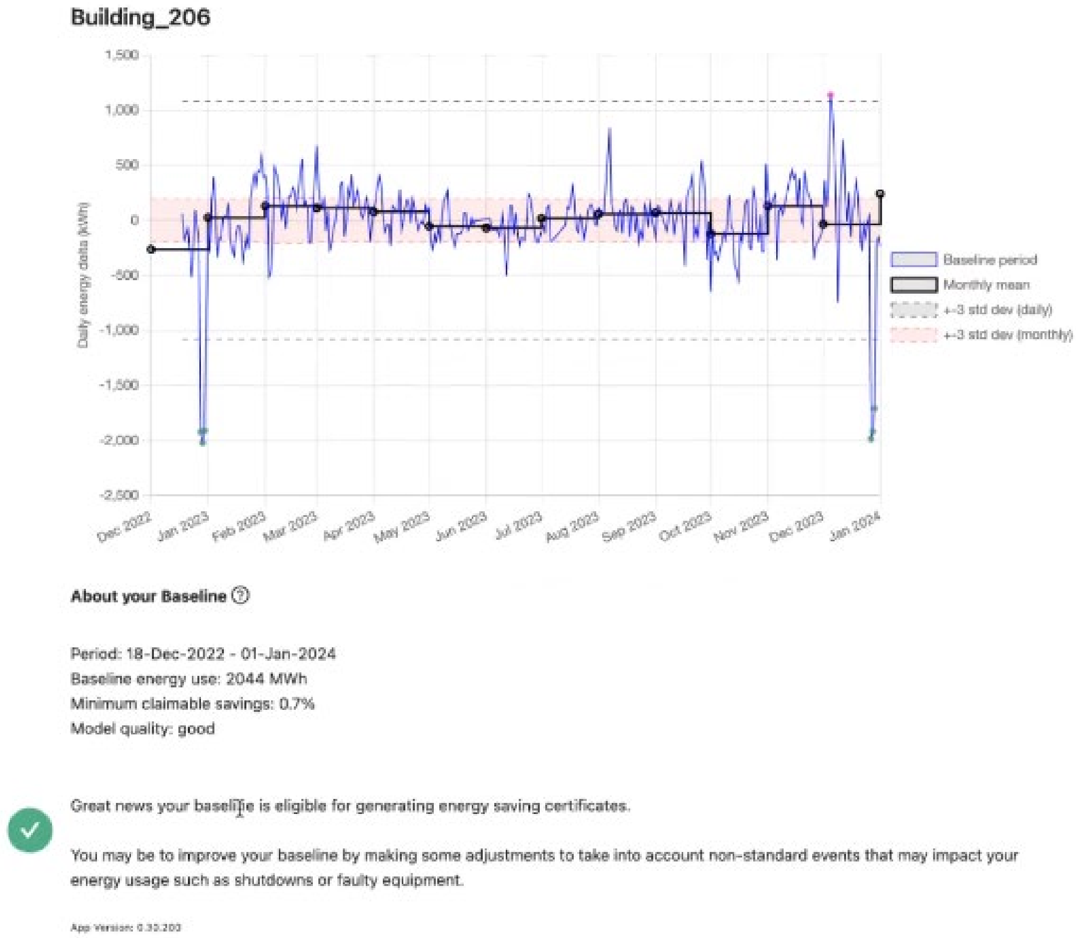

Figure 3.5: Screenshot of the baseline model eligibility window in the Web Portal

Daily values above the upper horizontal black dashed line indicate days where energy use is under-estimated by a large amount compared to other days (i.e. actual consumption is higher than expected based on the model). Likewise daily values below the lower horizontal black dashed line are significantly over-estimated. These days are referred to collectively as outlier days. Outlier days, during the baseline period, may be considered for possible exclusion from the model fitting process if it is suspected that non-routine events occurred on those days.

The monthly average daily energy delta is shown by the black stepped line. Entire months that are under or over-estimated by the model are indicated by those months that are above/below the horizontal red dash-dotted lines. In general, under and overestimated months indicate that the model is failing to capture a consistent trend in the data. If the amount under/over is relatively small, and only occurs for a few months, then this is unlikely to be significant problem. However, if there is a clear trend of under/over-estimated months at certain times of the year or over time, or if the values are far outside the bounds for a given month, then the model may fail to meet the eligibility criteria.

Additional values provided on the dashboard are i) baseline energy use, ii) minimum claimable savings, and iii) model quality.

Baseline energy use is the total measured energy consumption over the baseline period but including extrapolations for any missing or excluded days.

Minimum claimable savings is the estimated lowest measured percentage savings amount that could be credited with a non-zero savings given the accuracy of the fitted baseline model. An example is shown in Figure 3.6. In this Figure, the solid line is the claimable savings using the Accuracy Factor as specified in the NSW Energy Savings Scheme Rule [16]. These factors create step changes in claimable savings as certain thresholds are passed. In the example illustrated by Figure 3.6, the first minimum claimable savings threshold is passed at 3.9% measured savings. And, due to the inaccuracy of the model, the claimable savings is only 4.6% when the measured energy savings are 11.6% of site consumption.

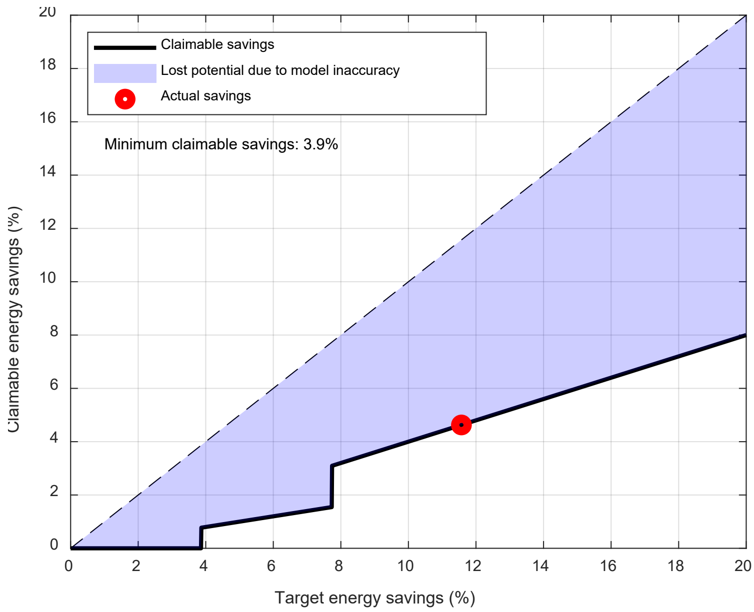

Figure 3.6: Visualisation of the difference between measured (or targeted) energy savings and claimable energy savings

Model quality is a non-numerical field with values of 'fail', 'poor' and 'good'. A value of 'fail' indicates that the algorithm has not successfully generated a baseline. A detailed error log is available for further diagnosis. A value of 'good' indicates that a baseline model has been created and has passed all the model criteria. A value of 'poor' indicates that a baseline has been successfully generated but that one or more of the baseline model criteria has not been met. No distinction is made between a model that fails many criteria or fails the criteria by a large amount, and a model that only just fails to meet one criterion. Hence, a model denoted as 'poor' could be, for the most part, actually quite a good model. Hence, it is important to view and consider the warning messages returned.

A list of common messages and a description of the cause and potential solutions is provided in Table 3.3.

Table 3.3: Summary of baseline model warnings displayed by the Web Portal along with potential user actions

Message	Characteristic & meaning	Cause & possible solution
A trend of increase/ decreasing energy use with time is identified	Energy consumption is trending over time. Monthly mean delta is consistently above /below dashed lines towards the start or end of the baseline period	Could indicate a site where occupancy/production are gradually changing or where new generation is gradually coming online. A baseline cannot be established if consumption is trending. The only option is to recalculate the baseline when the site operation stabilises.
A seasonal trend is identified	Energy consumption is higher in some seasons	Could indicate additional equipment being activated over specific periods and that is not accounted for by the ambient temperature independent variable. An automated baseline may not be feasible.
The model is a poor fit to the data (both CVRMSE and NMBE criteria fail).	The model is very poor & is unlikely to be usable.	Consumption is influenced by additional variables not considered by the automated algorithm. Consult with an M&V professional.
The model is reported to not capture the trends in the data (R2 or CVRMSE criteria fail)	The model is poor & is unlikely to be usable.	Consumption is influenced by additional variables not considered by the automated algorithm. Consult with an M&V professional.
The model is reported to capture (some) trends but consistently under/over predicts (NMBE fails)	Model errors are biased toward under/over prediction.	Consider re-baselining using a model with a coarser time resolution such as a daily model.
Model residuals are strongly auto-correlated	The model error on any given day is similar to the error on the previous/next day which could cause uncertainty to be under-estimated.	Estimated savings may still be usable although associated uncertainty ranges may be too narrow. Re-running the analysis using a coarser time resolution (for example a daily analysis model) is recommended.
Energy use is consistently lower/ higher than expected N months	There are whole months where consumption is above/below the prediction using the model fit to all months.	Consider whether there are any unaccounted for non-routine events and if so, add the relevant dates to the excluded period & re-run the baseline. Larger exceedances or more exceeded months indicates that the model is not capturing the underlying variability in the data.
Excessive missing data	Too many days in the baseline period have failed the missing data criteria for 1 or more months.	There is a problem with one or more of the input data sources. Inspect the baseline data to check which periods are missing. Consider modifying baseline start/end dates. Re-run the baseline once the missing data issue is resolved.
Excessive excluded data	The combination of missing and excluded data exceeds the allowed amount for 1 or more months.	Reduce the number of days excluded from the model for the identified month(s) and/or check whether the missing data criteria is also failed for those months.

3.4 Piloting the streamlined M&V tool and its component

Various examples and case studies were investigated to gain experience with use of the M&V tool and to validate its potential efficacy for certificate calculations. These pilots are described in the following subsections.

3.4.1 Testing the tool's baselining capability on 13 Australian buildings

13 demonstration sites were used (i) to test the automated end-to-end process of adding a site using the Web portal through to viewing a baseline model, and (ii) to get a feel for how many sites might pass all of the criteria, to create a successful baseline model. Net meter data, from NMI meters, was ingested into the M&V tool to replicate the information expected to be available using the NMI meter ingestion process, that would occur via the electricity market operator AEMO. The sites were a mixture of commercial office buildings and combined office and research facilities. Where an eligible baseline model was not obtained, the underlying cause of the failure was investigated.

For all sites, 12 months of data (Nov 2022 – Nov 2023) was used to construct the baseline models. No days were excluded and default values were used for all other settings. The post-code associated with each site was the CBD of the capital city in the corresponding state and MVApp linked data from the nearest BOM weather station to this postcode. Given some sites are located significant distances from these postcodes, differences between this weather data and the actual conditions at the sites are a potential source of model error for these examples.

A baseline model was successfully created for 12 of the sites with the model failing to run on 1 site due to failure to find the relevant meter data. A 'good' baseline model was obtained for 5 of the 12 sites (41.7%).

The seven sites that returned poor baseline models failed on one or more criteria. Figure 3.7 shows plots of the daily actual energy use timeseries, daily outliers, monthly average, model estimated energy use and the expected allowable range of monthly estimated energy use for 6 sites. These sites were selected as representative of different characteristic behaviours.

The model for site 201 (top left) was close to passing all criteria, failing on the CVRMSE criteria by a relatively small amount. Inspection of the data reveals a clear daily energy use pattern but with significant amounts of variability from week to week. For example, some weeks have consistent daily energy use values twice as high as the previous week, and this variation is not explained by temperature, irradiation or holiday variables used. Inspection of the hourly data reveals that the site has PV generation which, when combined with the fact that the actual site is located approximately 550km inland from the location used for the irradiance data, may be a significant cause of the unexplained variations.

The baseline model for site 203 (top right) failed the time trend criteria (and several others). The figure shows a very clear trend of decreasing energy use from the start to the end of the baseline period with under-estimated months at the start and over-estimated months at the end. Since creation of a baseline requires a stable use pattern, it is appropriate for the baseline to fail for this site and selected period.

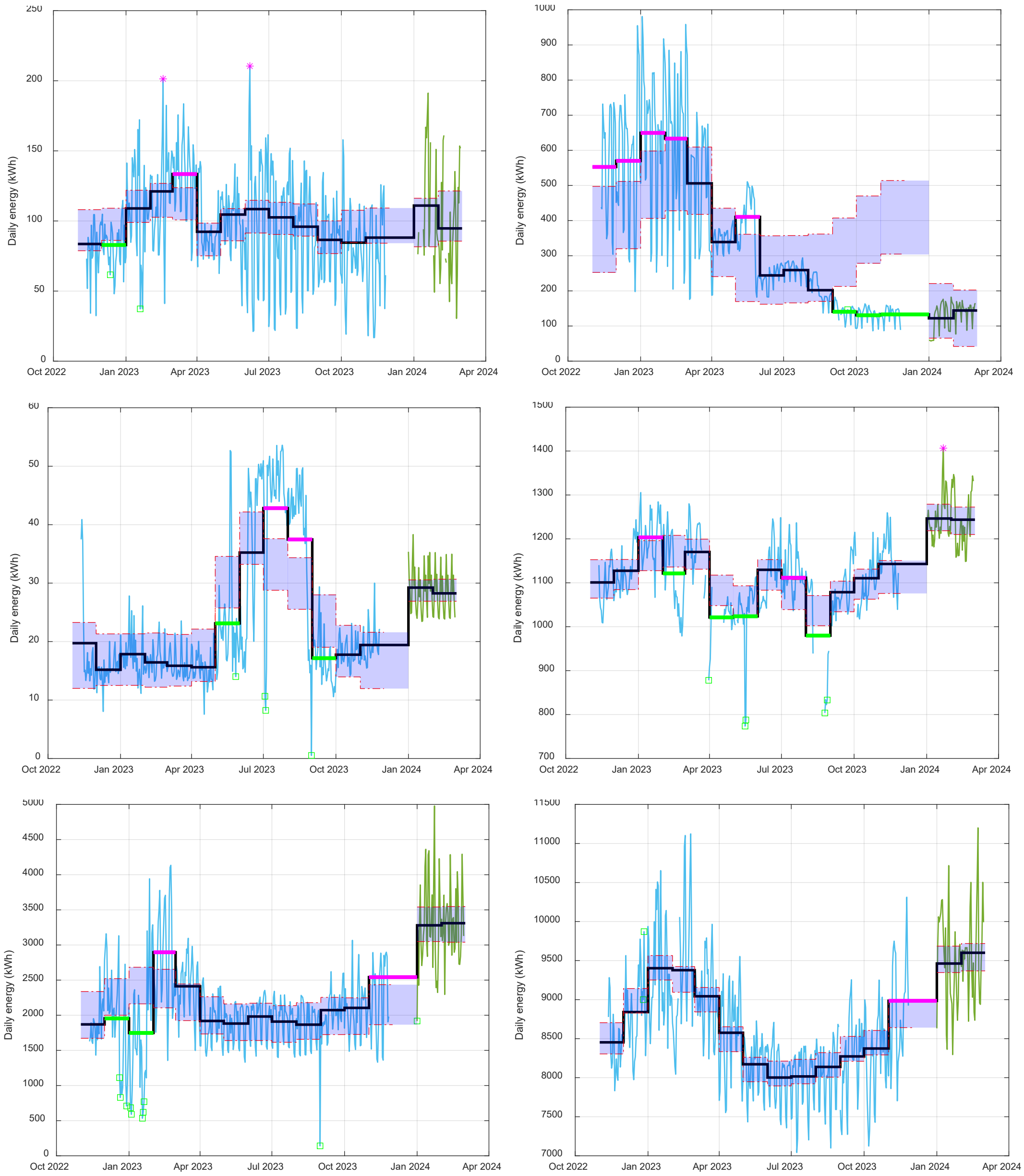

Figure 3.7: Daily energy use variation plots. Actual daily energy use during the baseline period (blue line), monthly mean estimated energy use (black line), expected range of monthly estimated (blue shaded region), daily outliers (symbols) and monthly outliers (pink and light green lines). Top left: case just failing CVRMSE criteria only (201). Top right: case failing time trend (203). Centre left: case failing CVRMSE and showing large seasonal variation (204). Centre right: large spikes in consumption coupled with periods of lower and higher consumption (207). Bottom left: data quality issues confounded by the presence of many meters (509). Bottom right: case passing all criteria (311).

The model for site 204 (centre left) failed the CVRMSE test. However, unlike site 201 which displayed large variability throughout the year, the model for site 204 is quite a good fit over summer, autumn and spring but under-estimates usage by a large amount in winter. This is typical of a site with high energy consuming equipment that is used seasonally. This may be, for example an electrical heating system that is either manually activated or activated based on the season as opposed to the actual daily temperature.

Site 207 (centre right) displays large daily outliers (mostly lower than expected energy use) as shown by the green symbols. Also present are longer periods of lower and higher energy use consistent with non-routine events and significant gaps in the data (missing data). This site houses a large astronomy telescope and associated equipment whose energy consumption patterns are unknown but potentially variable. This model fails the R2, over/under-estimated months and missing data criterion. Manual use of exclusion days, and rectification of missing data issues could result in a good baseline using this data, though this is not possible with an entirely automated process.

Site 509 (bottom left) had multiple NMI meters (6 data streams) and suffers from severe data-quality issues. Some of these streams had 1 or more periods of several weeks duration with identical (duplicate) non-zero values. The automated data processing rules would have removed these periods from the data streams in question but not excluded the time intervals entirely. In addition, some of the data streams look to have started part-way through the period which may indicate changes to the site (for example addition of buildings, new PV generation or meter reconfiguration). These data issues are flagged by MVApp and reported in the logs but are otherwise not visible to the Web-portal user.

Finally, 5 of the sites resulted in a 'good' baseline passing all the criteria. Site 311 (bottom right) is an example of the daily energy use plot for such a site. Daily energy use varies over the year, but the trends are captured by the model. There are a small number of daily outliers and only 1 under-estimated month.

All 5 of the sites with a 'good' baseline were CSRIO sites with largely office-based usage. Only one other CSIRO office-based site (Pullenvale) did not achieve a good baseline. The other CSIRO sites that failed the baseline criteria included the Parkes observatory, Narrabri Telescope and Canberra Deep Space communications complex. The 3 Property NSW sites (201, 202 and 203) also failed the baseline for the reasons described above.

This case study shows that the CSIRO automated M&V tool does a good job of identifying those sites that are unsuited to (and should not be) calculating energy savings through automated analysis. It also shows that the automated approach is more likely to be suited to office-based applications as opposed to sites with potentially bespoke high energy consuming equipment.

3.4.2 Testing the tool's ability to detect and predict energy savings in over 150 buildings, using simulated energy saving interventions

Energy savings were artificially simulated and applied to each of the EVO portal buildings that passed all the baselining criteria. The M&V tool was then used to try and detect and calculate the energy savings. This was done to test the ability of the M&V tool to correctly identify energy saving interventions in buildings.

Of the 367 buildings in the EVO portal, 178 sites (48.5%) and 159 sites (43.3%) would have passed the statistical and other compliance tests for creating a valid baseline for certificate creation, using the hourly interval model and using the daily model respectively.

Because only 12 months of data was available, baseline models were fit to 11 months of the data, and an average 20% energy saving intervention was simulated for the remaining one month of data. The intervention was applied to workdays and office hours only, using a 'vshape' temperature dependent weighting factor of 0.2. That is, a higher energy saving was applied to higher and lower temperatures, but the saving was such that it averaged precisely 20% over the month.

The distribution of _site-by-site_ energy savings (for the ½ hourly interval analysis model) is illustrated in Figure 3.8. Perfect prediction would have found every building achieving a 20% energy saving. However, Figure 3.8 shows energy savings, in individual buildings, ranging from 0% to 30%, with a distribution around a peak frequency of just under 20% energy savings.

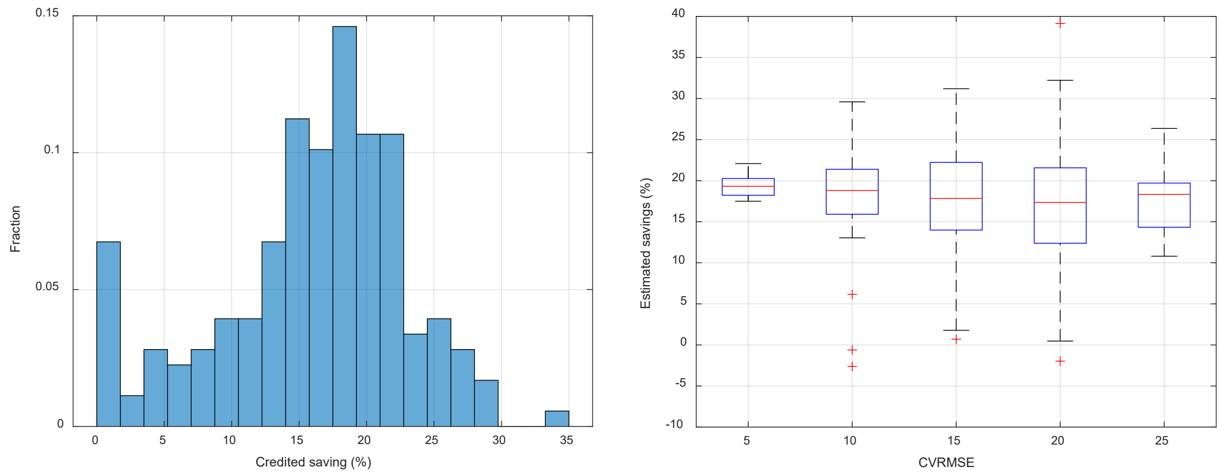

Figure 3.8: Distribution of credited percentage saving (left) and boxplots of estimated saving percentage as a function of CVRMSE (right) for sites with a valid baseline model based on the interval analysis model

Detected _aggregate_ energy savings are summarised in Table 3.4 for the relevant sites (178 sites using the interval model and 159 sites using the daily model).

Table 3.4: Summary aggregate energy savings across buildings with valid baseline models[2]

	Daily model	Interval model
Actual energy saving (sum of all valid models)	1.342 GWh	1.980 GWh
Calculated energy saving (sum of all valid models)	1.325 GWh	1.978 GWh
Credited energy saving (sum of all valid models)	1.217 GWh	1.822 GWh

It is evident that, while there is significant spread in calculated energy savings when considered on a site-by-site basis, the calculated and credited energy savings (for certificate purposes) match well with the actual energy savings when taken on aggregate over all the buildings.

It is important to note that the above results are based on 1 month 'post-retrofit' periods. It is likely that the estimated site level percentage savings would be much closer to the simulated amount if analysing a full year of data as any skew present in the estimates for the selected month would tend to average out over the year. Hence, these results should be viewed as a worst-case scenario.

[2] Note: the magnitude for the daily model is less as fewer buildings had valid baseline models and hence the aggregation contains fewer buildings.

3.4.3 Testing the impact of excluding a portion of available meter data in a case study of a high efficiency equipment retrofit at an industrial site

This case study consists of an industrial waste-water treatment site where an actual energy saving measure was implemented. In contrast to the other case studies, this case study aims to study the impact of different approaches and different interpretations of M&V guidelines by practitioners.

The energy savings project involved replacing 1 of 4 aeration blowers with a high efficiency unit. The measurement boundary was the energy use from all 4 blowers. Energy savings credits were awarded under the NSW Energy Savings Scheme based on a PIA M&V analysis. The consultant's report, calculations and associated 15-minute datasets corresponding to pre- and post-intervention periods were provided. The data included the total air-flow rate for the 4 blowers, some additional process variables related to the plant operation, weather variables, the overall site energy consumption, and the total blower energy consumption.

The consultant's PIA M&V analysis was based on 1 year of pre-intervention data used to construct the baseline model and 16 months of post-intervention data used to construct an operating energy model. It used blower total air-flow rate as a primary independent variable and the total blower energy consumption as the dependent variable. The PIA M&V analysis excluded 26 days (7%) of the baseline data from the model fitting process; stated to be due to non-routine plant operation on those days.

The energy savings calculated by CSIRO's MVApp were compared with those determined by the consultant's analysis for the same 'normal operation year'. Predicted energy savings were 114.4 MWh ±13.6MWh compared with 125.2MWh ±4.9 MWh for the CSIRO MVApp and the consultant's analysis respectively, a difference of 9%.

Currently MVApp does not automate the construction of 'normal operation year' as an independent variable. The NSW PIAM&V guide (IPART, 2023b) gives limited information on how to choose normal year variables. The IPMVP guidelines (EVO, 2022) are also open to interpretation. The impact of five different approaches for choosing normal year data, for the single independent variable (airflow in this case), were evaluated using MVApp. Across the 5 normal year creation methods, calculated energy savings ranged between 98.7 MWh and 114.4 MWh, a variation of 15%.

Using the ***actual*** post-retrofit year airflow data (rather than expected 'normal' airflow data), the MVapp energy savings were calculated to be 78.8 ± 8.1 MWh.

Another factor influencing the baseline calculation, is the removal of data that the assessor determines to be unrepresentative of routine operation (so-called 'non-routine events'). Removal of such data could potentially be automated, to remove the need for assessor's judgement and to enable non-skilled users to use the tool.

The influence of including or excluding 'non-routine event' days from the baseline was examined, using CSIRO's MVApp, with 5 different automation strategies.

Method 1: Preferentially removing days with the highest energy use

Method 2: Randomly removing days

Method 3: Preferentially removing days with the lowest energy use

Method 4: Preferentially removing days with the highest value of the independent variable

Method 5: Preferentially removing days with the highest baseline model error

Each of these methods is 'blind' to whether or not the data exclusions would be justified by real plant non-routine operational considerations. Methods 1 and 3 examine the extreme outcome of selectively aiming to decrease or increase the baseline respectively.

Results are summarised in Figure 3.9 which plots the estimated savings versus the percentage of baseline data excluded for each of the 5 different exclusion methods. Removing days randomly (light blue line) leads to almost no change in the estimated saving which provides some assurance that the estimated savings are insensitive to the amount of data used to train the model.

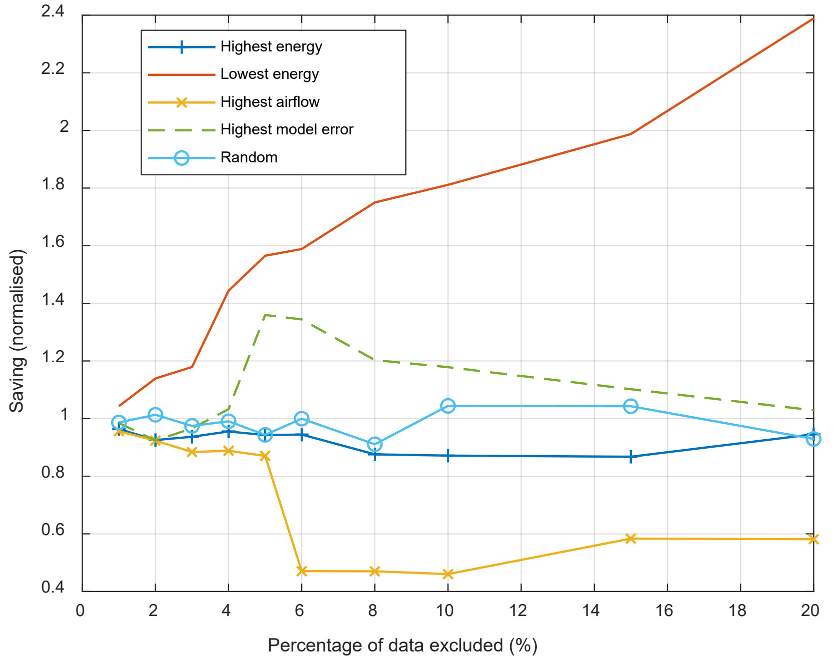

Figure 3.9: Variation of estimated savings as a function of percentage of excluded data for different data exclusions strategies

The green dotted line (which excludes those data points that create the highest baseline error statistics) appears, in this case study, to be linked with some of the lowest energy consumption periods. This could be linked, for example, to plant shut-downs.

Using the MVApp, with and without exclusions, the consultant's choice to exclude 26 days (7%) of the baseline data, from the model fitting process, led to (i) an increase in the calculated energy savings by approximately 10% and (ii) a substantial reduction in the calculated statistical uncertainty bound (i.e. it improved certainty).

This case-study highlights the legitimate ability to judiciously select baseline model settings and data exclusions to achieve quite different energy saving results. This suggests that a Scheme Administered M&V Tool could be beneficial to the integrity of certificate schemes.

3.5 NABERS integration and appetite for streamlined M&V

Around 40 potential users of the streamlined M&V tool were consulted to ascertain if the proposed tool would be likely to be utilised (if made available), and to discuss possible impacts associated with implementation.

A particular target user group that was consulted was NABERS assessors. NABERS assessors provide assessments for commercial buildings greater than 1,000m^2 of floor area, whenever they are sold or leased under Australia's CBD regulation (https://www.cbd.gov.au/). This typically leads to regular assessments, enabling certificate generation to be integrated into the existing NABERS process with very little extra effort for the building owner. This has the potential to drive adoption of certificate generation from low/mid-tier buildings (a poorly represented sector in the current schemes).

Importantly, the value of certificates in the schemes are quite high compared with the cost of performing a NABERS rating. This suggests that there is room for a margin to be taken, sufficient to provide a meaningful incentive for relevant stakeholders.

While the current activities and responsibilities of NABERS assessors and certificate creators (APs and ACPs in Victoria and NSW respectively) are currently separated, consideration should be given to the possibility of reducing or combining activities as a means of further streamlining the process and reducing costs. Indeed, many of the administrative functions of NABERS assessors and APs/ACPs are aligned. For example, NABERS assessors (i) have requirements for relevant evidence and supporting documentation to be stored and (ii) are subject to routine audits for quality assurance.

If the streamlined M&V tool processes are suitably configured and automated, it may be feasible for the NABERS assessor to input the relevant data, without need to engage a separate AP/ACP. This would significantly improve accessibility and reducing compliance costs compared to the current situation.

It is noted that NABERS methodologies are already included in both the NSW ESS and the Victorian Energy Upgrades schemes. However, these have seen limited uptake due to the stringency of the rules relating to what can be claimed. Furthermore, these approaches are based on annual energy savings and, consequently, are not suitable for future scheme needs (eg in the Peak Demand Reduction Scheme).

Significant support for these ideas was identified in the industry consultation conducted in this project (Figure 3.10).

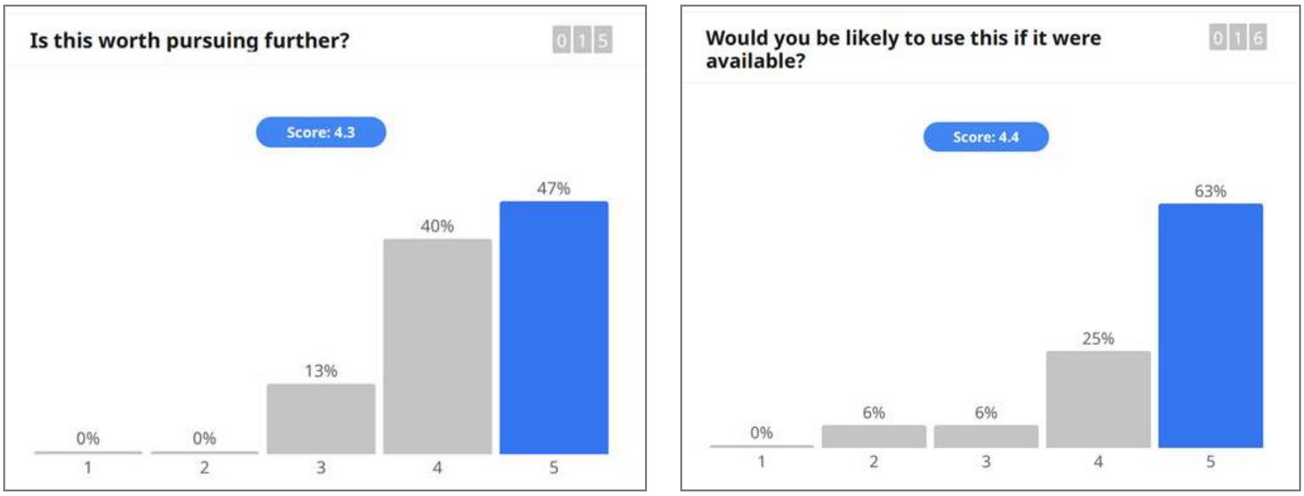

Figure 3.10: Perceived favourability toward the streamlined M&V approach from a survey of predominantly NABERS assessors

Sustainability managers from some of Australia's leading property portfolios (through the Sydney Better Buildings Partnership) were also surveyed with similar positive reaction to the streamlined M&V approach. Sustainability managers stressed the importance/value of avoiding duplication of effort by integrating with NABERS (Figure 3.11)

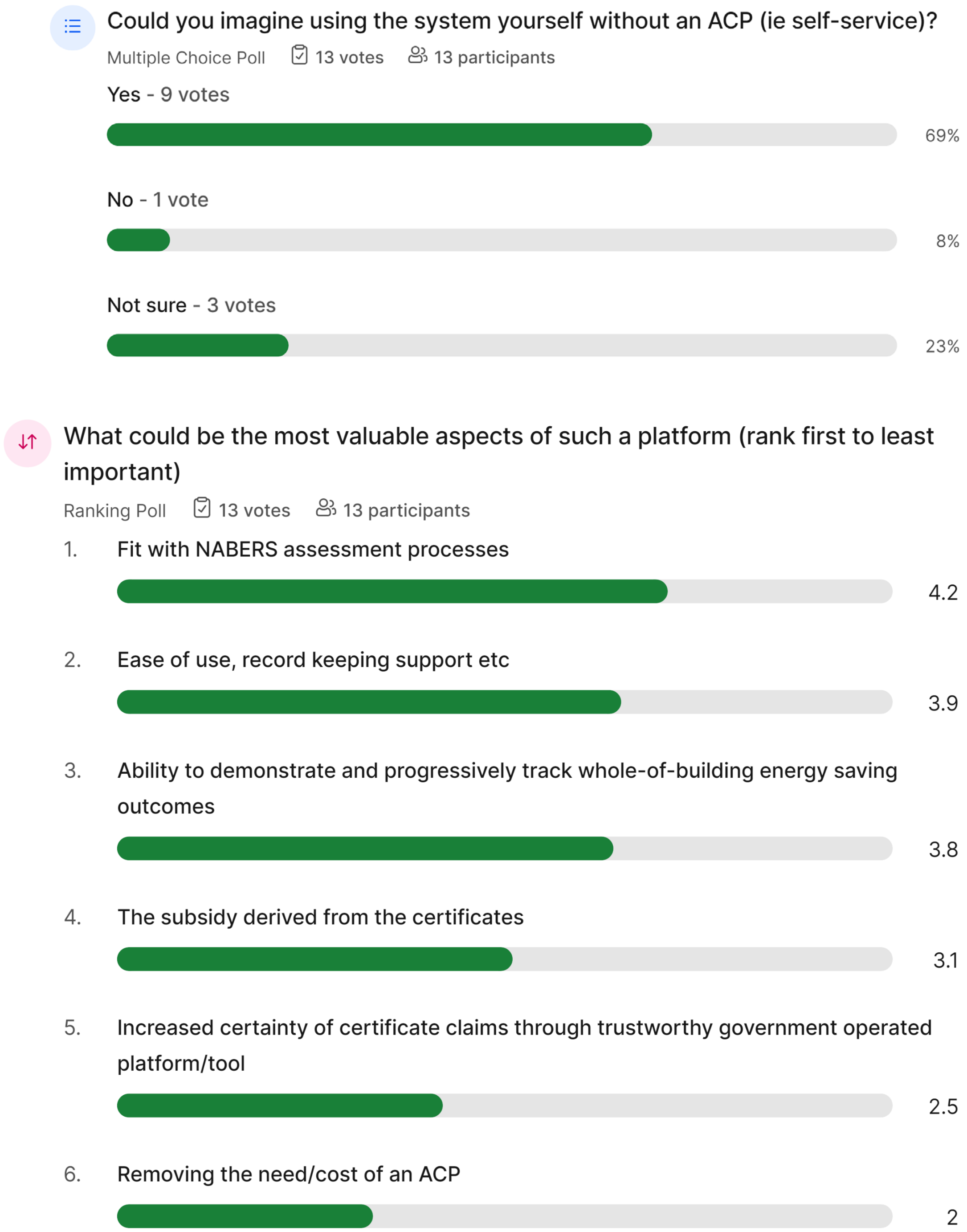

Figure 3.11: Perceived utility of the streamlined M&V approach and factors influencing utilisation, as perceived by property portfolio owner's sustainability managers

Some common sentiments expressed in the group table discussions were

- Highly attractive features of the MVP measurement and verification tool included
  - Direct access to and use of NMI data
  - Standardised calculations with a simple easy-to-use interface
  - Quick results

- Beyond certificate generation, assessors saw potential for other use-cases for the tool, including as a customer engagement tool for communicating the business case for new energy saving investments.
- Further work is needed on the tool to include multiple NMIs and gas consumption. Going forward, electrification is a key intervention that should be supported. The selection of baseline duration and the confounding effects of different possible normalisations were discussed.
- There was also desire for further information on diverse topics including (i) data security/ governance, (ii) certificate price volatility, (iii) need for training (iv) quality control, (v) allocation of responsibility for issues and (vi) potential for gaming (eg double dipping on certificate creation using the different available methods)

While inevitably there remain plenty of uncertainties, at this point in the journey, there was a strong sentiment that this approach should be implemented and iterated, as issues arise.

Relevant to the existing scheme rules, the current PIA M&V method was seen as very generous with respect to the acceptable duration (10 years) of the established baseline. This suggests that any goal of pursuing annual after-the-fact (performance based) certificate creation is unlikely to be attractive against the upfront returns available from the PIA M&V method. Of course, the streamlined M&V tool could be used for M&V in the existing PIA M&V method. But the full vision of performance-based certificate creation would be diminished.

4 Conclusions and Next Steps

The RACE White Certificates Project examined the appropriateness and feasibility of:

1. Incorporating a dedicated Energy Management Information System (EMIS) Activity into national white certificate schemes – to take advantage of the energy savings potential of 'smart' energy analytics and HVAC controls technology. The aim of this work is to create level playing field access to certificate schemes, for this class of energy saving technology.
2. Developing a streamlined measurement and verification (M&V) tool for reducing the administrative burden/cost associated with the process of calculating eligible energy savings in the national white certificate schemes. The aim of this work is to increase the range of technologies that can participate in the certificate schemes and to enhance the integrity of the scheme by removing barriers to performance-based certificate creation.

Conclusions from this research are provided below.

WP1: EMIS Activity

Potential EMIS products and service providers were mapped, and a supplier survey was conducted to ascertain industry perspectives. Based on the findings of this research, two EMIS Activities were proposed: a Foundational EMIS and an Advanced EMIS.

The proposed Foundational EMIS covers the relevant EMIS software-as-a-service (SaaS) digital infrastructure that is necessary for (i) deploying energy analytics, (ii) communicating relevant information to decision makers, and (iii) measuring energy saving outcomes.

A detailed list of performance-based requirements for the Foundational EMIS, is suggested in Section 2.5.1. These requirements have been provided to the Australian Building Codes Board (ABCB) for possible inclusion as optional requirements in the National Construction Code (NCC).

Based on typical energy savings observed by Kramer et al (2020), it is proposed that energy savings be attributed to the Foundational EMIS at a deemed rate equivalent to 3% of site energy consumption over 5 years. Certain exclusions are suggested, regarding building typologies and sizes, where a Foundational EMIS would be considered existing practice. The upfront deemed certificates would help to overcome known barriers to investment in energy management infrastructure. Financial investment analysis suggests that this incentive would neutralise most of the one-off cost of setting up the EMIS, but with ongoing maintenance costs to be paid for by ongoing energy cost savings.

The proposed Advanced EMIS Activity is for deploying energy saving software applications (Apps). This includes (but not limited to) energy analytics, such as fault detection and diagnosis (FDD), and advanced energy saving controls. It is proposed that certificates from this Activity be generated using measurement and verification. In this way, the proposed Advanced EMIS Activity would be performance based.

To enable M&V-based certificates to be calculated cost-effectively, in buildings, it would be necessary to implement a streamlined M&V methodology, such as that developed in work package 2 of this project.

It is proposed that eligibility for the Advanced EMIS be restricted to those buildings that have a Foundational EMIS. Based on data from Kramer et. al. (2020) the certificate creation potential of the Advanced EMIS would be much higher than that of the Foundational EMIS.

EMIS providers were consulted on the proposed EMIS Activities. They were strongly supportive of the approach, and the proposed Activities. They saw value in a register of qualified products/services, to simplify eligibility evaluation and to support product marketing. They were interested in the potential to become an Accredited Person (AP) to enable them to generate certificates, as part of their standard solution implementation process. This could further reduce administration costs and help to stimulate energy savings in difficult-to-reach smaller low/mid-tier buildings.

EMIS providers emphasised that deploying EMIS technology does not necessarily (by itself) lead to savings without ongoing implementation of rectification works. This is covered in the proposed EMIS Activities by requiring a formal 'energy management committee' to be established. Such a committee should meet regularly (at least quarterly) to consider opportunities to action the advice from the EMIS technology.

WP2: Streamlined M&V

Energy savings (achieved by implementing an energy efficiency Activity) can be calculated by comparing actual (post intervention) energy consumption against a prediction of what the energy consumption would have been if the intervention had not occurred (the 'baseline'/counterfactual). This process is called measurement and verification (M&V).

A 'human centred design' process, run with relevant ESS industry participants, recommended developing a streamlined 'low administration' M&V process for the NSW ESS Scheme. The proposed pathway involves uploading meter data into a Scheme administered web-portal, which then performs standardised M&V calculations for the site and manages record keeping on behalf of users. The aim of the new approach is to automate and standardise the M&V process, to reduce cost and improve calculation integrity.

Automation can be achieved both in (i) the collection of data (D) and (ii) in the deployment of M&V analytics (A). Four levels of automation were identified for each of these aspects. A literature review did not find any existing M&V applications that provide full automation (D4A4). The vast majority of applications, identified by the review, use D1 or D2 level data automation and A1 or A2 analysis automation.

To better satisfy the needs of Australia's certificate schemes, CSIRO developed a minimum-viable-product streamlined M&V software tool, hosted on the Data Clearing House (DCH) data management platform.

The streamlined M&V tool uses National Meter Identifier (NMI) data. This was chosen because it is the most reliable and ubiquitous source of energy consumption truth, and it avoids the need for additional metering to be installed. Subject to obtaining a data agreement with AEMO, the tool is expected to access this meter data directly from AEMO, via an API, in a similar way to the Energy Made Easy website (https://www.energymadeeasy.gov.au/). The CSIRO DCH-M&V application will then be achieving approximately D3A3 level of automation.

CSIRO M&V analytics algorithms were benchmarked against other international M&V tools using a portal provided by the International Efficiency Valuation Organisation (EVO). Analysing data from

367 real-world commercial buildings, the CSIRO tool achieved a median ‘Coefficient of Variation of the Root Mean Square Error’ (CVRMSE) score of 33.75% and ‘Net Mean Bias Error’ (NMBE) score of 0.04% placing it in the top 5% of all models and very close to the top performing model.

The M&V algorithms calculate statistical metrics and conduct additional tests to evaluate the quality of the fit of the delivered baseline model. These tests incorporate existing requirements of the NSW Energy Savings Scheme. Collectively a given model must pass all the criteria to achieve an overall ‘good’ rating. A failure of one or more criteria results in a ‘poor’ rating.

Of the 367 buildings in the EVO portal, 178 sites (48.5%) and 159 sites (43.3%) would have passed all these tests to creating a valid baseline for certificate creation (using an hourly interval model and using a daily model respectively).

The full end-to-end streamlined M&V software tool was tested on 13 demonstration sites. The sites were a mixture of commercial office buildings and combined office and research facilities. A baseline model was successfully created for 12 of the sites with the model failing to run on 1 site due to failure to find the relevant meter data. A ‘good’ baseline model was obtained for 5 of the 12 sites (41.7%). The underlying cause of the baselining failures was investigated for those buildings that did not obtain an eligible baseline model. It showed that the CSIRO automated M&V tool does a good job of identifying those sites that are unsuited to (and should not be) calculating energy savings through automated analysis. It also showed that the automated approach is more likely to be suited to office-based applications as opposed to sites with potentially bespoke high energy consuming equipment.

The software was further tested with simulated energy saving interventions applied to over 150 buildings. The aim was to see if the M&V tool could correctly identify energy saving interventions in buildings. The simulated energy saving intervention was calibrated to achieve 20% savings in each building. A distribution of predicted energy savings was found, ranging from 0% to 30%, with a peak prediction frequency of just under 20% energy savings. While this represented a significant spread in calculated energy savings, on a site-by-site basis, the calculated energy savings matched very closely with the actual energy savings when taken on aggregate over all the buildings.

A further pilot of the software was conducted on a case study high-efficiency aeration blower equipment retrofit at an industrial site. The sensitivity of the calculated energy savings to various alternative M&V analytics settings (each being broadly acceptable under the current scheme M&V guidelines) was examined. Using the same assumptions, CSIRO’s M&V analytics found 9% less energy savings compared with a consultant’s report.

In sensitivity testing, a significant difference in energy savings was obtained when using a normalised-year of operation compared with the actual post intervention year of operation. A 10% difference in calculated energy savings was also found depending on the decision to select, or not, exclusion of certain ‘non-routine’ days. The case-study highlights the legitimate ability to judiciously select baseline model settings and data exclusions to achieve quite different energy saving results. This suggests that a Scheme Administered M&V Tool could be beneficial to the integrity of Australian certificate schemes.

Around 40 potential users of the streamlined M&V tool were consulted on the potential efficacy of the proposed streamlined M&V tool. Users included a large number of NABERS assessors. NABERS assessors are well suited to adding certificate creation to their existing service offering. Given the existing skills and qualifications of NABERS assessors, and the locked down methodology of the streamlined software tool, it may be feasible for NABERS assessors to input the relevant data, without need to engage a separate AP/ACP. This would significantly improve accessibility and reduce compliance costs compared to the current situation. The consultation found significant support for the streamlined M&V approach.

Sustainability managers from some of Australia's leading property portfolios (through the Sydney Better Buildings Partnership) were separately surveyed with similar positive reaction to the streamlined M&V approach. Sustainability managers stressed the importance/value of avoiding duplication of effort, by integrating with NABERS.

4.1 Recommendations and Next Steps

EMIS Activity Next Steps

Based on (i) identified strong industry support and (ii) the potential to attract additional energy savings from the hard to reach low/mid-tier property sector, this project recommends that the proposed Foundational and Advanced EMIS Activities be implemented in the relevant national certificate schemes. Such legislation could use the suggested eligibility criteria and savings calculation methods described in Section 2.

Streamlined M&V Next Steps

The project recommends that further research and tool development be undertaken to enable the streamlined M&V approach to be implemented in relevant national certificate schemes. This recommendation is based on:

(i) identified strong industry support,
(ii) the potential to expand the range of projects and buildings that can cost-effectively access the schemes,
(iii) the potential to reduce unnecessary transaction costs associated with certificate creation,
(iv) the potential to improve the integrity of the existing project-based certificate generation methods; and
(v) the potential to strategically support the future evolution of certificate schemes towards time-of-use based energy management objectives (eg building on the NSW Peak Demand Reduction Scheme).

The opportunity to provide the streamlined M&V analytics to industry as an API plug-in should be investigated. This could help industry to apply scheme rules appropriately and consistently (rather than rely on industry to interpret detailed written technical rules and assumptions). This approach is sometimes called "Rules as Code".

The required additional research and tool development work is intended to address various questions raised during the stakeholder consultations, and to consider additional use-cases and scheme integration opportunities identified over the course of the project.

As part of the project, an independent review was conducted on the CSIRO M&V tool and the streamlined M&V methodology. The identified scheme considerations and new tool functionalities are listed in Table 4.1.

Table 4.1: M&V methodology development considerations

Consideration	Priority	Comments and Recommendations
The M&V tool does not currently deal with gas and diesel	High	Many buildings have gas heating. Add gas to M&V functionality in the tool
The M&V tool does not currently deal with multiple NMIs in aggregate	High	Many buildings have multiple NMIs within their NABERS scope. Add multiple NMI functionality in the tool
The M&V tool does not currently deal with electricity exclusions from the main meter (used in NABERS)	Low	Sub-metered exclusions are moderately common in NABERS ratings. However, exclusions are often trivial or relatively constant. Review the extent to which such exclusions are material to outcomes.
The methodology needs to consider treatment of on-site solar	Medium	Adding solar during the certificate creation period potentially leads to unintended certificate creation. Define rules around when to submeter solar and when to use tool algorithms
The methodology needs to consider treatment of non-routine events	Medium	The tool allows the user to exclude non-routine days which could be open to some level of abuse. Define rules and automate the process (prevent the user from selecting exclusions)
The methodology should consider impact of changing building use (occupancy, floor area) on baseline persistence	Medium	NABERS ratings require occupancy, and floor area normalisations to account for longer-term changing use patterns Further develop the tool to extract floor area and occupancy data from NABERS ratings
Given that the tool has access to interval data granularity, Scheme Administrators may have an opportunity to incentivise demand (kW) savings.	Medium	The Peak Demand Reduction Scheme (PDRS) currently excludes most of the commercial buildings sector. And it only has deemed methodologies (no M&V based approach). Investigate the viability of an M&V based approach for the PDRS Scheme.

An externally facilitated team workshop was run to consider new methodology research and tool development work. The workshop process used a conceptional ‘sailboat’ brainstorming exercise (Figure 4.1)

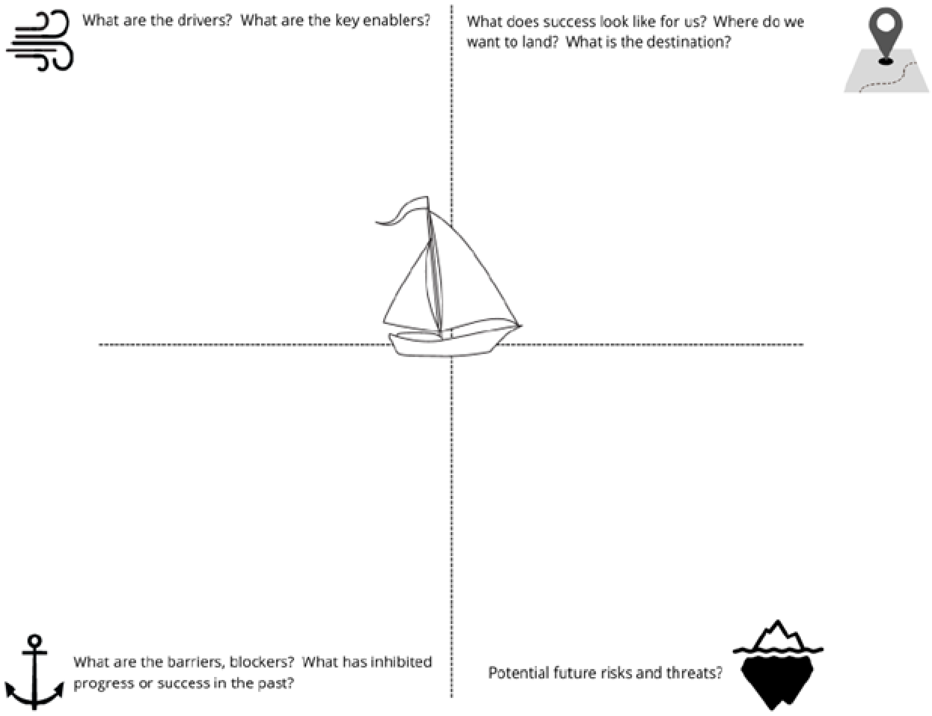

Figure 4.1: Four quadrant 'sailboat' brainstorming methodology

Based on the findings of the workshop, a high-level work plan was developed for the next phase of research and development for the streamlined M&V methodology. The work plan is illustrated in Figure 4.2.

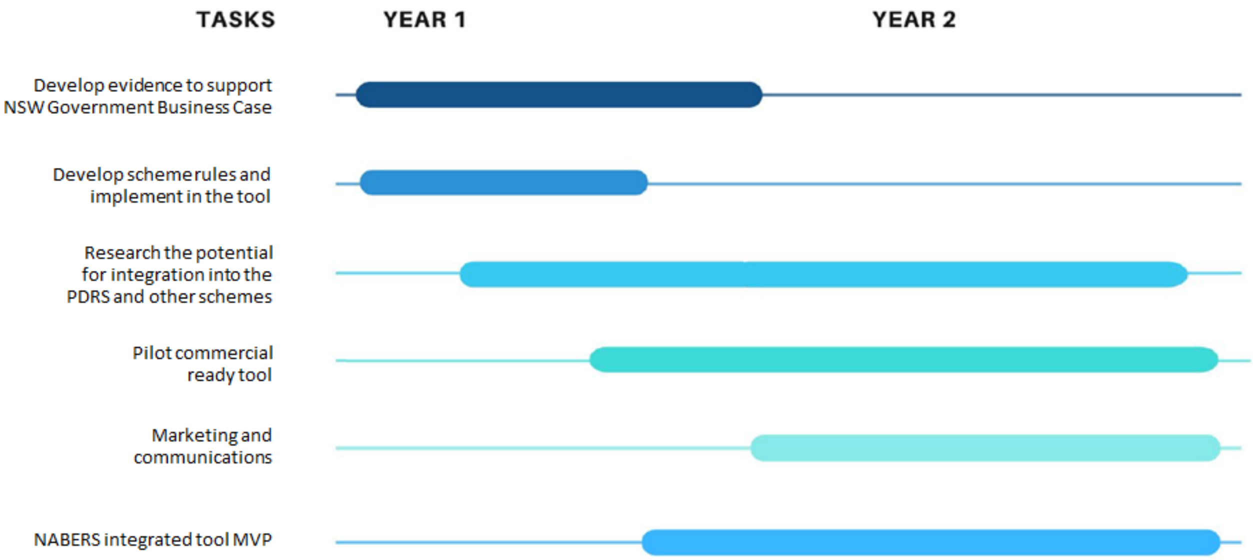

Figure 4.2: High level plan for additional research and development to exploit the streamlined M&V methodology

The proposed project would complete the tool, within 2 years, ready for implementation in certificate schemes. It would also create appropriate rules and guidelines for overseeing tool use (to maintain scheme integrity). The impact of implementing the tool would also be assessed, in terms of both new certificate creation potential and administrative cost reduction potential.

While delivering a deployable tool and framework for measurement and verification of energy savings, the proposed project would also begin to exploit additional opportunities – including opportunities in the PDRS and potentially in the wholesale demand response mechanism (WDRM).

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