Australia's National
Science Agency

RACE for 2030: Industry 4.0 Opportunities in White Certificate Schemes

WP1 Energy Management Information System (EMIS) Activity Analysis: Final Report

Stephen White

January 2024

Citation

White S.D., (2024), ‘WP1 Energy Management Information System (EMIS) Activity Analysis: Final Report’, CSIRO, Australia.

Copyright

Important disclaimer

Contents

Figures

Tables

1 Introduction

1.1 EMIS technology concepts, applications and product benefits

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"*.

This description of an EMIS is synonymous with concepts of 'digitalisation', a suite of technologies that can be used to create more efficient and comfortable buildings. Digitalisation technologies are typically used to enable (i) data capture and management, (ii) data-analytics (e.g. machine learning, AI) and (iii) to achieve digital connectivity between machines and human users.

Digitalisation is typically hosted on a cloud platform. The cloud platform is the infrastructure of an EMIS. Importantly, an Energy Management Information System 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). And it makes the data accessible, both (i) to data analytics software/machines and (ii) to relevant stakeholders/humans in easy-to-consume formats and visualisations.

Features of an EMIS, and some of the services it can provide, are illustrated in Figure 1.1

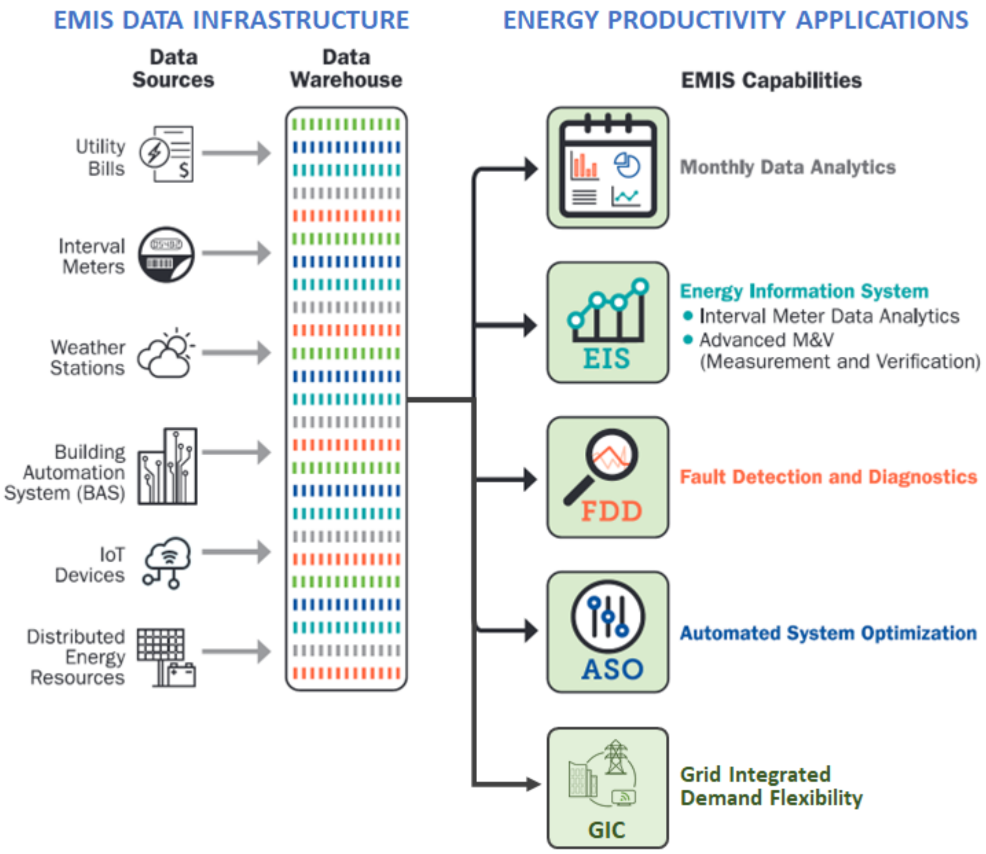


Figure 1.1: Data inputs and key capabilities of an EMIS (adapted from Kramer et. al., 2020)

In different uses cases, a cloud EMIS platform could variously be called a Data Platform, or an Internet of Things (IoT) Platform, or a Distributed Energy Management System (DERMS) Platform.

<u>At an operational/engineering level</u>: the EMIS platform can be used to deliver physical energy savings by optimising the use of energy consuming equipment. It can also enable buildings to provide distributed energy resources (DER) and demand flexibility to support the electricity grid.

<u>At a scheme/programme/business administration level</u>: an EMIS platform provides the IT backbone for stakeholders to participate in markets and administrative processes. Scheme governance can be encoded in digital services through the platform's permissioning system (software for granting access rights to different users of the platform). Financial settlement of energy productivity services can be streamlined through digitalisation of measurement and verification (M&V) processes.

Some key opportunities where an EMIS can be an enabler of improved energy performance in both new and existing buildings, include:

- **<u>EMIS for energy efficiency</u>**. Active energy consumption monitoring and management practices, assisted by metering and digital information management systems, can improve energy efficiency with excellent return on investment.
  - Kramer et al. (2020) identified median annual energy savings of 9% using equipment **fault detection and diagnosis** (FDD data analytics) technology with payback times of around 2 years. FDD involves automating the process of detecting faults in the operation of physical services in a building (particularly HVAC systems) and diagnosing the causes of these faults. In this context, faults may include, for example (i) stuck or leaking dampers and valves, (ii) sensors reading incorrectly or not at all, (iii) heat exchanger fouling, (iv) equipment (e.g. chillers, pumps etc) switched off or electronically locked out, etc. These faults may be triggers for maintenance, or for changes to be made to equipment control strategies.
  - The NSW Government (2015) provide guidance for a range of **advanced control strategies**, with energy savings from each strategy ranging between 5 and 30%. Zhang et al (2022) found that use of high-performance control sequences (per ASHRAE Guideline 36) for Variable Air Volume (VAV) airconditioning systems would, on average, deliver energy savings of 31%. Across 1,500 buildings/373 million ft^2 of floor area in North America, Crowe et al. (2020) found that recommissioning buildings controls achieved a median simple payback time of 1.7 years. These advanced control strategies can include dynamic or seasonal adjustment of setpoints. They can also include look-ahead controls, based on forecasts of load, weather and energy prices.
  - Various other studies suggest that integrating state-of-the-art sensors and controls can save 29% of site energy consumption (Fernandez et.al., 2017) and between 10% and 20% of commercial building peak load (Kiliccote et al, 2016, Piette et al, 2017)

- **<u>EMIS for load flexibility</u>**. Advanced controls can optimise energy consumption, taking into account dynamic system-level constraints or market signals from the electricity grid. Shifting energy consumption in commercial buildings has the potential to provide highly cost-effective flexible demand resources.

- The Energex "Broad Based" and "Targeted" DM programs (Energex, 2022) demonstrate the ability to provide flexible demand from buildings at a capital cost of $249/kVA and $65/kVA respectively. This is a fraction of the cost of large-scale batteries ($789/kVA and $1,058/kVA for 1 hour and 2 hours of storage respectively, GenCost Report Graham et al (2021))
- NERA (2022) estimate that high levels of flexibility would reduce consumer electricity prices by between $6 and $18/MWh depending on scenario.
- GBCA (2023) claim that, "*by shifting one third of the load in buildings for just three hours a day, five days a week, we would reduce Australia's annual Greenhouse Gas (GHG) emissions by 0.6% (equivalent to 180,000 homes), without decreasing energy use; and reduce the cost of supplying electricity to Australia's buildings by $1.7 billion each year*".

The Property Council of Australia (2022) suggest that "*Buildings are the batteries capable of delivering enormous load flexibility to our energy system at little to no cost, through efficiency measures, shifting peak heating and cooling loads and soaking up excess supply when renewables are plentiful to store energy and provide EV charging*."

Flexibility from commercial buildings would be particularly attractive for addressing emerging minimum demand issues because maximum solar PV generation (occurring around midday) can be readily soaked up in precooling, just prior to maximum building cooling load at around 2 to 3pm in the afternoon. The RACE for 2030 B4 'Flexible Demand and Demand Control' Opportunity Assessment (Brinsmead et al, 2021) identified building HVAC loads as a priority sector using a HUFF (Homogeneous, Ubiquitous, Financially and technically Feasible) scoring matrix.

- **EMIS for electrification**. Digital EMIS solutions can help to manage electric vehicle charging so that electrical current limits, on existing switchboards (that were not built for EV charging), are not exceeded. Smart building "Apps" can provide a user-friendly interface to manage EV charging expectations, including through congestion-based tariff structures.

  EMIS solutions can also help to better match instantaneous electricity demand with times of lowest carbon intensity in the electricity grid (using real-time grid carbon intensity rather than average annualised carbon intensity). The Green Building Council of Australia (GBCA, 2023) provide examples of days where the CO_2 emissions of case study buildings have been reduced by more than 10%, by synchronising electricity demand with grid carbon intensity.

- **EMIS for built environment productivity**. Rapid advances in digitalisation are opening up new horizons of understanding for how buildings are being used. With this information, space utilisation and energy using systems can both be optimised, to suit actual usage - vastly improving efficiency relative to the current model where desks and services are provided even when there is no-one there. Furthermore, digitisation of data-steams associated with indoor environment quality can lead to better management of pollutants and irritants, decreasing building related sickness and transmission.

Importantly, EMIS platforms bring new connectivity between industry actors that exist beyond the physical boundaries of a building's location. This connectivity can (i) enable DER participation in electricity markets, (ii) streamline processes for participation in government incentive schemes and rating schemes and (iii) engage facilities staff, contractors and occupants through user friendly mobile devices. EMIS platforms offer a new approach for delivering energy efficiency at scale, and for aggregating smaller flexible demand assets into a utility-scale fleet of resources. Counterfactually, without EMIS platforms it would be impossible to utilise these flexible commercial building assets, at scale, as distributed energy resources to support the electricity industry transition.

While so called "smart-meters" are a component of digitalisation, metering by itself is rarely enough to understand a building and drive improvements. For example, in the US DoE's Smart Energy Analytics Campaign, Kramer et al. (2020) identified median annual energy savings of only 3% from smart meters and simple metering analytics.

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 1.2).

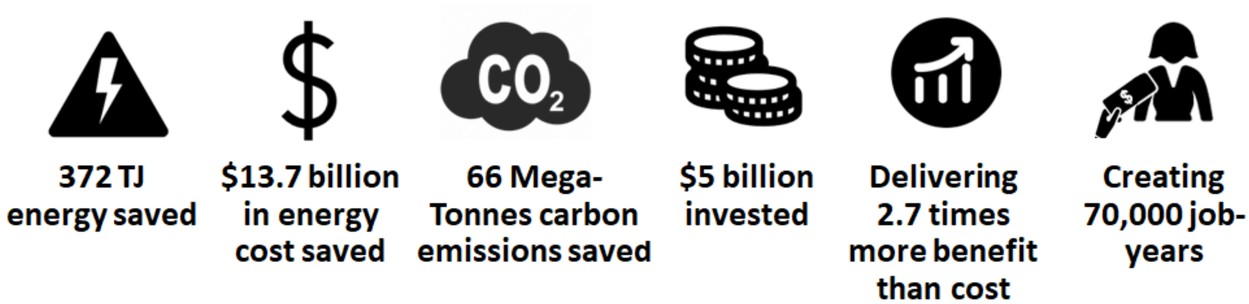


Figure 1.2: Impact (technical potential) of implementing EMIS technology in the non-residential buildings sector (White et. al., 2023)

1.2 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. In this way, white certificate schemes can fall into the category of being a market-based instrument.

White certificate schemes have generally been found to be highly cost effective. In Great Britain, they have produced 7.41 euro in benefits for each euro spent, excluding CO_2 savings (Giraudet and Finon, 2014). The ENEA (2015) claim that the 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 the tax deductions approach also available in Italy.

There are many possible variants in the detailed implementation of any given 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. As a result, the energy saver reduces energy consumption, with concomitant reduction in energy bills. They also earn certificates from the scheme. These certificates can then be purchased by the obligated party to provide a further financial incentive to act.
- The Accredited Certificate Provider (ACP): An entity that utilises the approved calculation methods to create Energy Savings Certificates. 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 (iii) 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 has been implemented. This can be in the form of evidence that certain energy saving equipment has been installed.
- An evidence-based calculation of the energy savings achieved. Some typical approaches, for this calculation, are provided below:
  - In some simple cases, the Scheme Administrator may provide predetermined 'deeming' factors for standardised energy saving 'Activities' such as retrofit of specific energy saving products. These deemed savings may represent the full life savings of the product. This allows low-cost upfront creation of certificates.
  - In more bespoke scenarios, the energy savings may be determined through modelling by expert engineering design consultants.
  - In a third alternative 'metered baseline' calculation methodology, the difference between metered energy consumption before (the baseline) and after the intervention, can be used to determine energy savings.

Methods for measurement and verification (M&V) of energy savings (including determining a baseline from measured data) are described by the Efficiency Valuation Organization (EVO) (evo-world.org). EVO provide training and accreditation for M&V practitioners, which is offered in Australia by the Energy Efficiency Council.

M&V techniques and their respective application suitability are reviewed both (i) in a companion project report and (ii) in separate literature (e.g. FEMP, 2015). Therefore, detailed analysis of M&V approaches is outside the scope of this report.

1.3 The challenge

While EMIS technology is widely known to save energy, the exact amount of energy savings is very difficult to know prior to investment in the technology. This makes it difficult to justify forward creation of certificates. Consequently, there is a need for more sophisticated calculation methods such as the measurement and verification method (Victorian Energy Upgrades Programme, NSW

Energy Savings Scheme and SA Retailer Energy Productivity Scheme) or the metered baseline method (NSW Energy Savings Scheme).

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 that requires mechanical and electrical contractors to implement revised control tune-up settings and perform problem-rectification (in response to advice from the data analytics). 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.

The aim of this report is to review the potential for, and practical implications of, implementing EMIS technology (in buildings) as a recognised energy saving activity in white certificate schemes. It considers EMIS stakeholder roles and products, and the relevant decision-making considerations involved at different stages of the EMIS implementation journey.

The report documents research analysis conducted by RACE for 2030 research participants, based on the premise of previously published Victorian EMIS consultation papers (Victorian Government, 2021). It is not official government policy or advice.

Information will be gathered together as a means of identifying key questions to ask industry, in order to fill gaps in knowledge. This information will hopefully be useful, for enabling a possible future EMIS energy saving Activity to be designed and implemented in white certificate schemes; with reduced risk and maximum impact.

2 EMIS product and stakeholder mapping

2.1 Products and providers

The various EMIS end-use applications (products and services) are described in Section 1.1 and illustrated in Figure 1.1. These include:

- Visualisation, information distribution and **monthly energy bills analysis** (course level analytics) to provide site-level information transparency to management.
- Interval (time-of-use) electrical **meter data and sub-meter data analytics** for more granular analysis of what equipment is consuming energy and when.
- **Fault detection and diagnosis** of equipment operational issues utilising more detailed data collection (beyond just electricity consumption data), that can provide insight into what maintenance and recommissioning actions could be taken to reduce energy consumption.
- **Advanced building controls**, to provide dynamic high level (supervisory) control adjustments for automated system optimization.
- **Grid integrated building controls**, to provide the capability for adjusting site demand in response to real-time electricity industry price signals or emissions intensity data. This system-level optimization (rather than building level optimization) aims to synchronise the timing of building electrical demand with the availability of renewable energy generation in the grid.

Figure 2.1 provides a map of key stakeholders in the non-residential buildings industry and the typical interactions involved in implementing and using an EMIS. In this Figure, the EMIS is taken as both (i) a data platform for building management and (ii) a suite of potential energy savings applications.

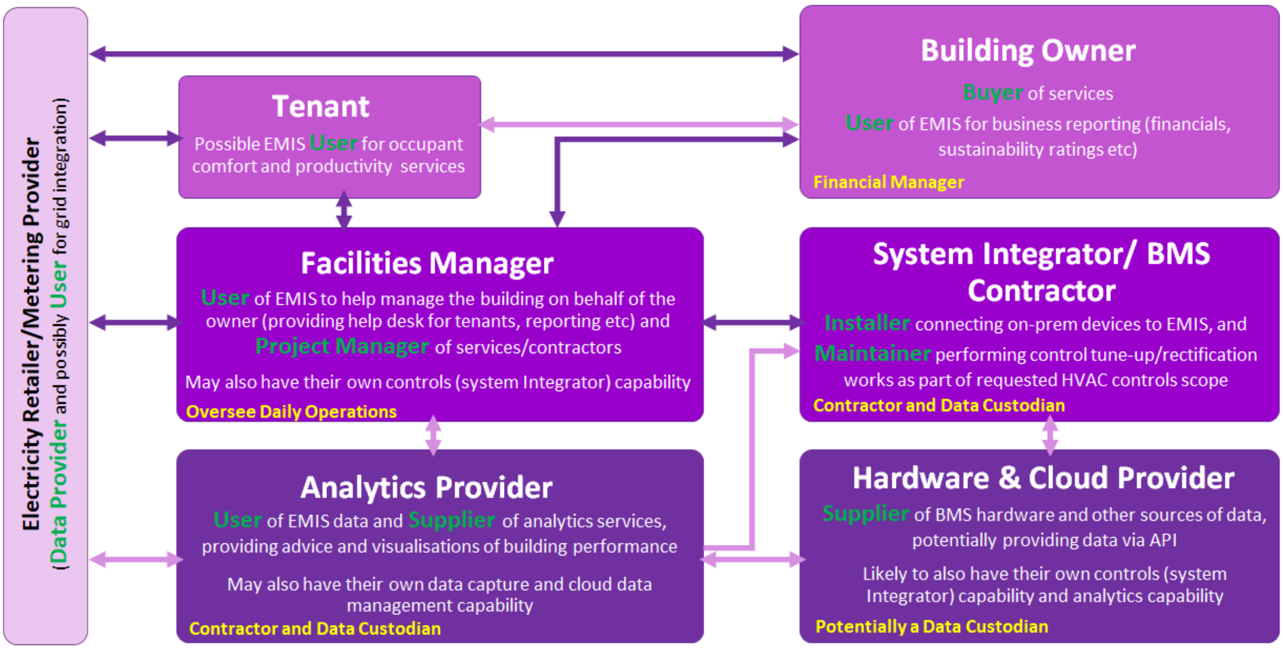


Figure 2.1: Industry actors and roles involved in implementing and utilising EMIS products/services

A typical, but not universal, pathway for implementing EMIS applications, involves the building owner expressing the desire to improve the building's energy performance and working with the building's facility manager to identify energy saving opportunities. As part of this process, the need for analytics is identified and the facility manager puts out a tender to procure a provider of analytics services. Once deployed, the analytics service operates in a 'discovery phase' to identify operational issues in the equipment (stuck valves/dampers, faulty control logic etc). This is followed by a 'rectification phase' where a purchase order is placed with the BMS contractor to fix the issues identified in the discovery phase.

Alternatively, a more direct approach could be to simply ask the building's BMS contractor to conduct a review of the buildings performance and implement opportunities for improving performance. Such an approach avoids the need for deploying a dedicated analytics service but relies on the skill of the BMS contractor to, perhaps somewhat intuitively, discover opportunities for energy savings. The BMS contractor may be assisted by a range of software features that come natively within the BMS hardware itself.

In either case, the deployment and utilisation of EMIS technology is generally a process of progressive opportunity discovery and implementation, that is achieved over a period of time. In this sense, it is more akin to a continuous improvement process, rather than a capex investment in efficient equipment to replace old inefficient equipment.

Furthermore, it is clear that fault detection and diagnosis (FDD) services (as an EMIS use-case example) could potentially be provided by a number of the Figure 2.1 actors in the building ecosystem. The Nexus Labs FDD Buyers Guide (2023) identifies a range of FDD vendors/products including:

1. FDD software as a service (SaaS): These vendors focus on providing FDD analytics software, and customer support for that product, as their primary solution. In Figure 2.1 this would likely be the Analytics Provider.

2. FDD as a hardware feature: These vendors provide some level of FDD as just one feature of the building management system (BMS) or integration platform. In Figure 2.1 this would likely be the controls Hardware Provider.

3. FDD as work conducted by a service provider: Third-party service providers wrap FDD into their contracted services, such as commissioning or monitoring-based commissioning or maintenance. In Figure 2.1 this would likely be the System Integrator/ BMS Contractor.

Similarly, for advanced building controls (as a second EMIS use-case example), there are a range of both (i) low-level control solutions, that would be implemented by the BMS contractor using relevant local controls hardware, and (ii) high-level (supervisory) control solutions that could potentially be implemented through a Software-as-a-Service (SaaS) model. Currently, most Analytics Providers have relatively limited offerings for advanced controls.

Clearly, the difference between EMIS products and services can be somewhat blurred, particularly when the business models and services provided by any given company can strongly overlap across the illustrated ecosystem.

The picture can be further complicated by commercial relationships between actors. For example, the BMS contractor may perceive the analytics provider as policing the quality of their workmanship.

As a result, they may have limited appetite to deploy the advice of analytics providers, where that may shine a light on previously poor management of HVAC plant (and they may charge accordingly for any recommended rectification works).

Another example of issues associated with commercial relationships between actors is access to data. Hardware providers (BMS, field controllers, metering) have often used proprietary protocols to communicate with their hardware. This can make the engineering task of accessing data, time consuming and expensive. Hardware providers may also operate their own cloud platforms to keep control of data inside their own eco-systems. Despite the general assumption that data should belong to the building owner, data has a practical tendency to find its way to the service provider and be inaccessible to the building owner.

From the perspective of creating an EMIS Activity for a white certificate scheme it will be important to identify what the Activity is aiming to reward. Is it to reward:

- Installation of particular hardware or software technology products *at point of sale*? It would be relatively straight forward to prove that it had been implemented, but choosing this (i) may disadvantage other service-based offerings that perform the same task (but are not eligible) and (ii) is not a guarantee that rectification works will subsequently be performed or that savings will result.
- Implementation of a process of energy efficiency control improvements *over a period of time*? Assuming that industry accepts that any such process requires continuous monitoring and proof of efficacy (rather than forward creation of certificates), this could be rewarded through a measurement and verification/metered baseline method. However, it may be difficult to identify exact cause and effect between various individual energy saving actions and measured savings.

2.2 Technology/implementation costs and possible impact of certificate value on financial viability

A wide range of different scenarios exist that can significantly influence the cost of deploying an Energy Management Information System. Consequently, it is difficult to single out universally valid costs.

With costs reported across 72 organisations and a large sample of buildings, in the US Smart Energy Analytics Campaign, Kramer et al (2020) appears to provide a statistically representative estimate of the cost of establishing an EMIS for two of the key (but lower level) energy productivity use-cases. These costs are reported in Table 2.1.

Table 2.1: Cost of an Energy Management Information System (EMIS) for two use-cases

COST COMPONENT	METER DATA ANALYTICS	FAULT DETECTION AND DIAGNOSIS
Installation and configuration cost	USD 0.01/ft^2 (~AUD 0.14/m^2)	USD 0.06/ft^2 (~AUD 0.86/m^2)
Annual recurring software cost	USD 0.01/ft^2 (~AUD 0.14/m^2)	USD 0.02/ft^2 (~AUD 0.29/m^2)
Annual inhouse labour	1 hr per month	8 hr per month

Another source, the Nexus Labs FDD Buyers Guide (2023), suggests the following budget costs for fault detection and diagnosis (FDD) software-as-a-service 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

They note the possibility of other indirect costs to consider during FDD deployment, including:

- Integration with building systems: There may be costs associated with tweaking or decoding building automation systems to ensure smooth integration.
- Hardware costs: Some FDD products or integration situations may require additional hardware, which can vary in terms of purchase, lease, or subscription models.
- Ongoing consulting services: These services may support processes that utilize the FDD results - such as interpreting results, prioritizing activities, and tracking work orders or energy conservation measures (ECMs).
- Cost of change management: FDD implementation may require changes in existing work-force roles and responsibilities and may involve new roles.
- Software and data modelling updates: Keeping the FDD software up to date and/or reconfiguring due to changes in the building (e.g. new HVAC equipment for a new tenant)

Consideration will also need to be given to the extra cost to fix 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$).

These costs are not dissimilar to costs from Australian suppliers, although the business models of some Australian FDD SaaS suppliers have some or all of the upfront cost amortised into the annual recurring software cost, in order to minimise upfront costs. Some providers may be willing to install the system for free and recover all costs via an annual subscription.

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

Interestingly, industry discussions on barriers to digitalisation suggest that industry considers the cost of digitalisation to be high. The disconnect between ‘paybacks less than two years’ and ‘high cost’ is perhaps reconciled by considering that the cohort of buildings appearing in the studies of Kramer et al (2020) and Crowe et al. (2020) may have been buildings representative of a relatively good scenario. Presumably, other less amenable buildings were not considered suitable and therefore did not proceed to implement an EMIS solution. And, as a result, they would have been excluded from the cohort of buildings investigated.

Less amenable buildings may, for example, include buildings with old legacy BMS systems that are difficult to connect to. In this case it may only be feasible to implement an EMIS Activity when done in conjunction with a complete refurbishment of the building’s control systems. This and other purchasing/supply chain factors create a large spread in the possible cost of implementing an EMIS.

In a recent example, a building was already planning to do a ‘head end upgrade’ to the BMS at a cost of $600K. For an additional $40K, the BMS hardware provider was willing/able to open up access (connectivity) to third party data analytics providers. Based on the marginal $40K cost, on top of existing works, FDD was projected to have a simple payback of ~2 years and 78%RoI. However, if all of the planned 'head end upgrade' costs were to be attributed to the FDD project alone, then the estimated simple payback time would have been greater than 7 years.

In summary, there is clearly a spectrum of financial scenarios for EMIS technology from (i) attractive financial scenarios where no additional financial incentive is required, to (ii) unattractive scenarios where white certificate incentives would probably not materially change the business case, and (iii) everywhere in between.

2.2.1. Indicative impact of white certificates on EMIS financial return

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

Assumptions are detailed in Table 2.2 and the resulting financial outcome of investing in an EMIS is compared with and without certificates in Figure 2.2 and Figure 2.3 for NSW and Victorian schemes respectively. The SA Retailer Energy Productivity Scheme is not included here as it doesn't have a market for trading certificates.

The assumptions reflect a continuous improvement/continuous maintenance approach (rather than simple invest and forget).

Table 2.2: Base case assumptions for EMIS financial analysis

ITEM	ASSUMED VALUE	SOURCE
Building size	30,000m^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) 13% (year 3) 13% (>year 3)	Kramer et al (2020), average savings from FDD in campaign cohort
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	

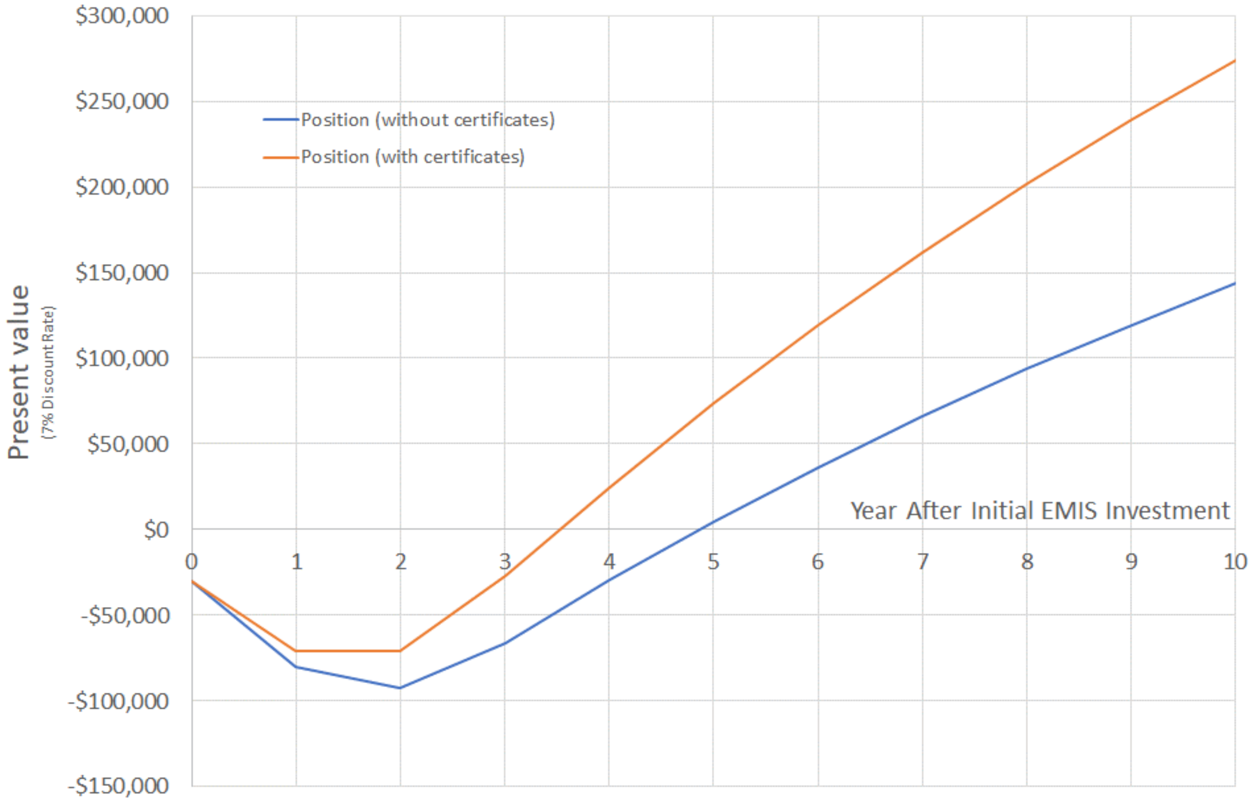


Figure 2.2: Financial position after implementing an EMIS product/service, with and without certificates in NSW.

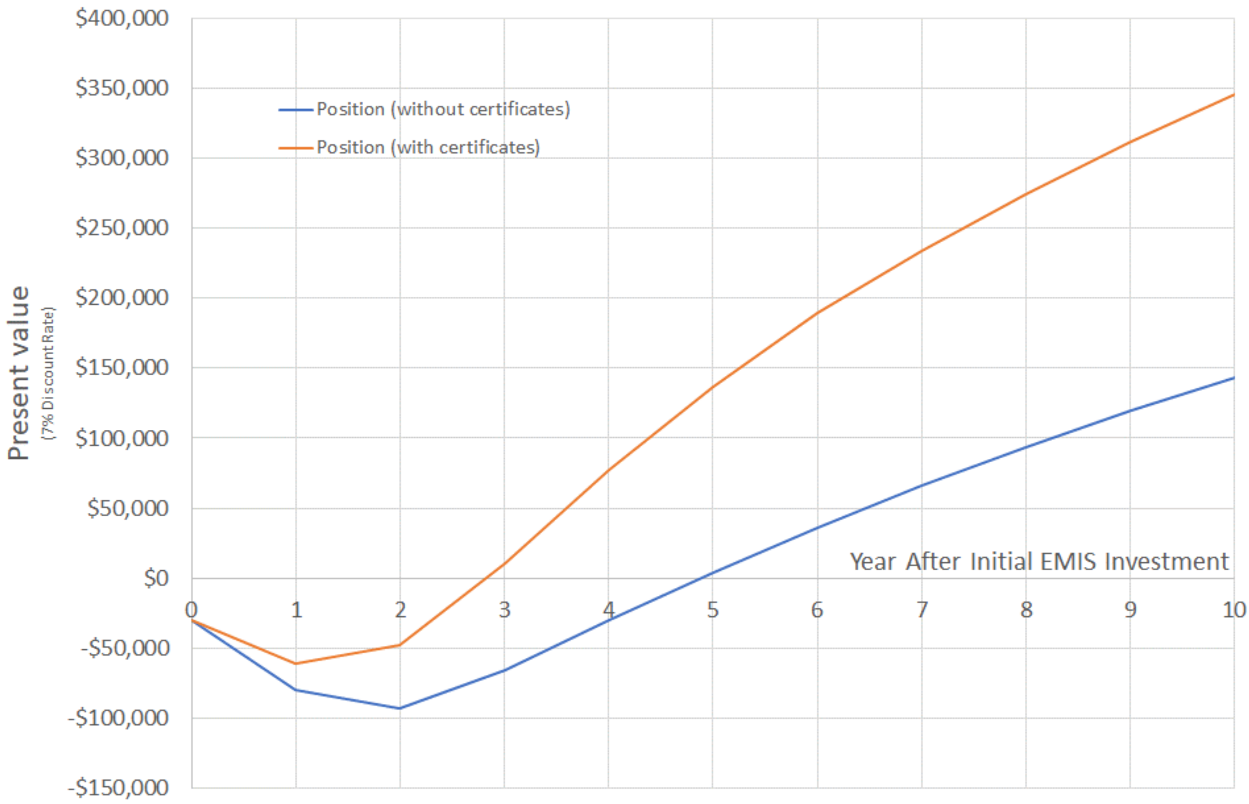


Figure 2.3: Financial position after implementing an EMIS product/service, with and without certificates in Victoria.

Under these assumptions, the 10-year IRR with and without certificates is 64% and 28.5% respectively. Some sensitivities to the assumptions are provided in Table 2.3: Impact of various assumed parameters on NPV after 3 years (with VEEC certificates).

Table 2.3: Impact of various assumed parameters on NPV after 3 years (with VEEC certificates)

ITEM	50%	75%	BASE CASE	125%	150%
Energy price (15c/kWh)	-$85,536	-$37,315	$10,906	+$59,127	+$107,348
Energy savings (growing to 13%)	-$123,948	-$56,521	$10,906	+$78,333	+$145,760
White certificate price ($85/$T_{CO2-e}$)	-$27,506	-$8,300	$10,906	+$30,112	+$49,318
Rectification costs ($2→$0.5 $/m^2)	+$70,840	+$40,873	$10,906	-$19,061	-$49,028

It is understood that industry has a strong preference for forward creation of certificates. This provides the energy saver with greater certainty in the business case to invest.

A suggestion is that an EMIS Activity could be rewarded with both (i) deemed certificates and (ii) certificates based on measured energy savings. This “hybrid deemed/M&V” approach would ideally provide sufficient incentive in the early years to invest, while still being sufficiently performance based to maintain rigour (i.e. the majority of whole-of-life certificates awarded on measured savings).

The financials of an EMIS Activity were rerun, using the same assumptions as detailed in Table 2.2, but with different levels of forward deeming of the 10-year whole of life energy savings. In each of these new scenarios, the number of certificates awarded for actual measured savings is discounted by the proportion of certificates that are forward created. For example, if 20% of the expected whole of life savings are forward-created then the number of certificates from measured energy savings are discounted by 20% (i.e. only 80% of the savings are counted for annual certificate creation purposes).

The resulting financial outcome of investing in an EMIS, with different levels of forward creation, is illustrated in Figure 2.4 for the Victorian VEEC scenario.

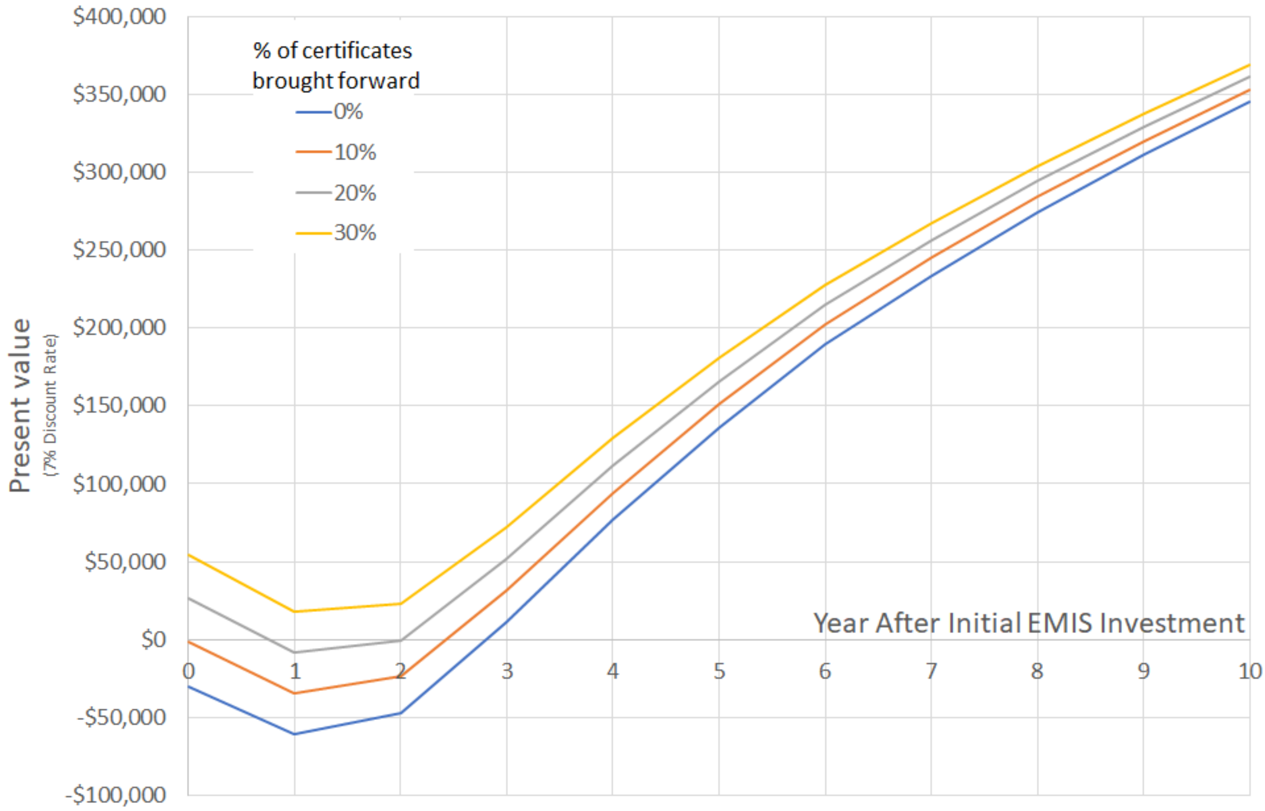


Figure 2.4: Financial position after implementing an EMIS product/service, with various levels of VEEC certificate creation brought forward.

Importantly, implementing the EMIS analytics service does not, by itself, automatically lead to savings without subsequent actions taken, based on the knowledge generated. Hence, care should be taken to ensure that excessive forward creation does not lead to incentivising initial purchase at the expense of sustained implementation.

It appears that around 10% forward creation would deliver a scenario where investment in a software as a service (SaaS) EMIS platform would be free of charge, but still require some later skin-in-the-game investment, from the energy saver, to implement rectification works.

2.3 Barriers to implementing EMIS solutions.

Despite demonstrated cost-effectiveness, various barriers prevent widespread adoption of EMIS solutions that would boost energy performance. These are well documented in the International Energy Agency's 'Energy Efficiency 2021' (2021), the Digitalisation Working Group of the EE Hub (Otte et al, 2022) and the US Department of Energy (2021) Grid Interactive Efficient Buildings Roadmap.

These sources corroborate findings from focus group research in the RACE for 2030 B2 'Industry 4.0 for energy productivity' Opportunity Assessment (Trianni et al, 2022), which ranked barriers under categories of (i) Technical barriers, (ii) Economic barriers, (iii) Behavioural barriers and (iv) Regulatory barriers. A simple poll of a focus group, for each of these barrier categories, ranked the importance of the barriers as illustrated in Figure 2.5.

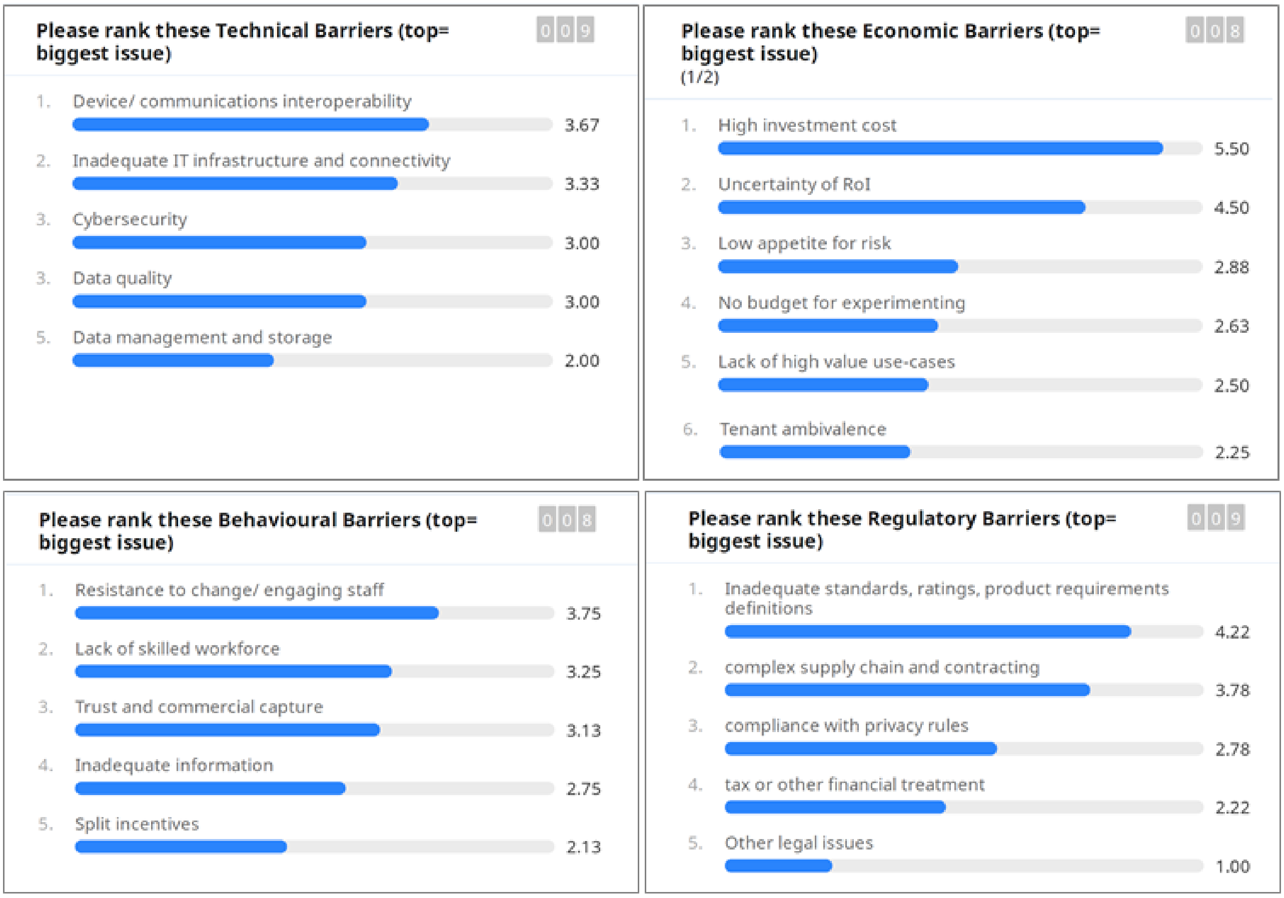


Figure 2.5: Focus group ranking of the importance of barriers to utilising digitalisation for improving energy performance (Trianni et al, 2022).

Similar findings were obtained from industry consultation in the RACE for 2030 B4 'Flexible Demand and Demand Control' Opportunity Assessment (Brinsmead et al, 2021).

Core issues for both digitalisation and flexible demand include:

- **Complexity and trust**: Industry identified the uncertainty involved in purchasing and implementing EMIS technology, with associated digital connectivity and metering system requirements. Building owners generally see this as a complex product and would like more guidance on product requirements. Complexity and trust issues include those relating to cyber security and privacy. Industry further identified complexity associated with evaluating potential energy savings and participating in energy productivity schemes. They expressed a strong desire for easy to understand, firm payment methodologies, such as fixed unit prices or feed in tariffs.

  With customers being relatively unaware of schemes and electricity markets, 3rd party service providers and electricity retailers typically incur a significant transaction cost to educate the customer. Electricity retailers expressed a reluctance to invest in customer acquisition, unless the requisite digital connectivity and control capability is already known to exist in a given building.

- **High cost/uncertain return on investment**: Despite wide-spread demonstration of attractive payback-times from EMIS technology, industry perceives the cost of IT infrastructure and digital connectivity to be high and the returns uncertain (see above).

Ongoing industry development is required to extend favourable economics to an increasing share of the industry, particularly to low/mid-tier buildings.

The transaction cost and complexity associated with establishing baselines, as part of measurement and verification processes, also contributes to perceived cost and uncertainty barriers.

Further analysis/characterisation of the barriers found that the task of retrofitting digitalisation-based (EMIS) energy performance strategies, can be divided into two steps (1) establishing IT infrastructure and connectivity and (2) deploying data analytics (both for energy performance applications and other non-energy prop-tech applications). This two-step journey is illustrated in Figure 2.6.

Most of the barriers to adoption relate to the first step.

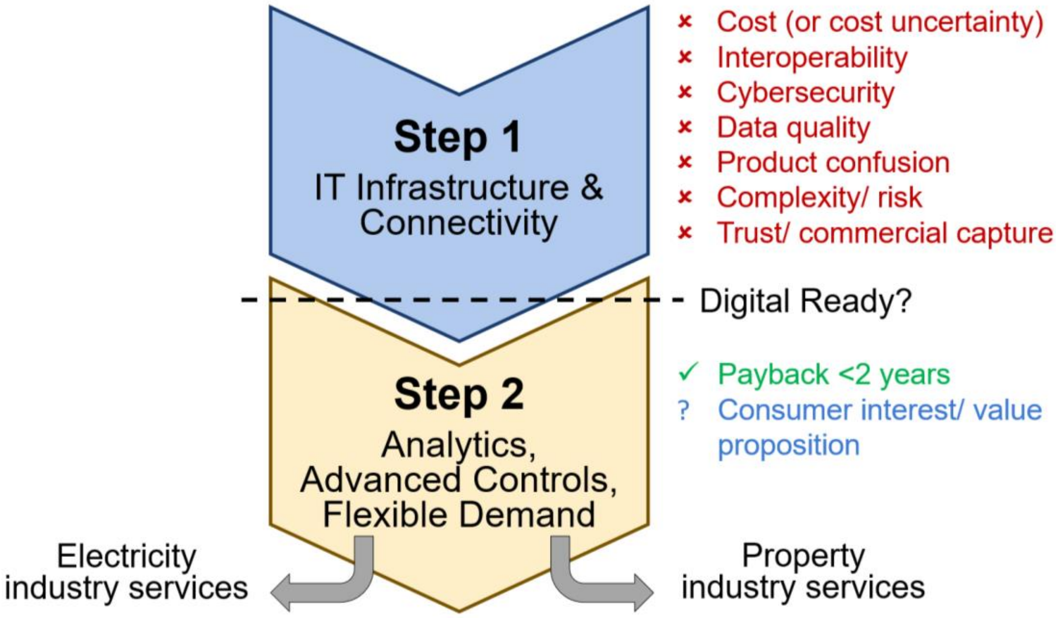


Figure 2.6: The journey involved in implementing digitalisation-based energy performance improvements in existing buildings (Trianni et al, 2022).

This distinction between the uncertainty and complexity of step 1 (deploying the EMIS *infrastructure*), compared with the relatively attractive economics of deploying the final step 2 EMIS *application/service*, highlights the potential catalytic role that could be played by some level of forward creation of certificates.

The RACE for 2030 B4 'Flexible Demand and Demand Control' Opportunity Assessment (Brinsmead et al, 2021) summarised the characteristics required of any successful intervention to be;

- Make it easy and trustworthy,
- Make it relevant,
- Make it financially visible and viable.

2.4 Intervention points for white certificates provision

Noting these barriers, it is also important to consider which stakeholder (property owners, facilities managers, contractors, product-suppliers and/or specialist energy analytics companies) is best placed to manage the cost and uncertainty of deploying EMIS solutions. Energy analytics companies and building services contractors have the relevant expertise to manage implementation risks and may have more core-business motivation to deliver energy savings. This could make them an attractive target for policy intervention, rather than relying solely on policies that target the property owner.

Building services contractors could potentially hold a key to cost effective implementation of EMIS technology in legacy buildings. When building services contractors are called in, to provide equipment upgrades (replace end-of life hardware controls), it would be a relatively simple addition to the scope of works to connect up the new equipment to an EMIS. With no increase in hardware cost, and no additional 'truck-rolls', the marginal cost of the EMIS connection could be very low.

By way of example, the low cost of the Energex 'Broad-Based' flexible demand program (Energex, 2022) can be attributed to the business model of integrating installation of the DRED device with the purchase of a new airconditioner, rather than trying to provide the DRED device as a dedicated retrofit.

Another reference example is the NYSERDA Real Time Energy Management (RTEM) Program. It provides grant incentives through a panel of qualified vendors, representing both system (hardware/ SaaS platform) providers and service providers.

Another potential intervention point in the life of commercial office buildings is when a building is leased. At that point, the landlord and tenant may agree on a "green-lease". Template green-lease clauses are readily available (e.g. at https://www.betterbuildingspartnership.com.au/projects/green-leasing/). A significant portion of these clauses relate to information management and energy performance expectations, both being tasks that are enabled by EMIS technology. Access to certificates could help reduce friction in the adoption of green leases and ensure ongoing attention to, and utilisation of, EMIS analytics results. Suggested 'Digital Ready' green lease clauses have been drafted for consideration.

2.5 EMIS product survey

A survey was sent out to representatives of the EMIS supplier industry. The Survey contained four questions. The survey can be found in Appendix A.

Seven responses were returned. A summary of feedback from these responses – for each question - is provided below, clustered into four categories of EMIS provider (reflecting different technologies or service provision model).

The material extracted from the responses, and provided below, has been chosen for its provision of quantitative input and/or qualitative perspectives. Feedback provided in italics are direct (or partly truncated) quotes.

1. Please list the EMIS products and services that you offer customers. For each of these products/services, please
    a. attach relevant marketing collateral (that you would typically provide to your customers), that explains (i) how the product/service works, and (ii) the expected energy saving benefits.

b. Explain how you believe the product/service fits into the general category of being an Energy Management Information System (EMIS) product. Where relevant, please comment on possible fit with one, or more of the proposed EMIS activity categorisations listed in the table above.

Four types of product/service provider were identified as follows:

	PRODUCT/SERVICE	# OF RESPONSES IN THE CATEGORY
1	EMIS consulting services (planned preventative maintenance, energy optimisation), provided utilising services of SaaS partners *"The EMIS product itself with fancy dashboards and information is not necessarily useful to the end-user who are non-technical people. We apply new rules or diagnostics on the EMIS products, to create insights and recommendations to the End-users"* Some energy savings estimates were provided. They appear to reflect site conditions, more so than the specific technology categories listed.	3
2	Controls hardware manufacturer with SaaS platform providing analytics and cloud based supervisory controls. Also providing installation, commissioning and maintenance – i.e. end to end offering	1
3	Dedicated third party SaaS provider, providing one or more of the proposed EMIS technologies *"[we] leverage the infrastructure established by Integrated EMIS technologies, and fits into the general category of an advanced EMIS as it is a software layer that analyses historical telemetry data generated by building sensors to deliver optimised controls strategies that enhance a building's energy efficiency".*	3
4	SaaS tool that is primarily used to provide back to base intelligence on the performance of a company's HVAC product. The HVAC product is manufactured installed and maintained by the company as an end-to-end service. *"The majority of solutions for EMIS, are integration and software packages that do not have sufficient validation and verification, documentation or design considerations covered to be called EMIS, as they don't cover the data fundamentals. Most systems in the market are reliant on the data being providing to be accurate, in the majority of cases this is a poor assumption that results in mis-diagnosis and incorrect analytics. A lot of systems currently wait until they have sufficient data, collected to then determine from that data, there is errors, it is then a process of elimination to find the errors, and correct the collection of the data. This is a significant waste of time effort and money for clients, this results in EMIS systems being costly wastes of time"*	1

2. Are there any criteria that you would propose for defining what is/isn't an EMIS (for the intended purpose of establishing eligibility as an EMIS in an energy saving certificate scheme)?

   a. Please explain any features, characteristics or capabilities that could be measured or in some way quantified as evidence to a scheme auditor.

	PRODUCT/SERVICE
1	R1 *"EMIS should do monitoring only and should not be commanding any outputs to the field. It should be vetted by a professional before instructing any changes to site"* R2 *"Some suggestions:* • *Data captured at 15 minutes interval (as a minimum)* • *Monitor data integrity at 15 minutes interval* • *Device are online > 95%/day?....a major issue"*

	R3 *"I believe what is and isn't an EMIS should be dependent on the level of service a customer requires. If the customer is looking for basic reporting on their energy use, that might just be using Excel, but if they were to invest in a data platform, they might still be limited to [quite specific] "Integrated or Advanced EMIS" functions as most products only have one level of offering."*
2	R1 *"archiving function is an important criterion as EMIS, i.e., must be able to store historical energy data for the past 2-5 years"*
3	R2 *"Most systems these days will fit the above criteria in some way and if they don't there are supporting systems that can be used to expand their offering. EMIS should achieve savings (automatically or manually), therefore any system that is just basic data collection with no visualisation shouldn't be deemed an EMIS. (e.g. A BMS that collects data and stores it but performs no reporting or visualisation. Whereas a BMS that collects the data and displays the energy consumption and produces reports is a basic EMIS)"* R3 *"In our opinion, the EMIS definition by Lawrence Berkely National Laboratories addresses the underlying criteria sufficiently. Should monitor:* • *kWh savings (normalised for load / weather)* • *HVAC system (or subsystem) COP* *The EMIS solution should be able to provide an operational outcome that the technology enables, and there should be a methodology of verifying that this operational outcome has been implemented. With this in mind, our advice is aimed at avoiding the typical "we installed 100 sub-meters for a GreenStar point but don't use them" style schemes. As such, we would not recommend that hardware only solutions be considered unless they have supporting workflow and/or software solutions to M&V the results.* *If analytics are deployed, there should be a way to define what faults were identified and how rectification of these faults saved energy. Data should be provided showing the before/after state prior to rectification. If energy monitoring solutions are provided, data should be provided demonstrating how an 'outlier' was found. Then, quick notes should be provided on the rectification steps with clear trends showing the improvement in energy performance. If supervisory control is provided, the above principles should also be adhered to whilst describing the control methodology implemented and results".*
4	R1 *"Following possible criteria:* • *Monitor data* • *Determine parameters for optimal operations* • *Analyse data* • *Check for deviation from optimal operation* • *Report and notify when required* *An EMIS system must be capable of achieving the desired outcome, energy and carbon savings for the building owner, tenant or operator. If the system cannot achieve this fundamental goal, it is not an EMIS. What is not an EMIS:* • *A piece of data visualisation software is not an EMIS.* • *An IoT device with a simple data visualisation is not an EMIS* • *A BMS that records energy data is not an EMIS* • *An integration platform, hardware and software is not an EMIS* • *A monitoring platform and remote connection to a site is not an EMIS* • *A peak demand monitoring system is not an EMIS* *It is much more difficult to determine what criteria is needed to be an EMIS because it is relevant to the data being monitored and the operation or functions being monitored to save energy. e.g.* • *An energy meter, fault detection IoT device, visualisation software and analytics for a food production facility piece of equipment is an EMIS because it monitors the complete operation of the piece of equipment and provides information that can be used to set parameters that indicate when the piece of food production equipment is not operating within its optimal parameters. And it should contain the ability to notify someone when the equipment is outside optimal parameters.* • *A building without HVAC equipment may just need energy meters, on major energy end use and provide data and notifications for deviation from set parameters* • *A building with HVAC&R systems MUST include temperature, humidity and CO2 monitoring for determining energy performance of the HVAC equipment, and internal thermal comfort, otherwise it is not an EMIS."*

3. Please comment on the validity of the cost estimates provided above. Do you believe they're reasonably representative of typical industry costs and payment structures.

	PRODUCT/SERVICE
1	R1 *"There is significant costs in R&D to developing these models and templates, and with the cut throat cost cutting nature of the industry, its definitely a hurdle. There are also no Central Standards or Design Guides to set a baseline for how these systems are set up and how it must 'comply'"* R2 *"The above cost estimates appear accurate. From experience, the energy monitoring and verification component can be up to 8 hours per month depending on how embedded energy monitoring practices are within the organisation and how much time is spent troubleshooting and identifying energy efficiency measures. "*
2	R1 *"I don't believe budget cost proposed by Kramer et all (2020) is accurate at all for Australian market, whereas the budget cost from Nexus Lab is lot closer to reality, however with the current inflation please consider increase of somewhere between 3 – 6%.* *With our solution, the budget cost would be lot higher than this if the installation involves control function of mechanical plant as there would be many hardware components & physical installation required (hence labour cost)"*
3	R1 *"Lower end of the scale seems very high. For smaller assets I would agree that implementation could be around $1.08USD and licencing could be $1.29USD. For larger assets (>30,000m²) cost could bas as low as $0.11 USD for implementation and the same for setup"* R2 *"Yes, as a broad estimation of the costs involved in the aforementioned technology categories these are reasonable estimates"* R3 *"Agreed in that implementation costs are typically split out from ongoing software costs (however, these costs are frequently amortized as part of longer engagements). Implementation costs for FDD have a median of $0.10/ft² & ongoing SaaS & support of $0.08/ft². Pricing models are based on typical building sizes; however, if customers are able to provide detailed points lists for analysis, prices are frequently negotiated as the typical range accounts for risk associated with project unknowns.* *In house labour can be typically divided into the below categories, each with respective time allocations. Note, these time allocations are related to FDD functionality.* 1. Point/Data Updates: Updating of points for data ingestion based on site changes, tenant fit-out works, controller replacements, etc. More 'dynamic' sites required higher time allocations [4hours/month] 2. Application Updates/Tuning: Tuning of applications (visualisations, analytics, etc.) to meet site specific requirements that are identified post implementation. Time requirements decrease the longer the software has been deployed [2 hours/month] 3. Engineering Analysis of Data: Utilising the software to analyse the data and triage faults/issues as per site requirements. Frequency of analysis is generally in line with site maintenance schedules/budgets [4hours/analysis] *Customer requirements and in-house skill sets typically dictate the amount of time required for support engagement.*
4	*The supply, install, project management, Data visualisation, analytics subscription costs, ongoing maintenance costs and design and engineering for the roll out across various sites we did costs are as follows:*

Cost component	Meter Data Analytics	Fault Detection and Diagnosis
Installation and configuration cost design and engineering, supply, install, project management, Data visualisation	AUD 1.84/m²	AUD 5.5/m² to 11.5/m²
Annual recurring subscription and maintenance costs Device maintenance, software maintenance, database maintenance, data storage, communications equipment, data transfer fees	AUD 0.30/m²	Included with HVAC&R maintenance – no additional costs per annum
ANALYTICS - Annual inhouse labour Analysis and reporting, communications with clients	1 hr per month per site @ $220/hr	4 hrs per month per site* @ $220/hr

**The hours allocated to a site for diagnostics and fault detection will vary significantly with the size and complexity of the site"*

4. We would welcome any other suggestions or information that you think may be relevant.

	PRODUCT/SERVICE
1	R1 *"It is very difficult for end-users to compare on equal footing. We suggest a Certification Level, to apply to EMS systems, to rate these systems, to enable easy selections. Similar to selecting a Fridge, without a Energy Star Rating, price is the main indicator. Some clients are willing to spend much more as long as its justifiable, however it is very difficult to compare the engineering capabilities behind the EMS systems, aside from fancy graphics and 'cool' dashboard.* *We have seen many 'cool' dashboards put in place in Lobbies, to show Tenants how 'Green' the building is, however that's all it is. It's a Fancy Dashboard. There are no engineering initiatives or actions being made, based on the information provided."* *Would like to see some standards/guides/rating system to differentiate capability and practice from basic to good – not fancy graphics"* R2 *"Whilst product choice is important, I don't believe it should be the defining factor in how "good" an EMIS product is. Some other factors which should be considered are:* • *Level of customisation and adaptability of the product. For example, most products can model and collate data from open industry protocols, but are they also able to integrate from a wider variety of data sources such as CSV, API, human manual inputs etc.* • *Deployment flexibility. Some clients will require an on premises only deployment with out data going into the cloud. Some clients may have a mix of on premises and cloud sites, but still wish to view their data in the single platform.* • *Level of product and platform support. For example, most of our clients do not have a dedicated "data manager", "building optimisation manager" or in house engineer. It is often our clients require an expert to collate all the different types of information, make the data accurate and available and coordinate effort to implement and drive change. When inevitably there are data errors or devices go offline, they require external support to repair and reinstate data functionality. Thus, it is imperative that a support program is in place to ensure reporting is accurate and consistent"*
3	R1 *"[It would be good to use] Specific methodologies for creating a boundary condition around HVAC subsystems that leverage expert knowledge of the interdependencies and BMS data. (e.g. for a chilled water plant, using Daily Thermal Load delivered to the field (kWrh) and Weighted Average System Lift (delta between Wet-Bulb temperature and chilled water leaving temperature, weighted by instantaneous kWr) as independent variables in a baseline model predicting plant energy consumption."* R2 *"Software tooling is most effective when deployed in parallel with good maintenance regime. Many building owners/operators are looking for a 'magic bullet' which will fix all their equipment; however, issues with hardware/equipment cannot be rectified with software alone. We believe it will be important to make sure maintenance activities are also incentivised in parallel with deployment of software. Thus when software identifies 'low hanging fruit' [i.e. - improperly calibrated CO_2 sensor leading to excessive OA intake], site teams are willing to engage vendors to come and rectify the issues. "*
4	R1 • *" "One size does not fit all". Software that proports to be a EMIS solution for most applications/buildings will typically fail to provide the optimal outcomes and maximise energy and maintenance savings. Bespoke software solutions need to be built per building typology taking into account complex operational procedures of the building. How a building is used has a significant impact on potential energy savings. A generic EMIS software solution does not account for this. (also note my previous comments a software solution alone is not an EMIS)* • *It is not valid to separate a FDD from the BMS, the design of the BMS and the functional description are integral components of the BMS/FDD. A deep understanding of the functioning of the equipment being monitored is critical in an effective FDD. Otherwise, a software only solution will generate significant false positive faults.* • *In the Kramer et al (2020) table 4 and table 5, clearly show the EIS and FDD support learnings that result in operating the building more efficiently. It is not a direct result of the EIS or FDD that is providing the savings, but better knowledge around how the buildings and the systems operate that results in the later year savings jumping significantly above years 1 and 2.* • *It is also likely that due to the EIS and FDD equipment renewal and upgrade projects were implemented resulting in the savings, the capital costs of these needs to be accounted for with the costs benefit ratio calculations.* • *For any certificate scheme involving HVAC&R equipment, the reporting of savings must be linked to the thermal comfort and indoor air quality records. Temperature, internal and external, humidity internal and external, and CO_2 internal and external needs to be reported for the same intervals and as the energy data, across the 12months prior and post the EMIS system implementation. Current requirements in The VEEC's allows for suppliers to hide things like widened set points, and poor indoor conditions, while reporting good energy savings. This results in post project retro actions to set the systems back to original settings, as occupant complaints escalate and facility managers must revert back to the previous operational parameters."*

Key take homes from this survey include:

1. There is significant antagonism amongst product/service-suppliers to the idea that an EMIS is simply a data visualisation tool. There is significant belief in the need to provide HVAC-domain specific expertise to support the EMIS technology.
2. There are warnings against just installing technology and expecting the operational problems of a building to then solve themselves. The need for rectification works, based on analytics advice, was stressed repeatedly.
3. There are many claims about what an EMIS is. Respondents found it difficult to be prescriptive about what an EMIS is (being more comfortable saying what it wasn't rather than what it is). Some guidance material and/or standard and/or rating scheme was identified as a possibly useful tool that could be provided to help guide energy consumers toward better EMIS solutions (rather than the existing confusion, leading to a race to the bottom - purchasing based on lowest cost alone).
4. There were significant differences amongst the responses in regard to cost. This perhaps results from the product confusion, described above, and what respondents considered normal/necessary to be inside scope. The SaaS software cost alone was probably difficult for people to isolate out from the broader service, particularly for those who are not directly providers of a SaaS platform.

3 White certificate implementation considerations

Some considerations, relevant to the implementation of EMIS technology in any general Energy Efficiency Obligation Scheme, are provided in this section. These considerations reflect literature and other RACE for 2030 Cooperative Research Centre perspectives and recommendations. The information is from a research perspective and should not be taken as specifications or guidelines for any scheme or government advice.

3.1 Recognising different levels of EMIS

In the Victorian Energy Upgrades Program, a Prescribed Activity is an activity that will result in a reduction in greenhouse gas emissions that would not otherwise have occurred if the activity was not undertaken. This could be in the form of

- modifying or replacing an appliance, a structure or any equipment so as to reduce consumption of electricity or gas, where there is no negative effect on output.
- replacing equipment or systems that use electricity or gas with an energy source that emits lower levels of greenhouse gases.
- installing high efficiency appliances or equipment.

These Activities are set out in Schedule 2 (regulation 10) of the Victorian Energy Efficiency Target Regulations (2018). Calculation methods for these Activities are provided in the Victorian Energy Upgrades Specifications (2018).

The Victorian Energy Upgrades Program provides additional flexibility to undertake other activities, not explicitly defined in regulation 10, through Project Based Activities under the Victorian Energy Efficiency Target (Project-Based Activities) Regulations (2017). A Project Based Activity could include deployment of EMIS technologies.

However, greater certainty would be provided to investors if a dedicated EMIS Activity was created, that provided clarity on what EMIS technology is/isn't eligible and how to prove a claim.

One possible categorisation of different EMIS products and services, into three levels of increasing complexity and value ("Foundational", "Integrated", "Advanced"), is provided in Table 3.1 below.

Table 3.1: A possible three tier categorisation of EMIS activities

FOUNDATIONAL EMIS	INTEGRATED EMIS	ADVANCED EMIS
Basic energy monitoring	Advanced energy monitoring with basic controls	Advanced energy monitoring and controls
Data monitoring	Fault detection and diagnostics	Supervisory control
Data visualisation and normalisation	Direct equipment control (BMS)	Automated system optimisation
Data analytics and reporting	System optimisation advice	Advanced flexible demand capability, grid-integration

The **Foundational EMIS** could be conceived as being similar to the existing 'in-home display unit' Activity (Part 30 of regulation 10) – focussing on information provision and interpretation – but, in this case, for use in non-residential (rather than residential) buildings. In similar way, features of interest could include;

- Advanced Metering Infrastructure, that includes:
  - A data platform that enables the user to manage measurement data and derived information, and exercise 'ownership' of that data (including ability to grant permission for third parties to access near real-time consumption data at no additional cost through both API and csv file formats)
  - Measurement of electricity consumption at least every 30 seconds, and gas consumption at least every 30 minutes,
  - Cloud storage of electricity and gas consumption information, in 30-minute time stamped intervals, for a minimum rolling 3-year history,
  - Ingestion of time stamped weather data and weather forecast data to the data platform via API,
  - A gateway or other means to communicate these measurements direct to the cloud for viewing by the building owner and nominees, through a web browser. The gateway should be able to support communications backhaul for other sensors and/or BMS data.
- Visualisations, trending and anomaly detection in meter data, including:
  - Reporting of average monthly electric power and gas consumption and comparison of consumption with previous months (in both numerical format; and in visual formats that allow the consumer to readily distinguish between low and high consumption),
  - Conduct relevant data quality checks including checking for continuity of upload and checking for outliers, indicative of failed reads or extremes,
  - Apply weather normalisation and other optional normalisations of energy consumption data, to enable appropriate like-for-like comparison of energy consumption data – results to be reported in visual formats that compare against historical performance,
  - Ability to establish a baseline of the energy consumption of the building and ability to forecast future energy consumption in a manner that's suitable for performing measurement and verification.

Many of these features are described by Bannister and Yeoh (2023), in a guide that articulates a number of suggested 'digital-ready' clauses suitable for green-leases (See Appendix C).

Progressing in complexity to the Integrated EMIS and Advanced EMIS, it could be beneficial to define these services as additional to (or building upon) the Foundational EMIS - rather than as alternative EMIS Activities with alternative functionality (creating the potential for duplicating certain functionalities). Separating the Activities in this way, the aim would be to:

- Allow the energy saver to choose as many of the three Activities as they like, rather than be limited to just choosing one of three alternatives. This could also allow the energy saver to do the Activities at different times (i.e. staple on additional activities as and when they feel comfortable to progress to increasing complexity), rather than all at once.

- Potentially utilise different energy saving calculation methodologies for the different EMIS Activities.

Hopefully, this approach would avoid overlap, duplication and associated confusion between the three Activities.

Taking this approach, the **Integrated EMIS** Activity could focus on fault detection and diagnosis. Similar to the existing 'in-home display unit' Activity (Part 30 of regulation 10), and the Foundational EMIS described above, it would aim to provide information and interpretation – but with focus on HVAC equipment. Consequently, data collection would focus on the building management system (BMS). Features of interest could incorporate the above Foundational EMIS functionality with the addition of;

- Monitoring of BMS data, that includes
  - Capture of key BMS data points, at least every 30 minutes, including at minimum
    - Status (on/off/percentage on) of significant energy consuming/generating equipment and variable speed drives (including batteries, electric vehicle charging stations and standby generators)
    - Indoor air quality metrics (zone temperatures, humidities and CO_2 sensors)
    - Supply and return air temperatures,
  - Cloud storage of BMS data in 30-minute time stamped intervals, for minimum rolling 3-year history,
  - means to communicate these measurements direct to the cloud for viewing by the building owner and nominees, through a web browser,
  - A data platform that enables the user to manage measured data and derived information, and exercise 'ownership' of that data (including ability to grant permission for third parties to access near real-time BMS data, at no additional cost, through both API and csv file formats)
- Visualisations, trending and BMS data collection anomaly detection, including:
  - Conduct relevant data quality checks including checking for continuity of upload and checking for outliers, indicative of failed reads or extremes,
  - Reporting of average equipment usage and comparison of usage with previous months (in both numerical format; and in visual formats that allow the consumer to readily distinguish between low and high usage).
- Fault detection and diagnosis analytics:
  - Reporting of common faults in the operation and maintenance of HVAC equipment based on expected physics-based rules/HVAC operating principles. This may be supported by data-driven comparison with historic (normal) equipment operation.
  - Structured reporting of detected faults such that important faults can be readily identified for early rectification.

Many of these features are described by Bannister and Yeoh (2023) (particularly the automated fault detection 'minimum application'), in a guide that articulates a number of suggested 'digital-ready' clauses suitable for green-leases (see Appendix C).

It is important that information from Foundational and Integrated EMIS Activities are integrated into the operational processes and procedures of a building. For example, a building should have an energy management committee that meets at least quarterly to formally consider the information provided by the Foundational and/or Integrated EMIS. This body would then oversee, and create accountability for, implementing relevant rectification works identified by the FDD analytics. Evidence of this could be cited annually and/or incorporated into a green-lease.

Finally, the **Advanced EMIS** Activity could focus on automated building controls re-commissioning and supervisory HVAC management from a cloud platform. Traditional HVAC control strategies are typically designed for set and forget operation. Consequently, various rule-of-thumb setpoints/ constraints are generally baked into the control strategy during initial commissioning (e.g. chilled water supply temperature, condenser water temperature, supply air temperature and/or fan pressure) to ensure that comfort conditions can always be met, even in worst case scenarios.

A number of more advanced/dynamic control strategies are described by the NSW Office of Environment and Heritage (2015), each claimed to have the potential for significant savings (5% to 30% each). The aim is to automate these control processes to activate and create energy savings during off-peak days. Opportunities also exist for predictive control, making real-time supervisory decisions that incorporate knowledge of day-ahead forecasts of relevant variables (e.g. future electricity prices, weather forecasts etc.). Serale et al. (2018) reviewed the state of the art in Model Predictive Control (MPC). They found that case studies of MPC implementation showed a wide spread of energy savings outcomes, ranging from 0% to 40%.

Opportunities also exist for shifting load across time of day to better match electricity demand with the availability of renewables (particularly solar PV generation). This takes advantage of passive structural thermal storage in a building and/or active thermal storage banks (e.g. chilled water storage or ice storage). This ability to achieve carbon savings, by shifting load, suggests a possible future need for time-of-use based Energy Attribute Certificates.

All of these advanced control approaches have seen relatively limited application to date. Features of interest, that could enable this technology, would likely include the above Foundational EMIS and Integrated EMIS functionalities, along with the addition of;

- Ability for the cloud data platform to dispatch high-level control and demand response requests by writing to BMS points.
- Control optimisation strategies, which may include
  - Forward-looking energy demand prediction capability, in 15 minute periods up to 1 day ahead, based on historic energy consumption data, weather forecast data, and control set point data.
  - Utilisation of weather forecasts to identify opportunities for dynamic adjustment of high-level control set points.
  - control mechanisms that can shift electricity consumption to minimise the building's electrical peak demand charges.
  - control mechanisms in place (preferably automatic or semi-automatic) that can respond to grid-level demand response requests/events and offer a range of demand reduction or deferment measures to minimise electrical load during such events.

The Demand Management/Response 'minimum application' described by Bannister and Yeoh (2023), provides some additional guidance on what might be required in the Advanced EMIS.

With reference to the alternative product/service types discussed in Section 2.1, Table 3.2 comments on how these proposed EMIS Activities might fit with industry stakeholders.

Table 3.2: Role of different suppliers in proposed three tier EMIS activities

	FOUNDATIONAL EMIS	INTEGRATED EMIS	ADVANCED EMIS
Software as a service (SaaS)	Third party energy insights companies offer SaaS data platform products. Value is provided through innovative meter data interpretation and visualisations (assuming meter data can be obtained cost-effectively from meter providers). **They will want to provide Foundational EMIS requirements.**	Third party fault detection and diagnosis (FDD) analytics companies offer SaaS platform products, with analytics rules. **They may be best positioned to provide Integrated EMIS requirements.** Value is provided by identifying rectification actions that will save energy and reduce maintenance costs. FDD analytics companies will often provide a hardware gateway product to extract data from the BMS.	Third party 'smart buildings' companies offer SaaS platform products, that deploy AI technology to provide control optimisation. To date these offerings have seen relatively little uptake, possibly because there is fear in the industry of possible unsupervised negative outcomes.
Hardware feature	Metering hardware providers will typically have their own proprietary data platform and can provide visualisations. **They may be best positioned to provide Foundational EMIS requirements.** However, greater competition/ optionality and extensibility (to higher level EMIS Activities) is possible, if the energy saver can have unfettered access to use their meter data. Consumer Data Right (CDR) reform may improve access and reduce cost of data access.	BMS hardware, by itself, is not well placed to provide FDD analytics. Although some BMS hardware companies also offer SaaS services, as a separate offering (as above). Data extraction from the BMS may be difficult. Legacy BMS systems may not have the necessary functionality. Even for a modern BMS, hardware providers may hide behind proprietary communications protocols and be reluctant to provide data access to third party FDD SaaS providers.	BMS hardware can be programmed to deploy advanced control optimisation technology, either (i) locally or (ii) enhanced through cloud connectivity. Indeed, BMS products may have some of these features available out-of-the-can in the hardware. However, deployment of these features will normally be done by the site BMS contractor based on individual circumstances of the building.
Skilled service provider/ contractor	The Foundational EMIS, alone, may not be able to directly identify the cause of changing energy consumption. Facilities Management and/or BMS Contractors would need to be called in to support opportunity scoping and to implement any energy saving changes.	The Integrated EMIS will provide advice (decision support) on what needs to be done to save energy. But the BMS Contractor will need to be called in to implement rectification works that deliver the energy savings.	The Advanced EMIS will provide direct measurable energy savings through optimised control. At this point in the technology's maturity, implementation would be expected to be done locally by the BMS Contractor. **So they may be best positioned to provide Advanced EMIS requirements.**

3.2 Evidence of energy savings, additionality and appropriateness of the reward

Clearly, any energy saving certificate created should represent actual saved energy, as best as possible. The savings should be calculated with basis in engineering evidence and the savings should be from voluntary action to save energy, rather than from compliance with mandatory legal or regulatory requirements.

While energy savings schemes are inherently a reward scheme for taking action (even if that action is already cost-effective and/or the practice is widespread), the scheme would ideally also stimulate adoption of new energy saving activities that are currently under-utilised. In this way, energy saving schemes can help to stimulate innovation and drive additional energy savings than would otherwise be possible through business-as-usual activities.

In the case of the proposed three EMIS Activities, the Foundational EMIS and Integrated EMIS are generally existing practice for the large office buildings sector (particularly premium grade), but relatively less adopted in existing small and low/mid-tier buildings, and other building typologies. New construction will likely include much of the requisite hardware capability of the Foundational EMIS by default (even if not activated as a service). The Advanced EMIS is only in the early stages of adoption.

As a general observation then, there appears to be high potential for incentivising new (additional) energy savings from each of these EMIS activities, compared with business-as-usual.

One of the key features of EMIS technologies is that it relies on 'digital readiness', including the ability to extract data from site to a cloud Software-as-a-Service platform. As discussed in Section 2.3, this creates a set of significant barriers, particularly in the case of retrofit to existing buildings.

One of these barriers is the lack of certainty of energy savings from an EMIS. Specifically, it is difficult to know how much energy will be saved, prior to investment in measurement and monitoring digital infrastructure, that is necessary to identify the energy saving opportunities. Some level of deemed savings could help to overcome this barrier.

Foundational EMIS energy savings calculation

The proposed Foundational EMIS can provide much of the digital ready infrastructure needed to drive energy savings in all three of the proposed EMIS Activities.

Kramer et al (2020) tracked the average benefits of 'Energy Information System (EIS)' technology across 22 buildings in the US Smart Energy Analytics Campaign. This EIS technology is essentially the same as the proposed Foundational EMIS. They found persistent energy savings of around 3% compared with baseline.

Given the issues relating to financial certainty in this Activity, and the limited savings claim (as a percentage) involved, it is proposed that the Foundational EMIS attract deemed savings equivalent to 3% of annual electricity consumption for a life of 5 years. In the large building example of Section 2.2, this deeming rate would provide an upfront incentive of around $32,500 which is similar to the expected upfront cost of the Foundational EMIS.

As an additional comparison, the in-home display unit Activity calculation (equation 30.1, reproduced in Figure 3.1) in the Victorian Energy Upgrades Specifications (2018) allows for around 2.5MWh (over 5 years) of electricity savings, in an area without gas reticulation.

Noting that annual residential electricity consumption in an area without gas reticulation is 6.87 MWh (Acil Allen, 2019), the equivalent deemed energy savings (from digital ready infrastructure in homes) is around 7.3% of annual consumption.

Clearly, the deemed savings proposed here, for a non-residential building, is conservative compared with the existing in-home display Activity.

To ensure effectiveness and to target the measure towards buildings beyond business as usual, the eligibility for deemed savings from the proposed Foundational EMIS Activity could be restricted to (for example):

Method for Determining GHG Equivalent Reduction

Scenarios 30A and 30B: Installing an in-home display unit

The GHG equivalent reduction for each scenario is given by Equation 30.1, using the variables listed in Table 30.2.

Equation 30.1 – GHG equivalent emissions reduction calculation for Scenarios 30A and 30B

$$GHG\ Eq.Reduction = Electricity\ Savings \times EEF \times Lifetime \times Regional\ Factor$$

Table 30.2 – GHG equivalent emissions reduction variables for Scenarios 30A and 30B

Input type	Condition	Input value
Electricity Savings	For upgrades in a gas-reticulated area	0.39
	For upgrades in a non-gas reticulated area	0.51
Lifetime	In every instance	5.00
Regional Factor	For upgrades in Metropolitan Victoria	0.98
	For upgrades in Regional Victoria	1.04

[88] In a determination made under regulation 36(6).

118 Victorian Energy Upgrades

Figure 3.1: Energy savings for in home displays.

- Buildings that are less than 5,000 m^2 floor area.
- Buildings that have a green-lease and/or an energy management committee that meets monthly, with external consultant advisors, to formally consider the information provided by the Foundational EMIS.
- Foundational EMIS technology that includes a Software as a Service data- platform that is (i) connected to the building's BMS through an appropriate cloud gateway and (ii) provides the ability for the building owner to grant permission for third parties to access near real-time energy consumption and BMS data, at no additional cost, through both API and csv file formats.

These additional restrictions would ensure that the Foundational EMIS is not a zero cost Activity.

Integrated and advanced EMIS energy savings calculation

The energy savings achieved from fault detection and diagnosis and from advanced building controls will vary significantly between buildings and technologies. Amongst other things, the energy savings will depend on the state of repair of the operating equipment and the skill with which the control strategies have been implemented and maintained. As a result, two otherwise identical buildings (in construction and equipment selection) could yield quite different energy savings results. Consequently, it is not realistic to predict these savings in advance. Furthermore, the rate of energy saving will likely increase steadily as rectification/re-commissioning work progresses (rather than seeing energy savings arrive at a single point in time).

In these circumstances, deeming or upfront calculation of greenhouse gas savings is not an appropriately robust way of predicting energy savings. Instead, the approach for calculating the reduction in greenhouse gases will need to follow the Project Based Activity 18(1)(b) calculation methodology under the Victorian Energy Efficiency Target Project Based Activities Regulations (2017) – 'annual reporting of savings using a baseline energy model and measured energy consumption'.

Details of how to implement this calculation methodology (including the need to perform regression analysis with independent variables such as weather) are given in the Measurement and Verification in Victorian Energy Upgrades Specification Version 7 (2022) and calculated using equation 3 and 5. Because the savings are measured, there is no forward creation of certificates and no decay factor.

Given that the proposed certificate calculation methodology is the same for both the Intermediate and Advanced EMIS Activities (and the measured energy savings can only be claimed once), the reason to keep the two activities separate would only be to place specific restrictions on eligibility for one or both of the Activities. For example, noting the higher level of adoption of fault detection and diagnostics (FDD) - compared with automated building controls re-commissioning and supervisory HVAC management from a cloud platform - the Integrated EMIS Activity could be restricted to buildings that are less than 5,000m^2 floor area for example.

As described in Section 3.1, the separate categorisation of each of the three Activities aims to allow the energy saver to claim certificates from all of the Activities. As the Intermediate and Advanced EMIS Activities would almost certainly require implementation of the Foundational EMIS, the combined certificates generated from the Intermediate and Advanced EMIS Activities would then be

$$\text{Certificates}_{\text{Intermediate and Advanced EMIS}} = \text{Deemed Certificates}_{\text{Foundational EMIS}} + \text{Certificates}_{\text{Annual Creation}}$$

A discount could be embedded inside the Accuracy Factor of equation 3 or as a separate factor to reflect uncertainty in the annual creation certificates and/or avoid possible duplication with the Foundational EMIS (deemed 3% savings). Such a factor could be calculated as follows:

$$AF = \frac{\left(\sum_t 0.97\, E_{BM,t} - \sum_t E_{meas,t}\right)}{\left(\sum_t E_{BM,t} - \sum_t E_{meas,t}\right)}$$

3.3 Effort to administer, governance and gaming risks

3.3.1 Balancing rigour/administrative burden with value creation

For the indicative financial impact calculations, arising from fault detection and diagnosis technology as presented in Section 2.2.1, the value of certificates (priced at $30/MWh) is around $0.7/m^2 per yr. The cost of obtaining these certificates must be much less than this. So, to be financially attractive (e.g. retain say 90% of the certificate value), one wouldn’t want to spend more than around one day per year, of staff time, on the administrative task of creating certificates for a 10,000m^2 floor area building.

With this in mind, quite streamlined processes will be required for (i) validating that the given EMIS activity has been implemented and (ii) for performing the calculations (demonstrating energy savings) as discussed in Section 3.2.

Noting the application ubiquity and documented statistical evidence around expected energy savings from these use-cases, the administrative burden of proof can hopefully be reduced through some level of standardisation on eligibility and associated administrative processes, as discussed below.

Validating Foundational EMIS implementation and energy savings

The core of the proposed Foundational EMIS Activity involves installation, commissioning and maintenance of a range of engineering capabilities including (i) advanced metering infrastructure (AMI) (ii) cloud connectivity to onsite AMI and BMS hardware, and (iii) web browser-based user interfaces including basic visualisations of energy consumption KPIs.

This capability has a reasonable level of complexity to it and could have various product-to-product variations and/or bespoke implementations if not standardised. This could significantly increase the administrative costs of certifying sufficiency. Hence, implementing a register of 'qualified' (approved) engineering products that are eligible for certificates, would overcome this issue and help to keep administrative costs for energy users to a minimum.

This would enable energy users to simply demonstrate proof of purchase and installation of the registered (pre-approved) product, to justify the proposed deemed certificates.

Validating Integrated and Advanced EMIS implementation and energy savings

Certificate creation, for the proposed Integrated and Advanced EMIS Activity, involves regular after-the-fact measurement and verification of the actual savings achieved. Hence (in contrast to the deemed Foundational EMIS), the specific product (or rectification works) that unlock the energy savings is of less importance than the fact that the energy savings are measured and real.

Consequently, the task of minimising the administrative burden for the Integrated and Advanced EMIS Activity should be linked to automating and streamlining the '*annual reporting of savings using a baseline energy model and measured energy consumption*' method. This task is the subject of research package 2 in the RACE for 2030 White Certificates project. Hence, the methods and tools for achieving this are discussed in detail in separate reports, with only a light discussion in Section 3.3.2.

Having moved to '*annual reporting of savings using a baseline energy model and measured energy consumption*', the Intermediate and Advanced EMIS Activities would capture all energy saving actions that occur inside the boundary of the meter point. In this way, it would not be possible to easily distinguish between savings that occurred as a direct result of the EMIS from other energy saving actions that might occur (purposefully or inadvertently).

As discussed above, this does not have to be an issue, so long as the energy savings (the purpose of the scheme) are real. It does however suggest that, to avoid double-dipping, once the baseline energy model and measured energy consumption calculation method is chosen, no other certificate creation method should be allowed that could save energy inside the boundary of the chosen meter point.

3.3.2 Mapping the journey of the administrative process

Some keys to success for keeping administration requirements to a manageably low level, will likely relate to the ability to:

- ***Automate access to data and data processing*** utilising cloud-based data-scraping (e.g. for NMI data) and automated M&V algorithms. It is noted however, that not all buildings/ scenarios will be suitable for establishing an automated baseline.

- ***Avoid unnecessary consulting fees*** and transaction costs associated with the use of a VEU Accredited Person (AP): In this regard, it would be attractive if the EMIS provider were an AP for their own product. In this way the cost of certificate creation could be embedded inside the product price and able to be competitively sourced as a bundle. The automated software tools (previous bullet point) could help reduce consulting hours and also reduce the risk for EMIS providers wanting to provide AP services.
- ***Ensure that the timing of fees is delayed*** to a point in the journey where there is sufficient certainty in the business case for generating certificates: In this regard, a software tool that pre-screens for the likelihood of being able to establish a satisfactory baseline (prior to incurring costs) would give confidence that future EMIS savings will be able to be measured.

The process might look something like Figure 3.2 below

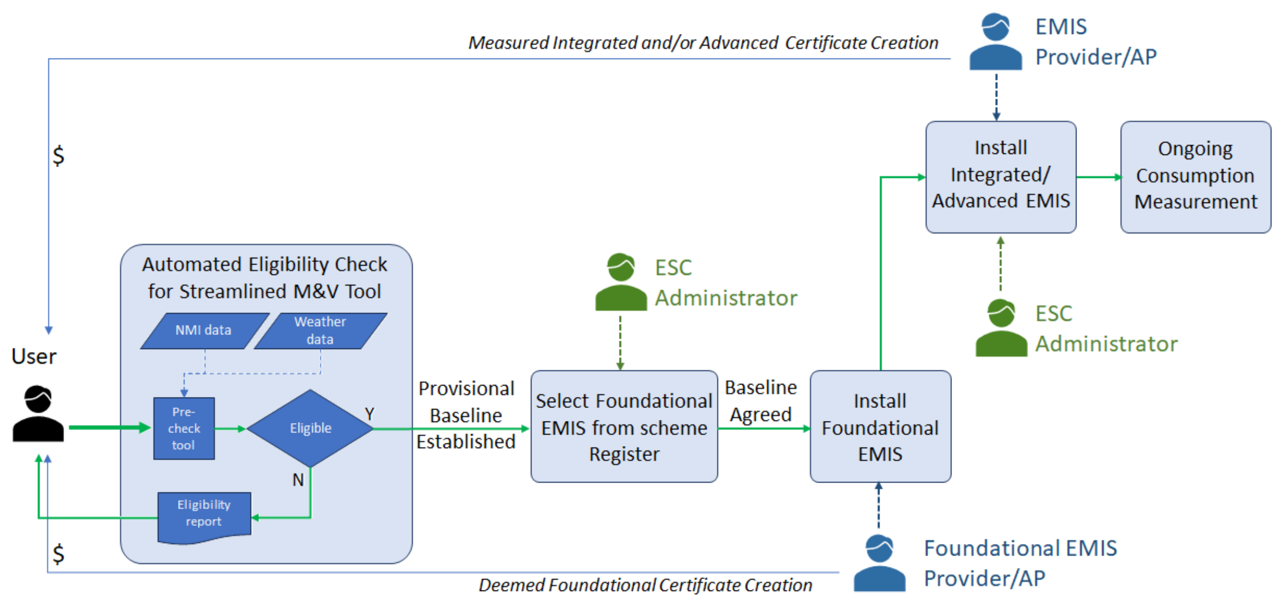


Figure 3.2: Steps involved in implementing EMIS activities.

Friction in these steps would likely be reduced if the automated measurement and verification capability were provided by an independent government platform. Such an automated M&V tool could be provided for free or as a deferred cost (cost recovered from future certificates generated). In this way:

1. The upfront cost of establishing M&V baselines and business-case development can be minimised, reducing investment uncertainty and overcoming consumer first-cost bias for building owners.
2. The compliance risk, and the transaction cost of generating certificates, can be reduced for service providers.
3. Data access (in standard formats) and scheme integrity remain under the control of the scheme administrator. Consultation with the NYSERDA RTEM grant program in the USA, identified that lack of access to data, inconsistent data and reliance on provider claims, had made it difficult to conduct fully quantitative program reviews.

4 Consultation

4.1 Suggested areas for feedback from industry

A range of policy questions arise that could impact on the rigour of the proposed EMIS Activities. Alternative options for addressing these policy questions will likely have commercial implications that make the proposed Activities more or less attractive for industry. A balance needs to be found between stringency of the administrative requirements and the incentive provided to industry to adopt. Some of these policy questions and their corresponding commercial questions are listed in Table 4.1 below.

Table 4.1: Questions for consideration relating to scheme requirements and commercial feasibility.

	POLICY CONSIDERATION	QUESTIONS FOR INDUSTRY FEEDBACK
1	Should EMIS products/services be included as an Activity in the VEU Scheme (either to increase scheme efficacy or to achieve a more level playing field)?	• Would you like a dedicated EMIS Activity in the VEU Scheme? • Why is it necessary? How would it help? • What impact do you hope could be achieved by introducing this?
2	How could the eligibility of an EMIS product/service be characterised (in a way that's effective and simple to apply)?	• What products and services should be in-scope? • How would you define them? • Is a register of pre-approved products a good idea? Should eligibility be limited to products on this register?
3	What evidence should be provided to justify generation of certificates (both (i) that action has been taken and (ii) that energy savings have been achieved)?	• What evidence could you provide that work has been completed and that energy savings are being achieved? • Would the reward from the certificates justify the work involved? Could an automated M&V tool help? • Does initial deeming at an assumed 3% savings, followed by metered savings for additional certificates seem fair?
4	Who should provide relevant documentation? What level of skill, independence and accreditation should be required? What audit powers would be adequate?	• Would you (EMIS provider) be willing and able to become an AP for the purposes of a new EMIS Activity? Would availability of an automated M&V tool help? • Would you (building owner) feel comfortable to self-service use an automated M&V tool if available? • What record keeping and audit provisions would you expect?
5	What's to stop people just installing kit for deemed savings and then forgetting about it? Could there be double dipping with other Activities?	• What is the likelihood that deemed savings would be sufficient to see SaaS platforms installed free of charge? Under what circumstances would this be most likely? • Would you be willing to forgo other certificate creation methods for Activities that would fall under the same M&V meter (to avoid double dipping)? • How do you feel about inserting a requirement for having an energy management committee to regularly review and implement advice from the EMIS? Could a green-lease be used as evidence (where applicable)?
6	How would an EMIS Activity fit with other requirements and business processes?	• What regulatory/compliance requirements are relevant to the use of EMIS technology? • How could processes relevant to an EMIS Activity be streamlined to fit with processes for obtaining NABERS ratings? • Would you support efforts to promote interoperability and data-access through EMIS eligibility requirements?
7	Could an EMIS Activity trigger cybersecurity, privacy or other unintended risks?	• Are there any risks or unintended consequences that you think might arise from implementing an EMIS Activity?
8	Catch all	• Is there anything else we should know?

4.2 Workshop plan

Feedback is required to better understand the opportunity for an EMIS Activity, by gauging industry sentiment to the ideas proposed and asking some of the questions tabled in Section 4.1. This can also give a better understanding of the likely industry response, if an EMIS Activity were introduced.

Feedback was obtained through an online industry consultation workshop with both EMIS product and service providers, and accredited persons (APs) who generate certificates for eligible Activities. A separate workshop will be held with building owners as part of work package 2 (WP2) but with focus on streamlined M&V.

The workshop plan is detailed in Table 4.2. It had primary focus on product-fit and implementation practicalities. The breakout groups were led by a table chair from amongst the project team, and industry participants were pre-assigned/separated onto breakout group 'tables' according to stakeholder type. This approach aimed to preserve the distinct 'voices' of the different stakeholder types.

Table 4.2: Workshop plan for practitioners (product suppliers and APs).

TIME	ACTIVITY	RESPONSIBLE
9:00-9:10	**Welcome** • Purpose, investigation team introductions and logistics	Chris Iape
9:10-9:30	**Presentation** • EEO schemes and certificate generation (deemed vs PBA) • Fit (or not) of EMIS technology. • What we heard from the product survey • Philosophy behind a suggested three-level EMIS approach and suggested methodology for generating certificates. • The need to streamline M&V and the MBM approach.	Stephen White
9:30-9:50	**Breakout Group Session 1: The vibe** • What do you like about what you've heard? • Do you see any unintended consequences/scheme risks?	Table chairs/ All
9:50-10:10	**Session 1 Feedback** • Report back from breakout groups • Sneaky slido: Would a product register be useful (strongly yes/yes/maybe/no/strongly no)? • Sneaky slido: How significant would a $30,000 upfront incentive be in a 30,000m^2 building?	Chris Iape and table chairs
10:10-10:40	**Breakout Group Session 2: Practicalities** • Would it be good for EMIS providers to get accredited (become an AP) to enable them to generate certificates as part of the installation process? • How could implementation of rectification works be incorporated into requirements? • What functionalities could a Scheme Administrator operated 'platform' provide to reduce the administrative burden of generating certificates from an EMIS Activity?	Table chairs/ All
10:40-10:55	**Session 2 Feedback** • Report back from breakout groups • Sneaky slido: Would you be likely to take advantage of an EMIS Activity if it was included in the VEU Scheme (strongly yes/yes/ maybe/no/strongly no)?	Chris Iape and table chairs
10:55-11:00	**Concluding thoughts**	Chris Iape

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.

4.3 Workshop Findings

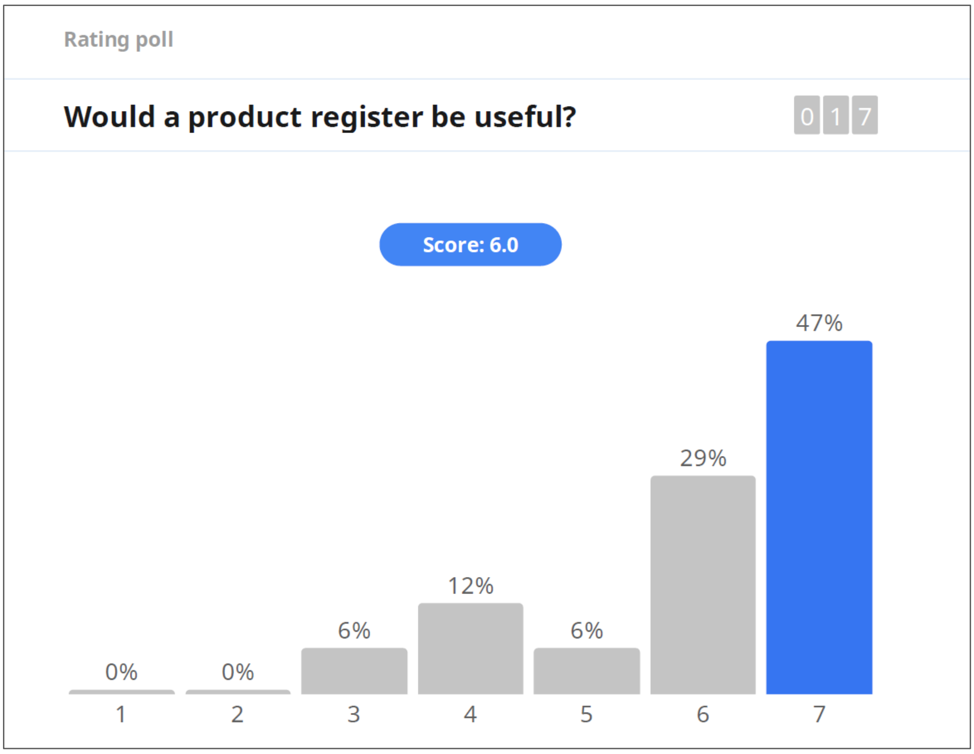
The introductory presentation given at the workshop is provided in Appendix B. Relevant commentary, and Slido poll results, from the workshop are summarised below.

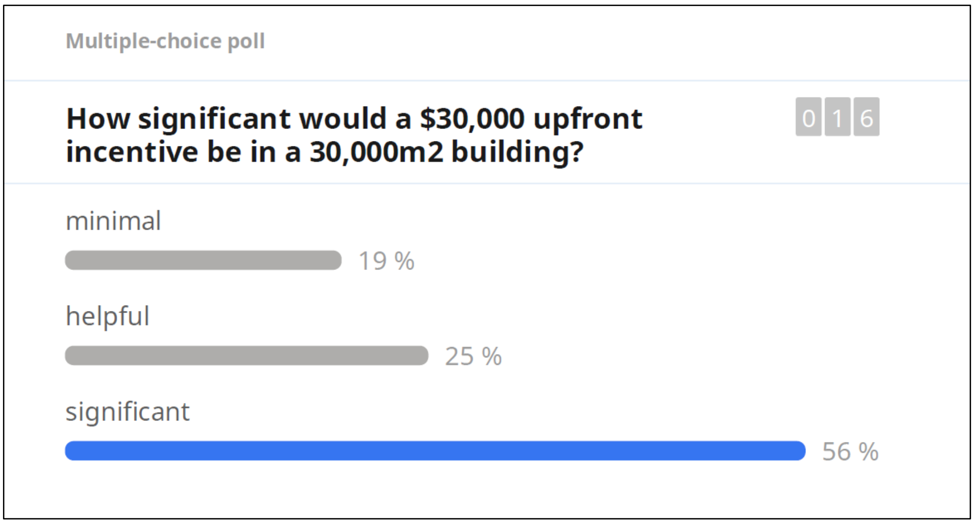
Breakout Group Session 1 (What do you like? / What are your concerns?)

- People were supportive and pleased with the general concept.
- People liked the idea of splitting into more than one EMIS with (i) the foundational EMIS being eligible for deemed certificates and (ii) additional certificates for implementing energy saving advice/controls. Some upfront certificate financials are probably required, but there needs to be a balance between upfront and performance-based reward. It was noted that ultimately deemed certificates are just a rebate/subsidy so one might ask the question "do they need to go through the more complicated certificate scheme, why not just hand over the money?"
- Participants were particularly happy with application of this to smaller/ lower-tier buildings that have limited ability to participate in the Schemes under existing rules.
- There was a general desire for performance-based savings rather than deemed (noting that this isn't consistent with the lived reality of current Scheme operation!), and participants cautioned against excessively rewarding the foundational EMIS. There was some worry that BMS suppliers could use an EMIS Activity to get credits for something they would do anyway.
- Participants noted that there are plenty of ways for automated M&V to go wrong.
    - A lot of the savings result from human-centric processes (that implement advice) rather than from the software technology advice alone. High level imprimatur is important.
    - Relying on unthinking automated metering upload (with associated boundaries around what the meter covers) could lead to erroneous allocation of savings which creates risks around additionality. Participants want to know who gets assigned the risk associated with the validity of automated processes.
    - If everything gets automated, then how do industry maintain its skills? Who audits the automated tools? Could this end up with loss of integrity over time?
    - Dealing with anomalies is "very interpretive". Data gaps often need to be filled. How will this get handled?
- Participants suggested that Scheme rules would need to be carefully thought through:
    - What rules apply to the baselines. Is gas in? How long does the baseline last? What if the building changes ownership, or other changes?
    - Eligibility thresholds could lead to poor outcomes if not set right. It would be good to accept (and allow for) some trial-and-error on the eligibility thresholds as the approach is refined. Settings for the thresholds might benefit from considering exclusions and methods developed by NABERS.

- Could there be additional weight placed on more fine-grained sub-metering (because it should provide a clearer picture of the savings achieved compared with coarser site-level metering)
- Success will likely be determined by how simple we can make it, while still maintaining rigour/integrity of the Scheme.

Session 1 Slido Poll Results





Breakout Group Session 2 (implementation practicalities and possible business response)

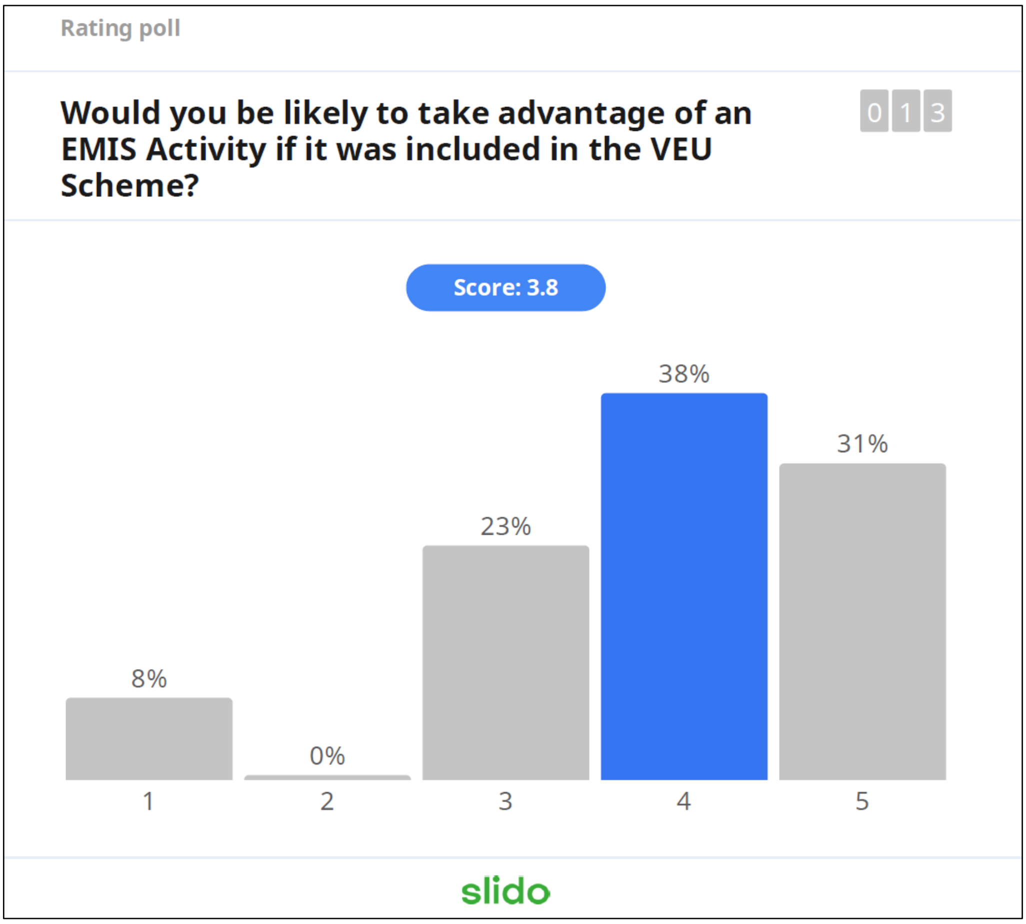
1. **Is it good for EMIS providers to get accredited to generate certificates from their products/services?**
    - Participants seemed relatively sanguine about EMIS providers doing this (noting that (i) providers already can under existing rules, and (ii) 'independent' APs in the current

system have a degree of conflict of interest anyway). There was a feeling that the EMIS provider is more appropriate to be an AP than an EMIS hardware manufacturer.
- What's the role of an independent AP then - larger more complicated sites? If EMIS product/service providers did take on the role, then they would likely need to hire APs anyway to manage the complexity/risks and significant administrative burden of the Schemes. It was noted that M&V can suck up ~15 to 20% of the certificate value.
- The EMIS provider is probably better placed to take the risk than an independent AP.
- An EMIS provider said they would like an incentive to get accredited.
- If incentivising a provider, they should use standards to avoid interoperability issues and vendor lock-in.

2. **How could rectification works requirements be incorporated into Scheme rules?**
    - Needs high level imprimatur (not sure what KPI would demonstrate that – minimum budget allocation?)
    - Evidence of a contract to manage the process of rectification works.
    - Could benefit from some guidance documentation around what constitutes an appropriate process for considering and implementing rectification works.
    - Evidence of a rectification works plan (this is required in other Activities anyway albeit this is unlikely to be known upfront)
    - Some other schemes have implemented processes (see NYSERDA RTEM, RESET).
3. **What functionalities could a Scheme Administrator operated 'platform' provide to reduce the administrative burden of generating certificates from an EMIS Activity?**
    - The M&V platform could provide basic dashboarding and provide a sense of progress tracking for the building owner. Focus on the fundamentals (i.e. are we saving energy?).
    - Record keeping functions would bring down costs. Vendor able to upload evidence.
    - Drop downs of standard options. Data base of accredited users, etc.
    - Allowance for other independent (normalisation) variables.
    - Data integrity checking and guidelines for data upload. This is a significant problem for existing certificate creation.
    - Ability to resample data at click of a button.
    - Easy to use APIs. Does this force each EMIS provider to create software to connect?
    - Two-way transparency. Lots of documentation/instruction manuals.
    - Case studies of successful implementations and other guidance, marketing collateral and training material.

Participants were not informed of the filters, and stringency mechanisms, that are being considered in Work Package 2 of the project. Participants were therefore (understandably) unable to calibrate responses with any perspective on the fraction of buildings that would/wouldn't be able to use the streamlined M&V tool. The likelihood (and possible fear) of APs becoming redundant, due to ubiquitous use of automated processes, was not discussed in the available time.

Session 2 Slido Poll Result



The workshop gave a generally positive sense that product providers would likely engage with an EMIS Activity if implemented.

5 EMIS Activity Recommendations

It is beyond the scope and responsibility of this work to provide detailed and prescriptive requirements, for any proposed EMIS Activity in future white certificate schemes. However, the analysis and consultation findings provide evidence for a number of strategic recommendations as follows:

1. Stakeholders felt that there was a particular need for an EMIS Activity (and associated automated M&V tools) to stimulate the market in smaller buildings and low/mid-tier buildings.
2. It is useful to have more than one EMIS Activity (rather than one). This enables specific EMIS capabilities to be separately rewarded and/or have separate eligibility criteria.
3. Stakeholders were comfortable with the proposed division of EMIS capability into three EMIS Activities (Foundational, Integrated and Advanced) as summarised in Table 5.1.
4. Stakeholders were comfortable with deeming certificates for installing (i) basic energy and equipment monitoring hardware and (ii) cloud data management and visualisation software (i.e. the proposed Foundational Activity), at rate equivalent to 3% of baseline energy consumption over 5 years. This deeming rate is conservative, compared with expected energy savings, and was still seen as providing a significant incentive for industry uptake.
5. Stakeholders expressed a desire to strive for measured energy savings (rather than forward creation of certificates) from other (Integrated and Advanced) EMIS capabilities. Stakeholders were comfortable that Scheme administrators should therefore seek to automate M&V processes - noting that the scale (and hence value) of certificate creation in the property industry does not give much room for significant investment in measurement and verification.
6. Rules should prevent double counting of Activities, if using a metered baseline method.
7. Stakeholders emphasised that deployment of EMIS technology does not necessarily lead to savings with out ongoing implementation of rectification works. Consequently, a requirement for generating certificates should be establishment of an 'energy management committee' (including external expert advisor), that meets regularly (at least quarterly) to consider opportunities to action the advice from the EMIS technology.
8. Stakeholders liked the idea of maintaining a register of qualified products/services, in a similar manner to that implemented by the NYSERDA RTEM program.
9. Stakeholders were comfortable with EMIS providers acting as an accredited person (AP), for the purpose of creating certificates from deployment of their own products and services, via an independent authorised automated measurement and verification (M&V) tool.
10. Stakeholders felt that government provision of an authorised automated measurement and verification (M&V) tool would be a good way of (i) reducing the upfront investment cost for building owners, (ii) reducing the compliance risk and transaction cost for service providers, and (iii) maintaining the integrity of the scheme.

Table 5.1: Proposed suite of EMIS activities

	FOUNDATIONAL EMIS	INTEGRATED EMIS	ADVANCED EMIS
Scope	• Basic energy metering and equipment monitoring • Cloud data access, visualisation, normalisation and reporting • Consumer data right style data sovereignty and 3rd party provider enablement	• Fault detection and diagnostics • System optimisation advice • BMS equipment operational scheduling	• Supervisory (SaaS) control optimisation • Grid integrated control (flexible demand)
Eligibility Constraints	• All non-residential buildings • Qualified vendor products	• Buildings <5,000 m^2 floor area • Must have a Foundational EMIS • Must demonstrate an oversight process for actioning findings from analytics	• All non-residential buildings • Must have a Foundational EMIS • Qualified vendor products • Must demonstrate an oversight process for checking that the service is continuously functioning
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	Annual IPMVP Option B or C measurement and verification
Comments	Provides infrastructure for the other EMIS Activities and capability for M&V	Performance based creation of certificates	Performance based creation of certificates

6 References

ACIL Allen Consulting, (2019), "Victorian Energy Usage Profiles: Profile Calculation Methodology and Results", Report to Essential Services Commission, https://www.esc.vic.gov.au/sites/default/files/documents/victorian-energy-usage-profiles-report.pdf

Bannister P. and Yeoh J., (2023),"Green Leases: Proposed Digital Ready Clauses ", DeltaQ report REP00898-B-001 provided to CSIRO, included in Appendix C

Brinsmead T.S., White S., Bransden C., Stanley C., Hasan K., Nagrath K., Briggs C., Leak J., Harkins-Small L., Murray-Leach R., Jennings K., Sprague M., Northey J., Walgenwitz G. and Alexander D., (2021), "Flexible demand and demand control: B4 Opportunity Assessment", RACE for 2030 Cooperative Research Centre, https://www.racefor2030.com.au/opportunity-assessment-reports/

Crowe E., Mills E., Poeling T., Curtin C., Bjørnskov D, Fischer L., Granderson J. (2020), "Building commissioning costs and savings across three decades and 1500 North American buildings", Energy & Buildings 227, https://doi.org/10.1016/j.enbuild.2020.110408

DCCEEW, (2022), "Australia's emissions projections 2022", Department of Climate Change, Energy, the Environment and Water, Canberra, https://www.dcceew.gov.au/climate-change/publications/australias-emissions-projections-2022

ENEA Rapporto Annuale Efficienza Energetica, (2015), ISBN 9788882863173

FEMP (2015), "M&V Guidelines: Measurement and Verification for Performance-Based Contracts: Version 4.0", (2015), https://www.energy.gov/sites/default/files/2016/01/f28/mv_guide_4_0.pdf

Fernandez N., Xie Y., Katipamula S., Zhao M., Wang W. and Corbin C., (2017) "Impacts of Commercial Building Controls on Energy Savings and Peak Load Reduction" Pacific Northwest National Laboratory, PNNL-25985, https://buildingretuning.pnnl.gov/publications/PNNL-25985.pdf

Giraudet L-G., and Finon D., (2014), "European experiences with white certificate obligations: a critical review of existing evaluations. Economics of Energy and Environmental Policy; 4(1):113–30.

Graham P., Hayward J., Foster J., Havas L., (2021), "GenCost 2020-21: Final report" (particularly see Appendix table B.7) https://publications.csiro.au/publications/publication/PIcsiro:EP2021-0160/SQgencost/RP1/RS25/RORECENT/STsearch-by-keyword/LISEA/RI1/RT6

Green Buildings Council of Australia, (2023), "From net zero to zero: A discussion paper on grid-interactive efficient buildings", https://gbca-web.s3.amazonaws.com/media/documents/grid-interactive-efficient-buildings-discussion-paper_Q0FoGV8.pdf

International Energy Agency (2021), “Energy Efficiency 2021”, https://www.iea.org/reports/energy-efficiency-2021

Kiliccote, S., Olsen, D., Sohn, M.D. and Piette, M.A. (2016), “Characterization of demand response in the commercial, industrial, and residential sectors in the United States”. Wiley Interdisciplinary Reviews Energy and Environment, 5(3): 288– 304. https://www.osti.gov/pages/biblio/1439198

Kramer H., L.G., Curtin C., Crowe E, and Granderson J. (2020), “Proving the Business Case for Building Analytics”. Lawrence Berkeley National Laboratory, https://eta-publications.lbl.gov/sites/default/files/kramer_provingbuildinganalytics_october2020.pdf

Lees E. and Bayer E., (2016), “Toolkit for energy efficiency obligations”, Brussels, Belgium: Regulatory Assistance Project; https://www.raponline.org/wp-content/uploads/2016/05/rap-leesbayer-eeotoolkit-2016-feb.pdf

NERA (2022), “Load Flexibility Study Technical Summary” https://arena.gov.au/assets/2022/02/load-flexibility-study-technical-summary.pdf

Nexus Labs FDD Buyers Guide, (2023), https://www.nexuslabs.online/buyers-guide-to-fdd

NSW Office of Environment and Heritage (2015), “I am Your Optimisation Guide: Heating, Ventilation and Air conditioning Systems”, ISBN 978 1 74359 990 1, https://www.environment.nsw.gov.au/resources/business/150317hvacguide.pdf

Otte K., Stelmach T., Chandan V., and Delgado A. (2022), ““Digitalisation in the Buildings Sector: A Literature Review”, Energy Efficiency Hub https://energyefficiencyhub.org/wp-content/uploads/2022/09/DWGReport-1.pdf

Piette M.A., Watson D., Motegi N., Kiliccote S. (2007), “Automated critical peak pricing field tests: 2006 pilot program description and results”. Lawrence Berkeley National Laboratory, LBNL-59351, https://eta-publications.lbl.gov/sites/default/files/62218.pdf

Property Council of Australia (2022), https://info.propertycouncil.com.au/property-australia-blog/valuing-energy-efficiency

Serale G., Fiorentini M., Capozzoli A., Bernardini D. and Bemporad A. (2018), “Model Predictive Control (MPC) for Enhancing Building and HVAC System Energy Efficiency: Problem Formulation, Applications and Opportunities”, Energies 2018, 11, 631; doi:10.3390/en11030631

Trianni A., Bennett N., Hasan A.S.M., Katic M., Lindsay D., Cantley-Smith R., Wheatland F.T., White S., Dunstall S., Leak J., Pears A., Cheng C.-T., and Zeichner F., (2022), “Industry 4.0 for energy productivity: B2 Opportunity Assessment”, RACE for 2030 Opportunity Assessment, https://www.racefor2030.com.au/opportunity-assessment-reports/

US Department of Energy (2021), “A National Roadmap for Grid-Interactive Efficient Buildings”, https://www.energy.gov/eere/buildings/grid-interactive-efficient-buildings

Victorian Government, (2022), “Measurement and Verification in Victorian Energy Upgrades: Specifications, Version 7”, https://www.energy.vic.gov.au/__data/assets/pdf_file/0037/590599/Measurement-and-Verification-in-Victorian-Energy-Upgrades-Specifications-Version-7.0.pdf

Victorian Government, (2021), “Victorian Energy Upgrades Proposed Activity: Building Energy Management Information Systems (EMIS) Issues Paper”, https://engage.vic.gov.au/project/victorian-energy-upgrades-new-activities-consultation/page/victorian-energy-upgrades-building-energy-management-information-systems

Victorian Government, (2018), “Energy Efficiency Target Regulations 2018”, Statutory Rule Number 145/2018, https://www.legislation.vic.gov.au/in-force/statutory-rules/victorian-energy-efficiency-target-regulations-2018/008

Victorian Government, (2018), “Victorian Energy Upgrades Specifications 2018, version 13.0”, https://www.energy.vic.gov.au/__data/assets/pdf_file/0029/597170/victorian-energy-upgrades-specifications-version-13.0.pdf

Victorian Government, (2017), “Victorian Energy Efficiency Target (Project-Based Activities) Regulations 2017”, Statutory Rule Number 46/2017, https://www.legislation.vic.gov.au/in-force/statutory-rules/victorian-energy-efficiency-target-project-based-activities-regulations/003

White S.D., Foo G., Rottcher P., and Bannister P., (2023), “Scoping the Digital Innovation Opportunity for Energy Productivity in Non-Residential Buildings”, https://www.energy.gov.au/government-priorities/buildings/commercial-buildings/digital-innovation-opportunity-energy-productivity-non-residential-buildings

Zhang K., Blum D., Cheng H., Paliaga G., Wetter M., and Granderson J. (2022), “Estimating ASHRAE Guideline 36 energy savings for multi-zone variable air volume systems using Spawn of EnergyPlus”, Journal of Building Performance Simulation, Vol 15(2), https://www.tandfonline.com/doi/full/10.1080/19401493.2021.2021286

Appendix A Product/service provider survey

Digitalisation Solutions for Energy Saving Certificate Schemes

Energy Management and Information System (EMIS) Activity

Product Survey

Background

The Victorian Energy Upgrades program enables eligible energy saving products and services to earn extra income by generating Victorian Energy Efficiency Certificates (VEECs).

There are various new energy saving products and services, powered by advances in digital technology, that could attract VEECs. These are classified here under the general heading of 'Energy Management and Information Systems' (EMIS).

Unfortunately, the energy savings derived from implementing an EMIS activity are often difficult to predict prior to investment. And the energy savings are often difficult to determine (calculate/measure) cost-effectively.

The administrators of the Victorian Energy Upgrades program have been exploring the potential for (i) improving eligibility requirements for EMIS technologies and (ii) streamlining energy saving calculations to reduce the administrative burden associated with generating certificates from EMIS products and services (e.g. https://www.vgls.vic.gov.au/client/en_AU/search/asset/1302501/0).

Establishing new incentives, inside the various State-based energy saving schemes, would hopefully lead to greater uptake of EMIS technology and reduce carbon emissions.

What is an Energy Management and Information System (EMIS)?

Lawrence Berkely National Laboratories (Kramer et. al., 2020) claim that EMISs 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 analyse the data*".

Some of the possible features and use-cases of an EMIS are illustrated in Figure 1 below.

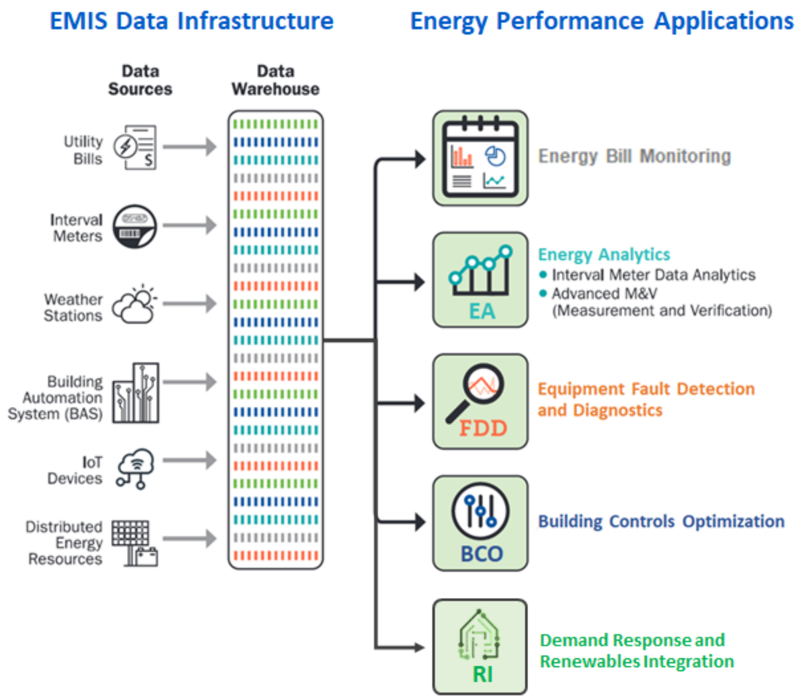


Figure 1: Some EMIS features and use-cases (adapted from Kramer et al, 2020)

Figure 1 is conceptual/illustrative only, and should not be seen as defining an EMIS. Not all of the features and use-cases depicted in Figure 1 are required to provide energy savings. The quantity and diversity of data that needs to be collected will change depending on use-case. Innovators could utilise the digitalisation concepts (implied in Figure 1) to develop various other use-case products and services, capable of saving energy.

One possible categorisation of different EMIS products and services, into three levels ("Foundational", "Integrated", "Advanced") of increasing complexity and value, is provided in the table below.

Foundational EMIS	Integrated EMIS	Advanced EMIS
Basic energy monitoring	Advanced energy monitoring with basic controls	Advanced energy monitoring and controls
Data monitoring	Fault detection and diagnostics	Supervisory control
Data visualisation and normalisation	Direct equipment control (BMS)	Automated system optimisation
Data analytics and reporting	System optimisation advice	Advanced flexible demand capability, grid-integration

Scalability/suitability for inclusion in energy saving certificate schemes

The US Smart Energy Analytics Campaign investigated the business case for EMIS technology (Kramer et al, 2020). Across 72 organisations and a large sample of buildings, the campaign found that EMIS technology is often commercially attractive, with typical paybacks of less than 2 years. This suggests that an EMIS Activity has good potential to become an attractive option in an energy saving certificate scheme.

While a wide range of different scenarios exist that can significantly influence the cost of EMIS technology, Kramer et al (2020) provide estimates of cost as detailed in the table below.

Cost Component	Meter Data Analytics	Fault Detection and Diagnosis
Installation and configuration cost	USD 0.01/ft^2 (~AUD 0.14/m^2)	USD 0.06/ft^2 (~AUD 0.86/m^2)
Annual recurring software cost	USD 0.01/ft^2 (~AUD 0.14/m^2)	USD 0.02/ft^2 (~AUD 0.29/m^2)
Annual inhouse labour	1 hr per month	8 hr per month

Another source, the Nexus Labs FDD Buyers Guide (2023), suggests the following budget costs for fault detection and diagnosis (FDD) software-as-a-service 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

This Product Survey

The purpose of this survey is to better understand the currently available commercial products and services that could potentially fit under the broad category of an EMIS Activity.

This information will hopefully inform the development of criteria that could be used to determine the eligibility of different products and services, if an EMIS Activity was implemented, in future, in any of the State-based energy saving certificate schemes.

Such criteria would hope to avoid relevant products and services from being unfairly excluded from eligibility, while also avoiding perverse outcomes that might arise if unsuitable products and services gained entry to the schemes.

The survey is intended to be filled in by suppliers of potential EMIS products and services.

The results of the survey will be compiled into a confidential report provided only to the relevant government energy saving certificate scheme administrators. An in-confidence copy of the report will also be given to the RACE for 2030 Cooperative Research Centre (the organisation funding the project) solely as evidence of milestone delivery.

Thank you for your contributions to this survey!

The EMIS Product Survey

1. Please list the EMIS products and services that you offer customers. For each of these products/services, please
    a. attach relevant marketing collateral (that you would typically provide to your customers), that explains (i) how the product/service works, and (ii) the expected energy saving benefits.
    b. Explain how you believe the product/service fits into the general category of being an Energy Management Information System (EMIS) product. Where relevant, please comment on possible fit with one, or more of the proposed EMIS activity categorisations listed in the table above.
2. Are there any criteria that you would propose for defining what is/isn't an EMIS (for the intended purpose of establishing eligibility as an EMIS in an energy saving certificate scheme)?
    a. Please explain any features, characteristics or capabilities that could be measured or in some way quantified as evidence to a scheme auditor.
3. Please comment on the validity of the cost estimates provided above. Do you believe they're reasonably representative of typical industry costs and payment structures.
4. We would welcome any other suggestions or information that you think may be relevant.

Please return you completed survey to

Dr Stephen White
Energy Efficiency Leader
CSIRO Energy Business Unit
E: stephen.d.white@csiro.au
M: 0408 487 664

Thanks again!

Appendix B Product Service Provider Workshop: Introductory Presentation

Energy Management Information Systems

Department of Energy, Environment and Climate Action

Victorian Energy Upgrades

VICTORIA State Government

RACE EMIS project

- *The project aims to investigate and test opportunities within Australia's State-based white certificate schemes. The goal is to encourage the adoption of energy-saving Industry 4.0 technologies and simplify the measurement and verification processes by leveraging Industry 4.0 technology.*

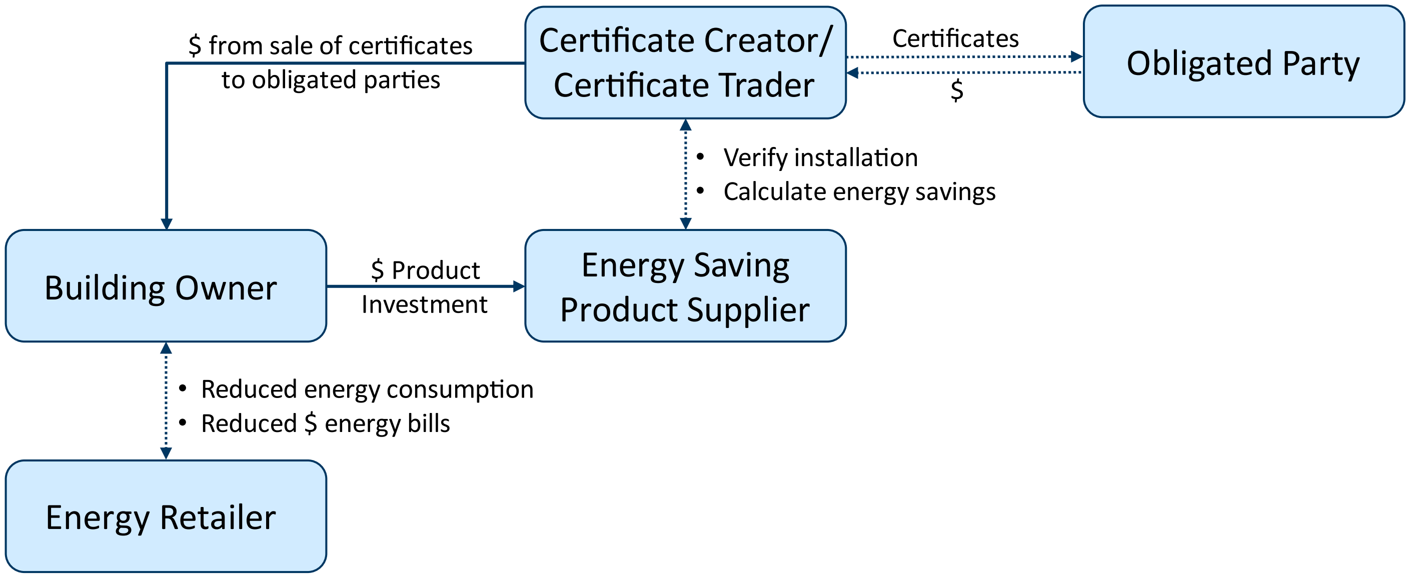
- *Energy Management Information Systems has been identified as an area of investigation that can support Industry 4.0 technology.*

Visit energy.vic.gov.au
to find out more about the program

Email:
energy.upgrades@delwp.vic.gov.au
or
veu@esc.vic.gov.au

RACE for Industry 0 for White Certificate Schemes

Energy Efficiency Obligation (EEO/White Certificate) Schemes

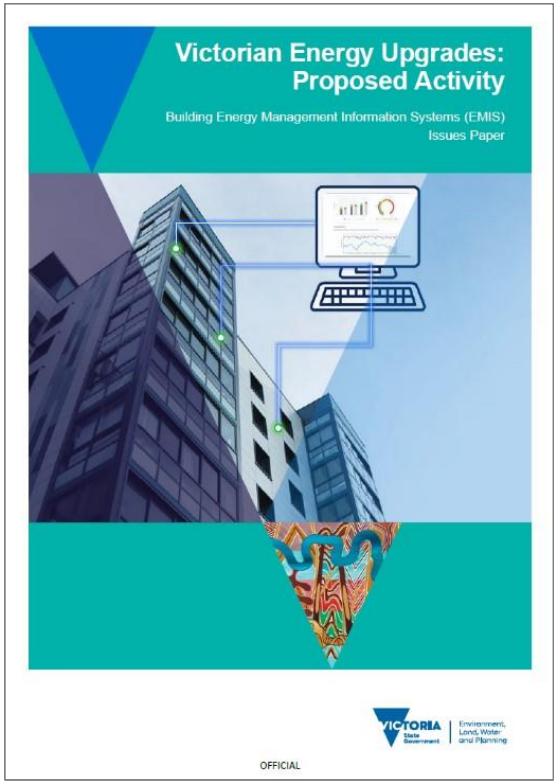


What if the State energy savings schemes rewarded an EMIS Activity?

“Stakeholders agreed with the Systems EMIS … upgrade Activities identified”

and requested the administrator to

- Define eligible **products**.
  - Create a register of approved products for the EMIS activities?
- Define eligible **use-cases**.
- Provide a certificate calculation **M&V method**.
  - Including evidence requirements

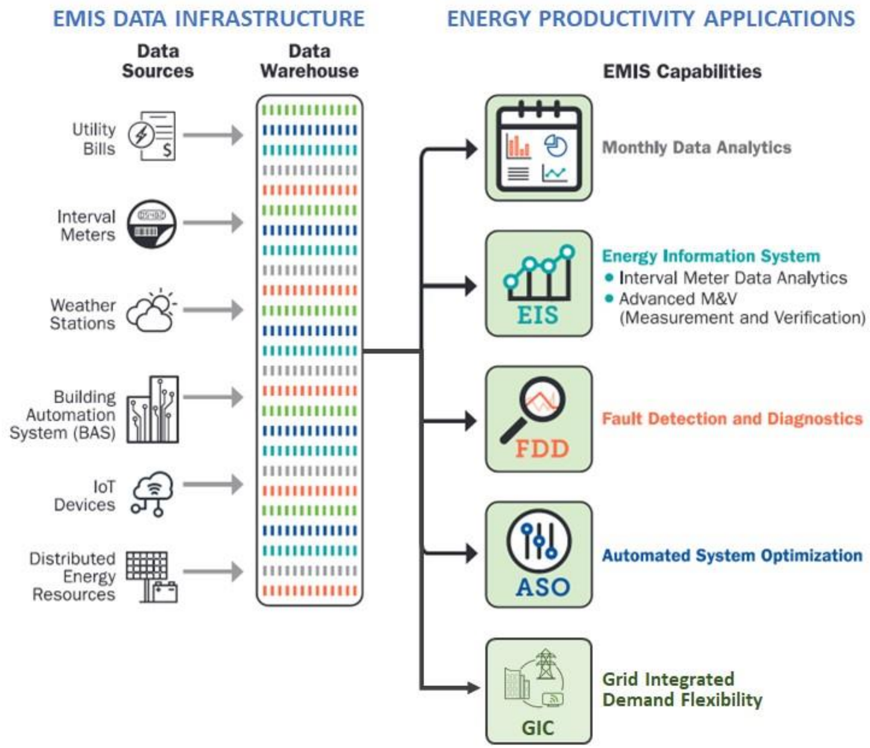


The Challenges

1. What is an EMIS?
   - Infrastructure and/or Application?

2. Are savings attributable to the technology or the process?
   - When is it "done"?

3. How do you predict or measure savings?
   - How valid is forward creation of certificates?
   - How cost-effective can M&V be?



Product Survey Findings

(seeking information on available EMIS products, suggestions on possible eligibility criteria and costs)

- Installing the technology alone will not solve the operational problems of a building.
- Domain expertise is required to perform rectification works (utilising analytics advice).
- It's easier to say what an EMIS is not than what it is.
  - Some guidance material and/or standard and/or rating scheme might be useful to help guide consumers toward better quality EMIS solutions (rather than see a race to the bottom)
- Significant differences in perceptions of cost (probably reflecting what respondents considered normal/necessary to be inside scope)
  - SaaS platform is perhaps only part of the required solution

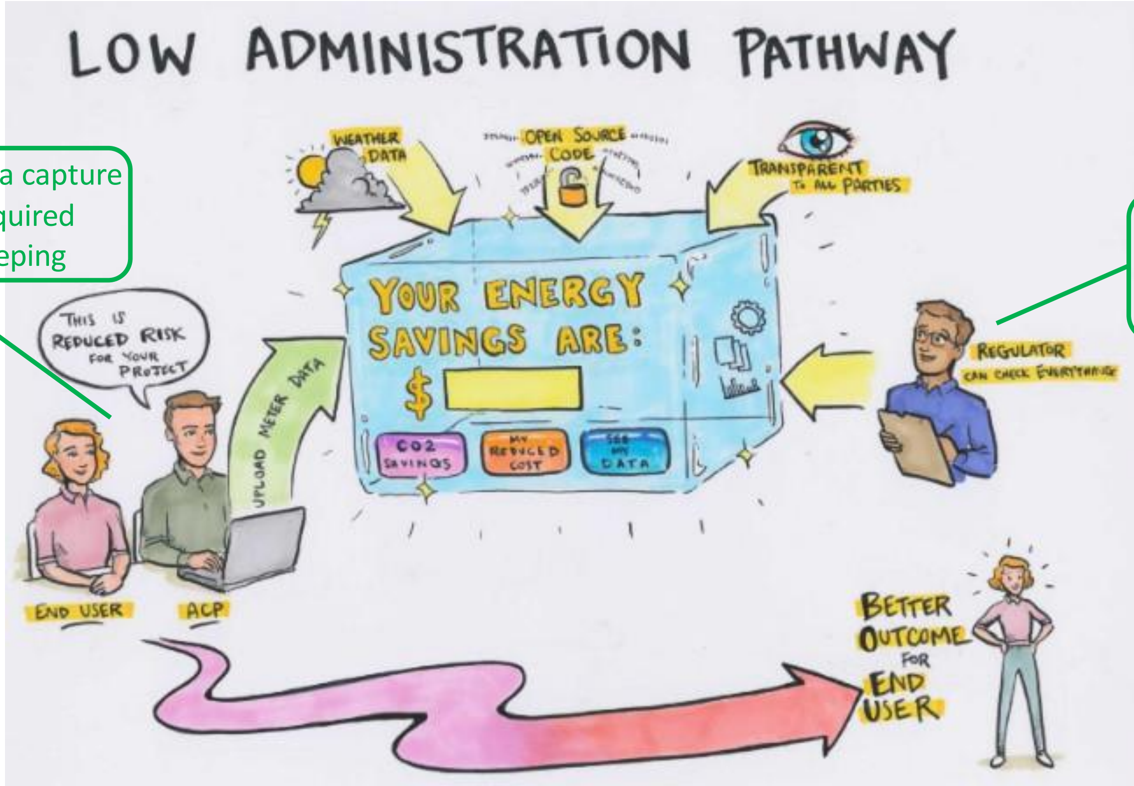
Three Activities rather than one?

	Foundational EMIS	Integrated EMIS	Advanced EMIS
Scope	• Basic energy and equipment monitoring • Data access, visualisation, normalisation and reporting	• Fault detection and diagnostics • System optimisation advice • BMS equipment operational scheduling	• Supervisory control optimisation • Grid integrated control (flexible demand)
Eligibility	All non-residential buildings	• Buildings <10,000 m^2 floor area • Must have a Foundational EMIS • Must demonstrate oversight	• All non-residential buildings • Must have a Foundational EMIS • Must demonstrate oversight
Certificate creation	Deemed at a rate of 3% of energy consumption for 5 years (~$1/$m^2$)	Annual measurement and verification	Annual measurement and verification
Comments	Provides infrastructure for the other EMIS' and capability for M&V	Performance based creation of certificates	Performance based creation of certificates

A streamlined ‘metered baseline’ M&V tool?

Noting a value of certificates ~$20,000/yr for a 30,000$m^2$ building

- Simplify meter data capture
- No calculations required
- Minimal record keeping

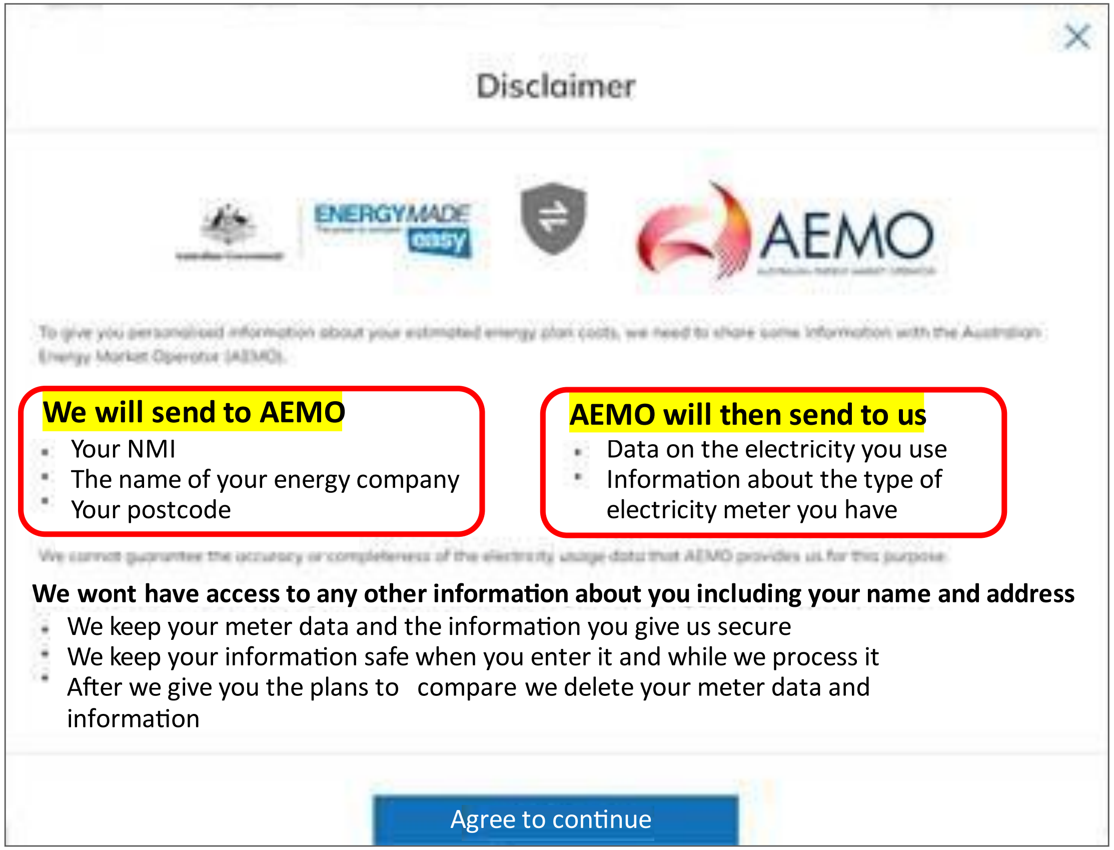


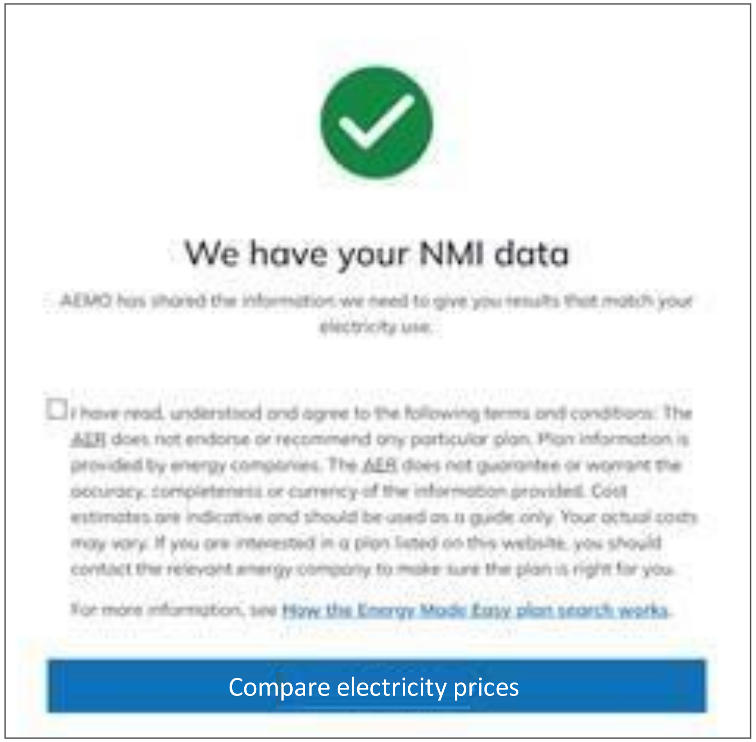
- Provide M&V rules and data/ records management processes
- Transparency and trust

Source:
NSW Government’s Energy Security Safeguard Implementation team

How streamlined is streamlined?

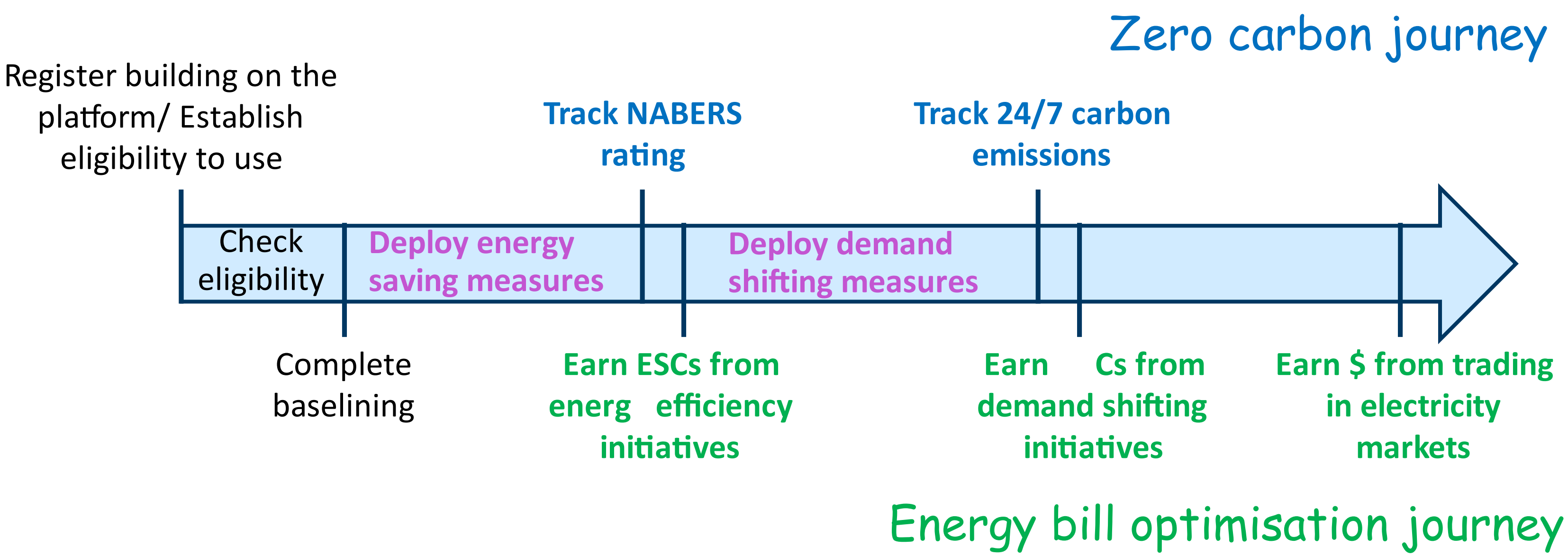
Energy Made Easy Bill Comparison Website (example of concept only)





What else could we build off this?

Could this incentivise more than just energy saving certificates……



Thank You

Dr. Stephen White

Energy Efficiency Leader
CSIRO Energy Business Unit
Email: stephen.d.white@csiro.au
Ph: +61 408 487 664

Australia's National Science Agency

Appendix C Green leases: proposed digital ready clauses

Green Leases

Proposed Digital Ready Clauses

ABN: 486 288 97870

Date:	14 April 2023
Version:	1.0 – DRAFT/FINAL ISSUE
Prepared for:	Stephen White Energy Efficiency Domain Leader CSIRO
Author:	Dr Paul Bannister, Dr Joyce Yeoh
Reviewer:	Stephen White
Our Reference:	REP00898-B-001

Executive Summary

This report sets out proposed clauses for inclusion in green leases covering:

1. Digital ready **infrastructure**: ensuring the building has the basic digital infrastructure required to enable the building to adopt and utilise smart building technologies that support the intent of a green lease.; and
2. Basic digital **service functionality**: a minimum suite of currently available smart building applications that enable improvement of building efficiency and operation in line with the intent of a green lease.

For each of these clauses, a schedule of acceptance criteria is provided to enable the more precise interpretation of the proposed lease clauses. Furthermore, commentary is provided as to the background and justification of each clause.

Table of Contents

1 Introduction

1.1 Background

Over the past two decades, green leases – that is, leases which specify environmental requirements as well as commercial requirements – have gained popularity amongst both tenants and landlords. The Australian Government has been a leader in this process, having proposed one of the first green leases in the world more than 15 years ago, and subsequently driven uptake across its leased portfolio.

To date, green leases have focussed on achieving outcomes such as improving NABERS and Green Star ratings, including support for these outcomes by building in requirements for improved communication on energy efficiency and environmental issues between landlord and tenant. Underlying this has been a mutual recognition that the achievement of higher environmental outcomes necessitates a more collaborative relationship between tenant and landlord.

Across this time period there has been increasing digitalisation of all aspects of society and more specifically of work and workplaces. Across all sectors, digitalisation has been instrumental in facilitating improved, more timely communication and streamlining of technical and administrative transactions. In the building sector, digitalisation has become an important enabler of green lease objectives that can now be incorporated into updated green lease requirements.

For buildings, this digitalisation is expressed in terms of the "smart buildings" concept: buildings that have the digital infrastructure and services that can enable streamlined and enhanced building performance reporting processes and provide operational insights that would be impossible without extensive automated data capture and analysis. These operational insights help drive efficiency, operational and productivity outcomes.

Examples of digitalisation insights include services-oriented functionality such as automatic fault detection and peak demand management/response, as well as occupant-focussed services such as desk allocation, meeting room allocation and occupant interaction with air-conditioning to provide optimisation of comfort. Digitalisation can also be used to automate measurement and verification (M&V) processes. M&V can be used to provide baselines for reporting and verification of achieved savings, as well as potentially for financial settlement associated with performance-based contracting (eg EPCs).

While the development of smart buildings has advanced considerably, implementation is still in a developmental phase, with adoption of smart building functionality generally done in a piecemeal manner. Such approaches are inherently inefficient and frequently involve the duplication (and more) of data and communication infrastructure, with consequent additional costs and barriers to implementation.

To resolve this inefficiency and gain full access to the benefits of digitalisation in buildings, one must first consider the digital infrastructure of smart buildings ahead of the implementation of any specific individual functionality. This ensures that data is highly accessible for subsequent analysis and reporting processes. It also means that new smart building functionality can be quickly and readily added to the building, operating with the existing infrastructure rather than each functionality having to install its own bespoke hardware and communications. This concept of providing an integrated digitalisation infrastructure capability for the adoption of smart building technologies is known as making a building "digital ready". With this digital ready infrastructure in place, it is then possible to identify and implement smart building applications that deliver value to the building operations and justify the investment in the digital ready infrastructure.

1.2 Digital Ready and the Green Lease

The Australian Government, and other tenant organisations, stand to gain much from the roll-out of digital ready buildings.

Digital ready building requirements support and extend existing green lease requirements by driving adoption of enabling infrastructure for enhanced building operation, and by providing tools that support transparency and clear communication of energy efficiency and environmental issues between landlord and tenant.

Digital ready building requirements also support the adoption of functionality that can add value to property assets. In the short term, digital ready buildings could adopt, or be required to adopt, current smart building technologies such as automatic fault detection at lower cost and potentially higher functionality than might otherwise be possible. Furthermore, the green lease is a natural vehicle by which to enable integrated and effective integration of the benefits of smart building applications into everyday operational procedures.

In the medium to long term, digital ready buildings can readily adopt new functionalities such as space management (ideal for hot desking environments and meeting room management) and proactive comfort control, again supported by the collaborative tenant/landlord relationship fostered by the green lease. In both the short and the long term, a green lease enabled digital ready building will reduce operating costs and potentially improve occupant satisfaction with the building.

The green lease is a natural vehicle by which tenant organisations can use their negotiating power to ensure that the buildings they are leasing are both fit-for-purpose and future proof for ESG reporting and for current and future smart building technologies.

In this report, two new green lease clauses are proposed, supported by schedules of acceptance criteria and background supporting information. Each section of the body of the report presents and discusses material associated with an individual clause of the report.

2 Digital Ready Infrastructure

2.1 Proposed Lease Clause A: Digital Ready Infrastructure

The Landlord shall ensure that the building is digital ready, which requires that:

(a) A **data platform** is provided.
(b) *Data* from *building control and monitoring systems* and *related systems* is:
  i. **Uploaded** and accessible in near real-time to the platform
  ii. Readily **locally accessible** to the tenant and their service providers
  iii. Readily **remotely accessible** to the tenant and their service providers
  iv. Subject to **data quality** control processes
  v. **Stored independently** of the vendors of individual building control and monitoring systems

vi. **Stored expandably** to accommodate new systems and applications
vii. Stored in a documented **structured data format**
viii. Managed to acceptable **cyber security standards**

As defined in more detail in Schedule 1A.

2.2 About this Clause

2.2.1 Purpose

The purpose of this clause is to set a minimum requirement of digital readiness for the building. This digital readiness is defined in terms of the presence of a fully-functioned data integration platform that accepts data from all relevant building systems and collates it into a single, structured database. This database is then used as a primary data source for reporting and for any smart building applications.

2.2.2 Benefits

By collating the data to a single database, a number of key benefits are achieved.

1. Data is held independently of building services vendors, so access to data that has been uploaded to the data platform is not dependent upon a continuing relationship with individual building services vendors.
2. Data is collated into a single "source of truth" which can assist in implementation of data-reliant functionality.
3. Uniform levels of data quality control can be applied.
4. Data can be shared between systems, enabling decisions to be made on the basis of more diverse data not necessarily available to any individual system.
5. Duplication of communications and data infrastructure between applications is reduced, as all can log into the data platform rather than creating their own connections
6. Cyber security is improved as the number of data connections into the building is reduced
7. The platform provides a level of future-proofing for the building against expected increases in demand and availability of smart building applications.

2.3 Schedule 1A: Interpretation of Clause A

For the purposes of this schedule:

- A performance requirement is the overarching intent of the clause item. In cases where a proposed solution does not exactly match the acceptance criteria, the performance requirement should be used to assess whether the clause intent has been met.
- Acceptance Criteria are a list of key attributes required for the proposed solution to be deemed as meeting the intent of the clause.

2.3.1 Definitions

Data means real time and contextual information on the operation of plant and equipment and information from sensing devices within the *building control and monitoring systems*, as well as *related systems.* This includes data relevant to building operation that is imported from external data sources such as weather data and forecasts and information generated, stored or transmitted by any application using data from *building control and monitoring systems* associated with the building.

Building control and monitoring systems includes but is not limited to heating, ventilating and air-conditioning systems and associated controls, lighting control systems, occupancy/presence/motion sensors, indoor environment quality sensors, energy meters, electric vehicle charging systems, solar power systems, access control systems and demand management systems associated with the building.

Related Systems includes but is not limited to:

(a) External data sources such as weather data and forecasts;
(b) Data generated, stored or transmitted by any application using data from building monitoring and control systems in the building; and
(c) Static data such as asset registers of heating ventilation and air-conditioning equipment, relevant to the operation of the energy using systems of the building.

2.3.2 Clause A a) Data Platform

Performance Requirement:

A data platform is provided that collates and makes the *data* accessible in the manner described in the balance of this clause.

Acceptance Criteria:

Compliance with the acceptance criteria for the balance of this clause

2.3.3 Clause A b) (i) Upload

Performance Requirement:

Data is uploaded for all *building monitoring and control systems* and *related systems* to the platform in near real time and can be used for near-real time action on the system.

Acceptance Criteria:

1. The data uploaded shall include all relevant analog and digital points from monitoring and control systems relating to, as a minimum:
   a) Energy metering,
   b) Heating, ventilation and air-conditioning system control,
   c) Indoor environment quality monitoring, and
   d) (optional) Other technologies nominated by the tenant (e.g. lighting, lighting control, tenant experience)
2. Data is uploaded to the platform and normally available for analysis no later than:
   a) For building mechanical, occupancy and electrical controls: 10-15 mins after the data point is generated;
   b) For metering systems: 5 minutes after the point is generated;
   c) For all systems: as fast as required to support applications loaded at the commencement of the lease
3. Provision is available for adjustment of upload data speeds to suit new applications.

2.3.4 Clause A b) (ii): Locally accessible

Performance Requirement:

Data for each of the *building control and monitoring systems* can be accessed via a user interface to the data platform on an authorised user's PC/laptop.

Acceptance Criteria:

Each of the *building control and monitoring systems* can be accessed via a single user interface to the data platform which shall have the following attributes:

a. Is a configured interface that enables authorised users to visualise system *data* and operational status.
b. Enables visualisation of *data* in a graphical format including the ability to compare individual data streams integrated over time periods and in time series.
c. Provides for the secure access to data only by authorised users.
d. Is available to the tenant's authorised users at no cost to the tenant and with no impediment.
e. Is able to provide bulk downloads of data to the authorised users for external analysis

2.3.5 Clause A b) (iii): Remotely accessible

Performance Requirement:

Data on the data platform is remotely accessible via well-established data engineering methods.

Acceptance Criteria:

Data on the data platform for all *building control and monitoring systems* is accessible via a single machine-to-machine interface, such as (in order of preference):

1. Via a documented protocol as agreed upon by the parties (examples of protocols include REST API and MQTT),
2. Push data through an ETL tool – email address or secure FTP location,
3. Integration through use of an edge device (e.g. NUC)

2.3.6 Clause A b) (iv): Data Quality

Performance Requirement

All data uploaded to the data platform is subjected to data quality tests to ensure that data is well matched to the source.

Acceptable Criteria

1. Minimum data quality checks. The data platform shall incorporate the following data quality checks as a minimum:
   a. Continuity. Data streams shall be checked for continuity of upload
   b. Outliers. Data streams will be checked for outliers indicative of failed reads or extremes
2. Data quality checks shall be conducted regularly and on an ongoing basis for all incoming data streams.
3. Reporting and Resolution. The data platform shall:
   a. Where possible, incorporate processes to automatically resolve identified data quality issues.
   b. Provide data quality indicators for all data streams, with regular reporting including alerts for unresolved data quality issues.

2.3.7 Clause A b) (v) Stored independently

Performance Requirement:

For each *building control and monitoring system*, current and historical *data* is stored on the data platform and available independently of the *building control and monitoring system's* vendor at no cost to the tenant.

Acceptance Criteria:

Data on the data platform shall be:

a) Available to the tenant via a single local or remote interface at no cost.
b) Stored for a minimum of three years before archiving or deletion
c) Available and accessible to the tenant except in so far as may impinge upon the privacy of third parties such as former lessees of the premises.
d) For analog data, captured and stored in a timeseries format on a timebase sufficient to represent behaviour of the data stream (not more than 15 minutes)
e) For digital data, captured and stored at change-of-event thresholds that are relevant to the datastream.
f) For metering data, captured and stored based on a consistent time interval (not longer than 5 minutes)
g) Stored independently of the vendor of each *building control and monitoring system* such that it remains available to the tenant even upon a change of vendor, including any vendors associated with the storage of the data.

2.3.8 Clause A b) (vi): Stored expandably

Performance Requirement:

The storage and interface systems for the data platform must be able to accommodate an increased number of sensors or datapoints.

Acceptance Criteria:

The storage and interface for the data platform must be able to accommodate an increased number of sensors or datapoints in a manner that is able to be readily deployed with:

a) Minimal disturbance to existing data; and
b) Seamless integration with existing data; and
c) No negative impact on the speed/latency of exiting data
d) Data reliability and speed of access similar to existing data

2.3.9 Clause A b) (vii): Structured data format

Performance Requirement:

Data in the data platform is stored in a documented structured data format.

Acceptance Criteria:

The stored *data* in the data platform is structured with a commonly used and validated operational metadata system, such that (in order of preference):

a) The data structure has a documented graph-based metadata model that structurally incorporates the physical relationships between different pieces of equipment and their data streams; or
b) Data is "tagged" and naming convention is provided and documented.

2.3.10 Clause A b) (viii): Cyber security standards

Performance Requirement:
Data security and privacy in the data platform are managed in a manner compatible with the tenant's Cyber Security and Data Privacy policies at the time this lease is signed.

Acceptance Criteria:
The Landlord shall provide details of the cyber security arrangements/policies/equipment for the data platform for approval by the Tenant with respect to:

a) Cyber security of data that carries information that may measure or impact the operations of the Tenant
b) Privacy of data that carries information that may measure, impact or identify the tenant or their staff and contractors

At minimum, any data network must be provided with the following security elements:

b. firewalls
c. intrusion detection system
d. intrusion prevention systems
e. off-site monitoring systems

3 Smart Building Applications

3.1 Proposed Lease Clause B: Smart Building Applications

(a) The Landlord shall ensure that the building has as a minimum the following smart building applications linked to the data platform:
   i. A **monitoring and verification** application
   ii. An **automatic fault detection** system
   iii. A **demand management/response** system
   iv. A **digital operation and maintenance logbook**

   As defined in more detail in Schedule 1B.

(b) All smart building applications must also comply with the requirements of Clause A.

3.2 About this Clause

3.2.1 Purpose

The purpose of this clause is to ensure that a minimum set of useful smart building applications (e.g. program packages that deliver interpretation of data to yield insights into the operation of the building) are available, consistent with achieving the green-lease objectives of improving ESG outcomes. The minimum applications are based on applications that are available and of known value to building operation. Note that each of the applications also has a level of management and reporting integrated with it to ensure effective use.

It is expected that in situations where a given application is inappropriate for a particular building, it would be deleted from the clause.

3.2.2 Benefits

The applications offer the following benefits:

Monitoring and Verification

Monitoring and verification applications provide the ability to identify whether building performance has improved (or got worse) relative to a historical baseline. This is an essential activity both for day-to-day operation ("Am I doing better than last year?") and for operation after changes have been made ("Is this new chiller saving me as much energy as I was promised?").

Automatic Fault Detection

Real buildings have thousands of potential points of failure, many of which are difficult to manually detect, because they are so numerous and often physically difficult to see. As a result, it is common for a significant number of items of equipment to be in failure until identified in a routine maintenance check. This can lead to poor performance both in terms of energy use and comfort. Automatic fault detection systems use the data from operating components to look for the common signals of failure and identify potential failed items on a continuous basis. This is an order of magnitude more effective at identifying failed items than standard processes. Indeed, the major problem with automatic fault detection systems is that they are so effective that the number of failures reported can be overwhelming. This is why such systems must include reporting tools that allow prioritisation of failures so that the most important items get addressed at a higher priority to minor items. Having made such prioritisations, it is then necessary for the identified faults to be rectified; this is a process that often requires some management. As a result it is critical to ensure that the automatic fault detection system is integrated into facilities management and maintenance procedures, as otherwise there is a risk that it will be poorly utilised.

Demand Management/ Response

Zero-carbon buildings will require a zero-carbon electricity supply. Achieving a zero-carbon electricity supply will require very high levels of variable renewable energy generation, with concomitant requirement for high levels of dispatchable storage and active management of loads. With some of the cheapest sources of dispatchable storage and load flexibility existing in buildings, the affordability and reliability of the future electricity grid will rely on buildings being able to contribute their flexible resources into the grid.

For this reason, the journey to zero-carbon buildings includes industry adoption of demand response activities, whereby sites provide load reductions in response to signals (and financial incentives) from the electricity grid. These signals may occur at times other than the peak demand of the building and are caused by a wide range of external factors. Financial incentives are available through schemes such as the RERT and the Wholesale demand mechanism (and, for batteries, the Frequency control Ancillary Service (FCAS)). For building owners, these schemes may be easiest accessed through a retailer or similar. Such schemes operate by providing signals when potential demand events are expected, and providing financial rewards both for being available to respond to an event and for actually responding.

The demand management and response application required under this clause seeks to ensure the existence of the technical ability to participate in demand management and response, if so desired, while also recognising that negotiation is required between the landlord and tenant as to the nature of the response. As such, it does not require that there be a commercial contract for providing this service.

It is important to ensure that demand response activities do not compromise the tenant's comfort, as the cost of lost productivity would likely exceed the benefits available from demand response. As a result, the clause includes requirements for ongoing consultation between landlord and tenant to ensure that demand management/response activities would not create adverse comfort impacts.

Digital Operation and Maintenance Logbook

Historically, building documentation has tended to be stored – with varying levels of effectiveness – in hard copy format. As a building ages and personnel change, there can be significant loss of information which makes the task of managing the building's operations and efficiency increasingly difficult. To some extent in recent years this approach has been replaced by haphazard storage of digital records which may even be worse than the previous approach, as electronic data is easily lost.

A digital operation and maintenance logbook overcomes this problem by providing a single location for all building data. This covers static data, such as as-built drawings and manuals, as well dynamic data such as maintenance reports. By providing a structure for this, the logbook ensures that nothing gets lost. By locating the logbook on the data platform, it creates opportunities to link this type of data to the more dynamic data being logged from control and monitoring systems.

3.3 Schedule 1B: Interpretation of Clause B

For the purposes of this schedule:

- A performance requirement is the overarching intent of the clause item. In cases where a proposed solution does not exactly match the acceptance criteria, the performance requirement should be used to assess whether the clause intent has been met.
- Acceptance Criteria are a list of key attributes required for the proposed solution to be deemed as meeting the intent of the clause.

3.3.1 Clause B (a) (i) Monitoring and verification

Performance Requirement:

The Landlord shall ensure that a system for monitoring and verification of energy savings and performance is installed, linked to the data platform, configured and available for use.

Acceptance Criteria:

1. A system for monitoring and verification shall be installed, linked to the data platform, be fully configured and ready for use.
2. The system shall have the ability to:
   a. Provide monitoring and verification of energy savings in accordance with IPMVP Options B and C
   b. Provide forecasts of solar PV production (if relevant)
   c. Accept a user-defined baseline/ benchmark, or automatically determine a baseline from historical building data and weather data
   d. Compare current building performance against the baseline, both numerically and graphically

3.3.2 Clause B (a) (ii) Automatic Fault Detection

Performance Requirement:

The Landlord shall ensure that a system for the automatic detection of common operation and maintenance faults within the heating ventilation and air-conditioning system is installed, linked to the data platform, configured and integrated into the management, maintenance, tuning and optimisation processes for the building.

Acceptance Criteria:

a) The landlord shall ensure that a system for the automatic detection of common operation and maintenance faults within the heating ventilation and air-conditioning system is installed, with the following minimum functions and features (as relevant to the building):
   i. Fault detection processes for chillers, boilers, air handlers, heating and cooling coils, VAV and other terminal units and packaged air-conditioners covering partial and total failures of equipment and control.
   ii. Structured reporting of detected faults such that important faults can be readily identified for early rectification
   iii. Key performance indicators for failure/success of plant operation including space temperature control
   iv. Data to be drawn from the data platform; fault reporting to be loaded to the data platform
b) The landlord shall ensure that the use of the automatic fault detection system is integrated into the operational processes and procedures of the building including:
   i. Integrated use of the automatic fault detection application in the identification of works to be undertaken by the maintenance contractor
   ii. Allowance within relevant maintenance contracts to address identified faults
   iii. Monthly reporting of fault and space temperature control KPIs to the building's energy management committee

3.3.3 Clause B (a) (ii) Demand Management/Response

Performance Requirement:

The building shall have the ability to manage, where relevant, electrical demand in response to:

a) Local peak demand charges
b) Grid-based demand response requests

Without impinging upon utility or comfort of the tenant.

Acceptance Criteria:

1. The building shall have demand management/response capability of at least the following minimum functionality:
   a) The following systems, where applicable and appropriate, shall be capable of receiving and responding to a demand response signal:
      i. Air conditioning (house and tenant, separately)
      ii. Electric vehicle charging
      iii. Synchronous generators
   b) The building shall have a forward-looking electrical demand prediction application linked to the data platform that uses historical electrical demand data, weather forecast data and other contextual data as required to provide a forward estimate of electricity demand in 15 minute periods up to 1 day ahead.
   c) The building shall have control mechanisms in place that can identify potential local peak demand events (such as might affect the building's electrical peak demand charges) and offer a range of response of demand reduction or deferment measures to minimise avoidable peak demand charges, where possible
   d) The building shall have control mechanisms in place (preferably automatic or semi-automatic) that can respond to grid-level demand response events and offer a range of response of demand reduction or deferment measures to minimise electrical load during such events, where possible.

   e) The building shall monitor temperature control within tenancy spaces to ensure that demand management and response activity does not noticeably compromise tenant comfort.
   f) The building shall have the ability to calculate achieved demand reduction in line with the requirements of the relevant tariffs and schemes.
2. The building energy management committee shall:
   a) Agree and actively review/adjust acceptable demand management and response measures
   b) Review success or failure of demand management and response activities for the period preceding each meeting.
   c) Review space comfort and amenity monitoring during demand management and response events.

3.3.4 Clause B (a) (ii) Digital Operation and Maintenance Logbook

Performance Requirement:

The building shall have a digital operation and maintenance logbook on the data platform that is fully integrated into the building's operation and processes.

Acceptance Criteria:

The building shall have a digital operation and maintenance logbook that:

a) Contains up-to-date records for
   i. As-built Equipment list (Asset register) including all items, the relationship between these items (e.g. terminals associated with each air handler), and their location
   ii. Building services drawings (covering mechanical, electrical, hydraulic and fire services, including schematics)
   iii. Building management system functional description
   iv. Maintenance records for each asset
   v. Commissioning results for each asset
   vi. Electricity and gas metering trees
a) Is used as the primary reference and reporting point for contractors and suppliers conducting works on the building's heating, ventilating and air-conditioning systems and associated controls, lighting control systems, occupancy/presence/motion sensors, indoor environment quality sensors, energy meters, electric vehicle charging systems, solar power systems, access control systems and demand management systems.
b) Is located on the data platform.

REP00898-B-001

Green Leases: Proposed Digital Ready Clauses

As Australia's national science agency and innovation catalyst, CSIRO is solving the greatest challenges through innovative science and technology.

CSIRO. Unlocking a better future for everyone.

Contact us

1300 363 400
+61 3 9545 2176
csiro.au/contact
csiro.au

For further information

Energy Business Unit
Dr Stephen White
+61 2 4960 6070
stephen.d.white@csiro.au
csiro.au/energy