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# End of pilot evaluation

Smart Batteries for Key Government Buildings

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**Prepared for**

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# Executive summary

## Program objectives

The Smart Batteries for Key Government Buildings program was developed to support the installation of smart batteries at NSW government owned sites to reduce operating costs and help establish a strategic demand response capability to increase energy security. The program provided grant funding to participating agencies to install smart batteries and subject matter support and funding to develop feasibility studies and business cases.

The program was initially conceived in two stages – a pilot in public schools and hospitals and a broader second stage with more funding open to wider government agencies – but due to funding cuts during the program lifetime only an expanded version of the first stage pilot was delivered. It ultimately funded battery installations at Port Macquarie Base Hospital, seven public schools and sixteen buildings managed by Property NSW.

## Purpose and audience of this evaluation

This outcome evaluation considers the performance of the Smart Batteries for Key Government Buildings program against six key evaluation questions developed during program design. It is intended for an audience of policymakers to share lessons learned and support decision-making about future programs, particularly those involving deployment or adoption of novel technologies or interagency collaboration.

## Evaluation methodology

This was a mixed-method, utilisation-focused evaluation. Due to the de-scoping of the program, it was identified early on that the primary intended use of this evaluation would be the distribution of lessons amongst government agencies to inform future programs.

This evaluation was structured under three monitoring and evaluation (M&E) packages:

- M&E1: Analyse energy and associated impacts
- M&E2: Analyse change in knowledge, attitudes and practices (KAP) among government agencies
- M&E3: Assessment of battery and Virtual Power Plant (VPP) markets

Key inputs to the evaluation include program documentation, solar photovoltaic (PV) and smart battery operating data, and a program of semi-structured interviews with relevant stakeholders, including the program team and program sponsor, agency stakeholders, relevant site managers, NSW Treasury and the retailer for the whole of government electricity contract. We used semi-structured interviews to ensure we could capture deeper insights from program participants, in order to identify and explore potential stakeholder biases. The pool of interviewees was carefully chosen to ensure the broad perspectives and the broad experiences of different program stakeholders were captured. Thematic analysis was performed on interview transcripts to elicit the overall key findings and recommendations. These findings were then triangulated with other data sources, e.g., other stakeholder interviews, program documentation and limited quantitative data, to identify similarities and explain discrepancies.

Quantitative analysis under M&E1 was limited due to lack of available data on battery outcomes.

# Key findings

The program faced considerable challenges during delivery, including a significant reduction in overall project funding, the impacts of the COVID-19 pandemic during implementation, and the lack of an Australian battery standard, which was not legislated until a year into program delivery. Battery implementation has been delayed at some sites, and some batteries are yet to be commissioned or installed.

While limited data availability and the ongoing implementation process makes a robust assessment of site-level benefits challenging, the program has had value in identifying barriers and challenges to technology deployment that can be used to inform future government initiatives. Participation in the program has built familiarity with battery technologies among participating agencies and all agencies are exploring new use cases to maximise the future value of the assets, including orchestration as part of a Virtual Power Plant (VPP). These batteries are well positioned to test the viability of using batteries connected to a VPP to generate additional revenue streams for government buildings, which may in turn lead to future spillover investment in participating agencies and across government more broadly.

The program ran between 2018 and 2022 and funded 3,240kWh of battery capacity across 24 NSW Health, Property NSW and Department of Education sites. This evaluation commenced in July 2022, with interviews conducted in October and November. As such, evaluation findings only cover the period prior to November 2022.

Key findings against the key evaluation questions developed for the program are outlined below.

## KEQ1: New pathways to technology adoption

The program logic accurately mapped the technology adoption pathways that played out in practice. While there is not yet sufficient battery use data to assess some end of program outcomes, there are promising early indicators and strong evidence that the program contributed to avoided network augmentation costs. The program had a positive contribution to VPP services even though orchestration activities under the program were descoped – the program required installed batteries to be VPP compatible and all participating agencies are now independently pursuing orchestration.

There is additional value from the project not captured by the program logic in lessons learned for future programs.

Although the formal staging was discontinued when funding was reallocated, a staged approach across and within agencies within the pilot may have contributed to a smoother rollout. This would have allowed for communication between participants to ensure challenges were identified early and avoided in subsequent installations. While staging needs to be balanced with project timelines, some form of staging in a pilot program involving new technology deployment will be beneficial in avoiding extended and repeated delays.

## KEQ2: Participant challenges and program responses

The program design broadly addressed the major challenges reported by agencies as barriers to installing smart battery technology, including upfront capital costs and limitations on knowledge and technical expertise.

The program revealed many unforeseen challenges that were not addressed through the initial program design, such as logistical challenges and technical complexities, particularly in the context of battery deployment in regional areas. There is considerable value in the identification of unforeseen barriers in the implementation phase that can be considered for future programs. Flexibility in program design allowed these barriers to be overcome without critical impacts on program delivery.

The program has driven positive change in knowledge, attitudes and practices among participating agencies, with all agencies reporting increased interest in battery technology following participation.

## KEQ3: Energy, bill savings and emissions benefits

It is too early to make a comprehensive quantitative assessment of energy consumption and bill savings from the batteries installed under the program.

However, early data available from Department of Education (DoE) batteries and solar systems suggests a correlation between program participation and consumption and bill savings, and a positive emissions reductions impact.

The program successfully demonstrated that batteries can be installed in network-constrained sites in lieu of network upgrades. Batteries at network-constrained sites are underutilised, suggesting the accepted process for calculating maximum demand is overly conservative for these sites.

## KEQ4: Broader impacts on solar battery storage and VPP markets

The program has had positive impacts on smart battery and VPP supply chains, developing supplier capacity and prompting changes in the market (new product development) and to the whole of government contract to make it easier for government sites to access VPP and FCAS (Frequency Control Ancillary Services) benefits.

Participation in the program has driven increased interest in battery technology in participating agencies; this may translate to spillover if program batteries go on to demonstrate lucrative VPP or FCAS revenue streams and if these successes are communicated.

## KEQ5: Peak reserve capability increase

The program is likely to have an impact on peak reserve capability across the broader network in the future as the batteries become VPP orchestrated, depending on the negotiation of agency-level agreements with the relevant battery operators. VPP use cases that could be used for grid level demand response are not currently operational.

While some batteries are being used for site-level demand response, this may or may not coincide with network peaks.

## KEQ6: Potential future benefits

Financial benefits from the installed batteries are likely to increase. Participating agencies are pursuing new VPP orchestration and FCAS use cases to maximise revenue from their batteries. These revenue streams are expected to be more lucrative than the initial peak shaving or solar smoothing use cases.

Program design specifications to ensure batteries are VPP-compatible and the changes in knowledge, attitudes, and practices (KAP) driven by the program have set agencies up well to realise these future benefits, even though VPP orchestration was descoped in the pilot.

# Recommendations

The SBKGB program identified challenges with smart battery technology adoption across agencies that may have value in informing future government programs – particularly those involving deployment or adoption of novel technologies or interagency collaboration.

We have identified nine recommendations based on lessons learned from this evaluation. These recommendations, their rationales and benefits are summarised in the table below.

*Table 1: A summary of key recommendations resulting from this evaluation*

| | Recommendation | Rationale | Benefit |
|---|---|---|---|
| 1 | **Co-design of key program considerations with participating agencies** | A number of points were identified where participant experiences expectations diverged from the program design, including concerns about program ownership, appetite for the program, and the availability of excess solar PV on government buildings | Co-design may help to build flexibility and adaptability to participant needs into future programs to ensure they are right-sized, can be implemented smoothly, and to ensure no inadvertent barriers are built into program design. |
| 2 | **Prioritise rigorous and consistent data collection** | At the time of this evaluation there was no access to sufficient data to quantitatively assess program outcomes. Analysis for this evaluation found that where battery operating data is available, it is formatted inconsistently and there is a reliance on external delivery partners for monitoring and data management. | Assessing program outcomes is essential to improving future policy and program design. |

| | Recommendation | Rationale | Benefit |
|---|---|---|---|
| 3 | **Build structured knowledge sharing and dissemination into the program design** | Lessons learned and insights for future programs were key objectives of the rescoped pilot. However, after the program was decentralised, the role of the program team in compiling insights and sharing knowledge between agencies and more broadly appears to have been limited. | Sharing knowledge and lessons learned beyond the program participants can lead to spillover benefits. Sharing experiences within the program, between participants, can lead to a smoother rollout and greater long-term program benefits. |
| 4 | **Stage implementation in phases** | Agencies faced shared implementation challenges that may have been avoided with better sharing of lessons from a preliminary implementation phase. Within agencies, stakeholders and delivery partners reported delays and additional costs associated with mistakes repeated across multiple sites. | Completing and compiling lessons from end-to-end installation at a single pilot site before progressing to additional sites may have helped mitigate cost and delay. |
| 5 | **Acknowledge technical complexity in procurement processes** | Interviewees raised concerns that standard procurement processes that emphasise lowest cost procurement disfavour experienced contractors, as they are likely to submit higher quotes in recognition of the technical complexity of the engagement. There is a risk that contracts are awarded to less experienced contractors who may not have a full understanding of the complexity of the project, causing implementation challenges, delays and additional work. | Structuring procurement processes to ensure they give appropriate weight to having the technical capability to deliver would help to avoid delays and added costs during implementation. |

| | Recommendation | Rationale | Benefit |
|---|---|---|---|
| 6 | **Build buy-in at all levels of participating agencies** | Although the program team made concerted efforts to build agency buy-in for the program, interviewees acknowledged that participation was largely reliant on individual drivers of change within each agency, and that lack of buy-in from other staff, including executives and on-the-ground staff (e.g. site level managers) was found to be a roadblock to implementation and delivery of the program | Greater initial executive buy-in, perhaps supported by program co-design, and top-down communication of the benefits of participation to on-the-ground staff, may support smoother rollouts in future. |
| 7 | **Provide funding for ongoing maintenance and operation** | Interviewees noted that a lack of funding for maintenance, monitoring, ongoing operation and decommissioning was a barrier to participation in the program, and raised concerns that over the program lifetime these costs may outweigh the benefits of the batteries.<br><br>In the absence of ongoing funding, there is a risk that assets are poorly maintained, and agencies miss out on the full suite of potential future benefits. Agency stakeholders commented that data monitoring, maintenance and asset management for the batteries relies on existing teams and staff with no additional resourcing to support these new responsibilities. | Operational funding over the lifetime including provisions for monitoring and data capture will help to maximise benefits and may also improve data visibility, allowing for a better assessment of program success. |

| | Recommendation | Rationale | Benefit |
|---|---|---|---|
| 8 | **Explore new funding mechanisms for public benefits** | Interviewees with agencies found a focus on the economic business case for batteries at site level, with interviewees claiming spillover would be constrained due to the poor business case – batteries are not yet at an adequate payback threshold (from savings or revenue) to justify the capital expenditure at a site level. However, many of the benefits of batteries are realised beyond a site level, e.g. reduced energy prices from avoided network infrastructure, reduced peak energy demand, and improved grid stability. The value of these benefits is not factored into site level business cases. | Facilitating policy that creates or improves the revenue stream for these batteries to reflect the value of these community-level benefits is likely to unlock future spillover and maximise the benefits from batteries installed under the program |

| | Recommendation | Rationale | Benefit |
|---|---|---|---|
| 9 | **Batteries as substitutes for network augmentation** | The DoE batteries deployed under the program have successfully demonstrated the possibility of battery installation as a substitute for expensive network augmentation, yielding a net operational saving to government.<br><br>Operational data from the batteries installed at network-constrained school sites shows these batteries have not been discharged as the sites have not approached their grid constraint (i.e. the maximum demand those sites can pull from the network). These batteries were not programmed for other uses to preserve their capacity for the primary network augmentation use case. We recommend these batteries now be considered for other use cases. While the calculations conducted for this program followed the acknowledged standard for estimating grid constraints, these results may suggest that the accepted methodology is overly conservative for similar sites. | If the maximum demand methodology is systematically overestimating demand across a broader range of cases, refining the methodology may mitigate the risk of funding unnecessary upgrades.<br><br>Batteries installed at sites as a substitute for a genuine expensive network augmentation would yield a net operational saving to government. |

# Table of contents

SECTION 1

# Background on the program and evaluation

This section includes background on the Smart Batteries for Key Government Buildings program and the context, methodology and limitations of this evaluation.

## 1.1 The Smart Batteries for Key Government Buildings program

The Smart Batteries for Key Government Buildings program was developed to support the installation of smart batteries at NSW government owned sites, including public schools and hospitals, to reduce operating costs and help establish a strategic demand response capability to increase energy security.

For the purposes of this program, smart batteries installed were required to be communications enabled (able to form an internet connection), capable of being remotely monitored, and capable of responding to remotely-provided commands within prespecified operating parameters (e.g. commands to charge and discharge the battery).

The program was approved by NSW Cabinet to be funded from the Climate Change Fund (CCF) for delivery between 2018-2022. The program was first administered in 2018 by a team in the Department of Planning and Environment (DPE), which shifted to the Department of Planning, Industry and Environment (DPIE) in 2019, and now sits with the Office of Energy and Climate Change (OECC) in Treasury (2022 onwards).

It was initially conceived in two stages:

- Stage 1: Pilot funding to deliver batteries in public schools and hospitals, selected as they represent the governments largest energy users. This stage would be used to test delivery, identify risks and challenges to inform stage 2.
- Stage 2: Broader funding for more agencies and sites to participate.

The initial stage 1 objectives were to:

- Demonstrate that a total aggregated battery storage capacity of up to 13 megawatts (MW) at NSW government sites can be achieved
- Demonstrate that reduced operational costs for the NSW government can be achieved
- Demonstrate that Virtual Power Plant (VPP) which provides aggregated demand response services can improve the security and reliability of the NSW electricity network
- Demonstrate that VPPs can assist in reducing peak demand on the NSW distribution network
- Identify institutional barriers for government agencies to adopt clean energy technologies
- Reduce net greenhouse gas emissions

The program experienced significant funding cuts during stage 1 due to the machinery of government and changes in funding priorities. From $20 million approved, actual grant funding (excluding operational expenditure and labour costs) decreased to $4.37 million, and the scope of the program was reduced to no longer require VPP integration. Funding eligibility was restricted to stage 1 negotiations already in progress with NSW Health (MoH), NSW Department of Education (DoE) and Property NSW (PNSW).

The key objectives for the program following its funding changes were to:

- Test selection and delivery approaches to inform development of robust pilot resources and processes for future roll outs
- Demonstrate success and build confidence in benefits that can be achieved through the installation of smart batteries at government sites
- Build internal capability and confidence of Delivery Partners in procuring, installing, commissioning, operating, and maintaining systems

This evaluation was undertaken between July and December 2022, when the program was substantially concluded. Some installation and commissioning continues to be finalised. Table 2 below summarises program delivery and the current state of battery implementation at each of the participating agencies.

*Table 2 – Implementation status of batteries by agency*

| | Ministry of Health | Department of Education | Property NSW |
|---|---|---|---|
| **Total capacity** | 1,600kWh (initial battery)* | 360kWh | 1,280kWh** |
| **Number of sites** | 1x Port Macquarie Base Hospital | 4x network constrained school sites<br>3x non-network constrained school sites | 16x sites |
| **Initial use cases** | Site-level demand response<br>FCAS revenue | Avoided network augmentation costs<br>Site-level demand response<br>Load shifting | Site-level demand response<br>Load shifting |
| **Future use cases** | VPP orchestration | VPP orchestration<br>Redeployment of batteries to new sites | VPP orchestration<br>FCAS revenue |
| **Implementation status (as at Oct-Nov 2022)** | Initial battery installed and commissioned | All batteries installed and commissioned | 13 sites installed but not yet commissioned due to metering issues at sites<br>3 sites yet to be installed (expected July 2023) |
| **Next steps** | Commissioning second battery<br>In negotiations with battery operator around FCAS and VPP use cases | Batteries to be managed under the Smart Energy Schools Pilot Program (larger smart battery and VPP program) | Concluding installation and commissioning<br>Negotiating battery operation contract (incl. FCAS and VPP) with battery operator (expected to be completed September 2023) |

*MoH have subsequently installed a second smaller battery under the SBKGB funding envelope

**Planned capacity; final installed capacity may vary based on installation at remaining sites

## 1.2 This evaluation

Common Capital has been engaged to conduct the end of pilot outcome evaluation for the program. Six key evaluation questions have been developed for this evaluation:

| KEQ | Description |
|---|---|
| **KEQ1** | To what extent does the program unveil better pathways in helping participants understand new technology adoption which impacts key government buildings? Was the staged approach effective in ensuring initial learnings can be used to inform future rollouts of smart batteries in other settings? |
| **KEQ2** | How well does the program address the challenges of the participants and other key stakeholders involved in the program? |
| **KEQ3** | To what extent are the participants saving electricity and reducing bills and greenhouse gas emissions? |
| **KEQ4** | To what extent did the program drive uptake of, or investment in, Solar Battery Storage and VPPs? What can we learn for future rollouts of new tech? |
| **KEQ5** | To what extent has the project increased the peak reserve capability in NSW (i.e. demand response)? |
| **KEQ6** | To what extent are facilities positioned to realise benefits from the batteries after the program concludes? |

The output of this evaluation is intended to support decision-making about future programs and share lessons learned.

This outcome evaluation does not include an assessment of the program’s net economic benefit at state or facility level, with cost: benefit analysis to be conducted under a separate economic evaluation.

# Methodology

This was a mixed-method, utilisation-focused evaluation. Due to the de-scoping of the program, it was identified early on that the primary intended use of this evaluation would be the distribution of lessons amongst government agencies to inform future programs.

This evaluation has been designed under three monitoring and evaluation packages:

*Table 3 - Evaluation M&E packages*

| M&E package | Description | KEQs addressed |
|---|---|---|
| **M&E1** | **Analyse energy and associated impacts**:<br>Assess changes to energy management resulting from increased solar, battery installation and VPP, as well as subsequent greenhouse gas and bill impacts. | KEQ3<br>KEQ5 |
| **M&E2** | **Analyse change in knowledge attitudes and practices (KAP) among government agencies**<br>Assess the change in KAP among government agencies as a result of the program's knowledge sharing regarding renewable energy generation and storage. | KEQ2<br>KEQ6 |
| **M&E3** | **Assessment of battery and VPP markets**<br>Understand how the program has directly and indirectly contributed to change in markets for medium-scale batteries and VPP, especially amongst government agencies. | KEQ1<br>KEQ4 |

Key inputs to the evaluation include:

- **Program documentation**, including funding agreements and planning documents, execution and project management documents, interim reports and the prior process evaluation.
- **Solar PV and smart battery operating data**, where available, although data availability and quality has been a key challenge conducting this evaluation; we have only been able to access data for a limited number of DoE sites.
- **Interviews with relevant stakeholders**, including the program team and program sponsor, agency stakeholders, relevant site managers, NSW Treasury and the retailer for the whole of government electricity contract.

The pool of interviewees was carefully chosen to ensure the broad perspectives and the broad experiences of different program stakeholders were captured. Thematic analysis was performed on interview transcripts to elicit the overall key findings and recommendations. These were then triangulated with the other data sources.

This evaluation report is structured by KEQ, with a final recommendations section compiling key lessons and recommendations identified throughout the report.

# Limitations

Limitations to the findings of this evaluation include:

- **Program implementation is ongoing:** Although this is an end of pilot outcome evaluation, installation and commissioning of batteries funded under the program is ongoing. A complete view of outcomes is not possible for all batteries across all agencies.
- **Limited data availability:** We have not been able to access key monitoring data in a format conducive to analysis for some of the batteries installed due to site-level monitoring and communication issues and challenges accessing data held by agencies and delivery partners. This lack of data is a barrier to assessing some quantitative outcomes of the program, e.g. the savings, energy and emissions benefits to be quantified under KEQ3. Specific data limitations are identified and discussed in context throughout the evaluation as relevant to the KEQs.
- **Limited implementation documentation:** The program documentation made available for this evaluation was largely limited to the project planning documentation held by OECC, with limited documentation from the implementation phase made available by agencies. Some agencies, particularly PNSW, saw considerable deviation between planned and delivered installations.
- **Reliance on interview findings**: In order to compensate for limited data availability and implementation documentation, our evaluation draws heavily on findings from semi-structured interviews with program stakeholders. There are potential limitations to these interview findings, including interviewee bias (noting we spoke with agency stakeholders most engaged with the program), incomplete memory, conflicting perspectives, limited availability of key stakeholders, etc. Where relevant these considerations have been flagged directly throughout the evaluation.
- **Stakeholder turnover:** Due to staff turnover in government, we were not able to elicit interview perspectives that covered the earliest phases of the program from the program team or from all participating agencies.

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SECTION 2

# Assessment of key evaluation questions

This section systematically addresses the six key evaluation questions laid out in the Smart Batteries for Key Government Buildings evaluation plan.

## 2.1 KEQ1 – New pathways to technology adoption

*To what extent did the program unveil better pathways in helping participants understand new technology adoption which impacts key government buildings?*

*Was the staged approach effective in ensuring initial learnings can be used to inform future rollouts of smart batteries in other settings?*

## Key findings

- The program logic accurately mapped the technology adoption pathways that played out in practice.
- There is strong evidence the program contributed to avoided network augmentation costs; while it's too early to assess the contribution to most other end of program outcomes, there are promising early indicators.
- The program had a positive contribution to VPP services even though these activities were descoped.
- There is additional value from the project not captured by the program logic in lessons learned for future programs.
- Although the formal staging was discontinued when funding was reallocated, a staged approach across and within agencies under the pilot may have contributed to a smoother rollout.

## Smart batteries funded under the program were intended to drive operational savings, reduce peak demand and spillover in VPP and battery markets

The SBKGB program logic (reproduced in Figure 1 below) describes the expected pathways to change the program was expected to drive. The program was a grant program, which by its nature, relies on a 'learn by doing' theory of change. In brief, this can be described as follows:

- Funding is offered to sites to increase smart battery storage
- Sites funded under the program benefit from energy arbitrage and on-site energy generation, leading to reduced energy bills, reduced greenhouse gas emissions, reduced peak demand for electricity and reduced network augmentation costs
- Batteries installed under the program are connected to a VPP, improving the technical and commercial readiness of VPP services
- The program shares its success with government and the broader public, spurring further government and private sector investment in smart energy

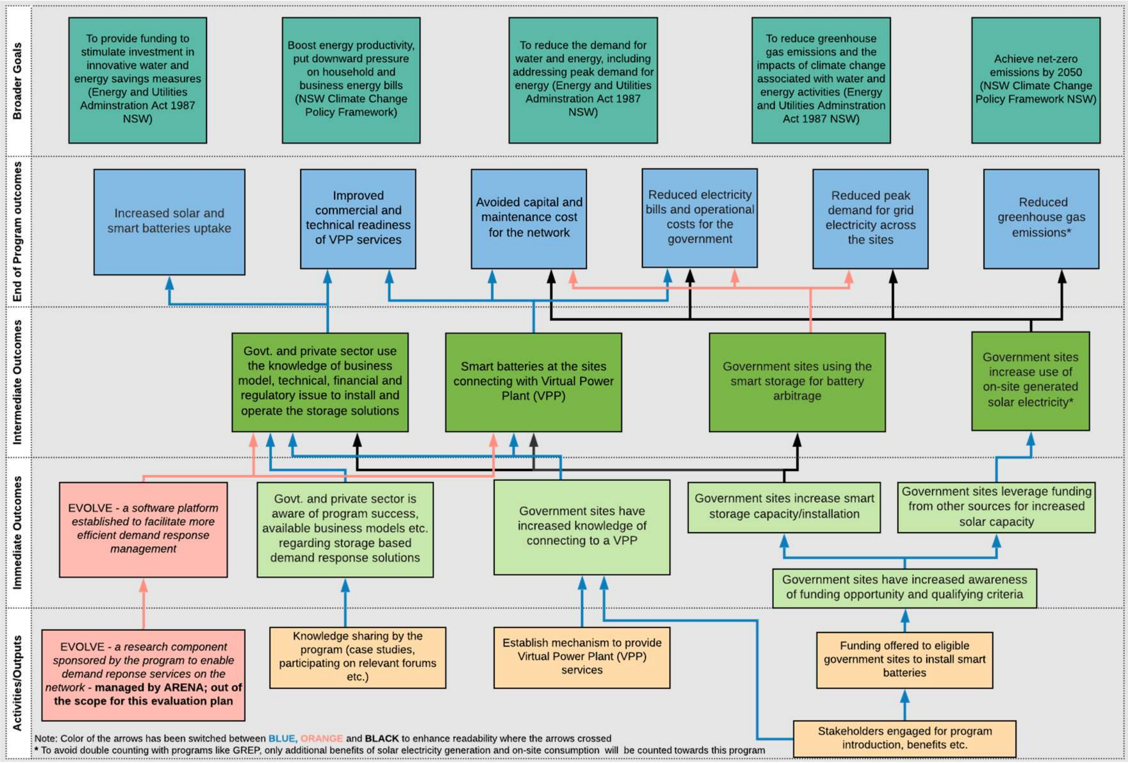


*Figure 1 - SBKGB program logic*

## The program logic functioned broadly as anticipated

Our review of the program logic found it accurately mapped the technology adoption pathways that played out in practice.

Strong areas of alignment between the program logic and implementation are described below.

- **Stakeholder engagement and delivery (activities, immediate outcomes) driving smart storage and solar (intermediate outcomes):** The program implementation components of the knowledge tree functioned broadly as anticipated, with the work of the program team to engage agency stakeholders successfully driving smart battery installations and leveraging funding for solar at agency level, contributing to intermediate solar generation and battery use outcomes.
- **Government awareness (immediate outcomes), installation and operation (intermediate outcomes):** The program was found to have improved government agency awareness of and interest in smart battery storage technology and its potential use cases. There is evidence that agency experience with the program influenced future implementation by government in the instance of DoE, with subsequent delivery of the Smart Energy Schools Pilot Program (SESPP) informed by the SBKGB program – although there is no suggestion of causal link between the two battery programs. The program has also spurred broader interest in batteries in MoH (discussed further in KEQ2).
- **Avoided capital and maintenance costs for the network (end of program outcomes):** There is strong evidence from the DoE examples that the funded batteries reduced network augmentation costs (discussed further in KEQ3). DoE sites tested the

installation of batteries at grid-constrained sites to avoid the need for network upgrades, with the batteries programmed to discharge only when the schools approached their maximum demand threshold. The pilot had a lower cost to implement at these sites compared to network augmentation, resulting in a significant capital expenditure saving.

- **VPP mechanism (program activities) driving site-level connection (intermediate outcomes) and improved readiness of VPP services (end of program outcomes):** Although the requirement for batteries to be VPP-orchestrated was descoped when the program experienced funding changes, the program still required batteries to be VPP-compatible. All agencies are now pursuing VPP orchestration, driving changes in VPP services as anticipated by the original program logic. Interviewees reported that the program prompted changes to the whole of government electricity contract to better enable future VPP integration and has spurred a major energy stakeholder to develop a new dispatching platform to support FCAS participation for smaller batteries like those installed in PNSW sites (discussed further in KEQ3 and KEQ6).

## There is not yet enough data to assess the program's contribution to broader end of program outcomes

Due to implementation timeframes, there is insufficient data on battery use to assess the other components of the program logic, particularly the other end of program outcomes:

- **Reduced electricity bills and operational costs:** Battery use data is only available for batteries at network constrained schools, which are contributing to capital expenditure savings from avoided network augmentation (discussed above) but do not have an impact on energy bills. Limited bill data available for non-network constrained school sites shows a promising correlation between a decline in energy bills and the program lifetime, but in the absence of battery data we are unable to definitively attribute these savings to the program (discussed further in KEQ3). We do not yet have data available from site-level demand response or solar smoothing use cases at MoH or PNSW sites to assess energy consumption and expenditure benefits.
- **Reduced peak demand:** While the reported battery use cases suggest batteries at MoH and non-constrained school sites will reduce peak demand at those sites, we do not have data to validate or quantify the impact. Batteries are not currently being used for grid-level demand response (discussed further in KEQ5).
- **Reduced greenhouse gas emissions:** While the requirement for sites to independently install solar has leveraged additional funding for solar energy, this appears to have been a barrier for agencies to identify suitable sites to participate (discussed further in KEQ2). Available data from school sites suggests the increased solar is contributing to reducing greenhouse gas emissions; however, there is insufficient data from solar generation to quantify these benefits with confidence (discussed further in KEQ3).
- **Increased solar and smart batteries uptake:** It is too early to assess program spillover, as the PNSW and MoH batteries are not yet able to report outcomes and the VPP and FCAS use cases, expected to be most lucrative, are yet to be demonstrated. However,

the program has driven significant interest in participating agencies (discussed further in KEQ2) that may convert to future spillover (discussed further in KEQ4).

## The dissemination of practical implementation lessons should have been more explicitly captured by the program logic

As a pilot, the SBKGB program identified significant challenges or barriers to implementation of smart technology. There is significant value in sharing these barriers, identified mitigation strategies and lessons learned beyond the program to inform the design of programs with similar goals or operating models.

This is identified as a key objective of the re-scoped SBKGB program: *Test selection and delivery approaches to inform development of robust pilot resources and processes for future roll outs.*

Although the program logic anticipates sharing the success of the program as a key activity to drive spillover (e.g. publishing case studies to build government awareness of the success of the program), development and dissemination of practical knowledge and resources relating to what the program learned about the challenges and barriers of installing batteries in key government sites could have been included more explicitly.

Building structured knowledge sharing and dissemination into the program design as a desired outcome, supported by program activities and outputs (e.g. facilitating formal communication between participants through workshops and regular program meetings, collating lessons learned, structured dissemination), may help the program team and agencies to prioritise these outputs and maximise the value of lessons learned for future policy.

## Planned staged delivery of the program was dropped when funding was cut

The SBKGB program was initially developed to be delivered in two stages: a pilot program to install batteries in public schools and hospitals, which would go on to inform a larger rollout of smart battery funding rounds for other interested agencies. Due to funding changes, the staged approach was ultimately discontinued and only the pilot stage proceeded, with eligibility expanded to agencies beyond DoE and MoH.

Within the pilot phase, there was no staging of delivery to allow agencies to learn from one another. Although information was shared informally via the program team, there was no formal process for agencies to discuss and learn from one another’s experience, or to provide these lessons more broadly to other government agencies. In interviews, agency stakeholders reported having limited awareness of each other’s programs and ultimately chose to install different batteries with different use cases at different sites. However, agencies faced many similar challenges (discussed further in KEQ2), suggesting a potential missed opportunity to collaborate and share lessons that could have contributed to a smoother rollout.

Within the agencies that installed batteries at multiple sites (DoE and PNSW), interview findings suggest that a missed opportunity to stage rollouts contributed to time and cost increases. Agency stakeholders and delivery partners recount instances where the same installation or commissioning error or challenge was encountered at multiple sites delivered concurrently, leading to repeated rework. End-to-end delivery at an initial ‘pilot’ site may have led to smoother rollout, although we acknowledge the need to work to whole of program delivery timeframes.

### Recommendations

- Prioritise rigorous and consistent data collection (with data made available to both agencies and OECC) to enable ongoing monitoring over the program lifetime and a robust end of pilot evaluation. Where data is not yet available for a robust evaluation, consider delaying the outcome evaluation until data can be collected.
- Where programs involve innovative technology, staging delivery, both within and across participating agencies, may contribute to a smoother rollout and minimise additional costs and delays.
- Where identifying lessons learned is a key objective, structure knowledge sharing and dissemination into both the program logic and program activities from the outset, including clear roles and responsibilities for knowledge sharing.

## 2.2 KEQ2 – Participant challenges and program responses

*How well does the program address the challenges of the participants and other key stakeholders involved in the program?*

### Key findings

- Program design broadly addressed the major challenges reported by agencies as barriers to installing smart battery technology.
- The program identified unforeseen barriers in the implementation phase that can be considered for future programs.
- Flexibility in program design allowed these barriers to be overcome without critical impacts on program delivery.
- The program has driven positive change in knowledge, attitudes and practices among participating agencies, with all agencies reporting increased interest in battery technology following participation.

Interviews with the program team, agency stakeholders, participating sites and delivery partners identified a range of challenges experienced by participants, characterised in Table 4 below. The table considers whether the program has been able to resolve or mitigate the barrier – either through program design, or by virtue of agency participation, e.g. as program participation builds confidence in battery technology.

These challenges have been characterised as:

- **Pre-existing:** Barriers that had prevented agencies from installing or investing in battery technology prior to the program.
- **Program implementation**: Barriers identified over the course of program implementation that made implementation more complicated, added time or cost, or may constrain the benefits agencies receive from the installed batteries.

*Table 4 – Participant challenges and program approach to addressing challenges*

| Challenges | Description | Phase | Program approach to address challenges |
|---|---|---|---|
| **Upfront capital cost** | Agency stakeholders cited the high upfront capital expenditure as a barrier to previous battery installation. | Pre-existing | **Addressed by program design:**<br>The program covered the capital expenditure associated with installing batteries. However, upfront cost will continue to be a barrier to installations outside the program. |
| **Perceived poor business case** | The program team, delivery partners and agencies suggested that batteries are perceived to yield relatively low value (in energy bill savings) relative to the high upfront cost, leading to a long payback period.<br>Potentially more lucrative revenue streams, e.g. from FCAS or VPP orchestration, are uncertain.<br>The DoE avoided network augmentation use case has a strong value proposition as batteries are cheaper than network upgrades. | Pre-existing | **Partially addressed by program design:**<br>The program improved the economic business case for the batteries installed by covering capital expenditure. It also demonstrated that batteries can be used to avoid network augmentation costs, suggesting a positive business case for batteries in buildings that would otherwise have to pay these charges.<br>However, the poor business case may continue to be a barrier to additional installations outside the program, as the full suite of potential revenue from installed batteries (including VPP orchestration and FCAS) has not yet been delivered.<br>The program may help to resolve this barrier if the batteries installed can successfully demonstrate high revenue from streams like FCAS and VPP orchestration. |

| Challenges | Description | Phase | Program approach to address challenges |
|---|---|---|---|
| **Knowledge and expertise limitations** | Batteries are complex new technologies. A relatively high level of technical knowledge is required to understand and make decisions about battery system design, procurement and use cases.<br>The program team noted that battery technology is not core business for other agencies. | Pre-existing | **Addressed by program design:**<br>The program provided technical support to participants in the form of support from the program team through the procurement process, and funding for feasibility studies for battery installation, although we note MoH chose to self-fund their feasibility study.<br>Agency stakeholders were positive about the support provided.<br>Participating in the program has built knowledge and expertise within agencies; however, a risk was identified that this experience is concentrated within individuals and not institutionally embedded. |
| **Health and safety risks** | MoH and DoE agency stakeholders noted health and safety concerns, e.g. fire risk, as a barrier to installation in hospitals and schools. | Pre-existing | **Improved through program experience:**<br>Agencies worked with technical support provided under the program or other consultants to mitigate safety risks.<br>Participating in the program has helped demonstrate the safety of the technology. |
| **Maintenance burden** | Agency stakeholders suggested the cost and labour associated with ongoing operation and maintenance of the batteries and disposal at end of life were barriers to installation.<br>DoE stakeholders raised concerns about the feasibility of ongoing battery maintenance without dedicated project funding.<br>This maintenance burden was cited by MoH as a potential barrier to broader hospital participation. | Pre-existing / program implementation | **Partially addressed by program design:**<br>Battery maintenance costs were funded for MoH due to a negotiated funding agreement; DoE and PNSW are responsible for their own maintenance costs.<br>In program design, the requirement for agencies to co-contribute to maintenance costs was thought to show agency commitment to pilot participation.<br>In practice, agencies described maintenance cost as a barrier and reported challenges sourcing additional internal resources to dedicate to the project, which may constrain future benefits. |

| Challenges | Description | Phase | Program approach to address challenges |
|---|---|---|---|
| **Low risk appetite for untested technology** | The untested nature of battery technology, particularly in schools and hospitals, were noted by agency stakeholders and delivery partners as reasons installation had not been pursued before. Stakeholders raised questions about whether they would work in these contexts. | Pre-existing | **Improved through program experience:**<br>Participation in the program has and is expected to improve familiarity with batteries and demonstrate battery use cases (avoided network augmentation successfully demonstrated; peak lopping, FCAS and VPP orchestration to be demonstrated). |
| **Lack of agency buy-in** | Interviews with the program team, stakeholder agencies and delivery partners revealed that lack of buy-in at all levels of the agency – including executive and on-the-ground staff – was a barrier to implementation.<br>Buy-in of site managers was identified as particularly important in DoE and PNSW interviews as they can act as gatekeepers to successful installation. Even engaged site managers were found to have limited awareness of the program and its benefits in interviews. | Program implementation | **Partially addressed by program design:**<br>The program team engaged in extensive relationship building at the start of the program to get agency buy-in.<br>However, the program team noted the challenges of maintaining buy-in on the basis of bottom-up individual relationships, e.g. negotiations for the participation of other agencies were dropped due to staff turnover.<br>Challenges during implementation suggest that higher buy-in across agencies may have made battery rollout easier. Buy-in was identified as a particular challenge for PNSW, where PNSW, facility managers (FMs) and tenants have competing priorities; FMs and tenants are involved in implementation but do not see benefits from the batteries, which are realised centrally by PNSW. |

| Challenges | Description | Phase | Program approach to address challenges |
|---|---|---|---|
| **Limited supply chain competency** | The lack of an established supply chain has been a historical barrier to installation.<br>Limited supply chain competency was cited by agency stakeholders and delivery partners as a complication during program implementation.<br>Interviewees perceived the procurement process to prioritise lowest cost offers over experienced contractors, leading to the selection of inexperienced contractors or strategic under-bidding from experienced contractors. Both of these scenarios were identified as adding cost and delay in implementation. | Pre-existing / program implementation | **Improved through program experience:**<br>The program has contributed to broader supply chain competency, as discussed under KEQ4, and agencies have developed working relationships with delivery partners.<br>However, there was some concern that expertise built in delivery partners via the program will not be retained by government if those suppliers are outbid by cheaper suppliers with less experience in subsequent procurement rounds.<br>Challenges evaluating technical experience relative to cost in the procurement selection criteria have not been addressed and are beyond the remit of the program. |
| **Requirement for sites to have solar** | The program design specified that sites needed to have pre-existing solar PV or self-fund new solar to be eligible for the pilot.<br>The program design assumed that the primary preliminary battery use case would be storage of excess solar and viewed the requirement for agencies to co-contribute as a sign of commitment to the program. | Program implementation | **Unforeseen challenge that arose during implementation:**<br>The requirement for existing or self-funded solar may have been a barrier to entry to the program due to a lack of suitable sites with solar and challenges allocating additional funding within agency.<br>The program team observed that the assumption that there was excess oversized solar on government buildings was incorrect. Battery use cases under the program are ultimately not solar dependent as no sites have sufficiently oversized solar to need to store excess generation; solar is used for self-consumption and battery use cases have batteries charging from the grid.<br>Not all solar installations driven by this requirement were additional, e.g. additional school solar capacity was already funded under the Cooler Classrooms Program. |

| Challenges | Description | Phase | Program approach to address challenges |
|---|---|---|---|
| **Technical complexity** | Agency stakeholders and delivery partners noted that the technical complexity of battery designs and use cases posed a challenge to implementation.<br>Battery use cases under the program are not 'out of the box' functionalities for smart batteries and require detailed commissioning.<br>Some sites, particularly schools, were identified as challenging installations due to the complexity of their physical locations.<br>PNSW batteries have still not been commissioned due to technical issues with existing meters. | Program implementation | **Partially addressed by program design:**<br>The program provided technical support to participating agencies, as described above. However, agency stakeholders and delivery partners across agencies noted that technical complexity was higher than anticipated and that delivery partners were learning on the job to deliver installations under the program.<br>Participation in the program has helped build knowledge and technical skills within both agencies and in delivery partners; however, concerns were raised that agencies are reliant on knowledge sitting with external delivery partners.<br>Agency stakeholders and delivery partners noted that technical complexity is likely to be an ongoing challenge in operation and maintenance of these batteries and any future projects. |
| **Regional implementation** | Delivery partners for DoE and PNSW batteries noted challenges working in regional sites dispersed over a large area, including difficulties sourcing appropriate local contractors, travel time and costs, and supply chain delays. | Program implementation | **Partially addressed by program design:**<br>Challenges with regional implementation were not addressed by program design or agency implementation. Site selection was constrained by use cases, with the DoE network augmentation use case requiring more remote sites.<br>There are benefits to regional implementation, as the broad distribution of sites helps share benefits in regional communities.<br>Staging of implementation within agencies may have reduced cost and delay (as discussed under KEQ1). Flexibility given to agencies to manage implementation under non-binding contracts allowed the program to adapt to delays associated with regional implementation. |

| Challenges | Description | Phase | Program approach to address challenges |
|---|---|---|---|
| **COVID-19** | All interviewees noted the impact of the COVID-19 pandemic and associated supply chain disruption, state lockdowns and changing site policies on implementation and timeframes. | Program implementation | **Partially addressed by program design:**<br>COVID-19 was an unexpected challenge during implementation. Flexibility given to agencies to manage the implementation under non-binding contracts allowed an adaptive response to COVID-19 related challenges. |
| **Program ownership** | The program team and stakeholder agencies noted a disconnect in expectations around program ownership and risk between DPIE and participating agencies.<br>As DPIE allocated funding through the Climate Change Fund, they saw value in retaining control and oversight to ensure the money was spent responsibly and the program was successful. However, from an agency perspective, extensive DPIE oversight and signoff was seen as a project delivery risk; agencies expressed the view that they needed to be able to run their own projects. | Program implementation | **Unforeseen challenge that arose during implementation:**<br>The program had to be adapted in response to this barrier. DPIE originally planned a greater degree of control over program implementation, e.g. centrally managed procurement.<br>DPIE and participating agencies reported engaging in extensive negotiations over appropriate levels of oversight prior to finalising contracts. |
| **Logistical barriers** | Delivery partners and stakeholder agencies identified logistical barriers to battery implementation over the course of the program, such as identifying compliant locations for batteries of various sizes. | Program implementation | **Unforeseen challenge that arose during implementation:**<br>This barrier was exacerbated by the lack of buy-in across agencies, particularly at site level, and miscommunication between sites and delivery partners on technical considerations for battery location and connectivity. |

| Challenges | Description | Phase | Program approach to address challenges |
|---|---|---|---|
| **Ownership of energy assets** | Concerns about ownership or self-management of energy assets may pose a barrier to future battery revenue.<br>School and hospital sites both highlighted the importance of maintaining control over their own assets in interviews for energy security purposes. However, FCAS and VPP orchestration revenue pathways require control of the batteries to be handed to a third-party provider. | Program implementation | **Unforeseen challenge that arose during implementation:**<br>This is an emerging barrier. We note the FCAS and VPP use cases are fundamentally different from more typical energy projects pursued by government agencies, generating revenue from ongoing management rather than bill savings from one-off installations or interventions.<br>Future participation in FCAS and VPP revenue streams by some sites may help resolve this barrier if the batteries installed under the program can demonstrate the benefits of these use cases without energy security drawbacks. |
| **Lack of quantitative data on battery usage outcomes** | Technical constraints (e.g. delayed commissioning, complications establishing monitoring capability) and reliance on delivery partners for ongoing monitoring, due to lack of resourcing or technical skills within the agency, mean agencies have had limited visibility over data on real battery operations. Data has not been collected consistently as intended by the evaluation plan (discussed under KEQ3). | Program implementation | **Unforeseen challenge that arose during implementation:**<br>Data collection was anticipated as a key part of the program, with collection requirements laid out in the evaluation plan.<br>This barrier may have been exacerbated by program delays (so no or limited data is available), limited capability to monitor and interpret data given technical complexity of the battery arrangements, and limited agency resourcing for monitoring. |

## The program's design and flexibility supported successful mitigation of barriers experienced by participants

The program design was able to resolve key challenges faced by participants and mitigate barriers to prior installation of smart batteries, most notably cost, value proposition and technical support. Funding for the upfront cost of batteries improved the value proposition for agencies and provision of funding to support feasibility studies helped clarify the use case and benefits for agencies.

The experience of installing batteries under the program has further helped resolve challenges around agency comfort and confidence in untested technologies (discussed further below), the health and safety implications of batteries and the logistics of implementation.

The program revealed many unforeseen challenges that were not addressed through the initial program design, particularly through the program implementation phase, as outlined in Table 4 above. The identification of unforeseen challenges has value for future programs, which can be targeted to address these barriers in the design phase. Identifying barriers to uptake was an explicit program goal under phase 1 (the initial pilot) and these are lessons are an important outcome of the program.

These implementation challenges were broadly manageable under the program, largely due to the flexibility of the funding arrangements in place. Agencies did not report critical implementation failures and no variations to contracts were required to manage changes over the program lifetime.

## However, some barriers require continued attention

Some key challenges remain unresolved upon conclusion of the program and may constrain future spillover or benefits from already installed batteries.

- **Uneconomic site-level business case:** Interviewees noted the poor business case for batteries in government buildings (with the exception of the avoided network augmentation use case) is likely to constrain spillover until there is more certainty around FCAS and VPP revenues. Batteries are not expected to generate sufficient operational savings to meet payback threshold requirements. However, these batteries also yield significant benefits beyond site-level (avoided network augmentation costs, grid stability and peak demand response) that are not captured in site-level business cases. Identifying or developing market mechanisms that capture the value of community-level benefits for battery owners and operators will improve site-level business cases and help drive greater spillover.
- **Continuing to build agency buy-in**: The program team made significant effort to build buy-in in participating agencies, but acknowledged this was largely dependent on individuals. Continuing to build buy-in – especially as battery benefits are realised – will maximise positive outcomes from the program.
- **Data availability:** The absence of accessible data from the project remains a key barrier to understanding its overall success and the benefits being derived from the installed batteries. As data becomes available from more recently commissioned batteries,

ensuring this data is collected in a consistent, usable format is crucial to the program's value as a demonstration case to drive spillover and future investment.

# The program drove changes in knowledge, attitudes and practice in participating agencies

Under M&E package 2, we interrogated the influence of the program on the knowledge, attitudes and practices (KAP) around battery technology in participant agencies. Developing agency confidence in the benefits of battery technology was a key objective of the program.

The analysis above demonstrates the importance of these factors, with capacity factors like untested nature of the technology and lack of technical expertise identified as key participant challenges.

## Agencies had limited experience with battery technology prior the program

None of the participating agencies had prior practical experience implementing battery technology. DoE stakeholders raised examples of possible prior projects involving smart batteries but had incomplete memory and no direct personal experience with these projects. MoH stakeholders noted that the Port Macquarie Base Hospital installation was one of the first global installations of a smart battery at a hospital.

While the stakeholders in energy and sustainability teams within agencies engaged for the project had knowledge of battery systems and spoke confidently about the barriers to installation, broader agency knowledge was acknowledged to be limited.

Agencies were broadly uncertain of the benefits, feasibility and appropriateness of deployment of batteries at government sites prior to the project. These attitudinal challenges are outlined above – including uncertainty about the untested nature of battery technology, uncertainty around the value proposition and health and safety concerns. DoE and MoH stakeholders questioned the appropriateness of piloting new technologies in sensitive sites like schools and hospitals with particular safety and energy security needs.

Generally low or unfavourable baseline KAP are evidenced by the unforeseen reluctance of agencies to take part in the program. The program team reported their early anticipation that the program would be oversubscribed even at its initial $14 million funding allocation, and that a single agency could easily use the entire program funding. In fact, the program team reported negotiations for the participation of DoE and MoH in the program took significantly longer than expected, and DoE had challenges identifying suitable sites to trial the technology due to uncertainty around appropriate use cases and the program requirement that sites install solar.

## The program successfully increased comfort, familiarity and interest in battery technology in participating agencies

Interviews with agency stakeholders and delivery partners provided compelling evidence that the program team drove change in KAP in participant agencies. There was broad agreement that agencies had improved their comfort level and familiarity with smart battery technology.

Many of the attitudinal challenges or perceived risks have been directly mitigated by participation in the program, e.g. initial concerns about fire risk have been assuaged by the technical support provided by the program and the successful, safe delivery and operation of onsite batteries. Interviewees attested that the program had value in building executive familiarity and risk tolerance even in the absence of concrete findings as to financial benefits from the technology.

We note that the stakeholders involved in our interview process were those most engaged with the project, and thus there may be some bias to these perspectives. However, a reported increase in investment and interest in batteries following participation in the program provides evidence for the influence of the program on KAP factors.

*Table 5 - Evidence of interest in battery technology by agency*

| Agency | Evidence of growing interest in battery technology |
|---|---|
| **MoH** | MoH stakeholders note significant increase in interest in battery technology at health sites. The Port Macquarie Base Hospital case study has been presented at numerous forums within health and Lithgow Hospital, Murrumbidgee Hospital and Ambulance NSW have expressed interest in battery technology.<br>This interest has not informed concrete plans or investment due to a lack of available funding from external sources (analogous to the program) and the poor value proposition in the absence of capital funding.<br>MoH representatives noted they would be eager to go through the program again at other sites, e.g. if it had progressed to its planned second phase.<br>MoH are in ongoing negotiations with their battery operator about future use cases for their existing batteries at Port Macquarie Base Hospital. |
| **DoE** | DoE has since commenced a larger program of investment in smart battery technology in schools, the Smart Energy Schools Pilot Project (SESPP).<br>There is no identified causal link between the SBKGB program and the subsequent SESPP – no outcomes from the then-incomplete SBKGB program were available when SESPP was funded, and the SBKGB program was not reported to be used in the business case for SESPP. There is overlap in objectives between the programs, e.g. both programs are testing the avoided network augmentation use case in a school context. However, agency and delivery partners suggested that increased comfort levels with battery technology at executive level may have contributed to the decision to fund battery technology.<br>There was consensus from education stakeholders and delivery partners working on both programs that implementation for SESPP had proceeded more smoothly and avoided implementation challenges identified in SBKGB. |

| Agency | Evidence of growing interest in battery technology |
|---|---|
| **PNSW** | PNSW interviewees did not mention plans or interest in additional investment. We note that as the PNSW batteries are yet to be commissioned, SBKGB is still ongoing from a PNSW perspective, and the agency has yet to see benefits from installation.<br>Interest may also be constrained as PNSW reported that the most suitable sites based on the business case (the "low-hanging fruit") were put forward under SBKGB. As use cases that do not rely on solar (e.g. to generate VPP / FCAS revenue) are demonstrated, other sites may become more attractive.<br>PNSW are continuing to invest in the batteries installed under SBKGB, actively negotiating with their battery operator on a maintenance and operation contract for FCAS / VPP use cases to maximise benefits from their installations. |

The extent to which changes in KAP are dispersed across agencies as opposed to concentrated in stakeholders varies. While there was broad agreement that agency attitudes had changed outside immediate program stakeholders, particularly at executive level, interviewees within agencies raised concerns that the increased knowledge built by the program sits with individuals. It is not clear how well lessons from the program have diffused across agencies. Program team, agency and delivery partner interviewees observed that engagement with the program and successful implementation largely depended on having individual knowledgeable staff members to drive the program within each agency. Staff turnover poses a potential risk to future programs and future benefits from the SBKGB batteries given this reliance on individual knowledge.

The knowledge growth driven by the program in industry (e.g. delivery partners) is considered under KEQ4.

### Recommendations

- A structured process of knowledge sharing and dissemination with regards to lessons learned and barriers to implementation would maximise the value for future programs.
- Where programs involve collaboration with multiple agencies, we recommend a program of co-design with participating agencies to understand appetite for, and barriers to, participation in the relevant program.
- Where programs have complex implementation requirements, prioritise building buy-in at all levels of participating agencies. Where possible, structure incentives and communicate the value of programs so that 'on-the-ground' staff see and understand the benefits of participation.
- When programs involve novel or complex technologies, ensure procurement processes give appropriate weight to having the technical capability to deliver, to avoid delays and added cost.
- Where programs involve novel technology, a structured process to share benefits and lessons learned within agencies would support building change in institutional knowledge, attitudes and practices and mitigate the reliance on individual drivers of change.
- Explore policy options that help develop market frameworks to better capture the benefits of small to medium batteries to help overcome a narrow view of site-level financial costs and benefits in assessing battery use cases.

## 2.3 KEQ3 – Electricity, bill savings and emissions benefits

*To what extent are the participants saving electricity and reducing bills and Greenhouse Gas Emissions?*

## Key findings

- It's too early to make a comprehensive quantitative assessment of energy consumption and bill savings from the batteries installed under the program.
- Early data available from DoE batteries and solar systems suggests a correlation between program participation and consumption and bill savings and a positive emissions reductions impact.
- The program successfully demonstrated that batteries can be installed in network-constrained sites in lieu of network upgrades.
- Batteries at network-constrained sites are underutilised, suggesting the accepted process for calculating maximum demand is overly conservative.

## There is insufficient data available to make a quantitative assessment of program benefits

Quantification of the emissions, bill savings and energy consumption benefits from the program is complicated by implementation timeframes and data collection challenges. Table 6 below outlines data constraints and available data by agency.

*Table 6 – Data availability across agencies*

| Agency | Data constraints |
|---|---|
| **MoH** | Monitoring of site-level demand response capability only commenced in October 2022. The battery operator holds the relevant monitoring data. This has not been passed onto OECC for analysis yet. |
| **DoE** | Battery use data is available for 3 of 4 network constrained sites, which tested the use of batteries as a substitute for network augmentation. This data shows no battery use as the schools have not exceeded their grid demand threshold. While bill data is available for these schools, this battery use case does not impact site electricity bills as the batteries have not discharged.<br>Battery use data is not available for non-network constrained schools, which simulated a network constraint but also tested site-level demand response and solar smoothing use cases, due to issues with monitoring data collection.<br>Bill data that overlaps with the battery operating period is available for 1 of 3 non-constrained sites. |
| **PNSW** | No data available. At time of analysis, most batteries were installed but not yet commissioned due to metering issues at sites. |

This lack of quantitative data is a key challenge for the program. At time of interview, the MoH battery had only recently become operational and the PNSW batteries remained uncommissioned, so these sites were not yet realising benefits. While there are clear economic benefits to avoided network augmentation, DoE stakeholders interviewed for this evaluation at both a site and agency level did not have access to outcomes data to speak confidently to the bill, energy or emissions savings the non-network constrained site DoE batteries were delivering. It is unclear how data is being collected and monitored for each of the school sites.

Despite the lack of data on outcomes, all agencies are now considering tailoring the use of the batteries to target new revenue streams through participation in the wholesale market via VPP orchestration and the FCAS market. The perception within each of the agencies is that the economic case for using the batteries to target these alternative revenue streams is much stronger than optimising the batteries for site-level demand management. This is likely true. However, we have not been able to quantitatively compare the benefits of both use cases due to the lack of available data, which leaves us without a baseline to identify the future incremental benefit of VPP and FCAS revenue.

A key finding of this evaluation is that access to most of the available data is controlled by external delivery partners, and there is lack of clarity on individual staff responsibilities for monitoring and reporting within OECC and the agencies. While MoH staff appeared most engaged in active monitoring and the ongoing operation of the batteries, this was dependent on the individuals involved and was not a feature of program design. This will be a barrier to accurately assessing benefits from different use cases moving forward. Reliance on external consultants for data and monitoring was also identified to add risk, as personnel changes in these external organisations may strand sites or agencies with assets that they are unable to monitor.

In the absence of more data, we are unable to make a comprehensive assessment of battery benefits. However, early indicators (as detailed below) suggest the program is likely to contribute to energy, bill savings and emissions benefits.

## Early indicators suggest a positive correlation with energy and bill savings and program timeframes

For the non-constrained school site where bill data is available, comparison of monthly energy use (kWh) and cost ($) both before and after battery installation shows a correlation between energy and bill savings and battery commissioning (see Figure 2 and Figure 3 below).

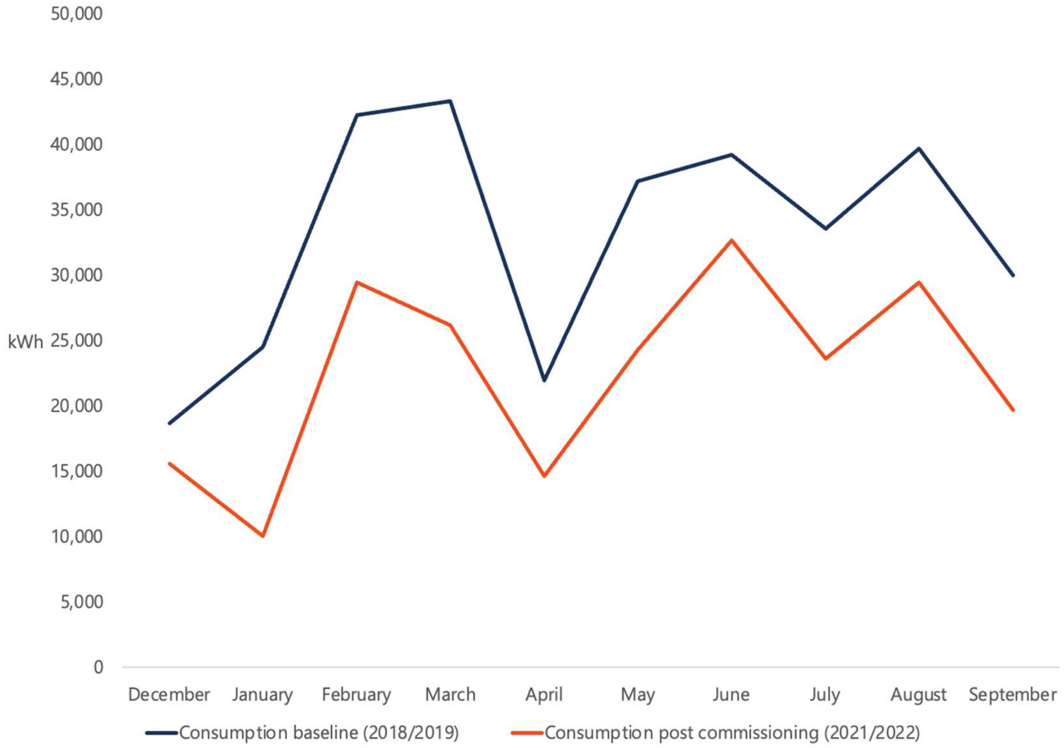


*Figure 2 – Baseline (2018/2019) grid energy consumption compared to post PV and battery commissioning (2021/2022) energy consumption for Jamison Public School (extracted from energy bills). 2019 used as baseline year to control for impacts of COVID-19.*

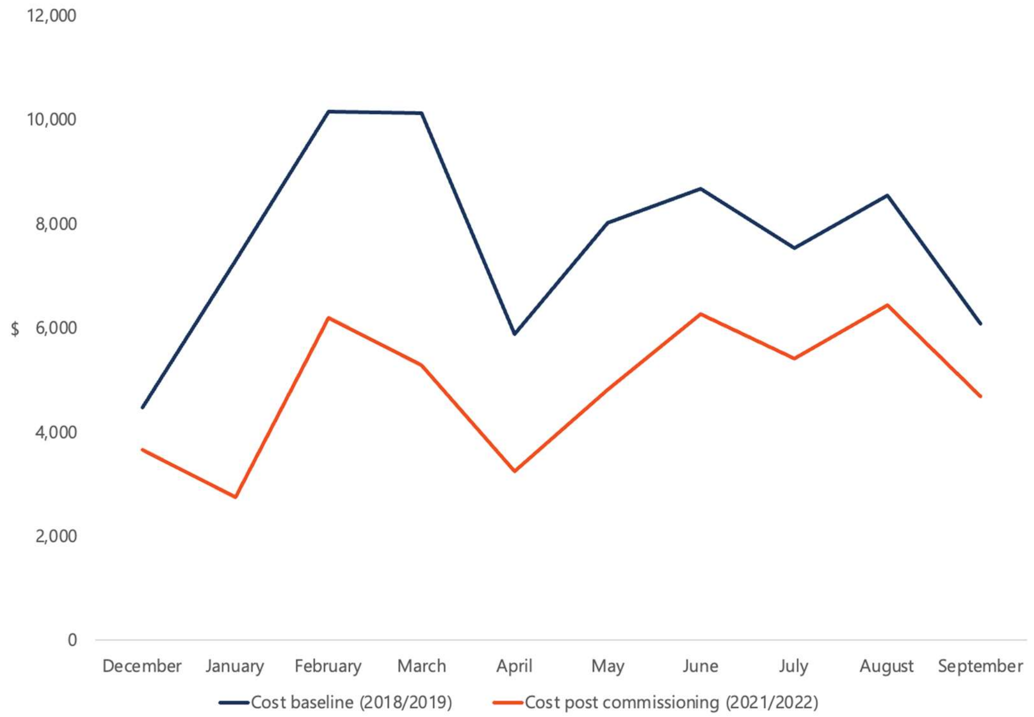


*Figure 3 – Baseline (2018/2019) energy cost compared to post PV and battery commissioning (2021/2022) energy cost for Jamison Public School (extracted from energy bills). 2019 used as baseline year to control for impacts of*

However, we note that this is a correlation only. Factors external to the program, including changing energy tariffs, weather patterns (notable El Nino and La Nina periods) and a changing school demand profile (e.g. additional demand from HVAC under the Cooler Classrooms Program) are also likely to have impacted energy use and cost over this period. The impact of batteries installed under the program on energy and bill savings cannot be definitively isolated from the impacts of these non-program factors in the absence of inverter data from the site.

We are unable to perform this simple analysis for the other two non-network constrained schools as we do not have access to energy bills that overlap sufficiently with the time the batteries had been operational.

## Additional solar PV installations have contributed to emissions reductions

Program requirements specified sites should have an existing solar PV system that was sufficiently sized or that could be upgraded to a sufficient size to support the installation of the battery. This was to ensure that there was no net increase in GHG emissions as a result of the operation of the battery.

Solar PV was to be sized to ensure there was either some excess solar available to charge the battery (existing systems) or that additional renewable energy capacity was added to offset any increase in emissions that may occur. Table 7 below shows the additional solar PV capacity that was added across all participating sites, where known; note that we are unable to differentiate new and existing solar at some PNSW sites due to lack of documentation.

*Table 7 – Additional solar capacity installed at participating sites*

| Agency | Site | Additional solar PV capacity (kWp)* |
|---|---|---|
| **MoH** | Port Macquarie Base Hospital | 160 |
| **SINSW** | Stockinbingal Public School | 9.9 |
| | Lake Wyangan Public School | 7.92 |
| | Beckom Public School | 16 |
| | Tharbogang Public School | 19.8 |
| | Jamison High School | 20.46 |
| | Nimbin Central School | N/A – existing solar |
| | Singleton High School | 31.35 |

| | | |
|---|---|---|
| PNSW | Albury | 15.2** |
| | Armidale | N/A – existing solar |
| | Bathurst – Panorama | N/A – existing solar |
| | Bathurst – William | 68.4 |
| | Broken Hill | 47.79 |
| | Cootamundra | 31.35** |
| | Goulburn | 54.72** |
| | Grafton | 38.76** |
| | Griffith | 68.4** |
| | Gunnedah | 37.24** |
| | Inverell | 31.15 |
| | Lithgow | N/A – existing solar |
| | Moree | 64.98 |
| | Nowra | N/A – existing solar |
| | Orange | 84** |
| | Parkes | 96.12** |
| | **Total** | **317.75 – 743.54** |

* kWp (kilowatt peak) refers to the amount of peak output of the system, i.e. the power produced in optimum conditions (bright sunshine)

**Unable to differentiate new and existing solar

A known additional 317.75kWp solar PV was installed at participating sites, with up to a potential further 425.79kWp at eight PNSW sites where we are unable to differentiate new and existing solar.

PV generation and consumption data has not been provided for most sites, so we have been unable to properly calculate the emissions, energy and bill benefits of the additional PV installation.

However, we have been able to extract some basic solar PV data from four school sites from the SINSW Battery Storage Technical Case Study. We have modelled the GHG emission reductions attributable to the additional PV capacity at these sites at a site-level (based on self-consumption) and overall (including PV exported to grid), shown in Table 8 below. The data has been extrapolated to cover a 12-month period for comparison. The projected total avoided GHG emissions reductions attributable to the additional PV installed at these four sites over 12 months was 61 $tCO_2$-e.

*Table 8 – Solar generation, consumption and export over available monitoring period, with projected annual emissions reductions*

| Site | Monitoring period | Total PV generation | Total PV consumption | Total PV exported to grid | Total energy consumption from grid | Projected annual site level emissions reduction ($kgCO_{2\,e}$) | Projected annual total emissions reduction ($kgCO_{2\,e}$) |
|---|---|---|---|---|---|---|---|
| **Stockinbingal Public School** | 25/03/21 to 13/01/22 (10 months) | 10.15 MWh | 7.03MWh | 3.11MWh | 9.96MWh | 6,900 | 9,900 |
| **Lake Wyangan Public School** | 15/11/21 to 13/01/22 (2 months) | 2.88MWh | 2.87 MWh | 0.01MWh | 4.18MWh | 13,800 | 13,800 |
| **Beckom Public School** | 26/03/21 to 13/01/22 (10 months) | 13.55MWh | 6.79MWh | 6.76MWh | 6.24MWh | 6,700 | 13,300 |
| **Tharbogang Public School** | 26/03/21 to 13/01/22 (10 months) | 24.01MWh | 9.39MWh | 14.7MWh | 11.3MWh | 9,200 | 23,600 |
| **Total** | | | | | | **36,600** | **60,600** |

## Batteries at network-constrained schools helped avoid expensive network augmentation requirements

The primary objective of this program at the four network constrained schools was to avoid or defer the need for network augmentation to cater to the increased site demand from the installation of HVAC under the Cooler Classrooms program.

Battery installation at these sites successfully demonstrated the viability of batteries as alternatives to network augmentation. Across the four constrained sites, battery installation saved an estimated $447,046 from day one compared to the cost of upgrading the network. This saving was sufficient to cover battery installations across the remaining three non-constrained DoE sites.

*Table 9 – Utilisation of batteries at network-constrained school sites*

| Site | Estimated network upgrade cost | Delivery cost, including solar | Savings |
|---|---|---|---|
| **Stockinbingal Public School** | $200,000 | $65,560 | $134,440 |
| **Lake Wyangan Public School** | $200,000 | $71,760 | $128,240 |
| **Beckom Public School** | $200,000 | $109,658 | $90,342 |
| **Tharbogang Public School** | $200,000 | $105,976 | $90,024 |
| **Total** | $800,000 | $342,954 | **$447,046** |

However, battery use data shows that these batteries are underutilised. Table 10 below shows, for each site, the available grid capacity at each site (the network threshold beyond which point battery discharge is required to meet demand); the estimated maximum demand at the sites following HVAC installation; the actual recorded maximum demand at each site and the number of discharge events from each battery.

*Table 10 – Utilisation of batteries at network-constrained school sites*

| Site | Available grid capacity | Estimated max demand with HVAC | Actual recorded max demand (since commissioning) | Discharge events |
|---|---|---|---|---|
| **Stockinbingal Public School** | 85A | 93A | 26A | Nil |

| | | | | |
|---|---|---|---|---|
| **Lake Wyangan Public School** | 65A | 73A | 17.3A | Nil |
| **Beckom Public School** | 41A | 89A | 27A | Nil |
| **Tharbogang Public School** | 69A | 95A | 47A | Nil |

None of the batteries have discharged outside testing as the school sites have not approached the available grid capacity limit since installation. Three of the schools are operating well below the grid limit imposed on them and as such could explore other options for maximising value from the batteries. This is a positive finding as it means the batteries are likely to deliver greater ongoing financial benefits in the future than previously anticipated. Beckom Public School is operating closer to its limit than the other three sites. 12 months of monitoring data (capturing seasonal changes in energy use) should be assessed before any decisions are made about the possibility of exploring other battery use cases at this site.

The estimated maximum demand calculations were performed by Public Works using the accepted method under AS/NZS 3000. However, this data suggests the method is overly conservative when applied to smaller sites, e.g., schools. We recommend considering a broader review of maximum demand calculation and available real demand data post-network augmentation. If the maximum demand methodology is systematically overestimating demand across a broader range of cases, refining the methodology may mitigate the risk of funding unnecessary upgrades.

## Recommendations

- A quantitative assessment of outcomes should be conducted when 12 months of battery use data is available from each agency.
- Prioritise data collection and monitoring with clearly defined roles and responsibilities, including a data owner within each agency, and develop a comprehensive data collection plan at the outset of the program with a standard format for data collection.
- Scope the viability of batteries as an alternative to network infrastructure upgrades at a broader range of sites requiring network augmentation.
- Consider a broader review of maximum demand calculation, and a refinement to the methodology should it be found to systematically overestimate demand across a range of use cases.

# 2.4 KEQ4 – Broader impacts on solar battery storage and VPP markets

*To what extent did the program drive uptake of, or investment in, solar battery storage or virtual power plants? What can we learn for future rollouts of new technology?*

## Key findings

- The program has had positive impacts on smart battery and VPP supply chains, developing supplier capacity and prompting market changes to make it easier for government sites to access VPP and FCAS benefits.
- Participation in the program has driven increased interest in battery technology in participating agencies; this may translate to spillover if program batteries are used to demonstrate lucrative VPP or FCAS revenue streams.

### Batteries installed under the SBKGB program were unlikely to be installed without program funding

Our analysis has found that the batteries installed under the program were highly additional, i.e. they were unlikely to be installed without program funding.

Battery installations at PNSW and MoH sites still have a fundamentally poor use case given their high upfront cost and long payback period. Funding for batteries is unlikely given these fundamentals (e.g. batteries would not meet MoH's internal payback threshold for investment) and these agencies did not report any independent plans to fund batteries.

While the DoE batteries had a more promising business case as they avoided network augmentation fees, SBKGB was the first program to test this use case, and there was no evidence from DoE stakeholders to suggest plans had progressed to test this use case under other programs, e.g. SESPP. The avoided network augmentation use case for the SBKGB batteries was only arrived at within DoE after significant engagement with the program team.

### The program has had a positive impact on supply chain readiness

The program has had a positive impact supporting delivery partners to build their capability in installing, commissioning, operating and maintaining systems – a key program objective following the program's change in funding.

Delivery partners interviewed for this evaluation reported varying levels of expertise with complex smart battery systems, but none had detailed experience at analogous sites prior to commencing the project.

*Table 11 – Experience of delivery partners by agency*

| Agency | Experience of delivery partners at similar sites |
|---|---|
| **MoH** | Note that we were unable to directly interview delivery partners on the Port Macquarie battery installation for this project.<br>MoH interviewees noted that their delivery partners had significant prior experience with smart battery systems – however, the hospital use case was a unique world-first installation. |
| **DoE** | DoE delivery partners had broad residential and commercial experience, but no prior experience at school sites – again, because these batteries represented a new use case that had not previously been tested in Australia. |
| **PNSW** | PNSW delivery partners were highly experienced in solar and battery systems, however the PNSW sites represented smaller scale battery installation and operation that they had not done before. |

Interviewees noted there were unique challenges to installation at government sites, including the health and safety sensitivity of schools and hospitals, infrastructural complexity at school sites, and IT and communications challenges with DoE infrastructure

There was broad consensus from delivery partner interviewees that the program had been valuable in enhancing their capability to install and commission smart battery systems at sites of this nature. Delivery partners spoke highly of the value of the program as a learning exercise for their businesses. This has helped maximise the benefit of the subsequent SESPP; DoE retained a key delivery partner for that program, where the improved capability and key lessons learned under the SBKGB program contributed to a smoother battery rollout. Batteries installed under the program have not been operational long enough for an assessment of the program's contribution to capability to operate and maintain these systems.

We note an unanticipated benefit of agency-led rather than centrally managed procurement is that these benefits are shared between the multiple delivery partners engaged by each agency, so the program has had a broader impact on the overall market. However, this also meant that delivery partners faced similar challenges across different programs; lessons could not be applied contemporaneously as different delivery partners were acting in silos.

Some interviewees voiced concerns that knowledge gained by delivery partners isn't retained by government should government select a different delivery partner for subsequent projects. This is exacerbated by the lowest cost procurement challenges identified under KEQ2, as delivery partners who have been through the delivery process with government are likely to quote higher for subsequent services due to their prior experience, with increased understanding of project complexity and the potential for extra costs and delays. However, the overall contribution to supply chain readiness and market capability assessed in this section is positive.

## The program has driven direct changes in VPP services and FCAS markets

Interviews with PNSW, NSW Treasury and the whole-of-government electricity contract provider found that the PNSW tranche of batteries delivered under the program directly triggered changes to the whole of government contract's VPP provisions. The renegotiated electricity contract includes new provisions to make it easier for government agencies to orchestrate their batteries in a VPP.

Similarly, the PNSW project has prompted the whole-of-government retailer to develop a new dispatching platform to allow smaller-scale commercial batteries (of the kind installed in PNSW sites) to access wholesale FCAS markets, which is likely to have spillover to other smaller commercial batteries.

## The program has identified key factors to unlock future spillover

It is too early to meaningfully assess spillover. Program implementation is ongoing and MoH and PNSW sites do not yet have data on assessable outcomes from their installed batteries to prompt further investment. However, the changes the program has driven in agency KAP (discussed under KEQ2) are a key enabler of future spillover.

The program helped identify key factors to improve the business case for batteries and accelerate future spillover, including:

- Aligning installations with savings from avoided network augmentation
- Additional funding support or decreasing upfront cost of batteries
- Improved revenue from FCAS or VPP streams

Interview findings suggest that battery market development is currently constrained by high upfront battery costs, which require high revenue to achieve a good payback on the initial investment. While the SBKGB program assumptions projected a year-on-year decrease in battery prices, this has not eventuated. Interviewees were uncertain about the trajectory to lower battery prices due to factors including previously inaccurate projections of price falls, a relatively well-established production line for batteries (suggesting limited opportunities to identify efficiencies or reach further economies of scale) and the limited resource base for lithium-ion batteries.

In lieu of declining upfront costs, higher revenue is needed to improve the business case for smart batteries and unlock future investment. Interviewees were more bullish about improvements in battery revenue as FCAS, VPP and grid-level demand response functionalities become established and the scale of potential revenue from these uses becomes clearer. Interviews suggested that this may be accelerated by changing electricity market conditions, as increasing electricity price volatility makes storage capacity more valuable.

The batteries installed under the SBKGB program have value as demonstration cases for these services. The interest built by the program may translate to greater spillover in future investment if the SBKGB batteries demonstrate strong revenue and thus an improved business case for future installations.

### What can we learn for future rollouts?

Planning for spillover requires a strong understanding of barriers to deployment and whether they can be resolved by the program. Should the SBKGB batteries go on to successfully demonstrate the revenue potential from FCAS or VPP, materially improving the business case, this is likely to convert the interest generated by the program at participating agencies into future spillover.

Facilitating stronger communication between agencies and delivery partners may have aided the diffusion of lessons learned across agency silos. A structured process to communicate the outcomes and successes of the program, including revenue from future use cases, may help maximise future spillover.

#### Recommendations

- A structured process to communicate the outcomes of the program, now and into the future (i.e. as VPP and FCAS use cases are demonstrated) to wider government agencies and battery and VPP markets may help maximise spillover benefits.

## 2.5 KEQ5 – Peak reserve capability increase

*To what extent has the project increased the peak reserve capability in NSW (i.e. demand response)?*

#### Key findings

- VPP use cases that could be used for grid level demand response are not currently operational.
- The program is likely to have an impact on peak reserve capability as the batteries become VPP orchestrated, depending on agreements with operators.
- While some batteries are being used for site-level demand response, this may or may not coincide with network peaks.

### The batteries installed under the SBKGB program have increased overall network capacity

The known contribution of the SBKGB program to network capacity by agency is detailed in Table 12 below.

*Table 12 – Battery capacity installed under the program*

| Agency | Total storage capacity |
|---|---|
| **MoH** | 1,600 kWh at one site; note MoH is installing a second smaller battery at the Port Macquarie site not included in this total |
| **DoE** | 360 kWh across seven sites |
| **PNSW** | 1,280 kWh across 16 sites; note battery installation is not complete at three sites and additional capacity may be installed |
| **Total** | 3,240 kWh across 24 sites |

## However, they are not currently being used for grid-level demand response

We are unable to make a quantitative assessment of what proportion of that storage is available to respond to peak events because the batteries installed by the SBKGB haven't been commissioned for that use case, i.e. the storage is not meaningfully available in reserve to manage grid level peaks.

The batteries installed under the SBKGB program that are currently operational (excluding network-constrained school batteries, which are only programmed to discharge when sites approach their grid demand threshold) are being used to manage site-level demand, not for network-level demand response. Site demand may or may not coincide with broader network peaks as school and hospital sites have different energy use profiles to commercial or residential buildings.

The batteries are likely to support a reduction in grid level demand in the future. We expect grid-level demand response to be part of future VPP use cases, depending on individual arrangements between the relevant agencies and their VPP operators.

### Recommendations

- A quantitative assessment of outcomes should be conducted when 12 months of battery use data is available from each agency, including demand response impacts following VPP orchestration.

# 2.6 KEQ6 – Potential future benefits

*To what extent are facilities positioned to realise benefits from the batteries after the program concludes?*

## Key findings

- All agencies are interested in maximising the commercial value of their batteries and planning to use their batteries differently in the future.
- Future revenue streams from VPP orchestration and FCAS are expected to be more lucrative than initial peak shaving or solar smoothing use cases.
- The changes in KAP driven by the program and the program design specification to ensure batteries are VPP-compatible have set agencies up well to realise future benefits.

### Agencies are planning to use batteries to access additional revenue streams in future

All agencies are developing plans to optimise their battery use and access future revenue streams. All agencies are exploring participation in FCAS and VPP revenue streams. Likely changes to benefits derived from batteries by each agency are outlined below.

*Table 13 - Future benefits to be derived from batteries*

| Agency | Future benefits to be derived from batteries |
|---|---|
| **MoH** | MoH is in discussions around its planned final FCAS and VPP orchestration use cases for the Port Macquarie battery.<br>Likely new sources of benefit: VPP orchestration, FCAS |
| **DoE** | The school batteries are to be managed under SESPP, with underutilised batteries to be considered for VPP orchestration or redeployed.<br>Likely new sources of benefit: VPP orchestration, avoided network augmentation costs or energy savings at other sites |
| **PNSW** | PNSW is in negotiation with a delivery partner to manage and operate its batteries, including VPP orchestration and FCAS.<br>Likely new sources of benefit: VPP orchestration, FCAS |

The scale of the benefits from future VPP orchestration in terms of site revenue potential is still unknown and no data is available to support a quantitative assessment. Interviews suggested that FCAS and VPP revenues may be higher than expected in some cases, with MoH interviews noting the business case for VPP orchestration has substantially increased over the project lifetime due to independent market developments.

However, in other cases, benefits may be lower than expected. Interviews with PNSW stakeholders and delivery partners suggest revenue from participation in FCAS is likely to be lower for PNSW batteries as these batteries are smaller than the optimal size for FCAS participation. They likely face high metering costs to participate. Only five of the PNSW batteries are likely to be suitable for FCAS under current arrangements. However, a positive outcome of the project is that the whole-of-government electricity retailer is now exploring alternate dispatching platforms to enable smaller batteries to participate in FCAS markets.

## Program design and changes in KAP driven by the program have left agencies well placed to realise these future benefits

Despite the challenges faced by participant agencies over the program, all are well-placed to realise benefits from changing battery use into the future. Participating in the program has provided agencies with the physical battery assets they need to explore these revenue pathways, helped identify challenges, and supported them to develop the skills and experience to further explore potential benefits from battery technology. The flexibility and agency-run delivery model has fostered agency ownership of the program and agencies are in independent negotiations with partners around VPP and FCAS revenue options.

To that end, the specification that batteries be VPP-enabled for future functionality – even following the descoping of the program – is a key success of program design that will support participants to realise future benefits. VPP orchestration is expected to be a major revenue source for each agency in future.

### Recommendations

- Prioritise rigorous and consistent data collection to enable ongoing monitoring over the program lifetime and a robust end of pilot evaluation.
- A quantitative assessment of outcomes should be conducted when 12 months of battery use data is available from each agency, including the trial of new use cases like VPP and FCAS.

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SECTION 3

# Recommendations

This section summarises key lessons from the Smart Batteries for Key Government Buildings program and identifies recommendations for future government programs.

The SBKGB program has identified challenges with smart battery technology adoption across agencies that may have value in informing future government programs.

Recommendations and lessons learned from this program may support:

- Future programs involving smart battery technology, whether they are managed by OECC or other agencies
- Future programs involving deployment or adoption of complex or novel technology at government sites
- Future programs involving significant interagency collaboration

Our recommendations are structured across nine themes: program co-design, data management and handling, knowledge sharing and dissemination, staging, procurement, buy-in, maintenance funding, market policy exploration, and batteries as a substitute for network augmentation.

## Co-design key program considerations with participating agencies

Where future programs involve collaboration with multiple agencies, we recommend a program of co-design with participating agencies to understand their appetite for and barriers to participation in the relevant program. A structured process to understand the needs, drivers and operating situation may help avoid false assumptions or inadvertent barriers to participation in program design.

Elements to be considered in co-design should include funding arrangements, scope of funding, roles and responsibility, and validation and review of the program logic and desired outcomes, noting that a review of ultimate climate benefit outcomes needs to sit with the CCF.

Interviewees identified a number of points where SBKGB program design diverged from participant experience or expectations, including:

- **Concerns about program ownership**: While the program was initially intended to be more heavily centrally administered by DPIE (including functions like procurement), this was a barrier to agency participation. The program was ultimately adapted to give agencies a greater level of control.
- **Appetite for the program**: The program was anticipated to be oversubscribed but ultimately faced challenges identifying suitable sites, with lengthy negotiations with potential partner agencies.
- **The availability of excess solar PV on government buildings**: The requirement for sites to provide or self-fund additional solar was identified as a barrier to participation, as agencies faced challenges identifying suitable sites.

The program response to these identified barriers was successful: DPIE and participating agencies negotiated appropriate levels of control, and procurement and implementation responsibilities were significantly devolved to agencies, with the program team acting in a support capacity.

Building this flexibility and adaptability to participant needs into future programs at the earliest stages of design through a co-design process may better ensure programs are right-sized, can be implemented smoothly, and no inadvertent barriers are built into program design.

## Prioritise rigorous and consistent data collection

As noted previously in this evaluation, we do not yet have access to sufficient data to quantitatively assess program outcomes. This is due to implementation delays (many batteries were not yet or only recently commissioned at time of analysis) and data collection challenges (data not available in suitable format for commissioned batteries).

Gathering data to demonstrate program outcomes is essential to improving future policy and program design. However, it takes effort to identify program information, and to set up and maintain systems that can capture this data. This task often falls on operational staff for participants, who may not be aware of the broader value of their data to government, and who consequently may not prioritise this effort.

For this project, we recommend a quantitative assessment of outcomes should be conducted when 12 months of battery use data is available from a representative sample of batteries across each agency.

For future programs, we recommend:

- **Prioritising rigorous and consistent data collection** to enable ongoing monitoring over the program lifetime and a robust end of pilot evaluation. Where data is not yet available for a robust evaluation, consider delaying the outcome evaluation until data can be collected.
- **Ensuring clearly defined roles and responsibilities** for data monitoring, including identifying a data owner within each participating agency who is responsible for working with key delivery partners to extract and format all required data. Consider including data collection in funding agreements (where appropriate), and separately allocating funds to this collection. Develop a comprehensive data collection plan at the outset of the program with a standard format for data collection.
- **Commencing as soon as possible** as data becomes available, to allow earlier monitoring of data quality and earlier intervention when there are challenges with data collection or data format. Test the collected data regularly.

Analysis for this evaluation found that, where battery operating data is available, it is formatted inconsistently and there is a reliance on external delivery partners for monitoring and data management. Ensuring a data owner for each project within an agency, responsible for capturing data in an agreed format, may improve data availability and quality in subsequent projects.

Including funding to cover asset monitoring in initial funding allocations may support participating agencies to prioritise data monitoring – see also 'Provide funding for ongoing maintenance and operation' below.

## Build structured knowledge sharing and dissemination into program design

Lessons learned and insights for future programs were key objectives of the rescoped SBKGB pilot. However, after the program was decentralised, the role of the program team in compiling insights and sharing knowledge between agencies and more broadly appears to have been limited.

For future programs, we recommend structuring knowledge sharing and dissemination into both the program logic and program activities from the outset, with clear allocation of responsibility for knowledge sharing, as a key objective of the pilot phase. We recommend an enhanced role for the program team in future programs to synthesise lessons learned across agencies and share these more broadly via mechanisms like formal workshops and touchpoints between agencies.

We identified potential benefits from knowledge sharing at all levels:

- **Beyond the program**: We have identified a role for the program team in sharing key findings and lessons learned to participants beyond the program, including a broader range of government agencies and batteries and VPP markets. Understanding the lessons learned in the program and overall program outcomes is key to unlocking spillover benefits among these parties.

Understanding barriers to implementation, given the innovative use cases and implementation settings under SBKGB, may support battery and VPP suppliers to develop or tailor products to address these barriers and support a wider variety of battery use cases.

- **Between participants**: Interviews revealed that agency installations operated in silos, with limited awareness or understanding of one another's projects. While there were benefits to running independent projects, e.g. tailoring use cases to agency needs and sharing supply chain benefits across multiple delivery partners, we identified many common challenges across agencies.

  Where programs involve multiple agencies, facilitating communication of key lessons between participating agencies and delivery partners may help foresight barriers or implementation challenges and avoid delays and additional costs.

- **Within agencies**: While there is strong evidence the program has built capability and driven changes in KAP within agencies, some interviewees raised concerns that these changes are concentrated in individuals and vulnerable to staff turnover.

  Facilitating a structured process to share benefits and lessons learned within agencies may help embed institutional knowledge, attitudes and practices and mitigate the reliance on individual drivers of change.

For this program, we recommend OECC continue to work with agencies to collate lessons learned, particularly as they relate to barriers or implementation challenges, and identify insights for future programs.

Despite the de-scoping of VPP orchestration for the pilot phase, all agencies are now pursuing VPP use cases. We recommend the program team remain engaged with agencies to understand the benefits and outcomes of these use cases.

## Stage implementation in phases

Where future programs involve novel technology, we recommend staging delivery both within and across participating agencies to support smoother rollout and minimise additional costs and delays.

The initial program planned a two-stage delivery so that lessons from the preliminary pilot phase could inform a smoother second stage rollout. This staged delivery was ultimately discontinued when the program funding was reduced.

However, even within the pilot phase, staging delivery across and within agencies (as far as possible within project timeframes) may have contributed to a smoother overall rollout. Agencies faced shared implementation challenges that may have been avoided with better sharing of lessons from a preliminary implementation phase. Within agencies, stakeholders and delivery partners reported delays and additional costs associated with mistakes repeated across multiple sites. Completing and compiling lessons from end-to-end installation at a single pilot site before progressing to additional sites may have helped mitigate cost and delay.

## Acknowledge technical complexity in procurement processes

Where future programs involve novel or complex technologies, we recommend structuring procurement processes to ensure they give appropriate weight to having the technical capability to deliver, to avoid delays and added cost.

Agency stakeholders and delivery partners commented on the importance of procuring contractors with the correct skills and experience to deliver the project, particularly when working with novel or complex technology. Interviewees raised concerns that standard procurement processes that emphasise lowest cost procurement disfavour experienced contractors, as they are likely to submit higher quotes in recognition of the technical complexity of the engagement. There is a risk that contracts are awarded to less experienced contractors who may not have a full understanding of the complexity of the project, causing implementation challenges, delays and additional work.

## Build buy-in at all levels of participating agencies

Where programs have complex implementation requirements, prioritise building buy-in at all levels of participating agencies. Where possible, structure incentives and communicate the value of the program so that ‘on-the-ground’ staff see and understand the benefits of participation.

Although the program team made concerted efforts to build agency buy-in for the program, interviewees acknowledged that participation was largely reliant on individual drivers of change within each agency, and that lack of buy-in from other staff, including executives and on-the-ground staff (e.g. site level managers) was found to be a roadblock to implementation and delivery of the program. We identified a disconnect between effort and incentives: while successful delivery largely depends on the cooperation and effort of on-the-ground or site-level staff, the revenue and savings benefits of the program are expected to be realised at agency level.

Greater initial executive buy-in, perhaps supported by program co-design, and top-down communication of the benefits of participation to on-the-ground staff, may support smoother rollouts in future.

## Provide funding for ongoing maintenance and operation

In future programs where assets require maintenance, ongoing monitoring and management, allocating funding to these functions as part of initial grant funding may maximise benefits over the lifetime of the asset.

Interviewees noted that a lack of funding for maintenance, monitoring, ongoing operation and decommissioning was a barrier to participation in the program, and raised concerns that over the program lifetime these costs may outweigh the benefits of the batteries. While some agencies now have plans for maintenance and operation in place (DoE under a subsequent program, MoH funded under SBKGB), these arrangements were not accounted for in program design.

In the absence of ongoing funding, there is a risk that assets are poorly maintained, and agencies miss out on the full suite of potential future benefits. Agency stakeholders commented that data monitoring, maintenance and asset management for the batteries relies on existing teams and staff with no additional resourcing to support these new responsibilities.

Operational funding over the lifetime including provisions for monitoring and data capture may also improve data visibility, allowing for a better assessment of program success.

## Explore new funding mechanisms for public benefits

We recommend the government explore policy options that help develop market frameworks to better capture the benefit of small to medium batteries. There is an enduring market barrier to small to medium battery deployment where the value of public benefit yielded by batteries is not captured by the actors incurring the costs of battery installation.

Interviewees with agencies found a focus on the economic business case for batteries at site level, with interviewees claiming spillover would be constrained due to the poor business case – batteries are not yet at an adequate payback threshold (from savings or revenue) to justify the capital expenditure at a site level. However, many of the benefits of batteries are realised beyond a site level, e.g. reduced energy prices from avoided network infrastructure, reduced peak energy demand, and improved grid stability. The value of these benefits is not factored into site level business cases.

Facilitating policy that creates or improves the revenue stream for these batteries to reflect the value of these community-level benefits is likely to unlock future spillover and maximise the benefits from batteries installed under the program.

## Batteries as substitutes for network augmentation

We recommend scoping the viability of battery substitutes for network infrastructure upgrades at a broader range of sites where network augmentation is required to meet changing demand profiles. The DoE batteries deployed under the program have successfully demonstrated the possibility of battery installation as a substitute for expensive network augmentation, yielding a net operational saving to government.

Operational data from the batteries installed at network-constrained school sites shows these batteries have not been discharged as the sites have not approached their grid constraint (i.e. the maximum demand those sites can pull from the network). These batteries were not programmed for other uses to preserve their capacity for the primary network augmentation use case. We recommend these batteries now be considered for other use cases. While the calculations conducted for this program followed the acknowledged standard for estimating grid constraints, these results may suggest that the accepted methodology is overly conservative for similar sites.

We recommend considering a broader review of maximum demand calculation and available real demand data post-network augmentation. If the maximum demand methodology is systematically overestimating demand across a broader range of cases, refining the methodology may mitigate the risk of funding unnecessary upgrades.

SECTION 4

# References

This section includes work by other organisations referenced in the course of this evaluation. Program documentation and data provided by the evaluation team is not included.


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