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CRC

SP0018: Report

The commercialisation of CSIRO Energy Efficiency Policy Adoption Diffusion Modelling



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Acronyms

ABM	Agent-Based Modelling
API	Application Programming Interface
BE	Behavioural Economics
BTS	Bureau of Transport Statistics
CRC	Cooperative Research Centre
CRM	Customer Relationship Management
CSIRO Organisation	Commonwealth Scientific and Industrial Research Organisation
DM	Demand Management
EE	Energy Efficiency
ERP	Enterprise Resource Planning
FTE	Full Time Equivalent
GADM	Global Administrative Areas
GEES	Grids and Energy Efficiency Systems
GEMS	Greenhouse and Energy Minimum Standards
GIS	Geographic Information System
HVAC	Heating, ventilation, and air conditioning
IP	Intellectual Property
MVP	Minimum Viable Product
NASA	National Aeronautics and Space Administration
NED	Nudge-Emergence-Diversity model
NEM	National Energy Market
PCA	Property Council of Australia
PV	Photovoltaic
TRL	Technology Readiness Level
UAT	User Acceptance Testing

Executive Summary

This paper is a review of the potential commercialisation and adoption pathways for a suite of energy efficiency policy-uptake modelling capabilities from the Commonwealth Scientific and Industrial Research Organisation's (CSIRO). Common Capital undertook this review for the Cooperative Research Centre (CRC) for Low Carbon Living and CSIRO.

We reviewed the maturity of the capabilities as products and considered them against the potential markets they address. We compared them against competitor products in these markets. We then generated potential products and business models for the commercial deployment of these capabilities. We tested products and business models in interviews with 11 potential users from a cross-section of potential market segments. We then analysed and refined the business models testing them against a high-level financial analysis and CSIRO's commercial and impact objectives, and developed a high-level roadmap for commercialisation and adoption.

This review finds that the CSIRO has high-quality research capability and significant domain expertise in behavioural economics (BE) driven agent-based modelling (ABM). This includes an adaptable modelling framework, application development process along with potentially valuable underpinning data. CSIRO has also developed four domain-specific applications that are at varying levels of maturity.

These capabilities potentially have some distinct advantages over alternative products on the market, subject to the demonstration to customers of the validity of forecasts. More work is also needed to reach a scalable commercial product. The deployment of these capabilities for new use-cases currently requires non-insignificant customisation which is reliant on the expertise that are narrowly held within CSIRO. If they were to be commercialised, products would also require the further user testing, as well as a more formal user interface, hosting platform, software security, IP management, product and end-user documentation, licensing framework and customer support.

We considered a matrix of potential business models through which the capabilities could be developed into products and deployed. Our preliminary consultations with users reduced these to four possible (and potentially complementary) business models that warrant deeper investigation. These are bespoke single-purpose applications, a generic multi-purpose framework, consulting services, and data licensing. We identified three priority customer segments, with users in each that have a strong interest in collaborating with CSIRO on further product testing and development. These are:

- Energy and water Corporates and utilities with a range of potential use cases for bespoke applications

and data, for use on energy product development and marketing (incl. non limited to energy and water efficiency);

- Niche energy consultancies interested in a generic framework and data that they can adapt and incorporate into their existing modelling tools to support their modelling of energy market demand for utilities and government; and

- Energy and environment policy makers interested in a generic framework and data that they can adapt and incorporate into their existing modelling tools.

In the short term, there is an opportunity and need for consulting services from CSIRO to support product development and testing, and user-capability building. Our high-level financial analysis estimates a potential profit in the order of \$86,000-\$125,000 per annum for successfully commercialisation. However, the cost and revenue estimates need to be tested robustly through an extensive user needs assessment, which was out of scope for our review.

We set out a three-year road map to clearly identify the next steps, questions, and decisions points to refine these options with potential users and partners. Depending on the outcomes of investigations, the road map provides three alternative pathways:

1. Free download - Non-commercial, impact-focused release of the capabilities. Complete existing research and consulting obligations to provide proof of concept and engage early adaptors, then make the framework and data available royalty-free.
2. License the framework and data – continue development of the framework and BE data using existing CRC funding and co-investment consulting. In parallel, engage with niche consultants to ensure the framework development leads to a product that they value sufficiently to pay for a license.
3. Royalties from bespoke applications – applications ranging from demand forecasting for asset management or operations planning through to real-time customer engagement recommendations. Enterprise software vendors such as ERP and CRM solutions will be channel partners and fund the application build.

The next step is to engage with the organisations that expressed interest to quantify the commercial opportunities, the investment required and the likelihood of success. Based on this, the CSIRO can refine the financial model provided to assess whether to wind the research project down or proceed with licensing the framework and data. If framework licensing proceeds, the outcomes will inform a second Go / No-go decision to proceed with bespoke applications.

Next Steps

The next step is to engage with the organisations that expressed interest to quantify the commercial opportunities, the investment required and the likelihood of success. As part of the market review, we were able to provide a high-level assessment of the interest based on a general description of the product in a one-hour telephone conversation. However, in all cases, they wanted to see a evidence of successful backcasting and have access to CSIRO scientists for in-depth use-case workshops, product demonstration and trials. The use-case of most value to prospective users of the energy model is a demonstrated ability to forecast uptake of solar PV.

Ask these questions to determine the size of the opportunity

- What challenge or opportunity can this technology used for?
- Do you want to proceed with a project?
- What budget do you have?
- Who is the decision-maker?
- What process and timeline applies to reach a decision?

Ask these questions to determine the effort to deliver a project?

- What are the functional requirements for the software?
- What data is needed?
- What other services do we need to provide?

Based on the information collected, update and refine the financial model provided and use this to assess whether to wind the project down or to proceed with licensing the framework and data. See section 5.2 for a detailed decision flow chart.

Preface

The CRC for Low Carbon Living and CSIRO engaged Common Capital to conduct a review of the commercialisation and adoption of software to model scenarios for the uptake of energy efficiency policies.

Policy background

CSIRO, with support from the CRC for Low Carbon Living, is developing tools to support the design and development of energy efficiency policies. These tools are to model the market adoption of clean energy products and services for commercial buildings, residential buildings, transport and water.

Current context

Governments across Australia are increasingly looking to market-based policies to drive energy efficiency and carbon abatement. The CSIRO believes that these tools can help agencies rapidly understand the potential impacts of policy interventions. The tools may also be useful for policy analysts outside government, including those in research or advocacy roles in the private and not-for-profit sectors.

CSIRO now seeks to identify potential commercialisation opportunities for this Intellectual Property (IP) to ensure the ongoing viability of the tools.

The engagement

Common Capital was contracted to:

- Stage 1 - review the current status of the energy efficiency policy modelling tools.
- Stage 2 - conduct a product and user review.
- Stage 3 - develop potential tool solutions to meet customer needs.
- Stage 4 - develop commercialisation strategies that achieve the agreed success measure for each tool and document the next steps.
- Stage 5 - develop and refine a final report and conduct a presentation.

This report is a draft for the Stage 5 final report.

Success measures

The CSIRO corporate plan (CSIRO, 2017) sets out performance measures and targets and discusses the push to create sustainable revenue streams. The success measures for the contribution towards these objectives by the commercialisation of this IP are:

- Impact – adoption by at least two external organisations with tangible links to implemented energy efficiency policies or actions.
- Science excellence – publication of at least two peer-reviewed papers.

- Research partnerships – all research projects to have at least one research partner.
- Revenue – fund at least one Full-Time Equivalent (FTE) person by June 2019 and a trajectory towards funding two FTEs by June 2020.

These success measures are to be achieved without significant investment in software development while also balancing commercial and research priorities.

The structure of this report

This report has five chapters and supporting appendices that bring together the findings from our research and analysis.

- Chapter 1 is a review of the product review with Appendix 1 summarising the model data, Appendix 2 in the full report summarising the application development process and Appendix 3 in the full report describing the Technology Readiness Level stages.
- Chapter 2 is the market review with Appendix 4 in the full report summarising existing suppliers and Appendix 5 in the full report summarising the customer interviews.
- Chapter 3 brings the product and market reviews together in a competitive review.
- Chapter 4 describes three commercialisation scenarios with Lean Canvas models in Appendix 6 and a summary of revenues and expenses is in Appendix 7.
- Chapter 5 sets out the next steps.

1. Product review

A modelling framework and an application development process have been created along with some underpinning data. Also, the CSIRO has high-quality research capability and significant domain expertise. However, more work is needed to reach a commercial offering. Four market opportunities were identified and informed the selection of market research targets.

1.1 The CSIRO has created expertise and IP for assessing policy options

Research in the “Energy Transition Pathways” Grids and Energy Efficiency Systems (GEES) program has created expertise and IP in the use of Agent-Based Model (ABM) and Behavioural Economics (BE) to model uptake from energy efficiency interventions.

An ABM simulates the interactions of multiple, autonomous agents that operate in a defined environment. This enables emergent, more complex behaviours to be observed.

BE includes psychological, social, cognitive, and emotional factors in decision making. An application of BE is to inform policies that nudge community behaviour in cost-effective manners. For the most part, the rules governing the agents in the ABM are based on BE.

In recognition of the ABM and BE influence, the models are referred to as Nudge-Emergence-Diversity (NED) models.

A modelling framework has been created using the NetLogo software application. NetLogo is a widely used ABM tool and is freely available under the GNU Public Licence. NetLogo is, in the spirit of the Logo language, a “low threshold and no ceiling” tool, that is, it is relatively easy to use but still powerful. As such, it is suited for use by domain experts without a programming background. The framework built by the CSIRO provides the core elements of a BE driven ABM and therefore enables relatively rapid development of bespoke solutions for specific applications.

With an application development process... An application development process has been created and is flow charted in Appendix 2 in the full report. This process is client centred and determines how much modification of existing software and what additional data are required to meet the client’s needs.

..and underpinning data

Access to data is a critical factor for all forms of modelling, not just ABM. The CSIRO’s research has created IP in the underpinning data sets. The data sets are:

- Household survey data – describing the individual level decision priorities, circumstances, dwelling types, stated intentions for various decisions, current adoption of sustainability-related behaviours, level of financial stress, postcode, research profile (which information sources they use), cognitive parameters, etc.
- Household technology data – upgrade probabilities for different electricity technologies by year.

- Geographic Information Systems (GIS) mapping data including Australian local government area regions and names.
- Sales agent data – performance data for sales agents such as current sales success rates, cost of sales, and income and expenses from successful sales.
- Commercial building demographics such as location, office space and building age.
- Commercial building ability to retrofit data – likelihood that a commercial building will adopt a retrofit.
- Commercial building retrofit options – economic costs and benefits of different office building retrofits.

Appendix 1 summarises these data sets.

There are four research projects based on the framework, process and data. The CSIRO has a global reputation for excellence in basic and applied research. The research by Dr. Moglia and others under the GEES program contributes to that reputation with numerous publications and the creation of significant domain “know how”. This forms part of the IP that has commercialisation potential.

Four research projects on the use of BE driven ABM to forecast market adoption of clean energy products and services have been entered into. The projects are:

- Residential buildings – describes the uptake of low carbon and energy efficient technologies and practices by households under different interventions.
- Commercial buildings – describes the uptake of low carbon and energy efficient technologies and practices by building owners under different interventions.
- Water – enables water companies to better understand the decisions made by community members when they are presented with a range of water conservation products and services or are selecting water using appliances and fixtures such as washing machines and taps.
- Transport – a decision support tool to identify and prioritise investment that encourages the diffusion and adoption of low carbon suburban transport modes.

The residential building application is the most advanced. The water and transport applications were not sufficiently progressed for a copy to be provided at the time of this review. Both of those models have now been completed.

Collaborative research projects with potential clients have demonstrated that BE driven ABM can deliver value when applied to real-world scenarios.

And the software is at varying levels of market readiness software is a product that is ready for market release when:

- Customers value and will pay for the feature set offered.
- The software is secure and does not pose a risk to the customer.
- Customers have tested the software and deem it fit for purpose.

- A licence agreement is available.
- End-user documentation is available.
- Support processes are in place.

Technology Readiness Levels (TRL's) are a way of identifying the technology maturity of software development projects and are widely used to assess whether the software is ready to be deployed. For example, TRLs are used by National Aeronautics and Space Administration (NASA, 2012).

TRLs are based on a scale from 1 to 9 with 9 being the most mature technology. For example, TRL 7 is a Minimum Viable Product (MVP) demonstration showing operational feasibility with most software bugs removed.

The diagram below shows the TRL scale and Appendix 3 in the full report has a detailed description for each stage which is adapted from NASA's model (Talbert, 2010).

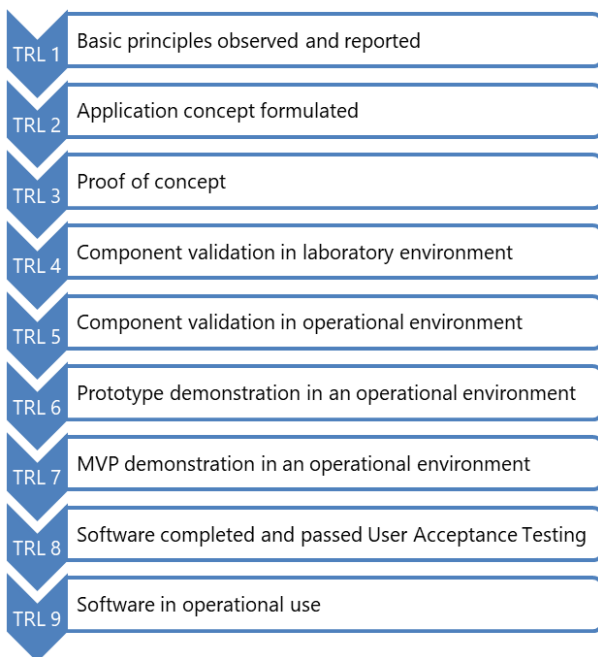


Figure 1: Technology Readiness Scale

The TRL's for the existing software are assessed for two scenarios:

- Product – the software is a product in which a non-technical end user can change assumptions via a user-friendly interface, run simulations and view outcomes.
- Framework – the software is a framework that an end user with modelling and programming skills can modify to incorporate their own IP or to address related but different policy questions.

The TRLs for the existing software are shown in the table below.

Table 1: Assessed technology readiness for tools, at the time of writing

Software	Offering	TRL
Residential	Product	4
	Framework	5
Commercial	Product	4
	Framework	5
Transport	Both	2
Water	Both	5
Framework	Framework	5

1.2 But more work is needed

Enhance the feature set to be commercially attractive

This engagement was structured on the basis that there are four models that are candidates for commercialisation. These are models for the market adoption of clean energy products and services for residential buildings, commercial buildings, transport and water.

The review in chapter 1.1 found that the commercial and residential buildings models are at a technology readiness level suitable for investigating market interest (but not products ready for commercialisation) with the other two at the concept stage.

Therefore, further, development is needed to enhance the feature set sufficiently before one or more of the models can be commercialised.

The market research identified interest by organisations in accessing the framework and data so that they can modify or extend them for their requirements. While the framework TRL is higher than that of the models, further development is still required.

Also, there is market interest in accessing BE/ABM modelling data. At the time of conducting the review, a full description of the available data was not available. It is possible that a richer data set, particularly more behavioural data, along with a process to provide updates and extensions is needed to provide more compelling commercial proposition.

Ensure the software is secure

Testing is required to ensure the software is secure with no compromises to integrity, authentication and availability. It is critical that the software can resist malicious attack and not be the means by which clients' systems are compromised.

User testing

User testing gives valuable feedback on features and uncovers issues that are not apparent in a laboratory environment.

IP management

Ensure third party copyright is respected and develop a licence agreement.

Product and End-user documentation

Product documentation is required to ensure that the software can be supported and enhanced when the original author is not available. End-user documentation is required to enable the use of the software and to minimise the requests for support.

Customer support

A customer support help desk process and resources are required to provide ongoing support to customers. Depending on the size and nature of the customer base, this can include a service level agreement, issue management ticket system, staffing, a knowledge base and other support tools such as remote access software.

1.3. The potential products

A matrix of potential product offerings

As a first step to designing the market research, “straw man” draft business models were created based on a desktop review of product and research information combined with input received at the project start-up meeting. From these, the following matrix of potential product offerings was developed.

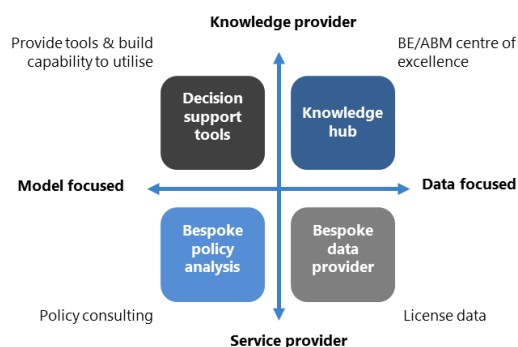


Figure 2: Matrix of Product Offerings

Identifies four product opportunities

Four product opportunities were identified based on the matrix of market offerings:

- Decision support tools – provide the modelling framework, the underpinning data and build the client’s organisational capacity to utilise these.
- Bespoke policy analysis – use the modelling framework and the underpinning data as a tool to provide policy analysis and recommendations on a project by project basis.
- Knowledge hub – become a BE/ABM centre of excellence with an extensive set of resources and

capability which are offered to clients on a fee for service basis.

- Data provider – build a comprehensive BE database that is licensed to end users.

Which informed the market research targets

These four product opportunities informed the selection of target market segments for the interviews. These are:

- Policy-makers
 - Federal and State government departments such as environment, energy, transport and water.
 - Local government.
- Research and advocacy groups:
 - Not-for-profit organisations in relevant fields.
 - Large corporations with research and advocacy staff such as energy retailers and distribution companies.
 - Research organisations such as universities.
- Policy consultants who develop regulation impact statements, cost-benefit analyses and other policy analysis for government and private sector customers.
- Large corporates and utilities such as energy and water that need demand forecasting for strategic and operational planning plus sales & marketing to influence consumer behaviour and increase the uptake of energy efficiency products and practices.

Appendix 4 in the full report shows the type of people interviewed, what target market segment they are in, the interview template and key points from each interview. The next chapter discusses the outcomes of the interviews.

Market review

There are many solutions on the market. There are BE specialists, BE driven software applications and there are numerous other consultancies. However, there is market interest for BE driven ABM as the acknowledged limitations of neo-classical rational actor models lead to market opportunities.

2.1. There are many solutions in the market

A desktop study identified typical competitors and substitutes to the use of BE and ABM for energy efficiency policy evaluation. These are shown in Appendix 4 in the full report and are summarised below.

There are BE specialists

Six leading global BE specialists are profiled. These organisations primarily conduct audits and reviews to identify opportunities to use BE theory and practice and then propose behavioural interventions that are tracked qualitatively or quantitatively. Two, The Behavioural Architects and Behavioural Insights, have an Australian presence. Behavioural Insights is of interest as they have commercialised several BE driven software tools.

Four Australian government-backed BE units or consultancies are profiled. One of these, Behaviour Works Australia, claims to be the largest applied behaviour change research unit in Australia with projects in health, energy, water, waste, pollution, biosecurity, education, social inclusion, finance and safety.

There are BE driven software applications

Four BE driven software applications are profiled. Of particular relevance is one particular consultant company's analytics-as-a-service platform, consultant company model. This is a cognitive-based computational model using a multi-disciplinary approach with artificial intelligence, simulation, behavioural science, and game theory, ABM, engineering and micro-economics. The consultant company use their model in their energy efficiency policy analysis consulting. The consultant company was interviewed as part of this project.

And there are numerous other consultancies

The "big four" (EY, KPMG, PwC and Deloitte) all offer energy efficiency consulting and BE driven approaches as does the economics specialist, Frontier. A further four large policy consultants are profiled – Allen, Urbis, Jacobs and Pitt & Sherry. These have extensive capabilities and strong reputation but are substitutes rather than direct competitors.

2.2. But, there is market interest for BE driven ABM

The limitations of neo-classical rational actor models are acknowledged

Most believe that the currently used neo-classical rational actor models have significant limitations. This is particularly so for modelling disruptive rather than incremental interventions. Most are interested in a new approach if it provides better projections.

However, some do not see modelling as the best mechanism. These organisations prefer to use qualitative research – literature, practice reviews and interviews – to form a view as to the best intervention and then market test it.

The role of other actors should be modelled

Many agree that the focus on the bilateral relationship between government/utility and consumer fails to consider the hugely influential role of other actors in the supply chain.

A "what if" tool to explore options is of value

The market research identified interest in a low-cost way to explore interventions and narrow down the options before incurring significant costs.

And availability and access to data is an issue

Most identified the lack of data as a major impediment to the use of BE, especially as clients are not prepared to pay the cost of collection for one-off projects. This was one of the strongest messages from the market research.

2.3. Which leads to market opportunities

The 2 x 2 matrix of potential market offerings set out in chapter 1.3 was the working assumption entering into the market research which interviewed 11 Energy Efficiency (EE), potential users. These interviews found that the potential market offerings are better represented as a continuum between a focus on the framework and a focus on services.

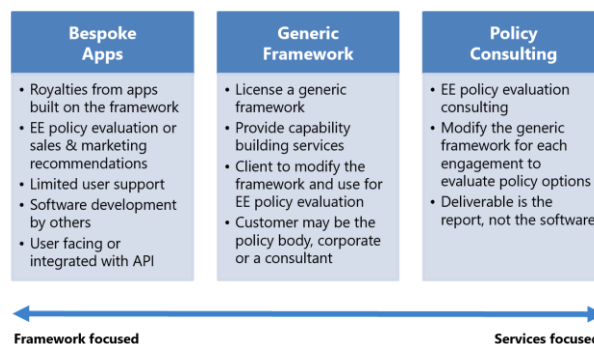


Figure 3: Commercialisation Options

A fourth market opportunity is providing access to BE data as the high cost of collection and maintenance precludes obtaining this for one-off projects. The CSIRO data sets were described to potential customers in general terms and further work is required to identify the minimum viable dataset to be of commercial interest.

Competitive review

There are significant strengths and opportunities but there are weaknesses and threats to be countered. The customers' needs and CSIRO's competitive advantage inform the proposed products and their value proposition.

3.1. There are significant strengths and opportunities

Strengths

Positive feedback from the interviews confirmed several strengths that support market interest in the IP. The strengths are:

- The use of ABM:
 - Gives insights into emergent phenomena which are difficult to predict using other modelling approaches or intuitively.
 - Handles complex or stochastic behaviours well.
 - Provides a natural description of a system that assists clients' understanding.
 - Presents a flexible methodology for testing ideas and providing predictions for multiple scenarios.
- The use of BE which aligns with the market's growing understanding of the limitations of neo-classical rational actor models and the demand for something better. There is a general awareness of the power of BE.
- Modelling the influencers in the supply chain is perceived as unique and valuable.
- The framework and associated IP provides a "quick start" for organisations wanting to use BE driven ABM rather than spending one to two years to reach this point.
- BE data is valuable and no one of these organisations can independently afford to collect this data. The CSIRO is seen as an appropriate body to facilitate shared access.
- The domain "know how" and research expertise.
- The CSIRO brand opens doors and is trusted.
- A funded runway to achieve the commercialisation goals.

Opportunities

The interviews with prospective users provided some insights as to the opportunities and confirmed that there is a market for this IP. This interest is summarised in the full report and is confidential. All organisations with an interest level of Medium or above agreed to have follow up meetings where a more detailed presentation can be received. Those with a High-interest level pushed for such a presentation to occur sooner rather than later.

Actors from three main customer segments were interested in the potential of CSIRO's capabilities: utilities, consultants, and policymakers.

Interviews with the consultant and a utility company identified the limitations of current energy demand forecasting as a significant pain point in the energy industry. This is a common

pain point for utilities, policymakers and the consultants that advise them. It extends well beyond energy efficiency policy to commercial valuations of utilities and policy-making on energy market reliability. If CSIRO's capabilities could be demonstrated to accurately forecast uptake activities that impact on energy market demand, then interviewees indicated they would be of great value. Accurate forecasting of uptake for solar PV (out-side feed-in tariff scenarios) is the single most valuable use-case. Other use-cases such as demand for electric vehicles or air conditioning are also of potential, but lesser value.

A consultant company are very interested in working with CSIRO to access and test commercialisation of the framework and data. They view off-the-shelf BE software as of low value for consultants. An informal framework that consultants can incorporate into the consultant's existing models is of greater value as it allows for consultant value-add and differentiation from competitors.

A utility company is interested in seeing a product demonstration and workshop with CSIRO to identify use-cases across up to a dozen different teams in the utility from product development, demand forecasting and marketing. There is potential demand in the utility for an informal framework that can be incorporated into existing modelling and development of purpose-specific applications.

Policymakers are interested in more in-depth demonstrations of the modelling results, framework and data sets. They see potential to help with modelling uptake of policy interventions. One department has internal quantitative analysis capabilities and a framework is of potential interest to them. Both agencies issue multiple consultancies each year in this space, which either CSIRO or consultancies using CSIRO's BE framework could bid for.

Within the constraints of the research scope of this project, we believe that reason to think these experiences are common to policymakers, utilities and consultancies. Interviews supported this finding. Chapter 5 outlines the next steps to these and other issues.

3.2. But there are weaknesses and threats to be countered

Weaknesses

The weaknesses that impact the commercialisation potential include:

- The low TRL stage of potential products.
- Only a small amount of unique, proprietary content currently in the data.
- Lack of case studies, in particular, back-casting examples that validate a photovoltaic (PV) uptake model.
- The tension between the allocations of effort for commercial activities versus research.
- The absence of dedicated marketing and sales resources.
- Limited funds to address the above.

Threats

The threats to the commercialisation potential include:

- The long selling cycles for this type of product.
- The entrenched position of existing approaches and vendors.
- Political changes disrupting customer priorities.
- Ensuring IP ownership and control, for example how to maintain control of the data when access is provided to it.

The next stages will develop commercialisation strategies that consider and mitigate these weaknesses and threats.

3.3. Market comparison

The table below compares the NED model with the main product offerings in the market.

Table 2: Market comparison table

Product	Method	Science	Model	Offering
NED Model (CSIRO)	Agent-Based Model	Behavioural sciences (considers psychological, social, cognitive, and emotional factors in decision making)	Buyer Influencer Seller	White box (the logic is exposed) or black box (the logic is not revealed)
Model by a consultant company	Agent-Based Model	Behavioural sciences, game theory (rational conflict and co-operation) and microeconomic theory (scarce resources)	Buyer Seller	Black box
Rational actor models (Most common approach)	Neoclassical economics (maximising buyer utility and/or seller profits in a supply & demand model)	Rational actors operating independently with relevant information and with preferences that can be identified and scored	Buyer Seller	White box or black box depending on the engagement.
BE driven analysis & research	Problem: Understand and collect evidence Behaviour: Identify drivers and develop interventions Impact: Trial interventions and evaluate outcomes	Behavioural sciences	No model as do not believe behaviour can be modelled	White box

Based on the strengths, weaknesses, opportunities and threats and the market competitors identified above, this chapter uses Osterwalder's value proposition canvas (Osterwalder, 2014) to identify customer needs and Michael Porter's idea of competitive advantage (Porter, 1998) to identify the best competitive positioning.

Competitive advantage

Michael Porter (Porter, 1998) identifies two generic competitive advantages – low cost through efficiency or differentiation through a unique offering. Differentiation is recommended given the unique combination of IP and research skills to support this.

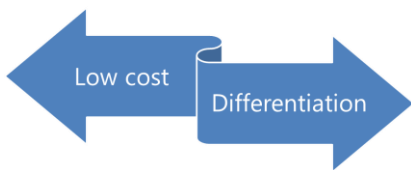


Figure 4: Low Cost vs. Differentiation

Value proposition canvas

A strong value proposition is required to demonstrate differentiation. Osterwalder (Osterwalder, 2014), the creator of the business model canvas, has also created a value proposition canvas that helps identify the value proposition. The image below (Mulder, 2017) shows the concept.

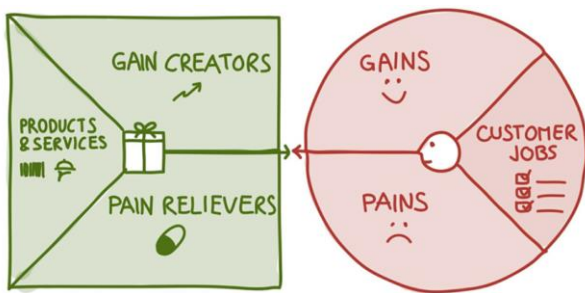


Figure 5: Value Proposition Canvas

The process is to first focus on customer needs (the right-hand side) and then test the value proposition against this (the left-hand side).

Customer needs

We identified four main types of use-case across three customer segments. These use cases, and their relative significance to each customer segment are summarised below.

Table 3: "The Job" needs ratings

The Job	Policy Makers	Corporates & Utilities	Consultants
Develop EE policy	●	◐	●
Forecast & manage demand	◐	●	●
Grow sales of EE products	◐	●	●
Project justification	◐	●	●

Job component: ○ = Nil ◐ = Small ◑ = Moderate ◒ = Significant ● = High

For each customer segment, we then synthesised customer challenges that the CSIRO product suite can help solve into 5 general categories of pain points to support the value proposition. The relative significance of these pain points, by customer segment are summarised below.

Table 4: The Pains Ratings

The Pains	Policy Makers	Corporates & Utilities	Consultants
The cost to create and maintain models	◐	◐	●
Limitations of current approaches	◐	●	●
Lack of corporate understanding of tools	●	◐	◐
Availability of data	●	◐	●
Sub-optimal or even adverse outcomes	◐	●	●

Pain level: ○ = Nil ◐ = Small ◑ = Moderate ◒ = Significant ● = High

Finally, we synthesised the perceived potential benefits of the CSIRO product suits into 6 gains that support the value proposition. The relative significance of these gains by customer segment are summarised below.

Table 5: "The Gains" Needs Ratings

The Gains	Policy Makers	Corporates & Utilities	Consultants
Accurate recommendations			
Identification of novel solutions			
Accommodate changing requirements			
A solution that can be deployed widely			
A solution that is within budget			
Recognition as a thought leader			

Gain importance: ○ = Nil ◐ = Small ◑ = Moderate ◒ = Significant ● = High

3.4. The proposed products and value proposition

The customer needs and CSIRO's competitive advantage identified in chapter 3.3 are used below to recommend proposed products and identify their value proposition.

The proposed products

Given the CSIRO's competitive advantage through differentiation and the customers' needs, three potential products are proposed:

- **Consulting** – co-investment projects where the CSIRO uses its research expertise and domain knowledge to enhance the existing BE driven ABM framework to provide policy recommendations as a consultancy service.
- **Generic framework** – a BE driven ABM framework that provides a starting framework that an end user with modelling and programming skills can modify. This allows them to customise the solution to incorporate their

own IP and/or to address related but different policy questions. Potential customers include policy consultants who wish to differentiate their market offering and larger organisations that have in-house modelling and analysis capability.

- **Bespoke applications** – BE driven ABM applications that are custom developed for clients who require recommendations in response to the same question, for example, what solar/battery solution should be offered to a specific customer. This may be a background application that receives a data package about the client from a CRM system and returns the recommendation via an API. The software may be developed by partnering with a vendor that has a product they wish to enhance with this IP.

Chapter 2.3 identified a fourth market opportunity, the BE data. Although there is strong interest in the BE data, it is recommended that this not to be offered as a standalone product as:

- Obtaining ongoing revenue is challenging unless there are significant updates.
- It is likely that a significant investment in building out the data set is required for it to be commercially attractive as a standalone product.
- More value can be extracted by bundling it with the bespoke applications and framework opportunities.

Value proposition

Value propositions for the three potential market offerings are summarised and matched against the customers' needs identified in chapter 3.3 in the table below.

Table 6: Comparison of options

	Consulting Full fee or co-investing	Generic framework A framework that the end user can modify	Bespoke app. An application that is simple to use
PAIN RELIEVERS			
Cost-effective			
Accurate forecasts			
Simple to use			
Data is available			
GAIN CREATORS			
Novel solutions			
Flexible			
Can be deployed widely			
Recognition as a thought leader			

Value proposition: ○ = Nil ◐ = Small ◑ = Moderate ◒ = Significant ● = High

3.5. Market size

The following estimates are of the NSW, VIC and ACT markets as these are the most accessible for the team. Estimates are based on the market testing and the consultant’s commercial experience in this domain. These estimates are very high level and considerably more work is needed to validate them.

Consulting
Potential targets are:

- Around 10 various government energy efficiency policy-making departments in the environment, energy, transport and water, each with one to two consulting contracts in the range of \$100k to \$200k per year.
- Energy efficiency policy groups in the top three energy retailers – mostly use in-house analysts. However, it estimated that there are around six external consultancies per year in the \$50k range.
- The top three energy retailers also have significant sales & marketing budgets that are an opportunity. This could be a bespoke application making near real-time sales

recommendations, a bespoke framework that informs sales programs or consulting. It is estimated at a \$100k to \$300k project opportunity per year.

- The larger electricity generation companies have a strong interest in better demand input assumptions for National Energy Market (NEM) modelling, including potential uptake of electric vehicles. Currently modelling is dominated by neo-classical rational actor models but is estimated at two to four \$100k to \$200k opportunities per year.

Licensing the NED framework and BE data

- Four to five specialist small consultancies each with two to six projects per year. The pricing model is yet to be determined but \$5k per project and \$10k per capability consultancy are assumed for opportunity sizing purposes.
- Eight to 10 large consultancies – there may be an opportunity but will be a much harder sell. However, these firms will have much larger budgets. One consultant company with its model solution are in this category but have advised they have no interest in collaborating with the CSIRO.

Bespoke applications

The size of the addressable market is very speculative, but the size of the prize for the energy and water utilities and energy resellers is large. Significant initiatives such as advanced forecasting or sales support tools have annual license charges of \$500k and above so present royalty opportunities of \$25k pa and greater.

Commercialisation scenarios

Three scenarios are set out – project wind down, NED framework licensing and bespoke applications royalties – with supporting Lean Canvas business models, revenue and expense summaries.

4.1. Commercialisation scenarios

Scenario #1 – Project wind down

Engage with the organisations that expressed interest during the market survey to quantify the commercial opportunities, the investment required and the likelihood of success. Based on this, refine the financial model provided to assess the viability of proceeding with licensing the framework and data. In this scenario, which is for the decision is to not proceed with licensing the framework and data, the actions are:

- Complete existing research and co-investment consulting obligations.
- Develop user documentation.
- Create a downloadable package of the NED framework and data.
- Present the framework to one or two niche consultants who provide energy efficiency policy advice.
- Place the package online as a free download.

Scenario #2 – NED framework licensing

Engage with the organisations that expressed interest during the market survey to quantify the commercial opportunities, the investment required and the likelihood of success. Based on this, refine the financial model provided to assess the viability of proceeding with licensing the framework and data. In this scenario, which is for the decision is to proceed with licensing the framework and data, the actions are:

- Engage with niche consultants to inform framework development.
- Actively seek co-investment consulting & other funding sources.
- Continue development with consulting, CRC & other funding.
- Complete framework as a product & promote it.
- Establish licence agreements & web portal access.

Lean Canvas models for consulting and framework licensing are in Appendix 6 in the full report and a summary of revenues and expenses is in Appendix 7 in the full report. Modest license fees are recommended as it increases the likelihood of uptake, thereby balancing revenue and impact goals.

Scenario #3 – Bespoke application royalties

This scenario is an extension of Scenario #2. Engage with the organisations that have licensed the framework, or are clients of licensees, to quantify the commercial opportunities, the investment required and the likelihood of success. Based on this, refine the financial model provided to assess the viability of proceeding with seeking royalties for applications. In this

scenario, which is for the decision is to proceed with seeking royalties for applications, the actions are:

- Engage with the target markets of strategy, marketing, sales and operations groups in energy and water utility providers and resellers with high-value problems.
- Develop relationships with application providers in the target markets who want to be channel partners and adopt BE driven ABM to enhance their products.
- Provide high-level science support to channel partners so they can develop and sell applications.

A Lean Canvas model for the combined scenarios of framework licensing and bespoke applications royalties is in Appendix 6 in the full report and a summary of revenues and expenses is in Appendix 7 in the full report. Application providers who want to adopt BE driven ABM to enhance their products in this target segment will contribute the required software development and pay significant licence fees once the technology is proven.

See Appendix 4 in the full report for examples of other BE driven applications being brought to market by BE consultancies, e.g. <https://www.beapplied.com> which is an online recruitment platform that uses behavioural science and data analytics to remove unconscious bias from the recruitment process.

4.2. Web portal costs

There may be a requirement for providing access via a web portal. A full technical evaluation of web hosting options is beyond the scope of this report but Appendix 8 in the full report has possible options as a starting point for estimating the costs for the portal build.

Table 7: Estimation of web portal costs

Task	Hours
Define requirements	24
Design the architecture	8
Build front end (Wordpress or similar)	60
Build backend controller (Custom plugin for Wordpress or similar)	60
Build a database (MySQL)	24
Test & debug	24

Document	16
Contingency	32
Project management	32
TOTAL	280

Assuming very light usage, the following is an indicative annual hosting cost based on Amazon Web Services.

Table 8: Estimation of web portal costs

Resource	Cost (pa)
Compute (EC2 t2.micro)	\$700
Database (RDS db.t2.micro)	\$300
Sundry (data, storage etc.)	\$50
Support	\$1,200
Free tier discount	-\$750
TOTAL	\$1,500













4.3. Financial analysis

A financial analysis spreadsheet is provided as part of the report deliverables. Screenshots are included in Appendix 7 in the full report and a number of tables summarise the revenue and expenses for the two commercial scenarios.

The financial analysis indicates an initial loss in 2018/19 but a profit for the following years, and with option 3 being the preferred choice from a financial perspective.

4.4. Outcomes against success measures

If well executed, achievable outcomes against the success measures for the three scenarios are:

	Impact	Science Excellence	Research Partnerships	Revenue
Scenario #1				
Scenario #2				
Scenario #3				

Met success outcomes: ○ = No ◐ = Slightly ◑ = Partially ◒ = Mostly ● = Fully

Next steps

A decision flowchart sets out the next steps. This commences with meeting the prospects identified in the market research interviews and to make a Go / No-go decision to proceed with developing and licensing the framework. If framework licensing proceeds, the outcomes will inform a second Go / No-go decision to proceed with bespoke applications.

5.1. Meet with the market research prospects

There is interest

The interviews with prospective users found interest in further engagement. This will provide deeper market research to identify the features required for the product to be commercially attractive and assess the prospects for uptake.

The following expressed high interest in a follow-up meeting in the near future:

- Org 1. for licensing of the framework and data
- Org 2. for licensing of the framework, data and potential bespoke applications across multiple areas of the business
- Org 3. for licensing of the framework, data and potential bespoke applications
- Org 4. for consulting or licensing of the framework and data

The following expressed medium interest in a follow-up meeting for consulting:

- Org 5.
- Org 6. (who are in the early stages of incorporating BE into analysis qualitatively, and may have a future interest in quantitative methods)

Provide a demonstration and more in-depth information.

As part of the market review, we were able to provide a high-level assessment of the interest based on a general description of the product in a one-hour telephone conversation. However, in all cases, they wanted to see a demonstration and have access to CSIRO scientists for an in-depth conversation.

Ask these questions

Ask these questions to determine the size of the opportunity

- What challenge or opportunity can this technology used for?
- Do you want to proceed with a project?
- What budget do you have?
- Who is the decision, maker?
- What process and timeline applies to reach a decision?

Ask these questions to determine the effort to deliver a project?

- What are the functional requirements for the software?
- What data is needed?
- What other services do we need to provide?

Update the financial model

Based on the information collected, update and refine the financial model provided and use this to assess whether to wind the project down or to proceed with licensing the framework and data. See section 5.2 for a detailed decision flow chart.

5.2. Decision flow chart

Apply this decision flow chart based on the outcomes from section 5.1.

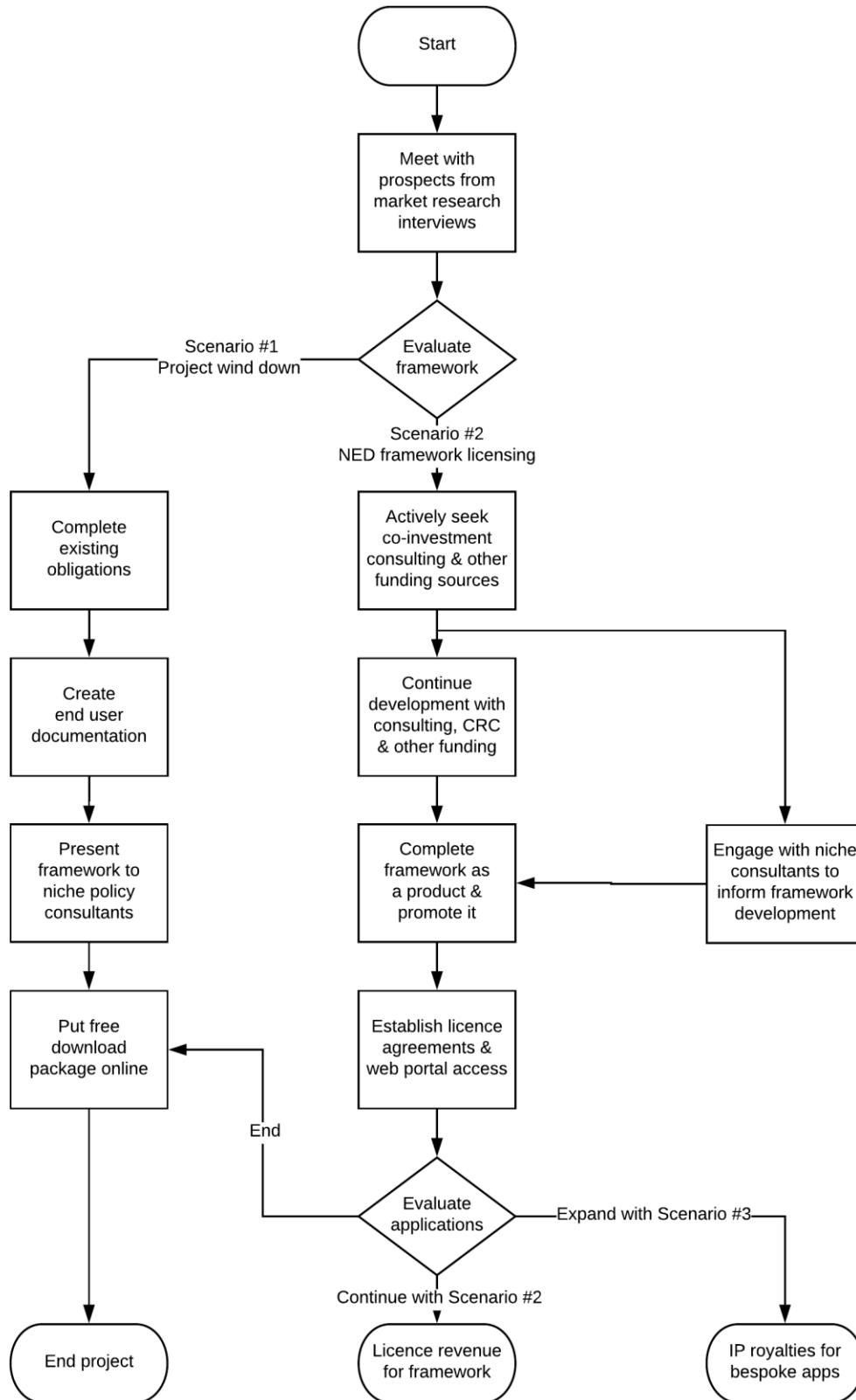
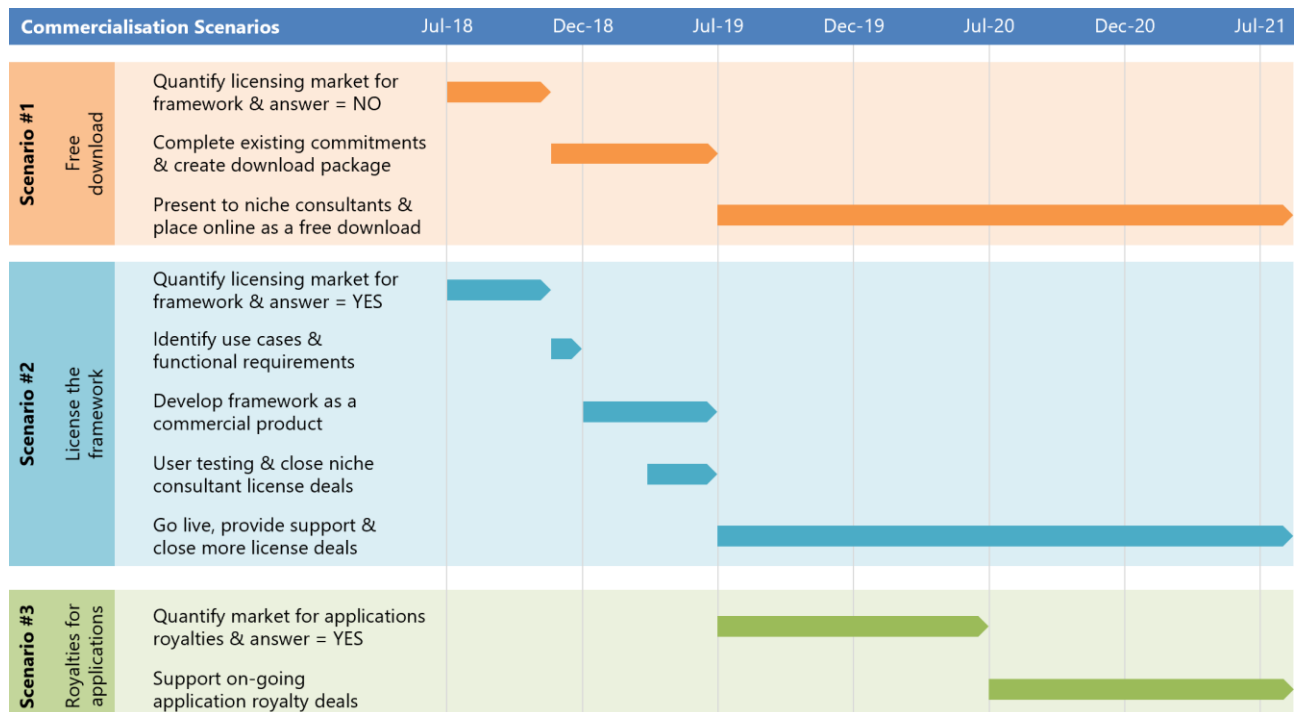


Figure 6: Proposed Strategy Decision Flowchart

5.3. Next steps timeline



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Appendices

CSIRO model data

Types of data

There are different types of data that allows CSIRO to model adoption behaviour:

- *Survey data, i.e. data related to how decision makers make choices.* For householders, this is typically based on survey data. For other types of decision makers (i.e. agents), this is typically based on focus groups or interviews. This helps to quantify the trade-offs that decision makers make.
- *Context data, especially for commercial buildings i.e. data related to the context in which decisions are being made.* This is typically based on third-party data, such as maps. Sometimes this is based on literature or expert judgment.
- *Data related to key model parameters.* This is typically based on expert judgment, literature and/or extensive sensitivity analysis to help modellers judge the most appropriate range of values. We do not report on this here, but this is an integral part of the models and reported in the relevant project reports/papers.

Model	Types of decision makers
1. Energy efficiency in commercial building	<ul style="list-style-type: none"> • Commercial building owners
2. Household energy efficiency	<ul style="list-style-type: none"> • Households • Sales agents • Information sources
3. Water conservation behaviours	<ul style="list-style-type: none"> • Households • Plumbers • Information sources • Water utility
1. Commuter mode choices	<ul style="list-style-type: none"> • Commuters.

Household survey data

For three of the models (all except for in the commercial buildings model), the key decision makers are householders. Therefore, there has been several iterations of a household survey undertaken, but for which we here report the scope of the latest and most relevant version. The household survey now has a rather refined scope and set of questions, aligning with literature on relevant social science constructs. The household survey can easily be adapted to new contexts. The latest version of the household survey is quite with around 150 questions. The cost is currently approximately \$6,000 for 600 respondents, but this may change depending on any changes to the design. This data is analysed to define motivation and uncertainty functions for the household/commuter agents.

There are questions relating to the following topics:

2. Consent to participate in the survey
3. Age
4. Location
5. Gender
6. Education
7. Number of people in household
8. Number of children in household
9. Approximate household income
10. Employment status
11. Length of unemployment, if unemployed
12. Tenure category
13. Post code
14. Whether the household pays for water
15. Whether the household pays for electricity
16. Type of dwelling
17. Size of property
18. Proportion of property, being garden/lawn
19. Priorities

- a) Being part of a community
- b) Aesthetics
- c) Having a comfortable house
- d) Spending time with friends and family
- e) Being self-sufficient
- f) Personal health
- g) Spending time in nature
- h) Protecting the environment
- i) Financial security
- j) Improving the value of the house/property
- k) Living frugally
- l) Being prepared for hard times
- m) A simple life
- n) Having the latest technology
- o) Having the best of everything
- p) Buying the best brand
- q) Buying quality things

20. Time Poverty

- a) So busy that struggle to look after own health
- b) So busy that struggle to look after own house
- c) Struggle to juggle too many things

21. Plumber

- a) When was plumber last at house

- b) Average frequency of seeing a plumber
- c) Trust in plumber advice

22. Self-reported methods for saving water indoors

- a) Turning off taps when brushing teeth
- b) Turning off taps when soaping
- c) Having shorter showers
- d) Using half flush button more often
- e) Flushing toilet only when soiled
- f) Comply with water restrictions
- g) Only switch on washing machine when full
- h) Re-use grey water on plants

23. Self-reported methods for saving water outdoors

- a) Adhere to water restrictions for outdoor water use
- b) Watering with recycled grey water, such as water from the washing machine
- c) Install drip irrigation system
- d) Use mulch and/or water absorbing crystals/or other types to retain soil moisture
- e) Plant drought tolerant and/or native plants

24. Stated intentions on dishwasher purchases

- a) Water efficient dishwasher
- b) Energy efficient dishwasher

25. Reasons for not saving water (several options provided)

26. Garden irrigation frequency

27. Number of baths in household

28. Number of showers in household
29. Number of toilets in household
30. Having a dishwasher
31. Type of washing machine
32. Agreement with reasons for saving water
 - a) It is important to use less water to promote the security of Sydney's water supply
 - b) It is important to use less water to reduce pressure on the environment
 - c) It is important for me to use less water in order to save money
 - d) It is important to use less water in order to reduce greenhouse gas emissions
 - e) It is too much effort to use less water around the house
 - f) I would put more effort into reducing water use around the house during times of drought
 - g) I am concerned that Sydney will experience water shortages in the future
 - h) I worry about how water shortages will affect my way of life
 - i) I worry about how water shortages will affect my water bill
 - j) My friends and family are worried about future water shortages
33. Awareness of intervention program(s) & how the person may have become aware of program & participation in intervention program & time when participated in program.
34. Stated intention for participation in program (repeated for 7 designs of program)
35. Triggers of behaviour change
 - a) Home renovations
 - b) Purchasing an appliance
 - c) Garden landscaping
 - d) Prompt / information on bill

- e) Recommendations from tradespeople
- f) Attention in social media
- g) Extreme hot dry conditions
- h) Bill Shock
- i) Sales promotion
- j) Water restrictions (different levels)
- k) Dam levels dropping to below threshold(s)

36. Rainwater tank

- a) Space for another rainwater tank
- b) Ownership of rainwater tank
- c) Use of rainwater
 - i) Toilet flushing
 - ii) Gardening
 - iii) Laundry
 - iv) Drinking
 - v) Everything
- d) Rainwater tank maintenance
 - i) Clean gutters
 - ii) Service and test pump
 - iii) Service and test automatic switch
- e) Reason for purchasing a tank (7 different possible reasons)

37. Energy efficiency in household

- a) LED lighting
- b) Energy efficient air conditioner (4 stars or more)
- c) The main source of cooling in the house

38. Stated intentions for

- a) Purchasing a hybrid car
- b) Energy efficient dishwasher
- c) Electric car
- d) Energy efficient washing machine
- e) The solar hot water system
- f) The home battery storage system
- g) Solar PV system
- h) Combined solar PV system with home battery storage

39. Reasons for not installing solar PV system

40. Perceived behavioural control for

- a) Installing Solar PVs
- b) Society reducing greenhouse gas emissions
- c) Personally conserving water
- d) Society conserving water

41. Personal priorities for reducing greenhouse gas emissions

42. Stated reasons for reducing greenhouse gas emissions

- a) to help provide a future for coming generations
- b) to help the economy
- c) because I worry about sea level rise and/or more intense storms and droughts
- d) to reduce pressure on the environment
- e) to save money

43. Stated reasons for using less energy

- a) use less energy around the house to reduce my greenhouse gas emissions

- b) It is too much effort to use less energy around the house

44. Climate change concern

- a) I am worried about climate change and its impact on the environment
- b) I am worried about climate change and its impact on future generations
- c) I am worried about climate change and its impact on the economy

45. Perceived peer pressure for solar PVs

- a) Most of my neighbours have solar PVs (solar panels)
- b) Most of the people I know have solar PVs (solar panels)
- c) It is expected of me that I should install solar PVs on my property
- d) I feel pressured by others to install solar PVs (solar panels)

46. Self-reported effort to reduce energy in last 12 months

47. Self-reported method for reducing energy

- a) Installed energy efficient lighting
- b) Changed my behavior
- c) Turned down my heater
- d) Installed solar PVs (solar panels)
- e) Installed a solar hot water system
- f) Purchased an energy efficient appliance
- g) Installed an energy efficient heater or AC
- h) Installed insulation
- i) Turn down thermostat of AC
- j) Motion sensor for lighting
- k) Smart home energy management system

48. The stated reason for reducing energy

49. The stated reason for not reducing energy

50. Triggers of energy use behaviour change

- a) Home renovations
- b) Buying an appliance
- c) Advertising
- d) Social media
- e) The behaviour of friends or neighbours
- f) Comments by neighbours
- g) Electricity price increase by 5%
- h) Electricity price increase by 10%
- i) Electricity price increase by 20%

51. The frequency of mode of travel to work

- a) Public transport
- b) Car
- c) Walking
- d) Cycling

52. Factors that influence the choice of commuter mode

- a) Travelling time
- b) Reliability
- c) Comfort
- d) Health benefits
- e) Flexibility

f) Environmental impact

53. What mode has the shortest traveling time

54. What mode is the most cost-effective

55. What mode is more reliable

56. What mode is more comfortable

57. What mode has more health benefits

58. What mode provides more flexibility

59. What mode has more environmental benefits

60. Postcode of place of work/study

61. Number of cars owned by the household

62. Number of car parking spaces at home

63. How long does the commute normally take

64. Trip facilities

a) Free access to car parking at work/place of study

b) Secure bike parking and end-of-ride facilities workplace

c) Distance from home to the nearest public transport node

d) Distance from work to the nearest public transport node

e) Service frequency at the transport node closest to your home during your commute time

f) By public transport, how many connections does it take to get from your home to work

65. Mode perceptions – agreement with statements

a) I feel safe when I use public transport

b) I worry about how dirty it is when I use public transport

c) I worry about catching a cold or the flu on public transport

- d) I find it very relaxing when I use public transport
- e) I can trust that I arrive at appointments in a timely manner when I use public transport
- f) I feel uncomfortable being around so many people when I use public transport

66. Complexity of trip

- a) How often do you combine trips to your place of work/study with other activities, such as school or childcare drop off, shopping, attending appointments, meeting with friends, etc.?
- b) How flexible is your arrival time at your place of work study?

67. Perceived peer pressure, agreement with statements

- a) Most of the people I know use public transport to get to work
- b) It is expected of me that I should use public transport to get to work
- c) I feel pressured by others to use public transport to get to work

68. What, if anything, makes you less likely to use more active forms of transport such as cycling or walking?

- a) Safety concerns
- b) No suitable track to ride or walk along
- c) Poor lighting along the way
- d) Hot weather
- e) Cold weather
- f) Wet weather
- g) Not adequate shower facilities at work
- h) It takes too much time
- i) Lack of fitness

69. Comparison with others

- a) I often compare myself with others with respect to what I have accomplished in life

- b) I always pay a lot of attention to how I do things compared with how others do things
- c) I always like to know what others in a similar situation would do
- d) I am not the type of person who often compares myself with others
- e) I often try to find out what others think who face similar problems as I face
- f) I never consider my situation in life relative to that of other people
- g) I often compare how I am doing socially (e.g., social skills, popularity) with other people

70. Decision approach

- a) I set targets to be achieved with minimal effort
- b) I am okay with any choice that yields the minimum result
- c) I choose the option that meets the absolute minimum
- d) I always set the highest targets
- e) I set the highest standards for my household
- f) I never settle for second best
- g) No matter how satisfied I am with what I currently have, it is only right for me to be on the lookout for improvements
- h) I choose what I really need at the lowest price

Technology data

Dataset name	Technology data.
Description	<p>Upgrade probabilities for different electricity technologies by year. Technologies included:</p> <ul style="list-style-type: none"> • Appliances. • Hot water. • Heating, ventilation, and air conditioning (HVAC). • Lighting. • “Technology X” – a generic electricity consuming technology.

	<p>Two datasets are included for each technology – household “attribute” data that defines how householders evaluate that technology and choose a replacement, and probability each year that the technology will be replaced.</p> <p>Household attribute data includes:</p> <ul style="list-style-type: none"> • Price: Relating to the upfront cost of the technology. • Aesthetics: Relating to the aesthetics of the technology. • Electricity use: Relating to the electricity use of the technology and thus inherently to the greenhouse gases emissions from the use of the technology. • Environment – other: Relating to environmental issues, other than those relating to emission of greenhouse gases. • Comfort: Relating to comfort aspects of the technology. • ROI: Relating to the financial return on investment on the technology. • Ongoing costs: Relating to the ongoing costs of operating the technology. • Resale value: Relating to any improvements in the resale value of the property related to installing the technology. <p>Probability data is calculated from the above for each technology. This data includes the probability that equipment will be replaced and whether that replacement is energy efficient.</p>
Type	Transmuted data.
Owned	CSIRO.
Complexity	Simple.
Applicability	All household electricity retrofit models.

Recommendations data

In each of the water conservation and residential energy efficiency models, there is data on what types of information sources that households will seek out when researching their choices. There is furthermore expert judgments on to what extent each of the information sources will recommend a particular behaviour. In the absence of reliable data, this is however considered an input into the modelling capability which is subject to sensitivity analysis by users.

Dataset name	Information source data – residential households.
Description	Value weightings for different sources of information for household retrofits – for each household type, what is the preference to use a particular information source based on price, aesthetics, comfort, energy use, ongoing costs, resale value etc. Includes settings for status quo and upgrades.
Type	Transmuted data derived from the survey.
Owned	CSIRO.
Complexity	Simple.
Applicability	House retrofit models. However, it is possible that people may apply different weights to information sources for non-electricity retrofits.

Commercial buildings data

The dataset on commercial buildings was an extract from the Federal Government's commercial building disclosure program¹. It covers building data, size, areas, location, and energy and water usage for all buildings or tenancies over 2000 square meters which captures about 80% of Australia's office floor space. The data from the CBD program is public data - although the information is in pdf certificates on the CBD site and hence very difficult to scrape so Dept. did the data extract for CSIRO. The model also draws on a data set from Geosciences Australia that had all of the commercial buildings in Australia based on type, age, location, size and some energy information. Data also includes a purchased Geosciences dataset which CSIRO has some licensed rights to². The cost of updating this data is around \$7k for a data extract. CSIRO also has a good data set from the City of Melbourne from their 1200 Buildings Program. This data is owned by the City of Melbourne, and may also be publicly available

Dataset name	GIS data.
Description	Mapping data including Australian local government area regions and names.
Type	Raw data.
Owned	GADM (Global Administrative Areas) database. The licence is not for resale.
Complexity	Complex.
Applicability	All models.

¹ Data was provided by Bethel Sendaba at Dept of Environment. Stanford Harrison is an alternative contact for an up to date version.

² Contact Seongwon Seo for details

Dataset name	Commercial building demographic data.
Description	Commercial building demographics including: <ul style="list-style-type: none">• Location.• Office space.• Building age (before or after 1980).• Owner type (small, medium or large).• Building type (low or high rise).• Property Council of Australia Quality Grade Rating.
Type	Survey data.
Owned	CSIRO.
Complexity	Simple.
Applicability	All office retrofit models.

Dataset name	Ability to retrofit data.
Description	Likelihood that a commercial building will adopt a retrofit, by category of building (by age, type and Property Council of Australia (PCA) grade) and building owner (large, medium, small). This data is calculated using barriers to retrofit identified and quantified by the Warren Centre in 2009.
Type	Transmuted data.
Owned	CSIRO. Underlying Warren Centre data is public domain, CSIRO analysis is unique.
Complexity	Simple.
Applicability	All office retrofit models.

Other agent data

Dataset name	Sales agent data.
Description	<p>Performance data for sales agents:</p> <ul style="list-style-type: none"> • Current sales success rates. • Cost of sales. • Income and expenses from successful sales. • Ability to source discounts. • Proportion of sales where discount is offered.
Type	Transmuted data.
Owned	CSIRO.
Complexity	Simple.
Applicability	The “sales agents” are specified in the model as Accredited Certificate Providers, suggesting that the data is specific to Energy Savings Scheme. However, the data is likely to be applicable to other sales agents as it is relatively generic.

Available data by parameter, access data set

Name	Sector focus	Description	Access	Source
Household survey data #1	R	Data ~800 households in Sydney, used to parameterise the RES-NED.	Model-only	OEH NSW
Household survey data #2	W	Survey data from 417 households across Sydney used to parameterise the WAT-NED.	Available	CSIRO
Household survey data #3	W, R, T	Another household survey of 600 participants across Sydney. Can be used for all sorts of purposes.	Available	CSIRO
Information source parameterisation data	R	Values on information source attributes based on expert judgments and literature	Limited-use	CSIRO
Technology parameterisation data	R	Values on technology attributes based on expert judgment and literature.	Limited-use	CSIRO
Adoption barrier data	C	Probabilities associated with barriers to adoption for commercial building owners. Based on interviews of owners.	Limited-use	CSIRO
Adoption barrier data	C	Likelihood that a commercial building will adopt a retrofit, by category of building (by age, type and Property Council of Australia (PCA) grade) and building owner (large, medium, small). This	Limited-use	CSIRO. Underlying Warren Centre data is public domain, CSIRO analysis is unique

Name	Sector focus	Description	Access	Source
		data is calculated using barriers to retrofit identified and quantified by the Warren Centre in 2009		
Building stock data	C	Data on building attributes, including location and size	Model-only ¹	Department of Energy and Environment;
Building stock data	C	Data on building attributes, including location and size	Model-only / Publically-available ²	Sustainability Victoria
Building stock data	C	Data on building attributes, including location and size	Model-only ³	Geosciences Australia

Note: W: Water sector; R: Residential Energy efficiency sector; C: Commercial Buildings Energy Efficiency Sector.

¹ **Note:** Available from the Federal Governments commercial building disclosure program.

² **Note:** Partially available from <https://www.melbourne.vic.gov.au/business/sustainable-business/1200-buildings/Pages/melbourne-retrofit-survey.aspx>

³ **Note:** we purchased a license to use the data. We paid \$7k for the data extract.

Type of access:

- Model-only: For use in modelling tools only.
- Limited-use: Developed for model but potentially useful also for other applications.
- Publically-available: Available for anyone to download.

Available: Survey data owned by CSIRO, useful for many possible applications.

Application development process

