Regional and Remote Communities Reliability Fund - Microgrid

MyTown Microgrid

Conceptual Data and Analytical Framework

Milestone 2.5 – June 2021

Research Team

Work Package Leads: Ed Langham, Jay Rutovitz, and Heather Smith, UTS

Chief Investigator: Dr Scott Dwyer, UTS

Key support

Heyfield Community Resource Centre
Wattwatchers Digital Energy
Federation University Australia
UTS Faculty of Engineering and IT
Public Interest Advisory Centre
AusNet Services

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About the project

MyTown Microgrid is an innovative, multi-year, multi-stakeholder project that aims to undertake a detailed data-led microgrid feasibility for the town of Heyfield (Victoria), built on a platform of deep community engagement and capacity building.

The project received funding under the Australian Government's Regional and Remote Communities Reliability Fund Microgrids stage 1 funding round. It also received funding from the Latrobe Valley Authority as part of the Gippsland Smart Specialisation Strategy.

Executive Summary

The Data and Analytical Framework provides the basis for a data-led approach to a microgrid feasibility, supporting effective collaboration between the project partners and data owners. The framework:

- Describes the main types of data, their sources, the tools, and the processes by which the proposition of a microgrid (or other local energy system utilising microgrid technologies) is assessed.
- Is instrumental to guide the analysis undertaken as part of the techno-economic work package of the MyTown Microgrid Project.
- Will serve to provide a replicable framework for use as part of the decision support tool work package.

Each of the six module identifies the data that will be required and/or analysis to be undertaken. Initial data collection is clustered in the first three modules, which identify the situation in Heyfield, develop options for working with the existing network infrastructure and identify the range of technical solutions that should be considered. The fourth module on the analytic engine uses all these inputs to develop scenarios and technical configurations which, alongside the fifth module, business models provide input to the last module, the decision support tool.

The process is naturally iterative. Each module informs the others, and inputs, options and analysis need to be tested with the community and with each project partner. Modules will change as initial results are used and improved.

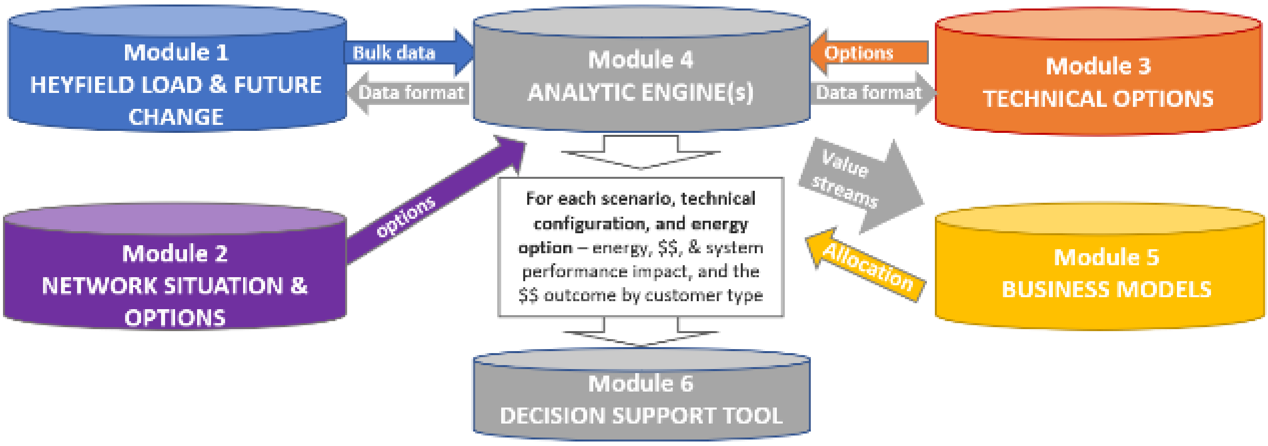

Figure 1 - Analytical framework summary

The outcome of the project will be a decision support system and tools for any community wishing to explore microgrid and local energy options. Wattwatchers are the lead partner and data provider to the project. The use of rich datasets in this project will help guide future communities on the level of local data collection needed in order to explore community solutions.

Key elements of the Data and analytical framework

Heyfield Load and Future Change

Various data sources (such as real time energy data from Wattwatchers energy monitoring devices, local network load and aggregated smart meter data from AusNet Services, home energy audit data from the Ecologic platform, and information collected via community surveys and workshops) will be used to develop a rich understanding of Heyfield. Information about the existing loads and local context will be used to characterise the current energy profile. Information about energy assets and resources, plus community ambitions and expectations, will be used to shape future possibilities and scenarios.

Network Options

The Network topology helps define the boundary/ies of possible microgrid solutions. The existing network assets, network performance and planned network investments will provide a reference case that reflects the costs and benefits of business as usual. Network options that are developed will capture the improvement to network performance or cost that can be expected from different approaches.

Technical Options

The technical options module defines the use and configurations of technologies that will utilise Heyfield's energy assets and resources. It defines the current and future costs and the performance and capacity of different technological options.

Analytic Engine

Heyfield data, technical and network options will be combined to develop options and scenarios. The modelling and analysis will characterise existing and future loads, storage and control opportunities for load flexibility and diversity. It will package different technologies to develop a range of cost and performance outcomes associated with different microgrid solutions.

Business Models

Options for ownership, control, governance and distribution of costs will all be developed through the module for business models. Private, community and network assets will all be considered as well as trading arrangements. The business models provide the new flow of value as energy flows change.

Decision Support Tool

Performance and costs metrics will be produced for each scenario and technical configuration from the analytic engine. The decision support tool combines these with the business model options to demonstrate the performance, costs and benefits each stakeholder can expect.

Contents

1 Introduction

1.1 Project objective

The Heyfield MyTown Microgrid project aims to undertake a detailed data-led microgrid and local energy feasibility for the town of Heyfield (Victoria), built on a platform of deep community engagement and capacity building. Over the three-year duration, the project will also develop the knowledge and tools to make it faster, easier, and cheaper for other regional communities to understand local energy propositions for their community. This project takes a novel approach to a community-based microgrid feasibility process by:

- Using multi-data source platforms to calculate demand, flexibility and supply.
- Undertaking deep community and stakeholder engagement.
- Co-designing community-centric business models with enshrined benefits and consumer protections.
- Wrapping technical, market, economic and regulatory analysis into fit-for-purpose decision support tools.

From the community's perspective, the deployment of a microgrid - or a local energy solution utilising microgrid technologies - seeks to improve community agency over:

- Energy supply and usage, including maximising the utilisation of local renewable energy
- Energy bills
- Local quality and reliability of supply

In developing the local opportunities, the community is also seeking to maximise complementary social and economic development outcomes to improve the resilience of Heyfield and the Latrobe Valley region in a low carbon, climate resilient future.

1.2 Techno-economic analysis - work package 3 (WP3)

The techno-economic analysis aims to provide a list of energy options and undertake techno-economic assessment to define a set of potentially viable energy portfolios. The scoping will include possible host sites and potential partner organisations. The analysis will provide the base information for the decision support tool and is expected to involve the following tasks:

- Undertake local energy options scoping, using information supplied by community partner and external renewable energy datasets. Screen to identify key options.
- Define a list for detailed investigation, to be tested with community reference group.
- Detailed techno-economic assessment using load and community data to deliver a set of potentially viable energy resource portfolios. Each modelled to provide insight on community benefits, wider economic benefits, and system benefits.
- Identify "least data" path for replication. The project expects that subsequent communities will not necessarily have access to rich sources of energy data and the tools from this project intend to be useful to future communities based on a minimal level of data accessibility.

1.3 Decision support tool - work package 5 (WP5)

The Decision Support Tool aims to help communities understand their options and the indicative economic case for a microgrid. It will bring together the data streams and intelligence information into accessible summaries of the key business case outputs to rapidly bring stakeholders to a ‘go - no go’ decision point.

Producing the decision support tool is expected to involve the following tasks:

- Identify key questions, datasets, and metrics, modelling & analysis tasks, and information flows,
- Scope available tools and identify gaps,
- Write specification for decision support tool to integrate a set of standardised complex datasets into readily interpretable set of outputs and that quantify & map the key costs and value streams.

1.4 Report objective – data and analytical framework

The Conceptual Data and Analytical Framework documented in this report details how the techno-economic analysis in work package 3 and the decision support tool in work package 5 will be produced.

The framework maps the different data types to be used, and identifies how these will be transformed into intelligence that will assist the community to develop and make decisions on a viable package of energy options, including definition of the modelling and assessment tasks.

1.5 Overarching questions

Five overarching questions guide how the framework is implemented and how the different solutions are assessed. These are:

1. Does the energy solution benefit the community by:
    a) Increasing access to affordable, cleaner, more reliable energy supply?
    b) Improving local energy system performance?
    c) Driving local economic benefits?
    d) Increasing community resilience (e.g. secure access to electricity in emergency situations)?
    e) Increasing energy literacy and engagement within the local community?
    f) Building local skills and capability to support microgrids and related energy solutions?
2. Does the energy solution benefit the whole energy system?
3. Is it technically and economically feasible, and with what optimised configuration?
4. What is the right business model to maximise community benefit and commercial viability?
5. How can other communities replicate the process?

The possible benefits from an energy solution will be analysed through the lens of affordability, value and access to value. The performance of the electricity system, including security of supply, reducing curtailment of solar energy, and the impact on consumer equipment will offer one source of value beyond financial considerations. Broader economic benefits could include: creating or allowing more economic development, keeping money local and creating local jobs, increasing local renewable energy, increasing local decisions/ community empowerment/ capacity & skills, and increasing community resilience in the face of bushfire.

The impact on the electricity system beyond Heyfield will be considered, including the overall cost and emissions of the broader system. Technical and economic feasibility will consider what might be considered optimal and also the ongoing resilience of the system and the community plus the ease with which the system might be able to expand or change in future.

The following metrics for each option or scenario have been proposed and will allow for comparison within the decision support tool:

Core Business Case

1. Energy and financial flows within the community plus imports/exports
2. Network reference case for current and future costs
3. Capex and Opex (both for the proposed microgrid/local energy solution and for consumers), including extreme events such as bushfire
4. Value/ potential sources of income

Energy System Performance

1. Outages/ year (number, time & cost of unserved energy)
2. Voltage excursions/ year
3. Constrained solar
4. Appliance life - power quality costs

Broader Economic Benefits

1. % energy spend which stays in Heyfield
2. % local renewable energy
3. % Capex and Opex which stays local
4. Spare energy and capacity

Future Proofing

1. Cost of additional energy and capacity
2. Constrained development *(what metric?)*
3. Capacity for transport / gas loads
4. % load moved to flexible / manageable

1.6 Energy solutions to be compared for Heyfield

Within the constraints of the existing system, local distributed energy is expected to be a source of value, and indeed is already being developed by communities and providers around Australia. Not only would a microgrid deliver better outcomes if local distributed energy activity is optimised, it is unlikely to be viable without them.

In the case that a full islandable microgrid system is not viable, local aggregation, control and management of distributed energy may still improve energy outcomes and reliability, and provide community value.

Both of these broader energy solutions (a microgrid or local aggregation and control) rest on local distributed energy as a foundation. The three concepts are described below:

Local distributed energy options

Communities often deliver energy efficiency retrofit schemes and solar bulk buys because they help reduce household and business bills. Retailers and product suppliers are starting to find ways to encourage demand management and move energy loads from high price to low price periods. Many communities develop schemes themselves and are starting to explore community level solutions such as larger renewable generation projects and community batteries. Generally, these projects are delivered on each individual business case. The growth of local distributed energy is a pre-requisite to two solutions that will be explored, both of which provide more coordination of distributed energy resources.

Microgrids

Microgrids allow for part of the electricity system to be islanded and to continue to supply electricity without the support of the main network. The boundary of the system to be isolated will determine the size and ambition of the microgrid. A number of alternatives might be feasible:

- disconnecting the two main supply points to Heyfield and powering everything downstream
- disconnecting the town centre at four points to focus on powering the centre
- multiple disconnection points to power clusters of households and businesses on easy-to-isolate lines via a series low voltage microgrids to allow islanding in emergency situations
- or a series of autonomous emergency sites to maintain the most essential business and emergency operations during times of limited grid supply.

Local aggregation control and management

Even without investing in the ability to isolate and island from the grid, a number of energy solutions could improve energy outcomes and speed an energy transition in Heyfield. Each of these require an investment in aggregation of resources through additional control and management systems and could include: load and supply balancing to improve power quality issues, community storage, aggregated buying and selling into wholesale markets, peer to peer trading and/or virtual power plants.

1.7 Process overview

An overview of the process for progressing from techno-economic analysis to decision support tool appears in Figure 1.

Early tasks are to develop the energy options and the network options. Network information about the possible boundary of a microgrid, network constraints, network performance issues and future investment will frame the energy options for:

- A general increase in local distributed energy resources, such as more solar and battery systems within the community
- Microgrids that can be islanded from the centralised grid when needed
- An increase in local control and management with aggregation to perform as a virtual power plant

Each energy option and its associated network option will be tested as a package with the community reference group. These discussions will ensure the full suite of ideas have been considered and screened before detailed analytic work begins. The community reference group will also help define the community ambitions, the local resources that should be considered, context to understand Heyfield today and the scenarios that best capture opportunities for Heyfield in future.

Energy consumption and generation data (from Wattwatchers devices, from home energy auditing using the Ecologic platform, and aggregated smart meter and load data from AusNet Services) will be collected. The full suite of information inputs for analysis are detailed further in Section 2 – overall analytics framework. The Heyfield load, within the various boundaries defined by different network options, will be characterised as residential and business loads and defined by the applications that make up the load, both now and in the future. Models from detailed data will be extended to estimate all loads within the study area.

The modelling to underpin the techno-economic analysis is to be agreed by the technical partners once potential tools have been investigated. The choice of modelling tools will be influenced by the desire to create a decision support tool that can be readily accessed by future communities.

The techno-economic analysis that will drive the decision support tool is expected to require a number of iterations as users test options and combine options with business models. In order to support decision makers a number of technical options will be developed. A technical option is a package of energy investments and the associated network configuration that produces a viable improvement in energy supply and use. Each technical option will be optimised against a number of alternative load scenarios. The minimum data requirements to produce the load scenarios and effectively model the technical options within these load scenarios will be determined.

The analytics process therefore produces a range of full scenarios, each of which offer a technical configuration to serve an imagined future load. The performance and cost of each scenario is calculated and the metrics for each scenario (see Section 1.5 Overarching questions) are provided to the decision support tool:

- The core business case
- Broader economic benefits
- Energy system performance
- Opportunities to future proof the Heyfield community

Finally, the scenario outputs will be integrated with business model options within the decision support tool. This allows users to explore the options, to learn about the outcomes of different technical choices and starting assumptions and to appreciate the impact of business models on the financial outcomes for different stakeholders.

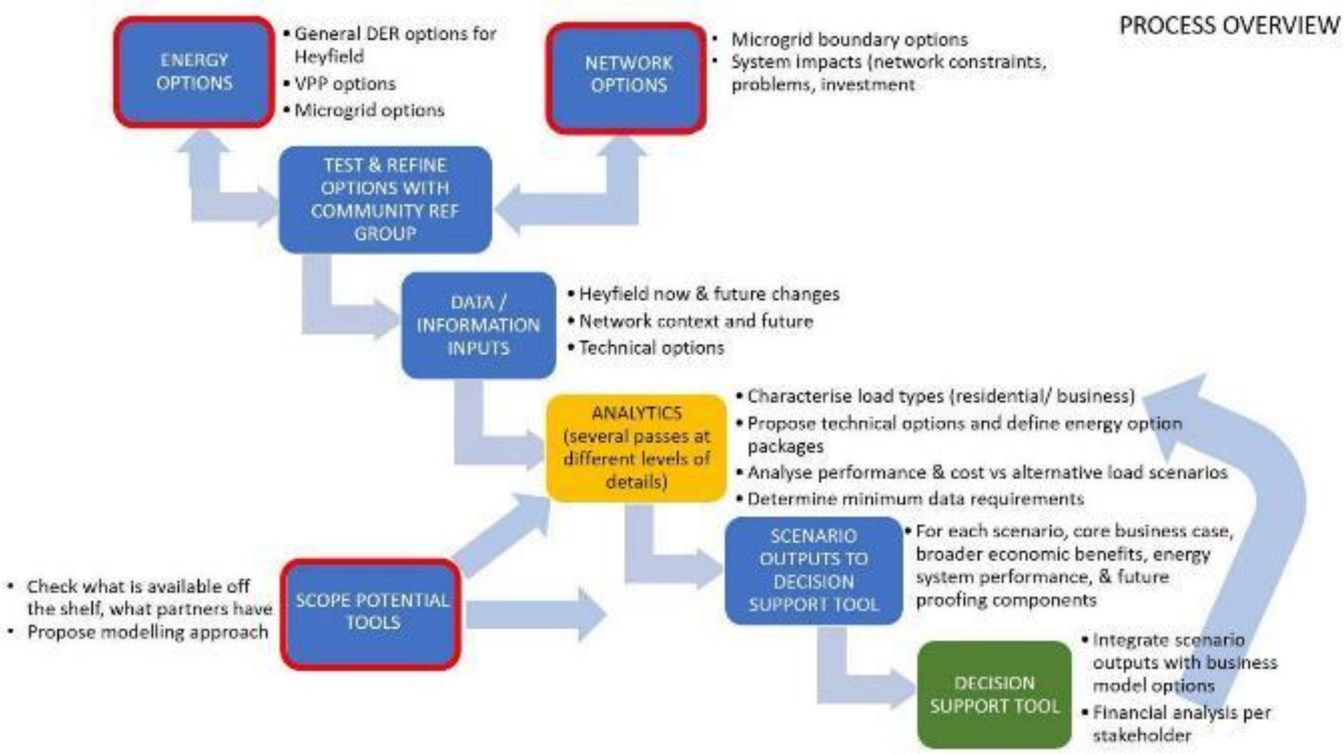

Figure 1. Overview of the techno-economic analysis to decision support tool process.

This framework document is likely to evolve over time, as the project evolves. This is the first iteration.

1.8 Data Privacy

The project will collect energy data and contextual information from individuals. Best practice will be followed to ensure individual privacy is protected. Much of the data used for analysis and design will be from aggregated data sources. The project aims to identify the level of real, individual data that is beneficial for future, similar projects and the extent to which data can be estimated from other sources as an alternative.

Use of identifiable data will be managed and restricted in accordance with:

- Ethics approval for the project
- Privacy policies of data providers (Wattwatchers, Ecologic, Ausnet services)
- Licence agreement with Ausnet services
- Informed consent provided by participants

In practice this means raw data will not be shared beyond the project's data analysis team and will be stored securely. Anonymised or synthesised versions of the data may be made available to help other communities understand the value proposition for microgrids in their towns.

2 Overall analytics framework

The Data and Analytical Framework is based on six main areas of work (modules). Each module identifies the data that will be required and/or analysis to be undertaken. The six modules are:

1. Heyfield load and future change – to identify the current and growth situation/s in Heyfield,
2. Network situation and options – to understand options for working with the existing network infrastructure,
3. Technical options – to identify and characterise the range of local energy solutions that should be considered,
4. Analytic engine – synthesises inputs from the first three modules to develop scenarios and technical configurations,
5. Business Models - assesses suitable business models, and
6. Decision support tool – assisting the community in the development and understanding of of the synthesised options in order to facilitate decisions.

The process is naturally iterative. Each module informs others. Inputs, options and analysis need to be tested with the community and with each project partner. Modules will vary as initial results are used and improved. Figure 1 provides an overview of the process that is anticipated to integrate each piece of work within the broader project.

The interaction between the six modules is shown in Figure 2, with more detail for each module in the following sections.

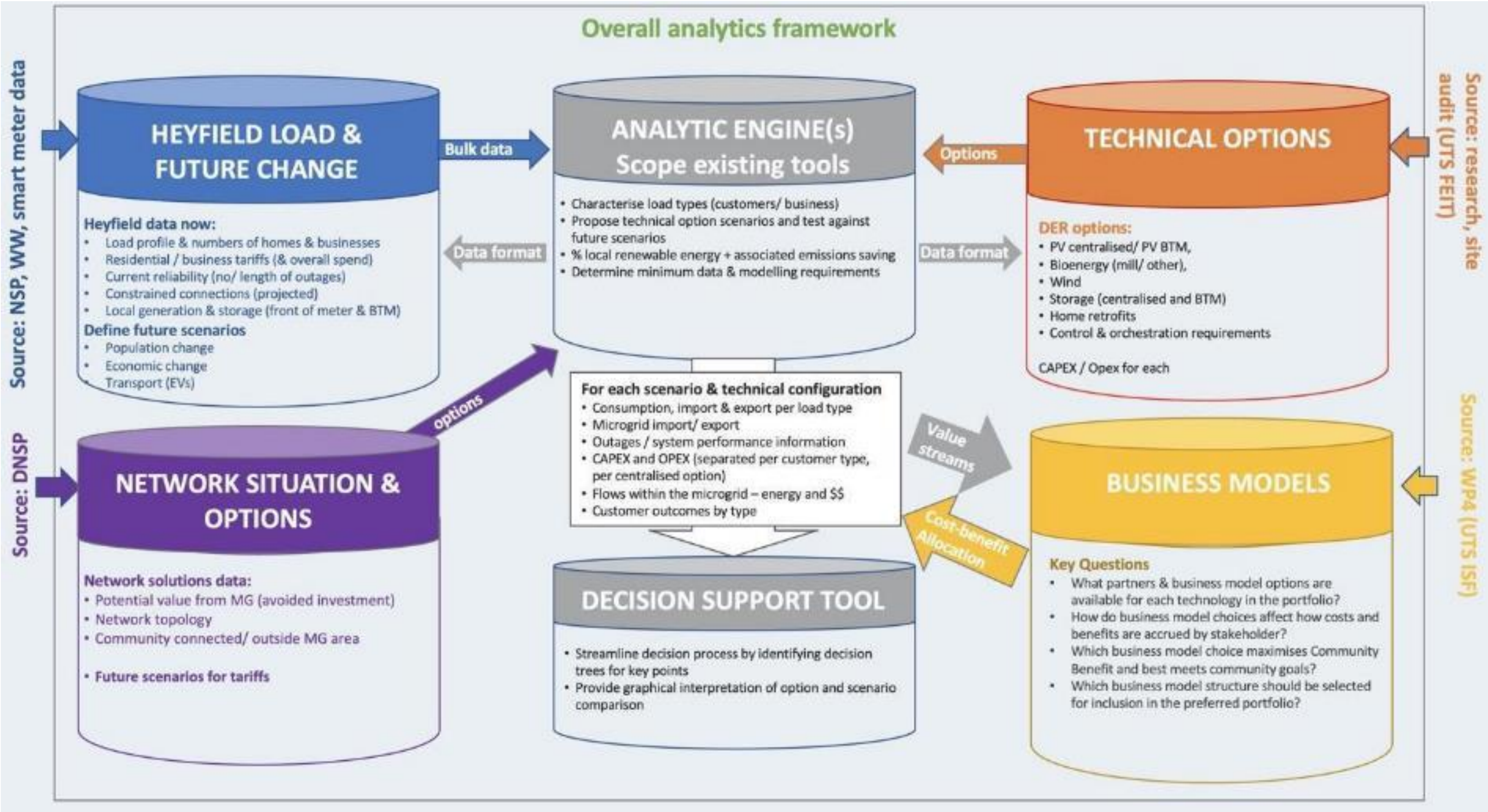

Figure 2 – Overall analytics framework

3 Heyfield Load and Future Change

Wattwatchers devices can be connected to monitor the incoming meter, solar PV systems and any circuits in the main switchboard. Additional information will be needed from households and businesses being monitored in order to fully understand the Wattwatchers data, and the intention is that this information will be collected using the Ecologic energy audit platform.

The roll out of Wattwatchers devices will cover less than 10% of Heyfield households and further data may be obtained with permission from the AusNet Services smart meter data, and from the Ecologic energy audits. The Ecologic energy audits will be used to obtain contextual information about the detailed usage data, and to inform the energy efficiency options characterisation (Section 4). The network service provider, AusNet Services, already has data about Heyfield at the aggregate level.

A number of external factors are needed to track the drivers that impact on changes in load – across days, seasons and into the future. These include things such as the projections and aspirations for population change, the economic development scenarios, and technological change such as the switch to electric vehicles (EVs) or high demand induction cooking.

The future scenarios will also include information about the energy assets and other community infrastructure that the community may choose to exploit in order to realise both local solutions and their aspiration for a very high renewable energy penetration.

Figure 3 captures the data inputs relating to Heyfield's load, its energy resources and its generation and storage assets. The analysis tool will define the data input requirements and data availability will in turn influence the level of analysis that can undertaken. The use of these data inputs is detailed further below:

Wattwatchers devices

Wattwatchers devices are targeted to be deployed at 75 residential sites and 12 commercial sites. Two schools will also integrate the Wattwatchers installation with an energy education program. 3 public community dashboard displays will be used for broader community engagement and project visibility.

Wattwatchers also has a number of existing devices already installed in the region under another program and the data from these will be accessible as well. The equipment monitored will depend on the installation. Devices will be installed at a range of locations and across different customer types – e.g. solar and non-solar households. On a single phase household, with adequate space in the switchboard, Wattwatchers devices can be used to monitor up to 6 circuits. The order of priority for connecting circuits is:

1. Grid connection
2. Solar generation
3. Battery storage Systems
4. Electric vehicle Charging
5. Air-Conditioning
6. Electric Hot Water
7. Pool pumps
8. Oven
9. Kitchen power circuits
10. General power circuits
11. General lighting circuits

The Wattwatchers data resolution will typically be 5 minutes and will provide timeseries data of the demand (kW) and energy (kWh) used at each site. Further details are provided in the ***Data Sampling Plan***.

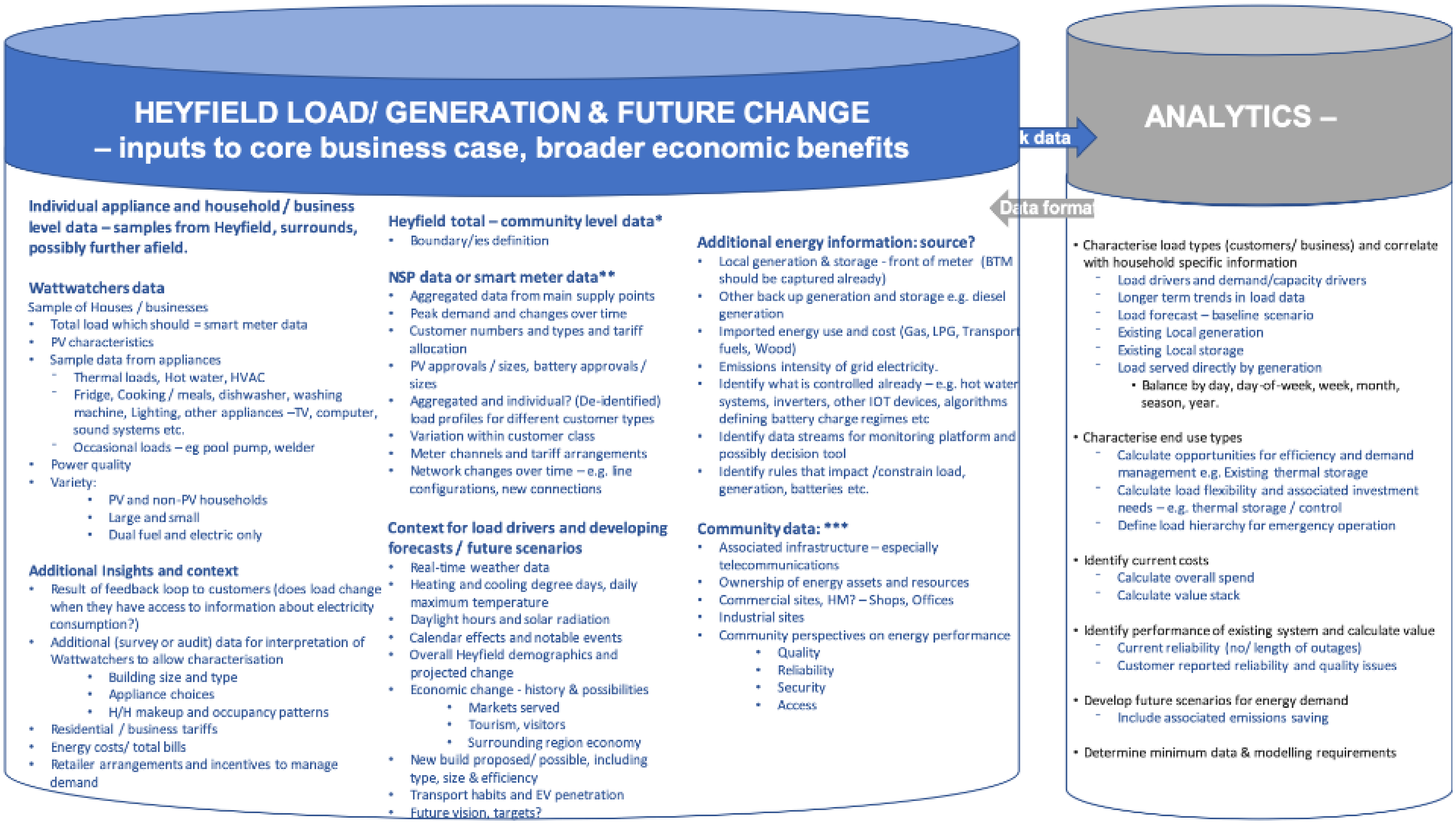

Figure 3 – Heyfield Load/Generation and future change

**An accurate measure or estimate is needed for total energy consumption. **see also Network options. ***see also Technical options.*

Additional Data

Customer data from the Wattwatchers devices will be supplemented with smart meter data from AusNet Services where approvals are obtained from the end customers. Smart meter data is typically provided at half hour intervals and, like Wattwatchers devices, provides a timeseries of electricity use on site. Remaining customer loads will be estimated by calculating the number of energy users within the microgrid zone or aggregated data zone and by comparing with aggregated data for Heyfield which is expected to be obtained from the network service provider.

The detailed data will be used to identify the total load with a breakdown to particular energy uses and usage trends. Thermal loads such as hot water, heating and cooling can potentially provide load flexibility and energy storage. Many loads will follow occupancy patterns such as lighting, fridges, cooking and other appliances. Some loads will only occur in some households. Examples include pool pumps, spas and welding equipment.

The modelling will account for differences between customers such as solar and non-solar households, dual fuel households with gas or wood bills in addition to electricity costs and differences associated with building size, age and design.

The model of supply and demand matching with generation in a microgrid needs to be in real time and the modelling will need to account for any differences between 5 minute intervals, half hour intervals and instantaneous loads.

Data context and energy use drivers

A self-administered energy audit (using the Ecologic platform) will provide the model with necessary context regarding the breakdown of the load recorded by the Wattwatchers device or smart meter data. Some information about the household circuits will be captured during the initial installation. The householder will then have an opportunity, through the energy audit platform, to supplement this data with information about building envelope, the appliances and occupancy patterns, other fuel use and energy costs.

Other external variables can also drive load patterns. The obvious example is weather. Where available, the data for all identified load drivers will be used in the model, such as:

- Real-time weather data
- Heating and cooling degree days, daily maximum temperature
- Daylight hours and solar radiation
- Calendar effects and notable events
- Overall Heyfield demographics

Historical and projected changes plus an understanding of possible futures is relevant information for modelling and analysis. The community engagement process is expected to assist in compiling the story for Heyfield and considering:

- Demographic change
- Economic change - history & possibilities
    - Markets served
    - Tourism, visitors
    - Surrounding region economy

- New build proposed/ possible, including type, size & efficiency
- Transport habits and EV penetration
- Future vision and any targets that have been or might be set

To the extent that data is available, information will also be collected to understand local sources of energy supply including emergency supplies, alternative fuels and investments in batteries. Any regulation or control systems that guide or constrain operation of distributed energy resources will also be identified.

It is an ambition of the project to use some of these data sources in an ongoing manner within the decision support tool so the difference between once-off or ongoing data collection will be noted as data sources are identified.

The Ecologic platform for energy audits

To join the MyTown Microgrid, community members will be required to undertake an energy audit using the 3rd party Ecologic app. However, participants do not need to have a Wattwatchers device installed in order to have an energy audit. Up to 500 community members will be offered the free energy audit service, with an option to expand this to 1,000 households if there is sufficient demand.

The energy audit will involve either the trial participant or a trained member of the community group (who will receive 1.5 hour training and will also be shown how to train others) completing a short set of questions in the Ecologic app. These questions relate to the built form of their home and the types of appliances they have. This will require the downloading and use of the Ecologic app.

This process allows Ecologic to collect data on energy use and carbon emissions for a residential dwelling. A small number of ISF staff will be provided with Ecologic account administrator rights where they can export Excel files of data. Where data is to be exported as Excel files, this will be done to a secure shared folder that cannot be accessed by non-ISF staff.

Where the energy audit is being undertaken remotely or in person by HCRC staff, consent will be obtained to complete the energy audit on behalf of the participant.

Where the energy audit is self-assessed, downloading the Ecologic app will refer partners to a website landing page hosted by the HCRC which will provide informed consent.

Load aggregation

It is anticipated that the electricity network provider, AusNet Services, will provide current and historical data to confirm the total electricity consumption for the Heyfield community within boundaries defined by the network configuration. Data on approvals for battery, solar and other generation connections, on new connections, on customer numbers, on control configurations (eg for hot water systems) will also be sought from AusNet Services at the aggregated level for Heyfield.

Load characterisation

The Heyfield load, generation and future change data will be used in the analytics engine to:

- Characterise load types (customers/ business) and correlate with household specific information
- Characterise end use types
- Identify current costs

- Identify performance of existing system and calculate value
- Develop future scenarios for energy demand; and
- Determine the minimum data and modelling requirements for future users of the decision support tool.

4 Network Options

Information about the electricity network topology, assets and performance will be used to define and map the boundaries of possible microgrid solutions. The picture of network performance will be constructed from information directly obtained from AusNet Services and from the experiences of customers.

Information about planned future investments will be used to calculate the potential value of non-network or microgrid solutions, and also to calculate the potential value in reducing unserved energy and/ or improving reliability.

The options for operating the network in traditional modes and in modes that can support the various energy solutions proposed will be developed and costed.

Network information required to develop network options can be categorised as follows:

- Boundary information: high level definition of potential microgrids, including disconnection points
- Asset information: a stocktake of the current capacity, performance, and future maintenance requirements and costs for the Heyfield area
- Control and Management: current ability externally control and/ or call on customers to reduce demand.
- Understanding network performance: determining the current issues for Heyfield,
- Supply and Demand: a top down assessment of the load
- Planned investment and calculated cost of unserved energy: this is a necessary element of the business case(s)

Boundary information

The layout of the existing network defines what may be possible in terms of a microgrid and where options for reducing constraints or improving performance might best be located. AusNet Services provide a publicly available portal which maps the existing network at high and medium voltages. Further access to low voltage (LV) asset information, including the location and rating of LV transformers will extend the knowledge of the network topology.

Defining the edges of the existing network and switching or sectionalising points where parts of the network can be disconnected will be necessary to understand the boundary options for a microgrid. A number of options that allow complete isolation (known as islanding) from the centralised grid will be explored during this project and each will have different boundaries.

Understanding the nodes or points in the network where electricity flow might be constrained creates boundary or constraint information for the other local energy solution options that will also be considered as part of this project.

Consideration of boundaries should include the system impact up and downstream from the connection points.

Asset information

Electricity network assets include poles, wires, transformers, meters, switches, power quality and protection equipment. Capacity and performance specifications for assets will be used to model the network and also to estimate its value, and the future cost of maintaining the network.

The network modelling will test the technical feasibility of microgrids and other energy solutions, contributing to the overall design. The capital and operational expenditure estimated for the Heyfield network assets (Capex and Opex) contribute to the business case for alternatives by providing a reference case.

Control and Management

It is anticipated that some loads like hot water systems will have been originally connected with control systems that can manage the timing of the load. As smart meters were rolled out in Victoria, the options for control will have changed and smart meters incorporate this control but the exact configuration of how this is utilised in Heyfield is currently being clarified.

Network management will involve control and management via protection systems, autoreclosing devices on faults and remote control capability. The management techniques designed into the system need to be understood in order to best conceive of alternative energy solutions.

Understanding Network performance

Power supply quality and reliability are key metrics for the project. Anecdotal evidence of network performance can be confirmed via the voltage and power production data from smart metering, Wattwatchers devices and SCADA data. Momentary faults may not be fully detected through this approach as the data sets will often be delivered for 15- or 30-minute intervals. Further data may be required from field reports to identify the types of faults and probable causes.

Supply and Demand

Data from smart metering, Wattwatchers devices, and energy audited data will not be comprehensive and will be used to estimate total loads. The location of data sets will be mapped back to the network in order to understand how loads and distributed generation impact in specific parts of the network. SCADA data from the medium voltage network will be used to identify aggregate loads related to each part of the network that is monitored by a SCADA point.

Developing the business case

The reference case for future network options relies on estimates of future expenditure if the network continued to invest in a traditional manner. The vision for future Heyfield load and economic growth in the region will provide a number of scenarios that will need to be costed. Some information about future network costs will therefore be established by the existing forecasting and planning systems used by AusNet Services. Additional work will be required to imagine network requirements for future scenarios that have not currently been considered formally. Trends in changes to load, generation and investment choices will also be necessary to establish the reference case.

4.1 Minimum data requirements to determine microgrid boundaries

The project is expected to have access to AusNet Services data portal which provides asset location and detail at the low voltage (LV) level. This is one level deeper than the publicly available 22kV and SWER network information and it provides more detail about asset ratings. Final project outcomes will consider the options available to communities without a data licence agreement and partnership arrangement with their network service provider. This will include the boundary and cluster identification that can be achieved in the absence of an official network map and without technical expertise. Inaccurate information about the number of loads under consideration and the constraints in the existing network will have implications for the reliability of results from the analytic engine. A qualitative comparison will be undertaken of the boundary options identified at an early stage of the project, with public information only, and the options identified after access to portal information.

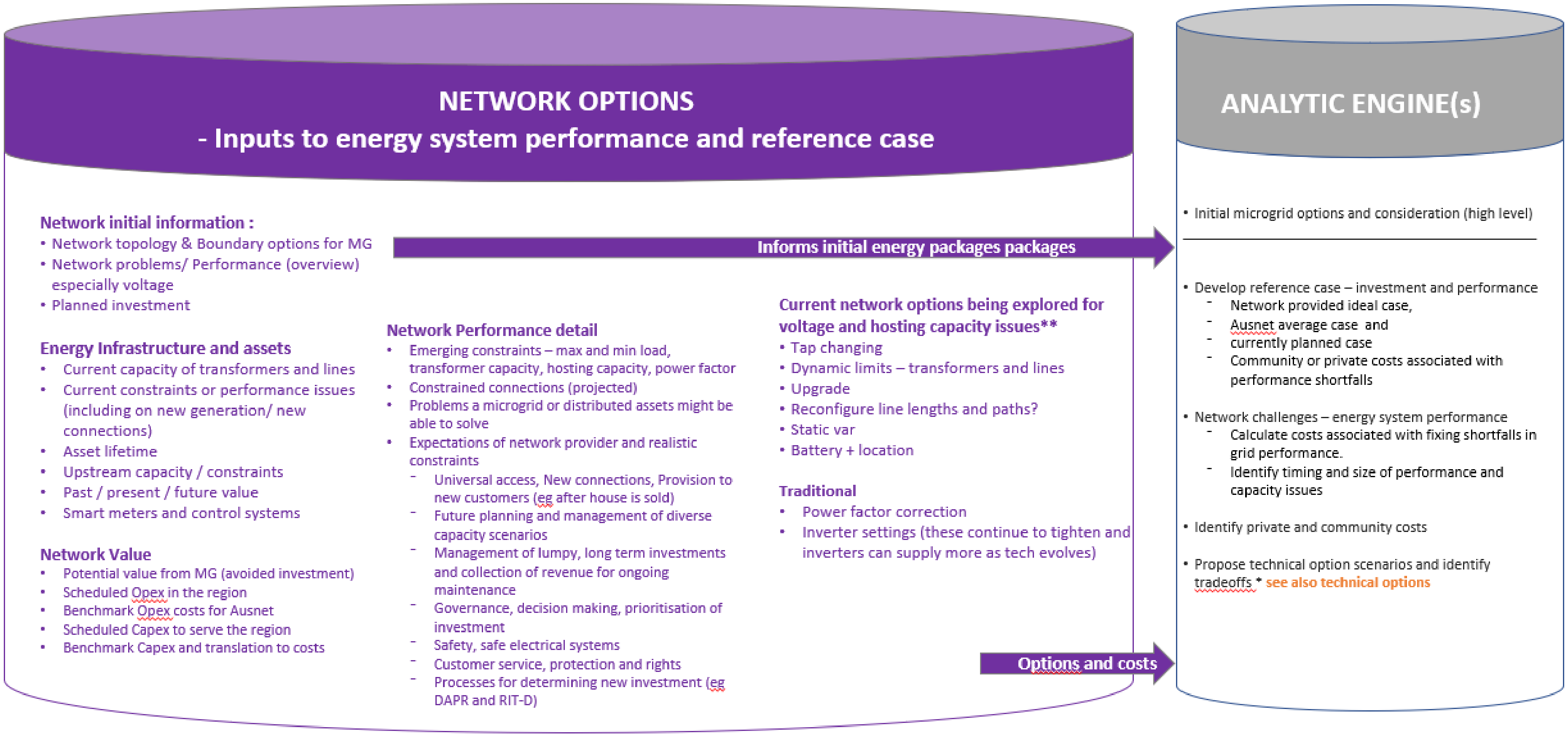

Figure 4 – Data requirements to develop network options

5 Technical Options

The energy assets and technical options will be screened to make a list of suitable options. This involves assessing the distributed energy options that can be employed including: generation options, storage options, flexibility, load matching and balancing options – all considered in the light of community assets and systems.

Technical options can be categorised by scale, location and purpose served.

The following scales match the options that might produce energy solutions across Heyfield:

- Community exporting – larger than the 2-5MW scale that captures much of the existing Heyfield load
- Community-wide - capturing much of Heyfield and some or all of the largest loads.
- Cluster scale - larger than a single site and designed to serve a cluster of sites
- Industry – designed with an industrial load in mind, for example the Timber mill or a dairy.
- Commercial – most non-residential sites are dominated by heating and cooling loads plus office equipment
- Residential – the smallest and most populous scale with a variety of loads to consider
- Transport and Heat loads that can be electrified do not exist on the network at the moment but warrant specific consideration.

Technical solutions will be located:

- On a site, which is likely to be behind a meter with consideration of private ownership by the site owner. The meter usually represents the boundary for the network business with reduced control over the appliances that are connected or visible to the network.
- On the low voltage 240V system with a dedicated connection.
- On the 22 kV system with a dedicated connection and transformer.

The location of technical options is likely to impact on the business case for each and on the business model that can feasibly be considered.

The following general categories capture some of the technical options to be considered for the various scales and locations identified above:

- Generation
- Electrical storage
- Thermal storage
- Pump storage
- Energy efficiency
- Demand management
- Control and management

The development of technical options will consider the local energy resources and assets that could be utilised for additional local value. The cost / benefit profile for different options is often context specific and creates different results depending on the utilisation that can be achieved. Future costs and changes in technology also need to be considered for use in the technical analysis.

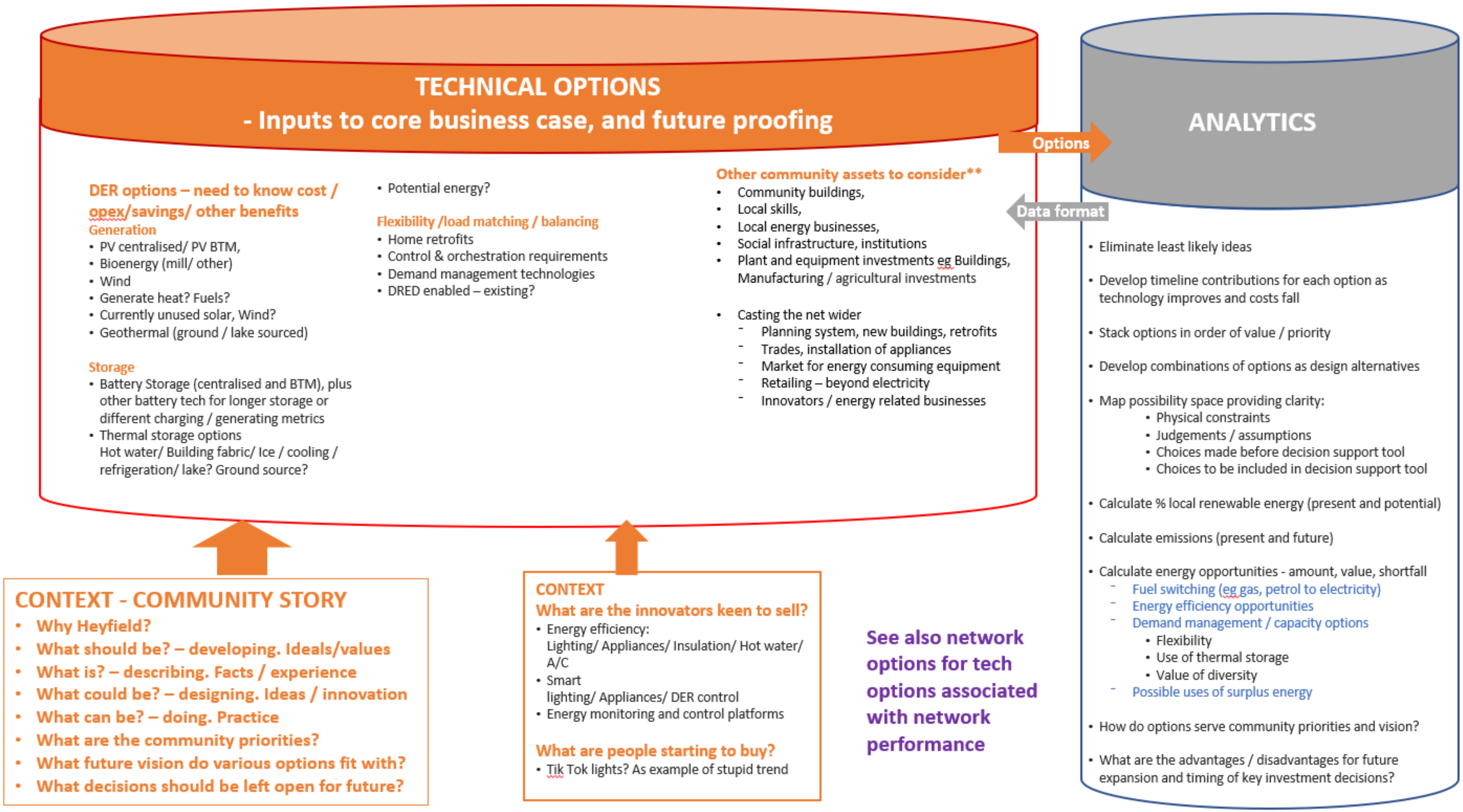

Figure 5 – Exploring, screening and analysing feasible technical options

6 Analytic Engine

The previous modules (Heyfield data, technical and network options) will be synthesised to develop and cost options and scenarios. For each scenario or technical configuration, the primary outputs from the analytical engine will be:

- Consumption, import & export per load type
- Microgrid import/export
- Outages/system performance information
- CAPEX and OPEX (separated per customer type, and per centralised option)
- Overall value streams
- Emissions and proportion of renewable energy supply

The analytical engine will allow comparison of these indicators between scenarios, where scenarios may be groups of technical options.

6.1 Inputs and outputs

Information inputs

Information about the existing loads and local context from will be used to characterise the current energy profile.

The amount of energy efficiency retrofit and demand management potential will be calculated and capacity for thermal storage and load flexibility. Essential loads requiring supply in emergencies will be included.

The existing network assets, network performance and planned network investments will provide a reference case that reflects the costs and benefits of business as usual. Scenarios involving new network and technical options will be costed and optimised to test again the identified metrics in the best possible way.

Energy solutions and scenarios

Feasible energy solutions will be developed based on the analytics and combinations of technology and network options that optimise cost and energy performance. A number of load scenarios for future Heyfield operation will be constructed and energy solutions tested for each.

Some solutions will focus on the investments that appear worthwhile regardless of progress on a microgrid or virtual power plant (VPP) option. These are likely to include investments at every site that may incorporate generation, storage, energy efficiency and demand management and are referred to as the distributed energy resource (DER) solutions.

A series of microgrid solutions will be developed based on different boundaries and clustering arrangements.

A series of control, management and aggregation solutions that do not rely on the islandability of microgrids but nevertheless reduce system constraints and improve local outcomes will also be developed. These are referred to as virtual power plant (VPP) solutions.

For each solution the core business case, broader economic benefits, energy system performance, & future proofing components will be made explicit as metrics for the decision support tool and business model steps of the process.

Data requirements

Minimum data and modelling requirements will be determined so that other communities can also use the tools developed by this project to make decisions about microgrid opportunities for their own places.

6.2 Modelling tools and minimum data requirements

A key objective of the project is to develop processes and tools which are replicable by other communities which may not have the analytic resources available for this project. Where possible, open source modelling tools will be used for the analytics. A first step in the process will be to undertake and document an audit of potential modelling tools.

Another objective is to determine the minimum data requirements for pre-feasibility for microgrids and the associated local energy solutions. To this end, the analytical engine will be used to compare outcomes with differing levels of data. Table 1 gives an outline of what will be compared.

Table 1 Minimum data determination

Item	Project data	Compare outcomes with
Energy data from Wattwatchers residential device	Project will have data from approximately 75 devices	50/ 25/ 10 Wattwatchers devices Wattwatchers data from another region Smart meter data only Ecologic data only “Typical” energy use data (Victorian average) + postcode data for PV and batteries
Energy data from Wattwatchers non-residential device	Project will have data from 12 devices installed in major business premises	Smart meter data only Ecologic audit information from some of the businesses only “Typical” energy use data for different business types SCADA data for an aggregate of loads in Heyfield with an estimation of residential/non-residential split Publicly available zone substation data with estimations of load allocated to Heyfield
Aggregate load and load cluster data	Project will request SCADA data where monitoring exists and aggregate smart meter data for some load clusters	Use of load model data that reproduces measured results in another part of the network
Data interval	Project will have access to some 1 minute and 5 minute data. Project will primarily use 15, 30 and 60 minute data intervals.	Record the materiality of differences in results when using finer grained data sets. Identify results that remain valid when only powered by daily or monthly data.
Weather data. Solar and wind resource data	Measured weather data Actual solar production	Nearest BOM weather data that provides required dataset Melbourne Airport data Modelled solar production

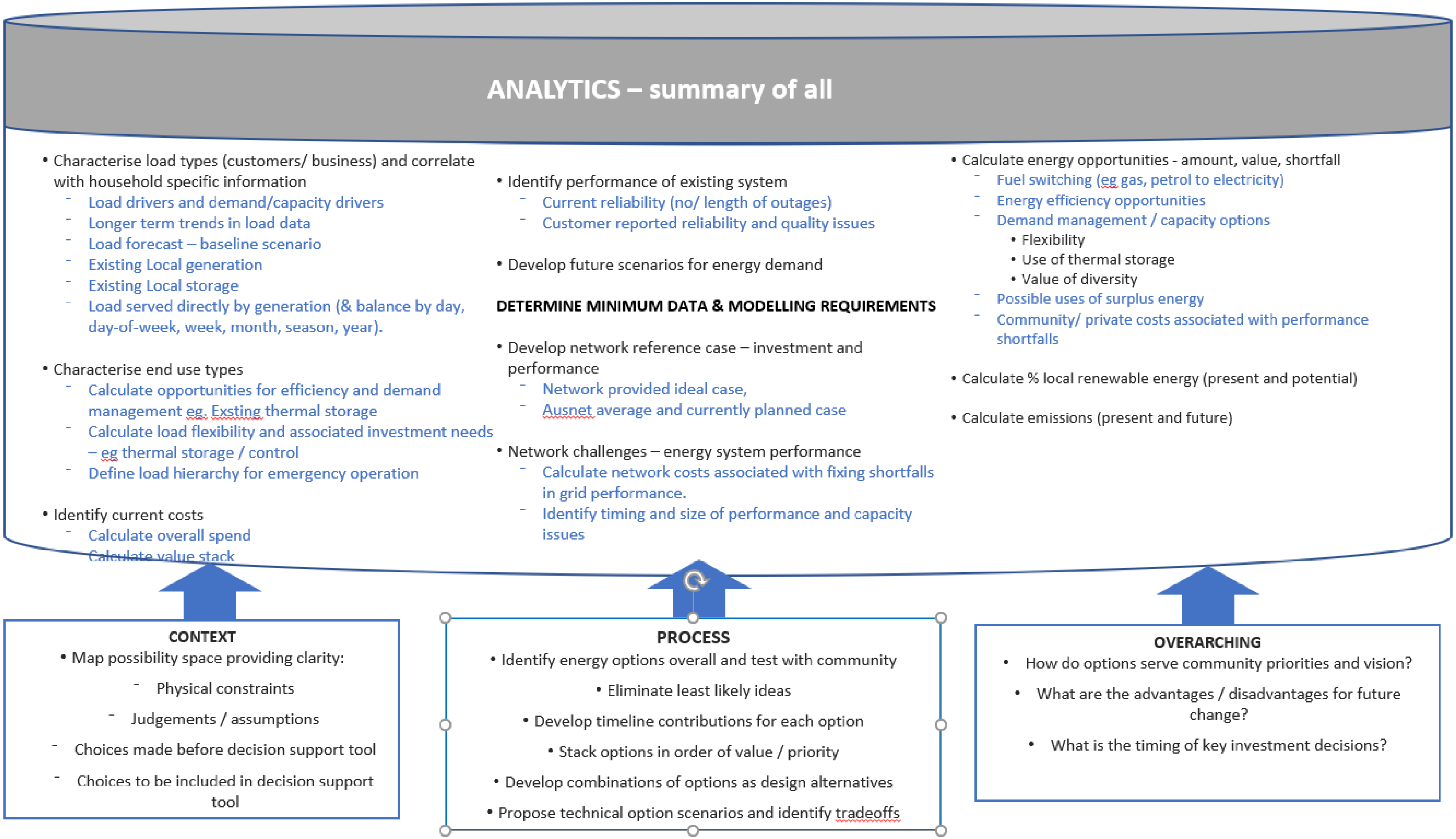

Figure 6 – Analytic Engine

7 Business Models

Energy solutions require a business model that identifies and allocates the costs, the risks and responsibilities and the benefits. As far as possible, the analytic engine will identify and quantify all the value streams associated with different energy solutions.

For some value streams it may not be possible to monetise outcomes, for example additional comfort in energy efficient homes, long term economic growth for the region, or increased resilience. The business model module will aim to make all the value streams explicit, even when not monetised, and indicate the likely and possible beneficiaries.

In all cases the analytic engine will provide information about the capital costs and operating costs of energy solutions, with management risks identified alongside. Commercial business models to provide investment and recoup benefits for technical options often already exist for private investments. Business models to provide collective or community wide benefits have been identified by assessing a range of case studies of other community energy and microgrid projects. Additional business models will be developed that consider new ways to allocate costs, benefits, responsibilities and risks.

Business models cannot be separated from control and governance. The reference case within the analytic engine makes the traditional cost-benefit allocations explicit. The existing regulatory arrangements and network planning processes define current and future investments in the Heyfield network. The existing trends for private energy investments, current energy costs and the scenarios agreed with community representatives define the private value flows in the reference case.

The business model may have some bearing on how the capital or operating costs are incurred or 'observed' by the community, but most importantly will define the ways that value or 'benefits' will be allocated between stakeholders. This effect will have to be integrated into the analytical engine, so that the stakeholder costs and benefits per package of options, and per business model, are explicit. Stakeholder types include individual residents, the community at large, individual businesses, and the network operator.

Ideally the module will characterise a number of alternative business models and define allocation of the various value streams per stakeholder[1] for each, so that these can be integrated into the analytical engine to allow comparison between the financial effects of alternative business models as well as between energy options.

Only financial aspects of the business model, and the flow through costs and benefits, can be compared by the analytical engine, while wider governance questions will need to be compared qualitatively through the business model co-design process.

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[1] Noting that stakeholders will include: different residential customer, differentiated by size, solar ownership, and within or outside of the microgrid.

BUSINESS MODELS

Key Questions

- What partners & business model options are available for each technology in the portfolio?
- How do business model choices affect how costs and benefits are accrued by stakeholder?
- Which business model choices best meet community goals?
- Which business model structure should be selected for inclusion in the preferred portfolio?

What partners & business model options are available for each technology?

- What partner/deployment options are available in the market for each technology in the portfolio?
- What are the business model implications of each potential partner choice in terms of costs/benefits, risks and responsibilities?
- What other bespoke grassroots approaches to ownership & governance warrant inclusion?

How do business model choices affect how costs and benefits are accrued by stakeholder?

- What are the key value flows created by each option?
- How are costs and benefits accrued: Specifically what value is allocated to the *individual customer*, to the *microgrid community*, to the *network provider*, and to the *wider community*?
- What costs/benefits are not monetised (e.g. volunteer labour)?
- What are the qualitative risks and benefits associated with each option?

Which business model choices best meet community & project goals?

- How do the available business model options rank against community goals, and maximise community benefit? This includes short- and long-term costs, governance and control, equity of access, flexibility to integrate new technology or service providers, local economic development co-benefits, developing social connection, etc.
- How compatible is each business model option with future scenarios (e.g. zero carbon, circular economy, climate change, community change)?
- Which has the best replication potential in other communities?

Which business model structure should be selected for inclusion in the preferred portfolio?

- Main business model/partner options directly compared via stakeholder cost-benefit using 'Business model comparison module' alongside qualitative factors. This is taken into Business Model co-design process.
- Resulting community selection of business model options integrated into final business case / option choice.

Figure 7 – Business Models

8 Decision Support Tool

The decision support tool is intended for use by the Heyfield community and future communities interested in developing local energy options and considering microgrids, to assist and where possible streamline decisions. Any design for a superior energy solution involves trade-offs. The decision support tool aims to allow individuals, community groups and groups of technical experts mixed with community members to explore the implications of trade-offs and different decisions on the energy design and outcomes. Collective decisions rely on the learning of each stakeholder. The data analysis and visualisation techniques used for sharing understanding of the challenges and options in Heyfield will be suitable for adoption by future communities for customising to their own specific situation.

There are a number of possible roles for the DST, with increasing degrees of complexity:

1. A series of decision trees to accompany the 'How to guide', for example covering how to identify alternative network boundaries and the associated high level considerations.
2. A graphic interface between the analytical engine and the community, in order to make outcomes for different stakeholders more understandable. It is noted that this will only be usable by other communities if it links to off-the-shelf or open source analytical tools
3. A model that allows users to select different scenarios, different business models and different technical configurations that work together as an energy solution and see how the benefits and costs play out.

The third option, while ideal, is unlikely to be possible within the scope of this project.

The decision support tool, in whatever form, is intended to present outcomes for the alternative energy option packages under the four main metrics:

- Core business case:
  - *Community*: are energy services cheaper, the same, or more expensive at an economy-wide and community-wide level
  - *Stakeholders*: are energy services cheaper, the same, or more expensive at the individual customer level (noting that customers will be characterised into a series of typical cases, including residential with and without solar, within and outside of the specific energy solution, commercial sites), are projects viable for developer, for the management company, and what is the impact on the network provider.
- Broader economic and societal benefits: does the solution transfer energy spending to the community, does it create jobs, does it reduce emissions or increase the proportion of renewable energy in the system;
- Energy system performance: what are the impacts on reliability, both within the community and up or downstream; and
- Future proofing: how resilient are the proposed solutions to future change, either in the community or technological change.

An iterative process will be needed with the community to define the options to be compared, with a process of presenting high level options early on, even if only indicative, as part of a screening process. This is needed in order to allow a reasonable number for detailed examination and will be integrated with the co-design process for the business model.

Selecting different options and exploring the outputs of the decision support tool will help everyone understand the impact of different choices on the energy solutions that are available to the community of Heyfield. The outcomes that are preferred by individuals can be workshopped and discussed so that everyone has a deeper understanding of the interplay between values and technical options when designing improved energy outcomes for a community.

The specification for the Decision Support Tool is incorporated as Appendix A to this report.

9 Appendix A: Analytical engine and Decision Support Tool specification

The goal of the Decision Support Tool (DST) is to rapidly bring stakeholders to a 'go – no go' decision point by integrating a set of standardised complex datasets and considerations into a readily interpretable set of prerequisites, graphical outputs and figures. This will quickly enable a community to arrive at an understanding of whether a microgrid opportunity offers better technical, economic and social outcomes for the community.

9.1 Specification of DST Modules & Analytical Engine Functions

The DST needs to support the journey of the community through the microgrid feasibility process. Adjacent to learning about microgrid options will be a growing awareness of energy use, energy resources, generation and storage technologies and the social changes associated with an energy transition. Some of these decision stages can be supported by DST itself, others by facilitation or guidance materials. The community dashboard provides real time information and the opportunity for community members to learn about local supply and demand. The analytical engine then supports the modelling of options portfolios and scenarios which provide the link between data curated and outputs presented through the DST.

Each core function of the DST is outlined below as "modules" alongside the specific stage of the community journey through the microgrid feasibility and co-design process in Figure 7 below. How this is supported by core features of the Analytical A later image (Figure 8) includes the relationship to the other resources generated by the project.

Figure 7 – DST Modules and Analytical Engine Functions to Support Feasibility Community Journey

Feasibility Community Journey	DST Modules	Notes
Entry & Goal setting	0. Pre-qualifier screening	Qualitative screening questions or decision tree that orients community as to whether they are in the position to follow this journey now.
Data collection & monitoring	1. Data input guidance/screens	Minimum viable data inputs regarding number of customer types, top down network data, existing solar uptake.
Situation analysis & futures	2: Community dashboard	Present high level town energy situation: key end uses, constraint times, total demand and amount of local energy required for self-sufficiency
Asset mapping	2b. Upload & mapping of energy asset locations	Sourced from workshop; presented on dashboard
Options list	3. Data input template; Option cost curves; MCA framework against goals	Option costs & potential as inputs; Cost curves per kWh, kW, & kWp in key constraint times as outputs; MCA framework is qualitative framework to assess options or portfolios against community goals/risks
Boundary definitions		
BM Choices #1	4. BM Comparison Module by stakeholder	Assists stakeholders to compare and choose between different ways to bring a technical option to market. Outputs inform business model co-design process.
Draft portfolios	5. Overall business case cash flow by stakeholder	From perspective of: different customer types in the community; the network business; Asset owners; Potential service providers.
BM Choices #2	[Iterates using Module 4]	
Final portfolios	[Iterates using Module 5]	
Investment plan		

9.2 DST Design Principles

In designing the foundations of the DST, the following design principles will be applied. The DST should:

1. Support communities in understanding whether a microgrid could add value and might be viable in their area, with the least time investment and data requirement possible.
2. Allow flexibility for communities to use 'best available' data that could be high level or granular
3. Be freely available, or readily accessible at low cost if the value proposition requires data sources to be updated or paired with community microgrid facilitation services, and which supports the replication of the feasibility process.
4. Dovetail with other community co-design resources.
5. Seek to limit unfunded maintenance of data or code to prevent becoming obsolete.
6. Quantify where the key costs and value streams lie, to start to inform which stakeholders those costs and benefits will accrue to.

9.3 Desirable Criteria for Selection of Analytical Engine

The datasets and basic functions of the analytical engine are outlined in Section 6 of this document. It is not within the scope of this project to develop an analytical engine for option analysis and microgrid planning or optimisation from scratch. As such, one of numerous existing tools will be used and potentially expanded upon to meet the project goals for analysis. In addition to meeting features outlined in Figure 7 above, the desirable criteria for shortlisting the analytical engine follow below. While no tool is likely to meet all desirable functions, the analytical engine should:

1. Be designed for application at the *local and/or regional* scale of analysis
2. Be compatible with analysis at the *hourly to minute* timescales
3. Incorporate the implications of *network topology* (structure)
4. Be compatible with linking *data supply from the chosen DST platform*
5. Be *open source or sufficiently low cost* to limit barriers to community replication regarding program access or maintaining underlying databases
6. Have an active *user community* of developers, practitioners and/or consultants
7. Provide results that can be transparently understood and iterated
8. Manageable setup time including useable libraries that grow and are updated

Working to the above criteria and functions outlined in Section 6 and Figure 7, a scan of the commercially available off-the-shelf and open source tools was undertaken. A shortlist of the following tools will be assessed against the criteria, with the goal of selecting one more more in combination to deliver the project goals:

- HOMER
- SAM
- DER CAM
- GridLAB-D
- MATPower

This will be done alongside PowerFactory and other power flow modelling tools given these are likely required for the more detailed design phase.

9.4 Digital Platform Options for DST

The actual platform upon which the DST is built is inextricably linked to the selection of analytical engine: its access arrangements and costs, and data input and output formats.

The optimal project outcome would be building the DST modules on top of the Wattwatchers/Rayven ADEPT platform where basic Community Dashboard functionality is already being developed, providing issues of platform access arrangements and cost can be navigated to meet the above design principles. The DST would use Python based (ideally open source) code to curate data and feed the analytical engine, within which more detailed options iterations can be performed.

Figure 8 – Alignment of DST and Analytical Engine Specifications with other project resources

Feasibility Community Journey	DST Modules	Notes	Analytical Engine Features	Other resources [External reliance]
Entry & Goal setting	0. Pre-qualifier screening	Qualitative screening questions or decision tree that orients community as to whether they are in the position to follow this journey now.		Facilitation agenda for visioning & futures workshop
Data collection & monitoring	1. Data input guidance/screens	Minimum viable data inputs regarding number of customer types, top down network data, existing solar uptake.		[Opt: Collation of existing data streams] Ecologic audits; Wattwatchers Monitors Network data pack definition [DNSP reliance]
Situation analysis & futures	2: Community dashboard	Present high level town energy situation: key end uses, constraint times, total demand and amount of local energy required for self-sufficiency	Pulls data from community dashboard (2) & DST database (1), and Wattwatchers/Ecologic. MAY be required for computation logic underpinning whole of community demand situation.	*[Iterative feedback with community on included content]*
Asset mapping	2b. Upload & mapping of energy asset locations	Sourced from workshop; presented on dashboard		Facilitation agenda for asset identification session
Options list	3. Data input template; Option cost curves; MCA framework against goals	Option costs & potential as inputs; Cost curves per kWh, kW, & kWp in key constraint times as outputs; MCA framework is qualitative framework to assess options or portfolios against community goals/risks	Pulls data from options list specification (4).	Facilitation agenda for option screening
Boundary definitions			Handles a small number of scenarios created by different boundary definitions and future change parameters (latter could be as a portfolio 'stress test').	[Network advice] Decision tree description Facilitation agenda to select preferred boundary options
BM Choices #1	4. BM Comparison Module by stakeholder	Assists stakeholders to compare and choose between different ways to bring a technical option to market. Outputs inform business model co-design process.	*Ideally* has ability to compare multiple ways of delivering a given option under different business model assumptions (5). If not this could be done in the DST separately.	Facilitation agenda for BM preferences
Draft portfolios	5. Overall business case cash flow by stakeholder	From perspective of: different customer types in the community; the network business; Asset owners; Potential service providers.	Incorporates all plausible supply and demand side options into optimisation engine to deliver potential portfolio combinations and generate data granularity for stakeholder outcomes (6)	[Microgrid planning & optimisation model] Facilitation agenda for portfolio choices
BM Choices #2	[Iterates using Module 4]			Facilitation agenda for BM preferences
Final portfolios	[Iterates using Module 5]		Power flow modelling ideally harnesses data pre-existing optimisation modelling to streamline process.	[Power flow modelling] Facilitation agenda for portfolio choices
Investment plan				Heyfield example as template