



# Mapping Energy Efficient Product Supply Chains

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## About the authors

The Institute for Sustainable Futures (ISF) is an interdisciplinary research and consulting organisation at the University of Technology Sydney. It has been setting global benchmarks since 1997 in helping governments, organisations, businesses and communities achieve change towards sustainable futures. ISF utilises a unique combination of skills and perspectives to offer long term sustainable solutions that protect and enhance the environment, human wellbeing and social equity.

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## Executive Summary

The Victorian Department of Environment, Land, Water and Planning (DELWP) commissioned the Institute for Sustainable Futures, University of Technology (ISF) to undertake a study of supply chains for energy efficiency products. There were two key objectives:

1. To map the supply chain for four energy efficient product segments: identify how they are structured and how they operate, characterise the participants, their roles and how they connect to each other.
2. To understand the impact of supply chain characteristics on the Victorian Energy Upgrade (VEU) program and other energy efficiency programs: how, why and when they influence customer adoption of energy efficient product incentives, as well as how this might change or be influenced in the future.

Thirty organisations were interviewed over a three-week period to gather information on the organisation of supply chains and the way in which they mediate energy efficiency programs. For each supply chain:

- a map has been produced with supporting analysis on the role, structure and influence of each of the agents;
- an analysis has been produced of the key drivers and potential blockers of change.

There are general findings that relate to supply chains and energy efficiency and specific findings that relate to each of the supply chains under investigation.






## General findings: a supply chain approach to energy efficiency policy and programs



Supply chain analysis needs to become embedded in how policy makers approach policy and program design and implementation. The VEU program currently has a very low presence in each of the supply chains examined – and indeed in all supply chains outside lighting – so a different approach may be needed. Our report contains a range of insights and information on how these four supply chains operate but it can only be regarded as a preliminary analysis that needs to become an on-going part of operations – it is not something that can be done through a one-off analysis in a static document.

Table 1: Criteria for Guiding Supply Chain Actions

It is a cultural approach that policy makers need to apply to each area that is supported by more resources, market research and active engagement with players in the supply chain.

To support the development of a supply chain approach, our report contains criteria (Table 1) for identifying supply chain agents to work with for the VEU program.

Factor	Criteria
<b>Scale</b> 	<p><b>What is the potential scale of VEU use within each category?</b></p> <p>The starting point should be the estimated level of savings and Victorian Energy Efficiency Certificate (VEEC) creation within each sector, product or supply chain (maximum, feasible and likely levels). The larger the saving, the greater the justification for DELWP staff to invest effort.</p>
<b>Efficiency</b> 	<p><b>At which point in the supply chain is the agent able to exert influence most cost-effectively?</b></p> <p>Incentives and other program resources should be directed at the agent(s) in the supply chain that are able to influence the most participants for a given level of incentive or funding. As this study demonstrates, the agent(s) that can exert the most influence varies between supply chains.</p> <p>Another consideration is the potential for standardisation or scaling-up. Is there scope for incorporation of VEU information in ‘standard’ business decision-making systems (e.g. standard specifications, procurement guidelines etc.) that can enable aggregation and scaling as has occurred for the major success story (lighting) to date?</p>
<b>Influence</b> 	<p><b>Who are the change agents?</b></p> <p>The potential scope of influence is one factor to consider – but arguably it can be more important to identify motivated agents who are able and willing to drive an increase in the uptake of energy efficiency products.</p> <ul style="list-style-type: none"> <li>– Which actors in the supply chain are most likely to be able or be motivated to capture the VEU revenue? This in turn is related to how significant that revenue might be for them and how easily they can fit VEU into their business/operating model.</li> <li>– Which actor’s business model is aligned to the objectives of the VEU? Specialist, new-entrant or ‘disruptive’ businesses and aggregators that have a focus on energy efficiency products or services should have a particular focus for programs that are aiming for market transformation (not just deployment).</li> </ul>

Factor	Criteria
	<ul style="list-style-type: none"> <li>- Which agents have climate change, sustainability targets – or buyers in a supply chain with sustainability goals - or other drivers that support energy management in addition to price and security interests?</li> <li>- Is high profile government endorsement of the product or service as a 'good thing to do' likely to be a motivator?</li> </ul>
<p><b>Effectiveness</b></p> 	<p><b>How important is the level of incentive for the supply chain agent?</b></p> <ul style="list-style-type: none"> <li>- Is it essential to enable the action to meet their internal investment hurdles? Can they use VEU to quantify and prepare a more powerful internal business case?</li> <li>- What is the scale of incentive relative to the product cost for the consumer and time/effort for each market intermediary? Unless it is a significant benefit it will not be sufficient to motivate action.</li> <li>- Where does the incentive accrue? Does the agent need to share it with others in the supply chain and/or the end consumer?</li> </ul>
<p><b>Complementarity</b></p> 	<p><b>Can the VEU complement or amplify other programs?</b></p> <p>The VEU program can be more effective where it can be 'packaged' with other programs or incentives. One of the key considerations is that VEU program revenue is often considered uncertain so if it can be combined (without double-counting) with other initiatives that provide recognition, funding (e.g. a grant program) or another benefit it can be much more effective.</p>

As part of this study, we have also undertaken an analysis of the fit or influence different policy instruments can generally have with different supply chain agents (see Section 6.2).

The key focus for this analysis was the VEU and supply chains for specific products but there are a couple of important points to keep in mind:

- While we have examined supply chains for specific products, in practice they are often part of systems in which the approach to individual

products is shaped by overall designs and packages of work (especially in commercial buildings);

- The VEU program should also be considered in the context of other initiatives as it can often be much more effective as part of a suite of tools for improving a building's efficiency. For example, the financial incentive from VEU on its own may not be sufficient to motivate a builder to ensure the best solution, but it could be if it comes with awards and recognition that enhance their brand and helps win future work.

## Specific findings: implications for each of the project supply chains

The key focus for our research was to map the structure of each of these supply chains and to identify agents within the supply chain that could be the focus for the VEU program (and other programs) to increase the uptake of energy efficiency products. Within the scope of this project, we undertook interviews with a cohort of key actors within each supply chain. A range of opportunities for taking a more targeted approach to energy efficiency policy implementation were identified for each of the supply chains.

### Residential heating and cooling

For residential heating and cooling, there are many different routes to market and switching between pathways depending on pricing and opportunities – but there are two dominant pathways to consumers within the supply chain: the big-box retailers (around 20 per cent) and installers (around 70 per cent). There are three dominant manufacturers which import air-conditioning units with around 80 per cent market share (and a host of smaller operations that import by the container-load and often sell outside major retailers). The fundamental challenges with residential heating and cooling are that the VEU incentive is a relatively small portion of system cost for an individual system, and that it is a fragmented eco-system with lots of ‘man-in-van’ operators.

In relation to the key agents in the supply chain:

- Manufacturers have a shared interest with energy efficiency program policy makers in improving the quality of installations - which can have as big an impact on energy consumption as the quality of the unit – because poor installation leads to higher warranty claims. Only one of the leading manufacturers has an accreditation scheme for installers, and program makers should consider how it can be extended to other manufacturers. AIRAH and/or AREMA could be potential partners.

In view of the strategic significance of residential heating and cooling, there may be a case for bundling and focusing VEU revenues on manufacturers for selling higher rated units where the quantum of incentive is a greater proportion of system cost – the ‘golden carrot’ initiative in the US for refrigerators is a past example here;

- The retailers could be a focal point for VEU incentives but there are a number of issues. The size of the incentive may not be sufficient to influence purchasing decisions (notwithstanding the impact it could have on salespersons if they could keep part or all of it as a ‘commission’) and concerns have been expressed by manufacturers about the quality of installation from retail sales;
- The installers are the key supply chain agent but there is a high level of fragmentation. A NSW Department of Planning, Industry and Environment (DPIE) (formerly NSW Office of Environment and Heritage) initiative to establish a body that registers installers, which manages certificates and recoups payments to installers, is worth consideration for piloting in the VEU to drive higher uptake;
- The feasibility of focussing on major developers that bulk-buy air-conditioners for commercial developments should be further assessed, as the incentive may work better due to scale of purchases.

Although not strictly part of the supply chain, the scope to collaborate with financial institutions should be considered. The recent release of an offer linking mortgages to home star ratings could be a game-changer for residential energy efficiency and they have scale and capacity to aggregate certificates across many end-users.



## Commercial Heating, Ventilation and Air-Conditioning (HVAC)

For Commercial Heating, Ventilation and Air-Conditioning (HVAC), building performance rating systems (such as, particularly NABERS, Green Star and LEED) which is based on actual performance, have driven major change through the supply chain. They have achieved this by creating tools to measure and verify energy efficiency, which then translate into rents and asset valuations. Rating systems are being extended to other building types and sizes. The 'data revolution' is at an early stage but can be seen to be having a major impact where it is used to identify opportunities, reduce or avoid costs of extra metering, undertake predictive maintenance, and support ongoing optimal performance. Data analytics must focus on 'business value' - not just energy savings. Correlating maintenance costs, equipment life, cleaning costs, facility management outcomes and real time weather data can underpin financially solid business cases for change.

The key agents in the commercial HVAC supply chain were the building owners (which often set energy performance standards to which other parties work towards e.g. a specified NABERS rating), engineering and energy consultants (which identify options and develop conceptual designs), builders (delivery responsibility), the mechanical contractors (the gatekeeper to the rest of the supply chain in many cases and with responsibility for translating designs into technology packages), and facility managers (who generally sub-contract to maintenance or mechanical contractors for service and replacement of equipment including HVAC). Data analytics can drive quality assurance and accountability to address problems with product substitution and poor workmanship: for example correlation of HVAC energy against wind speed and direction can help to focus attention on building air leakage.

Implications and opportunities that were identified for targeting agents in the HVAC supply chain:

- **Engage with engineering and energy consultants and property funds on use and design of VEU:** consultants are the key agent that handle VEECs. We were only able to speak to a handful of building owners and consultants but each of them had specific comments on the VEU and its low usage for HVAC. Consultants may well have been engaged and provided comment for the VEU review. However, there is likely to be value in specifically engaging with them on an on-going basis. This would build their knowledge, and capability while also enabling their input to be incorporated into scheme design and implementation.
- **Reduce transaction costs for HVAC:** most of the project methods require costly metering, baselines, and monitoring and verification that is too expensive relative to the potential returns from VEU, even for larger buildings. There were a range of suggestions for addressing this issue in interviews including:
  - Train NABERS<sup>1</sup> accredited assessors to be able to do assessments at the same time (including but not limited to HVAC), so that is an incremental additional cost for assessment. This could also be a vehicle for harmonisation between the Victorian VEU program and the NSW Energy Savings Scheme (ESS);
  - Consider how new building control and data systems to reduce the costs of monitoring and verification to demonstrate savings can be used more commonly. Air-conditioning is seasonal and there are many variables so it can be difficult and expensive to prove savings – real time data analytics can be helpful. While this is currently permitted, there appears to be low awareness or use. Simplification of compliance and verification is essential if the VEU program is to be effective in supporting HVAC upgrades.

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<sup>1</sup> NABERS (National Australian Built Environment Rating System) is a national rating system that measures the energy efficiency, water usage, waste management and indoor environment quality of Australian buildings, tenancies and homes.

- **Support new HVAC services business and entrants improving the efficiency of operating HVAC systems:** facility management is in general often a block to improved efficiency in the use of HVAC, due to limited understanding and a range of incentives and cultural practices that operate against more pro-active approaches. There are opportunities to work with facility managers to improve their knowledge of opportunities. However, the larger opportunity may be the emerging group of building analytics and HVAC services firms whose business models are based on efficiency gains from ‘tuning’ buildings and efficiency retrofits. Engaging with this sector to understand how the VEU (and other mechanisms) could be used to support the growth of these ‘disruptive’ businesses and projects lifting the operational efficiency of HVAC systems is recommended. Certificate creation can be linked to verified improvements in NABERS certificates but appear to be under-utilised at present.
- **Owner education on maintenance standards:** opportunities to use education programs, in particular to improve demand for higher quality maintenance. For example, model clauses of contracts with good performance provisions and case studies of the benefits of proactive operation and maintenance for owners to encourage and enable them to exert leverage.
- **Co-funding with a grant scheme to drive market transformation for upgrades that can achieve a step-change improvement such as chiller replacements:** the use of grants through a complementary program, to an energy efficiency obligation scheme to target high-value opportunities, could be a way to demonstrate the scope for the VEU program. Grants provide better revenue certainty and risk-sharing. Chiller replacement was identified by several respondents as the biggest-ticket item for a step-change in efficiency that had previously been targeted through grants. This could be done so again in concert with the VEU program.
- **Addressing split incentives for mechanical contractors:** this is not an easy part of the supply chain to target as they will only respond where there is ‘low hassle factor’ – but they are a crucial player and there can be

a split incentive insofar as the mechanical contractor is incentivised to reduce capex and the contract price which can have an impact on equipment selection. There are efficiency-focused businesses emerging here and engagement with this link in the supply chain is recommended due to the significance of its influence.

### Commercial and Industrial Water Heater and Boilers

In relation to the Commercial and Industrial Water Heater and Boiler supply chains, the supply chain for the commercial sector is similar to HVAC with some product-specific variations (e.g. there is a very limited supply chain for heat pumps, so manufacturers for these products are dealing directly with consumers). In the case of industrial businesses, there are some differentiators. This includes specialist contractors who play an equivalent role to mechanical contractors for certain industrial processes, which are more bespoke than the commercial sector. Another key difference is that while ‘package boilers’ are more common for the commercial sector, bespoke solutions are more common in the industrial sector with more local manufacturing taking place in these instances.

A major disruptive change on the horizon is the emergence of zero emissions and gas targets for major building owners of Premium and A-Grade buildings and portfolio owners (and also gas reduction and emissions targets for some industrial businesses with global headquarters). NABERS emissions factors are also currently being reviewed to ensure they are up-to-date and that they don’t distort choices towards gas boilers rather than heat pumps. Water heaters are a significant factor in the NABERS rating and so updated emissions factors will change the relative incentive from gas boilers towards heat pumps. Australian supply chains are historically organised around gas technologies and the electrification of heating (using heat pump solutions) represents a major systemic change. With many ‘blockers’ to its growth, agents at different parts of the supply chain agreed that the impact of these developments will eventually drive change. Building owners have already begun engagement with the supply chain.

Gas boilers look likely to remain an important technology for some time, especially for mid-tier buildings and many industrial sectors. However, the



priority between facilitating more efficient gas boilers or promoting the switch to heat pumps will become an increasingly significant question for policy makers to resolve.

An interesting emerging trend is the shift in focus to gas consumption by organisations that have signed a 100 per cent renewable energy Power Purchase Agreement for their electricity such as Victorian local councils. For many councils, gas boilers in aquatic centres are major contributors to gas use (e.g. 80 per cent of City of Yarra's gas consumption). Yarra is organising a workshop to educate council staff on application of heat pumps to this situation. So local government could potentially play a leadership role regarding switching from gas for others in the commercial sector.

In the industrial sector, heat pumps are at a demonstration stage so there is a limited role for the VEU program to date. ARENA and other stakeholders are currently working on demonstration projects which are needed to build confidence and the evidence base on the operation of the technology, its applications and costs. The VEU program could build on this work to incentivise broader adoption but it is more likely at this stage that the VEU can provide a useful incentive in commercial buildings to support the emergence of heat pumps. Heat pump manufacturers noted they had been regularly specified for projects but been cut from projects when budgets tightened. The growth of heat pumps in the commercial sector may have positive spill-overs for the industrial sector through awareness raising, even if they have different requirements (e.g. higher temperatures).

### **Advanced Glazing**

Advanced window products include double and triple glazing, low emissivity single glazing, secondary glazing products (panels and films that can be retrofitted without replacing the complete window) and additional window units installed inside the existing window. Most of the supply chain is located in Australia, apart from the component manufacturers that are generally overseas. The key agents are the builders/installers, designers/architects, glass processors (which can be influential in their selection and advice to builders and sometimes have promoted low emissivity single glazing over other options), fabricators and the customer,

A traditional pathway along the supply chain typically starts with the manufacturer of components (glass, frames, etc.), with the glass processed separately, which are then integrated into full windows by fabricators, who then sell direct to builders for installation. Approximately 90 per cent of windows are installed by builders, or by installers contracted by builders. Architects and designers can play a role by specifying the type of glazing to be installed by the builder. Alternate pathways include retrofits, secondary glazing products and secondary windows. In these cases, the end-user purchases directly from the window fabricator or secondary product retailer. However, this is still a very small part of the market.

The supply chain is a major barrier to the uptake of advanced glazing. There are cost-effective advanced window products that are market standard in many other nations. Rating schemes are not effective drivers of demand for advanced glazing. Stakeholders reported the VEU incentive is small relative to cost and in the context of low demand, and there are mark-ups in the supply chain that do not reflect the underlying cost. There were reports that glass processors and window fabricators invested in double glazing production capacity when 5-6 star regulations were introduced. However, these production lines have since been under-utilised because builders found alternative lower cost ways to comply with the new standards. The capacity to increase production at relatively low marginal cost may exist.

Given cost-effective products have existed in other nations for quite some time but are not being supplied at cost in Australia, the first-best solution would be to design a regulatory mechanism that creates a requirement specific to glazing. For example, a requirement for an average maximum overall U-value for glazing on new homes, set at the equivalent of standard double glazing, and maximum Solar Heat Gain Factor for glazing exposed to summer sun. This could operate as part of the National Construction Code, as it would help to achieve the regulated minimum (summer and winter) building star ratings, but it would allow flexibility in selection of glazing for individual windows.

Given double and triple glazing are cheaper alternatives in many other markets, it is likely the growth in demand and competition would quickly push the price down. It is a clear case of market failure. As one of the interviewees

put it: *“there isn’t a single other sector in the economy that hasn’t moved in the past 12 years like glazing - it’s almost impressive. That shows you the market isn’t going to move.”* If a regulation was to be included in the National Construction Code, action would be needed quickly for inclusion in the 2022 update.

Either as an alternative – or better as a lead-in or as a bridge to regulation - there are other options for targeting incentives and supporting programs within the supply chain:

**Targeted consumer education to build the small but growing market demand amongst higher-end and environmentally conscious buyers.**

There is a small market segment now purchasing advanced glazing – learnings from robust consumer research and focused promotion on this segment based should lead to increased demand.

**Active promotion of the VEU incentive at builders based on the WERS.**

The Window Energy Rating Scheme (WERS) broadly appears to have legitimacy within the sector. However, at present its role is educative – certificate creation is low. Further investigation is needed to understand why uptake is low, as *prima facie* it is a point in the supply chain where there is a mechanism to support uptake with the application of a financial incentive thorough the VEU. It may be that the way the supply chain operates, combined with weak customer pull, prevents it from working effectively – which would underline the case for regulation. Once the supply chain started functioning more effectively for these types of products then the use of the VEU may improve.

Support for the emerging energy efficiency retrofit sector that can install glazing where the window does not need to be replaced is also worth further investigation. However, certifying the efficiency benefits from these disparate products may be challenging.



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## 1. Introduction

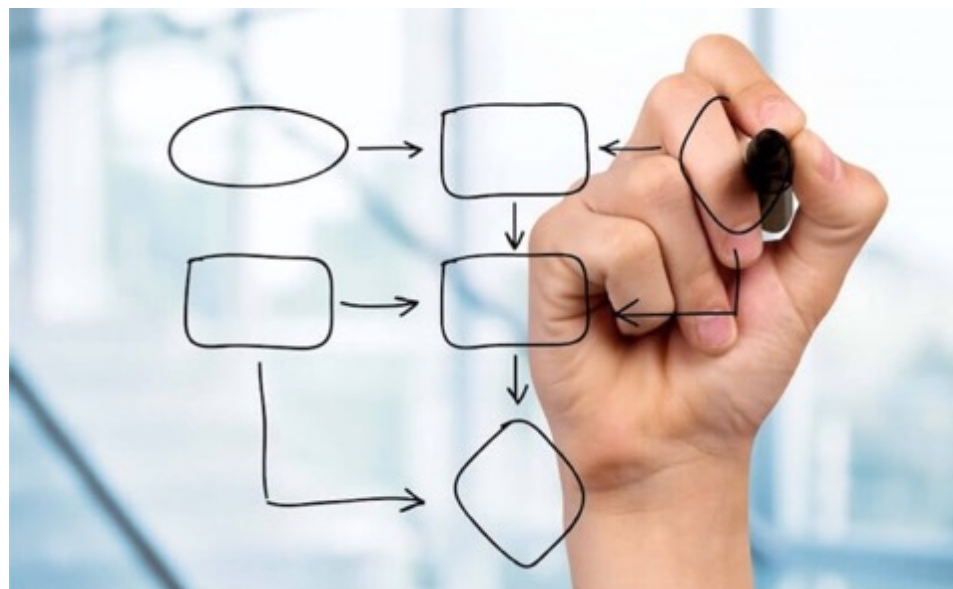
### 1.1 Why Supply Chains Matter

Supply chains are the systems and processes through which products or services are manufactured and stored, selected, purchased and ordered, distributed to customers and installed and maintained. Supply chains are more than just mechanistic distribution or logistic chains; there are multiple actors interacting and shaped by different incentives and capabilities to connect with consumers in often highly fragmented markets.

Understanding how and why energy efficiency product supply chains work is crucial for designing effective energy efficiency schemes that can help consumers, businesses and industry cut their energy bills and their emissions. Complex webs of people and organisations are involved in decision-making about selection, design, installation, commissioning, operation and replacement of appliances and equipment. For many market intermediaries and decision-makers, energy performance and operating costs are a lower priority compared with other competing factors such as budget constraints, shortage of time, ease of solution, or invisibility due to 'packaging' of a number of elements. Each participant in the supply chain makes decisions and influences others within a framework shaped by many forces.

Despite major pressures for adopting newer or more efficient technology to the benefit of customers, a single market intermediary (e.g. a tradesperson, equipment specifier or wholesale distributor) can sometimes 'block' the path to action. For some products, supply chains may have developed in a particular way decades ago and changed very little since.

Decision-makers often have 'trusted' advisers, contractors or suppliers who are favoured above 'new' and unfamiliar alternatives. Indeed, many key supply chain partners simply accept the recommendations of these trusted agents.



These trusted intermediaries also operate within their own frameworks. For example, many tradespeople rely on product wholesalers (such as plumbing and electrical wholesalers) to simplify their 'paperwork' and provide credit. Many designers and consultants receive commissions from specific equipment and service providers. Or they may be much more familiar with offerings of certain providers and their sales staff, so they can minimise the time they spend and avoid the perceived risk of going with a new supplier. Consequently, it is important to understand supply chains so to understand where the drivers and blockers are for energy efficiency products, where it is most efficient for policy to target incentives, and where there might be need to act to remove blockages.

## 1.2 Study Background: objectives, scope and methodology









The Victorian Department of Environment, Land, Water and Planning (DELWP) commissioned ISF to map the supply chains of several energy efficient product categories to build an understanding of these complex webs and the relationships with the Victorian Energy Upgrade (VEU) program and other energy efficiency programs. This was undertaken through consultation with decision-makers, industry associations, and the various actors involved in the targeted supply chains. There were two main objectives to this work:

1. To map the supply chain for four energy efficient product segments: identifying how they are structured and how they operate, characterising the participants, their roles and how they connect to each other.

2. To understand the impact of supply chain characteristics on the VEU program and other energy efficiency programs: how, why and when they influence customer adoption of energy efficient product incentives, as well as how this might change or be influenced in the future.



Table 2 illustrates the energy efficiency product supply chains and sectors considered in this study. In total there are four categories of product, but five supply chains are described due to both commercial and industrial sectors being included for Water Heaters and Boilers. Within each product category, a number of different types of Energy Efficient Product were highlighted. In practice, for the commercial and industrial sector in particular, technologies are often considered within a system.

Table 2: Scope of Study – Energy Efficiency Product Supply Chains covered

Product category	End use application (residential, businesses, industry)			Types of Energy Efficient Product:
				
Space heating and cooling				<ul style="list-style-type: none"> <li>• High efficiency heat pumps (reversible A/C units, air source heat pumps, and ground source heat pumps)</li> <li>• High efficiency gas boilers (gas space heaters, ducted heaters)</li> </ul>
HVAC				<ul style="list-style-type: none"> <li>• High efficiency heat pumps (reversible A/C units, ducted air conditioning)</li> <li>• Mechanical Ventilation with Heat Recovery</li> </ul>
Water heaters and boilers				<ul style="list-style-type: none"> <li>• Hot Water Heat Pumps</li> <li>• High efficiency gas water heaters and boilers</li> </ul>
Advanced glazing				<ul style="list-style-type: none"> <li>• Insulated Glazed Units (Double, triple, quadruple, secondary glazing, low-e, spectrally selective and other coatings and argon gas fill) and window frames</li> <li>• Draught stripping</li> </ul>



**There were two elements to the project:**

	<p><b>Phase 1:</b> Mapping of different supply chains for key selected products, including interviews with knowledgeable people from business organisations.</p>
	<p><b>Phase 2:</b> Analysing the supply chains for their impact on energy efficiency incentives and schemes, focussed in the VEU program but also commenting on others.</p>

The process for gathering insight and data involved desktop research based on interviews (including stakeholder mapping, the development of supply chain mapping template and preliminary flow diagrams of supply chains). The snowballing technique was used as a discrete method of identifying knowledgeable people within supply chains to gather deep insight on the different supply chains quickly, through a process of reference from one person to the next. While the project team had numerous contacts through their long and extensive work on supply chains, this enabled them to approach new participants to deepen that insight along the whole supply chain, using the credibility from being recommended by a named person known to them.

In all, semi-structured interviews were conducted with more than 30 organisations (See Appendix A – List of Organisations Interviewed for a full list and interview discussion guide).

**A few points to note:**

- Interviewees who had a strong view across the entire supply chain were comparatively rare. It was common for individuals to have visibility over only part of the supply chain. This is a reflection of the complexity and disaggregation of supply chains.
- Over 30 organisations were interviewed across the different supply chains. Naturally, participants bring a viewpoint that reflects their experiences, organisation and position in the supply chain. It is not a comprehensive or ‘representative sample’ – but intelligence from a collection of key informants.
- Some parts of the supply chain were harder to reach and their operations less transparent. Notably, wholesalers and big-box retailers were not interviewed directly. However, a number of interviewees had direct experience of working with or for these organisations and were able to talk at some length about their supply chain activities.
- Data on exact numbers of the businesses active at different points of the supply chain is hard to find. Data was gathered from Ibis Industry reports, interviews, and industry association directories. If more detailed information was required in future, an industry survey of businesses could return more granular data. This activity could potentially ‘piggy-back’ on surveys conducted by industry groups, market researchers or academics.

### 1.3 The Victorian Energy Upgrades Program – overview and assessment of activity to date

The Victorian Energy Upgrades program (previously the 'VEET scheme') is established under the *Victorian Energy Efficiency Target Act 2007*, the *Victorian Energy Efficiency Target Regulations 2018* and the *Victorian Energy Efficiency Target (Project-Based Activities) Regulations 2017*. This legislative framework places a legal requirement on energy retailer companies to meet an annual greenhouse gas emissions reduction target by surrendering Victorian Energy Efficiency Certificates (VEECs) (Victorian Department of Environment, Land, Water and Planning, 2019).

Every Victorian household and business can receive rebates or discounts on energy saving products. Each upgrade allows businesses accredited under the program called 'accredited providers' to generate VEECs. Each certificate represents a reduction in one tonne of greenhouse gas. Accredited providers then sell their VEECs to energy retailers for them to surrender to meet their compliance obligations. As illustrated in Table 3 the current target for energy retailers for 2020 is a reduction of 6.5 million tonnes CO<sub>2</sub>-e.

Table 3: Victorian Energy Efficiency Targets for 2016-2020

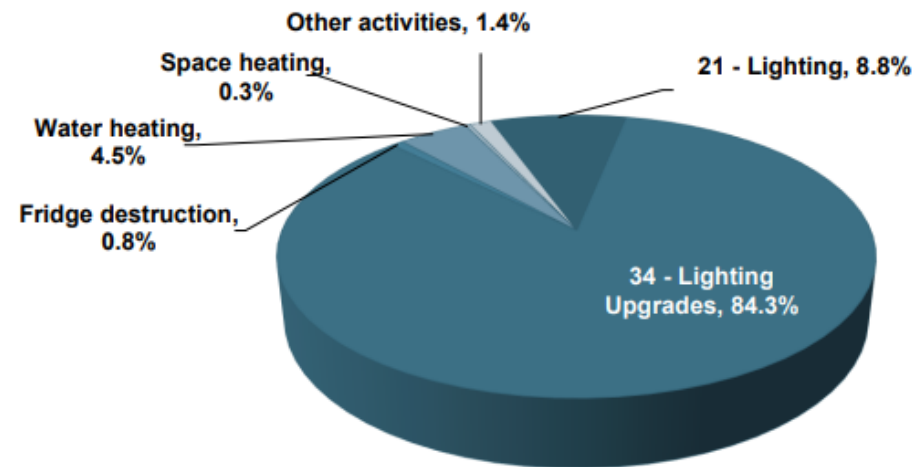
Year	Amount of Victorian Energy Efficiency Certificates (VEECs)	Target Tonnes CO <sub>2</sub> -E Greenhouse gas abatement
2016	5.4 million	5.4 million
2017	5.9 million	5.9 million
2018	6.1 million	6.1 million
2019	6.3 million	6.3 million
2020	6.5 million	6.5 million



The 2019 target of 6.1 million certificates was reached in early 2019 and at the time of this report, 80 per cent of the 2020 target certificates are created. The program is administered by the Essential Services Commission (ESC), which is the independent regulator of the retail energy industry in Victoria. Its role is to oversee compliance and performance reporting by energy businesses, and to accredit businesses and the products and services which are eligible under the program (Victorian Department of Environment, Land, Water and Planning, 2019).

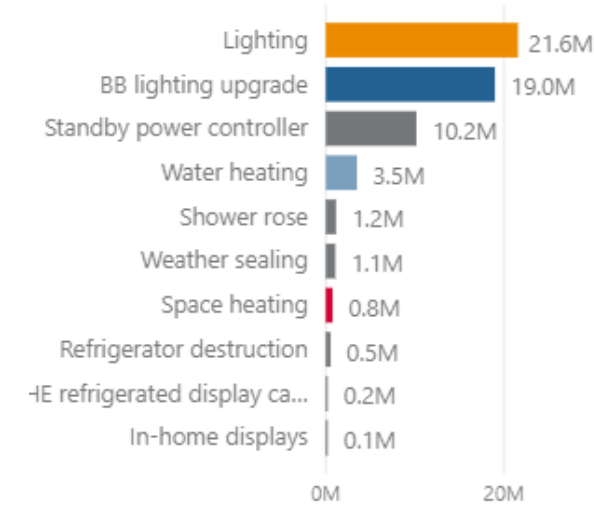
As illustrated in Figure 1 (Essential Services Commission, 2019a) lighting activities accounted for more than 93 per cent of certificates created in 2018.

Figure 1 Percentage of total VEU certificates created by activity type – 2018



The VEU program is a market-based program. The value of certificates can fluctuate due to consumer supply and demand rates relative to the government-set targets. Consequently, the availability of products and services can also vary over time (Victorian Department of Environment, Land, Water and Planning, 2019). The list of activities, according to the VEU Registry is outlined in Appendix B – List of VEU Activities.

Figure 2: Top ten activities based on VEECs registered



The VEU data dashboard provides performance data for the VEU program since it commenced in 2009, updated on a weekly basis. The top ten activities from the dashboard in Figure 2 (Essential Services Commission, 2019b) show Lighting upgrades and Standby Power Controllers as the largest activities followed by Water Heating and Shower Rose replacement.

The NSW Energy Savers Scheme and South Australian Retailer Energy Efficiency Scheme also have a high proportion of lighting upgrade activities. Lighting is currently the lowest emissions reduction activity with a proven business case, scalable product with low transaction costs for certificate creation and well-developed supply chains. Each of the energy efficiency obligations have been reviewed and found to be reducing emissions and delivering significant benefits to households and businesses, but broadening the reach of these schemes and influencing other energy efficiency supply chains outside lighting is a challenge for all of the energy efficiency obligation schemes.



## 2. Residential Space Heating and Cooling

**The Heating and Cooling industry in Australia is characterised by a manufacturing base that's strongly rooted overseas for electric technologies, with multiple channel partners that take and modify products for the Australian market.**

The overseas manufacturing subsidiaries often have limited technical capabilities and decision-making power. Gas technologies still involve significant local manufacturing of heating and evaporative cooling products.

Victoria varies from other states because of the colder climate and the high penetration of gas (around 90 per cent of homes have access to gas compared to less than 50 per cent across Australia) based on decades of low prices, as well as the influence of the Gas & Fuel Corporation's effective marketing over decades. For those areas with cold winter months, 'effective' central heating is seen by many home buyers as an essential. This is extending to cooling as climate heating progresses expectations about the provision of 'effective' cooling. This seems to be part of the explanation for the shift from evaporative cooling to reverse cycle air conditioning, as evaporative cooling is less effective as humidity increases, consumes a lot of water (a 'precious' resource), requires windows to be open, and can be perceived as noisy.

Some manufacturers seek exclusive/partially exclusive contracts with dealerships and trade resellers. Installers and tradespeople are the most influential due to their presence at the point of sale, the volume of product that goes through them, and their strong sensitivity to factors (e.g. cost) that don't always result in the most efficient solution being installed.

As the replacements market increases relative to new installations, the significance of service companies is increasing as they are called out to deal with failures of existing systems. Equipment and appliance retailers are also influential for the products that they are able to offer.



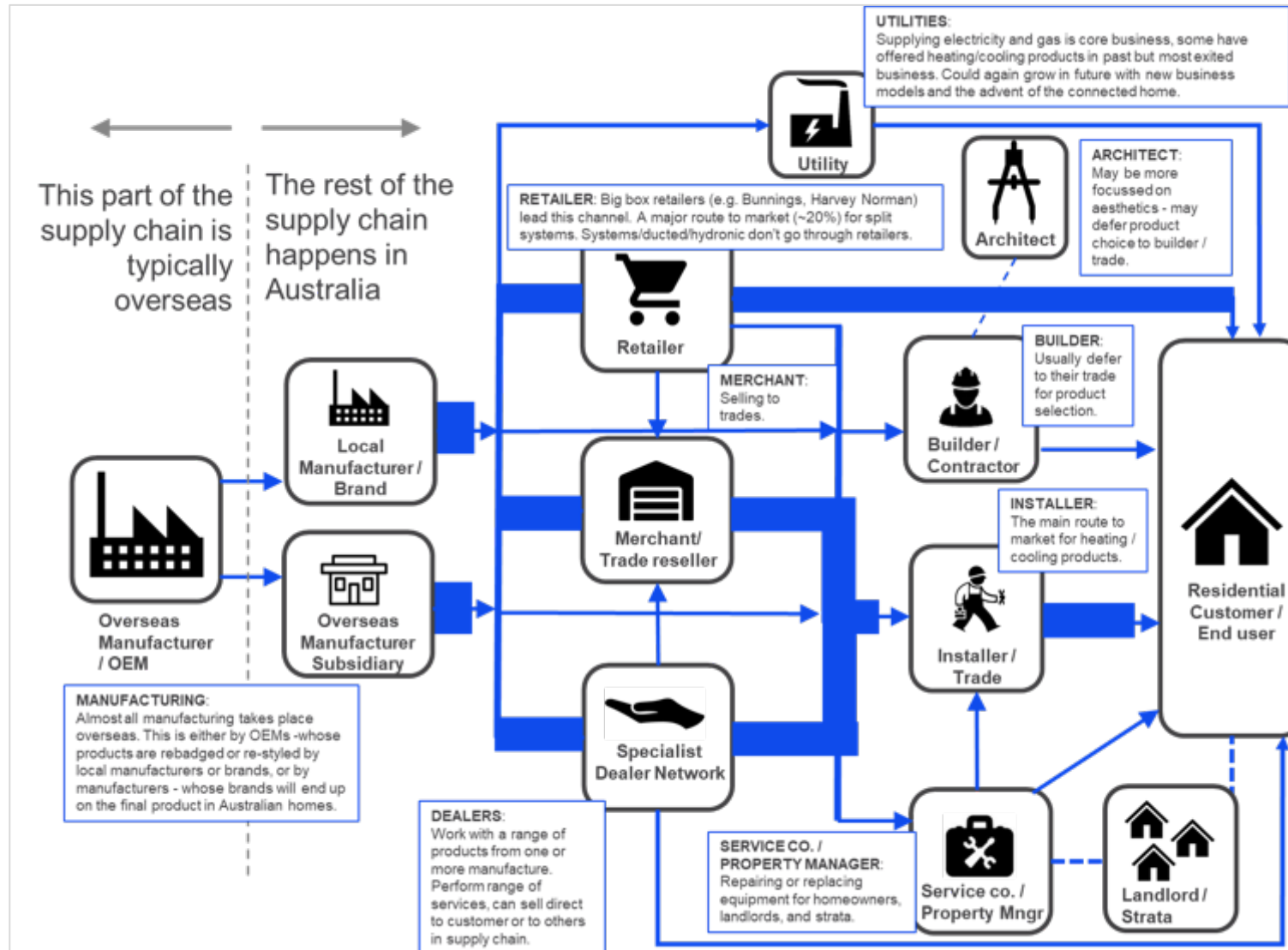
For households, many appliance/building-related purchases are made as part of a home purchase, a major renovation, or in response to the failure of an appliance, so 'packaging' may limit choice and hide costs and impacts of incentives. Factors that play a role in product choice by the consumer include brand reputation, discounts or special offers, the narratives of sales people and designers, and physical constraints.

In many apartment buildings, central systems are provided by developers, so individual unit owners and residents may have little influence. Unit occupants may have to pay significant fixed daily charges, regardless of their energy use. Developers may find central solutions attractive, as the costs can effectively be shifted onto future occupants and the capital costs reduced.

## 2.1 Mapping the Supply Chain

Figure 3 is a stylised representation of the key agents in the residential space heating and cooling supply chain. Note: The thicker blue arrows denote the most common supply chain routes.

Figure 3: Map of the Residential Space Heating and Cooling Supply Chain



## 2.2 Profiling the Supply Chain: role, structure and influence

For each of the supply chains, the influence of the major agents is categorised as either low, medium or high based on the following rating and definition:

**Low** = rarely exerts an independent influence on the supply, selection or use of energy efficiency products

**Medium** = sometimes exerts an independent influence on the supply, selection or use of energy efficiency products depending on circumstances

**High** = often exerts – or can exert – an independent influence on the supply, selection or use of energy efficiency products

Table 4 summarises the major supply chain agents and their influence in the residential space heating and cooling supply chain.

Table 4: Summary of Role, Structure and Influence of Residential Space Heating and Cooling Supply Chain

Supply Chain Agent	Influence
Retailer	High
Installers / Tradespeople	High
Service Company	High
Manufacturer	Medium
Merchant / Trade Reseller	Medium
Specialist Dealer Network	Medium
Builder / Contractor	Low
Property Manager (Rental & Strata)	Low
Energy Utilities	Low





Table 5 provides more detailed commentary on the role, structure and influence of the residential space heating and cooling supply chain.

Table 5: Detailed Role, Structure and Influence of Residential Space Heating and Cooling Supply Chain

Supply Chain Agent	Role	Structure	Influence
<b>Retailer</b>	<ul style="list-style-type: none"> <li>They deal in up to ~7kW split system reverse cycle air conditioners. They are one of the major channels for these products with around 1/3 of the market. This includes big box retailers offering Tier 1 products to smaller shops offering the lesser known brands</li> <li>They offer a one-stop shop to customers, with premises available to inspect product with the ability to arrange installation</li> <li>Systems and ducted heating and cooling products don't go through retailers</li> </ul>	<ul style="list-style-type: none"> <li>Small number of big box retailers with nationwide coverage, include Bunnings, Harvey Norman, Good Guys, and Dick Smith</li> <li>Some also offer a trades service, selling business to business</li> </ul>	<p><b>HIGH</b></p> <ul style="list-style-type: none"> <li>Present at point of sale, they are also well-known brands and can offer a smooth customer experience as a single touchpoint</li> <li>They will typically recommend one of their licensed installers but customer can also source their own installer</li> <li>Narratives of sales staff can be very influential – and commissions influence what they promote</li> <li>Sales agents driven by commission, with incentives on one brand strongly driving behaviour</li> <li>Installers, builders, and service companies will also source product from retailers (especially when prices are low from heavy discounting or if they sell 'high value brands')</li> </ul>
<b>Installers / Tradespeople</b>	<ul style="list-style-type: none"> <li>This is the main route to market</li> <li>Systems/ducted/multi room/hydronic more typically installed for new build but can be retrofitted as part of major renovations, or where there is space within the ceiling cavity or under floor. This is a more intrusive process so it is more likely to involve tradesperson</li> <li>Split systems market mostly a replacement one, with installers receiving their product from one or more sources. Unless exclusive (e.g. Daikin) to one brand, installers will</li> </ul>	<ul style="list-style-type: none"> <li>Lots of players – very fragmented market</li> <li>More major players are those who are specialists, shifting volumes</li> <li>The Victorian Building Authority is one option for a central body to engage with but the fragmentation is one of the major challenges for energy efficiency programs</li> </ul>	<p><b>HIGH</b></p> <ul style="list-style-type: none"> <li>The end tradesperson / installer is the most influential person in the case of a changeover or distressed purchase</li> <li>On a changeover, a consumer will be less concerned about the type of product and wants an inexpensive, quick solution as much as possible</li> <li>Consumers want to trust the installer in the systems that they are recommending</li> <li>Where installers/trades working with a builder on a renovation, it is usually left to</li> </ul>

Supply Chain Agent	Role	Structure	Influence
	<p>source appliances from where the product is cheapest/has the best promotion. Where they have a line of credit will also influence where they choose to purchase (some will have this with more than one reseller)</p> <ul style="list-style-type: none"> <li>• A refrigerant handling license as well as plumbing / electrician skills/qualifications is required</li> <li>• For gas systems plumbing expertise is required for replacement of boilers and water heaters</li> </ul>		<p>them to choose the product. Where the client is the homeowner and they are more closely involved, they may be encouraged as part of an upsell to move up to a more 'premium' product or larger capacity</p>
<b>Service Company</b>	<ul style="list-style-type: none"> <li>• Service companies are those providing repair services to installed systems</li> <li>• These companies also sell and install new systems</li> <li>• They may be affiliated with one or more manufacturers and their products</li> </ul>	<ul style="list-style-type: none"> <li>• Small number of nationwide service company players (e.g. Airmaster, AE Smith) and then a very fragmented market of smaller players covering a particular state or area</li> <li>• They may have relationships with appliance retailers, referral websites (e.g. Hi-Pages, Yellow Pages) and do their own local promotion</li> </ul>	<p><b>HIGH</b></p> <ul style="list-style-type: none"> <li>• Where a system breaks down and needs to be repaired or replaced, the service company is particularly well placed to suggest the replacement product for the client</li> </ul>
<b>Manufacturer</b>	<ul style="list-style-type: none"> <li>• Almost all manufacturing takes place overseas – not gas appliances. This is either by Original Equipment Manufacturers (OEMs) - whose products are rebadged or re-styled by local manufacturers or brands; or by the manufacturers whose brands will be on the final product</li> <li>• Manufacturers sell to other business including the installers, trades, and major builders</li> <li>• Manufacturers don't sell direct to customer/end users. However, they do directly promote to them. All tend to have online platforms which form the basis of a lead referral system (usually an online</li> </ul>	<ul style="list-style-type: none"> <li>• For electric systems, the two main OEMs are Midea and Gree Electric (who sell under their own brand, as well as supplying to other manufacturers to re-badged or adapted for the Australian market) - both these companies are Chinese electric appliance manufacturers each with annual turnovers of more than AUD\$50bn</li> <li>• Based on interview responses, the three leading manufacturers and their market share are Daikin (60 per cent of the market), Panasonic and Mitsubishi (20 per cent)</li> <li>• The remaining 20 per cent includes other Asian manufacturers, as well as locally</li> </ul>	<p><b>MEDIUM</b></p> <ul style="list-style-type: none"> <li>• Manufacturer decisions influence the availability of technology and particular products in Australia</li> <li>• They play a role in influencing policy and standards development through industry associations</li> <li>• Gas appliance manufacturers may oppose new standards on the basis of employment impacts</li> <li>• Through the use of overseas subsidiaries, specialist dealer networks, and service businesses, manufacturers are looking to have more control over their supply chains and become more vertically integrated</li> </ul>

Supply Chain Agent	Role	Structure	Influence
	<p>contact request form, or list of local installers for requesting a quote)</p> <ul style="list-style-type: none"> <li>• They also influence retailers by offering discounts, commissions, and funding complementary advertising campaigns</li> </ul>	<p>based companies (e.g. ActonAir, Kelvinator, Lennox) who work with OEM products</p> <ul style="list-style-type: none"> <li>• For gas systems, there is a much more limited range of manufacturers selling product in Australia - this includes locally available products from Brivis (ducted gas heaters), Seeley/Braemar, with other gas space heating products typically from Asia (Rinnai –who also manufacture in Melbourne, KD Navien) or Europe (Bosch, Sime)</li> </ul>	
<b>Merchant / Trade Reseller</b>	<ul style="list-style-type: none"> <li>• These sell 'B2B' – Business-to-business, including installers, trade, builders, service companies, etc.</li> <li>• They may be general trade, plumbing or refrigeration merchants selling parts as well as whole appliances</li> </ul>	<ul style="list-style-type: none"> <li>• There are several large players (including Tradelink, Bentons, Burdons, Reece, and Kirby) who are national/multi-national</li> <li>• There are also lots of smaller, family-run companies that contribute to the rest of a very fragmented market</li> </ul>	<p><b>MEDIUM</b></p> <ul style="list-style-type: none"> <li>• Present at point of sale, they are also well-known brands to the trades</li> <li>• They will offer credit accounts to their business customers up to a certain value</li> <li>• Installers, builders, and service companies will also source product from retailers (especially when prices are low from heavy discounting)</li> </ul>
<b>Specialist Dealer Network</b>	<ul style="list-style-type: none"> <li>• Dealers typically work with a range of products from one or more manufacturer</li> <li>• They will undertake marketing and sales activities, organise site assessments, arrange installation and carry out warranty repairs and servicing</li> <li>• They will have one or more vehicles, offices, warehouses</li> <li>• They can sell direct to the customer/end user, or to others in the supply chain</li> </ul>	<ul style="list-style-type: none"> <li>• Ranges from nationwide networks established by Tier 1 manufacturers (like Daikin or Mitsubishi), those with tens of employees, to one person companies. This contributes to a very fragmented market</li> <li>• For electric systems, the biggest player, Daikin, does not go through big-box retailers – only through its own dealerships and accredited installers. Mitsubishi often through dealerships as well</li> <li>• For gas systems, accredited service providers operate in a similar way as electric. Service and install is offered, with manufacturer websites acting as a lead</li> </ul>	<p><b>MEDIUM</b></p> <ul style="list-style-type: none"> <li>• Where dealing directly with the customer/end user, they are present at the point of sale</li> <li>• Also sell to almost all other channel partners, as well as end customers</li> <li>• Driven by commission and incentives, will strongly influence behaviour</li> </ul>

Supply Chain Agent	Role	Structure	Influence
		referral platform to a local installer or service technician	
<b>Builder / Contractor</b>	<ul style="list-style-type: none"> <li>Builders involved in renovation of existing buildings where the heating / cooling system is being replaced or upgraded - will subcontract installation to a qualified installer</li> </ul>	<ul style="list-style-type: none"> <li>Large number of independent builders for renovation in a very fragmented market</li> <li>Also large nationwide builders but that's typically new build only</li> </ul>	<p><b>LOW</b></p> <ul style="list-style-type: none"> <li>Usually rely on their electricians and/or plumbers -very cost driven</li> <li>Where working closely with the homeowner client, then they may be more inclined to be influenced by them on the choice/brand of product</li> </ul>
<b>Property Manager (Rental) Property Manager (Strata)</b>	<ul style="list-style-type: none"> <li>Property Managers (Rental) are those that oversee the management of rental properties for real estate agents engaged by owners (landlords) - role includes repairs or replacement heating and cooling appliances</li> <li>Property Managers (Strata) are those that oversee the management of multi-unit dwellings (apartment block, townhouse, etc.) engaged through strata committees - role includes repairs or replacement heating and cooling appliances</li> </ul>	<ul style="list-style-type: none"> <li>Rental property managers typically employed by real estate agencies, such as Hocking Stuart and Ray White</li> <li>Small number of nationwide Strata management players who mostly deal with major developments (e.g. Savills, CBRE, JLL) and large number of smaller state specific players (e.g. Property Managers Melbourne, G&amp;H Property Group, Different)</li> </ul>	<p><b>LOW</b></p> <ul style="list-style-type: none"> <li>Potentially high influence but this is not exercised currently</li> <li>Where a system breaks down and needs to be repaired or replaced, the property manager will typically seek the cheapest, most convenient replacement option which could be from a retailer, trade reseller, a 'trusted' supplier/installer/maintenance contractor, or a dealer network</li> </ul>
<b>Energy Utilities</b>	<ul style="list-style-type: none"> <li>Energy utilities provide gas or electricity supply to their customers' homes</li> <li>Energy related products such as split system air-conditioners are sold, marketed, or recommended via their websites</li> <li>Only one energy retailer was found to be offering heating and cooling products (ActewAGL – split systems), although in the past others did offer this</li> <li>Origin Energy no longer sell new systems but still honour existing customer contracts for its discontinued offering</li> </ul>	<ul style="list-style-type: none"> <li>Origin Energy, AGL and EnergyAustralia are the largest energy retailers in Australia</li> <li>Medium size players include Alinta Energy, Red, ActewAGL</li> <li>Smaller players include Enova, Diamond Energy, and Powershop</li> </ul>	<p><b>LOW</b></p> <ul style="list-style-type: none"> <li>The saturation of the split system market and the involvement of big box retailers and specialists has made the heating and cooling product market a difficult one for utilities to operate in</li> <li>However, systems that provide both heat and cool means that there is a potential opportunity for utilities to move towards a 'comfort as a service' business model. New entrants or innovative plays by existing utilities could lead to growth in this sales channel in the future</li> </ul>



## 2.3 Pressures for Change

Table 6 provides some of the major drivers for change for the Residential Space Heating and Cooling Supply Chain.

Table 6: Pressures for Change in the Residential Space Heating and Cooling Supply Chain

Drivers	Blockers
<p><b>Vertical integration (Manufacturers)</b></p> <ul style="list-style-type: none"> <li>Greater control over supply chains</li> <li>Through the use of overseas subsidiaries, specialist dealer networks, and service businesses, manufacturers are looking to have more control over their supply chains and become more vertically integrated</li> </ul>	<p><b>Split Incentives or Externalising Cost (Landlord, Service Co., Property Manager)</b></p> <ul style="list-style-type: none"> <li>Lack of incentive for installing most efficient, most suitable system as CAPEX is the driver and not OPEX</li> <li>Total installed cost and speed of response/low complaint levels may also be drivers</li> </ul>
<p><b>Energy efficiency as a differentiator (Manufacturers)</b></p> <ul style="list-style-type: none"> <li>Major manufacturers are trying to improve energy efficiency credentials and respond to those customers who want the best (highest rated efficient) product</li> <li>Phase-in of climate-zoned reverse cycle a/c rating label may affect public profile – positive if promoted strongly, negative if consumers confused by more complicated label</li> </ul>	<p><b>Lack of transparency (Retailers, Installers, Dealers)</b></p> <ul style="list-style-type: none"> <li>Lack of transparency and driven by commissions or incentives - not the most efficient solution for the consumers home (leading to increased likelihood of oversizing)</li> <li>Energy efficiency sold as one of a number of features of a premium appliance</li> <li>Energy efficiency thus becomes associated with 'more expensive' products, which can discourage certain parts of the market.</li> </ul>
<p><b>Consumer empowerment (Customer / End Users)</b></p> <ul style="list-style-type: none"> <li>Increasingly empowered consumers choosing to shop for heating/cooling products in the same way they shop for consumer electronics or white goods</li> <li>Using social media, internet, and comparison websites for their information. Greater awareness of energy/running costs and energy rating labels</li> </ul>	<p><b>Price driven market (All)</b></p> <ul style="list-style-type: none"> <li>The supply chains have multiple routes that quickly shift based on where the best prices/incentives exist</li> <li>This leads to installation of the most inexpensive product that is capable of meeting minimum energy performance standards</li> </ul>
<p><b>Electrification (Customer / End Users)</b></p> <ul style="list-style-type: none"> <li>Movement towards a preference for all electric homes through rising gas prices, potential to avoid high ongoing fixed charges for gas supply, increased awareness of low cost of electric heating/cooling solutions, and high levels of solar PV penetration</li> </ul>	<p><b>Inconsistent Regulations (All)</b></p> <ul style="list-style-type: none"> <li>Where state regulations vary this can lead to product dumping over state lines of more inefficient products (this can also occur at an international level)</li> </ul>
<p><b>Digitalisation (Customer / End Users, Manufacturers)</b></p> <ul style="list-style-type: none"> <li>Growth of apps, smart thermostats and Thermostatic Radiator Control Valves (TRVs), and other devices for managing / monitoring energy use, and controlling appliances</li> <li>For electric systems, this has grown as a booming rooftop solar market is giving rise to increased energy literacy and engagement with energy (via solar monitoring apps.</li> </ul>	<p><b>Lack of consumer choice (Consumer)</b></p> <ul style="list-style-type: none"> <li>Much of the market is owned by overseas manufacturers who decide what products to bring to Australia</li> <li>Where Australian regulations are unique to the country and require specially developed products, this also limits the choice of energy efficient products consumers have elsewhere</li> </ul>

Drivers	Blockers
<p>engagement with installation process, exposure to peak pricing, etc.). Lot of products have unfriendly interface</p> <ul style="list-style-type: none"> <li>Potential for application of data analytics is under-utilised by most products and services</li> </ul>	
<p><b>New business models (Customer / End Users, Manufacturers, Utilities)</b></p> <ul style="list-style-type: none"> <li>Movement towards more service based applications, with consumers used to paying for music or movies as a service</li> <li>With commodity appliances that provide heating and cooling, opportunity is there to provide ‘Comfort as a Service’</li> </ul>	<p><b>Making the right decision (Consumer)</b></p> <ul style="list-style-type: none"> <li>Energy labelling website is confusing – for example, the default setting of the calculator is not ‘all models’, so options to sort different product criteria and to see the list of best products is not obvious to user</li> </ul>
<p><b>Finance propositions (Banks, Customer/End Users)</b></p> <ul style="list-style-type: none"> <li>Engagement by banks in energy related finance offerings, e.g. Bank Australia’s discount mortgage for 7-star new or refurbished homes, or ANZ’s zero interest loan for energy upgrades in New Zealand</li> <li>Bank Australia’s offer to discount mortgages by 0.4 per cent if they buy or renovate homes to be 7-star under NatHERS or the residential energy efficiency scorecard could be a game changer as it enables homeowners to increase the value of their asset by investing in energy efficiency</li> </ul>	

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### 3. Commercial Heating, Ventilation and Air-Conditioning

HVAC provides comfort for millions of workers and visitors in more than 140 million square metres of non-residential buildings in Australia. HVAC is estimated to account for just over 40 per cent of commercial building energy use (ASBEC 2016). A range of factors impact on HVAC energy consumption including system efficiency, design, installation, building design and fabric, climate and on-going operation and maintenance. Most of the activity in HVAC energy efficiency has been in new commercial buildings, primarily due to the influence of policy and regulatory mechanisms such as commercial building rating tools (NABERS and Green Star) that drive performance, the Section J minimum energy performance standards in the National Construction Code, and requirements for mandatory disclosure of energy performance in office buildings under the Commercial Building Disclosure scheme.

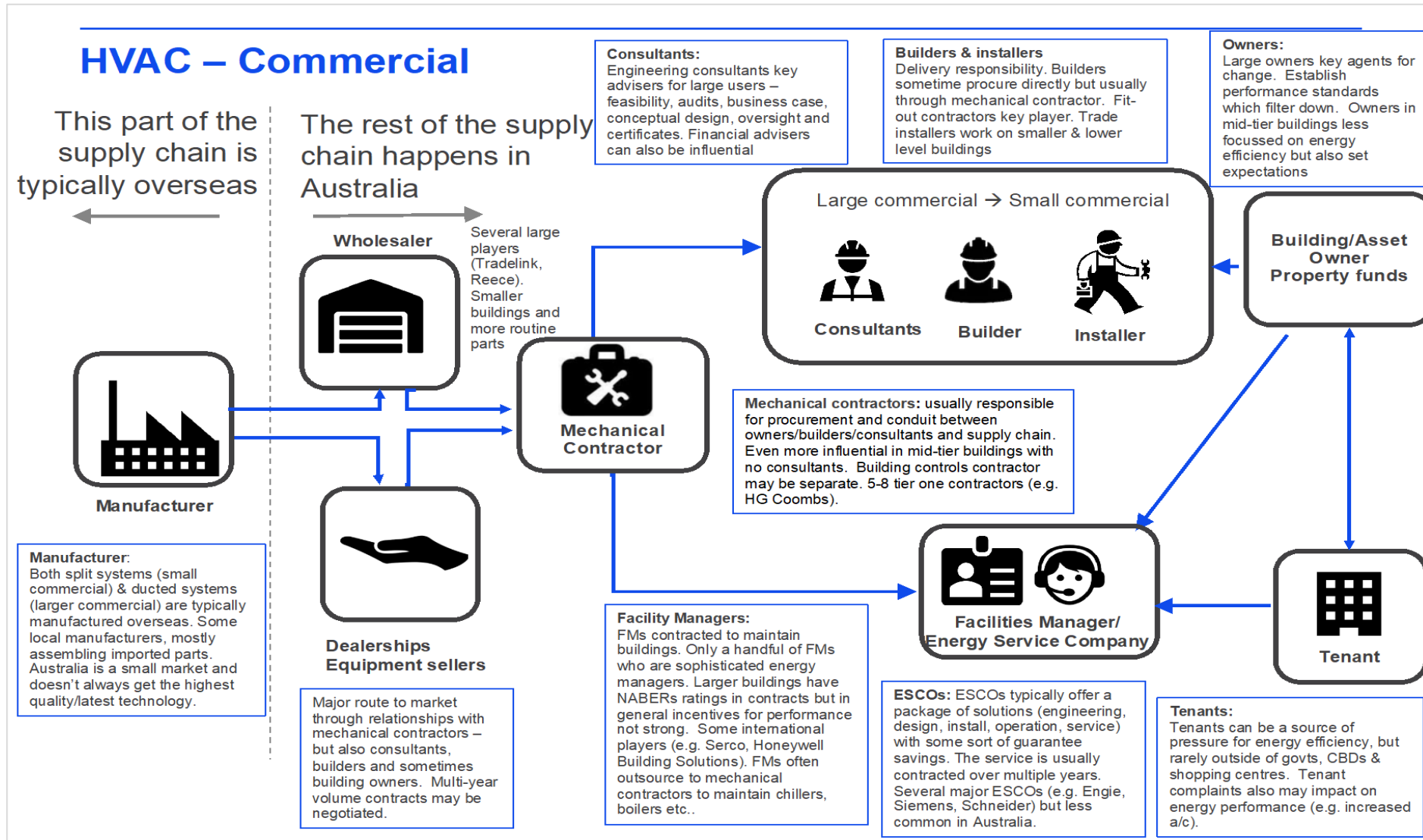
There are major differences between the top-end of the market and mid-tier buildings where energy efficiency is a much lower priority. Building and asset owners play a key role, establishing performance standards that filter down through the supply chain - these are a key agent for change. The products are typically made by overseas manufacturers, through which the products flow to local offices, Australian re-sellers/wholesalers or dealerships. The mechanical contractors are the party usually responsible for procurement and act as a conduit between owners, builders, consultants and other parts of the supply chain. The size and complexity of building will influence whether consultant engineering firms are used, builders, or just installer and tradespeople. In general, if the building is larger or providing specialised services (e.g. health care), the more likely an engineered solution and the presence of consultant/engineering firm/specialist contractors.



### 3.1 Mapping the Supply Chain

Figure 4 is a stylised representation of the key agents in the commercial HVAC supply chain.

Figure 4: Map of the Commercial HVAC Supply Chain





### 3.2 Profiling the Supply Chain: Role, Structure and Influence

For each of the supply chains, the influence of the major agents is categorised as either low, medium or high based on the following rating and definition:

**Low** = rarely exerts an independent influence on the supply, selection or use of energy efficiency products

**Medium** = sometimes exerts an independent influence on the supply, selection or use of energy efficiency products depending on circumstances

**High** = often exerts – or can exert – an independent influence on the supply, selection or use of energy efficiency products

Table 7 summarises supply chain agents influence in the commercial HVAC supply chain.

*Table 7: Summary of Role, Structure and Influence of Commercial HVAC Supply Chain*

Supply Chain Agent	Influence
Mechanical and Maintenance Contractors	High
Building and Asset Owners (large owners)	High
Tenants (large owners)	High
Consultants	Medium-High
Builders, Fit-out contractors and Installers	Medium-High
Manufacturer	Medium
Wholesalers, dealership networks and equipment sellers	Medium
Facility Managers and ESCOs	Medium
Building and Asset Owners (mid-tier)	Low
Tenants (mid-tier)	Low



Table 8 provides more detailed commentary on the role, structure and influence of the commercial HVAC supply chain.

Table 8: Detailed Role, Structure and Influence of the Commercial HVAC Supply Chain

Supply Chain Agent	Role	Structure	Influence
<b>Mechanical and Maintenance Contractors</b>	<ul style="list-style-type: none"> <li>Mechanical contractors are generally responsible for the procurement, detailed design and installation of HVAC equipment – and often servicing, repairs, upgrade and procurement for facilities managers</li> <li>They translate conceptual specifications into specific equipment packages</li> <li>The building control system contractor - which can be under or alongside the mechanical contractor – is also an important influence on HVAC performance as these systems become more sophisticated and have more influence on operation</li> </ul>	<ul style="list-style-type: none"> <li>Fragmented with many players but a top-tier of contractors</li> <li>Small number of tier-one contractors (5-8) who are able to provide an integrated service to major CBD buildings</li> <li>Beneath them there are tiers of sub-contractors with different levels of service and quality</li> <li>The mechanical contractors association says there are fewer layers of sub-contracting in Victoria relative to NSW.</li> </ul>	<b>HIGH</b> <ul style="list-style-type: none"> <li>Mechanical contractors are often the interface between the two ends of the supply chain</li> <li>End-users may not have much visibility on the supply chain except through the mechanical contractor unless they are an anchor tenant for a new building</li> <li>They are even more important in mid-tier buildings where there are rarely consultants involved who can provide independent advice and oversight</li> <li>Big variations in approaches of contractors and cost-cutting approaches to achieve contracted standards or to manage project budget overruns</li> <li>Often designers adapt previous designs to reduce time and risk for them</li> </ul>
<b>Building and Asset Owners</b>	<ul style="list-style-type: none"> <li>Building and asset owners are the key player because they set the energy performance standards and financial criteria that filter through the supply chain.</li> <li>But they are often focused on 'image' and features that will attract tenants, such as views (large windows), impressive aesthetics</li> <li>Typically, rely heavily on rating schemes – which are interpreted by project teams and consultants</li> <li>Perceptions about the economics of energy efficiency measures influence behaviour: there is often a failure to recognise the 'multiple benefits'</li> </ul>	<ul style="list-style-type: none"> <li>There is a primary distinction between premium building owners and mid-tier building owners</li> <li>There is a growing body of commercial buildings with ratings and improved efficiency, creating demand for more efficient HVAC</li> <li>Outside this sector there is large, diverse group collectively known as mid-tier buildings which has been difficult to influence</li> </ul>	<b>HIGH (Large owners)</b> <b>LOW (Mid-tier)</b> <ul style="list-style-type: none"> <li>Around 10 major property owners/funds in particular have been key agents of change</li> <li>There is a larger, more educated group of building and asset owners who create demand for energy efficiency products</li> <li>There may be potential to apply their approaches more widely through training, model specifications, Measurement and Verification etc.</li> <li>Across the building sector in general, however the influence is often low as there is limited interest and connection between energy efficiency, tenancy and rates</li> <li>Different investment time-frames impact on owner approach e.g. short-term and speculative investment militates against energy efficiency investments</li> <li>In mid-tier/smaller buildings, family or small investors may focus on stable revenue and minimum change, and may not</li> </ul>

Supply Chain Agent	Role	Structure	Influence
	<ul style="list-style-type: none"> <li>Perceptions regarding impacts on asset value and attraction of high-paying, long term tenants are the highest priority e.g. if future benefits of energy efficiency measures funded by debt are underestimated, they may be rejected</li> <li>Adoption of Energy Upgrade Agreements can be affected by such perceptions, as they may be seen to increase costs for future tenants if savings are undervalued</li> </ul>		<p>be focused on 'detail' as long as tenants are satisfied and stay</p> <ul style="list-style-type: none"> <li>Simplistic investment criteria are often used, and tax minimisation can be a motivator</li> <li>They may be reluctant to borrow to fund energy efficiency measures because of concerns about ability to repay and risk of future higher costs for tenants</li> <li>Potential improvements in data analytics and measurement and verification offer potential for owners to be alerted to problems or potential for improvement, accountability of operators, development of quantified business cases for improvement</li> </ul>
<b>Tenants</b>	<ul style="list-style-type: none"> <li>The tenants are the end-user or consumer</li> <li>Where there is a link between tenancy levels and rates and energy performance ratings, tenants can be very influential</li> <li>Other factors such as comfort influence tenants and their interactions with facility management</li> <li>Many tenants rely on building managers and may not recognise the significance of fit out decisions for energy performance, e.g. new walls blocking air flow, selection of lighting and controls, exhaust fans.</li> </ul>	<ul style="list-style-type: none"> <li>Some primary distinctions between types of tenants</li> <li>Governments and big corporates are more aware of energy efficiency and ratings and therefore influential</li> <li>They are more likely to engage more sophisticated technical advisers and sign longer term leases</li> <li>Owner-occupants can have longer time perspectives</li> </ul>	<p><b>HIGH (Large tenants)</b> <b>LOW (Mid-tier)</b></p> <ul style="list-style-type: none"> <li>The same distinctions apply as for building owners between the upper end of the market and the wider building stock</li> <li>Tenants in mid-tier building are likely to be less knowledgeable or have less leverage</li> <li>Where there is no link between the performance rating and tenant rates or direct ownership, there is a split incentive between the owner (responsible for investing in HVAC equipment) and tenant (who pays the energy bills)</li> <li>If energy costs are included in overall 'outgoings' charges, consideration of energy may be masked</li> <li>A single tenant or small number of tenants means they have more influence and the logistics of mobilising for change can be easier</li> <li>Sustainable Australia Fund has had some success in upgrades of commercial buildings with single tenants</li> </ul>
<b>Consultants</b>	<ul style="list-style-type: none"> <li>Consultants and engineering services firms play an important role as key advisers for large users and on new builds and major refurbishments</li> </ul>	<ul style="list-style-type: none"> <li>There are around 10-15 major consultancies – but smaller entrants and boutique consultancies are emerging with specialisations</li> </ul>	<p><b>MEDIUM-HIGH</b></p> <ul style="list-style-type: none"> <li>The key moment for change tends to be periodic work or capital programs (often on a 5-year schedule) or there is a trigger for an audit (price increases) or equipment failures</li> </ul>

Supply Chain Agent	Role	Structure	Influence
	<ul style="list-style-type: none"> <li>The first step for many larger users is to commission a consultant to do an audit and produce recommendations on changes based on a preliminary business case</li> <li>If the business decides to proceed, the consultants may do a conceptual design, firm up the business case based on quotes and may then continue to play a role through the process providing oversight on the tender and installation process</li> <li>Consultants will also generally manage energy efficiency certificates for clients</li> <li>Architect's building design can play a key role in determining overall thermal performance</li> <li>Financial and tax consultants can drive many decisions, especially if they apply narrow benefit criteria high discount rates that militate against efficiency projects with longer returns.</li> </ul>	<ul style="list-style-type: none"> <li>Examples include building analytics firms using data and modelling, artificial intelligence and on-going engagement with facility managers to 'tune' and optimise HVAC systems both for efficiency and demand management</li> <li>Chiller scheduling and real time performance monitoring using data analytics seems to offer significant benefits in efficiency, reliability and equipment life</li> </ul>	<ul style="list-style-type: none"> <li>Consultants are for large users, new builds and major building refurbishments often the first port of call so play an important role shaping options</li> <li>Some industry sources feel their influence has diminished over time ('subbies in suits') and shifted to builders and mechanical contractors who hold responsibility for translating designs into reality</li> <li>They are very important for the VEU program as they are usually the party responsible for advising on and implementing usage of certificates as a funding source</li> </ul>
<b>Builders, Fit-out contractors and Installers</b>	<ul style="list-style-type: none"> <li>Builders have responsibility for the delivery of HVAC systems in new-builds and major retrofits</li> <li>Typically, this occurs through design-and-construct competitive tenders</li> <li>Fit-out contractors can play more important roles in tenancy refurbishments or at the start of tenancy fit out</li> <li>Adoption and active use of NABERS tenant rating may be significantly lower than base building rating</li> </ul>	<ul style="list-style-type: none"> <li>There is a group of major firms and an extensive network and hierarchy of contractors and sub-contractors</li> </ul>	<p><b>MEDIUM-HIGH</b></p> <ul style="list-style-type: none"> <li>Builders exert a lot of influence as the lead contractual party responsible for delivery</li> <li>Project managers and clients often set the framework and write specifications for tenders which builders then interpret and adapt</li> <li>Builders may have established supply chain partners with a collection of head-contractors – and therefore contracts or preferred suppliers - or assemble partners subsequent to tenders</li> <li>Building control systems may also be directed by builders as they are integrated with security</li> </ul>



Supply Chain Agent	Role	Structure	Influence
			<ul style="list-style-type: none"> <li>For smaller buildings, installers are a key source of advice for owners that do not have the same access to consultants and expertise</li> <li>Substitution of equipment for less efficient alternatives by builders and contractors occurs due to delivery times, changing budgets or opportunistic strategies to cut costs</li> <li>There is a focus on meeting client specifications and minimising contractor risk</li> <li>Commissioning may not be done thoroughly due to budget overruns and lack of performance data</li> </ul>
<b>Manufacturer</b>	<ul style="list-style-type: none"> <li>HVAC systems and components are manufactured internationally</li> <li>The manufacturers and their local offices make decisions about which products to import</li> <li>There is some local design and manufacturing, which involves primarily assembly of imported components, including chillers, heat exchangers, and design of layouts</li> </ul>	<ul style="list-style-type: none"> <li>The manufacturing sector for commercial HVAC is more concentrated than residential because there is a smaller number of larger systems</li> </ul>	<p><b>MEDIUM</b></p> <ul style="list-style-type: none"> <li>Manufacturer decisions can influence the availability of technology in Australia</li> <li>Australia is a small market so not all models are available</li> <li>Ultimately, the equipment choice lies with owners, designers, builders and contractors</li> <li>The Australian Refrigeration Equipment Manufacturing Association (AREMA) observes that some members that specialise in higher equipment efficiency equipment may have lost share in recent years due to cost-pressures</li> </ul>
<b>Wholesalers, dealership networks and equipment sellers</b>	<ul style="list-style-type: none"> <li>Sales and distribution of HVAC systems and components</li> <li>For larger buildings and more sophisticated equipment, the major route to market appears to be through dealerships and equipment sellers</li> <li>For smaller or mid-tier buildings, the route to market is more evenly split between wholesalers and the dealerships and equipment sellers</li> </ul>	<ul style="list-style-type: none"> <li>There are three different types of businesses: <ol style="list-style-type: none"> <li>Wholesalers selling more standardised or modular systems and/or parts (e.g. pipes, ducting), especially for smaller buildings</li> <li>Australian branded systems which are imported and re-branded or assembled using international components</li> </ol> </li> </ul>	<p><b>MEDIUM</b></p> <ul style="list-style-type: none"> <li>These intermediaries aim to establish on-going contractual relationships with purchasers of HVAC systems and equipment, be they the mechanical and maintenance contractors, consultants, builders and owners, and supply through competitive tenders</li> <li>Contractual arrangements can lock-in particular technology suppliers</li> <li>Sometimes, larger asset and building owners have preferred or multi-year contracts with a supplier</li> <li>Builders and mechanical contractors also sometimes have contractual relationships and preferred suppliers</li> </ul>

Supply Chain Agent	Role	Structure	Influence
		<p>3. National offices of international brands selling equipment which may also be customised</p>	<ul style="list-style-type: none"> <li>• Equipment sellers also aim to influence consultants so their technology or products are specified in their engineering designs</li> <li>• The more common arrangement however appears to be competitive tenders or some type of selection process</li> <li>• General view amongst interviewees was that there is reasonably good competition and product availability</li> <li>• Big difference in quality available in capital cities and regional areas</li> <li>• Equipment sellers can become important sources of advice and develop personal relationships</li> <li>• Wholesalers have a lower influence but can be the salesperson who has the ear of key decision makers for the building types outside the premium sector</li> </ul>
<p><b>Facility Managers and Energy Service Company's</b></p>	<ul style="list-style-type: none"> <li>• Facility managers are contracted to maintain and 'operate' buildings across a range of services including the HVAC system</li> <li>• In general, the role of facility managers is often marginal to energy efficiency decision-making. Many facility managers sub-contract HVAC services to a mechanical or maintenance contractor. Facility managers deliver a wide range of building services, they may be from a non-technical background and be viewed by building owners as simply implementation service providers who have no role in strategic decision-making.</li> <li>• ESCO's are specialist energy management service companies who</li> </ul>	<ul style="list-style-type: none"> <li>• Facility management has become a fast-growing service sector with a diverse, highly competitive market comprising contractors, in-house teams, professional agencies and associations</li> <li>• Some major companies and bigger property managers keep it in-house - but in general it is a highly fragmented sector with low barriers to entry, tight margins, highly competitive</li> <li>• There is a handful of energy specialist/facility management companies now operating that service, tune and retrofit HVAC systems.</li> </ul>	<p><b>MEDIUM</b></p> <ul style="list-style-type: none"> <li>• Facility managers are potentially an agent able to influence behaviour 'upwards' (to building owners), 'downwards' (building occupants) and 'sideways' (professions, contractors)</li> <li>• In major buildings with high star ratings (5-stars plus) contracts include requirements for maintenance of NABERS ratings</li> <li>• Arrangements for the party responsible for maintaining the NABERS rating can vary significantly</li> <li>• In general, however, interviewees agreed the incentives provided by performance standards was weak</li> <li>• Owners exert less oversight and pressure for value from maintenance expenditure</li> <li>• Curtis et. al. (2017) analysed the role of facility managers in a Victorian program<sup>2</sup> and found 'complex building ownership arrangements, poor communication skills, isolation from key decision making processes, a lack of credible business</li> </ul>

<sup>2</sup> The program was Smarter Resources, Smarter Business Energy Efficient Office Buildings Program.

Supply Chain Agent	Role	Structure	Influence
	may have responsibility for HVAC systems		<p>cases and information, split incentives and the prospect of business disruption can all impact on FM's ability to drive organisational change.'</p> <ul style="list-style-type: none"> <li>• Facility management could be a major influence for more efficient HVAC systems but is rarely so at present</li> <li>• Lack of meaningful, understandable real time feedback on performance and loss of long term data undermine optimisation of performance – but emerging real time data analytics creates a major opportunity for improvements</li> <li>• Mechanisms to ensure accountability and set standards may be weak</li> <li>• ESCOs may be risk-averse, so apply conservative approaches linked to the duration of their performance contract</li> </ul>

### 3.3 Pressures for Change

Table 9 provides some of the major drivers for change in the commercial HVAC supply chain.

Table 9: Pressures for Change in the Commercial HVAC Supply Chain

Drivers	Blockers
<p><b>Extension of rating and regulatory schemes</b></p> <ul style="list-style-type: none"> <li>• The National Australian Building Energy Rating Scheme (NABERS) is a world-leading instrument which has driven major change through energy efficiency product supply chains for the commercial building sector. A key feature that underpins its credibility is its reliance on actual data, rather than design intent or modelling. Its high profile in building foyers and simple star rating metrics reinforce engagement. It is being extended to new classes of buildings and if it can be established, it should become a driver of demand. NABERS is a proven mechanism for driving demand for greater energy efficiency including HVAC systems.<sup>3</sup></li> </ul>	<ul style="list-style-type: none"> <li>• For sectors outside the major areas where there has been major movement (e.g. offices), ratings mechanisms may still need to be connected to key financial drivers (e.g. hotels and occupancy rates) in the way they have in sectors such as office buildings. They may not work as effectively even though there are short paybacks.</li> <li>• It takes time and resources to establish effective benchmarks with industry awareness, acceptance and uptake.</li> </ul>

<sup>3</sup> Extending NABERS to incorporate a peak demand rating as well as annual greenhouse gas emissions could offer significant benefits through reduction of investment in energy supply infrastructure, as well as providing a basis for retailer obligation schemes and other incentive programs to allocate funds and monitor outcomes.

**Drivers**

- There is some increase in adoption of NABERS Indoor Environment Quality rating as costs of sensors and recognition of productivity and staff satisfaction increases.
- Commercial Building Disclosure (CBD) Scheme reporting threshold has been reduced from 2000 square metres to 1000 square metres. All offices greater than 1000 square metres must obtain a Building Energy Efficiency Certificate upon sale or lease to inform decisions by interested buyers or tenants. The CBD scheme is currently under review. Further changes could include application to hotels and office tenancies and in time the threshold could be reduced further. The CBD scheme is also proven as a driver of demand in concert with NABERS.

**Blockers**

- Sophisticated data analytics are still in early days: driving this harder could be a game changer for accountability and benchmarking if communicated effectively.
- Lack of promotional strategies and budgets mean that awareness of potential is low among influencers.
- Lack of sophistication in financial analysis, and lack of solid data on which to build business cases is a problem.
- Lack of confidence in emerging technologies (and supply/maintenance networks) – demonstration projects and active promotion of success stories via business networks and specialist media may help.

**New entrant businesses and disruptive business models**

- In building controls, there are new entrants and disruptive businesses – system integrators who develop generic products and algorithms that are not linked to a specific supplier. Building management systems can now be installed that coordinate and analyse data from many diverse data streams, systems and meters.
  - In facility maintenance, building analytics firms and systems are creating pressure for:
    - More pro-active and sophisticated building operation. There is growing market for HVAC tuning to increase their NABERS star ratings (typically systems waste a lot of energy which can be eradicated with better operation).
    - Predictive maintenance which increases the likelihood of HVAC upgrades instead of last-minute like-for-like replacements when systems fail or approach the end of their life.
    - HVAC service operations and ESCOs are a small but growing feature of commercial building maintenance and operation. Building analytics and controls businesses may move further into maintenance.
    - The entry of new businesses and models offers an opportunity to reform this sector.

- Facility management standards and practices are in general a significant block to more efficient HVAC operation and system selection due to a range of factors:
  - Low margin, competitive business.
  - Facility managers are often from other backgrounds (e.g. security), manage many types of operations, and don't have energy knowledge or understanding of technology options.
- Low-risk approach that is compliance driven (e.g. safety), favours short-term fix-ups over systemic changes and replacement, and like-for-like where replacements are needed.
- Lots of players are needed to be lined up for more sophisticated approaches to building tuning – but often basic data not available to even work out what is going on, ensure accountability and support preparation of a strong business case.
- Focus is on responding to complaints, and this often leads to 'tweaking' that undermines performance. Sustainability Victoria used HuxConnect portable sensors in a trial project a while ago, and facility managers were very positive for its other benefits.

**Growth of data technology and systems**

- Data analytics is an emerging force for accountability, identification of faults and inefficiencies, and to underpin preparation of convincing business cases. Control systems will continue down the Internet-of-things pathway with improved data and analytics becoming widely available.

- Knowledge or access to expertise to use the data. Many data analytics specialists apply narrow approaches and fail to take advantage of multiple data streams to add value. Few data analytics people focus much on energy – A2EP work in preparing a guide for Industry 4.0 found that major data



**Drivers**

**Blockers**

- It is driving the development of new businesses, which may end up disrupting existing models, and opens up opportunities for greater energy efficiency. The 'data revolution' is in the early stages.

- players were generally focused on other issues – but adding energy data to these data streams can enhance business value and identify what actions and business units should be targeted.
- Proprietary systems that limit end-user access to data and delete data after a short time.

**Electricity and gas price increases**

- Rising prices are a catalyst for energy audits and efficiency projects including HVAC upgrades.

- Whilst price shocks can be a catalyst for energy audits and retrofit/upgrade programs, every time a new system or an increase in rating is pursued there are mark-ups at each stage of the process – consultants, contractors, suppliers.
- Big electricity price rises may slow or even reverse in the next few years, reflecting the impact of renewable energy Power Purchase Agreements (PPAs), on-site solar and energy storage and management. There could be decline in management focus on energy unless organisations have climate and net zero emission commitments.
- Policy focus on energy price instead of total energy cost (and multiple benefits of energy efficiency and energy productivity) is misleading and shifts focus to cheaper contracts, renewable energy instead of measures that cut amount and optimise timing of energy use.

**Climate change and sustainability awareness and targets**

- Corporate emissions and sustainability targets and rising consumer awareness of environmental impact of energy usage drives greater interest in energy efficiency as well as renewable energy. Big corporates with sustainability targets drive action throughout their global subsidiaries and increasingly supply chains and may have dedicated sustainability capital expenditure budgets and processes separate from their standard capital expenditure processes. Some organisations have internal commitments to cut emissions.

- Information gaps on how to translate climate change and sustainability imperatives into action e.g. net zero emissions buildings and need for improved tracking of performance.
- Climate commitments may be linked to high level targets several years into the future and sometimes lack urgency.
- Lack of financial signals for individual managers and decision-makers within organisations to factor in climate impacts: introduction of a 'net zero emission' commitment for existing operations effectively introduces a carbon price equal to the cost of buying carbon offsets, which could be made visible to each decision maker.
- We have no accounting system that estimates the 'lifetime' climate (and offset) cost of decisions such as equipment purchases over the period of business ownership. This should be an element of the business case for each decision.

## Drivers

### **Growth of demand response incentives, cost-reflective pricing and Prosumers**

- Demand response incentives and mechanisms are growing - and will accelerate when the National Electricity Market moves towards a genuine 'two-sided' market from 2021, with bidding from demand management aggregators HVAC appears to be a highly prospective source of wholesale demand response – if aggregators can mobilise building owners and managers.
- Other trends create organisations with greater capacity and interest in higher-performing and optimising HVAC:
  - There are more users with spot exposure or more cost-reflective pricing which also creates incentives for higher-performing and optimised HVAC.
  - There are more users with on-site solar and embedded networks (which internalise the electricity consumption of tenants) and interest in maximising yields through energy efficiency and demand management.

## Blockers

- It is still a new sector with many of the classic issues that confront emerging technologies and business models:
  - Much stronger action than present proposals will be needed to influence retail consumers before we capture the full potential of demand response.
  - Lack of status and resources of emerging businesses.
  - Institutional mechanisms are being established but are not yet in operation, and may be distorted by incumbent businesses.
  - Opaque pricing arrangements which for most users do not deliver clear price signals.
  - Lack of consumer protection.
  - Complexity of multiple players and constant change.

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## 4. Water Heaters and Boilers

These technologies (boilers, steam systems, furnaces and ovens) vary greatly in size and application from large industrial units delivering high temperature steam across a large site to package units for heat and hot water distributed within a commercial building or serving a single item of equipment. Water Heaters and Boilers in commercial buildings are strongly influenced by the mechanical contractor.

Water Heating and Boilers for the industrial sector is similar in that the mechanical contractor (or specialist contractor is still the major influencing party. However, there are not typically involved with installers and consultant/engineering firms responsible for installation. Product managers will be driven more by energy costs, and ESCOs will be present, offering a package of solutions.



## 4.1 Mapping the Supply Chain

Figure 5 is a stylised representation of the key agents in the water heaters and boilers supply chain for commercial buildings.

Figure 5: Map of the Water Heaters and Boilers Supply Chain (Commercial)

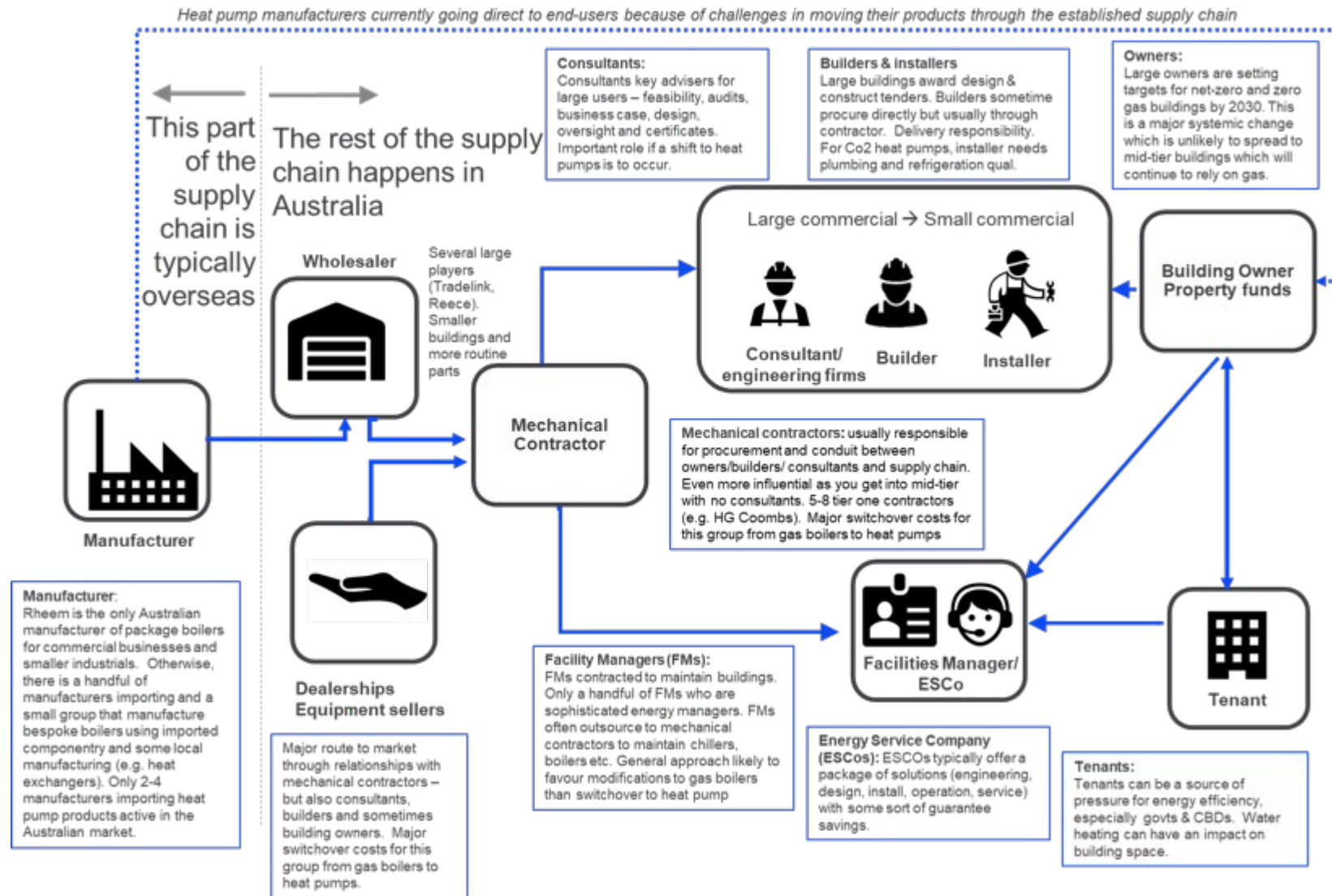
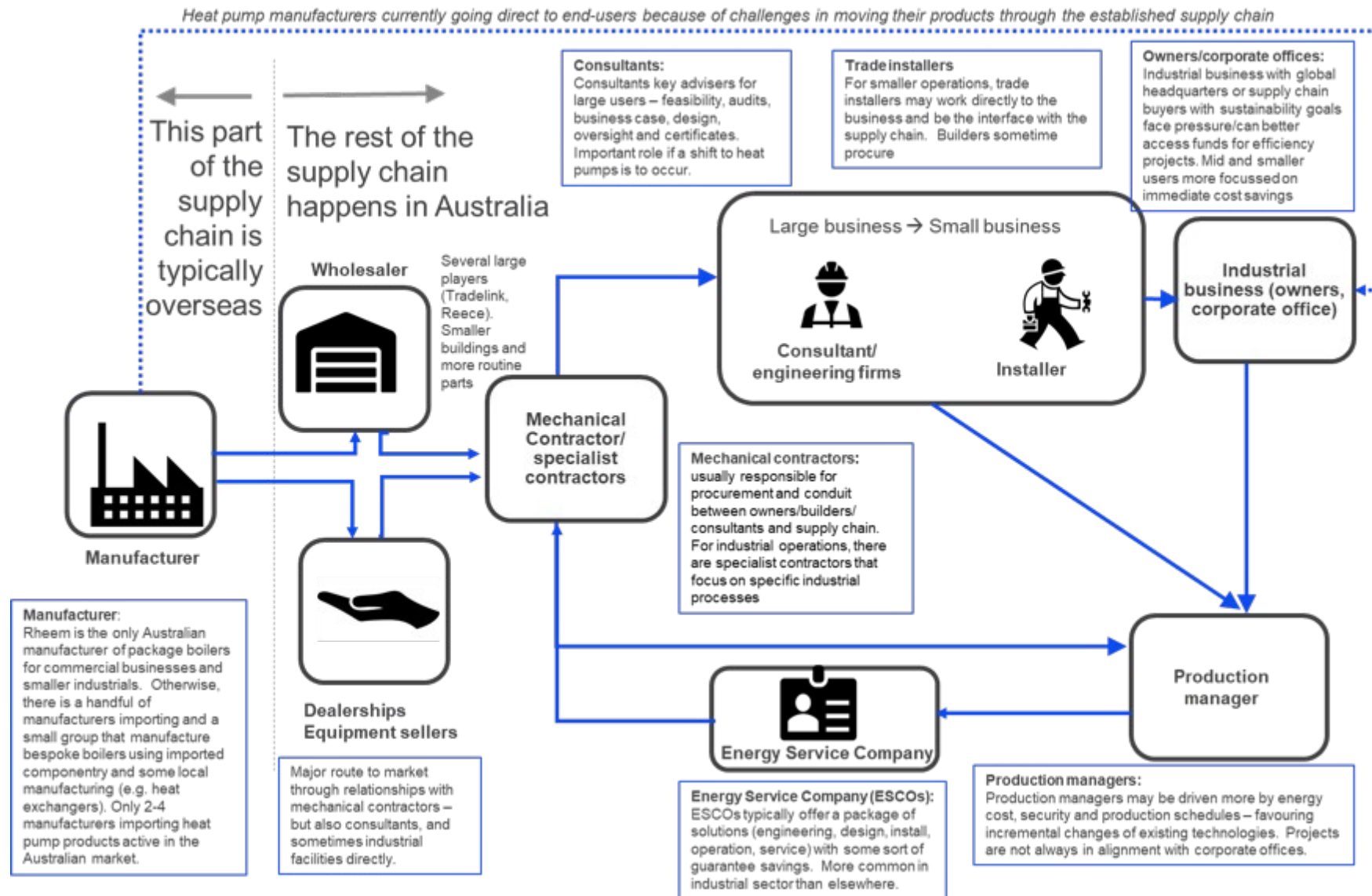




Figure 6 is a stylised representation of the key agents in the water heaters and boilers supply chain for the Industrial segment.

Figure 6: Map of the Water Heaters and Boilers Supply Chain (Industrial)



## 4.2 Profiling the Supply Chain: role, structure and influence

For each of the supply chains, the influence of the major agents is categorised as either low, medium or high based on the following rating and definition:

**Low** = rarely exerts an independent influence on the supply, selection or use of energy efficiency products

**Medium** = sometimes exerts an independent influence on the supply, selection or use of energy efficiency products depending on circumstances

**High** = often exerts – or can exert – an independent influence on the supply, selection or use of energy efficiency product.

Table 10 summarises the supply chain agents and their influence in the water heaters and boilers supply chain.

Table 10: Summary of Influence of Agents in the Water Heaters and Boilers Supply Chain

Supply Chain Agent	Influence
Mechanical and Maintenance Contractors	High
Building and Asset Owners (large tenants)	High
End-users (industrial) and Tenants (commercial) – large tenants	High
Consultants	Medium-High
Builders, plumbers and Installers	Medium-High
Manufacturer	Medium-High
Wholesalers, dealership networks and equipment sellers	Medium
Facility Managers and Energy Service Companies	Low
Building and Asset Owners (mid-tier)	Low
End-users (industrial) and Tenants (commercial) – mid-tier	Low



Table 11 provides more detailed commentary on the role, structure and influence of the water heaters and boilers supply chain.

Table 11: Detailed Role, Structure and Influence of Water Heaters and Boilers Supply Chain

Supply Chain Agent	Role	Structure	Influence
<p><b>Mechanical and Maintenance Contractors</b></p>	<ul style="list-style-type: none"> <li>Mechanical contractors are generally responsible for the procurement, detailed design and installation of the equipment – and often servicing, repairs, upgrade and procurement for facilities managers. They translate conceptual specifications into specific equipment packages.</li> <li>The building control system contractor which can be under or alongside the mechanical contractor – is also an important influence on performance as these systems become more sophisticated and influence on operation.</li> </ul>	<ul style="list-style-type: none"> <li>Fragmented with many players but a top-tier of contractors.</li> <li>Small number of tier-one contractors (5-8) who are able to provide an integrated service to major CBD buildings. Beneath them there are tiers of sub-contractors with different levels of service and quality. The mechanical contractors association says there are fewer layers of sub-contracting in Victoria relative to NSW.</li> </ul>	<p><b>HIGH</b></p> <ul style="list-style-type: none"> <li>Mechanical contractors are often the interface between the two ends of the supply chain. End-users may not have much visibility on the supply chain except through the mechanical contractor. They are even more important in mid-tier buildings where there are rarely consultants involved who can provide independent advice and oversight.</li> <li>Big variations in approaches of contractors and cost-cutting approaches to achieve contracted standards.</li> <li>There are strong pressures amongst this group to do running repairs or 'like-for-like' replacements. While this will generally still lead to significant efficiency gains due to improvements in technology, it can lead to over-sizing and miss opportunities for more efficient heat pumps. Like consultants, knowledge on heat pumps and their applications is generally low. 'System-level' issues such as lack of pipe and fitting insulation, lack of condensate return, end-use waste, etc. may not be seen as part of their job.</li> <li>There is an additional point of influence for efficiency for boilers as safety inspections are periodically required under safety regulations. Generally, it is a 'compliance' exercise but could be a moment to influence efficiency. The challenge for a program intervention is these represent a lot of small transactions.</li> </ul>
<p><b>Building and Asset Owners</b></p>	<ul style="list-style-type: none"> <li>Building and asset owners are the key player because they set the energy performance standards that filter through the supply chain.</li> </ul>	<ul style="list-style-type: none"> <li>There is a primary distinction between premium building owners and mid-tier building owners.</li> </ul>	<p><b>HIGH (Large tenants)</b> <b>LOW (Mid-tier)</b></p> <ul style="list-style-type: none"> <li>Around 10 major property owners/funds in particular have been key agents of change. They will exert</li> </ul>

Supply Chain Agent	Role	Structure	Influence
	<ul style="list-style-type: none"> <li>Major building owners are setting zero gas targets - and some big industrials also have specific gas reduction strategies – which could be a disruptive impact on a supply chain oriented around gas boilers.</li> <li>Role of financial analysts within firm or as consultants.</li> </ul>	<ul style="list-style-type: none"> <li>For mid-tier buildings, gas boilers will remain the dominant technology.</li> <li>Amongst the industrial sector, there is a similar split between early-movers with pressures from global head offices, supply chains or internal targets to move away from gas boilers.</li> <li>For the majority, especially smaller or less high profile businesses, gas boilers will remain the dominant technology.</li> </ul>	<p>influence on the supply chain and also the larger body of buildings that have NABERS ratings and are increasingly educated and responsive to energy and building management trends.</p> <p>Across the building sector in general, however the influence is often low as there is limited interest and connection between energy efficiency and costs and tenancy and rates.</p>
<b>End-users (industrial) and Tenants (commercial)</b>	<ul style="list-style-type: none"> <li>For commercial buildings, where there is a link between tenancy levels and rates and energy performance ratings, tenants can be very influential. Other factors such as comfort influence tenants and their interactions with facility management. For many commercial buildings, water heating is not a major energy user (exceptions include hotels, hospitals).</li> <li>There is a larger group of industrial end-users with significant process heat requirements with exposure to gas usage and prices. Some industrial end-users are focussed on energy prices and security of supply with traditional investment hurdles and are averse to major changes which disrupt production. Other end-users have corporate sustainability targets, set either locally or through global offices, which are increasingly important. There may be internal sustainability funds governed by different criteria to standard</li> </ul>	<ul style="list-style-type: none"> <li>Some primary distinctions exist between types of tenants. Governments and big corporates are more aware of energy efficiency and ratings and therefore influential. They are more likely to engage more sophisticated technical advisers.</li> <li>The industrial sector is very diverse and depends on end-use and business size primarily.</li> </ul>	<p><b>HIGH (Large tenants)</b> <b>LOW (Mid-tier)</b></p> <ul style="list-style-type: none"> <li>The same distinctions apply as for building owners between the upper end of the market and the wider building stock. Tenants in mid-tier buildings are likely to be less knowledgeable or have less leverage.</li> <li>Where there is no link between the performance rating and tenant rates or direct ownership, there is a split incentive between the owner (responsible for investing in equipment) and tenant (who pays the energy bills).</li> </ul> <p>In general, consumers are not well informed. This is especially so of heat pumps. The distinction is less pronounced in the industrial sector due to the diversity but there is certainly a difference between organisations with and without corporate sustainability targets.</p>

Supply Chain Agent	Role	Structure	Influence
	investment and capital expenditure criteria, including funds to reduce use of gas.		
<b>Consultants</b>	<ul style="list-style-type: none"> <li>Consultants and engineering services firms play an important role as key advisers for large users and on new builds and major refurbishments.</li> <li>The first step for many larger users is to commission a consultant to do an audit and produce recommendations on changes based on a preliminary business case. If the business decides to proceed, the consultants may do a conceptual design, firm up the business case based on quotes and may then continue to play a role through the process providing oversight on the tender and installation process.</li> <li>Consultants will also generally manage the involvement of funding from energy efficiency certificates for clients.</li> </ul>	<ul style="list-style-type: none"> <li>There are around 10-15 major consultancies – but smaller entrants and boutique consultancies are emerging with specialisations in the commercial sector.</li> <li>There is consolidation occurring with mergers between engineering consultancies and equipment suppliers to create more holistic or 'end-to-end' services.</li> </ul>	<p><b>MEDIUM-HIGH</b></p> <ul style="list-style-type: none"> <li>The key moment for change tends to be as (often on a 5-year schedule) require updating, there is a trigger for an audit (price increases) or equipment failures. Consultants are for large users, new builds and major building refurbishments often the first port of call, so play an important role shaping options.</li> <li>Some industry sources feel their influence has diminished over time ('subbies in suits') and shifted to builders and mechanical contractors who hold responsibility for translating designs into reality.</li> <li>Whereas consultants are well-versed in gas boilers, there were different views on their knowledge in relation to heat pumps. Manufacturers noted some consultants were knowledgeable and considered them as an option, but in general experience is low and others thought there were scepticism amongst consultants about heat pumps (partly based on bad experiences with heat pumps installed through a stimulus program that were noisy and didn't work well in cold weather). Rapid rate of change in heat pump supply chains and technologies means high risk of knowledge being out of date.</li> </ul> <p>Metering of gas equipment and detailed understanding of energy flows/losses from steam and hot water systems can be limited, so losses may go undiscovered.</p>
<b>Builders, Plumbers and Installers</b>	<ul style="list-style-type: none"> <li>Builders have responsibility for the delivery of water heaters in new-builds and major retrofits. Typically, this occurs through design-and-construct competitive tenders.</li> </ul>	<ul style="list-style-type: none"> <li>There is a group of major firms and an extensive network and hierarchy of contractors and sub-contractors.</li> </ul>	<p><b>MEDIUM-HIGH</b></p> <ul style="list-style-type: none"> <li>Builders exert a lot of influence as the lead contractual party responsible for delivery.</li> </ul>



Supply Chain Agent	Role	Structure	Influence
	<ul style="list-style-type: none"> <li>The majority of products are chosen by plumber or builder – often based on ease of installation, minimising the risk of call-backs by selecting known products and manufacturer incentives.</li> </ul>		<ul style="list-style-type: none"> <li>For smaller buildings, installers are a key source of advice for owners that do not have the same access to consultants and expertise.</li> <li>Substitution of equipment for less efficient alternatives by builders and contractors occurs due to delivery times, changing budgets or opportunistic strategies to cut costs.</li> </ul> <p>Building developers may enter contract with supplier so that consumers pay high daily connection charge as alternative to developer up-front capital investment.</p>
<b>Manufacturer</b>	<ul style="list-style-type: none"> <li>Water heaters and boilers are primarily manufactured internationally. The manufacturers and their local offices make decisions about which products to import.</li> <li>There is some local manufacturing of hot water systems, tanks storage hot water systems.</li> <li>There is a handful of local boiler manufacturers, which primarily involves assembly of imported components (boilers, shell etc.). Bespoke boilers needed for some sectors (e.g. hospitals)</li> <li>Manufacturers have maintenance contracts with larger businesses.</li> </ul>	<ul style="list-style-type: none"> <li>Multiple small to medium local players in a fragmented market offering new systems as well as associated services such as refurbishment, control upgrades, and servicing.</li> <li>International boiler manufacturers also present such as Rinnai offering ‘banks’ of gas boilers together as a modular solution, as well as specifically designed products for commercial and industrial applications from international leaders Bosch.</li> <li>One major local manufacturer of package boilers for commercial businesses and small industrials.</li> <li>There are only 3 or 4 manufacturers supplying heat pumps in Australia – and none above 90 degrees yet. Manufacturers prefer to test newer products in bigger markets closer to home base to manage risks more tightly.</li> </ul>	<p><b>MEDIUM-HIGH</b></p> <ul style="list-style-type: none"> <li>Manufacturer decisions can influence the availability of technology in Australia. Australia is a small market so not all models are available.</li> <li>There has been significant increase in the efficiency of gas boilers being supplied to Australia in response to rising gas prices and local efficiency programs.</li> <li>Ultimately, the equipment choice lies with owners, builders and contractors. However, boilers are often over-sized to ensure security of supply which leads to lower efficiency even if ‘down rated’.</li> </ul> <p>Manufacturers may also exert influence in a maintenance role. Burners typically need to get replaced several times in the lifetime of a boiler.</p>
<b>Wholesalers, dealership networks and equipment sellers</b>	<ul style="list-style-type: none"> <li>Sales and distribution of water heating systems and components through equipment sellers/dealerships and wholesalers.</li> <li>For gas technologies, there is a well-established network of suppliers. It is very limited (almost</li> </ul>	<p>There are three different types of businesses:</p> <ol style="list-style-type: none"> <li>Wholesalers selling more standardised or modular systems and/or parts (e.g. pipes, ducting), especially for smaller buildings.</li> </ol>	<p><b>MEDIUM</b></p> <ul style="list-style-type: none"> <li>These intermediaries aim to establish contractual relationships with purchasers of HVAC systems and equipment, be they the mechanical and maintenance contractors, consultants, builders and owners, and supply through competitive tenders.</li> <li>Contractual arrangements can lock-in particular technology suppliers. Sometimes, larger asset and</li> </ul>

Supply Chain Agent	Role	Structure	Influence
	<p>non-existent) for heat pump products.</p>	<ol style="list-style-type: none"> <li>2. Australian branded systems which are imported and re-branded or assembled using international components.</li> <li>3. National offices of international brands selling equipment which may also be customised.</li> </ol>	<p>building owners have preferred or multi-year contracts with a supplier. Builders and mechanical contractors also sometimes have contractual relationships and preferred suppliers. Equipment sellers also aim to influence consultants so they are specified in their engineering designs.</p> <ul style="list-style-type: none"> <li>• The more common arrangements however are competitive tenders or some type of selection process. General view amongst interviewees was that there is reasonably good competition and product availability. Big difference in quality available in capital cities and regional areas.</li> <li>• Equipment sellers can become important sources of advice and develop personal relationships.</li> <li>• Wholesalers have a lower influence but can be the salesperson who has the ear of the building types outside the premium sector.</li> </ul>
<p><b>Facility Managers and Energy Service Company's (ESCOs)</b></p>	<ul style="list-style-type: none"> <li>• Facility managers are contracted to maintain and 'operate' buildings across a range of services. Many facility managers sub-contract these services to a mechanical or maintenance contractor.</li> <li>• Inclusion of clear performance standards and accountability (e.g. using Measurement &amp; Verification reporting) and, increasingly, real time data analytics offers potential for improved outcomes.</li> </ul>	<ul style="list-style-type: none"> <li>• Some major companies and bigger property managers keep it in-house - but in general it is a highly fragmented sector. Low barriers to entry, tight margins, highly competitive.</li> <li>• There is handful of energy specialist/ facility management companies now operating these services.</li> </ul>	<p><b>LOW</b></p> <ul style="list-style-type: none"> <li>• Facility managers are likely to sub-contract to a mechanical contractor for decisions on the running, servicing and replacement of water heaters and boilers. The emergence of energy management service companies may change this in future.</li> <li>• ESCOs are focused on profit and reliability within the period of their contract, not whole of life.</li> </ul>

## 4.3 Pressures for Change

Table 12 provides some of the major drivers for change in the water heaters and boilers supply chain.

Table 12: Pressures for Change in the Water Heaters and Boilers Supply Chain

Drivers	Blockers
<p><b>High Gas Prices</b></p> <ul style="list-style-type: none"> <li>High and volatile gas prices are a significant catalyst for businesses to consider upgrades, replacements or switching to a heat pump.</li> <li>High gas prices have also led some businesses to conclude they are able to better manage exposure to electricity price movements than gas (due to other options such as renewable energy power purchase agreements)</li> </ul>	<ul style="list-style-type: none"> <li>Very low gas prices for many years means technology development stalled in Australia and there are a lot of low efficiency boilers (and other gas technologies like furnaces) and associated heat distribution systems. These are 30-50 year assets with long lives.</li> <li>There are a lot of businesses with gas boilers for whom increased operational efficiency – rather than replacement with a more efficient boiler or heat pump – will remain the major avenue to manage exposure to gas prices.</li> </ul>
<p><b>Pressure for lower emissions from head contractors or businesses in supply chains</b></p> <ul style="list-style-type: none"> <li>Large corporates at the top of supply chains with sustainability targets are driving pressure through their supply chain for emissions reductions.</li> <li>In general, this creates pressures for efficiency measures to reduce emissions, but timing of change is linked to dates of targets and costs and PR benefits of other emission reduction or offset options.</li> </ul>	
<p><b>Early movers with zero gas or gas reduction targets and changes to NABERS</b></p> <ul style="list-style-type: none"> <li>Major building and asset owners are setting targets for zero emissions and zero gas buildings by 2030.</li> <li>Some industrials have ambitious emissions targets - also sometimes including specific goals to reduce or eliminate gas and dedicated budgets.</li> <li>Some Councils with aquatic centres are looking at heat pumps as alternatives to gas boilers as part of their zero carbon commitments.</li> <li>NABERS emissions factors are currently being reviewed updated as they do not reflect current electricity grid emissions intensities. NABERS staff have specifically identified a risk the emissions factor distort choices towards gas boilers vis-à-vis heat pumps. Water heaters are a significant factor in the NABERS rating. Updated emissions factors will change the relative incentive between gas boilers and heater. How NABERS treats RE PPAs, especially for new buildings, will also be a significant factor.</li> <li>Organisations and governments that have achieved 100 per cent renewable electricity targets are now turning to electrification strategies (e.g. ACT, Victorian local councils).</li> </ul>	<ul style="list-style-type: none"> <li>Engagement has begun between owners, builders and contractors. Builders and contractors are pushing back at this stage, questioning whether it is feasible, but there are examples of European buildings pressure for change will build.</li> <li>Supply chain intermediaries between the manufacturer and consumer for the sales of heat pumps are rare. The typical supply chain that exists for gas boilers and other water heating technologies does not really exist in Australia – manufacturers are going straight to end-users and trying to work backwards to develop the supply chain when they win orders.</li> <li>Consequently, there are many potential blockers to this driver: <ul style="list-style-type: none"> <li>Installation costs for heat pumps are high and ignorance and outdated information are widespread – which leads to heat pumps being removed from projects after very limited analysis, even when they are specified originally in designs.</li> </ul> </li> </ul>

Drivers	Blockers
<ul style="list-style-type: none"> <li>• Combined with the sustainability targets of major owners, the change in the NABERS will be a significant driver for supply chain change.</li> <li>• It is early days, but international work has begun on development of equipment MEPS and labelling based on systems approaches. EnergyConsult has been working with E3 on this.</li> </ul>	<ul style="list-style-type: none"> <li>○ There are knowledge and skill gaps e.g. CO2 heat pumps need a mix of plumbing and refrigeration qualifications.</li> <li>○ There is significant technology lock-in throughout the supply chain from the manufacturers through the wholesalers, equipment sellers, builders and plumbers and contractors and consultants (all of whom may have volume contracts or receive commissions) and 'like for like' replacement is common.</li> <li>○ There is low knowledge about heat pumps and their uses. Focus on upfront capital cost or short 'payback period', not lifetime cost.</li> <li>○ Resistance from local manufacturers and gas distribution networks.</li> <li>○ Local electrical distribution network capacity to accommodate increased demand from fuel switching.</li> </ul>
<p><b>Growth of on-site renewable energy and interest in storage and demand management</b></p> <ul style="list-style-type: none"> <li>• Heat pumps can act as a source of storage, utilise renewable energy and improve returns on on-site solar.</li> </ul>	<ul style="list-style-type: none"> <li>• There are other options on storage and demand management. Information and understanding on heat pumps and how they compare to other storage options is low.</li> </ul>

## 5. Advanced Glazing

Advanced window products include double and triple glazing, as well as secondary glazing products.

For double and triple glazing, the three main components are:

1. Sealed insulated glass
2. Gas fill (either dry air or dry argon) and in some cases coating e.g. low emissivity (low-e)
3. Frame, which also has a strong impact on thermal performance<sup>4</sup>.

Secondary glazing products include panels and films that can be retrofitted without replacing the complete window, and additional window units installed inside the existing window.

A traditional pathway along the supply chain would start from the manufacturer of components (glass, frames, sealants etc.), with the glass processed separately, which are then integrated into full windows by fabricators who sell direct to builders for installation. Approximately 90 per cent of windows are installed by builders or by installers (mostly fabricators or tradespeople) contracted by builders. Fabricators are typically SMEs. Architects and designers can play a role by specifying the type of glazing to be installed by the builder. Most of the supply chain is located in Australia, apart from the component manufacturers that are generally overseas.

Alternate pathways include retrofits (e.g. Ecostar), secondary glazing products (e.g. Magnetite) and secondary windows (e.g. stopnoise). In these cases, the end-user can purchase directly from the window fabricator or secondary product retailer. However, this is still a very small part of the market and have challenges for widespread roll-out via incentives. For example, some window frames cannot easily be easily retrofitted and require a builder to install double glazing. Secondary glazing products are also difficult to standardise and certify because their performance and durability is not as good as traditional double glazing, and can be variable depending on the circumstance.

<sup>4</sup> <https://www.yourhome.gov.au/passive-design/glazing>

Table 13 summarises the supply chain agents and their influence in the advanced glazing supply chain.

*Table 13: Summary of Influence of Agents in the Advanced Windows and Glazing Supply Chain*

Supply Chain Agent	Influence
Builder /installer	High
Customer	Medium
Architect/designer	Medium
Window fabricator	Medium
Dealer	Medium
Secondary glazing retailer	Medium-Low
Glass processor	Medium
Components Manufacturer	Low



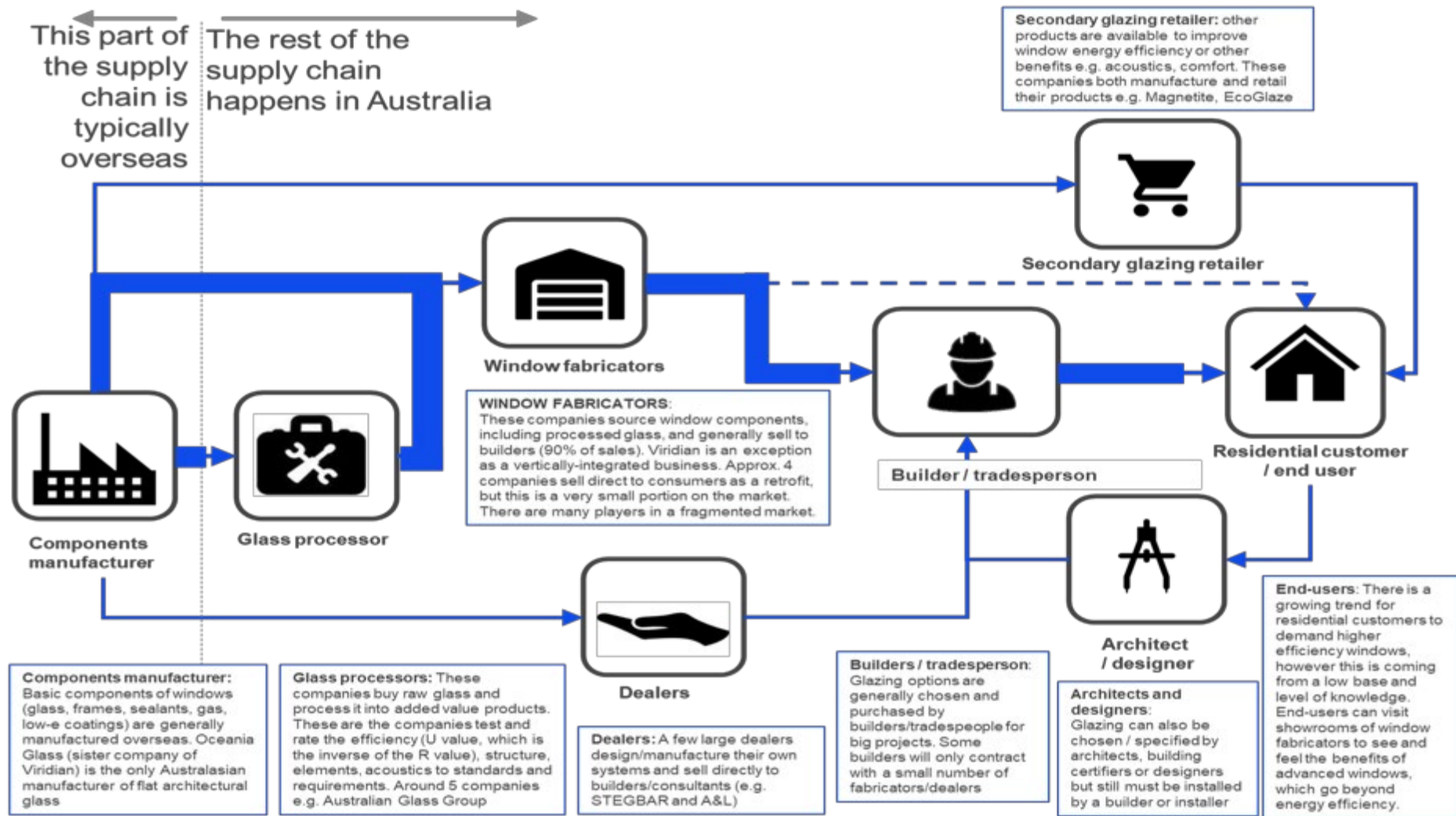


## 5.1 Mapping the Supply Chain

Figure 7 is a stylised representation of the key agents in the advanced glazing supply chain.

Note: The thicker blue arrows denote the most common supply chain routes.

Figure 7: Map of the Advanced Glazing Supply Chain



## 5.2 Profiling the Supply-Chain: role, structure and influence

Table 14 provides more detailed commentary on the role, structure and influence of the advanced glazing supply chain. Importantly, some of the agents play multiple roles. Installation, for example, can be undertaken by builders, window fabricators, occasionally glaziers and sometimes sub-contracted to a tradesperson.

Table 14: Detailed Role, Structure and Influence of the Advanced Glazing Supply Chain

Supply Chain Agent	Role	Structure	Influence
<b>Builder ( including Installers/glaziers)</b>	<ul style="list-style-type: none"> <li>Choice of glazing is most often made by builders or their consultants (for big projects). Some builders will only contract with a small number of fabricators/dealers. Building certifiers are sometimes involved at design stage</li> <li>Installation of windows is physically challenging; therefore some builders will subcontract to window installers (some are fabricators) or glaziers (if the frame is already installed). Volume residential builders may employ specific tradespeople for window installation.</li> </ul>	<ul style="list-style-type: none"> <li>Fragmented structure, with many builders and consultants.</li> </ul>	<p><b>HIGH</b></p> <ul style="list-style-type: none"> <li>80-90 per cent of residential glazing is through a builder who may only contract with particular providers</li> <li>Energy raters can incorporate advanced glazing using NatHERS tools – but typically aim to deliver the lowest cost compliance rating for the client. Government promotion and incentives may influence behaviour and encourage consumer ‘pull’</li> <li>Volume residential builders may add advanced glazing at the margin so they don’t have to change a standard building design when orientation varies, in order to meet the National Construction Code: it is cheaper to install a couple of higher performance windows than change window sizes and have to vary plans for planning approvals</li> <li>The introduction of separate summer and winter requirements for residential buildings in the NCC may focus more attention of coated glazing solutions as being cheaper than expensive external shading.</li> <li>If installers have negative attitudes to advanced glazing, they potentially block adoption. There are no obvious positives for tradespersons for installing advanced glazing but there can be negatives.</li> <li>Double and triple glazing products are heavier therefore, if they are installing, they may have to</li> </ul>

Supply Chain Agent	Role	Structure	Influence
			<p>employ more people to carry heavy window units, or call fellow workers away from core activities to move them. Heavy items create potential OH&amp;S issues (although lifting equipment is now relatively standard for high-rise buildings).</p> <ul style="list-style-type: none"> <li>• Further, the trend to large windows increases the incremental cost and weight of advanced glazing units. Large windows next to doors or full height require safety glass and thicker glass, further increasing the additional cost of advanced glazing units.</li> <li>• If different types of glazing unit are specified for different facades or areas of the building, installers may become confused and install the wrong ones.</li> </ul>
<b>Customer</b>	<ul style="list-style-type: none"> <li>• Generally, there is a low level of customer knowledge about glazing who do not often demand better efficiency standards</li> <li>• There is a trend towards greater demand for double and triple glazing, including low-e and other coatings and argon fill, but this is slow and starkly different to Europe and the US where demand for efficiency is already high</li> <li>• Other drivers such as comfort, reduced condensation and noise may accelerate demand in the future, as they are already recognised by households with advanced glazing as significant benefits</li> </ul>	<ul style="list-style-type: none"> <li>• Residential</li> </ul>	<p><b>MEDIUM</b></p> <ul style="list-style-type: none"> <li>• Most buy homes from volume builders or are offered a limited range of options. Double glazing is not a high visibility feature, and sales people may not be trained to demonstrate its benefits</li> <li>• Educated customers can demand advanced glazing products from builders, however they may be faced with limitations where builders only offer a handful of products they are willing to work with, and often seem to charge a price premium.</li> <li>• Customers currently are not often demanding high efficiency products, thus only have a medium influence. However, if this were to change, a customer-pull could drive builders to deliver a wider range of more affordable advanced glazing products.</li> <li>• The WERS website provides efficiency star ratings but is not widely promoted and does not have very</li> </ul>

Supply Chain Agent	Role	Structure	Influence
			<p>user-friendly sort function for customers since it is focused on providing information to builders</p> <ul style="list-style-type: none"> <li>• Trends, such as Passivhaus, are driving more consumers to seek out very high efficiency products, however they are still generally a luxury item given the costs are so much higher than single-glazed options.</li> <li>• It may not be possible to enter characteristics of the best imported windows into NatHERS tools, so their performance may not be properly recognised in ratings to help the customer justify or rationalise the large extra cost.</li> </ul>
<b>Architect/designer</b>	<ul style="list-style-type: none"> <li>• Glazing can also be chosen / specified by architects or designers but must be installed by a builder</li> </ul>	<ul style="list-style-type: none"> <li>• Fragmented and many. Architects may subcontract to engineering contractor or NatHERS rater. There are a high number of designers (often engineering consultants subcontracted to designers).</li> </ul>	<p><b>MEDIUM</b></p> <ul style="list-style-type: none"> <li>• Double or triple glazing is currently perceived as a premium or niche product, which are often included in architecturally designed houses. Thus, architects and designers have a strong influence in the current market. However this may be less so if advanced glazing becomes more mainstream.</li> <li>• A significant number of designers for high-rise buildings have sophisticated knowledge from large commercial buildings (where they design buildings with glazed facades that must meet National Construction Code, NABERS and Green Star standards) and architectural aesthetic aims.</li> </ul>
<b>Window fabricator</b>	<ul style="list-style-type: none"> <li>• Window fabricators source raw components, including processed glass, and sell the final window product. Approximately 90 per cent of sales are to builders. There are many players in a fragmented market, and most companies are very small, even some “one-man-</li> </ul>	<ul style="list-style-type: none"> <li>• Fragmented with many SMEs – these are often one person or SME contractors.</li> </ul>	<p><b>MEDIUM</b></p> <ul style="list-style-type: none"> <li>• Fabricators do not often sell direct to the consumer but do have a lot of the knowledge and sometimes have public showrooms</li> <li>• Low consumer interest in Australia for residential glazing reduces their incentive for investing and promoting higher efficiency products</li> </ul>

Supply Chain Agent	Role	Structure	Influence
	<p>bands". Two-thirds of the companies sell into the residential market. Large companies include Capral, AWS and Rylock. Most are Australian-based but most import some product as well</p> <ul style="list-style-type: none"> <li>• Some fabricators manufacture complete windows while others will specialise on one element (e.g. complete frames ready for different glass products to be installed by builders or glaziers).</li> <li>• Double and triple glazing is a standard feature of international manufacturer product range – in European and US markets single glazing might not even be available or is more expensive because of lower scale. Passivhaus glazing is generally sourced from overseas fabricators e.g. Germany</li> <li>• Fabricators can sometimes sell direct to consumers for retrofit, however this is a small portion of the market and there are only about four companies that offer this in Victoria e.g. EcoStar, Thermosmart and Thermotek</li> <li>• Some fabricators install complete window units for builders including new build and renovations, as well as replacements for broken or old windows.</li> </ul>		<ul style="list-style-type: none"> <li>• However, this level of interest is slowly trending upwards, with more customers demanding better window products. Note: there appears to be higher demand in the commercial sector</li> <li>• Fabricators that sell direct to consumers for retrofit have more influence, however this is still a very small portion of the market.</li> <li>• Where fabricators are undertaking installation, the same factors mentioned above apply where they could be a blocker if they develop a negative attitude due to, for example, the additional weight.</li> </ul>



Supply Chain Agent	Role	Structure	Influence
<b>Dealer</b>	<ul style="list-style-type: none"> <li>Design and manufacture their own systems and sell directly to builders/consultants (e.g. STEGBAR and A&amp;L)</li> </ul>	<ul style="list-style-type: none"> <li>Few and large</li> </ul>	<p><b>MEDIUM</b></p> <ul style="list-style-type: none"> <li>As above, the dealer processes and fabricates</li> </ul>
<b>Secondary glazing retailer</b>	<ul style="list-style-type: none"> <li>Secondary glazing products can be sourced directly from a retailer e.g. the Magnetite clear optical grade acrylic panel. They can provide good efficiency results, however are not as strong as double glazing and can be variable in different circumstances including installation quality. Customers should seek products that are tested by WERS</li> <li>There are also a diverse range of products with differing levels of efficiency and co-benefits. Some products are effectively a second window installed on the inside of the existing one, often mainly for noise control. These can be opened to allow access to the cavity and for ventilation. These also have thermal qualities (e.g. 'Stop Noise')</li> <li>Also there are products that are more 'integrated' and can be integrated on existing windows such as EcoGlaze (see <a href="https://www.ecoglaze.com.au/">https://www.ecoglaze.com.au/</a>)</li> </ul>	<ul style="list-style-type: none"> <li>Few and diverse</li> </ul>	<p><b>MEDIUM-LOW</b></p> <ul style="list-style-type: none"> <li>Secondary products still have a small market share and have lower efficiency benefits than double and triple glazing</li> <li>However, these products are much easier to install and can be significantly cheaper, which may lead to high uptake if they become more popular e.g. in the inner city and for lower-income households</li> <li>The co-benefits of these products (e.g. noise, reduced condensation) may also drive uptake.</li> </ul>
<b>Glass processor</b>	<ul style="list-style-type: none"> <li>These companies buy from raw glass manufacturers and process it into value-added products. For example, 'hard coat' is a tough</li> </ul>	<p>~ 5 companies.</p>	<p><b>MEDIUM</b></p> <ul style="list-style-type: none"> <li>The glass processor is the business that upgrades the glass to be more energy efficient, testing it and</li> </ul>

Supply Chain Agent	Role	Structure	Influence
	<p>coating (e.g. low emissivity, tint, spectrally selective) that improves performance of single glazing but is tough enough to cope with regular cleaning etc.</p> <ul style="list-style-type: none"> <li>• These companies test and rate the efficiency (U value, which is the inverse of the R value), structure, elements, acoustics to standards and requirements. They then sell direct to window fabricators who incorporate the upgraded glass product with other components - an example company is Australian Glass Group</li> </ul>		<p>rating it after it has been processed. Thus, these businesses have influence over offering a range of energy efficient products and other co-benefits including thermal improvements and noise reduction. Commercial interests have sometimes led glass processors to promote single glazing to builders and glaziers.</p> <ul style="list-style-type: none"> <li>• There are some indications that many glass processors and window fabricators invested in double glazing capacity when 5-6 star regulations were introduced, but that it is under-utilised because builders and designers have found cheaper ways to comply with 6 star. Capacity to increase production at relatively low marginal cost may exist.</li> </ul>
<p><b>Components manufacturer</b></p>	<ul style="list-style-type: none"> <li>• Basic components of windows are generally manufactured overseas. Window components include glass, frames, sealants, coating and gas fillers (mainly Argon)</li> <li>• Oceania Glass (a sister company of Viridian Glass) is the only Australasian manufacturer of flat architectural glass. The Viridian Glass Group is the only vertically integrated from glass manufacturing and processing, to window fabrication</li> </ul>	<ul style="list-style-type: none"> <li>• Many components, with half a dozen reputable global glass manufacturers.</li> </ul>	<p><b>LOW</b></p> <ul style="list-style-type: none"> <li>• These companies are often overseas and are manufacturing raw products i.e. are not involved in upgrading products to higher efficiency standards.</li> </ul>

## 5.3 Pressures for Change

Table 15 provides some of the major drivers for change in the advanced glazing supply chain.

Table 15: Pressures for Change in the Advanced Glazing Supply Chain

Drivers	Blockers
<p><b>Cheaper secondary glazing products are emerging</b></p> <ul style="list-style-type: none"> <li>• These cheaper products can be purchased and installed without a builder (however their performance and durability is not as good as double and triple glazing)</li> <li>• These products can also offer co-benefits including improved thermal and acoustic properties</li> </ul>	<p><b>The cost for installation of standard double or triple glazing products is high (~\$1000/m<sup>2</sup>)</b></p> <ul style="list-style-type: none"> <li>• Materials costs account for ~20-25 per cent of the overall price, which means there is likely to be very high mark-ups along the supply chain in the Australian market</li> <li>• This is much higher than overseas markets e.g. Europe. Builders are able to do this because of low volume and supply in the Australian market</li> </ul>
<p><b>New standards being introduced</b></p> <ul style="list-style-type: none"> <li>• Window Energy Rating Scheme (WERS) is accredited by the Australian Fenestration Rating Council and provides a third party certification to give consumers confidence in the performance of primary and secondary glazing products. However, it is yet to drive widespread uptake</li> <li>• A review of the National Construction Code is underway to increase the minimum standard for new builds. Any increase in: <ul style="list-style-type: none"> <li>○ the requirement will increase likelihood of double glazing being installed in new builds, particularly in colder climates</li> <li>○ rating requirements (as is being explored by the ABCB for NCC2022) would most likely markedly increase demand for double glazing in new builds (assuming window sizes remain the same), which could ultimately drive down the price for double glazing</li> </ul> </li> <li>• Recent changes to NCC may focus more attention on coated glazing and maybe double glazing.</li> </ul>	<p><b>Builders are driven by compliance - which does not require high performance glazing</b></p> <ul style="list-style-type: none"> <li>• Builders that are using NatHERS ratings can often find cheaper ways than double glazed windows to achieve higher ratings e.g. insulation. There are no minimum standards or mandates requiring window efficiency performance in the residential sector</li> <li>• With Green Star ratings for large residential blocks, there may be some issues with substitution of lower performance product, or installation of unsuitable product for a given orientation – lack of labelling/permanent identification on glazing units may be part of the problem</li> <li>• NatHERS tools allow selection of a wide range of windows – but don't allow characteristics of many of the best European windows to be entered</li> <li>• Separate summer and winter rating requirements in the NCC may help. But lack of focus on demand reduction benefits, and the reality that NatHERS regulation includes an assumption that someone is home to pull down light-coloured internal blinds when solar radiation on a window exceeds 200 watts/m<sup>2</sup> means the value of advanced glazing is under-emphasised.</li> </ul>
<p><b>Retrofit products that disintermediate the builder</b></p> <ul style="list-style-type: none"> <li>• Where a window frame does not need to be replaced, consumers can purchase a retrofit product directly without a builder</li> </ul>	<p><b>Consumers have limited choice</b></p> <ul style="list-style-type: none"> <li>• It is not generally possible for homeowners to purchase products directly from fabricators and some builders will only contract with a small number of fabricators because it is a fragmented market</li> </ul>

- However, this is a very small portion of the market and only 4-5 companies provide this service and bespoke design and installation adds to cost

**Consumer demand for efficient products is increasing**

- More efficient window products – for example, the voluntary Passivhaus standard – is generating interest / demand from consumers. However, this does not have a very strong influence because builders can often meet building envelope efficiency levels using other cheaper levers e.g. insulation
- In the case that a consumer does demand double or triple glazing, builders may only offer a handful of products to choose from that often have very high mark-ups (see first two blockers)

**Education is not targeted to influencers**

- There is variable knowledge of energy efficient products with builders and architects of energy efficient products. Homeowners also have limited knowledge of advanced glazing products and their co-benefits

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## 6. Policy and Program Implications

### 6.1 Cross-case analysis: Key findings from the supply chain analysis

#### What role do incentives play in the business case for each energy efficient product?

The role depends on how well the design of the incentives matches the perceptions and priorities of all of the decision makers in a supply chain. If it is well-matched, it will eventually lead to a customer/end-user pursuing an action which is supported by the VEU program. However, the supply chains, business models and policies are not in place to deliver the energy efficient improvements that the VEU scheme aims to achieve. The policy and regulation needs to be designed and implemented in a way that it enables newer technologies, proposition, and business models to be developed, financed, and deployed at scale. The NSW government has been applying end-user analysis to ESS, and has gained useful insights into the issues with the existing scheme's design and operation. This is likely to be relevant to all energy retailer obligation schemes. Perceptions shape priorities, and priorities determine which actions supply chain actors actually get around to doing. The barriers to the adoption of energy efficiency measures are well documented (e.g. upfront cost, lack to time, required commitment, etc.). However, the likelihood of action can increase where there are changes in the external environment (for example, the rise in sales of solar PV systems in response to increased anxiety over bush fires and climate change, or higher, more volatile gas prices). Government promotion also has an 'endorsement' effect especially if this is supported with some form of financial subsidy or incentive and effective promotion/awareness campaigns. Experience from the water efficiency rebate scheme in Victoria was that even though the rebates weren't always claimed, the government providing support was a signal to people that making efficiency improvements was a virtuous thing to do amid the circumstances they were experiencing firsthand. Cost was not a primary consideration for water tanks.

#### What split incentives exist?

Split incentives can be defined as those transactions where the flow of benefits and cost are not accrued to the person who pays, thus impairing the investment decision. It is one kind of barrier, strongly linked to the way each actor in the supply chain assesses what are the available benefits to them.

Relevant for all the supply chains, one of the most commonly cited split incentives exists with a landlord/tenant situation. This is where the property manager or landlord (who are responsible for the equipment but is not responsible for the energy bills) respond to a product replacement need by deferring to the easiest or lowest cost solution, but not necessarily the most energy efficient or lowest operating cost solution. Another type of split incentive exists where key supply chain actors (like mechanical contractors or the builders) are more focussed on upfront cost and ease, rather than the efficiency of the solution and the operating costs over the lifetime of the product.

#### For key parts of the supply chain, how are these organisations, sectors or equipment changing (growing, shrinking, diversifying, consolidating)?

While all the supply chains are fairly well established, virtually all of the sectors are continually undergoing some form of change all the time. A common trait is that each step in the supply chain typically has a few very large players who may be national or international, then there are many small to medium players that comprise the rest of what make up very fragmented markets. This fragmented nature is particularly the case with the parts of the supply chain present at the point of sale (installers, trades-people, trades, builders, etc.).



### **Growing:**

- Heating and Cooling (residential): The market is current a saturated one and there was not much evidence of growth at any stage along the supply chain. One major manufacturer from Europe had recently entered the Australian market establishing a “sister company”. However, it had found working with the supply chains to ensure quality of install, as well as the right product was selected, was something that was challenging and had to be actively managed.
- HVAC and Water Heaters and Boilers (C&I): A small number of heat pump players are actively trying to enter the commercial and industrial segment.

### **Shrinking:**

- Heating and Cooling (residential): Utility involvement has been shrinking as the market for split systems has become saturated and hyper-competitive with decreasing margins. However, this could grow in the future with new business models and propositions based around service offerings and involving connected home technologies.

### **Diversifying:**

- Heating and Cooling (residential): Manufacturers looking to become vertically integrated in the split system market as some look to gain greater control of the supply chain. An example is Daikin’s 2017 acquisition of Airmaster so it can provide servicing as well as new product.
- HVAC and Water Heaters and Boilers (C&I): There is specialisation of certain value chain actors being undertaken. For the consultancies, while there are 10-15 major firms, smaller boutique businesses are emerging with specialisations such as in building energy analytics. Facility Management companies are also specialising in the energy and analytics space.

### **Consolidation:**

- Heating and Cooling (residential): As the new build housing market has slowed (a primary driver of the residential market for heating and cooling products), it is possible that it will see consolidation along the entire supply chain as larger players look to absorb smaller ones. With a weakened Australian dollar, this could see more acquisitions from overseas.

- Advanced Glazing (residential): There has been some recent Mergers and Acquisitions (M&A) activity as Australia’s Viridian Glass (which is also vertically integrated) was purchased by a private equity firm in 2019.

### **What business models would work facilitate greater participation throughout the supply chain in EEO schemes (e.g. aggregation, incentives, education or promotion of incentives higher up the chain etc.)?**

New business models can potentially help but deeper understanding of the motivators, drivers, and values of the different supply chain actors is essential to knowing how they will respond to different models. If more efficient products are to be deployed, a combination of measures will be required to replace this in a way that provides consumers and businesses with more efficient products with the same (or a better) experience. Gaining such an understanding would require more structured market research that could involve the establishment of installer panels, focus groups, and ongoing surveys. Ideally this would be at a both Federal and state level. Following analysis and synthesis of the results from such market testing, controlled pilot schemes could allow new approaches to be tested to examine their effectiveness. It is likely that some participants will be interested in change, while others will try to block, so finding the right partners is important.

### **When are different parts of the supply chain likely to be called upon (e.g. when does investment in energy efficiency in products happen, such as end of financial year, new business ownership, renovation)?**

For heating and cooling, the investment is typically included in a new home or part of a renovation (involving the builder/contractor) or as part of a distressed purchase (involving any other parts of the supply chain which have an end-user interface).

For HVAC, and water heaters and boilers, the investment may also be part of a renovation or a new premises fit out (whole building or tenancy), involving the mechanical contractor as the main conduit between the owners/builders/consultants and supply chain. It can also be part of a distressed purchase, which would then involve a facility management company, who again may defer to a mechanical contractor.

For advanced glazing, the builder or architect will typically be called upon with a renovation or premium/custom new home. Where the customer/end user buys direct, they will go to a secondary retailer. There is an emerging retrofit market where the customer or home-owner goes directly to the manufacturer or the retailer.

## 6.2 Implications for the Victorian Energy Upgrade program and other Energy Efficiency Obligation schemes

All energy efficiency programs should consider the supply chain before implementation, both for where to focus finite resources and incentives and to understand where the blockers to change may be. There are many potential participants in the 'chains' that underpin decision-making, installation, commissioning, maintenance, operation and eventual disposal of equipment, and construction, sale, operation, renovation and demolition of buildings.

Existing practitioners and suppliers may resist change for many reasons such as perceived risk, need to redesign business model, high workloads, businesses based on high volume/low margins/fast installation, lack of marketing/communication skills (and time for discussion/education). Supply chains for 'new' offerings incur high costs due to low volume, need for advertising, compliance tests, lack of access to supply chains controlled/influenced by incumbents.

Many players are SMEs with limited time, capacity and incentive to change, while customers are generally poorly informed or constrained by circumstances. Outdated information and crude financial analysis also undermine change. In the case of energy efficiency obligation schemes, the impact in supply chains outside lighting has been limited so clearly some changes in approach are needed to expand the reach of these schemes.








A supply chain approach cannot be distilled into a one-off report at a point of time such as this. It is a cultural approach that policy makers need to apply to each initiative, supported by resourcing, market research - and cooperation with the players in the supply chain who genuinely want to take action and are capable of long term commitment and believe that growing the industry (not just their business) is important.

## Criteria

Given the large number of participants, there is a need to target key participants and influencers, so this requires development of criteria to guide action. These are outlined in Table 16.

Table 16: Criteria for Guiding Supply Chain Action

Factor	Criteria
<b>Scale</b> 	<p><b>What is the potential scale of VEU program use within each category?</b></p> <p>The starting point should be the estimated level of savings and VEECs creation within each sector, product or supply chain (maximum, feasible and likely levels of savings). The larger the saving, the greater the justification for DELWP staff to invest effort.</p>
<b>Efficiency</b> 	<p><b>At which point in the supply chain is the agent able to exert influence most cost-effectively?</b></p> <p>Incentives and other program resources should be directed at the agent(s) in the supply chain that are able to influence the most participants for a given level of incentive or funding. As this study demonstrates, the agent(s) that can exert the most influence varies between supply chains. One agent may influence other agents in the same area, or upstream or downstream, depending on their status and networks.</p> <p>Another consideration is the potential for standardisation or scaling-up. Is there scope for incorporation of VEU program information in 'standard' business decision-making systems (e.g. standard specifications, procurement guidelines etc.) that can enable aggregation and scaling as has occurred for the major success story to date (lighting)? Where a credible agent publishes standard specifications or guidelines, these may be adopted by others. Government could track down key organisations and help them to improve their procurement specs and then promote them – universities, large retail businesses and office based business (banks etc.) tend to have guidelines. Australian Standards and NatSpec (for buildings) as well as sustainable supply chain school, Ecocheck, are examples of prospective partners.</p> <p>One of the learnings from NSW Energy Savings Scheme work on supply chains is that focussed interventions on particular key agents are likely to deliver better returns because State Governments do not have the scale of resources to move the entire residential energy efficiency supply chain for example.</p>
<b>Influence</b> 	<p><b>Who are the change agents?</b></p> <p>The potential scope of influence is one factor to consider – but arguably it can be more important to identify motivated agents who are able and willing to drive an increase in the uptake of energy efficiency products. Specialists who are 'thought leaders' in their sectors can be effective – they are the ones who are asked to speak at specialist conferences, write articles in industry magazines, win awards etc. Organisations like ARENA identify some of these people to sit on advisory panels etc. Through them - and through journalists for industry magazines - you can find the innovative companies.</p> <ul style="list-style-type: none"> <li>Which actors in the supply chain are most likely to be able or be motivated to capture the revenue that flows from involvement in the VEU program? This in turn is related to how significant that revenue might be for them, or how they value other benefits from involvement. Since VEU doesn't seem to have</li> </ul>

Factor	Criteria
	<p>a very high profile in most sectors, potential partners may be identified via business networks and associations. There would need to be some process to work out with them how and why VEU might help within their spheres, support them to develop narratives, allocate time for talks etc.</p> <ul style="list-style-type: none"> <li>• Which actor's business model is aligned to the objectives of the VEU program? Specialist, new-entrant or 'disruptive' businesses and aggregators that have a focus on energy efficiency products or services should have a particular focus for programs that are aiming for market transformation (not just deployment). Start-ups can be interesting partners.</li> <li>• Which agents have climate change, sustainability targets – or buyers in a supply chain with sustainability goals - or other drivers that support energy management in addition to price and security interests?</li> <li>• Is government endorsement of the product or service as a 'good thing to do' likely to be a motivator? Are there other non-financial benefits that could be signalled or accessed (e.g. avoiding food loss and food quality are more important in the refrigerated cold chain)?</li> </ul>
<p><b>Effectiveness</b></p> 	<p><b>How important is the level of incentive for the supply chain agent?</b></p> <p>Is it essential to enable the action to meet their internal investment hurdles? Can they use the VEU program to quantify and prepare a more powerful internal business case, potentially factoring in benefits not previously built-into analysis?</p> <p>What is the scale of incentive relative to the product cost? Unless it is a significant benefit it will not be sufficient to motivate action.</p> <p>Where does the incentive accrue? Does the agent need to share it with others in the supply chain and/or the end consumer? Or can the agent capture a share of a VEU created by someone else?</p>
<p><b>Complementarity</b></p> 	<p><b>Can the VEU program complement or amplify other programs?</b></p> <p>The VEU program can be more effective where it can be 'packaged' with other programs or incentives. One of the key considerations is that VEU program revenue is often considered uncertain so if it can be combined (without double-counting) with other initiatives that provide recognition, funding (e.g. a grant program) or another benefit it can be much more effective.</p>

## Policy Instruments and Supply Chain Agents

Some policy instruments are in general better suited to different supply chain agents.

Not all supply chains are the same but the current and potential impacts of different instruments on supply chain agents are rated based on interviews for this project and observations across other projects.

Table 17 outlines supply chain agents and degree to which a variety of policy instruments influence the supply chain using the following key of low, medium and high.

Brackets are used to indicate where there is considered to be potential to change the typical situation. For example, a low (medium) rating would suggest policy instruments have typically not exerted influence but changing market dynamics or technology changes means there may be an opportunity to influence the agent.

Table 17: Policy Instruments and Supply Chain Agents

Supply chain Agent	VEU	Regulatory Standard	Rating Schemes	Grants	Information, training, awards
<b>Manufacturers</b>	<p><b>LOW (MEDIUM)</b></p> <ul style="list-style-type: none"> <li>Low certainty on demand impacts – until it becomes clear a technology can generate certificates at scale such as lighting and that their supply chains are likely to promote them and end consumers place value of their features.</li> <li>However, if VEECs were applied to sales by manufacturer the incentive could potentially be more effective.</li> <li>For example, the price of a household refrigerator at the factory may be say \$300, while its retail price may be \$900. For the manufacturer, \$50 could fund a more efficient compressor, higher performance insulation or smarter electronics. For a retail buyer of an air-conditioner, the VEU</li> </ul>	<p><b>HIGH</b></p> <ul style="list-style-type: none"> <li>Compliance driven and often key focus of regulatory standards (e.g. MEPS). Reputation is important, so exposure for non-compliance is a significant issue</li> <li>Most Australian MEPS are weak – and if strengthened, they may reduce impact of VEU while achieving a better outcome. It was observed that higher MEPS reduces the scope to claim certificates for HVAC relative to lighting for</li> </ul>	<p><b>MEDIUM</b></p> <ul style="list-style-type: none"> <li>Rating schemes have created a stable demand that have pulled energy efficiency products through Australian supply chains.</li> <li>Credibility and industry respect are key to rating scheme effectiveness</li> <li>Effective promotion of rating schemes is fundamental, but government budgets are tiny compared with</li> </ul>	<p><b>LOW</b></p> <ul style="list-style-type: none"> <li>Grants can be an effective mechanism for manufacturers but generally Australia has a limited local sector and demand is needed to pull through more efficient products developed and manufactured overseas.</li> <li>Australian representatives of firms may potentially be influenced if they can capture value</li> </ul>	<p><b>MEDIUM</b></p> <ul style="list-style-type: none"> <li>In the past, there were annual award events for appliance labelling leaders – these were powerful as they promoted in-house competition and inter-firm competition, as well as senior management attention.</li> <li>Some manufacturers run training programs which could be supported by Government or the content could be incorporated into</li> </ul>

### Key:

- Low** = policy instrument will typically exert little to no influence on the supply chain agent selection or use of energy efficiency products
- Medium** = policy instrument can exert influence on the supply chain agent selection depending on circumstances and the design of the intervention
- High** = policy instrument are able to exert significant influence on the supply chain agent selection or use of energy efficiency products based on past experience



Supply chain Agent	VEU	Regulatory Standard	Rating Schemes	Grants	Information, training, awards
	incentive is low and may be outweighed by other discounts.	example, as the MEPS sets the baseline from which VEU savings are calculated.	what is needed to compete for attention in the markets.	from VEU (e.g. by selecting efficient product options from their manufacturer's range).	education/training courses.
<b>Builders</b>	<p><b>LOW (MEDIUM)</b></p> <ul style="list-style-type: none"> <li>In general, the impact of financial incentives available from the VEU program are low.</li> <li>There could be scope for targeting major developers as large-scale buyers. There may be a way for a builder to act as an aggregator, and allocate VEUs to their product and service providers, while taking a percentage, and gaining access to some kind of promotional certification for the buildings they offer to consumers. The Property Council and major property owners could be an avenue for targeting bulk purchases.</li> </ul>	<p><b>HIGH</b></p> <ul style="list-style-type: none"> <li>Builders are compliance driven so regulatory standards have a big impact. Audits and enforcement is needed to make current regulations more effective across all jurisdictions (noting an audit program is currently being undertaken on new builds by the Victorian Building Authority).</li> <li>Home builders usually have a budget item for 'features' that give them a 'point of difference' in the marketplace. So they are not always compliance driven, as they want to include features their sales people can highlight. But if the feature is difficult to explain or not highly valued by consumers, it will not be very attractive. Work behind</li> </ul>	<p><b>MEDIUM</b></p> <ul style="list-style-type: none"> <li>Ratings schemes have created performance standards and expectations that filter from owners to builders. There is often significant discretion for builders to meet these standards.</li> <li>There could be scope to consider how to more effectively combine VEU with a rating schemes where they are targeted at builders (e.g. WERS).</li> </ul>	<p><b>LOW</b></p> <ul style="list-style-type: none"> <li>Outside major builders, the fragmented nature of the sector means grants are unlikely to be a cost-effective mechanism.</li> </ul>	<p><b>MEDIUM</b></p> <ul style="list-style-type: none"> <li>Recognition for builders can be an important complement to a financial incentive – as awards and recognition can build profile and the quality of their brand and therefore help them win future work. It may well be more powerful than the financial incentive of the VEU program. But the award and the scheme behind it must be effectively promoted, so that consumers recognise that it means the winner really is a leader.</li> </ul>

Supply chain Agent	VEU	Regulatory Standard	Rating Schemes	Grants	Information, training, awards
		the '17 things' website and Liveability.com.au real estate agent training may help.			
<b>Mechanical contractors</b>	<p><b>LOW</b></p> <ul style="list-style-type: none"> <li>They would need a streamlined system if they were to be targeted, probably managed by their regular trade supplier who would require a commission for their work. These people generally hate paperwork or any additional 'hassle'.</li> <li>Maybe if VEU funded Measurement and Verification and data analytics that allowed performance requirements to be set and verified, combined with streamlined payments.</li> <li>Up-front payment is much more attractive than regular payments over time. A mix of up-front and ongoing performance payments may work.</li> </ul>	<p><b>HIGH</b></p> <ul style="list-style-type: none"> <li>But only if effectively enforced or very easily verified.</li> <li>Mobile phone apps are being used by some PV installation firms to ensure quality control by requiring GPS tracking, sign-off regarding the tasks, and time and date-stamped photos of completed work and bar codes of items installed.</li> <li>Data analytics are evolving so that it is becoming possible to benchmark actual performance against predicted performance as a form of quality assurance/ accountability.</li> </ul>	<p><b>MEDIUM</b></p> <ul style="list-style-type: none"> <li>More likely to influence them if consumers are very aware of the scheme and there is 'consumer pull'. Or if rating is written into specifications AND checked by site staff, or other methods.</li> </ul>	<p><b>LOW</b></p> <ul style="list-style-type: none"> <li>One simple but effective model was applied to electricians by the State Electricity Commission of Victoria in the early 1990s. Electricians were given 'paid a cash bonus (\$2) for each efficient light fitting they bought from wholesalers.</li> </ul>	<p><b>MEDIUM</b></p> <ul style="list-style-type: none"> <li>As a key agent, education and training focussed on ensuring contractors are up to date on technology developments are important. It was also suggested they are better informed on the costs of technologies rather than the savings and benefits, which limits their capacity and belief in more efficient technologies.</li> <li>It is often difficult to get tradespeople to 'make time' to learn about new things unless it will be mandated, they see an easy business benefit, or there is another attraction (e.g. a BBQ!). The Plumbing Industry Climate Action Centre (PICAC) has a mobile training unit, which may be a useful</li> </ul>

Supply chain Agent	VEU	Regulatory Standard	Rating Schemes	Grants	Information, training, awards
					model. Some appliance manufacturers have mobile training/ information units for trades and sales staff in regional areas.
<b>Facility management</b>	<p><b>LOW (MEDIUM)</b></p> <ul style="list-style-type: none"> <li>Generally not a factor – <u>but</u> could be a lever for change with new entrants in the HVAC services sector (see policy section below).</li> <li>Facility managers could be encouraged to use evidence of creation of VEECs as an indicator of performance of equipment for their procurement processes.</li> </ul>	<p><b>HIGH</b></p> <ul style="list-style-type: none"> <li>Primarily compliance driven operators – but convenient monitoring and clear specifications for performance would make it easier for them to hold contractors to account.</li> </ul>	<p><b>MEDIUM</b></p> <ul style="list-style-type: none"> <li>Contracts with ratings commitments in major buildings – but often incentives don't flow through to others. Scope for improvement.</li> </ul>	<p><b>MEDIUM</b></p> <ul style="list-style-type: none"> <li>New entrants use grants to demonstrate new technologies and approaches. High costs and risks in early stages of market entry may justify grants.</li> </ul>	<p><b>MEDIUM</b></p> <ul style="list-style-type: none"> <li>Low levels of knowledge in many sections. Finding mechanisms to improve knowledge and recognise and certify progressive facility managers could have a good payback.</li> <li>Facility managers are often not very popular, as their focus is on dealing with complaints and they often don't respond as quickly as staff would like. Data analytics and portable monitoring systems can help them to reduce frequency of problems and diagnose problems faster – this seemed to be valued by facility managers in the Energy Efficient Office</li> </ul>

Supply chain Agent	VEU	Regulatory Standard	Rating Schemes	Grants	Information, training, awards
					Building program run by Sustainability Victoria (Pape 2016).
<b>Consultants</b>	<p><b>HIGH</b></p> <ul style="list-style-type: none"> <li>The major users and generators of certificates. They will often use the VEU program if incentives and transaction costs make it viable.</li> </ul>	<p><b>MEDIUM</b></p> <ul style="list-style-type: none"> <li>Many are compliance driven – but need mechanisms for quality assurance of implementation.</li> </ul>	<p><b>HIGH</b></p> <ul style="list-style-type: none"> <li>If well designed and adequately resourced and promoted.</li> </ul>	<p><b>LOW</b></p> <ul style="list-style-type: none"> <li>It can reduce the cost of more time consuming activities so consultant can offer clients higher value services, or spend more time seeking information doing analysis, explaining to client and contractors, etc. when adopting new approaches, but in general not a major lever.</li> </ul>	<p><b>MEDIUM</b></p> <ul style="list-style-type: none"> <li>Professional credits can be an incentive, as can helping them to make a business case to clients – apps, standard formats, model guidelines, rating schemes etc. may make their task easier.</li> </ul>
<b>Owners/end-users</b>	<p><b>MEDIUM</b></p> <ul style="list-style-type: none"> <li>Variable, depending on level of control and scale of reduction in their costs of implementation and relative to perception of future saving and work involved in applying.</li> <li>If contractor makes it easy (e.g. as solar rebates have been) interest may increase.</li> </ul>	<p><b>LOW</b></p> <ul style="list-style-type: none"> <li>Regulatory standards target other actors in the supply chain. They can be used to demonstrate quality of work or products to consumers.</li> <li>Low standards can undermine consumer interest e.g. mandated 6 star sounds high but is actually modest by global standards, but home sales people can</li> </ul>	<p><b>HIGH</b></p> <ul style="list-style-type: none"> <li>See regulatory comment.</li> <li>Must be well designed, credible, very visible and well promoted. Scope for extending rating schemes to other sectors and building types.</li> </ul>	<p><b>HIGH</b></p> <ul style="list-style-type: none"> <li>Use of complementary grants to target high-value opportunities (e.g. chillers) could be a way to demonstrate the scope for VEU involvement. Grants provide better revenue</li> </ul>	<p><b>MEDIUM</b></p> <ul style="list-style-type: none"> <li>Opportunities to use education programs in particular to improve demand for higher quality maintenance. For example, model clauses of contracts with good performance provisions and case studies of the benefits of proactive operation and maintenance.</li> </ul>

Supply chain Agent	VEU	Regulatory Standard	Rating Schemes	Grants	Information, training, awards
		use it to convince buyer their house is energy efficiency whilst focussing on other sales features.		<p>certainty and risk-sharing.</p> <ul style="list-style-type: none"> <li>Chiller replacement was identified by several respondents as the biggest-ticket item that had previously been targeted through grants and could be done again in concert with the VEU program.</li> </ul>	<ul style="list-style-type: none"> <li>Effective communication over a sustained period is critically important, as decision-makers generally only pay attention when they are 'in the market' to buy something. For example, only a small proportion of households buy a major appliance in any given year.</li> </ul>
<b>Tenants</b>	<p><b>LOW</b></p> <ul style="list-style-type: none"> <li>Tenants are in general highly unlikely to make use of incentives given the administration.</li> </ul>	<p><b>LOW</b></p> <ul style="list-style-type: none"> <li>If applied to building owner, landlord, Owners Corporation or CO Manager may be effective – if monitored and enforced.</li> <li>Mandated standards are widely used for rental properties in other countries. Victoria has released a consultation paper on minimum heating standards for rental homes.</li> </ul>	<p><b>HIGH</b></p> <ul style="list-style-type: none"> <li>If they have choice, and understand significance of rating for their circumstances and experience.</li> <li>Scheme must be well designed, credible etc.</li> <li>If high comfort low energy bills rental properties could be rated and promoted some landlords or rental agents may be interested.</li> </ul>	<p><b>MEDIUM</b></p> <ul style="list-style-type: none"> <li>For vulnerable households it may get them into a better home.</li> <li>For landlords that are capital-short it may support a building or equipment upgrade.</li> </ul>	<p><b>LOW</b></p> <ul style="list-style-type: none"> <li>In general low – but can be an effective mechanism for engaging with apartment buildings and strata committees.</li> <li>Case studies and personal stories could focus attention on important features.</li> </ul>



## Implications and Recommendations for the VEU program

While we are emphasising that supply chain considerations should be a part of the on-going operation of energy efficiency programs and initiatives, we have identified (in Table 18) a number of specific implications or recommendations for the VEU program for each of the four supply chains.

Table 18: Implications and Recommendations for the VEU Program

Supply Chain	VEU Implications and Recommendations
<b>Residential Space Heating and Cooling</b>	<p>There are two major routes to market in the residential space heating and cooling supply chain: retailers and installers. NSW Department of Planning, Industry and Environment (DPIE, formerly NSW Office of Environment and Heritage) undertook detailed consultation for the ESS and estimates around 20 per cent of the market goes through major retailers and around 70 per cent of the market goes through installers directly via various routes.</p> <p><b>Manufacturer accreditation</b></p> <p>In the course of this project, we were told only one of the major manufacturers has an accreditation system for installers and that installer quality is a major impact on the size and efficiency of residential air-conditioning. Investigating options to extend the coverage and quality of accreditation systems is potentially one point of influence on installers should be considered.</p> <p><b>Retailer incentive</b></p> <p>While retailers are therefore one potential option for targeting the incentive, NSW DPIE investigations found the quality of installations was much lower for air-conditioning systems purchased through retailers (based on multiple sources including manufacturers). If an incentive were to be applied at retailers, complementary measures would be required to improve installation quality. Adding an incentive would increase the margin for retailers and help create more educated and motivated salespersons - but the incentive for a single 5-star air-conditioning system relative to the market standard of a 3 or 3.5-star system is low and is not considered by stakeholders interviewed sufficient to be a major influence on consumer purchasing decisions.</p> <p><b>Installer incentive</b></p> <p>The installers are the major route to market but the key issue here is the high fragmentation and finding agents that can exert influence. A NSW DPIE initiative is worth considering. As the air-conditioning category was not performing well, the NSW DPIE established an administrator to issue certificates, recruit installers, train them on systems using an app, collect data and provide the installer with an incentive which the administrator recouped. It was accompanied with a major promotional push. The scheme was functioning well but has been discontinued for the present due to an unrelated problem. It was intended as a short-term push ahead of a rule change to the Energy Savings Scheme. Residential space heating and cooling has a major impact on energy use but it is challenging finding a focal point to influence installers through which most of the market flows. Our study did not have the resources to examine different arrangements across jurisdictions but the NSW initiative – or an equivalent mechanism – is worth consideration.</p> <p><b>Bulk buyers</b></p>

Supply Chain	VEU Implications and Recommendations
	<p>The VEU program could try to engage with bulk buyers such as developers and builders for commercial developments where scale could make the incentive more attractive. It would need to be combined with some form of recognition to amplify the benefit beyond savings. They may be able to become aggregators on behalf of suppliers. The Property Council of Australia and major property owners would be a starting point for consultation.</p> <p><b>Financial institutions</b></p> <p>While not formally part of the product supply chain, collaboration with financial institutions could be a game-changer for a range of energy efficiency products in the residential sector. The announcement by Bank of Australia in March 2020 that they will provide a 0.4 per cent discount on mortgages for homes that have a 7-star energy efficiency rating is the type of product that could be a game-changer. It is a tangible incentive that can increase the value of the most valuable asset that most households own. Financial institutions appear to be a high-value partner as they can manage the transaction costs of a scheme like the VEU program, aggregate many end-users and exert a high degree of influence.</p>
Commercial HVAC	<p><b>Co-funding with a grant scheme to drive market transformation for upgrades that can achieve a step-change improvement such as chiller replacements.</b></p> <p>The use of grants to target high-value opportunities could be a way to demonstrate the scope for VEEC creation. Grants provide better revenue certainty and risk-sharing, and need not be linked to a specific amount of avoided carbon emissions at a specific price/tonne. Chiller replacement was identified by several respondents as the biggest-ticket item for a step-change in efficiency that had previously been targeted through grants and could be done so again in concert with the VEU program.</p> <p><b>Reduce transaction costs for HVAC.</b></p> <p>Most of the project methods require costly metering, baselines and monitoring and verification that is too expensive relative to the potential returns from the VEU program, even for larger buildings. Old chillers might not have the right monitoring equipment and adding data loggers can add costs. One major property owner compared VEU unfavorably to the ESS for ease and costs of claiming certificates.<sup>5</sup> Transaction costs need to be dramatically reduced to build a mass uptake. There were a range of suggestions for addressing this issue in interviews:</p> <ul style="list-style-type: none"> <li>• Train NABERS accredited assessors to be able to do rating assessments at same time such that is an incremental additional cost for assessment. This could also be a vehicle for harmonisation between the VEU and ESS programs if ratings are undertaken at same time.</li> <li>• Use of new building control and data systems to reduce the costs of monitoring and verification to demonstrate savings. Air-conditioning is seasonal and there are many variables so it can be hard and expensive to prove savings – real time data analytics can be helpful. Simplification is essential if the VEU program is to be effective in supporting HVAC upgrades.</li> </ul> <p><b>Engage with consultants and property funds on use and design of VEU activities</b></p> <p>One major property owner said they had found some consultants do not understand or know about VEECs (and had to engage someone else to specifically handle VEEC's on some projects) and that in general it was hard to keep up with changes and program specifics. We were only able to speak to a handful of building owners and consultants but each of them had specific comments on the VEU program. Our study did not therefore</p>

<sup>5</sup> As a specific example, the property owner said they knew they could retrospectively claim ESC's under the ESS for a chiller upgrade but did not know if this was possible under the VEU program.

Supply Chain	VEU Implications and Recommendations
	<p>have the time or resources to test if this view was widespread (and we are mindful there is a scheme review occurring) but we report this feedback because these are the key agents that handle VEECs. Consultants may have been engaged and provided comment for the VEU review but there is likely to be value in specifically engaging with them on an on-going basis to build their knowledge, capability and incorporate input into scheme design, trials and implementation.</p> <p><b>Support new HVAC services business and entrants improving the efficiency of operating HVAC systems.</b></p> <p>DELWP should consult with the emerging group of building analytics and HVAC services firms to understand how the VEU program (and other mechanisms) could be used to support the growth of businesses and projects lifting the operational efficiency of HVAC systems. Certificate creation could be linked to verified improvements in NABERS certificates.</p> <p><b>Owner education on maintenance standards.</b></p> <p>Opportunities to use education programs in particular to improve demand for higher quality maintenance. For example, model clauses of contracts with good performance provisions and case studies of the benefits of proactive operation and maintenance.</p>
<p><b>Commercial Water Heaters and Boilers</b></p>	<p>The biggest issue to emerge from the qualitative research undertaken for this project was the emergence of heat pumps. This is especially in the commercial sector where major building owners have begun working on how to achieve zero emissions and zero gas targets but there are also drivers within industrial sectors. Australian supply chains are organised around gas technologies and switching represents a major systemic change so there are many 'blockers' to its growth. Gas boilers will remain an important technology, especially for many industrial sectors, for quite some time – but the question of priority between facilitating more efficient gas boilers or heat pumps will become an increasingly significant question to resolve for energy efficiency programs.</p> <p>When organisations with zero net emission commitments implement renewable energy power purchase agreements or similar arrangements to eliminate emissions from their electricity use, their focus shifts to cutting gas use with technologies such as heat pumps. Targeting such organisations may accelerate change.</p> <p>In the industrial sector, heat pumps are at a demonstration stage so there is a limited role for the VEU program. ARENA and other stakeholders are currently working on demonstration projects which are needed to build confidence and the evidence base on the operation of the technology, its applications and costs. As large users are generally outside the VEU program – and unlikely to opt-in given the emergence of other revenue streams such as wholesale demand response - the focus of the VEU program for gas efficiency needs to be mid-sized users.</p> <p>The VEU program may provide a useful incentive in commercial buildings and facilities such as aquatic centres to support the emergence of heat pumps. Heat pump manufacturers noted their technology had been regularly specified for projects but cut when budgets tightened. All parts of the supply chain interviewed agreed there was going to be change driven through the commercial building supply chain by large owners for the use of heat pumps. There is scope for the VEU program to support and facilitate this disruptive supply chain change in collaboration with other stakeholders such as NABERS.</p>
<p><b>Advanced Glazing (Residential)</b></p>	<p>In the case of residential glazing, there is a cost-effective alternative that is market standard in many other nations. Rating schemes are not effective drivers of demand for advanced glazing, stakeholders reported the VEU incentive is small relative to cost and in the context of low demand there are mark-ups in the supply chain that do not reflect the underlying cost.</p>

Supply Chain

VEU Implications and Recommendations

Given cost-effective products have existed in other nations for quite some time but are not being supplied at cost in Australia, the first-best solution would be to design a regulatory mechanism that creates a requirement specific to glazing. For example, a requirement for an average maximum overall U value for glazing on new homes, set at the equivalent of standard double glazing, and maximum Solar Heat Gain Factor for glazing exposed to summer sun. This could operate as part of the National Construction Code, as it would help to achieve the regulated minimum (summer and winter) building star ratings, but it would allow flexibility in selection of glazing for individual windows. Given double and triple glazing are cheaper alternatives in many other markets, it is likely the growth in demand and competition would quickly push the price down. It is a clear case of market failure. As one of the interviewees put it: "there isn't a single other sector in the economy that hasn't moved in the past 12 years like glazing - it's almost impressive. That shows you the market isn't going to move." If a regulation was to be included in the National Construction Code, action would be needed quickly for inclusion in the 2022 update.

Either as an alternative – or better as a lead-in or bridge to regulation - there are other options for targeting incentives and supporting programs within the supply chain:

**Targeted consumer education to build the small but growing market demand amongst higher-end and environmentally conscious buyers.**

There is a small market segment now purchasing advanced glazing – a focused promotion on this consumer segment could help increase demand.

**Active promotion of the VEU incentive at builders based on the WERS**

There is a rating scheme that broadly appears to have legitimacy within the sector and the VEU uses the WERS rating. However, at present, its role is educative – certificate creation is low. Further investigation is needed to understand why uptake is low as prima facie it is a point in the supply chain where there is a mechanism to support uptake with the application of a financial incentive. It may be that problems with the supply chain and low demand prevents it from working effectively – which would underline the case for regulation. Once the supply chain started functioning more effectively use of the VEU may improve.

## Appendix A – List of Organisations Interviewed

#	Organisation Name	Supply Chain(s)			
		Residential Space heating and cooling	Commercial HVAC	Commercial & Industrial Water heaters and boilers	Advanced residential glazing
1	Energy Efficiency Council (2 interviews)	•	•	•	•
2	Plumbing Industry Climate Action Centre (PICAC)	•	•	•	
3	Australian Sustainable Built Environment Council (ASBEC)	•	•	•	•
4	Australian Institute of Refrigeration, Air-Conditioning and Heating (AIRAH)	•	•		
5	Australian Department of Agriculture, Water and the Environment		•		
6	Green Building Council of Australia	•	•	•	•
7	NABERS		•	•	
8	Master Builders Association	•	•		•
9	Fenestralia/Peter Lyons and Associates				•
10	Australian Passive House Association		•		
11	Six Capitals Consulting		•	•	
12	Australian Glass and Window Association (AGWA)				•
13	Mayekawa Australia			•	
14	Mitsubishi Heavy Industries Australia			•	
15	Stiebel Eltron	•			



#	Organisation Name	Supply Chain(s)			
		Residential Space heating and cooling	Commercial HVAC	Commercial & Industrial Water heaters and boilers	Advanced residential glazing
16	The Expert Group	•	•	•	•
17	A.G. Coombs	•	•	•	•
18	CA Group Services	•			
19	Redshed Architects Pty Ltd				•
20	Air-Conditioning and Mechanical Contractors' Association (AMCA)		•		
21	Australian Renewable Energy Agency (ARENA)			•	
22	NSW Environment, Energy and Science Group (EES), NSW Department of Planning, Industry and Environment (2 interviews)	•	•	•	•
23	Team Catalyst Pty Ltd	•	•	•	•
24	Alfa Laval			•	
25	Australian Refrigeration Equipment Manufacturers (AREMA)	•	•		
27	Northmore Gordon		•	•	
28	IQ Group (2 interviews)	•	•		
29	Australian Alliance for Energy Productivity			•	
30	Airmaster		•	•	

## Appendix B – List of VEU Activities

1A - Water heating - Gas/LPG storage replacing electric resistance
1B - Water heating - Gas/LPG instantaneous replacing electric resistance
1C(08) - Water heating - Electric boosted solar replacing electric resistance (revoked 30/6/14)
1D(08) - Water heating - Gas/LPG boosted solar replacing electric resistance (revoked 30/6/14)
1D(18) - Water heating - Heat pump replacing electric resistance
1E(08) - Water heating - Electric boosted solar replacing electric resistance (revoked 9/12/18)
1F - Water Heating - Gas/LPG boosted solar replacing electric resistance
2(08) - Water heating - Solar retro-fit kit (revoked 9/12/18)
3A - Water heating - Solar replacing gas/LPG (revoked 30/6/14)
3B - Water heating - Gas/LPG boosted solar replacing gas/LPG
4(08) - Water heating - Solar pre-heater (revoked 9/12/18)
5(08) - Space heating - Ducted gas replacing ducted gas (revoked 9/12/18)
5(18) - Space heating - Ducted gas heater
6(08) - Space heating - Ducted gas replacing central electric resistance heater (revoked 9/12/18)
7(08) - Space heating - Ducted air heat pump replacing ducted air heat pump (revoked 9/12/18)
7(18) - Space heating - Ducted air to air heat pump
8(08) - Space heating - Ducted air heat pump replacing central electric heater (revoked 9/12/18)
9(08) - Space heating - Gas/LPG space heater (revoked 9/12/18)
9(18) - Space heating - Gas/LPG room heater

10(08) - Space heating - Space air to air heat pump (revoked 9/12/18)
11(08) - Ceiling insulation (revoked 9/12/18)
12 - Underfloor insulation
13 - Double glazed window
15 - Weather sealing
16 - Lighting (revoked 31/12/10)
17 - Low flow shower rose
18 - Purchasing HE refrigerator or freezer (revoked 27/10/10)
19 - Destruction of pre-1996 refrigerator or freezer
20(08) - High efficiency ducted gas heater (revoked 9/12/18)
21A(08) - Lighting - Incandescent GLS lamp replacement (revoked 9/12/18)
21A(18) - Lighting - Incandescent GLS or CFL replacement
21B - Lighting - Incandescent reflector lamp replacement
21C - Lighting - 12V halogen lamp replacement
21D - Lighting - 12V downlight and transformer replacement
21E - Lighting - Mains voltage GU10 halogen lamp replaced with GU10 lamp
21F - Lighting - Mains voltage GU10 downlight replaced with integrated downlight
22 - High efficiency refrigerator and freezer
24 - High efficiency television
25 - Energy efficient clothes dryer
26 - High efficiency pool pump

28 - Gas heating ductwork
29(08) - Standby power controller (revoked 9/12/18)
30 - In-home display unit
32 - Refrigerated display cabinet
33 - Refrigeration/ventilation fan motor
34 J6(08) - Building based lighting upgrade (revoked 9/12/18)
34 J6(18) - Building based lighting upgrade
34 Non J6(08) - Building based lighting upgrade (revoked 9/12/18)
34 Non J6(18) - Building based lighting upgrade
34NBB (08) - Non building based lighting upgrade (revoked 9/12/18)
35(18) - Non building based lighting upgrade
PBA measurement and verification

Source: Essential Services Commission, 2019c

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