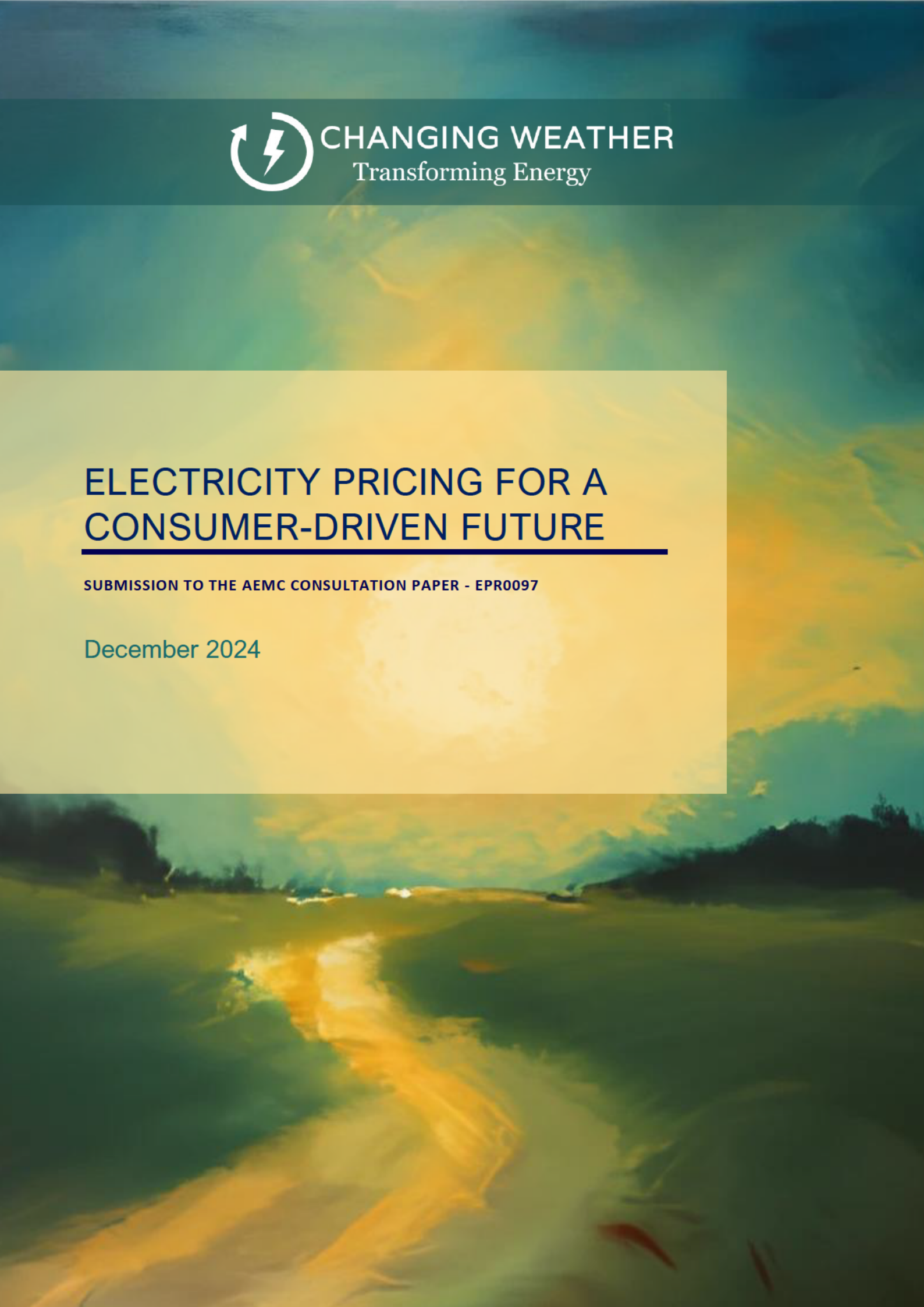

CHANGING WEATHER
Transforming Energy

# ELECTRICITY PRICING FOR A CONSUMER-DRIVEN FUTURE

**SUBMISSION TO THE AEMC CONSULTATION PAPER - EPR0097**

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## ABOUT HEATHER SMITH

Heather Smith is the Principal of Changing Weather and an electrical engineer.

I have worked in renewable energy, energy efficiency, climate change policy and community energy. It has meant working at the fringe of the mainstream energy sector for most of the past 30 years. But are all these ideas for making our energy systems better about to become the mainstream?

To find out I have been working on a PhD – "redesigning the electricity grid with microgrids". Projects in Heyfield, Venus Bay and Arkaroola will underpin my academic results.

In 2016, I was awarded a Churchill Fellowship on the topic of governance and community energy, and travelled to USA, Germany, Denmark, UK and Japan to investigate the changes in electricity markets that are being stimulated by community led energy initiatives. This experience has changed my expectations of Australia and made me keenly aware of our unique challenges welcoming so much wind and solar energy into our energy system.

I also chair the Coalition for Community Energy and advocate for community-led approaches to realizing our energy future.

## SUBMISSION IN A NUTSHELL

In a nutshell:

- The AEMC need to take a moment to reflect on the value and purpose of price signals in the midst of a dynamic and rapidly changing context – our energy transition to renewable electricity.
- Such a reflection would identify actors beyond consumers that need to be considered in this review. The energy corporates, the designers of energy using equipment or vehicles and publicly minded citizens, community groups and governments all need outcomes from price signals and face particular barriers that are relevant to this review.
- Consumer values and social practices are not static. They are informed by how we imagine and learn about the future so snapshots of *current* preferences and consumer archetypes are *misleading*.
- Affordances of technology, economics and social norms shape consumer choices more strongly than the marketing lens that this review proposes. A clear-eyed view is needed of the attempt at consumer empowerment (and the marketing lens) via the Power of Choice, its limitations and failures. This review must try a different approach and a new method for framing the problem.
- I would welcome an opportunity to present my own chapter on tariffs, prepared for my Thesis.

Thank you for the opportunity to submit,

Heather Smith

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## PRICE SIGNALS TO DRIVE BEHAVIOUR AND INVESTMENT

There are two lucrative behaviours/investment decisions that will benefit all consumers in a renewable electricity market:

- Using surplus renewable electricity that would otherwise be wasted.
- Reducing peak load or building capacity for peak load locally that also serves other purposes. This should be devised to lead to better utilization of network and generation assets.

This review needs to explore the prices and support that will facilitate these behaviours, and drive the economically efficient investment decisions when taking the system as a whole and in the long term.

My RenewEconomy article also discussed the opportunities and challenges from focusing on these two ends of the price spectrum: https://reneweconomy.com.au/how-to-stop-wasting-cheap-renewables-and-drive-a-faster-transition/

I have been working on a follow up article that discusses the details and offers a tariff calculator that anyone can use. The key idea behind the calculator is that our energy businesses, market bodies and regulators are making some basic choices that we might decide we would rather make differently.

## WHAT ARE PRICE SIGNALS FOR?

Price signals are the most important way for sellers and buyers to allocate investment between them for our future energy system.

Billions of dollars (around $40bn?) is spent every year to cover the operating costs of our electricity systems and to provide the investment signal for the capital costs. Almost half of the cost in the electricity system is considered residual. Whether residual costs are to cover profit, risk, overheads, bureaucracy, government programs or sunk investments is academic. All residual costs are outside the price signal and must be recovered in other ways, even if through tariffs.

Ideal markets expect that the price of the good will find an equilibrium where the seller receives money at something lower than cost and may make a small seller surplus. The buyer receives the good at a price lower than they were willing to pay and may make a small buyer surplus. Electricity markets are far from ideal. There are information and power asymmetries. There are long term technology and housing choices that lock consumers into consumption. Network businesses are monopolies. Retail competition is subdued.

The arrival of decentralised options, consumer energy resources and electrification options that puts fuels in competition with electricity encourages us not to give up on less-than-ideal markets, and not to give up on price signals. David Osmond crunched AEMO's figures to $1.2trillion (~$40bn/year) in petrol and gas savings by 2050, some half of which will be needed to buy more electricity. The big question is how these funds might flow through price signals and investment choices.

The extent to which buyers or sellers within the electricity system each capture value is a fair allocation question. The extent to which the investment can be speedily enabled for an urgent energy transition is a globally relevant question for all citizens of the planet. The suite of technologies and energy using patterns locked-in by this wave of change is also a public value question because it needs to respond to the values of current and future generations for sustainable and just outcomes.

Price signals can be empowering. Consumers can find themselves making knowledgeable investments and choices that accord with their values, their self-interest and their long term desires for well functioning energy systems. They are more likely to make these investments if it is profitable to do so. “Sellers” in our electricity system can find themselves with the socially approved level of funds to invest in new networks, generation and storage assets.

If price signals are to be responsible for divvying up money between buyers and sellers to the tune of more than $20bn per year, then this review is timely and essential.

If the dream is that the allocation of the ~$20bn will accord with our society’s values, then we must make sure the price signals work well and be prepared to take additional steps when they don’t.

## BARRIERS FACED BY SELLERS

Network businesses and network resets do not equate price signals for peak load with actual investment behaviour and decisions within the network business. There is a good chance that improving the price signal will provide some more information about consumer costed alternatives, but it is not clear how well price can be used to influence network investment decisions. There are other information flows that could be used to influence network planning. Levels of investment and potential control at the local level will show up in connection approvals and energy profile data. Governance and control of network constraints will occur across the system and will face rapidly changing dynamics. Many of these constraints occur for clusters of 30 – 100 households. Pricing for requests to increase capacity within businesses will also play a role in the dynamic of buyer vs seller investment decisions. Feeder level constraints will impact mixed supplies of ~2000 homes and small businesses. Zone substation capacity upgrades impact at the 20,000 homes, business and industry level. These planning level price signals are fraught with power and information asymmetries. In particular RIT-D processes don’t allow time for alternative visions and partnerships to compete with a DNSP-led planning application.

Most retailers are in the habit of treating price signals as a risk to be managed, with the financial impact to be smoothed. This is a clear challenge for the energy system. Regulated network tariffs have created tariff structures far more successfully than the retail sector. Some of this stems to the ASX and futures markets, and the structure of hedge products. Making sure that prices, hedges and significant financial decisions orient toward the future CER system and pricing is a challenge for the AEMC to consider.

As explained in further detail below, generation price signals are all linked to the wholesale market and all the additional features placed around that. Some of the challenges, shared the world over (eg see the “price is Wrong” by Brett Christophers) is that these markets are designed around capacity scarcity and hence dispatchable power, rather than around resource scarcity. It may be that a focus on the top 100 hours of dispatchable peak capacity, which becomes a focus on the most expensive 20% of capacity, could result in more appropriate price signals throughout the generation and retailing markets.

I know someone on Amber’s pass through retail arrangements. He has found predicting how to charge his EV almost impossible at times. In fact he works harder than the retailers who have hedged away all of the uncertainty. This shouldn’t be the case unless there is a unanticipated failure in the system. Day ahead pricing, wind and solar predictions do not vary so much that there needs to be significant volatility in the lead up hours to final dispatch and significant disconnect with the 24 hour prior price.

Structure and design need to be transformed for all sellers.

## BARRIERS FACED BY BUYERS

The flows of savings to electricity consumers need to be converted into diverse markets for products and services. Retailers could get involved in these markets. Network businesses will face barriers to becoming involved due to their monopoly status, but there may be collective benefits for building skills, expertise and knowledge at the network level too. We need to understand the barriers faced by these markets, many of which will be novel, innovative and emergent.

A long term commitment to redirecting the flow of funds to consumers via a price signal for certain behaviors will be essential for new markets and technology designs to emerge.

I discuss the market failures associated with consumers direct relationship to the price signal below. These are many, and well known. I also offer a framework for adjusting the economic viewpoint across different timeframes.

## ALLOCATING COST TO DETERMINE PRICE SIGNAL

**Residual Costs**

As mentioned above, residual costs are significant and their allocation is a choice. At the moment we don't use residual costs deliberately to ensure price signals behave the way we might intend. Here some key ideas for using residual costs more effectively:

- Don't burden the price signal for cheap renewables with residual costs.
- Be wary of over-pricing peak load with residual costs.
- Use residual costs deliberately to retain postage stamp pricing principles, while also starting to reveal true local prices.
- Use residual costs deliberately to introduce shadow carbon pricing.
- Consider increasing residual costs to provide the necessary information and supports for behavioural change.
- Consider using residual costs to manage an insurance product where consumers can experience the up side of economically productive behaviour without the bill shock of mistakes and disadvantageous energy use.

**Capital Costs**

The wholesale market design allocates capital costs as marginal prices for dispatchable generation. It uses Ramsey-Boiteux pricing so the cheapest cost (SRMC) energy progressively pays off its capital as the merit order dispatches higher priced sources. The final peaking generation (eg diesel generators) will never recoup its capital under Boiteux pricing, only its fuel costs. Fans of the NEM wholesale market design argue that allowing the market price to float uncapped is the key to every dispatchable generator recouping its capital.

Under this regime wind and solar investment will decline without external sources of revenue because they are not dispatchable. The RET and capacity markets provide some of this revenue and are resolved in the wholesale market. Likewise risk and missing money are managed in futures markets and resolved in the

wholesale market. It appears both the wholesale market and futures market structure electricity sales in ways that are not compatible with variable renewable electricity. Additionally, both remain distant from the needs of decentralised investments and consumers.

Marginal pricing based on Ramsey pricing is not the only way to allocate capital costs. I have experimented with alternative models of scarcity pricing for renewables. Hydro, storage, wind and solar are all resource-constrained and therefore enter the market differently to fossil fuels which are capacity-constrained. Scarcity for the former means some kWh are more precious than others. Scarcity for the latter means the peak kW are precious.

Network costs are poorly understood and allocated across time of day and season. From a residential consumer perspective there is strong alignment between centralised generation capital to serve peak loads and network capital to serve peak loads. In a renewable future and in most climates we can take a few extreme hot evenings and many of the chilly winter evenings and focus on these ~100 hours per year as the main drivers of electricity system costs.

Businesses offer a diversity opportunity because many do not need to be operating on summer and winter evenings. At the right price, many would choose not to operate for those ~100 hours per year.

For major investments in new peak capacity, or in capacity to replace retirements we don't have a clear understanding if the investment is best made at the consumer site or in utility scale dispatchable options.

It is clear that a price signal is needed for peak load. The extremely sharp pricing created by the wholesale market has patchy results in driving investment. Allocating capital costs is ultimately a choice and the range of different choices that could be made should be explored in this review.

**Operating Costs**

Many short run marginal costs and operating costs can be allocated easily to consumers on a kWh or per customer basis. Where they can't, we need to consider if they are best classified as residual or capital costs, or associated with another price signal that could be considered.

## WHAT DECISIONS COULD PERFECT PRICING ACHIEVE?

The big investments are:

- Generation
- Networks
- Storage and flexibility
- Electrification

Each investment contributes to an increasingly capital-intensive energy sector because there is limited spatial or temporal mobility in electricity systems.

Our ability to increase the utilisation of capital and of renewable resources is key to driving long term benefits for consumers.

## RENEWABLE GENERATION AND NETWORKS

We know that an enormous level of investment is likely to flow to solar generation. All or most might be economically optimal as decentralised investments made by "buyers". At the moment decentralised solar is more profitable than centralised solar. Households with and without solar would be financially better off using surplus solar that is currently wasted or exported to businesses. This opportunity needs a triage of more accurate price signals, information and better technological solutions.

We know that affordable renewable generation to cover night time and winter will require significant wind energy. Prices signals could help us understand the viability of wind investments within our existing networks in comparison to those that will also requires significant investment in new transmission infrastructure.

My modelling of renewable energy futures is consistent with finding from the AEMO ISP and from modelers such as David Osmond. We will have significant surplus renewable electricity if our load profiles do not change and this will be a cost-efficient outcome even when 30% or more of a new investment is thrown away. In fact, I think ***40% of the year*** will ultimately become times of surplus renewable energy at zero-marginal cost.

Our system experiences price separation whenever exports are constrained and this means value is local. In other words, the surplus solar is in your neighbour's system which has been blocked from exporting via high voltages or dynamic operating envelopes and the surplus solar should set the price of electricity consumption for you at zero, regardless of what the rest of the system is experiencing.

## STORAGE, FLEXIBILITY AND ELECTRIFICATION

We know that storage is likely to be valuable throughout the electricity system. At local levels, households, businesses and communities can avoid costs associated with connections by co-locating storage with energy consumption. These consumers can also value storage above market rates due to the additional benefits of energy reliability, security and continuity. These advantages compete with economies of scale to create economic reasons for decentralised investments.

The renewable future creates a smaller sharper window for dispatchable generation. Ie where the peak 100 hours used to represent 15% of capacity, they now represent 20%.

The options to invest in business flexibility will be as diverse as there are types of industries. Many may also be interested in justifying on site batteries or generators for business continuity reasons.

Electrification choices will remain with consumers.

## LOCAL COLLECTIVE ASSETS AND GOVERNANCE

Without truer price signals we will struggle to understand when investments are best made locally. In renew economy I wrote:

"Households are wary of the electricity businesses being granted control of their equipment. Confidence in the energy system is at a five year low and people aren't trusting the information that comes at them from energy companies.

Should network businesses, electricity retailers, product suppliers, aggregators or households be in charge of coordination?

The benefits are mainly unlocked if each low voltage feeder can be managed. That means clusters of 30 – 100 homes, small groups of businesses and sometimes a mix of both are interdependent in the quest for better use of renewable energy.

If you read my last article you know that I think community energy is a key ingredient in our energy transition. This is more than a feel-good claim about everybody being given the chance to participate in shaping the energy future.

Communities are the scale at which we need to solve the technical challenge of capacity on the low voltage system and the economic challenge of suitably pricing, using and expanding rooftop solar generation.

Once we build the capability for optimising local renewables we will have the necessary control and governance in place to strategically purchase surplus wind and reduce peak load – both activities that will benefit the system as a whole.

Regardless of who ends up coordinating household and business energy, some level of local negotiation and agreement will need to be in place.

Community energy is ready to be part of the process that will help us all to access as much renewable energy as possible. We need the system to make changes to local pricing so surplus rooftop solar is cheap to buy and solar constraints are easily lifted.

We need the system to start experimenting with local coordination and information from a range of possible players. Most of all, we need to look together – past tomorrow and all the way to 100% renewable energy – so we can grapple with the looming challenges before they are upon us."

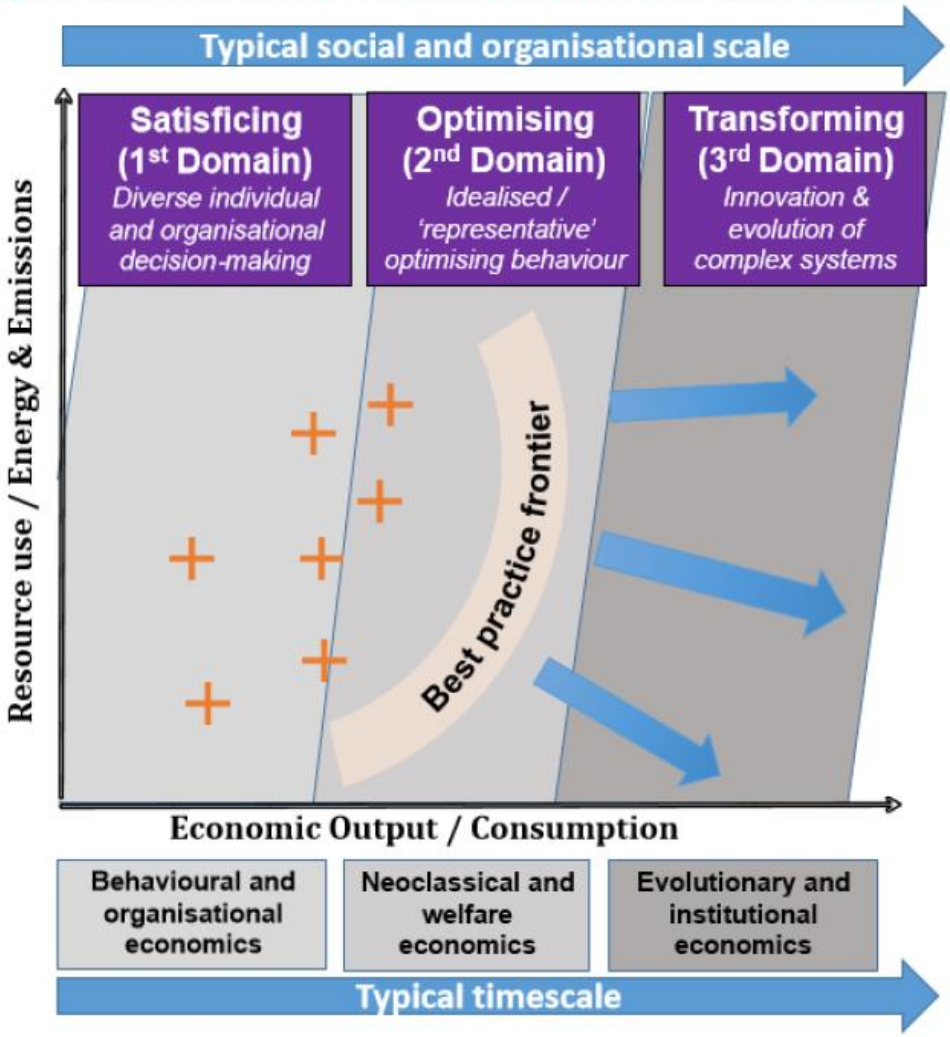
I would like to reiterate that price signals, collective assets at the local level, local coordination and local governance are all non-existent in our energy market at the moment and I believe they are essential.

## BARRIERS TO UPTAKE

There are many barriers to buyers and sellers. I suggest some relating to the buyers below. These were originally discussed in my submission to the senate enquiry for residential electrification and they are relevant to the discussion here.

In planetary economics[1] the authors suggest we use different economics across three timeframes. An image from their work has been copied below. I frame my suggestions across these three domains.

**Figure 1. Resources and economic outputs in the three domains**




*Source: Planetary Economics (PE), adapted from Figure 2.3 (b) [p60] and 2.7 [p72]*

### SHORT TERM

Information asymmetries, tenant/landlord market failures are all well known across the energy efficiency sector. (parent/teenager is also a market failure, usually manifested in long showers). Residential electrification will be the same. Over the last 30 years Governments have reduced the support they offer at the information and advisory level and reduced their own research and expertise. A limited amount of

[1] https://climatestrategies.org/publication/planetary-economics/

support for household energy advice is frugally funded in the welfare sector because avoiding bill shock can be essential for low income households.

Access to the knowledge to make an informed decision that weighs a significant investment against calculated savings remain enormous barriers. For a start, the savings calculation will have a wide range of results due to a household's unique circumstances.

Access to capital affects everyone, not just those on low income. There are always some times that are better than others to make a decision to spend money. Unfortunately these times are often accompanied by the stress of other major investment decisions (eg part of a renovation) or the urgency of replacing a broken appliance.

If some understanding about the change in energy consumption does not accompany a change in technology decision then savings can be undermined by the ways a household adapts to the change. This will be especially important for generating uptake in flexible load. A household that overrides flexibility for convenience will end up with a system that costs more.

**Possible solutions:**

Social and cultural support for residential electrification will make energy knowledge more widespread and socially acceptable. Community energy can help here. Inner West Community Energy, for example, offer an evening in the pub once a month for people to explore the decision to install rooftop solar. People are then connected with a range of recommended local installers for quotes and the group monitor the ongoing installer/customer relationship to support people through any problems that arise.

Nudges, from behavioural economics, streamline the default decision into being the one that best serves long term finances. Marketing, financial support, subsidies and recommendations on products and suppliers can all be oriented to send people along the best path without taking away the choice to go elsewhere.

## MEDIUM TERM

Prices do not reflect costs. This reality fundamentally undermines the ability of the residential sector to respond with the options that generate optimal investment across the electricity system.

There is deadweight in every system that leads market solutions away from the ideal. In electricity, the deadweight accounts for over 50% of the pricing that consumers experience.

- DNSPs publish long run marginal prices that equate to less than half their costs.
- I estimate that generation costs reflect only 2/3 of wholesale market pricing.
- Retailing is essentially a per customer cost – independent of energy consumption.
- Environmental charges need to be recouped so if consumption falls, prices will rise. Or if consumption falls amongst one customer cohort, another will disproportionately bear the burden of price increases.

**Possible solutions:**

There are two main price signals that need to be more clearly honed:

- **Lowest prices:** Use of surplus renewable energy needs to be clearly signalled at low prices. This is starting to happen and in South Australia the solar sponge period has a network charge of only 2.5c/kWh but there is no equivalent price signal for variable wind.

- **Highest prices:** No retailer wants to be the one to scare away customers but household tariffs don't come close to reflecting marginal costs for network and generation at peak times. Peak prices are the key driver of new investment. A customer's ability to reduce peak load is dependent on 1) their understanding of the contribution they make to peak load, 2) flexibility to do something about it (and ease) and 3) an incentive to act.

I offer a number of suggestions for making the pricing regime work better:

- **Making it work – peak pricing**: I suggest 85c/kWh for the top 5% of times when system-wide peak load occurs (winter and summer evenings) better reflects the marginal price to networks and generators during those times. (It is even higher if we focus on the top 1% of times which call on 20% of our capacity). We could support all households to enable management of peak load *in advance* of trying to make our pricing more cost-reflective. Another idea is to create a class of flexible loads that can be turned off during these times by networks and be managed by retailers and customers to offer affordability and convenience at other times - priced accordingly.
- **Making it work – deadweight costs**: Deadweight costs can be recovered against all parts of the market that don't represent surplus renewables, although care should be taken on how they are allocated for the most expensive 1% or 5% of the market. When surplus renewable times represent 40% of our low cost times, this may cause inequity if we haven't done enough work bringing everyone along the residential electrification journey. Supporting this journey in all disadvantaged communities should be a priority.
- **Making it work – investment incentives**: The electricity sector has experienced consistent growth for much of the past 70 years, which has obscured any less than optimal investment decisions. Much of the infrastructure is used at a 25% utilization factor and this reflects in our costs. If households are to bear the costs of a renewable future, they must also benefit. This will be undermined if local investments don't lead to reduced network and generator investment. Local pricing will be key to the tension caused by new investment and new management regimes. It requires that we re-assess the commitment to postage stamp pricing and look clearly at the existing inequities and the danger of exacerbating cross subsidies between customer classes. I look at this more closely below in my comments on Low Voltage networks.

As discussed above – price signals also need to work in the opposite direction and there are barriers for sellers here too.

## LONG TERM

In the long term, the activities we need to incentivise are innovation, experimentation, sensemaking, shared purpose and restructuring of systems to transform.

The technology driven approaches of the energy sector and all the energy market bodies underestimate the nature of social change that will need to occur alongside technological change.

Our financial and regulatory architectures will need to transform as much as our physical architecture and, most importantly, social license, social practices, on-ground business model and behavioral innovations will all need to keep up. The Government needs to think deeply about how best to support this innovation and transformation, so that it can accelerate change. At the moment, the neglect of social issues puts our targets and ambitions at significant risk of underperformance.

**Community energy sector innovation**

Community energy groups do four important things that innovators in the private sector cannot do or struggle to do:

1. Generating social license for the energy future
2. Frugal Innovation - approaches that rely on volunteering and scant profits (which includes market failures like energy efficiency)
3. Business model, governance and financing innovation
4. Delivering public goods at the community level and bridging markets (eg reliability that the electricity market can't fund)

Community Energy groups pioneered bulk buys and facilitated connections to trusted suppliers.

Community Energy groups pioneered cheap finance, crowd sourced finance and revolving funds.

Community Energy groups put democratic governance, fairness, public good and community benefits at the heart of their business models.

As already mentioned, household investment can be agile, speedy, often privately funded, and involve thousands of small experiments which is a sure way to get to the future faster. Community Energy groups can facilitate faster uptake and quicker learning at the household level.

Importantly community energy groups often provide informed consumers to advocate for structural change in the electricity sector.

**Other systems**

It has taken over a decade to take a small step forward in energy efficiency within the building code. If we know that the regulatory path is too slow to facilitate ideas like building mass for heating and cooling load flexibility, then we must find novel ways within the building code to support such developments and experimentation.

Other systems that need to change are:

- Transport. Residential Electrification is also an opportunity to reform the interaction of different vehicles on our streets. Safety for slower vehicles like bicycles and scooters, separation from cars, new rules and etiquette in relation to pedestrians etc. could lead to a bounty of smaller, slower and much more efficient electric vehicles. Replacing the many diverse trips that we currently do in our cars, with fit-for-purpose transport modes that reduce congestion and enhance our cities and suburbs.
- Gas needs to be supported to withdraw completely from the household sector instead of muddying the future with untruths and well resourced marketing.
- Finance, especially no interest loan schemes in the low income sector need a rethink about how to best fund investments with long term benefits for society at large.

**Values and Vision:**

Most people are actively trying to imagine a better life for all Australians, future generations and our fellow travelers on this fragile planet. In my work, community members volunteer to help build value across their places and amongst their people. Their values helps us understand the shared purpose we might have for residential electrification and the transformation of our electricity systems.

Here are the values communities articulate and the problems we could go about solving well:

Sustainability and self-sufficiency equals:

- 100% renewable energy supplied and used locally
- Circular economy on all materials used in the energy future - no landfill

- Technologies without environmental impact throughout the supply chain

Affordability and equity equals:

- A concerted effort to have true prices for cheap surplus renewables alongside risk management against the bill shocks of peak pricing
- Development of business models that support sharing
- Transformation of low income homes with accompanying support to learn how they can work
- No one left behind - access to investment and energy savvy need to be equalised

Safety, reliability and resilience equals:

- Smart hierarchies of energy needs and development of models so everyone can access essential energy
- Support for innovations that share the responsibility for full time reliable electricity between centralised (network and wholesale market) and decentralised approaches
- New, long lasting energy storage systems - eg backup renewable fuels and simple, cheap ways to use them

Innovation and having more say equals:

- A commitment to acceleration of our pace of change
- A cultural change around who can participate, how we make sense of complex change together and how we collaborate - especially between insiders and outsiders because that is where true system transformation is triggered from.
- A clearer model for how Government allocates resources to innovation and why
- Ongoing capacity building and learning from everyone

Community wealth and prosperity equals:

- A focus on which parts of the energy value chain we can localise and excel at,
- Engaging at the community level and building collective assets such as community batteries, public spaces providing energy services, shared renewable power stations
- Building energy savvy at the community-level and providing energy information services
- Generating shared savings that can support community organisations and build community cohesiveness.

## THE INEQUITY IN LOW VOLTAGE NETWORKS

In my work across Ausnet Services territory I have seen a wide range of low voltage network arrangements. Some transformers only serve a few households but in denser areas there can be over 150 households on a single transformer. Many transformers are 100kVA or 200kVA. 315kVA and 500kVA transformers are less common and serve more customers or serve a mix of residential and shops. It appears that newer developments are more likely to have undergrounding and ground mounted, larger transformers.

**capacity utilisation**

- Some transformers have less than half the capacity in use. This might have been to allow for more developments or densification in the same area. It bodes well for residential electrification because plenty of electrification can happen before there is any peak load problem or new investment needed.
- In one exercise looking at overloaded transformers, the allocation of capacity per customer ranged from 1.2kW to 3kW per customer. Transformers can be overloaded for short periods but overloading can also reduce the transformer lifetime.

- The utilisation on these transformers ranges from 17% to 41% and the average is 27%. (ratio of average load to transformer capacity and a sign of poor capital utilisation). The current impact of solar is only a 2% drop in utilisation due to load being serviced locally rather than via the transformer[2]. These are overloaded transformers which skews utilisation upward. In general, utilisation is much lower.
- Ausnet now insist that developers install transformers that will supply 7kW per household, SA Power Networks insist on 5kW per household. This may be generating the surplus capacity of the future[3], but in the context of residential electrification it is probably good to overbuild at this stage and in this part of the network.
- On a transformer where capacity is well matched to load, there is a good chance that underlying load already exceeds transformer capacity because our peak load used to be in summer afternoons and this peak airconditioning load is now served by rooftop solar.
- Load flexibility will increasingly disconnect the local Low Voltage system from the centralised system with more times of the year when the only way of supplying load is via local rooftop solar. If load consistently exceeds transformer capacity, control of flexible load will be the key to managing supply at peak times for the odd occasions when a passing cloud or even an eclipse reduces the ability for rooftop solar to serve the peak load.

**Capacity inequality**

There is a substantial difference, almost 6:1 difference, in the capacity allocations (1.2kW per household vs 7kW per household). It places quite different constraints on different households. To some extent we are familiar with inequalities – when we live at the end of a line in a remote location we become quite used to having a poorer quality supply than city-dwellers. However this seems extreme.

One solution is that DNSPs make major investments across their infrastructure. Some of this might occur in any case. For example, a major part of SA Power Network's distribution infrastructure reaches old age over the next decade[4]. Two things to consider are that:

1. we want to end up with more cost-effective and better utilised infrastructure overall and
2. some of the choices about investment could benefit residential electrification, while others will work against it.

**Separation of markets**

When there is a constraint on the transformer at the low voltage level a financial separation occurs. This separation of markets not priced correctly. The main reason is a long-standing commitment to postage-stamp pricing across territories where all customers pay the same price for electricity whether they are next door to the generator or at the other side of the network. Residential Electrification, once again, raises the need for local price signals. Work by UTS circa 2015 showed that it was cheaper for some solar generators to duplicate electricity networks rather than transport electricity modest distances of 100-300m. The move to allow export pricing is an attempt fund the local investments required and allow the wastage of surplus solar

[2] Under high residential electrification scenarios these feeders would have 6 times the level of solar to get up to 1:1. i.e. solar produced = electricity consumed (before electricity consumed is expanded by including gas and transport loads)
[3] At the Zone Substation level (Medium Voltage) there is less likelihood of overbuild because DNSPs monitor for the risk of unserved energy at the Zone Substation level and are only allowed to invest when overload seems likely.
[4] The current pricing regime doesn't easily accommodate widespread replacement of assets. A higher-than-normal level of investment would result in a price jump.

to be a market driven choice. A plethora of trial tariffs have been developed to accommodate the Labor Government's community batteries. None of these tariffs provide price symmetry because network tariffs are weighted down by 10-15c of cost-recovery that is independent of energy consumption. A behind-the-meter battery co-located with load can receive 18c/kWh price differential on network charges between peak and off-peak pricing (differential and therefore income for charging and discharging at different times). This increases to 22c/kWh if it is also co-located with rooftop solar. Many trial tariffs offer a 2 -4c/kWh differential and fail to reflect that the act of charging supports the network by reducing improving voltages and solar hosting capacity, and discharging supports the network by reducing the peak load. So a battery should be worth more. A few trail tariffs do attempt to reflect the value of discharging at peak times, but only for a few payments per year and only in locations where the network is overloaded.

**Set and forget at the local level**

In two separate discussions Ausnet and Ausgrid have reflected that they find it hard to justify additional investments at the Low Voltage level for monitoring and control signals and would rather imply the situation from smart meter data. As residential electrification increases and there is a substantial part of the network's traditional role being fulfilled by local rooftop solar, local batteries and local flexible load, we need to question this approach.

The investment in control and monitoring technology at the household level (smart homes) can frequently exceed $1,000 per home in a situation where $5,000 - $10,000 per home for energy bills is the norm. ie capital equivalent to 10%-20% of annual expenditure. The 100 households on a low voltage feeder will cumulatively spend around $450,000 per year on electricity when fully electrified and will have invested substantially in rooftop solar to provide much of the energy themselves at no cost. The resistance to creating control and monitoring information at the local level appears to belong to an older mindset about a passive approach to low voltage networks and needs to be questioned.

I believe we should also experiment with local governance and local input to any monitoring and control regime. Some literature suggests 100 homes is too local to be comfortably or efficiently governed. Local government appears to exist at a scale that might be too large. Community groups exist as service providers in communities between these two scales.

## PROVOKING CHANGE

The transitions literature, innovation literature and political economy literature are all quite clear that existing regimes reinforce the status quo and are resistant to change. Government needs to be clear-eyed about this challenge. It is obvious that we need to change before climate change forces disastrous and conflict ridden change upon us.

How do we get more outsiders catalysing and provoking changes within the electricity sector so that well-directed changes can occur as fast as possible?

One important idea is to improve the knowledge we develop together. Using both alternative knowledge and the wisdom of the status quo is essential. Open minded, open hearted and open-goal based consultation is needed to reconcile these two knowledge bases. Both knowledges need to be able to challenge each other with a goal of improving the quality of decisions, building relationships and trust. Dialectic reasoning for developing a shared truth, dialogic exploring for imaginative solutions to shared views of the challenge.

Outsiders must be involved in setting the agenda for any consultation.

Outsiders must be supported to participate. There are three income levels on display in any consultation. The wealth comes from the insiders – all on substantial salaries, paid for their time and paid to develop the resources being considered. The middle income groups often contribute discretionary effort to their participation. They might be salaried but they work for the social sector (low salaries!) and often volunteer additional time in order to participate. Many participants are expected to contribute with no value in return. This inequality leads to unequal consideration of views.

There are three types of knowledge involved in every consultation[5]:

1. Disciplinary knowledge like engineering or economic expertise
2. Process knowledge like bringing insights into regulatory, political and policy and how things could be changed
3. Local knowledge and insights into the interests and preferences of stakeholders

Alternative perspectives need to contribute to each of these knowledge domains. Outsiders can bring novel ways of analysing the problem or alternative disciplinary experience that can contribute solutions.

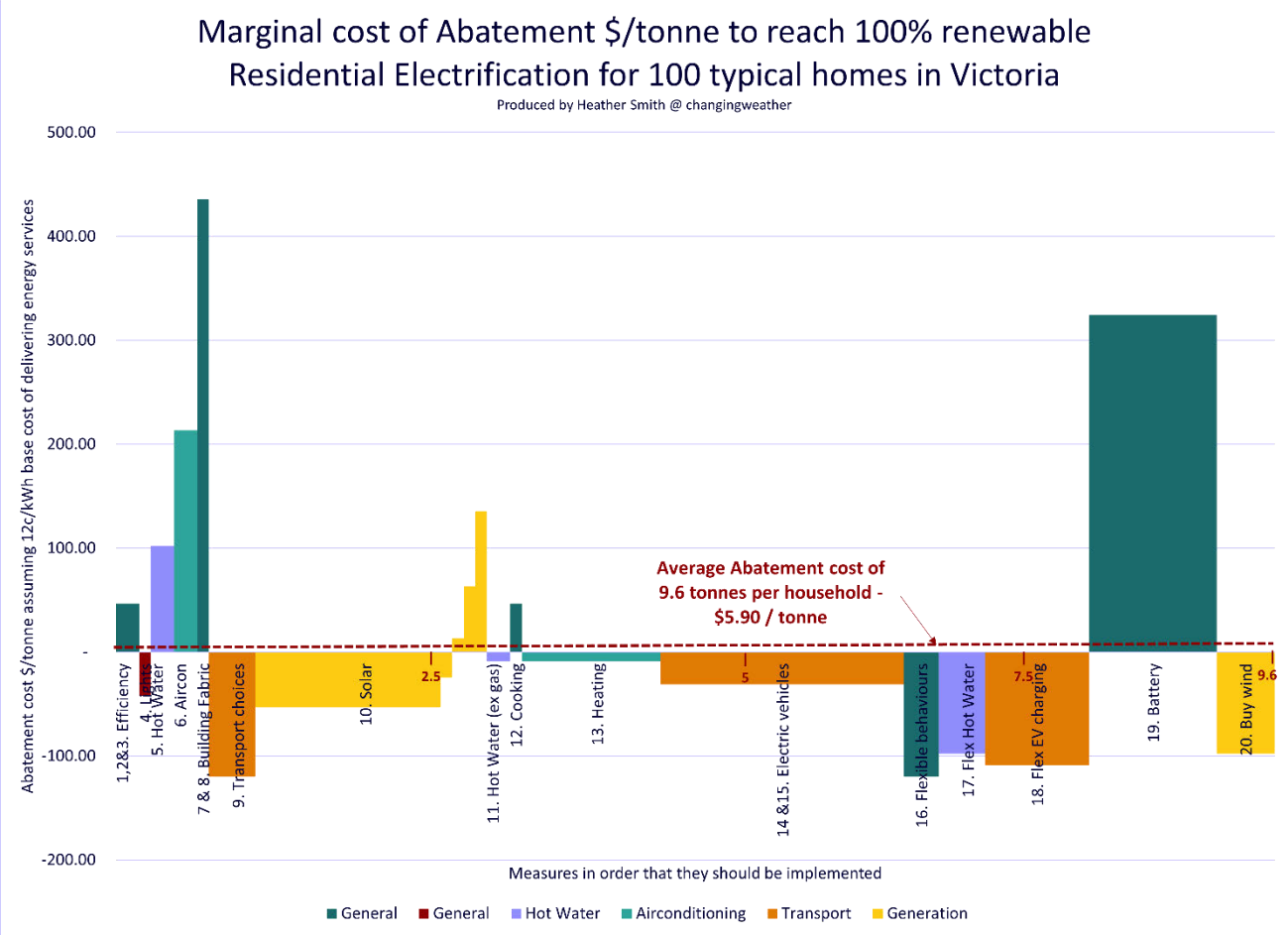
Sometimes the alternative perspective is simply about looking further into the future. Early solar modelling didn't predict the problems of export limits at the low voltage level even though the ultimate goal of 100% renewable energy hasn't changed in 20 years.

Sometimes the alternative perspective comes from a different worldview. Insiders tend to assume that the current system rules are fairly fixed. Outsiders might come from overseas where local government has a much stronger role in electricity governance (for example) and therefore better appreciate that our system foundations can and maybe should change.

[5] https://www.nap.edu/catalog/12434/public-participation-in-environmental-assessment-and-decision-making

The following 20 steps are graphed below:

1. Make things easy to turn off when not in use
2. Replace inefficient fridges
3. When buying, buy efficient (eg televisions, washing machines, induction cooking)
4. Keep making lighting efficient
5. Hot Water upgrades to heat pumps (make it flexible!)
6. Efficient Air conditioning systems (make it smart!)
7. Improve insulation, draughts and building fabric
8. Doing a reno? - make efficiency and flexibility investments
9. Mode shift on transport - use walking, cycling and public transport for 2,000km/yr)
10. Rooftop solar
11. Convert gas hot water to electric heat pumps
12. Convert gas cooking to electric with induction stovetops (keep the gas BBQ as backup)
13. Convert gas heating to reverse cycle airconditioning - flexible and smart!
14. Buy electric bikes and scooters (also mowers!)
15. Buy an electric vehicle
16. Move as many activities as possible into daytime
17. Control hot water to heat up flexibly with surplus renewables
18. Control transport charging flexibly to use renewables
19. Buy a battery
20. Buy surplus wind




These homes have approximately 6kW of rooftop solar each. This produces a surplus in summer but not in winter. Closer to 10kW is required for full self-sufficiency once vehicles are added to the mix. Vehicle charging infrastructure will be well suited to a variety of locations in communities, not just at home. The battery is the most expensive investment and much could be displaced by buying renewable energy from the electricity market. This would reduce the abatement cost further.

## OPTIMAL TIMELINE

As expressed in my opening vision, I believe we should electrify the residential sector fully to renewable electricity by 2030 – ie over the next 7 years. I also believe there is substantial capacity for rapid change as new technologies take hold and achieve widespread adoption.

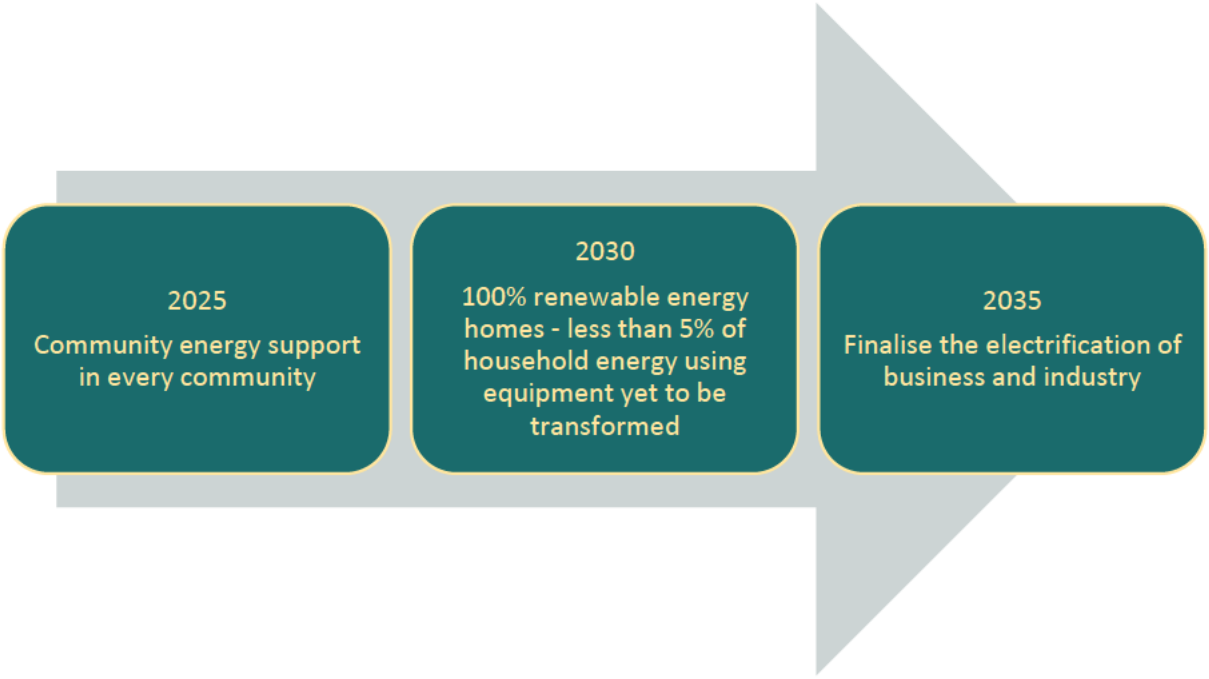
Global emissions need to reduce ***to 20% of current levels*** by 2030 for a credible attempt at maintaining temperature rises below 1.5°C. That means our biggest and easiest sectors must be transformed as deeply as we can manage and as quickly as possible.

High income countries, 16% of the world's population, are responsible for ***74% of excess resource*** use.

Australia, therefore, with financial capacity and prolific usage needs to go hard on reducing emissions.

Electricity will be our first sector to transform. Our residential sector will use ¼ of our energy in a renewable, electric future and it is already poised to transform with all technology available. Households directly draw on services that will account for another ¼ to ⅓ of energy use whose transformation they can influence.

We should behave as a global citizen, rather than as a country focused on optimising our strategic economic advantage from such a transition. We should concentrate our efforts on the learning that is needed to create 100% renewable energy communities and we should share this knowledge freely with the rest of the world.



## REVIEW QUESTIONS AND ANSWERS

### QUESTION 1: REVIEW APPROACH

I consider that the focus on consumers and consumer barriers is too narrow for this review.

We must appreciate that consumer values can easily be reflected as citizen values but that is not what you understand if you focus on the self-interest of consumers when asking them, when referring to them and when conceiving of their long term interests only as individuals.

My work in community energy highlights that many ordinary people want to participate in the energy transition and they frequently refer to collective benefits above self-interest. It is important that this review treat consumers like citizens and enquire into the type of future system that will attract society wide approval. It needs to understand stakeholders as coming from all the sectors that will benefit from the investment of Billions of dollars into homes and businesses. And it needs to understand that public goods like a fair and equitable society, mitigating climate change, and an energy system that distributes value progressively, not regressively is in the long term interests of consumers. I have included some values insights in the Appendix.

We must also appreciate that price signals are intended to provide two-way information. We must interrogate the behaviour and impact of price signals on the energy businesses. And we must consider their barriers and perverse incentives that may undermine the intention of this pricing review, which is to use prices to allocate value in an economically efficient manner.

Finally, I remain frustrated at the present focus that much of the literature on consumer attitudes and preferences. It is misleading to ask someone how they might prefer to behave without giving them information about the financial savings that could result from particular decisions. Economists often highlight that consumers say one thing and yet behave in a different manner. I believe those administering such surveys have a naturally incomplete view of energy futures and so it is impossible to take a useful marketing approach to the task at hand. A rich and diverse consumer market will experiment its way to the future. Your approach of focusing at the outset on future consumer experiences appears to assume that you don't expect consumers to help solve the future but rather provision them with whatever they need at any cost. This is not how we came to have a solar industry, and won't be how we get to 100% renewable energy.

The price signal can activate many other sectors, indeed create new markets, if it is enduring.

This review will fail if it focuses on how consumers prefer to buy their electricity. It must also explore the conditions under which they would be prepared to change and their preferences for programs, supports, consumer protections and relationships that would help them invest wisely or choose to outsource such investment to others.

### QUESTION 2: CONSUMER PREFERENCE PRINCIPLES

*What are your views on our proposed Consumer Preference Principles?*

I believe you need to investigate consumer preferences around control and governance as these become increasingly important in the energy future and trust remains low with energy businesses.

I think you also need to understand why many people think the electricity industry is not a level playing field for those who take the trouble to invest in their own generation and electrification.

I encourage you to consider the values that currently motivate consumers to participate in energy transition activities and consider how they might be included in your principles. (see Appendix)

I also encourage you to consider that different values are at play when:

- Changing behaviours, using different technologies – every day

- Choosing an electricity provider – perhaps every few years
- Making a significant investment – once off decision, every appliance lifetime ~15years
- Making a major, scary decision – eg home renovations, new vehicle. ~15years+
- Supporting community, society and planet – long term commitment

*Are you aware of additional existing research that could help us refine the CPPs?*

SA Power Networks went through a thorough co-design process generating principles for electricity billing in around 2016. Eg. Avoiding bill shock and simplicity for understanding bills both featured.

*How might the CPPs help us in assessing whether our decisions will lead to good consumer outcomes?*

Good consumer outcomes are most likely to come from the process, not the right principles. I would suggest that the process will make good quality decisions and build consumer trust if it remains iterative – we are all embarking on a journey to an uncertain future. It also needs to draw on diverse knowledge, lived experience, contextual understanding from real consumers, alternative technical expertise, diverse stakeholder and process knowledge about how changes will manifest into final investment flows.

Truer price signals will help open possibilities for better consumer outcomes in any case.

Legitimacy of any AEMC rulings and social licence for changes that eventuate may result from clarity in communications and participation where anyone can feel heard. The AEIC struggled with the same problem – how do you give people more certainty and understanding when the future is inherently contested and unknown?

## QUESTION 3: CONSUMER ARCHETYPES

I am not convinced that engagement is a useful dimension. There will always be people along a spectrum of engagement and the energy transition will eventually catch up with everyone. Will their willingness to engage affect the pricing options to be offered to everyone?

Resources – knowledge, money, skills, relationships, seem fairly important.

Focusing on residential consumers is a shortcoming. Small businesses behave like residential consumers in terms of resources and knowledge. As you go to larger scale businesses, some can afford to professionalise and sometimes outsource advice and procurement issues. Any shift in value flows to consumers begs the question about the markets and skills required to change the way of buying and using energy within business and industry. These B to B markets are smaller and more specialized than consumer markets.

A dimension that may be worth exploring is the “who should do the work of change” dimension.

The markets, government and not for profits that serve up solutions to consumers, if the flow of investment funding goes to decentralised and consumer-led investments, are a significant stakeholder in this review. They are completely missing in this framing around consumer archetypes and may need to represent the types of providers consumers are willing to interact with.

When we look around the average street, there are many car types. Each reflects different consumer personalities, values and budgets. We need to expect that the energy transition may be similarly diverse.

## QUESTION 4: IMAGINING TECHNOLOGIES

*What electricity products and services are available internationally that aren’t available here?*

Services from government or not for profits to retrofit homes and aligned legislation on housing performance for energy efficiency – although we will need to think about renewable homes and flexible energy performance too.

Flexibility markets and control technologies

Day ahead pricing and contracting for many consumers.

Location based markets

Futures markets and utilities that buy energy efficiency and demand management in preference to building new capacity.

In 2016, Nest thermometers boasted (at a US energy conference I went to) that they could solve peak load and consumer interactions while the energy sector didn't stand a chance because they had so little experience dealing with consumers directly.

*Which technological trends may impact the electricity market, beyond those already discussed in this paper?*

Distributed computing technology, distributed manufacturing technologies

Ice storage for flexible cooling loads

Cheaper storage will drive more mobile storage technologies

The transport sector could transition around a more diverse suite of large and small transport technologies.

I would like us to consider metering that allows for a trickle feed or control to reduce to essential only loads. This could be used to supply free energy, provide a trickle of energy even after disconnection and provide load shedding in emergencies that opts for less, rather than none.

*What types of pricing structures might align well with the proposed Consumer Preference Principles?*

- Peak load focused on a small number of hours in the year
- Surplus solar times
- Flexible pricing for loads that can be controlled eg to soak up surplus wind
- Discounts for low income consumers
- Insurance against bill shock, accompanied by genuine support to transform electricity useage

## QUESTION 5: HOW CONSUMERS COME TO KNOW ABOUT OPTIONS

We can imagine that tariffs, products and control systems become more integrated but it is hard to see who and how. The integration may be a market failure, in which case the work of local government information systems or community energy groups could be a key way to help people navigate these choices.

## QUESTION 6: PROTECTING CONSUMERS WHILE INNOVATING

Clearly this is important. I believe early adopters are sometimes willing, able and knowledgeable about the risks they take. I have seen some installer relationships in communities thrive because they were willing to fix mistakes and therefore a level of cross subsidy exists between easy and difficult installations. Investment in education and skills will help. It may be that some insurance inside the trades and installation sector could assist in ensuring problems don't have an outsize impact on these small businesses but encourage learning and improvement inside the sector. There are some interesting coops and mutual arrangements emerging in the Netherlands where groups of freelancers insure each other for sick leave and cover the work that gets dropped during health emergencies.

## QUESTION 7: BARRIERS

I've written extensively about barriers in this submission. I believe the short, medium term and long term economic approaches discussed above contain important concepts about tackling barriers across the timeframes. The AEMC need to pay particular attention to the structures and designs that get embedded into its new approach. These are the transformations that will either provide a clear and successful path forward, or carry too much baggage from the past and therefore continue to need reforming as the energy transition progresses.

## QUESTION 8: NETWORK TARIFFS

Simple to understand and act on. Empowering and no gotcha's. We have heard plenty from consumers that these are important features of a pricing regime. We also need to understand that networks are the main actors structuring tariffs for everyone.

I would advocate for a time of use structure that teaches everyone:

- Expensive – hottest and coldest evenings when there is no wind
- Cheap – controllable load that can chase the wind
- Cheapest – daytime, with a possible adjustment for when it is actually sunny
- Progressive - Discounts for low income
- Action required – support for transformation if you are consistently failing at responding yourself

I would be keen to experiment with local optimisation and appropriate local tariffs. Ultimately local, renewable, community microgrids may be a way to open markets to competition, to help the electricity market work more effectively and to experiment with local governance that supports effective energy transition.

## QUESTION 9: ROLE OF ENERGY SUPPLY BUSINESSES

I think at this stage we should keep an open mind to the actors for market-based provision, government-based provision and mutual self-interest based provision (ie many community models). All should be encouraged and enabled to experiment, which may require some open-mindedness by AEMC as to what the innovation landscape looks like.

## QUESTION 10: SCOPE AND BOUNDARIES

The electricity system boundary at the consumer premises has not quite moved past the electricity meter but it has evolved rapidly in the area of standards and equipment connection rules. I can imagine different boundaries at the local transformer. Indeed many countries leave local government to do electricity purchasing on behalf of the whole community and eschew household level retail competition. Consumers generally don't want to know the three segment structure for electricity services and vertical integration persists in some places. The benefits for consumers need to be jointly delivered by generators networks and retailers so there may need to be some stronger alignment enforced.

No answers, just a plea to be less rigid with how this might evolve, and an embrace of the experimental might be needed. The answer probably lies amongst the 100 experiments that fail.

## QUESTION 11: ASSESSMENT CRITERIA

The AEMC needs to also reflect on the shortfalls of its process when it assesses the outcomes of this review. A transformation will reach beyond the scope and therefore the AEMC will need to be prepared to make recommendation for changes in other sectors and for potential problems with its own limitations.

In any triple loop learning framework we need to go beyond, “did we get it right?” to “are we doing the right thing?”.

# APPENDIX A – TYPICAL CONSUMER VALUES EXPRESSED WHEN DISCUSSING FUTURE ENERGY SYSTEMS

The ranking of values by the Venus Bay and Tarwin Lower community is shown in the Figure below

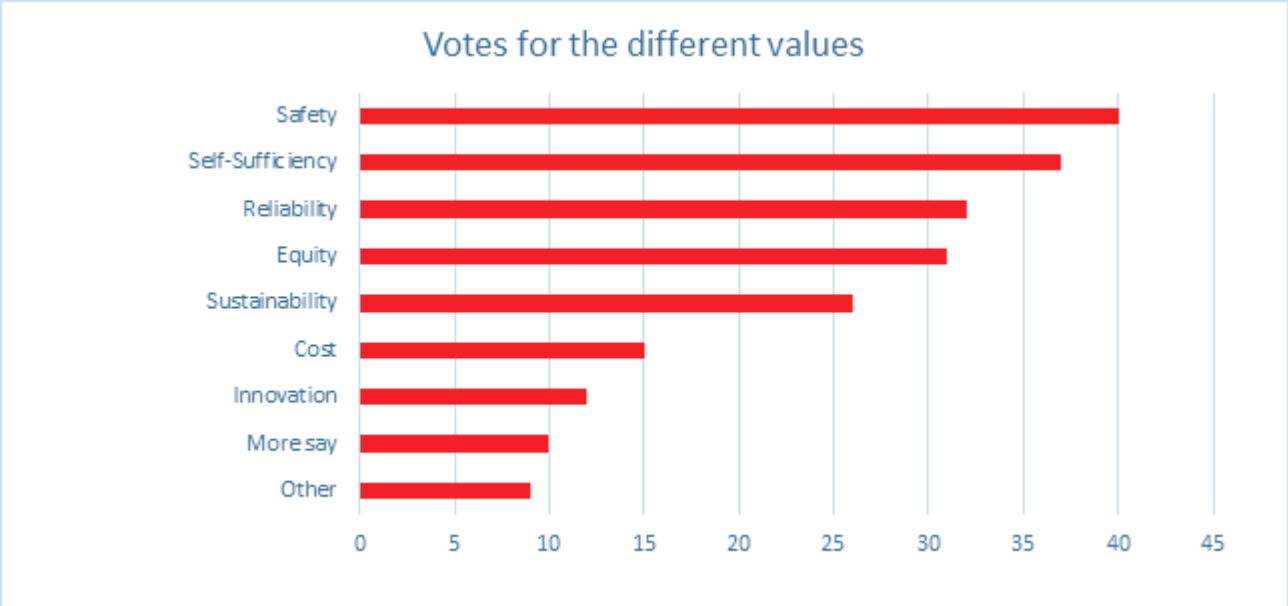



*Figure Community Values for local energy solutions*

Participants described these values as follows:

Safety for us is ……..

- safe places for people to go during outages as a priority
- at personal and community levels
- Critical for keeping communications channels powered up during emergencies e.g., bushfire,
- Providing power for medical needs
- Pumping water for drinking and other uses
- choosing batteries that won't combust or cause fires
- prioritising communications for essential services
- relief and recovery hubs = Centre of Resilience
- Electrical system safety

Self-sufficiency for us is ……

- localised
- a process involving community
- connected to reliability
- separation from big profit driven companies

- having control and say about our energy
- Inclusive of economic benefits for us and government,
- Being smart about not using so much energy,
- putting power of decision making on energy back in community
- A strong community value
- Having a microgrid

Reliability is ……

- resilience
- Strongly related to self-sufficiency,
- crucial as it influences quality of life
- important when prioritising placement of energy systems at sites, clusters and whole-of-community
- Energy that works no matter what
- Accommodation of a fluctuating population
- The ability to support small clusters so a break in the line doesn't affect everyone down the line,
- secure energy supply in at least one place in each large cluster,
- important for businesses and food safety & security, petrol, post office

Equity is ……..

- related to cost
- Involving of the whole community (locals, businesses, groups, visitors)
- Not limited by geography
- Possible ownership of the grid
- supporting everyone in community
- About sharing power and fair usage
- When people with medical needs are prioritised
- Visionary
- When finance & ownership models deliver multiple benefits
- Accessible and inclusive of full-time, part-time, visitors, businesses and community groups

Sustainability is …..

- Inclusive of cost – "if it's not cost effective, it's not sustainable",
- it is 'renewable' energy,

- helping us move away from fossil fuels,
- environmentally friendly, I
- Technology that is reusable or recyclable
- being prepared to link to wind energy,
- long lasting technology, going many days without grid power
- scalable to suit essential needs,
- keeping size & scale low will have positive impact on sustainability,
- Protective of the environmental
- About leadership

Cost……

- Is included in self-sufficiency
- Takes into consideration upkeep
- Includes selling excess power to earn an income that helps pay for upkeep
- Is about lowering energy bills and impacting positively on cost of living
- Effectiveness of each component
- keeps domestic bills down,
- Is reduced by government investment
- Needs to consider scalability and add-ons to enable cost comparisons,
- includes adaptability and open source,
- Encourages living simply and using less

Innovation is …..

- less important for our communities, but we can help lead the way for others and be role models for other end-of-line communities
- we can learn from and improve on what's come before
- integrating future tech like electric vehicles, Wi-Fi transmission
- evident in systems that adaptive, modular, replicable and emerging technologies
- Seen in equity models that cover essentials needs first then enough and everything
- how we can get more control over the grid
- Our opportunity to be leaders because we have been left behind

More say is ……

- included in self-sufficiency,
- Influencing flexible or community feed-in tariffs

- buy-in of non-residents too
- our energy future
- continued engagement of people in the study and the plan as it's rolled out,
- encouraging others to have more say by role modelling how community can lead in the design and decision making

Other values and considerations ……

- Community building
- Collaboration
- Who runs it/owns it/maintains it/covers insurance,
- location needs to not damage peace and tranquility of our landscapes or be divisive to our communities,

CHANGING WEATHER

Transforming Energy

335 Angas St, Adelaide 5000 changingweather.com.au