VISION FOR THE FUTURE ENERGY SYSTEM

National Electricity Market

AUSTRALIAN
ENERGY
COUNCIL

The future potential is clear. Australia can harness our abundance of renewable resources to deliver low cost, reliable and clean energy for all. The technology we need to achieve this is here, and there is every reason to believe continued rapid advancements in clean energy technology and scale will continue creating even more opportunities to deliver better energy for customers where and when they need it.

We are at a critical juncture where much of our current system that has served us well for over half a century needs to be replaced, independent of Government policy. This creates challenges and costs as well as opportunities. The choices we make now will determine how quickly, reliably and cheaply we can transition to a better energy future.

Energy2050 aims to define what a successful transition to net zero by 2050 looks like for Australian energy consumers, focusing on the core trilemma of reliability, affordability and sustainability.

This vision is broadly consistent with official projections out to 2050, but if these projections don't tell us everything about what is required to deliver the transition. If they are the "what", Energy2050 seeks to be the "how".

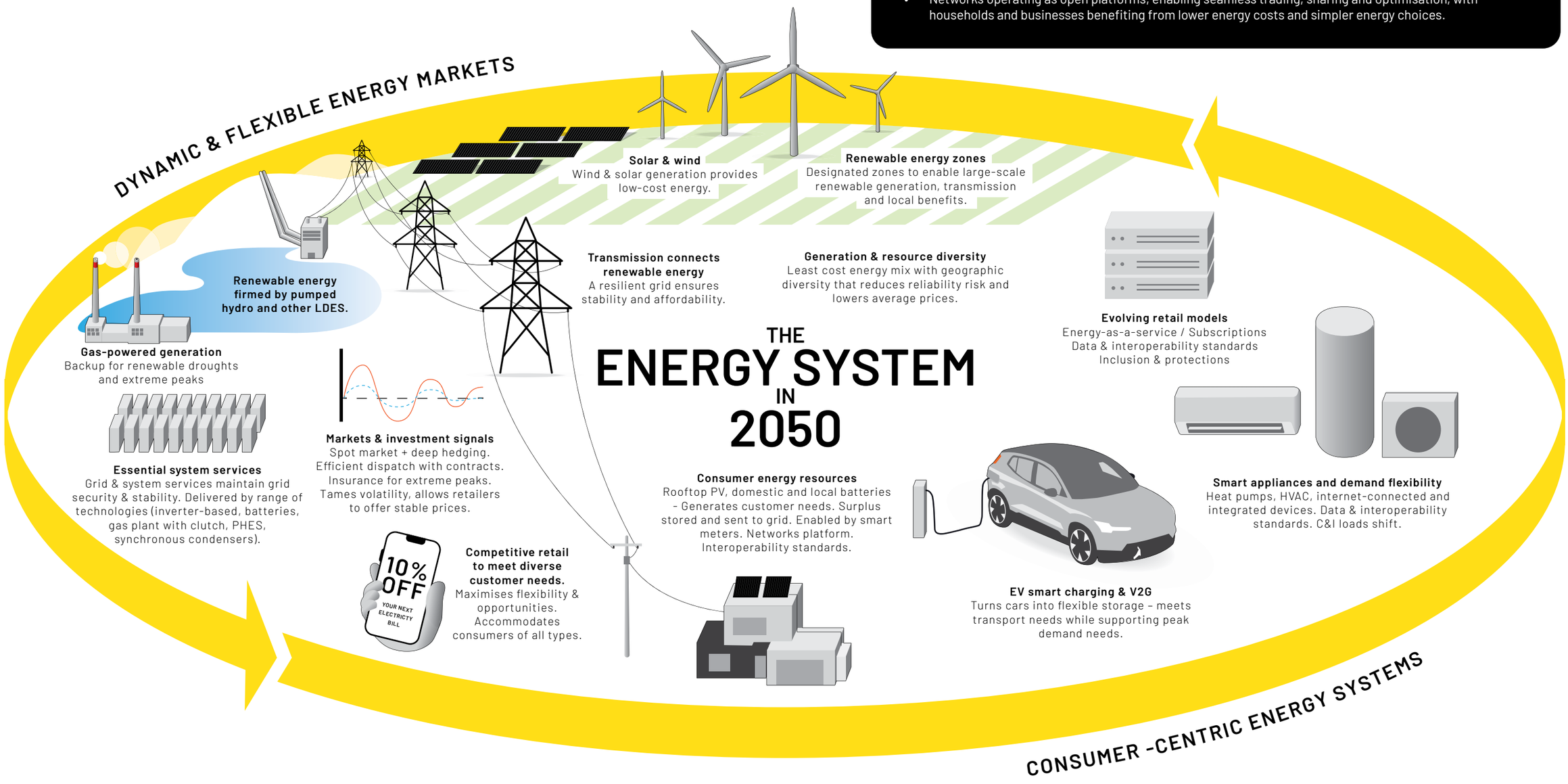
The AEC's vision for 2050 is deliberately intended to be a positive, aspirational "light on the hill". We recognise that makes it a challenging goal to achieve, but as with any such goals, the purpose is to drive action from today with a view to getting as close to these outcomes as possible, as a result of well informed, intentional policy design choices rather than by accident.

The Vision is for a decarbonised energy system based on two key pillars: dynamic and flexible energy markets and customer-centric energy systems. These work together to deliver energy system security, affordability and sustainability.

Energy2050 Vision

A 2050 energy system will be:

- Driven by dynamic and flexible wholesale and contract markets that efficiently reward generation, storage, firming, demand response and a broad range of essential system services to meet customer needs at lowest cost;
- A system with customers at the centre – from households to heavy industry – able to participate as much or as little as they choose, with frictionless engagement and trusted service providers acting on their behalf; and,
- Networks operating as open platforms, enabling seamless trading, sharing and optimisation, with households and businesses benefiting from lower energy costs and simpler energy choices.



The Priorities

The delivery of our Energy2050 vision will require a partnership between industry, governments, and policy makers, all working in concert to develop frameworks that will see a 2050 energy system that is secure, sustainable, and affordable. Energy2050 identifies seven priority areas of focus, each with a number of actions that will create and strengthen these frameworks, and assesses their impact on energy affordability:

Priority		Actions to Deliver	How this drives affordability
1	**Establish clear, durable market and policy frameworks**	Prioritise orderly coal exit pathways to: • Create space for firmed renewables • Improve investment signals for flexible supply - gas/hydro/long-duration storage • Understand and procure competitively for system security • Early, place-based transition planning for affected regions.	A stable market and policy environment will deliver lower wholesale prices than a chaotic one. Competitive procurement for ESS will be lower cost.
2	**Timely transmission delivery**	• Reform the Integrated System Plan to better reflect the likely pace and costs associated with the transition • Strong incentives for managing cost and avoiding delay.	Transmission needs to be delivered on time to enable the generation and storage that will keep wholesale prices down.
3	**Develop new gas supply**	• Drive new supply by removing unnecessary barriers to approvals • Domestic gas reservation set up on forward looking basis • Foster development of opportunities for gas decarbonisation (for example, carbon capture and storage, biomethane, and hydrogen) • Support demand reduction via efficient electrification.	Keeps gas prices as low as possible by incentivising new supply A focus on efficient electrification will deliver lower overall energy bills
4	**Unlock more value for customers**	• Reward customers for supporting the energy systems through their use of consumer energy resources • Align network incentives and market signals to ensure CER can be coordinated at scale.	Ensures customers are rewarded for using their own energy resources in the most efficient way, keeping costs low for all consumers, including those without these resources.
5	**Enable new retail models that benefit a diverse and changing customer base**	Create regulatory and market frameworks that: • Foster the development of more innovative retail models, (e.g. subscriptions, fixed-price offers and energy-as-a-service); and • Ensure sufficient flexibility to allow retailers to cater to a much more diverse customer base with different needs.	Establishes the foundations of a customer-centric energy system that delivers energy at the lowest cost, tailored to different customer needs.
6	**Support large energy users**	• Enable growth industries through integrated resource planning • Focus assistance for energy intensive businesses on helping them transition.	Ensures large users can access competitively priced energy without imposing costs on other users.
7	**Streamline emissions reduction plans**	• Realign jurisdictional emissions targets to deliver a nationally consistent trajectory • Drive reductions across all sectors • Avoid technology targets.	Enables least-cost abatement.

What the system could look like in 2050

The likely physical configuration of the system and the inherent uncertainties are described in the table below.

System Element	Uncertainties
Low-cost solar and wind generation will take advantage of Australia's abundant solar and wind resources. This will be geographically dispersed relative to the historic system.	The mix of wind and utility scale solar is unclear. There's a chance another technology will take market share. The contribution of offshore vs onshore wind is also unclear. While offshore wind has potential to play an important role, its cost characteristics relative to onshore wind are currently a challenge yet to be overcome.
Renewable energy zones should be developed across the system to tap into high-quality wind and solar areas using economies of scale and providing new employment opportunities	The precise number and locations of REZs are unknown and will depend on the generation mix.
Transmission networks, existing and new, will connect the renewable energy from REZs through to consumers, bringing low-cost electrons to heavy industry, businesses and households.	There may be an opportunity for more hosting on the distribution networks. There may be merit in seeking to locate new industry closer to generation.
Firming and shaping technologies will smooth out the variations in renewable supply: batteries for everyday variations, and strategic pumped hydro energy storage (PHES) projects or other long duration energy storage (LDES) for longer-term and seasonal variations.	PHES are large, long lead time assets and it is unclear how many new projects will get built, especially as government support is likely to be critical. The Tasmanian system has scope to play a bigger role in supplying the NEM if the interconnection is there. If long duration batteries or other LDES become cost-effective this could crowd out PHES.
Gas-powered generation will provide necessary back up with critical power supply when it is needed, both for 'renewable droughts' of 'dark and still' conditions, or to meet peaks in consumer demand.	Gas may play a larger or smaller role than anticipated. If there is only a small role for gas, the gas network may struggle with the required flexibility.
Batteries, gas, pumped hydro energy storage (PHES) and other network investments will deliver essential system security (ESS) services to maintain grid security and stability.	There is a need to make a switch from relying on spinning machines for ESS to relying on inverters. How and when this occurs remains to be determined.
Rooftop solar and local batteries, connected to distribution networks both in front of and behind the meter, will generate consumers' own electricity, store it for when they need it, and supply the excess back to the grid.	The scale of distributed resources is uncertain, as is how its owners will use it and whether they will allow their resources to be aggregated and orchestrated to optimise system needs or self-manage to meet their own needs.

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Demand side deep dive

Customer-centric energy systems mean customers of all types and sizes can choose to participate as much as they want - from completely disengaged, passive consumers of grid electricity through to prosumers seeking to actively manage their consumption and produce energy.

For retailers understanding customers in this new energy system will be critical.

	1. Simple Limited engagement	2. CER service Retailer coordinates CER	3. Blended Self-managed / sourced
VALUES	Simplicity, reliability,certainty, comfort, convenience, safety, privacy, fairness, equity, environmental sustainability	SIMPLE + Choice, control, reduced costs / rewards	SIMPLE + Choice, control, agency, reduced costs / rewards
COST NEEDS	Affordability, reduced bills, certainty, no surprises	SIMPLE + Savings, rewards, access to capital intensive CER	SIMPLE + maximised savings, rewards, access to capital intensive CER
SERVICE NEEDS	Energy as an essential services, on-demand, flat / stable prices	Energy manager / partner, dynamic prices	Energy concierge, network / wholesale market cost pass through
COMMS NEEDS	Clear communications, billing information and customer rights	SIMPLE + information on energy services and value of increased engagement	SIMPLE + Education on energy services and value of increased engagement

Realising the Future CER Vision

Retailer-led CER coordination will see retailers evolve their service offerings to get the most for customers.
Retail orchestrated BESS with PV designed to give customer flexibility. Reduces cost to serve.

Current State

Retailers are adapting to the rapid increase in CER, changing consumer expectations, evolving business models, changing reform landscape and ability to deliver cost-effective solutions.

Future state

Retailers are flexible service providers capable of orchestrating diverse energy resources (both in front and behind the meter), managing dynamic prices and enabling value to customers in an evolving energy ecosystem.

Future Retailer Functions

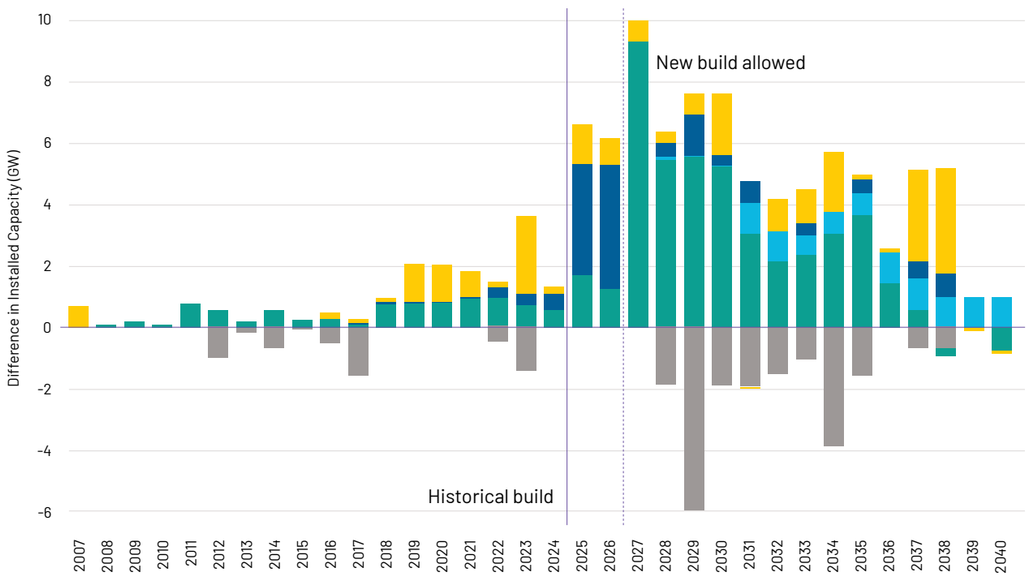
1. Optimiser of CER to deliver low-cost energy
2. Integrator of all CER / demand response assets
3. Protector of customer safety, CER security and data privacy

Retailers must work collaboratively with all parts of the sector, regulators and policy makers to best achieve these functions and maximise the benefits for all consumers.

Supply side deep dive

To hit the NEM's 2030 and 2035 targets, the rollout of renewables will need to accelerate dramatically in the next few years and be supported by firming capacity (storage, gas) and new transmission.

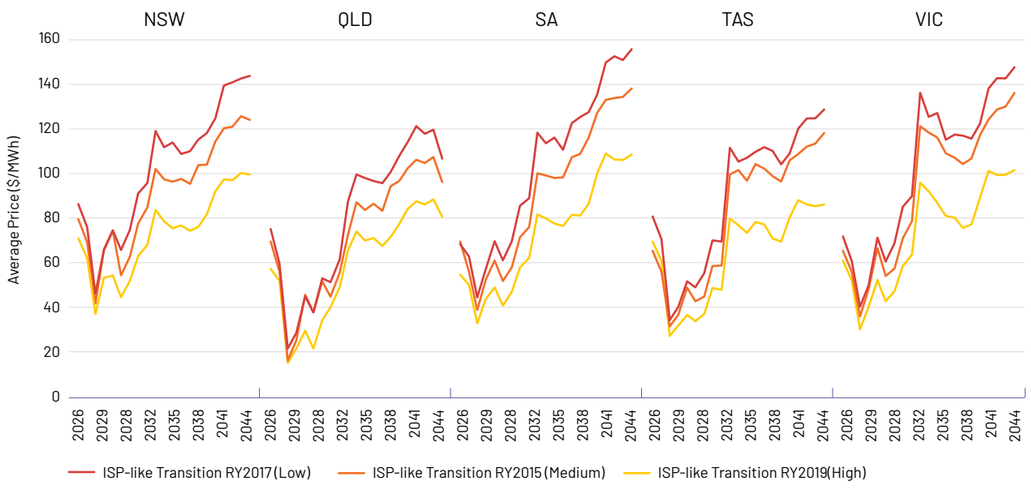
Modelled YoY new capacity for the NEM (GW)



Source: Endgame Economics

Average FY price ($/MWh) for an ISP-like transition (median, low, high weather reference year)

As renewables grow, wholesale power prices will fall. Renewables backed by firming technologies like storage will set the price when coal has exited the grid. Price fluctuations will still occur but will largely be driven by the availability of wind.



Source: Endgame Economics

FAQs

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Dynamic and Flexible Energy Markets

Q. Can competition and market forces deliver the transition, or do governments need to step in?

A. Both play essential roles. Competition can deliver the cheapest mix of renewables and storage, just as it drove down solar costs, but markets work best when supported by clear government frameworks. No market can be expected to meet emissions targets without some mechanism to internalise these targets, for example. Stable investment signals and well-designed support schemes help attract the private capital needed. Competition in the supply of rooftop solar and batteries to homes and businesses has worked well for Australia, while the take-up has also been supported by government schemes and now Consumer Energy Resources are becoming an important part of the grid. When markets and policy work together effectively, the transition becomes faster, cheaper, and more reliable for everyone.

Q. Is the current electricity market still fit for purpose as renewables dominate?

A. Current market design is technology neutral and should be robust to many changes. However, it was informed by the characteristics of coal, hydropower and gas plants, so it needs to evolve alongside the rapid growth of wind and solar. Investors need greater financial certainty to build the backup capacity the grid requires. Encouragingly, new mechanisms are being developed to address this. Getting state and federal policy settings aligned will be important to give businesses and investors the confidence to build what Australia needs.

Q. What do governments need to do to reach net zero by 2050?

A. Clear, consistent emissions targets and a credible plan for transitioning away from coal are fundamental. Aligning state and federal policies and streamlining approvals for new projects will help accelerate progress. Supporting regional communities through the transition is equally important. The goal is stable, long-term policy settings that give businesses and investors the certainty needed to commit to the significant infrastructure Australia needs to build.

Q. Why are fossil fuels still part of the energy mix on the path to net zero?

A. Renewables can't always generate power on demand, sometimes the wind drops or clouds roll in for days. Gas will be critical in the medium term to maintain reliability as it acts as a backup for these gaps, keeping the lights on when solar and batteries fall short. In the longer term, gas is still expected to be needed in 2050, but in much smaller amounts and eventually using cleaner fuels like green hydrogen or biomethane. It's a bridge that helps manage a responsible and reliable transition.

Q. What happens when the sun isn't shining and the wind isn't blowing?

A. This is one of the central challenges of the transition. The answer lies in combining several solutions, batteries for short gaps, pumped hydropower which works like a giant rechargeable dam, flexible gas plants for longer dry spells and peak demand periods, and smart demand management that shifts when we use power. No single technology solves this alone, but together they can keep electricity reliable and affordable even during extended periods of still, cloudy weather.

Q. Can Australia really afford the energy transition, or would it be cheaper to stick with the energy mix we already have?

A. We cannot stick with the energy mix we already have. We are at a critical juncture where much of our current system that has served us well for over half a century needs to be replaced, independent of Government policy. That requires significant new investment and large-scale upgrades.

The least cost, lowest impact pathway is an energy system dominated by renewables (wind and solar, including rooftop solar) and firmed with battery storage, gas and pumped hydropower. There is generally broad alignment across industry about this energy mix given these technologies are readily available and cost less to build and run than other technologies. There is every reason to believe continued rapid advancements in clean energy technology and scale will continue creating even more opportunities to deliver better energy for customers where and when they need it.

Energy systems are always evolving. As we head to 2050 and beyond, new technologies may emerge to play a meaningful role too. This is one reason to ensure we have the right technology-agnostic market signals to encourage investment in emerging technologies as they become commercially viable.

Q. As Australia moves toward a low-emissions energy system, will gas still have a role in generation, our homes and businesses?

A. Gas will continue to have an important role as dispatchable plant and backup for renewables, both during renewable "droughts" and to meet peaks in demand.

There will be very little household and small business gas use as these customers progressively electrify their space heating, hot water and cooking needs. Industrial gas use will only decline slowly to 2050. This reflects the fact that industrial users may find it harder to switch to lower emissions alternatives.

Consumer-centric Energy Markets

Q. Who is really driving Australia's energy transition?

A. It's genuinely a team effort. Everyday customers have played a remarkable role — Australians have installed more rooftop solar per capita than almost anywhere on Earth. Industry is stepping up at the wholesale level, building large-scale renewables and storage. Government policy provides the essential framework that ties it all together. When all three work in concert, Australia is well placed to deliver an affordable, reliable clean energy future.

Q. As rooftop solar, household batteries and electric vehicles become more common, what role will they play in the future energy system and can households still make money from them?

A. These technologies are known as Consumer Energy Resources (CER) and allow consumers to generate and use their own power, reduce reliance on the grid and reduce costs. Retailers will evolve into system orchestrators, coordinating and managing CER, demand flexibility, and wholesale exposure on behalf of customers, while shielding households and small businesses from complexity and risk. Consumers will be actively rewarded for flexibility through dynamic pricing and/or automated optimisation of their CER.

Q. As Australia transitions to a renewable-dominated energy system, what will happen to household electricity bills?

A. While renewable energy is the lowest cost solution available currently, this may not translate into significantly lower prices over the medium to longer term. This is because when thermal plant, like coal generation exits the system, renewables backed by non-weather dependent sources (like gas, hydropower and battery storage) will increasingly determine wholesale electricity prices. From year to year, wholesale price fluctuations will become more common, largely driven by a more weather dependent renewable energy system, and particularly the availability of wind.

Retailers will continue to play a key role in managing wholesale price fluctuations (volatility) behind the scenes, providing price stability and predictability. To do this in a high renewables system however, there will need to be changes in the market regulatory frameworks to ensure that retailers can sufficiently manage this volatility risk and develop the right products and services to support customers.

For households, by 2050, a large part of the transition will be the electrification of the home as gas is phased out. Electricity will more commonly be used for space heating, hot water, cooking and transport.

So, households will shift from having three energy bills (gas, electricity and petrol) to one electricity bill.

Retailers will work with customers to coordinate their rooftop solar, battery and electric vehicles in a way that delivers the most bill savings and supports the efficient operation of the electricity system with customers. In this way, the system operates to share value between those who participate to those who are less engaged and need more support.

Energy companies might even operate more like insurance companies – consumers will purchase a product that ensures security of supply. For those that can't or don't want to be actively engaged in their energy use, retailers will offer simpler, fixed price products and services (like subscription plans and multi-year contracts) that result in more predictable and manageable bills.

Q. What about households and businesses that don't have rooftop solar or batteries?

A. Coordinated Consumer Energy Resources like rooftop solar and batteries will help keep overall system costs lower. Virtual power plants, where electricity from different home installations is coordinated, for example, can see all households benefit from rooftop solar and home batteries. But it will still be important there are value-sharing mechanisms to ensure the benefits are distributed fairly, rather than concentrated among already advantaged households. Some households may choose not to opt in to coordination, and in that case, it's important that we work out how to send them the signals that align their CER use with the system's needs. Regulation in this environment should prioritise customer outcomes, fairness, service quality and consumer welfare, rather than focusing narrowly on controlling electricity prices.

Q. As coal power stations close over the coming decades, what happens to the towns and communities that rely on them?

A. There is no "silver bullet" approach to conducting a just transition for regional development. To allow towns and communities to make a successful transition will need timely and proactive planning, comprehensive community and broader stakeholder engagement along with resourcing targeted to promoting economic growth and diversification. Clear, consistent communication on local benefits and project impacts as well as tangible community benefits such as jobs, infrastructure and investment and local participation in project planning and monitoring will be key ingredients to making the transition.

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