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Electricity and Energy Sector Plan Taskforce
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AI GROUP RESPONSE TO THE ELECTRICITY AND ENERGY SECTOR PLAN DISCUSSION PAPER

The Australian Industry Group (Ai Group) welcomes the chance to make a submission on the Electricity and Energy Sector Plan Discussion Paper (the Paper).

Ai Group is a peak national employer organisation representing traditional, innovative and emerging industry sectors. We have been acting on behalf of businesses across Australia for nearly 150 years. Ai Group is genuinely representative of Australian industry. Together with partner organisations we represent the interests of more than 60,000 businesses employing more than 1 million staff. Our members are small and large businesses in sectors including manufacturing, construction, engineering, transport & logistics, labour hire, mining services, waste services, the defence industry, retail, aged care, civil airlines and ICT.

A successful energy transition is strongly in Australia's national interest. Our economic opportunities in a world pursuing net zero emissions are very substantial if we pursue them effectively, and form a hedge against the likelihood that other countries' transitions will shrink their demand for Australia's fossil exports. And minimising global temperature increases will minimise the serious social, economic and environmental impacts Australia faces from climate change.

At COP28 Australia and all other Parties to the Paris Agreement reiterated their determination to pursue temperate increases of no more than 1.5°C. That goal is very challenging; will require substantially stronger efforts around the world; and could be exceeded even with those efforts, given the slim carbon budget remaining and the range of uncertainty around the sensitivity of the climate to greenhouse gas concentrations. But it is worth pursuing. Every fraction of a degree matters, and a period of global net negative emissions (another substantial challenge in its own way) following global net zero would turn a target miss into an overshoot.

For any of that to be possible – competitive advantage and climate success – the transition of the electricity and energy sectors is central. Directly or indirectly, they are the enablers of the bulk of decarbonisation expected from industry, transport, resources and the built environment. And if Australia is to meet its potential as a clean energy superpower and contributor to global decarbonisation, electricity in particular must scale up dramatically while achieving extremely low costs.

Achieving competitiveness is vital. Australia has strong clean resource endowments, a stable polity and relatively low cost of capital. But there are many other nations with claims to energy advantage; and progress on technologies like floating offshore wind, advanced geothermal and advanced nuclear may well provide nations that currently think of themselves as energy-poor with domestic resources that offer security at a mediocre but manageable price. Australia needs to be very focussed on realising our potential energy advantage, or we will have no convincing case to make to our potential customers for clean energy and clean energy-intensive products.

Many factors contribute to competitive energy costs. Greater global deployment of technologies with strong learning rates, like solar photovoltaics, will cut costs for subsequent deployment everywhere. More specific advantage comes from:

- maintaining relatively low costs for capital, through both the design of energy markets and policy and, as far as possible, their stability; as well as broader economic policy influencing inflation, interest rates and the level and destination of savings;
- making Australia a better place to build at all scales than other jurisdictions, through effective system planning; access to strong local and global supply chains and skills; timely, predictable and well-coordinated approvals processes; and a pro-clean-development culture;
- prioritising clean energy competitiveness. Policy always faces multiple values and competing demands and while win-win outcomes are possible, trade-offs are real and need to be confronted. Australia should not lightly make choices that compromise competitiveness in clean energy. For example, policy to foster local supply of clean energy componentry should not diminish access to international components nor raise their costs.

The annexure overleaf responds to many of the issues raised in the Paper. For any questions in relation to this submission, please contact Ai Group Director of Climate Change and Energy Tennant Reed (tennant.reed@aigroup.com.au, 0418 337 930).

Sincerely yours,

Louise McGrath
Head of Industry Development & Policy

Annexure

Mobilising investment

1. What actions are needed to attract the required large scale private capital and household investment in the energy transformation, with or without government intervention?

The Paper is correct that a large absolute amount of investment will be needed over the next several decades for the electricity and energy sectors, and behind-the-meter consumer energy resources, to transition and take up opportunities. On the other hand, Australia's economy-wide levels of capital investment have been comparable to other advanced economies and in the last five years we've become a net lender to the rest of the world. While the investment share of GDP may still need to rise, the composition of investment certainly needs to change more. It is worth thinking about prioritisation and relative incentives in this broader investment context, not just dynamics specific to the energy and electricity sectors.

With respect to electricity market design, governments have overlaid a patchwork of interventions on top of the wholesale energy only market and associated financial market that were originally intended to guide investment in the National Electricity Market. These interventions, most obviously including public underwriting of various new assets, responded to very real problems:

- The underlying NEM design had a strong track record in squeezing efficiencies out of the legacy assets bequeathed it by State electricity authorities, but little record of supporting new investment (in large part because little new investment was needed during its first fifteen years);
- Large amounts of new investment were then suddenly needed in bulk generation, flexible resources and transmission;
- Emissions reductions have become an increasing priority and the wholesale electricity market does not have a means of valuing them following the repeal of the carbon pricing mechanism;
- Policy and market uncertainty amid massive technological change threatened to raise risk premiums for new electricity sector investment.

The interventions are a very important fact of the electricity system. But they are not yet a scalable or sustainable *substitute* for the electricity market. The various State and Federal contracting arrangements all appear to have been budgeted and agreed with the view that the wholesale energy market would ultimately provide the revenue to pay for supported projects; the contracts would have little net cost over the long term, particularly given the scope for clawback of past payouts if realised electricity prices rose high enough subsequently.

But if this is the underlying assumption, it is not at all clear that it is correct. We are headed towards an electricity system where the vast majority of bulk energy is produced at a short run marginal cost of zero. Is the energy-only market with marginal pricing credible as a basis for the recovery of the costs of new investment under those conditions? It is possible that the financial overlay of private and public contracting, and the physical overlay of energy storage, will make it work. It is also possible that wholesale markets as currently designed will not deliver the revenue hoped for and that underwriting schemes will continue to be needed and have significant net payouts over time. A fundamental re-examination of the core mechanism should be central to the work underway on post-2030 electricity market design.

Several other issues should be part of that work to ensure we can attract and sustain the efficient investment needed to provide energy services at least cost and net zero emissions.

How should we reward efficient investment in flexible resources, especially those that are very rarely used but important for backup? The prospect of occasional very high spot prices is a risky foundation for new assets and probably will not suffice to bring on substantial new gas peaker capacity, even if the Market Price Cap were significantly increased (a change of which most energy users would be extremely wary). Such peakers are excluded from the Capacity Investment Scheme to avoid perverse emissions impacts, although they play an essential low-utilisation backup role during rare renewables droughts in the Integrated System Plan and other modelling exercises. A Capacity Mechanism could support such assets but a previous round of development ran into fierce concerns from many stakeholders, including on emissions impacts.

That raises the salience of the broader question of how emissions should be managed in the electricity sector. While there is now a significant emissions value to guide decisions such as economic regulation of networks, there is no market or policy constraint on generation emissions. In recent years this may have begun to be perceived as fine, since the vast bulk of electricity emissions come from coal generation and coal is retiring anyway due to age and economics. However there are still strong reasons to address electricity sector emissions more comprehensively:

- The rate and sequencing of coal retirements would likely be more certain and rational with a carbon constraint and value signal;
- The absence of a carbon constraint has left no answer that is both efficient and credible when fears arise that other energy reforms will have perverse consequences for emissions; and
- A further horizon looms of investment and operational decisions that do not concern coal and would benefit from a carbon signal. In ISP scenarios the NEM has important residual emissions due to the use of gas peakers. In principle these could be substituted with or upgraded to peakers that burn hydrogen or biodiesel, but there is no policy or market signal to close the cost gap.

Past efforts at carbon price signals in the wholesale electricity market were complicated by the close link between carbon prices and wholesale electricity prices in a market dominated by highly emissions intensive coal generators. This need not be the case under a future signal:

- As coal retires, energy storage takes on more everyday flexibility roles, and gas settles into a (likely long-lasting) backup role, emissions intensive generators would set wholesale prices much less often;
- Mechanism design can moderate wholesale price impacts. Emissions baselines, as used in the Safeguard Mechanism, seek to limit the portion of emissions for which an emitter is liable to sharpen marginal incentives while limiting overall liabilities. Grandfathered but time-limited emissions rights can provide assurance of overall emissions budgets while limiting out of pocket costs to market participants.

The idea of sharper locational signals for investment has been much discussed in recent years, with a deep divide evident between energy market bodies (whose staff broadly think locational signals are necessary for efficient investment) and energy investors and developers (who largely think proposed locational pricing would be negative for financeability without offsetting benefits). More dialogue may not overcome these entrenched differences.

In the short term government contracting, particularly the Capacity Investment Scheme, and other incentives will play a crucial role in catalysing necessary investments. At the same time we should develop a new, efficient and credible mix of market and policy mechanisms that can support investment over the longer term and ensure that contracting liabilities are manageable. A capacity mechanism is worth examining again but will require a convincing and workable answer to emissions incentive fears. Options for the latter could include emissions performance standards, or building on the electricity element of the Safeguard Mechanism.

The previous effort to design a Post-2025 NEM produced only moderate results after considerable effort. Many factors contributed, but one was the lack of consensus on change from stakeholders. Some thought that the underlying NEM design remained the best available and should not be changed in substance. Rather more thought that the main game was public contracting schemes and NEM reform would risk undermining those. We are hopeful that a fresh round of market reform consultation will find stakeholders readier to hear a case for change.

Enabling electrification

2. What actions are required to ensure Australia's energy systems can enable increased electrification, while maintaining equity, reliability and security?

3. What insights do you have on the pace, scale and location of electrification, and how to embed this in system planning?

4. How can electrification efforts be sequenced to align with expansion of electricity generation and network capacity?

The rate, extent and quality of electrification and demand-side flexibility are so important to the evolution of the supply side that their detail must be central to the Electricity and Energy Sector Plan. While an effort to demarcate the boundaries between Plans that leaves behind the meter / behind the farm gate matters to the other Plans is understandable, it is not efficient or responsible.

Electricity demand is certain to expand, whether through electrification of many activities currently powered by fossil fuels; growth of clean energy-intensive industries like green hydrogen and green iron (though this depends on global demand for clean products and Australia's success in pursuit of energy competitiveness); and potentially by the expansion of other activities like AI (though past experience with dramatic improvements in information technology efficiency suggest that even strong AI growth may not disrupt energy systems). It is tempting to think that Australia just needs a supply focus to meet these needs.

However a strong focus on the demand side, and especially on the quality of electrification, can make large resources available to the electricity system at low incremental cost. On the other hand poor quality electrification could create immense and costly pressures on generation, transmission and distribution.

For example, if all registered passenger vehicles in Australia were battery electric vehicles (BEVs) with at least 50 kilowatt hours of storage, that would be more than 700 gigawatt hours of storage, (or double Snowy 2.0) of which around 10% would be used for transport daily. At this penetration, maximum peak charging capacity would be around 280 gigawatts (or more than 100 times Snowy 2.0); if all chargers were bidirectional, discharge would be equivalent.

BEV penetration is rising rapidly but will take a long time to mount up. Vehicle-to-grid services are much more challenging to activate than smart charging. There are almost no bidirectional chargers and their cost increment is currently significant. Nonetheless activating even a small fraction of the positive electricity system potential of BEVs would be extremely consequential for the amount and mix of other system investments required. And equally, failing to at least ensure effective concertation of charging could mean a requirement for vastly higher investment in meeting peak demand.

Other elements of electrification and demand-side flexibility have substantial systemic consequences too. Major energy-using household appliances can be controllable and may increasingly have integrated batteries. Fully electrifying space heating and water heating in Victoria – whose large population, high gas penetration and cool winters make it the most significant residential gas user – might add nothing to peak network demand if done through high efficiency appliances and strong coordination of time of use, distributed generation and storage; or it might add perhaps 11 GW to peak demand (roughly doubling it) if done with low efficiency appliances whose usage, other than among solar households, overlaps the evening peak.

And the consequentiality of the demand side is just as great when we look beyond the electricity system to gas. AEMO projections have repeatedly highlighted that expected Eastern Australian gas supply will not meet expected gas demand by the late 2020s, and will fall ever further short thereafter. New actions and investments are required – whether on the supply side, demand side or both. The Gas Statement of Opportunities projections make clear that the assumed rate of electrification is a very major swing factor in supply adequacy, but the GSOO process is not set up to consider or proposed proactive demand-side options for remedying shortfalls.

Supply side gas options will be important, especially given the time needed for demand side transition policies to build up. But supply side options (including new production, transport, storage, and liquefied natural gas imports) all have serious problems.

Extended supply options involve emissions that can be substantial and hard to reconcile with carbon budgets on the way to net zero. While some might be able to be repurposed, generally they add to the sunk capital that will be stranded as energy transition proceeds. In the case of LNG imports, depending on how their relationship with the local market is mediated, they may increase local energy prices. And new local production appears fairly costly.

Demand side transition – whether to electrification or, for some energy users, biogas or hydrogen; or simply improving the efficiency of existing gas use – is necessary over time. Doing it more rapidly is challenging, but a very important option for easing medium-term gas system pressures as well as long term net zero.

We therefore urge the Government not just to put demand side transition on an equal priority footing with supply side investment, but to try to co-optimise the two. A more proactive process is needed to generate actionable demand-side options for consideration alongside the supply-side options considered in the ISP, GSOO and so forth.

Many elements will contribute to the quality of electrification and demand-side flexibility, including:

- Standards, regulation and enforcement. Up-to-date product standards are important to ensure high-quality and capable appliances. Other forms of regulation are important to quality of installation or the performance of new buildings and rental properties. Ai Group members have recently been raising concerns with the Victorian and NSW Governments about instances of poorly installed heat pump hot water systems.

- Network and retail pricing structures and wholesale energy market design. The way people pay for energy, or are paid for their services, need to encourage the creation of value for all – and operate in ways that are actually useful and accessible. Innovation by retailers and energy services providers is crucial.

- Skills. There is a major task to upskill existing plumbers and electricians, for instance to boost familiarity with heat pumps and safe handling of low-global warming potential refrigerants.

- Supply chains. Signaling product demand well ahead will be important to enable sufficient access to smart, efficient and controllable appliances.

- Awareness and education. Consumer comfort and understanding are central to activation of the potential for shifting loads and providing grid services.

Achieving progress on all these elements is complex but an essential complement to supply-side efforts if we are to achieve an affordable, reliable energy system that enables net zero across the Australian economy.

Growing alternative low carbon fuels

5. What policy settings and certainty are required to support a fair, equitable and orderly transition for the decarbonisation of both natural gas and liquid fuels?

6. What actions are required to establish low carbon fuel industries in Australia, including enabling supply and demand, and what are the most prospective production pathways?

7. Are the proposed policy focus areas for managing the liquid fuels transition (outlined in Section 4 of the discussion paper) the correct areas to focus on, and what is missing?

"Least cost" approaches

Policy to drive transition in gas and liquid fuels can learn important lessons from experience with electricity sector transition. That includes how to think about least cost abatement and emerging technologies. One approach has been to prioritise deployment of the current lowest-cost technologies, leaving others til cheaper opportunities are exhausted or relativities change. An alternative – or, more properly, complementary – view has been to drive early deployment of expensive technologies that demonstrate strong learning rates and thus have the potential to become cheap with experience.

The latter approach can also make a claim to be 'least-cost', judged over the whole sweep of energy transition rather than optimising at a single point in time. That longer view is also important when considering applications that offer some emissions reductions in the medium term but are not a plausible part of a net zero pathway. These may be worthwhile in the near term simply to build scale and deployment of clean fuel technologies; but the amount of new locked-in or stranded demand-side capital should be minimised.

Thus policy for transition of gas and liquid fuels should be open to supporting technologies that currently have high costs, but only where they have a plausible path to being cost effective and relevant over the long term through scalability and learning rates.

Managing gas network asset value loss

All stakeholders, including gas distribution network operators, now appear to expect at least a significant amount of electrification of energy services currently provided by natural gas. While some uptake of biogas and hydrogen by appropriate energy users can be expected, utilisation of the existing gas networks will be less than was once expected.

Among the important questions this raises is the fate of the Regulatory Asset Base (RAB) – the value of the gas networks that, under our system of economic regulation, they expect to recover from customers over time. The existing regulatory framework was well suited to its original context – eternal gas networks that grow cheaper and more useful as more customers connect – but is not functional in a context where demand declines significantly over the long term and where segments, or whole networks, may exit.

All the options for dealing with the RAB of declining gas networks are unattractive in one way or another:

- Status quo – the RAB will be recovered from remaining customers. This promotes a 'death spiral'; customer exit means the RAB is recovered from fewer customers via higher unit prices, driving more exit, driving higher prices. Impacts on those least able to switch could be intense and inequitable.
- Accelerated depreciation – more of the RAB is recovered in the near term before customers are able to exit. This means higher gas user costs now and if pushed far enough to address long term issues it will still accelerate a death spiral.
- Exit fees – exiting customers are charged their share of the RAB at the time of exit. This is very unpopular and disincentivizes the transition that many governments want to see.
- RAB mergers – gas distribution RABs could be merged with electricity distribution RABs, enabling continued recovery of costs from a stable customer base. But it would be unwelcome to many electricity users, and significant work may be needed to match RABs.
- Write-downs – the value of RABs could simply be reduced by regulators and asset operators, and never fully recovered. However, this would mean ripping up the regulatory bargain (that networks earn low returns on investments that must be approved; but once approved, investments will be recovered). That would be unwise at a time when we expect electricity networks (often also gas network operators) to make large new investments.
- Nationalisation – RAB losses could be taken onto public finances, either through buybacks or long-term payments. This is unlikely to be welcomed by Treasuries.

Some combination of these options will likely be needed and it is important to start work soon among many stakeholders (energy users, energy networks, governments) to arrive at the least worst combination. If left in place, the status quo approach to repaying the RAB will become highly inequitable and dysfunctional.

Bioenergy

Biogas specifically and bioenergy more broadly offer important opportunities to meet vital economic needs while reducing emissions at low or moderate cost. When feedstock is well-situated, existing industrial gas use can transition with minimal change in core production processes.

However there are at least three major complexities to biogas.

- Situationality. The economics of biogas are best where existing waste feedstock is easily available near the end use. Gathering wider feedstocks comes at a higher cost increment. Growing dedicated energy crops would be still more costly.
- Neutral and inclusive versus tailored and compartmentalized policies. The existence of several tiers of biogas cost, together with other currently-costly alternatives in clean hydrogen production, creates a tension in policy design. Broadly inclusive policies which incentivize takeup of the currently cheapest solution have often been used by Australian policy makers, as in the Large-scale Renewable Energy Target or the various State energy efficiency schemes. However depending on the overall ambition, these can easily be saturated by takeup of activities that are close to business as usual, delaying further development and deployment of higher cost but ultimately more scalable solutions. On the other hand, tailored or compartmentalized policies can address each individual opportunity, at the cost of potentially missing efficiency opportunities and over-relying on policy maker judgment.
- Competing demands. The inputs that can support biogas – municipal waste, agricultural waste, forest waste, and energy crops – could also support a range of other applications including sustainable aviation fuel (SAF), biochemicals and bioplastics, biodiesel, and bioenergy with carbon capture and sequestration (BECCS). There is not enough sustainably and economically producible feedstock to supply all these applications at transition-relevant scale. Prioritisation will be needed. In the medium term it is likely that SAF will be a dominant application due to sectoral commitments and passengers' relative willingness, or at least capacity, to pay the premium involved. In the long term, the world will almost certainly overshoot the carbon budget for 1.5°C and plausibly will seek to bring itself back within that budget through a period of net negative global emissions. The demand for negative emissions would be significant, and BECCS is both more scalable than reforestation and considerably cheaper than Direct Air Capture with Carbon Capture and Sequestration (DACCS). SAF and BECCS would require very large amounts of biomass.

Hydrogen

Hydrogen has many potential uses in a decarbonised economy, though there are competitors for almost all its roles and it will only prevail in some contexts. Electrolytic hydrogen is very expensive today, but it has a plausible pathway to much lower costs based on learning rates in renewable energy and (with less certainty) electrolyser production. It could scale very dramatically if demand were high enough – Australia has enormous renewable energy potential and while freshwater is precious, desalination is a minor and very feasible addition to the energy and capital requirements of electrolysis. Getting to low cost hydrogen requires:

- Continued focus on unlocking the cheapest renewable electricity production. While some very cheap or free electricity will be available from the otherwise-curtailed output of generation built to meet non-electrolysis needs, the electricity intensity of electrolysis is so great that a transition-relevant volume of hydrogen cannot be produced in this way. Electrolytic hydrogen will require dedicated electricity resources whose full cost it covers, but it cannot achieve deep cost reduction goals while paying for the full costs of the grid reliability standards expected by other energy users. Therefore truly cheap and large scale electrolysis will either be off-grid, or have a very carefully defined relationship with the grid to avoid unwanted cross-subsidies in either direction. This may allow for mutual value from demand response by grid-connected electrolysers when the rest of the system is under unusual stress.
- Support for deployment of early and expensive hydrogen production capacity. Innovation is vital and Australian researchers and startups have much to offer, but learning by doing is likely to be the main

driver of cost reduction in electrolysers. Global deployment and learning will drive declines, but Australia has a strong interest in contributing to and accelerating this given our aspiration to export hydrogen or (more plausibly) derivative products. The Hydrogen Headstart program looks set to be a strong early driver, supplemented by the NSW Hydrogen Target. Expanding Headstart or complementing it with supply chain-focussed support is worth considering.

- Early demand is essential to catalyse early supply, and support should be offered where the use cases either make long term sense, or put minimal capital at risk of stranding. Green ammonia must have hydrogen, green iron likely requires it, and heavy long distance transport is a plausible use case. There are significant cost gaps, investment requirements and operational disruptions to be managed in uptake in these contexts, and policy drivers will be needed. The Safeguard Mechanism will play a role, potentially supplemented by a Carbon Border Adjustment Mechanism, but transitional investment support is likely also needed. By contrast, use of hydrogen as a source of low-grade heat may not make long term sense, and significant investments predicated on eventual full substitution are at least premature.

The rewrite now underway of the National Hydrogen Strategy will be important for determining and signalling a coherent view of the plausible high-value applications for hydrogen. Early indications from the consultation so far are positive.

Building Australia's clean energy workforce

8. What actions are required to ensure workforce requirements for the energy transformation are met, while supporting equitable outcomes?

Achieving our energy sector transition will require pulling multiple skills levers: training and retraining are foundational; domestic workforce mobility needs to be facilitated; skilled migration will be important; automation could be transformative and needs to be embraced. Australia has emerged from the pandemic with a tight economy rather than the structural unemployment that many feared. That is an important achievement, but it means that for the foreseeable future, our challenge is not to drive job growth per se, but to achieve our economic, social and environmental objectives with the skills and people available. Trade-offs are very real.

Training and retraining are clearly foundational and require clear policy objectives driving effective policy instruments, strong leadership and genuine collaboration. To achieve this we need policymakers, business leaders and the education and training system on the same team.
Policymakers need to set clear national policy objectives, provide the right pathways and incentives, and to communicate them clearly. This will give businesses the confidence to invest and take action for the medium to longer term.

Business leaders will need the capability and foresight to see what's over the horizon, to understand the regulatory and policy framework and formulate their strategies accordingly. The education and training system needs to work as an effective partner in developing the skills and capabilities needed to get us there. Together, we need to build the capability to navigate this significant transition. This means continuing to develop data and modelling at the national level and enhanced support for businesses to undertake workforce planning and connect with others to share insights. This may mean thinking of new platforms to share information and solutions.

We need to build the education and training system to take us there. This means a better connected, more integrated tertiary education system encompassing both VET and higher education, implementing the recommendations of the Noonan review of the Australian Qualifications Framework and strengthening and extending the apprenticeship system. It also means incentivising greater collaboration between education and training providers and industry, including stronger research linkages between universities and businesses and more opportunities for work integrated learning.

We also need to assist existing or 'at risk' workers to gain the skills and capabilities needed to thrive in a transitioning economy. This means embedding clean economy literacy across all qualifications, increasing access to short form training and developing generic skills and capabilities like collaboration and communication which are becoming more important than ever.

Workforce mobility is crucial because much of the new energy and electricity infrastructure need will be distant from existing assets. It is important to fairly manage the impacts of coal asset closures on affected workers, and on nearby communities; but these can be distinct problems with distinct solutions. While videoconferencing and remote operation have roles to play, as do temporary accommodation and in some cases fly-in fly-out, it will be important to make it as easy as possible for people to move permanently for energy sector work.

That ease of movement is significant to energy, but solutions lie outside energy policy. Perhaps the greatest overlap is that a sustained boost to housing supply, whether in urban cores or their fringes, requires the same positive and permissive attitude to smart development that energy transition needs.

Skilled migration will be important not only because of the challenges of matching the rate of local skills acquisition to demand growth, but because some of the necessary skills are not present in Australia at all. For example, the recent *Silicon to Solar* study that informed the Solar SunShot program found that Australia simply lacks many of the highly specialised skills involved in production of polysilicon, ingots and wafers and solar cells. Skilled migration will be needed, at a winimum to train the first generation of local workers. Our skilled migration program needs to be kept closely informed of the emerging needs of the energy transition.

Automation will be of tremendous importance in expanding Australia's capacity to get transition done. This will take many forms, from artificial intelligence augmenting analytical capabilities and compliance, to assistive robotics in manufacturing and construction, to autonomous systems in monitoring and maintenance. There has been widespread nervousness in recent years about the prospect that various kinds of automation might create major social and employment dislocation. In fact the challenge of delivering energy transition, alongside other major social needs, is so large that we should welcome all forms of productivity-enhancing automation, while maintaining a strong safety net and building an education and training system that is more responsive and more accessible.

Maximising outcomes for people and business

9. What actions are required to ensure better energy outcomes for people and businesses, and maximise their benefit from the energy transformation?

Our main observation here is that many reforms, such as the construction of transmission or the uptake of dynamic and time-of-use energy network pricing, carry both the potential to make some individuals worse off at first, and the expectation of societal gains that are more than large enough to compensate the losers.

If our response to the risk of short-term losers is to defer necessary action – whether explicitly, or implicitly by making reforms opt-in – then we will all be worse off over the long term. Education, assistance and compensation are well worth paying for to achieve faster deployment of supply-side assets and faster activation of more responsive demand.

10. What social licence and circular economy aspects should be considered as part of the pathway for the energy transformation?

Social license is a colossally important topic. Failure to secure sufficient social license for the deployment of new energy infrastructure would lead either to escalating damage to energy reliability and affordability as new assets go unbuilt and old assets decay; or to significant strife as assets are built over the objections of host communities, likely leading to backlash that strangles further deployment.

These are grim alternatives, but they should be fully avoidable. Four important elements to a social license strategy are:

- Transmission. While transmission projects are often themselves controversial, they are crucial to unlocking access to renewable energy zones that are more distant from intensive land uses and hence both more economically attractive (as land prices are low) and less subject to social license problems (as they impact fewer people).

- Appropriate financial incentives for affected landholders, including both hosts and (at a lower but significant rate) immediate neighbours. There is strong evidence that financial incentives are effective in avoiding or allaying the objections that can arise when neighbours feel they are experiencing disruption without a material stake in the success of energy projects.

- Approvals processes that offer adequate but time-bound opportunities for intervention by affected parties, enabling timely decisions. In public debate, approvals processes are often discussed mostly in terms of their impact on new fossil energy developments. The ultimate constraint on these developments is demand in local and international energy systems that are transitioning towards net zero emissions. Predictable, time-bound approval processes with the necessary minimum of veto points and relitigation opportunities are essential to enable Australia's own transition.

- Building the public case for new development. New development of energy infrastructure faces misperceptions. Regional communities often believe that projects primarily benefit cities while imposing costs on regions; in fact all energy users' power bills will be substantially higher, and their reliability substantially lower, if new assets cannot be built where they are needed. On the other hand, within urban areas status quo bias slows the upgrade of properties and densification of residential areas that are necessary to lift the availability and energy performance of housing supply. Governments and stakeholders should both make the case for change.

With respect to the *circular economy*, the resource requirements for energy transition are significant and will be much more manageable with significant attention to the recovery of materials at end of life. The product stewardship arrangements under development for solar panels, alongside other e-waste, will be important and useful. Potentially the Government's efforts to foster an Australian solar supply chain can provide an avenue for the flow of recovered materials. Meanwhile, the steep growth in demand for lithium seems likely to support a strong recycling sector globally and perhaps locally, with appropriate scrutiny of the quality of practices here and in any overseas locations to which we send end-of-life batteries.

11. What are other gaps in Australia's energy sector decarbonisation policy and what actions are required to address them?

There is a significant challenge in the scale difference between scenarios for Australia's domestically-oriented transition and our needs if we are to succeed in clean energy-intensive export markets.

One aspect of this challenge is coherence. If we are to offer a truly compelling long-term economic case for large-scale export-oriented production of green metals and chemicals, we ultimately need to achieve all-in costs of electricity supply to those industries that are very low by global standards while scaling supply enormously. If we cannot deliver low costs, those energy intensive exports will not exist. That would simplify our energy deployment challenge, but at the cost of missing out on substantial economic benefits. Planning for these scenarios needs to be internally coherent:

- projected export-oriented energy intensive industries cannot be sustained at transition relevant scale on surplus energy spilled by generators primarily built to meet domestic demand; and

- Export-oriented energy intensive industry competitiveness will rely in the long term on the cheapest bulk energy and minimizing reliance on any but the cheapest storage and other flexibility services. Offshore wind, for example, may add important value in the broader energy system through diversity and higher capacity factor, but it is unlikely to ever support a competitive advantage for energy intensive activities – both because it is much higher cost than onshore renewables, and because there are many other jurisdictions that could deploy large offshore wind capacity and Australia has no special advantage.