ENGINEERS
AUSTRALIA

Review of Climate Change Policies

Engineers Australia submission to the Department of Environment and Energy

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1. Executive summary

Who we are

Engineers Australia is the peak body for the engineering profession in Australia. With 100,000 individual members across Australia, we represent all disciplines and branches of engineering. Engineers Australia is constituted by Royal Charter to advance the Science and practice of engineering for the benefit of the community. Engineers Australia's response is guided by our Charter and Code of Ethics which states that engineers act in the interest of community, ahead of sectional or personal interests towards a sustainable future. Engineers are members of the community and share the community's aspirations for Australia's future prosperity.

Our vision

Engineers Australia accepts the comprehensive scientific basis regarding climate change and has addressed this in its sustainability and climate change policies[1]. The influence of anthropogenic climate change can have very serious environmental and community consequences and engineers are uniquely placed to provide both mitigation and adaptation solutions. Engineers Australia encourages national greenhouse gas emission reduction targets to be pursued to enable transition to renewable and sustainable energy, water, transport, industry and agriculture systems.

Background

Engineers Australia has extensive involvement in public debate on energy policy, releasing *The future of electricity generation report* in 2017, making submissions to the review of the National Electricity Market (NEM), and the inquiry into modernising the electricity grid, as well as having a climate change policy since 2007. There are large numbers of engineers who work in the energy sector, who will be crucial to providing Australia with reliable energy in a carbon constrained economy.

Climate change and energy policy

Any changes to Australian energy policy will need to comply with the Paris climate change conference agreement (Paris COP21) which saw Australia set an emission reduction target of 26 to 28 per cent reductions on 2005 levels by 2030. For Australia to be successful in achieving this target all aspects of energy use will need to play a role, and this should be set out by the Australian government through a national transition plan which details the major milestones to achieve our international commitment.

The present position of national climate change policy leadership has resulted in ambiguity and confusion as individual jurisdictions have adopted their own targets and policies. The long-term character of the challenge requires a national transition plan which seeks bi-partisan support for political stability but still allows flexibility for future technological advances.

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[1] Engineers Australia, Climate change and sustainability policies. https://www.engineersaustralia.org.au/Government-And-Policy/Policy-Reports

Future workforce, innovation, research and development

To meet challenges in a carbon-constrained future the nation needs a skilled workforce which has the ability to innovate. Workforce planning is always required to maintain a stable and healthy economy, and as the workforce evolves, new jobs will emerge as technology advances. A key strategy has been the push in the development of scientific, technological, engineering and mathematical (STEM) skills of the workforce. However, there needs to be policies which address the falling rates of students completing engineering-enabling subjects in year 12. If we are to build the engineering capability of the future, policy makers must now address the issue of falling participation in these subjects. Governments must also work to promote best practice collaboration between research organisations and industry, which will to further advance productivity, innovation and progression.

The electricity and transport sectors

Australia needs an energy mix which can provide the nation with secure and affordable energy, within environmental constraints. All options which can provide minimal externalities including environmental damage, health effects and greenhouse gases, must be on the table for consideration. Electricity generation and transport are two of the nation's highest emitting industries, and these two sectors should be targeted by climate change policies.

For electrical generation, policies need to consider new generation options, new technologies in transmission and distribution, as well as behind the meter technologies that will help consumers generate their own energy and make their energy use more efficient.

For the transport sector, programs and policies should lead to an efficient and low-emissions transport system, including fuel efficiency standards and alternative fuelled vehicles.

Complementary policies

The Australian Government has signalled energy productivity as a major focus of Australia's energy policy through the National Energy Productivity Plan (NEPP). This plan does not take full advantage of energy efficiency as a form of direct action which achieves results in most policy environments. Australia has a real opportunity to exploit the benefits of energy efficiency throughout the economy. Australia should more aggressively pursue energy efficiency policies as it offers dual benefits: it is an effective way for Australia to reduce its emissions, and it avoids the opportunity cost associated with unnecessary expenditure on energy.

Impact on jobs, investment and regional Australia

Climate change policies can influence the employment prospects of many Australians, especially in regional areas. This is due to many large capacity fossil fuel power stations located on the fringes of major cities and in small regional towns. Quite often communities can become dependent on the economies of the power station and policies which change the viability of these stations can limit employment opportunities in that community. Both Commonwealth and State Governments must work to find the best possible outcomes for workers and their families, including helping displaced people to shift into other jobs and opportunities through

structural adjustment packages or through the investment and stimulation of new industries in those areas.

Key messages

Engineers Australia believes that 2017 review of climate change policies will need to ensure that future climate change policies:

1. Ensure that the Federal Government takes the lead on climate reduction through strong climate change policies which seek bi-partisan support for political stability.

2. Develop Australia's future skilled workforce which can address the future issues associated with a carbon constrained economy. Policies must be implemented which produce the required number of STEM graduates.

3. Target (but not limit the scope to) the electricity generation, transport and built environment sectors, considering all options which will provide minimal externalities.

4. Fully exploit the benefits of energy efficiency measures throughout the economy, which can bring immediate reductions in emissions.

5. Find the best possible outcomes for displaced workers who might be affected by climate change policies, through structural adjustment packages or investment and stimulation in new industries.

2. The integration of climate change and energy policy

2.1 National transition plan for an effective national approach

Australia has an abundance of natural energy resources which have underpinned national prosperity over the past 50 years. Energy is an essential input for all Australian industries with transport, electricity supply, manufacturing and mining the largest users. Australian energy policies often mix trade and domestic energy consumption policies together. The two are inextricably linked because Australia is a net importer of transport fuels such as oil and refined petroleum products, while being a net exporter of other energy fuels such as coal.

Energy policy should be comprehensive and cover all sources of energy supply and demand. Any future updates or changes to energy policy will be constrained by the Paris climate change conference agreement (Paris COP21) to an emission reduction target of 26 to 28 per cent reductions on 2005 levels by 2030. This target will be exceedingly difficult to achieve unless all aspects of energy use play their parts. There has been much public discussion that current climate change policies may be inadequate to meet Australia's emission reduction target, and that stronger emission reduction policies are required.

Engineers Australia believes that for Australia to succeed in an energy constrained future, an energy transition plan needs to be implemented to ensure a national approach. This plan would need to detail the changes that are required to meet our Paris COP21 commitments. Engineers Australia believes that a plan will need to include (but not be limited to) the following:

- The electricity sector and Australia's aging fleet of fossil fuel power stations
- Australia's transport system and our current reliance on oil
- Opportunities for energy efficiency

Australia's climate change policies have undergone substantial changes in recent years. Uncertainty surrounding these policies can influence heavy-emitting generators decisions about remaining in the market, continue Australia's reliance on oil for transport, and reduce the opportunities to fully exploit energy efficiency measures throughout the economy.

At the same time new renewable or low-emissions technology in electricity generation, transmission, distribution, storage and transport can be stifled as their ongoing profitability under the current policy scenarios is limited. While government tone about the importance of a transition to help tackle climate change has in recent years become more positive[2], real action, and a real transition plan are missing from the national discourse. Doing nothing is not an option if Australia is going to follow through with the commitment to Paris targets.

[2] Frydenberg. J, 26 April 2017, *Meeting the Challenges of a Once in a Century Transition in Global Energy Markets*. www.joshfrydenberg.com.au

2.2 Multi-party support

Climate mitigation challenges are long-term, and to address them as such will require a strategic and coordinated policy direction that will continue over many generations. For this to be possible, a national transition plan for climate change policy needs to seek bi-partisan support for political stability, while at the same time allowing flexibility for whatever arises in the future. Flexibility will allow Australia to quickly adjust to any major advances or changes in new technologies, staying up to date with the most affordable, reliable energy options which aims to satisfy the entire community.

The transition from the present energy profile to a different profile will involve changes to the existing pattern of production, transformation, transport and utilisation across all sectors of the economy; that is, changes to the 'fleet' of current infrastructure and investments. Investments in energy infrastructure are capital intensive with long asset payback periods and asset lives. This means that the strategy needs to be seen in terms of decades rather than years, and that energy strategy must be linked with long-term industry and social strategies that extend beyond political cycles. Investment to reduce emissions intensity in transport and energy efficiency can bring more immediate benefits, and bi-partisan support for these measures should be investigated promptly.

2.3 State-based policies

A clear strategic direction for climate change policies at a national level is required to lead nation towards its reduction targets. The present position of national climate change policy leadership has resulted in ambiguity and confusion as individual jurisdictions have adopted their own targets and policies. This includes state and territory governments in South Australia, Victoria, Queensland and the ACT committing their region to their own specified renewable energy targets.

The federal government must now look at each set target and determine if it is possible for each state and territory to meet its target and determine the best way forward. As electricity generation is the highest emitter in country, electricity transfers between jurisdictions may require further investigation. National direction may be required to plan where each state's generation will go, along with a corresponding plan that outlines targeted investment in the network to ensure energy can be moved around as required. Even with a state target set, it may not be possible for a certain state to achieve its target due to transmission constraints.

3. Future workforce, innovation, research and development

3.1 Role of research, development and innovation

In the short term, innovation will be crucial if Australia is to meet its international emission reduction commitments with minimum disruption to the normal functioning of society and the economy. Policies which encourage the development of better collaboration between research organisations and industry will be critical, along with investment into research and development, and the availability of a skilled workforce.

Innovative environments do not just happen, they are the outcomes of interaction between individual and corporate ideas, entrepreneurship, risk taking and investment and government policies to foster these factors and policies that address barriers to innovation. The World Economic Forum currently ranks Australia:

- 12th for scientific research institutions
- 22nd for innovation capacity
- 24th for company spending on research and development
- 33rd for university-industry collaboration on research and development
- 63rd on government procurement of advanced technical products, and
- 17th in availability of scientists and engineers[3].

If Australia is to succeed, then clearly improvements in the key areas of innovation capacity, research and development, collaboration, procurement at availability of a skilled workforce needs to improve. The Australian government recently outlined a national innovation and science agenda, recognising that policies need to be developed to prepare for future challenges. New and innovative ideas are the beginning of technological advance, but it is engineers that translate new ideas into new products and services. Australia's 'ideas boom' depends on the skills of engineers to bridge the gap between idea and practical products and services that will drive economic growth.

Furthermore, there needs to be a national organisation established with the responsibility of monitoring developments of all technologies worldwide so that the best innovations can be quickly adopted. There also needs to be a better connection between research organisations and industry, as while there has been great development in prototypes in universities, they can struggle to be realised in practice. What is critical is that the operating regime of any technology is fully understood, modelled and tested when being introduced on a large scale.

[3] World Economic Forum, 2016, Global Competitiveness Index 2016-17 edition. www.reports.weforum.org

3.2 STEM policies for engineering workforce

Australia will be relying on its engineers to help meet its ambitious greenhouse reduction targets, and policies which encourage the development of more engineers are required. Workforce planning is always necessary to maintain a stable and healthy economy. As the workforce evolves over the coming decades, new jobs will emerge as technology advances.

Engineers Australia reinforces that engineers are critical to the implementation of long-term strategic policies addressing the link between energy generation and use, resource consumption, and climate impacts. Engineers are well placed to understand and assess the viability of climate change mitigation and adaptation strategies needed to make a difference and have the practical know-how to implement these strategies.

Throughout the world, analysists have argued that a key strategy to achieving a technologically and innovative based economy is to push the development of science, technological, engineering and mathematical skills of the future workforce. These views have been previously supported in work by the Chief Scientist and have given rise to a broad wave of support for attention to STEM skills in the development of Australia's future workforce[4].

The STEM skills of the future workforce will need to be aligned with national economic development policies, and in the areas of significant national interest such as the research and development of climate abatement strategies and technologies. A recent report by the Grattan Institute observed that this alignment has not happened yet, as science and information technology graduates were finding it difficult to find work after graduation[5]. Engineering graduates however are more adaptable than other STEM graduates, and the report found that this attribute applied both to the areas of their training and the wider economy.

Nevertheless, there needs to be a greater importance placed in addressing falling rates of students completing STEM enabling subjects in year 12. We have already seeing indications that it is going to be increasingly difficult to attract students to engineering courses, because the percentage participation of students in year 12 studying advanced maths, intermediate maths and physics is falling[6]. Studying STEM subjects at school is about mathematical and scientific literacy and understanding, it is rarely an end in itself.

The study of year 12 subjects which are critical to a STEM education are required to build Australia's engineering capability, and in turn the ability to create solutions to climate change issues. For Australia to develop more of its own engineers we need a sufficient flow of high school students who are interested in engineering and who have studied the subjects that engineering relies on. Policy makers must consider the future workforce needs in the energy sector so that the nation can build a skilled workforce ready to solve the challenges of the future.

[4] Chief Scientist, Science, Technology, Engineering and Mathematics: Australia's Future, 2 September 2014, www.chiefscientisst.gov.au
[5] Grattan Institute, Mapping Australia's higher education 2016, 7 August 2016, www.grattan.edu.au
[6] Engineers Australia, 2017, Engineers Make Things Happen. www.engineersaustralia.org.au

4. Electricity and transport

4.1 Opportunities and challenges for the electricity sector

Opportunities for new technologies

The transition to an energy mix which can provide Australia with secure and affordable energy, within environmental constraints may take a number of decades to implement. Not only will a wide mix of different energy options need to be considered, but energy policy strategies planning for the short-term should also be implemented. This means that all options that can provide minimal externalities (environmental damage, health effects, greenhouse gases) must be on the table for consideration.

There needs to be a more holistic approach to the role of new technologies. Not only will new technologies for distribution and transmission play a key role in modernising the grid, but also new generation technologies will change the system. Electricity generation is Australia is the biggest contributor to greenhouse gas emissions, and so should hold the biggest focus of attention. Technologies need to be viewed together at every level of the process chain.

Energy options which can be deployed in the near to short term:

- *Energy efficiency and optimal integration*: It is here that engineers employ the latest digital technology to optimise flows between generators and users, matching forecasted demand with supply. Energy efficiency will be addressed in more detail in section 5.
- *Increased interconnection*: Studies should be undertaken of the value of constructing new interconnectors, particularly between regions. This would identify opportunities where some regions that may have more synchronous capacity may assist others by providing ancillary services to increase security. The analysis is critical, particularly with the announcements of the retirement of further synchronous generation in the NEM.
- *Hot water storage*: Hot water storage allows consumers to match the high supply of solar power with the peak time of hot water usage. The development of smart meters and devices will be essential in the development of this technology. This technology is already in Australia.
- *Distributed generation:* Distributed generation gives the power back to the consumer by allowing them to charge a battery at the right time, and eliminated the cost and inefficiencies that are generally associated with distribution and transmission.
- *Synthetic inertia and synchronous condensers:* Synchronous condensers are spinning motors whose shafts are not connected to a mechanical load, and consume very little real energy while providing inertia[7]. New controllers are available that will transiently

[7] Chief Scientist, December 2016, *Independent Review into the Future Security of the National Electricity Market, Preliminary Report*.

convert the non-synchronous mechanical inertia of a wind turbine into synthetic inertia[8]. These are already being used in wind turbines installed overseas.

Energy options which could be deployed in the mid to longer term:

- *Energy storage*: Energy storage provides the capability to allow energy to be scheduled for delivery at a later time than when it is produced, or to a different location, and is an important enabling technology for many forms of renewable energy. The major forms of energy storage are heat, chemical energy, kinetic energy and gravitational potential energy (e.g. pumped storage hydro discussed below).

- *Concentrated solar thermal:* Concentrating solar thermal covers a number of different collector and power production technologies. Typically, the technology is close to being commercial, but currently constrained by higher cost. Technology trends are to improve economics of the technology by improved conversion efficiency and reduced material costs.

- *Hydro*: The major types of hydro-electric power stations are stored-water, pumped storage and "run-of-river'. The carbon intensity of pumped storage hydro systems depends on the source of electricity taken from the grid to power the pumping cycle and the efficiency of the entire pump-run cycle. The 'run-of-river' technology provides opportunities for small scale implementation, with lower environmental impact. For pumped hydro to be successfully deployed, the grid and the market would need to be configured and operated in a way that optimises the use of renewable energy.

Energy options worthy of further consideration in the longer term, along with research and development:

- *Geothermal*: Geothermal technology has a number of different manifestations:

    - Low-grade heat for heating and cooling buildings
    - Tapping underground steam sources in thermally active areas
    - Tapping heat from deep hot rocks or hot sedimentary aquifers.

  Advantages of the technology are the capacity to be scheduled to meet demand, the capacity to load follow, and a lower exposure to international energy prices. Disadvantages of the technology are long construction times, and water demands (or production from sedimentary aquifers) during operation and earthquake issues.

- *Nuclear energy:* Nuclear power has the ability to provide long term energy security as modern nuclear power reactors are built with sixty-year life spans, and they also have near-zero carbon emissions[9]. Before nuclear energy is pursued further as an energy option there are issues which will first need to be addressed which are:

[8] Chief Scientist, December 2016, *Independent Review into the Future Security of the National Electricity Market, Preliminary Report*.
[9] Engineers Australia, 2015. Submission to the Nuclear Fuel Cycle Royal Commission. www.engineersaustralia.org.au/about-us/government-submissions

  - Two pieces of Commonwealth legislation that prohibit the licensing of a nuclear power reactor in Australia.
  - The ability to generate electricity at a price that generates profits that are large enough to create a return on investment. As there is a wide difference in the costs of projects in different countries, a full feasibility study would be required to establish the cost of a nuclear project in Australia.
  - Public concern over the safety of nuclear energy. There are concerns that the nuclear industry is unsafe and has waste disposal problems, and these concerns cannot be ignored and public debate is essential before any possibility of the option of nuclear energy being used in Australia. Strong political leadership is required to address these issues.

- *Ultra super-critical coal and carbon capture and storage:* Ultra supercritical coal and carbon capture and storage should not be completely discounted as a low emissions options, but the fast pace of advancements in renewable technology has dominated the future electricity generation discussion. If these coal technologies are to be considered in a future energy mix, advocates need to put forward arguments in the context of an overall transition plan which would verify their claims that it could keep prices lower, including costs for upgrading and extra maintenance while also achieving climate reduction targets.

Challenges for new technologies

There are already clear signals indicating that a shift away from major fossil fuel power stations is underway, with new technologies filling the void. Companies such as large banks which usually provide the investment into large power projects are more strictly governing investment in energy projects. This may stifle any proposals of retrofitting existing coal power stations, or building new major coal power plants.

Further delaying a shift as part of energy policy increases the likely risks and costs of a transition in the electricity sector, as it can take decades to plan, permit, finance and build new power infrastructure[10]. Challenges to the transition to new technologies need to be addressed, and this should be fully considered in a national energy transition plan.

National electricity rules and reforms to accommodate technological change have been slow. This has not led to an efficient or effective technological revolution in the integration of new technologies, including demand management, and the electricity grid needs to incorporate this. The visibility and forecasting of the electricity grid must improve and to drive that forecasting, there must be more storage for back-end data correlation. If the input data is visible, and open to checking by academic institutions, generating and storage opportunities will be visible to investors.

There is a need for market reform, as there is a need for updated resources (such as energy storage) to be fairly included in the market. A truer market for services is required to

[10] Stock, A, 2014, The Climate Council, *Australia's Electricity Sector: Ageing, Inefficient and Unprepared.* www.climatecouncil.org.au

incentivise market participants, particularly the new technologies to incorporate services features in their design and operation. Modern meters, information systems and fast communications can now handle five minutes' settlement. The current 30 minutes is a legacy of the 1990's and a five-minute market could open up short duration response opportunities.

Smart meters need to be accompanied by 'smart pricing'. As meters are deployed, the energy usage charges should better reflect the costs. Consumers will respond accordingly by shifting discretionary loads or adding storage. Smart pricing and smart meters also requires smart appliances, and there needs to be incentives for manufacturing more efficient appliances. Current government subsidies provide an advantage to those who can afford to take up these new technologies, but at a cost to the whole community, as only those who can afford it benefit from it.

Energy sector policies should consider the full portfolio of electricity generation options, choosing the most suitable based on the locations to be serviced and including the possibility of distributed generation to rural and regional centres.

4.2 Opportunities and challenges for the transport sector

The transport sector is a significant greenhouse emitter in Australia and has yet to be targeted by formal emission reduction policies. The transport sector can be directly targeted in emission reduction through improved energy efficiency in the use of existing fuels, more efficient vehicles, and through the adoption of alternative fuels changing the transport modal mix. Just as consumers have moved ahead of policy makers in other areas of policy makers in other areas of energy use, many Australian motorists have chosen more fuel efficient cars leading to some improvements in these areas.

Mandatory fuel efficiency or emissions standards for light vehicles are in place for approximately 80 per cent of the global light vehicle market, including the USA, the EU, China, Japan and India. The Australian government has recently released three consultation papers on proposed vehicle emissions and fuel quality measures, aiming to better align Australia's fuel quality standards with international best practice.

Motor vehicle technology is changing with more hybrid-fuelled and electric vehicles becoming available, and new hydrogen fuel cell vehicles emerging. Conventionally fuelled vehicles have improved energy efficiency potential, but there are limits to progress and it is prudent for government policies to embrace a diversity of potential solutions.

Australia will need to make an overall transformational change in the transport sector, optimising effective freight, transport and energy strategies, leveraging on economies of scale. Broader changes to existing transport models are required; primarily a shift from road to rail for long haul freight, and from cars to public transport (buses and light rail) for urban transportation.

Transport infrastructure projects should ensure that all major projects achieve a net economic, social and environmental outcome within a sustainable framework for the future. This will need to include appropriate price signals to internalise externalities. These issues have been

discussed in Australia for some time but there has been a dearth of action and overall progress has been slow.

Policy makers need to develop strong, enforceable transport industry policies which promote action on Australia's greenhouse gas reduction targets. Programs and policies should lead to an efficient and low-emissions transport system, including mandatory fuel efficiency standards for all vehicles, as well as active encouragement of alternate fuelled vehicles. Direct infrastructure planning and investment should be directed towards active integration of more efficient transport modal mixes, particularly in urban transport areas and between urban and regional centres.

5. Complementary policies

5.1 The National Productivity Plan

The Australian government has signalled energy productivity as a major focus of Australia's energy policy, and emissions reduction policy, and this is directed by the Australian National Energy Productivity Plan (NEPP). Through this plan the nation will manage and embrace changes in the energy industry, and help meet emission reduction targets.

Energy productivity is measured as Gross Domestic Product (GDP) per energy unit used, and energy productivity is the combined outcome of restructuring towards lower energy consuming industries and energy efficiency. The NEPP sets a notional target of 40 per cent improvement in energy productivity between 2015 and 2030. Over half of this target is expected to be through a continuation of current trends within existing funding programs.

Engineers Australia views this as a passive approach, relying too heavily on industry restructuring and not taking full advantages of energy efficiency as a driving force to improve Australia's energy productivity. Energy efficiency is a form of direct action that achieves results in most policy environments. Energy efficiency is the key to a dynamic energy productivity policy, reducing emissions by reducing the energy required for powering homes, businesses, vehicles and industries.

5.2 Energy efficiency and optimisation

Energy efficiency has already played a big part in reducing the demand in energy consumption. However, much of this improvement has been led by consumers and other energy users who have made energy choices in their own interests, rather than because of political leadership. Engineers Australia believes the political attention given to higher energy bills tells Australians only half the story because it neglects the potential of energy efficiency to reduce those bills.

Consumer choices have already made significant contributions to the reduction in electricity consumption as consumers have been increasingly seeking energy efficient products and appliances. This has also been influenced by Commonwealth and state household energy programs including solar hot water, ceiling insulation and home energy rating schemes. This trend is expected to continue in the coming decades as consumer preferences and behaviours continue to change[11]. Although there is an expected increase in the use of electrical appliances in households as the population increases, less energy is consumed as the energy efficiency of these products also continues to improve. The traditional household with a stationary home computer and entertainment system is slowly being replaced by mobile devices with Wi-Fi connections, which use relatively less electricity.

Australia has a real opportunity to exploit the benefits of energy efficiency throughout the economy. While energy efficiency often requires capital investment, most opportunities deliver

[11] Australian Energy Market Operator, 2016, *National Electricity Forecasting Report June 2016,* www.aemo.com.au/

a financial return to householders and businesses who implement it[12]. The potential to implement energy efficiency policy measures will reduce electricity demand, and reduce emissions. The built environment alone has the potential to reduce projected emissions in half by 2050, and could meet over half of the national energy productivity target, and more than a quarter of the national emissions target[13]. As a member of the Australian Sustainable Built Environment Council (ASBEC) Engineers Australia supports the recommendations put forward in the ASBEC publication *Low Carbon, High Performance* which outlines the potential for the built environment to contribute to meeting carbon reduction goals.

Australia should more aggressively pursue energy efficiency policies in electricity generation as it offers dual benefits: it is an effective way for Australia to reduce its emissions, and it avoids the opportunity cost associated with unnecessary expenditure on energy. To realise the full potential of energy efficiency across the economy, and promote investment in energy efficiency, barriers to energy efficiency efforts need to be addressed. This includes split incentives, information failures, lenders favouring existing and familiar approaches and assigning higher risks to new approaches and other disadvantages experienced by early adopters. The removal of these barriers, along with more aggressive energy efficiency policies are essential in promoting energy efficiency.

Energy efficiency is primarily achieved at household and business user ends, but it also has ramifications for how the network is managed. It is here that engineers employ the latest digital technology to optimise flows between generators and users. As certain parts of electricity generation are monopolistic (mainly in transmission and distribution), reform to regulate in these areas is necessary to complete an energy efficiency program.

Engineers Australia believes that Australia needs an energy efficiency target to account for changes achieved and to guide progress, and this could be a policy similar to the one proposed by the Prime Minister's Task Group on Energy Efficiency in 2010. There is split jurisdictional responsibility for energy efficiency improvements and this has been a key factor in why progress has been slow. Much of the improvement made has not been because of political leadership but because consumers and other energy users have made their own energy saving choices.

There is substantial potential to build on this foundation through fundamental reform to energy efficiency governance arrangements and the extension of energy efficiency programs to all sectors of the economy. Energy efficiency is an integral aspect of engineering and Australia's engineering profession is well placed to contribute to the implementation of an energy efficiency target quickly and effectively.

5.3 Information and data analytics

Policies should also utilise the latest modern information technology, communications and data analytics, as they can be used to improve supply network efficiency and reliability, in particular when faced with the challenges posed by intermittent renewable energy sources. Modern

[12] ClimateWorks Australia, 2015, *Australia's Energy Productivity Potential*. www.climateworks.com.au
[13] Australian Sustainable Built Environment Council, 2016, *Low Carbon, High Performance*.

electronics technology can be used to improve energy efficiency in a wide range of environments.

The use of control and communications technology in smart buildings reduces energy consumption by optimising functions such as passive heating and cooling. Energy wastage can be reduced by the use of sensing technologies by using room occupancy sensors to automatically control lighting and air conditioning systems.

Smart electricity meters offer a range of capabilities to manage and reduce energy consumption, and coupled with mobile device applications they can allow the consumer to be aware of their energy usage, and modify behaviour. Smart meters allow differential time-of-day pricing to modify consumer behaviour and reduce peak demand. Social media offers the possibility of engaging customers in times of network stress or catastrophic weather events, to switch off non-essential consumption.

With the proliferation of domestic PV solar systems and the likely proliferation of on-site battery storage, communications technology offers the prospect of real-time monitoring and optimisation of feed-in from multiple sources, to maintain network stability. On-site storage including electric vehicle battery packs could be coordinated across the network to balance supply and demand at the local level, to minimise transmission losses and fossil fuel backup generation usage.

5.4 The energy prosumers

With the emergence of smart technology that is more accessible than ever before, consumers can now make informed choices about energy usage, producing and storing energy themselves[14]. These consumers are more commonly being referred to as 'prosumers'. Further consideration of active polices which are aimed towards the consumers who will actively pursue low-carbon technologies, can further advance behind the meter technologies and build up economies of scale.

It is estimated that consumers, and not utilities, will determine over $200 billion in system expenditure by 2050[15]. Consumer behaviours are going to change the way the grid operates, and there has already been evidence of this with the strong uptake of solar PV to remove reliance on the grid. If this is realised on a large scale, there is the opportunity for exchanges of energy between different parties.

If the uptake of rooftop solar and storage continues, the supply and demand fluctuations may require additional management on the electricity grid. This customer demand is then hidden from the market as it is behind the meter, which can cause planning issues. A strategy needs to be devised that addresses this unseen demand, including how this information is collected, what body collects it, and who administers it.

[14] Mouat. S, 24 June 2016. Renew Economy, *A new paradigm for utilities: the rise of the prosumer.* www.reneweconomy.com.au
[15] Energy Networks Australia, CSIRO, 2016, *Electricity Network Transformation Roadmap: Key concepts report 2017-27*.

6. Impact on jobs, investment and regional Australia

6.1 Transition plan required for jobs and regional communities

Engineers Australia has previously addressed the issue of the energy workforce in its report, *The Future of Australian Electricity Generation* which was release in early 2017. A large number of engineers work in the energy sector, being involved in the construction, planning, design, maintenance and operation of Australia's electrical generation systems[16]. Many more engineers will be involved in the future research and development of new energy technologies as well as the implementation of many energy efficiency measures. A change in Australia's energy mix will ultimately influence those who currently work in the energy industry.

Large capacity power stations employ large numbers of people, and they are usually located in regional areas and on the fringes of major cities in small regional towns[17]. These communities become dependent on the economies of the power station and, if the power station were to close, the local town economy and community can be greatly affected. Widespread community dependence on a major power plant in a regional area can create pressure on decision makers to continue the status quo, and delay a transition.

When reviewing climate change policies, the government needs to also put forward transition plans for energy industry workers to upskill, or transition into new industries. Both Commonwealth and state governments must work together to ensure the best outcome for workers and their families, by investigating further options for structural adjustment packages or through the stimulation of new industries in those areas.

Structural adjustment has long been discussed as a mechanism to handle significant changes in the economy. Because the closure of a major power station could greatly affect the local community, some compensation or training to affected workers through the method of structural adjustment can be used to assist in a transition.

The argument for structural adjustment assistance is that it has the aim of reducing short term economic disruption during a transition period, and it has the potential to minimise long-term unemployment[18].

In 2016, the announced closure of one of Australia's largest capacity power stations, the Hazelwood power station and mine made headline news, highlighting the importance of these

[16] Engineers Australia, 2016, *The Engineering Profession: A Statistical Overview*.
[17] Alcorn, D and Stanton, K, June 2016, *What will fill the hole left by coal?* https://www.theguardian.com/australia-news/2016/jun/29/what-will-fill-the-hole-left-by-coal?CMP=share_btn_link
[18] Argy, F, 1999, *Distributional effects of structural change: some policy implications*. Australian Government Productivity Commission, Structural Adjustment – Exploring the Policy Issues. www.pc.gov.au

stations to rural and regional jobs. Governments have already pledged almost $100 million to help with the closure, but there are fears workers won't be able to find new jobs[19].

The aim of the adjustment should include plans for energy industry workers to upskill, or transition into new industries. Governments have the ability to put forward training packages and this can include training these workers to be skilled in the production and maintenance of emerging renewable technologies. Some structural adjustment methods point to compensation being delivered at a region-wide level, to provide for agreed purposes[20].

However, if there are not clear rules set in place for structural adjustment, costs associated with the program can quickly escalate. Identification of the most affected workers needs to occur, so that benefits are not wasted[21]. Any compensation should look to facilitate adjustment rather than providing passive support, and any method of compensation should be transparent to ensure accountability.

There is real potential to transition some of these regional workers into new energy technology workforces. Research conducted in the United States has found that growth in solar-related employment could help to absorb potential job losses in the coal industry[22].

A study which compared existing coal industry jobs to ones in the solar industry found that many of the skill sets were readily transferable. The study found that a relatively minor investment in retraining enables the vast majority of coal-fired power station workers to transition into solar related positions[23].

This example shows that relatively minor investment in retraining could allow the vast majority of coal workers to switch to solar related positions in the event of the shut-down of a coal-fired power station, providing a future for these workers, while also adding to the skills of Australia's renewable workforce. This is particularly the case with solar thermal technologies where the 'back end' involves steam-based or hot fluid boilers and turbines. As Australia moves towards a new energy mix, it is essential that Australia has the people with the right skills needed to implement and operate these new technologies.

At the present time there is limited information around to identify if policy changes in transport or energy efficiency will influence employment rates. If stronger policies in these areas are implemented, then the stimulation of new employment opportunities or structural adjustment packages for affected workers would also need to be considered.

[19] Drape, J and Meehan, M, November 3, 2016. *The Australian, $85m support for sacked Hazelwood workers.* www.theaustralian.com.au
[20] Walsh, C, 1999, *Structural adjustment: a mainly regional development perspective*. Australian Government Productivity Commission, Structural Adjustment – Exploring the Policy Issues. www.pc.gov.au
[21] Gray, M, 1999, *Policy issues in structural adjustment*. Australian Government Productivity Commission, Structural Adjustment – Exploring the Policy Issues. www.pc.gov.au
[22] Louie, P and Pearce, J, 2016. Retraining investment for U.S. transition from coal to solar photovoltaic employment. *Energy Economics*, Volume 57, June 2016, Pages 295–302
[23] Louie, P and Pearce, J, 2016. Retraining investment for U.S. transition from coal to solar photovoltaic employment. *Energy Economics*, Volume 57, June 2016, Pages 295–302

6.2 Policies for investment

In the 2015 Australian Energy White Paper, the government states that it does not favour any intervention in promoting the transition away from coal-fired power plants, and that this should be left to the energy market to signal these changes[24]. The paper states that prematurely forcing new technologies in the energy market through policy interventions runs the risk of early adoption coming at a higher cost and lower efficiency than if that product found its way onto the market by a competitive basis.

Engineers Australia believes that some government intervention is warranted to kick start this transition in the light of the Paris COP21 agreement, and the subsequent emission reduction targets that were set. Australia will need to take advantage of emerging technologies that can provide reliable electricity supply, but also reduce emissions. For investors of new zero and low emission technologies, governments can initiate change by creating sustainable markets by filling funding gaps, and creating enabling infrastructure for new technology.

For emerging technologies, policies to create initial markets must run alongside research and development programmes, far ahead of widespread deployment of the technologies, and draw on competitive market forces where possible. Fostering the development and deployment of emerging technologies expands the number of low carbon technologies available at scale on a commercial basis, providing more flexibility and lowering overall cost[25]. Engineers Australia believes that to reduce emissions in the electricity generation sector and in turn the transport sector, all options need to be considered.

[24] Australian Government, Department of Industry and Science, 2015, *Energy White Paper 2015*, www.ewp.industry.gov.au
[25] International Energy Agency. 2015. *Energy and Climate Change, World Energy Outlook Special Report*.

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