Collaboration on Energy and Environmental Markets

UNSW SYDNEY

Submission to the Australian Government's Technology Investment Roadmap Discussion Paper – *A framework to accelerate low emissions technologies*

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The UNSW Collaboration for Energy and Environmental Markets (CEEM) undertakes interdisciplinary research in the design, analysis and performance monitoring of energy and environmental markets and their associated policy frameworks. Our focuses on the challenges and opportunities of clean energy transition within market oriented electricity industries. Technology roadmapping can play a key facilitating role in achieving such energy transition and CEEM researchers has been exploring the opportunities and challenges of such exercises for several decades. More details of this work can be found at the Collaboration website www.ceem.unsw.edu.au. We welcome comments, suggestions, questions and corrections on this submission, and all our work in this area. Please feel free to contact Associate Professor Iain MacGill, Joint Director of the Collaboration at i.macgill@unsw.edu.au.

1 Introduction

We welcome the opportunity to provide comment on the Australian Government's Technology Investment Roadmap Discussion Paper – *A framework to accelerate low emissions technologies*. This is important and challenging work. In our submission we briefly present:

- some general thoughts on technology roadmapping, and lessons from earlier efforts
- our views on the process outlined for development of this roadmap, linked to the specific questions posed by the Government for stakeholder views

2 The technology roadmap process: low-cost lessons from previous experience

There is growing Australian and global experience on the challenges yet value of technology roadmapping as a key input into Government regulatory, market and policy frameworks. Lower emission energy technology roadmapping has been undertaken in Australia for at least the last two decades – one of this submission's authors was involved in a Renewable Energy Technology Roadmap undertaken for the Federal Government in 2001-2[1]. Other notable roadmapping exercises include the Prime Minister's Chief Scientist report[2] from 2002 with scenarios of Carbon Capture and Storage deployed from 2005 onwards, the Federal Government's Uranium Mining, Processing and Nuclear Energy inquiry[3] of 2006 with what proved to be optimistic scenarios for nuclear power in Australia, and the assessment undertaken for the National Framework for Energy Efficiency in 2008. Technology roadmapping has also contributed to a range of Energy White Papers from 2004, 2011 and 2015. While the most recent CSIRO work[4] is incorporated into this roadmap, in our view the process would benefit from more formal consideration of the experiences – good and bad – of previous efforts.

The fact that a particular prioritised technology from two decades ago failed to achieve success doesn't necessarily mean that prioritisation was mistaken – energy innovation inherently has uncertainties, and risks must be taken within a portfolio approach. The experience of Hydrogen is illustrative in this regard. After the considerable promise shown in the 1990s with new fuel cell technologies, Hydrogen lost favour and interest as technology commercialisation stalled, and other technologies emerged. Now, however, changed circumstances, technology progress and, critically, new use cases have seen this option receive new attention. Still, there are certainly lessons to be learned from serial failures as well as the successes, some highlighted in the Discussion paper. The academic literature has a wealth of detailed assessments of the success and failure of technology innovation efforts in the energy sector to date including success in the case of PV[5] and energy storage, and failure in the case of Carbon Capture and Storage.[6] As Hydrogen demonstrates, circumstances can change, but the case needs to be made as to why 'it's different now' when earlier technology prioritisation failures are identified for further support.

Recommendation: Undertake a detailed, public, review of previous Australian energy technology roadmapping efforts – their successes and failures – and international experience on 'best practice' energy technology innovation to guide next steps of this energy technology innovation process.

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[1] Hugh Outhred, Iain MacGill and Muriel Watt (2002) *Renewable Energy Technology Roadmap Final Report*, UNSW Unisearch report to the Australian Sustainable Energy Industry Association, January.

[2] PMSEIC (2002) *Beyond Kyoto – Innovation and Adaptation*, Report to the PMSEIC Meeting, Australian Government.

[3] UMPNSER (2006) *Uranium Mining, Processing and Nuclear Energy – Opportunities for Australia*, Australian Government.

[4] CSIRO (2017) *Low Emissions Technology Roadmap – Main and Technical Reports*, available from www.csiro.au.

[5] See for example, Cheng Zheng and Daniel M.Kammen (2014) "An innovation-focused roadmap for a sustainable global photovoltaic industry," *Energy Policy*, Vol. 67, April.

[6] See for example, Christian Von Hirschhausen, Johannes Herold and Pao-Yu Oei (2012) "How a "Low Carbon" Innovation Can Fail—Tales from a "Lost Decade" for Carbon Capture, Transport, and Sequestration (CCTS)," *Economics of Energy & Environmental Policy*, Vol. 1, No. 2, March.

Lessons from past experience certainly include the importance of technology specific funding support rather than generic incentives alone, as highlighted in this Discussion paper. However, the also highlight that the process of technology prioritisation needs to be highly transparent around assessment criteria and their measurement. The prospective 'users' of these technologies have a key role in the process as well as the prospective technology providers. More generally still, almost everyone is a stakeholder in Australia's future energy system and questions of 'social license' have had major impacts on the progress of some technologies and underlying business models in Australia as elsewhere[7]. This would seem to be a weakness of this roadmapping process to date.

Successful roadmapping and innovation processes also need the independence to be able to discontinue funding for previously or currently favoured technologies that have failed to deliver, despite the political and industry pressures that may resist such efforts. Recent technology innovation developments have highlighted that killing off support for technologies that fail to progress can be as important, if not more, than prioritisation of the more promising ones.[8] As noted above, formal evaluation processes are key here given the sensitivities involved. Finally, innovation efforts need to deal with the technology 'lock-in' of current energy systems. Arguably some of the greatest energy innovation in Australia is the progress in distributed energy resources, a suite of technologies that came from outside the existing energy industry. Government efforts need to "open up energy systems to more radical technologies and business models, and ensure that institutions and common infrastructures facilitate their deployment."[9]

Recommendation: Develop more transparent and inclusive technology assessment processes, that don't only select priority technologies but identify technologies that have failed to deliver. These processes need to ensure that stakeholders other than energy incumbents – particularly energy users and disruptive technology providers and business models – are at the table, rather than on the menu.

Lessons also include the importance of the broader regulatory and policy context for low energy transition when undertaking technology roadmapping and its potential facilitating role in supporting changes to these regulatory and policy arrangements for greatest impact. We need both national targets and technology focussed innovation efforts.[10] Technology roadmapping and development efforts without ambitious mandated targets risk being too little and too late for the task at hand. Mandated targets without underlying technology innovation efforts risk failing to drive the longer-term technology and infrastructure change required for clean energy transition.

Recommendation: Success in technology roadmapping will critically depend on targets for decarbon-isation and the broader policy and regulatory frameworks for driving this. This context goes well beyond particular technology initiatives and needs to be articulated in this roadmapping process.

[7] As highlighted by the International Energy Agency's TCP on User Centred Energy Systems, where Australia is leading an annex on demand side participation and our 'social license to automate'.

[8] Gary Pisano (2019) "The Hard Truth About Innovative Cultures," *Harvard Business Review*, January-February Issue.

[9] Jim Watson (2008) *Setting Priorities in Energy Innovation Policy: Lessons for the UK*, Discussion Paper for the Energy Technology Innovation Policy Project of Harvard University.

[10] Iain MacGill (2008) Assessing Australia's Sustainable Energy Technology Options: Key Issues, Uncertainties, Priorities and Potential Choices, *Asia Pacific Journal of Environmental Law*, Vol II, Issues 1&2.

3 Recommendations for improving the proposed roadmapping process, and in response to the requested stakeholder input

Setting a clear vision: *(addressing **a** and **b**)*

While a technology vision is clearly required, the setting of measurable economic (really commercial) goals such as a production price target on hydrogen is not adequate alone. Cost competitive low-emission alternatives for existing emission intensive energy technologies appears possible in some cases (for example, given the falling costs of wind and PV), but isn't an appropriate basis for goals unless energy markets internalise what are currently 'external' emission costs. As noted above, we also need a broader vision around decarbonisation including overall emission targets to guide technology policy.

Survey of new and emerging technologies *(addressing **a** and **b**)*

The breadth of sectors and technologies covered, albeit briefly, in the discussion paper is both a strength and weakness. In particular, it is difficult to establish a suitable basis for comparison of priority options across such diverse areas, with very different measurement challenges and policy options. As one example, greenhouse gases from fossil-fuel power generation have far better measurability compared with imputed changes in net carbon fluxes across agriculture and other land-use change. Most technology roadmapping exercises tend to focus on a suite of comparative technologies for this reason, and the work underway here in Australia should consider ways to drive the more focussed and detailed technology roadmapping required. The summary of selected technologies with the potential to reduce emissions across the economy requires significant assumptions in terms of costs and potential scale. We recommend that all input data and the calculation methods be made public, ideally with associated modelling tools, to facilitate wide stakeholder engagement and participation in these estimations.

Australia's technological needs and comparative advantage: *(addressing **a, b** and **e**)*

We certainly agree that Australia needs to find its own particular technology pathway within a broader global technology context. However, a key challenge with assessing comparative advantage is that it is often backward looking and misses new opportunities. As one example, while Australia is currently a major energy export exporter, our future might more lie in exporting energy intensive commodities and products rather than energy, which our customers then turn into these same outputs. It is also unclear how the roadmapping process arrived at the key technology challenges and opportunities. As for the technology assessments, greater transparency on the process and any associated calculations of arriving at these priorities will greatly improve this technology roadmapping process.

Identifying priority technologies: *(addressing **b**)*

Technology prioritisation is almost always the most vexed and contested aspect of technology roadmapping. It involves considerable judgement as well as more quantitative analysis. As noted above, it benefits from highly transparent processes and broad stakeholder involvement. Again, we recommend that all input data and the calculation methods be made public, ideally with associated modelling tools, to facilitate wide stakeholder engagement and participation in these estimations. As noted above, the prioritisation process needs a complementary de-prioritisation process that identifies formerly promising technologies that have failed to deliver and are now being overtaken by other options. Picking winners is great if you can do it, picking some losers is likely inevitable given the uncertainties involved, but continuing to pick losers must raise questions about the quality of the process.

More generally, broad trust in the process is key to success. For example, some experts argue that the UK's "new policy direction', with its weakened support for renewables and energy efficiency schemes yet strengthened promotion of nuclear power and non-conventional gas, suggests an emerging 'policy apparatus for incumbency' which strengthens key existing technology regimes while potentially

damaging emerging technology innovations.[11] Any widespread perception by Governments, industry, NGO and broader community stakeholders that this roadmapping exercise is 'rigged' for particular technologies will damage the trust and consensus required for effective technology innovation and progress.

Identifying efficient deployment pathways and setting economic goals for key technologies: *(addressing **b** and **c**)*

As the discussion paper notes, governments have an important role to play in supporting energy technology innovation for reasons including market failures around R&D and commercialisation. However, the discussion paper doesn't adequately address the most significant market failure for low-emission technologies which are the currently unpriced externalities of fossil-fuel based energy provision. Addressing these externalities through policy – whether directly or indirectly – will be key to achieving efficient 'economic' emission reductions. Here we use 'economic' in the broadest sense of the word including social and environmental costs and benefits. This should not be confused with 'commercial' goals based on markets with major unpriced externalities. Setting stretch goals based on current emission intensive energy costs ignoring these externalities risks stranded investments, and failure to achieve our shared climate goals. It is true that a wide range of energy efficiency options, and some renewable generation technologies, are cheaper than their high emission alternatives even neglecting environmental harms. However, this may not be the case for future new entrant technologies that will also face a range of other market failures and first mover disadvantages, including incumbent market power, lack of scale economies, regulatory distortions and capital market barriers.

Balancing overall investment portfolio and implementing investments: *(addressing **b** and **c**)*

Portfolio approaches have proven capabilities in managing risk and reward, although they have demonstrated limitations in managing some types of risks – particularly low probability but extremely high consequence outcomes (nuclear power being a pertinent example). A key requirement for effective portfolio approaches is the ability to test the assumptions and uncertainties attached to different technology options – yet another reason for highly transparent, ideally public data and tools, that went into the assessments.

The scale of low emission energy transition required to avoid dangerous global warming is so great that private investment will definitely be required. However, this investment must be carefully guided. Investor certainty is often cited as the key requirement to leverage private investment. A risk here, however, is that investor certainty is provided for investments that don't actually support low emission energy transition. Inappropriate government underwriting can certainly leverage private investment. Whether it is socially beneficial or not, depends on the quality of the government processes identifying such opportunities. While climate change might represent a risk that will in the end need to be managed by Government, we still need to align private investment as best possible with this risk.

Assessing the impact of technology investments: *(addressing **b** and **e**)*

This is a critical task which is again, aided by highly transparent inputs into the technology roadmap. More broadly, the process of technology roadmapping should be iterative and ongoing – as General Eisenhower is reputed to have quipped – 'plans are nothing but planning is everything'. While the yearly LET statements are a good first step, there is an opportunity to take advantage of IT advances to make the roadmap a more engaging and ongoing process through a web-based platform that supports regular updating, and invites ongoing stakeholder contributions and debate to this key roadmapping exercise for Australia.

[11] Phil Johnstone, Andy Stirling and Benjamin Sovacool (2017), "Policy mixes for incumbency: Exploring the destructive recreation of renewable energy, shale gas 'fracking,' and nuclear power in the United Kingdom," *Energy Research & Social Science*, 33, Nov.