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ACCELERATING LOW-EMISSIONS ENERGY INNOVATION – AN AUSTRALIAN PERSPECTIVE

Chris Greig and Robert Pritchard

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Executive Summary

Addressing climate change at the same time as meeting the world's need for energy obviously requires very deep reductions in global greenhouse gas emissions. This cannot be achieved without massive transformation of the entire energy economy and new technological advances, for which innovation is essential.

Innovation is, however, characterised by patient, long-term investment and a high level of failure.

Traditionally risk-averse countries such as Australia will need to develop a broadly innovative culture and an explicit strategy to de-risk and accelerate low-emissions energy innovation.

The task for the 20 countries that signed on to the *Mission Innovation* initiative at COP 21 in Paris is to accelerate collaboration between the public and private sectors, not only in domestic economies but internationally.

This will not simply happen by itself. It requires that the public and private sectors should work very differently. It will entail the establishment of a formal mechanism to orchestrate collaboration between the public and private sectors, a mechanism that is driven and resourced by both sectors and that is itself innovative in its design and modus operandi.

Each country will be different although many may follow a broadly similar model. All countries will have much to learn from each other.

The main operational functions of a formal collaborative mechanism would be:

- **To identify and promote transformative opportunities that have potential for rapid scaling;**

- **To orchestrate a 'portfolio approach' - promoting technology diversity and neutrality from the bottom up, preserving optionality and including over time all emissions-generating industry sectors and sub-sectors;**

- **To engage all key players and stakeholders throughout each stage of the innovation chain; and**

- **To employ a multidisciplinary, stage-gated procedure with investment decisions supported by independent assessment of technical, social and regulatory factors, ensuring good governance along the way.**

Genuine collaboration between the public and private sectors is likely to lead quickly to the recognition of the need for development of a number of sectoral roadmaps, or the enhancement of roadmaps that already exist, followed by the orchestration of collaborative efforts to accelerate low-emissions technologies across all main greenhouse gas-emitting sectors and sub-sectors.

I. Introduction

In Paris, the 21st Conference of the Parties to the UNFCCC delivered what was widely hailed as an historic agreement to limit climate change.[1] In addition, 20 countries including Australia signed on to *Mission Innovation,* an initiative that aims to double investment in clean energy innovation over five years.[2]

The intended nationally determined contributions (INDCs) of the parties referred to in the Paris Agreement provided collective guidance as to what each intends to achieve by specified dates (in Australia's case, by 2030) in order to *'hold the increase in the global average temperature to well below 2ºC above pre-industrial levels and to pursue efforts to limit the increase to 1.5ºC.'* The adoption of the Paris Agreement was clearly a major step forward but all of the supporting decarbonisation implementation measures that will be necessary to achieve the agreed goal have yet to be addressed. Every five years, the INDCs are to be reviewed.

Motherhood statements about innovation are not enough. It has fallen to each country and to the energy industry in all of its components to squarely address the very ambitious challenge of converting the *collective intention* of the parties into *effective and affordable decarbonisation plans* and implementing the *Mission Innovation* initiative.

This short paper provides an Australian perspective on how this challenge might be addressed.

II. Innovation and Technology Will Provide the Vital Thread

For more than a decade leading up to the Paris Conference, the decarbonisation debate has tended to swirl around issues that could be described as banal. They have included issues such as 'market failure,' carbon taxes, emissions trading schemes, the polluting effect of fossil fuels and the idea of completely replacing them with renewables. This has generated considerable political dissent. Some extremists have even blamed climate change on capitalism itself. Ultimately, the path of least resistance for transforming the energy economy lies in a scenario where low-emissions energy systems are at least as cheap as traditional systems.

In addressing the low-emissions challenge post-Paris, innovation and technology will almost certainly provide the vital thread. This should enable much more technologically-informed and more cost-effective policies to be framed and implemented. This will need to be informed by and to build on the lessons of past international efforts, such as the work of the Asia-Pacific Partnership on Climate Change and Development, the Clean Energy Ministerial and the extensive technology collaboration programmes of the International Energy Agency.[3]

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[1] UNFCCC, Conference of the Parties, 21st Session, Paris, 30 November to 11 December 2015, *Adoption of the Paris Agreement,* Document FCCC/CO/2015/L.9/Rev 1

[2] Joint Launch Statement, *Mission Innovation: Accelerating the Clean Energy Innovation, www.mission-innovation.net.*

[3] See *Energy Technology Perspectives 2015, Mobilising Innovation to Accelerate Climate Action,* IEA, Paris, May 2015.

At the same time, the post-Paris low-emissions challenge is subtly different: it is more about accelerating emission reductions in pursuit of global climate goals than about pursuing certain emissions reduction technologies. This points to the need to change the mission of the Intergovernmental Panel on Climate Change from integrated assessment analysis of climate change impacts and response options to one of monitoring and oversight of performance and progress against commitments.

It is emphasised that innovation is a much wider concept than invention. It has long been recognised that innovation is a way of doing things and requires a systems approach.[4]

III. Low-Emissions Energy Innovation Policy Must Be Context-Driven: Factors of Time, Scope, Scale, Risk Tolerance and Competition

Policies to accelerate the transition to a low-emissions energy sector cannot be implemented without technologically reliable solutions that are both scalable and affordable.

The right context is critical when framing a policy to drive innovation. Five contextual factors stand out: *time, scope, scale, risk tolerance* and *competition*.

Time

Although innovation at scale is urgent for the achievement of the Paris low-emissions goals, innovation at scale typically requires patient, long-term investment, with outcomes more likely achieved over 30 years and beyond, rather than the 15-year period agreed in Paris. This is due to the typically long-lived nature of energy infrastructure and the inherent lock-in of emissions for several decades. At the same time a rapidly changing technology landscape demands a rigorous and continual techno-economic assessment of all main options, pathways and impacts.

Scope

In defining the *scope* of the challenge, the critical role that energy services play in a diverse array of economic sectors should be recognised. While much of the socio-political attention has been directed towards the residential and commercial sectors, especially in electricity supply, energy is also a critical enabler of other important economic sectors including defence, agriculture, aviation, road and rail transport, ports and shipping, secondary materials production, automotive and other manufacturing industries, as well as resources development and production for export markets.

Scale

The *scale* of the challenge of supplying the world with reliable and affordable energy is enormous and generally underestimated. The scale of investment required for low-emissions energy innovation is correspondingly enormous and underestimated. Capital for this purpose has so far been unavailable at anywhere near the levels required, at least through conventional channels of intermediation. As a result, global emissions have increased by over 50% since the Intergovernmental Panel on Climate Change was

[4] See for example Peter Drucker, *Technology, Management and Society,* Heinemann, London, UK, 1970

established in 1991 and are on track toward a further increase of another 50% by 2040.[5] Not only must this trend be halted but deep reductions in global emissions must be achieved. In this respect, policies must remain focussed not only on the intermediate (2030) targets set in Paris but on the longer-term, deeper reductions required by 2050 and beyond.

Risk Tolerance

A key contextual issue is *risk tolerance*. Innovation is characterised by patient, long-term investment. Inevitably, it also involves a percentage of project failures.

Innovative cultures accept and learn from failure. Many participants at the Energy State of the Nation forum in Sydney in March 2015 complained that they were having to 'tread water' because of a high level of policy uncertainty. Investors tend to defer making investments until policy uncertainties over the long term can be reduced to a tolerable level. Private sector investment in innovation will be similarly deferred in the absence of policies to incentivise innovation and reduce its inherent risks.

The Australian government recognised the need to develop a generally more-innovative culture in its 2015 National Innovation and Science Agenda but a specific low-emissions energy innovation agenda now also needs to be elaborated.

Competition

In the context of markets and competition amongst energy technologies, small countries such as Australia must recognise their limitations. Australia boasts few prominent energy technology providers and manufacturers. These limitations need to be accommodated by:

- focussing local research and innovation investment on key technology niches where Australia can play a leadership role;
- encouraging and rewarding international collaboration across a broader suite of technologies with its *Mission Innovation* partners; and
- supporting those local activities that enable and inform domestic deployment at scale.

IV. Recognition of a Special Need

Addressing the low-emissions challenge cannot commence without the recognition by policymakers of a special need for a low-emissions energy innovation initiative in which all prospective innovative technologies can be encouraged and developed. The rationale for this is four-fold:

The risk of failure along the innovation chain

Sound management requires acceptance of the risk of failure along the innovation chain, that is; the three distinct phases encompassing (1) research and development, (2) demonstration and (3) commercialisation and market uptake if widespread commercial deployment of low-emission technologies can be achieved. Barriers to deployment include short-term or unstable policy environments, regulatory delays, insufficient government and

[5] *Climate Change 2014: Mitigation of Climate Change*, IPCC Fifth Assessment Report, Working Group III.

private sector funding as well as the constraints of intellectual property (IP) protection and technology licensing requirements.

The need to accelerate collaboration

Collaboration is the central feature in any innovation-driven economy and must be accelerated. The primary idea of collaboration is to expose technologies to a greater number and wider range of users. This requires expanded IP pooling, cross-licensing and royalty-sharing arrangements for the purpose of protecting IP value chains against free riders. In the energy sector, collaboration must extend across governments, private asset owners, and technology providers, OEMs and universities. Critically, the proportion of innovation-active businesses collaborating with universities or other research institutions should be expanded. Collaboration can also be accelerated by innovative financing techniques.

Industry-university collaboration provides particularly fruitful opportunities. These can leverage expertise, funding and equipment whilst ensuring efforts are directed to priority areas likely to deliver commercial outcomes. Those collaborations will be most effective if industry is deeply engaged in setting research agendas, designing the portfolio, designing the risk management framework and in governance oversight.

The need to focus on the international context

The broader international context needs to be better understood. Facilitating international collaboration will drive a more efficient energy innovation portfolio and accelerate commercial outcomes. But international collaboration needs to be focussed on those areas and with those partners where collaboration can make a genuine difference.

The need for public support

Public awareness and support are necessary. Genuine stakeholder engagement and public outreach should be undertaken in an open, participative and consistent way. How to build or maintain the public's trust in all energy technologies also needs to be addressed.

V. Developing a Low-Emissions Energy Innovation Initiative

In all countries, the public and private sectors will need to work together very differently if they are to successfully address the low-emissions energy challenge in a timely manner. This must entail a new initiative or partnership between the two sectors.

The low-emissions energy innovation initiative requires the establishment of a formal mechanism to orchestrate collaboration between the public and private sectors, a mechanism that is driven and resourced by both sectors and that is itself innovative in its design and its modus operandi.

Each country will be different although many may follow a broadly similar model. All countries will have much to learn from each other. Whatever the design of the mechanism, transparency will need to be a key feature.

A formal collaborative mechanism would facilitate independent reviews and make recommendations to stakeholders on more effective measures for the most affordable

transition to a low-emissions energy economy; act as a custodian and clearing-house of information that is helpful for both domestic and international collaboration; identify barriers to innovation, leap-frogging them where possible; reduce red tape; assure the integrity of collaborative work; and publish an annual report to stakeholders.

It is emphasised that a formal collaborative mechanism should not replicate, override or impede the multiplicity of existing institutions.[6]

A formal collaborative mechanism would provide an overarching connection amongst existing institutions, work flexibly with them, facilitate their enhanced collaboration with industry and international partners and, importantly, guard against the creation of additional red tape.

The main operational functions would be four-fold:

(i) *A focus on genuinely transformative opportunities that can 'move the needle' and have potential for rapid scaling*

Scalability is an essential feature of low-emissions energy technologies. Not all technologies or ideas have the potential to transform the energy sector to a low- emissions future. Incentives should not be made available to everyone that fits within a broad category of eligibility. Public investment should mandate that all proposals provide a conceptual verification of the potential for rapid scaling of development and deployment.

There needs to be a level of competition where grants or other rewards are made to those who successfully innovate, to assist them to proceed to the next stage of know-how development, and to those who create technical and commercial synergies with others through collaboration. Investments should require genuine collaboration between universities, industry and government.

Furthermore, all proposals should be multidisciplinary in scope so that all of the risks and barriers to investment are dealt with at each stage of development. They include technical, economic, business, social acceptance and regulatory risks and barriers.

(ii) *A diversified innovation investment portfolio*

The rationale for a portfolio approach was outlined in a paper published by the Energy Policy Institute of Australia two years ago.[7]

The relative merits and shortcomings of alternative low-emissions energy technologies cannot be reliably predicted before a significant level of deployment of each technology has been achieved. Successful innovative organisations deal with this problem by preserving optionality, maintaining diversity and supporting a portfolio of options.

[6] In the case of Australia, existing institutions include CSIRO, Innovation and Science Australia, the Australian Renewable Energy Agency (ARENA), the Clean Energy Finance Corporation, universities, industry transformation research hubs and various cooperative research centres.

[7] Chris Greig, "Energy Innovation Policy and the Need for a Portfolio Approach,' Energy Policy Institute of Australia, Public Policy Paper, Paper 4/2013, November 2013.

In this respect, technology diversity and neutrality should be the paramount and fundamental principle of modern energy policy. There should be no exceptions to this principle - it is imperative for a secure, resilient and affordable energy supply system.[8]

In an Australian context, on the supply-side, the portfolio needs to include renewable energy systems, low-emissions fossil fuel systems and nuclear technologies. On the demand-side, the portfolio needs to include smarter electricity grids and storage technologies as well as a range of demand management, energy efficiency and energy productivity measures.

Innovation should also not be confined to the traditional energy sector. A low-emissions energy innovation policy will affect all emissions-generating sectors and sub-sectors, including legacy industries that may have largely been ignored or perhaps may have resisted disruptive innovations. Innovation in all sectors will contribute to the low-emissions transformation of the economy. Their respective importance is indicated in the table below.

Table: Emissions by Sector (Australia) – Projections for 2020

Electricity	31.5%
Direct combustion	18.9%
Transport (road, rail, air and shipping)	17.4%
Agriculture	13.5%
Fugitive emissions	7.7%
Industrial processes and product use	5.7%
Land use, land use change and forestry	3.5%
Waste	1.7%
Total (equivalent to 593 Mt CO2-e)	100%

Source: Department of Environment, *Tracking to 2020: Interim Update of Australia's Greenhouse Gas Emissions Projections,* December 2015, Canberra, p 7.

Improving the prospects of low-emissions energy technologies should involve innovation and technology enhancements that reduce investment risk and project costs across all potential technologies. A bottom-up approach is essential, where industry is incentivised, rather than compelled, to innovate.

(iii) *Collaboration and knowledge-sharing amongst all key players and stakeholders*

Assuring sustained and enduring success from an innovation system from basic research to deployment and commercialisation requires the involvement of all the key players and stakeholders from the sector. This includes governments, regulators, technology providers, service providers and contractors, technology users, research institutions and private sector financiers.

[8] Energy Policy Institute of Australia, "Principal Recommendations in Response to the Energy Green Paper," Energy Green Paper Submission, 4 November 2014.

Energy innovation policy should encourage and incentivise participation by the key players and stakeholders at each stage of the innovation chain and reward the positive contributions across the full innovation chain.

It is critical such engagement includes rigorous monitoring, post implementation review and feedback of learnings, both nationally and with international *Mission Innovation* partners, so as to assure learning-by-doing and knowledge sharing. This will help accelerate commercialisation and reinforce learning curves and cost reduction rates.

Assuring future widespread deployment is also critical. It can be postulated that the secret to success is to reveal secrets to others and work together in exploiting them. Policies should encourage and reward the widest possible communication of innovation success to facilitate knowledge-sharing and learning-by-doing. Open access to intellectual property arising from government-supported innovation will be necessary. This will however require legal incentives and safeguards to protect core or background IP.

(iv) A stage-gated approach and robust independent reviews

The inevitable failures among first-of-a-kind and early mover projects make it critical that innovation policy embodies a portfolio investment approach. It also requires that the governance process should employ a stage-gated approach so that projects that are clearly failing may be reframed or terminated. This allows valuable funding to be redirected to support more promising options.

The inherent uncertainties associated with new energy technologies mean that misinformation about performance, cost and scalability is common among project proponents, funders and policymakers. There is also potential for project proponents to adopt a level of 'optimism bias' around the current status and potential of projects and to be reluctant to terminate projects which may be destined for failure.

Government-supported independent expert reviews are critical to inform investment decision-making as to the merit of proceeding to the next stage of project development in the context of the broader portfolio of options being pursued. Obtaining this 'external view' helps to avoid decision-making being unduly affected by optimism bias and is an aid to good governance.

VI. Getting Started

Governments and businesses in many countries may have been scaling back their investment in energy research at a time when the need to increase and accelerate energy innovation has never been more pressing. Presently low oil and gas prices provide relief for energy-dependent consumers but at the same time reduce the incentive to invest in much-needed energy efficiency measures. In the case of energy-exporting countries such as Australia, low export prices make it more challenging for exporters to invest in emissions-reduction measures. A greater and more enduring problem for investors is policy uncertainty over long-term emissions reduction. Another problem is the straightforward fear of failure, which causes businesses to limit research funding and delay investments that carry high risk.

Responding quickly and effectively to the challenges thrown up by the *Mission Innovation* initiative will be difficult but not impossible. We reiterate that money is not the main problem - it is more an organisational and administrative problem.

We also reiterate that innovation is a much wider concept than invention.

The starting point in any country ought to be the establishment of a formal special-purpose collaborative mechanism resourced by the public and private sectors that defines, encourages and develops a low-emissions energy innovation sector, that rewards successful innovation across an open and diversified portfolio of technologies and that facilitates the domestic and international collaboration process.

This will require the progressive gathering and analysis of considerable data and making it available to those who wish to contribute to the common goal of emissions reduction.

The establishment of an effective collaborative mechanism between the public and private sectors is likely to lead quickly to the recognition of the need for development of a number of sectoral roadmaps, or the enhancement of roadmaps that already exist, followed by the orchestration of collaborative efforts to accelerate low-emissions technologies across all main greenhouse gas-emitting sectors and sub-sectors.

Another issue that will need to be to addressed at an early juncture will be how IP laws and technology licensing practices can be adapted to support transformational projects of the scale and reach envisaged by the signatories to the *Mission Innovation* initiative.

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ABOUT THE AUTHORS

Chris Greig is Professor of Energy Strategy, Director of the UQ Energy Initiative and Director of the Dow Centre for Sustainable Engineering Innovation at the University of Queensland.

Robert Pritchard is a lawyer and Executive Director of the Energy Policy Institute of Australia.