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Dr Alan Finkel
Technology Roadmap Secretariat
Department of Industry, Science, Energy and Resources
Australian Government
Canberra ACT

21 June 2020

Dear Dr Finkel and the Technology Roadmap Team

WWF-Australia is pleased to provide a summary submission to the Technology Investment Roadmap Discussion Paper (Discussion Paper). WWF-Australia has been at the forefront of supporting the transition to zero-carbon technologies and low-carbon land use in Australia and globally for decades.

The Discussion Paper outlines a range of technologies that are essential to the decarbonisation of Australia and the world. However, there are a few technologies included such as gas that are significant contributors to climate change and expensive and that we recommend not be pursued further.

In our submission we recommend that:

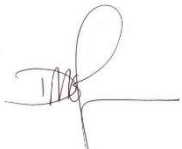
- Further investigation be undertaken into land-use, agricultural and blue-carbon decarbonisation technologies, including technologies to mitigate the risk of catastrophic bushfires.
- Heat pumps for commercial, industrial and residential applications be prioritised through the Technology Investment Roadmap process.
- Zero-carbon firming renewables be a priority technology cluster in the Technology Roadmap and establish a stretch-target in the order of reducing the LCOE of firming solar and wind. Firming technologies should include batteries, pumped hydro, flexible demand and greater transmission as priorities.
- A target of 700% renewables for Australia be set as a stretch-goal in the Technology Investment Roadmap process and that a dedicated Renewable Exports Strategy be developed covering the six renewable export opportunities outlined in this submission.
- The following five most promising renewable export technology and industry be pursued further through the Technology Investment Roadmap process:
 1. Renewable hydrogen and ammonia,
 2. Green steel through both electric arc furnaces and direct reduction using hydrogen,
 3. Green aluminium with a focus on flexible potline technology,
 4. Batteries, both the manufacture and use of, and
 5. Enabling technologies such as smart meters, low-inertia grid management technologies, microgrid management technologies, smart inverters and AI.
- The final Technology Investment Roadmap clearly address the following three questions:
 1. How the Technology Investment Roadmap relates to Australia's international climate commitments under the Paris Agreement?

2. How will the latest climate science continue to inform the prioritisation of technologies, the setting of stretch goals, the implementation and regular updating of the Technology Roadmap and annual Technology Statements?
 3. How the Technology Roadmap compliments other necessary climate policies and programs?
- The following three filters be applied to prioritising technologies:
 1. Is the technology zero emissions. Alternatively, is the technology at risk of becoming a stranded asset as the world decarbonises?
 2. Cost reduction potential and learning curves.
 3. Co-benefits.
 - The Technology Investment Roadmap process be supported through the continuation of ARENA and by Government programs for:
 1. Onshore commercialisation of technology
 2. The creation of local demand
 3. Capacity Building
 4. Support for supply chain development in Australia.
 - The Government get started through a Renewable Recovery stimulus package.

Please find attached to this Submission WWF-Australia's Renewable Recovery Policy Paper and our Hydrogen Position Paper. In addition, we would welcome the opportunity to submit a more detailed technical paper that discusses both the renewable export and land-carbon technology opportunities.

WWF-Australia would be pleased to discuss our submission and recommendations further with the Reference Panel. Please contact Nicky Ison, Energy Transition Manager, WWF-Australia on NIson@wwf.org.au or 0402 034 580.

Yours sincerely,



Dermot O'Gorman

Technology Investment Roadmap: WWF-Australia Submission

21 June 2020

Introduction

Australia has been a world-leader in zero-carbon technologies and jurisdictions such as South Australia, Tasmania and the ACT are at the forefront of the global transition to clean energy. Queensland is currently leading efforts to scale up carbon farming through the Land Restoration Fund. With our abundant land, world-leading solar and wind resources, expertise and strong trading relationships, it is imperative that Federal Government policies and programs be put in place to capitalize on our comparative advantage and position Australia to prosper into the future as the world decarbonises. Without urgent action, it is likely that Australia will be left behind.

About WWF-Australia

WWF-Australia is one of Australia's largest and most trusted environment organisations. WWF-Australia has been at the forefront of supporting the transition to zero-carbon technologies and low-carbon land use in Australia and globally for decades.

Currently, WWF-Australia's clean energy programs include:

- **The Business Renewables Centre – Australia (BRC-A)**. BRC-A is a member-based platform of over 200 companies, that streamlines and accelerates corporate purchasing of large-scale wind and solar energy and storage. In partnership with the Institute for Sustainable Futures at UTS and Climate Kic-Australia, WWF-Australia coordinates the BRC-A, providing training, resources and helping to broker relationships between corporates purchasing renewables and renewable project developers.
- **The Science-Based Targets Initiative (SBTi)**. This global program supports companies across a range of sectors to set climate science-based targets to reduce their own greenhouse gas emissions and then develop evidence-based plans to reduce their emissions. SBTi is a partnership between WWF, UN Global Compact, CDP and the World Resources Institute.
- **Renewable Powerhouse Campaign**. This campaign aims to help accelerate Australia to become the world's leading renewable exporter by 2030, helping to drive a domestic transition to clean energy, while positioning Australia to prosper in a zero-carbon world. The first phase of this campaign is advocating for a Renewable Recovery to the COVID19-induced economic crisis. This campaign is working with a range of companies including Unilever, Australian Ethical Investment, Sonnen and more.
- WWF-Australia, in partnership with the NSW Government, is also currently scoping the potential to establish the **Business Alliance for Reducing Embodied Carbon in Construction (BARECC)**. Similar to the BRC-A, the BARECC would work with building material suppliers and customers to help grow capacity and demand for decarbonised building materials such as steel, cement, concrete and glass.

WWF-Australia is also actively involved in a range of activities related to carbon storage and sequestration in soils and biomass, including on-going field projects in Australia as well as our international work on guidelines, credible standards and robust methodologies for carbon offsets, crediting and markets.

Based on the wealth of experience and knowledge built up through delivering these programs and campaigns, WWF-Australia is pleased to provide a submission to the Technology Investment Roadmap.

Agriculture and land use

While technologies that could help reduce emissions from land use are included in the Discussion Paper, WWF-Australia recommends that further investigation be undertaken into two broad categories (with some technologies flagged in the roadmap):

- **Technologies for monitoring, reporting and verifying GHG emissions in agriculture and land use.** This includes low cost soil carbon measurement, but also improved technology to monitor carbon emissions from land use change and from bushfires.
- **Technologies for carbon emission reductions and sequestration in the agriculture and land use sector.** This includes feed supplements to reduce livestock methane emissions, as noted in the road map, but also genetic selection or modification of livestock to reduce enteric fermentation.

Other topics not flagged in the road map include the need for improved methods to enhance soil carbon, new methods for blue carbon sequestration (e.g. seagrass and mangrove protection and restoration), as well as technologies to mitigate the risk of catastrophic bushfires.

Australia's comparative advantage - technologies foundational to energy decarbonisation

There are three technologies that are foundational to Australia's decarbonisation and future economic prosperity. These foundational technologies help unlock other technologies which in turn unlock new decarbonisation and economic opportunities for Australia.

Energy efficiency and electrification technologies

Energy efficiency is both the cleanest and most cost-effective way of reducing carbon pollution. Internationally, there is a trend towards homes, buildings and industry becoming more energy efficient. Unfortunately, Australia lags behind most of the OECD in increasing energy efficiency, to our cost. For example, ClimateWorks found that certain Australian companies could be much more competitive and achieve growth in annual profits of 2-13% by increasing their energy productivity to that of their best performing peers within their sector globally.

One form of energy efficiency measure is electrification. Shifting transport, heating and industrial processes from combustion to electricity-based processes typically involves a significant reduction in primary energy use and also presents significant decarbonisation and economic benefits. Heat pumps are one energy efficiency and electrification technology that can be applied in commercial, industrial and residential settings and as such we recommend be prioritised through the Technology Investment Roadmap process.

Renewable energy technologies – wind and solar

Renewable technologies, particularly wind and solar are now the least-cost technology option for new power generation in Australia and many countries around the world. As the world moves to act on climate change and fulfil the promise of the Paris Climate Agreement, places that have the best solar and wind resources have a significant comparative advantage. Add to this our large land mass and thus geographic diversity of weather patterns, it means there are few countries that are as well positioned as Australia to prosper in a low-carbon future than Australia.

The deployment of solar and wind at all scales is foundational to the success of other zero-emissions technologies. Through electrification solar and wind are not only going to power our existing electricity needs, but transport, heating and industry as well. Solar and wind will also be foundational to new export opportunities and the revitalisation of local manufacturing. Scaling up and accelerating the deployment of wind and solar and continuing to ensure these technologies advance down the cost curve

are thus essential to the success of everything from chemical production such as ammonia to electric vehicle uptake.

Firming technologies

The move towards electricity systems based on variable renewables, makes the need for firming technologies such as battery storage, pumped hydro and flexible demand urgent. Greater geographic diversity of renewables through transmission is another way of firming renewable and ensuring electricity system reliability into the future.

WWF-Australia recommends that zero-carbon firmed renewables be a priority technology cluster in the Technology Roadmap and establish a stretch-target in the order of reducing the LCOE of firmed solar and wind. Firming technologies should include batteries, pumped hydro, flexible demand and greater transmission as priorities.

Positioning Australia for the future – Renewable Export Opportunities

Economic competitiveness now aligns with international decarbonisation efforts to which Australia has committed. Positioning Australia to prosper into the future, involves embracing the opportunities associated with renewable exports, as many global industries and other countries are likely to need Australia's help in their efforts to decarbonise.

WWF-Australia's renewable export typology

WWF-Australia has identified six main types of renewable energy export opportunities that Australia should actively pursue. They are:

1. Clean hydrogen-based fuel. Using renewable electricity to electrolyse water. Renewable hydrogen can then be converted into derivative projects such as ammonia and synthetic fuels.
2. Direct electricity transfer via undersea cables. (Like the Suncable plan to export electricity to Singapore).
3. Renewable powered products. Increasing Australian manufacturing and minerals refinement powered by renewables for example steel and iron, cement, aluminium, copper, plastics, fertiliser, chemicals, etc.
4. Australia's clean energy expertise. Legal, financial, business and engineering, particularly in deploying and managing renewable energy systems, including education and training.
5. Components for clean energy technologies. For example wind turbine blades, inverters, batteries and the minerals such as lithium, nickel and copper essential to their production.
6. Software and services. The tech that supports the operation of clean energy systems e.g. the software and smarts needed for demand management, microgrids, and grid integration of renewables.

700% Renewables

To unlock the renewable export opportunities outlined above, Australia must have much greater ambition with respect to renewables deployment. Australia should be aiming over the next 20-30 years to have a renewable industry on the scale of our current LNG export industry. According to Darren Miller, CEO of ARENA this would mean targeting 700GWs of wind and solar or 700% renewables, as this would deliver a similar amount of energy to our current LNG export industry.

Research by the ANU Grand Challenge and the Energy Transition Hub based out of Melbourne University is currently helping to identify some of the challenges and opportunities to moving Australia to 500-2000% renewables.

WWF-Australia recommends that a target of 700% renewables for Australia be set as a stretch-goal in the Technology Investment Roadmap process and that a dedicated Renewable Exports Strategy be developed covering the six renewable export opportunities outlined above.

Promising renewable export technologies and opportunities

Through WWF-Australia's work on Renewable Exports, we have identified five promising technology and industry opportunities that we recommend be pursued further through the Technology Investment Roadmap process. They are:

1. **Renewable hydrogen and ammonia.** WWF-Australia believes renewable hydrogen is essential to the full decarbonisation of the global economy. In particular, the generation of cost competitive renewable hydrogen is critical to domestic decarbonisation and several of Australia's renewable export pathways including:

- The direct export of renewable hydrogen,
- The decarbonisation of derivative chemical products such as ammonia that have significant export markets, and
- The manufacture and export of green steel and green cement.

WWF-Australia is supportive of the H2 below \$2kg stretch goal in the Technology Investment Roadmap, however we recommend it be pursued in accordance with the following criteria:

- Being renewable only,
- Being traceable,
- Stringent public, worker and environmental safety practices being adopted,
- Being developed in accordance with sustainability principles,
- Target applications that are difficult to electrify,
- The industry being structured so as to lower energy costs to Australian consumers.

See Appendix A for WWF-Australia's Hydrogen Position Paper which expands on this recommendation.

2. **Green Steel.** As the world's leading exporter of iron ore, Australia is well placed to capture greater value of this export by utilizing our renewable resources to create, use and export green steel. Electric arc furnaces and direct reduction using renewable hydrogen are technology pathways that should be pursued.

3. **Green alumina and aluminium.** As the world's leading exporter of bauxite and second largest exporter of alumina, Australia is well placed to capture greater value of these exports by utilizing our renewable resources to create, use and export green alumina and aluminium. Three technologies are critical to the decarbonisation of aluminium and ensuring Australia can keep its existing aluminium industry and eventually expand it:

- Flexible potlines
- Inert anodes
- Zero-emissions high temperature industrial process heat, most likely through renewable hydrogen.

4. **Batteries.** Batteries are a critical technology for the global decarbonisation of the power and transport sectors. As the world's largest exporter of lithium ore (sopodium) and a country with large reserves of other minerals critical to battery production such as nickel Australia is well positioned to play a significant role in the global battery industry. Australia's high uptake of rooftop solar has also made us an attractive early market for home batteries. There are opportunities for Australia in both the use of and manufacture of batteries and as such should be a high priority.

5. **Enabling technologies.** Globally, there is a shift to smarter, more digitally based energy systems, particularly in the power sector. The increased digitisation of the grid is critical to the integration of high penetrations of renewables, distributed energy resources, electric vehicles, flexible demand and for the establishment of microgrids. A large number of remote communities, combined with our high uptake of wind and solar means Australia has advanced capabilities in enabling technologies such as smart meters, synchronous condensers, low-inertia grid management technologies, microgrid management technologies, smart inverters and AI a priority for the Technology Investment Roadmap. We can build on this technological capability which will be required around the world.

For more information about WWF's work on renewable exports see – [wwf.org.au/renewables](https://www.wwf.org.au/renewables).

Finalising the Technology Investment Roadmap & prioritising technologies

WWF-Australia has a number of recommendations for the process of finalising the Technology Investment Roadmap, making recommendations to Government and prioritising technologies.

Alignment with climate science

WWF-Australia supports the Federal Government's focus on technology development and deployment as a key element of decarbonising Australia and positioning us as a renewable export superpower. However, we recommend the final Technology Investment Roadmap clearly address the following three questions:

- How the Technology Investment Roadmap relates to Australia's international climate commitments under the Paris Agreement?
- How will the latest climate science continue to inform the prioritisation of technologies, the setting of stretch goals, the implementation and regular updating of the Technology Roadmap and annual Technology Statements?
- How the Technology Roadmap compliments other necessary climate policies and programs?

Setting a zero-net emissions goal by 2050 at the latest, supported by regular carbon budgets is likely to be essential to unlocking the private sector investment needed to deploy these technologies at scale.

Filters to prioritise technologies

During the consultation four filters were presented to help prioritise the technologies identified in the Discussion Paper. They were:

- Large-scale abatement
- Large-scale economic opportunity
- Technologies where Australia has a comparative advantage
- Technology readiness.

In addition, to these filters WWF-Australia recommends the following three filters be applied:

1. ***Is the technology zero emissions. Alternatively, is the technology at risk of becoming a stranded asset as the world decarbonises?*** The Technology Roadmap technology prioritisation process should prioritise zero emissions technologies and explicitly exclude low-emissions technologies that continue to expand the use of fossil fuels (coal, oil and gas). WWF-Australia advocates for an emission pathway that keeps global warming below 1.5°C for a climate-resilient future and works for nature-friendly solutions and a just transition towards net-zero emissions. A comprehensive transition away from fossil fuels is an urgent priority to achieve this goal. Government support for fossil-fuel based technologies is inconsistent with this goal.

2. **Cost reduction potential and learning curves.** The decarbonisation technology solutions that have been most commercially successful and have played the biggest role in reducing carbon emissions globally have been modular technologies such as heat pumps, solar PV modules, wind turbines and batteries that have steep learning curves and exhibit strong cost reductions through increasing scale. This filter will help identify technologies that have the most chance of commercial success.
3. **Co-benefits.** Many technologies identified in the Discussion Paper do not only present an economic opportunity for Australia and help lower Australia's carbon emissions, they deliver other benefits as well. The opportunity for co-benefits such as health and increased resilience in the face of disasters should be applied to the technologies.

Maximising the value of Australia's zero emissions technologies

Support for innovation and technology research and development is incredibly important. However, to help decarbonise Australia and capture the economic value of decarbonisation technologies support must extend beyond the research and development phase.

The lack of support for solar PV commercialisation in Australia presents a cautionary tale and it is essential that the government processes deployed to implement the Technology Roadmap are designed to avoid repeating this situation with technologies that are prioritised through the Roadmap process. The Ministerial Panel should recommend that the Technology Investment Roadmap be supported by programs for:

- Onshore commercialisation of technology
- The creation of local demand
- Capacity Building
- Support for supply chain development in Australia.

As the Discussion Paper acknowledges ARENA and CEFC have and continue to play a critical role in the research and development, commercialisation, market-scale up, capacity building and support for the deployment of zero-carbon technologies. It is critical that ARENA and CEFC are funded to continue this work.

While we support expanding the mandate of ARENA and CEFC to sectors beyond electricity to support energy efficiency and the decarbonisation of transport, we do not support ARENA or CEFC being used to fund fossil fuel projects. This is in-line with Australia's G20 commitment to phase out inefficient fossil fuel subsidies.

Get started with a Renewable Recovery

In a [report commissioned by WWF-Australia](#), EY found an economic recovery based on renewables would boost local manufacturing, grow existing sectors and unlock new industries, increase exports, reskill our workforce, and reduce carbon pollution. This is the first step to take to become a "renewable energy powerhouse" - winning the race to the top that COVID-19 has presented us with. By combining what our nation is famous for - endless sunshine, huge land area, powerful winds, world-class expertise, and strong trade relationships – with the global shift to a low carbon future, we could lead the world in the export of renewable energy, technology.

WWF-Australia has developed a \$2 billion Renewable Recovery package of five stimulus measures that focus on accelerating the roll-out of five zero-carbon technologies identified in the Discussion Paper and this submission. These measures can unlock 45,000 jobs in the short-term, lower power bills, and help stimulate our economy helping us to emerge from recession. See Appendix B for WWF-Australia's Renewable Recovery Policy Paper.