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Fiscal stimulus for low-carbon compatible COVID-19 recovery: criteria for infrastructure investment

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Abstract

To counteract the recession caused by the measures to contain the coronavirus (COVID-19) pandemic, governments are implementing fiscal stimulus measures for economic recovery. In addition to keeping people in jobs and businesses afloat, public investment can improve productivity and economic growth prospects, resilience and quality of life for the long term. Importantly, it can also help achieve long-term low-carbon trajectories, especially where new stimulus spending goes to infrastructure projects. This paper takes stock of approaches for evaluating and choosing options for public investment in projects and programs that support economic recovery, are consistent with a low-carbon transition, and bring broader economic, environmental and social benefits. We develop a multi-criteria analysis framework and illustratively apply this to infrastructure projects and programs in Australia that have previously been designated as priorities. Promising categories for public stimulus include renewable energy supply including by fast-tracking renewable energy zones and transmission investment, some types of transport infrastructure projects, energy efficiency programs including retrofits of public housing and buildings, and land management projects including to restore ecosystems that were damaged in Australia's bushfires. Investments like these hold promise to create jobs and local economic activity, while supporting lower-carbon outcomes and achieving other societal goals. Comprehensive evaluation of public investment options along a clear set of criteria can help improve decision making on public infrastructure investments, and transparency about public policy objectives may also inspire greater public confidence in how governments make funding decisions in COVID-19 recovery.

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COVID-19; stimulus; infrastructure; low-carbon trajectories; environmental benefits; multi-criteria assessment

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1 Introduction

Economic slowdown or recession is following the coronavirus (COVID-19) pandemic and the lockdown measures taken to control it. Governments are responding by spending public funds to counteract the drop in economic activity. Having started with wage and business subsidies to cushion immediate impacts of lockdown, government spending in many jurisdictions is evolving towards programs to stimulate economic activity, by way of public investments including in infrastructure.

Stimulus spending is aimed at counteracting economic recession, keeping people employed and businesses afloat. It also offers the chance to make investments that will improve productivity, environmental outcomes and resilience to a variety of possible future shocks, social outcomes and quality of life. While there is a need for governments to help counteract the impacts of recession, well-timed and well-chosen public investments during economic recessions can have strong positive impact with high economic multipliers, which means that the overall economic activity triggered is much higher than the direct investment (Auerbach and Gorodnichenko 2012; Baum et al. 2012; Batini et al. 2012). Such government programs can also meet other societal objectives, including to address social objectives, climate change and local environmental benefits. Governments' economic support policies have a central importance in the response to the pandemic-induced world recession of 2020 (OECD 2020).

There have been many calls for designing recovery stimulus packages that focus on low carbon objectives and may protect economies from future shocks (European Climate and Environment Ministers 2020; Vetter 2020; Dixson-Decleve et al. 2020; Galvin and Healy 2020). The World Bank and the International Monetary Fund (IMF) are in support of these calls with reports that the IMF will lend governments $1 trillion, providing guidance that the funds should support a 'green recovery' (Hammer et al. 2020; Battersby et al. 2020; Darby 2020; Reuters Staff 2020). Moving beyond short-term income and business support measures, governments have many options to support economic activity while helping lay better foundations for the future, including for low-carbon growth. This may include investment in the education sector and workforce upskilling, support for applied R&D and the

development of new industries, improvements in public health systems, support to community organisations and so forth.

It also, and importantly, can include accelerated investment in government funded projects, including infrastructure – the topic of this paper. Such investments will need to fulfil certain criteria to be attractive, such as job creation, speed of delivery, and usefulness of what is being created.

Such public stimulus investment creates a specific opportunity to help the transition to lower-emissions economies and thus the global climate change response. The need to decarbonise economies is urgent and widely acknowledged, and cost effective low-emission technologies in energy, transport, industry, buildings and other sectors are available. Consequently, large public investment plans as part of the COVID response offer a unique opportunity to help put the world on a low-carbon post-pandemic growth trajectory.

Investment in infrastructure, broadly defined, can be of particular importance for low-carbon outcomes. If investments in infrastructure that facilitate a low-carbon transition are accelerated, this will accelerate low-emissions outcomes. Conversely, if stimulus spending goes to infrastructure that is geared towards carbon intensive systems, this can lock in high emissions trajectories. Infrastructure stimulus funding may have the added benefit of infusing business and consumer confidence as they can be seen as a visible expression of a recovering economy, and may also carry the perception of being 'fairer' in comparison to welfare expenditure (Schwartz et al. 2009). In an assessment of the Australian economy's resilience in the global financial crisis, the government's announcement of the *Nation Building and Jobs Plan* is interpreted as one of the crucial factors responsible for boosting business confidence in Australia (McDonald and Morling 2011).

Other environmental and social goals will usually also present as important objectives. These may include diverse objectives such as reducing local pollution, improving land management or biological diversity, achieving more equitable outcomes in access to public services, improving living conditions for the poor and low-income earners, and so forth. Economic stimulus packages with identified environmental components are often referred to as 'green stimulus'.

An example of a stimulus program with multiple aims is the one being developed in Europe. The European Commission is developing a €750 billion economic stimulus plan and Members of the European Parliament have stated that these funds should be targeted towards those hardest hit by the crisis, while still prioritising climate action, a digital strategy and a new EU health programme to ensure that medical supplies are available across the EU (European Commission 2020a). The recovery strategy will include renovations of buildings and infrastructure, renewable energy projects (especially wind, solar and kick-starting a clean hydrogen economy in Europe), a move towards cleaner transport and logistics, and a 'Just Transition Fund' to support re-skilling and help businesses create new opportunities (European Commission 2020b).

Government responses to the 2008 'global financial crisis' have provided experience with the design and implementation fiscal stimulus measures. As governments are once again embarking on stimulus, many organizations, companies and groups in society are proposing programs or projects for funding. The choices can be consequential. Government's decision making can benefit from clarity about objectives and criteria for choosing investment options more so than in 'normal' times given that large amounts of money may be in play and decisions may be made in a hurry, with limited information and under pressure from particular constituencies.

Governments may choose investment options because they fulfil specific objectives, or they may screen options for minimum performance on a core set of criteria, or evaluate them according to their expected performance across various dimensions in a multi-criteria framework.

A systematic evaluation of options will require a list of objectives and indicators, and it will benefit from an existing stocktake of options as a starting point. Australia has an independent statutory body, Infrastructure Australia, which maintains an Infrastructure Priority List and evaluates projects to support better infrastructure decision-making (Infrastructure Australia 2020a). Australia is among only a few countries that have an independent evaluator of infrastructure projects (Wegrich et al. 2017).

In this paper, we construct a list of criteria for stimulus spending based on a synthesis of the literature and of recent proposal, and illustratively evaluate a sample of proposed infrastructure projects and

programs for Australia, drawing on Australia's infrastructure priority list and similar resources. Our focus is the potential to stimulate the economy following the COVID-19 induced economic slowdown, in a way that is compatible with low-carbon objectives, as well as other environmental and societal benefits. A structured analysis of this kind can help inform policy makers on the types of projects that could support the short term goals of a COVID-19 recovery while making progress on longer term objectives. It also presents an added opportunity for transparent analysis to underpin decision making. We illustrate how such criteria could be applied and broad conclusions, identifying several categories of public investment that perform well according to the criteria. We do not make assessments for specific projects.

This article is structured as follows. Section 2 provides a brief review of experiences with previous stimulus programs and some recent recommendations for green stimulus programs. Section 3 compares eight studies that proposed evaluation criteria for green stimulus programs and two current stimulus programs by Australian subnational governments. Using all ten examples, we develop a list of suggested evaluation criteria for infrastructure projects and programs as part of a COVID recovery stimulus in Australia. Section 4 presents information on Australian infrastructure projects that were assessed as high-priority before the pandemic and shows how a multi-criteria analysis could be applied to reassess a range of projects and programs. We discuss several investment options that are promising on the basis of the criteria chosen. Section 5 concludes.

2 Lessons from previous stimulus programs and proposals

2.1 Infrastructure investment following the global financial crisis

Infrastructure investment has historically been an important part of stimulus spending programs as it promotes job-creation and long-term economic growth, increases private sector spending, maintains the productive capacity of the economy, meets expanding infrastructure needs, has a large element of domestic input relative to imports, and can potentially address ecological issues (Congressional Research Service 2009; Schwartz et al. 2009; Watt and Nikolova 2009; Flyvbjerg 2009). Infrastructure investment can include capital investment in transportation, communications, energy, public utilities,

environmental projects, construction and maintenance of public buildings such as schools and hospitals and so forth (Bivens 2017; Sutherland et al. 2009).

As a response to the global recession in 2008, many countries increased infrastructure investment in addition to other measures to stimulate the economy, such as fiscal transfers and monetary policy. Developing countries on average focused more on infrastructure spending with spending levels three times higher than developed economies (ILO 2011; Khatiwada 2009). Infrastructure stimulus spending mostly focused on projects with short establishment timeframes, such as the building and repair of roads, bridges, railway lines and rural infrastructure.

Several countries accommodated environmental initiatives in their stimulus packages. The 'green' share of major global economic stimulus plans announced until 2009 has been estimated at 15% of total stimulus investment. The types of projects identified as being part of a green stimulus included energy efficiency, water waste and pollution control, and low-carbon power generation (Robins et al. 2009).

In the United States, the American Recovery and Reinvestment Act (ARRA) was legislated in 2009, as a follow up to the Economic Stimulus Act of 2008. Under ARRA, infrastructure projects made up around 15% of total spending (Bivens 2017; Council of Economic Advisers 2010).

Most European Governments in their stimulus programs focused on infrastructure as an important area of spending (Watt and Nikolova 2009). Several EU member countries provided subsidies for green technologies and sustainable transport, and there were large investments in efficient heating systems, home insulation and other energy saving measures. However, some of the 'green' measures in EU member states, such as the 'cash for clunkers' program that encouraged modernization of the vehicle fleet, were widely criticized for a lack of green attributes (Watt and Nikolova 2009).

In Australia, infrastructure investments included school construction and refurbishment, increased spending on social and defence housing, local community infrastructure, road and rail projects and home insulation programs (Stoney and Krawchenko 2012; Makin 2010). The 'green' share of the Australian fiscal stimulus as estimated by UNEP was third highest amongst G20 countries, estimated at 21% of spending and amounting to 0.87% of GDP (UNEP 2009). Out of a budget of $42 billion AUD

for economic stimulus during 2010-2012, a total of $ 22.4 billion AUD was allocated for infrastructure developments (Stoney and Krawchenko 2012). The $2.8 billion AUD Homeowner Insulation Program (HIP) was a crucial part of the Energy Efficient Homes Package announced under infrastructure developments. The program, however, was terminated prematurely and led to an enquiry into the planning and implementation of the scheme following the death of several installers (ANAO 2010).

2.2 Effectiveness of 'green' infrastructure in stimulus spending

Amidst rising concern about climate change, fiscal stimulus packages were seen as an opportunity to promote recovery through 'green growth' (De Serres et al. 2010). For example, the United Nations Environment Program (UNEP) advocated for a 'Global Green New Deal' (Barbier 2009) to address climate-change, environmental degradation and rising poverty. The purpose of this initiative was to guide governments in the process of reconfiguring businesses and supporting infrastructure spending to boost employment, stimulate economic growth while improving economic sustainability. UNEP recommended energy efficiency improvements, renewable energy technologies, sustainable transport, ecological conservation, and sustainable agriculture programs (UNEP 2009). Direct funding for clean energy technologies through fiscal stimulus was seen as having the added advantage of overcoming credit market failures (Newell et al. 2019).

Success of infrastructure stimulus spending in part depends on governance, such as intergovernmental relationships between federal, state and local governments and their respective roles in assessing infrastructure needs (Congressional Research Service 2009). Governments may attempt to gain politically through project selection and distribution of funds (Stoney and Krawchenko 2012). Implementation delays with government infrastructure spending can produce negative effects with reduced private investment in the short-run (Leeper et al. 2010).

2.3 Proposals for fiscal stimulus during COVID-19

Many organizations and think-tanks have recently proposed principles and indicators for fiscal stimulus packages. Here we give a short overview of key features some of the proposals in the discussion, without claim to comprehensiveness in selection of proposals.

The World Bank has produced a checklist that recommends focussing on economic growth, along with risk assessment, resilience assessment, and a contingency plan for exposure and vulnerability to disasters and climate-change. Other sustainability indicators in the checklist include the sustainability of human, social, environmental and cultural capital, as well as decarbonisation and a positive impact on market failures (World Bank 2020).

The Australia Institute published a list of design principles for effective economic recovery interventions (Denniss et al. 2020), evaluating a range of potential stimulus projects using a multi-criteria analysis framework. Key features are that projects should be timely and targeted towards affected sectors, regions and communities, and that activities should provide co-benefits, promote domestic production, target regional areas and have high labour intensity.

The New Zealand Government has indicated that infrastructure investment will be a key area in stimulus spending (Small 2020). It has tasked the infrastructure industry reference group to identify projects that can be initiated within six months after the construction industry is allowed to operate. In response, New Zealand's Climate Change Commission provided a set of design principles for stimulus package design (Carr 2020), which recommends stimulus investments that can deliver long-term climate benefits, advocates bringing forward future transformational climate change investments, and highlights the need to maintain current market, regulatory and policy measures for long-term climate change goals.

In the United States, climate and social policy experts from academia and civil society have developed a proposal that recommends focusing on job creation, strategic and targeted investment towards communities that have suffered economic hardship, leveraging existing public agencies and assets, and the potential for carbon emission reductions (Green stimulus proposal 2020). The Centre for American Progress has released design principles for infrastructure investment as part of fiscal stimulus packages, recommending long-term infrastructure investment in traditional sectors with a focus on repair projects, and highlighting the need to focus on sustainable infrastructure programs that involve decarbonisation (Centre for American Progress 2020).

A recent survey of academics' and government officials' views about the most desirable recovery policies highlighted the importance of connectivity infrastructure, general R&D spending, education investment, clean energy infrastructure, and clean energy R&D spending (Hepburn et al. 2020). These were the options that overall were identified as having a large long-run multiplier and strong positive impact on climate outcomes. Other policy options that were highly regarded included healthcare investment and worker retraining. In terms of potential impact on emissions, energy efficient buildings upgrades (including retrofits) and projects focused on green spaces and natural infrastructure fared well in this expert survey.

2.4 Previous fiscal stimulus investment criteria

We have reviewed eight studies and proposals that have proposed evaluation criteria to assess infrastructure investments and that included criteria for low-carbon or broader environmental outcomes (Table A1 in the appendix). These include six proposals published in 2020 and addressed specifically at COVID-19 stimulus, and two from 2009 addressing 'global financial crisis' stimulus.

Investment under an economic stimulus is often judged against established criteria of being timely, temporary and targeted (Feldstein 2009; Stone and Cox 2008; Elmendorf and Furman 2008). On the timeliness criteria, infrastructure investments often fail due to required long-lead times on project planning, approval, development and construction (Brahmbhatt 2014). The International Labour Organization in its review of global fiscal stimuli (ILO 2011) reasoned that unless infrastructure stimulus funding is aimed at 'shovel-ready' or pre-existing infrastructure projects, it generally scores poorly on timeliness. Major infrastructure projects tend to have long planning horizons and complex project management issues, creating risks of cost-overruns and in project implementation (Flyvbjerg 2009).

On the other hand, focusing on 'shovel-readiness' of projects generally excludes 'visionary' investments that can bring broad-based change (Hanak 2009). Long-lived investments, such as in mass-transit systems, tend to have a larger effect on stimulating spending while reducing risk-averse saving (Zenghelis 2014). Long-lead times are no impediment if a recession is expected to be long.

Bowen et al. (2009) developed a comprehensive multi-criterion for assessing potential benefits of green proposals that are part of fiscal stimulus spending. The study's main focus was assessing proposals on the merit of facilitating short-term economic recovery and the long-term goal of tackling climate change. Assessment criteria included timeliness, job creation potential, long-term social returns with respect to climate change objectives, reduced lock-in effects from low-carbon capital stock, as well as targeting investments towards areas with under-utilized resources.

The OECD (OECD 2009) also developed guidelines for the design and implementation of stimulus packages. For infrastructure investments, the OECD highlighted the need to focus on projects that can be implemented quickly. The OECD also prioritised projects aimed at energy and resource efficiency and long-term environmental sustainability. It recommended targeting areas with under-utilized resources and leveraging existing public agencies and programs for the disbursement of stimulus funds.

2.5 Assessment of project options using defined criteria

Evaluations made of the likely performance of infrastructure investment options during the global financial crisis provides an indication of the broad lines along which assessments for different project categories may go. We compare the evaluation criteria applied in Bowen et al. (2009) and Strand and Toman (2010) for a selection of project categories that those authors identified as 'green' stimulus (Table A2).

The broad picture that emerges is that among the categories examined in these two studies, the programs that tend to most closely match green stimulus objectives are afforestation and ecosystem restoration programs, energy efficiency upgrades and renewable energy projects. The suitability of public transport projects, power grid expansion projects and projects related to recycling systems, bioenergy and energy from waste had mixed assessments and are likely to depend on the nature and context of specific projects.

2.6 Australian project evaluation criteria

The governments of Australia's two most populous States, New South Wales (NSW) and Victoria, have put forward project evaluation criteria as part of the response to COVID-19 (Victoria State

Government 2020; NSW Government Planning Industry and Environment 2020). These criteria are summarized in the appendix (Table A3), using similar categories to those above, with an additional category ‘Governance’ as this was a distinct component of these Australian States’ criteria.

The Victorian Government criteria specifies reductions in greenhouse gas emissions, while the New South Wales criteria specifies environmental benefits and mentions green infrastructure. Both governments give an indication of desired timeliness. The NSW document states that development applications will be prioritised where assessment can be completed within six months, and planning proposals will be prioritised when progression to development application stage is feasible within six months. The Victorian document states that a project “preferably commences within 12 months or can be enabled to commence within 12 months through fast-tracking.

3 Our criteria

On the basis of ten lists, proposals and studies, we have developed a set of evaluation criteria that would be applicable for decisions about COVID-19 stimulus investment in infrastructure projects and spending programs in Australia (Table 1).

We identify the following nine criteria: employment, economic activity, timeliness, reduced implementation risk, compatibility with low carbon objectives, environmental benefits, social benefits, resilience, and governance. We illustrate these criteria by identifying 'desirable' and 'undesirable' factors, as well as a neutral range of 'compatible' factors.

All of the studies and proposals that we reviewed (refer to Tables A1 to A3 in the appendix) have a criterion for impacts on employment and/or various facets of economic impacts, and most take a project's timeliness into account. Most consider decarbonisation and/or the risk of stranded assets due to future emissions constraints. Most also consider environmental impacts and broader aspects of sustainability. Some discuss resilience to economic, environmental and climate shocks, technological impacts, and a variety of other aspects.

Employment and timeliness are two criteria that are central for assessments of suitability as stimulus measures. These will need careful consideration, often on a case-by-case basis. For example, a prime goal of stimulus is to provide employment opportunities for people who have lost jobs, which in the short term includes workers in the travel and hospitality industry, and businesses that have experienced large falls in revenue. Projects will differ in how equitable their employment effects are; for example, large-scale engineering or some types of remote area projects may favour male, higher-income and mobile workers. So a well-designed stimulus initiative, with a portfolio of programs and projects, will need to ensure that the jobs created are targeted at job seekers, established quickly and result in equitable employment benefits in terms of pay, gender and regional dispersion.

Table 1: Proposed evaluation criteria for stimulus investments

Employment	• Desirable: creation of jobs for workers who have lost their jobs in the recession or are at risk of losing it, including jobs at businesses that fulfil demand created by the infrastructure works. • Desirable: jobs that match the available work force in terms of skill sets and location. • Desirable: equitable employment outcomes (e.g. in terms of pay, gender and regional outcomes). • Compatible: job creation gradually over time, or needing extensive training or skills development. • Undesirable: projects that create few jobs or only specialized jobs in fields with high employment.
Economic activity and growth	• Desirable: activities with high amounts of domestic economic activity per dollar of public funding spent (high economic multiplier effect). • Desirable: improvements in economic productivity and future growth prospects. • Desirable: investments that produce future fiscal revenue or savings to governments. • Desirable: projects previously identified as having strong economic/business cases or broader public benefits. • Undesirable: projects that lead to small or only temporary economic benefits.
Timeliness	• Desirable: projects that can be started quickly, ideally within less than one year (depending on scale). • Desirable: activities that deploy their employment and broader economic effects rapidly. • Compatible: programs that can start soon at limited scale and ramp up over time. • Undesirable: projects with long lead-times.
Reduced implementation risk	• Desirable: low risk of unintended adverse consequences, delays of implementation, non-delivery of project outcomes, or budget overrun. • Undesirable: projects that carry high implementation risks.
Compatibility with low carbon objectives	• Desirable: projects that reduce greenhouse gas emissions. • Desirable: projects that support or enable the longer-term shift to a low carbon economy. • Compatible: projects that will be neutral or near-neutral in their impact on emissions. • Undesirable: projects that increase emissions or lock in high-emissions production or consumption patterns.
Environmental benefits	• Desirable: projects that provide local environmental benefits, such as reductions in air pollution, improvements in water quality, improvements in ecosystems, and/or that provide environmental amenity. • Compatible: projects with minimal disruption or impact on local environments. • Undesirable: projects that adversely impact local environments.
Social benefits	• Desirable: positive social outcomes, such as more equal access to public services and resources (including gender equity, cost of living reductions for low income earners, improved public health and safety). • Desirable: activities that respect indigenous rights and prevent cultural loss. • Undesirable: activities that increase inequality of access to services or run counter other social goals.
Resilience	• Desirable: infrastructure that is resilient to natural disasters and climate change, to possible outbreaks of COVID-19 and other disruptions. • Undesirable: projects that cannot be easily paused or operate with social distancing.
Governance	• Desirable: high standards of probity and transparency (including in the selection process). • Undesirable: choice and implementation of publicly funded programs with limited due diligence, community engagement and transparency.

4 Assessing stimulus spending options in Australia

Having kept COVID-19 infection rates to a comparatively low rate including through early lockdown and social distancing, Australia now faces the prospect of a recession induced by business disruptions, ongoing restrictions on some activities, and adverse international economic conditions. The immediate effect of the COVID-19 shut-down measures was to reduce activity in hospitality, tourism and travel, as well as tertiary education. And second-round effects are likely to include the construction industry and other fields of business. International economic conditions will largely determine impacts on the resources sector.

The initial policy response by the federal government consisted of a wage subsidy scheme, higher unemployment benefits and selective business support. These measures were aimed at lowering the increase in unemployment, providing a better social safety net than previously and tiding businesses over the duration of the lockdown. Unless the hope of an immediate (or 'V-shaped') economic recovery were to materialize, the next phase of government interventions will likely include direct government investment in economic activity, including investment programs. As detailed above, Australia's two most populous States had already taken preparations for this at the time of writing in June 2020.

This section provides example assessments of selected categories of projects and programs using the criteria developed above. We do not provide assessments of individual programs or projects.

4.1 Infrastructure project lists

An assessment of infrastructure investment options in Australia can draw on a large number of infrastructure projects that were deemed to be priority projects or initiatives by Infrastructure Australia before the COVID-19 pandemic (Figure 1), as well as Australian projects in the Australia & New Zealand Infrastructure Pipeline (ANZIP).

Infrastructure Australia was established as part of the Infrastructure Australia Bill 2008 and was established to advise governments on Australia's future infrastructure needs. In the Infrastructure Australia Bill, the role of Infrastructure Australia was noted as advising governments, investors and owners of infrastructure on: • nationally significant infrastructure priorities; • policy and regulatory

reforms desirable to improve the efficient utilisation of national infrastructure networks; • options to address impediments to the development and provision of efficient national infrastructure; • infrastructure policy issues arising from climate change; • the needs of users; and • mechanisms for financing investment in infrastructure.

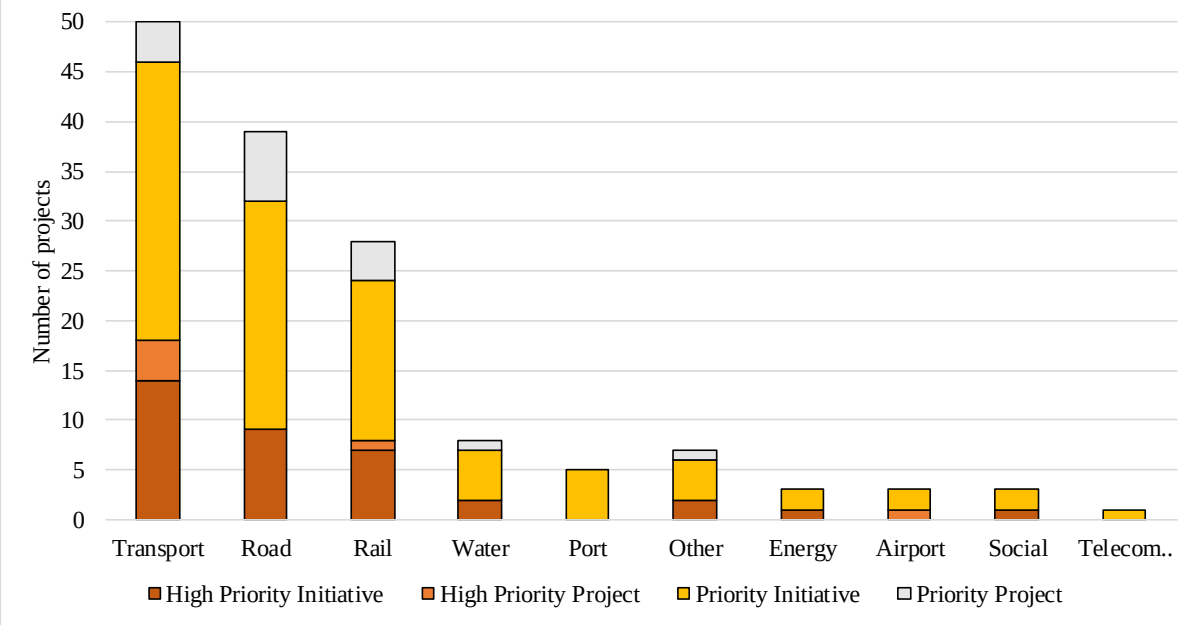
Infrastructure Australia receives infrastructure proposals throughout the year from proponents. For example, the 2020 priority list includes government institutions (e.g. councils and State or Territorial bodies) and non-government institutions (including the Freight on Rail Group, the Royal Automobile Club of Victoria and the Royal Automotive Club WA). Infrastructure Australia evaluates the proposals using an evaluation framework. The proposals that appear on the Infrastructure Australia list are categorized into different levels of priority (i.e. high priority and priority) and whether they have a full business case. Projects are proposals that are at an advanced stage of assessment (with a developed business case) and initiatives are promising proposals that need further development and assessment.

ANZIP is a joint initiative between the Australian Government, the New Zealand Government and Infrastructure Partnerships Australia, which is an independent infrastructure intelligence unit. The ANZIP list provides detail on upcoming infrastructure investment and major construction opportunities. The ANZIP lists the projects based on the stage of progression through the development process (i.e. through from 'prospective' to 'preferred bidder announced').

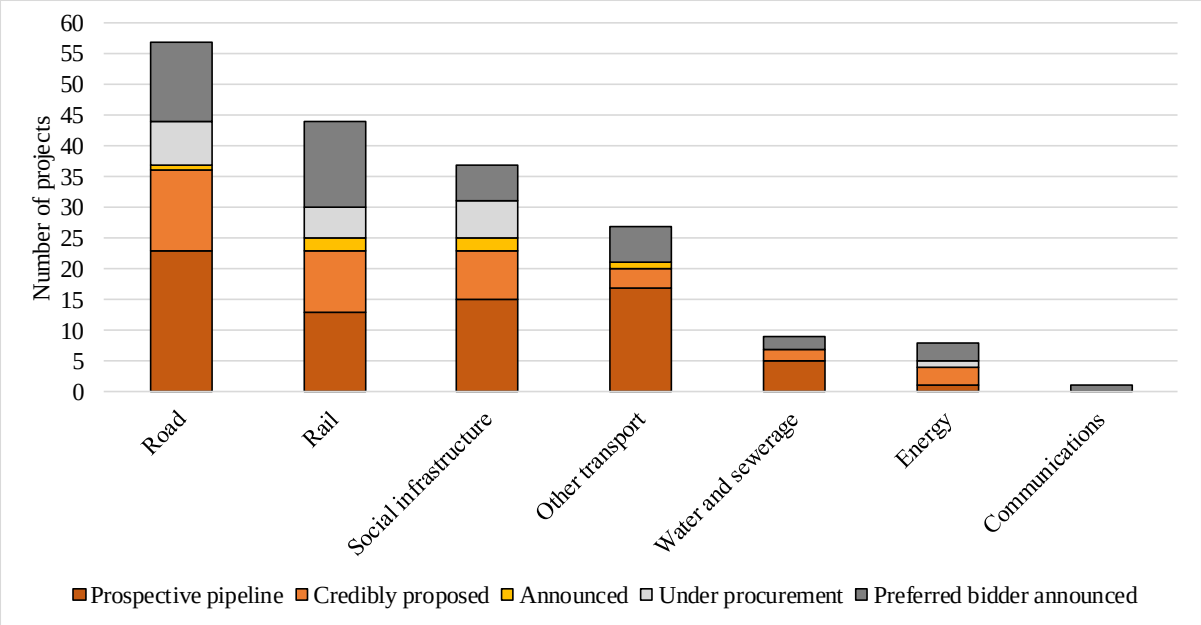
Road and rail projects dominate the projects on both lists, accounting for 46% and 55% of all projects on the Infrastructure Australia and ANZIP list respectively. We have reclassified the Infrastructure Australia list as most of the road and rail projects were originally listed as transport projects. Projects that mentioned both road and rail are classed as a transport project (Infrastructure Australia 2020a; Infrastructure Partnerships Australia 2020).

Figure 1: Number and sector of projects on the Infrastructure Australia priority list and Australia-New Zealand infrastructure pipeline

a) Infrastructure Australia priority list (Infrastructure Australia 2020a)



b) Australia & New Zealand Infrastructure Pipeline (Infrastructure Partnerships Australia 2020)



Note: We counted the number of projects using the sector categories and status from the relevant sources. Both the Infrastructure Australia priority list (Infrastructure Australia 2020b) and Australia & New Zealand Infrastructure Pipeline (Infrastructure Partnerships Australia 2020) are continually updated and are available online.

4.2 Assessing projects and programs using selected categories

We now apply our suggested framework of criteria (specified in Table 1) to several clusters of proposed projects and programs in Australia. The projects and programs are chosen from the two lists of infrastructure projects, as well as some other sources, and grouped into three categories. These are: energy projects/programs (Table 3), environmental resource projects/programs (Table 4), and transport projects (Table 5).

We aim firstly to show how a multi-criteria analysis could be applied to reassess infrastructure priorities as part of a COVID-19 stimulus in Australia, and secondly to provide indicative assessments for categories of projects. We do not evaluate individual projects, rather our assessments aim to capture broad features of projects within different categories. While we do present projects from the Infrastructure Australia (IA) priority list and the ANZIP list, these are examples that fit into the selected categories. Programs have been selected from a range of sources, including the priority project list of the NSW government (NSW Government 2020a) and the Australian Capital Territory Fast Track program (ACT Government 2020).

We have attributed high/medium/low classifications where in our assessment there are strong attributes associated with the criteria proposed. Otherwise we have refrained from assessment or indicated that project specific assessments would be needed.

One important area that generally needs project specific assessments is timeliness. How advanced an individual project is in terms of approvals and a developed business case will be a crucial factor with regards to timeliness. Expansion of existing, scale-able programs – for example in ecosystems restoration or energy efficiency – will usually be more timely than large, capital-intensive building projects such as public transport that may require planning processes or even land acquisition.

The types of programs that are on the whole most likely to match green stimulus objectives are afforestation and ecosystem restoration programs, energy efficiency upgrades and renewable energy projects and related infrastructure.

This is consistent with the broad assessment of green stimulus proposals made after the global financial crisis (Table A2). Our analysis suggests that projects in these categories tend to be implementable in a relatively short time frame, bring positive employment and economic benefits, have notable positive impacts on decarbonisation or environmental quality or both, and can bring social benefits, for example through lower energy costs.

Public transport projects may bring large relevant benefits, but will need secured corridors or have well-developed planning that can be fast-tracked. Active transport infrastructure will have notable health and auxiliary benefits for those who will use these walkways and cycle paths.

There are some large-scale infrastructure projects that are close to approval and could be fast-tracked to achieve economic stimulus and decarbonisation goals. Renewable Energy Zones (REZs), which are geographic areas slated for large scale wind and solar power installations, are a key example. Systems analysis has been completed and suitable locations have been identified (AEMO 2019). The NSW State government has already identified three zones and begun planning for one (NSW Government 2020b).

There are also a range of transport projects that are well advanced in planning and preparation or that could also be fast-tracked, including light-rail and metro projects.

Project specific assessments are also an issue for other factors, such as employment and the impact on environmental factors. For example, where a power grid expansion project links up a Renewable Energy Zone its impact on decarbonisation will be higher than general grid improvements. Some projects may have greater employment spill-overs, where other services are directly increased due to the implementation of an infrastructure project. Other projects may be in vulnerable ecological areas and we expect that environmental impact assessments will be completed. However, there will be some projects and programs that have established business cases in place and could be fast-tracked.

4.3 A closer look at selected project categories

A range of infrastructure projects and programs were being implemented, prepared or under consideration before the COVID-19 pandemic, with differing levels of public funding support. These

include many types of transport infrastructure projects; Renewable Energy Zones (REZs) and expansions of the power transmission network to support renewables; residential energy efficiency programs and improvements to public housing, schools and other government assets; and land management and improvement of ecosystems, especially in areas impacted by Australia's 2019-20 bushfires.

Here we discuss some aspects of these categories of projects based on the criteria proposed, with a view to their suitability to be ramped up as part of a COVID-19 economic recovery response.

4.3.1 Renewable energy investments and expansions of the power transmission network to support renewables

Renewable energy investments, including in REZs, will generally perform positively against the majority of the criteria set out above.

Renewable energy investments are fully compatibility with *low carbon objectives*. Wind and solar power are likely to be the dominant type of electricity supply in future in Australia, given their cost advantage relative to newly built coal fired power plants, electricity from gas plants, and nuclear power plants (if such existed in Australia).

The *economic case* for renewables supply expansion is strong. The addition of renewables has been shown to reduce electricity wholesale prices in the National Electricity Market (AEMC 2019). Accelerated investment in renewables supply will tend to improve the cost base of Australian industry and businesses and thereby can increase economic output. There is very little risk of making unproductive investments under stimulus programs.

Employment impacts are significant for large scale renewables projects during the construction phase. The fact that the construction jobs are largely in regional and rural areas may be a benefit in economic recovery investment. Around 70 percent of employment from renewables in Australia to date is outside capital cities, and there are also ongoing jobs in operation and maintenance roles (Clean Energy Council 2020).

To the extent that lower wholesale prices are reflected in lower electricity prices for households, renewables investment can also have positive *social benefits* by easing cost-of-living pressures.

Impacts on the *local environment* need to be assessed on a case-by-case basis. Renewable energy supply projects are generally highly *resilient* to external shocks. There are well established practices for *good governance*, including for the provision of power offtake agreements by State governments through auctioned feed-in tariffs (Buckman et al. 2019).

The *timeliness* of renewables investment depends on the duration of a COVID-19 recession response strategy, and on the state of preparation of individual projects and options to fast-track projects. A pipeline of large-scale wind and solar projects exists and very large amounts of new capacity have come online over the last three years (Clean Energy Regulator 2020). There have been signs that investment is slowing.

There is a risk that projects that are well advanced in planning and preparation may be put on hold by commercial developers given uncertainty about the economic outlook. So there may be ready opportunities for governments to ensure continued rapid implementation, for example by providing electricity offtake agreements.

It may also be possible to fast-track planned Renewable Energy Zones, for example by starting with specific portions of REZs, taking advantage of the modularity and scalability of renewable energy parks. In order to expedite processes, governments could get generation assets built under contract as part of stimulus programs and own them or sell them to market participants after construction.

The Australian Energy Market Operator in its 2018 Integrated System Plan (ISP) assessed 34 candidate sites for REZs across east Australia, along with the need for network upgrades to support these zones. So far, the NSW Government has committed to three REZs and is preparing to develop the Central-West REZ pilot near the town of Dubbo (NSW Government 2020b). The benefits that the NSW government list as part of the rationale for supporting REZs are improving electricity reliability by delivering significant amounts of new energy supply, increasing affordability by reducing wholesale electricity costs, supporting emissions reduction by delivering reductions in the electricity sector, and

engaging communities in regional development. Fast-tracking REZs that have been assessed as viable in this way may be an attractive option also for other State governments.

The renewable and low-emission energy sector have higher short to medium term employment multipliers compared to the fossil-fuel sector. The impact on employment from renewables can be 2.5 to 4 times higher than that from investment in oil, gas and coal (Pollin et al. 2009; Garrett-Peltier 2017). Recently, Ernst & Young conducted an assessment for WWF as part of a proposed renewable-led stimulus package and identified employment multipliers of 4.8 and 4.95 for jobs in renewable infrastructure and energy efficiency, which was compared to 1.7 for fossil fuel industries (WWF 2020).

New transmission lines and other grid investments are needed to support new large scale renewable energy generation, including in REZs. In addition to the assessments made in the 2018 ISP, there are a range of projects (listed in Table 3) that have been proposed to improve the power transmission network and support the operation of the National Electricity Market through grid interconnectors.

Similar assessments as for large-scale renewable energy investments apply to the necessary grid expansion, with the caveat that these may less scalable. The risk of creating unproductive assets appears negligible.

4.3.2 Energy efficiency programs and improvements to public housing, schools and other buildings

Programs focused on energy efficiency and other improvements to existing buildings, in particular public buildings, may be assessed favourably under the criteria.

Retrofits and upgrades to buildings support *low carbon objectives* when they improve energy efficiency, replace gas heaters with electric heating, and the install roof-top solar systems.

Building works generally bring large and localized *employment* effects and benefits for small and medium sized businesses.

The *economic case* is strong, in particular for most energy efficiency improvements where future savings on energy costs typically pay back for the initial investments over relative short periods of time.

In the case of public buildings, this also presents advantages to the future fiscal positions of federal, State and local governments.

Social benefits can be significant especially through improvements to public housing that result in lower energy costs to residents and higher quality of living. Social benefits may also include improved physical conditions and comfort in public buildings such as schools and hospitals.

Timeliness is usually excellent, as building improvement projects can be started quickly and are highly scalable. *Implementation risks* tend to be very low as these are well practiced activities, and resilience to any future COVID-19 outbreaks or other external shocks is high. *Good governance* can be assured by implementing projects under standard (though possibly expedited) public procurement guidelines.

Some existing energy efficiency programs and other retrofit programs are likely to have been delayed by the response to COVID-19 pandemic. The prioritising of stimulus provides an opportunity to expand these programs and bring forward future stages of these programs. One example program that had to be temporarily suspended was the Victorian Healthy Homes Program managed by Sustainability Victoria, which was to provide home energy upgrades to up to 1000 Victorian households with someone who lives with complex healthcare needs and have low incomes (Sustainability Victoria 2020). Another candidate for expansion is the Australian Government program to improving the energy and emissions performance of buildings (Department of the Environment and Energy 2020). An example of a program fast-tracked as part of COVID-19 stimulus is part of the Queensland Government's Advancing Clean Energy School initiative, which includes the installation of solar installations and energy efficiency measures (Queensland Government 2020).

These examples of programs for targeted improvements of public housing and public buildings are in contrast to stimulus initiatives that aim to create greater demand for the building industry but without regard to social or environmental benefits, such as the Australian government's HomeBuilder program which provides subsidies for private home buildings and renovations (Australian Government 2020).

4.3.3 Land management programs and improvement of ecosystems, especially in areas impacted by bushfires

Expansion of existing programs for better land management, afforestation and the improvement of ecosystems could be suitable candidates for a green COVID-19 recovery. In particular, there is an opportunity to boost the environmental response to the bushfires that ravaged Eastern Australia in the 2019/2020 summer.

Employment effects are highly positive, with jobs and business opportunities created by such programs located in regional and rural areas, including in regions that have suffered economically from the bushfires. Employment can be created at relatively low skill and wage levels. The large majority of expenditure is typically spent on local wages and business inputs, and little on capital goods.

Some types of projects, such as afforestation, directly support *low carbon objectives*. All projects in this broad category by definition have positive local *environmental effects*. They may lead to longer term *economic benefits* through regional revitalisation and by making rural areas more attractive for tourism or as a place of residence.

Implementation risks tend to be low when existing programs are expanded and there is high *resilience* to potential future disruptions as most projects can be readily halted.

Supporting, expanding, or replicating existing programs should be considered as this may lead to better timeliness and mean that projects can start sooner than later. An example is the Landcare Australia Bushfire Recovery Grants 2020, which as of early June 2020 had announced just 23 grants funded with just over $300,000 AUD. Larger initiatives such as the federal government's 'bushfire recovery funding for wildlife and their habitat', which has $150 million allocated, could be fast-tracked and expanded (Department of Agriculture Water and the Environment 2020).

There have also been calls for establishing a National Environmental Fund that would support wildlife and ecosystem recovery (ACF 2020). This would go beyond having volunteers provide the labour for these restoration works. The Australian Capital Territory is an example where people who

had recently lost their jobs were employed to perform bushfire recovery as part of a COVID-19 stimulus (Brown 2020).

4.3.4 Transport infrastructure and public transport projects

Among the many identified options and proposals for transport infrastructure and public transport projects, some would rate highly according to the criteria identified.

Timeliness can be achieved by fast-tracking large projects that have a well-developed business case and have necessary approvals or are well advanced in the approvals process. This is not the case for many large projects especially where new transport corridors are required. Fast-tracking can often readily be achieved for smaller, local projects and improvements of existing transport infrastructure.

Employment effects are generally strong, with much of the total expenditure going to local labour and businesses. Smaller and simpler projects, such as building or refurbishing footpaths and cycle paths, may employ people without specialised skills as manual labourers Mass transit projects in particular may have notable positive long-term economic benefits, including spill overs for local business.

To the extent that transport projects lead to reductions in passenger vehicle traffic, they contribute to *low carbon objectives*. *Local environmental effects* depend on the type of project and local context.

There can be large *social benefits* from projects that increase active travel, e.g. health and community benefits from walking and cycling, and from projects that provide better connectivity across cities.

Resilience to future COVID-19 outbreaks or other shocks is usually high especially for small projects. *Implementation risk* is a project-specific question and may rise with the scale of projects. Large scale transport infrastructure projects are notorious for the risk of cost-overruns (Sovacool et al. 2014).

There are a number of relevant projects on the Infrastructure Australia priority list that are at a late stage of development. Which of these projects can be fast-tracked is a matter for relevant government bodies to assess.

Table 2 Summary of assessments in four broad categories of infrastructure investment

Renewable energy investments and expansions of power transmission	Energy efficiency programs and improvements to public housing and buildings	Land management programs and improvement of ecosystems, especially in bushfire areas	Transport infrastructure and public transport projects
• Directly supports ***low carbon objectives***. • ***Economic case*** for renewables supply expansion is strong, including through lower electricity prices. • ***Employment impacts*** are significant for large scale renewables projects during the construction phase, some ongoing jobs in operation and maintenance roles. Jobs are largely in regional and rural areas. • ***Impacts on the local environment*** need to be assessed on a case-by-case basis. • ***Timeliness*** of renewables investment depends the state of preparation of individual projects and options to fast-track projects. Scale-ability of renewables projects can enable early start of parts of larger projects such as Renewable Energy Zones.	• Retrofits and upgrades to buildings (eg for energy efficiency, electric heating and rooftop solar) support ***low carbon objectives***. • Building works bring large and localized ***employment impacts*** and benefits for small and medium sized businesses. • ***Economic case*** is strong. Provides future savings on energy costs and can improve the future fiscal positions of Federal, State and local governments. • ***Social benefits*** can be significant esp in public housing and for low income earners. • ***Timeliness*** is usually excellent. Building improvement projects can be started quickly and are highly scalable.	• ***Employment effects*** are strong, with jobs and business opportunities created in regional and rural areas. • Some types of projects, such as afforestation, directly support ***low carbon objectives***. • Other ***environmental benefits*** arise by definition. • Longer term ***economic benefits*** can occur through regional revitalisation and by making rural areas more attractive for tourism or as a place of residence. • ***Implementation risks*** tend to be low when existing programs are expanded. • High ***resilience*** to potential future disruptions.	• Assessment is highly dependent on particular projects and context. • ***Timeliness*** can be achieved in small-scale projects or by fast-tracking projects that are in advanced stages of preparation. This may not be the case for many projects in the pipeline, especially large and complex projects. • ***Employment effects*** are generally strong. Smaller projects, such as building and refurbishing footpaths/cycle paths, may employ people without specialised skills. • To the extent that transport projects lead to reductions in passenger vehicle traffic, they contribute to ***low carbon objectives***. • ***Social benefits*** can arise from projects that increase active travel, including the health benefits from walking and cycling, and from projects that provide better connectivity across cities and reduce travel time or increase safety.

Source: Jotzo/Longden/Anjum 2020

5 Conclusions

In response to the recession triggered by COVID-19, governments have many options to provide fiscal stimulus through public investment in infrastructure, going beyond short-term income and business support and in addition to support other measures that are beneficial to economy and society such as fostering education and skills, new industries and the community sector. In choosing stimulus investments, governments will want to also lay the ground for future improvements in economic prosperity and provide broader public benefits, such as positive social and environmental outcomes.

Crucially, accelerated public investments in infrastructure as part of stimulus programs provides the opportunity to support low-carbon growth objectives.

Based on a review and synthesis of proposals, experiences and assessments, we have provided a list of criteria that can be applied in the choice of infrastructure projects and programs as part of a publicly funded stimulus response. We have identified a list of criteria that includes employment, economic activity and growth, timeliness, reduced implementation risk, compatibility with low carbon objectives, environmental benefits, social benefits, resilience and governance; and operationalised those criteria for qualitative assessment.

We have illustratively applied this list of criteria to a selection of projects and program categories (though not individual projects) outlined in stimulus program proposals and priority infrastructure investment lists for Australia. According to this broad assessment, a range of investment options are particularly promising. These include fostering investment in large scale renewable energy supply including through Renewable Energy Zones and expansion of power transmission, energy efficiency programs especially for public housing and public buildings, land management programs, afforestation and the improvement of ecosystems especially in areas impacted by bushfires, and specific types of transport infrastructure and public transport projects.

Comprehensive evaluation of public investment options along a set of criteria like these could help improve decision making on public infrastructure investments, not only during the COVID-19 response but also in future. Transparency about public policy objectives and the likely performance of different options relative to these objectives may also inspire greater public confidence in how public funding decisions are made.

Table 3 Evaluation criteria applied to example energy projects/programs that could form part of Australia'a COVID-19 recovery stimulus

Major project categories	Examples from Infrastructure Australia (IA), the Australia & New Zealand Infrastructure Pipeline (ANZIP) and other sources	Employment	Economic activity	Timeliness	Reduced implement. risk	Compatibility with low carbon objectives	Environmental benefits	Social benefits	Resilience	Governance
Renewable energy promotion via REZs (incl. accelerated planning process, increase renewable electricity production)	*- NSW Government – Central-West Renewable Energy Zone (REZ) Pilot* *- Darling Downs, Qld, REZ* *- Northern South Australia, SA, REZ* *- North-west Tasmania, REZ* *- Moyne, VIC, REZ*	*High for rural areas*	*Project specific assessments required*	*High for the sites that have already been identified as pilots and can be fast-tracked so construction can start within a year*	*High for projects that have approval and can be fast-tracked*	*High compatibility with low carbon objectives for sites with high solar/wind quality*	*Project specific assessments required*	*High/Medium (Contingent on local project factors and its impact on communities)*	*High in terms of being able to pause for COVID-19 outbreak* *Variable for other types*	*High as assessments of solar/wind quality have been completed* *Local consultation will need to occur*
Increased renewable energy production outside of REZs	*- Victorian Renewable Communities program* *- Asian Renewable Hub (ANZIP-Prospective pipeline)* *- Arrowsmith Hydrogen Project (ANZIP-Prospective pipeline)* *- Macintyre Wind Farm (ANZIP-Announced)* *- Western Downs Green Power Hub (ANZIP-Announced)* *- Kidston Pumped Hydro project (ANZIP-Announced)* *- Kaban Green Power Hub (ANZIP-Announced)* *-Queensland Government Apprenticeship centre in renewable hydrogen* *-Solar Victoria solar panel rebate* *-Solar Victoria solar hot water rebate* *- Solar Victoria solar rebates for renters* *- Queensland Government loans for household solar systems* *- Solar Victoria loans for solar PV systems*	*High for existing projects that have approval and can be fast-tracked (when including spill-overs)* *Medium/Low for more complex projects (or lower spill-overs)*	*Project specific assessments required*	*High for projects that have approval and can be fast-tracked*	*High for projects that have approval and can be fast-tracked*	*High*	*Project specific assessments required*	*High/Medium (Contingent on local project factors and its impact on communities)*	*High in terms of being able to pause for COVID-19 outbreak* *Variable for other types*	*Project specific assessments required*

Major project categories	Examples from Infrastructure Australia (IA), the Australia & New Zealand Infrastructure Pipeline (ANZIP) and other sources	Employment	Economic activity	Timeliness	Reduced implement. risk	Compatibility with low carbon objectives	Environmental benefits	Social benefits	Resilience	Governance
Improvements to public housing, schools and other government assets (including energy efficiency, solar panels, the replacement of gas heaters and other energy programs)	*- Queensland Government's Advancing Clean Energy School initiative* *- Victorian Govt. Energy efficiency upgrades for high-rise public housing* *- ACT Government improvement to public school facilities* *- ACT Government battery storage installation in public schools* *-Ivanhoe Stage 1 – social housing, affordable rental, community spaces and new school* *- ACT Govt. Community facility upgrade with solar PV installation* *- ACT Govt. solar PV installation in low-income ACT housing tenants* *- ACT Govt. gas-to-electric conversions in low-income -ACT housing tenants*	*High for existing projects that can be rolled out in communities across Australia and provide work for qualified trade-persons (especially electricians)*	*Project specific assessments required*	*High for projects can be fast-tracked or expanded to other regions or public buildings*	*High for projects that are operating and can be expanded*	*High when the focus is on energy efficiency, the replacement of gas heaters, and the installation of roof-top solar PV*	*Project specific assessments required*	*High (when the projects focus on social housing and public buildings)*	*High in terms of being able to pause for COVID-19 outbreak* *Variable for other types*	*Project specific assessments required*
Energy/Water efficiency programs (including retrofits and programs that are either utility-driven or local-authority-driven)	*- Australian Govt. Energy Efficient Communities Program* *- ActewAGL Big Business Light Switch* *- Actsmart Business Energy and Water Program* *- Victorian Healthy Homes Program* *- NT Govt. Home Improvement Scheme* *-Solar Victoria solar hot water rebate* *- Australian Govt. Improving the energy and emissions performance of buildings*	*High for existing programs that can be easily expanded* *Medium/Low for more complex projects*	*Project specific assessments required*	*High for existing programs that can be easily expanded*	*High for existing programs that can be easily expanded*	*Energy efficiency retrofit - High* *Water efficiency retrofit – Low/neutral*	*Energy efficiency retrofit – depends upon air pollution reductions* *Water-efficiency retrofit - Medium*	*High (when the projects focus on disadvantaged households)*	*High in terms of being able to pause for COVID-19 outbreak* *Variable for other types*	*Project specific assessments required*

Major project categories	Examples from Infrastructure Australia (IA), the Australia & New Zealand Infrastructure Pipeline (ANZIP) and other sources	Employment	Economic activity	Timeliness	Reduced implement. risk	Compatibility with low carbon objectives	Environmental benefits	Social benefits	Resilience	Governance
	- ACT Government The Energy Efficiency Improvement Scheme									
Smart electricity grid/Microgrid	*- Smart Grid, Smart City* *- Remote energy systems – BushLight program* *- LaTrobe Valley microgrid program* *- Community Energy Hubs project (microgrid)* *-Kaban Green Power Hub (ANZIP-Announced)* *- SWIS Transformation*	*Medium for existing projects that have approval and can be fast-tracked* *Low for more complex projects (or lower spill-overs)*	*Project specific assessments required*	*Medium for existing projects that have approval and can be fast-tracked* *Low for more complex or larger projects*	*High for existing projects that have approval and can be fast-tracked* *Medium/Low for more complex or larger projects*	*High*	*Project specific assessments required*	*Project specific assessments required*	*High in terms of being able to pause for COVID-19 outbreak* *Variable for other types*	*Project specific assessments required*
Energy storage	*- Pumped hydro Battery of the Nation (ANZIP – Prospective pipeline)* *- NSW Govt. Snowy 2.0 energy storage* *-Solar Victoria solar battery rebate* *- ACT Govt. NextGen Energy Storage program* *- SA Home battery scheme* *- Northern Territory Government Household and Business Battery scheme* *- Northern Territory Large-scale battery energy storage system for Darwin-Katherine system* *- Victorian big battery (ANZIP-Credibly proposed)* *- Queensland Government loans and grants for battery systems*	*Medium for existing projects that have approval and can be fast-tracked* *Low for more complex projects (or lower spill-overs)*	*Project specific assessments required*	*Medium for existing projects that have approval and can be fast-tracked* *Low for more complex or larger projects*	*High for existing projects that have approval and can be fast-tracked* *Medium/Low for more complex or larger projects*	*High*	*Project specific assessments required*	*Project specific assessments required*	*High in terms of being able to pause for COVID-19 outbreak* *Variable for other types*	*Project specific assessments required*
Power transmission network expansion	*- NSW Govt/Transgrid – Powering Sydney's future transmission link development (ANZIP – Credibly proposed)*	*Medium for existing projects that have approval*	*Project specific assessments required*	*Medium for projects that have approval*	*High for projects that have approval*	*High*	*Project specific assessments required*	*Project specific assessments required*	*High in terms of being able to pause for*	*Project specific assessments required*

Major project categories	Examples from Infrastructure Australia (IA), the Australia & New Zealand Infrastructure Pipeline (ANZIP) and other sources	Employment	Economic activity	Timeliness	Reduced implement. risk	Compatibility with low carbon objectives	Environmental benefits	Social benefits	Resilience	Governance
	- NEM Near-term optimization (Priority initiative) *- Project Energyconnect (ANZIP- Under Procurement)*	*and can be fast-tracked* *Low for more complex projects (or lower spill-overs)*		*and can be fast-tracked* *Low for more complex or larger projects*	*and can be fast-tracked Medium/Low for more complex or larger projects*				*COVID-19 outbreak* *Variable for other types*	
Power grid interconnectors	*- NEM Future connectivity and reliability (IA-High priority initiative)* *- South West Interconnected System transformation (IA-Priority initiative)* *- Second Bass strait interconnector-Marinus link (ANZIP-Credibly proposed)* *- Humelink (ANZIP – Credibly proposed)* *- Keranglink (ANZIP – Credibly proposed)*	*Medium for existing projects that have approval and can be fast-tracked* *Low for more complex projects (or lower spill-overs)*	*Project specific assessments required*	*Medium for projects that have approval and can be fast-tracked* *Low for more complex or larger projects*	*High for projects that have approval and can be fast-tracked Medium/Low for more complex or larger projects*	*High (when assumed to be related with expansion of renewables)*	*Project specific assessments required*	*Project specific assessments required*	*High in terms of being able to pause for COVID-19 outbreak* *Variable for other types*	*Project specific assessments required*

Table 4 Evaluation criteria applied to example environmental projects/programs that could form part of Australia'a COVID-19 recovery stimulus

Major project categories	Examples from Infrastructure Australia (IA), the Australia & New Zealand Infrastructure Pipeline (ANZIP) and other sources	Employment	Economic activity	Timeliness	Implementation risk	Compatibility with low carbon objectives	Environmental benefits	Social benefits	Resilience	Governance
Land management; afforestation; improving, expanding and developing parkland, wetlands and rural ecosystems; improvements in condition of natural resources	*- South Australia Open space grant program* *- Landcare Australia Bushfire Recovery Grants 2020* *- National Landcare program: Smart farming partnership Round 2* *- Junior Landcare Grant for gardens* *- SA Govt. Open spaces and places for people grant* *- ACT Govt. Open space and landscaping improvements across Canberra* *- ACT Govt. Lower Cotter catchment restoration program*	*High for existing programs that can be easily expanded* *Medium/Low for more complex projects*	*Project specific assessments required*	*High for existing programs that can be easily expanded* *Medium/Low for more complex projects*	*High for existing programs that can be easily expanded* *Medium/Low for more complex projects*	*Afforestation – High* *Parklands/ wetlands/ ecosystem development – Medium*	*High*	*High for programs that result in notable amenity benefits via improved landscape and open spaces* *Otherwise project specific assessments required*	High in terms of being able to pause for COVID-19 outbreak Variable for other types	Project specific assessments required
Non-hazardous environmental clean-up	*- Tasmanian sewerage infrastructure upgrades (IA-Priority initiative)* *- Australian Govt. National Landcare Clean up Australia and Keep Australia Beautiful grant* *- South-east Melbourne Advanced waste processing facility (ANZIP-Prospective)*	*High for existing programs that can be easily expanded* *Medium/Low for more complex projects*	*Project specific assessments required*	*High for existing programs that can be easily expanded* *Medium/Low for more complex projects*	*High for existing programs that can be easily expanded* *Medium/Low for more complex projects*	*Low*	*High*	*High amenity benefits for Landcare etc.* *Otherwise project specific assessments required*	High in terms of being able to pause for COVID-19 outbreak Variable for other types	Project specific assessments required
Development and expansion of waste recycling systems	*- NSW Govt. West Nowra Landfill expansion* *- NSW Govt./Visy Industries Dry Recyclables Facility* *- NSW Govt./Benedict Recycling Penrith Resource Recovery facility* *- National waste and recycling management (IA-High priority initiative)*	*Project specific assessments required*	*Project specific assessments required*	*Project specific assessments required*	*Project specific assessments required*	*Project specific assessments required*	*Medium/High (Contingent on project type, scale and impact*	*Low*	*Project specific assessments required*	*Project specific assessments required*

Table 5 Evaluation criteria applied to example transport projects that could form part of Australia'a COVID-19 recovery stimulus

Major project categories	Examples from Infrastructure Australia (IA), the Australia & New Zealand Infrastructure Pipeline (ANZIP) and other sources	Employment	Economic activity	Timeliness	Implement. risk	Compatibility with low carbon objectives	Environmental benefits	Social benefits	Resilience	Governance
Mass transit and rail freight	*- Sydney Metro: City and Southwest (IA-High Priority Project)* *- Brisbane Metro (IA-High Priority project, ANZIP-Announced)* *- Freight Inland Rail (Priority Project)* *- Gold Coast light rail (Priority project)* *- Beerburrum to Nambour Rail upgrade (Priority project)* *- Rail network optimisation program (High priority initiative)* *- Canberra public transport improvements (priority initiative)*	*High if notable spill overs occur* *Medium for existing projects that have approval and can be fast-tracked* *Low for more complex projects (or lower spill-overs)*	*Project specific assessments required*	*Medium for existing projects that have approval and can be fast-tracked* *Low for more complex or larger projects*	*High for existing projects that have approval and can be fast-tracked (key issue is having an approved corridor)* *Medium/Low for more complex or larger projects*	*High*	*Project specific assessments required*	*Project specific assessments required*	*Project specific assessments required*	*Project specific assessments required*
Green transport infrastructure	*- National electric vehicle fast charging network (High Priority initiative)* *- Active transport (walking and cycling) access to Sydney CBD (Priority initiative)* *- ACT Govt. Footpath and cycle path network upgrades in Canberra*	*Medium for projects that have approved corridors and can be fast-tracked* *Low for more complex projects*	*Project specific assessments required*	*High for projects that have approved corridors and can be fast-tracked* *Low for more complex or larger projects*	*High for existing projects that have approved corridors and can be fast-tracked* *Medium/Low for more complex or larger projects*	*High*	*High*	*High for active travel infrastructure*	*Project specific assessments required*	*Project specific assessments required*

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Appendix

Table A1: Overview of evaluation criteria used to assess infrastructure investments and green stimulus

Criteria used/ proposed to assess projects	Stimulus proposals							
	Post-COVID-19 proposals						2008 GFC proposals	
	The World Bank (World Bank 2020)	**Green stimulus proposal** (Green stimulus proposal 2020)	**The Australia Institute** (Denniss et al. 2020)	**Climate Action Tracker** (Climate Action Tracker 2020)	**Centre for American Progress** (Centre for American Progress 2020)	**NZ Climate Change Commission** (Carr 2020)	**Bowen et al.** (Bowen et al. 2009)	**OECD** (OECD 2009)
	Sustainability checklist for assessing economic recovery interventions	*Guiding principles for stimulus spending*	*Design principles for fiscal stimulus spending in response to COVID-19*	*Green stimulus framework*	*Guiding principles for investment in infrastructure under fiscal stimulus spending*	*Guiding principles for aligning economic recovery with climate goals*	*Criteria for assessing potential benefits of 'green' proposals under fiscal stimuli spending*	*Guiding principles for designing and implementing stimulus packages*
Employment	Short-term employment intensity; Targets employment inclusivity, gender balance, vulnerable and underemployed populations; New jobs use skills already existing in local populations; New jobs require similar skills as those of jobs lost	Employment intensity; Family sustaining, career-track; Targets low-income and workers of colour	High direct employment intensity; Targets affected workers	Targets unemployed resources; Safeguards existing jobs	Targets communities facing greatest need;	Inclusive	Employment intensity; Targets underutilized resources	Targets under-employed, vulnerable groups, low-skilled youth, women, older workers and workers at a greater risk of falling into unemployment
Economic activity and growth	Economic multiplier; Domestic content; Targets affected sectors; Ability of workforce to shift a new or different sector (if demand is generated is an unaffected sector); Measures to facilitate transition of workers to required investment	Strategic investments and economic diversification; Targets low-income, communities of colour, indigenous, communities suffering disinvestment and communities that have historically faced the brunt of pollution and climate harm	Targets domestic production; Targets affected sectors; Targets regional disadvantage	Short-term economic multiplier	Spending focused on traditional sectors such as highways, public transportation, water, affordable housing, community health facilities, rural broadband, school, child-care centres among others; Prioritize repair projects; Provide funding certainty; Redresses historical investment disparity and discrimination	Investment in transformational climate change investments	Domestic fiscal multiplier	

Criteria used/ proposed to assess projects	**The World Bank** (World Bank 2020)	**Green stimulus proposal** (Green stimulus proposal 2020)	**The Australia Institute** (Denniss et al. 2020)	**Climate Action Tracker** (Climate Action Tracker 2020)	**Center for American Progress** (Centre for American Progress 2020)	**NZ Climate Change Commission** (Carr 2020)	**Bowen et al.** (Bowen et al. 2009)	**OECD** (OECD 2009)
Timeliness	Timeliness of full-implementation; Impact on employment and economic activity within 6-18 months		Timeliness of response	Economic stimulus and job creation should occur within 18 months	Shovel-readiness of infrastructure project;	Offers both short-term and long-term climate benefits	Shovel-readiness (extent to which spending would occur within 12 months or more);	Shovel-readiness of infrastructure project;
Implement-ation risk	Contingency plan for future COVID restrictions; Impact on local/national debt and its sustainability				Investment in traditional sectors in infrastructure		Fiscal sustainability (extent to which funding is likely to be shifted forward in time)	
Decarboni-sation and stranded asset risk	Contribution towards economic decarbonisation/ NDCs; Increases energy security; Integration of low-carbon technology/strat egy; Carbon/energy-intensive development lock-in effects; Stranded asset risk	Supports rapid cuts to carbon pollution consistent with keeping global warming as close as possible to 1.5 degrees C; Protects salaries, benefits and retirement of fossil fuel workers		Accelerate uptake of low-carbon infrastructure; Enables sectoral transitions towards full decarbonisation; Stranded asset risk	Supports transition from fossil-fuels towards clean energy with the goal of all economic production achieving net zero carbon emissions by 2050	Carbon/energy-intensive development lock-in effects; Stranded asset risk; Prioritize transformational climate change investment; Emissions reduction;	Lock-in effects of long-lived low-carbon capital stock	Carbon/energy intensive, polluting energy technology lock-in effects.; Promotes clean alternatives
Environ-mental benefits	Environmental sustainability; Biodiversity and ecosystem protection; Promotes redevelopment of polluted land;			Contributes to development of natural capital development	Protects and ensure transparent environmental review process			Supports long-term environmental sustainability
Resilience and adaptive capacity	Increase socio-economic resilience and adaptive capacity; Infrastructural resilience; Assessment for vulnerability to natural disasters and climate change risk;	Prevent future crises		Societal and infrastructural resilience to pandemics, natural disasters and climate-change		Increases resilience to climate change impacts		

Criteria used/ proposed to assess projects	**The World Bank** (World Bank 2020)	**Green stimulus proposal** (Green stimulus proposal 2020)	**The Australia Institute** (Denniss et al. 2020)	**Climate Action Tracker** (Climate Action Tracker 2020)	**Center for American Progress** (Centre for American Progress 2020)	**NZ Climate Change Commission** (Carr 2020)	**Bowen et al.** (Bowen et al. 2009)	**OECD** (OECD 2009)
Social benefits (and sustainable growth)	Offers career track jobs with ability to unionize, safety, health and durability; Improves public health and productivity; Strengthens social protection systems; Promotes skill-building and advancement; Respects indigenous rights; Prevents cultural losses; Helps in delivering universal access to essential infrastructure services; Improves local economic productivity through improved infrastructure services; Contributes to labour participation of women, people with disability and excluded groups; Increase energy security		Delivering co-benefits with potential for lasting benefits	Contributes to human (skill development and health) and physical capital growth; Poverty alleviation; Inclusive growth	Equitable; Potential to boost wages, benefits, opportunities for advancement and ability to unionize; Promotes informed public engagement in the planning process	Provides immediate and long-term climate benefits for NZ workers, households, communities, and regions; Prepares displaced and future workers through investment in education and retraining to transition towards jobs created from a low-emission economic transformation	Long-term social returns with respect to climate change objectives	Modern project with potential to raise energy and resource efficiency
Other	Addresses market failures; Contributes to asset/export diversification; Supports technological innovation through early stage R&D investment; Target high-growth potential technology; Promotes development or pilot projects of low-carbon technology deployment by making it widely available or reducing cost			Promotes removing existing barriers to decarbonisation; Accelerate take-up of low-carbon technologies	Infrastructure spending should extend over a long period of time;			Combines investment in physical infrastructure with skills and innovation related assets to maximise long-term productivity growth

Table A2: Comparison of the evaluation criteria applied in Bowen et al. (2009) and Strand and Toman (2010) for a post-GFC 'green' stimulus

Major project categories and example projects	Source of assessment	Employment	Economic activity	Timeliness	Compatibility with low carbon objectives	Other environmental benefits
Afforestation and ecosystem restoration programs						
Afforestation, expanding and developing parkland, wetlands and rural ecosystems	*Bowen et al. (2009)*	*Best*	*In between best/worst*	*Best*	*Best*	
Non-hazardous environmental clean-up	*Strand and Toman (2010)*		*Low/Medium*	*High*	*Low*	*High*
Expanded biological carbon sequestration	*Strand and Toman (2010)*		*Low*	*Medium*	*Medium*	*Variable*
Energy efficiency upgrades						
Smart infrastructure and buildings for increasing energy efficiency, monitor, meter and regulate delivery and consumption of energy efficiency and water	*Bowen et al. (2009)*	*In between best/worst*	*Best*	*In between best/worst*	*Best*	
Residential energy efficiency (lofts etc.), either utility-driven or local-authority-driven	*Bowen et al. (2009)*	*Best*	*Best*	*Best*	*In between best/worst*	
Energy efficiency measures for public buildings	*Bowen et al. (2009)*	*Best*	*Best*	*Best*	*In between best/worst*	
Energy efficiency retrofits	*Strand and Toman (2010)*		*Medium*	*High*	*Medium*	*Medium*
Renewable energy						
Renewable energy promotion (e.g. through accelerated planning process)	*Bowen et al. (2009)*	*Best*	*Best*	*In between best/worst*	*Best*	
Increased renewable electricity production	*Strand and Toman (2010)*		*Variable*	*Low*	*High*	*Medium/High*
Public transport projects						
Mass transit and rail freight	*Bowen et al. (2009)*	*Best*	*In between best/worst*	*In between best/worst*	*Best*	
Green transport infrastructure	*Strand and Toman (2010)*		*Low*	*Low/Medium*	*Medium/High*	*Medium/High*
Power grid expansion projects						
Smart power infrastructure/grid modernization	*Bowen et al. (2009)*	*Best*	*Best*	*Worst*	*Best*	
Power grid expansion	*Strand and Toman (2010)*		*Medium/High*	*Low*	*Low/Medium*	*Variable*
Recycling systems, bioenergy and energy from waste						
Development and expansion of recycling systems	*Strand and Toman (2010)*		*Low*	*Low*	*Low/Medium*	*Variable*
Introduction of new forms of bio-energy	*Strand and Toman (2010)*		*Variable*	*Low/Medium*	*Medium/High*	*Variable*
Expansion of currently cultivated bio-energy	*Strand and Toman (2010)*		*Low*	*Medium/High*	*Variable*	*Variable*

Table A3 Project evaluation criteria used by two Australian subnational governments

Criteria used to assess projects	NSW Government Priority project criteria	Victorian Government priority projects eligibility criteria
Employment	Development projects – total direct and indirect job creation within six months; Planning proposals – job creation in the short to medium term; Creates a significant pipeline of jobs over 10-20 years; Project encourages job creation in identified strategic and key centres, Project encourages local job creation in places/regions with underemployment; Project encourages job creation in areas impacted by bushfires/drought; Can potentially attract and generate other forms of employment generating development; Safeguards existing jobs affected by COVID-19 pandemic including in tourism, hospitality and/or creative industries; Provides job opportunities for Aboriginal people; Project seeks to achieve innovative and sustainable design outcomes; Provides jobs in a location with a displaced workforce with relevant adaptable skills	Promotes creation of significant number of new jobs (construction or ongoing); Safeguards existing jobs
Economic activity and growth	Project ensures consistency with government policy with respect to its assessment of public benefit; Project strategic merit assessment of outcomes/aims align with expected directions and/or priorities outlined in relevant state, regional and/or district plans; Targets transportation infrastructure, green infrastructure, public places and social infrastructure and services infrastructure; Promotes housing growth	Significant short to medium term economic impact; Requires significant expenditure; Aligns with Victoria's economic strategy; Aligns with government policies and priorities; Contributes to local procurement and supply chain opportunities; Supports vulnerable communities, regions, industries or sectors
Timeliness	Determination within three months Shovel-ready within 6 months	Shovel-ready; time-period for realising benefits Preferably commences within 12 months or can be enabled to commence within 12 months through fast-tracking
Implementation risk	Extent to which funding is secured; Suitable management and resolution of flooding, bushfire, contamination and ecological concerns; For rezoning and site compatibility assessment, project provides investment certainty for project to progress to assessment of development application within 6 months	Satisfies due diligence considerations of financial/non-financial risk, project risk and economic impact, supply chain risks; Has secure financial capital notwithstanding potential impacts of coronavirus; Project's technical and compliance issues are well understood; Project leverages existing projects and/or procurements
Low carbon objectives	N/A	Delivers reduction in greenhouse gas emissions;
Environmental benefits	Provides environmental benefits; Provides green infrastructure	Increased environmental resilience; Environmental sustainability
Social benefits	Projects create public benefit through delivery of moderate to high level of additional housing supply with a significant share of build to rent, social, affordable or key worker housing; Potential link to delivery and state or regional level infrastructure Provides significant public space; Assists in supporting, sustaining and expanding creative industries	Contributes to net community benefit; Contributes to the availability of social infrastructure, particularly social housing and affordable housing or community facilities
Governance and probity	Project has suitable arrangements for ensuring equitable and transparent selection of projects; Project has suitable arrangements to ensure project assessment throughout the lifetime of the project	Project has safeguards in place or has scope for putting safeguards in place that ensure probity and integrity of the application in case the application is expedited; Project proposal has progressed through planning processes where views of relevant stakeholders have been sought