MINISTRY OF BUSINESS, INNOVATION & EMPLOYMENT
HĪKINA WHAKATUTUKI

How can policy help stimulate climate investment?

A literature review

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Abstract

Climate investment – investment aimed at climate change mitigation or adaptation – plays a key role in achieving climate goals. However, climate investment faces many challenges, including short-termism, physical and transition risks, and deep uncertainty. These challenges mean that the scale of global climate investment to date has been limited. Wide-ranging and co-ordinated policy action is needed to kick-start and support climate investment.

JEL classification

Q5, G41

Keywords

Climate investment, climate finance

Executive summary

- **Climate investment is a key enabler in addressing the climate crisis.** The climate crisis requires urgent action, at scale, and across the whole economy. Climate investment includes spending on low-emissions technologies and energy systems, climate-friendly business models, and climate-resilient assets and infrastructure. This type of investment can help lower emissions and adapt to some of the effects of climate change, and thus plays a vital role in achieving climate goals.
- **Climate investment has long time horizons.** Climate investment is shaped by investment decision-makers' expectations, attitudes and awareness of the distant benefits of climate action, weighed up against the near-term costs. Short-termism in investment decision-making works against climate investment.
- **The choice of discount rates is therefore critical.** Discounting is perhaps the most important conceptual issue for climate investment. A high discount rate tilts decisions towards investment projects that deliver net benefits in the near term, whereas a low discount rate tilts decisions towards projects that deliver net benefits over the longer term. A high discount rate – such as that used in the New Zealand public sector – therefore discourages climate investment.
- **Climate investment involves risks and uncertainties.** There are two main risks: physical risks such as from extreme weather events or sea level rise; transition risks such as from policy, legal, technology, and market changes aimed at reducing emissions (mitigation) and adjusting to climate change impacts (adaptation). As well as risks, climate change also introduces deep uncertainty to investment decision-making, which means there is disagreement about the probability distributions of key parameters in models or the values of outcomes. These risks and uncertainties work to lower and postpone climate investment.
- **Other challenges include lock-in and stranded assets.** Lock-in arises through a combination of systemic forces that perpetuate high-emissions infrastructure and business practices in spite of known environmental externalities and the existence of cost-effective remedies. Stranded assets are ones that suffer from unanticipated or premature write-downs, devaluations or conversion to liabilities during the transition to a low-emissions economy or due to climate change impacts. Lock-in and stranded assets highlight the role of *di*vestment in achieving climate goals.
- **The scale of global climate investment to date reflects these challenges.** While there has been some growth in climate investment and its financing, most estimates of the scale of investment come to broadly similar conclusions – that both climate investment and its financling fall far short of what is needed.
- **There is a very strong rationale for government intervention in climate investment.** The main rationale is the negative externality that arises due to the damage that emissions and maladaptation inflict on others. Other market failures

include incomplete capital markets, information and co-ordination failures, the market power of incumbents, and positive knowledge spillovers from innovation.

- **A systemic approach to climate investment policy is often suggested.** Fundamentally, the deep transformation in investment patterns and behaviours needed to achieve climate goals requires wide-ranging and co-ordinated policy action. In addition to addressing market failures, this deep transformation suggests a market creating/market shaping role for government.
- **Such a policy approach involves complementing a robust carbon price with a suite of other measures,** which for mitigation investment includes: regulatory measures when pricing is not efficient or too low; specific measures to bring low-emission technologies to commercialisation; addressing barriers in the financial system such as a lack of information on low-emissions investment; improving governance across the financial system as a whole to address financial incentives that favour short-termism; government acting as a market shaper/maker by providing 'patient' (long-term) capital or being first purchaser. The overall aim is to kick-start mitigation investment and address underlying problems such as system inertia.
- **Internationally, while some progress is being made, policy efforts to stimulate climate investment have been assessed as vastly inadequate.** Europe in particular is making progress on some of the foundational work needed to support mitigation investment, such as developing taxonomies and improving disclosure regimes. However, global finance and investment for mitigation remain marginal, and ultimately global emissions are high and rising. Even less progress has been made in adaptation policy and adaptation investment.
- **Aotearoa New Zealand is at the start of our climate investment policy work.** Progress to date includes establishing the overarching framework for climate change policy and improving the disclosure regime. However, New Zealand lacks even basic data on climate investment, and has yet to assess the scale and pace of investment needed. In addition, the lack of a robust carbon price, the absence of pricing of agricultural emissions, and high public sector discount rates are likely to inhibit climate investment. Like other countries, New Zealand has made less progress in adaptation policy than in mitigation policy.
- **Overall, much more needs to be done.** In New Zealand, this work could include:
    - improving basic data and reporting, including assessing the scale of climate investment needed
    - recognising the systemic nature of climate investment, which means that a comprehensive and co-ordinated package of policies is needed
    - seriously considering fundamental issues such as carbon pricing, pricing of agricultural emissions, and public sector discount rates
    - strengthening the evidence base about the effects of climate investment policies, as currently this is extremely sparse.

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1 Introduction

1.1 Motivation

It is unequivocal that human influence has warmed the atmosphere, ocean and land, and that widespread and rapid changes have occurred (IPCC 2021). There is strong scientific consensus that limiting global warming to well below 2°C requires a transformation in the structure of global economic activity on a massive scale (Krogstrup and Oman 2019).

In response to the climate crisis, Aotearoa New Zealand has set mitigation targets of reaching net zero emissions of long-lived greenhouse gases (GHGs)[1] by 2050 and reducing biogenic methane emissions between 24-47% by 2050 (Climate Change Commission 2021). New Zealand's adaptation goals are set out in the National Adaptation Plan (NAP) (New Zealand Government 2022b): 1) reduce vulnerability to the impact of climate change; 2) enhance adaptive capacity and consider climate change in decisions at all levels; and 3) strengthen resilience to climate change.

Investment can play a key role in achieving New Zealand's climate targets and goals.[2] However, the relationship between climate change and investment is complex and not widely understood. This literature review aims to shed light on this relationship, and in particular considers how policies might stimulate what we term 'climate investment' – investment aimed at climate change mitigation and adaptation.

1.2 Research questions and purpose

This literature review examines the following questions (the main question is in bold):

- What is meant by 'climate change' and 'investment'? What is the relationship between climate change and investment? What theories help in understanding this relationship? What does available evidence say about this relationship?
- How can policy influence this relationship? **In particular, how can policy stimulate climate investment?** What evidence is there of the effectiveness of policies? What progress has New Zealand made in line with policy prescriptions and evidence?

The main purpose was to inform the design of a key informant study (Pells and Howard 2022) – a companion paper to this present report. Ultimately, the aim of both reports is to contribute to the evidence base for policies aimed at supporting climate goals.

[1] Long-lived gases are carbon dioxide (CO2)), nitrous oxide (N2O), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs) and sulphur hexafluoride (SF6).

[2] In the remainder of this report, we use the term 'climate goals' to include both New Zealand's 2050 mitigation targets and the adaptation goals.

1.3 Approach

This literature review was undertaken in the first half of 2022. The scope included climate change mitigation and adaptation, climate investment and its financing, and public and private climate investment. There is an emerging body of literature on climate *finance*, but less on climate *investment* and in particular adaptation investment. To keep the review manageable, we focused on recent, highly cited, and/or overview papers from authoritative sources.

2 Definitions

Definitions matter because, if governments aim to shift investment into thematic areas such as 'climate investment', clarity around this and other terms makes the desired shift more likely. The European Union's (EU's) new taxonomy or classification system of environmentally sustainable economic activities could help provide some of the needed clarity.

2.1 Climate change

The Intergovernmental Panel on Climate Change (IPCC) defined **climate change** as "a change in the state of the climate that can be identified (eg by using statistical tests) by changes in the mean and/or the variability of its properties and that persists for an extended period, typically decades or longer" (IPCC 2018). Climate change may be due to natural internal processes or external forcings such as modulations of the solar cycles or volcanic eruptions. Climate change may also be due to persistent anthropogenic (resulting from human activities) changes in the composition of the atmosphere or in land use.

The UN Framework Convention on Climate Change (UNFCCC) distinguished between climate change attributable to human activities, and climate variability attributable to natural causes. The UNFCCC (1992, cited in IPCC 2018) defined climate change as "a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods".

Climate change mitigation is "a human intervention to reduce emissions or enhance the sinks of greenhouse gases" (IPCC 2021). **Climate change adaptation** is "(in human systems) the process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities; (in natural systems) the process of adjustment to actual climate and its effects" (IPCC 2021).

In sum, climate change arises through human and other processes. In terms of climate action, the scope of this report includes both mitigation and adaptation.

2.2 Investment

Investment can be defined in many different ways. Here, we define **investment** as "the purchase of assets that are used to create future value", based on Parker's (2010) economic definition. This definition emphasises that investment provides a key economic link between the present and the future; the benefits from investment accrue over time and involve giving up something in the near term. We use the term

'value' in a broad sense – not just the monetary worth of the benefits arising from the asset, but also environmental and other benefits (and costs).

Investment is a *flow* that adds to the *stock* of capital. Capital stocks include natural capital, human capital, social capital, and financial and physical capital (Burton 2018). The capital stock increases as long as there is enough new annual investment to replace the worn out capital (depreciation) and still contribute some extra.

For example, imagine a manufacturer is upgrading its factory over a period of five years. The desired capital stock is the factory in five years' time. Investment is the purchase each year of new machinery and equipment, and spending on training in how to use the equipment etc, to move towards that desired position.

Investment can be categorised in various ways including by who undertakes the investment – government, households, businesses etc. For example, we define **business investment** as "the purchase of new tangible and intangible assets by businesses for production purposes, where tangible assets include buildings, machinery and inventories, and intangible (or knowledge-based) assets comprise computerised information, innovative property and economic competencies" (Pells 2020).

These economic definitions differ from what many people think of as investment, which is investing in financial assets like stocks and shares. However, stocks and shares etc are picked up in the *financing* of investment. The main financing options for business investment ranked in order of prevalence are internal finance (using accumulated profits), debt finance (borrowing from banks etc) and equity finance (issuing new shares of stock either privately or publicly on the stock exchange) (Pells 2020).

2.3 Climate investment, climate finance etc

Throughout this present report we use the term **climate investment** to mean investment, or the purchase of assets that are used to create future value, aimed at climate change mitigation or adaptation. This includes spending on energy systems, technologies, business models, assets etc that lead to low-emissions management practices or consumer behaviours, and spending on infrastructure and other assets that are resilient to the effects of climate change.

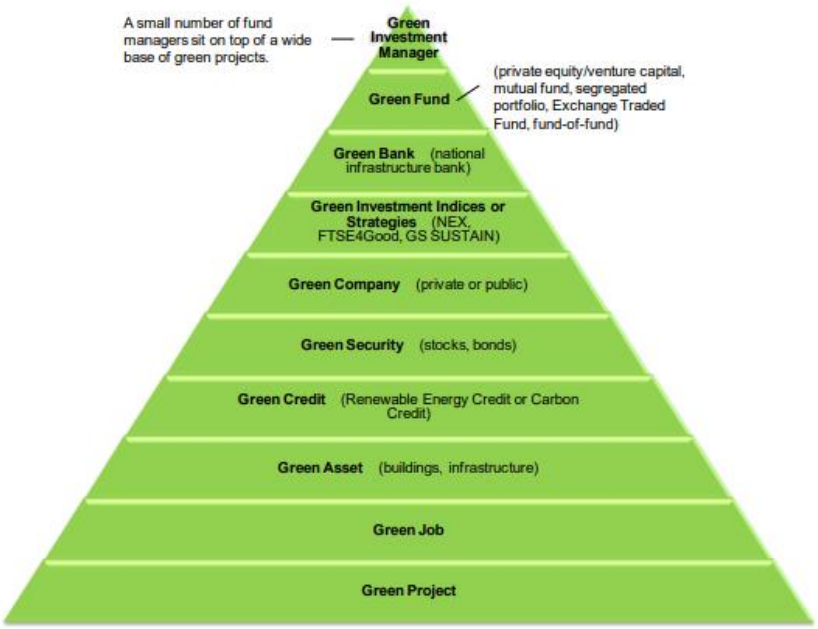
Climate finance is defined by the UNFCCC as "local, national, or transnational financing – drawn from public, private, and alternative sources of financing – that seeks to support mitigation and adaptation actions that will address climate change".[3]

Green investing seeks to support business practices that have a favourable impact on the natural environment.[4] Often grouped together with socially responsible investing (SRI) or environmental, social, and governance (ESG) criteria, green investments focus on companies or projects committed to the conservation of natural resources, pollution reduction, or other business practices that have net natural environment benefits.

[3] https://unfccc.int/topics/climate-finance/the-big-picture/introduction-to-climate-finance
[4] https://www.investopedia.com/terms/g/green-investing.asp

Therefore, SRI is the broadest concept discussed above, followed by green investment and then climate investment. Figure 1 below depicts a 'green investment pyramid' and illustrates the wide range of green investment-related terms and activities.

Figure 1: Green investment pyramid



Source: Inderst, Kaminker and Stewart (2012)

In recognition of challenges around definitions, the EU has developed a taxonomy or classification system, establishing a list of environmentally sustainable economic activities.[5] The EU commented that the taxonomy could play an important role in helping to scale up sustainable investment, as it could:

- provide businesses, investors and policymakers with appropriate definitions for which economic activities can be considered environmentally sustainable
- create security for investors
- protect private investors from 'greenwashing' (the act of misleading consumers about environmental performance (Netto, et al. 2020))
- help companies to become more climate-friendly
- mitigate market fragmentation
- help shift investments where they are most needed.

[5] https://ec.europa.eu/info/business-economy-euro/banking-and-finance/sustainable-finance/eu-taxonomy-sustainable-activities_en

3 The relationship between investment and climate change

The relationship between climate change and investment is complex and bi-directional – climate change affects investment behaviour and decisions, and investment affects climate change mitigation and adaptation actions. On the latter, the long time horizons for climate investment benefits to arise, and the physical and transition risks and deep uncertainty around climate change, weigh heavily against climate investment. These challenges are reflected in the lack of climate investment to date globally.

3.1 Theories about the relationship

3.1.1 Investment involves expectations about *current* costs and *future* benefits

In theory, the main determinant of investment is expectations about the anticipated returns (benefits versus costs) (Jones 2009). For businesses, the benefits include the extra revenue generated by the investment, and the costs include interest paid on loans, depreciation of the asset, any capital gain or loss in the asset price, taxes etc.

A key point is that the benefits of investment arise at some future date. It may take years to reach the desired capital stock (asset stock) (see section 2.2), and the path of investment will need to take into account the costs of adjustment. Infrastructure assets in particular have long time horizons.

A further important point is about perceptions. Businesses and other organisations will only invest if the *perceived* benefits of investment exceed the associated costs. Awareness of climate risks and opportunities is therefore a core element of climate investment decisions (European Investment Bank 2021).

For example, in relation to investment for adaptation, the literature suggests that the perceived risks are based on a subjective judgement of potential damage, which is driven by cultural and ideological factors such as trust in institutions and personal experience (European Investment Bank 2021). Even if climate risk forecasts do exist, business managers are often reluctant to act until a natural disaster occurs. As a result, unless the business is located in an area characterised by high risks of natural disasters, it is unlikely to perceive climate risks or to invest in climate adaptation measures.

3.1.2 Climate investment has long time horizons and is prone to myopia

Infrastructure in particular can shape development for decades or centuries, a duration that often extends beyond infrastructure's lifetime because the economic system reorganizes itself around it (Hallegatte, et al. 2012). These authors argued that sectors

in which decisions should already take into account climate change because the sectors involve long-term planning, long-lived investments and some irreversibility in choices, and are exposed to changes in climate conditions include:

- Water infrastructures
- Land-use planning (eg in flood plain or coastal areas)
- Coastline and flood defences
- Building and housing
- Transportation infrastructure
- Energy production.

Because of the long time horizons involved in climate investment, there is a tendency for the current generation to ride free by pushing the costs of dealing with climate change onto future generations (Nordhaus 2019).

Business managers who are present-focused are unlikely to advocate for significant organisational changes – to the strategy or the main business model – that could lead to absolute emissions reductions (Feyen, et al. 2020). Instead, present-oriented business managers are more inclined to seek incremental changes, or changes that lead to immediate results, while avoiding significant investments in climate change mitigation. While incremental changes might improve a business' carbon efficiency, they are unlikely to be sufficient to bring down absolute emissions.

Short-termism among businesses arises from investment appraisals based on discounted cash flow analysis and short-term performance management which result in the immediate future being weighted heavily compared to the distant future (Slawinski, et al. 2017). Others have pointed to reward and incentive systems that create short-term biases and direct managerial attention to immediate personal goals. While the use of such management practices is standard in most businesses, these practices may become a source of inaction when they start to dominate organisational decision-making on sustainability issues that clearly have non-financial aspects as well.

Short-termism also arises in the public sector. The socio-political factors affecting public climate investment include: the length of political voting cycles (how long-term can investments be before politicians are held to account for them); the transmission of risk information from state to society; lay perceptions of risk; and the length and nature of issue-attention cycles (Tompkins and Adger 2005).

3.1.3 The choice of discount rate is therefore critical

Discounting is perhaps the most important conceptual issue facing current climate policy (Nordhaus 2019).

Discounting is a factor in all investment decisions and involves the relative weight of future and present payoffs (Nordhaus 2006). It is especially important in a climate change context, as many of the benefits from climate investment are likely to accrue very far ahead in the future.

There are two broad views about the discount rate for climate investment. The first is the approach taken in Cline (1992) and the Stern Review (2006), which basically argues from a philosophical standpoint to treat all generations equally. This approach yields a low discount rate, around 1% per year. A second approach is the descriptive approach, advocated by Nordhaus (1994). This approach assumes that investments to slow climate change must compete with investments in other areas. The benchmark should therefore reflect the opportunity cost of investment. The descriptive approach yields a market rate of return of around 5% per year.

The choice of discount rate is critical to investments with a long time horizon. A zero discount rate means that future generations into the indefinite future are treated equally with present ones; a positive discount rate means that the welfares of future generations are reduced or 'discounted' compared to nearer generations.

3.1.4 Climate change involves both risk and uncertainty

In his seminal 1921 paper, Knight made a distinction between two levels of ignorance about our uncertain future – that which can be reliably quantified (Knightian risk) and that which cannot (Knightian uncertainty) (Hallegatte, et al. 2012). Essentially, risk can be assigned a probability whereas uncertainty cannot.

Climate-related *risks* tend to be grouped into two major categories – physical risks and transition risks (Task Force on Climate-related Financial Disclosures 2017). Physical risks resulting from climate change can be event driven (acute) such as extreme weather events, or longer-term shifts (chronic) in climate patterns such as sea level rise. Transition risks arise from the extensive policy, legal, technology, and market changes to address mitigation and adaptation requirements related to climate change.

Physical and transition risks for climate investment manifest themselves through four financial risk channels, which impact physical and financial assets, thus affecting financial sector balance sheets (Feyen, et al. 2020)

- **Operational risk.** This includes damages to financial infrastructure and office buildings (physical risks) as well as reputational impacts of not adjusting to low-emissions investment policies and potential greenwashing (transition risks).
- **Market and liquidity risk.** The re-assessment of financial projections and risk premia will impact asset valuations. This re-assessment could trigger losses and tighter funding and liquidity conditions, particularly when it is due to, for example, a disaster (physical risks) or a sudden policy, technology, or consumer preferences shock (transition risks).

- **Credit risk.** Borrower repayment capacity could be adversely affected due to, for example, damages (physical risks), higher energy prices or lower productivity (physical and transition risks). Lower collateral prices amplify credit risk, particularly when uninsured.
- **Underwriting risk.** Physical risks can impede pricing accuracy of (re-)insurance liabilities causing losses to insurers, raising premiums or even rendering some activities or geographies uninsurable, which could raise fiscal costs if governments step in to backstop losses. Lower availability of insurance or higher premiums may have important repercussions on investments and loans.

Insurance companies tend to be at the forefront of the thinking on how to integrate climate-related risks and opportunities in investment decisions, and so can play an important role in climate investment (Chen, Fu and Chang 2021). This role includes limiting insurance coverage, divesting high-emissions assets, investing in low-emissions assets and sharing their information and expertise. A similar point was made by Lawrence, Blackett and Cradock-Henry (2020) – that insurance signals before and after climate events can act as early warning of the need for individual and collective climate action.

As well as risks, climate change also introduces *deep uncertainty* to investment decision-making. Deep uncertainty can be defined as: "when the parties to a decision do not know or cannot agree on (a) the models that relate the key forces that shape the future, (b) the probability distributions of key variables and parameters in those models, or (c) the value of alternative outcomes" (Lempert, et al. 2003, cited in Fay, et al. 2015).

Climate change introduces deep uncertainty in investment decisions through several channels including (Hallegatte, et al. 2012):

- the future emissions of GHGs
- the response of the climate system to these emissions
- the local changes due to global climate change
- other systems' response to climate change (eg ecosystems or coastlines).

Non-linearities, tipping points and extreme complexity contribute to climate change uncertainty (Krogstrup and Oman 2019). Risks and impacts are non-linear as global temperature rises. Rising temperatures interact with other biophysical systems to create tipping points beyond which catastrophic outcomes can occur, including thawing of permafrost with release of vast additional amounts of GHGs, or the change of ocean streams.

3.1.5 Uncertainty is the enemy of investment

Uncertainty affects both the level and timing of investment. In terms of the *level* of investment, increased uncertainty tends to lower investment. This is particularly the case if investment is irreversible – once a factory is built it cannot be 'unbuilt' – and adjustment costs are high (Fuss and Vermeulen 2004).

In terms of *timing*, uncertainty increases the value of the waiting option thereby making it optimal to postpone investment (Grimes, et al. 2014). While waiting may incur a loss of benefits now, it means that more information can be acquired about the uncertain future.

The risks and uncertainties involved in climate change therefore work to lower and postpone climate investment. Mitigation investments are characterised by two major sources of uncertainty that differentiate them from other long-term investments: uncertainty around their ability to deliver carbon abatement, and uncertainty around the future value of avoided emissions (Krogstrup and Oman 2019).

Some argue that climate-related risks may still be under-priced, thus hampering the transition to a low-carbon economy and efficient risk management (Feyen, et al. 2020). This is because:

- these risks materialise beyond investor horizons
- they are not adequately measured and disclosed
- social and environmental externalities are not properly accounted for.

3.1.6 Climate uncertainty and other factors can lead to lock-in and stranded assets, and thus value depreciation of emitting businesses

Much of the literature has focused on how investor perception may unjustly disadvantage renewable technologies, which are characterised by high uncertainty, long lead times and high capital costs. Also discussed in the literature is the manner in which past investments in fossil fuels may influence the risk-return perception of decision-makers and the related concept of 'lock-in' (Curtina, et al. 2019).

The term carbon lock-in can be defined as "industrial economies have become locked into fossil fuel-based technological systems through a path-dependent process driven by technological and institutional increasing returns to scale" (Unruh 2000). This condition arises through a combination of systemic forces that perpetuate fossil fuel-based (and other high-emissions) infrastructures in spite of their known environmental externalities and the apparent existence of cost-neutral, or even cost-effective, remedies.

Koomey (1989, cited in Curtina, et al. 2019) first applied the concept of stranded assets to the climate policy arena by identifying the potential for 'early obsolescence' of infrastructures built up around fossil fuels under low-carbon transition, which could pose risks for the value of stocks and financial markets. Stranded assets can be defined as assets that "have suffered from unanticipated or premature write-downs, devaluations or conversion to liabilities" (Caldecott and McDaniels 2014, cited in Ang and Copeland 2018). The term stranded assets is also used in the context of adaptation, for example in relation to managed retreat and climate events that destroy assets or make them inaccessible. Managed retreat is the purposeful, coordinated movement of people and assets (eg buildings, infrastructure) away from risks (New Zealand Government 2022b).

One effect of stranded assets is value depreciation of businesses (Ang and Copeland 2018). For example, Moody's warned that carbon-intensive sectors (eg unregulated utilities and power companies, and coal mining) face significant credit risk. Coal companies have experienced value depreciation from climate-related factors.

3.1.7 Climate change also creates investment opportunities

Many of the concepts and theories about climate investment focus on the challenges and risks involved. As well as risks, climate change also presents a number of opportunities for investment (Task Force on Climate-related Financial Disclosures 2017). Opportunities arising from organisations' efforts to mitigate and adapt to climate change include:

- resource efficiency and cost savings
- the adoption of low-emission energy sources (which could potentially generate cost savings)
- the development of new products and services, and access to new markets
- building resilience along the supply chain.

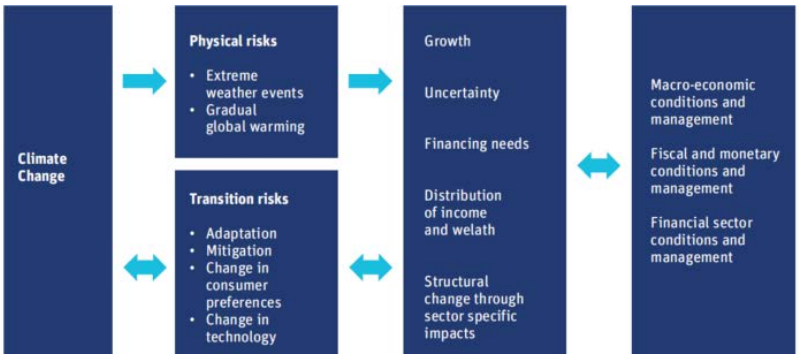
Ultimately, climate change affects businesses' and other organisations' operating environments, and so organisations need to respond to emerging opportunities and threats and reflect these in their investment decisions.

3.1.8 Some conceptual frameworks aim to describe the relationship

The relationship between climate change and investment is complex, bi-directional and probably best thought of as systemic. Climate change affects investment behaviour and decisions, and investment affects climate change mitigation and adaptation actions and thus ultimately (via mitigation) climate change itself. A number of conceptual frameworks aim to frame thinking about the nature of this relationship, and we highlight a few of these frameworks here.

Feyen, et al.'s (2020) conceptual diagram – see Figure 2 – picks up some of the ideas above about how climate risks affect investment. While Figure 2 focuses on macro-financial conditions rather than investment per se, it does illustrate some of the impacts of physical risks and transition risks arising from climate change.

Figure 2: Transmission of climate risks to macro-financial conditions



Source: Feyen, et al. (2020)

Looking at the relationship between climate change and investment from the opposite direction, the Global Investor Coalition on Climate Change (GICC) (2015) identified some of the ways in which investment can aid climate change mitigation and adaptation – see Figure 3. The framework highlights the role of investment beliefs, assumptions, risks and opportunities in shaping mitigation and adaptation actions. Similarly, the IPCC (2014) developed a framework for thinking about how climate finance flows can aid climate change mitigation and adaptation.

Figure 3: Framework for considering climate change investment solutions

Source: Global Investor Coalition on Climate Change (2015)

The two figures above provide a helpful simple depiction of the relationship between investment and climate change. In reality, the picture is much more complex. A New Zealand study brought in some of this complexity by using critical systems thinking to characterise and assess how climate change impacts cascade across domains including infrastructure and finance (see Lawrence, Blackett and Cradock-Henry 2020). The implications of the study included highlighting the dependencies between three waters infrastructure, flood risk management and utilities planning, and the need for integrated multi-hazard approaches in some locations.

3.2 Evidence about the relationship

3.2.1 While climate investment is growing, it falls far short of what is needed, reflecting some of the challenges identified above

The limited existing evidence suggests that progress on climate investment remains marginal. For example, from 2010–2019 there were large increases in the global deployment of solar energy (>10x), onshore wind (4x) and electric vehicles (EVs) (>100x) (IPCC 2022). However this growth was from a very low base; the share of solar and wind in the electricity market and EVs in the vehicle fleet are still very low – around 3%, 6% and 1% respectively in 2020.

In addition, investment for adaptation has become available more slowly than for mitigation in both developed and developing countries, with adaptation accounting for less that 10% of global climate finance flows between 2017-20 (IPCC 2022).

Estimating the amount of investment required to reach climate goals is difficult. Factors such as the precise path of the transition, changes in behaviour and the rate at which technology costs fall and efficiency gains are made, are all subject to significant uncertainty (HM Treasury 2020).

However, the overall consensus from modelling is that climate investment is woefully inadequate. The IPCC is an authoritative source for climate change modelling and data. The IPCC (2022) estimated that globally, average annual modelled investment requirements for 2020 to 2030 in scenarios that limit warming to 2°C or 1.5°C are a factor of three to six time greater than current levels, and total mitigation investments (public, private, domestic and international) would need to increase across all sectors and regions.

3.2.2 Climate finance is also growing but from a low base and has been assessed as falling short

Climate finance is also growing but from a small base. Globally, annual tracked total financial flows for climate mitigation and adaptation increased by up to 60% between 2013/14 and 2019/20 (in USD2015), but average growth has slowed since 2018 (IPCC 2022). These financial flows remained heavily focused on mitigation and have developed unevenly across regions and sectors. Public and private finance flows for fossil fuels are still greater than those for climate adaptation and mitigation combined.

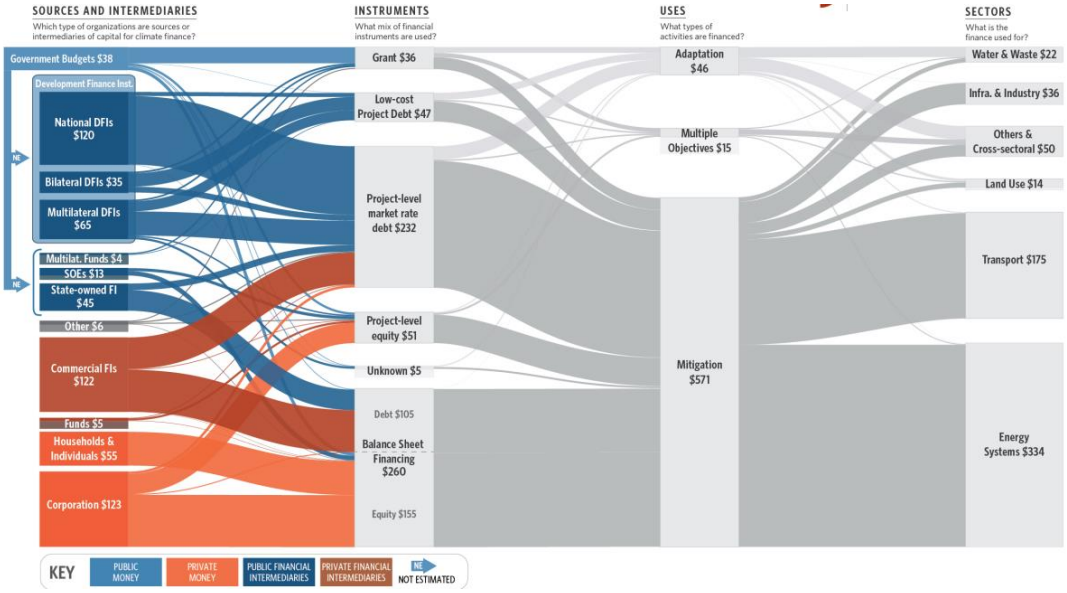
The Climate Policy Initiative's (CPI's) (2021) Global Landscape of Climate Finance series captures available data on primary financing supporting GHG emissions reductions and climate resilience activities. The Landscape consolidates data from a wide range of primary and secondary sources. The CPI's working definition of climate finance is aligned with the recommended operational definition of the UNFCCC Standing Committee on Finance which states: "Climate finance aims at reducing emissions, and enhancing sinks of greenhouse gases and aims at reducing vulnerability of, and maintaining and increasing the resilience of, human and ecological systems to negative climate change impacts".

The CPI (2021) found that climate finance has been trending upwards, increasing from USD364 bn in 2011/12 to USD632 bn in 2019/20. In 2019/20, CPI found (see Figure 4):

- the public sector provided the majority (51%) of global climate finance
- renewable energy represented 51% of total climate finance in 2019/2020, most (69%) coming from the private sector; transport was next, accounting for 30%
- market-rate debt was the most commonly used financial instrument
- mitigation activities accounted for the vast majority (90%) of finance flows, with adaptation activities only accounting for 7%
- climate finance raised and invested in the same country accounted for three-quarters of the tracked investments.

Figure 4: Global climate finance flows along their lifecycle, 2019/20

Values are averages of two years' data, in USD billions



Source: Climate Policy Initiative (2021)
Note: DFI = Development Finance Institutions, SOE = State-owned Enterprise

The CPI argued that action falls far short of what is needed. The CPI (2021) estimated that to meet climate objectives by 2030, annual climate finance would need to increase by 588% to USD 4.35 trillion. While the CPI's estimates should probably be regarded as indicative, others have come to broadly similar conclusions. For example, the IPCC (2022) found that alignment of financial flows with low-emissions pathways remains slow, and there is a climate financing gap and persistent misallocation of global capital.

'Green bonds' are debt securities which are used to finance investment projects with an environmental benefit. The first green bond was issued in 2007 by the European Investment Bank. Since then, green bonds have developed rapidly but represented less than 1% of the global market in 2018 (OECD/The World Bank/UN Environment 2018).

4 Policy prescriptions and international evidence

A systemic policy approach is suggested to kick-start climate investment and address underlying problems such as system inertia. A robust carbon price needs to be complemented with wide-ranging regulatory reforms and other measures. Globally, progress on climate investment policy has been limited and evidence of the effects of such policy is sparse.

4.1 Basic policy rationale for climate investment policies

4.1.1 There is a very strong rationale for government intervention

The fundamental policy rationale for mitigation investment is the negative externality that arises due to the damage that emissions inflict on others (Stern and Valero 2021). An externality is the cost or benefit of production or consumption on agents who do not participate in the production or consumption decision. These costs and benefits spill outside the market and are not captured in market prices. In the absence of a robust carbon price, markets do not internalise the price of carbon emissions, and this reduces the incentives to invest in low-emissions alternatives. Nordhaus (2019) argued that global warming is the most significant of all environmental externalities.

Similarly, negative externalities arising from maladaptation also provide a strong rationale for government involvement in adaptation investment.[6] One example of such an externality is when a household invests in measures to protect its property from flooding which causes flooding of neighbouring properties.

In addition, markets do not fully capture the societal co-benefits associated with climate investment. These co-benefits include increased health through reduced air pollution, preservation of nature and biodiversity, and enhanced energy security (Krogstrup and Oman 2019).

Market failures regarding mitigation investment include (Krogstrup and Oman 2019):

- **Negative externalities arising from emissions and positive externalities arising from mitigation** – see above.
- **Common pool and free rider problems.** Local entities lack incentives to adequately mitigate through markets as climate stability benefits accrue mainly to other actors, resulting in free rider behaviour (the well-known ‘prisoner’s dilemma’).
- **Time inconsistency or impatience that leads to short-termism.** Climate risk is characterised by the existence of a ‘tragedy of the horizon’, as the catastrophic

[6] Maladaptation is actions that may lead to increased risk of adverse climate-related outcomes, increased vulnerability to climate change, or diminished welfare, now or in the future.

impacts of climate change will be felt beyond the traditional horizons of market participants. Prices may not reflect the long-term benefits of mitigation.

- **Governance problems and interactions with regulation and accounting standards** can amplify both common pool problems and short-termism in finance, hampering the finance of long-term uncertain investments.
- **Incomplete and imperfect capital markets.** Imperfect information about investment projects may give rise to credit rationing. Markets for trading climate risks are impaired by incomplete information and knowledge.
- **Co-ordination failures.** At the international level, a lack of co-ordination increases uncertainty and inhibits investment. At the national level, new low-emissions technologies may struggle to gain traction due to a lack of co-ordination among small players in the face of powerful incumbents (Fay, et al. 2015).
- **Economies of scale and market power.** Market power from incumbents may reduce incentives to invest in new capital. Large established firms may exert undue influence via their strong market positions and abilities to lobby for example. This may inhibit the entry of new firms and the uptake of breakthrough technologies.
- **Knowledge spillovers from investment in climate innovation.** An innovator is unlikely to be able to capture all the financial returns from investments in climate-related R&D and innovation, which means that investments tend to be lower than the 'socially optimal' level (Stern and Valero 2021). There is a strong case for industrial policy to support climate-friendly sectors (Rodrik 2014).

4.1.2 Climate investment is also prone to government failures

Public coordination or government failures regarding mitigation investment are very similar to those affecting markets (Krogstrup and Oman 2019):

- **Common pool and free-rider problems.** National and local levels of governments may lack incentives for climate mitigation action, since the benefits of these mostly accrue to citizens of other jurisdictions or countries.
- **Collective action and capture by powerful interest groups.** Economic agents gaining from the status quo may have the ability to coordinate targeted lobbying of government and the media, while those who would gain from changing the status quo are many with little ability to coordinate.
- **Time inconsistency and inability to commit.** Governments are subject to election cycles and can have limited ability to make long-term commitments.

Nordhaus (2019) argued that free-riding lies at the heart of the failure to deal with climate change. No single country has an incentive to cut its emissions sharply. Suppose that when country A spends $100 on abatement, global damages decline by $200. However, country A might get only $20 of the benefits and so will be reluctant to invest. The outcome is a non-cooperative free-riding equilibrium in which few countries undertake strong climate-change policies – a situation which the author argued closely resembles the current international policy environment.

4.2 Policy prescriptions for climate investment

4.2.1 Carbon pricing is necessary for climate investment…

Raising the price of carbon,[7] through emissions trading schemes or a carbon tax, can stimulate low-emissions investment in a number of ways as it (Nordhaus 2019):

- provides signals to consumers about which goods and services are emissions-intensive and should therefore be used more sparingly
- provides signals to producers about which inputs are emissions-intensive (such as coal and oil) and which are low-emissions (such as natural gas or wind power), thereby inducing businesses to move to low-emissions technologies
- gives market incentives for inventors, innovators, and investment bankers to invent, fund, develop, and commercialise new low-emissions products and processes.

Carbon pricing is necessary for an efficient transition towards a low-emissions economy (Fay, et al. 2015). It is also an efficient way to raise revenue, which can be used to support poverty reduction and development or to reduce other taxes.

The shadow price of carbon (SPC) is a key concept for climate investment (Krogstrup and Oman 2019). The SCP is a theoretical price used for business planning and investment. It adds a hypothetical surcharge to market prices for goods or services that involve CO2 emissions in their production.

In New Zealand, the main emissions pricing instrument is the Emissions Trading Scheme (NZ ETS) established in 2008. The NZ ETS is discussed further in section 5. More recently, the Climate Change Commission (2021) recommended that central government should start to factor shadow emissions prices into policy and investment analysis. This is starting to happen. For example, the Treasury has introduced shadow carbon pricing into its Long-term Fiscal Strategy (Treasury 2021).

4.2.2 …but not sufficient

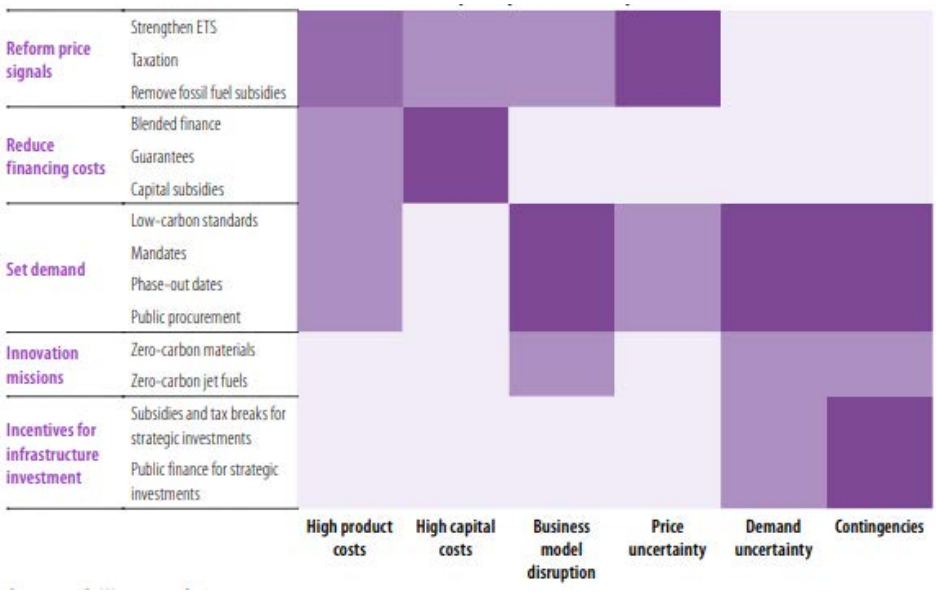
However, carbon pricing alone is insufficient to justify the kind of long-term, risky investments that are required for frontier innovation. Many commentators have suggested that governments should kick-start the transition either by temporarily supporting investments in low-emissions technologies or by imposing additional regulations or performance standards (see for example Stern and Valero 2021; Fay, et al. 2015; Hallegatte, et al. 2012).

Therefore, a robust carbon price needs to be complemented with a suite of mutually reinforcing policies, regulations and investments if new low-emissions technologies are to overtake high-emissions ones (Stern and Valero 2021). This support is needed until the new technology has gained sufficient productivity advantage and is able to benefit from its own patterns of path dependence. Policy needs to accelerate this process,

[7] The term ‘carbon pricing’ is widely used in the literature. However, strictly speaking the term should be ‘GHG pricing’ to pick up long-lived GHG gases other carbon, as well as short-lived gases such as biogenic methane.

given system inertia, and that delay is costly and would necessitate a longer transition. The European Investment Bank (2021) illustrated how such a broad package of policies might help address some of the challenges identified in section 3 – see Figure 5 below.

Figure 5: Barriers to low-carbon investment (x-axis) and policy solutions (y-axis)



Source: European Investment Bank (2021)
Note: Darker shading indicates that the policy solution has greater impact on the barrier

In New Zealand, a number of commentators have argued for the need for policies in addition to carbon pricing in order to achieve climate goals. While the prime focus of these policy prescriptions is not necessarily climate investment, many of the prescriptions are relevant to climate investment.

In particular, the Climate Change Commission (2021) identified a range of barriers and market problems that need other policies alongside emissions pricing. The Commission commented that emissions pricing plays a more limited role where decisions are made by individuals, or by small businesses or firms for whom energy and emissions are not business critical. These decision-makers are less likely to optimise effectively for cost, largely due to behavioural factors, lack of information or capability.

Also in New Zealand, Hall and McLachlan (2022) argued that emissions pricing alone is insufficient to achieve climate goals and should be part of a broader policy mix. The authors put forward three main arguments: emissions pricing alone cannot be expected to induce the necessary levels of behaviour change and technological transition in the urgent time frame required; non-pricing policies can deliver emissions reductions, even within the context of emissions trading under a volume cap; even if emissions pricing could induce sufficient change, there are political economy constraints on reaching the adequate price in a feasible and equitable way.

Similarly, Leining (2022) and the Centre for Sustainable Finance (2021) argued that companion policies to emissions pricing are needed. The Centre suggested that mobilising private capital for the transition requires an integrated multi-faceted policy, regulatory and investment response from government.

4.2.3 A systemic approach to climate investment policy is suggested, including smoothing the transition

Wide-ranging systemic change is needed to address the underlying problems of institutional inertia and vested interests in climate investment (OECD/The World Bank/UN Environment 2018). These authors suggested that governments need to move away from a sectoral approach to infrastructure planning and financing, and move towards a more systemic, forward-looking and whole-of-government approach to infrastructure decisions.

The OECD/The World Bank/UN Environment (2018) suggested that the systemic policy changes needed for climate investment at scale involve action across three core areas:

- First, governments should make greater efforts to improve the overall business environment and the investment climate. This means, amongst other things, implementing clear and predictable regulations, enforcing property rights and the rule of law, growing local financial markets, and developing options to mitigate regulatory, corruption and currency risks.
- Second, developing a strong and stable climate policy framework to orient the economy away from emissions-intensive activities to level the playing field with low-emissions alternatives. Core climate policies are an essential component of such a framework, including a robust and credible price on emissions, regulatory measures when pricing is not efficient or too low, fossil fuel subsidy reform and specific measures to bring low-emissions technologies to commercialisation.
- Third, aligning the overall policy framework with climate goals. For instance, a number of obstacles embedded in current financial systems and regulations that are hindering the allocation of finance to long-term low-emission infrastructure investments need to be addressed. Such barriers range from the lack of definitions, information, data and capacities on low-emissions, resilient infrastructure investment, to the governance of financial institutions and the financial system as a whole, including financial incentives across the system that favour short-termism.

Fay, et al. (2015) argued that a systemic approach also involves minding the political economy and smoothing the transition for those who stand to be most affected. Reforms live or die on the basis of how well the political economy is managed: a climate policy package must be attractive to a majority of voters and avoid impacts that appear unfair or that are concentrated in a region, sector, or community. Thus, reforms have to smooth the transition by not only protecting vulnerable people but also avoiding concentrated losses and sometimes compensating powerful lobbies. The authors commented that fortunately, getting rid of environmentally harmful subsidies and pricing carbon provide additional resources with which to improve equity, to protect those affected, and, when needed, to appease opponents.

4.2.4 New policy frameworks may be needed, included a market shaping role for government

Some argue that existing policy frameworks, government revenues and economic interests continue to be entangled in fossil fuels and emissions-intensive activities. Deeper efforts are therefore needed to drive systemic change, overcome institutional inertia and break away from the vested interests that are often barriers to low-emission, resilient development (OECD/The World Bank/UN Environment 2018). Krogstrup and Oman (2019) suggested that a new policy framework and toolkit may be needed to achieve the required system-level transformation for climate investment given the existential threat of climate change.

New policy tools and frameworks to drive systemic change include the 'market shaping' approach advocated by Mazzucato (2021) and others. Taking her inspiration from the 'moonshot' programmes which successfully coordinated public and private sectors on a large scale, Mazzucato called for the same level of boldness and experimentation to be applied to global challenges like climate change and poverty. The state's role in addressing these challenges includes shaping markets and directing economic activity in socially desirable directions – or 'missions' – to achieve collective value. The focus is on systemic change rather than just 'fixing' market failures.

4.2.5 Transition concepts are helpful when considering systemic change

Transition concepts and frameworks have been used to examine historic transitions (Pells 2021). These concepts are helpful when considering long-term issues like climate change and climate investment, and when thinking about the system-wide policies that might be needed to support climate investment and the hard-to-achieve transition to a low-emissions and climate-resilient economy.

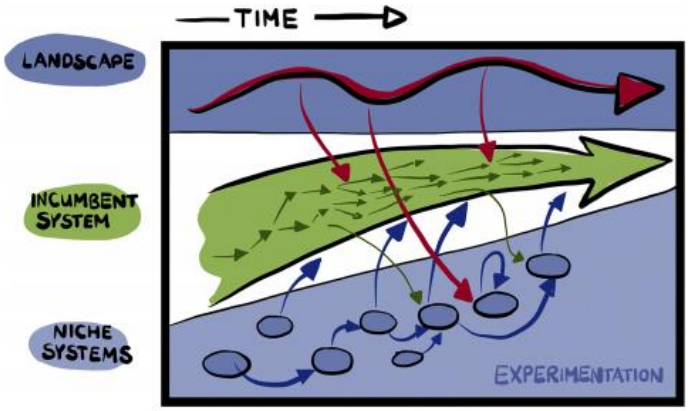
The Multi-level Perspective (MLP) framework is a highly prominent framework in transition studies (Pells 2021). The MLP framework posits that transitions come about through interactions at three levels (Geels and Schot 2007):

- **Niche-innovations/systems** (micro level) are where radical novelties emerge. Niche-innovations are developed by small networks of dedicated actors, often outsiders or fringe actors.
- **The incumbent system/regime** (meso level) comprises market incumbents, regulations and standards that support the status quo, sunk investments in machinery and infrastructure etc. Structures are developed that make it difficult to deviate from mainstream practice and that lead to lock-in and path dependence.
- **The landscape** (macro level) is an exogenous environment shaped by macro-economic conditions, deep cultural patterns, political developments etc where changes take place over decades.

The MLP framework argues that transitions come about through the pressure that niche-innovations and the landscape exert on the incumbent system or regime. Niche-innovations build up internal momentum, through learning processes, price and performance improvements etc. Landscape changes create pressure on the incumbent

regime and create windows of opportunity for niche-innovations. The alignment of these processes enables the breakthrough of novelties in mainstream markets where they compete with the existing regime. Figure 6 provides a simple visual depiction of these ideas; a more detailed version is available in Geels and Schot (2007).

Figure 6: Simple depiction of the Multi-Level Perspective framework



Source: Leendertse and Rijnsoever 2020

The consensus around government's role in system-wide transitions is that policy tends to act as an enabler and shape the direction of the transition, rather than directly instigate and control the transition (Pells 2021). In recognition of this lack of full control, policies should join in with ongoing dynamics and build on bottom-up initiatives.

Kanger, Sovacool and Noorkõiv (2020) drew on some of the ideas in the MLP framework to consider policy intervention points for transformative systems change for decarbonising the economy – see Table 1.

Table 1 highlights the wide-ranging policies needed to bring about systemic change for decarbonisation and the challenges involved. The policies span areas such as innovation support, regulatory reform, skills and labour policies, urban planning and international co-operation. In section 5 we use the framing in Table 1 to assess New Zealand's progress in developing policies to support systemic change for climate investment.

Table 1: Policy intervention points for transformative systems change in decarbonisation

Intervention point	Underlying aim	Examples
Stimulate different niches	To guarantee the presence of various alternatives for systems change	Subsidies and regulatory shielding for niches in various systems, e.g. Chinese New Energy Vehicle policy
Accelerate the niches	To scale up single niches and to align different niches to each other	Providing support for entering the markets and/or creating links between various niches, e.g. Danish wind energy policy
Destabilize the regimes	To weaken the position of incumbent regime actors hindering the transition	Removal of various forms of regulatory and financial protection favouring incumbents, e.g. national energy subsidy reforms
Address the broader repercussions of regime destabilization	To anticipate and manage the broader societal impacts resulting from systems change	Provision of financial and educational support for structural unemployment and skill mismatch, e.g. German restructuring of the Ruhr valley
Provide coordination to multi-regime interaction	To ensure that the input-output relations between the regimes would be complementary	Devising mutually supporting interventions in multiple systems, e.g. the urban transition in Freiburg
Tilt the landscape	To alter the broader framework conditions enabling change in the directionality of locally bounded socio-technical systems	Participation in international negotiations to arrive at collectively binding agreements, e.g. the ban on chlorofluorocarbons

Source: Kanger, Sovacool and Noorkõiv (2020)

4.2.6 Disclosure can help address information problems

Turning away from system-wide policies, in the remainder of this sub-section we consider some specific policies suggested to promote climate investment.

Measuring and disclosing adequate climate-related information is a first step in making markets more efficient and addressing information asymmetries in financial markets (OECD/The World Bank/UN Environment 2018). Private investors and governments can make better decisions with improved transparency and access to information on the climate-related performance and exposure of assets and businesses, as well as on financial systems as a whole.

The work of the Task Force on Climate-related Financial Disclosures (TFCD) is prominent in this area. The TFCD (2017) structured its recommendations around four core elements of how organisations operate: governance, strategy, risk management, and metrics and targets – see Figure 7. Also note the work in Europe to develop a taxonomy of environmentally sustainable economic activities (see section 2).

Figure 7: Core elements of climate-related financial disclosures

Source: Task Force on Climate-related Financial Disclosures (2017)

Key considerations for disclosure regimes include the use of common definitions and avoiding 'greenwashing (IPCC 2022). Greenwashing is the process of conveying a false impression or providing misleading information about how a company's products are more environmentally sound.[8]

New Zealand has recently introduced a disclosure regime (see section 5.1) and is the first country in the world to require some of the financial sector to report on climate risks in accordance with robust standards, based on the TFCD framework.[9]

4.2.7 Financing policies can improve access to finance

Recommendations about climate finance policies typically fall into two broad categories: 1) making the investments more attractive and 2) leveraging private resources to make the most of available capital (Fay, et al. 2015). These approaches involve well-known steps, such as improving the investment climate (clear and predictable regulations and enforcing the rule of law and property rights), developing local capital markets, and providing a pipeline of bankable projects – something that has proved difficult for many countries and is now recognised as an even greater challenge than a lack of capital.

However, Fay, et al. (2015) argued that closing the financing gap most likely also requires a deep reform of the international monetary system, including financial sector risk assessment and stress tests that have a longer time horizon and consider a broader set of risks (such as carbon exposure), along with compensation packages more attuned to long-term returns and risks.

Government can also be a direct investor, by providing some of the 'patient capital' (or long-term capital) needed for climate investment (OECD/The World Bank/UN Environment 2018). This can help address some of the challenges around the long time horizons involved in climate investment.

[8] https://www.investopedia.com/terms/g/greenwashing.asp
[9] https://www.beehive.govt.nz/release/nz-passes-world-first-climate-reporting-legislation

In New Zealand, policy developments in financing and funding climate investment include the establishment of the New Zealand Green Investment Finance Limited (NZGIF) to direct private sector capital into investments that reduce emissions.

4.2.8 Lower public sector discount rates can help address short-termism

As noted in section 3.1, the choice of discount rate is critical for investment decision-making. The public sector discount rate reflects how government values outcomes that occur in the future relative to those that occur in the present (Creedy and Passy 2017). A high discount rate, by lowering the weight that is attached to future outcomes, tilts decisions towards projects that deliver net benefits in the near term. Conversely, a low discount rate tilts decisions towards projects that deliver longer term benefits.

In New Zealand, the default discount rate for public sector cost-benefit-analyses is 5%.[10] This is at the high end of the spectrum (Parliamentary Commissioner for the Environment 2021), and is akin to the descriptive approach outlined in section 3.1. In other words, the discount rate favours present generations over future ones, and therefore work against climate investment. In contrast, guidance from the UK's Green Book suggests a 3.5% discount rates for the first thirty years of a programme and then a schedule of declining discount rates.

4.2.9 Accelerated depreciation can encourage the replacement of high-emissions assets

Accelerated depreciation allows deductions for declines in the value of a fixed asset to occur at a rate above that expected in conventional practice (House and Shapiro 2008, cited in Koowattanatianchai, Charles and Eddie 2019). This effectively allows businesses to claim more depreciation expenses during the earlier years of an asset's life, thus encouraging businesses to upgrade their assets. If accelerated depreciation is targeted, it can encourage businesses not simply to improve technology and spur innovation in a general sense, but to replace high-emissions equipment with low-emissions equipment. In this way, it can potentially help alleviate some of the problems discussed in section 3.1.[11]

Koowattanatianchai, Charles and Eddie (2019) considered the history and evolution of accelerated depreciation worldwide. These authors noted that accelerated depreciation was originally used in the defense sector, and more recently it has tended to be used to achieve environmental goals. Many European countries have provided accelerated depreciation for capital expenditures on energy-saving/efficient plant, machinery and equipment (eg windmills and energy-efficient buildings and vehicles). The Dutch

[10] https://www.treasury.govt.nz/information-and-services/state-sector-leadership/guidance/financial-reporting-policies-and-guidance/discount-rates

[11] Note, however, that a life cycle assessment (LCA) approach is useful to determine if accelerated depreciation is helpful in lowering emissions. The LCA approach assesses embodied carbon across the life cycle of an asset. Deliberately stranding a high-emissions asset is only worthwhile from a mitigation perspective if the reduction in emissions from the new low-emissions asset outweighs the increase in emissions from replacing the original asset with a new one.

government has been the most generous in this regard, with several accelerated depreciation schemes and granting free depreciation or depreciation of up to 75% of investment costs for qualifying assets. Many countries worldwide have followed this trend, with various rates of accelerated depreciation being permitted to investments in renewable energy projects such as windmills and solar power projects.

New Zealand previously had limited accelerated depreciation, which was briefly reintroduced during the COVID-19 pandemic.[12]

4.2.10 Policies can help address problems such as risk and deep uncertainty

National governments have a crucial role to play in minimising obstacles to climate investment such as risk and uncertainty (European Investment Bank 2021). For example, governments can minimise regulatory uncertainty, communicate climate policy goals and develop a comprehensive framework that supports these goals. Otherwise, the uncertainty will cause businesses to adopt a wait-and-see strategy by delaying their investments until information is more reliable. Ambiguous government policies prevent businesses from committing to long-term climate change strategies.

Hallegate, et. al (2012) suggested some strategies for dealing with deep uncertainty in investment decision-making. These strategies include:

- **No-regret strategies.** These strategies yield benefits even if forecasts reveal to be wrong. For example, controlling leakages in water pipes is almost always considered a very good investment from a cost-benefit analysis point-of-view, regardless of how climate changes.
- **Reversible and flexible strategies.** The aim is to keep as low as possible the cost of being wrong about future climate change. Examples include insurance and early warning systems that can be adjusted every year in response to the arrival of new information on risks. Another example is restrictive urban planning.
- **Safety-margin strategies.** The aim is to reduce vulnerability at negative, null, or negligible cost. For example, to calibrate drainage infrastructure, water managers in Copenhagen use runoff figures that are 70% larger than their current level.
- **Strategies that reduce decision-making time horizons.** Reducing the lifetime of investments is an option to reduce uncertainty and corresponding costs. One example is the forestry sector choosing species that have a shorter rotation time.

Hallegate, et. al (2012) also considered methodologies to make decisions under deep uncertainty, from cost-benefit analysis to real options analysis and robust decision-making. The authors concluded that it is extremely unlikely that any single methodology would be appropriate across the board, and instead, a menu of methodologies is required.

[12] https://taxfoundation.org/new-accelerated-depreciation-policies-to-spur-investment-australia-austria-germany-new-zealand/

4.2.11 There is some debate about optimal timing and sequencing

Some argue that climate investment should start low and grow over time (Nordhaus 1991 & 1992, cited in Vogt-Schilb, Meunier and Hallegatte 2018), partly due to the long delays between investments in abatement and returns in averted damages (see section 3.1). Others – probably the majority – argue the opposite, stressing the importance of aligning short-term emissions reduction action with long-term emissions reduction targets: given the limited ability of economies to switch overnight to low-carbon technologies, if short-term efforts are too modest, subsequent efforts will need to be much stronger.

As well as timing, the sequencing of climate investment also matters. For example, there is little point in electrifying the transport system unless the electricity grid is based on renewables rather than fossil fuels.

Intuitively, it might be thought that climate investment should start with the least expensive options and progress by ascending cost order. However, Vogt-Schilb, Meunier and Hallegatte (2018) developed a theoretical model that provides counter-intuitive policy guidance, as it suggests that more investments should be done in the sectors with *higher* costs. The reason is that to cope with the increasing carbon price, all sectors should eventually lower their emissions. In each sector, two factors drive the optimal speed at which to deploy abatement capital: 1) the magnitude of the transition, and 2) the availability of appropriate resources (such as skilled workers and production lines). At any point in time, sectors where unabated emissions are higher and sectors where abatement capital is more expensive should receive more abatement investment, to smooth their transition and reduce adjustment costs. This partly reflects that, if different sectors are competing for abatement resources, these resources should be used in sectors with the highest abatement potential. In addition, there is a need for early investment in equipment that will take time to deploy such as low-emissions power plants or public transport infrastructure.

4.2.12 Policy prescriptions for investment in adaptation are less advanced

Few policy prescriptions appear to have been developed specifically about stimulating climate investment for adaptation.

Some policies have been suggested around infrastructure planning. For example, the OECD/The World Bank Group/UN Environment (2018) identified some transformative areas that they believe are key to aligning infrastrucure with climate goals. Firstly, rethink infrastructure planning at all levels of government to align with climate objectives and make resilience the norm in infrastructure decisions.

Secondly, empower city governments to build resilient urban societies, by developing capacity to more effectively plan and finance the right infrastructure in the right place, aligning national and local fiscal regulations with investment needs, and building climate finance capacity.

The main policy work in New Zealand around adaptation is reflected in the Government's first National Adaptation Plan (see New Zealand Government 2022b).

4.3 International evidence about the effectiveness of climate investment policies

4.3.1 Evidence on the effectiveness of climate investment policies is scarce, especially in relation to adaptation

As Krogstrup and Oman (2019) put it, the literature is scarce on the desirable package of measures for climate investment.

When searching for studies about the effectiveness of climate investment policies, we found that much of the evidence is descriptive – it describes the types of policies that commentators believe should be/have been put in place, or the amount of money that should be/has been invested (see section 3.2). Often policy prescriptions focus on the benefits of the proposed policies rather than the potential costs or negative effects. Very few studies use robust methods to establish the effectiveness of policies, such as methods based on credible counterfactuals. This possibly reflects that much of the policy work is fairly recent, and so insufficient time has elapsed in which to examine the effects of these policies. It probably also reflects data limitations.

Investment in adaptation is even harder to track than investment in mitigation (European Investment Bank 2021). Adaptation is more diffuse and can be included in a wide range of investments across many economic sectors. Investors typically do not identify adaptation investments separately in their accounts.

4.3.2 However, it is clear that the policy response to date is inadequate

Most commentators agree that policy action to date round stimulating climate investment has been limited, especially in relation to adaptation (see for example OECD/The World Bank/UN Environment 2018, Nordhaus 2019).

Ultimately, gobal progress to date remains incremental across the board – on emissions reductions, policy ambitions and capital re-allocation (OECD/The World Bank/UN Environment 2018). At a global level, emissions are high and rising, fossil fuels continue to dominate the global energy mix, and the price of carbon remains defiantly low (Krogstrup and Oman 2019). While this limited progress may be due to many factors, it is likely that inadequate policies around climate investment play a role.

4.3.3 Europe is leading the way on climate investment policy

Europe is a world decarbonisation leader (European Investment Bank 2021). Europe is the only major jurisdiction in the world that has seen emissions trend downwards in recent years (UN Environment 2018).

An integral part of the European Green Deal is the Green Deal Investment Plan, also known as the Sustainable Europe Investment Plan (European Investment Bank 2021). This plan aims to finance a sustainable transition while supporting the regions and communities most exposed to its impact. In brief, it combines legislative and non-legislative initiatives and has three main objectives:

- mobilise funding of at least EUR 1 trillion from the EU budget and other public and private sources over the next decade
- put sustainability at the heart of investment decisions across all sectors
- provide support to public administrations and project promoters for creating a robust pipeline of sustainable projects.

As part of the European Green Deal roadmap, the European Commission adopted the EU action plan on sustainable finance (Sustainable Finance Action Plan) in 2018 (European Investment Bank 2021). This plan aims to channel private financial flows towards investments that support the Paris Agreement's targets by 2050, and more broadly the United Nations Sustainable Development Goals. The Sustainable Finance Action Plan involves three key steps:

- establishing a framework for facilitating sustainable investment based on a unified classification system or taxonomy – adopted in June 2020 (see section 2)
- introducing obligations for institutional investors and asset managers to disclose how they integrate ESG factors in their risk assessment
- providing low-carbon and positive-carbon impact benchmarks to give investors a clearer understanding of the carbon consequences of their investments.

The UK has also made progress with climate investment, for example by developing a Green Finance Strategy (UK Government 2019).

4.3.4 Evidence suggests that carbon pricing is effective but inadequate

Carbon taxes or emissions trading systems that increase the price of carbon have been found to be effective at reducing carbon emissions (Krogstrup and Oman 2019). For example, a 2009 OECD study investigated the effects of carbon prices on innovation, using firm-level data on patent grants for climate-change related innovation. The study found that UK businesses subjected to the full rate of the UK Climate Change Levy on fossil fuels and electricity were more likely to innovate and register patents than businesses subjected to a reduced rate.

Aghion, et. Al (2016, cited in Stern and Valero 2021) found that in the car industry, businesses tend to shift innovation from high-emissions (internal combustion engine) to low-emissions (electric) when they face higher tax-inclusive fuel prices. The authors also found that there is path dependence in innovation type – based on both the aggregate spillovers to which businesses are exposed, and businesses' own innovation histories. These findings imply that a carbon tax not only helps mitigate climate change directly, through reducing carbon consumption, but also indirectly by re-orienting R&D investments towards low-emissions technologies and away from high-emissions ones.

Evidence about the effects of carbon pricing suggests that a robust carbon price will cause concentrated losses in carbon-intensive sectors, especially in the form of stranded assets – whose owners may therefore oppose the reform and in some cases have the power to veto it. Johnson, et al. 2015 (cited in Fay, et al. 2015) estimated that,

for a carbon price consistent with the 2°C target, the value of coal power plants stranded worldwide between now and 2050 could reach $165 billion.

However, existing studies suggest that carbon prices remain far below levels required to support investment in low-carbon technologies such as carbon capture and storage (Ang, Röttgers and Burli 2017). In addition, carbon prices remain too fluctuating to sufficiently impact renewable investment, and are unstable, not applied widely enough or riddled with exemptions. Carbon taxes would have to increase very substantially given response elasticities (Stern and Valero 2021). Areas in which elasticities are low include energy efficiency, urban planning, infrastructure; carbon pricing is also limited in its effect on adoption of higher-cost mitigation options (IPCC 2022).

4.3.5 Investment incentives, accelerated depreciation and other policies have been found to stimulate climate investment

Overview studies that have examined some of the more robust evidence on climate investment suggest that some climate investment policies have desired effects.

For example, Ang, Röttgers and Burli (2017) reviewed some of the existing evidence about the effect of climate mitigation policies on investment in renewable power and other green investment. Studies suggest that investment incentives, such as feed-in tariffs (FiTs), renewable energy quotas, auctions and tax incentives, have contributed to significant increases in renewables investment in the decade 2005-15.

Bernardini, et al. (2019, cited in Feyen, et al. 2020) showed that, following the progressive introduction of economic incentives by the European Union to stimulate investment in renewable energy, the profit of electric utility companies using non-renewable energy inputs fell sharply.

Anderson and Hong (2022) evaluated large-scale subsidy program for E-bikes in Sweden. They found complete pass through of the average $500 subsidy to consumers, a near doubling of E-bikes sold but one-third of adopters are non-additional; and a savings of 1.3 tons of carbon emissions during the life of the E-bike. Combining these estimates, they concluded that an e-bike subsidy program can only be justified with a social cost of carbon that is several hundred dollars higher than what is typically used.

Koowattanatianchai, Charles and Eddie (2019) considerd evidence of the effects of accelerated depreciation on environmetal outcomes. The authors commented that while robust empirical results are scarce, studies suggest some positive effects. For example, a case study of a Brazilian chemical plant found that an accelerated depreciation scheme increased the expansion of Combined Heat and Power (CHP) plants in Brazil by 24%. The authors concluded that the scheme is costly to government, yet induces technological advancement and improves the feasibility of ventures that would not otherwise have occurred.

However, Koowattanatianchai, Charles and Eddie (2019) also commented on some potential drawbacks with accelerated depreciation. The targeted nature of accelerated depreciation means it favours firms that normally make long-term rather than short-term investments ie well-established firms. New firms, whose income is likely to be

negative and are not in a positive tax position, will most likely not find tax benefits from accelerated depreciation. Depreciation accounting under accelerated depreciation is also complex and involves greater administrative costs, as was seen in France where few businesses took it up.

4.3.6 Access to credit/finance policies should be carefully targeted

Climate finance is growing rapidly from a very low base, but still accounts for a tiny proportion of overall finance flows (see section 3.2). Available evidence suggests that access to finance policies should be targeted to defined goals, and that demand-side policies need to be considered before supply-side ones like access to finance.

Jayachandran (2021) examined the effects of access to credit on climate investment, focusing on robust microempirical research in low- and middle-income countries. The overall finding was that increasing access to credit tends to raise emissions unless it is focused on the 'right' (climate-friendly) type of investment. The author pointed out that the effects of increasing access to credit on climate outcomes are theoretically ambiguous – on the one hand, credit might enable businesses to expand production and thus lead to more emissions, and on the other, it could facilitate investment in low-emissions technologies. Evidence tends to support the former. For example, one study found that access to capital had a negative effect on forest protection in Sierra Leone as it enabled households to clear the land. The implication is that access to credit policies need to be carefully targeted to achieve climate goals.

In terms of government support for early stage finance, in the US van den Heuvel and Popp (2022) found that stimulating demand will have a greater impact on low-emissions energy innovation than investing in startups that will then struggle through the 'valley of death'. To study the causes of VC's failure in 'cleantech'[13] in the early 2010s, the authors used data from a database of companies launched in the US between 2000 and 2020. The comprehensive coverage of the database allowed the authors to explore three factors that could explain the failure of VC in cleantech: financial constraints specific to funding cleantech, relatively weak demand for low-emissions products and limited potential for outsized returns. The authors found that weak demand for cleantech was the main reason for the fall in VC investments. They concluded that, rather than investing themselves in startups bound to struggle through the valleys of death, governments wishing to support cleantech startups can first implement demand-side policies that make investing in cleantech more viable.

4.3.7 Disclosure, if done well, has been found to have positive effects

Some progress has been made in relation to disclosure. A study by the Cambridge Centre for Sustainable Finance (2018, cited in (OECD/The World Bank/UN Environment 2018) estimated that two thirds of G20 member states have engaged with the TCFD recommendations in some form, mainly through statements of support for the aims and recommendations of the Task Force. At the time, Australia, Canada, the EU, Italy, Japan, South Africa, Turkey and the United Kingdom had conducted consultations with

[13] Any process, product, or service that reduces negative environmental impacts

the private sector on sustainable finance generally and on disclosure requirements as an important building block of sustainable finance more specifically.

MBIE reviewed international evidence about sustainability reporting (see Meech and Bayliss 2021). The authors found evidence of many positive effects of sustainability reporting on investments and finance. For example, studies have found that ESG investments outperform other investments, businesses undertaking sustainability reporting have improved sustainability performance over time, and sustainability reporting is associated with improvements in business performance. However, the authors pointed out that few studies have used causal techniques to examine the effects of sustainability reporting, and it may be that businesses undertaking sustainability reports differ from the business population at large in ways that make them better-performing than non-ESG businesses.

Looking more broadly at information disclosure for climate investment, Fay, et al. (2015) found that the record of information disclosure programmes is mixed, although they are effective if done well. Some labeling reports information that is too abstract, too vague, or too difficult to understand. For example, the kilometers-per-gallon or miles-per-gallon measure used to evaluate vehicle fuel efficiency has been found to lead people to undervalue the fuel and cost savings of replacing inefficient vehicles.

Battiston (2019, cited in Krogstrup and Oman 2019) found evidence that the data needed to manage climate financial risk are complex and fragmented, suggesting a role for regulators in supporting the creation of agencies responsible for collecting, validating and disseminating climate-relevant data.

4.3.8 Some policies aimed at infuencing attitudes are effective

Fay, et al. (2015) examined evidence about the effectivenss of policies aimed at bringing about the behaviour changes needed for climate investment. The evidence seems to highlight findings from behavioural insights:

- Evidence abounds about people being tempted by the low price of a refrigerator (Tsvetanov and Segerson 2014) or being inconsistent in their treatment of time (Ainslie 1975). The implication is that even with good information, people may not purchase a cost-effective energy-efficient appliance.
- People are easily influenced by social norms. The often-quoted experience of the US Opower energy conservation programme illustrates the strengths and limitations of the use of social norms in energy conservation programmes. In this programme, home energy reports were mailed to residential utility customers, providing them with feedback on how their own energy use compared with that of their neighbours. The effect was shown to be strong, with energy consumption reducing by 2% initially, equivalent to an increase in electricity prices of about 11–20%, but decreasing rapidly over time. However, as the experience was repeated, new habits were formed, with homeowners investing in new appliances or developing new consumption habits.

- People tend to stick with the default option, which is why many energy companies set the default program for consumers to be the greener but more expensive tariff, which consumers can opt out of. In southern Germany, an energy company found that 94% of its customers stayed with the default green option, whereas only 4% switched to a cheaper one, 1% switched to a more expensive greener one, and 1% switched to another supplier.
- A critical challenge has to do with the salience – that is, the importance or the visibility of the issue. Thus, businesses for which energy costs are a small share of overall costs, or wealthy individuals for whom energy costs are a small share of their income, may choose not to devote attention to what is a small issue calling on their limited time and attention span. Thus, it appears that business investments in energy efficiency require rates of return substantially higher than for investments with comparable risk.

5 New Zealand policies and evidence

It is probably fair to say that New Zealand is near the start of our climate investment policy work. Progress to date includes establishing the overarching legislative framework for climate change policy and improving the disclosure regime. However, New Zealand lacks even basic data on climate investment, and has yet to undertake any analysis of the scale and pace of investment needed. In addition, the lack of a robust carbon price and high public sector discount rates inhibit climate investment.

5.1 New Zealand policy developments on climate investment

5.1.1 Like other countries, New Zealand's progress to date on climate change has been limited and we face challenges

As in many other countries, emissions are not yet trending downwards in New Zealand. Gross emissions of both long-lived gases and biogenic methane trended upwards until the early 2000s and have roughly stabilised since (Climate Change Commission 2021). However, within total biogenic methane emissions, emissions from dairy rose steeply until about 2015 and have only started to plateau more recently. The lack of a downward trend in emissions suggests that policy, including in relation to climate investment, has yet to achieve desired outcomes.

Compared with other countries, a particular challenge for New Zealand is our unusual emissions profile – nearly half of New Zealand's emissions come from the hard-to-abate agriculture sector (OECD 2022).

A key opportunity for New Zealand is that much of our electricity generation is from renewable energy – around 80% in 2020 (MBIE 2021a). The share of renewables in *total* primary energy supply was around 40% in 2020, one of the highest shares in the OECD. If transport and industrial heating sectors can shift away from consuming fossil fuels to using electricity, emissions could be significantly reduced. However, as demand for electricity increases, there is a high risk of more reliance on higher-emitting electricity sources if growth in the supply of electricity from renewable energy cannot keep pace with increased demand. This highlights the importance of investment in renewable sources of electrification in achieving New Zealand's climate goals.

Again, like many other countries, New Zealand has made less progress regarding adaptation compared with mitigation. For example, Lawrence, Wreford and Allan (2022) argued that attention to adaptation has until recently been crowded out by an almost singular focus on reducing emissions through the NZ ETS and carbon offsets, without a comprehensive suite of complementary adaptation policies and regulations.

5.1.2 The overarching framework for climate change policy has been set out

The Climate Change Response (Zero Carbon) Amendment Act 2019 sets out the framework for New Zealand's climate change policy.[14] This framework is designed to support New Zealand to join global efforts to address climate change and to provide more certainty and stability around climate action (Climate Change Commission 2021). Key elements include:

- long-term emissions reduction targets for 2050
- a system of emissions budgets to step Aotearoa towards the 2050 emissions reductions targets (2050 targets)
- National Climate Change Risks Assessments and National Adaptation Plans
- a Climate Change Commission to give independent, expert advice on reducing emissions and adapting to climate change, and to monitor the Government's progress towards meeting emissions reduction and adaptation goals.

The longstanding New Zealand Emissions Trading Scheme (NZ ETS) is the primary lever for emissions reduction in New Zealand (OECD 2022). The NZ ETS is a market where emissions permits are traded. The government limits the supply of emissions units into the market which then sets the emission price based on unit supply and demand (Leining 2022). Buyers are businesses in the NZ ETS, all of which are required to give the government a unit for every tonne of GHG emissions (CO2 equivalent) they emit. Sellers are eligible foresters who receive units from the government for carbon dioxide absorbed by their trees and entities that hold more units than they need. Units also enter the market through free allocations from government to businesses that are emissions intensive and highly exposed to international competition. For 2022, the auction reserve price was set at NZ$30 per unit and the cost containment reserve trigger price (a form of price ceiling) at NZ$70 per unit (Leining 2022).

However, agriculture, a key source of New Zealand's emissions, is not included in the ETS. The Government has committed to introducing an agricultural emissions pricing mechanism by 2025 (New Zealand Government 2022a). The mechanism will be informed by recommendations from He Waka Eke Noa – Primary Sector Climate Action Partnership.

5.1.3 New Zealand has made progress on disclosure

The Financial Sector (Climate-related Disclosures and Other Matters) Amendment Act 2021 (Act) requires around 200 financial market participants to prepare climate statements in accordance with standards issued by the External Reporting Board.[i] These standards are based on the TCFD framework. The first climate statements are expected to be produced in early 2024.

[14] https://environment.govt.nz/what-government-is-doing/areas-of-work/climate-change/mandatory-climate-related-financial-disclosures/

The Act states that the new climate reporting requirements will apply to:

- registered banks, credit unions, and building societies with total assets of more than $1 billion
- managers of registered investment schemes with greater than $1 billion in total assets under management
- licensed insurers with greater than $1 billion in total assets or annual gross premium revenue greater than $250 million
- listed equity issuers (if the market price of all quoted and unquoted equity securities exceeds $60 million) and listed debt issuers (if the total face value of the quoted debt exceeds $60 million).

The four Crown Financial Institutions with greater than $1 billion in assets under management (the Accident Compensation Corporation, New Zealand Superannuation Fund, Government Superannuation Fund Authority and the National Provident Fund) will also be required to make climate-related disclosures.

5.1.4 Progress has also been made in other climate investment policy areas

Progress has been made in New Zealand to encourage investment in electric vehicles and low-emissions cars. The Clean Car Standard – a Co2 emissions standard for imported new and used light vehicles – is expected to take effect in late 2022.[15] In July 2021, the Clean Car Discount was introduced to encourage New Zealanders to switch to an electric vehicle (EV) or plug-in electric hybrid vehicle (PHEV). A discount, in the form of rebate, is available for imported new and used light EVs and PHEVs. From 2022 the Clean Car programme was expanded to offer a range of rebates for imported new and used zero and low-CO2 emission vehicles. High CO2 emission vehicles are charged a fee – the higher the CO2 rating the greater the fee.[16]

As noted in section 4.2, shadow carbon pricing, as recommended by the Climate Change Commission (2021), is starting to be used in New Zealand. For example, the Treasury introduced shadow carbon pricing into its fiscal and economic analysis in its Long-term Fiscal Strategy (Treasury 2021). In addition, in 2020 Treasury's cost-benefit analysis (CBAx) guidance was expanded to include climate change shadow prices to enable agencies to make consistent assumptions (Treasury 2020).

The New Zealand Infrastructure Commission (2022) has released an infrastructure strategy. The strategy includes five strategic objectives, one of which is "enabling a net-zero carbon emissions Aotearoa". Recommendations under this strategic objective include setting a strategic direction in the Government's Emissions Reduction Plan (New Zealand Government 2022a) that public sector infrastructure investment

[15] https://www.transport.govt.nz/area-of-interest/environment-and-climate-change/clean-cars/
[16] The fee is paid at the time the vehicle is first registered in New Zealand, with the fees provided for under the Land Transport (Clean Vehicle Discount Scheme Charges) Regulations 2022, which also lists which vehicles are excluded.

programmes must be compatible with New Zealand's international commitments on emissions, and developing a national energy strategy.

The Energy Efficiency and Conservation Authority (EECA) focuses on energy efficiency and the use of renewable energy sources. One initiatives that is particularly relevant to climate investment is the Decarbonising Industry fund. This fund provides support for reducing emissions in process heat, and electricity transmission and distribution infrastructure upgrades.[17]

Other recent developments include in 2018, establishing the New Zealand Green Investment Finance Limited (NZGIF) to direct private sector capital into investments that reduce emissions (New Zealand Government 2022a). The 2021 Government Budget provided $300 million of additional funding for NZGIF to invest into mitigation measures, most notably decarbonising public transport, waste and plastics, and banning default KiwiSaver funds from investing in fossil fuel production.

5.1.5 The ERP and NAP include actions regarding climate investment

Two key initiatives in New Zealand are the development of the first ERP and first NAP.

The first ERP includes strategies and actions relevant to climate investment including the following (see New Zealand Government 2022a):

- Emissions pricing – improve market governance and review free industrial allocation in the NZ ETS and actions related to introducing a pricing scheme for agriculture.
- Funding and finance – establish the Climate Emergency Response Fund (CERF) to ensure the climate is prioritised in the Budget process.
- Planning and infrastructure – improve the resource management system to promote lower emissions and climate resilience.
- Research, science and innovation:
    - establish a portfolio of Climate Innovation Platforms to support and coordinate strategic, effective and innovative initiatives
    - set research priorities through Te Ara Paerangi Future Pathways science-system reform programme (also see MBIE 2021b).
- Behaviour change – establish a fund to drive behaviour change.
- Energy – develop a national energy strategy.
- Transport – a wide range of actions including:
    - integrate land use, urban development and transport planning and investments to reduce transport emissions

[17] https://www.eeca.govt.nz/co-funding/industry-decarbonisation/about-the-government-investment-in-decarbonising-industry-fund/

    - deliver major public transport service and infrastructure improvements in Auckland, Wellington and Christchurch
    - produce a national EV infrastructure plan.
- Building and construction – progress regulatory change to reduce embodied emissions of new buildings.
- Agriculture:
    - Introduce a scheme to price agricultural emissions from 2025
    - establish a new Centre for Climate Action for agriculture to drive a step change in research, development and commercialisation of emissions reduction technologies.
- Forestry – update NZ ETS yield tables to include indigenous species.
- Waste:
    - invest in organic waste processing and resource recovery infrastructure
    - invest in sorting and processing infrastructure for construction and demolition waste.

The draft NAP includes strategies and actions aimed at reducing the key adaptation risks to New Zealand identified by the National Climate Change Risk Assessment for New Zealand (NCCRA) in 2020 (Ministry for the Environment 2020). Strategies and actions relevant to climate investment including the following (see New Zealand Government 2022b):

- pass legislation to support managed retreat
- provide access to the latest climate projections data
- design and develop an adaptation information portal
- produce guidance for dynamic adaptive pathways planning
- (after 2024) ensure minimum regulatory requirements for buildings take into account future climate data
- develop a method for assessing impacts on physical assets
- update the criteria of the CERF in 2022 to extend the scope for adaptation.

5.1.6 It is too early to say if actions will bring about systemic change

In Table 2 below we provide a very rough assessment of progress to date in New Zealand's policies to support *systemic* change in climate investment – mainly mitigation investment. The first two columns draw on the framing by Kanger, Sovacool and Noorkõiv (2020) – see section 4.2. The third column provides some examples of relevant policy developments in New Zealand. The fourth column provides our assessment of the extent to which the policies are likely to address the intervention points in Kanger, Sovacool and Noorkõiv's (2020) framing.

Table 2: Policies to support systemic change in climate investment

Intervention point	Underlying aim	NZ climate investment examples	Comment
Stimulate different niches	To guarantee the presence of various alternatives for systems change	Climate Innovation Platforms to be developed[18] Te Ara Paerangi Future Pathways under development[19]	The research, science and innovation system has the potential for greater impact in stimulating low-emissions industries and technologies. It is too early to say whether Climate Innovation Platforms and Te Ara Paerangi Future Pathways will achieve this impact
Accelerate the niches	To scale up single niches and to align different niches to each other	NZGIF to continue to invest in decarbonisation	The ERP appears to have limited actions to help nascent low-carbon industries and technologies to establish and scale up
Destabilize the regimes	To weaken the position of incumbent regime actors hindering the transition	Agricultural emissions pricing from 2025	The lack of pricing of agricultural emissions to date suggests a status quo bias and effectively results in higher emissions pricing in other sectors
Address the broader repercussions of regime destabilization	To anticipate and manage the broader societal impacts resulting from systems change	A national equitable transition strategy to be developed[20]	It is too early to say the extent to which the national equitable transition strategy will anticipate and manage the broader societal impacts of climate investment and the transition to a low-emissions economy in general
Provide coordination to multi-regime interaction	To ensure that the input-output relations between the regimes would be complementary	The Climate Change Executives Board has been recently been established[21]	It is too early to say the extent to which the Climate Change Executives Board will effectively co-ordinate climate investment
Tilt the landscape	To alter the broader framework conditions	The NZ ETS will be strengthened, including phasing out free industrial allocation	To date the carbon price has been low and fluctuating. Free allocation and the lack of agricultural emissions pricing have limited the incentives that the NZ ETS has provided for climate investment Lowering discount rates would tilt investment towards longer-term climate investment. However, no work appears to be planned on changing guidance about discount rates

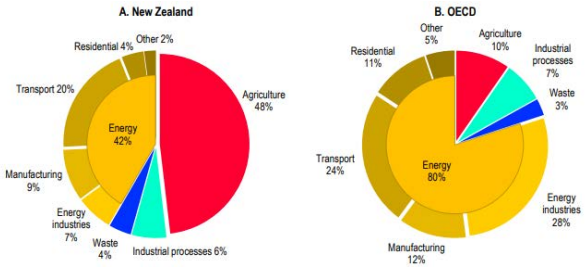
Source: Kanger, Sovacool and Noorkõiv (2020), New Zealand Government (2022a and b) and author

[18] Climate Innovation Platforms are mission-focused and aim to coordinate action on key challenges and take opportunities in New Zealand's shift to a low-emissions future.
[19] Future Pathways aims to set research priorities to address the challenges that New Zealand faces.
[20] The equitable transition strategy will develop tangible initiatives to address challenges and leverage opportunities that are targeted toward those groups in most need of support.
[21] The Climate Change Chief Executives Board (CE Board) is responsible to the Prime Minister and is made up of the chief executives who are responsible for delivering the policies and strategies in the ERP.

A key take-out from Table 2 is that many of the climate investment-related actions in the ERP and NAP are new or are at an early stage of development, so it is too early to say if they will achieve the type of systemic changes discussed in section 4.2. However, the NAP does include some system-wide strategies and actions which is encouraging.

In its latest survey of New Zealand (see OECD 2022), the OECD stated that further measures are needed to reduce emissions. The OECD commented that New Zealand has a solid institutional framework, and that the NZ ETS has been strengthened by aligning it with the goals of the Paris Agreement, phasing down free allocations to emissions-intensive exporting activities, and subjecting agriculture to emissions pricing from 2025. The latter is important given New Zealand's unusual emissions profile with agriculture accounting for 48% of emissions in 2019 – see Figure 8 (New Zealand Government 2022a).

Figure 8: GHG emissions share (excluding land use, land-use change and forestry), 2019



Source: OECD (2022)

However, the OECD also commented that New Zealand is not on track to meet either its updated 2030 Nationally Determined Contribution (NDC1) (its international abatement commitment)[22] or its 2050 domestic emissions targets. The OECD argued that the carbon price is too low and efficient complementary measures, which address market failures not corrected by carbon pricing alone, still need to be taken. The OECD provided examples of these complementary measures, some of which are relevant to climate investment. They include:

- higher carbon prices increase demand for housing that is close to amenities and well served by public and active transport options, but complementary urban planning policies and transport policies are needed to make the supply of such housing more responsive to demand
- higher carbon prices increase demand for more energy-efficient buildings, but regulations that establish more demanding standards reduce information failures that arise from buyers not being well informed
- EV charging infrastructure helps to overcome coordination problems; people will not buy EVs if the charging infrastructure is inadequate and investors will not supply such infrastructure if there are too few EVs to make it profitable.

[22] NDC1 does not distinguish between GHGs in the same way as New Zealand's domestic targets.

5.2 New Zealand evidence about climate investment policies

5.2.1 New Zealand evidence is sparse

There is a lack of New Zealand evidence on climate investment policies to support climate goals, and on climate investment in general. For example, a review of research related to climate change risks in New Zealand by McKim (2016, cited in Ministry for the Environment 2020) identified only two pieces of (grey) literature on finance (including banking and insurance) and climate change. It concluded that "a general lack of published research in this area, at least in the New Zealand context, is evident".

New Zealand lacks even some of the basic descriptive evidence outlined in section 4. For example, no formal assessment appears to have been undertaken on the scale and pace of climate investment needed to achieve the 2050 targets. This seems an important gap, because in the absence of such an assessment, policy developments may be predicated on false assumptions about the extent of climate investment work needed to support our climate goals.

Having said that, the Ministry for the Environment (2020) discussed some of the investment and funding needed in New Zealand for adaptation to climate change. The Ministry commented that significant and ongoing funding is required to implement adaptation actions. Some of the most pressing needs in New Zealand relate to the impacts of sea-level rise, which includes rising groundwater and salinisation, erosion and more damaging storm surges. One metre of sea-level rise from the present day, which may be experienced by 2100, will expose more than 49,000 existing buildings to a 100-year, extreme sea-level flood. These buildings have a replacement value of about $12.4 billion. Where managed retreat is the only option, significant investment will be required to support these communities.

Storey, et al.'s (2020) research on managed retreat and insurance retreat also highlighted the scale of the adaptation challenge. Storey found at least 10,000 homes in New Zealand's four biggest cities would be effectively uninsurable in three decades, with Wellington the first to start losing access to affordable insurance – in 15 years.

5.2.2 A key study has been undertaken on climate finance

In terms of financing climate investment, a key study is Hall and Lindsay's (2018) literature review and interviews on climate finance in New Zealand. The authors defined climate finance as "investment and expenditure – public and private, domestic and transnational – that demonstrably contributes to climate mitigation, adaptation or both". They found that there is already a range of financial flows within New Zealand that meet climate finance definitions. The main financial instruments globally, in descending order of amount funded, are balance sheet financing, debt financing and equity financing; the authors provided New Zealand examples of these instruments. Note that these three instruments are the main ones used to finance business investment in general (Pells 2020), not just climate investment.

Hall and Lindsay (2018) found that, despite this availability of instruments, there are significant opportunities to increase the volume and effectiveness of climate finance

flows in order to better align with New Zealand's international obligations and expectations. The authors suggested that government can play any combination of at least four roles. The four roles appear to align with the systemic approach to climate investment policy discussed in section 4.2, and are:

- direct investor – the New Zealand government already provides multiple grants in areas like energy efficiency and sustainable land management
- investment manager – which emphasises the importance of financing pipelines for climate-aligned projects and companies to nurture innovation to maturity, to provide growth capital for ideas that work
- market maker – which recognises government's capacity to support climate-aligned projects and companies through its procurement activities by being first purchaser, or a large-scale purchaser, of climate-aligned goods and services
- trailblazer – which recognises government's capacity to lead the way globally, especially in those sectors where New Zealand has unique mitigation opportunities, such as land use and transport powered by renewable energy.

Hall and Lindsay (2018) made ten recommendations spanning areas such as disclosure and reporting, climate finance tracking, developing a pipeline of climate aligned projects, and climate change leadership.

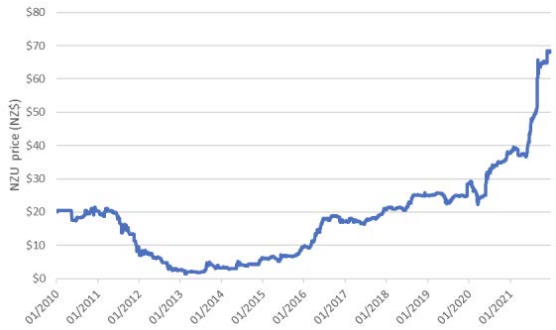
5.2.3 As with other countries, New Zealand's carbon price has fluctuated and is not yet at a level consistent with climate goals

A robust and stable carcbon price is considered fundamental in terms of sending clear signals to investors and providing some of the certainty needed for long-term mitigation investment (see section 4.2). Existing evidence suggests that the NZ ETS has not yet delivered a carbon price consistent with New Zealand's climate goals:

- The Climate Change Commission's (2021) modelling suggested that marginal abatement costs of around $140 per tonne of CO2 abated in 2030, and $250 in 2050 in real prices, are likely to be needed to reduce emissions from energy use.
- Hasan (2020, cited in Hall and McLachlan 2022) estimated that, to reduce road transport emissions by 44% by 2030, a carbon price of $235/tCO2 is required.
- MBIE (2021, cited in Hall and McLachlan 2022) compared a high price pathway that rises from $84 per tonne in 2025 to $250 per tonne in 2050 with a counterfactual reference scenario that assumes a constant $35 per tonne in real terms. The high price pathway only realises a 12–18% reduction in transport sector emissions by 2050, rather than the 84% reduction that is required.

In addition to the lack of a robust carbon price, like many other countries New Zealand has also experienced fluctuating prices – see Figure 9.

Figure 9: NZU prices in the NZ ETS, 2010 to 2021



Leining (2022) based on data from Jarden

5.2.4 Other studies include ones on disclosure and behavioural changes

MBIE's literature review on sustainability reporting (see Meech and Bayliss 2021) considered New Zealand as well as international evidence. A key finding was that New Zealand businesses use varying frameworks and standards for sustainability reporting. This causes inconsistency across reports and it can be difficult, or even impossible, to compare between reports. The authors argued that mandatory reporting would provide greater consistency, comparability and accountability to sustainability reporting. While New Zealand has introduced new climate reporting requirements, these do not yet cover the full range of ESG disclosures.

Leining (2011) reviewed New Zealand and international evidence, and drew on discussions with New Zealand stakeholders, to consider the effects of attitudes and bahavious on mitigating climate change. Key findings included that people's ideologies and world views, as well as social norms and networks, fundamentally impact how they receive and respond to information about climate change. People's emotional responses to climate change are important predictors of their willingness to mitigate. In addition, factors such as personal capabilities and habits, material costs and rewards, regulations, policies, technologies, etc also drive behaviour. Specifically on investment, findings included that people are loss averse and seek to avoid stranded assets. While Leining's (2011) study related to mitigation attitudes and behavious, many of the findings also seem relevant to adaptation. For example, loss aversion is likely to be an important consideration for managed retreat, as people can form strong attachments to their homes and a particular location.

Personal attitudes about climate change are found to be cyclical. For example, belief about climate change fell around the time of the Great Recession (Milfont, Wilson and Sibley 2017). Recent business surveys by EECA support this notion, and indicate New Zealand businesses have deprioritised tackling their climate initiatives during Covid.[23]

[23] https://www.eeca.govt.nz/insights/eeca-insights/climate-change-and-new-zealand-business/

6 Conclusions

Climate investment plays an important role in achieving climate goals. For example, investing in climate-friendly technologies, business models, infrastructure and assets, and divesting fossil-fuel based ones, can help achieve mitigation goals. Investing in resilient infrastructure and assets that can withstand the effects of climate change can help achieve adaptation goals.

Stimulating climate investment is challenging. Many factors, such as long time horizons, and risks and uncertainties, work against climate investment. Therefore, it is perhaps not surprising that the scale of global climate investment to date has been limited.

Government plays a key role in the climate investment market by helping to address various market failures. This includes ensuring the NZ ETS, and the forthcoming pricing of agricultural emissions, addresses the fundamental negative externality that arises from emissions and incentivises climate investment. This role also includes improving disclosure regimes and providing information to address information problems in finance and other markets, and providing direct support for green innovation in recognition of positive knowledge spillovers.

However, given the urgency of the climate crisis and the systemic nature of climate investment, as well as addressing market failures, government can also play a more active 'market shaping' role in climate investment. A key point is that a range of systemic forces that perpetuate high-emissions investment – such as vested interests of market incumbents, a lack of co-ordination among new players, status quo bias and other cognitive and behavioural biases – mean that it is very hard to shift investment patterns and behaviours to a low-emissions trajectory. A systemic perspective such as that used in the Multi-Level Perspective and other transition frameworks can help identify the wide-ranging and co-ordinated package of policies needed to achieve the desired shift in direction.

New Zealand is starting to develop some of the wide-ranging policies needed to stimulate climate investment. Importantly, establishing the fundamental policy framework should provide some of the certainty needed to encourage climate investment. However, determining the adequacy of current policy efforts is hampered by the lack of an assessment of the scale and pace of climate investment needed, as well as a lack of robust evidence about the effects of climate investment policies.

To further contribute to the evidence base, we undertook a key informant research study exploring the question: *What would it take to mobilise investment to achieve New Zealand's climate goals?* (see Pells and Howard 2022). The study drew on this present literature review in its design, and fleshed out the findings here with concrete New Zealand examples. In particular, the study provided more information than this present report on adaptation investment, a key gap in the literature. The study also identified wide-ranging actions needed to mobilise climate investment, supporting the conclusion above – that policy to support climate investment requires a systemic approach.

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