Global Green Growth Institute

Global Green Growth Institute
Seventh session of the Council
Bali, 23-24 July 2015

Strategic Discussion I: Policy Barriers to Green Investment: How Sound Policy Can Drive Investment, Green Growth, and Job Creation

Summary[1]

1. For the world to meet the twin challenges of improving human welfare whilst preventing catastrophic climate change and environmental degradation, it will need to develop a model of green economic growth. The discussion paper focuses on the following: First, rather than focusing on establishing billions of dollars in "new" resources for green investment, it draws attention to greening the trillions of dollars in infrastructure investment that will be deployed under any growth scenario. Second, it looks beyond infrastructure, and examines how to enable the broader set of non-infrastructure assets to support the sustainability of growth. The distinction between these two types of assets will be important: the barriers to green investment, and the policy levers available to overcome them, are different for each.

2. Delegates are invited to reflect on the following questions in light of the barriers to green investment, and opportunities to overcome them, outlined in this paper:

- Where should GGGI focus in order to remove barriers to green investments?
- What kind of strategic initiatives could GGGI engage in in your country to help unlock infrastructure investment?
- Are there additional in country activities that GGGI could engage in?
- What experience have you had in the past in these areas both positive and negative that could help inform the way forwards?

[1] The full discussion paper will be shared in due course.

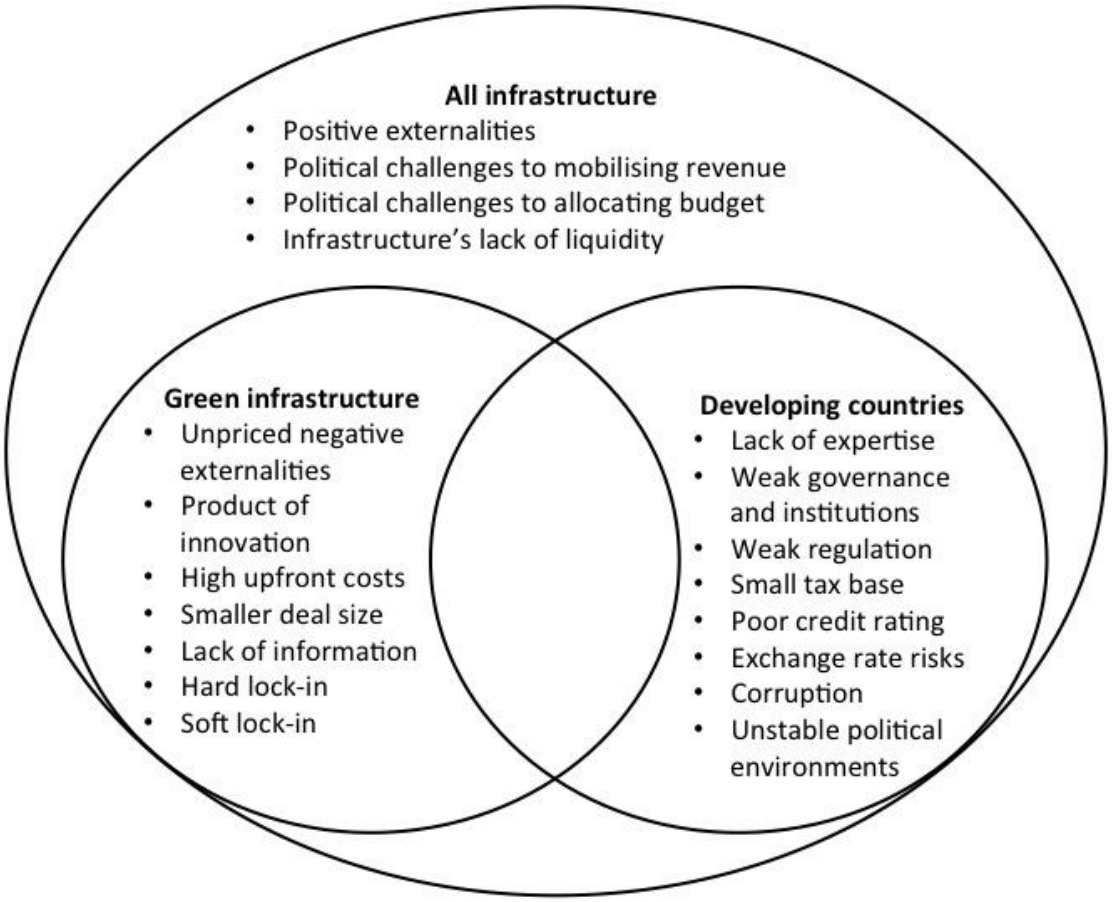
The importance of infrastructure for green growth

3. Infrastructure is crucial to global economic growth: an estimated US$90 trillion of infrastructure investment is necessary between now and 2030 if we are to meet and maintain global economic growth targets.

4. *Which* infrastructure we build in the near term is crucial. 'Building right' is as important as 'building more' infrastructure. Some infrastructure locks in patterns of inefficiency, like poorly planned roads and sprawling cities that lock in private transportation dependence or poor housing stock. Conversely, infrastructure can also lock in efficiencies and facilitate decarbonization, energy efficiency, and pollution reduction.

5. The barriers to greening infrastructure "nest" within barriers to infrastructure development more generally. We currently spend about US$1.7 trillion per year when optimal levels are estimated at about US$6 trillion per year. Despite the importance of infrastructure to growth, political opposition to big government spending has driven the global shortfall in infrastructure investment. The governments of least developed countries are additionally hampered by insufficient tax bases and poor credit ratings. The figure below shows some of the policy barriers/risks of the global infrastructure challenge, and those specific to developing countries and green investments.

Figure 1. The nested barriers to infrastructure development



6. It is within the context of a global infrastructure gap that the challenge of greening infrastructure must be considered. The *Better Growth, Better Climate* report estimated a premium of at most 5% on global infrastructure investment between high- and low-carbon development patterns, not accounting for the substantial co-benefits to low-carbon choices. This means that the annual infrastructure investment needs are US$6 trillion for the business-as-usual scenario, and US$6.3 trillion for the low-carbon, low-pollution alternative.

7. Paling in comparison to this massive number are the US$100 billion per year that developed countries agreed to mobilize by 2020 for climate mitigation and adaptation projects in developing countries, and the roughly comparable level of global development aid. From this perspective it is clear that greening investment is not centrally about finding international public funds for green infrastructure. It is about shaping the allocation of vast global capital resources in the economy toward better investment choices.

Greening investment beyond infrastructure

8. Beyond infrastructure, greening growth will also require shifting the US$400 trillion of forecasted investment globally.

9. In some cases, non-infrastructure green technologies can provide the same public benefits as infrastructure, essentially replacing the need for it. Just as mobile phones have replaced the need for landlines, distributed renewable energy systems will continue to diminish the need for electricity grids. Energy efficiency technologies can reduce the need for increased energy generation.

10. Unlike infrastructure, which tends to be planned by governments, non-infrastructure green assets and practices will be diffused through markets. Hence, decisions about their implementation are highly distributed among households and firms. The government still plays a critical role, but the financing and policy tools at its disposal are different. This will require scaling up financial products, and institutions capable of delivering them, for much smaller and distributed transactions. Bangladesh's Infrastructure Development Company Limited (IDCOL) has been able to finance very small solar PV installations at scale, by packaging finance, grants, and technical supports to local entrepreneurs that on-lend to households: they have already provided services to 13 million people.

Implications for governments and international financial institutions

Lack of green private investment is often indicative of other problems, like poorly enforced regulatory standards, weak institutions, or misaligned incentives, rather than lack of availability of capital

11. Where private investment is lacking, it is frequently a sign of other structural barriers, rather than lack of funds. Poor regulatory environments and weak institutions can create a confluence of investment risks that prevent capital deployment even where the demand for assets or services are substantial. Only in some developing country contexts is there an actual scarcity of capital, and, even then, businesses and projects can frequently attract foreign direct investment if these offer adequate returns on investment and institutions and the policy environment are strengthened. The Moroccan Agency for Solar Energy

(MASEN) provides an example of where a commitment to strong institutional capacity, and a package of incentives, can draw in private capital.

12. The main barrier facing green infrastructure and non-infrastructure options alike is that market prices do not reflect the social and economic costs of polluting alternatives. Rather than addressing this problem, public policy often exacerbates it. This issue is illustrated most plainly by the fact that globally, governments directly subsidized fossil fuels to the tune of US$775 billion in 2012, seven times the subsidies provided to renewable energy.

13. A restructuring of incentives will also be necessary to unlock investment in energy efficiency measures. As it stands, most utilities are paid according to how much electricity, water, and gas that they sell, not how much they save. Government policies that 'make negawatts pay' can unleash investment in energy saving measures, both by utilities and by private ESCOs.

14. Reducing distortionary subsidies and taking measures to align social and private costs and benefits will be a first step in shifting private investment towards green infrastructure and non-infrastructure businesses and technologies.

Regulation and information-based tools are often at least as important as public investment

15. A second barrier common to both infrastructure and non-infrastructure is the lack of knowledge and technical capacity surrounding green options. This barrier is common to both developed and developing countries, but is most pronounced in the latter. In order to shift private investment to any green technology, steps will need to be taken to train financial institutions, workforces, and consumers about green technologies and practices.

16. To this end, regulatory and information-based tools are often more effective than fiscal levers. Green investment indices can help investors assess risk in unfamiliar green technologies. Public training programs, agricultural extension services and building codes can help train the workforces that will build green infrastructure and produce green products. Green labels like ENERGY STAR can inform consumers about the cost-saving green products.

Governments must adopt a long-term commitment to and vision for infrastructure planning and investment

17. The core barrier to infrastructure spending is that it has broad, diffuse public benefits that are not easily captured by a private market in the form of a price (i.e. it has positive externalities). For this reason, the public sector, through its ability to identify and evaluate public benefits, mobilize public revenue, and set policy, is almost always fundamental to the planning and oversight required for infrastructure projects, whether publicly designed and financed, blended finance, or the product of a public private partnership.

18. It is vital that governments adopt a long-term perspective when planning infrastructure development. As mentioned, infrastructure development can lock in specific development pathways. On one hand, large-scale construction of highly polluting power plants and sprawling cities will almost certainly send the planet beyond the 2℃ target. On the other

hand, green infrastructure choices – compact cities well connected by public transit and served by renewable electricity – will lock in efficiency gains for decades.

19. It is necessary for governments – with their overarching perspective on national developments – to guide infrastructure development towards desired outcomes.

20. A useful tool to facilitate infrastructure planning is a shadow price on environmental damages. For example, a shadow price on the social cost of carbon could shift government cost benefit analyses in favor of green infrastructure choices over polluting ones.

21. Green infrastructure frequently has higher upfront costs, but it has lower costs over its lifetime because it frontloads technical and design inputs to offset future inputs, such as fuel. If budget-constrained governments focus too much on the upfront costs, they may forgo the future savings that green infrastructure provides.

22. The public sector must also take the lead on financing. Although the private sector plays an increasingly important role in financing and delivering infrastructure, discussed later, private capital has always and will continue to fall short of meeting infrastructure needs. The public sector must have a high level of commitment to financing its institutions, planning, and projects, and in leveraging private finance through tools like blended financing and public private partnership.

23. Public private partnerships (PPPs) provide an opportunity to overcome short-term fiscal bottlenecks, and harness private sector expertise. PPPs do provide another tool for public procurement of crucial services, and an alternative means of financing them. However, PPPs do not replace the need for government investment and planning. In fact, PPPs rely on good public planning and capacity to get the most out of private partners.

24. Likewise, the private sector can bring innovation to service delivery, but there are also circumstances where the public sector is best placed to demonstrate the feasibility of new forms of infrastructure so as to encourage the entrance of private actors.

25. Singapore provides an example of a forward-looking and integrated approach to transportation and urban land-use planning. The country planned a system of high-density satellite towns with strong transport links to the central city, preventing urban sprawl and minimizing private car ownership, and leveraged PPPs to deliver it.

To mobilize sufficient private investment in infrastructure, new financial products will be required that are attractive to institutional investors

26. Institutional investors, with around US$80 trillion of assets under management, represent the largest source of potential investment for green infrastructure. Currently, only a small share of institutional investors' portfolios is invested in infrastructure globally; currently, an even smaller share is invested in green infrastructure in developing countries. This is a missed opportunity.

27. Green infrastructure investments are particularly well suited to institutional investors' needs. These investors are capable of deploying large amounts of capital demanded by infrastructure projects upfront, and they seek the low-risk returns that infrastructure projects can provide. Furthermore, as many institutions are publicly controlled and have

long time horizons, their interest in decarbonizing the economy is greater than other types of investors that tend to seek short-term returns. However, institutional investors demand liquidity in their investment portfolios, which is difficult to achieve in infrastructure.

28. Green bonds and yieldcos are just two of many financial mechanisms/approaches that promise to unlock institutional investor capital by enabling greater liquidity in sustainable infrastructure investments and structuring them as assets familiar to these investors. International financial institutions can enhance the effectiveness of these products by providing guarantees to reduce the risk to investors.

Scaling up green investment in non-infrastructure assets will require public and private finance to shift to high-risk/high-reward markets and financing structures

29. Some of the green technologies and practices are a product of innovation, causing them to be beset with risk – both real and perceived. It is frequently this risk that deters private investors. Shifting private investment towards higher-risk investments will require targeted public finance and policy at different stages along the innovation process. Government support for R&D will be essential to sow the seeds for green technologies of the future. However, governments will also be needed to help nascent green technologies and businesses bridge the 'valley of death' by helping bring risky technologies and sectors to commercial viability. Kenya's geothermal industry provides an example of where the government stepped in to provide early investment and demonstrate the viability of the sector, paving the path for private investment.

30. Finally, during the commercialization phase of new green technologies, governments' financial support can generally be eased, but other interventions may still be required. Policies that provide niche markets for new green technologies can provide security for entrepreneurs while they establish supply chains and a track record of success. In developing countries, policies to unlock consumer finance can enable rapid diffusion of cost-effective green products that are held back only by the purchasing power of consumers.

31. Green bonds and yieldcos, discussed above, are just two of the more recent financial innovations that help attract private capital to green investments. These reduce risk by making infrastructure a more liquid investment and in the form of a more familiar asset. The broader range of instruments that attract private capital can be categorized as (1) increasing returns, (2) reducing risks, and (3) transformational. More examples of these are provided in Appendix 1.

32. Governments and international financial institutions can be highly effective in shifting investment towards green technologies and firms. It is vital that these institutions learn how to green investment today, as the window to shift development paths towards green trajectories is rapidly closing.

Appendix 1. Examples of financial approaches to attract private capital for climate mitigation[2]

Category of Instrument Sector	*Increasing Returns*	*Reducing Risks*	*Transformational*
Large-scale clean energy	**1. Bankable Power Purchase-Like Agreement for Energy Efficiency** **2. Subsidised Renewable Feed-in Tariff**	**3. Mezzanine Debt Enhancement** **4. Clean Energy Loan Guarantee** **5. Mono-Line Insurance Mechanism for First Loss**	
Bio-carbon	**6. Advanced Market Commitment (AMC) for REDD+**	**7. Political risk insurance mechanism for climate-related investments**	
Energy access	**8. Emission Reducing Under-writing Mechanism to Purchase for CERs from LDCs**	**9. Public-private fund to absorb potential first loss from high-risk investments in LDCs**	**10. Revolving fund for low-carbon social enterprise focusing on energy access** **11. Pooled fund for small-scale venture capitalists to promote low-carbon social enterprises in least-developed countries (LDCs)**

Source: Abyd Karmali[3], "New Approaches to Mobilise Climate Finance"; CMIA[4], CLGCC[5], IETA[6] & IGCC[7], "Submission to Co-Chairs Information Note on the Business Model Framework of the Green Climate Fund"

[2] This table is part of a report that was prepared by 12 international business associations representing a range of financial and industry perspectives and thousands of member companies covering geographies in developed and developing countries; it was presented to the Green Climate Fund in 2013 as well as at the White House.
[3] Managing Director, Bank of America Merrill Lynch (BofAML) & Special Advisor to the Climate Markets and Investment Association (CMIA)
[4] Climate Markets & Investment Association
[5] European Union Corporate Leaders Group on Climate Change
[6] International Emissions Trading Association
[7] Investor Group on Climate Change

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Enabling public and private green investment:

Discussion Paper for the Global Green Growth Institute 2015 Council Meeting

Authors: Ilmi Granoff, James Ryan Hogarth, and Alan Miller

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Executive summary

For the world to meet the twin challenges of improving human welfare whilst preventing catastrophic climate change and environmental degradation, it will need to develop a model of green economic growth. This discussion paper focuses on the following: First, rather than focusing on establishing billions of dollars in "new" resources for green investment, it draws attention to greening the trillions of dollars in infrastructure investment that will be deployed under any growth scenario. Second, it looks beyond infrastructure, and examines how to enable the broader set of non-infrastructure assets to support the sustainability of growth. The distinction between these two types of assets will be important: the barriers to green investment, and the policy levers available to overcome them, are different for each.

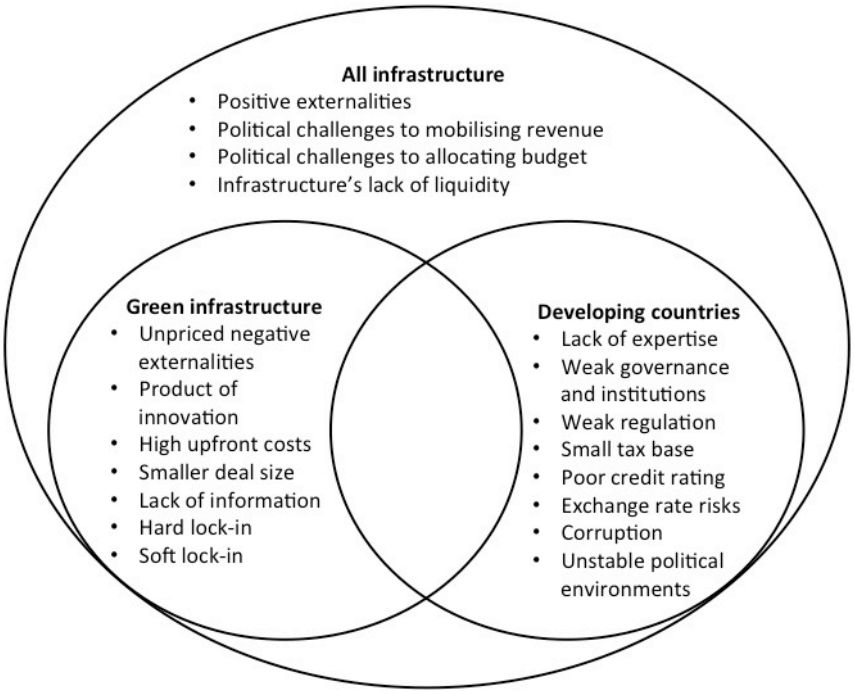
The importance of infrastructure for green growth

Infrastructure is crucial to global economic growth: an estimated US$90 trillion of infrastructure investment is necessary between now and 2030 if we are to meet and maintain global economic growth targets.

Which infrastructure we build in the near term is crucial. 'Building right' is as important as 'building more' infrastructure. Some infrastructure locks in patterns of inefficiency, like poorly planned roads and sprawling cities that lock in private transportation dependence or poor housing stock. Conversely, infrastructure can also lock in efficiencies and facilitate decarbonisation, energy efficiency, and pollution reduction.

The barriers to greening infrastructure "nest" within barriers to infrastructure development more generally. We currently spend about US$1.7 trillion per year when optimal levels are estimated at about US$6 trillion per year. Despite the importance of infrastructure to growth, political opposition to big government spending has driven the global shortfall in infrastructure investment. The governments of least developed countries are additionally hampered by insufficient tax bases and poor credit ratings. The figure below shows some of the policy barriers/risks of the global infrastructure challenge, and those specific to developing countries and green investments.

Figure 1: Venn diagram showing the nested barriers to infrastructure development



It is within the context of a global infrastructure gap that the challenge of greening infrastructure must be considered. The *Better Growth, Better Climate* report estimated a premium of at most 5% on global infrastructure investment between high- and low-carbon development patterns, not accounting for the substantial co-benefits to low-carbon choices. This means that the annual infrastructure investment needs are US$6 trillion for the business-as-usual scenario, and US$6.3 trillion for the low-carbon, low-pollution alternative.

Paling in comparison to this massive number are the US$100 billion per year that developed countries agreed to mobilize by 2020 for climate mitigation and adaptation projects in developing countries, and the roughly comparable level of global development aid. From this perspective it is clear that greening investment is not centrally about finding international public funds for green infrastructure. It is about shaping the allocation of vast global capital resources in the economy toward better investment choices.

Greening investment beyond infrastructure

Beyond infrastructure, greening growth will also require shifting the US$400 trillion of forecasted investment globally.

In some cases, non-infrastructure green technologies can provide the same public benefits as infrastructure, essentially replacing the need for it. Just as mobile

phones have replaced the need for landlines, distributed renewable energy systems will continue to diminish the need for electricity grids. Energy efficiency technologies can reduce the need for increased energy generation.

Unlike infrastructure, which tends to be planned by governments, non-infrastructure green assets and practices will be diffused through markets. Hence, decisions about their implementation are highly distributed among households and firms. The government still plays a critical role in shifting private decisions towards green options, but the financing and policy tools at its disposal are different. This will require scaling up financial products, and institutions capable of delivering them, for much smaller and distributed transactions. Bangladesh's Infrastructure Development Company Limited (IDCOL) has been able to finance very small solar PV installations at scale, by packaging finance, grants, and technical supports to local entrepeneurs that on-lend to households: they have already provided services to 13 million people.

Implications for governments and international financial institutions

Governments must adopt a long-term vision for infrastructure planning and commitment to developing a pipeline of investable green infrastructure projects

The core barrier to infrastructure spending is that it has broad, diffuse public benefits that are not easily captured by a private market in the form of a price (i.e. it has positive externalities). For this reason, the public sector, through its ability to identify and evaluate public benefits, mobilize public revenue, and set policy, is almost always fundamental to the planning and oversight required for infrastructure projects, whether publicly designed and financed, blended finance, or the product of a public private partnership.

It is vital that governments adopt a long-term perspective when planning infrastructure development. As mentioned, infrastructure development can lock in specific development pathways. On one hand, large-scale construction of highly polluting power plants and sprawling cities will almost certainly send the planet beyond the 2°C target. On the other hand, green infrastructure choices – compact cities well connected by public transit and served by renewable electricity – will lock in efficiency gains for decades.

It is necessary for governments – with their overarching perspective on national developments – to guide infrastructure development towards desired outcomes.

A useful tool to facilitate infrastructure planning is a shadow price on environmental damages. For example, a shadow price on the social cost of carbon could shift government cost benefit analyses in favour of green infrastructure choices over polluting ones.

Green infrastructure frequently has higher upfront costs, but it has lower costs over its lifetime because it frontloads technical and design inputs to offset future inputs, such as fuel. If budget-constrained governments focus too much on the upfront costs, they may forgo the future savings that green infrastructure provides.

The public sector must also take the lead in planning and financing. Although the private sector plays an increasingly important role in financing and delivering infrastructure, discussed later, private capital has always and will continue to fall

short of meeting infrastructure needs. The public sector must have a high level of commitment to financing its institutions, planning, and projects, and in leveraging private finance through tools like blended financing and public private partnerships (PPPs).

Crowding in private investment will require public funds to be delivered through public financing mechanisms (PFMs) that are more complex than those used in traditional budgetary channels. Green banks and dedicated green funds in multilateral development banks could be more effective institutional relationships in leveraging private investment for green infrastructure and non-infrastructure assets.

PPPs provide an opportunity to overcome short-term fiscal bottlenecks, and harness private sector expertise. PPPs do provide another tool for public procurement of crucial services, and an alternative means of financing them. However, PPPs do not replace the need for government investment and planning. In fact, PPPs rely on good public planning and capacity to get the most out of private partners.

Likewise, the private sector can bring innovation to service delivery. Nonetheless, to develop a pipeline of investable green infrastructure projects there are also circumstances where the public sector is best placed to demonstrate the feasibility of new forms of infrastructure so as to encourage the entrance of private actors.

Singapore provides an example of a forward-looking and integrated approach to transportation and urban land-use planning. The country planned a system of high-density satellite towns with strong transport links to the central city, preventing urban sprawl and minimizing private car ownership, and leveraged PPPs to deliver it.

Lack of green private investment is often indicative of weak institutions, poorly enforced regulatory standards, misaligned incentives, or other institutional problems, rather than lack of availability of capital

Where private investment is lacking, it is frequently a sign of other structural barriers, rather than lack of funds. Poor regulatory environments and weak institutions can create a confluence of investment risks that prevent capital deployment even where the demand for assets or services is substantial. Only in some developing country contexts is there an actual scarcity of capital, and, even then, businesses and projects can frequently attract foreign direct investment if these offer adequate returns on investment and institutions and the policy environment are strengthened. The Moroccan Agency for Solar Energy (MASEN) provides an example of where a commitment to strong institutional capacity, and a package of incentives, can draw in private capital.

The main barrier facing green infrastructure and non-infrastructure options alike is that market prices do not reflect the social and economic costs of polluting alternatives. Rather than addressing this problem, public policy often exacerbates it. This issue is illustrated most plainly by the fact that globally, governments directly subsidized fossil fuels to the tune of US$775 billion in 2012, seven times the subsidies provided to renewable energy.

A restructuring of incentives will also be necessary to unlock investment in energy efficiency measures. As it stands, most utilities are paid according to how much electricity, water, and gas that they sell, not how much they save. Government policies that 'make negawatts pay' can unleash investment in energy saving measures, both by utilities and by private ESCOs.

Ultimately, it will be essential to strengthen institutional frameworks to reduce policy risks and promote sustained green growth in developing countries. Institutional reform will often require long-term technical support for governments. In the near term, simultaneous to such transformation reform, DFIs and green banks can help overcome barriers associated with weak institutions, unstable policy environments, and currency exchange rates, to buy down private investors' risks through loan guarantees, insurance products, and blended financing mechanisms.

Reducing distorting subsidies and taking measures to align social and private costs and benefits, and reducing risks will be a first step in shifting private investment towards green infrastructure and non-infrastructure businesses and technologies.

Regulation and information-based tools are often at least as important as public investment

A second barrier common to both infrastructure and non-infrastructure is the lack of knowledge and technical capacity surrounding green options. This barrier is common to both developed and developing countries, but is most pronounced in the latter. In order to shift private investment to any green technology, steps will need to be taken to train financial institutions, workforces, and consumers about green technologies and practices.

To this end, regulatory and information-based tools are often more effective than fiscal levers. Green investment indices can help investors assess risk in unfamiliar green technologies. Public training programmes, agricultural extension services and building codes can help train the workforces that will build green infrastructure and produce green products. Green labels like ENERGY STAR can inform consumers about the cost-saving green products.

To mobilize sufficient private investment in infrastructure, new financial products will be required that are attractive to new sources of private capital, such as institutional investors

Institutional investors, with around US$80 trillion of assets under management, represent the largest source of potential investment for green infrastructure. Currently, only a small share of institutional investors' portfolios is invested in infrastructure globally; currently, an even smaller share is invested in green infrastructure in developing countries. This is a missed opportunity.

Green infrastructure investments are particularly well suited to institutional investors' needs. These investors are capable of deploying large amounts of capital demanded by infrastructure projects upfront, and they seek the low-risk returns that infrastructure projects can provide. Furthermore, as many institutions are publicly controlled and have long time horizons, their interest in decarbonizing the economy is greater than other types of investors that tend to seek short-term returns. However, institutional investors demand liquidity in their investment portfolios, which is difficult to achieve in infrastructure.

Green bonds and yieldcos are just two of many financial mechanisms/approaches that promise to unlock institutional investor capital by enabling greater liquidity in sustainable infrastructure investments and structuring them as assets familiar to these investors. International financial institutions can enhance the effectiveness of these products by providing guarantees to reduce the risk to investors.

Scaling up green investment in non-infrastructure assets will require public and private finance to shift to high-risk/high-reward markets and financing structures

Some of the green technologies and practices are a product of innovation, causing them to be beset with risk – both real and perceived. It is frequently this risk that deters private investors. Shifting private investment towards higher-risk investments will require targeted public finance and policy at different stages along the innovation process. Government support for R&D will be essential to sow the seeds for green technologies of the future. However, governments will also be needed to help nascent green technologies and businesses bridge the 'valley of death' by helping bring risky technologies and sectors to commercial viability. Kenya's geothermal industry provides an example of where the government stepped in to provide early investment and demonstrate the viability of the sector, paving the path for private investment.

Finally, during the commercialization phase of new green technologies, governments' financial support can generally be eased, but other interventions may still be required. Policies that provide niche markets for new green technologies can provide security for entrepreneurs while they establish supply chains and a track record of success. In developing countries, policies to unlock consumer finance can enable rapid diffusion of cost-effective green products that are held back only by the purchasing power of consumers.

Green bonds and yieldcos, discussed above, are just two of the more recent financial innovations that help attract private capital to green investments. These reduce risk by making infrastructure a more liquid investment and in the form of a more familiar asset.

Governments and international financial institutions can be highly effective in shifting investment towards green technologies and firms. It is vital that these institutions learn how to green investment today, as the window to shift development paths towards green trajectories is rapidly closing.

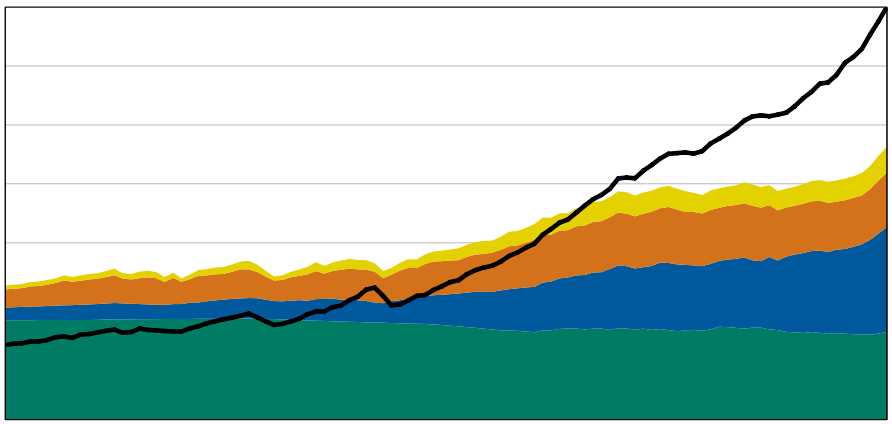
1 Introduction

1.1 The need for green growth and its potential

Economic growth is still a central measure of a country's ability to improve human welfare, but it has become increasingly clear that the quality of that growth is as important as its quantity. Fear of the climate crisis is driving this need to change our growth model. The historic model of economic development threatens to undo itself from the global climate impacts it creates. At the same time, more local and immediate impacts— issues like rising air pollution in the rapidly expanding metropolises of emerging economies, and rising inequality and persistent poverty even in countries with rising wealth – have also driven home the need for a new growth model.

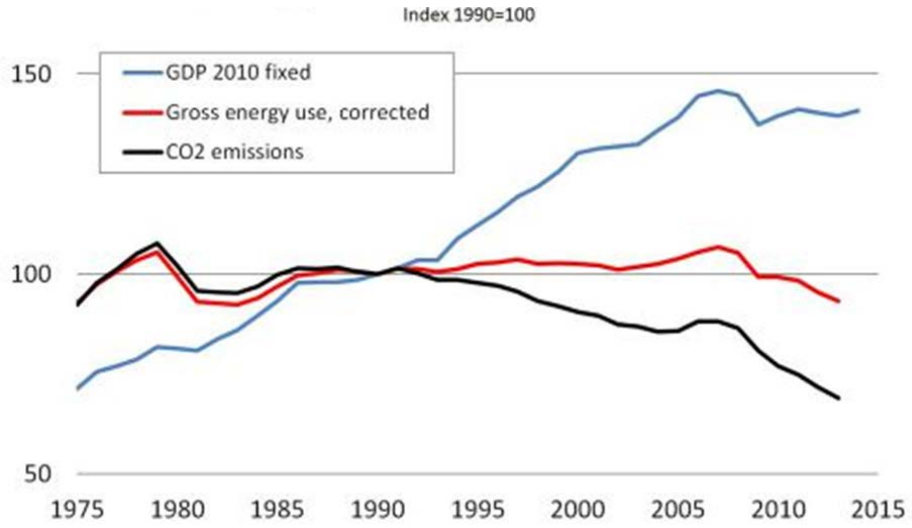
"Green growth" refers to economic growth that is driven by, or at least compatible with, improved efficiency of resource use and reductions in pollution, particularly of greenhouse gases (GHGs). In the 20th century, global economic growth at least partly "decoupled" from rates of resource consumption (see Figure 2). Absolute decoupling economic growth from emissions has proven more difficult, due primarily to the importance of energy in many economic processes. However, as illustrated by the case of Denmark in Figure 3, some countries have had success in recent decades.

Figure 2: Global metabolic rate of key resources compared to global growth, 1900-2005.



Source: (Fischer-Kowalski & Swilling, 2011)

Figure 3: GDP, energy use and CO2 emissions in Denmark, 1975-2015



Data sources: (Danish Energy Agency, 2015; Statistics Denmark, 2015)

These partial successes offer promise that green growth could be accelerated through appropriate public policy regimes. Beyond decoupling growth from resource-use and pollution, higher quality growth will also need to be more inclusive, ensuring that the benefits and opportunities that emerge are widely shared in the economy and bring about concrete social welfare gains.

1.2 The importance of infrastructure investment for green growth

In the last year, the Global Green Growth Institute and other major research institutions prepared a report for the New Climate Economy Commission, entitled *Better Growth, Better Climate*. The report focused on one dimension of green growth—the benefits of making growth low-carbon in particular—but the findings were relevant to the larger question of economic transformation toward greener development models. One of the most striking findings of *Better Growth, Better Climate* is about the relationship of growth and sustainability to infrastructure—the roads and rail, power plants and lines, pipes and wires, and other large infrastructure assets, that enable people, goods and services to move about efficiently. Expenditure on infrastructure can provide a short-term direct boost to growth. It can also enable longer-term increases in productivity by unlocking investment in other parts of the economy through the provision of power, transportation, and communication.

Which infrastructure we build in the near term is crucial. Once built, infrastructure is often expensive or impossible to alter. Hence 'building right' is as important as 'building more' infrastructure. Some infrastructure locks in patterns of inefficiency, like poorly planned roads and sprawling cities that lock in private transportation dependence or poor housing stock: symptoms of that economic inefficiency emerge in the form of congestion, air pollution, and GHG emissions. Conversely, infrastructure can lock in efficiencies, and facilitate decarbonisation, energy efficiency, and pollution reduction. The type of infrastructure built in the next decade and a half will determine whether the world continues to emit GHGs at a rate sufficient to cause global mean temperature to rise beyond 2˚C, the limit scientists have determined will likely avoid dangerous climate impacts.

There is a major global gap in infrastructure investment generally. Infrastructure investment falls short in both developed and developing economies. Current estimates are that about US$90 trillion of investment in infrastructure is necessary between now and 2030 if we are to meet and maintain global growth targets, or about US$6 trillion per year. Current spending is closer to US$1.7 trillion per year (Global Commission on the Economy and Climate, 2014).

Better Growth, Better Climate estimated a premium of at most 5% on global infrastructure investment between high and low-carbon development patterns, not accounting for the substantial co-benefits to low-carbon choices, such as reduced air pollution and congestion (Global Commission on the Economy and Climate, 2014). In other words, annual infrastructure investments need to be about US$6.3 trillion per year between now and 2030 for green options, US$94.5 trillion in total.

Paling in comparison to these massive numbers, developed countries have agreed to mobilize an additional US$100 billion annually, starting in 2020, for climate mitigation and adaptation projects in developing countries. Between 2020 and 2030 these funds would add up to US$1 trillion. Equally insufficient are the roughly comparable level of global development aid, on the order of US$135 billion per year (OECD, 2015).

From this perspective it is clear that greening investment is not centrally about finding international public funds for green infrastructure. It is about shaping the allocation of vast global capital resources in the economy, public and private, toward better investment choices. At best international public finance can complement and facilitate these choices, indeed it must, but ultimately it will be about shaping the investment decisions of governments and the financial sector across the economy.

1.3 Greening investment beyond infrastructure

Choices about capital deployment in infrastructure assets will be critical, but infrastructure is not the only part of the economy in which capital allocation choices can affect green growth outcomes. Greening growth will also require shifting much of the US$400 trillion of forecasted investment globally towards resource and pollution efficient options (IMF, 2014).

An increasing array of technologies have replaced the need for much of the capital intensive, long-lived, and often complex infrastructure that provided the backbone of economic productivity in the last century. Just as mobile phones have replaced the need for landlines, distributed renewable energy systems will replace the need for centralized generation and in some contexts even the need for electricity grids. ICT helps society to connect without landlines, but also enables people to connect even without mobility. These innovations do not eliminate the need for large physical assets—mobile phone towers and satellites still must be built—but they radically transform the productivity effect of those assets on the economy. To deliver the 9 zetabytes of internet traffic in 2010, the globe would need 13 trillion mail coach journeys and 190 billion horse/days across seamless global roadways (Fouquet & Hippe, 2014).

In essence, we are increasingly able to provide the same services once requiring large, capital intensive infrastructure assets by other means. Where those services are less resource or pollution intensive, particularly if they are less GHG intensive, they are greener. Solar panels, distributed wastewater systems, even weather forecasting systems, are requiring lighter physical capital investments. These still need to be financed at scale, but they require financing models, instruments, and institutions, capable of delivering numerous small deployments of capital.

There are also major areas of capital deployment only indirectly related to infrastructure investments— agricultural and forestry, the resource and pollution intensity of consumer goods manufacture, for example. The sustainability of growth also hinges on the sustainability of these investments. So, while some green innovations may reduce the need for US$90 trillion in infrastructure investment between 2015 and 2030, greening the economy will require looking to change the broader US$400 trillion in capital investment over the next 15 years.

1.4 Scope of the paper

This discussion paper aims to explore the barriers to getting financing to flow to green investments. Given the vastness of the economy that is implicated in resource consumption and pollution, it would be impossible to capture this in every dimension. To break down the problem, Sections 2 and 3 examine the barriers and solutions to green infrastructure and non-infrastructure investments, respectively. The distinction between infrastructure and non-infrastructure assets is important because the barriers to investment, and the policy levers available to unlock investment, are very different in each. Specific country-level examples are included in each section that illustrate how government policies and public finance can be used to unlock flows of private investment. Section 4 concludes with a discussion of the implications for international financial structures.

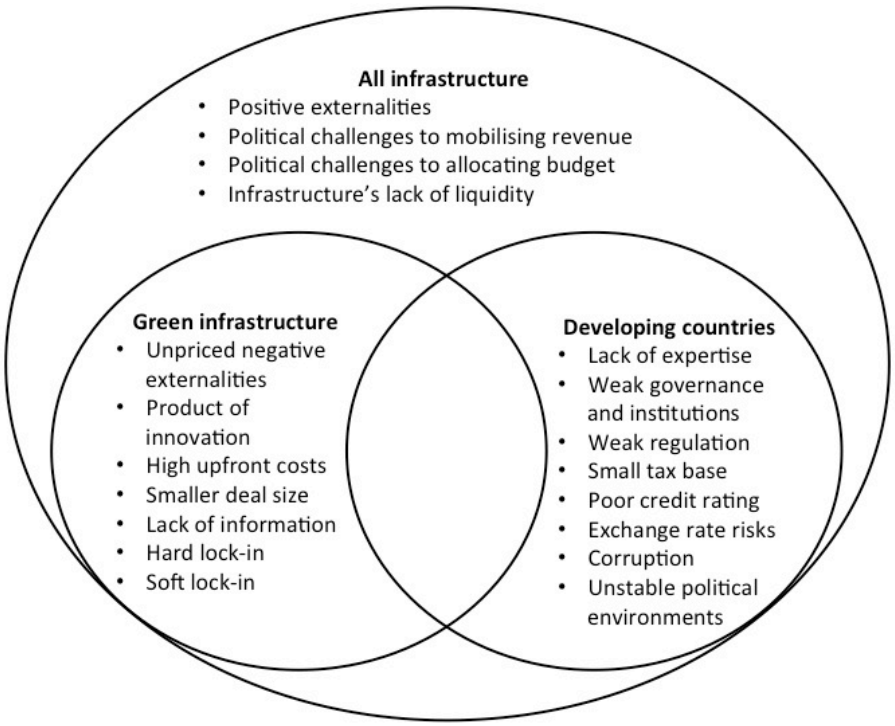
2 From $1 trillion to $90 trillion: barriers and enablers of green infrastructure investment

Global discussions about greening investment, particularly for developing countries, have shifted away from how the US$100 billion per year (US$1 trillion between 2020-2030) pledged in Copenhagen should be allocated, and towards the necessary transformation of the US$90 trillion to be invested in infrastructure over the next 15 years. The US$100 billion of "climate finance" is still a critical tool for facilitating greener development, but green growth will require both that capital allocations to scale up of infrastructure, more broadly, are pollution and resource efficient.

2.1 Understanding the barriers to green infrastructure investment

Green infrastructure investment in developing countries faces a series of nested challenges: a number of barriers pertain to all infrastructure investments; a series of additional barriers are specific to green infrastructure; others still are specific to infrastructure investments in developing countries. Figure 3 illustrates this relationship. This section will address these in turn, to tease apart both the larger infrastructure investment challenge, and the challenges specific to shifting that capital deployment to more sustainable choices in developing countries.

Figure 4: Venn diagram showing the nested barriers to infrastructure development



2.1.1 Common barriers to all infrastructure

Once built, infrastructure has the potential to enhance productivity and benefit the public at large (IMF, 2014). This is true in developed as well as developing countries. In the former, a 2014 IMF study showed that each 1$ of GDP invested in infrastructure would achieve 1.5% GDP growth within four years (ibid). In developing countries, the picture is more complicated, but equally critical. A combination of population and economic growth is driving the need for a broad array of services including power, water, and communications. Capturing the benefits of infrastructure development in the developing world, however, requires scaling up domestic capacity to plan infrastructure effectively and then deliver it.

The core barrier to infrastructure spending is that it has **broad, diffuse public benefits that are not easily captured by a private market in the form of a price** (i.e. it has positive externalities). For this reason, the public sector, through its ability to identify and evaluate public benefits, mobilize public revenue, and set policy, is almost always fundamental to the planning and oversight required for infrastructure projects, whether publicly designed and financed or the product of a public private partnership (PIMAC, 2014). Although the private sector plays an increasingly important role in financing and delivering infrastructure, discussed later, private capital has always and will continue to fall short of meeting infrastructure need (Bhattacharya, Romani, & Stern, 2012).

Many countries, developing and developed alike, underspend on infrastructure. Aside from least developed countries (which suffer from an inadequate tax base) and countries with poor credit ratings (which cannot borrow at an affordable rate), the main constraints preventing public investment in infrastructure lie within the political economy. **Governments frequently face political challenges to appropriating sufficient revenue for infrastructure investment** (either through taxes or debt), and to focusing infrastructure investments on choices that maximize public benefits. Barriers to infrastructure therefore go to the core of public fiscal policy. Grappling

with the underfinancing of infrastructure ultimately requires grappling with mobilizing public revenue and allocating fiscal resources toward material but diffuse public benefits.

To bypass political constraints on budgets, it is becoming increasingly common for governments to turn to the private provision of infrastructure – with models of engagement ranging from public private partnerships (PPPs) to public guarantees for private financing. Beyond its political palatability, private participation can provide additional benefits including efficiency gains through greater expertise, technological and other forms of innovation, and incentives for tighter control of costs and performance. However, provision of infrastructure through PPPs also has risks: private firms' need to recoup costs plus a profit can lead to higher user fees; protracted tendering processes can cause delays; inadequate public sector comparators[1] can lead to governments forgoing potentially large revenue streams and receiving inadequate value for money; and inflexible, long-term contracts can reduce competition, negating any incentive for efficiency gains (Colverson & Perera, 2012; Sarmenot, 2010). Regardless of whether infrastructure is provided through a PPP or other models, good public management will require political leadership, trained staff, and adequate information and data to allow good analysis of costs and benefits (Airoldi et al., 2013; Florizone & Carter, 2013).

Existing infrastructure PPPs have already been able to mobilize capital from commercial and investment banks in the developed world and in some emerging economies. To scale up funding for infrastructure, governments and PPPs are increasingly looking to the US$80 trillion of assets managed by institutional investors — pension funds, sovereign wealth funds, insurers, and other long-term asset managers. Institutional investors appear particularly well matched for infrastructure investment. They have the ability to deploy large amounts of capital up front and are often seeking stable, lower risk returns. These investors of more "patient" capital are typically capable of larger capital deployments, looking for long-term stable returns that appear to align well with the nature of infrastructure assets.

Despite this apparent alignment, a very small portion of this large resource invested in infrastructure, and an even smaller share going to developing nations. According to the IFC,

> *"Many factors contribute to this low percentage, including the diversity and complexity of the entities managing large assets, the dominant conservatism and inertia that govern their investments, and the emphasis on fiduciary duty that is driven in large part by nationally specific regulation, lack of suitable financing vehicles and investor inexperience with direct investing" (IFC, 2013, pp. 53-54).*

These factors all create barriers to capital allocation from institutional investors into infrastructure assets. Most critical, however, is that **infrastructure lacks the liquidity of securities, like stocks and bonds, making it difficult for institutional investors to dispose of assets** as their financial needs demand. In all contexts, scaling up private infrastructure investment will require grappling with these barriers.

2.1.2 Additional barriers to green infrastructure investments

Green infrastructure investments face a series of barriers that are additional to those faced by traditional infrastructure. First and foremost, **environmentally damaging infrastructure receives an implicit subsidy** insofar as its social and economic costs

[1] A public sector comparator refers to the total risk adjusted costs of the public sector providing the service in question.

are not taken into account in government decision-making. The impact of this "externality" can be considerable, particularly for infrastructure like coal power generation that emits large quantities of air pollutants and GHGs. A tonne of coal with a market price of US$25/tonne may have a much higher societal cost when climate impacts and other externalities are fully taken into account. For example, a comprehensive review of the environmental costs of environmental degradation in India by the World Bank identified annual costs equivalent to about US$80 billion per year or 5.7 percent of GDP – the largest source of damages from particulates released by coal burning (Burney & Ramanathan, 2014). The same analysis estimated that the benefit of reducing particulates by 30 percent amounted to over US$100 billion a year in reduced health costs (World Bank, 2013). If these social and environmental costs are not taken into account within government decision-making then green infrastructure is placed a significant disadvantage.

Even with the omission of externalities, many of the improvements necessary to "green" infrastructure investments involve very low or even zero incremental costs if done at the design and construction stage. For example, a recent review of EBRD investments with adaptation components found that most were 'no regret' measures i.e., they were sensible business decisions in the near term independent of climate risk (Vivid Economics, 2015). Of course, while these "no-regret measures" are net beneficial when measured economy-wide and therefore in the public interest, they may represent a shift of benefits from certain sectors and stakeholders to others, creating political economic challenges to transformational change.

Despite the cost-effectiveness of these green infrastructure investments, they often face **additional barriers as a product of innovation**. This is not necessarily innovation in the sense of technological invention; rather, precisely because green infrastructure entails changing practices, it entails a degree of novelty. It is important to note that not all 'innovation' is sustainable, but common to green infrastructure are novel designs, processes, and products. Novelty, in turn, is a source of 'perceived risk' for investors (public or private) whom are unwilling or unable to evaluate unfamiliar investments. Novelty is also a source of actual risk. Some types of green infrastructure are, in fact, new inventions and have not yet been proven reliable at scale or in the specific context or site for which they are considered.

Greener infrastructure also tends to have **higher upfront costs than its environmentally damaging alternatives**. High upfront costs are often cited as an attribute of renewable energy assets (IRENA, 2012), but may be regarded as a common attribute of sustainable infrastructure more generally. This is because reducing the need for material inputs over an infrastructure's lifetime tends to entail upfront costs in design and physical capital, although with the benefit of lower operating costs.

A further barrier commonly faced by green infrastructure is the **lack of awareness about the downside risk of alternative options**. Part of this lack of awareness revolves around the environmental and social costs of dirty infrastructure discussed earlier. However, a lack of awareness around other issues – such as the risk that climate change poses to poorly designed infrastructure – can present barriers to the construction of resilient infrastructure. Knowledge about projected impacts of climate change is often limited to environmental officials outside the decision-making for infrastructure projects. Even when climate change is recognized as an issue, analysing its implications for specific localities and near-term time periods can be a challenge (Cervigni et al., 2015; Vivid Economics, 2015).

A final barrier to green infrastructure is the **'lock-in' that has been created where alternative environmentally damaging infrastructure is already constructed**.

Lock-in is often referred to as a future challenge to current investment choices, but likewise economies can be locked in through the incumbency of historic investment choices that were made without taking into account climate change and other negative externalities. Once polluting or resource-intensive infrastructure is built, green retrofits can often be costly or technically impossible to implement. It becomes more challenging to phase out such infrastructure before the end of its productive life cycle, creating a *hard lock-in* of dirty development pathways. While urban green growth projects may look to design new, low-carbon and dense cities, for example, already-sprawling cities have locked in private transportation dependence. Likewise, poor building stocks have locked-in inefficient energy use. Promoting green infrastructure where locked-in alternatives already exist is economically and technically challenging. Less tangibly, the institutions, technical knowledge, vested interests, cultural values, and political lobbies surrounding incumbent industries create a *soft lock-in* of the status quo, and, in turn, a disadvantage to innovative alternatives. To illustrate, consider the interplay between established workforces, distribution networks, shareholder interests, fossil fuel subsidies, and political lobbies that work to lock in a transportation system based around the petroleum-powered automobile and lock out alternative means of transport (Unruh, 2000).

2.1.3 Additional barriers in developing countries

Developing countries face the above barriers, plus a series of barriers of their own. It is important to distinguish these: solving them will not necessarily make infrastructure, or the economy, more sustainable, but they will need to be overcome (along with those in the prior section) if economies are to invest in green infrastructure.

Public provision of infrastructure often faces human resource constraints, including **governments' lack of expertise in planning, financing, and implementing projects**. Insufficient project preparation on the government side, in turn, leads to poor infrastructure choices that reduce the economic return to investment. This can strain public budgets that spend or take on debt but fail to see the revenue gain from corollary growth. It also can create wariness on the part of the private sector to invest. That caution is amplified by private investor concern over risks posed by issues such as immature regulatory frameworks, politicized decision making, and difficulties with land acquisition (Gilbert, 2013).

In addition to human resource constraints, many of the poorest nations, particularly in Africa, face additional obstacles due to their **low baseline of existing services, low population density (which increases service costs), weak governance and regulatory frameworks, and dependence on development assistance** (Foster & Briceno-Garmendia, 2010). Currency **exchange rate risks, poor credit ratings (especially utilities with tariff structures that fail to recover costs), and small tax base make raising capital for infrastructure sometimes impossible without external support.** Furthermore, investors will often be hesitant to invest in countries where they perceive there to be **policy risks, such as the risk of political instability or that governments will breach their terms of contract or even appropriate private property at some point in the future**. In countries with high debt, poor credit ratings, and significant currency exchange rate and policy risks, some assumption of risk by international financial institutions is often essential to reduce borrowing costs to manageable levels.

Many of the barriers unique to developing countries centre not on the availability of finance, but on the ability of regulatory frameworks and institutional capacity to create a viable enabling environment. Summarizing the complex and country specific nature of these barriers, a review of strategies for attracting greater investment in clean energy finance for the G20 by the IFC concluded:

An overriding conclusion is that while financing is almost always a necessary element for success, it is often not the primary barrier to greater [inclusive green growth] investment. Indeed, the absence of financing is often an indicator of other deficiencies in the enabling environment, such as poor policies, inadequately proven technologies or business models, or lack of consumer awareness and acceptance (IFC, 2013, pp. 7-8).

Combined, these barriers serve to trap developing countries into low levels of existing services, making it harder, in turn, to develop and deliver new services.

On top of these barriers, green infrastructure is often inhibited by developing countries' desire to boost growth in the short term and clean up later – as many industrialized nations have done in the past. Even the development of traditional green infrastructure, such as wastewater treatment plants and landfills, is often sidelined in favour of infrastructure like roads and power plants that will help to boost GDP in the near term.

2.2 Overcoming the barriers to green infrastructure investment

Scaling up global green infrastructure investment will require overcoming not only the barriers specific to green infrastructure; but also the obstacles that pertain to infrastructure development more generally, and those specific to developing countries. This section examines the policy levers available to overcome the sum of these barriers in order to promote green infrastructure development.

2.2.1 The importance of government planning

Whether financed from debt, public coffers, or other sources, getting the most out of capital deployment in infrastructure requires effective government planning that centres on delivering lasting public benefits from public works. In planning infrastructure development, governments must take a long-term view that takes into consideration trends in innovation and risk of lock-in to more expensive and polluting alternatives. The social and environmental costs of dirty infrastructure can be factored into cost-benefit analyses through tools such as a 'shadow price on carbon', described in Box 1. To assess the risk of lock-in, governments should consider both the average lifespan of the different technologies in question, as well as the current trends in innovation in cutting edge technologies. For example, when weighing a fossil-fuel power plant against a solar power plant, governments should take into consideration the rapidly declining costs of solar electricity.

Box 1. Placing a shadow price on carbon in government cost-benefit analyses

In some countries, international financial institutions, and corporations, the externalities associated with climate change are being quantified with a carbon price of "social cost of carbon" (SCC). In the U.S., for example, the Environmental Protection Agency (US EPA, 2013) defines the SCC as "a comprehensive estimate of climate change damages and includes, among other things, changes in net agricultural productivity, human health, and property damages from increased flood risk." The agency provides a range of SCC estimates with varying discount rates and costs rising over time, but with an average current value of about US$40 per tonne CO_2e (US EPA, 2013).[2] These

[2] The methodology for estimating the SCC, including the selection of an appropriate discount rate, is not settled. Some analysts advocate a much higher number than EPA, arguing for example that costs could be in excess of US$200 per ton when the impact of climate change on the economic growth of developing nations is taken into

values are used, for example, in the U.S. government's analysis of costs and benefits from proposed regulations to reduce emissions from coal burning power plants (US EPA, 2014). Similarly, the World Bank has adopted a SCC of US$30 per tonne rising over time for its economic evaluations, although the results are non-binding on investment decisions (World Bank, 2014).

While lock-in is typically discussed as a negative, better infrastructure choices can lock-in efficiency gains for decades to come. Singapore's Green Plan, described in Box 2, provides an example of how planning around compact and efficient urban forms can boost creativity and growth, whilst locking in sustainable behaviour from infrastructure users.

Box 2. Singapore's integration of urban and transport planning

For decades, Singapore has applied a forward-looking and integrated approach to transportation and urban land-use planning. The country created a system of high-density satellite towns with strong transport links to the central city, preventing urban sprawl and minimizing private car ownership. Four forms of public transport – bus, Mass Rapid Transit (MRT), Light Rapid Transit (LRT) and taxi – now account for over 60% of peak mode trips in trips. The goal is to expand this share to 75% by 2030 (Flemmich, 2012; King, 2014).

Singapore's success was based on a tight regulatory framework combined with economically sound financing arrangements (Boey & Su, 2014). The Land Transport Authority (LTA) develops the public transport infrastructure and purchases the rail operating assets. It then leases these assets to privately-owned operators to operate and maintain. Two privately owned companies operate the entire rail and bus networks. Each has the exclusive right to operate rail and bus services in a distinct Area of Responsibility. Operators pay license charges, retain revenues from fares and rental of commercial spaces in rail stations and bus interchanges, and pay for the operating costs without government subsidies. The presence of two operators allows for benchmark comparison, and gives a better idea of reasonable costs and service levels. Recognizing that public transport has the characteristics of a natural monopoly, the government has established a strong regulation framework to prevent the operators from abusing their market power to set excessively high fares and cut corners. It also provides significant public finance and fiscal rewards for efficient operation (Flemmich, 2012; King, 2014).

Singapore's consistent and long-term commitment to a compact urban development model based on quality public transit should serve as an illustrative model to rapidly urbanizing countries (Boey et al., 2014).

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account (Moore & Diaz, 2015). Quoting the Intergovernmental Panel on Climate Change (IPCC, 2007), EPA notes that its SCC estimate is incomplete as the models used "do not currently include all of the important physical, ecological, and economic impacts of climate change recognized in the climate change literature because of a lack of precise information on the nature of damages and because the science incorporated into these models naturally lags behind the most recent research."

2.2.2 Dedicated public financing of green infrastructure

Beyond planning, governments must also take the lead on financing green infrastructure. Although the private sector plays an increasingly important role in financing and delivering infrastructure, discussed later, private capital has always and will continue to fall short of meeting infrastructure needs. The public sector must have a high level of commitment to financing green infrastructure projects outright, and to leveraging private finance through tools like blended financing and public private partnership.

In developing countries that are unable to raise sufficient public capital for green infrastructure domestically, development finance institutions (DFIs) – including national, bilateral, and multilateral development banks – will need to play a critical role in filling the gap and drawing in foreign direct investment. New development banks in emerging markets, including the Asian Infrastructure Investment Bank and the BRICS[3] New Development Bank, with US$50 billion and US$100 billion in authorised capital respectively, are also potentially major sources of green infrastructure financing (Morris & Gleave, 2015).

DFIs are already providing significant finance for green infrastructure. In 2013 alone, DFIs invested a combined total of US$126 billion in climate-related projects (Climate Policy Initiative, 2014). Climate change considerations are also becoming a design consideration for infrastructure projects, with DFI requirements for evaluating the risks of climate change (ADB, 2014). To secure the necessary scale of finance for green infrastructure, DFI investment will need to be scaled up, focused on low-carbon, sustainable infrastructure, and spent in a way that leverages further investment from private sources.

The following sections will discuss steps to 'crowd in' private investment for green infrastructure. Executing these steps will require public funds to be delivered through public financing mechanisms (PFMs) that blend public and private capital, and that are more complex than those used in traditional budgetary channels.

As complex PFMs are often required to leverage private investment, the creation of dedicated green banks (either at the national or international level) or green funds within existing DFIs could prove to be more effective institutional arrangements than traditional budgetary channels. Such institutions enable financial and technical expertise to be established in a single government body, rather than expecting existing institutions to rapidly change professional expertise and operational structure.

These fit for purpose institutions would be better positioned to support complex and riskier fund raising techniques for green infrastructure projects, such as green bonds and private equity investment (discussed further in Section 2.2.5). Furthermore, green banks and DFIs would be more capable of blending public and private finance through a diverse set of public financing mechanisms: not only those related to infrastructure but also more distributed, flexible goods that provide green services, such as retail credit for efficiency retrofits, distributed solar (the latter are discussed further in Section 3.2.4). For example, risk guarantee facilities within these institutions, similar to the World Bank's Multilateral Investment Guarantee Agency (MIGA), can buy down private investors' risks associated with currency exchange rates, unstable policy environments, and innovative green technologies. Appendix 1 outlines the broad range of public financing mechanisms that can be used to attract private capital, while Appendix 2 categorized them as (1) increasing returns, (2) reducing risks, and (3) transformational. One example is offered by the UK Green

[3] Brazil, India, Russia, China, and South Africa

Investment Bank, discussed in Box 3. In the United States, there are also a growing number of green banks at the state level (Berlin et al., 2012; Green Bank Academy, 2014).

Box 3: UK Green Investment Bank

The Green Investment Bank was established by the UK government in 2012 to invest in wind, biomass and other green infrastructure projects that struggle to gain funding elsewhere because their risk profile is too high for private investors. The original capitalisation of the publically owned bank was relatively small at £3.8 billion, and it has been further constrained by rules that prevent it from borrowing like a normal bank. Nonetheless, the bank has invested £2 billion in 50 green infrastructure projects since its inception. For every £1 spent it has attracted an additional £3 from private sources, and in 2013 it recorded a profit demonstrating that green banks could offer good value for money (Green Investment Bank, 2015).

One of the more recent and creative efforts to identify innovative ways to use donor funds to leverage private investment in climate projects is the Global Innovation Lab for Climate Finance, a collaboration of public donors and private investors. In May 2015, the participants selected four concepts from more than 100 proposals and are now in the process of seeking donor support to implement them. In May 2015, the participants selected four concepts from more than 100 proposals. Four proposals were approved:

- **The Climate Development and Finance Facility** will facilitate early-stage development, construction financing, and refinancing to fast-track renewable energy projects in developing countries, mobilizing at least USD 2 billion in private finance out to 2020.
- **Energy Savings Insurance** will insure the value of savings generated by energy efficiency investments.
- **The Agricultural Supply Chain and Adaptation Facility** will partner with agribusiness companies to provide local farmers with technical assistance and access to finance for climate-resilient investments.
- **The Long-Term Foreign Exchange Risk Management** instrument will provide tools to address currency and interest rate risk for climate relevant projects in developing countries (Rom-Povolo, 2015).

The Lab is now actively seeking financial commitments and support for implementing each of the four concepts.

2.2.3 Public private partnerships provide a promising tool in the toolkit for green infrastructure development

Singapore's successful use of a public-private partnership (PPP)[4] to deliver mass transit systems (discussed previously in Box 2) is part of an international trend to rely increasingly on private provision to fill the infrastructure gap. Experience shows that PPPs are complex and time consuming to develop, require public skill and

[4] Contractual arrangements wherein governments share responsibility for the design, financing, construction, and operation of energy, water, telecommunications, and other public infrastructure.

commitment to implement effectively, and can become controversial when large awards are being made to private parties.[5]

Despite their challenges, PPPs can make significant contributions to filling the infrastructure gap through the introduction of expertise, resources, and efficiency. PPPs are particularly attractive options for green infrastructure that requires deep commitments to finance higher upfront costs. In some cases, private entities are able to borrower at lower rates than public authorities, lowering the cost of capital for such assets. However, the concession of public services to private entities represents foregone public revenue from public assets, so cost reductions should not be assumed but rather analysed.

It is important to acknowledge that PPPs have a mixed record as a public performance tool in delivering sustainable infrastructure (Colverson et al., 2012). At the very least, enabling private investment in green infrastructure through PPPs requires strong government oversight, and frequently fiscal commitment, to ensure effective delivery.[6] It should be evaluated as a tool among other tools, such as performance contracting, Box 4 provides a successful example of a PPP to deliver water services in Senegal that strong government oversight with mixed ownership of assets, private operation and maintenance, and subsidized services for low-income customers.

Box 4. Public private partnership for water service delivery in Senegal

In 1996 the government of Senegal created a public company, Société Nationale des Eaux du Sénégal (SONES). SONES owns all the fixed assets for water service delivery, and functions as an independent sector regulator, setting tariffs and standards for service quality. Senegalaise des Eaux (SDE), a subsidiary of a major French water company, manages the water system under a 10-year operation and maintenance contract. The program has successfully increased

[5] A case in point is the Philippines, where more than US$20 billion in PPPs have been approved as part of a national effort to make badly needed improvements in the country's transportation system. Last year, a 30-year concession to build, operate, and eventually transfer a toll road to public ownership was awarded after a competitive bidding process. The initial winning bidder was disqualified on a technicality and the contract was awarded to another conglomerate bidding half as much. After months of controversy the President ordered the bidding process rerun (Moss, 2015). Similar problems have slowed implementation of infrastructure PPPs in Indonesia, where despite strong support at the highest level, the rate of project development has been disappointing: "According to BAPPENAS, Indonesia's Ministry of National Development Planning, only 24 PPPs have made it to construction or operation, with no new PPPs reaching financial close—signed contracts between the government, winning bidder and financing parties— since 2009. Most are stuck in the preparation and transaction stages. Out of the 48 PPP projects worth more than US$57 billion (approximately 570 trillion rupiah) announced in 2013 by BAPPENAS, 26 are in preparation stage and 21 are in transaction stage. Even the five PPPs identified as showcase projects are struggling, and only one—the Central Java Power Plant—is signed and currently embarking on financial close" (Lin, 2014).

[6] Korea, a country with among the most successful records of infrastructure development and finance, has a government agency specifically dedicated to PPP development and evaluation – the Public and Private Infrastructure Investment Management Center. PIMAC supports line ministries to evaluate proposed infrastructure investments prior to deciding whether a project will be publicly executed or implemented in some form of PPP. In this manner, it ensures both effective infrastructure planning and sensible use of the PPP structure in particular.

water production by 18% and connected over 80,000 households between 1996 and 2003. Early disputes concerning public sector investments and technical efficiency targets were resolved through renegotiation of terms with a significant positive financial impact on SDE (UNDP, 2012).

Despite this success story, developing countries frequently lack the coordinated and knowledgeable public sector management, transparent legal frameworks, and stable political environments necessary for effective and equitable service delivery through PPPs. The participation of donors and/or international financial institutions could prove instrumental in improving government capacity and mitigating risks to private investors. The Global Infrastructure Facility convened by the World Bank is attempting to create enabling environments for infrastructure PPPs in developing countries. The programme brings governments together with institutional investors, development banks, donor countries, and technical and advisory partners (World Bank, n.d.).

Government solicitations for PPPs that are designed in a flexible manner that allows the private sector to respond in the most cost-effective way have been shown to produce significant cost and time savings, as well as innovation. For example, when issuing a private concession for the construction of a road and tunnel in the U.S. city of Miami, the government specified the desired outcome and some general parameters but left much of the specific design considerations to the private bidders. The winning bidder relied on an innovative drilling technology used for the first time in the country and cut costs in half relative to the state's projection (Parker, 2009).[7]

This example provides an important lesson for how PPPs can be used to promote green infrastructure development. Rather than designing contracts that are overly prescriptive about the specific technologies to be used, governments can simply set environmental targets and spur innovative solutions to those targets. For example, it could establish the limit of pollutants that a firm is permitted to produce while delivering the contracted service, whether that be electricity, transport, water, or otherwise. Another approach could entail establishing a fixed price for the concession based on a public comparator, and having proponents compete for better environmental and social performance criteria (O. Perera, pers comm).

2.2.4 Active government programmes to develop a pipeline of investable green infrastructure projects

Given the real and perceived risks associated with innovative green infrastructure, there is a dearth of investable green infrastructure projects throughout much of the world, especially in developing countries. Governments have an important role to play in providing long-term support to nascent green infrastructure technologies in order to develop a pipeline of investable projects. Where governments lack the institutional and regulatory capacity to develop investable projects (as discussed in Section 2.1.3), DFIs can offer technical support to help overcome for specific subsectors, rather than waiting for wholesale government transformation before investing in sustainability. Morocco's solar industry and Kenya's geothermal industry, discussed in Box 5 and Box 6, offer two good illustrations of how a package

[7] Similarly, in India, when issuing a call for bids to build a convention centre, the government specified only the minimum capacity of the convention hall. The flexibility in terms allowed the private sector to develop plans that integrated commercial opportunities, such as food and beverage purveyors and hotels (Airoldi et al., 2013).

for a particular subsector—including national planning, political leadership, sector specific institutional strengthening and effective utilization of international development assistance—can attract private investment in the development of green infrastructure. Both cases illustrate that cutting edge clean technology projects can be implemented in developing countries when the right conditions are present – but that a strong combination of committed, persistent, public and private partners is required.

Box 5. The Moroccan Agency for Solar Energy (MASEN)

The government established The Moroccan Agency for Solar Energy (MASEN) in 2010 as the vehicle for mobilizing and blending resources and allocating risks to key players.[8] MASEN is responsible for feasibility assessment, design, development, and financing of solar projects in Morocco, along with contributing to expertise and research in the solar industry. Its aims are both to develop energy and to support the development of a new industrial sector in Morocco through training, capacity building, and research and development (R&D).

The first project to be developed using this model was Ouarzazate 1 – a concentrating solar power plan using fields of mirrors to generate heat to operate a turbine and generate power. Bids were invited to develop a Solar Power Company (SPC) to operate the plant on a 'build, own, operate and transfer' basis, supported by a 25 year fixed term Power Purchasing Agreement (PPA) between MASEN and the SPC. Multiple companies bid for the project, and a Spanish Saudi consortium won. The project went from 'idea' to financial close between 2009-2013 – less than the 6 years typical for projects of this capacity. The tariff offered by the winning bidder (US$0.184) was 25% lower than initial cost projections, one of the least expensive contracted to date, reducing the required public revenue subsidy from the forecast US$60 million to US$20 million (Whitley & Granoff, 2014).

Box 6. Geothermal power development in Kenya

Olkaria III geothermal power in Kenya illustrates some of the same combination of public planning, private investment, and international financial support to develop a clean power technology. The Olkaria III project is the first privately funded and developed geothermal project in Africa. **The project had a cost of USD 445 million. Initially financed by equity in the late 1990s, the project was able to attract debt needed for its expansion only in 2009 after renegotiation of the power purchase agreement (PPA) and the attachment of a government security package to back the payments to the off-taker, the utility Kenya Power and Lighting Company.**

Importantly, the project was only investable after decades of technical and financial support from the public utility and development partners to prove the viability of the resource and reduce risk to private investors. The private developer Ormat provided equity financing with an initial USD 40 million commitment in the years 1998-1999, which reached USD 150 million in 2006. Ormat had to extend its equity commitment for longer than originally expected, securing debt financing only 11 years from the inception of the project. Several bilateral and international development institutions played a key role in restructuring the debt including two German DFIs (DEG and KFW) and the U.S.

[8] MASEN is a limited company which is 25% owned by the Government of Morocco, ONE, the Hassan II Fund for economic and social development, and the Société d'Investissements Energétiques (SIE).

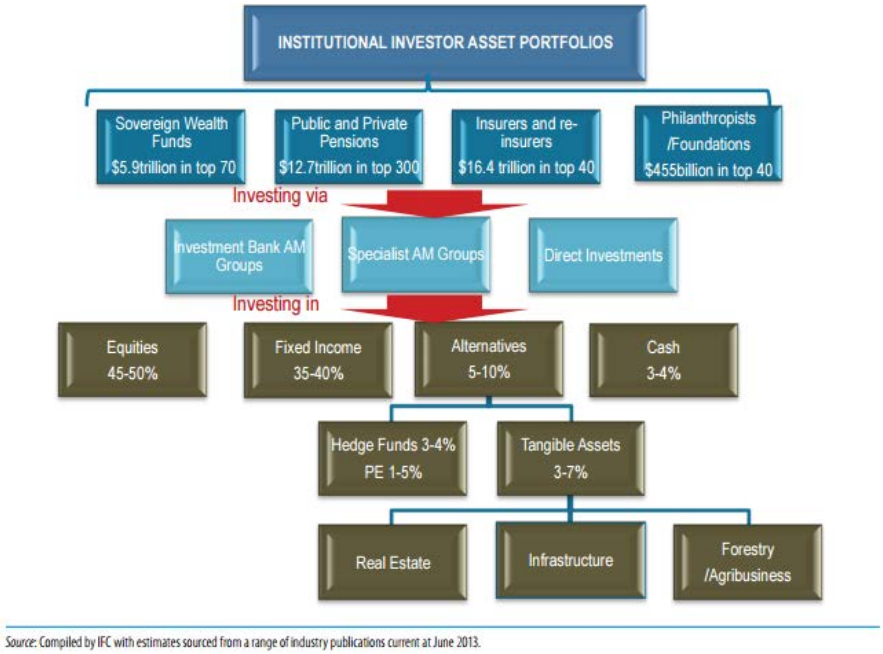
Overseas Private Investment Corporation (OPIC) (Micale, Trabacchi, & Boni, 2015).

2.2.5 Unlocking institutional investment in green infrastructure

The issue in scaling-up green infrastructure to the level necessary to meet global environmental challenges is not the availability of capital – substantial sums are available as discussed below. The issue is rather that inadequate capital is directed to infrastructure in general, let alone that in developing nations or green infrastructure.

As discussed above, the holy grail of private infrastructure finance is the US$80 trillion or more of capital controlled by "institutional investors". The ownership and form of these assets is illustrated in Figure 5 from an IFC (2013) report for the G20. Unlocking institutional investor capital for green infrastructure represents a potential double win, whereby filling the infrastructure investment gap will lock-in efficiency and productivity gains rather than emissions and waste. A number of policy levers are available to shift streams of private finance towards green infrastructure. These are discussed below.

Figure 5: Typical Investor Portfolios and Allocations



Source: (IFC, 2013)

Green Bonds and Yieldcos

Two recent innovations in the securitization of green infrastructure assets demonstrate the potential for enabling private investment: green bonds, and yieldcos. Green bonds and yieldcos for sustainable projects are examples of green debt and equity securities, respectively. The familiarity of such financial instrument makes them easier for investors to do due diligence, while their liquidity aligns them with institutional investor needs. These securities also overcome the challenge posed by the smaller, more flexible assets that often characterize green investments, like solar PV installations or distributed technologies, that can replace larger physical ones: they allow the bundling of projects for portfolio financing through a familiar financial product.

Green Bonds are standard, fixed-income financial instruments where the proceeds are exclusively utilized for financing climate change mitigation or adaptation related projects or programs.[9] The market for green bonds globally has grown rapidly in recent years with strong support from international financial institutions (and more recently corporate participation). Between 2007 and 2014, annual issuances grew from less than US$5 billion to US$37, with total cumulative assets now exceeding US$500 billion (Climate Bonds Initiative, 2014). Recent predictions are that the market will be two to three times as large in 2015 (World Bank, 2015).[10] Box 7

[9] Most authorities cite a World Bank issuance in response to request from Swedish banks in 2008 as the first such formal issuance (Coston et al., 2014). Currently, there is no standard international definition for what projects or programmes qualify for Green Bonds, although voluntary principles have been developed under the auspices of the International Capital Market Association (ICMA, 2015).

[10] China's financial policies are a key variable in projections of the growth in the green bond market, as the country combines substantial growth with a relatively attractive bond market for investors. The major barrier to growth has been restrictions on foreign investment in the China's bond market, but recent reports such restrictions may be changing (Hulac, 2015). In some developing countries green bonds have a captive market as pension funds and other long-term asset holders are required to invest primarily within the country, creating demand for even relatively smaller bond issuances (Latin Finance, 2014).

discusses the potential use of green bonds to finance renewable electricity development in India.

Box 7. Green bonds for renewable electricity in India

India's renewable electricity potential is estimated to exceed 3,000 GW. Currently, only a fraction of this amount — 32.8 GW, or a little over 1 percent — has been developed. The government has set an ambitious target of installing 165 GW of additional renewable capacity by 2022. It is currently looking into ways of facilitating the needed capital investment – estimated at USD 200 billion.

Currently, there are some major barriers to financing large renewable power projects in India. For one, they suffer from an asset-liability mismatch (financing tenures are typically 5-7 years without public support, while wind and solar projects may require a decade or longer for full cost recovery). Renewable power projects are generally only able to borrow with high interest rates, increasing their cost by 24-32 percent relative to similar projects financed in the U.S. or Europe. Finally, India imposes limits on commercial lending in the electricity sector, which results in competition to access capital vis-à-vis thermal power projects.

A recent US AID (2015) study presented green bonds as a potential option to overcome these financing barriers and accelerate investment in renewable energy in India. However, the instrument, itself, is not without challenges. These include high currency hedging costs, poor sovereign ratings (currently at BBB-), and low tenure. Currently, green bond tenures are mainly concentrated between 3-10 years, with only some issuances reaching or exceeding the ~15 years tenure that is generally required to finance many forestry and some renewable energy investments.

The US AID (2015) study proposed that green bonds be piloted initially through a smaller scale issuance ranging between USD 150-250 million: “Such an early participation could provide an opportunity to Indian entities to capture attention of investors (in a yet uncluttered Green Bonds market), potentially leveraged for future issuances, thereby enabling better terms (due to expected low risk perception by international investors) for prospective similar issuances.” To further support the market, the study proposed credit enhancement through donor agencies; low tenure bond issuance (for example 3-5 years) to reduce costs; issuance for high performing, low risk existing projects rather than those under development; and use of bullet payments at bond maturity as a low cost source of equity to expand installed capacity.

In recent years, yieldcos have also increased in popularity a financing vehicle for renewable energy assets. Yieldcos are publically-traded companies that own portfolios of established and operational renewable energy projects including utility scale solar PV, concentrated solar power, wind, hydro, biomass and co-generation plants. Yieldcos pay dividends to shareholders from revenue raised through electricity sales.

At least 15 yieldcos are in existence today in the United States, Canada, and Europe, the majority of which went public in the last three years. These have a market capitalization of over US$20 billion (Berger, 2014). Three yieldcos launched in 2014 – TerraForm Power, NextEra Energy Partners, and Abengoa Yield – held a combined 1.76 GW of solar PV and CSP assets at the time of their initial public offerings.

For developers, the sale of equity in existing low yielding assets is an affordable way to raise capital through financial markets for new projects with potentially high returns. For investors, yieldcos offer liquid investments with stable fixed returns generated through electricity sales that do not require the same level of due diligence

that would be required were they to invest in renewable energy assets directly. Essentially, yieldcos offer them a way to invest in low-risk established renewable power plants, without holding onto riskier renewable energy assets (Roselund, 2014).

As explained by Ahmad Chatila, the CEO of the parent company of Terraform Power, SunEdison, "while we forgo higher short-term gross margins, giving up about US$25 million in Q1 gross margins, we create higher long-term value of more than US$120 million in those same projects for SunEdison shareholders" (as cited in Roselund, 2014). Earlier this year, SunEdison announced that it will launch a second yieldco in mid-2015: TerraForm Power Global will aim to raise US$700 million for solar, wind, and hydro assets in emerging markets, including Brazil, China, India (Goossens, 2015), and Honduras (Beetz, 2015).

As with green bonds, governments and international institutions could help to support further development of yieldcos by providing technical capacity and risk guarantees, and governments can ensure reliable consistent regulatory environments and project terms (such as PPAs), to facilitate bundling. As discussed in Section 2.2.2, green banks and DFIs could be particularly effective in supporting the development of these financial products given they would have more tailored technical and financial expertise.

Regulatory and knowledge-based measures to channel finance away from climate risk and towards green assets

Beyond lost opportunities, the failure of institutional investors to green their portfolios creates financial risks. One strategy for promoting green investment is to increase awareness of the risks from inaction: "Only a few years ago, the failure to properly quantify and communicate the risks of a widely traded commodity—mortgage-backed securities—caused major damage to the US and ultimately the global economy. According to the IMF, total resulting losses now approach US$4 trillion. A significant share of the losses were incurred by pension funds and insurance companies typically viewed as among the more risk-averse and cautious segments of the investment community" (IFC, 2013, p. 61). Several NGOs are focused on identifying whether climate change presents similar system risks for investors with portfolios that contain carbon intensive and climate vulnerable businesses.

Mercer Associates, an investment advisory firm, recently analysed the financial risks of climate change based on scenarios of future warming and policy responses. The study found clear winners and losers among industry sectors, with the greatest losses in the coal industry and some of the biggest gains in renewable energy. Mercer Associates (2015) advised that investors engage with the companies in their portfolio, to ensure that they are managing and reporting climate risks appropriately; and with policymakers, to help shape regulations.

The insurance industry is centrally positioned as both a holder of climate risk and as a potential driver of risk management. For the most part the industry has been slow to recognize such risks, although there are signs of change (UNEP, 2014)

Evidence suggests that other types institutional investors also fail to adequately account for climate risks in their investment decisions. The Asset Owners Disclosure Project (AODP), an NGO, annually surveys large asset owners regarding their response to climate risks. Their latest survey of the top 500 such firms in 2015 found that "nearly a half of the funds surveyed (232) did absolutely nothing to protect investments under their stewardship from the threat of climate change" (AODP, 2015a).

In some countries, increasing awareness of the risk that climate change poses to financial markets, as well as the planet, has motivated regulatory measures to increase climate risk disclosure and management. In the U.S. the regulatory agency that oversees publicly traded stocks has issued guidelines that require companies to disclose the risks of climate change, and New York state has called for more diligent enforcement of the requirements (Steyer, 2015). The AOPD together with another NGO, ClientEarth, has started a legal project to challenge pension fund managers to fulfil their legal duties to protect investments from the financial risks posed by climate change (AODP, 2015b).[11] This is a potentially potent strategy given that some of the largest pension funds are publicly owned, and many private pension funds are regulated to some degree.

Recently, some have gone beyond calling for institutional investors to disclose and manage climate risks, and begun calling for targeted green investment strategies. For example, a rapidly growing student campaign in the U.S. and U.K. is calling for university endowments to divestment from fossil fuel companies (BBC, 2015). Pension funds in South Africa have been directed by regulation to include a broader set of environmental and social considerations in their investment decisions – in effect to consider externalities as well as traditional financial returns. This guidance was a substantial departure from industry practice, and a coalition of industry with some international support is currently working on means of implementation (IFC, 2013, p. 62). Measures that encourage or require institutional investors to avoid climate risk and give greater consideration to green investments would be a highly significant step towards unlocking capital for green infrastructure.

[11] The groups are looking for a test case and are not limited to any one jurisdiction.

3 From US$94.5 trillion to US$400 trillion: Non-infrastructure green investment

As discussed in the introduction, shifting investment to green infrastructure is only part of what is required to promote green growth. Much of the projected US$400 trillion that will be investment globally over the next decade and a half will also need to target non-infrastructure technologies and practices.

In fact many innovations from this broader array of goods and services can deliver the benefits of infrastructure without the need to finance and build large, complex physical assets. For example, distributed energy technologies can reduce the need for utility-scale generation, transmission and distribution lines, and energy efficiency technologies can reduce the need for increased energy generation generally.

Unlike infrastructure, which tends to be planned by governments, non-infrastructure green assets and practices will be diffused primarily through the choices of households and enterprises. Commuters will choose to cycle, bus, or drive electric vehicles over fossil fuelled ones. Manufacturers will choose resource efficient and recyclable inputs. Farmers will adopt agroforestry and no-till agricultural practices. And construction firms will begin using better insulation, natural ventilation and passive solar design, and more efficient heating, ventilation, and air conditioning (HVAC) systems.

The market-based manner in which non-infrastructure assets and practices are diffused does not imply that governments will not play a role – quite the contrary. Private investment in green technologies and businesses will not be forthcoming without the appropriate risk-adjusted returns, and governments will have a central role to play in managing the incentives for individuals and firms, driving innovation, and, in some circumstance, mandating or banning specific technologies or practices.

Section 3.1 will discuss the barriers to investment in green non-infrastructure assets and practices, and Section 3.2 will discuss the policy tools available to governments to overcome those barriers.

3.1 Understanding the barriers to non-infrastructure green investment

3.1.1 Economic barriers

Many of the economic barriers inhibiting the diffusion of green non-infrastructure assets and practices are the same as those faced by green infrastructure. In both cases, the non-priced damages of polluting activities place green assets at a competitive

disadvantage.[12] Consider a private landowner deciding on whether or not to log and develop their land. While the ecosystem services provided by the standing forest will be enjoyed on a wide-scale, without intervention, the costs of maintaining those services will fall solely on the landowner. Thus, from the perspective of the landowner, the net benefit from logging and developing a forest will outweigh the net benefit from preserving or reforesting it. In contrast, from society's point of view, preservation of natural capital stocks may be optimal.

However, given the highly distributed nature of decision-making, non-infrastructure green investments face a series of different challenges. Technologies that improve the energy efficiency of buildings are often inhibited by *split incentives*: although the investments may be quite profitable over the lifetime of the building, those who pay the costs (such as a landlord or building contactor) are not the ones reaping the benefits (the building buyer or tenant), and thus have the incentive to choose a cheaper carbon-intensive alternative.

3.1.2 Financing barriers

Smaller transactions

Financing is often more difficult to come by for small projects. "Transaction cost" problems arise where the deal size is too small for the efficient deployment of capital. Often it is the structure of the institution that makes the transaction cost high, rather than inherent limitation of deal structure. Paradoxically, multilateral development banks (MDBs) have trouble deploying numerous small loans, while Citigroup does not, because of its retail banking capacity. This is not because MDBs are cumbersome, but because MDB operations were established around certain financial products for certain clients (e.g. governments and, increasingly, private infrastructure investors) whereas retail banking operations were designed to provide consumer credit products.

Technological risk

As with infrastructure, many green non-infrastructure technologies are at an early stage of development. The risk inherent in investing in these new technologies presents an even greater financial barrier for non-infrastructure assets than for infrastructure, because the majority of capital will come from private sources, which, unlike governments, do not have the liberty to maintain budgets in the red.

The riskiest point to invest in a technology is the research and development (R&D) stage. Even beyond R&D, however, businesses encounter frequent difficulties in raising funds for the initial deployment of a new technology. This so-called pre-commercialization phase involves capital-intensive activities such as large-scale demonstration and repeated testing of commercial viability. At the same time the risk profile remains too high for many private investors.

Many of the financial tools necessary to overcome high risk have long been available in the financial sector, but have been slow to be applied to green businesses and technologies, or to the development finance context. Financial products for green investments are still limited to a few asset classes (primarily debt), and lending practices are based on models adapted to conventional technologies. As with infrastructure, if a bank has little practice in lending to, for example, a distributed

[12] Although the benefits of green investments will accrue widely (sometimes globally), and will outweigh the net costs, those deciding on whether to make low carbon investments will generally not realize the full net benefits. Instead they will typically be faced with high private costs, and low returns. The inverse is true for those deciding on whether to make polluting investments, which will have an overall negative impact on society, but will have more private benefits than costs.

energy project, the cost of evaluating the economic viability of the project tends to be high. As a result, many potentially viable technologies and business models fail to commercialize for lack of funds, causing the pre-commercialization phase to be termed 'the valley of death.'

3.1.3 Additional barriers in developing countries

On top of the economic and financing barriers inhibiting investment in green non-infrastructure technologies and practices, a series of additional barriers exist in developing countries. The lack of technical knowledge about green options and how to implement them is perhaps an even greater barrier to non-infrastructure technologies and practices than it is to infrastructure, due to the distributed nature of decision-making – simply put, more people need to have the knowledge. For example, a number of agricultural techniques, including no-till systems and agroforestry, have been shown to reduce GHG emissions while increasing productivity; however knowledge about these practices is sparse. Retail banking and agricultural credit is often non-existent in rural areas, further inhibiting the development of green industries.

In developing countries, the higher upfront costs of green technologies are even more inhibiting for non-infrastructure options than for infrastructure, because much of the investment in these technologies will need to come from low-income consumers. Low-income households and firms often lack the purchasing power necessary to pay the upfront costs of green products such as energy efficient buildings and cars, solar home systems and biogas digesters, even if these would save money in the long run. This issue is compounded by a lack of consumer finance in developing countries, which prevents consumers from spreading out upfront costs over time.

3.2 Overcoming the barriers to non-infrastructure green investment

Part of the challenge in shifting investment to green non-infrastructure assets and practices revolves around infrastructure choices – people are much more likely to cycle to work, rather than drive, if bike lanes are available. However, many of the tools needed to shape non-infrastructure investment decisions exist in other policy domains. Given that the choices about capital allocation in non-infrastructure assets are highly distributed, the financing and policy tools available to shift these choices towards green options are different from those available to influence infrastructure decisions.

3.2.1 Getting the price right

The first step in shifting investment to green assets and practices is to align the costs and benefits of private actions with the impact that those actions have on society. Many government policies distort economic incentives in the wrong direction. For example, Bast, Makhijani, Pickard, & Whitley (2014) revealed that global subsidies for the production and use of fossil fuels amounted to US$775 billion in 2012.[13] Subsidies for renewable energy, in contrast, totalled just US$101 billion in 2013. Fossil fuel subsides have numerous knock-on effects on the viability of green investments. For example, they reduce any cost savings that would be derived from energy efficiency improvements (Gray & Tatrallyay, 2012).

Beyond reducing *bad* subsidies, governments can use two broad approaches to align private and social costs and benefits. First, they can penalize environmentally damaging behaviour through environmental taxes or regulatory restrictions (building

[13] This figure does not include the un-monetised costs associated with air pollution and GHG emissions.

codes, emissions caps, protected areas, etc.). For example, the textbook solution to reducing GHG emissions is a carbon tax equal to the SCC (discussed in Box 8). Recently a group of six European-based oil and gas companies endorsed the need for a carbon price to incentive efforts to reduce carbon emissions (Geman, 2015). Second, they can reward green behaviour through public provision (for example, of public bus rapid transit), subsidies (including payments-for-ecosystem-services), and mandated use (such as mandatory biofuels blends). Box 8 provides a useful illustration of how Costa Rica has used payments-for-ecosystem-services to subsidise green behaviour. Importantly, pricing tools will not be sufficient to induce sufficient private investment in green assets and practices due to misaligned incentives and signals and inadequate flows of information. Further regulatory and information-based policies will be required (Fay et al., 2015). Some of these are discussed in the remaining sections.

Box 8. Costa Rica's *Pago por Servicios Ambientales*

Begun in 1978 as a tax incentive for reforestation in efforts to maintain the lumber stock, Costa Rica's direct payment scheme has evolved to direct subsidies in efforts to maintain carbon sequestration, biodiversity, watershed services and scenic beauty. In the last decade, Costa Rica invested USD 200 million in contracts to subsidise 8000 landowners 25 percent of their land-value annually. The scheme protects 8 percent of the country's landmass, which is on top of a further 12 percent protected by national parks. The scheme is financed 50 percent by a 3.5 percent carbon tax on fuels (unique within in the developing world), and 50 percent by World Bank loans, Global Environmental Facility grants, and a carbon-purchase by the Norwegian government. To date, Costa Rica is the only developing country to turn around forest loss (Umaña, 2009) – a feat, which experts partially attribute to its direct payments scheme, and partially to a thriving ecotourism industry and substantial protected areas.

3.2.2 Making energy efficiency pay

Technologies and practices that improve energy efficiency can frequently cost-effective due to potential energy savings. However, energy saving technologies and practices face specific barriers that inhibit their diffusion. One of the main risks in all energy efficiency projects is that the project may not deliver the energy savings expected at the outset. As discussed earlier in Section 2.2.2, the new Global Innovation Lab for Climate Finance aims to address this barrier through an Energy Savings Insurance facility to insure the value of savings generated by energy efficiency investments (Rom-Povolo, 2015).

There are also problems with the economic incentives surrounding resource efficiency. In particular, energy utilities that sell electricity and gas are uniquely positioned to promote energy efficiency measures, in that they possess universal knowledge of their clients' energy use through billing relationships and can generally secure low-cost financing. However, with utilities' revenues tied to the amount that they sell, efficiency is often viewed not as an opportunity, but as a threat to their financial success (Lovins, 2011). In order to green energy markets, it will be necessary to alter the price signals facing utilities by *decoupling* their earnings from total energy sold.

Governments can achieve decoupling through two measures. First, they can periodically adjust electricity and gas prices so that the utility's revenues are consistent with what is authorised. Second, they can reward utilities for cutting clients' bills by allowing them to adjust prices so that they can share in energy

savings that they make possible. Essentially, such reforms reward utilities for buying *negawatts* (saved watts) instead of building costlier new generation (Lovins, 2011). California's decoupling laws are credited with making it the most energy efficient state. Regulators allow utilities to share up 12% of gains made through energy savings, and penalise utilities that fail to achieve at least 65% of their efficiency targets. Twenty-seven US states are now implementing decoupling laws for gas and electricity (Stahl, 2012).

Energy Service Companies (ESCOs) offer another model whereby the negawatts can be capitalised in order to drive energy efficiency improvements in households and firms. ESCOs provide capital and technical support to households and firms to implement energy saving measures and, in return, assume a portion of the earnings from future energy savings. Box 9 discusses South Korea's ESCOs industry. As observed in the South Korean example, ESCOs themselves are dependent on improved flows of information and external financing to cover the high upfront costs of energy efficiency technologies.

Box 9. Korea Energy Management Corporation (KEMCO)

South Korea's economy is highly energy intensive, and the cost of energy imports represents a significant bane for the economy. A 2006 report revealed that South Korea ranked first among all OECD member states in terms of energy consumed per unit of GDP.[14] Around the same time, the Korea Energy Management Corporation (KEMCO) – the agency responsible for promulgating efficient energy consumption – reported that the industrial sector could save an estimated US$130 million per year through energy savings measures that would cost of US$242 million. In other words, the measures would pay for themselves in under two years (Hansen et al., 2009).

The government had already taken a number of steps to reduce the country's dependence on energy imports through energy efficiency measures. It had created the legal basis for ESCOs in 1991. However, fewer than 10 were created by 1997, at which point the government began to take more aggressive action. It established a Pre-notification System of Energy Prices to make consumers more responsive to the high costs of energy. It began awarding a 3-10% tax deduction on income or corporate taxes to ESCOs, households, and enterprises that replaced old industrial kilns, installed alternative fuel facilities, or implemented energy-saving technologies (Hansen et al., 2009; Morgado, 2014). Finally, it mandated that firms and commercial and residential buildings undergo energy audits carried out by KEMCO[15] (Morgado, 2014). Depending on the results, KEMCO provided technical assistance and recommendations for energy efficiency improvements (Hansen et al., 2009).

In 2006, the government established the US$655 million Rational Energy Utilization Fund. From this fund, KEMCO either provides loans directly, or provides loan guarantees for enterprises and ESCOs for the installation of energy efficiency technology, renewable energy, and cogeneration facilities, and for the production of energy-efficient products. The loans can cover the full amount of the implementation costs and come with highly favourable terms: a low interest rate of 2.25-3.5%, about half of prime rate, and a three to five-year grace period followed by a five-year repayment period (Hansen et al., 2009; Kim Yeon Su, 2007).

[14] South Korea consumed 0.23 tonnes-of-oil-equivalent per US$1000 of GDP. The OECD average was 0.19 (Hansen, Langlois, & Bertoldi, 2009).

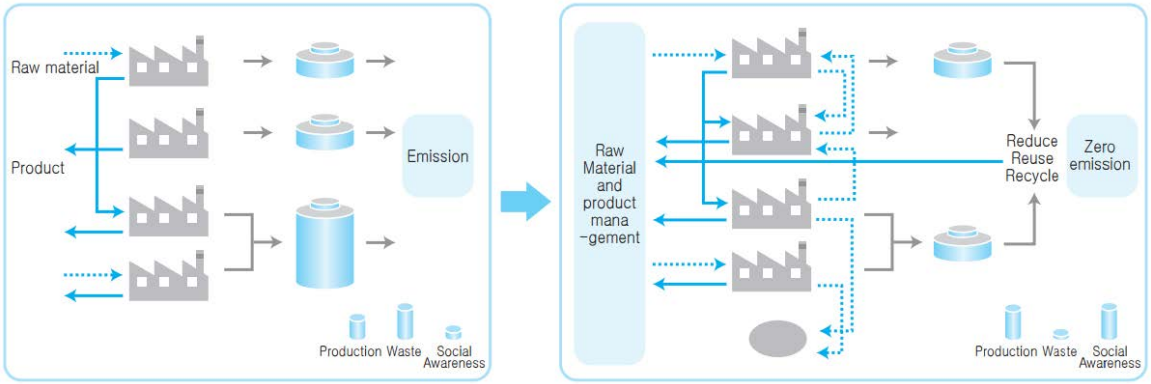
[15] Property owners with energy consumption larger than 2000 tonnes-of-oil-equivalent (TOE) are required to submit an energy audit report to KEMCO before obtaining a building permit. Smaller firms and buildings receive a waiver or discount on the audit fees (Morgado, 2014).

By 2012, the number of ESCOs in South Korea had grown to over 230, and approximately US$502 million in funding from KEMCO and banks was provided for energy efficiency measures. These measures are estimated to have saved approximately 550 kilo tonnes of oil equivalent, or 5.7 TWh. At US$90.91 per MWh, the cost of the energy saved is cheaper than the cost of electricity in the country, which in 2013 was sold at the fixed price of US$98.9 per MWh for manufacturers and 146.2 per MWh for households (Kim Da-ye, 2013; Morgado, 2014).

3.2.3 Eco industrial parks

An increasingly common means by which governments shape the behaviour of private firms is the creation of industrial parks with environmental objectives – known as eco industrial parks. The co-location of firms in eco-industrial parks allows them to be serviced more cost-effectively through renewable electricity, mass transit systems, and wastewater treatment facilities (Park, n.d). Additionally, as illustrated in Figure 6, green industrial parks aim to link businesses with complementary materials and process requirements, such that the by-products and waste discharged from one firm becomes an input for another (Huber, 2012, p. 3). Materials recycling and recovery systems are formed among resident firms. In this manner, eco-industrial parks improve resource efficiency and minimize pollution (Cho, 2012). Successful eco industrial parks exist in numerous countries, but notably Denmark, the Netherlands, South Korea, and China.

Figure 6: The concept of eco-industrial parks: A conventional industrial park (left) and an eco-industrial park (right)



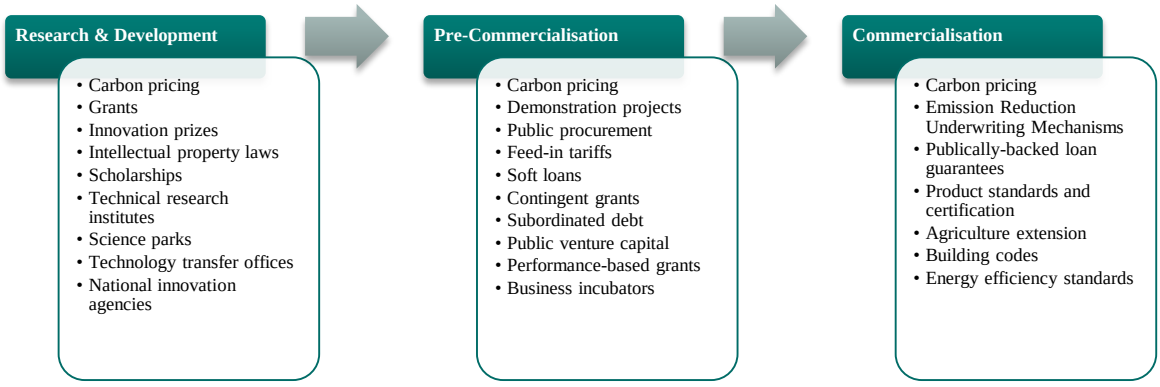
Source: (Cho, 2012)

3.2.4 Orienting finance towards higher risk investments

Once market prices reflect social costs and gains, steps will still need to be taken to orient public and private finance towards higher risk green investments. As discussed earlier, investment risk varies across different phases the development of a technology or business. Figure 7 shows how government policy needs to target each of these phases to unlock investment throughout the innovation chain. Public financing mechanisms (PFMs) – such as performance-based grants, demonstration projects, public venture capital, loan guarantees, and public procurement mechanisms – can address several of the investment hurdles discussed earlier. Just as green banks are effective at delivering PFMs to blend public and private investment in infrastructure (discussed in Section 2.2.2), they could be highly effective at securing blended finance for green non-infrastructure assets and

practices. Green banks could be designed with the operational structure and human resources capacity to deliver financing instruments that are better suited to non-infrastructure sectors, and at scale. Generally speaking, the higher the risk of the activity, the more capital intensive the public support must be. Regulatory and information-based instruments become more appropriate for attracting private capital in the commercialization phase, where green technologies are already cost-competitive with their environmentally damaging alternatives.

Figure 7: Public support for different stages of development and risk-profiles



Source: (based on Hogarth, 2012)

Catalysing Research and Development

A system to support R&D of new technologies and innovative business models is necessary to supply a constant pipeline of investable projects. However, given that the risk profile of technologies at the R&D phase is too high for traditional investors, funding is generally dependent on public support. Indeed, many of the strongest examples of growth-driving innovation – from IT to biotech – required significant public investment in innovation at the outset (Mazzucato, 2011). Publically-funded technical research institutes could be instrumental in fostering novel green technologies and business models. Public financial support could also promote private experimentation with new green technologies and practices. PFMs effective at this stage are grants and contingent grants, the latter of which are loaned to project developers without interest or repayment until business is viable.

Innovation prizes offer a further tool to direct private R&D towards groundbreaking discoveries (see Box 10). Payments are made to project developers only after they achieve a pre-determined goal. Green innovation competitions could be established for commercially viable technological innovations in carbon capture and storage, large-scale energy storage, tidal and wave electricity generation, nuclear fusion, solar aircrafts, etc. Innovation prizes are only awarded when an inventor is successful, and because the prize money is less than the amount the government would need to spend to develop the same technology, innovation prizes are largely risk free and highly cost-effective. Innovation prizes leverage not only the private investment and technical expertise of the winners of the competition, but also of numerous other participants. Private investors are frequently keen to support the viable innovations that come forth. Despite the benefits, innovation prizes do not provide predictability in funding and cannot replace other PFMs. However, they are a useful supplement that could spur private initiatives and produce unexpected gains.

Box 10. The X Prize Foundation

The X Prize Foundation is a non-profit organisation that awards monetary prizes (worth millions of US dollars) to inventors of pre-determined technological innovations. The foundation was inspired by the 1919 innovation competition that awarded US$25 thousand to the first to achieve a nonstop flight between New York and Paris. X Prizes have been awarded to inventors of a private reusable spacecraft, a precise rocket system, a technology for oil spill clean-up, and automobiles that get 100 miles to the gallon equivalent.[16,17] Current competitions offer awards for research that leads to a private moon landing, artificial intelligence, mobile health diagnostic tools, educational apps for self-learning among children aged 2-5, and groundbreaking research on ocean acidification. In the words of Peter Diamandis, CEO of the X Prize Foundation, the benefits of innovation competitions is that they can "change what people believe to be possible."

Bridging the Valley of Death

Risk capital targeted at the phase between R&D and commercialization is particularly important for nascent small and medium enterprises. The main type of private investment at the pre-commercialization phase is venture capital. Bank loans for new green technologies will often come with stringent terms, such as high down payment, high interest rates, and a long approval process. Venture capitalists specialise in high-risk equity investments in companies and projects that offer potentially high returns, but that other investors deem too risky. Although a well-developed risk capital market can be instrumental in driving the uptake of new technologies, such markets are often absent in developing countries.

Crowdfunding offers a fast growing alternative to traditional venture capital – one that is not as constrained by geography (infoDev, 2013). Globally, over 700 online crowdfunding platforms enable people to invest almost any amount in a project or business: "The global crowdfunding market is expected to exceed US$90 billion by 2025, which would be almost twice the size of the global venture capital industry today, and almost 20 times the size of the global crowdfunding market in 2013" (Carbon Trust, 2015). Although green technologies and firms represent only a small share of crowd-funded projects, a number of firms have successfully raised funds for modest-sized wind and solar power projects (Frankfurt School-UNEP Centre/BNEF, 2015).

Frequently, firms aiming to commercialize new technology will require public support to bridge the valley of death. Public financial support for demonstration projects can help firms build a track record for new products so that they can more easily access private risk capital. Public procurement schemes, such as government programmes to purchase solar panels for rural schools and hospitals, can further build a product's track record and can create a niche market for technologies that are not yet commercially viable while market infrastructure and distribution outlets are established. PFMs such as loan guarantees, subordinated debt,[18] and public venture capital can buy down the risk for private investors, and secure blended finance at the pre-commercialization stage. Government support can also go a long way in

[16] Miles per gallon gasoline equivalent is a unit of measure of the average distance travelled per unit of energy consumed. It is used to compare across fuels.
[17] 100 miles to the gallon = 100 km to 2.35 litres
[18] Subordinated debt is repaid and claims profits only after other investors have first claim on rewards.

overcoming perceived risk by showing that it is willing to get its own 'skin in the game.'

Non-financial support may also be critical at the pre-commercialisation phase. Even with public financial support, technical experts and aspiring entrepreneurs often lack the business knowhow to attract investors and bring good ideas to the market. Public investment in on-the-job technical training, mentoring or business incubators can provide the combination of business and technical skill sets required.

When providing public finance for higher risk technologies and companies, it must be accepted that a not all investments will succeed. Some companies will go bankrupt, and some technologies will fail to commercialize. Failed investments are likely to create political backlash due to the perception of wasted tax dollars. Nonetheless, it is important that public financing schemes be evaluated based on the performance of the entire portfolio rather than individual investments. As illustrated Box 11 on the American Recovery Act, public financing programmes can be instrumental in fostering new green industries. Provided that transparent procedures to evaluate applications and monitor investments are in place, they can even turn a profit. The example of the American Recovery Act illustrates the value and perils of a high-risk high return approach to financing innovation. Although the programme was a strong success by all financial measures, it also came under fire for the failure of one of its investments taken in isolation, showing that even when effective, there are political challenges to conveying the public policy benefits of this approach.

Box 11. The American Recovery Act's Clean Energy Package

The American Recovery and Reinvestment Act was launched in 2009 in the midst of the worst recession the country had seen since 1930. It injected US$787 billion in fiscal stimulus into the American economy, equivalent to 5.5% of the GDP. The massive investment aimed, first and foremost, to save and create jobs and prevent further economic deterioration. However, a secondary aim of the Recovery Act was promote the deployment of low-carbon energy technologies. In total, US$90 billion in public spending and tax exemptions were provided to clean energy technologies[19] (Aldy, 2013).

The Department of Energy (DOE) was allocated over US$35 billion; more than triple its 2009 appropriation for civilian energy activities. Given that the primary purpose of the Act was economic stimulus, it was necessary for the funds to be spent quickly. The DOE was required to expand its traditional focus on science, applied research, and demonstration to include the scaling up of commercial technology deployment (Aldy, 2013).

As a stimulus package, the performance of the clean energy portfolio of the Recovery Act was mixed. The stimulus funds supporting clean energy and energy efficiency technology created an estimated 169 thousand direct jobs (C2ES, 2013). However, the same spending was projected to create over 700 thousand jobs (Aldy, 2013). As a clean energy investment portfolio, however, the Recovery Act was an undeniable success. The US$46 billion invested clean energy leveraged more than US$200 billion in private sector and non-federal government spending on clean energy, more than 37% of the co-investment secured by the Recovery Act as a whole (Council of Economic Advisors, 2010b). Rebate programs helped to diffuse over one million ENERGY STAR-labelled energy efficiency appliances in a very short period (C2ES, 2013). Through tax

[19] US$25 billion for renewable power generation, US$20 billion for energy efficiency, US$24 billion for low-carbon transportation technologies, US$10 billion for electricity grid modernization, and the rest for carbon capture and storage technologies and clean energy manufacturing (Aldy, 2013).

credits, grants, and loan guarantees the Recovery Act caused investment in wind power in 2009-10 to be triple the amount projected in the Energy Information Administration's (EIA, 2009) business-as-usual scenario. Between 2008 and 2009, wind generating capacity increased 60%, and solar photovoltaic capacity grew almost 300% (Aldy, 2013; Solar Energy Industries Association, 2011).

Despite this success, it was the DOE's investment in renewable energy the generated some of the most high profile most controversy around the Recovery Act. Most notably, when a solar company, Solyndra, defaulted on a US$535 million loan guarantee in 2011, it was portrayed in the media as a national scandal. However, as a whole, the DOE loan programme that invested in Solyndra has a default rate of less than 2.28%, a level that any financial institution would deem a success. When the interest collected on the programme's loans is factored in, the programme is operating in the black[20] – this despite the fact that in the programme's inception, Congress did not anticipated that it would generate an income, and even set aside US$10 billion to cover its losses (Brady, 2014).

The loan guarantees provided under the stimulus package ended in September 2011. However, by helping commercial providers and private investors gain experience with utility-scale solar plants, the initial investments provided by the DOE laid the foundation for a rapidly growing industry that is now entirely commercially financed: "In total, over 8,100 MW of utility-scale PV solar have been installed in the United States through the first three quarters of 2014. This is 57 times more installed utility-scale PV solar than the EIA had projected just seven years prior" (DOE, 2015, p. 4).

Scaling-up cost-effective green technologies and practices

At the commercialisation phase, private investment in green technologies and businesses will generally be more forthcoming than in previous phases. Nonetheless, as discussed, undeveloped financial markets may continue to hinder diffusion in developing countries.

Information-based instruments, such as green investment indices, could help to attract green foreign investment in areas where investors are hesistant due to a lack of on-the-ground knowledge. Green investment indicies highlight companies' environmental performance as well as their financial performance. The S&P and FTSE have launched green indices in cooperation with the World Bank and the European Investment Bank respectively. Governments and international financial institutions could play an important role in promoting sound green indices, by supporting the development of methodologies to assess companies' environmental impact and facilitating data acquisition.

To unlock market diffusion of green technologies and practices, governments will also frequently need to address the risks facing green entrepreneurs. For example, government policies such as minimum biofuels blends and feed-in tariffs can reduce risk for entrepreneurs by providing a guaranteed niche market for green products while they build skills, supply chains, and track record of success. Performance-based funding, such as grants-per-unit-sold have proven highly effective in kick-starting off-grid solar industries in developing countries (Miller, 2009). Tax breaks and grants-per-unit-sold could be provided to companies for each invoiced sale of

[20] Since the DOE lending programme was founded in 2005, it has provided a total of US$34.2 billion in loans. US$780 million in loans have defaulted, resulting in a loss rate of 2.28%. The DOE has collected US$810 million in interest, meaning that the portfolio is US$30 million in the black.

fuel-efficient automobiles, solar water heaters, efficient cookstoves, and biogas digesters.

International financial institutions can provide technical and financial support for such programmes. For example, the Ugandan global energy transfer feed-in tariff (GET FiT) was launched in May 2013 to allow international institutions to supplement the electricity prices offered to small-scale independent power producers that sell renewable electricity to the national grid. Power producers using solar, hydro, biomass, and bagasse and producing 1-20 MW are eligible. Though still in its infancy, the governments of Norway, Germany, United Kingdom, and European Union have offered financial support to the programme, while the World Bank has provided a partial risk guarantee facility (GET FiT Uganda, 2014).

A further barrier to the diffusion of many cost-effective green technologies in developing countries is the purchasing power of consumers. Financial institutions often perceive small investors as risky and are reluctant to extend the necessary loans at an affordable rate. Loan guarantee schemes can be effective in encouraging microfinance institutions, savings and credit cooperatives (SACCOs), and banks to extend consumer loans.

While financing is necessary to scale-up of commercially viable technologies, the lack of finance is often not the main barrier that governments need to address. Closing the knowledge gap will also be critical step in promoting transitions to greener economies. Governments can help train workforces to use green methods and manufacture of green products. For example, it can fund universities and technical institutes to develop training programmes that award certifications and accreditations in energy efficiency. Voluntary labels and standards, like ENERGY STAR, can be developed to provide consumers with information on cost-saving green products. As the European Union did in 2006, governments could mandate the disclosure of buildings' energy use, enabling investors and tenants to make more rational choices (Lovins, 2011).

Finally, the fact that non-infrastructure assets require smaller investments than infrastructure does not mean that they cannot deliver services at the same scale. To illustrate, Box 12 explains how Bangladesh's Infrastructure Development Company Limited (IDCOL) program has helped deliver off-grid solar home systems to millions of energy poor households across the country in a short period of time. With the appropriate price signals and policy frameworks, market forces can generally deploy cost-effective products and services at scale much more quickly than infrastructure can be planned, approved, and built.

Box 12. Bangladesh's Infrastructure Development Company Limited

The Bangladeshi Infrastructure Development Company Limited (IDCOL) delivers financing to partner organisations that install rooftop solar installations in order to assist Bangladesh in reaching universal electricity access by 2021. Since its inception in 2003, Bangladesh's Infrastructure Development Company Limited (IDCOL) has promoted the diffusion of around 3 million off-grid solar home systems (SHSs): "As a result, 13 million beneficiaries are getting solar electricity which is around 9% of the total population of Bangladesh" (IDCOL, 2014). In 2014, over 65 thousand SHSs were being installed under the program each month, making it one of the fastest growing renewable energy programmes in the world.

IDCOL is owned and funded by the state and managed by the private sector. It provides low-cost financing and technical capacity-building to 47 partner organizations, ranging from NGOs through the private sector to multilateral financial institutions. In turn, these organizations install and extend or secure consumer finance for customers, and provide after sales service. IDCOL aims to have promoted the diffusion of 6 million SHSs by 2017 (IDCOL, 2014).

4 A summary of the implications for governments and international financial structures

For the world to meet the twin challenges of improving human welfare whilst preventing catastrophic climate change and environmental degradation, it will need to develop a model of green economic growth. At the heart of this challenge, are investments in infrastructure. Infrastructure itself is resource and pollution intensive. Furthermore, it shapes the intensity of other economic activities. Once constructed, infrastructure development is difficult to reverse, meaning that it locks-in specific development pathways. The infrastructure choices that the world makes over the next 15 years will largely determine whether we are able to limit global warming to less than 2˚C.

The barriers to greening infrastructure "nest" within barriers to infrastructure development more generally. Despite the importance of infrastructure to growth, political opposition to big government spending has driven a major shortfall in infrastructure investment globally. The governments of least developed countries are additionally hampered by insufficient tax bases and poor credit ratings. It is within this context of constrained government budgets, that the challenge of greening infrastructure must be considered.

Beyond infrastructure, greening growth will also require shifting investment in other parts of the economy. In some cases, non-infrastructure green technologies can actually replace those services traditionally provided by infrastructure. In other cases, non-infrastructure technologies and practices shape sustainability outcomes in ways that are not directly related to infrastructure. Unlike infrastructure, which is largely planned by governments, non-infrastructure technologies and practices are generally diffused through markets. Hence, decisions about their implementation are highly distributed among households and firms. Governments still have an important role to play in shifting private decisions towards green options, but the financing and policy tools at its disposal are different. This will require scaling up financial products, and institutions capable of delivering them, for much smaller and distributed transactions.

This discussion paper aimed to explore the barriers to green infrastructure and non-infrastructure investment, and the policy levers available to overcome those barriers. What follows are a series of conclusions.

4.1.1 Governments must adopt a long-term vision for infrastructure planning and commitment to developing a pipeline of investable green infrastructure projects

The core barrier to infrastructure spending is that it has broad, diffuse public benefits that are not easily captured by a private market in the form of a price (i.e. it has positive externalities). For this reason, the public sector, through its ability to identify and evaluate public benefits, mobilize public revenue, and set policy, is almost always fundamental to the planning and oversight required for infrastructure projects, whether publicly designed and financed, blended finance, or the product of a public private partnership.

It is vital that governments adopt a long-term perspective when planning infrastructure development. As mentioned, infrastructure development can lock in specific development pathways. On the one hand, large-scale construction of highly polluting power plants and sprawling cities will almost certainly send the planet beyond that target. On the other, green infrastructure choices – compact cities well connected by public transit and served by renewable electricity – will lock-in efficiency gains for decades.

It is necessary for governments – with their overarching perspective on the national development – guide infrastructure development towards desired outcomes. A useful tool to facilitate infrastructure planning is a shadow price on environmental damages. For example, a shadow price on the social cost of carbon could shift government cost benefit analyses in favour of green infrastructure choices over polluting ones.

Green infrastructure frequently has higher costs upfront, but lower costs over its lifetime, because frontloads technical and design inputs to offset future inputs, such as fuel. If budget-constrained governments focus too much on the upfront costs, they may forgo the future savings that green infrastructure provides.

The public sector must also take the lead in planning and financing. Although the private sector plays an increasingly important role in financing and delivering infrastructure, discussed later, private capital has always and will continue to fall short of meeting infrastructure needs. The public sector must have a high level of commitment to financing its institutions, planning, and projects, and in leveraging private finance through tools like blended financing and PPPs.

Crowding in private investment will require public funds to be delivered through financing mechanisms (PFMs) that are more complex than those used in traditional budgetary channels. Green banks and dedicated green funds in multilateral development banks could be more effective institutional relationships in leveraging private investment for green infrastructure and non-infrastructure assets.

PPPs provide an opportunity to overcome short-term fiscal bottlenecks, and harness private sector expertise. PPPs do provide another tool for public procurement of crucial services, and an alternative means of financing them. However, PPPs do not replace the need for government investment and planning. In fact, PPPs rely on good public planning and capacity to get the most out of private partners.

Likewise, the private sector can bring innovation to service delivery. Nonetheless, to develop a pipeline of investable green infrastructure projects there are also circumstances where the public sector is best placed to demonstrate the feasibility of new forms of infrastructure so as to encourage the entrance of private actors.

Singapore provides an example of a forward-looking and integrated approach to transportation and urban land-use planning. The country planned a system of high-

density satellite towns with strong transport links to the central city, preventing urban sprawl and minimizing private car ownership, and leveraged PPPs to deliver it.

4.1.2 Lack of green private investment is often indicative of weak institutions, poorly enforced regulatory standards, misaligned incentives, other institutional problems, like or rather than lack of availability of capital

Where private investment is lacking, it is frequently a sign of other structural barriers, rather than a lack of funds. Poor regulatory environments and weak institutions can create a confluence of investment risks that prevent capital deployment even where the demand for assets or services is substantial. Only in some developing country contexts is there an actual scarcity of capital, and even then, businesses and projects can frequently attract foreign direct investment if these offer adequate returns on investment and institutions and the policy environment are strengthened. The Moroccan Agency for Solar Energy (MASEN) provides an example of where a commitment to strong institutional capacity, and a package of incentives, can draw in private capital.

The main barrier facing green infrastructure and non-infrastructure options, alike, is that market prices do not reflect the social and economic costs of polluting alternatives. Rather than addressing this problem, public policy often exacerbates it. This issue is illustrated most plainly by the fact that globally, government subsidised fossil fuels to the tune of US$775 billion in 2012, seven times the subsidies provided to renewable energy.

A restructuring of incentives will also be necessary to unlock investment in energy efficiency measures. As it stands, most utilities are paid according to how much electricity, water, and gas that they sell, not how much they save. Government policies that ‘make negawatts pay’ can unleash investment in energy saving measures, both by utilities and by private ESCOs.

Ultimately, it will be essential to strengthen institutional frameworks to reduce policy risks and promote sustained green growth in developing countries. Institutional reform will often require long-term technical support for governments. In the near term, simultaneous to such transformation reform, DFIs and green banks can help overcome barriers associated with weak institutions, unstable policy environments, and currency exchange rates, to buy down private investors’ risks through loan guarantees, insurance products, and blended financing mechanisms.

Reducing distorting subsidies, taking measures to align social and private costs and benefits, and reducing risks will be a first step in shifting private investment towards green infrastructure and non-infrastructure businesses and technologies.

4.1.3 Regulation and information-based tools are often as important, or more important, than public investment.

A second barrier common to both infrastructure and non-infrastructure is the lack of knowledge and technical capacity surrounding green options. This barrier is common to both developed and developing countries, but is most pronounced in the latter. In order to shift private investment to any green technology, steps will need to be taken to train financial institutions, workforces, and consumers about green technologies and practices.

To this end, regulatory and information-based tools are often more effective than fiscal levers. Green investment indices can help investors to assess risk in unfamiliar green technologies. Public training programmes, agricultural extension services and building codes can help train the workforces that will build green infrastructure and produce green products. Green labels like ENERGY STAR can inform consumers about the cost-saving green products. In developing countries, consumer education

and quality assurance programs, such as those implemented by the Lighting Africa programme, can also be even more important than financing.

4.1.4 To mobilise sufficient private investment in infrastructure, new financial products will be required that are attractive to new sources of private capital, such as institutional investors

Institutional investors, with around US$80 trillion of assets under management, represent largest source of potential investment for green infrastructure. Currently, only a small share of institutional investor's portfolios are invested in infrastructure. A smaller share is invested in green infrastructure, and a smaller share still is invested in green infrastructure in developing countries. This is a missed opportunity.

Green infrastructure investments are particularly well suited to institutional investors' needs. These investors are capable of deploying the large amounts of capital demanded by infrastructure projects upfront, and they seek the low-risk returns that infrastructure projects can provide. Furthermore, as many institutions are publicly controlled and have long time horizons, their interest in decarbonising the economy is greater than other types of investors that tend to seek short-term returns. However, institutional investors demand liquidity in their investment portfolios, which is difficult to achieve in infrastructure.

Two new financial products – green bonds and yieldcos – promise to unlock institutional investor capital by enabling greater liquidity in infrastructure investments. International financial institutions can enhance the effectiveness of these products by providing guarantees to reduce the risk to investors.

4.1.5 Scaling up green investment in non-infrastructure assets will require public and private finance to shift to high-risk/high-reward markets and financing structures.

Green technologies and practices are generally a product of innovation, causing them to be beset with risk – both real and perceived. It is frequently this risk that deters private investors. To shift private investment towards higher risk investments, will require targeted public finance and policy at different stages along the innovation change. Government support for R&D will be essential to sow the seeds of green technologies of the future. However, government will also be needed to help nascent green technologies and businesses bridge the 'valley of death' by helping bring risky technologies and sectors to commercial viability. Kenya's geothermal industry provides an example of where the government stepped in to provide early investment and demonstrate the viability of the sector, paving the path for private investment.

Finally, during the commercialisation phase, government financial support can generally be eased, but other interventions may still be required. Policies that provide niche markets for new green technologies can provide security for entrepreneurs while they establish supply chains and a track record of success. In developing countries, policies to unlock consumer finance can enable rapid diffusion of cost-effective green products that are held back only by the purchasing power of consumers.

As demonstrated by the numerous examples throughout this paper, governments and international financial institutions can be highly effective in shifting investment towards green technologies and firms. It is vital that these institutions learn how to scale up successful models now, as the window to shift development paths towards green trajectories is rapidly closing.

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Appendix

Table A1: Examples of Public Financing Mechanisms

Public Financing Mechanism	Description	Financial Barrier Addressed
Grants	Grants are provided without any repayment	(i) Lack of sufficient capital; (ii) costly development process
Contingent grants	Grants are loaned without interest or repayment until business is viable	(i) Lack of capital for upfront costs
Innovation prizes	Ex-Ante prizes to stimulate R&D	(i) High and risky development costs
Performance-based grants	Grants are awarded based on stipulated achievement (e.g. grants-per-unit-sold or grant-per-unit financed)	(i) Insufficient incentives for low carbon or adaptation activity
Soft loans	Provides debt capital at concessional interest rates	(i) Financing gap during project development stage
Loan guarantees	Government buys down risk to unlock debt financing	(i) High credit risks, particularly perceived risks; (ii) lack of consumers with enough purchasing power for products
Demonstration projects	Governments, often in partnership with a private company or NGO, will finance initial demonstration of a new product in order to demonstrate its viability	(i) Lack of track-record and knowledge of viable technology prevents marketability and access to capital
Public procurement	Government purchases products to provide a guaranteed market for entrepreneurs and demonstrate viability of product	(i) Lack of track-record and knowledge of viable technology prevents marketability and access to capital. Does not address consumer' lack of purchasing power
Subordinated debt	Subordinated debt is repaid and claims profits only after other equity investors have first claim on rewards.	(i) Aims to attract other equity investors
Public venture capital	Equity Investment in nascent business	(i) Lack of private risk capital
Feed-in Tariffs	Government guarantees long-term procurement of privately produced electricity fed onto the grid at a fixed-rate	(i) Natural monopoly of electricity grid prevents private production

Source: Based on (Gomez-Echeverri, 2010)

Table A2: Examples of public financing approaches to attract private capital for climate mitigation

Category of Instrument **Sector**	*Increasing Returns*	*Reducing Risks*	*Transformational*
Large-scale clean energy	**1. Bankable Power Purchase-Like Agreement for Energy Efficiency** **2. Subsidised Renewable Feed-in Tariff**	**3. Mezzanine Debt Enhancement** **4. Clean Energy Loan Guarantee** **5. Mono-Line Insurance Mechanism for First Loss**	
Bio-carbon	**6. Advanced Market Commitment (AMC) for REDD+**	**7. Political risk insurance mechanism for climate-related investments**	
Energy access	**8. Emission Reducing Under-writing Mechanism to Purchase for CERs from LDCs**	**9. Public-private fund to absorb potential first loss from high-risk investments in LDCs**	**10. Revolving fund for low-carbon social enterprise focusing on energy access** **11. Pooled fund for small-scale venture capitalists to promote low-carbon social enterprises in least-developed countries (LDCs)**

Source: Abyd Karmali[21], "New Approaches to Mobilise Climate Finance"; Climate Markets and Investment Association, European Union Corporate Leaders Group on Climate Change, International Emissions Trading Association & Investor Group on Climate Change, "Submission to Co-Chairs Information Note on the Business Model Framework of the Green Climate Fund"[22]

[21] Managing Director, Bank of America Merrill Lynch (BofAML) & Special Advisor to the Climate Markets and Investment Association (CMIA)

[22] This table is part of a report that was prepared by 12 international business associations representing a range of financial and industry perspectives and thousands of member companies covering geographies in developed and developing countries; it was presented to the Green Climate Fund in 2013 as well as at the White House.

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ISSN: 2052-7209

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