Risk and reward

Redefining infrastructure finance in the age of climate change
With news headlines increasingly dominated by images of extreme weather events across the world, from storms, floods and landslides to extreme temperatures, droughts and wildfires, there is little doubt that such events are increasing in magnitude and frequency as a result of climate change. There is also little doubt that they are putting the world’s critical infrastructure at risk.

Yet, with the cost of adapting to and mitigating the impact of increasing climate change shocks rapidly outpacing the ability of governments to fund the necessary investments, there is a growing need for private sector capital and expertise to step in. However, while there is growing evidence of public-private partnership (PPP) arrangements helping to bring forward investment in large-scale infrastructure, climate resilience is still not being adequately integrated into PPP policy frameworks, jeopardizing the performance of these investments.

This is no easy feat, and best practices are still in development. At the same time, the increasing focus on sustainable infrastructure is creating opportunities for investment. So why and how should climate risk and resiliency be mainstreamed into policy? And at this juncture, what are the leading practices governing the development of infrastructure PPPs?
Climate risks have a hefty price tag

Countries around the world need to spend trillions of dollars on infrastructure in the coming years to resolve decades of deferred maintenance. This will only be exacerbated by rapid urbanization and population growth in emerging markets, increasing demand for new infrastructure. Before factoring in climate shocks, closing the infrastructure gap by 2030 requires investment estimated at US$40t to US$50t. Mounting climate threats on infrastructure assets is only going to increase this already significant shortfall.

The effect is felt hardest in developing countries. A report released by the United Nations Environment Programme (UNEP) in May 2016 found that the cost of adapting to climate change in developing countries could be between US$140b and US$300b per year by 2030, and as much as US$280b to US$500b per year by 2050, a figure that is four to five times greater than previous World Bank estimates. However, it is not only emerging markets that are feeling the pain – there are countless examples of major populations being dramatically impacted by extreme weather events. For example, in 2012, Hurricane Sandy caused more than US$15b of damage on New York and New Jersey’s infrastructure, while uncontrollable bushfires in Australia continue to cause significant damage to a wide range of infrastructure, from bridges and power lines to schools and hospitals.

The capital requirements are significant, and the public sector can only provide a small share of the capital required to enhance the resilience of a country’s infrastructure. This creates a critical role for the private sector to not only invest, but to also support the development of innovative delivery solutions to maximize their impact at the lowest cost.

PPPs and climate resilience

PPPs are widely used to finance and operate infrastructure in many countries, particularly in developing regions. Risk sharing, or risk transfer, to the private sector is the key differentiator for PPPs compared with traditional public procurement, where governments carry the bulk of the risks. The advantage of PPPs is that governments and private investors share investment and delivery risks by allocating them to the parties best able to manage them. With the concepts of resiliency and sustainability increasingly tied

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2. UNEP defines adaptation as the process of adjustment to actual or expected climate and its effects in order to moderate harm or exploit beneficial opportunities.
to innovations in technology, financing and operational capabilities, areas where the private sector is often able to develop innovative solutions and effectively manage risks and rewards effectively, it is perhaps little surprise that there is growing interest and appetite to leverage the PPP model to bring forward large-scale resilient infrastructure.

We are already seeing such structures being used to successfully bring forward projects designed to mitigate or adapt to climate change challenges that might not otherwise be built if reliant on public sector funds and technical capacity or private sector innovation alone. The emergence of such projects can broadly be categorized as those to reduce carbon emissions, and those to adapt to the consequences of climate change.

**PPPs to reduce carbon emissions**

These types of projects seek to prevent, slow or reduce the impact of future climate change events through implementation of infrastructure-based solutions that reduce carbon emissions through a more efficient use of resources, whether reducing absolute consumption or switching to lower-carbon resources or technologies.

Such projects typically cover the build-out of large-scale renewable energy capacity such as wind, solar, geothermal or hydro; the electrification of mass transit systems; the embedding of energy efficiency or resource management solutions into new or existing infrastructure projects (such as LED lighting on new road systems, or more efficient heating/cooling systems in social infrastructure such as schools and hospitals); or a shift to more advanced or sophisticated technologies (such as waste management landfill and incineration solutions shifting to advanced thermal treatment technologies).

While some such projects are being developed and deployed fully within the private sector, the sheer scale and strategic importance of many projects, regulatory constraints or public ownership of the infrastructure often means demand is driven by central or local governments, though deployed via PPPs to also take advantage of private sector capital or innovation. Prominent examples include the Masen strategic risk model to bring forward some of the largest and most innovative solar projects in the world, an approach that has earned it the prestigious Champions of the Earth 2016 award from the United Nations for its entrepreneurial vision.

**PPPs to adapt to climate change consequences**

This category covers projects that are designed to enhance the resilience of a community or against the effects of climate-related events, or address climate effects that have challenged the ability of infrastructure to perform effectively. These projects can be further divided into those that address power and utilities-related infrastructure needs, where the projects themselves are a direct response to the challenge of resilience, and those that seek to improve the resilience of transport and social infrastructure.

**A clear need to adapt ...**

There is growing evidence that both the public and private sectors are already starting to embrace new opportunities to address increasing climate risks through the development of more resilient greenfield (new infrastructure) and brownfield assets (repurposing or retrofitting existing infrastructure). However, this will need to increase exponentially to keep pace with the destructive pattern of...
Power and utilities infrastructure

These assets typically involve some kind of complex and substantial civil infrastructure, where the design for, and transfer of, climate change risks are increasingly integral to the purpose and success of the project. Examples include flood defense systems (see the Fargo-Moorhead flood diversion case study on page 5); storm water management; power continuity (e.g., endurance of transmission and distribution systems during or after extreme weather events or extreme seasonable temperatures, increasing demand for distributed generation, microgrids and storage, and underground cables); and broader power supply reliability (e.g., African hydropower facilities are forecast to see revenue losses of up to 60% in severe dry climate scenarios by 2050⁴).

Transport and social infrastructure

The application of climate change resiliency in transport and social infrastructure most typically involves the incorporation of climate-resilient design elements or measures to enhance the ability of such infrastructure to continue functioning and/or significantly reduce potential damage from severe weather events and changing climate patterns.

This represents the most far-reaching application of climate change resiliency, but also a significant opportunity for high levels of private sector technical and commercial innovation to address sometimes conflicting project objectives (since, to deliver more sustainable long-term infrastructure solutions, upfront costs may be higher). Examples include measures to enhance the resilience of roads or bridges in the event of flash floods or landslides, and minimize the impact of operational disruption of mass transit systems in the event of extreme snowfall, storm-related power outages or even extreme temperatures.

major climate events, both in rebuilding existing infrastructure that has already failed to cope with climate events, and to build new or retrofit existing assets to endure future shocks.

An increasing amount of private capital is being channeled toward investments in carbon-reduction projects. However, investment in climate adaptation infrastructure is arguably even more critical given the urgent need to address increasingly severe climate-related events. The adoption of PPPs to bring forward investment in climate-resilient infrastructure is not yet meeting this need – or the increasing investor appetite – for such assets but, in recent years, this has started to change, and a few countries are starting to pilot projects or evaluate potential solutions.

**... Demanding mainstreaming of climate risks into policy**

Though significant progress has been made by governments and multilateral development agencies to develop policy frameworks, processes, tools and knowledge that promote climate resilience, there is still an increasing need to bring these into the mainstream PPP process.

Climate events alter the environmental conditions that infrastructure projects need to withstand, shifting the calculus for how infrastructure should be planned, designed, financed, constructed and maintained. Failure to manage the impacts of climate hazards will most certainly result in construction delays, asset failures, poor project performance, increased cost and decreases in financial returns. Further, the lock-in effect of PPP contracts over a long period and the effect of PPP investment decisions on the whole-life physical and economic performance of the infrastructure asset makes the management of climate risks in infrastructure PPPs extremely important.

**Challenging the status quo**

Bringing climate risk into the PPP mainstream is challenging. Uncertain events that have typically been considered to be outside the contractual design and operational requirements of the private sector participant usually result in “force majeure” (or other termination) provisions that see political or extreme weather events as a shared or public sector risk. This widely accepted approach to termination provisions that see political or extreme weather events as a shared or public sector risk, or else shared termination risks, particularly given their dynamic and uncertain nature. The challenge for the public sector is therefore redrawing the parameters within which the private sector is required to innovate by clearly defining the expectation of what the relevant technical solution needs to achieve. It needs to embed its resilience objectives into the technical performance specification that underpins what the private sector is required to deliver, and the metrics by which its performance will be measured and rewarded or penalized.

**The dynamic nature of climate risks makes quantifying and apportioning risk difficult**

Using design and performance specifications to capture what is effectively a new breed of risk is, however, no mean feat. Here are some of the challenges:

**Defining resiliency objectives**

- The dynamic and uncertain nature of climate-related events: this poses a significant challenge to define what the required infrastructure is to be resilient against. Whereas climate risks in the past could be characterized using probability distributions, based on the availability of decades or even centuries of data, climate change has created new uncertainties about the frequency and magnitude of events.

- Asymmetry of information and technical knowledge: defining the objectives of the technical solution through performance specification means that requirements will need to be more prescriptive. Simply requiring that the infrastructure must remain operational in storm conditions or be sufficient to withstand a 1 in 100 year flood will not be adequate to ensure resilience objectives are properly embedded in the design. Rather, technical requirements will need to specify temperatures, wind speeds, water depths, flow rates, outage periods and so on. This in turn will require the public sector party drafting the design specification, or those providing advisory support, to have access to sufficient data and knowledge to do so, as well as to enable the ongoing monitoring of these requirements.

- Building to the extreme: even where sufficient technological knowledge and forecast data exists to understand the potential climate change-related risks to an asset, and how this might translate into design requirements, the public sector must also...
Fargo-Moorhead flood diversion project, US

EY is currently advising on a US$2.2b project to design, build, operate and maintain a flood diversion channel along the Red River of the North that straddles the border between North Dakota and Minnesota in the US. The river’s flood stage has been exceeded in 50 of the last 112 years, and 8 of the 16 major floods on record have occurred since 2000, resulting in average annual flood damages in the Fargo-Moorhead region of around US$194.8m and rising. It has been estimated that 100-year and 500-year flood events would cause around US$6b and US$10b worth of damages respectively.

The urgent need for a more resilient solution prompted the Fargo Moorhead Flood Diversion Authority and the US Army Corps of Engineers (USACE) to advance a demonstration project using an innovative “split delivery” model. This approach will deliver a diversion channel using an availability payment PPP structure, while the USACE will use a traditional design-bid-build method to deliver an embankment, diversion control structure and dam at the southern end of the project.

The project has recently moved into the procurement phase, and the authority has made good progress in defining the objectives that will drive the design and performance specifications. For example, the 36-mile-long, 1,500-foot-wide diversion channel with 32,500 acres of upstream staging will seek to reduce a 100-year flood event from 42.4 feet to 35 feet at the Fargo gage (a major 2009 flood peaked at 40.8 feet). Furthermore, in acknowledging the cost trade-offs, the project is not technically being designed to prevent a 500-year flood event. However, the diversion channel will provide the region with a greater chance of endurance by reducing the river level in Fargo from 46.7 feet to 40 feet during such an event.
take a view on where its project should sit on the resiliency spectrum. This is both to clarify the project’s objectives and given potential implications for the trade-off between capital and operating costs. For example, building a project to withstand a category five hurricane may minimize operation and maintenance costs, given the infrequency with which these events may occur, and reduce the cost impact of less extreme events, but will likely be offset by higher capital costs upfront.

Evaluating projects and establishing contractual responsibilities

- The challenge to accommodate climate-resilient solutions in the procurement process: there may be concerns that innovative resilience measures proposed by private sector parties will require additional compensation, or that procurement bias will unfairly penalize those projects driving long-term resilience in favor of those with a lower upfront cost. This could distort decisions on whether to deploy or participate in a PPP process. The structure of the evaluation methodology will need to articulate clearly the priorities of the public sector party, and any potential trade-off between upfront cost and long-term resilience benefits.

- A disconnect between the design parameter and the life of the project: the whole-life costing approach to PPPs is primarily focused on the life of the contract rather than the asset, giving the private sector little incentive to spend more on making the asset sustainable in the long term. However, the nature of climate risks introduces a need for incentives to bring both private sector maintenance, and capital expenditure decisions made during the PPP, in line with what the asset requires over its lifetime. As such, both the performance specification and project appraisal processes will need to be clear and consistent on the expected life of the asset being evaluated.

- Seasonality: some projects will face a potential dilemma that the public sector is paying year round for an asset that may only be required two or three times a year, if at all. This could raise some value for money concerns, and creates a need for innovative performance standards and payment mechanisms.

- Event frequency risk: even when a project is designed to achieve a particular degree of resiliency, and some degree of seasonality exists, the risks associated with the unpredictability of the magnitude and frequency of even less severe events will still need to be addressed.

Operations and performance

- Acceptance testing: the contractual provisions will need to determine how the parties will be able to confirm that the infrastructure asset is fit for purpose. There may not be a severe weather event for several months or years, or any event that tests the design parameters fully at all within the life of a contract.

- Measuring performance: the unpredictable and dynamic nature of many climate-related events may impact how and when performance is best measured, and how it is rewarded or penalized. Even seasonality will mean performance is not required to the same extent throughout the year. Furthermore, there may also be other parallel variables affecting the performance of an asset, such as non-related technical faults, service delays or human intervention.

- Reactive maintenance: allocating post-weather event clean-up or remedial responsibilities to the private sector risks an unusually high spike in reactive maintenance costs. The challenge therefore arises of how to mitigate the cost impacts of the private sector potentially charging a premium for this risk, which could represent poor value to the public sector for an event that might never occur.

Key principles for action

The need to overcome these challenges and integrate this new class of risk into PPP-based solutions is becoming increasingly urgent – business as usual is no longer an option. Much of the step change required to achieve this will need to come from the public sector, equipping itself with the right resources to redefine its infrastructure objectives and the parameters within which the private sector needs to innovate.

Though there is no single handbook on how to achieve this, three key principles can guide policy-makers in how to incorporate and allocate climate risks better in infrastructure PPPs.

A. Integrate climate resilience into the project appraisal and contract framework

Although design and performance specifications are critical tools for embedding resiliency objectives into a project and lifting historically unallocated risks out of the “force majeure” bucket, broader integration of climate risk is still necessary for successful execution:

- Shifting mindsets: opportunity cost or “business as usual” scenarios should more accurately capture the risk of not incorporating adequate climate-resilience measures into project requirements. This is to overcome potential misconceptions about cost escalation, particularly given that future repairs or retrofits could be more expensive than financing measures from the outset. This will likely include a shift in focus toward whole-of-asset life, rather than the PPP contract life. Lenders will also need to get more comfortable with the trade-off between more innovative solutions and reduced long-term sustainability risks. They could also be more proactive in requiring consideration of climate risk and resilience in determining lending criteria and covenants. Shareholders in project companies should also ensure they understand the implications of climate change for investment performance.

- Defining project procurement and performance: in addition to drafting design and performance criteria that embed resiliency objectives into private sector solutions, it is important that these also flow consistently through the project appraisal framework. This is via clear project selection methodology and criteria for bidder proposals – and may require some
PPP policy to mainstream climate risk

Leading practice examples include Australia, where the national PPP guidelines provide a clear framework for including climate risk and adaption, including technical standards, an in-built risk assessment and “fit for purpose” checks on PPP assets. It also addresses the ability to modify the PPP terms through the life of the contract to reflect new technologies and other factors.

In the UK, government-issued draft guidance provides clarity on the delineation of risks between the public and private sector (primarily focused on social infrastructure), and seeks to strike a balance between giving private sector contractors just relief on their obligations for climate-related impacts, while protecting the Government from non-performance. For example, the private sector is considered to be broadly responsible for weather- and climate-related risks, though likely entitled to relief under large-scale, force majeure shocks.

Some governments are also sending increasingly strong signals about the national importance of climate change resiliency. In Canada, for example, Prime Minister Justin Trudeau has initiated a CA$120b (US$93b) federal sustainable infrastructure plan, some of which is likely to be allocated via PPP programs given the country’s successful application of this model to date.
experimentation with selection criteria weightings, and the recalibration of screening and project due diligence tools.

- **Contract capture**: it will be critical that a performance specification translates into a clear and explicit allocation of associated risks between the various parties in any formal project agreement. This will include contract negotiations, treating the use of force majeure and other termination provisions as a means of last resort. However, given the uncertain nature of future climate events, it will likely also mean building sufficient flexibility into contract management to adapt to unforeseen circumstances.

### B. Drive resilient, adaptive policy and regulation

For the proposals above to be executed at a project level, there is also a need for complementary and enabling policy and regulations at a federal or local level. Mainstreaming adaptation and resilience therefore requires an understanding, and tailoring of, the policy and institutional landscape, including an appreciation of the regional, sectoral and project-specific issues:

- **Removing barriers and sending signals**: governments can integrate climate adaptation and resilience into national or regional infrastructure policy, and even level the playing field by mandating the inclusion of climate risk and resilience considerations in infrastructure programs. It will also be important to ensure that existing legislation does not create conflicts or hinder the ability of local governments to adapt their procurement processes to incorporate climate resilience considerations.

- **Using regulation to support technical outcomes**: this might include, for example, developing common taxonomy in policy and regulations for assessing sustainability risks, to be used by both governments and private sector stakeholders. It could also mean enhancing regulatory requirements around the use of environmental impact assessment procedures, environmental and social standards, and weather forecasting tools to define more resilience-based metrics. Regulatory measures could also be used to emphasize transparency, such as private sector reporting on climate risks and related outcomes, or a requirement for independent third-party reviews of climate risks for projects.

- **A holistic approach**: integration across overlapping regulatory regimes should be considered where conducive to more efficient risk management (for example, regulation of water, energy and land use). Similarly, public sector infrastructure planning could shift toward a more multi-sector “systems” approach that flows down to determine project requirements, rather than assessing resilience needs on a project-by-project basis.

### C. Pioneer tailored financing, knowledge-sharing and best practice mechanisms

While national or state-level policy frameworks are an important starting point for systematic inclusion of climate risks in infrastructure PPPs, the global imperative is to develop efficient and effective regulatory, technical and financial models that address climate-resilient infrastructure needs. This means that there is significant potential for mitigation strategies to be “glocalized”; for global public and private institutions to play a role by developing and sharing innovation and best practices that will flow down to local projects. For example:

- **Breaking down knowledge barriers**: suitable cross-border platforms, such as multilaterals and other development institutions, will be crucial to increase education and awareness of climate risks, develop tools and guidance, and provide widespread access to consistent data to the benefit of both public and private stakeholders. International development partners can also encourage governments to incorporate specific emphasis on climate risk and adaptation in public investment management frameworks.

- **A multidisciplinary approach**: strategic partnerships with stakeholders representing multiple disciplines (e.g., professional advisors, engineering firms and scientific communities) to develop solutions that are responsive to technical, financial, legal and institutional issues will help to bring climate risk into the mainstream. This could include the development of climate screening and risk forecasting tools (such as climate vulnerability indexes, etc.) and other decision-support tools for the purpose of project appraisal. Insurers should also continue to promote awareness of climate risk, incentivize resilience-building actions and advise on novel risk mitigation instruments.

- **Financing change**: international development partners should further innovate and support new products while leveraging and expanding use of existing climate change finance and financial risk mitigation instruments. While some are relatively immature, there are various tools, such as index-based weather derivatives, catastrophe risk deferred draw-down options (CatDDO), sovereign insurance schemes and property catastrophe risk insurance, that could be useful tools to manage and mitigate climate change risk more effectively. Various global sources of climate finance, such as the Green Climate Fund, climate investment funds and green bonds, can also be useful financing sources for climate-smart infrastructure.

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The new normal
The dams, power plants and roads built today must withstand a future climate that is variable and unpredictable. Yet, with climate risk not yet properly assessed and embedded within PPP policy frameworks, integrity of this infrastructure and associated revenue streams will be in jeopardy.

However, with appetite for PPP-based projects still running high, and increasing evidence of innovative models bringing forward major climate mitigation projects, this presents an opportunity for officials, advisors and funders to work with each other and the private sector at a local, national and global level. Such collaboration will enable climate change risks to be effectively defined and embedded more firmly in clear and objective design and performance specifications, and lead to the establishment of best-practice projects and delivery approaches that can lay the foundation for mainstreaming climate change risk into more of the world’s major infrastructure projects.

Given the climate path we find ourselves on, business as usual is no longer an option.

Climate resilient infrastructure advisory at EY
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<td>EY Climate Change and Sustainability Services teams advise clients on assessing and understanding environmental and social metrics that are material to managing their operations. We help them make better business decisions by bringing sustainability into strategic risk, supply chain, marketing, product development, finance and internal audit. We also assist them in managing compliance and operational improvement using a pragmatic business approach focusing on cost-effective options to material risks.</td>
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