Water Infrastructure Criteria under the Climate Bonds Standard

Background Paper

Defining Expectations for Water Infrastructure-Related Certified Climate Bonds

Version 3.3

August 2022

Document revision number	Date	Summary of changes
3.3 Clarifications on assets within scope	August 2022	Clarifications made in the Criteria document regarding eligible desalination assets. Criteria themselves not changed.
3. Update to criteria to include desalination assets	January 2021	Specific criteria were developed and added for desalination plants. A separate low carbon energy threshold is set for plants, along with an extra section for brine disposal and feedwater in the A&R checklist.
2. Formal update to criteria (phase 2)	May 2018	Criteria added for nature-based and hybrid water infrastructure covering such purposes as water collection, storage, treatment and distribution, flood protection and drought resilience.
1. First publication of original Criteria (phase 1)	Oct 2016	

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1. Introduction

1.1. Funding the transition to a climate-resilient development trajectory

The current trajectory of climate change, expected to lead to a global warming of 3.1-3.7°C by 2100[1] poses an enormous threat to the future of the world's nations and economies. The effects of climate change and the risks associated with a greater than 2ºC rise in global temperatures by the end of the century are significant: rising sea levels, increased frequency and severity of hurricanes, droughts, wildfires and typhoons, and changes in agricultural patterns and yields. Avoiding such catastrophic climate change requires a dramatic reduction in global greenhouse gas emissions.

At the same time, the world is entering an age of unprecedented urbanisation and infrastructure development. Global infrastructure investment is expected to amount to USD 90 trillion over the next 15 years as the developed world maintains and upgrades existing investments while middle and low income countries expand their pool of infrastructure to meet new and emerging needs. The investment required over this period are estimated to be more than the value of the entire current infrastructure stock.[2]

To ensure sustainable development and stabilise climate change, this infrastructure needs to be both low-carbon and resilient to climate change without compromising the kind of economic growth needed to improve the livelihoods and well-being of the world's most vulnerable citizens. Ensuring that new infrastructure is low-carbon is estimated to raise annual investment needs by 3–4%.[3] Climate adaptation needs add another significant amount of investment, which is estimated at USD 280–500 billion per annum by 2050 for a 2-degree Celsius scenario.[4]

Traditional sources of capital for infrastructure investment (governments and commercial banks) are insufficient to meet capital requirement needs to 2030; institutional investors, particularly pension and sovereign wealth funds, are increasingly looked to as viable actors to fill these financing gaps. Bonds offer relatively stable and predictable returns, with long-term maturities. This makes them a good fit with institutional investors' investment needs.

"Labelled" green bonds are bonds where the proceeds are used for green projects and assets, mostly climate change mitigation and/or adaptation projects, and the bonds have been marketed accordingly. An increasing number of institutional investors have been guided to avoid carbon-intensive investments or projects that might increase or be exposed to climate risk. The rapid

[1] According to Climate Tracker, under current policies we could expect 3.1-3.7ºC: http://climateactiontracker.org/global.html
[2] The Global Commission on the Economy and Climate (2016). The Sustainable Infrastructure Imperative: Financing for Better Growth and Development. Available from: http://newclimateeconomy.report/2016/wp-content/uploads/sites/4/2014/08/NCE_2016Report.pdf
[3] The Global Commission on the Economy and Climate. Better Growth, Better Climate. Available from: www.newclimateeconomy.report
[4] UNEP (2016). The Adaptation Finance Gap Report.

growth of the labelled green bond market has shown in practice that the bond markets provide a promising channel to finance climate investments, expanding the pool of investors and funds available.

1.2. Water infrastructure as part of that vision

Given these trends, water-intensive investments present new risks and opportunities. Modern economies are already deeply water intensive: freshwater resources are essential for meeting water supply and sanitation needs, for most types of energy production, for agriculture, for terrestrial, aquatic, and near-shore marine ecosystems, and for industrial and manufacturing needs.

However, water and water infrastructure will play an even more fundamental role in resilient, low carbon economies. Many investors and decision makers view water strictly as a "sector" — water transport, treatment, and storage. However, water is also an enabling natural resource that spans many sectors. Water is an economic and ecological "connector" for a wide range of sectors. Statistics that highlight "water" in the bonds market are largely tracking traditional water sector projects, while water-intensive investments are found across a wide range of other categories.

From a climate mitigation perspective, water and water infrastructure often have a deep connection to carbon emissions.[5] Most forms of energy generation are water intensive, while water treatment and movement (e.g., irrigation, transport) are themselves energy intensive. Therefore, efforts to reduce the energy consumed and/or the amount of water treated or moved can all have very significant impacts on greenhouse gas emissions and make important contributions to rapid decarbonisation of the global economy.

In contrast, climate adaptation and resilience are emerging aspects of water management. Water infrastructure assets that are designed and operated to ensure adaptation and resilience are the newest type of water investments, while nature-based approaches to integrating ecosystems into water management systems or developing ecosystems as water "solutions" for flood control and water treatment and storage are also growing more widespread. Adapting existing and natural systems to future climate or building and integrating green, grey, and hybrid solutions to ensure effective adaptation are essential given the primacy of water in modern economies.

At the most basic level, climate change means that water quality, quantity, and the timing of its availability are evolving and will likely continue to do so for decades or centuries. The ability of water infrastructure — both grey or green — to provide robust, reliable services is essential to meet sustainable development goals (SDGs) and NDC (UNFCCC Nationally Determined Contributions) commitments, as well as the commitments of the 2015 Paris Agreement.

[5] Rodriguez, Diego J.; Delgado, Anna; DeLaquil, Pat; Sohns, Antonia. 2013. Thirsty Energy. Water Papers;. World Bank, Washington, DC. © World Bank. https://openknowledge.worldbank.org/handle/10986/16536.

1.3. The Goals of the Climate Bonds Standard and the Water Infrastructure Criteria

The global green bond market grew from USD11.5bn in 2013 to over USD266.1bn in 2019 (USD1 trillion cumulatively as of December 2020). Water infrastructure–related bonds are growing in line with this overall market growth, with USD30bn of bonds related to sustainable water management issued in 2017, up from USD12bn in 2016.[6] There has been USD98.7bn of cumulative investment in water infrastructure in green bond use of proceeds[7].

In the absence of clear and widely accepted definitions around the meaning of a "green" label, the green bond market's rapid growth has raised some questions around the environmental claims of these bonds and the potential for 'greenwashing': the use of bond proceeds that have little or uncertain positive environmental value. Weak or false claims can both shake confidence in the market and hamper efforts to finance a transition to a low carbon, climate resilient economy.

The Climate Bonds Standard and Certification Scheme is a tool to address greenwashing. It allows investors and intermediaries to easily assess the claims for the climate value of bonds, and to identify and invest in credible climate compatible assets/projects. Certification promotes transparency and effective communication.

The Climate Bonds Initiative convenes scientists, engineers, investors and other specialists in expert committees to develop clear, evidence- and research-based scientific criteria on what is 'climate-compatible'. Only bonds which meet these Criteria can be certified. The associated Certification scheme provides assurance on the climate credentials of Certified Climate Bonds by offering certification only where independent verifiers determine that the bond is aligned with requirements of the Climate Bonds Standard.[8]

In this context, the Water Infrastructure Criteria under the Climate Bonds Standard are intended to communicate to investors what water-related investments are resilient, effective, and sustainable over their operational lifetime. In addition, the Water Infrastructure Criteria provide issuers with a means to clearly differentiate their green bond offerings from non-certified issuances. By establishing this screening tool, the intention is to maintain transparency and credibility with respect to water-related bonds in the green bonds market.

A key objective has been to close the large gap between the credibility of labelling green and climate bonds in the finance market and the broader water management and science community. Significant shifts are occurring in how water-related projects are developed, incubated, and designed, particularly with reference to climate change. It is essential that these shifts are fully reflected in investment decisions.

[6] 'Green Bond Highlights 2017', available at https://www.climatebonds.net/files/reports/cbi-green-bonds-highlights-2017.pdf
[7] https://www.climatebonds.net/2020/12/1trillion-mark-reached-global-cumulative-green-issuance-climate-bonds-data-intelligence
[8] The Climate Bonds Standard has requirements on use of proceeds (alignment with green definitions based on sector criteria under the Standard), management of proceeds, reporting and disclosure, and external review. The Standard is aligned with the requirements of the Green Bond Principles (GBP). https://www.climatebonds.net/standards/standard_download

The scope of the Water Infrastructure Criteria in terms of assessing climate impacts includes both climate change mitigation and climate adaptation and resilience. Box 1 outlines what mitigation and adaptation might mean in the context of water infrastructure investments, highlighting the potential for confusion between policy makers, investors, customers, and water managers due to different understanding of key terms.

Box 1: Climate mitigation, climate adaptation, and mitigating impacts

Terminology differences between the policy, investor, and water management worlds can be enormous in the context of climate change, especially around the terms “adaptation” and “mitigation.”

In a climate policy context, climate mitigation refers to efforts to reduce rates of greenhouse gas emissions and/or to lower the concentration of greenhouse gases in the atmosphere. Climate mitigation projects include shifts to low-carbon energy generation sources, such as solar power and wind, or avoiding carbon-emitting activities such as deforestation. Climate mitigation has occupied the overwhelming amount of climate policy efforts within global governance and has also been the primary focus of national level climate policy in most wealthy and middle-income countries.

For many in the water community, however, the term “mitigation” refers to reducing or offsetting a negative impact, such as creating a new wetland following the destruction of a marsh in the course of implementing an infrastructure project.

The water community’s definition of mitigation is actually closer to the policy meaning of climate adaptation, which refers to efforts to address negative climate impacts like increased drought frequency, sea level rise or earlier snowpack melt. Unfortunately, some climate adaptation literature also refers to “mitigating climate impacts” (i.e., reducing negative impacts) but without any intended allusion to greenhouse gases (climate mitigation). Worse, the term “adaptation” is also widely used in biology and natural resource management to refer to concepts that have little relevance to climate adaptation, though both definitions can sometimes be found in single documents that reference climate change and ecosystems.

1.4. How the Water Infrastructure Criteria Were Developed

The Water Infrastructure Criteria were developed and rolled out in three phases.

Phase I developed eligibility Criteria for engineered or built water infrastructure for the purposes of water collection, storage, treatment, distribution, and flood and drought defence. These Criteria were released in October 2016. To date, five bonds have been certified by demonstrating compliance with these Criteria, four from the San Francisco Public Utilities Commission (USA) and a fifth from the City of Cape Town (RSA).[9]

Phase 2 began in April 2016 with the objective to develop complementary Criteria for nature-based solutions, which includes green and hybrid water infrastructure for such purposes as water collection, storage, treatment or distribution, flood protection, and drought resilience. These Criteria were released for use in the green bond market in March 2018.

Phase 3 began in August 2020 and provided scientifically robust and ambitious criteria for desalination plants. It was determined that Version 1 of the Water Criteria did not sufficiently capture the climate impacts of such assets. Specific criteria therefore would provide requirements for seawater and brackish water desalination. These Criteria were released in January 2021.

The Climate Bonds Initiative first convened two groups to develop these Criteria: a Technical Working Group (TWG) and an Industry Working Group (IWG). Appendix 1 lists the more than 100 members of these groups. A separate TWG was convened for the Desalination Criteria, with the original Water TWG and IWG providing feedback and approval.

The TWG is a group of key experts from academia, international agencies, industry and NGOs across a wide range of water expertise, selected for their insight into sustainable water management, often (but not always) with additional experience or knowledge around climate adaptation, resilience and/or mitigation issues relevant to water resources management. The TWG drafted the proposed Water Infrastructure Criteria, which detailed technical criteria for the eligibility of water infrastructure assets and projects as well as guidance on the tracking of eligibility status during the term of the bond.

These Criteria were further refined through engagement with finance and industry experts who have or might in the future be involved in the process of issuing, assessing, or investing in a water-related green or climate bond. As such, the IWG provides an industry voice about practicality and relevance. Special climate knowledge was not assumed with the IWG members, whose role is to review the Criteria and provide feedback based on the utility of the Criteria, refine its scope, as well as gauge potential demand and industry interest. A consensus based approach has been followed to reflect the issues, demands, and insights of both the IWG and TWG.

The Criteria were also released for wider public consultation. Final approval of the Criteria has been given by the Climate Bond Standards Board.

The purpose of this Background Paper is to give an overview of the Water Infrastructure Criteria and highlight opportunities for climate mitigation and adaptation, providing context to the work of the Water and Desalination TWGs under the Climate Bond Standard and Certification Scheme. It summarises the issues considered by the TWGs in developing the Water Infrastructure (and Desalination) Criteria, explaining how these issues have shaped the development of the Criteria.

[9] For more information on these bonds, see https://www.climatebonds.net/standards/certification

Those involved in the development of these Criteria over a five-year period have undertaken a comprehensive vision. It is, however, acknowledged that revisions will be needed over time. We emphasise that the Criteria may be amended either due to public feedback or future developments in water management and policy. However, amendments to the Criteria will not be applied retrospectively to bonds already certified under prior versions of the Criteria.

That said, these Criteria represent a significant shift in how the bonds market views water-related investments and the best mechanisms for communicating risk, confidence, and relevance between issuers, investors, and other key audiences that may also be important.

These Criteria will be reviewed annually by the Climate Bonds Initiative and other guiding partners. They are likely to be revised and refined over time as more information and insight becomes available — both as we learn more about the application of the Criteria to growing numbers of bonds, and how these Criteria relate to other sectoral areas.

In particular, we expect that some new applications such as nature-based solutions will become more mainstream and widespread, leading to more and more robust asset classes such as aquifer storage and groundwater recharge. Our hope too is that these Criteria themselves can help lead to a wider appreciation and more consistent application of climate vulnerability assessments and the development of adaptation plans.

In all cases, we appreciate suggestions and observations that we can consider during the revision process. Please contact us if you have questions or recommendations.

2. Water infrastructure in the context of climate change

2.1. What is water infrastructure

Modern and developing economies “float” on water resources and the infrastructure and natural capital necessary for energy production, the supply and storage of water resources, irrigation and aquaculture, disaster management and avoidance, and industrial and management applications.

Within the context of the Criteria, “infrastructure” does not always refer to manufactured or built assets made of concrete, stone, and steel. Biological and geological systems - often referred to as eco-hydrological systems - have always provisioned a wide range of ecosystem services for human settlements. Throughout the full range of the water cycle, eco-hydrological systems are the original “water infrastructure” - rivers and lakes, as well as aquifers, groundwater, snowpacks and glaciers, and the living and non-living systems that compose ecosystems. This ‘nature-based’ water infrastructure is essential for a wide range of water services and is increasingly being integrated within formal water management systems as green and hybrid infrastructure.

For this reason, while Phase 1 of the Criteria focused on built or engineered water infrastructure, Phase 2 of the Criteria extended the Criteria to include green, nature-based, or natural infrastructure. This includes the use of ecosystems and ecological processes to deliver water services, (such as the use of wetlands for water treatment and the use of biophysical structures for water storage, such as aquifers), as well as hybrid infrastructure (which blends built and green solutions, such as "room for the river" flood control solutions that mix ecosystems with built levies).

Additional detail is available below on the potential range of investments relevant within each function and sectoral Criteria.

2.2. Water infrastructure and climate change

All economies are deeply water intensive. Freshwater resources are essential for meeting water supply and sanitation needs, for most types of energy production (hydropower and thermal energy systems, as well as most solar and geothermal), for agriculture (especially irrigated farming and aquaculture), for terrestrial, aquatic, and near-shore marine ecosystems, and for industrial and manufacturing needs. Clean water is also essential also for health and sanitation purposes. Water use patterns tend to change with economic growth: in most developing economies, agriculture consumes 70 to 80% of national-level water resources, while the energy sector often uses more than 50% of water resources in countries such as the United States, France, and Japan.[10]

Water is also viewed as a resource essential to meeting the 2030 Agenda for Sustainable Development and the SDGs (Sustainable Development Goals).[11] Water is most prominently named in SDG 6, but many others such as SDGs 2 (hunger), 7 (energy), 11 (urban resilience), 13 (climate change), and 15 (ecosystems). Achieving these goals fundamentally requires long-term sustainable (and climate resilient) water resources management.

The connections between water resources, economic development and sustainability are relatively clear, but the relationship between water and climate change may be less obvious.

Climate change and variability have always been important drivers for biophysical systems, including for all human history and pre-history. However, anthropogenic climate change is altering most aspects of global and regional climate, including the water cycle.[12] The water cycle has proven to be both extremely sensitive to climatic fluctuations and very difficult to predict with confidence. Indeed, water is so important to human activities and economies that it has been called the "medium through which humans will experience most of the negative impacts of climate

[10] International Energy Agency. 2016. Water Energy Nexus. Paris: OECD/IEA. https://www.iea.org/publications/freepublications/publication/WorldEnergyOutlook2016ExcerptWaterEnergyNexus.pdf
[11] For instance, see Matthews, et al., 2017. A Thirst for Food Resilience: Climate-Smart Water Knowledge Integrates UNFCCC and SDG Policies for Food and Agriculture. Global Water Forum. http://www.globalwaterforum.org/2017/11/16/a-thirst-for-food-resilience-climate-smart-water-knowledge-integrates-unfccc-and-sdg-policies-for-food-and-agriculture/
[12] Refers to the process through which water moves between the oceans, atmosphere, and surface and groundwater.

change."[13] The World Economic Forum has called out water and the failure to adapt to climate change as two of the most dangerous threats facing economies today.[14]

Water infrastructure and ecosystems represent special challenges under these conditions because (a) they tend to remain on the landscape for climate relevant timescales, extending from decades to centuries (and even millennia in some cases), and (b) our management decisions and processes tend to be based on analyses of past rather than of emerging future conditions, which may be quite different than even the recent past. The long-held assumption that the past can predict the future, sometimes referred to as "stationarity", represents a serious challenge in how we manage our economy and define ecological sustainability.[15] If we keep building and managing water with an assumption of stationarity, we will see our infrastructure fade in efficiency and reliability and potentially fail catastrophically – patterns already evident in assets that are decades old.

While growing gaps in the "fit" between our ambient climate and existing water infrastructure are serious cause for concern, the rise of new approaches to resilient water management (including nature based solutions) represents a positive new vision for sustainable economies that can both adjust and adapt to emerging climate conditions and continue to slow the rate of climate change through lower greenhouse gas emissions. Water is both a symptom of a deep problem and the primary instrument for new solutions.

2.2.1. Water and Greenhouse Gas Emissions

From a climate mitigation perspective, water and water infrastructure often have deep connections to carbon emissions.[16] For instance, pumping groundwater or water from reservoirs to consumption points (cities, farms, energy production sites) can be very energy intensive given the volume and density of water resources and the distance covered. Distances of dozens to hundreds of kilometres are common for water transfers. Depending on the energy source, moving water may be highly GHG emissions intensive.

Likewise, water treatment facilities and processes can be especially "thirsty" for energy.[17] This can include urban wastewater, agricultural and industrial effluent treatment, desalinisation of sea water and some types of groundwater, where water quality is altered to meet some targets for acceptable use or for re-entering the environment.

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[13] Grey D, Sadoff C. W (2007) Sink or swim? Water security for growth and development. Water Policy 9: 545–571.D. GreyC. W. Sadoff2007Sink or swim? Water security for growth and development. Water Policy

[14] World Economic Forum. 2017. Global Risks Report 2017, 12th edition. Geneva: World Economic Forum. http://www3.weforum.org/docs/GRR17_Report_web.pdf

[15] Matthews JH, Wickel BA, Freeman S (2011) Converging Currents in Climate-Relevant Conservation: Water, Infrastructure, and Institutions. PLoS Biol 9(9): e1001159. https://doi.org/10.1371/journal.pbio.1001159

[16] World Bank Group. 2016. High and Dry: Climate Change, Water, and the Economy. World Bank, Washington, DC. https://openknowledge.worldbank.org/handle/10986/23665

[17] Rodriguez, Diego J.; Delgado, Anna; DeLaquil, Pat; Sohns, Antonia. 2013. Thirsty Energy. Water Papers. World Bank, Washington, DC. https://openknowledge.worldbank.org/handle/10986/16536

Therefore, efforts to reduce the energy consumed and/or the amount of water treated or moved can all have very significant impacts on greenhouse gas emissions and make a significant contribution to rapid decarbonisation of the global economy.

2.2.2. Adapting Water Management to Climate Impacts

The impacts of climate change on the water cycle can be complex. Shifts in the frequency and severity of droughts, flooding, and tropical cyclones are obvious trends that have been widely identified, but even these can be difficult to predict and prepare for in advance with confidence. These issues are arising in both the developed world (often with existing infrastructure) and in the developing world (where many bond issuances are for new investments). In both cases, climate change issues are becoming critical for water investors and decision makers.

For instance, in 2015, the U.S. states of California, Oregon, and Washington experienced a severe drought which the scientific literature linked to climate change.[18] In California, the amount of precipitation was well below average, while Oregon and Washington, to the north of California, received relatively normal amounts of annual precipitation. Their winter precipitation fell more as rain instead of a mix of both rain and snow in 2014–2015, while elevated air temperatures accelerated evapotranspiration and snowpack melting rates. The lack of snowpack and early runoff caused by higher temperatures exacerbated water scarcity across all three states. Drastic rationing was required by cities, farmers, and many industries, and both thermal and hydropower supplies were constrained. Record-level forest fires proliferated across the region.

California, in particular, was not prepared for the extent and severity of the drought nor its economic and ecological consequences. The drought revealed that many water-related investments had been conceived and managed in relative isolation from each other and without much consideration of how climate change could alter operations and management decisions between upstream and downstream stakeholders. The winter of 2016, however, saw a sudden shift to record-setting rains across all three states, abruptly ending the drought and transitioning to severe flood conditions that in a few cases surpassed the design conditions of major infrastructure. The partial failure of the Oroville Dam in northern California forced the evacuation of several hundred thousand nearby residents.[19]

Such a range of extreme impacts is completely novel in the experience of most decision makers and investors. Urban infrastructure, energy generation, agriculture, the forest fire regime, and environmental management trade-offs are all affected. Water managers and investors are looking more broadly than the individual footprint of any given project at a wider range of future conditions that may arise as a result of climate change.

Other common impacts from climate change on the water cycle include:

[18] Source: http://www.ldeo.columbia.edu/news-events/warming-climate-deepening-california-drought
[19] Source: https://www.nytimes.com/2017/02/14/us/oroville-dam-climate-change-california.html

- Shifts in the timing and seasonality of precipitation, a pattern already seen in areas such as South Asia with increasing variability in the Indian monsoon
- Shifts in the qualities of so-called climate engines such as the El Niño Southern Oscillation (ENSO) and the Pacific Decadal Oscillation (PDO) that influence precipitation over much of the earth's surface
- Water quality impacts, such as those seen in China's Yangtze basin, where more frequent and intense eutrophic conditions (which support algal blooms) are now observed even in winter.

In parts of the world such as South Asia, where climate change rates are quite high, even new investments for water storage, treatment, and irrigation are at high risk of disconnecting from their "intended" climate conditions over a matter of a few years, endangering the services they were intended to provide, water supplies for other stakeholders, the confidence of investors, and the sustainability of those investments against environmental conditions.

In the energy sector specifically, many large water-intensive energy production facilities which are more than 30 or 40 years old have begun to experience very significant impacts from climate change as water conditions have diverged from their initial operating parameters. Increased flooding, more intense droughts, and shifts in precipitation and snowpack patterns have become significant enough in many regions to require major adjustments in operations and design. In effect, many facilities have seen significant, sometimes enormous, drops in efficiency and capacity, requiring large reinvestments to ensure that green energy targets can continue to be met.[20] New facilities face the same challenge if they have not been designed to be resilient across a range of potential future climate conditions.

Moreover, individual projects and investments cannot in most cases be resilient in isolation. Water moves through basins and watersheds, and climate change is altering the hydrological cycle in different ways across these watersheds as well as the needs of diverse stakeholders. Agriculture, ecosystems, and cities (among many other groups) have demands that are shifting between upstream and downstream users. An emerging questions is how we allocate water resources across water users and ensure that adjustments in supply and demand between users can be made coherently and fairly even as needs and water conditions evolve over time. Gaps between available and needed water resources have led to widespread conflicts, including some on a catastrophic scale.[21]

Given this context, climate adaptation and resilience are one of the most important new aspects of water management. At the most basic level, climate change means that water quality and quantity and the "normal" seasonal variation are evolving and will likely continue to do so for decades or centuries. The conditions are often difficult to predict with the level of confidence that

[20] These stories are becoming quite common. Two well-documented stories come from Africa (https://www.nytimes.com/2016/04/13/world/africa/zambia-drought-climate-change-economy.html?_r=0) and California in the USA (https://www.nytimes.com/2017/02/14/us/oroville-dam-climate-change-california.html).
[21] https://www.theguardian.com/world/2012/jul/31/india-blackout-electricity-power-cuts

was assumed to be valid in the past. At the same time, the ability of water infrastructure to provide robust, reliable services is essential to meet and continue to meet SDG and NDC commitments.

For financial analysts, assessing water-related investments' exposure to climate risks has previously been largely opaque and ill defined. However, awareness of the need to consider climate risks related to water is growing rapidly and is now consistently identified as one of the most important threats to growth and profitability by groups such as the World Economic Forum. But progress on consistent and effective methodologies to quantify such risks has been slow. Investors are increasingly aware of these newly identified risks and seek assurance that "climate-compatible" investments are reliable, robust to diverse futures, and flexible in the face of uncertainty. The Water Infrastructure Criteria are designed to communicate how these issues have been addressed by the issuer, and to do so in a simple, clear format.

2.3. Desalination today and in the future

Desalination as the industrial process it is known as today has been a source of fresh water since the first half of the twentieth century. Both distillation and filtration technologies have been used for much of this time. The traditional image of desalination was dominated by fossil fuel-driven thermal techniques used by countries with high fresh water scarcity and easy domestic access to cheap fossil fuels. As such, in many regions, thermal desalination technology remains the most common technology (fossil fuel-based thermal desalination produces two-thirds of the water from seawater desalination in the middle east, for example) [22].

However, today membrane technology represents by far the dominant technology being used by developers when building new desalination plants. In 2019, reverse osmosis (RO), a membrane technology, accounted for 69% of the worldwide installed desalination capacity[23]. Multi-stage flash followed with 18%, and multi-effect desalination with 7%, both thermal technologies.

Considerable research goes into improvements to the industrial process of desalination. This links closely to a plant's costs as well as it's sustainability. Improvements to a plant's efficiency, which may encompass developments in membrane technology or improved quality control of the overall system. Due to the thermal energy demands of thermal desalination technologies, they generally have considerably higher energy consumption (lower energy efficiencies) than membrane desalination [24]. Other improvements to a plant's processes can include more efficient pre-treatment processes or reducing the conveyance requirements of the treated water.

The water produced from desalination can serve a range of uses including municipal drinking water, water for irrigation in agriculture or cooling water for other industrial processes. The feedwater for desalination can also be sourced in a range of different ways. The most common is

[22] Found here: https://www.iea.org/commentaries/desalinated-water-affects-the-energy-equation-in-the-middle-east
[23] Cherif, H. and Belhadj, J., 2018. Environmental Life Cycle Analysis of Water Desalination Processes. In Sustainable Desalination Handbook (pp. 527-559). Butterworth-Heinemann.
[24] Chae, S.H. and Kim, J.H., 2017. Integration of PRO into Desalination Processes. In Pressure Retarded Osmosis (pp. 129-151). Academic Press.

seawater desalination. It is unclear how many plants are in operation globally today, but various studies cite between 15,000 and 19,000 desalination plants operational today globally. Jones et al. (2019), a recent overview of desalination, estimates around 16,000 plants with a global installed capacity of around 95 million m^3 per day. Of this, 61% is seawater desalination, followed by brackish water at 21%. In terms of the geographical distribution of desalination, by far the most desalination plants are located in the Middle East and North Africa (roughly 48 of global capacity). East Asia and the Pacific (roughly 18%) and North America (roughly 12%) follow some way behind.

With membrane-based desalination being the overwhelming technology preference today for new desalination plants, this carries opportunities for new energy sources for decarbonisation. A sustainable development scenario development by the IEA suggests that, for the Middle East, renewable energy powering desalination will need to increase from 0.7% in 2016 to 41.4% in 2040 to be in line with the Sustainable Development Scenario (SDS). However, the New Policies Scenario, which reflects the impact of existing policy frameworks and today's announced policy intentions, projects a far less ambitious situation for renewable powered desalination. This would be significantly inadequate to align desalination with the Paris Agreement and limiting global warming to 1.5-degrees.

Table 1. IEA projections of the necessary energy mix for desalination in the Middle East to be aligned with the Paris Agreement

	Concentrated Solar Power	Renewables	Nuclear	Fossil Fuel	Oil	Natural Gas
2016	0%	0.7%	0.2%	67.2%	9.3%	22.6%
SDS in 2040	3.2%	41.4%	8.7%	15.3%	2.7%	28.8%

From 2016 – 2021, an investment of US$10 billion in desalination was expected. This would have added roughly 5.7 million cubic meters per day of new production capacity, which is expected to double by 2030. This projected increase underlines the importance of addressing the energy mix powering desalination to avoid subsequent increases in emissions associated with the sector. The long asset lifetime of desalination plants (25+ years) also makes the avoidance of fossil fuel lock-in of equal importance.

2.4. Desalination and climate change

A combination of population and economic growth, increased water consumption per capita and diminishing water supplies due to climate change and pollution, is intensifying fresh water scarcity in most regions[25]. Though not a silver bullet for water management, desalination represents a unique solution with high potential for provision of resilient water supply. The complex challenges facing the water sector means that a host of water management techniques must be considered on a regional and local scale that will best maximise their specific application and strengths. Desalination of seawater and brackish water can provide an unconventional yet reliable water supply to both large and small populations, independently without having to rely on an upstream supply from elsewhere or exhaust a non-replenished aquifer.

However, desalination brings with it a unique set of issues compared to other water management techniques. Typically, desalination plants require large amounts of energy which is generally created from fossil fuel sources, leading to significant amounts of emissions associated with the water produced. As such, while they can have positive effects on water supply, desalination plants have historically played a largely negative part in emissions mitigation. With desalination projected to experience considerable increases in its adoption globally, emissions associated with desalination are at risk of rising further. As a fraction of the world's energy consumption and GHG emissions, desalination was less than 0.2% of worldwide energy consumption in 2013[26]. Despite this, the projected increases in capacity, along with the need to decarbonise all parts of the economy, make climate action in the sector crucial.

A study by Lienhard et al. (2016)[27] explored the potential for low carbon desalination. The majority of emissions from desalination come from the energy used to generate the electricity or thermal energy which powers the plant (scope 2 emissions). The study provides figures on the representative direct GHG footprint of different types of desalination plants:

Table 2. GHG footprints of different technology categories of desalination (Lienhard et al., 2016)

Representative Direct GHG Footprint kg CO2 per m^3 (1000 L) fresh water	
Reverse osmosis (RO)	2.1 – 3.6
Multi-effect Distillation with Thermovapor Compression (MED-TVC)	8 – 16
Multistage Flash (MSF)	10 – 20

Thermal technologies such as MSF are most emissions intensive as they directly utilise fossil fuels to heat the water for desalination and are less energy efficient. As membrane technologies such as RO are powered by electricity, not only are they more efficient, but they can also be powered by renewable energy, an increasingly common practice.

[25] Richter et al. (2013); Djuma et al. (2016); Damania et al. (2017)
[26] Found here: https://jwafs.mit.edu/sites/default/files/imce/workshops/2016/Desalination/Desalination_Summary.pdf
[27] Ibid.

As such, the main opportunities for decarbonising the industry lie in either improving the energy efficiency of a plant and thus reducing its energy requirements or increasing the amount of energy sourced from renewable energy. Today, available desalination technologies have resulted in significant improvements in energy efficiency, while developments in renewable energy represent an opportunity for desalination plants to shift their energy source to carbon neutral sources. Desalination therefore has the potential to be a key component of global climate, and therefore water, resilience assuming technological and clean energy advances can be appropriately integrated.

3. Green Bonds for Water Infrastructure

3.1. Funding needs for Water-Intensive Investments: A Shifting Policy and Investment Context

Water investments have been highlighted globally through the 2030 Agenda and the SDGs, which depend heavily on water resources to meet targets for access to clean water, effective healthcare, and energy and food security.

In 2015, the international community, under the auspices of the UN Framework Convention on Climate Change (UNFCCC), set out targets in the Paris Agreement to slow the rate of climate change. National goals under the Paris Agreement are defined through a new instrument called Nationally Determined Contributions (NDCs). More than 80% of the NDCs to date explicitly mention water as necessary to meeting climate mitigation and adaption goals, and new and updated water infrastructure will be critical to meeting both NDC and global climate targets.

Annual global investment in water is estimated to be USD1-2 trillion, including construction, operations, maintenance of new infrastructure, and upgrades to existing assets over many sectors.

3.1.1. Investment need for desalination and current financing

The global water desalination market is estimated to be valued over USD 32 billion by 2025[28]. In 2016, an estimated USD 6.2 billion in capital investments were made in desalination[29]. Of this, 47 percent (US$2.9 billion) were financed using 'Build-own-operate-transfer' (BOOT) schemes. Here, the private partner finances the desalination facility and operates it for a long period of time, usually 20 to 25 years, in exchange for tariff-based payments linked to plant capacity and actual water demand. The contracts for these projects are awarded to the bidder with the lowest tariff[30]. Alternatively, delivery methods may include "engineering, procurement, and construction" (EPC), in which the private contractor is

[28] https://www.globenewswire.com/news-release/2020/01/29/1976640/0/en/Water-Desalination-Market-to-grow-at-a-CAGR-of-9-5-to-hit-32-billion-by-2025-Global-Industry-Analysis-by-Growth-Factors-Value-Chain-New-Technologies-Cost-breakdown-Investments-Oppo.html

[29] Based on figures cited in: http://documents1.worldbank.org/curated/en/476041552622967264/pdf/135312-WP-PUBLIC-14-3-2019-12-3-35-W.pdf

[30] ://documents1.worldbank.org/curated/en/476041552622967264/pdf/135312-WP-PUBLIC-14-3-2019-12-3-35-W.pdf

responsible for the design and the construction of the facility; or the "design-build-operate" method (DBO), in which the contractor is responsible for the operation of the plant for a limited number of years.

Bank debt and bond financing are the primary sources of funding in desalination. Equity may be 100% public or private or a mixture, depending on the nature of the public-private partnership involved in the implementation of the project. In the Middle East, for example, DBO projects are loan financed, whereas larger projects have mixed debt and equity financing. Building and developing new, more efficient and environmentally friendly desalination plants will thus require substantial amounts of capital. The finance gap can be at least partially filled by climate bonds which focus on climate friendly measures in plants which also reduce their own operation costs.

Currently, no projections or scenarios have been developed that explore the investment needed for desalination to align with the Paris Agreement or with IPCC warming scenarios.

3.2. Bond issuances to date

The green bond market emerged in 2007- 2008 with bonds issued by the World Bank and European Investment Bank (EIB). From 2007-2012, the market mainly featured development banks such as the EIB, IFC, and World Bank. As the market grew, there has been increasing diversification of both issuers and investors. In 2017, the labelled green bond market amounted to USD349.5bn outstanding, rising to USD1tn in 2020. Issuance in 2019 alone was in excess of USD266.1bn – a record high.[31]

Looking at water-related bonds in particular, USD23bn of green bonds relating to sustainable water management were issued in 2019, up from USD20bn in 2017. Overall, this sector represented 9% of all green bonds issued in 2019, which is a decrease from 13% in 2017.

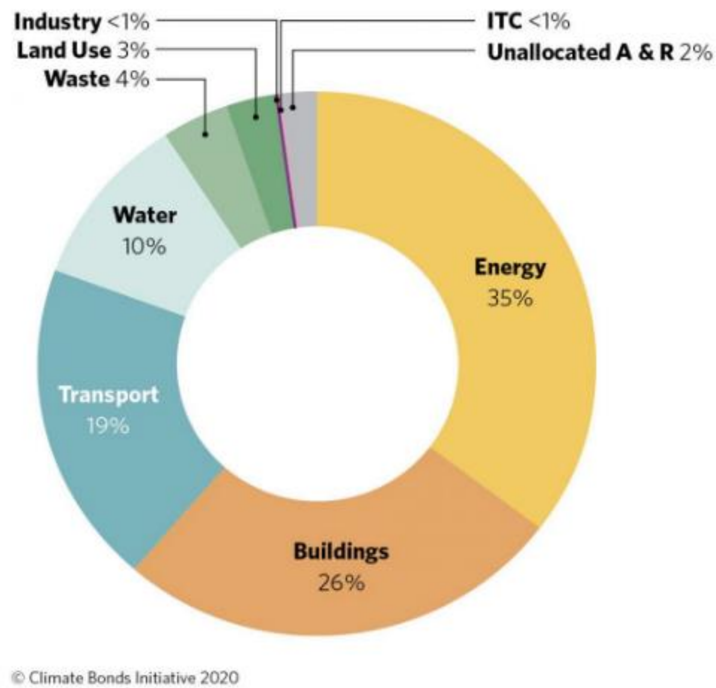
The proceeds of these water related bonds have been allocated to various water infrastructure assets/projects including water treatment with a focus on waste and drinking water upgrades; flood protection such as investment in levees, storm sewers, sea walls and other flood defences; restoration of natural water services and water efficiency and conservation; and other general water authority adaptation upgrades.

In the US, several labelled green bonds related to water infrastructure assets have been issued. An early issuer was DC Water, which came to market in 2014 and has subsequently returned to the market in 2015 with a USD100m issuance. Authorities with green bonds include a variety of state/provincial and city government entities: Massachusetts Clean Water, Indiana, New York, St. Paul in Minnesota, Connecticut and New Jersey. Four bonds totalling over USD1bn have been issued by San Francisco Public Utilities Commission, which were certified against the Climate Bonds Standard under the provisions of Phase 1 of these Water Infrastructure Criteria.

[31] 'Green Bond Highlights 2017' available at: https://www.climatebonds.net/files/reports/cbi-green-bonds-highlights-2017.pdf

One more notable bond issuance example certified under Version 2 of these Water Infrastructure Criteria was that of Central Arkansas Water (CAW). The US municipal green bond of USD31 million was used to buy and protect forests in order to secure clean drinking water.

Figure 1: Use of proceeds of green bonds issued since their inception



Box 2 below provides further clarification on the nature of green and climate bonds, vis-à-vis regular "vanilla" bonds.

Box 2: Climate Bonds, Green Bonds and Blue Bonds

Green bonds are just like regular (or "vanilla") bonds in that they are issued by a public or private entity, which guarantees to repay the bond over a certain period with interest. Green bonds, however, have one distinguishing feature over regular bonds: proceeds are explicitly earmarked for projects or assets with environmental benefits.

The idea of a climate bond is an extension of the green bond concept. The use of proceeds in a climate bond are earmarked for assets and projects with clear climate change benefits for climate mitigation, and climate adaptation and/or resilience.

"'Blue bonds" is a label sometimes used to refer to bonds driving capital toward water-related projects and assets. In reality, there is much overlap among green, blue and climate labelled bonds. Many green bonds are used specifically to fund climate mitigation and adaptation assets and projects. Further, as climate bonds move into climate resilience considerations, they are increasingly incorporating a range of traditional sustainability impacts. Blue bonds are green or climate bonds that emphasise the water ('blue') component of the investment.

3.2.1. Bonds in the Desalination sector

Notable bonds and loans issued to finance desalination projects include the USD758 million project finance loan by ACWA Power and Natixis. With a contractual tenor of 32.4 years, this finances the Taweelah Independent Water Plant (IWP) which, when completed in 2022, will be the largest reverse osmosis plant in the world[32]. Vigeo Eiris provided a second party opinion for the loan, moreover. It is claimed the plant will use the lowest amount of energy per cubic metre of water produced of any desalination plant. Spanish construction company Grupo ACS issued a EUR750 million green bond, of which 12% would be designated partially to desalination projects in the UAE, Peru and Africa[33]. The California Pollution Control Financing Authority issued a USD756 million bond to finance the Carlsbad Desalination Plant in San Diego[34].

3.3. Growing credible green finance for water

The rapid growth of the green bond market since 2012 has been met with questions around the environmental claims of these bonds. In the absence of clear and widely accepted definitions around what qualifies as "green", many investors have raised concerns about 'greenwashing,' where bond proceeds are allocated to assets that have little or uncertain environmental value. Such concerns can both shake confidence in the market and hamper efforts to finance a transition to a low carbon and resilient economy. High and credible standards are necessary for the sustainability of the broader market and for maximum environmental impact.

[32] https://www.waterworld.com/international/desalination/article/14169801/taweelah-iwp-obtains-the-first-ever-sustainable-loan-qualification-for-desalination-project
[33] https://www.globalwaterintel.com/news/2018/14/acs-green-bond-to-fund-desal-on-three-continents
[34] https://www.businesswire.com/news/home/20131205006552/en/Carlsbad-Desalination-Project-is-Named-%E2%80%9CDeal-of-the-Year%E2%80%9D-by-The-Bond-Buyer

The Climate Bonds Standard Water Infrastructure Criteria ensure the environmental value of certified assets and define both low carbon and climate resilient water infrastructure, including nature-based solutions. The Criteria focus on both the climate mitigation and the adaptation and resilience aspects of water infrastructure assets, as well as their impact and benefits on ecosystems from those investments. The vision of "green" here includes both the asset being financed and the larger eco-hydrological context of that asset over its operational lifetime.

Certifying a water-related green bond under the Climate Bonds Standard Water Infrastructure Criteria provides assurance on the climate and water sustainability credentials of those bonds. Certification allows issuers to demonstrate to the market that their water bond meets best practices for the claims of the climate integrity, management of proceeds, and transparency, making it easier for investors and intermediaries to identify and invest in low carbon and climate resilient water infrastructure assets/projects with genuine water and climate benefits.

4. Key issues considered in the Water Infrastructure Criteria

4.1. Scope of the Water Infrastructure Criteria

4.1.1. What assets and activities should be covered by these Criteria?

The Water Infrastructure Criteria apply to a wide range of water assets and projects, spanning industrial water efficiency, water treatment and reuse including water utility functions, aquatic ecosystem restoration and management, and water supply systems. In addition, assets and activities designed to ensure adaptation and resilience are the newest type of water investments, and as such, were deemed to be a major target for the
Water Infrastructure Criteria.

That is, the Criteria cover assets and activities relating to:

- Water monitoring: real-time and remote sensing approaches to understand shifts in water quality and quantity, including early warning systems for extreme events;
- Water capture and/or transfer: retaining water moving across the landscape or facilitating the bulk transfer of water resources;
- Water storage: keeping water for later allocation and delayed use;
- Water treatment: altering water to meet specific standards or the needs of stakeholders, consumers, or environmental applications;
- Water desalination: though a form of water treatment, it is addressed separately in the scope of these Criteria
- Flood defence: protecting against rising waters;
- Drought defence: addressing water scarcity;
- Storm-water management: coping with intense precipitation events, especially in urban settings;
- Ecological restoration / management: supporting intact or recovering damaged ecosystems in a shifting climate.

The Criteria can apply to both new assets and existing assets undergoing modification or repair, and those being refinanced.

They are also appropriate for a variety of construction types of water infrastructure, including:

- Built or engineered infrastructure, which refers to traditional water infrastructure investments. Examples include wastewater treatment plants, the use of concrete storm-water systems, and drip irrigation.
- Green, nature-based, or natural infrastructure, which includes the use of ecosystems and ecological processes in order to deliver water services, such as the use of wetlands for water treatment and the application of biophysical structures for water storage, such as aquifers.
- Hybrid infrastructure, which blends built and green solutions, such as “room for the river” flood control solutions that mix ecosystems with built structures such as levees.

Therefore, it is expected that many bond issuers will include in their portfolios assets and activities that span more than one sector, function and/ or construction type. The Criteria have been developed to be flexible to all these circumstances.

Where necessary, guidance is given regarding the appropriate sections of the Criteria relevant for specific components in a bond issuance.

4.1.2. What assets and activities are not covered by these Criteria?

Early in the development of the Criteria, hydropower represented a distinct cluster of issues relating to both climate mitigation and climate adaptation. For instance, while hydropower is a renewable source of energy, the scientific and engineering literature illustrates a complex picture in terms of the greenhouse gas impacts associated with water storage reservoirs associated with hydropower. As a result, the recognition of hydropower as a low-carbon energy source requires detailed examination.

Moreover, the application of climate adaptation approaches to hydropower has been quite recent, with a growing but still small number of cases available and some controversy over the sensitivity, exposure, and need to address climate impacts for existing and new assets. The path for future hydropower development is an important but sometimes divisive issue, and some projects have been associated with significant negative environmental and social impacts. For the TWG, it was unclear if these complexities around hydropower represented a significantly distinct break from other types of water infrastructure assets since the group did not contain a large proportion of hydropower specialists and experts.

As a result, hydropower related assets and activities are not covered by these Criteria. Readers are directed to the forthcoming Hydropower Criteria, open for public consultation in March 2018.

Water infrastructure assets or activities directly serving one or both of the following are not within scope of these Criteria:

- Mining operations
- Nuclear power

Rationale for this is consistent across all Climate Bonds sector criteria. The Climate Bonds Initiative currently do not have robust Criteria for either of these sectors. In the absence of competence or expertise on such sectors, the TWG chose to place such plants outside of the scope of criteria to avoid controversial or problematic issuances. Until criteria of the same standards as other sectors exists for these, the Climate Bonds Initiative takes no stance and excludes them from scope.

Once criteria do exist for such sectors, the assumption is that, for any water infrastructure assets seeking certification directly serving such purposes, the mine or nuclear plant would need to meet their own respective criteria in addition.

4.1.3. Automatically excluded assets and activities under these Criteria

Automatic exclusions under these Criteria include assets or activities directly or explicitly supporting fossil fuels, for example:

- Integrated Water and Power Plants (IWPP)
- Desalination plants providing water directly to fossil fuel power stations

4.1.4. How does this scope fit with other Sector Criteria under the Climate Bonds Standard?

The Water Infrastructure Criteria are intended to apply to a broad array of water investments and asset but there are some cases where other criteria such as Forestry/Agriculture or Transport may be a more effective fit even when water resources are a fundamental aspect of the investment. Indeed, there may be some cases when these lines are unclear.

For instance, for an asset involving the use of riparian forests and wetlands, these ecosystems may be managed for nutrient control for agricultural runoff (Forestry/Agriculture Criteria) as well as for flood defence (Water Infrastructure Criteria). Forest management, energy, some types of water treatment, and other types of agricultural assets may all blur sector criteria.[35]

[35] The link between water quality, water quantity, and forest management is complex. Many progressive water managers also consider themselves land managers, especially in forested areas, since land management can have a significant impact on runoff patterns and water quality. Some researchers and management institutions also claim important relationships between forest management and the ability to increase or alter runoff, water storage, and water supply, though these claims are more controversial and probably specialized. In the future, we may see the emergence of offerings that integrate climate mitigation benefits from land management (e.g., forest and soil carbon storage/sequestration) designed with a water quality benefit, but these concepts have not reached a stage where they can be easily formulated and presented through finance vehicles such as bonds. A clear application of how to link these areas has not been developed as of yet.

Where sector boundaries are not clear, the issuer should discuss with the Climate Bonds Initiative to determine the best sector Criteria fit. Generally, the primary purpose should be the basis for deciding on the appropriate Sector Criteria to apply.

In the case where a single issuance includes more than one asset in a portfolio and these assets span a number of sectors, the most appropriate Criteria should be applied to the individual underlying assets of the issuance. For example, a single bond offering may include both a stormwater control project and (quite separately) a building energy efficiency project. These individual projects may not even be directly linked except through the issuing authority and their bundling within a single bond. Here, the stormwater project should be evaluated against the Water Infrastructure Criteria, and the buildings energy efficiency project under the Buildings Criteria.

4.2. What climate impacts are addressed in the Water Infrastructure Criteria?

Relevant to all sectoral Criteria, the Climate Bond Standard aims to screen for assets and activities that:

- Align with a global economic transition that limits global warming to 1.5°C or less; and:
- Are adaptable and resilient to unavoidable climate change.

For water infrastructure assets including nature-based solutions, climate resilience and the ecological interactions of the investment are key concerns for long-term sustainability. If the design and operation of water projects do not anticipate shifting climate conditions (including the relationship of the water project with surrounding ecosystems), the reliability of water projects to function and be fit for purpose may be compromised. Climate change is altering the risk profile for water projects across all geographies and asset types. In addition, the expectation for green and climate bonds among investors is that these assets have an environmental benefit and/or are designed to minimise negative impacts on ecosystems.

Perhaps the best-known example of a major water project being compromised by changing climate conditions is the Hoover Dam in the USA's Colorado River Basin. The dam was planned, designed, and built in the 1920s and 1930s using assumptions of much higher mean river flows, yet over the last several decades, the timing and amount of precipitation in the upper basin have been deviating substantially from these assumptions. Under these unanticipated conditions, the dam's ability to supply water to regional cities, to generate hydropower, and to meet downstream water demand is reaching operational limits, necessitating considerable investment in auxiliary infrastructure (>1 billion USD) to maintain expected levels of service. Moreover, trade-offs between human needs and ecological requirements are becoming more difficult and limited.

Although the general practice of climate adaptation is still a comparatively young field in both theory and application, the assessment of climate risk for water-intensive projects has become widespread and normalised. Accordingly, the Technical and Industry Working Groups considered that climate resilience as well as climate mitigation must be a fundamental component of the Water Infrastructure Criteria under the Climate Bond Standard.

This decision reflects an emergent body of practice among water managers and professionals that will only become more widely understood and accepted as the climate adaptation sphere becomes more accurately defined and evaluated through new measuring and assessment frameworks.
As a result of these boundary conditions, the Criteria are intended to screen for water infrastructure related assets and activities that:

a. Support climate mitigation (i.e., reduce the rate of climate change);
b. Will be insulated from and robust to realised and credible future climate impacts and will not cause worsening environmental footprints as climate conditions continue to evolve.

Like other sector-specific Criteria under the Climate Bonds Standard, the Water Infrastructure Criteria do not attempt to address all environmental, social and governance aspects relating to water infrastructure. They can be supplemented by other relevant standards that cover areas such as stakeholder engagement, social or human rights as desired. (see Appendix 4 for details).

4.3. How to address climate mitigation in the Criteria?

Both working groups found that climate mitigation (reducing the rate of climate change by lowering GHG emissions into the atmosphere) is an important and relatively straightforward function for most water infrastructure assets. The exception is for desalination assets which is discussed in greater detail in section 4.8.

The Criteria ask for a reduction in net GHG emissions or (at a minimum) a neutral impact in the case of investments intended primarily to buffer climate impacts - in an effort to minimise the harm of future contributions of greenhouse gases to the atmosphere. Following the 2015 Paris Accord and the increasingly widespread recognition that reducing greenhouse gases emissions must be met through more sectors and economic activities over time, these low-carbon standards and methodologies can be expected to become more stringent in coming years. As such, the role of climate mitigation in the Criteria should be expected to increase over time, especially for grey infrastructure.

In terms of how to estimate GHG emissions impacts in grey water infrastructure, the Criteria advise utilising established standards and evaluation methodologies for carbon accounting in the water sector. For example, the UNFCCC Clean Development Mechanism (CDM), Voluntary Carbon Standard (VCS), and the American Carbon Registry (ACR).

Evaluating the climate mitigation potential of nature-based-solutions is more complicated. Several organisations, such as Conservation International, the Ramsar Convention, IUCN, and Wetlands International, have been attempting to describe a practical mechanism for accounting for the massive quantities of carbon - sometimes called blue carbon - that can be stored in near-coastal regions such as estuaries and in specific types of ecosystems, such as mangrove forests and seagrasses.[36]

Forests and soils have also received extensive attention at national and global policy levels for their role in sequestering and storing carbon, as well as their additional co-benefits (e.g. ecological restoration). The UNFCCC Kyoto Protocol defined a funding mechanism to support climate mitigation efforts for such terrestrial systems called REDD+. Efforts are now quickly emerging to include blue carbon into these assets.

There have also been efforts to explore the role of tropical peatlands, frozen tundra, and freshwater wetlands more generally as carbon storage mechanisms. Given that these ecosystems could become the target of funding, they may well also be a candidate for future green bonds. However, the science and assessment / monitoring methodologies are not yet ready for application.

4.4. How are climate mitigation and climate resilience balanced in the Criteria?

For longer-lived assets, the TWG suggested that the Water Infrastructure Criteria should also confirm that the assets themselves and their climate mitigation and other environmental benefits will be robust to future climate impacts through the evaluation of a climate vulnerability or risk assessment as well as have any resulting adaptation plan to address identified climate vulnerabilities. This is explained further in Section 4.5 below.

In reference to longer-lived, the TWG focused on the climate risks associated with water-related assets with an intended operational lifetime longer than 20 years — a timeframe now in use with the World Bank and other major sustainable development finance institutions.[37]

4.5. How to address climate adaptation & resilience in the Criteria?

4.5.1. How is climate resilience defined and addressed in the Criteria?

During the consultation process, the TWG quickly expressed that any Criteria should incorporate climate resilience - the ability for the asset and its intended climate and environmental benefits and services to endure in face of ongoing climate shifts.

Globally, the mechanism to assess climate risk and resilience is referred to as a climate vulnerability assessment or more simply a vulnerability assessment. Assessing climate vulnerability has become standard for almost all long-lived investments, though great variations exist in how those assessments are structured. Nonetheless, all vulnerability assessments essentially look at the climate related risks for a nation, region, project, asset or activity and define the level of concern or acceptable threat tolerance. Vulnerability assessments are a diagnostic tool. In most cases, they are integrated with the design and planning stages of the project cycle.

[36] https://www.nature.com/articles/d41586-018-00018-4
[37] For example, see Ray, P., and C. Brown, 2015, Confronting Climate Uncertainty in Water Resources Management. Washington, DC: World Bank Group.

They may also be included with other tools, such as environmental impact assessments or strategic environment assessments.

A great deal of variation between assessment methodologies exists, but the TWG does not feel that a consensus exists for recommending a single approach or tool for all contexts, asset classes, and types of institutions.

The TWG believes that requiring some form of climate risk diagnostic assessment is fair and appropriate as it has become mainstream for the majority of water investments. The Water Scorecard detailed in the Criteria reflects what the TWG and IWG believe to be reasonable, widespread, and meaningful aspects of vulnerability assessments, as well as to ensure that any necessary adaptation planning is explicitly linked to identified risks. These topics are explored in more detail below.

Once climate risks have been identified, then a secondary analysis is normally used to determine the most effective climate adaptation and resilience response to these risks. Most often referred to as an adaptation plan, these recommendations are the “response” to any risks diagnosed through the vulnerability assessment. Often, the adaptation plan appears as a final section in a vulnerability assessment document or integrated within sections in a vulnerability assessment that address specific climate risks. If climate risks are not seen as important in the vulnerability assessment, no adaptation plan is necessary.

While vulnerability assessments and adaptation plans have become normalised within technical members of the water community such as engineering, science, economics, and legal-governance specialities, the reporting of these processes to financing authorities and to investors has not. Therefore, the core emphasis on reporting resilience is a distinguishing feature of these Criteria. Indeed, investors are becoming rapidly aware of the need to make real or potential climate risks explicit for a wide variety of asset classes, and the Water Infrastructure Criteria represent a profound shift in how these risks and efforts to reduce or eliminate those risks should be assessed and communicated more broadly.

4.5.2. Using a process-based approach to assess climate vulnerability

How should climate risk, vulnerability and adaptation interventions be defined in a way that can be reported to investors? The TWG spent considerable time on this issue.

No single standardised definition for climate vulnerability, risk, or hazard (much less adaptation or resilience) was found. Resilience is often subjective, a negotiated measure or quality, reflecting local and regional priorities and choices among often complex trade-offs. For example, resilience for a water utility in Bangladesh is likely to look quite different to resilience for a water utility in the Netherlands, even one facing similar types of climate risks.

Indeed, the TWG noted that climate risk assessment is in a period of rapid evolution and development, and a set of impact or output based criteria that follows a single approach (even a majority use approach, if one exists) would likely become dated quickly and potentially reduce the likelihood of issuers using the Criteria. Instead, the TWG suggested that we follow a process-based approach, a choice that was validated by the IWG.

Such a process-based approach considers the breadth and scope of the vulnerability assessment as well as the level of detail that is pursued. Implicit in these Criteria is the assumption that vulnerability comes from both known, predictable threats as well as uncertain, difficult to evaluate threats. The Criteria thus evaluate the depth of the vulnerability assessment rather than the specific outcomes.

4.5.3. What resilience attributes were deemed most necessary to address in these assessments?

The Water Infrastructure Criteria focus on the resilience of both the intended/designed services of the asset (e.g. water storage) and the relationship between the asset and its surrounding ecosystems. More generally, the resilience attributes the TWG identified as most necessary for water infrastructure assets and activities are "robustness" (the ability to span a variety of credible climate futures) and "flexibility" (the ability to alter operations and modify design as the future unfolds). These attributes are reflected explicitly through the assessment of criteria for water governance and allocation patterns (whether the operations of the asset are flexible in the face of shifting conditions) as well as the explicit consideration of the uncertainty and credibility associated with future climate conditions as reflected in the assessment of technical eco-hydrological variables (whether the asset and its operations are robust and capable of encompassing a wide variety of potential future scenarios).

4.5.4. How might these qualities best be evaluated?

While climate mitigation contributions are relatively straightforward to evaluate, even quantify, developing a clear means of evaluating the climate adaptation and resilience of assets and activities was an early challenge in the development of the Criteria.

To achieve these goals, the TWG created a checklist to assess how the issuer's vulnerability assessment and adaptation plan (if required) explore risks associated with both the asset itself and its environmental footprint - how the asset interacts with ecosystems even if climate shifts alter the function of the investment and/or the ecosystem.

The IWG in particular insisted that a checklist should be easy to score and transparent in terms of the content used to adjudicate each criterion. The TWG was interested in a thorough coverage of resilience (as defined above) that was applicable to a wide class of assets. Ideally, the resilience criteria would also provide a kind of implicit decision support guidance for issuers, encouraging them to define resilience broadly and to implement comprehensively.

The checklist is divided into five main sections with a number of subdivisions. The main sections include vulnerability assessment criteria that apply to all issuers (Allocation, Governance, Eco-hydrological qualities).

The allocation section is intended to evaluate how water resources are divided among users and how resource mechanisms may either facilitate or reduce the ability of the issuer to adapt the asset as conditions change. The governance section explores how real or potential water conflicts may be avoided, reduced in scope, or adjusted and renegotiated. In most developed countries, governance and allocations systems are typically expressed through strong regulatory, legal, and institutional frameworks, and assets given such a context will score well.

The Criteria are written so as to be relevant to a global setting, appropriate for both developed and developing economies. Many of the items are derived from the OECD Water Governance guidelines. The technical section on eco-hydrological qualities explores in some depth how a design and/or operations was assessed for climate risks, including the comprehensiveness of ecological, hydrological, and climate qualities.

In addition, a fourth section includes additional vulnerability assessment criteria that apply specifically to green and hybrid assets only - these represent the major difference between phases 1 and 2 in the development of the Water Infrastructure Criteria. A fifth section includes additional assessment criteria that apply specifically to desalination plants. These represent the major difference between phases 2 and 3, along with mitigation requirements for desalination plants. Adaptation plan assessment criteria apply only to those assets where the vulnerability assessment has identified specific climate impacts that must be addressed.

The criteria in each section were developed and elaborated recursively with both the TWG and IWG. The criteria are unweighted and phrased as present/absent or pass/fail, though some criteria may not apply to specific types of investments. For both phases of the Water Infrastructure Criteria development, the elaboration and phrasing of each line occupied the majority of the development time and attention. The initial Criteria have held up well since the completion of Phase 1, but both working groups acknowledged that they may need to be adjusted or revised over time in order to remain relevant and useful.

There are a few “special” criteria, such as the requirement that a vulnerability assessment be prepared and available for investors, the presence of an adaptation plan (if required) that is also available for investors to peruse, and the use of two qualifying assumptions for the use of the Nature Based Solutions (NBS) criteria (described in more detail below). There is no need of a very detailed or lengthy adaptation plan - often they are quite brief and simple. The adaptation plan is intended to evaluate how the issuer plans to respond to risks that have been identified in the vulnerability assessment, which is often more detailed and technical than the adaptation plan.

The issuer must score a minimum of a 60 percent pass for all sections of the checklist. The working groups suggested that this threshold would be reasonable for the launch of the Water Infrastructure Criteria, with the recognition that the pass rate may rise or lower over time. Given broader trends among investors and infrastructure developers, it may be a safe assumption that the pass threshold will remain steady or increase in the future. Note that the 60 percent threshold will be revisited one year after the release of the Water Infrastructure Criteria and after green bonds being issued from at least 3 different issuers certified for both built and green/hybrid water infrastructure under the Criteria.

For the process of scoring, the issuer should prepare a document that makes available supporting information for the adjudication of the criteria. Guidance for the preparation of such a document is available here, which is intended to promote both transparency and clarity for investors.

4.5.5. What are the boundaries of the assessment?

Many specific elements of the Water Infrastructure Criteria address a tension around scale. While most assets are conceived at a localised project scale, the TWG found that much evidence around resilience for water issues - dating back to the nineteenth century - suggest that basin or watershed scales are important for meaningful action and management. That is, resilience at one locality is often in a complex relationship with resilience of upstream and downstream entities.

This larger hydrological relationship is explored in many criteria. As a result, an issuance with a vulnerability assessment that demonstrates an awareness of basin and sub basin relationships, including allocation and governance qualities, will score much higher. Wider boundaries mean a better score. Similar patterns exist for groundwater and aquifer management. By the same token, an asset that is conceived only as a local asset is a riskier investment simply from ignoring upstream/downstream relationships.

4.6. How are phase 2 Criteria relating to hybrid and green water infrastructure assets incorporated alongside phase 1 Criteria for built water infrastructure?

The general approach developed during Phase 1, focusing on built water infrastructure, was largely maintained in Phase 2, which addressed the special issues relating to NBS.

This continuity between phases was not an accident. During Phase 1, we constantly confronted questions around hybrid and green infrastructure, and while we knew that some of these questions must be deferred, we also knew that a strong foundation was critical to ensure the Criteria would remain relevant across a wide range of assets, asset classes, sectors, and situations.

However, beginning in 2016 during Phase 2, the TWG identified some issues specific to hybrid and green infrastructure that needed more focused treatment and a higher standard of credibility for both issuers and investors, most notably:

- Addressing the heightened difficulty of predicting future ecological and hydrological responses to climate impacts,

- Prioritising the incorporation of *existing* ecosystems and ecological processes, followed by the *restoration* of existing ecosystems, and then the *creation* of "new" ecosystems. In essence, we suggest working with existing and intact ecosystems or enhancing those ecosystems rather that constructing or engineering new ecosystems and ecological processes, although the latter is the primary choice at so-called brownfield sites.

These elements help ensure that the certification of nature-based-solution (NBS) assets will not result in greenwashing or the endorsement of low credibility, low resilience, or high-risk assets.

Conceptually, the TWG was very concerned about the basis for green and hybrid infrastructure. There were concerns that some investments might degrade existing ecosystems or that funded assets could lack a clear water services benefit for human communities. Since ecosystems are often very sensitive to climate shifts, many of the criteria emphasise ecological *processes* and functions, which are less dependent on specific set of species (which might alter or shift with ongoing climate change).

The criteria also distinguish between natural features (which are existing ecological processes and ecosystems) and nature-based solutions (which are somewhat broader, and include designed and reconstructed and ecological analogue approaches, such as "new" wetlands on brownfield sites). As a result, the issuer must prioritise the use of existing and restored systems and processes over modified or new ecosystems. These qualifying aspects are derived from well-developed concepts and definitions on the use of ecosystems as infrastructure, which were elaborated recently by IUCN[38] and the US Army Corps of Engineers.[39]

Assuming this inherent prioritisation, the five NBS sub-sections of the checklist explore the issuer's depth and quality of knowledge about the site; its ecosystems and relevant species; the larger spatial context beyond the project site; and monitoring and management capacities. These sections were proposed through the TWG as elements necessary to ensure a credible and sustainable green or hybrid asset. As with other criteria, these criteria should be scored and transparent for potential investors.

4.7. Dealing with complexity and uncertainty

Water management systems, especially water infrastructure, can have relatively long operating lifespans - usually decades, sometimes centuries or more. These long life cycles have important implications for how we conceive of sustainable and climate resilient infrastructure.

This longevity presents significant challenges to defining what climate resilience should look like. These challenges are especially large given the sensitivity of the water cycle to ongoing climate

[38] Cohen-Shacham, E., Walters, G., Janzen, C. and Maginnis, S. (eds.) (2016). Nature-based Solutions to address global societal challenges. Gland, Switzerland: IUCN.

[39] Bridges, T.S., K. A. Burks-Copes, M. E. Bates, Z. Collier, C. J. Fischenich, C. D. Piercy, E. J. Russo, D. J. Shafer, B. C. Suedel, J. Z. Gailani, J. D. Rosati, T. V. Wamsley, P. W. Wagner, L. D. Leuck, E. A. Vuxton. 2015. Use of Natural and Nature-Based Features (NNBF) for Coastal Resilience. ERDC SR-15-1. Washington, DC: US Army Corps of Engineers and U.S. Army Engineering Research and Development Center.

change and the difficulties in how we can determine future climate impacts with accuracy, precision, and confidence. The water cycle is very sensitive to minor climate shifts, and trends in how the precipitation, seasonality, intensity, and evolving flows are notoriously difficult to predict with confidence, especially for periods of interest further away in time. This makes designing, maintaining and operating water infrastructure challenging.

While the science of climate change is relatively new, the practice of ensuring that water management practices are resilient is even newer. In the words of a recent technical publication:

> *Today, water resources managers must account for much more complexity in their technical decisions. Many aspects of that complexity have rippling, interacting waves of uncertainty: emerging socio-economic circumstances, demographic and urbanisation trends, and eco-hydrological conditions. Globalisation, population increases, and economic cycling and transformation also stress water resources systems with risks that are hard to estimate and balance. Even the science of the water cycle and our vision of "sustainable use" of water have altered in profound ways since the [the modern era] began in 1955; many of the most important management insights from eco-hydrological science are less than 20 years old.*[40]

As a result, professionals in the water field have been actively developing methodologies to determine the best means of designing and operating water infrastructure that will function safely, profitably, and sustainably in a highly uncertain future.

While the techniques to assess and reduce water and climate change risks are evolving quickly, there is no clear consensus about best practices in the engineering, water management, climate science, or finance communities. Defining Water Infrastructure Criteria therefore faces the added challenge of knowing that current insights are likely to evolve significantly and rapidly in the near future, even as finance mechanisms, financial flows, and policy priorities direct increasing attention to both climate mitigation and climate adaptation.

For this reason, the Technical and Industry Working Groups view these Criteria as a starting point, to which additions and revisions will be needed over time including potentially broadening the climate focus. The Water Infrastructure Criteria will be reviewed at least annually in the first three years of its use.

4.8. Incorporating Desalination Criteria into the Water Criteria

The following sections describe the key issues that the Desalination TWG (separate to the Water TWG) discussed and addressed in developing Criteria for desalination plants. These additional criteria were developed following suggestions that the original mitigation component of the Water

[40] Mendoza, G., J.H. Matthews, A. Jeuken (eds). 2018. Collaborative Risk Informed Decision Analysis (CRIDA): Water Resources Planning & Design for an Uncertain Future. ICIWaRM Press: Alexandria, Virginia, USA.

Criteria was unsuitable for desalination. The resulting Desalination Criteria were approved by the Water TWG and the Climate Bonds Standards Board.

4.8.1. Scope of desalination criteria

A simplified view of the scope of desalination assets and activities might be limited to one type of asset: a desalination plant. However, distinctions can be made between plants based on: (i) size; (ii) type of water being desalinated (e.g. seawater or brackish water); or (iii) location (e.g. small island, inland or coastal plants).

Further distinctions can be made between plants based on the water quality (i.e. feed and product), site conditions (e.g. plant elevation) and location (e.g. conveyance requirements and topography). There is therefore considerable variation across desalination plants which affects their ability to decarbonise and operate sustainably. The following sections (4.8.2 – 4.8.4) discuss the possible distinctions that were discussed by the TWG and the decisions ultimately taken. The TWG decided that it was not necessary to distinguish between seawater desalination and brackish water desalination plants for mitigation or A&R.

The criteria for desalination plants are technology agnostic. That is, they do not distinguish between thermal and membrane technologies. However, because the underlying criterion for all plants is to be powered using low carbon energy, it is expected that this will effectively restrict certifications of thermal desalination plants which generally use fossil fuels.

4.8.2. Distinctions based on plant size

Plants differing in size will experience certain benefits and disadvantages. Larger plants will have access to economies of scale in the water they produce. This thus improves their efficiency and economic viability. At the same time, they will have more onerous management processes for greater quantities of brine (for example). Moreover, it may be more difficult for them to source a higher proportion of their energy from renewable sources. This is especially the case when considering limits to land availability and a limited supply of renewable power in certain regions.

Plant size can be taken to mean both the area of the plant and also the production capacity (m^3 of water / day). Larger plants that produce greater quantities of water per day (up to one million m^3 water / day) may see high energy efficiencies (low kWh / m^3 values). However, their overall energy demands may still be high. This is taken into account in these criteria. See Section 4.8.7 for more detail.

The TWG decided to not make any distinction in criteria for plants differing in size. Large and medium-sized plants (ranging in capacity from $1000m^3$ up to $1,000,000m^3$ of water produced per day) can feasibly integrate high levels of clean energy powering their processes. The lower energy and land requirements of smaller plants (with capacities at and below $100m^3$ per day) make them even more suitable for low carbon energy sources, such as solar or wind power. This can even be a directly owned energy source on site, without the need to take energy from the grid or establish a Private Purchase Agreement (PPA) for renewable power.

The Criteria require issuers to meet one mitigation threshold. This threshold reflects low carbon energy powering a desalination plant. Even with variations in plant size, this threshold is ambitious yet should be attainable even for large plants.

4.8.3. Distinctions based on feedwater type

DesalData, a comprehensive global database maintained by Global Water Intelligence (GWI), categories feedwater according to ppm Total Dissolved Solids (TDS). Seawater has the highest ppm TDS, followed by brackish water. Other categories (not in order of ppm TDS) are river water, pure water, brine and waste water. For simplicity, these criteria cover the desalination of seawater and brackish water, the two most common feedwater types, which accounts for 82% of desalinated water production globally[41].

There are considerable differences in the energy requirements and water destination of desalination plants depending on the feedwater they desalinate (seawater and brackish water). These differences may be partially due to the end use of the desalinated water, as desalinated brackish water is generally used more for industrial purposes than seawater[42], which generally serves drinking water purposes. Drinking water generally requires a higher water quality than water for agricultural, although there is considerable variation.

Seawater can be defined as water drawn from the sea. Brackish water is defined as water saltier than fresh water, but not as salty as seawater. It may come from estuaries or aquifers, for example. Certain human activities can produce brackish water, in particular certain civil engineering projects such as dikes and the flooding of coastal marshland[43].

The difference in energy requirements between seawater reverse osmosis (SWRO) and brackish water reverse osmosis (BWRO) desalination plants is largely due to the thermodynamic conditions of desalinating the feedwater. The lower starting salinity of brackish water means less osmotic pressure is needed to push the feedwater through the membrane and desalinate it. This means brackish water desalination requires considerably less energy than seawater desalination. This is reflected in the range of energy efficiencies seen across these categories (0.5 – 3 kWh/m^3 for BWRO and 3 – 6 kWh/m^3 for SWRO)[44].

In spite of these distinguishing characteristics, the TWG decided that there was no need to make distinctions between seawater and brackish water desalination plants. This is because these

[41] Jones et al. (2019)
[42] https://www.waterworld.com/international/desalination/article/16203131/membranes-now-dominate-95-percent-of-desalination-market
[43] https://www.eea.europa.eu/archived/archived-content-water-topic/wise-help-centre/glossary-definitions/brackish-water
[44] Roy, S. and Ragunath, S., 2018. Emerging membrane technologies for water and energy sustainability: Future prospects, constraints and challenges. Energies, 11(11), p.2997.

Criteria do not set thresholds based on plant energy usage, but only on low carbon energy. As such, plants using either feedwater type have the same ability to adopt low carbon energy.

Seawater and brackish water desalination plants do not only differ in their energy usage and emissions aspects. They also face different challenges in two key issues identified by the TWG for A&R. Brine disposal (and to an extent moving towards zero liquid discharge) involves different strategies and processes for a seawater desalination plant than for a brackish water one. The same goes for feedwater intakes. These issues and distinctions between categories, along with possible solutions, is discussed in more detail in sections 4.8.9 and 4.8.10. Despite this, the A&R component of the Water Criteria provides flexibility for the issuer. It allows them to use the solutions that best suits the conditions of the plant, while still requiring a robust plan or strategy in place to deal with both issues.

4.8.4. Other variation in desalination plants

The TWG also discussed other important distinctions between desalination plants based on a variety of factors. This included site conditions, such as plant elevation, or location, for example conveyance requirements and salinity of the feedwater (the Mediterranean is less saline than the Arabian gulf). Again, these factors affect the energy requirements, emissions, and a plant's approaches to dealing with intakes and brine discharge.

There were several reasons why it was unsuitable to distinguish based on these other factors. Firstly, there is similar reasoning as for the previous two sections. With the mitigation threshold being simply set on the carbon intensity of the energy source, there is no need for thresholds to differ between plants. Secondly, the availability of data in academic or industry literature on energy efficiency or CO_2 intensity based on these factors is poor.

Thirdly, the criteria aim for simplicity while still capturing the most important variation. Making distinctions on thresholds and requirements based on any variation seen across plants could result in overly complicated criteria. Despite this trade-off, a balance must be struck between the criteria's comprehensiveness and their usability for issuers.

4.8.5. Determining a metric for mitigation thresholds

A core principle of Climate Bonds Standard sector criteria is to, where possible, provide issuers with clear quantitative requirements that they must meet for eligibility. Through not prescribing specific technologies or practices for the issuer to implement, this allows the issuer to meet the threshold however is best for them.

The TWG explored first the potential for setting emissions intensity thresholds as the mitigation component for desalination plants. For example, this may have taken the form of a threshold for gCO_2/m^3 of fresh water produced. This threshold would be aligned with IPCC guidelines of 1.5-degree Celsius warming scenarios. Issuers could then fall below this emissions threshold either by having a low energy usage (or high efficiency), by having a large proportion of renewable power, or a combination of both. However, there is limited analysis or data which provides trajectories for desalination to align with the Paris Agreement.

What few studies do exist to analyse desalination emissions do not suitably inform appropriate thresholds for this process. An IEA study mentioned previously examined a Sustainable Development Scenario (SDS) for desalination's energy mix in the Middle East which aligns with the Paris Agreement. See section 2.3 (Desalination today and in the future) and Table 1 for further discussion. This study looks only at percentages of the energy sources powering desalination which incorporates existing plants and the geographical scope creates further limitations. It furthermore creates little opportunity for plants with a lower renewable energy share, but with higher efficiencies that are thus reducing their emissions. Lienhard et al. (2016)[45] provides indicative ranges of emissions intensities seen in desalination (see table 2). However, a higher level of data granularity is needed to determine what point in these ranges is suitably green, along with the assumptions that support the data. The study mentions the ranges depend on the fossil fuel source, without mention of plants powered by renewable energy.

Where a precedent has been set which helped inform TWG decisions was in the EU taxonomy on sustainable finance (hereafter referred to as the EU taxonomy). While desalination is not an economic activity for which criteria and definitions have been set, other industrial processes (such as the manufacture of aluminium) are. These sectors may face similar challenges in analysis and so this approach was chosen as the most appropriate route for meeting a mitigation component.

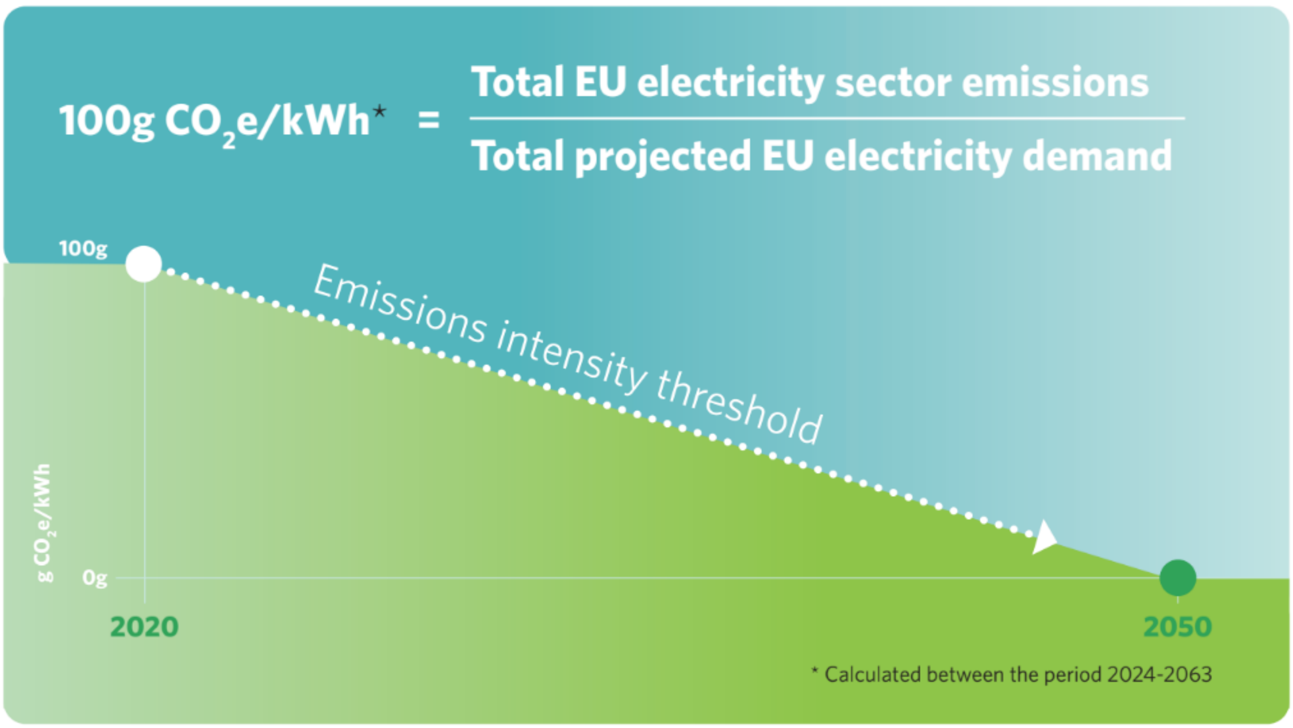
The issuer must demonstrate that their average carbon intensity of the energy used to power their desalination plant falls below a threshold of gCO_2 / kWh of electricity. This gives issuers a single clear threshold they must meet in order to meet the mitigation threshold. This means that any certified plant will undoubtedly be low carbon, despite its energy use, plant size, feedwater type or location.

A desalination plant may not meet this threshold and yet have a very high energy efficiency (or low energy usage). This might mean that, per m^3 of water produced, it may have similar levels of emissions to a plant that is less efficient yet does meet the threshold. It is acknowledged, therefore, that these criteria do not fully allow for issuers reducing their emissions across the whole spectrum of possible measures and practices. However, the TWG discussed at length the issue that allowing for efficiency to be part of a threshold. Under such a threshold, a plant could be certified that uses less energy for its size. However, it may still have a high energy demand, especially if a large plant. Combined with the use of high carbon energy, such a plant could produce large amounts of GHG. See section 4.8.7 for further rationale on this.

[45] Ibid.

4.8.6. Determining a threshold for mitigation thresholds

The carbon intensity threshold for the energy used by a plant is based off the same metric used by the EU taxonomy. This reflects low carbon energy and gives very little room for fossil fuel energy[46]. It reflects the necessary average value of power generation emissions between 2020 and 2050 to meet the net-zero by 2050 goal. It is based on knowing what projected electricity sector emissions are against projected electricity demand. Therefore, in the EU, the threshold of 100gCO_2/kWh tells us what new power plants should be emitting at most in order for the EU to meet a target of net zero by 2050. This ensures that the thresholds in these criteria are scientifically robust and align with best practice in the market.



It is acknowledged that the threshold of 100gCO_2/kWh reflects only EU projected emissions and electricity demand. CBI aims to set thresholds that fully reflect global data and variability. However, in the absence of regional granularity, the 100gCO_2/kWh threshold will be applied as default. Future iterations of the Criteria will be open to other work that has carried out similar methodologies for other regions. For now, however, this methodology is the best existing framework for determining Paris-aligned energy. Moreover, it broadly reflects green energy globally by virtue of the energy types it excludes, for example unabated gas generation.

This threshold is to be met for each year of the bond lifetime.

[46] More information and rationale for this threshold can be found in the EU taxonomy technical annex: https://ec.europa.eu/info/sites/info/files/business_economy_euro/banking_and_finance/documents/200309-sustainable-finance-teg-final-report-taxonomy-annexes_en.pdf

4.8.7. Potential emissions in energy efficient plants

The TWG discussed whether the mitigation component could be composed of two possible routes to compliance for issuers. One of low carbon energy and the other of high energy efficiency (low energy usage). However, the group was mindful that high energy efficiency is not a guarantee that a plant's emissions are low. Large scale desalination plants still utilise considerable amounts of energy and even the most energy efficient plants may have high levels of scope 2 emissions. The most extreme example that the TWG discussed might be a large plant located in a country where grid power is overwhelmingly comprised of fossil fuels, particularly coal. A plant may be highly energy efficient, yet its scope 2 emissions are still higher due to its energy mix.

An overarching principle across all Climate Bonds Standard sector criteria is that they should be ambitious in requiring issuers to decarbonise within their own power. While efficiency improvements would be an obvious way for plants to improve their own practices, this would not solve the issue discussed in the previous paragraph. Moreover, plants are continuously increasing their efficiencies for reasons of costs. Requiring best practice energy efficiency would thus merely reflect the most modern plants. It would not incentivise plants to adopt clean energy as their energy source – the crucial route to reducing their carbon footprint. Therefore, such an efficiency threshold would automatically favour new, larger plants that may be efficient, but still have extremely high emissions stemming from high fossil fuel use.

On the other hand, if a plant meets the low carbon energy threshold chosen, this demonstrates they are leading players in the sector that are aiming to ambitiously improve their practices and reduce their carbon footprint. A plant's energy usage matters less when the energy is already defined as low carbon. Renewable energy, and especially solar, is cheaper than coal and gas in most major countries[47] which can create extra incentive for plants. These significant opportunities for reducing a plant's costs meant the TWG was comfortable with setting a low carbon energy threshold as the sole mitigation requirement.

4.8.8. Desalination and grid stability

The TWG discussed the effect that desalination plants (particularly large-scale) might have on an electrical grid systems stability. The large energy requirement of desalination plants means they have greater effect on electricity demand in a grid. In particular, the rotation speed of high-power motors in Reverse Osmosis systems will influence the power grid. This is because their operation increases the Total Harmonic Distortion (THD) experienced by a grid as a result. However, in a large part of the world there is a maximum THD requirement, meaning that in those countries there is no adverse effect of RO on the grid. In other countries, the electricity tariff increases with THD. In essence, the accuracy of power consumption measurement is decreasing and hence there is a higher tariff. Whilst this motivates the user to solve the THD problem using active filter, it does not completely ban them. None the less, the TWG did not consider grid destabilisation to be a considerable concern.

[47] https://webstore.iea.org/download/summary/4153?fileName=1.English-Summary-WEO2020.pdf

Grid stability in light of increasing renewable energy integration was also discussed. The Criteria as they stand require plants to source a high amount of their energy from renewable sources. This can have destabilising effects on a grid. Renewable energy sources do not have the same stabilising characteristics as fossil fuel sources. As such, grid inertia is harder to ensure. However, concerns regarding instability and renewables diminishes continuously. Improved storage and grid control systems means renewable energy does not result in less stable electricity supply and can even result in greater stability. Additionally, renewables provide benefits to the grid in the form of flexibility.

In all, the TWG determined that grid instability was not a considerable issue to be addressed in these Criteria. In fact, requiring high amounts of renewable energy by large energy users such as desalination plants can positively disrupt grid systems by sending strong signals to grid markets for increased renewable energy penetration.

4.8.9. Brine disposal

Once seawater or brackish water has been desalinated, the remaining by-product is highly saline brine. The concentration of the remaining brine depends on the efficiency of the desalination plant in converting a high proportion of the feedwater to fresh water. The proportion of intake water that is converted into fresh water is known as the recovery ratio (RR), which is highly dependent upon the feedwater type and desalination technology. The higher the RR (between 0 and 1), the more freshwater has been produced from the intake, leaving lower volumes of higher concentrated. RR is partially dependent on feedwater type as well as the type of technology used in the desalination plant (for example, RO, MSF or MED).

The highly saline brine discharge requires careful management to avoid potential adverse impacts on surrounding ecosystem[48]. For example, in seawater desalination brine is often disposed of into the ocean. There is enough literature exploring the effects of brine discharge on aquatic environments along with substantial industry regulations that led to the TWG to designate brine disposal an important issue to capture. This is addressed in additional A&R requirements that have been added to the existing checklist in the Water Criteria.

In addition to sustainability goals, desalination plants are concerned with better management of brine in order to reduce their own disposal costs, including moving towards zero-liquid discharge. There are also unique uses for brine that can present economic opportunities for desalination plants[49], but such benefits are less widespread today.

The type of feedwater is a factor that creates different challenges for the disposal of brine. Generally, the more saline the feedwater, the lower the RR. Seawater desalination thus creates considerably greater volumes of brine that must be disposed of. At the same time, being coastally

[48] Roberts et al. (2010). Impacts of desalination plant discharges on the marine environment: A critical review of published studies
[49] Sanchez et al. (2015). Uses of the reject brine from inland desalination for fish farming, *Spirulina* cultivation, and irrigation of forage shrub and crops

located may mean they have more feasible and cheaper options to dispose of brine into the ocean without adverse effects on the surrounding environment. Despite this, the TWG agreed that there was no need to distinguish between plants based on feedwater as has been done for the mitigation component.

The A&R checklist in the Water Criteria is laid out as such that the issuer must provide evidence of meeting the requirements for each question relevant to them. However, they do not require specific measures or practices in place in order to comply. Instead, “evidence” of action, analysis or research should be sought to show that the issue is being broadly addressed. This continues to be the case, therefore, for brine disposal. The TWG agreed that common and feasible measures exist for desalination plants to deal with brine discharge. Diffusers were put forward as an obvious way seawater desalination plants should be disposing of brine. Moreover, in many countries or jurisdictions there are already considerably strict rules in place for plants to suitably deal with brine.

This requirement is found in section five of the A&R checklist in the Water Criteria.

4.8.10. Feedwater intake

Feedwater intake was the second issue identified by the TWG as needing addressing in the A&R component. Improving the quality of intake water substantially reduces a plant’s costs, particularly through reducing the amount of membrane fouling. It also reduces the need for chemical usage and reduces other environmental impacts on surrounding ecosystems[50]. These impacts from open-ocean intakes may include impingement and entrainment of marine biota, which can create large permitting and construction costs[51]. Impacts may be similar for brackish water in estuarine or other aquatic environments.

Similar to the issue of brine disposal, careful management of intake is in a plant’s economic interest. As such, there are numerous options available to plants which minimise the negative effects on feedwater intake on the aquatic environment. The TWG underlined subsurface intake wells which draw from subsurface aquifers as one of the most effective options in this regard. Like for brine disposal, the criteria again give the issuer flexibility in dealing with this issue. The requirement rather is that they must demonstrate that they have measures in place rather than being prescribed a specific piece of equipment or infrastructure.

In certain jurisdictions there are stringent regulations already in place which may make this requirement simple for issuers to meet. However, in places where this is not the case, the TWG agreed that this requirement would ensure issuers were suitably dealing with intakes. These measures may equally be different depending on whether the feedwater is brackish water or seawater.

[50]Dehwah & Missimer (2016). Subsurface intake systems: Green choice for improving feed water quality at SWRO desalination plants, Jeddah, Saudi Arabia
[51] Missimer et al. (2013). Subsurface intakes for seawater reverse osmosis facilities: Capacity limitation, water quality improvement, and economics

4.8.11. Desalination with respect to other water management techniques

The TWG discussed the issues surrounding water management more generally which is demonstrated by the Water Criteria. Desalination is one of many possible solutions that provides potable water which, even if best practice, may be secondary to other management solutions in terms of its carbon footprint and environmental credentials. For example, water conservation and re-use generally has a far lower carbon footprint than most desalination seen today[52]. They also carry fewer environmental impacts such as brine discharge or intake effects.

Desalination is usually considered as an option in locations where alternative options are not available[53]. This is principally down to cost, as both the construction and operation of desalination plants is more expensive than the alternatives. Desalination energy requirements and therefore costs become more comparable with more conventional water resource measures when the conventional water must be moved long distances to serve certain populations[54]. However, desalination is also becoming comparable with conventional supplies generally where the plant capacity is large and thus costs are lower.

The TWG decided that exclusions should not be made based on the use of the water, unless in certain dedicated examples such as cooling water in fossil fuel power stations (see section 4.1.3). A water or energy utility may be unable to control where the water is used by a municipality or consumer, for example. Consumer- and supply-side measures are outside of scope of these criteria for similar reasons. Certain issuers developing a desalination plant may also not have access to other options of water resources as it falls outside their competency, jurisdiction or expertise. For example, a private energy utility building a desalination plant cannot instead decide to implement a water reuse system in a municipality.

In all, there are numerous instances where issuers have little control over whether an alternative option would be a more suitable water resource option. The TWG therefore considered the mitigation and A&R requirements to be sufficient to ensure certified plants are climate-aligned. It was decided therefore to not to add further requirements for issuers to have exhausted all other reasonable water resource options prior to desalination.

4.8.12. Desalination driven by waste heat

The TWG discussed the prospect of including as eligible desalination plants that are powered by waste heat from various industrial processes. Thermal energy has the potential to power desalination through several ways. Most common are thermal desalination processes such as MSF or MED which can be directly powered by thermal energy. RO can also be powered from

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[52] Cornejo et al. (2014). Carbon footprint of water reuse and desalination: a review of greenhouse gas emissions and estimation tools

[53] Ibid. Gude & Fthenakis (2020).

[54] Plappally and Lienhard (2012). Energy Requirements for Water Production

thermal energy, although this affects efficiency. This is normally done so through the burning of fossil fuels. Integrated Water and Power Plants (IWPP) are a common example of this where desalination and power processes are closely coordinated to make the overall system more efficient. However, the source of energy is still fossil fuel-based.

There is growing research exploring the opportunities in utilising waste heat from industrial processes to power desalination[55]. Substantial amounts of energy are lost as a by-product of inefficient industrial processes (up to 50%)[56]. Utilising this waste heat could not only improve the efficiency of the system itself, but it could replace fossil fuel power for a range of desalination technologies. Equally, waste heat has applications arising from renewable power, such as CSP[57], which can ensure 24/7 operation.

The TWG acknowledges the importance of waste heat as one of many options that can replace directly powering desalination with fossil fuels. The emissions mitigation opportunity may also lie indirectly in displacing energy use from a grid with a high proportion of fossil fuels.

However, it was decided to exclude from eligibility desalination plants utilising waste heat from industrial processes or fossil fuel power plants for the following reasons: a) such desalination plants are directly linked to fossil fuel power which falls outside the scope of what may be considered ‘green’; b) it may be an suitable alternative, but there is little indication of what point such systems should not be considered up to; c) such systems may risk locking in fossil fuel assets, although the TWG stressed that extent of such lock-in is uncertain; and d) if not purely ‘green’, such assets may hold better promise for future work being carried out on transition finance[58]. Additionally, without criteria for certain manufacturing industries such as cement or iron & steel, the TWG does not include such assets within scope.

Desalination plants utilising waste heat from renewable energy (such as CSP) are still eligible if meeting the mitigation and A&R requirements.

4.8.13. Intermittency of renewable energy

One barrier frequently cited in desalination to complete integration of renewable energy into powering plants is that of intermittency. The intermittent nature of renewable energy may result in periods of low generation if there is low levels of sunlight or wind, with few ways of storing the energy for later use. End-uses of desalinated water often necessitate a constant supply and therefore constant production. However, the TWG were confident that this issue should not prevent a high proportion of renewable energy being the norm for plants. Technologies such as Concentrated Solar Power or pumped hydropower are ways of storing renewable energy to operate the plant constantly. More long-term, battery technology and green hydrogen may have developed enough to provide an extra storage solution.

[55] Shahzad et al. (2015). Future sustainable desalination using waste heat: kudos to thermodynamic synergy
[56] Wooley et al. (2018). Industrial waste heat recovery: A systematic approach
[57] Ibid. Shahzad et al. (2015)
[58] https://www.climatebonds.net/resources/reports/financing-credible-transitions-white-paper

Membrane fouling was also discussed as an issue that occurs when production rate might decrease (for example due to intermittent renewable supply). However, the TWG maintained that there are solutions and developing research that avoid such problems.

Appendix 1: Technical Working Group and Industry Working Group members

Water Infrastructure Criteria development has been led by a consortium consisting of the Climate Bonds Initiative, AGWA, Ceres, CDP and the World Resources Institute (WRI). To develop the Water Infrastructure Criteria, focusing on engineered or built or engineered water infrastructure, the consortium convened a Technical Working Group (TWG) and an Industry Working Group (IWG), with representatives from investors, public utilities, water NGOs and international policy bodies from around the world.

Technical Working Group Members:
Lead: John Matthews, Alliance for Global Water Adaptation (AGWA)
Ania Grobicki,RAMSAR
Aparna Sridhar, The Nature Conservancy (TNC)
Ari Raivetz, Organica Water
Betsy Otto, World Resource Institute (WRI)
Benjamin Denjean, Beijing Forest University
Bill Stannard, American Water Works Association (AWWA)
Bob Zimmerman, Charles River Watershed Association
Casey Brown, University of Massachusetts, Hydrology
Cate Lamb, Water Program, CDP
Cedo Maksimovic, Urban Water Research Group, Imperial College London
Cees van de Guchte, Deltares
Christian Severin, Global Environment Faciilty (GEF)
Charles B Chesnutt, USACE
Christine Chan, Alliance for Global Water Adaptation (AGWA)
Cynthia Lane, American Water Works Association (AWWA)
Dan Christian, Tetra Tech
Dave Hole, Conservation International
Debbie Larson-Salvatore, USACE
Elena Lopez-Gunn, Complutense University of Madrid
Erica Brown, Association of Metropolitan Water Agencies (AMWA)
Guy Pegram, Pegasys, South Africa
James Dalton, IUCN
Janet Cushing, USGS
Jason Fairbairn, Arup
John Joyce, Stockholm International Water Institute (SIWI)
Jorge Gastelumendi, The Nature Conservancy (TNC)
Junguo Liu, IIASA, Chinese Academy of Sciences
Karen Yacos, Ceres
Larry Band, University of Virginia
Laurna Kaatz, Denver Water
LeRoy Poff, Colorado State University, Stream Ecology Lab
Lisa Hair, US EPA

Maija Bertule, UNEP-DHI
Manisha Singh, WiseLion LLC
Marco Follador, Way Carbon
Margot Hill Clarvis, Earth Security Group
Matt Ries, Water Environment Federation
Melinda Massey, DC Water
Michael McClain, UNESCO-IHE
Monika Freyman, Ceres
Musonda Mumba, UNEP
Nancy Saich, European Investment Bank (EIB)
Peter Streit, California Organised Investor Network (COIN)
Rob Cadmus, RAMSAR
Rochi Khemka, 2030 Water Resources Group
Sebastian Hyzyk, European Investment Bank (EIB)
Sharlene Leurig, Sustainable Water Infrastructure Program, Ceres
Stefanie Lindenberg, European Investment Bank (EIB)
Tatiana Fedotova, WBCSD
Ted Grantham, University of California, Berkeley
Thomas Panella, Asia Development Bank
Todd Gartner, World Resources Institute (WRI)
Torgny Holmgren, Stockholm International Water Institute (SIWI)
Valerie Hickey, The World Bank
Will Sarni, Water Foundry
Xavier Leflaive, OECD

Industry Working Group members:
Adam Carpenter, American Water Works Association
Anais Blasco, WBCSD
Arturo Buenaventura Pouyfaucon, Abengoa Water
Bob Morgan, Beaver Water District
Cameron Ironside, International Hydropower Association
Chris Webb, HERRERA
Eric Schellekens, Arcadis
Gary Sharkey, PwC UK
Hannah Leckie, OECD
Jessica Robinson, Asria
Manisha Singh, Wiselion LLC
Martin Geiger, DEG
Matthew Kuzma, Organica Water
Mike Brown, San Francisco Public Utilities Commission
Monica Reid, Kestral Consulting
Nicole Hardiman, Illinois River Watershed Partnership
Paul Fleming, Seattle Public Utilities
Paul Wood, Water Fund LLC

Piet Klop, PGGM
Roman Gomez, IFC
Simon Petley

Appendix 2: Experts engaged in development of the Desalination Criteria

The addition of Criteria for Desalination to the Water Criteria has been led by a separate TWG comprised of desalination technical experts. These experts similarly included representatives from public utilities, water NGOs and international policy bodies from around the world.

Technical Working Group Members:
Paul Buijs, King Abdullah University of Science and Technology (KAUST), Water Desalination & Reuse Centre (WDRC)
Angelina Galiteva, President for NEOptions / Chair, California Independent System Operator (ISO)
Edward Jones, University of Utrecht
Heather Cooley, Pacific Institute
Molly Walton, Independent / formerly of the International Energy Agency (IEA)

Special thanks go also to Tom Pankratz, independent consultant and Global Water Intelligence, for valued input from an industry perspective.

Appendix 3: About the Water Infrastructure Criteria Consortium Members

About the Climate Bonds Initiative
The Climate Bonds Initiative is an investor-focused non-profit organisation working to mobilise debt capital markets for climate change solutions. It works as an independent resource for the green bond market with the aim to educate, inspire, convene and steer a global collaboration of institutional investors, governments, development banks and industry to shift capital to climate investments – at speed.

It has established and manages the Climate Bonds Standard & Certification Scheme, the only certification scheme globally for green bonds. In 2016, 10% of all green bonds issued around the world were certified under the Climate Bond Standard. As part of the roll out of the Standard, the Climate Bonds Initiative convenes technical and industry experts to develop the sector specific eligibility Criteria (or 'green definitions') which form the backbone of the Climate Bond Standard.

About Alliance for Global Water Adaptation
Founded in September 2010, the Alliance for Global Water Adaptation is a group of regional and global development banks, government agencies and ministries, diverse non-governmental organizations (NGOs), and the private sector focused on managing water resources in a sustainable way — even as climate change alters the global hydrological cycle. Water provides

coherence to climate change adaptation and mitigation, integrating energy, water, food production and agriculture, and ecosystems and the environment. AGWA is focused on how to help experts, decision makers, and institutions in the water community work more effectively.

About Ceres
Ceres is a non-profit organisation advocating for sustainability leadership. Ceres works to mobilise a powerful network of investors, companies and public interest groups to accelerate and expand the adoption of sustainable business practices and solutions to build a healthy global economy.

About Carbon Disclosure Project
CDP works to transform the way the world does business to prevent dangerous climate change and protect our natural resources. We see a world where capital is efficiently allocated to create long-term prosperity rather than short-term gain at the expense of our environment.

CDP holds the largest collection globally of self-reported climate change, water and forest-risk data. Through our global system companies, investors and cities are better able to mitigate risk, capitalise on opportunities and make investment decisions that drive action towards a more sustainable world.

About World Resources Institute
WRI is a global research organisation that spans more than 50 countries, with offices in the United States, China, India, Brazil, Indonesia and more. Our more than 700 experts and staff work closely with leaders to turn big ideas into action to sustain our natural resources—the foundation of economic opportunity and human well-being. Our work focuses on six critical issues at the intersection of environment and development: climate, energy, food, forests, water, and cities and transport.

Appendix 3: Existing green assessment frameworks and processes for water infrastructure assets and projects

For water management, relevant frameworks for the assessment of water climate bonds are not common or widespread. A number of relevant resources exist that have been reviewed to determine what might be leveraged in a set of water related criteria for bonds. These are briefly described here.

Green Bond Principles
The Green Bond Principles (GBP) are voluntary process guidelines that recommend transparency and disclosure and promote integrity in the development of the green bond market by clarifying the approach for issuance of a green bond.

The GBP provide high level categories for eligible Green Projects in recognition of the diversity of current views and of the ongoing development in understanding of environmental issues and consequences. Specifically, the category of sustainable water and wastewater management covers sustainable infrastructure for clean and/or drinking water, wastewater treatment, sustainable urban drainage systems and river training and other forms of flooding mitigation.

Common Principles for Climate Mitigation Finance Tracking
The Common Principles for Climate Mitigation Finance Tracking (the Common Principles) have been developed by the joint climate finance group of multilateral development banks (MDBs) and the International Development Finance Club (IDFC). The purpose is to set out agreed climate change mitigation finance tracking principles for development finance. The MDBs and the IDFC commit to the Common Principles in their respective, group-based climate mitigation finance reporting.

The Common Principles provide a list of activities eligible for classification as climate mitigation finance covering renewable energy, lower-carbon and efficient energy generation, energy efficiency, agriculture, forestry and land use, waste and waste water, and transport, etc. The treatment of wastewater needs to reduces methane emissions (only if net GHG emission reductions can be demonstrated and if not a compliance requirement to meet, for example, a performance standard or safeguard requirement) in order to be eligible.

China's Green Bond Endorsed Project Catalogue
The Green Bond Endorsed Project Catalogue (the Catalogue) was released by Green Finance Committee of China Society of Finance and Banking (the Committee), endorsed by China's regulators including People's Bank of China and China Securities Regulatory Commission (CSRC). The Catalogue provides categories of eligible projects and criteria for China's green bond market, covering 6 areas including energy saving, pollution prevention and control, resource conservation and recycling, clean transportation, clean energy and ecological protection and climate change adaption.

Eligible water projects include, for example, transformation of industrial water saving technology, agricultural water saving irrigation, transformation of urban pipeline network for water supply, integrated use of water resource, unconventional water use (including sea water desalination, treatment and reuse of brackish water, recycling water, mine water), and the supporting facility construction and operation of sponge city.

World Bank Green Bond Criteria
The World Bank established green bonds in 2007 with explicit reference to climate mitigation and adaptation. It has an internally defined process for qualifying bonds that engages directly with Bank clients (normally countries), often involving regional and technical support divisions of the Bank. Water projects to date have varied over an order of magnitude in the size of bond offerings (up to several hundred million USD), spanning irrigation, hydropower, and many multi-purpose infrastructure projects.

Sustainability is defined quite broadly by the Bank; sustainability criteria include consideration of the disruption to social and natural systems. Indeed, water bonds issued by the Bank have included money for resettlement of populations due to creation of new reservoirs (though this may not be viewed as a social consideration for some audiences). Generally, the Bank's procedures are not described in detail and it is unclear how these are applied in principle or what types of internal criteria are used to define offerings.

Ceres Green Bond Principles

These principles have been proposed as an overall reporting basis for green bonds for transparency. If investors and bond issuers follow the principles then we may expect a reporting standard to develop so that bonds can be compared and potentially ranked according to how they meet sustainability and resilience measures.

Barclays MSCI Green Bond Index

The Barclays MSCI index provides a measure for fixed income securities where the funds are used on projects with direct environmental benefits. This index was launched on 14 November 2014 following the trend of corporate investment in green bonds that began towards the end of 2013. The Barclays MSCI index, like other indices of this type, follows the principles laid out by Ceres.

Eligibility and classification is defined by the MSCI ESG Research group, and is based on the use of funds. To be eligible the use of proceeds must fall into one of the five specified categories or have 90 percent of the issuer's activity encompass one or more of the categories.

One of these categories is Sustainable Water, which covers products, services, and projects that attempt to resolve water scarcity and water quality issues; infrastructure and engineering projects developing new or repairing existing water and sanitation pipelines; technologies and products that reduce, reuse, or recycle water as a means of conservation; advanced materials, equipment, technologies, and services that filter or chemically treat wastewater for consumer or industrial use, including desalination; investments in protection of land, forests, and other vegetation in the upper watershed as means to improve the quality of water bodies and groundwater recharge areas; and climate resilience projects (flood relief, mitigation) and sustainable forestry/afforestation.

Distribution of drinking water without measurable improvements to water quality, water efficiency, or climate change resilience component is not eligible.

Although the index defines water sustainable projects as addressing both quality and quantity, currently these terms are not well defined. For example, projects that have an efficiency component are eligible, potentially conflating efficiency gains with sustainability. Similarly, water conditions are implicitly defined as static and fixed, unchanging in the future, which is problematic for projects that involve long-lived infrastructure.

Water Utilities Standards

Perhaps the best organised and defined group for integrating climate mitigation and climate adaptation are water utilities. Groups such as the Water Utilities Climate Alliance (WUCA) have been active for more than a decade, while professional organisations including the International

Water Association (IWA), the International Water Resources Association (IWRA), the Chartered Institution for Water and Environmental Management (CIWEM), the American Water Works Association (AWWA), and the American Water Resources Association (AWRA) have all actively been developing guidance on how to implement and integrate climate mitigation and adaptation, often led with the support of particular members (e.g., Seattle Public Utilities and DC Water in the US). Some cities have even published urban standards along these lines (e.g., San Francisco Public Utility Commission) or guidelines to connect resilience to broader management standards, such as the European Union's Water Framework Directive. Over time, we can expect these local and sectoral initiatives to become regulatory frameworks, but these remain some years away at this stage.

Appendix 4: Guidance on Water-Related Human Rights and Social Risks for Issuers, Underwriters and Bond Buyers

Many investors recognise that water-related projects can be linked to complex social issues, given that access to drinking water is a basic human right and negative impacts on water resources can significantly affect other human rights (e.g. livelihoods, health etc.). The Climate Bond Standard focusses on issues relating to climate change and does not cover the full spectrum of environmental, social or governance issues that may relate to water related green bonds.

For information, a number of well established guidelines or standards related to broader social and environmental impacts of water infrastructure are listed below.

The Human Rights to Water and Sanitation:
In 2010, the United Nation's (UN) General Assembly and Human Rights Council explicitly recognised that water and sanitation are essential human rights.[59] There are various duties that states have with respect to ensuring the provision of sufficient, safe, clean, affordable and accessible drinking water and sanitation services to those within their jurisdiction.[60] Where companies have taken on this role, they have particular responsibilities. For companies that do not act as water service providers, their responsibility is to respect their rights –i.e. to avoid negatively affecting them through their operations or those of their suppliers or other business relationships. Several resources have been developed to help guide action in this area:

> UN Office of the High Commissioner for Human Rights, *Realising the Human Rights to Water and Sanitation: A Handbook by the UN Special Rapporteur Catarina De Albuquerque,* 2014.
>
> UN Office of the High Commissioner for Human Rights, *Guiding Principles on Business and Human Rights*, 2011.
>
> Interfaith Center on Corporate Responsibility, *The 2013 ICCR Water Roundtable: Stakeholder Responsibilities in Managing Access to Water.*
>
> UN Global Compact, The CEO Water Mandate*, Guidance for Companies on Respecting the Human Rights to Water and Sanitation: Bringing a Human Rights Lens to Corporate Water Stewardship,* January 2015.

This Appendix was reviewed by the following individuals. Any errors, omissions or otherwise are our responsibility.

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[59] United Nations General Assembly, Resolution 64/292, August 3, 2010. http://www.un.org/waterforlifedecade/human_right_to_water.shtml

[60] UN Global Compact, The CEO Water Mandate, Guidance for Companies on Respecting the Human Rights to Water and Sanitation: Bringing a Human Rights Lens to Corporate Water Stewardship, January 2015. http://ceowatermandate.org/files/business-hrws-guidance.pdf

- Rachel Davis - Managing Director, Shift Project
- Patricia Jones - Senior Program Leader, Human Right to Water, Unitarian Universalist Service Committee
- Jamie Skinner - Principal Research, Natural Resources Group; Team Leader, Water, International Institute for Environment and Development

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