S&P Global
Ratings

COP25 Special Edition:

Climate Finance Takes Root

December 2019

Contents

2 Could Agriculture And Forestry Be The New Frontier For Green Bonds?

10 Green Evaluation Analytical Approach Update

48 Sink Or Swim: The Importance Of Adaptation Projects Rises With Climate Risks

57 Delays In Addressing Global Warming And The Longer-Term Ratings Implications

60 Infrastructure Seeks A Circular Solution To Sustainability

67 European Airlines Prepare For Take-Off On Climate Change

78 Energy Transition – Renewable Energy Matures With Blossoming Complexity

103 List of Sustainable Finance team contacts

Could Agriculture And Forestry Be The New Frontier For Green Bonds?

December 4, 2019

PRIMARY CREDIT ANALYST

Maurice Bryson

London

maurice.bryson@spglobal.com

SECONDARY CONTACTS

Anna Liubachyna

London

anna.liubachyna@spglobal.com

Michael Wilkins

London

(44) 20-7176-3528

mike.wilkins@spglobal.com

ADDITIONAL CONTACT

Industrial Ratings Europe

Corporate_Admin_London@spglobal.com

Key Takeaways

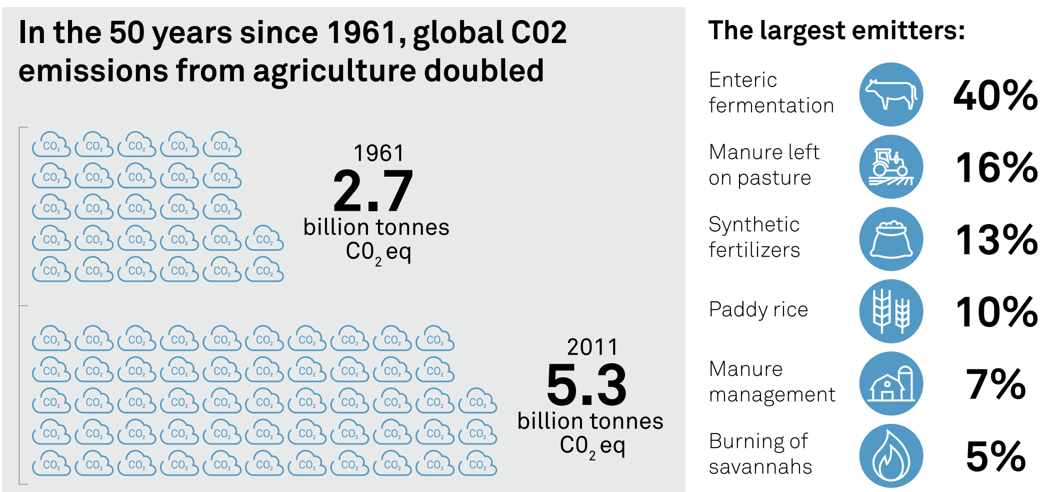
- The Intergovernmental Panel on Climate Change estimates that 23% of total anthropogenic greenhouse gas emissions are caused by agriculture, forestry, and other land use activities.
- The green bond market--a key source of capital for green initiatives--allocates a smaller proportion of capital to land use than to other eligible green project categories, but the land use part of the market shows potential for growth.
- So far, the green bond market targeting land use has focused on the forestry sector, as opposed to agriculture, with a geographical emphasis on Brazil.
- Using our Green Evaluation analytical approach together with publicly available information, we assessed two green bonds issued in 2017 by Fibria Celulose S.A. and Klabin S.A. to finance sustainable forestry projects.
- We found that these bonds would likely fall into the top half of our scoring range, indicating a relatively positive environmental impact.
- As the green bond market continues to expand, and pressure grows on the agricultural and forestry sectors to become more sustainable, land use could become a bigger feature of the market.

S&P Global Ratings believes that investment in sustainable land use is critical in mitigating climate change and bridging the gap between the need for increased agricultural production and a concern for the environment. However, unlike the transition to clean energy--which has to date been a focus of the $744 billion green bond market--sustainable land use is still a comparatively nascent green bond financing objective.

Though land use, which includes categories such as forest land, cropland, grassland and wetlands, currently only has a small presence in the green bond market, demand for sustainably produced agricultural and forestry commodities is set to increase. Moreover, green bonds could be instrumental in enabling this growth. According to estimates by the Climate Bonds Initiative (CBI), financing from green bonds for sustainable agriculture and forestry has already grown to $7.4 billion in 2018 from $208 million in 2013. To support this part of the green bond market, the CBI launched its Forest Criteria in 2018, and is due to launch its Agriculture Criteria in January 2020.

As the green bond market continues to develop, we believe it is vital that the focus on transaction transparency and impact assessment--which distinguishes green bonds from conventional bonds--remains robust to encourage further market scaling. We used our Green Evaluation analytical approach--newly expanded to include land use projects--to gauge the potential environmental contribution of two green bonds issued by Fibria Celulose S.A. and Klabin S.A., targeting sustainable land use in Brazil. The results show that green bond issuers and purchasers could view land use projects as making a positive environmental contribution.

As the green bond market continues to expand, and pressure on the agricultural and forestry sectors to sustainably increase production grows, green bonds targeting land use could become a larger feature in the market. However, there are challenges to overcome--not least, the scale of greenhouse gas (GHG) emissions from the sector (see infographic below).



Note--Agriculture classed as crops and livestock. Largest emitters figures are averages for period 2001-2010.
Source: Food and Agriculture Organization of the United Nations.

Agriculture And Forestry Have A Huge Impact On The Environment

The UN's Intergovernmental Panel on Climate Change (IPCC), the leading scientific authority on climate change, highlights the important role that global and regional land use plays in limiting global warming to 1.5°C above pre-industrial temperatures. Meeting this target, the IPCC has found, will be vital for avoiding the negative effects of climate change, such as those on health, livelihoods, human security, endurance of ecosystems, and economic growth. Moreover, the sustainable management of land resources is, according to the IPCC, essential to the provision of ecosystem services, such as the production of food and freshwater, that humanity and nature rely on. With the UN forecasting that the global population will grow from today's 7.8 billion to a peak of 10.9 billion by the end of the century, pressure on natural resources will inevitably increase.

Researchers at Pennsylvania State University have estimated that global agricultural production will have to increase by 25%-70% by 2050 in order to feed this swelling population. Agriculture already uses 49% of the global ice-free land surface, and the UN in its landmark Global Assessment Report on Biodiversity and Ecosystem Services estimates that 75% of the earth's surface has been severely altered by human actions. Therefore, the sustainable intensification of existing agricultural land could be a solution that increases food production, while limiting the environmental impact of agricultural systems.

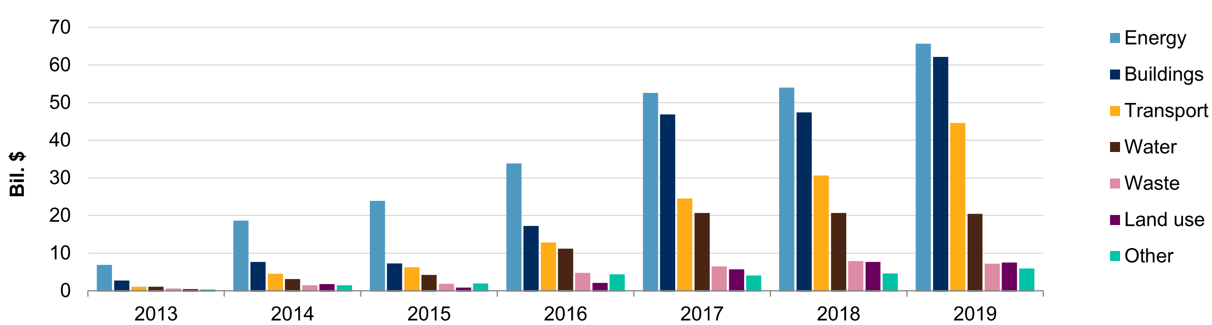
With increased land use change comes higher GHG emissions. Since the Green Revolution of the 1960s--a period that saw prodigious improvements in global grain yields driven by technological and agronomic advancements--intensive land use by the agriculture and forestry sectors has led to increased levels of GHG emissions, degradation of natural ecosystems, and a decline in biodiversity. From 2007-2016, agriculture, forestry, and other land use activities represented 23% of total net anthropogenic GHG emissions. According to the IPCC, agriculture accounts for 70% of global fresh-water use, and is considered a key driver in the potential extinction of one million species the UN estimates are at risk over the coming decades.

Proceeds From Land Use Green Bonds Are Skewed Toward Forestry Projects In Brazil

According to the CBI, a total of $744 billion of green bonds have been issued since the market's inception in 2007. Despite this overall market expansion, allocation of proceeds to land use projects has been relatively small. Only 3.3% of the total market, or just over $24 billion, has been allocated to land use initiatives, with renewable energy, building energy efficiency, and clean transport initiatives being the key eligible green projects financed by green bonds (see chart 1).

Chart 1

Land Use Is Emerging As A Green Bond Investment Category
Green bond issuance by use of proceeds, 2013-2019

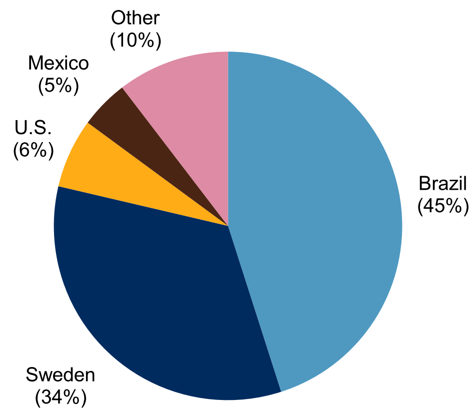


Source: Climate Bonds Initiative.

The CBI has three categories for land use bonds, based on the percentage of bond proceeds allocated to land use projects. Among bonds with more than 95% allocation of proceeds to land use, there are two notable trends: a preference for forestry projects, and a geographic emphasis on Brazil (see chart 2).

Chart 2

Brazil Is Leading The Way In Green Bonds Focused On Land Use
Green bond issuance with >95% allocation to land use projects, by country



Source: Climate Bonds Initiative.

Preference for forestry projects

The first trend, higher allocation to forestry than agriculture, is driven by a number of factors. First, investors consider forestry as a hedge to financial markets--trees grow irrespective of macroeconomic conditions. Second, large forestry companies have dominated the issuance of land use green bonds. This trend is less a reflection of the financial merits of forestry relative to agriculture, and more a symptom of the difficulty in aggregating farming projects. The UN's Food and Agriculture Organization (FAO) estimates that 83% of the world's farms are less than two hectares in size. Third, the global market for sustainable timber is more developed than sustainable agricultural commodities, as legislative frameworks, such as the EU's Timber Regulation, prohibits the sale of illegally logged timber or timber products in Europe.

This market focus on forestry is not without its issues. A criticism leveled at land use green bonds is that forestry companies are using the proceeds of their green bonds to grow business-as-usual industrial plantations. The fear of greenwashing--the misrepresentation of a company's products as environmentally sound--in forestry green bonds is understandable, and forestry issuers may need to consider making more concerted efforts to allay investor fears through improved transaction transparency (on proceeds allocation and impact reporting) and governance (on proceeds allocation). This could mean demonstrating how green bonds are being used to finance projects that fall outside general business purposes, such as Fibria Celulose's $700 million green bond issuance in 2017--which we assess below--that allocated some of the proceeds to the conservation of native forests.

Geographic emphasis on Brazil

The second trend, of financing land use initiatives in Brazil, is understandable, given its prominence in the global agricultural and forestry sectors. The FAO estimates that Brazil produces 26% of the total global soy crop, and is the second largest producer of beef. As a result of this, Brazil has seen wide-scale agricultural expansion in its natural ecosystems, and, depending on how it addresses Amazonian deforestation, will be a key player in determining the severity of global warming. Recent headlines highlight the plight of the Amazon rainforest, and experts warn that the Amazon is near a tipping point, as 15%-17% has been deforested. Scientists from George Mason University and the World Resources Institute estimate that should this figure reach 20%-25%, then the rainforest will no longer be able to create enough water to sustain itself. According to scientists, it is vital that Brazil's natural ecosystems are protected, and green bonds could be a pecuniary solution to enable these efforts.

Green Bonds Could Help Curb Deforestation In Brazil

Brazil is at a sustainability crossroads. From 2005 to 2013, Brazil lowered the rate of deforestation in the Amazon by 70%. Since then, however, deforestation rates have been increasing. This year has seen a record number of forest fires, and an 83% increase in the rate of deforestation until October compared to the same period in 2018. Much of this deforestation has been attributed to agricultural expansion. The growth of agriculture has been especially notable in the Cerrado--a 200-million-hectare tropical savannah famed for its biodiversity. The Cerrado's destruction has enabled Brazil to become the world's largest exporter of soy. With the Organization for Economic Co-operation and Development and the FAO forecasting growth in the global demand for soy of 1.6% per year, concerned investors are using green bonds to enable the sustainable management of land, and the sustainable intensification of agricultural production (see the box below).

Brazil is also among the world's largest producers of pulp. Two key producers, Klabin and Fibria Celulose (which merged with Suzano Papel e Celulose S.A. in 2019 to form the world's largest producer of pulp, Suzano S.A.), have targeted the proceeds from their green bonds primarily at the sustainable production of eucalyptus--a key feedstock for global pulp production.

A Potential Incentive For Soy Producers To Stop Deforestation

The Responsible Commodities Facility (RCF), an initiative led by Sustainable Investment Management, is exploring the use of green bonds to restore degraded agricultural lands in the Cerrado. The RCF would require soy farmers to commit to halting deforestation and instead direct the expansion of soy cultivation to existing cleared lands. In exchange, they would be eligible for a low interest revolving credit facility financed by green bonds. The soy produced through this initiative would then be sold through a dedicated exchange, thereby providing a market for certified sustainably produced soy.

We Assess Two Land Use Green Bond Issuances As Having A Positive Environmental Impact

As the majority of green bonds targeting sustainable land use focus on Brazilian forestry projects, we used publically available information to apply our newly expanded Green Evaluation analytical approach to two green bonds in this space: Fibria Celulose (issued on Jan. 17, 2017) and Klabin (issued on Sept. 19, 2017). We only evaluated the proceeds that were allocated to forestry activities and in scope of our Green Evaluation analytical approach.

Our analysis shows that these green bonds would likely fall into the top half of our scoring range (the E1 or E2 category, on a scale of E1 to E4, with E1 being the best and E4 the worst). These positive environmental scores are a function of measures the issuers have taken to restore degraded land and reestablish native forest cover, among other things.

Table 1

Examples Of Green Bonds In The Forestry Sectors

Company name	Fibria Celulose S.A. (now Suzano S.A.)	Klabin S.A.
Issue date	Jan. 17, 2017	Sept. 19, 2017
Company information	Fibria Celulose produces, sells, and exports short-fiber pulp in Brazil and internationally. It manufactures and sells bleached eucalyptus kraft pulp. It also exports its products to approximately 35 countries for educational, health, hygiene, and cleaning products. As of Jan. 14, 2019, Fibria Celulose operates as a subsidiary of Suzano S.A.	Klabin, together with its subsidiaries, operates in the paper and pulp industry in Brazil. It operates through forestry, paper, conversion, and pulp segments. The company also manufactures phytotherapic products; provides finance and reforestation services; and operates hotels. In addition, it exports its products.
Country of risk	Brazil	Brazil
Amount issued/to be issued	$700 million	$500 million
Description of proceeds use	Sustainable forest management; restoration of native forests and conservation of biodiversity; waste management; sustainable water management; water usage efficiency; renewable energy; generation of energy from renewable sources	Sustainable forestry; restoration of native forests and conservation of biodiversity; renewable energy; clean transportation; energy efficiency; waste management; sustainable water management; eco-efficient and/or circular economy-adapted products, production technologies, and processes; climate change adaptation
Evaluated proceeds use	Forest maintenance; forest protection and management; and forest restoration	Sustainable forestry and climate change adaptation
Source	Final offering memorandum	Final offering memorandum

S&P Global Ratings' Green Evaluation

S&P Global Ratings' Green Evaluation scores instruments targeted at financing environmentally beneficial projects according to their environmental impact. A Green Evaluation is based on three scores--a transparency score, a governance score, and a mitigation score (environmental impact) or adaptation score (resilience level). We evaluate instruments in each category and then combine the resulting scores into a final Green Evaluation.

A Green Evaluation is a point-in-time assessment, in part based on our estimate of the expected lifetime net environmental benefit of a project, should it perform to industry averages.

Green mitigation sectors that are in scope for the Green Evaluation include: green energy, green transport, green buildings, energy efficiency, fossil fuel power plants (decreased carbon intensity of conventional energy production), nuclear power, and water.

S&P Global Ratings has recently released two new modules: waste management, and agriculture and forestry. The agriculture and forestry module, which is the focus of this commentary, includes forestry protection, forestry expansion, sustainable farming, smart farming, crop-based products, and land restoration among its in-scope green mitigation sectors.

For more information, see "S&P Global Ratings Expands Green Evaluation Analytical Approach To Include Agriculture, Forestry, Land Use and Waste Management," published Dec. 4, 2019, on RatingsDirect.

We note that the Green Evaluation is not a credit rating, it does not consider the credit quality of the issuer, nor do we factor its results into our credit ratings.

What Does The Future Look Like For Land Use Projects In The Green Bond Market?

Our analysis shows that green bond issuers and purchasers could view land use projects as making positive environmental contributions. As the green bond market continues to expand, and as the pressure on agricultural and forestry production grows, land use could become a greater feature of the green bond market. However, there are concerns that green bonds targeting land use projects might be at a disadvantage relative to more seasoned eligible categories, such as renewable energy and clean transport.

To date, the adoption of green bonds targeting land use has been slow. A key obstacle limiting investor interest in such bonds has been the absence of a direct and immediate revenue stream, as clean energy infrastructure investments, such as wind farms, tend to generate. The RCF proposal targeting sustainable agriculture could overcome this hurdle. Its revolving credit facility structure, and the annual harvesting of soy, could allow it to garner an almost immediate, and certainly regular, revenue stream to repay its coupon. Equally, should binding legislation on sustainable agricultural commodities, or a market for sustainably produced soy, such as what is being proposed with the RCF, gather momentum, then this could be a catalyst for the expansion of land use green bonds. Further, there is now a political and financial momentum building behind sustainability targets and initiatives, which could help to spur allocation to green bonds targeting land use.

Green Financial Instruments Have Policy Support

Financing sustainable practices in agriculture and forestry is a topic being addressed at the highest political levels. Among the most notable international initiatives are the UN's Sustainable Development Goals (SDGs), a collection of 17 global goals designed to "achieve a better and more sustainable future for all". SDG 15, Life on Land, for instance, advocates greater investment in, and awareness of, the sustainable management of forestry and agricultural resources.

Land use is also referenced as one of the main areas for climate mitigation in the Paris Agreement--a landmark multilateral agreement in 2015 to limit global warming to well below 2°C above preindustrial temperatures. Moreover, the European Commission has put agriculture and forestry in its "taxonomy" of green activities, therefore highlighting them as sectors eligible for sustainable financing (see "Credit FAQ: The EU Green Taxonomy: What's In A Name?," published Sept. 11, 2019).

There is, therefore, a convergence of political and market interest in reducing the negative environmental effects associated with land use activities. As the IPCC makes clear, GHG emissions from land use must be curbed if climate change is to be arrested. Much like how the green bond market is financing the decarbonization of the energy system--another vital element in tackling climate change--green bonds may help to reduce the environmental impact of agriculture and forestry, and therefore play a meaningful role in limiting the effects of climate change.

Related Research

- Green Evaluation Analytical Approach, Dec. 4, 2019
- Climate Change and Land, IPCC, Aug. 8, 2019
- OECD-FAO Agricultural Outlook 2019-2028, July 8, 2019
- Amazon Tipping Point, Thomas E. Lovejoy and Carlos Nobre, Science, Feb. 2, 2018
- Business as usual: a resurgence of deforestation in the Brazilian Amazon, Philip Fearnside, Yale Environment 360, April 18, 2017
- Moment of truth for the Cerrado hotspot, Bernardo B. N. Strassburg, Thomas Brooks, Rafael Feltran-Barbieri, Alvaro Iribarrem, Renato Crouzeilles, Rafael Loyola, Agnieszka E. Latawiec, Francisco J. B. Oliveira Filho, Carlos A. de M. Scaramuzza, Fabio R. Scarano, Britaldo Soares-Filho and Andrew Balmford, Nature, March 23, 2017
- Agriculture in 2050: Recalibrating Targets for Sustainable Intensification, Mitchell C. Hunter, Richard G. Smith, Meagan E. Schipanski, Lesley W. Atwood, David A. Mortensen, BioScience, Feb. 22, 2017

Environmental, Social, And Governance:

Green Evaluation Analytical Approach

December 4, 2019

*(**Editor's Note:** On Dec. 4, 2019, we republished this article to incorporate the agriculture and forestry and waste management sectors, and to incorporate the analysis of several new technologies within the existing green energy, water, and fossil fuel power plant sectors.)*

PRIMARY CREDIT ANALYSTS

Corinne B Bendersky
London
+ 44 20 7176 0216
corinne.bendersky@spglobal.com

Beth Burks
London
(44) 20-7176-9829
Beth.Burks@spglobal.com

Noemie De La Gorce
London
+ 44 20 7176 9836
Noemie.delagorce@spglobal.com

SECONDARY CONTACTS

Michael Wilkins
London
(44) 20-7176-3528
mike.wilkins@spglobal.com

Michael T Ferguson, CFA, CPA
New York
(1) 212-438-7670
michael.ferguson@spglobal.com

Kurt E Forsgren
Boston
(1) 617-530-8308
kurt.forsgren@spglobal.com

See complete contact list at end of article.

OVERVIEW

1. S&P Global Ratings' Green Evaluation provides a relative green impact score for financial instruments that target the financing of environmentally beneficial projects. It also provides a second opinion, if requested, about a transaction's alignment with the Green Bond Principles. The Green Evaluation is not a credit rating, and it does not consider credit quality or factor into our credit ratings. The evaluation provides a relative ranking of financings globally. The analytical approach intends to increase transparency about how we carry out Green Evaluations. We first consider the governance and transparency of a financing from a green perspective. We then combine this assessment with an estimate of the asset's expected lifetime environmental impact in its region, relative to maintaining the status quo. The analytical approach can evaluate both mitigation and adaptation projects.

2. Mitigation projects aim to bring environmental benefits and target areas such as natural resources depletion, loss of biodiversity, pollution control, and climate change. Adaptation projects aim to reduce exposure to and manage the impact of natural catastrophes by, for example, making communities and critical infrastructure more resilient to the risk of extreme weather events due to climate change.

3. A Green Evaluation is based on three scores--a transparency score, a governance score, and a mitigation score (environmental impact) or adaptation score (resilience level). We evaluate a financing against each category and then combine the resulting scores into a final Green Evaluation.

4. The transparency score focuses on the quality of disclosure, reporting, and management of bond (or other financial instrument) proceeds.

5. The governance score assesses what steps have been taken to measure and manage the environmental impact of the proceeds of the financing, including certification, impact assessment, risk monitoring, and risk management.

6. The mitigation score reflects the environmental impact of the use of proceeds over the life of the assets. It takes into consideration variables such as sector, technology, location of the assets, and funding allocation. It considers a variety of environmental key performance indicators (eKPIs), such as carbon, water, pollution, and waste.

- The environmental impact calculation is done on a net benefit basis, meaning we consider each project's negative and positive environmental impact relative to the regional baseline (for example, the net benefit of a new renewable energy project compared with production from the conventional grid) for relevant eKPIs.
- The net benefit for each eKPI is compared against a range of modelled net benefit outcomes derived from relevant regional data to determine a ranking.
- The resulting ranking is a weighted average across the eKPIs applicable to that sector and is referred to as a net benefit ranking against the best-in-class technology within that sector or technology peer group.
- For financings that involve multiple technologies, we calculate the net benefit rankings based on funds allocated to each project to derive the net benefit ranking for the sector. If a financing covers multiple projects in different sectors, we repeat this process for each sector.
- We then determine the overall environmental impact for each sector based on where it fits within either our carbon, water, waste, or land use hierarchy. This indicates the sector's relative contribution to avoiding and coping with climate change.
- To derive the mitigation score for the project financing or portfolio of projects, we then calculate the environmental impact of each sector based on funds allocated to that sector.

7. The adaptation score reflects the estimated reductions in the costs of expected damages that projects achieve. To determine the resilience benefit that may be achieved through the use of proceeds, we analyze the benefit studies prepared for the project.

8. The last step is to combine the scores from transparency, governance, and either mitigation or adaptation to derive the final Green Evaluation on a scale of 0-100. Our assessment of transparency and governance does not enhance our final Green Evaluation--rather, its impact is neutral or negative. Poor transparency and governance may have a negative impact on the outcome, but good transparency and governance does not enhance a financing's overall environmental impact, in our view.

SCOPE

9. A Green Evaluation is a point-in-time assessment, in part based on an estimate of the expected lifetime net environmental benefit of a project should it perform to industry averages.

10. A Green Evaluation considers a broad variety of projects or initiatives a given instrument (debt or equity) finances. These projects include bond-financed projects, in line with the various green bond project taxonomies available, as well as conventionally financed projects outside of current green taxonomies that may have beneficial environmental implications.

11. A Green Evaluation is applicable to a wide variety of financial instruments, including those issued by corporate entities, project and structured finance vehicles, financial institutions, multilateral development banks, sovereigns, and municipalities. The evaluation is also applicable to financings by corporations whose businesses are solely focused on environmentally beneficial activities (such as wind turbine manufacturers), issuing general use-of-proceeds bonds. In addition, a Green Evaluation is applicable to portfolios of assets, including those held by financial or other institutions.

12. Our approach is relevant for pre- and post-closing of a financing and pre- or post-construction of an asset.

13. If proceeds are used for refinancing, the evaluation is based on disclosed information regarding

which investments or project portfolios are being refinanced and considers an assumed asset life from the point of refinancing as if undertaking a new evaluation. In cases where this information is not disclosed, the evaluation is based on the company's existing asset profile.

14. If the financing is issued by a financial institution, such as a bank, raising funds to on-lend, where specific projects have not yet been identified, the evaluation considers the underlying portfolio of assets financed by previous green issues. If all instruments finance the same portfolio of green assets without specific earmarking of assets, we assign all those instruments the same Green Evaluation.

Mitigation

15. Mitigation projects aim to provide increased mitigation of the effects of climate change. Green mitigation sectors that are currently in scope for Green Evaluations include:

- Green energy,
- Green transport,
- Green buildings,
- Energy efficiency,
- Fossil fuel power plants (decreased carbon or sulfur oxide emissions),
- Nuclear power,
- Water,
- Waste management, and
- Agriculture and forestry.

16. **Net benefit ranking.** The net benefit ranking calculation takes into account the full supply chain and operational phases over a project's lifetime. We consider the most material and quantifiable environmental eKPIs for each sector (see table 1). These include carbon emissions, water use, waste, land pollutants, eutrophication, and air pollution from sulfur oxides. Our selection of the eKPIs is based on the availability of robust quantitative data within each sector.

Adaptation

17. Adaptation projects aim to strengthen the resilience of buildings, critical infrastructure, and communities against the risk of extreme weather or longer-term shifts and variability in weather patterns caused by climate change. Strengthening flood defenses in coastal areas--to protect against the impact of storm surge due to rising sea levels, widely regarded as one consequence of climate change--is one example of an adaptation project.

18. The Green Evaluation framework assesses four categories. We look at transparency, governance, mitigation (environmental impact), and adaptation (resilience level) (see chart 1).

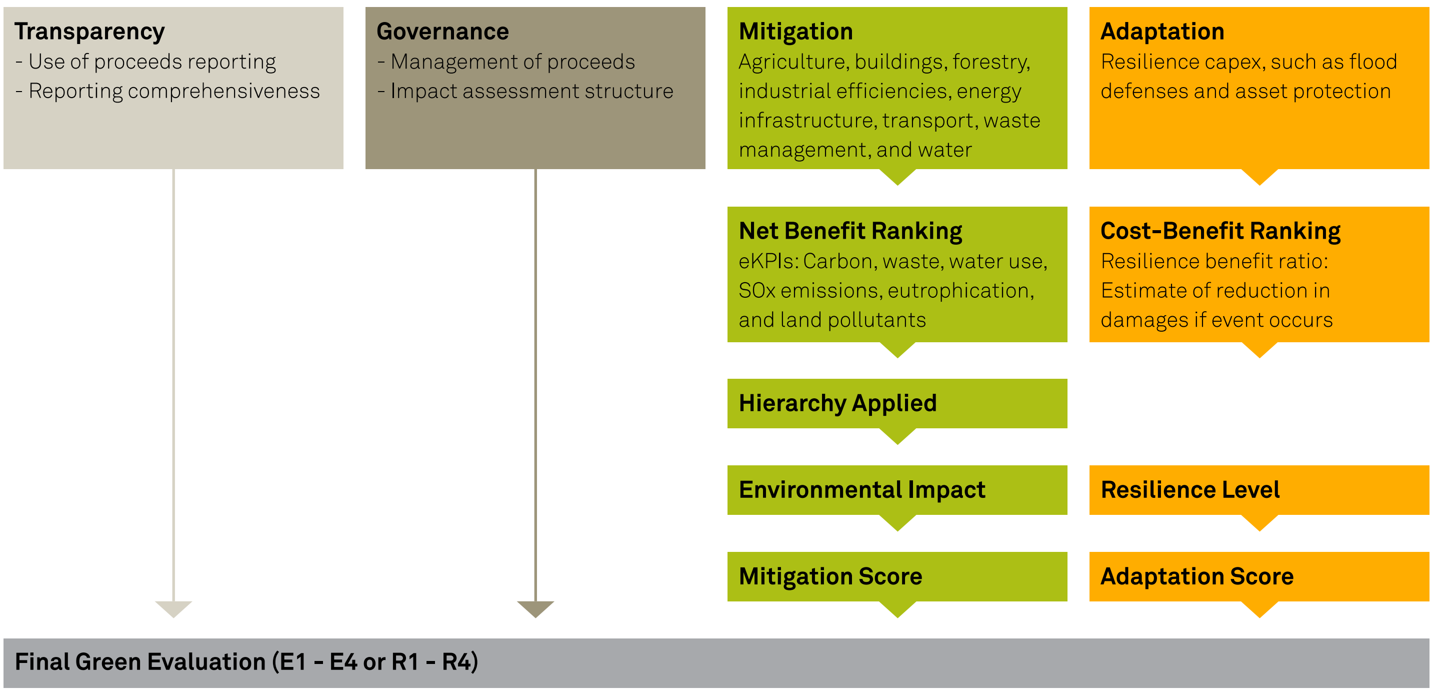
19. For mitigation projects, we estimate whether a project, over its life (including construction, operations, and decommissioning phases), is expected to create a net positive or negative environmental impact based on relevant eKPIs. We call this a net benefit ranking. We then overlay a hierarchy, which places the net benefit ranking of the specific technology within the broader context of the sector (for instance, solar power within the green energy sector). The outcome is referred to as the environmental impact. If applicable, we combine the environmental impact of

each sector to derive the mitigation score. We then combine the mitigation score with the transparency and governance scores to produce a Green Evaluation, which is mapped to an E score.

20. For adaptation projects, we determine the resilience level by assessing the increase in resilience a project is likely to provide. We map the resilience level to an adaptation score. We then combine that score with the transparency and governance scores to determine a Green Evaluation, which is mapped to an R score.

A. Transparency

Green Evaluation Analytical Approach



eKPIs--Environmental key performance indicators.

21. In assessing transparency, we look at the quality of reporting on the financing instruments. High-quality reporting enables investors and other stakeholders to understand and evaluate the governance of a transaction, as well as determine whether the promised environmental targets and performance are being achieved. Although not always available, independent certification of the environmental performance can further bolster stakeholders' confidence in the environmental effectiveness of the transaction, in our view.

22. Our evaluation of a transaction's transparency includes a qualitative review of:

- Use of proceeds reporting,
- Impact reporting and disclosure, and
- External verification of impact data.

23. We review public documentation of the financing transaction and, if available, actual reporting

and disclosure. Our qualitative analysis of actual (or promised future) reporting is based on questions we pose to the party seeking the green financing. (In this article, "entity" refers to the party seeking green financing.)

24. We evaluate each factor within transparency and apply weightings to determine the overall transparency score on a scale of 0-100.

Use of proceeds reporting

25. A single financing can fund multiple projects, all of which may have a beneficial environmental impact, but to varying degrees. Disclosure of the allocation of funds may be more or less detailed and can hamper an investor's ability to ascertain the overall environmental benefit. Alternatively, only a portion of the proceeds may be directed toward a project with a beneficial environmental impact. Our Green Evaluation analytical approach can accommodate either scenario. Allocating only a portion of proceeds to environmentally beneficial projects does not affect our Green Evaluation, which is based on the projects funded and applies only to that portion of the proceeds.

26. We identify the proportion of proceeds to be allocated to environmentally beneficial projects in our report.

27. In situations where the details of the projects to be funded have not been disclosed, we assume a worst-case allocation scenario.

28. We can provide our point-in-time Green Evaluation at any stage in the financing or project life. Our evaluation is based on the assumption that the project is completed and operational--if the evaluation is completed at a time when construction is anticipated to go ahead as planned--and operates within average industry expectations for the technology.

29. **Disclosure of the total signed amount of financings and the amount of allocated proceeds:** Our appraisal of disclosure of the amount of signed and allocated proceeds is twofold. First, we evaluate the total amount (signed for financing and the amount of proceeds allocated to the specific financing), if published, then we review the level of granularity of the reporting on allocation.

30. **Level of disclosure about proceeds allocated to projects:** Here we assess the depth of disclosure about proceeds allocated to eligible financings. This indicates to investors and stakeholders whether (and to what extent) an entity is following its objectives indicated at issuance. The disclosure (if any) can be project level or aggregate level by sectors. For financings being assessed pre-issuance, we look for documented intention to report.

31. **Frequency of reporting, or commitment to report, on the use of proceeds:** A commitment to report more frequently (as well as a commitment to publish the reports) leads to a higher level of transparency than publishing less frequently and gives the investor more frequent data points. Funds allocation reporting frequency can vary from annual reporting, to less frequent, to no reporting commitment at all.

32. **Disclosure about including and removing projects and financings from a portfolio:** A defined process for including and removing projects in a report is important for portfolios with financings that may be added or subtracted from the portfolio from time to time. In addition, by removing from the portfolio a project that does not meet an entity's environmental targets, the entity further demonstrates its commitment to its own green principles.

33. **Project selection protocol:** Here we assess whether an entity has disclosed the rules and principles governing its future allocation of funds. In other words, our evaluation will examine if the principles for selecting which projects to fund are clear and transparent. This is equally applicable for single-project financings.

Reporting and disclosure about environmental impact

34. **Commitment to reporting about environmental impact:** A commitment to disclosing the environmental impact of funded projects enhances transparency and informs environmentally conscious investors. Environmental impact reporting frequency can vary from annual reporting, to less frequent, to no reporting commitment at all.

35. **Disclosure of environmental impact:** The existence of (or commitment to) at least annual quantification and disclosure of eligible projects' expected or actual environmental impact is assessed separately. The disclosure (if any) can be quantitative or qualitative, and it may be at a project or aggregate portfolio level. We do not include the disclosure of specific annual quantitative environmental impact results in our net benefit ranking.

36. **Depth of disclosure of impact indicators:** We evaluate the existence and quality of environmental impact indicators in line with the characteristics of different technologies. Basic indicators include location, capacity (power generation) or energy savings (energy efficiency investments), vehicle carbon intensity (green transport), description of asset types (green buildings), waste diverted from landfill (waste management), and project land area (agriculture and forestry). Comprehensive indicators include additional disclosure related to estimated outputs such as capacity factors (power generation), impact on modal split (green transport), targeted or estimated savings (energy efficiency), estimated savings compared with baseline scenarios (green buildings), energy generated from waste (waste management), and sustainable wood production (agriculture and forestry). Advanced indicators have an additional layer of disclosure, such as estimated avoided carbon.

37. **Disclosure of lifecycle impact and a project's economic life** An important factor when disclosing a project's impact is the time period the disclosure covers. We can better understand the lifecycle (whole of life) impact on an annual basis if there are annualized impact indicators. The disclosures (if any) can cover the full lifetimes for all of the projects financed, the lifetimes for some of the projects financed, the economic life for all of the projects, and the economic life for some of the projects.

38. **Methodology for environmental impact calculation:** Disclosure of an entity's methodology for calculating the actual or expected environmental impact is viewed positively. It allows for a more thorough investigation by environmentally conscious investors and facilitates stakeholder discussions. For example, understanding an entity's baseline assumptions and scope when calculating avoided emissions provides added transparency for investors. When provided, the disclosure may or may not cover all projects; the former is preferable.

External verification of impact data

39. **Quality of assurance:** Certification that an entity's environmental impact assessment complies with an established assurance standard improves the transparency of the transaction, in our view. A third-party appraisal of an issuer's data quality that lacks compliance with an assurance

standard is not viewed as positively. Without any external verification of environmental impact data, an investor is less assured of the entity's claims regarding the environmental impact of the transaction and associated project or projects.

Treatment of general use of proceeds transactions by pure-play entities

40. "Pure-play" companies that focus solely on environmentally beneficial activities, such as solar panel or wind turbine manufacturers, often issue general use-of-proceeds bonds. We assume these issuances are fully committed to eligible green projects.

Portfolios

41. For portfolios of multiple financings, we would expect to review the criteria for selecting or deselecting assets within the portfolio.

B. Governance

42. In our governance assessment, we look at the procedures in place to manage proceeds allocation and to evaluate environmental impact over the life of the assets.

43. We consider whether there are well-defined procedures in place for:

- Selecting projects eligible to be financed,
- Preventing proceeds of the bond from being used for other purposes than the intended green financings,
- Appraising and managing environmental impacts, and
- Complying with environmental regulations.

44. We evaluate each factor within governance and apply fixed weightings to determine the overall governance scores on a scale of 0-100.

Management of proceeds

45. **Selection rules of eligible investments or financings:** The existence of a well-defined selection protocol is important for ensuring that proceeds are allocated to projects with environmental benefits. We view favorably transactions with well-defined environmental objectives and explicit selection principles to achieve those objectives.

46. **Proportion of total issued amount committed to green financings:** The higher the commitment to green financings, the higher the score on these factors because we view it is an indicator of the extent to which the proceeds are committed to being used or already are being used to finance environmentally beneficial projects.

47. **Tracking, non-contamination, and allocation of proceeds:** These three factors cover the oversight and internal control of proceeds. When analyzing issue-related governance processes, we consider whether a subaccount separation of proceeds is, or is intended to be put, in place (allowing for transparent tracking of the use of proceeds). We also assess any protocols in place to prevent proceeds from being used for purposes other than the stated financing objectives in the

documentation.

48. **Verification of proceeds allocation or future commitment to verify proceeds allocation:** A third-party review provides additional assurance to investors that proceeds are being allocated as expected. We therefore view the quality of governance as higher when an external independent reviewer reviews proceeds allocation. The provision of regular evaluations in line with an assurance standard is also viewed positively.

Evaluation of environmental impact

49. **Measuring the positive and negative environmental impact:** We look at whether a qualitative or quantitative environmental impact evaluation of the funded projects is available to investors. We view a quantitative and transparent evaluation of the environmental impact of the project over its full life cycle more favorably than just the economic life of the asset.

50. **Compliance with regulations:** For projects with intended environmental benefits, we expect an entity to evidence compliance with relevant environmental regulations. If an entity doesn't provide this evidence, generally we score governance lower.

Certificates against industry standards

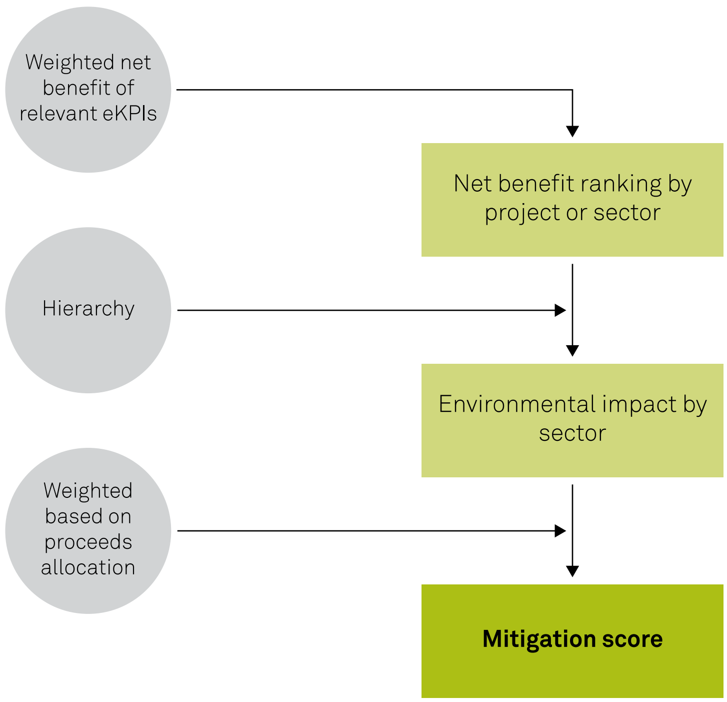
51. This factor currently covers green building certificates, such as BREEAM or LEED, and differentiates between their various levels as an assurance that issuers have considered industry standards or exceeded industry standards when financing such projects.

C. Mitigation

52. Our assessment of mitigation reflects the environmental impact of a financing's proceeds over the life of the assets that it finances. It considers a variety of eKPIs, such as carbon, water, waste, land pollution, eutrophication, and air pollution from sulfur oxides. We use those to determine a project's net benefit ranking. We then assess where each project fits within either our carbon, water, waste, or land use hierarchy (which indicates the sector's relative contribution to avoiding and coping with climate change) to determine the environmental impact. Finally, we calculate the environmental impact of each sector a project covers based on funds allocated to that sector to derive the mitigation score (see chart 2).

Chart 2

Determining The Mitigation Score



eKPIs--Environmental key performance indicators.

Net Benefit Ranking

53. In assessing a project from a mitigation perspective, we use a net benefit approach. We estimate a project's positive and negative impact compared with a baseline scenario to determine its net environmental impact overall compared with other technologies in the same sector. We call this a net benefit ranking. We consider the material stages of a project lifecycle, from the supply chain (including construction), through operations, to end of life. The operational phase is the assumed lifetime of the project or asset, minus an assumed one-year construction phase, and is the point at which we would consider the environmental impact of the project relative to its baseline.

54. For example, for a renewable wind energy project, we would consider the environmental impact of constructing, operating, and decommissioning a windfarm against the benefits of using the windfarm to produce energy instead of the conventional grid in that country over the lifetime of the windfarm.

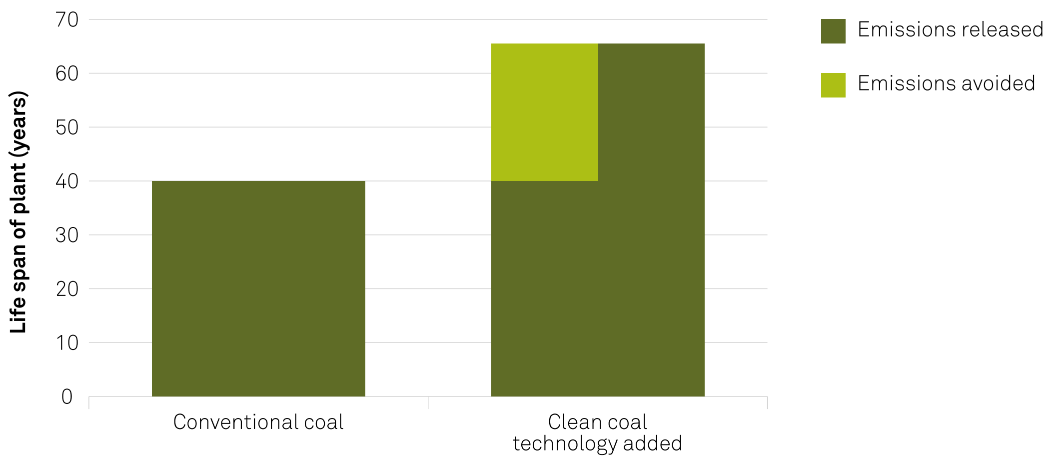
55. We estimate the positive and negative impact over the life of a project for each of the material eKPIs in its sector. For a renewable energy project, we estimate the net benefit to the environment over its lifetime after considering the carbon emissions, waste creation, and water usage (eKPIs for green energy) associated with the supply chain, operation, and decommissioning.

56. Our analytical approach compares emissions savings to a baseline scenario. For an energy project, for example, the baseline scenario would be the business-as-usual emissions rate for the grid system in the region where the project is based. Therefore, some projects, such as clean coal projects (which make the burning of coal more efficient and reduce emissions per megawatt-hour

of energy produced), could score very well in terms of absolute quantities of carbon saved. However, in this scenario, the project would also invest in a fossil fuel energy source and effectively extend the lifespan of the plant, thereby locking fossil fuel energy into the grid. As a result, total emissions from the asset over its lifetime would increase (see chart 3).

Chart 3

Emissions Released Over Project Life Span



Data requirements

57. The net benefit ranking is designed to compare the relative green impact of the projects being financed. We take into consideration the sector, the technology, and the location of each asset. (If the specific country, U.S. state, or Canadian province is not known, we use regional or global factors as appropriate.) We calculate the net benefit using conservative assumptions, meaning that, in the absence of disclosure, we assume the technology within the sector and country mix with the lowest net benefit. If the subsector type is known (for example, green power generation or green power technology), then the calculation can be refined further, with the most granular level of detail at the individual project level (for example, wind power generation or smart grid). This concept is illustrated below for the category of green energy.

Green Energy Technologies Considered Under The Green Evaluation

- Photovoltaic solar power generation
- Concentrated photovoltaic solar power generation
- Solar thermal
- Small hydropower generation (<30 megawatts)
- Large hydropower generation (>30 megawatts)
- Onshore wind power generation
- Offshore wind power generation
- Wave and tidal power generation
- Landfill gas power generation
- Geothermal power generation
- Biomass power generation
- Biomass cogeneration
- Fuel cells

Sector-specific approaches

58. When assessing a project's net benefit, we consider a variety of eKPIs by project type and sector. Table 1 shows the eKPIs for projects in several sectors, though not all sector and project types. We do not model expected growth or decline in energy demand or water availability. We work on the assumption that new generation assets will replace existing generation assets.

eKPIs Considered In Determining Net Benefit Ranking

Technology	Carbon	Waste	Water use	SOx emissions	Eutrophication	Land pollutants
Renewable energy	✓	✓	✓			
Green buildings	✓		✓			
Green transport	✓					
Energy efficiency	✓					
Water	✓		✓			
Fossil fuel power plants	✓	✓	✓	✓*		
Nuclear	✓	✓	✓			
Waste management	✓		✓§		✓§	✓
Forestry protection	✓					
Forestry expansion	✓					
Alternative farming†	✓		✓		✓	✓
Improvements in alternative farming	✓		✓		✓	✓
Improvements in conventional farming	✓		✓		✓	
Crop-based products	✓					
Land restoration	✓					

*For flue-gas desulfurization only. §For food loss reduction only. †Depending on the technology's benefit, two or three of four possible eKPIs are considered. SOx--Sulfur oxides. eKPIs--Environmental key performance indicators.

59. **Green energy.** A key environmental impact of renewable energy generation is that it supplies the grid with low-carbon electricity, which reduces the local or national carbon intensity of electricity. Indeed, we assume that the electricity a renewable energy power plant produces would have been produced by the existing power plants connected to the same grid in the event that this project had not existed. As a result, the amount of carbon dioxide avoided by a particular renewable energy power plant is dependent on the collective carbon content of all the energy connected to this grid, netted by the carbon costs of installing these assets. Adding renewable energy in a carbon-intensive electric system, heavily reliant on fossil fuels, will avoid more emissions as it replaces comparatively carbon-intensive electricity.

60. **Buildings.** Green building projects aim to reduce the environmental impact of buildings over their lifespan. Buildings accounted for one-third of global carbon emissions and half of global electricity consumption in 2012. Between 2000 and 2012, the sector's final energy consumption increased by an average annual 1.5%, well beyond the 0.7% that would limit the global

temperature rise to no more than 2 degrees Celsius above preindustrial levels, according to the International Energy Agency (IEA). Green buildings target a variety of environmental impacts. However, the focus remains primarily on two main eKPIs: energy efficiency and water saving. Globally accepted green building certifications include BREEAM, LEED, Energy Star, Green Star, and many others, according to the Whole Building Design Guide.

61. The two key types of commercial and residential green building projects are:

- Construction of new buildings, and
- Retrofit of existing buildings.

62. Within both subcategories are many asset types, including residential, retail, industrial, and health care. Examples of energy-saving initiatives in both new buildings and refurbishments include:

- Energy-efficient heating, ventilation, and air conditioning systems;
- Double glazing of glass windows and walls to improve thermal insulation;
- High-efficiency pool equipment;
- Smart meters;
- High-efficiency water heating; and
- Roof and wall insulation.

63. **Green transport.** A key environmental impact of low-carbon transportation sources is meeting transportation demand without emitting the carbon dioxide associated with fossil fuel combustion. That's because transport accounts for a large share of human-generated carbon dioxide emissions and requires significant evolution to meet climate goals. For instance, the IEA estimates that the electric vehicle market has to increase by 80% per year by 2025 to be on track with the 2-degree scenario. As a result, providing low-carbon transport solutions, such as electric private or public transport, is a key aspect of the energy transition and can achieve significant environmental benefits.

64. Project subcategories are:

- Urban rail system,
- Electric vehicles,
- Fuel-efficient vehicles, and
- National rail and freight systems.

65. **Energy efficiency.** The key environmental impact of energy-efficiency projects is their ability to provide the same service while reducing energy demand. Energy efficiency is integral to achieving a low-carbon transition in traditional sectors, such as buildings, transportation, and industry. The scope of the savings and the techniques required depend on the sector they are applied to and location. Energy efficiency should be distinguished from energy conservation, which is a broader term that includes foregoing a service, such as turning down the thermostat in the winter to save energy.

66. Many of these technologies are assessed in other sectors (green buildings, green energy, and green transport), leaving two main categories of projects to consider within energy efficiency: energy-efficient products (such as those with an Energy Star certification) and industrial

efficiencies.

67. **Water.** While other sectors, such as green energy, green transport, and green buildings are targeted at decarbonization of the economy, water-related mitigation projects focus on using water resources and networks more efficiently and improving the quality of water treatment for various end uses and the environment. Projects focusing on water are increasingly important as climate change warms the atmosphere, altering the hydrologic cycle and changing the amount, timing, form, and intensity of precipitation (see "Climate Change and Watersheds: Exploring the Links," Environmental Protection Agency Science Matters Newsletter, published August 2013). These projects aim to address problems of water scarcity and pollution, often at local and watershed levels. Therefore, the key environmental impact can be more efficient water use or distribution, increased levels of water recycling, and improved water treatment compared with the baseline scenario. Importantly, the majority of projects in this sector take into account regional scarcity factors.

68. We recognize that water projects improve the resilience to drought risk and, therefore, also have an adaptation element. We reflect that by incorporating water scarcity in the net benefit calculation. However, we consider projects whose main objective is to reduce water consumption or improve water quality as mitigation. At the same time, water projects whose primary motivation is to increase communities' resilience to drought will likely be considered as adaptation, provided that the resilience benefit is quantified (see section D).

69. The water sector in scope encompasses a broad range of water-focused projects, such as water demand reduction, water treatment, water treatment to increase supply, and wastewater treatment with or without energy recovery. The specific types of projects in scope are listed below.

70. Water demand reduction projects are:

- Conservation measures in residential buildings,
- Conservation measures in commercial buildings,
- Conservation measures in industrial equipment,
- Improved irrigation,
- Smart metering in residential buildings, and
- Reducing water losses in the water distribution network.

71. Water treatment to increase supply covers:

- Water desalination to supply potable municipal water,
- Recycling wastewater to supply potable municipal water,
- Recycling wastewater to supply non-potable water for agricultural uses, and
- Recycling wastewater to supply non-potable water for other industries.

72. Wastewater projects are:

- Biofiltration wastewater treatment with no energy recovery,
- Biofiltration wastewater treatment with energy recovery,
- Wastewater treatment with no energy recovery, and
- Wastewater treatment with energy recovery.

73. **Fossil fuel power plants.** The fossil fuel power plants sector considers a variety of carbon reduction initiatives in the conventional energy sector, including "clean coal" and coal-to-gas conversion projects. The global average efficiency of coal-fired power plants currently in operation is roughly 33%, significantly lower than the 45% efficiency possible with modern, ultra-supercritical coal-fired power plants, according to IEA analysis. These figures highlight scope for improving carbon efficiency within existing and planned conventional power generation capacity. The key environmental impact that these projects target is reducing greenhouse gas (GHG) emissions through the decreased carbon intensity of conventional energy production.

74. Project subcategories are:

- Coal plant efficiency upgrades,
- Flue gas desulfurization,
- Fossil fuel-based cogeneration,
- Oil refinery efficiency,
- Reduced flaring,
- New clean coal plants, and
- Coal-to-gas conversions.

75. **Nuclear.** The key environmental benefit of nuclear power generation is extremely low GHG emissions. Low-carbon power generation technologies, such as renewable power generation and nuclear, continue to play an important role in the decarbonization of the power sector, according to the IEA. However, the high carbon-intensity of uranium mining required to power nuclear technology reduces its net contribution to decarbonization, compared with renewable energy generation, when taking supply chain emissions into account (see "Sustainability of uranium mining and milling: toward quantifying resources and eco-efficiency," G.M. Mudd and M. Diesendorf, Environmental Science and Technology, 42:2624-2630, published 2008).

76. **Waste Management.** The key environmental benefits of waste management are reducing waste, reusing waste materials, avoiding GHG emissions, and minimizing land pollutants. Waste management practices vary in their intended environmental benefits. Certain technologies, such as anaerobic digestion, involve the recovery of gas generated by waste and converting it to energy, thereby reducing GHG emissions from landfills. Some waste management activities aim to reduce the quantity of waste sent to the local waste pathway. Others improve systems that avoid or reduce land pollution impacts.

77. Project subcategories are:

- Food loss reduction,
- Hazardous waste incineration,
- Waste composting,
- Waste to energy,
- Aerobic digestion,
- Anaerobic digestion, and
- Gasification pyrolysis.

78. **Agriculture and forestry.** A key environmental benefit of agriculture and forestry is more sustainable land use, which can support biodiversity, the sequestration of GHG emissions, the reduction of water use and pollutants, and soil enhancements. Land and forests play an important role in the climate system, acting as both a source and sink of GHGs, and in facilitating the exchange of energy, water, and aerosols between the land surface and the atmosphere. Agriculture and forestry projects aim to manage land more sustainably by preventing or reducing land degradation or both, maintaining land productivity, enhancing soil culture and biodiversity, and supporting mitigation and adaptation of climate change.

79. Project subcategories are:

- Forestry protection,
- Forestry expansion,
- Alternative farming,
- Improvements in conventional farming,
- Crop-based products, and
- Land restoration.

80. Forestry protection projects are:

- Forest restoration and protection, and
- Forestry protection.

81. Forestry expansion projects are:

- Forestry expansion for nontimber products,
- Plantation forestry, and
- Sustainable forest management for timber production.

82. Alternative farming projects are:

- Low tillage,
- Organic farming,
- Sustainable fertilizer,
- Drought-resistant crops, and
- Rotational grazing.

83. Improvements in conventional farming projects are:

- Rice intensification systems, and
- Precision agriculture and livestock systems.

84. Crop-based product projects are:

- Biofuels.

85. Land restoration projects are:

- Land restoration to natural state, and

- Land restoration to agriculture.

Weighting eKPIs and determining the ranking

86. In order to convert our estimate of the absolute net benefit impact in terms of each relevant eKPI, such as cubic meters of water, kilograms of land pollution, metric tons of sulfur oxides, metric tons of nitrogen (for eutrophication), metric tons of waste, and metric tons of carbon, into a relative ranking, the net benefit is compared against net benefit results for each eKPI and for each technology within a technology's peer group.

87. The comparison uses percentiles to assign a score. For example, if the carbon net benefit result of a project financing fits between the 20th and 30th percentiles of the representative range of carbon outputs, the instrument scores 30 out of 100. This net benefit ranking is a best-in-class approach because it compares a particular financing's environmental impact against results achieved for each eKPI within the sector.

88. To derive the representative range, net benefit calculations use all the available project types in the peer group and a group of relevant countries. For example, within the renewable energy sector, we refer to the 61 countries responsible for 95% of power generation capacity, according to the Shift Project, the U.S. Energy Information Administration, and IEA statistics. The carbon net benefit for every type of renewable energy power generation technology considered in the peer group (such as wind, solar, and geothermal) is calculated to produce the representative range.

89. Each eKPI for a given sector has a weighting, informed by using Environmental Valuations to understand the most material environmental impact of a particular activity. For example, carbon may be weighted at 70%, water at 20%, and waste at 10% for a particular sector. The net benefit ranking is a weighted average of the individual eKPI percentile scores for each project. If there are multiple projects within a sector being funded by the same transaction, we weight each project (based on funding allocation) to achieve a sector-level net benefit ranking. For sectors that cross our hierarchy categories (for example, water and carbon), we provide a subsector total by hierarchy level.

Sector Hierarchy And Environmental Impact

90. After determining the sector (and subsector, if applicable) net benefit rankings, we apply our carbon, water, waste, or land use hierarchy. This places the final mitigation score within the broader context of different sectors. In effect, this limits the mitigation score that projects or portfolios with potentially uncaptured negative effects are able to achieve (see chart 2). The carbon hierarchy differentiates between long-term green solutions and environmental impact reduction. For example, after applying the hierarchy, a clean coal project would not be able to achieve as high a score as a renewable energy project. Importantly, the hierarchy does not exclude any project type from the evaluation. The water hierarchy differentiates between system enhancements and demand-side improvements. The waste hierarchy differentiates between reductions in waste and pollution and waste management improvements. The land use hierarchy differentiates between maintenance of the natural state of ecosystems and intensive land use.

91. The water, carbon, waste, and land use hierarchy scores range from 0 (for example, extending the use of fossil fuel) to 100 (for example, renewables contributing to systemic change) and carry weights of 60%-75% (see tables 16-19). Higher hierarchy scores carry a heavier weight because we believe those projects are contributing the most environmental benefit. To determine the environmental impact score, we combine the weighted hierarchy score with the weighted net benefit ranking of each project or sector. The net benefit rankings are weighted 25%-40%.

Table 2

Carbon, Water, Waste, And Land Use: Hierarchy Scores And Weighting

Sector	Tier	Description	Hierarchy score (0-100)	Weighting of hierarchy score (%)	Weighting of net benefit ranking (%)
Carbon					
	1	Systemic decarbonization	100	75	25
	2	Significant decarbonization through low-carbon solutions	90	70	30
	3	Decarbonization by alleviating emissions of carbon-intensive industries	80	65	35
	4	Decarbonization technologies with significant environmental hazards	50	60	40
	5	Improvement of fossil-fueled activities' environmental efficiency	0	60	40
Water					
	1	System enhancements	100	75	25
	2	Marginal system enhancements	75	70	30
	3	System enhancements with significant negative impacts	62.5	70	30
	4	Demand-side improvements	50	65	35
Waste					
	1	Waste reduction	100	75	25
	2	Waste management withmaterial reuse	90	70	30
	3	Waste management for energy recovery	80	65	35
	4	Waste management improvements	50	65	35
Land use					
	1	Maintenance of natural state	100	85	15
	2	Low human intervention	90	70	70
	3	Alternative farming and forestry practices	80	65	65
	4	Improvements in conventional agriculture	70	65	65
	5	Intensive land use	50	60	60

Source: S&P Global Ratings.

Carbon hierarchy

92. The carbon hierarchy (see table 2) is based on an assessment of a technology's overall contribution to decarbonization of the economy. We apply the land use hierarchy to projects in the agriculture and forestry sectors, the waste hierarchy to projects in waste management, and the

water hierarchy to projects in the water sector (see paragraphs 98-113). We apply the carbon hierarchy to projects in energy, buildings, transportation, fossil fuels, and industrial efficiency sectors.

93. Projects contributing to systemic decarbonization are on the top rung of the carbon hierarchy. These include green energy projects and demand management.

94. The second level in the carbon hierarchy includes sector-specific solutions that are already compliant with a decarbonized, or green, economy. These include fully electric transport solutions or net-zero buildings (with zero net energy consumption). For instance, electric vehicles may achieve limited environmental benefits because of the carbon content of their electricity use, but as systemic change to the electricity grid takes place, the long-term benefits are likely to be significant.

95. Industrial efficiencies and energy efficiency projects with significant potential for environmental benefit (lowering the impact of carbon-intensive activities) come third in our hierarchy. These project types--for example, a hybrid vehicle--optimize the environmental impact of existing technologies rather than promoting new low-carbon solutions.

96. Projects that achieve immediate, and often meaningful, environmental benefits, but at the same time prolong the use of fossil fuels, are ranked lowest. This is because these projects lock in emissions for the long term (see "The effect of natural gas supply on US energy and CO2 emissions," Christine Shearer et al., Environmental Research Letters, 9 094008, Sept. 24, 2014).

Table 3

Carbon, Water, Waste, And Land Use Hierarchies

Sector	Technology
Carbon	
Tier 1: Systemic decarbonization	Green energy: Wind power
	Green energy: Solar power
	Green energy: Small hydro
	Green energy: Large hydro (excluding tropical areas)
	Energy efficiency: Energy management and control
Tier 2: Significant decarbonization of key sectors through low-carbon solutions	Green transport without fossil fuel combustion
	Green buildings – new build
Tier 3: Decarbonization by alleviating emissions in carbon-intensive industries	Energy efficient projects (industrial efficiencies and energy star products)
	Green transport with fossil fuel combustion
	Green buildings refurbishment
Tier 4: Decarbonization technologies with significant environmental hazards	Nuclear power
	Green energy: Large hydro in tropical areas
Tier 5: Improvement of fossil fuel-based activities' environmental efficiency	Fossil fuel power plants: Coal to natural gas
	Fossil fuel power plants: Cleaner fuel production
	Fossil fuel power plants: Cleaner use of coal
Water	
Tier 1: System enhancements	Recycling wastewater to supply potable municipal water
	Recycling wastewater to supply non-potable water for agricultural uses
	Recycling wastewater to supply non-potable water for other industries
	Wastewater treatment with no energy recovery
	Wastewater treatment with energy recovery
Tier 2: Marginal system enhancements	Reducing water losses in the water distribution network
Tier 3: System enhancements with significant negative impacts	Water desalination to supply potable municipal water
Tier 4: Demand-side improvements	Conservation measure in residential buildings
	Conservation measure in commercial buildings
	Conservation measure in industrial buildings
	Smart metering in residential buildings
Waste	
Tier 1: Waste reduction	Reduction in food loss
Tier 2: Waste management withmaterial reuse	Aerobic composting with fertilizer reuse
Tier 3: Waste management for energy recovery	Anaerobic digestion

Table 3

Carbon, Water, Waste, And Land Use Hierarchies (cont.)

Sector	Technology
	Gasification/pyrolysis with waste feedback
	Waste to energy
Tier 4: Waste management improvements	Hazardous waste management
Land	
Tier 1: Maintenance of natural state	Land restoration to natural state
	Forest protection and restoration
Tier 2: Low human intervention	Low tillage
	Forestry expansion for non-timber forest products
	Forestry protection
Tier 3: Alternative farming and forestry practices	Sustainable fertilizers
	Organic farming
	Drought-resistant crops
	Rotational grazing
Tier 4: Improvements in conventional agriculture	System of rice intensification
	Precision agriculture & livestock
	Sustainable forest management for timber production
Tier 5: Intensive land use	Plantation forestry
	Crop-based products (biofuels)
	Land restoration to agriculture

Source: S&P Global Ratings.

97. The principles applied to establish this hierarchy are:

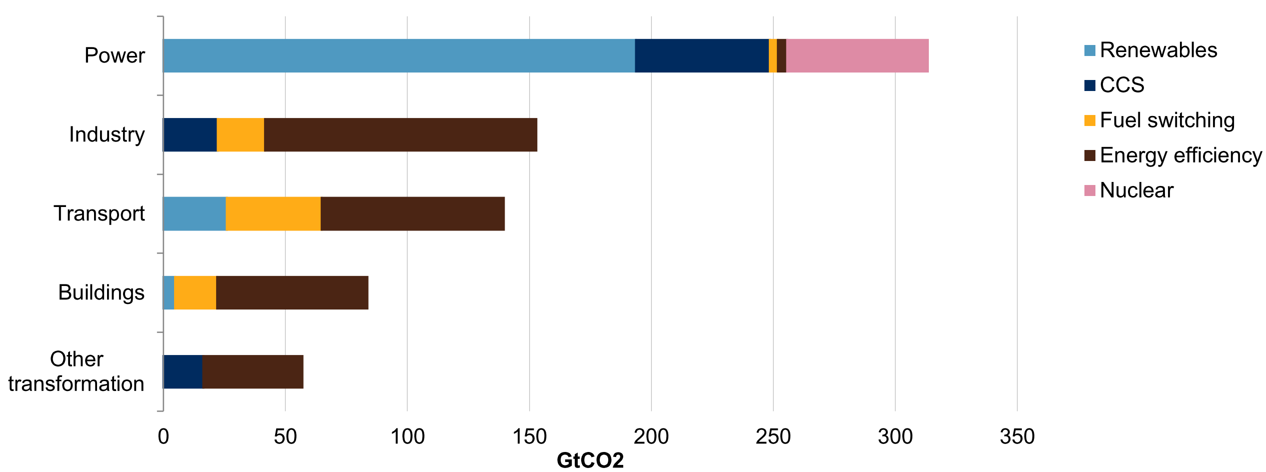
- Systemic solutions prevail over sector-specific solutions: Decarbonizing electricity affects not only the power sector, but also the entire carbon intensity of economies as electricity feeds through all other economic sectors (Scope 2 emissions as defined under the Greenhouse Gas Protocol). Because of this, solutions affecting this central aspect of energy transition have a wider reach than sector-specific solutions as they allow systemic change. For instance, the deployment of electric vehicles is highly dependent on an optimal energy demand management (smart grid solutions).
- Compare low-carbon solutions with technologies that provide marginal improvement: The hierarchy distinguishes between low-carbon solutions (such as electric vehicles), which are already compliant with a low-carbon economy, and "intermediary" technologies that aim to achieve environmental savings through a marginal improvement of carbon-intensive processes (such as hybrid vehicles). Although the latter might achieve significant savings by improving a very intensive baseline, it does not directly contribute to the deployment of low-carbon solutions.
- Isolate sectors with a particularly negative environmental impact: Large hydropower projects in tropical areas (of more than 30 megawatts) produce low-carbon energy. However, we differentiate these projects from other renewable electricity generation given the significant

methane emissions from rotting vegetation in large reservoirs in tropical areas (see "Do Hydroelectric Dams Mitigate Global Warming? The Case of Brazil's CuruA-una Dam," P. M. Fearnside, Mitigation and Adaptation Strategies for Global Change, Volume 10, Issue 4, pages 675-691, published October 2005). The significant carbon-intensity of uranium mining (see G.M. Mudd and M. Diesendorf) and uncertainty about hazardous nuclear waste management lead us to rank nuclear energy near the bottom of our green hierarchy, despite its low-carbon intensity during operations.

- Consider a broad green universe: Country-specific standards may differ from industry-accepted taxonomies, such as the Green Bond Principles or Climate Bonds Initiative. The inclusion of the clean use of coal or clean fossil fuel production in the Chinese Green Bonds standards, underlines the lack of consensus about how green these activities are and that the fossil fuel sector is still developing.
- Place projects that help to extend fossil fuels' lifespan at the bottom of the scale: Although a very carbon-intensive baseline can make the net environmental benefit of fossil-fuel plants retrofit from coal to gas transition or to clean coal significantly positive, these projects increase further fossil fuel usage and create "locked-in emissions" (see Christine Shearer et al., Sept. 24, 2014).
- Apply a carbon dioxide reduction potential approach: The IEA has estimated the potential carbon emissions reduction achievable per sector in a low-carbon scenario, compared with business as usual.

Chart 4

Cumulative CO2 Reductions By Sector And Technology In The Two-Degree Scenario To 2050



Note: A portfolio of low-carbon technologies is needed to reach the two-degree scenario; some solutions will be broadly applicable, while others will need to target specific sectors. CCS--Carbon capture and storage.
Source: International Energy Agency (2015), Energy Technology Perspectives 2015, OECD/IEA, Paris.

Water hierarchy

98. For the water projects listed in paragraphs 70-72, we apply our water hierarchy--and not the

carbon hierarchy. We have divided our water hierarchy into four tiers, based on the project's type of impact:

- System enhancements,
- Marginal system enhancements,
- System enhancements with significant negative impact, and
- Demand-side improvements.

99. **System enhancements:** Directly or indirectly increase the availability of fresh water. Projects that fall into the top tier of the water hierarchy are those that directly or indirectly increase the availability of fresh water. These are projects that do not have a significant negative water impact and deliver fresh water through the construction of new infrastructure. For instance, a wastewater recycling plant that delivers water to agriculture will fall into this tier of the hierarchy.

100. **Marginal system enhancements:** Improve the delivery of existing freshwater supplies. The projects that fall into the second tier of the hierarchy are those that directly or indirectly improve the delivery of fresh water through existing infrastructure. This second tier is for projects that upgrade existing water infrastructure, rather than build new infrastructure, and do not have any significant negative water impact. An example would be upgrading the water distribution network by reducing leakage from pipes.

101. **System enhancements:** Increase the availability of fresh water but have a significant negative environmental impact. The projects that fall into the fourth tier increase the availability of fresh water by building new infrastructure but cause a significant negative water impact in the process. For instance, this includes the construction of seawater desalination plants that dispose of waste saline solution, a byproduct of the desalination process, back into seawater.

102. **Demand-side improvements:** Measures that reduce the demand on potable water supplies. Projects that fall into the fourth tier of the hierarchy are those that reduce the demand on potable water supplies. These projects install technologies that aid in reducing the demand on freshwater sources in residential, commercial, or industrial settings. For instance, they can include the installation of smart meters in residential buildings or the installation of more efficient kitchen appliances in commercial buildings.

103. While the principles behind the carbon, water, waste, and land use hierarchies are similar, the definitions of systemic changes differ slightly for the different hierarchies. This is because, when considering carbon projects, systemic change refers to decarbonizing power supply networks. It is substituting the use of fossil fuels with renewable energy sources, such as wind and solar. For water supply networks, systemic change involves substituting ground water withdrawals with infinitely (locally) recycled surface water, where water is not treated as a once-used commodity (similar to using carbon one time by burning it to generate energy). For the agriculture and forestry hierarchy, systemic change involves restoring and regenerating degraded land and protecting biodiversity. For the waste hierarchy, systemic change involves reducing the quantity of raw materials required to produce goods and services and minimizing the polluting impacts of waste.

Waste Hierarchy

104. For waste projects (see paragraphs 76-77), we apply our waste hierarchy (not the carbon, water, or land use hierarchy). We divide the waste hierarchy into four tiers based on the project's type of impact:

- Waste reduction,
- Waste management with material reuse,
- Waste management for energy recovery, and
- Waste management improvements.

105. **Waste reduction: Reduce quantity of waste produced and prevent pollution.** Projects that fall into the first tier of the waste hierarchy are preventative measures, which avoid or eliminate the amount of waste and pollution produced and thereby divert waste volumes from the local waste treatment pathway. These projects offer production efficiencies that reduce the amount of waste and pollution produced.

106. **Waste management with material reuse: Recovery of resources from waste with materials reuse.** Projects that fall into the second tier of the waste hierarchy involve the reuse of waste products for use in other products. By reusing the waste as a material resource, these technologies support the transition to a circular economy.

107. **Waste management for energy recovery: Recovery of resources from waste for energy.** Projects that fall into the fourth tier of the waste hierarchy involve the reuse of waste products for energy generation. Technologies such as waste-to-energy plants incinerate waste intended for landfill and capture waste gas for power generation. By reusing the recovered gas, these technologies contribute to reduced GHG emissions and land pollutants. On the other hand, we believe those technologies have a lower contribution to a circular economy than technologies that fall in the waste management with material reuse category because the waste used for energy recovery reaches the end of its utility in the economy.

108. **Waste management improvements: Improved waste management with no reuse.** Projects that fall into the fourth tier of the waste hierarchy provide improvements in the environmental impact of the waste management system with no reuse of materials or energy recovery. Technologies such as hazardous waste incineration eliminate the toxic constituents in the waste stream and reduce the volume of hazardous waste to manage.

Agriculture and forestry hierarchy

109. For the agriculture and forestry projects listed in paragraphs 78-85, we apply our land use hierarchy--and not the carbon, waste, or water hierarchy. We have divided our land use hierarchy into five tiers, based on the impact the project has on land use and quality, with higher scores reserved for projects that maintain land in its natural state or minimize human impacts on ecosystems:

- Maintenance of natural state,
- Low human intervention,
- Alternative farming,
- Improvements in conventional agriculture and forestry, and
- Intensive land use.

110. **Maintenance of natural state: Restore and rehabilitate land to its pristine, natural state.** Projects that fall in the top tier of the land use hierarchy are those that return degraded land to its natural state and thereby enhance above- and below-ground biodiversity, improve soil quality, support climate change adaptation and mitigation, and optimize water cycling and storage. By returning the environment in its natural state, those projects enable permanent habitats for ecosystems to thrive over the long run, thereby bringing more environmental benefits than other projects in the scope of our green evaluation, in our view.

111. **Low human intervention: Minimal disturbance of land for human use.** Projects that fall into the second tier of the land use hierarchy are those that prevent or reduce the impact on land degradation from human land use. Technologies such as low agricultural tillage are intended to achieve sustainable food production with minimal impact on the soil and the atmosphere, while also supporting soil and water conservation. Similarly, forestry protection projects maintain forestland used for human purposes at a rate that maintains their biodiversity, productivity, and regeneration capacity.

112. **Alternative farming: Farming practices that improve land resilience over the long term.** Projects that fall into the fourth tier of the land use hierarchy change agricultural and forestry practices to significantly lessen their environmental impact over the long term by avoiding the use of intensive chemicals and pesticides, reducing water demand, or both. For instance, organic farming reduces the use of pesticides and fertilizers, thereby supporting improved soil quality, carbon sequestration, and biodiversity.

113. **Improvements in conventional agriculture and forestry: Improve yields from conventional agricultural production that relieves pressure on land elsewhere.** Projects that fall into the fourth tier of the land use hierarchy are conventional farming practices that achieve higher agricultural yields without significant land disturbance. The main environmental benefit of those projects is to reduce the need for converting additional land for agricultural purposes. For instance, rice intensification supports an increase in the productivity of irrigated rice by changing the management of plants, soil, water, and nutrients.

114. **Intensive land use: Significant land use with somewhat lower environmental impact.** Projects that fall into the fifth tier of the land use hierarchy are those that deliver some environmental benefits while requiring intensive use of land. Although a very carbon-intensive baseline can make the net environmental benefit of biofuels significantly positive, these projects require further land conversion for human use, resulting in increased water demand and degraded soil quality. Similarly, restoration of degraded lands for agricultural use may improve the condition of the land in the short term but is likely to result in some impact on biodiversity, conservation, and erosion protection.

Example of applying the hierarchy

115. Table 4 shows a simplified example of a best-in-class fossil fuel project and a worst-in-class green energy project before and after application of the hierarchy.

Table 4

Example: Best-In-Class Fossil Fuel Versus Worst-In-Class Green Energy Project

	Net benefit ranking (0-100)	Weight (%)	Hierarchy score (0-100)	Weight (%)	Environmental impact (0-100)
Best clean coal project	100	40	0	60	40
Worst green energy project	0	25	100	75	75

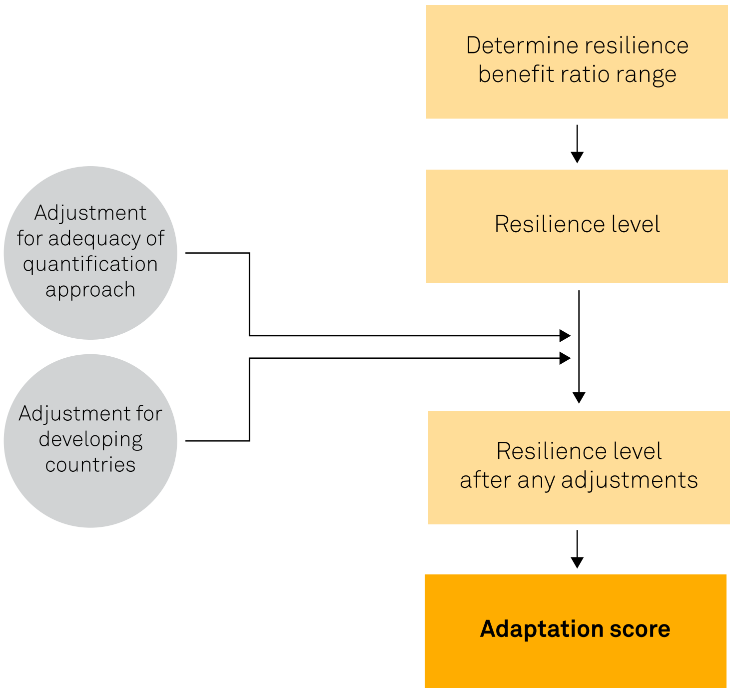
D. Adaptation

116. We base our evaluation of an adaptation project on the increase in resilience the project is likely to provide for the covered geographical area or asset base. This results in the adaptation score (see chart 5).

- First, we quantitatively evaluate the benefit of the added resilience, relative to the amount of the financing's proceeds, on a five-point scale. The benefit is the forecast reduction in the cost of expected damages caused by extreme weather events. It is based on an entity's analysis, to which we may apply quantitative adjustments.
- Second, we modify the evaluation score produced in the first step, based on our qualitative view of the adequacy of an entity's quantification approach, to determine the resilience benefit.
- Third, we may apply additional adjustments in certain cases--for example, for projects that are in developing countries where the resilience benefit may be understated because the likely significant social benefits are difficult to quantify.

Chart 5

Determining The Adaptation Score



117. We assess the environmental benefit on a five-point scale based on the resilience benefit ratio (see table 6). We define this as the ratio of the resilience benefit and the financing derived from the bond's proceeds. The rationale underpinning the calibration of the scale is further described in appendix 2 of "Evaluating The Environmental Impact Of Projects Aimed At Adapting To Climate Change," published on Nov. 10, 2016.

Table 6

Resilience Benefit Scale

Resilience level	Range of resilience benefit ratio
1	>=4
2	>=3 & <4
3	>=2 & <3
4	>=1 & <2
5	<1

118. After considering any adjustments made in stages 2 and 3, the resilience level is mapped to an adaptation score (see table 7).

Table 7

Deriving The Adaptation Score

Resilience level*	Adaptation score
1	100
2	75
3	50
4	25
5	0

*Including any adjustments.

Determining the resilience benefit ratio range

119. In our calculation, we consider damages caused by extreme weather events or weather patterns. The publication "Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation" by The Intergovernmental Panel on Climate Change (IPCC) is a summary of the current scientific understanding of the expected impact of climate change on extreme weather. We calculate the added resilience a project offers (the resilience benefit) by estimating the reduction in expected damages the infrastructure funded by the green bond is designed to achieve over the targeted period.

120. To determine the resilience benefit, we review the analysis an entity has already performed, in which it has quantified the benefit expected as a result of the capital expenditure. Typically, this analysis is part of the design process and is used to assess a project's viability. In our view, resilience benefits go beyond financial benefits and include reduction in humanitarian and ecological damage, both directly and indirectly. Although it is often difficult to put a financial value on those benefits, experts in the adaptation field have developed methodologies to capture these elements. To the extent that these factors are reflected in the benefit analysis an entity performs, we include them in our adaptation analysis.

121. Adaptation projects chiefly provide benefits in the case of extreme events, which are uncertain and require probabilistic representation. Therefore, methodologies used for funding purposes normally require that the benefit assessment is done on a probabilistic basis. In practice, these assessments incorporate the benefit over a variety of modeled events covering different severities of impact and probabilities of occurrence. The evaluation is also often performed over different long-term climate scenarios, incorporating projections of how climate change might develop and exposure to the resulting risks might grow. If the benefit analysis is not performed on a probabilistic basis, it is likely, with some exceptions, that we will assess the resilience level at the lowest level (5, or adaptation score of 0 out of 100).

122. Methodologies and assumptions used for different projects and in different countries vary, and those differences affect the quantification of the benefit. Differences in the methods and key assumptions used are often justified by the specific nature of the projects. Also, those differences reflect the uncertainty regarding how policies for reducing carbon dioxide emissions affect future carbon dioxide levels and the lack of scientific agreement about the impact of those climate change scenarios on extreme weather events. For example, some entities may calculate a greater benefit because their models assume that climate change may have a more severe impact on extreme weather events.

123. We consider the magnitude of the benefit as quantified by the entity seeking financing, regardless

of how sophisticated the analyses are. However, we require that the key elements of the benefit assessments be performed by an independent third party. These elements are:

- Probabilistic simulation approach to generate a sample of weather events and their financial impact,
- Climate change projections and their impact on the adaptation project, and
- Quantification of humanitarian and ecological benefits.

124. Calculating the benefit of adaptation projects often takes place amid considerable data, assumptions, and modeling challenges. These challenges may introduce material modeling uncertainty, which could cause the overall benefit to be overestimated. Therefore, if we think that the analysis may have materially overstated or understated the benefit, we may adjust it before finalizing the resilience level. Upward adjustments require prudence, so these are more limited. Our approach for such adjustments is informed by the experience we have gained from reviewing insurers' economic capital and natural catastrophe modeling, which we perform as a part of our rating analysis (see "A New Level Of Enterprise Risk Management Analysis: Methodology For Assessing Insurers' Economic Capital Models," Jan. 24, 2011; "How We Capture Catastrophe Modeling Uncertainty In (Re)insurance Ratings," April 27, 2016; and "Rating Natural Peril Catastrophe Bonds: Methodology And Assumptions," Dec. 18, 2013).

125. In determining any quantitative adjustments, we may use sensitivity analysis to assess the impact that any changes in key assumptions could have on the size of the benefit. We may use this to adjust the resilience benefit if we consider some of the tested alternative assumptions to be more appropriate than the central assumptions (for example, discount rates or climate change scenario).

126. In calibrating our adaptation scale, we considered two studies: Mechler's review of the literature on the benefit of adaptation projects ("Reviewing estimates of the economic efficiency of disaster risk management: opportunities and limitations of using risk-based cost-benefit analysis") and ECONADAPT project report "Assessing the economic case for adaptation to extreme events at different scales".

127. The lowest resilience level (5) indicates an adaptation project that would provide a lower benefit than the financing amount. To achieve the highest resilience level (1), the resilience benefit ratio must be at least 4x, which is approximately the average and median figures reported in those studies. Our rationale is that this represents a significant resilience benefit relative to the cost of constructing the project. Furthermore, we do not consider it appropriate to differentiate above the 4x level because to do so could reward projects that address highly vulnerable infrastructure, but on a smaller scale, instead of addressing vulnerabilities on a bigger scale, which carry lower resilience benefits.

128. Our calibration assumes that the entire cost of the adaptation project is met through the financing raised by the green financing. If the adaptation project is partially funded from other sources, we prorate the resilience benefit.

Adjustment for adequacy of quantification approach

129. In the second stage in determining our resilience assessment, we may apply a qualitative adjustment to the initial assessment, based on whether we view the quantification of the resilience benefit as robust, adequate, or less than adequate. This adjustment reflects the risk of overstatement and understatement of the benefit relative to the initial assessment in stage one. Also, this adjustment could be used to reflect a smaller modeling uncertainty than in typical

quantification approaches, which underlie the calibration of our resilience benefit scale.

130. In our qualitative assessment, we consider the following aspects of an entity's quantification approach:

- Scope of the model: Allows for all material benefits and negative impacts of the adaptation project.
- Modelling approach: Uses a probabilistic simulation approach to generate a sample of weather events representing the frequency, severity, and location of plausible events.
- Key financial modelling assumptions: Takes into account an assumed modeling period, as well as maintenance and financial assumptions (especially the discount rate), that are well justified and appropriate.
- Calibration data: Uses a long event history for calibration purposes.
- Key modelling assumptions: Bases vulnerability assumptions on a robust calibration.
- Exposure data: Sufficiently details exposure data to allow modeling of key damage drivers.
- Exposure growth assumptions: Allows for growth in exposure over the projection period, based on robust growth assumptions.
- Allowance for climate change and variability: Allows for projected climate change caused by global warming and climate variability in its modelling assumptions.
- Modelling uncertainty and sensitivity analysis: Considers the sensitivities of the benefit to alternative projections of climate change and exposure growth rates. Assesses the sensitivities of the key parameters of the modeled weather events and vulnerability assumptions.

131. Our qualitative assessment is adequate when even though not all of the above factors are captured extensively and robustly, no key factor is missed and there are no reasons to believe that the benefit is overstated. The typical quantification approach is normally assessed as adequate and our resilience benefit ratio scale incorporates the level of modeling uncertainty associated with that. For example, we consider that the methodologies used to gain public-sector funding in developed countries or financing from international development banks are a good benchmark for our adequate assessment. We therefore make no adjustment when we assess the quantification analysis as adequate.

132. When we consider the quantification approach robust--implying that it incorporates less modeling uncertainty than typical quantification approaches--we would reduce the assessment by one (for example, to resilience level 2 from resilience level 3). We expect that this may be the case for projects that are designed to allow for the uncertainties of estimating the impact of climate change. Such projects are typically flexible, allowing adjustments to their structure over time (for example, the height of flood defenses) to reflect improvements in the understanding of how climate change is likely to affect the covered area. We would apply this positive adjustment if the quantification strongly reflects the modeling factors listed in paragraph 129.

133. We may assess the quantification as less than adequate when some of the listed modeling factors are not captured appropriately or not reflected at all. If the quantification approach is less than adequate, we would increase the assessment by one because there may be a considerable risk that the resilience benefit is overstated.

Adjustment for developing countries

134. In the third stage, we apply additional adjustments for projects in developing countries. If no

probabilistic benefit analysis has been performed, we could assess it at resilience level 4 if the entity can provide another type of analysis (such as a scenario-based analysis) that demonstrates the benefit is likely to exceed the financing.

135. We anticipate using The Notre Dame Global Adaptation Index (ND-GAIN; http://index.gain.org/; see "Climate Change Is A Global Mega-Trend For Sovereign Risk") to identify countries that have high exposure to climate risk and high vulnerability. In our view, improved resilience in such countries is likely to have significant social benefits. Those potential benefits include fewer casualties, fewer displaced people, and fewer disrupted livelihoods following extreme weather events. If we believe these social benefits have not been adequately captured in the resilience analysis, we may modify the assessment, adjusting it upward by one level.

Examples of applying adjustments

136. Here are examples of how we could adjust the resilience level in the second and third stages of our adaptation assessment. If the resilience level in the first stage is 1, a positive adjustment in the second or third stage has no effect. Similarly, if the resilience level in the first stage is 5, a negative adjustment in the second stage has no effect. Furthermore, it does not neutralize a potential positive adjustment in the third stage. Hence, a positive adjustment in the third stage, for a project in a developing country, could result in a resilience level of 4.

137. On the other hand, if, in the first stage, we determine the resilience level is 2, 3, or 4, and we then factor in a negative adjustment in the second stage, the resilience level could be adjusted downward to 3, 4, or 5, respectively. A positive developing country assessment (in the third stage) on that same project could then move the resilience level back to 2, 3, or 4, respectively.

E. Determining The Final E And R Scores

138. For mitigation projects, our transparency, governance, and mitigation scores together determine a Green Evaluation, which we map to a scale of E1 to E4, based on quartiles, to get the E score. For adaptation projects, our transparency, governance, and adaptation scores together determine a Green Evaluation, which we map to a scale of R1 to R4, again based on quartiles, to get the R score (see table 8).

Table 8

Composition Of The E And R Scale

Green Evaluation	E score	R score
75-100	E1	R1
50-74	E2	R2
25-49	E3	R3
0-24	E4	R4

139. The overall Green Evaluation, on a scale of 0-100, consists of a weighted average of mitigation or adaptation, governance, and transparency. The weights are 60% for mitigation or adaptation, 25% for governance, and 15% for transparency. If both mitigation and adaptation are relevant, the overall Green Evaluation will consist of two separate assessments--one for the mitigation part and another for the adaptation part, both on a scale of 0-100.

140. We believe efficient governance processes have to be in place for the proceeds to achieve their environmental impact. Governance factors relating to proceeds management increase the

likelihood that proceeds are used for climate change mitigation and adaptation, and, as such, we deem them relatively more important than environmental reporting and disclosure. We therefore weight the governance score more heavily than transparency.

141. At the same time, we believe that transparency and governance do not enhance the overall environmental impact, assuming the assets function as expected. As such, in deriving the final Green Evaluation, we cap both transparency and governance at the level of the mitigation or adaptation score. If transparency or governance is as good as or better than the mitigation or adaptation score, the effect is neutral on our final Green Evaluation. However if transparency or governance is lower than mitigation or adaptation, the final Green Evaluation will be negatively affected.

142. The calculation to derive the Green Evaluation is x*G(capped)+y*T(capped)+z*M (see 9).

Table 9

Calculation Components

	Score (0-100)	Capped scores	Weight (0-100%)
Governance	G	if G > M then G(capped) = M	x
Transparency	T	if T > M then T(capped) = M	y
Mitigation or adapation	M or A	M = M, A = A	z
Final E score	x * G(capped) + y * T(capped) + z * M		
Final R score	x * G(capped) + y * T(capped) + z * A		

143. Tables 10-12 provide examples. The capped and weighted scores are combined to derive the Green Evaluation on a scale of 0-100 (see table 14, left-hand column.

Table 10

Strong Transparency And Governance Have A Neutral Impact On Strong Mitigation Or Adaptation Score

	Score (0-100)	Capped scores (0-100)	Weight (0-100%)	Weighted subscores
Governance	95	90	25	22.5
Transparency	95	90	15	13.5
Mitigation or adaptation	90	N/A	60	54
Green Evaluation				90

N/A--Not applicable.

Table 11

Strong Transparency And Governance Provide No Uplift To Weak Mitigation Or Adaptation Score

	Score (0-100)	Capped scores (0-100)	Weight (0-100%)	Subscore (0-100)
Governance	95	10	25	2.5
Transparency	95	10	15	1.5
Mitigation or adaptation	10	N/A	60	6
Green Evaluation				10

N/A--Not applicable.

Table 12

Weak Transparency And Governance Have A Negative Impact On Mitigation Or Adaptation Score

	Score (0-100)	Capped scores (0-100)	Weight (0-100%)	Subscore (0-100)
Governance	40	40	25	10
Transparency	40	40	15	6
Mitigation or adaptation	80	N/A	60	48
Green Evaluation				64

N/A--Not applicable.

144. When less than 100% of the proceeds are allocated to green projects, we evaluate the proportion of proceeds that is allocated to environmentally beneficial projects. In such cases, we will make it clear the portion of the proceeds that has been evaluated by putting a percentage after the score (e.g., E2 (50%)). For example, if an instrument was evaluated as E2 with an underlying evaluation of 74 and the entire use of proceeds fell within the scope of our approach, the resulting Green Evaluation would be E2 (100%). Similarly, if only 50% of proceeds were earmarked for in-scope

projects, the resulting score would be E2 (50%). The portion of proceeds would not affect the underlying Green Evaluation of 74 on our scale of 0-100.

REVISIONS AND UPDATES

This revised version of our analytical approach took effect on Dec. 4, 2019, the date of publication, and supersedes the previous version, "Green Evaluation Analytical Approach," originally published on April 26, 2017.

We made the following changes to this version:

- We have incorporated two additional sectors, agriculture and forestry and waste management, and added several new technologies within the existing green energy, water, and fossil fuel power plant sectors.
- The Green energy technology sector now includes biomass cogeneration and fuel cells.
- The water technology sector now includes improved irrigation, biofiltration wastewater treatment with energy recovery, and biofiltration wastewater treatment with no energy recovery.
- The fossil fuel power plants sector now includes flue gas desulfurization, cogeneration, oil refinery efficiency, and reduced-flaring technologies.
- We've incorporated three new environmental key performance indicators, including land pollution, eutrophication, and air emissions from sulfur oxides, which are used in the net benefit ranking for agriculture and forestry and waste management technologies.
- Hierarchies for agriculture and forestry and waste management projects were developed for technologies in these sectors.

GLOSSARY

Baseline The reference scenario used to calculate the net impact of the project--for example, the tons of carbon avoided owing to a particular low-carbon solution. For instance, the baseline of a new power plant is the electricity currently input to the grid by the existing plants in the region or country.

Construction/Implementation impacts The impact associated with the initial phase of a project, before it starts achieving environmental benefits. In the case of a physical infrastructure, the impact associated with the construction phase is accounted for as construction emissions. For projects focused on technology implementation, the implementation impact accounts for the impact associated with the deployment of the technology.

Green Bond Principles The Green Bond Principles are voluntary process guidelines developed by the International Capital Market Association that clarify the approach for issuance of a green bond. An issuer can seek advice from consultants and institutions ("second party") with recognized expertise in environmental sustainability to review or to help in the establishment of its process for project evaluation and selection, including project categories eligible for green bond financing.

Grid emissions factor This refers to a carbon dioxide emissions factor (tCO_2/MWh), which is the carbon intensity per unit of electricity generation in the grid system According to the UN Framework Convention on Climate Change.

Economic Life Economic life is the timespan during which the project makes an economic contribution before being decommissioned.

Eutrophication Eutrophication is caused when agricultural fertilizers, manure, organic waste, and other matter leach into bodies of water and disrupt aquatic ecosystems.

Environmental valuation Environmental valuation refers to the analysis of methods for obtaining empirical estimates of environmental values, such as the benefits of improved river water quality or the cost of losing an area of wilderness to development.

Modal shift The process by which a new supply of transportation displaces users from existing transportation means.

Modal split The distribution of transportation means used by passengers, depending on the city or city type. Depending on geographies, the prevalence of private cars as a means of transportation will vary, which affects the CO_2 savings that can be attributed to a given public transport infrastructure. Indeed, the more carbon-intensive the initial modal split is, the more a low-carbon public transport will avoid emissions by modal shift.

Smart grid Electricity network that uses digital and other advanced technologies to minimize costs and environmental impact while maximizing system reliability, resilience, and stability, according to the IEA.

2-degree scenario Holding the increase in the global average temperature to well below 2 degrees above pre-industrial levels. This is the main objective of the Paris Agreement.

Water scarcity A region is considered to be experiencing water scarcity when annual water supplies drop below 1,000 cubic meters (m3) per person (source: UN).

Related Research

S&P Global Ratings research

- Could Agriculture And Forestry Be The New Frontier For Green Bonds? Dec. 4, 2019
- Infrastructure Seeks A Circular Solution To Sustainability, Dec. 4, 2019
- Sink Or Swim: The Importance Of Adaptation Projects Rises With Climate Risks, Dec. 3, 2019
- Evaluating The Environmental Impact Of Projects Aimed At Adapting To Climate Change, Nov. 10, 2016
- How We Capture Catastrophe Modeling Uncertainty In (Re)insurance Ratings, April 27, 2016
- A New Level Of Enterprise Risk Management Analysis: Methodology For Assessing Insurers' Economic Capital Models, Jan. 24, 2011
- Rating Natural Peril Catastrophe Bonds: Methodology And Assumptions, Dec. 18, 2013

Other research

- Sustainability of uranium mining and milling: toward quantifying resources and eco-efficiency, G.M. Mudd and M. Diesendorf, Environmental Science and Technology, 42:2624-2630, 2008
- Do Hydroelectric Dams Mitigate Global Warming? The Case of Brazil's CuruA-una Dam, P. M. Fearnside, Mitigation and Adaptation Strategies for Global Change, Volume 10, Issue 4, pages 675-691, October 2005
- Climate Change and Watersheds: Exploring the Links, Environmental Protection Agency Science Matters Newsletter, August 2013
- The effect of natural gas supply on US energy and CO2 emissions, Christine Shearer et al., Environmental Research Letters, 9 094008, Sept. 24, 2014

This report does not constitute a rating action.

Contact List

PRIMARY CREDIT ANALYST

Corinne B Bendersky
London
+ 44 20 7176 0216
corinne.bendersky@spglobal.com

PRIMARY CREDIT ANALYST

Beth Burks
London
(44) 20-7176-9829
Beth.Burks@spglobal.com

PRIMARY CREDIT ANALYST

Noemie De La Gorce
London
+ 44 20 7176 9836
Noemie.delagorce@spglobal.com

SECONDARY CONTACT

Michael Wilkins
London
(44) 20-7176-3528
mike.wilkins@spglobal.com

SECONDARY CONTACT

Michael T Ferguson, CFA, CPA
New York
(1) 212-438-7670
michael.ferguson@spglobal.com

SECONDARY CONTACT

Kurt E Forsgren
Boston
(1) 617-530-8308
kurt.forsgren@spglobal.com

SECONDARY CONTACT

Olivier J Karusisi
Paris
(33) 1-4420-7530
olivier.karusisi@spglobal.com

ADDITIONAL CONTACT

Infrastructure Finance Ratings Europe
InfrastructureEurope@spglobal.com

S&P Global Ratings

RatingsDirect®

Sink Or Swim: The Importance Of Adaptation Projects Rises With Climate Risks

December 3, 2019

PRIMARY CREDIT ANALYST

David J Masters
London
(44) 20-7176-7047
david.masters@spglobal.com

SECONDARY CONTACTS

Michael Wilkins
London
(44) 20-7176-3528
mike.wilkins@spglobal.com

Dennis P Sugrue
London
(44) 20-7176-7056
dennis.sugrue@spglobal.com

Olivier J Karusisi
Paris
(33) 1-4420-7530
olivier.karusisi@spglobal.com

Key Takeaways

- Despite increasing attention, adaptation finance needs remain substantially higher than existing financing, with some estimates placing 2030 funding needs at 4x-9x what is currently being spent.
- Adaptation projects typically deliver significant resilience benefits (that is, they generate returns as a multiple of their cost). Investments to improve early warning systems against natural disasters, for example, can generate returns nearly 10x their cost.
- We expect that private sector financing for adaptation will increase, ultimately lessening the burden on constrained public sector entities and reducing the size of the adaptation gap.
- Demand from the private sector reflects both the perceived social benefits from adaptation investment projects and tangible economic benefits such as improving the resilience of their supply chain.

Since S&P Global Ratings' most recent review on the matter in December 2018 (see "Plugging The Climate Adaptation Gap With High Resilience Benefit Investments," published Dec. 7, 2018, on RatingsDirect), the need for climate change adaptation projects hasn't abated. Indeed, more people are noticing. We believe the recent surge in damage from extreme climate events has significantly increased the attention of public authorities on the need for investment in this area. According to the reinsurer Swiss Re, 2017-2018 insured losses from natural catastrophes, including climate related events, were $219 billion, the highest 24-month figure on record. In total, economic losses from natural catastrophes totaled $497 billion, with a further $40 billion during the first half of 2019. This implies uninsured losses from natural catastrophes of approximately $280 billion in 2017 and 2018 alone.

During 2018, only about 6% ($34 billion) of all climate change investments globally ($546 billion) focused on adaptation projects, with about 94% looking at mitigation, according to the Climate Policy Initiative. However, the imbalance is beginning to shift--in 2017, only 4% of climate funds focused on adaptation projects. Overall, the United Nations Environment Program (UNEP) forecasts adaptation costs in developing countries alone at $140 billion-$300 billion by 2030, and $280 billion-$500 billion by 2050. That is 4x-9x above the total amount of international finance available today--just to meet 2030 costs.

Over the past three years, the world has seen a flurry of extreme weather, most recently the Australia and California wildfires, and Cyclone Bulbul in India and Bangladesh. These events highlight that many countries are vulnerable to these events. Climate change is likely to make matters worse, irrespective of whether we manage to keep global warming to 2 degrees Celsius above preindustrial levels. Attention to climate change adaptation is therefore increasing, especially on how to finance it, given the need to raise enough public and private investment to fortify exposed countries and communities against the potentially devastating effects of physical climate risk.

The Global Commission on Adaptation forecasts that without adaptation, climate change could reduce growth in global agricultural yields by as much as 30% by 2050, as well as pushing more than 100 million people below the poverty line in developing countries by 2030. The GCA, co-managed by World Resources Institute and the Global Center on Adaptation, seeks to "accelerate adaptation by elevating the political visibility of adaptation and focusing on concrete solutions."

Still, governments aren't spending nearly as much money as one might expect. Part of it is political--it can be hard to justify the cost for something that might not happen. Part of it can be that governments are stretched financially as is. So one way to bridge the gap is with private investors. This makes the "resilience benefit" an important tool in raising funds.

Investment in adaptation can offer cost-effective protection against extreme weather damage, what we refer to as a resilience benefit. In particular, a strong resilience benefit and an attractive risk-return profile should attract private investors, bringing much needed money to the area. Introducing financial instruments that demonstrate a strong link between investment returns and resilience benefits could further help uptake in private sector adaptation investments.

What Is An Adaptation Project?

Adaptation projects aim to strengthen the resilience of buildings, critical infrastructure, and communities against the risk climate change presents. The world will need to adapt to greater heat and water stress, more severe droughts, floods, storms, and forest fires. Strengthening flood defenses is probably the most common adaptation investment. This is particularly true in coastal areas, where rising sea levels will mean increased storm surges.

An adaptation project could involve hard engineering infrastructure. This could include a floodwall; a nature-based solution, such as wetland restoration; or soft infrastructure, like developing an early-warning system. The project size could range from very large and complex to small and local. A project could solely aim to improve community resilience, for example, via flood defense. Or it could be an add-on to another project to ensure that it is climate resilient, for example, investing more to ensure that a new building is resilient to extreme weather events.

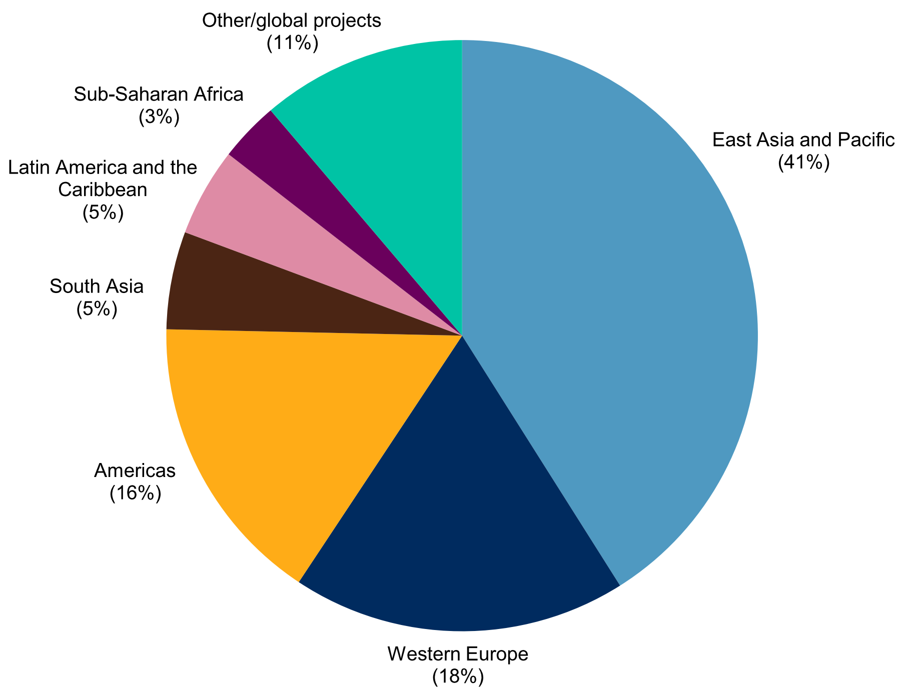
Adaptation Gap

It is very difficult to accurately estimate global adaptation needs. Any reliable estimate needs to account for exposure growth and the impact of climate change on extreme weather. Nevertheless, there have been several attempts to estimate adaptation investment needs, with the UNEP estimate being the most referenced. For its 2016 Adaptation Gap Report, UNEP combined national and sectorial studies to come up with an estimate for developing countries of $140 billion-$300 billion by 2030, and $280 billion-$500 billion by 2050. In other words, financing for adaptation in 2030 would need to increase by 4x-9x (based on 2018 adaptation financing expenditure of $34 billion) above current international adaptation spending today. While UNEP didn't update the adaptation financing requirements in the 2018 Adaptation Gap Report, it stated that, overall, various studies of the global cost of adaptation indicate higher financial needs. We expect that a significant amount of this will need to go to the most vulnerable countries--that is, the least developed economies (see chart 1 for the geographical distribution of climate finance investments). As part of this, in 2018, the World Bank announced its intention to increase its direct adaptation financing plans from 2021-2025 to $50 billion, or $10 billion per year, more than double its annual level of funding from 2015-2018.

The adaptation gap is not just an issue for developing countries. Although developed countries are more resilient to extreme weather events, many of them will need significant adaptation investments to be prepared for the potential impact of climate change. One important aspect is adapting to rising sea levels, one of the biggest threats from climate change. The impact is relatively more certain compared with other threats, and it therefore should be easier to see the need for adaptation investments.

Chart 1

Destination Region Of Climate Finance (2017-2018 Average)



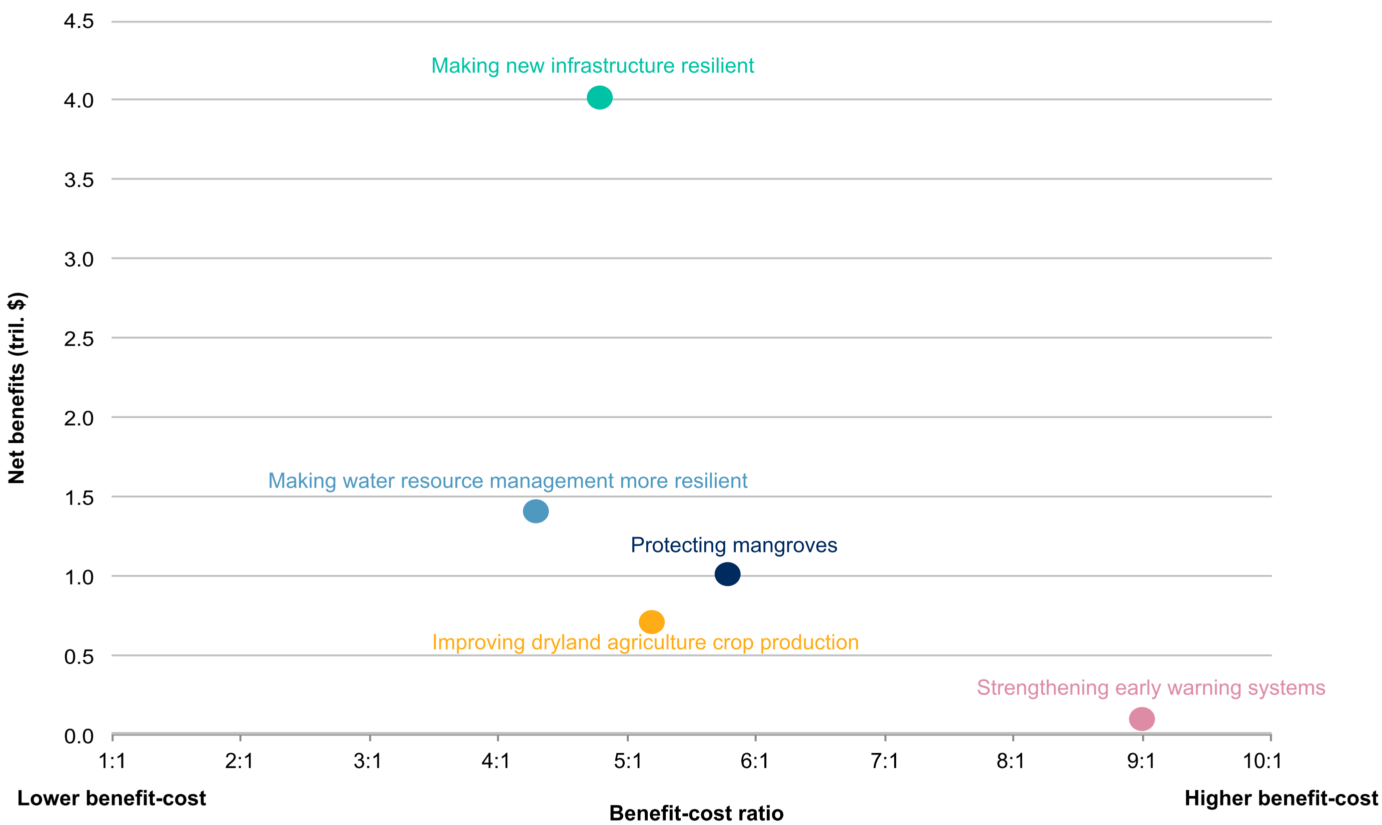
Source: "Global Landscape of Climate Finance 2019" Climate Policy Initiative, November 2019.

The Resilience Benefits

Adaptation in many cases is cost-effective. However, not every dollar spent on adaptation is equal. Specifically, the benefit-cost ratio of investing in early warning systems (for example, advance warning of a major storm event approaching) is nearly 10x, according to the GCA (see chart 2), so every dollar spent on early warning systems results in net benefits of nearly $10. Conversely, although providing a much bigger absolute benefit, the ratio from making new infrastructure more resilient is nearly 5x, according to the GCA. In total, the GCA estimates that total investments in adaptation of $1.8 trillion could lead to net benefits of $7.1 trillion by 2030, a four-fold return.

Chart 2

Illustrative Benefits And Costs of Selected Investments In Adaptation



This chart illustrates the broad economic case for investment in a range of adaptation approaches. The net benefits illustrate the approximate global net benefits to be gained by 2030 from an illustrative investment of $1.8 trillion in five areas. Actual returns depend on many factors, such as economic growth and demand, policy context, institutional capacities, and condition of assets. These investments do not address all that may be required within sectors--for example, adaptation in the agricultural sector will comprise much more than dryland crop production. The investments do not include all sectors--health, education, and industry sectors are not included. Due to data and methodological limitations, this chart does not imply full comparability of investments across sectors or countries. Source: Global Commission on Adaptation: "Adapt Now: A Global Call For Leadership on Climate Resilience," September 2019.

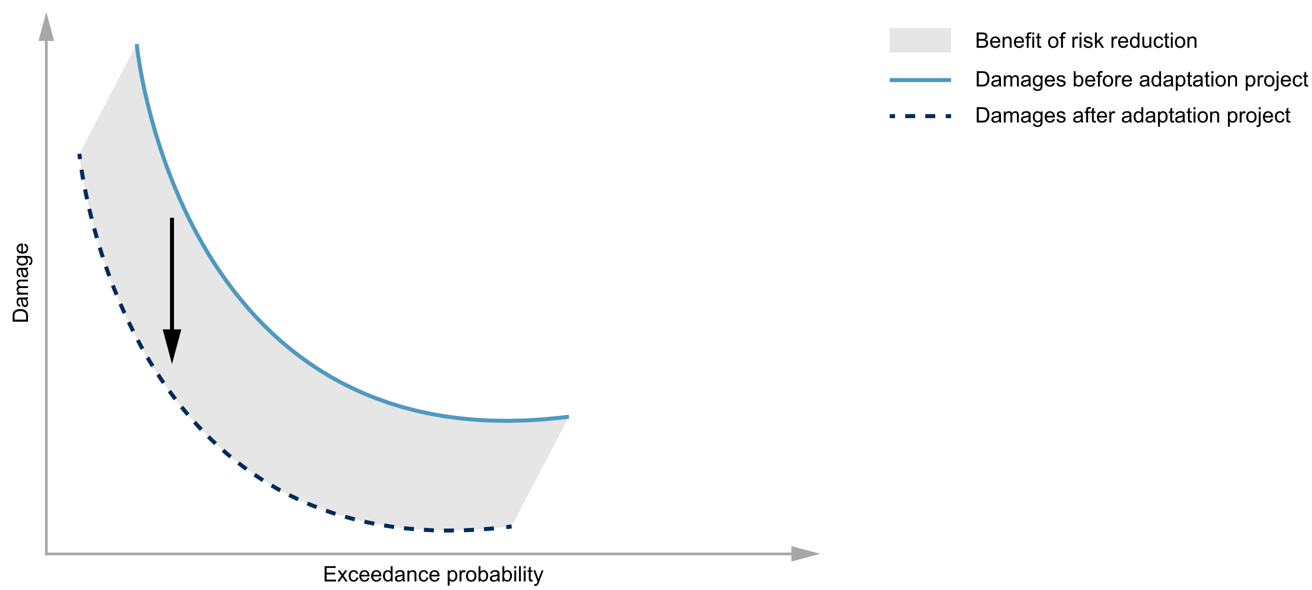
Assuming the cost-benefit analysis was performed on a probabilistic basis, projects such as these infrastructure-resilience ones, whose resilience benefit could exceed their cost by more than 4x, would achieve the highest level on the resilience scale of our "Green Evaluation Analytical Approach," published April 26, 2017.

Extreme weather events might disrupt economic activity, which also affects people's livelihoods. Businesses may be forced to close until damage is cleared or in case of a disruption to water and electricity services. Extreme weather events might cause higher operating costs. For example, businesses could use generators to supply electricity if there is a power failure or incur higher travel costs if there are transport disruptions. The economic disruption could extend beyond the affected region through global supply chains. For example, the floods in Thailand in 2011 had a global impact on computer and car production because the production of key parts was concentrated in the flooded area and many motor manufacturers operate a "just-in-time" approach to their supply chain. As a result, more than 50% of insured losses (which totaled over $15 billion) stemmed from business interruption claims. What's more, extreme weather events could weigh on public finances if spending is increased to help affected communities, and if they dampen economic activity.

Social benefits arise from reducing the risk of major disruption to the livelihoods of the people living in the affected area. Furthermore, ecological benefits might arise as adaptation projects help the natural environment.

Chart 3

Impact Of Adaptation On Expected Damages



Source: S&P Global Ratings.

Improved resilience could yield considerable secondary financial benefits. These investments may promote economic development in an area now adequately protected against extreme weather events. For example, the restoration of mangrove forests in coastal areas have two benefits. First, they protect coastal areas against storm surges. Second, they support local fisheries, as evidenced with Bangladesh's government initiated planting of mangrove forests. Furthermore, insurance costs could also drop in the protected area, reflecting reduced natural catastrophe risk and bringing another financial benefit.

Quantifying The Benefit

Quantifying the resilience benefits is progressing, as demonstrated by the estimates from the GCA. However, quantifying these benefits remains challenging, and estimates are often imprecise. Any analysis requires models to capture the variety of benefits across weather events of different magnitude and over a long projection period, for which detailed historical damage and exposure data are required. In addition, these models need to account for long-term climate scenarios, incorporating projections of how climate might develop and how exposure to the resulting risks might change because of growth in assets and population. (For more information regarding the challenges of quantifying the benefits, see "Plugging The Climate Adaptation Gap With High Resilience Benefit Investments."

Demonstrating the value of the adaptation benefit should be important in getting buy-in from all stakeholders: sponsors, the public, and investors. In particular, demonstrating a strong resilience benefit is likely to attract more private investors. This is because climate-minded investors will also consider the environmental benefit of investment opportunities, in addition to risk-return features.

It is true that the return of those investments is not directly linked to the expected resilience benefit of the investment. However, in many cases, adaptation investments will indirectly help returns. For example, if a local authority issues a green bond for an adaptation project, the project should help the local economy and community be more resilient to natural catastrophes--meaning the local community should suffer a smaller financial shock than without the adaptation project when a natural catastrophe happens. Everything else equal, this could lead to better credit quality for the issuer and a better investment return on all bond issues by the local authority, including the green bond used to finance the adaptation project.

Another investment case could be linked to the "public good" nature of adaptation projects, which are largely infrastructure projects providing a service to society. They reduce damage to property and provide other associated social and health benefits. So in much the same way that infrastructure projects such as hospitals, schools, and government buildings are funded by the public sector using concessions and public-private partnerships, similar structures could be considered for adaptation. This could provide a long-term revenue flow that would attract both infrastructure and green investors alike.

Barriers To Adaptation

We believe many adaptation projects with high resilience benefits are not seeing the light of day. The need for these works in densely populated areas of the U.S. (for example, around New York and Boston), Bangladesh, Indonesia, and the Philippines are well known and solutions are actively being considered, although implementing will take time due to the complexity of the projects and the size of investment required. However, there are many other lesser-known small areas that can be protected in a cost-effective way.

Given the high needs and benefits for adaptation, the obvious question is why the level of investment is so low. We believe the main factors behind this are the large sums involved and difficulties in demonstrating the value of adaptation to stakeholders, particularly in what timeframe. This makes it difficult to convince decision-makers to prioritize these projects relative to other development needs. Or it may be difficult to allocate significant amounts of financing to projects whose benefits might emerge only during an extreme weather event many years in the future.

Another important barrier for adaptation investments, in contrast to mitigation projects, is the difficulty of monetizing the benefits in the form of clear cash flow streams. Most of the benefits are to make society and business more resilient to unfavorable weather events, that is, to avoid costs. It is hard to estimate the specific benefit to every individual family or business in the area that would allow the project to explicitly charge to them for the benefits. As a result, public resources or development banks finance most adaptation projects. However, in times of strained public finances, these projects are unlikely to be high priority, especially when the expected benefit may not become evident in the near term.

Adaptation Projects Face Other Roadblocks

The large scale of adaptation projects requires significant amounts of finance and a complex approval process, which drains resources and leads to delays. They often require difficult decisions and trade-offs among different benefits and costs affecting various groups and communities, which typically leads to legal disputes and challenges. For example, an adaptation project might protect one area from flooding at the expense of increasing flood risk downstream.

Another important obstacle is social acceptance. Adaptation projects might change the daily lives of local communities. For example, a new seawall might restrict sea views and access to the beach, or may affect the natural environment. These inconveniences could make it difficult for local communities to support such projects if they are seen as disrupting daily life or lowering an area's attractiveness. As a consequence, the project could depress property prices or tourist activities, and the benefit of the increased resilience might not be sufficiently appreciated or understood to compensate for that.

Sometimes it might be difficult to undertake adaptation projects because of the lack of scientific certainty of the precise impact of climate change on extreme weather events, which complicates decisions about infrastructure design. The challenges for effective adaptation design, together with the potential negative financial or social impacts to some communities, could increase the risk of legal action, another possible factor deterring adaptation. On the other hand, authorities might face legal action if they don't build the necessary adaptation infrastructure, and communities suffer significant damage and disruption from climate change. However, they might also be under scrutiny if measures do not deliver the expected resilience benefits. Any legal or corrective actions could increase costs to sponsors and reduce the attractiveness to investors because of the reputational risk of being associated with failed adaptation infrastructure.

Finally, adaptation to climate change is a moving target because, by 2050, even countries that have taken action might have to enact additional measures if the 2 degree objective is to be met. One example of this is the Delta Programme in the Netherlands. This program focuses on flood defense, as well as freshwater supply continuity, in the low-lying, flood-prone Netherlands. As part of ongoing monitoring, a reevaluation exercise happens annually to assess the program's effectiveness in light of new information becoming available and amend it, as necessary.

The Need For Private Financing

We expect that due to the large size of the adaptation gap and constrained public finances, other sources would need to make considerable contributions to adaptation financing. Therefore, we see the need to attract private finance in this area, especially given the number of investors interested in opportunities in climate finance. We believe that the ability to demonstrate the resilience benefit of such projects through robust modeling will be an important catalyst. The Climate Policy Initiative estimates investment by the private sector in adaptation finance is at $500 million, which is very modest even allowing for disclosure and definitional challenges as to what constitutes adaptation financing. Furthermore, many countries where adaptation financing is most needed are subject to higher governance and transparency risks, which can further deter private sector investors.

Governments alone are unlikely to be able to provide sufficient financing to meet all future adaptation and mitigation needs. However, they continue to play the key role today and are likely to do so for the foreseeable future. Often, financing of major adaptation projects requires centralized, coordinated policy decision making. One recent example is the Environment and Climate Adaptation Levy, introduced by Fiji in 2017. Over $100 million has been raised via a 10% tax on prescribed services (e.g. hotel accommodation, tourist activities) and a 10% income tax on the rich. These proceeds have funded various infrastructure, cyclone rehabilitation, and agricultural development projects, in particular, to protect the country's natural environment, reduce its carbon footprint, and improve its ability to adapt to the impacts of climate change, including from rising sea levels and extreme storms.

One of the key challenges to facilitating private sector financing is that, often, upfront financing is required (either at the design or construction phase), but the payback only occurs much further down the road. Addressing these challenges is likely to require a partnership model, incorporating transferring risk to the capital markets (insurance, catastrophe bonds, or other derivative instruments), together with contingent financing from multilateral institutions and governments.

Related Research

- Determining The Resilience Benefit Of Climate Adaptation Financing, Dec. 7, 2018
- Plugging The Climate Adaptation Gap With High Resilience Benefit Investments, Dec. 7, 2018
- Climate Finance & Sustainability: Key Research By S&P Global Ratings, 2018, Nov. 21, 2018

This report does not constitute a rating action.

Environmental, Social, And Governance:

Delays In Addressing Global Warming And The Longer-Term Ratings Implications

December 3, 2019

PRIMARY CREDIT ANALYST

Bernard De Longevialle
Paris
(33) 1-4075-2517
bernard.delongevialle
@spglobal.com

S&P Global Ratings' look-back reviews published in 2017 and 2018 show that climate risk materially influenced less than 10% of our rating actions in recent years. Recent climate-related rating actions have typically stemmed from either physical risks, such as the 2018 wildfires in the case of Pacific Gas & Electric in the U.S. and Hurricanes Harvey, Irma, and Maria affecting reinsurers and local governments in 2017; or disruption to the operating environment in certain sectors, such as $CO2$ emission standards that led to negative rating actions of Volkswagen AG in 2015. Current global warming trends suggest that the materiality of climate risk for ratings is only likely to increase in the future. The longer the delays in addressing current trends in climate change, the more likely we could see economic and social disruptions, due both to higher physical risks and the need to transition to a low-carbon economy at a faster pace.

In its latest Emission Gap Report released on Nov. 26, the UN Environment Programme (UNEP) warned that the current trajectory for greenhouse gas (GHG) emissions points to global warming of more than 4 degrees Celsius by the end of the century. This may fall to 3.2 degrees if governments meet all of their current public commitments. According to scientific consensus, scenarios factoring in a rise of 3 to 4 degrees would have devastating consequences. These include major climate events such as severe droughts and heatwaves, as well as rising sea levels, which could ultimately have severe social, political, and economic consequences in many parts of the world.

Despite growing awareness about climate change by business, policymakers, and civil society, the transition to a low-carbon economy has so far remained slow. In the absence of immediately available and low-cost technical solutions to reduce GHG emissions, they have continued to rise by an average annual 1.5% over the past 10 years, with no tangible sign of a reversal. Confronted with difficult and complex policy decisions, as well as sometimes popular reluctance to absorb the immediate costs of moving to a low-carbon economy, policymakers and economic leaders have managed to reduce the carbon intensity of world GDP growth, but have not taken sufficient actions to materially slow global warming trends. To keep global warming to 2 degrees, GHG emissions would have to start dropping by 2.7% a year starting in 2020, versus 1.5% in the past decade, and reach a 40% reduction by 2030.

To keep global warming below 1.5 degrees, the efforts would be more than twice important at 7.6% reduction per year for the next decade. Both the 1.5 degree and the 2 degree scenarios would require a profound change to our fossil fuel-dependent economic model as well as to our social habits. Such structural changes might be possible, but the faster the speed of change, the more likely we could see economic and social disruptions. The challenges faced by the European automotive sector to prepare for the rapid tightening of CO_2 emission standards illustrates how disruption could play out in carbon-intensive sectors.

The more the delays in addressing the COP21 commitment to limit warming to well below 2 degrees, the greater the magnitude and speed future efforts would have to be to possibly reach this target. Our economic and social systems in the future could consequently be exposed to higher disruption risks and struggle to adapt quickly enough. A more gradual transition, resulting in later and lower reductions in GHG emissions, may be socially more acceptable and present lower short-term disruption risks, but the longer-term physical consequences of hotter global warming would be damaging.

This report does not constitute a rating action.

Environmental, Social, And Governance:

Infrastructure Seeks A Circular Solution To Sustainability

December 4, 2019

Key Takeaways

- The infrastructure sector is starting to recognize it could become more sustainable by adopting circularity, which aims at eliminating waste and the continual use of resources.
- According to consultants, pursuing a circular economy could be worth $4.5 trillion by 2030.
- Financial institutions (FIs) are taking the lead on signaling circular infrastructure investment opportunities to investors.
- Dutch airport operator Royal Schiphol Group's sustainability practices could be a prime example of how the circular economy can be implemented in the sector.

PRIMARY CREDIT ANALYSTS

Neesha-ann Longdon
London
neesha.ann.longdon@spglobal.com

Beata Sperling-Tyler
London
(44) 20-7176-3687
beata.sperling-tyler@spglobal.com

Michael Wilkins
London
(44) 20-7176-3528
mike.wilkins@spglobal.com

Global infrastructure spending has remained resilient in an environment of financial instability, underpinned mainly by interest from private sector investors. Private investors seeking long-term, stable returns are keen to fund infrastructure projects ranging from energy, to transport, to water infrastructure. These investors are providing support to governments facing a growing infrastructure funding gap. Yet, the sector is now awakening to the threats and opportunities that sustainability brings to realizing this long-term source of finance. Long-term climate risks are unlikely to leave any sector untouched as governments worldwide seek to maintain warming below 1.5 degrees Celsius under the 2015 Paris Agreement. This may force infrastructure projects to address energy use concerns, particularly as urban infrastructure consumes approximately two-thirds of global energy. Further, concerns over the recoupling of resource consumption and economic growth continue to grow. This adds pressure to address the resource-intensity of infrastructure often associated with the "take, make, and dispose" model under the linear economy.

To achieve the low-carbon transition, governments, finance, and industry leaders have convened at the 2019 United Nations Framework Convention on Climate Change annual conference (COP25) in Madrid, Spain, to discuss the best strategies for climate action, including pursuing a circular economy. Although the circular economy is new to the infrastructure sector, reception thus far has been promising. At its annual conference this year, the Major Projects Association, the U.K. body of organizations engaged in the delivery and development of major projects, presented the opportunities and challenges from sustainability and the circular economy to infrastructure projects, highlighting projects currently taking the lead on implementation. One of the key examples discussed was the integration of circular economy principles by Dutch airport operator Royal Schiphol Group (RSG) into its sustainability agenda. Moreover, financial institutions (FIs) are making progress to improve investor understanding of circular practices.

S&P Global Ratings has considered how pursuing a circular economy strategy could be compatible with the low-carbon transition and may also lead to significant benefits for infrastructure developers and investors. This may in turn encourage infrastructure projects to design for the future (including decommissioning considerations), adopt low-carbon materials, and achieve flexible designs to withstand the physical risks of climate change. The consultant firm Accenture Strategy estimates this approach to be a global growth opportunity worth $4.5 trillion by 2030. Nonetheless, the obstacles for realizing this growth are significant, and we are yet to see transformational action on a global scale.

Challenges For Infrastructure

The circular economy aims to transition away from the current linear economy based on the "take, make, and dispose" business model. The linear economy has come under heavy criticism in recent years for its over-consumption of finite raw materials, while disposing of products at end-of-life assuming they have no further value. The circular economy, by contrast, intends to realign business incentives to embed the values of "recover, reuse, and energy efficiency" into the business model. The Ellen MacArthur Foundation is a key knowledge platform engaging with business across a range of sectors to implement circular economy principles (see sidebar 1). Despite circular innovation's traditional focus on the manufacturing and electronics' sectors, we expect infrastructure investors and projects increasingly to view the circular economy as an effective strategy given the pressures to address the triple bottom line--concerning social and environmental impact beyond financial returns.

The Circular Economy Principles

Design out waste and pollution.

- Designing out the negative externalities, such as incorporation of renewable energy into the energy mix; designing transportation to reduce congestion.

Products and materials to be kept in use.

- Projects should be designed to last longer to preserve their embedded energy, labor and materials.
- Materials reaching their end-of-life in infrastructure projects should be viewed as a resource rather than waste to reduce landfills.

Natural systems are regenerated.

- Reducing consumption of primary materials promotes natural capital by allowing natural resources to regenerate.

Source: the Ellen Mac Arthur Foundation.

Infrastructure consumes a considerable proportion of global resources due to population growth and urbanization trends. Continuing along the linear economy may introduce significant long-term supply chain risks because urban infrastructure consumes 70% of global resources, yet only 9% of global resources are recycled, according to the Global Circularity Gap Report. High resource use generates significant waste risks from pollution and landfill, which are increasingly becoming a target for government regulation. The EU alone in its Waste Directive requires a 70% recycling rate of nonhazardous construction and demolition waste on projects by 2030. This is a clear signal for infrastructure projects to consider material recovery and reuse activities post-construction.

Infrastructure is also significantly exposed to climate risks, both as a contributor and victim of the adverse impacts (see: "Sink Or Swim: The Importance Of Adaptation Projects Rises With Climate Risks," published Dec. 3, 2019). Inclusion of concrete in the EU Emissions Trading Scheme has already brought attention to the supply chain risks from unsustainable material sourcing. Considering that building materials account for one-half the emissions in the industrial sector, diversifying the infrastructure material base will help to mitigate potential regulatory risks and price instability. Disaster-proofing buildings is also of key concern given that they are immobile and largely inflexible assets. Without this, faster capital depreciation of assets may occur given the projected increase in the frequency and intensity of extreme weather events.

Emerging Trend Towards The Circular Economy

We recognize the merits of the circular economy as businesses seek to align their sustainability strategies with wider social goals articulated by the United Nations (UN) Sustainable Development Goals (SDGs). In our view, sustainable infrastructure and circular economy initiatives could directly support the private sector's pursuit towards the SDGs (see sidebar 2). Commitment to reduce fossil fuel dependence (SDG7) has encouraged regulators to promote policies to de-risk the renewables asset class. At S&P Global Ratings, we expect the strong growth trend to continue over the coming decades (see "Energy Transition: Renewable Energy Matures with Blossoming Complexity," published Nov. 8, 2019). Working groups between the public and private sector may be necessary to ensure infrastructure's sustainability targets are in line with government objectives. Already, action by stakeholders within infrastructure show productive relations forming. Global infrastructure company Ferrovial, which owns a 25% stake in Heathrow Airport Holdings, is an active member of the Private Sector Advisory Group of the UN SDG fund promoting public-private partnerships for sustainable development. In addition, Ferrovial acts as chair to the Spanish Green Growth Group, which promotes both knowledge-sharing and public-private partnerships in circular economy and wider decarbonization initiatives.

The UN Sustainable Development Goals

Adopted in 2015, the 2030 Agenda for Sustainable Development emerged as a framework for global action to achieve prosperity and sustainable growth for the global population and the planet by both the public and private sector. The 17 Sustainable Development Goals were designed as interconnected, key markers for action, addressing global challenges.

We believe the SDGs are compatible with circular economy principles, given that the circular economy should be viewed as a strategy for achieving the following SDGs:

- SDG3: Good Health And Well-Being
- SDG6: Clean Water And Sanitation: In 2017, Dutch bank ING released a publication of the potential of the circular economy in to reduce water stress in six regions, including California, Ghana, and the UAE.
- SDG7: Affordable And Clean Energy
- SDG8: Decent Work And Economic Growth
- SDG9: Industry, Innovation, And Infrastructure
- SDG11: Sustainable Cities And Communities
- SDG12: Responsible Consumption And Production
- SDG13: Climate Action
- SDG17: Partnership For The Goals: Businesses cannot achieve full circularity in isolation. Rather, this will entail cross-sector collaboration. For example, the construction and materials sector will be required to rethink material selection to extend the lifespan of infrastructure projects.

Also contributing to knowledge-sharing is the thought leadership by FIs promoting investment opportunities. Dutch bank ING has established a dedicated program towards the circular economy, releasing publications on circular solutions such as the prospect of efficiency gains in water infrastructure. A key milestone in 2018 was the publication of the financial guidelines to investing in the circular economy by ING in partnership with fellow Dutch institutions ABN AMRO and Rabobank. In late 2018, the Ellen MacArthur Foundation partnered with Italian banking group Intesa Sanpaolo to finance projects based on circular economy metrics, including the £175 million sustainability-linked loan with Thames Water. S&P Global Ratings has witnessed record growth in green bonds for the sixth consecutive year, a market that currently stands at over $730 billion of cumulative issuance. More recently, we have also observed the increasing attention gained in the sustainability-linked loan arena, which we anticipate could be a key funding mechanism for circular economy projects (see “Why Linking Loans To Sustainability Performance Is Taking Off,” published Sept. 3, 2019).

A Realistic Strategy?

In our view, circular engagement in infrastructure is already occurring, with reported early signs of success. Early adopter Royal Schiphol Group (RSG) says it has lowered maintenance costs by embracing new circular business models based on service rather than product purchase. In partnership with Engie and Philips, RSG has initiated "light as a service" whereby RSG pays for light production while Philips and Engie retain ownership of the lamps and fittings. Accordingly, suppliers are responsible for the physical structure's performance and are incentivized to draw out a product's residual value--collecting, reusing, and recycling fittings--as they reach their end-of-life. By transferring part of the maintenance cost to suppliers, producers are thereby incentivized to provide innovative, durable products. From an investor perspective, this creates a cost benefit of spreading project-cycle costs.

Royal Schiphol Group's Circular Economy Strategy

RSG is aspiring to be a leading example in implementing sustainability towards an ultimate goal of improving the quality of life. The group has outlined four key priority areas, one of which includes pursing a circular economy strategy in line with the municipality of Amsterdam's circular economy programs, implemented since 2017. The group has committed itself to reusing and recycling residuals, applying circular design principles and, market-placing secondary materials. It has also aligned to the nationwide aspiration to be fully circular by 2050 and has asserted that all airports should be operating at zero waste by 2030.

RSG has incorporated circularity principles by minimizing primary resource consumption and finding new opportunities for materials to be reused. The group reports that adopting zero waste principles has:

- Increased the speed and flexibility during construction;
- Improved cost controls; and
- Improved indoor quality of life.

Moreover, RSG champions the need for joint ventures and partnerships in achieving the organization's circular goals. This recognizes the benefits of regional partners reusing materials such as concrete locally, particularly when the residual material value if low, overcoming additional costs associated with transportation.

For investors focused on achieving long-term value creation, the circular economy may be beneficial to realizing increased value upon decommissioning. Early adoption of the waste hierarchy approach may help projects to reduce exposure to waste risks. This has also been adopted by RSG to address waste concerns for projects further down the project cycle. Through established relations with regional partners, the group has found reusing concrete locally is beneficial to both parties, especially where residual material value and transportation costs are low.

As projects become increasingly complex, applying the reuse principle becomes more challenging. Existing building standards may not always be compatible with circular economy goals because they require projects to utilize non-recyclable and sometimes even toxic substances. RSG recognized airport terminal buildings are subject to stringent fire-safety standards involving impregnating building materials with a toxic fire-retardant. Further, transfer of materials between projects on a larger scale involves in-depth information on the demand and supply of materials, as well as storage capacity, and transportation costs. It is not yet clear how participants will overcome these conundrums and this has been the major challenge to the proposed EU funded Buildings as Material Banks (BAMB). Central to this is the development of material passports, encompassing information linked to building information modeling, including construction methods. Beyond the problems identified, this initiative also requires the development of an effective digital platform so that transactions can occur in real time. This is unlikely to occur in the short or medium term given that infrastructure is among the least digitally transformed sectors.

COP25 And Beyond

We believe circular engagement in infrastructure is continuously proving itself to be a credible strategy for lower capital and operational costs, with the added benefits of reducing environmental impact via resource-cutting. We expect to see further engagement for major projects. For example, the U.K.'s High Speed 2 (HS2) railway project is committed to collaborating with supply-chain partners to implement circular principles from the specification stage through to its operation.

We believe the infrastructure sector may need to undergo a major transformation in innovation and technology, which are currently significantly lagging. Knowledge-sharing platforms could also work to increase engagement among stakeholders. This is a crucial task since current investor interest in developed economies in Europe is not matched with developing economies, where the infrastructure funding gap is likely be most severe. Therefore, we view the inclusion of the circular economy in the COP25 agenda as important in helping nations achieve their climate goals. This is a step in the right direction to promote knowledge-sharing and innovative practices that we are steadily beginning to witness within infrastructure projects.

Related Research

- Sink Or Swim: The Importance Of Adaptation Projects Rises With Climate Risks, Dec. 3, 2019
- Energy Transition: Renewable Energy Matures with Blossoming Complexity, Nov. 8, 2019
- Why Linking Loans To Sustainability Performance Is Taking Off, Sept. 3, 2019
- Green Finance - Modest 2018 Growth Masks Strong Market Fundamentals For 2019, Jan. 29, 2019
- Raising Ambitions - COP24 Tilts Toward Achieving 1.5 Degrees Climate Target, Dec. 19 2018
- Bundling: A Growing Trend As Stakeholders Look To Unlock The Potential Of The Infrastructure Asset Class, Jan. 31, 2017
- Europe’s Investment Plan: How To Spend €315 Billion In Three Years, Jan. 15, 2015
- Global Infrastructure Investment: Timing Is Everything (And Now Is The Time), Jan. 15, 2015
- EU Infrastructure: Tackling The Funding Deficit To Unlock The Financing Surplus, Oct. 14, 2015

This report does not constitute a rating action.

S&P Global
Ratings

RatingsDirect®

European Airlines Prepare For Take-Off On Climate Change

November 21, 2019

Key Takeaways

- European airlines are ramping up efforts to manage emissions amid growing social and regulatory pressures.
- Given their heavy reliance on fossil fuels, we think they will achieve most of their net CO2 emissions reductions via market-based measures and significant operating and fleet efficiencies.
- Although we expect the additional cost burden of emissions regulations will be marginal over the medium term, we think rising cost pressures will gradually widen the difference between Europe's few strongest airlines and the weaker majority.

PRIMARY CREDIT ANALYST

Rachel J Gerrish, CA
London
(44) 20-7176-6680
rachel.gerrish
@spglobal.com

SECONDARY CONTACTS

Beata Sperling-Tyler
London
(44) 20-7176-3687
beata.sperling-tyler
@spglobal.com

Philip A Baggaley, CFA
New York
(1) 212-438-7683
philip.baggaley
@spglobal.com

Izabela Listowska
Frankfurt
(49) 69-33-999-127
izabela.listowska
@spglobal.com

Stuart M Clements
London
(44) 20-7176-7012
stuart.clements
@spglobal.com

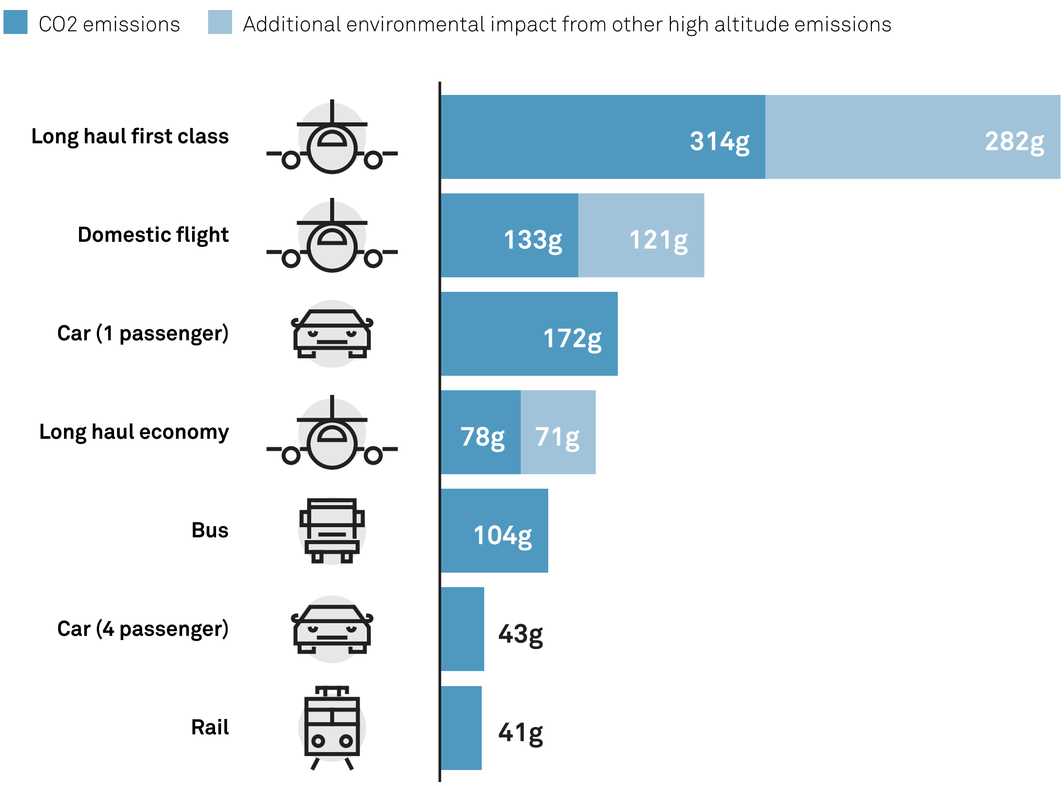
Karl Nietvelt
Paris
(33) 1-4420-6751
karl.nietvelt
@spglobal.com

See complete contact list at end of article.

Under growing environmental, regulatory, and social pressures, Europe's airlines are stepping up their efforts to offset or limit the impact of their emissions and communicate their efforts to the public. However, they don't face an easy task. Commercial flying remains a heavily carbon-intensive mode of transport (see chart 1), accounting for about 2.5% of global carbon dioxide (CO2) emissions. Although aviation produces just a small slice of global transport emissions (see chart 2), and transport as a whole emits only half the CO2 produced by the global power sector, aviation emissions are difficult to cut. Some experts expect aviation's share will rise as other sectors cut emissions, for example through electrification of ground transport, and as air traffic continues to expand at a faster rate than overall economic growth.

Emissions From U.K. Transport Modes

Emissions per passenger per km travelled

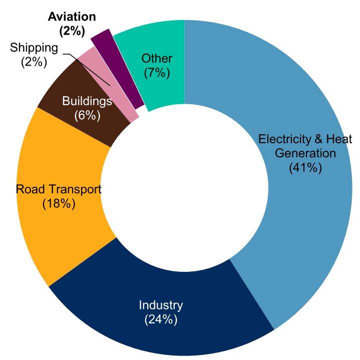


Source: BEIS/Defra Greenhouse Gas Conversion Factors 2019.

Global flights produced 895 million tonnes of CO_2 in 2018, out of a total 42 billion tonnes of CO_2 produced by humans. The U.S. (24% of the global total), the E.U. (19%), and China (13%) together are responsible for a large part of this, emitting over one-half of aviation CO_2 emissions in combination (see chart 3). What's more, flying at high altitudes means that CO_2 and other emissions, such as sulfur dioxide, nitrogen dioxide, and carbon monoxide, remain in the atmosphere for longer and have a potentially more damaging environmental impact.

Chart 2

Global CO2 Emissions By Sector 2017

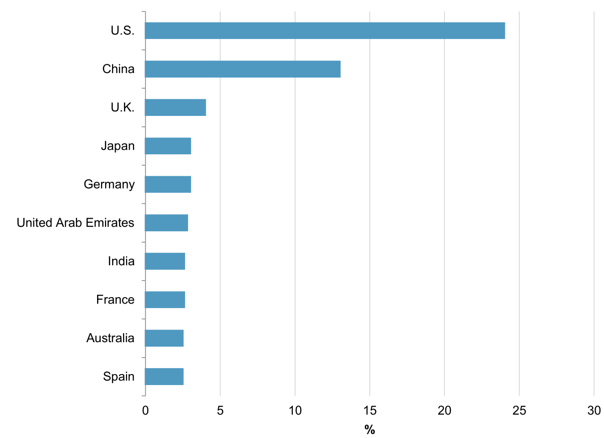


Source: International Energy Agency.

Chart 3

CO2 Emissions From Aviation In 2018 (% Of Global Totals)

Top 10 departure countries



Source: International Council on Clean Transportation.

In response to this challenge, the International Air Transport Association (IATA), representing 290 airlines and over 80% of total air traffic, has agreed global targets to mitigate CO2 emissions from air transportation. These include a cap on net aviation CO2 emissions from 2020 to achieve carbon-neutral growth, and a reduction in net aviation CO2 emissions of 50% by 2050 relative to 2005 levels. The industry's ultimate challenge in order to be able to achieve carbon-neutral growth is to improve operating--primarily fuel--efficiency at a quicker rate than air traffic growth to prevent overall fuel consumption and emissions continuing to rise. The International Civil Aviation Organization (ICAO), a U.N. agency, currently forecasts that the expected rise in global traffic of about 5% per year will likely surpass expected annual improvements in aircraft fuel efficiency of around 1%-2%.

The increase of the middle class (via both economic and population growth) particularly in Asia and a generational trend towards more spending on travel are significant global contributors to air traffic growth. In Europe, low-cost airlines continue to make air travel affordable and accessible. However, prevailing macroeconomic and political headwinds across Europe and the trade conflict between the U.S. and China translate to a downside risk to traffic growth, as do flight-shaming campaigns.

Environmental regulations currently center on market-based measures, primarily via the EU Emissions Trading Scheme and the Carbon-Offsetting and Reduction Scheme for International Aviation (CORSIA). Regulations to offset emissions via these market-based measures remain the most efficient way for airlines to mitigate the net environmental impact of airline pollution at present. Yet, they have significant inherent limitations depending on the type of offset. easyJet has recently announced it will offset the carbon emissions from the fuel used for every flight (at a cost of £25 million for its 2020 financial year), by investing in projects that include tree planting and protection against deforestation. The company recognizes that carbon offsetting is only an interim measure while new technologies are being developed. International Consolidated Airlines Group (IAG) estimates that market-based emissions schemes will drive almost 60% of its targeted 20% drop in net CO2 emissions by 2030. It expects a more efficient fleet and operations to account for almost 40%, and sustainable fuels below 5%.

A Potential Credit Impact For Airlines

Over the longer term, European airlines face direct risks from rising costs to meet environmental regulations, both those already in place today and those likely to arise from increased pressure for more forceful actions from governments. They will have to bear increasing financial liabilities associated with their carbon emissions. We believe that carbon costs will be more marginal over the short to medium term, compared with existing volatile fuel expenses, aircraft lease payments, and depreciation charges. However, any further cost pressure in the highly competitive, highly cyclical, capital-intensive European airline market will add to pressures and may further differentiate aircraft operators.

New processes to collect data on CO2 emissions could lead to further variations in landing charges at airports based on environmental factors. For example, Heathrow and Schiphol Airports differentiate the level of aeronautical charges to promote quieter and less-polluting aircraft. Some airports are investigating using environmental key performance indicators for slot allocation. European air carriers are now required to report their CO2 emissions on an annual basis, and this has increased public scrutiny on emissions.

Changes to fuel taxation are another potential risk. Currently, aviation kerosene is exempt from tax in Europe, unlike road fuel, which is charged a heavy excise duty. The imposition of a duty on flights would introduce complexities. For example, to avoid paying tax, airlines would likely fill up outside the taxation area. Some politicians favor an EU-wide aviation tax and many countries are considering additional environmental taxes. However, airlines are already subject to other taxes. For example, air passenger duty represents a significant tax in the U.K. IAG airlines paid €885 million in 2018. Some industry players are calling for the public finance tax to be renamed a "green tax" to be spent on environmental projects (indeed, initially it was introduced as a green tax). The national air traffic tax in Germany will go up significantly next year. Any such increase in taxes or costs would make smaller airlines even more vulnerable and could reduce the cost advantage for low-cost carriers and hence affect credit quality and ratings.

Airlines typically have been successful in passing on rising costs to customers via higher ticket prices. But their revenue gains have lagged fuel price movements, and higher prices will be more difficult to push through if the economy weakens. We believe that higher ticket prices could temper air traffic growth over the next decade.

Airlines also face some indirect risks from environmental pressures. Increased environmental reporting and public consciousness surrounding flying could further temper air traffic growth. Flight-shaming campaigns, such as "Flygskam" in Scandinavia, have led to a notable reduction in Swedish air traffic, and an increase in demand for rail services. In the past, Sweden's long winters and its high GDP per capita meant that long-haul air travel was popular. It is uncertain how this may translate to airlines in other countries. But some industry experts are shaving 1%-2% per year off their global air traffic growth projections as a result.

Airlines Take Action To Lower Emissions

Taking the necessary actions to lower emissions continues to be extremely challenging for the airline industry due to its heavy reliance on burning fossil fuels and the substantial costs of sustainable alternative fuels and technological innovation. Aircraft and aircraft engine manufacturers have already been steadily improving the fuel efficiency of their products for decades, making further significant improvements increasingly difficult. Still, sizable airline investments in new more fuel-efficient and quieter planes, and improved operating efficiency and air traffic management measures, continue to reduce fuel consumption and, in turn, emissions per passenger.

Clear economic incentives

In the highly competitive European airline industry, the incentive to reduce fuel is clear: fuel is typically an airline's largest or second-largest cost component, depending on labor structures, representing around one-quarter to one-third of operating costs, and fuel prices can be highly volatile. European airlines tend to be well hedged against movements in jet fuel prices and typically have a good track-record of passing rising costs through to customers via higher ticket prices. In recent years, airlines have made significant investments in new, more fuel-efficient and quieter planes, such as the A320neo and B737 MAX. These promise fuel reductions in excess of 15% (although the latter currently remains grounded by regulators). Swedish airline operator SAS estimates that the delivery of new and more fuel-efficient aircraft from Airbus will help it reduce its emissions by up to 18% on short-haul and up to 30% on long-haul flights. Deutsche Lufthansa AG (Lufthansa) will invest over €3 billion in fleet modernization this year, and estimates that its new aircraft reduce CO_2 emissions by up to 25%. New technology is also aiding fuel efficiency: easyJet reports that the introduction of sharklet wing tips on its aircraft since 2013 has led to a 4% saving in fuel consumption.

When considering an airline's environmental exposure, we take into account the following factors:

An airline's average fleet age. The newer the plane, the more fuel-efficient it typically is. The global average fleet is around 10-11 years, but for some low-cost carriers is currently around six years. When fuel prices are low, airlines tend to keep older planes flying for longer, as fuel efficiency is relatively less crucial to profit margins.

Global load factors. The percentage of seats filled on a trip are currently at record highs at about 85% on average, and higher than 90% for some low-cost carriers. This reduces per-passenger fuel costs and therefore emissions-intensity statistics. Adjusting cabin interiors to pack in more passengers can also help.

Flight duration and percentage of premium passengers. Flying long haul and first class is believed to be typically less environmentally friendly than short haul economy class. Legacy carriers lag behind low-cost carriers in this regard: first class long-haul flights are about four times more harmful than economy long haul per passenger per kilometer. However, premium passenger volumes remain very small (at about 5% of global revenue passenger kilometers). Another countervailing factor, is that taking off uses more fuel than cruising, so shorter flights or longer connecting journeys also tend to be more environmentally damaging. Also, low-cost carriers make money by fitting in more flights per day, and tend to drive high levels of air traffic growth. Given that a significant proportion of fuel is burned on take-off, we understand that non-stop, long-haul routes are relatively more fuel-efficient than the same mileage covered by the same aircraft and payload on two or more short-haul routes.

Type of aircraft. When full, widebody aircraft are more fuel-efficient and therefore less environmentally damaging on a per-passenger basis due to their size. Nevertheless, technology has allowed for longer range narrowbody aircraft to become increasingly popular for long-haul flights.

Route plans. Better route planning and a reduction in route restrictions can reduce fuel needs, both in the air and on the ground. Air Baltic Corporation implemented its E-GEN project in 2019, which uses commercial aviation technology (satellite-based navigation procedures) to improve operating and thereby fuel efficiency. Airlines have long pressed for more efficient and coordinated operations by Eurocontrol (the European air traffic controller organization), to minimize flight distances and duration.

Sustainable aviation fuels hold promise—but only in the long term

Despite hope that alternative fuels will offer the primary long-term solution to reducing airline emissions, progress to date has been limited. Kerosene-based jet fuel, an oil derivative, will likely remain the primary viable fuel source at least over the next decade. Aviation kerosene generates high energy per weight, making it suitable for flying, and presenting a challenge to replace. Aviation biofuel produced from bio-based feedstocks, such as agricultural and household waste, plants, and hydrogenated fats and oils, are already being produced and used in commercial flights. Yet, volumes are currently low, and prices are high--typically three to four times higher than conventional jet fuel--and infrastructure is limited. Only a handful of airports have regular biofuel distribution today. A key technological challenge of alternative fuels is that the energy density of airline fuel needs to be much higher than for ground transport.

Take-up of alternative fuels is very slow, but airlines are starting to invest in such projects. IAG will invest $400 million in sustainable aviation fuel over the next 20 years. British Airways is partnering with specialist Velocys to build Europe's first plant that will turn household waste destined for landfill into sustainable fuel, which produces 70% less CO2 emissions than fossil fuel. Lufthansa is also supporting the development of alternative fuels. The airline sees them as critical to achieving CO2-neutral flying in the long term, and calls for more funds to be channeled into sustainable fuel development.

However, IATA forecasts that, even if all options to increase production of alternative fuels are explored, usage could increase to only about 2% of total jet fuel demand by 2025 (from currently less than 1%). What's more, scaling up this production would also face serious land constraints. We understand that limiting global warming to below 2 degrees Celsius from pre-industrial levels, as per the Paris Agreement target, would require so much biofuel that it would take land approximately the size of Australia to produce the feedstock. Indeed, some critics argue that some biofuels actually result in more emissions than fossil fuels (for example, palm oil as a likely feedstock) and that land use should not be diverted from other important use (such as food).

The possible use of electrofuels--renewable electricity to produce hydrogen from water by electrolysis with carbon--have also sparked interest. However, they have not progressed much due to their high cost. They are three to six times more expensive than jet fuel.

The industry does not anticipate disruptive technological improvements to aircraft, such as electric aircraft and hybrid battery-fuel designs, in at least the next decade, even though airlines are working with manufacturers on research projects. SAS is engaged in a joint research project with Airbus related to the electrification of aircraft for large-scale commercial use. easyJet has a partnership with Wright Electric to develop an electric aircraft, with the hope that it will be viable for short-haul routes in Europe by 2030. The Israeli start-up Eviation unveiled an electric aircraft taxi called "Alice" in June 2019 that can carry nine passengers with a range of 1,000-2,000 kilometers.

However, large electric aircraft are unlikely to be available in the near future. The heavy batteries required mean that they will not be suitable for long-haul flights, and they require hours of charging so prevent a quick turnaround. Unlike jet fuel, the weight of the batteries does not decline as power is used up during a flight. The European Union Aviation Safety Agency (EASA) estimates that alternative clean propulsion technologies, such as electric-powered aircraft--are under development but are unlikely to be commercially ready before 2030. Others think it will take several decades.

Industry experts warn that transformative developments in technology, such as supersonic and urban mobility aircraft, will need to be carefully integrated into the aviation system to ensure they do not undermine environmental progress (supersonic aircraft can have between five and seven times more carbon intensity than traditional aircraft).

Market-Based Mechanisms Drive Lower Emissions

European airlines are at long-term risk of rising costs to meet environmental regulations and will have to bear increasing financial liabilities associated with their carbon emissions. Although we believe that the additional cost burden on airlines will be relatively marginal over the medium term, further cost pressure will likely ramp up, and may differentiate aircraft operators over time. We expect such cost pressures will also have an increasing impact on an airline's strategy and operations, such as fleet-purchasing decisions going forward.

In the longer term, we think an aircraft operator's ability to pass on additional carbon costs will be a key differentiator, and that this is likely to vary between operators. The degree to which an individual airline is able to pass on this cost will in our view be influenced by the efficiency of its route network, its market pricing point, and market dynamics. Furthermore, we think airlines with a higher proportion of premium revenues may find it easier to pass on carbon costs to passengers. This is because these costs will be a proportionately lower percentage of the ticket price than for low-cost and economy passengers.

Carbon-offsetting schemes can be an economical method for airlines to encourage passengers to travel in a more environmentally friendly way. However, from a climate perspective, many argue that such schemes are not a long-term solution. There are a variety of "offsets" available, but they do not remove CO_2 and other pollutants from the atmosphere. However, airlines generally agree that these schemes are better than imposing further environmental taxes already in place or under consideration in many countries. This is because these funds, typically, are not spent on environmental improvements but contribute towards general public finances.

EU emissions trading scheme (EU ETS) – cap and trade

This is a market-based mechanism managed by the European Commission to curb growth in emissions across the aviation, power, and industrial sectors. The system covers about 45% of the EU's greenhouse gas emissions. Following its launch in 2005, aviation was included in the scheme in its third phase (2013-2020). The cap-and-trade scheme applies to intra-EU flights only and aims to offer an economically efficient method of constraining airlines' CO_2 emissions while allowing them to grow within an overall emissions target. It sets a limit on the number of emissions allowances issued, which reduces each year, and thereby constrains the total amount of emissions of the sectors covered by the system. The scheme also offers credits when sustainable fuels are used. Any emissions permitted but not used can be sold (known as carbon trading). Hence, companies can either cut their own emissions or fund emissions reductions elsewhere.

With the industry continuing to grow at a faster rate than it can improve operating (fuel) efficiency, the result is that airlines will have to buy permits from other sectors to cover their emissions liabilities. Therefore, the cost to the industry is likely to increase substantially over time in line with emissions growth and the rising price of carbon, which is uncertain, and a reduction in allowances over time (by 2.2% per year from 2021). With some industry experts forecasting that EU carbon prices will increase to €40-€60 per tonne of CO2e (CO2 equivalent) over the next five years, this could be an unwelcome increase in costs for airlines over the medium to longer term.

EASA estimates that between 2013 and 2020 the EU ETS will achieve an estimated net saving of 193.4 million tonnes of CO2--twice Belgium's annual emissions--through funding of emissions reduction in other sectors. It estimates that the purchase of EU allowances represented about 0.3% of operating costs for airlines within the scope of the EU ETS in 2017, but this is increasing.

Under the EU ETS, airlines operating in Europe are now required to monitor and report their CO2 emissions annually, which brings further public attention to emissions.

CORSIA - international offsetting scheme

The International Civil Aviation Organization (ICAO), a U.N.-sponsored body, agreed a global market-based mechanism, the Carbon Offsetting and Reduction Scheme for International Aviation (CORSIA) in 2016, which starts in 2021. Full details are still being finalized. With 191 member states, this agreement covers most international routes, representing about 60% of global CO2 emissions, but excludes domestic journeys. It aims to stabilize net emissions from aviation at 2020 levels. The calculation of offsetting requirements will tighten over time (see text box). The scheme also allows targets to be met by using sustainable alternative fuels. It allows for emissions reductions that cannot be achieved in the aviation sector to be compensated through emission reductions in other sectors where the potential for quicker reductions is greater and the associated costs are lower, such as forestry projects. Airlines can purchase carbon credits from designated environmental projects around the world if their emissions exceed agreed targets. The eligibility of environmental projects will be decided by the ICAO Council, and will be important to CORSIA's credibility, alongside how the scheme is regulated. For example, in the annual climate negotiations, governments are still debating the accounting rules for global offset markets to prevent both buyer and seller claiming the emission reductions. Until the rules have been agreed, there is a risk that the offsets sold are also being claimed by both sides of the trade.

Calculation of offsetting requirement

The calculation of offsetting requirements will evolve over time from a "sectoral" approach to a combination of a "sectoral" component and an "individual" component. The sectoral component is based on the total CO2 emissions of each operator. Each operator will have to offset a given percentage of its CO2 emissions from flights subject to offsetting requirements. This percentage, the sector's "growth factor", will be identical for all operators and determined on the basis of the aggregated emissions from all operators. In contrast, the individual component is based solely on the increase in CO2 emissions of each operator.

Source: IATA.

CORSIA will begin its voluntary phase between 2021 and 2026, covering more than 75% of global international aviation emissions. All EU countries have agreed to join. Russia and India have not signed up and there is some uncertainty as to whether China will join the voluntary phase, which could deter other countries. The scheme is meant to be fully operational by 2027, and will eventually include all ICAO members and cover more than 90% of emissions.

In a downside scenario, the ICAO estimates that CORSIA could add up to 5% to fuel costs by 2035 (see text box). We don't expect the requirements to materially affect credit quality until at least 2025, but clearly the extra cost will be unwelcome, particularly for weaker airlines already struggling to make profits. We expect that stronger airlines will be able to pass on most of the extra costs via higher ticket prices. However, as the details of CORSIA have yet to be finalized and will be subject to review, uncertainty remains as to how the scheme will develop.

The EU may decide to withdraw the airline sector from the EU ETS if CORSIA is successful (which was the original plan). This would reduce costs for those airlines exposed to both schemes, but we understand that the schemes are likely to run in parallel for at least the next few years.

Estimated cost of CORSIA

The International Civil Aviation Organization (ICAO) estimates that given carbon prices--reflecting the monetary value of the damage caused by emissions--ranging from a low of $6 to $10 per ton of CO_2e to a high of $20 to $33 per ton, the estimated costs of carbon offsetting for operators would range from just 0.2% to 0.6% of total revenues from international aviation in 2025, and 0.5% to 1.4% of revenues in 2035. As per IATA, the offsetting cost in 2030 is equivalent to that of a $2.60 rise in jet fuel price per barrel. As per S&P Global Platts Analytics, jet fuel is currently about $80 per barrel (or $620 per metric ton) up from $60 per barrel three years ago. Given the inherent volatility in the fuel prices, we would not expect this to have a meaningful impact on credit ratings.

Airlines are communicating more on offsetting schemes and efforts. Ryanair Holdings' customers can offset the carbon cost of their flight by making a voluntary donation to its climate charity partners during the booking process. However, we note only a 2% uptake, perhaps signaling that consumers are less willing to pay for environmental efforts when they are footing the bill or uncertainty on how their fees will be spent. British Airways has announced that it will offset carbon emissions for all of its U.K. domestic flights from 2020 by investing in verified carbon reduction projects. These examples show that improvements are being made. Yet, whether there will be enough material improvements to meet the industry's goal carbon-neutral growth goal remains in the air.

Related Research

- Industry Top Trends 2020: Transportation, Nov. 18, 2020
- IMO 2020: The Coming Storm, Oct. 7, 2019
- ESG Industry Report Card: Transportation, Aerospace, And Defense, May 13, 2019
- Why The Transportation Sector Is On A Fast Track To Get Greener, May 10, 2019

Contact List

PRIMARY CREDIT ANALYST

Rachel J Gerrish, CA
London
(44) 20-7176-6680
rachel.gerrish@spglobal.com

SECONDARY CONTACT

Beata Sperling-Tyler
London
(44) 20-7176-3687
beata.sperling-tyler@spglobal.com

SECONDARY CONTACT

Philip A Baggaley, CFA
New York
(1) 212-438-7683
philip.baggaley@spglobal.com

SECONDARY CONTACT

Izabela Listowska
Frankfurt
(49) 69-33-999-127
izabela.listowska@spglobal.com

SECONDARY CONTACT

Stuart M Clements
London
(44) 20-7176-7012
stuart.clements@spglobal.com

SECONDARY CONTACT

Karl Nietvelt
Paris
(33) 1-4420-6751
karl.nietvelt@spglobal.com

SECONDARY CONTACT

Michael Wilkins
London
(44) 20-7176-3528
mike.wilkins@spglobal.com

SECONDARY CONTACT

Beth Burks
London
(44) 20-7176-9829
Beth.Burks@spglobal.com

Energy Transition: Renewable Energy Matures With Blossoming Complexity

November 8, 2019

Key Takeaways

- Over the past two decades there has been considerable de-risking of all types of renewable projects, ranging from solar and onshore wind to, more recently, offshore wind. However, there have been some notable credit events, such as reversals in policies, off-taker bankruptcies, and challenges in forecasting O&M expenses and wind resource.
- We expect renewable additions to continue over the next two decades at a strong annual growth rate of 7%. Still, over 50% of power produced will come from fossil-fired generation by 2040 under its most likely scenario (compared to close to two-thirds today) according to our forecasts.
- With renewables coming of age, we expect that while low risk, fixed price contract structures may still be available, new structures with a degree of merchant risk, the rise of corporate PPAs and counterparty risks, new technologies, and new policies for renewables will add to the complexity of renewable credit.

PRIMARY CREDIT ANALYSTS

Trevor J D'Olier-Lees
New York
(1) 212-438-7985
trevor.dolier-lees
@spglobal.com

Luisina Berberian
Madrid
+(34) 91-788-7200
luisina.berberian
@spglobal.com

Abhishek Dangra, FRM
Singapore
(65) 6216-1121
abhishek.dangra
@spglobal.com

Gloria Lu, CFA, FRM
Hong Kong
(852) 2533-3596
gloria.lu
@spglobal.com

Julyana Yokota
Sao Paulo
+ 55 11 3039 9731
julyana.yokota
@spglobal.com

SECONDARY CONTACT

Dario A Dell'Orto
New York
+ 1 (212) 438 9014
dario.dellorto
@spglobal.com

The World Of Renewables Has Dramatically Changed

Over the past two decades, the credit of many renewable financings have benefited from often-high-priced power purchase agreements (PPAs) or feed-in tariffs (FIT) and proven technology. In common with other new assets types, renewables have encountered challenges. For example, there have been significant credit losses with reversals in FIT policies in Spain and Italy, and PG&E went bankrupt (see "Suppliers In The Dark As PG&E Weighs Pulling The Plug On Power Supply Contracts," March 14, 2019). Furthermore, technology challenges and underestimations in operating costs and resource risk have resulted in reduced cash flows and rating actions.

Despite these teething problems, renewables have come of age and S&P Global Ratings expects the asset class to grow in capacity and with improving efficiencies and cost competitiveness. Even when factoring in massive renewable investments, but equally recognizing the likely increase in power demand by 40% over the next two decades, S&P Global Platts Analytics forecasts that over

50% of power produced will still come from fossil-fired generation by 2040 under its most likely scenario (compared to close to two-thirds today). Under Platts Analytics' two-degree scenario, the share of fossil-based generation comes down to 30% by 2040.

Certainly over time there has been considerable de-risking of all types of renewable projects, ranging from solar and onshore wind to, more recently, offshore wind. These trends have, however, resulted in thin lending margins and materially lower returns for investors. The drop in costs also has meant that governments are less willing to subsidize tariffs, with more competitive auctions and an inclination toward merchant pricing.

To mitigate the new risks posed by future renewable projects, lenders want both corporate PPAs and the availability of a floor price. Structuring corporate PPAs remains complex as projects cannot readily absorb the variance of generation due to resource risk (at least not on a short-period delivery basis), while buyers need to have certainty of supply. Consequently, outsourcing the balancing needs to a utility, traders, or aggregator, remains fundamental. Other challenges are the lengthening of corporate PPAs to tenors above 10 years, allowing for a higher share of debt-funding.

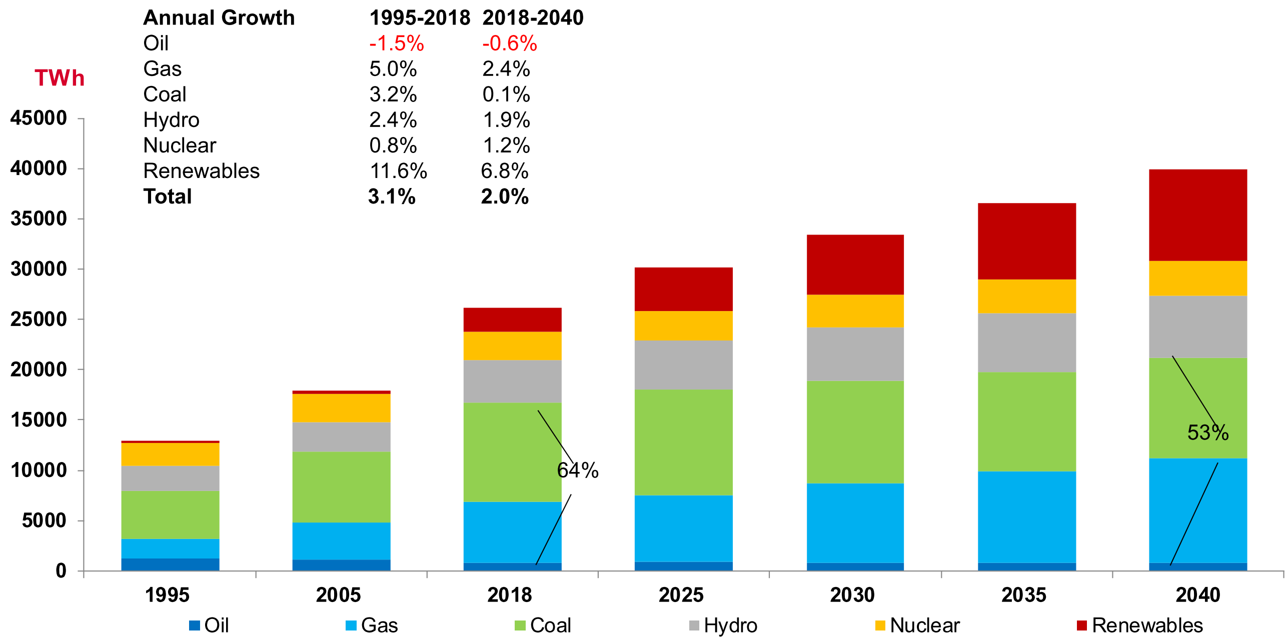
On a related note, counterparty risk has increased. Given the long-term visibility of their business models, utility and infrastructure companies are ideal off-takers, but more and more corporate entities seek to source part of their electricity needs from renewables. They often are less keen to enter into very long-term contracts or require more contractual flexibility.

The end game for renewables remains linked to innovation and technology, as battery storage development, automation of grids and aggregating of assets, and dynamic supply management of renewables should ultimately transition renewables from an intermittent source to closer to base-load (with a lesser need of back-up requirements).

Given the challenge of the energy transition ahead, we believe government policies will need to remain dynamic and supportive, to stimulate investment, grant permits, and reduce risks. Even if the asset class remains attractive, the need for investment is huge and the pace of transition cannot be taken for granted if returns become too thin (notably if current abundant liquidity decreases), or material merchant risk is on the rise, and, finally, if the consumer is not onboard in terms of affordability and access to land and location.

Chart 1

Electricity Supply Growth: Renewables Lead The Way, Yet Fossil Fuel Generation Still Grows



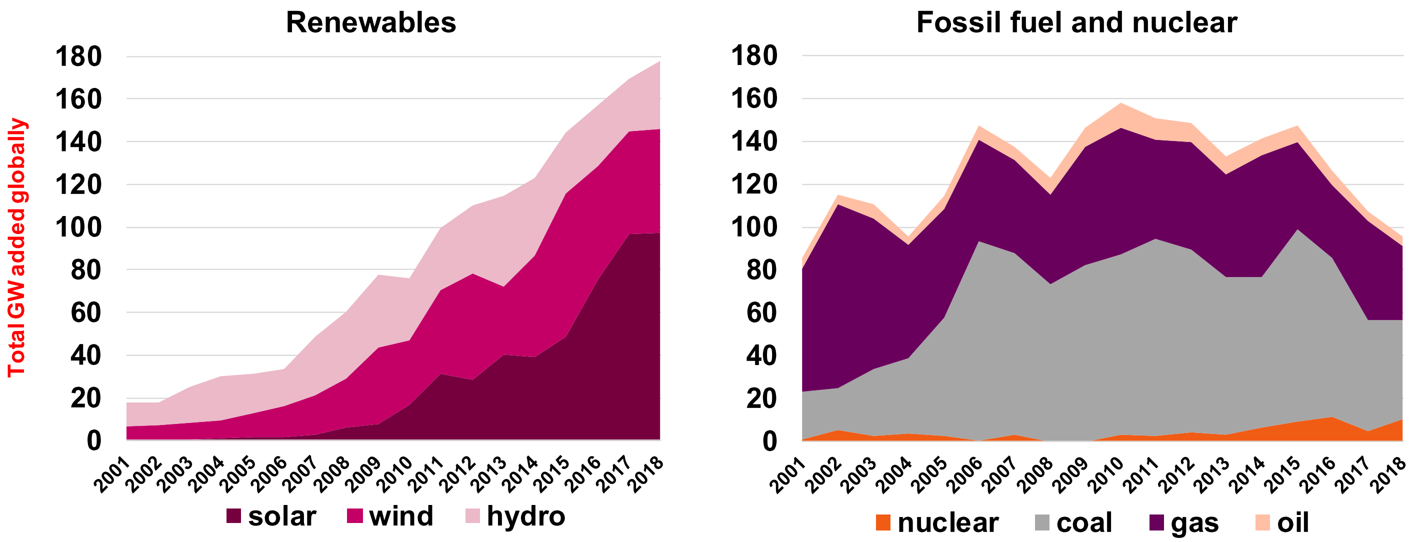
Source: S&P Global Platts Analytics, Scenario Planning Service (Sept. 2019).

Growth In Renewables Transitioning From Sprint To Long Distance

Worldwide investments in renewable energy infrastructure assets have been astronomical and at quite a sprint, totaling $2.6 trillion from 2010 through 2019 according to Global Trends in Renewable Energy Investment 2019, by BloombergNEF (BNEF) and the United Nations Environment Programme. Globally, renewable capacity additions outpace fossil fuel with solar emerging as the dominant technology. Key drivers of this meteoric growth have been government and corporate policies (as expressed through FITs, tax incentives, and PPAs) to meet clean energy goals, as well as declining installation costs, with economies of scale that are leading to grid parity.

Chart 2

Trends in global power capacity additions: renewables additions outpace fossil fuel, with solar now the largest technology



Source: S&P Global Platts Analytics, Global Solar PV Market Outlook (2019-2025), Aug. 2019

Despite the strong historical growth, in May 2019 the International Energy Agency (IEA) announced that renewable additions had plateaued in 2018; for the first time since 2001, there was no year-on-year growth. And recently, Platts Analytics announced a further reduction of over 10% year-on-year in 1H2019 across major markets (see S&P Global Platts Analytics' Global Solar PV Market Outlook (2019-2025), Aug. 16 2019). The aggregate numbers in the chart mask what has been happening in key markets and within the subsectors of renewables, such as:

- China's decision to address grid integration issues and control costs by reducing incentives slowed growth in solar.
- Changes in incentives led to slower growth of onshore wind in India and solar photovoltaic (PV) systems in Japan.
- In Europe, the phasing out of FITs for onshore wind, biomass, and solar projects has slowed the growth rate in countries like the U.K. and Germany.
- The U.S. grew modestly, reflecting in part that many of the states have met the initial renewable portfolio standards that were set.

Table 1

Net capacity additions by country and region (GW)

	China	United States	European Union	India	Japan	Other countries	World
2001	3	1	6	1	0	5	18
2002	4	2	7	1	0	9	23
2003	9	1	8	2	1	10	31
2004	11	0	10	4	1	9	34
2005	13	3	12	3	1	7	39
2006	14	4	11	4	1	10	44
2007	21	7	11	4	0	12	54
2008	29	9	16	5	1	9	67
2009	34	11	23	2	1	13	85
2010	33	7	26	4	2	16	88
2011	37	8	38	6	2	19	111
2012	36	18	34	2	2	25	118
2013	58	8	23	2	7	23	122
2014	56	12	19	8	11	30	135
2015	65	17	25	7	12	33	158
2016	66	24	22	12	9	38	171
2017	82	17	23	15	8	32	177
2018	77	18	22	14	7	40	177

Notes: The members of the IEA family are Australia, Austria, Belgium, Brazil, Canada, China, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, India, Indonesia, Ireland, Italy, Japan, Korea, Luxembourg, Mexico, Morocco, New Zealand, Norway, Poland, Portugal Slovak Republic, Spain, Sweden, Switzerland, The Netherlands, Singapore, South Africa, Thailand, Turkey, the United Kingdom, and the United States. Source: IEA.

Table 2

Net Capacity Additions By Technology (GW)

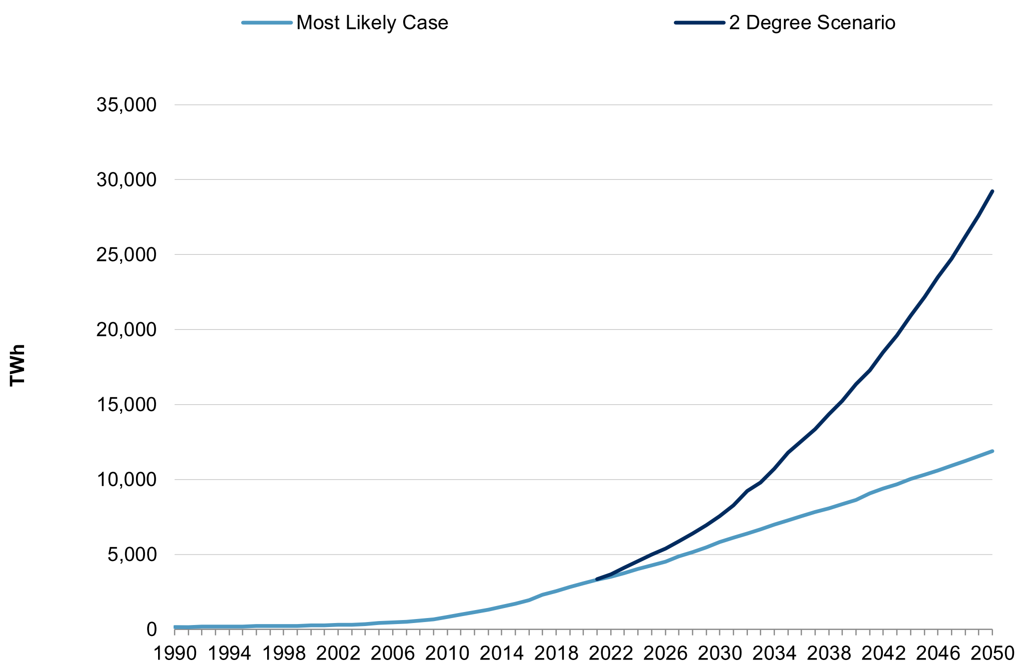
	Hydropower	Bioenergy	Wind	Solar PV	Other renewables	Total
2001	8	2	7	0	0	**18**
2002	14	2	7	0	0	**23**
2003	19	3	8	1	0	**31**
2004	22	2	9	1	0	**34**
2005	21	5	11	1	0	**39**
2006	25	3	15	2	0	**44**
2007	31	2	18	2	0	**54**
2008	32	4	24	6	0	**67**
2009	34	8	35	8	1	**85**
2010	33	7	31	17	1	**88**
2011	33	8	39	31	1	**111**
2012	34	6	47	30	1	**118**
2013	44	7	33	37	2	**122**
2014	38	6	49	40	1	**135**
2015	34	7	68	49	1	**158**
2016	36	9	51	75	1	**171**
2017	25	7	48	97	1	**177**
2018	20	9	50	97	1	**177**

Source: IEA.

The pause in growth is notable given how much decarbonization of the power generation sector is needed to meet to meet climate change goals . To meet these goals ,investment in renewables will need to increase significantly over the current run rate. BNEF/CERES (in "Mapping the Gap: Financing the Path to a 2°C Future," 2016) estimated the necessary increase in funding will be $5.2 trillion from 2015 to 2040, over a current base line of $6.9 billion.

Chart 3

Platts Analytics' long-term renewables outlook: Most likely case vs. 2 degree scenario

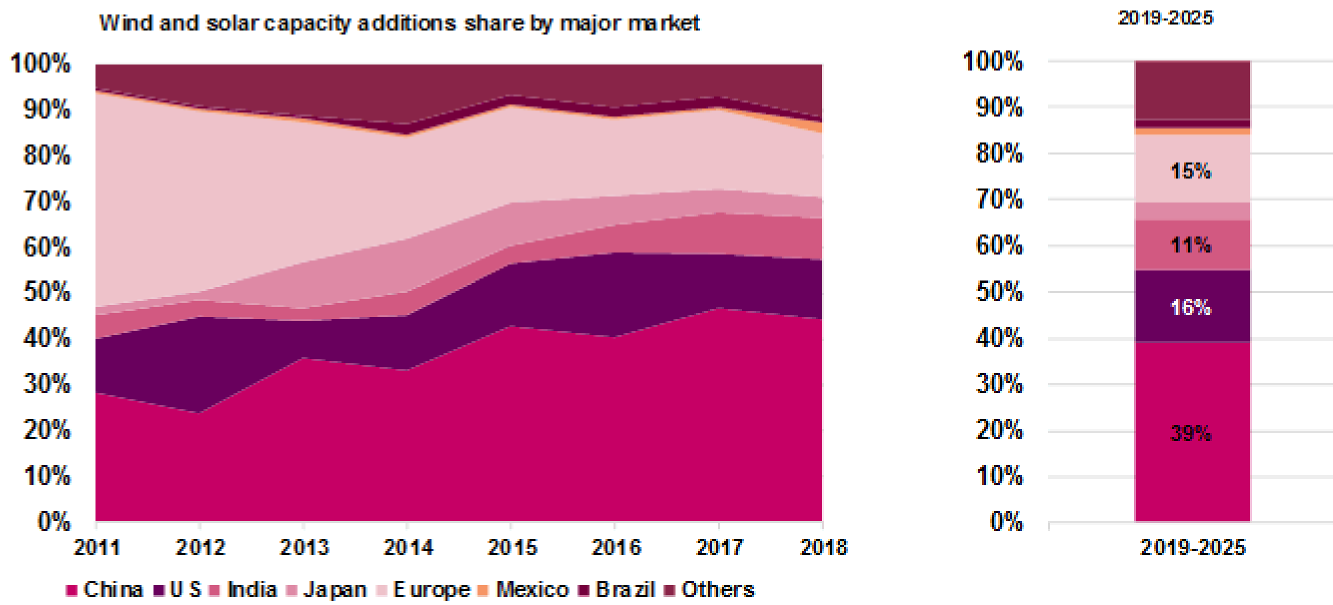


Source: S&P Global Platts Analytics, Scenario Planning Service (Sept 2019).

Emerging markets will account for the lion's share of the increased amount (about $4.3 trillion), as shown in chart 4.

Chart 4

Renewables outlook by region: China and U.S. lead in the near term, Europe faces challenges, new countries emerge



Source: Source: S&P Global Platts Analytics, Aug. 2019.

Despite the slowdown and other headwinds that might materialize (such as reduced demand due to the impact of any recession, and wider adoption of energy efficiency), we expect investment growth to pick up, driven by:

- Climate change-related policies;
- Lower costs of renewables driving grid parity;
- Higher oil prices;
- Demand for electric vehicles;
- Developments with battery and other storage;
- New technologies such as offshore wind floating platforms; and
- Innovations in financial markets.

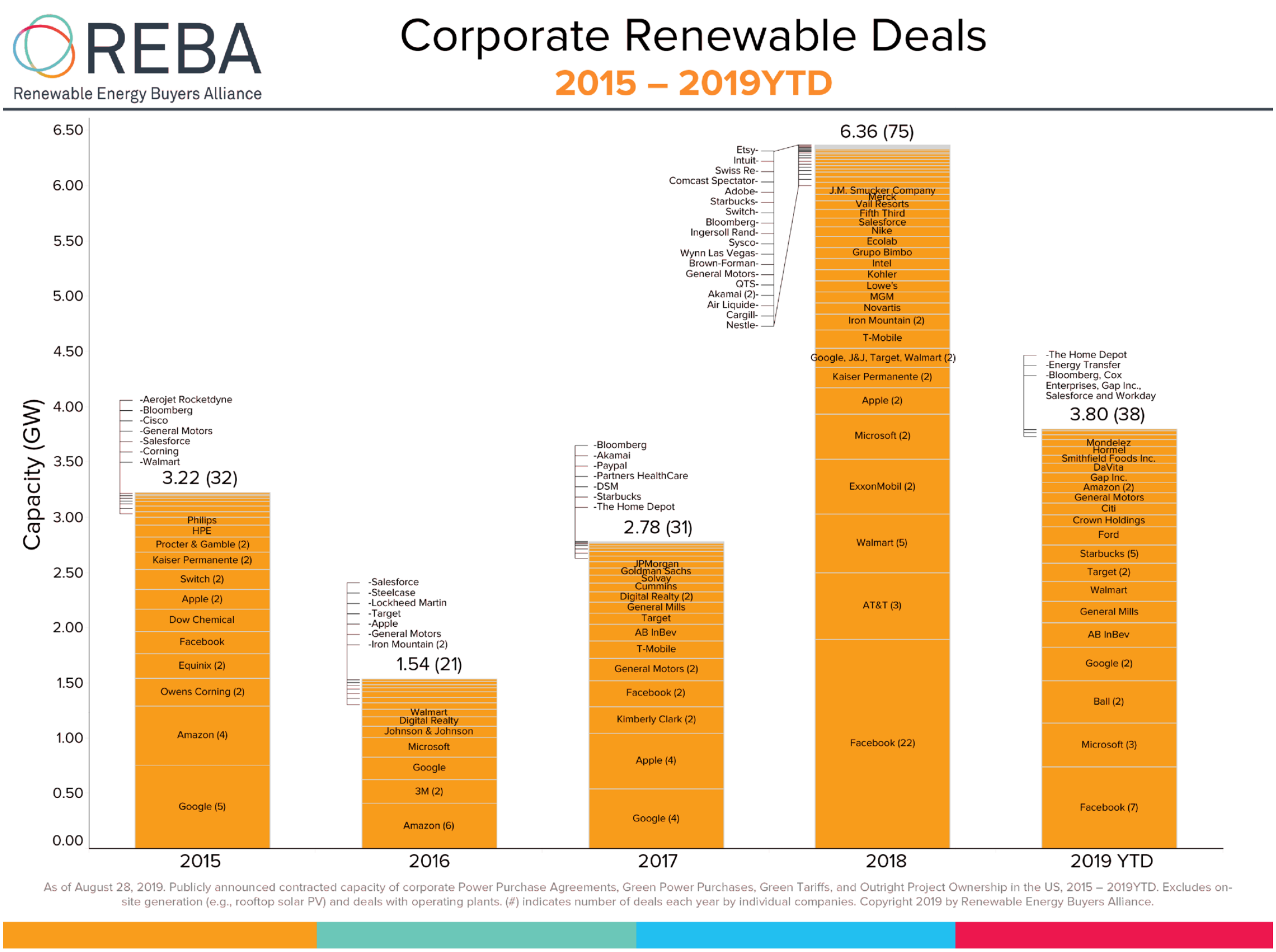
Corporate PPAs Are On The Rise Globally

As companies pursue their stated sustainable policies while also seeking competitive terms, reliability of supply, and the cost benefit of subsidies such as production tax credits in the U.S. or Renewable Portfolio Standard requirements in the U.K., the number of corporate PPAs has grown.

There are still speed bumps to growth in some jurisdictions. For example, FITs (where the government supports certain technologies by offering to purchase their generated power at rates higher than the market prices) are a disincentive to the development of corporate PPAs. Furthermore, some jurisdictions have laws that require all power to be purchased from national utilities or limit large corporate purchasers from buying power from a single supplier over an extended timeframe.

The U.S. and U.K. were early leaders in the growth of the corporate PPA market, but markets like Sweden, Spain, Mexico, China, and India are taking off. Corporate PPA tenors vary market to market; however, in the majority of cases, there is still not sufficient appetite from the counterparties to sign long-term PPAs covering the whole financing's life.

Chart 5



The delivery of power under corporate PPAs falls largely into two types:

- Direct: The generator and corporate customer are on the same grid, albeit the power is typically wheeled through a third-party utility.
- Indirect: The generator is in a different region from the corporate customer. The generator sells

power to its local utility and the customer buys power from its different local utility. There is a financial settlement between the generator and corporate customer.

In terms of credit risk, corporate PPAs share in common many of the same issues that traditional renewable PPAs with utilities face and additionally have other credit aspects to consider.

Traditional renewable PPAs were contractual arrangements between a developer-owned project and a utility with the following typical characteristics:

- Power was generated at the projects and wheeled to the off-taking utilities. The projects were typically financed with long-term debt that was supported by the long term PPAs through the tenor of the debt.
- Payments under the PPA were very predictable and covered operating expenses.

Table 3

Risk Type & Impact

Type	Impact
Intermittent supply	Renewables are subject to resource risk and this could lead to supply risks for the buyer absent balancing arrangements.
Basis risk	For indirect PPAs, if the PPA price is linked to wholesale price where the generator delivers there can be a basis risk between the wholesale/market price at which the buyer makes their purchase.
Pricing mechanism is not fixed	There is a whole range of pricing options for corporate PPAs. Any pricing pegged to market pricing introduces merchant power pricing risk.
Tenor of PPA shorter than debt maturity	This can open the project to contract renewable risk including merchant power pricing risk. Price reopener clauses in the PPAs are also viewed as a potential for merchant exposure.
Merchant power pricing risk	Wholesale prices can be volatile, difficult to predict, and subject to a combination of underlying assumptions on fundamentals such as macroeconomic assumptions (GDP growth, inflation, exchange rates), long-term energy capacity mix of the region, and interconnection developments (see below).
Out of market pricing	Tensions can be placed on the PPA if the pricing is above market prices (which could happen due to lowering of costs). This is a risk we see even for traditional PPAs, so we review the regulatory and judicial regime that underpins such contacts.
Counterparty	Typically, utilities have strong balance sheets that provide credit support to project financing. Corporate balance sheets range from strong to weak and it is not always the case that corporate off-takers are weaker. For example, in India, corporate PPAs often have better credit quality and collection track record compared to weak Indian State Utilities.
Economies of scale	Cost of capital falls with larger generating assets. There are many smaller companies that want to participate in corporate PPAs.
Corporate PPAs with multiple customers	As part of achieving economies of scale and also for risk diversification (e.g. the City of Melbourne led Melbourne Renewable Energy project bundled the needs of government, university, and private sector consumers). However, bundlings of different corporate credits can make the transaction more complex from a financing perspective.
Accounting treatment	For an indirect PPA, derivative accounting may be needed so as to record the contract on the company's balance sheet at fair value with respect to the prevailing market prices. This could introduce income statement and subsequently tax payment volatility unless hedge accounting can be applied.

It is not surprising that with a large diversity of corporate companies entering the space, there is an increasing number of innovations being proposed. For example, Microsoft Corp. (a major PPA user) announced in October 2018 the launch of a Volume Firming Agreement (VFA) that transfers weather-related risks to insurers. The product was created with REsurety, Allianz, and Nephila

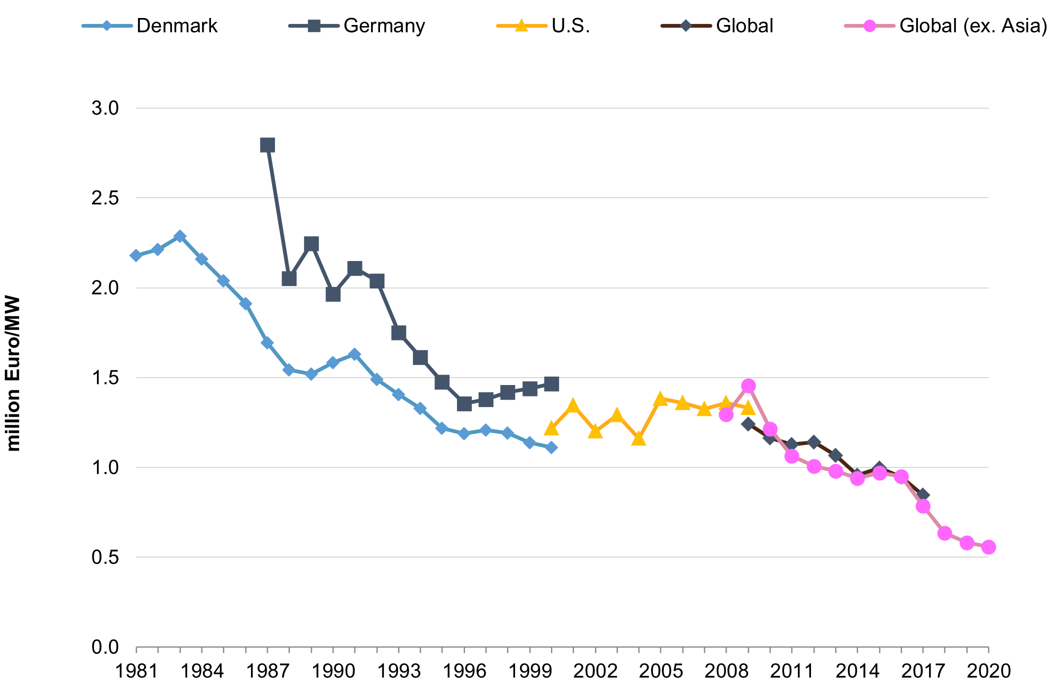
Climate as a complimentary product to the PPA. Another example is that of kWh Analytics' Solar Revenue Put. This is a credit enhancement that seeks to guarantee the production performance of solar assets.

Great Reliance On Merchant Financing Could Increase Credit Risk

Historically, renewable financing was supported by stable cash flows from FITs and traditional PPAs, with a tenor in line with the rated-debt maturity. Stable cash flows from investment-grade off-takers were a key support to the investment-grade ratings we assigned. As the renewable sector matures, with increasingly competitive costs versus thermal, and more jurisdictions are meeting their sustainable goals, some markets are tilting towards a market-driven approach, including merchant assets. The pace of change varies country to country, as does the appetite of investors to have such exposure.

Chart 6

Wind Turbine Price Trend



Source: Bloomberg New Energy Finance. Note: Data by contract-signing date.

There is some similarity to what happened in the U.S. in the 2000s with the rise of independent power producers and liberalization of markets. Today the U.S. has a significant number of merchant-supported financings, and most of those we rate are non-investment grade with the exception of hydro projects. Furthermore, such financings extensively use the term loan B market as a source of funding. The term loan B market is primarily found in the U.S. and has grown over time.

Increasingly, FIT schemes are no longer seen as the most efficient way to support renewables, as tariffs were not always aligned with the technology changes (and costs declines). Additionally, FITs resulted in growing the burden on end-user electricity prices.

Some governments are using auctions as a transitional step towards more market-based pricing. Through auctions, governments are able to set a more sustainable trajectory for renewable additions, including grid constraints or other supply/demand considerations.

Other governments, such as Spain, are pushing further into merchant financing for renewables. It awarded 8.7 gigawatts (GW) of new renewables contracts in 2016 and 2017 that may not receive any long-term government subsidies (see "The End To Subsidies: The Beginning Of A New Era For Spanish Renewables?" Feb. 7, 2018). Projects are being financed through the balance sheets of the companies or through project finance schemes, and some of them are without any PPAs. Such is the case of X-Elio, which, in March 2019, raised project finance debt for a greenfield solar PV portfolio of 421 megawatts (MW). The portfolio consists of 10 facilities that it won in the Spanish government's renewable energy auction in July 2017. The debt package for the portfolio, which does not have a PPA in place, is €203 million and was provided by Banco Sabadell, S.A. Institucion de Banca Multiple, and CaixaBank S.A. (Source: Inframation.)

Another example of a long-term merchant financing is the 21.5-year senior term loan provided to a special purpose vehicle named Zero-E Spanish PV, which is 100% owned by Zero-E Euro Assets. Zero-E is a subsidiary of Grupo Cobra and the €434 million funds were committed to build an 864 MW Spanish PV portfolio. The assets are part of the 1.55 GW of solar capacity Grupo Cobra won in Spain's third renewable energy auction, held in 2017. The transaction closed in August 2019, with Natixis S.A., Banco Santander S.A., Banco Bilbao Vizcaya Argentaria S.A. (BBVA), and CaixaBank providing the debt. (Source: Inframation.)

Sponsors may need strong balance sheets to fund the new renewables schemes being awarded, and project financing may be more challenging to structure, due to the implied volatility of earnings and the limited leverage potential, unless they manage to sign credit-supportive and long-term PPAs with third parties. However, in some emerging markets the appetite for PPAs or availability of large private off-takers may be more limited than, say, in the U.S. However, one can also argue that in these markets settlements of renewable auctions could stay high, as renewables developers need higher public support.

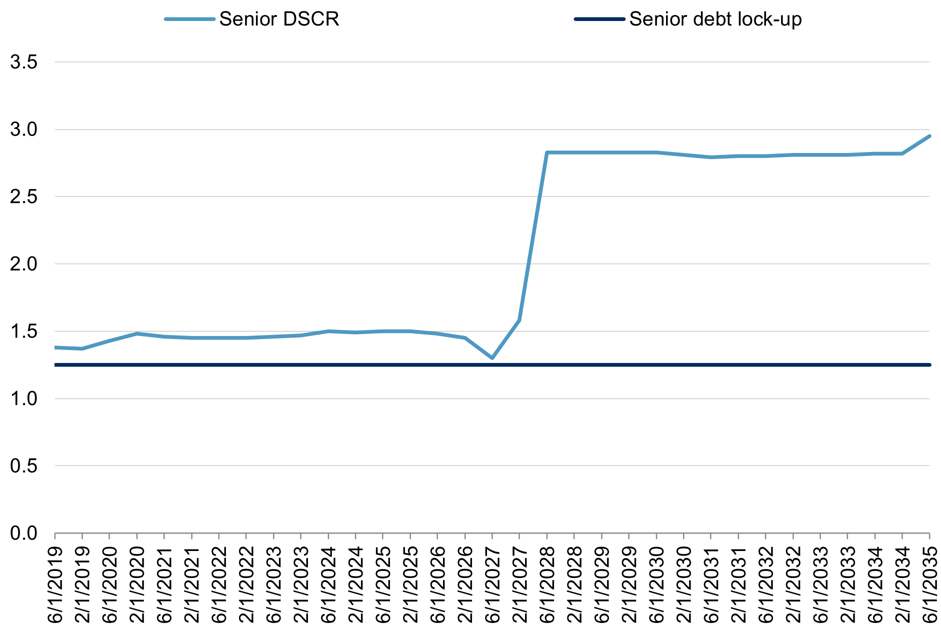
With greater exposure to merchant risk, we have observed structures with lower leverage and other risk mitigants such as cash sweep structures to pay down further debt if electricity prices are above or below forecasted scenarios. Some renewable auctions themselves can also be seen as mitigants, when settling at higher levels (for example, in Germany, where prices in recent wind and solar auctions have been trending higher).

In the absence of mitigants, greater reliance on merchant cash flows (market risk) will likely lead to an erosion of credit and even potentially undermine growth of renewables. Many of the merchant project we rate are non-investment grade. We have seen some exceptions, such as U.S. hydro deals (see "Credit FAQ: Hydropower Projects 101: How S&P Global Ratings Views The Risk Of Hydro," Jan. 12, 2017) and the offshore wind project WindMW GmbH.

WindMW is exposed to market risk only between 2027 and 2035, the assumed end of the asset life. Of course, forecasting cash flows in a merchant market more than a decade in advance is inherently challenging, especially in a market (Germany) that is in a state of considerable flux. However, we believe cash flows might drop by between 30% and 50% in a severe market downside case, but that a project like this would fare comparatively well because of a low operating cost position. The minimum annual debt service coverage ratio (DSCR) during the contracted period is nearly 1.4x, and this number ticks up later in our assessment. DSCRs exceed 2.5x during the riskier merchant phase due to lower debt outstanding, despite an expectation of weaker power prices.

Chart 7

S&P Global Ratings' Base Case DSCR (x)
As of Jan. 22, 2019



Note: All figures include values with x, e.g. 1.02x. DSCR--Debt service coverage ratio. Source: Standard & Poor's Financial Services LLC.

The degree of exposure some of our ratings have to market risk is reflected in our project finance ratings methodology. We evaluate how much cash flows can vary from our base case to a market downside. The more volatile the cash flows the higher the market risk. In contrast, payments under fixed price PPAs or FITs tend to have stable cash flows and often no market risk. We also assess the project's competitive position, which is influenced by support and predictability, barriers to entry, delivery costs, etc. (see "Project Finance Operations Methodology," Sept. 16, 2014). As an example of how volatile the cash flows can be, consider the spot prices in Spain.

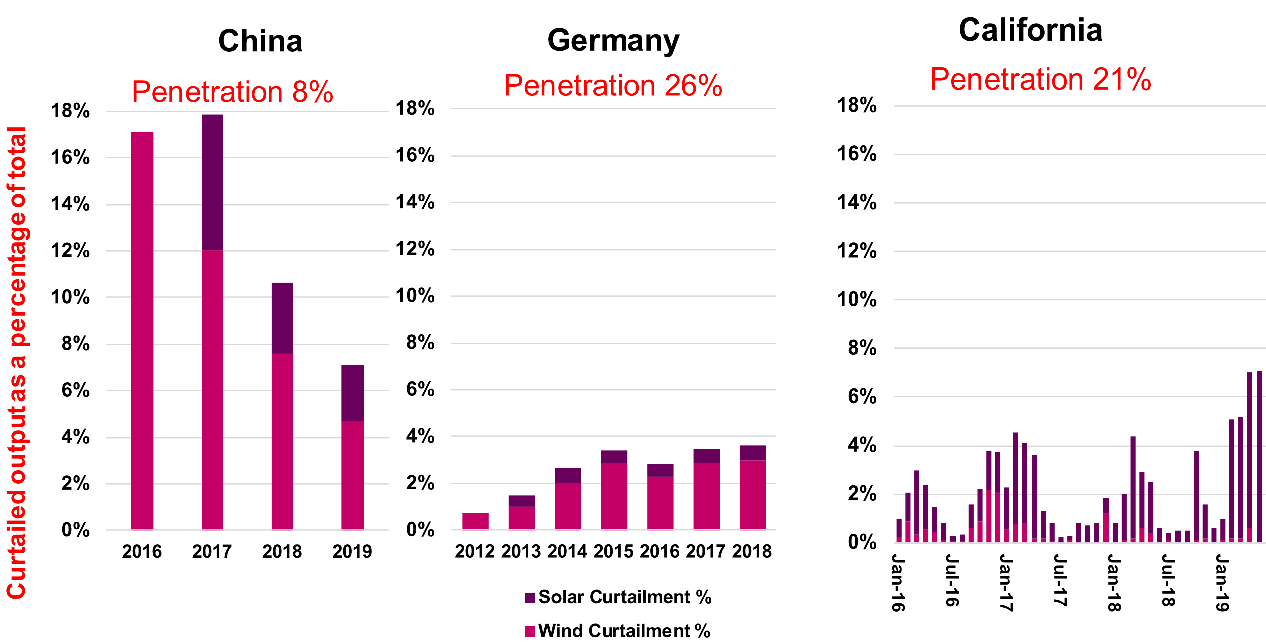
One of the challenges of selling electricity to the market directly will be the penetration of renewables at a certain time of the day, causing volatility in spot prices. This cannibalization risk exists for all renewable technologies, depending on the developments of each specific market. However, for solar this is even clearer since solar generally operates at the same time of day. Specifically for PV technology, this implies that the higher the penetration of PV assets generating, the lower the prices at the generation times. Hence, the capture price entitled for a PV asset could be well lower than a wind asset generating during the night. Consequently, this cannibalization effect could undermine the profitability of PV producers.

California's aggressive build-out of renewables has resulted in its now-famous duck-shaped supply curve (peaks in gross power demand are shaved off to a degree by coinciding solar generation).

Oversupply and/or insufficient transmission can lead to another credit risk: curtailment. Curtailment arises due to a number of factors, including emergencies on the transmission line, if the transmission line is overloaded, or if the transmission operator is optimizing plants that stay online during low price periods. The impact to credit can be material if there is an involuntary loss of production and payment. Traditional PPAs mitigate this risk by typically capping how much loss the generator faces. Absent mitigants, merchant generators are exposed to this risk, and we assess how much power might be curtailed. It varies market to market.

Chart 8

Renewable curtailments in key markets: more important when and where MWh is produced



Source: S&P Global Platts Analytics, Global Solar PV and Wind Market Outlook (2019-2025), Aug. 2019

Financing Structures Continue To Innovate

The flow of capital to fund renewables in developed markets has been torrential and we expect continued growth. As the sector matures in developed markets and expands in emerging markets we anticipate increased financial innovation in this space.

So far we have rated a wide variety of vehicles being used to channel capital into renewable assets, including project, corporate, securitization, and fund structures. In addition to the traditional providers of capital such as banks and institutional investors, we are seeing new types of financial institutions provide capital (e.g., Hannon Armstrong Sustainable Infrastructure Capital Inc.).

While there are mega-sized renewable projects, many projects, such as distributed generation, tend to be fairly small, and we have seen bundling as a strategy that governments and sponsors turn to so as to achieve more efficient or alternative forms of financing in both developed and emerging markets.

Table 4

Risk Type & Example

Type	Example
Project	The Vela Energy transaction involved the refinancing of bank loans used for construction of a bundle of 42 solar photovoltaic (PV) parks in Spain with permanent bond financing. By bundling 42 solar parks, the sponsors achieved sufficient scale to access capital markets for long-term financing. Parampujya Solar Energy Private Restricted Group, India's first rated international project bond, comprised a pool of 25 operational solar assets spread across India with different counterparties.
Corporate	Large corporate portfolios are another way to bundle assets in both developed and emerging markets. For example, AES has assets in North America, Latin America, Europe, the Middle East, and Asia. One of the most frequently used templates for raising international debt in India is use of a Restricted Group--packaging some of the operational projects (as investors are not comfortable with construction risk) with incurrence covenants (to cap leverage). However, the ring fencing of cash flows and hedging variations have different implications for credit risk. For instance, we evaluate Greenko Energy Holdings on a consolidated basis despite the use of Restricted Group due to loose ring fencing and ability to infuse/remove projects. We evaluate Renewable Power Restricted Groups with tighter covenants and ring fencing on a restricted group basis.
Fund	Allianz Group entered into a partnership under the IFC's Managed Co-Lending Portfolio Program. Under the agreement, Allianz intends to make an investment of $500 million, which will be co-invested alongside IFC debt financing for infrastructure projects in emerging markets worldwide.
Securitization	We have rated several rooftop portfolios, including SCTY LMC Series I, SCTY LMC Series I, SCTY LMC Series IV, SCTY FTE Series I, and SCTY FTE Series V. An example of an emerging market CLO securitization is the Bayfront Infrastructure Capital transaction, a special-purpose vehicle sponsored by Clifford Capital, which successfully securitized a bundle of loans to 30 projects from 16 countries in Asia-Pacific and the Middle East.

Emerging Markets: A Key Growth Area With Additional Credit Risk

Emerging markets range from investment-grade countries like Mexico and India to deeply speculative-grade countries. Some have local capital providers that are able to finance renewable assets--although even in these markets we see a desire to tap into larger pools of international money to optimize financing costs and flexibility; for example, the cross-border financing of 25 operational solar assets in India with 930 MW of total installed capacity across eight states owned by Adani Green Energy Ltd. (see "Presale: Parampujya Solar Energy Pvt. Ltd. Restricted Group," May 22, 2019).

Although there is significant capital interest in infrastructure, the credit risk of emerging markets makes it less attractive to institutional investors. Such elevated risks include political and regulatory uncertainty, embedded risks in government concessions, currency exchange rate risk, and policies that are often less developed and somewhat unpredictable. (See "It's Time For A Change: MLIs And Mobilization Of The Private Sector," published on Sept. 21, 2018). The recent temporary tariff freeze in Chile, for example, might be well absorbed by large conglomerates but might cause a cash flow burden to single asset renewable projects, and represents a disruption of the historical regulatory stability observed in the Chilean market (see "Regulatory Support Is Powering Latin America's Utilities," March 8, 2019).

Approximately 97% of total private capital investments mobilized by multilateral lending institutions (MLIs) in 2017 occurred in high- and middle-income countries, according to the MLI community's joint 2017 report "Mobilization of Private Finance." Mobilization among low-income countries increased only 4% in 2018, accounting for 3.4% of global private capital mobilization.

Table 5

Main Risks Holding Back Private Investors' Capital Deployment In Infrastructure

Type of Risk	Description	Credit impact*
Country risk (rule of law, currency convertibility and volatility, foreign exchange risk, political risk, strength of institution)	We define "country risk" as the broad range of economic, institutional, financial market, and legal risks that arise from doing business with or in a specific country and that can affect a nonsovereign entity's credit quality. For example, foreign exchange risk is a key concern to investors given the volatility of many emerging-market countries, long tenors of infrastructure debt, and inability/cost to fully hedge this risk.	The higher risk of doing business in a specific country is typically reflected in a higher business/operational risk assessment of the infrastructure asset. In some cases, a project's structure mitigates its exposure to specific country risks by political risk insurance or another instrument that transfers the relevant risk to a counterparty.
Sovereign creditworthiness	The potential to rate entities above the sovereign depends on our assessment of the ability of the entity (or project) not to default in the stress scenario likely to accompany a sovereign default.	Absent a full guarantee, infrastructure assets are generally rated no more than two notches higher than the respective sovereign given their high exposure to both economic conditions and potential changes in regulatory frameworks.
Transfer and convertibility risk (T&C)	We define T&C as the risk that a sovereign may restrict a nonsovereign entity's access to foreign exchange needed to satisfy its foreign currency debt service obligations. The T&C assessment is generally closely linked to the respective rating of a country and positioned typically one to three notches higher. In the eurozone area, however, such risk is assessed 'AAA' independently from the respective sovereign rating.	Absent a full guarantee, an issuer's rating would generally be capped by the T&C assessment on the respective country given the risk of currency controls that might be imposed by federal sovereign government on infrastructure projects and corporates in period of stress. Exceptions to this include export-focused corporates/projects whose rating may exceed the T&C assessment by one notch, if the entity passes a specific stress test.

Many risks holding back private investors could potentially be transferred to a third party. Credit enhancement aims to mitigate specific risks of a project that may weigh on its overall credit profile and therefore make that project less appealing to private-sector participants. We believe multilateral development banks will increase engagement with the private sector via credit enhancements to facilities private capital deployment. Plus, commercial insurers will likely continue to innovate to effectively deploy their capital across different projects and expanded geographies, and look at the whole capital structure beyond senior debt (see "It's Time For A Change: The Role Of Credit Enhancement In Mobilizing Private Investment In Infrastructure," Sept. 28, 2018).

The campaign to scale solutions for the financing of infrastructure in emerging markets is expanding. And according to investment bankers, multilateral development bank (MDB) officials, and government representatives working with the U.N.-affiliated Closing the Investment Gap Initiative (CIG) who spoke at a roundtable hosted by S&P Global Ratings on April 26, 2019, there are solutions in the offing (see "Emerging Markets Have Hope For Sustainable Infrastructure Projects, Roundtable Participants Say," May 7, 2019).

Technological Innovations (And Challenges) Continue To Emerge

Technological innovation continues to be vibrant in many areas of the renewable sector, driven by a desire for grid parity and fueled by gigantic expenditure. Technological change has been both incremental (where costs have been driven down or efficiencies driven up) and radical (with new types of technology being introduced).

Technology risk is an important credit factor for renewable ratings, particularly project finance ratings that are typically linked to the technological performance of the assets. Our approach to assessing technology risk is described in our construction methodology criteria ("Project Finance Construction Methodology," Nov. 15, 2013; see also paragraphs 13-17 of "Key Credit Factors For Power Project Financings," Sept. 16, 2014) and scores range from commercially proven to unproven. The latter can introduce significant credit risk absent robust mitigants.

Generally, when it comes to transactions that are seeking a corporate or project finance rating, we consider the technology predominantly proven, particularly if the issuer is looking for an investment-grade rating. We have seen portfolio transactions use a small proportion of technologies with limited or minimal track record; such is the case of Vela Energy Finance S.A. In these cases, we will discount cash flows from such technologies.

Not all innovations have gone smoothly. The rapidly evolving offshore wind industry has had setbacks along the way. Some turbine models are requiring major repairs, although whether this is just from normal wear and tear is unclear. Erosion on the leading edges of their blades, requiring removal and reconditioning, can not only disrupt generation but increase costs in the long term if the reconditioning was not forecasted in the first place. Although projects can benefit from contractual obligations from the turbine's manufacturer, it is not entirely clear if these will cover all costs, including additional labor and logistics work, and as a result these issues could have negative credit implications.

There are always new technologies entering large-scale commercial or utility applications. For example, there is a lot of expectation that battery technology that could accelerate deployment of renewables (see "Going With The Flow: How Battery Storage Economics Are Changing Power Consumption," Jan. 11, 2018). If we rate a financing that uses technology that we have not yet evaluated, we will need to form an opinion on how it will perform based on information either provided to us or available from public independent authorities--including field data, testing results, and any independent engineer opinions.

Table 6

Innovation	Description
Bifacial panels	Like the existing fleet of monofacial panels, bifacial solar modules absorb sunlight from the front of the module but also can absorb reflected sunlight onto the back, increasing energy production. In turn, this could lead to a balance of system optimizations. How the panels are installed is a key factor in how much energy is produced. Factors that impact production include tilt angle, roof or ground characteristics (flatness, reflective), and whether there is shading of panels by others. Mountings to accommodate higher tilts could add to the costs.
Passivator Emitter Rear Contact (PERC)	PERC is a relatively new technology that adds a dielectric passivation layer on the rear of the solar cell with the goal of achieving a higher energy conversion efficiency. PERC is increasingly being used although PV Evolution Labs (PVEL) has published the fifth Edition of its PV Module Reliability Scorecard in partnership with DNV GL, and highlighted that some PERC panels exhibited abnormally high degradation. However, not all PERC modules had this issue, which raises questions about reliability of performance.
Floating platforms	Floating offshore appears to be the next in line specifically for regions where seabed conditions are not suitable for fixed-bottom wind development, such as the western U.S. seaboard, eastern India, parts of eastern Asia, and southeastern Australia. Floating offshore has very high potential, although it's still in its infancy and at the moment is not considered proven technology. So far, multiple prototypes are being developed and tested but only one--Equinor's 30MW Hywind Scotland pilot park--has achieved pre-commercial scale. Windfloat Atlantic (25MW) was successfully commissioned in 2019, and we expect an additional 309MW across 11 projects throughout Europe to be commissioned between 2020 and 2022 .

Emerging Regulatory/Political Challenges In Asia

Regulatory uncertainties and political risks may reduce project returns unexpectedly and dampen investor confidence, especially in developing burgeoning renewable energy markets, as seen in Taiwan. Following local elections in November 2018, the island's regulator proposed a cut of offshore wind tariffs from 2019, and a production cap of annual full-load hours, which may hamper the efficient use of wind farms.

Earlier that year in China, under the mounting pressure of funding renewable subsidies, the government unexpectedly suspended the quota for new solar projects and further lowered the subsidy levels five months after the last cuts. This policy led to the slump of solar growth in China from the historic 53 GW new capacities in 2017 to 44 GW in 2018, with the hardest hit on the upstream and midstream manufacturers due to worsening capacity glut.

Payment delays in India are common but we are witnessing rising political risk with Discoms (state-owned distribution companies) under the new state government of Andhra Pradesh, which is attempting to renegotiate executed contracts, questioning the must-run status of renewables, and resorting to curtailment in order to avoid paying under the PPAs. This puts the fundamental longstanding credit protections for the Indian power sector at risk.

Last but not the least, trade protectionism may create headwinds for renewable growth. The U.S. is likely to continue with import tariffs on crystalline-silicon PV cells and modules, inverters, and other materials from China. On October 22, the exception for bifacial modules ended. India also significantly raised import tariffs on PV modules from China and Malaysia; the potential increase in investment costs casts doubt on India's ambitious target of 100 GW solar power by 2022.

Issues Of Repowering And Lifetime Extension

As the renewable energy industry matures, asset owners need to decide what to do with their seasoning assets. We are observing different strategies such as lifetime extensions, repowering, and decommissioning.

Lifetime extensions for wind farms and solar plants are becoming more of a trending topic of discussion as the choice to decommission might mean disregarding some clear benefits, including the extensive operational track record and associated performance data, connection to the grid and, most probably, the small amounts of debt outstanding.

Alternatively, repowering wind turbines by replacing either components or the entire turbine, is regularly viewed by operators as a viable option to face the rising operation and maintenance expense of aging equipment. Wind turbines repowering has improved output by up to 25% while extending turbines' lifespans by as many as 20 years, according to General Electric (source: EIA).

The current U.S. tax code also favors repowering. Owners of repowered projects can become eligible for the Federal Production Tax Credit (PTC) should the repowering encompass at least 80% of the turbine's value. This threshold furthermore affords owners the flexibility to replace individual components without decommissioning the entire asset. The National Renewable Energy Laboratory forecasts annual repowering expenditures of $25 billion by 2030. In Europe, repowering is incentivized by a dearth of attractive locations for greenfield wind projects. As assets approach the end of their lifetimes, it can be more favorable to repower than to invest in a new turbine elsewhere. Furthermore, as existing sites have historical data documenting their performance, investing in a repowering project bears less risk than investing in new turbines at unproven sites. There's also the fact that available sites could become scarcer in more mature markets.

While there are advantages to repowering, some markets may be more conducive to lifetime extensions. Given the relatively low energy prices forecasted over the next 10-15 years, the potential additional sales may not justify the investment required to repower a turbine. Instead, asset owners seeking to remain in operation may favor lifetime extensions, supported by the operational track record and associated performance data, connection to the grid, and, most probably, small amounts of debt outstanding.

Although lifetime extensions do not generally increase the asset's capacity or lifetime to the extent of repowering, lifetime extensions require significantly less investment, affording owners greater financial flexibility. Should prices increase over the short-term, owners retain the option to invest in less costly lifetime extensions that enable them to capture the benefits of increased prices without committing to a long-term operation, which would involve greater price uncertainty. In Europe, the absence of meaningful government subsidies or tax benefits equivalent to those available in the U.S. cements repowering as the costlier alternative, further encouraging lifetime extension. This may change as PTC and the U.S. solar investment tax credit (ITC) phase out per current legislation.

The Need For Storage And Hybrids Is Abundant, And The Right Technology Seems To Be In View

Regardless of the dispute for the best renewable alternative--either solar or wind--batteries are the third piece of the triangle among industry players. Compared to thermal plants, wind and solar assets experience intermittency issues; as such, batteries could solve the intermittent nature of these resources.

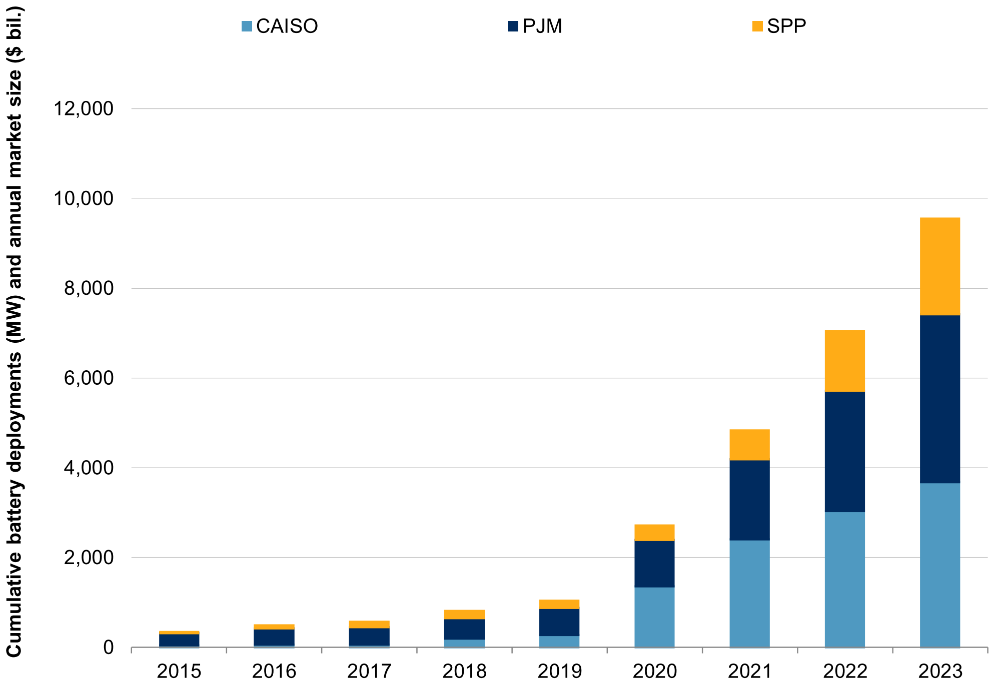
As of today, the predominant technology for energy storage is the hydro reservoirs--either pumped hydro or large hydro plants, which could be dispatched when the solar or wind assets are not operating. Still, these assets are supplying energy in the countries they are located in, and as such their use as availability storage (to reduce solar and wind intermittency) would depend on a complete shift of the energy matrix.

Currently there are few large-scale batteries projects worldwide. We expect this to change dramatically in the next five years, led largely by diminished costs. Furthermore, the development of batteries could get a boost from policies towards carbon emission reduction and by the growth of distributed generation.

For example, in the U.S., storage is already cost competitive for short-duration solutions that include fast-response ancillary services and frequency regulation. Moreover, we see C&I peak-shifting installations as the most economical because of rate arbitrage opportunities (i.e., under a time-of-use (TOU)-based variable-rate structure there is an incentive to shift or shave peak demand). Furthermore, grid storage to integrate renewables or substituting peaking gas assets are also competitive in markets like California, where we now see the possibility of no further natural gas-based peaking generation construction.

Chart 9

The U.S. Battery Storage Market Size Is Set For A 10-Fold Increase By 2023



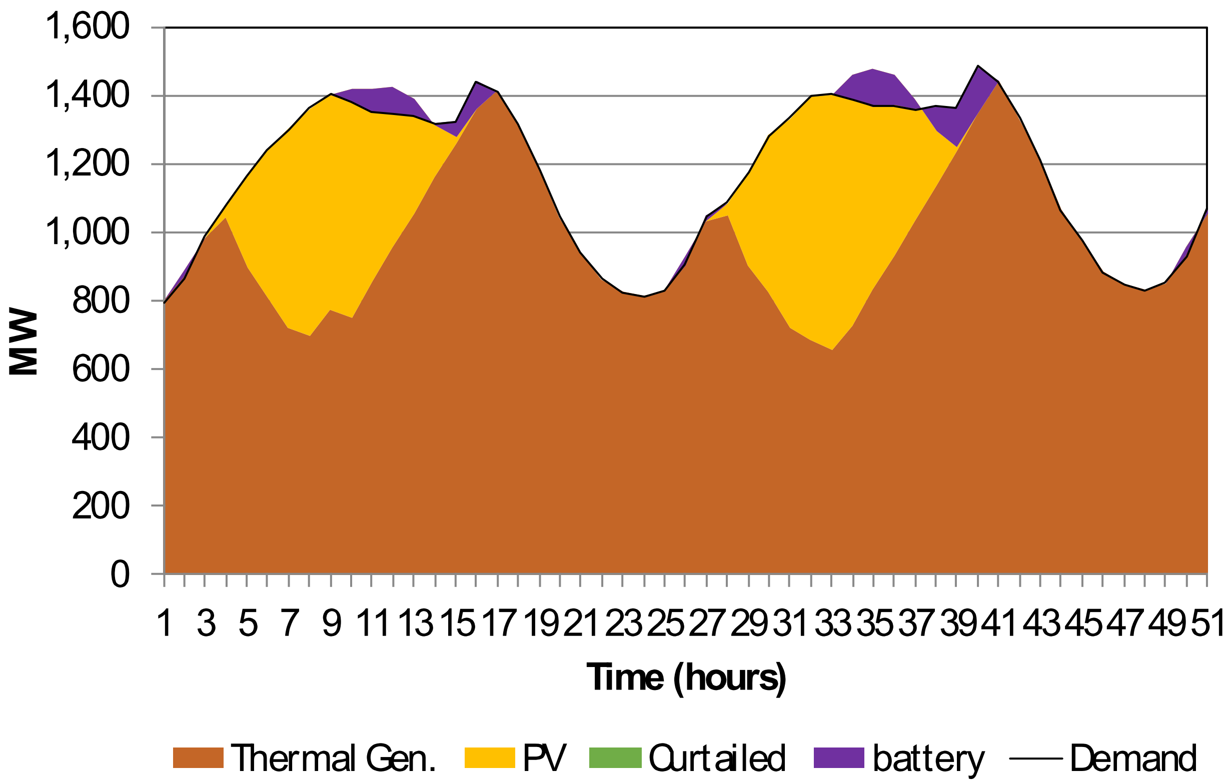
S&P Global Platts Analytics, U.S. Power Storage Outlook, June 2019.

In India, the State of Andhra Pradesh was evaluating an Integrated Renewable Energy Storage Project (IRESP), comprising 2 GW of solar power and 2 GW of wind energy capacity, with pumped hydro storage capacity of 8 GW. The project shall be designed for a discharge duration of eight hours. However, the new state government is reconsidering the project and could potentially scrap it.

We believe storage will become a key tool in global efforts to decarbonize the power sector in the years to come. Along this line, we believe there will be regulatory support to develop hybrid solutions of batteries/wind and/or batteries/solar to unlock the full potential of renewable energy in each jurisdiction, creating a solution that contributes to grid stability and to the balance of pricing to cover peak demand.

Chart 10

Storage as a solution to some of the flexibility issues, providing high ramping capabilities



Source: IRENA Flextoll, January 2019.

Grid Price Parity Is In Focus, Especially For China and India

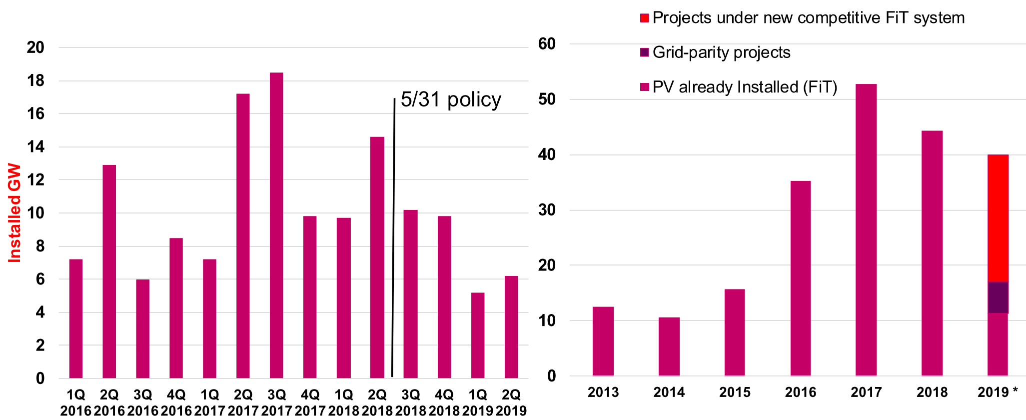
Grid parity is achieved when levelized costs of electricity (LCOE) of renewables are on par or even lower than the incumbent sources of generation, and government subsidies are no longer needed. When grid parity is achieved, deployment of renewables tends to become more sustainable. We have seen this in some or most renewable projects that are awarded through competitive bidding in many areas of the world, including India and China.

Technological innovation has been behind the drastic decline in construction costs, improving efficiency (such as solar conversion rate) and utilization. On top of that, the decrease in financing costs and other nontechnical "soft" costs are important to achieving grid parity, which is positive for the long-term sustainability of the industry.

China, as the largest market of wind and solar power, is likely to remove the subsidy on new capacities of onshore wind power and utility-scale solar power from 2021, and offshore wind power from 2022 (see "China Clears The Air On Solar And Wind Subsidies," April 15, 2019, and "China's Subsidy-Free Renewable Energy Projects May Spur Debt Increase For Developers," Jan. 16, 2019). Indeed on-grid tariffs in some solar pilot projects have been lower than local benchmark coal power prices. However, the higher-than-expected growth of renewables results in sizable deficits in funding subsidies, and the prolonged use of subsidy receivables constrains the liquidity of developers and inhibits healthy industry growth. In this context, the government is keen to push grid parity by reducing the subsidies for new capacities more frequently, providing policy support for subsidy-free projects, reducing curtailment of renewables, and implementing the renewable portfolio standards and tradable green certificates in China.

Chart 11

China: Installed solar PV capacity and projects approved under new policy set to come online this year



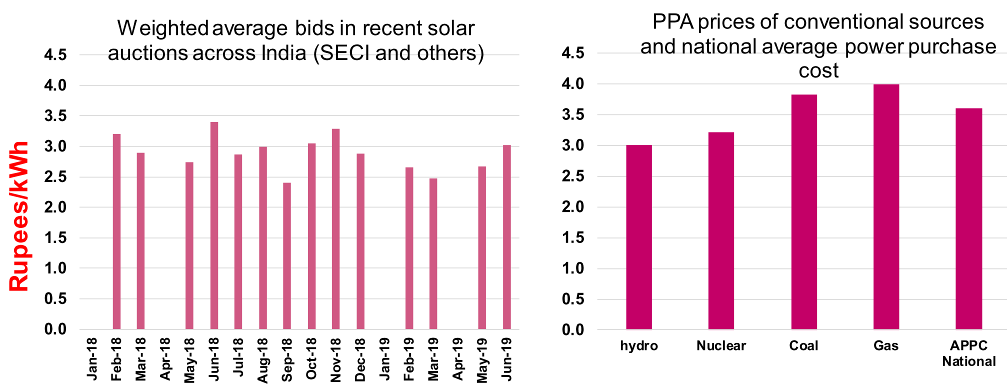
*2019 is Platts Analytics' forecast based on announced projects.

Source: S&P Global Platts Analytics, Global Solar PV Market Outlook (2019-2025), Aug. 2019

We believe achieving grid price parity has been one of biggest drivers of growth for Indian renewables. Renewables in India are now competing not just for "greenness" but also price. Competitive bid prices of around INR 2.5/kwh for both wind and solar is now cheaper than the cost of coal plant tariffs at around INR 4/kwh. So the states are happy adopting more renewables. India has had renewable purchase obligations (minimum percent of share of renewable power out of total electricity consumed) for states for some years, but most states fell short of these targets; financially weak states were not able or willing to pay more for cleaner electricity.

Chart 12

India: Bids in reported solar auctions still well below other conventional sources and national power purchase cost



Note: The APPC, or the Average Power Purchase Cost, is determined by the Central Electricity Regulatory Commission. The APPC is calculated to "ascertain the average cost of power from conventional sources of electricity. With a view to consider energy costs only, transmission charges have been excluded from these calculations."

Source: S&P Global Platts Analytics, Global Solar PV Market Outlook (2019-2025), Aug. 2019

The Indian government has discontinued FITs and subsidies for renewables since the industry can now compete on its own. India's renewable industry's good fortune is almost entirely driven by large domestic and international private sector investments, because of factors like:

- Falling capital expenditures and funding costs: A sharp fall in solar panel prices, rising efficiency of wind turbines, economies of scale for operations and maintenance, and lower cost of funding (down to about 9% of larger players from 12% earlier).
- Supportive policies like greater flexibility provided in new bids on choosing sites based on resource availability (rather than the off-taker's location), waiver of transmission charges for interstate renewable transmission, and stronger central counterparties making payments on time rather than the State Electric Utilities delaying payments. Renewables also enjoy grid priority.

Leadership Team:

Hans Wright

Managing Director,
Head of Analytical Innovation
Global Ratings Services
London

- B.Sc. Management Sciences, ACT
- Analytical & operational leadership with background in Financial Services and Lean

Bernard de Longevialle

Managing Director,
Global Head of Sustainable Finance
Global Ratings Services
Paris

- 26 years of experience in Financial Services across Western Europe, Emerging Markets and North America
- Former Head of Financial Services & Sovereign and Public Finance Ratings for the EMEA region
- Master in Political Science, Degree in Law

Michael Wilkins

Global Head of Analytics and Research for Sustainable Finance
Global Ratings Services
London

- MBA, qualification in carbon markets & analytics
- 24 years experience within infrastructure ratings

Kurt Forsgen

Managing Director,
Head of Analytics & Research
Corporates and Infrastructure
Boston

- MGA
- 25 years experience in the public finance ratings team

Ron Charbon

Managing Director,
Canadian Corporates
Corporates and Infrastructure
Toronto

- MBA
- A wealth of industrial corporate enterprise knowledge

Emmanuel Volland

Global FI Sector Lead -
Senior Director
Financial Institutions –
Analytics & Research
Paris

- More than 25 years of experience in Financial Services across Europe and Emerging Markets
- Former Analytical Manager for Financial Services - Middle East & Africa
- Masters in Finance - University of Paris La Sorbonne

Karl Nietvelt

Head of Analytical
Excellence & Research
Global Infrastructure Ratings
Paris

- Over 20 years of credit experience in Utilities, Infrastructure and Project finance as well as Oil & Gas/Metals & Mining
- Masters in Finance at ESSEC (Paris), combined with a Electro-Mechanical Engineering
- Degree from the University of Leuven (Belgium)

Patrice Cochelin

Analytical Manager
Sovereign & International
Public Finance Ratings
Paris

- 18+ years of experience in telecom, media, and technology
- Former Head of Telecommunications and Technology for the EMEA region
- Degree from the Ecole Supérieure de Commerce of Bordeaux business school

Senior Team:

Mike Ferguson

Director, Sustainable Finance
Global Ratings Services
New York

- Senior energy analyst with extensive knowledge of the U.S. power sector
- BA Political Science, BBA Finance, MS Accountancy, MBA

Florence Devevey

Director, Head of Steering for Sustainable Finance
Global Ratings Services
Paris

- 15 years of experience in S&P Global Corporate Ratings across various sectors in EMEA, including Media, Consumer Goods, Telecoms, and Leveraged Finance
- Master in Management from French business school HEC Paris, with a major in finance and accounting

Team Members:

Bruno Bastit

Associate Director, Sustainable Finance
Global Ratings Services
New York

- M.A. International Policy Economy

Beth Burks

Associate Director, Sustainable Finance
Global Ratings Services
London

- B.Sc. Mathematics

Corinne Bendersky

Associate Director, Sustainable Finance
Global Ratings Services
London

- Master of Public Policy, B.Sc. Environmental Studies

Noemie De La Gorce

Associate, Sustainable Finance
Global Ratings Services
London

- B.A. Economics

Tommy Englerth

Analyst, Sustainable Finance
Financial Services
New York

- B.A. International Business

Lizzy Moir

Analyst, Sustainable Finance
Global Ratings Services
London

- B.Sc. Mathematics

Anna Liubachyna

Analyst, Sustainable Finance
Global Ratings Services
London

- MSc Environmental Science, PhD in Forest Policy

Maurice Bryson

Research Assistant
Global Ratings Services
London

- B.Sc. Marine Biology
- M.Sc. Carbon Finance

Neesha-Ann Longdon

Research Assistant
Global Ratings Services
London

- B.A. Economics and Geography
- M.Sc. Environmental Economics and Climate Change