



Low-Carbon Infrastructure

Private Participation
in Infrastructure (PPI)

2002 TO H1 2017



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Acknowledgement & Disclaimer

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This report relies on data solely obtained from the Private Participation in Infrastructure Database. The database records investment commitments for infrastructure projects in low- and middle-income countries globally, at the time of financial closure. Infrastructure refers to energy, transport, and water and sanitation projects serving the public in low- and middle-income countries, including natural gas transmission and distribution, but excluding oil and gas extraction.

The PPI Database represents the best efforts of a research team to compile publicly available information, and should not be seen as a fully comprehensive resource. In most cases, the researchers are able to obtain information from public sources that are representative of the true nature of the projects, but in some cases, they may not be accurate or complete. In such cases, the database reports the project data which seems to be most accurate.

Index

Abstract	1
Executive Summary	2
1. Introduction	4
2. Low-Carbon Versus Conventional PPI	5
3. Energy Sector PPI: Renewable Versus Conventional Energy	7
3.1 Global Energy Trends and Comparison of Public and Private Contributions	10
3.2 Renewable Sources of Energy: Types, Project Shares, Capacity and Trends	11
3.3 Regional and Country-Level Energy PPI	15
4. Land Transport	17
4.1 Land-Transport PPI Investments by Region	19
4.2 Land-Transport PPI Investments by Capacity/ Network Length	20
5. Development Finance Institution Support to Low-Carbon and Conventional PPI	22
6. Government Support to Low-Carbon and Conventional PPI	24



Abstract

Climate change impacts are increasingly being recognized as urgent and critical threats to environmental and agricultural sustainability, food security, livelihoods, and human safety. Current levels of carbon emissions, which are bringing about climate change, are unsustainable and affect millions of lives adversely. One of the areas in which climate-related policy efforts are being concentrated is infrastructure development. Low-carbon infrastructure significantly reduces emissions while focusing on sustainable development in low- and middle-income countries, insulating them from negative climate impacts. This report documents and analyzes trends in low-carbon infrastructure investments¹ in low- and middle-income countries, particularly with respect to private-sector investments in infrastructure projects² as recorded by the Private Participation in Infrastructure (PPI)³ database. The report focuses particularly on “low-carbon” PPI in the energy and land-transport sectors, including railway investments that have the potential to take carbon-emitting trucks and other cargo carriers off the road; urban-transport projects (mass rapid transport) that have the potential to promote reduced usage of cars; and renewable-energy projects in the solar, wind and hydropower sectors. Conventional energy projects include energy projects that rely on non-renewable energy sources, and projects in infrastructure sectors that generally increase carbon emissions, such as roads that allow increased vehicular traffic. The data set is analyzed for the last 15 years, covering the period from 2002 to H1 2017 (first half of 2017).

1 “Investment” refers to investment commitments at the time of financial closure.

2 It is not limited to World Bank Group projects, but covers all infrastructure projects with private investment.

3 Private participation in infrastructure (PPI) as defined by the Private Participation in Infrastructure Database: http://ppi.worldbank.org/resources/ppi_methodology.aspx. “Investment” refers to private-investment commitments at the time of financial closure serving the public in low- and middle-income countries. The energy sector PPI information recorded does not include oil and gas.

Executive Summary

Low-Carbon PPI⁴

2010 was a turning point for low-carbon PPI, after which the number of new low-carbon projects has consistently exceeded the number of conventional PPI projects. In the 2010 – H1 2017 period, the total number of new low-carbon PPI projects (1,915) was double that of conventional PPI projects (815), whereas the number of new project investments in low-carbon and conventional projects was evenly distributed in the pre-2010 period (852 conventional projects versus 899 low-carbon projects). Conventional projects have generally been showing a downward trend since their peak in 2009.

Favorable government policies in the form of both direct and indirect government support have been instrumental in the surge in low-carbon projects. Government support to climate projects increased drastically from only three percent of all low-carbon projects receiving government support before 2010 to 51 percent of the projects receiving government support after 2010.

Low-carbon project investments exceeded conventional projects for the first time in 2012. Annual investment levels in low-carbon projects have been higher than in conventional projects, except in 2014 (and only marginally in H1 2017). In 2014, this was attributable to a number of coal and natural gas megaprojects in Turkey, Thailand and Morocco, whereas in H1 2017, Indonesia invested in two large coal-fired power plants and Jordan in an oil-shale-fired power plant.

More low-carbon projects received DFI support, but conventional projects received a higher amount of DFI loans. 401 projects (16 percent) of all low-carbon projects received DFI support, compared to 214 projects (14 percent) of conventional projects receiving DFI support. However, in terms of volume of support extended, the conventional smart projects received US\$52.9 billion, which was 11 percent higher than the US\$47.6 billion worth of support received by low-carbon projects.

Low-Carbon PPI in Energy (Renewables)

Share of renewables in terms of capacity and investment volumes is lower than the share of number of renewable energy projects. After 2010, about four-fifths (83 percent) of electricity generation projects were renewable energy projects, compared to only about half (52 percent) in the pre-2010 period. However, the renewable projects' share of capacity and investment volumes (63 and 65 percent) is much lower than 83 percent, because renewable energy projects tend to be smaller. The boost in renewables is driven by lower costs, as a result of technology improvements and competitive procurement.

Conventional energy projects remain larger, on average, than renewable energy projects, both in terms of generation capacity and investment. The average investment size of conventional energy projects over the past 10 years (US\$358 million) is 2.4 times that of renewable energy projects (US\$148 million). Conventional energy projects have had an average capacity of 513 MW over the same time period—about 2.5 times the average capacity of renewable energy projects.

⁴ Private Participation in Infrastructure (PPI) as defined by the Private Participation in Infrastructure Database http://ppi.worldbank.org/resources/ppi_methodology.aspx. "Investment" refers to private investment commitments at the time of financial closure serving the public in low- and middle-income countries. The energy sector PPI information recorded doesn't include oil and gas.

Although the number of solar energy projects is increasing, 88 percent of renewable energy capacity is attributable to hydropower projects. The average capacity per project for a solar energy project (16.9 MW) is substantially lower than average hydropower-project capacity (1.5 GW). Similarly, wind energy projects account for seven percent of renewable energy capacity, with an average capacity per project of 47.3 MW.

Renewable energy projects accounted for more than 50 percent of energy projects in more than 33 countries from 2002 to H1 2017, concentrated in South Asia and Latin America. Brazil, China, India, Turkey and Romania have the most renewable energy projects amongst all countries from 2012 to H1 2017.

Energy trends indicate the dominance of the private sector in renewables, while public entities are still supporting conventional sources globally (for all countries including high-, middle- and low income). In 2015, US\$325.0 billion worth of subsidies were spent on fossil fuels, compared to only US\$150.0 billion on renewables.

Low-Carbon PPI in Transport

Unlike in the energy sector, conventional projects (i.e., road projects) still dominate in the transport sector, although there has been a significant increase in the share of urban transport projects post-2010, and a slight decline in road projects. The share of PPI transport investments accounted for by road projects fell from 78 percent during the period from 2002 to 2009 to 72 percent in the period from 2010 to H1 2017. Urban transport's share of transport PPI investment was only five percent from 2002 to 2009, but almost tripled to 14 percent from 2010 to H1 2017.

The capacity of low-carbon transport projects increased 14-fold after 2010, from 22,592 km to 312,665 km. Low-carbon or climate-friendly transport projects grew from 37 percent of additional transport network capacity pre-2010 to 85 percent of total added capacity after 2010, driven mainly by increased railway network length.

South Asia is the only region where low-carbon projects accounted for a low share of additions to transport network capacity, standing at two percent in the 2002 to H1 2017 period. For other regions, they were in the 40- to 100-percent range.

Share of road projects receiving capital subsidy more than doubled in the post-2010 period. Thirty-one percent of road projects (90 projects) were given a capital subsidy in the pre-2010 period, compared to 71 percent (180 projects) without subsidies.

1. Introduction

Climate change is the change in global climate patterns evident from the mid to late twentieth century, attributed largely to the unprecedented levels of carbon dioxide produced by the burning of fossil fuels such as coal, diesel and natural gas. Climate change poses a critical threat to environmental and agricultural sustainability, food security, livelihoods, and human safety. Extreme weather events, record-high global temperatures, and melting Arctic ice are a few of the potentially irreversible effects of climate change. These conditions are expected to significantly reduce crop yields, extend and intensify heat waves and monsoon periods, lead to erratic rainfall patterns, and irreparably damage eco-systems.

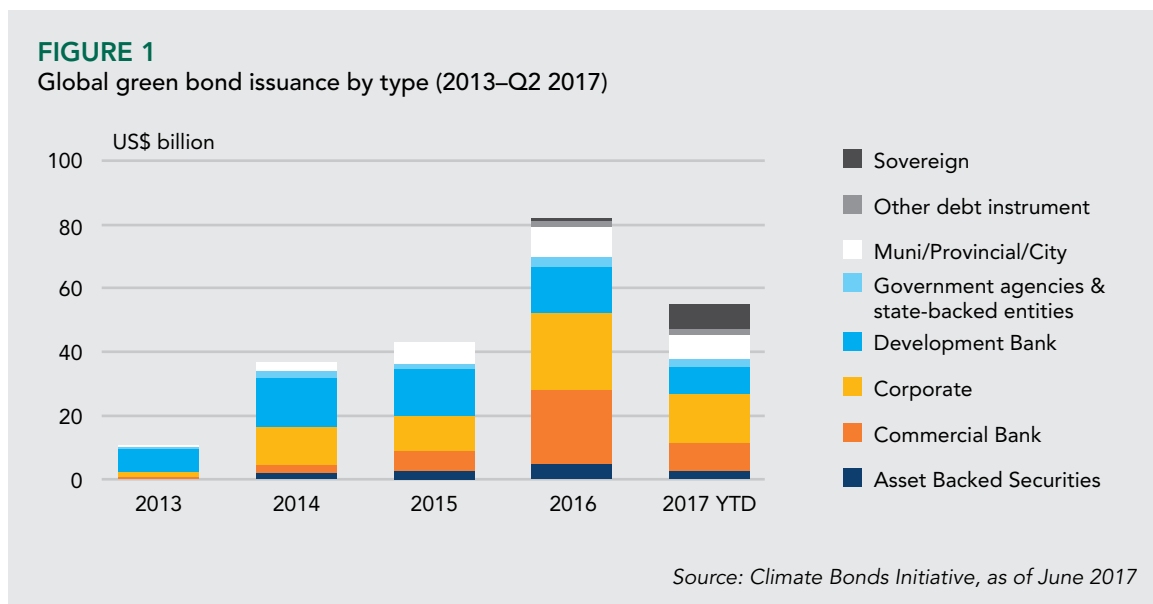
Infrastructure investment and use have a significant impact on global greenhouse gas (including carbon) emissions, and ultimately on climate change. Approximately 70 percent of global greenhouse-gas emissions emanate from infrastructure construction and operations such as power plants, buildings and transportation systems. Significantly, two-thirds of this can be attributed to the energy sector. The current business-as-usual scenario (BAU) would have considerable negative impact by 2050. Based on the current rate of emissions from key infrastructure industries, more than 720 million people would be pushed into extreme poverty, with projected deaths per year rising from 150,000 to 250,000 per year (WHO). The vast majority of such casualties are expected to be in emerging-market and developing economies, which are densely populated and act as global growth engines, attracting massive infrastructure investment and spending. Thus, a shift in the allocation of resources from carbon-intensive infrastructure to low-carbon infrastructure is needed. Low-carbon infrastructure helps build resilience in vulnerable countries and protects against exposure to extreme climate change events. Most importantly, low-carbon infrastructure is also crucial for preventing a reversal of development gains made so far, particularly in emerging markets and developing economies that houses communities with a disproportionate exposure to climate change impacts.

Governments and multilateral organizations are rapidly intensifying efforts to promote low-carbon and resilient infrastructure that will help reduce the carbon and climate impacts of current industrial, agricultural, urban and infrastructure systems. Some of the initiatives undertaken during the 21st and 23rd sessions of the UN Conference of the Parties to the UN Convention on Climate Change (COP 21 and COP 23), including the 2015 Paris Agreement, are evidence of member states' commitments to reduce carbon footprints and address an array of climate change issues.

COP 23 in 2017 saw positive outcomes in the way of concrete initiatives to reduce carbon emissions, including several initiatives with direct implications for infrastructure development. The United Kingdom and Canada, along with 25 other countries, signed the "Powering Past Coal" alliance, looking to phase out coal plants and restrict future coal plants that do not have carbon capture and storage (CCS) technology. The event also drove consensus that regular stock-taking of action on the ground in 2018 and 2019 would be essential to measure progress toward achieving the Paris Agreement objectives. It also turned attention to financing options for sustainable development.

Climate finance is integral to carbon reduction and the adoption of environmentally friendly technology. Fiji led the way in COP 23, issuing US\$50 million worth of green bonds to finance clean energy

projects. Green bonds are one key source of climate finance aimed at funding climate-friendly projects.⁵ Whereas such bonds gained traction in 2014 and 2015, COP 21 in 2015 gave the climate-finance initiative real impetus, and the value of the issuances almost doubled between 2015 and 2016 (Figure 1). The first half of 2017 has already seen more than US\$50.0 billion in issuances and is slated to meet its target of US\$100.0 billion in 2017.



2. Low-Carbon Versus Conventional PPI

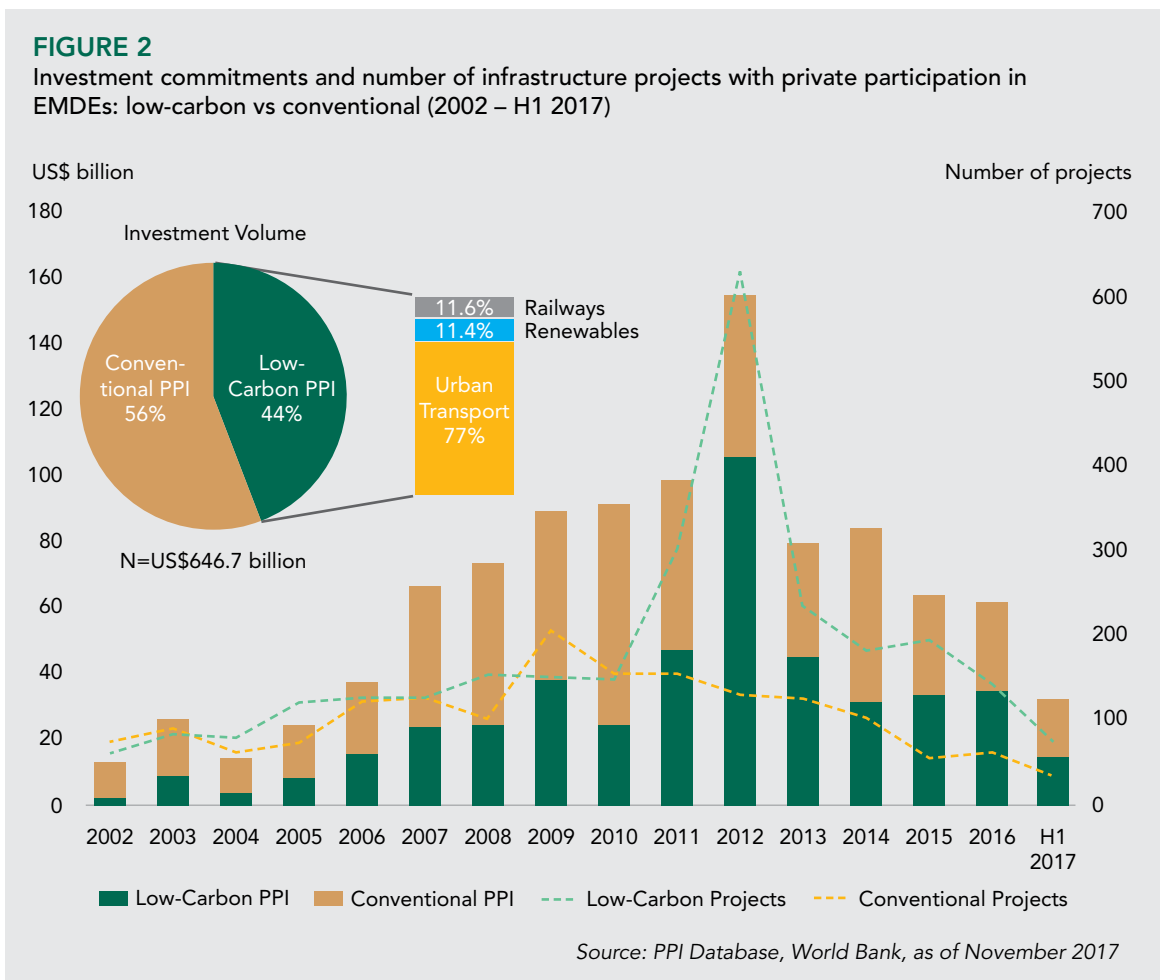
Given the significant impact low-carbon infrastructure can have on mitigating the adverse effects of climate change arising from increased carbon emissions, this report aims to capture and analyze trends in low-carbon PPI investment. Low-carbon investments include investments in development projects that reduce carbon emissions; minimize or eliminate use of conventional energy sources, or replace conventional technology with clean technology. Conventional energy investments are associated with projects that generally increase carbon emissions and contribute negatively to climate change.

In this report, low-carbon PPI includes private investments in two low-carbon infrastructure areas—renewable energy and climate-friendly transport projects. Renewable energy comprises energy generated from renewable sources such as sunlight, water, wind, and geothermal heat, which are naturally replenished on a human timescale. Renewable energy projects include solar energy and hydropower projects. Climate-friendly transport projects include railways and urban transport projects that have the potential to take carbon-emitting trucks and other cargo carriers off the road and promote the reduced usage of cars.

⁵ http://treasury.worldbank.org/cmd/pdf/What_are_Green_Bonds.pdf

Conventional PPI comprises investments in conventional energy sources, mainly coal, natural gas, and diesel, as well as investments in road projects that contribute to climate change through increased carbon-dioxide emissions from vehicular traffic.

Low-carbon PPI project investment levels surpassed conventional energy project investments for the first time in 2012 (Figure 2), and have remained higher since, except in 2014 (also, they were only slightly higher in the first half of 2017). The exceptions were attributable to some large conventional power projects that were logged during those periods—in 2014, several coal and natural gas megaprojects (investments of US\$1 million or greater) were undertaken in Turkey, Thailand and Morocco, accounting for 35 percent of overall energy investment, and in H1 2017, Indonesia invested in two large coal-fired power plants, and Jordan invested in an oil-shale-fired power plant. Excluding these outlier megaprojects, the trend towards greater investments in low-carbon projects holds.



Between 2002 and H1 2017, conventional projects received 56 percent of total investments; low-carbon projects received 44 percent. Urban transport accounted for 34 percent of the total PPI investment, or 77 percent of low-carbon investment, while railways and renewables accounted for five per-

cent of the total investments or 11 percent of the low-carbon investment, respectively. Typically, urban transport projects are large-scale projects that require high investments, compared to renewable energy projects. However, after 2012 (the year when investments in low-carbon projects outgrew investments in conventional projects), the share of urban transport has represented 17 percent of total low-carbon PPI, as renewable energy projects have garnered a lot of PPI investments. This has led to a decrease in the share of PPI investments in urban transport on a percentage basis, though PPI investments on an absolute basis have increased.

The number of low-carbon projects exceeded the number of conventional projects between 2004 and 2006, and again from 2010 to H1 2017. In the 2010 to H1 2017 period, the number of new low-carbon PPI projects (1,915) was double that of conventional PPI projects (815), whereas the number of new project investments in low-carbon and conventional projects was evenly distributed in the pre-2010 period (852 conventional projects versus 899 low-carbon projects). 2012 was an exceptional year, when the number of low-carbon projects jumped two-fold from 2011 levels and four-fold from 2010 levels. Aside from the 2012 spike, the number of low-carbon projects has generally increased since 2002, excepting marginal declines in 2009, 2014 and 2016. Conventional projects have generally been showing a downward trend since their peak in 2009.

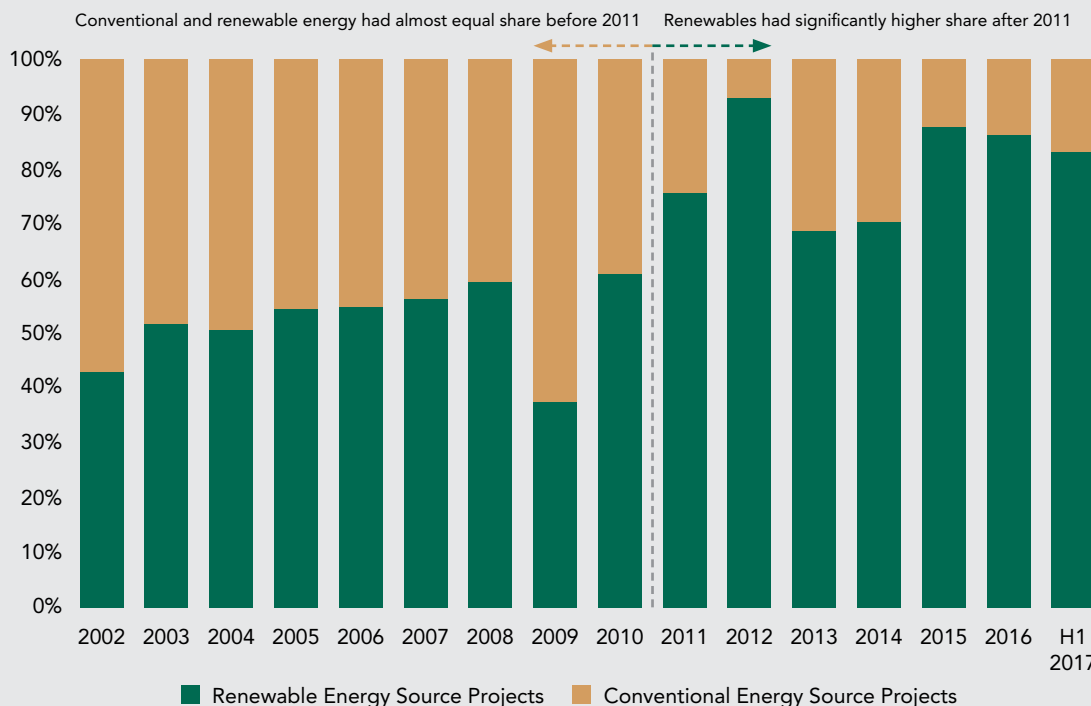
3. Energy Sector PPI: Renewable Versus Conventional Energy

Energy projects are broken down into two categories—renewable energy sources (low-carbon sources) and conventional energy sources. Renewable energy generates energy from clean sources such as hydro, sunlight, waves, wind and tides. Generating energy from these sources minimizes the negative environmental impact. On the other hand, conventional energy sources generate energy from fossil fuels. Extracting as well as generating energy from these sources leads to higher CO₂ emissions and negative environmental impact. More importantly, the supply of conventional energy sources is finite, whereas renewable sources are infinite.

With respect to energy projects in the last 15 years, we notice a clear trend before and after 2011. At their lowest level, renewable energy projects accounted for 35 percent of total projects (2009) and peaked to 95 percent of total projects in 2012. Prior to 2011, we see that renewables' share of projects is less than or almost equal to conventional energy projects (hovering around 35 to 55 percent). This jump substantially after 2011, whereby the proportion of renewable energy projects goes up to over two-thirds of all energy projects (ranging from 72 to 95 percent). Much of this can be attributed to rising fossil-fuel prices, newer renewable energy technology advancements coupled with lower risk, and greater acceptance and awareness of climate change impacts, which made investors look at renewable energy sources as a long-term feasible alternative.

FIGURE 3

Distribution of number of renewable and conventional energy projects with private participation in EMDEs (2002 – H1 2017)



Source: PPI Database, World Bank, as of November 2017

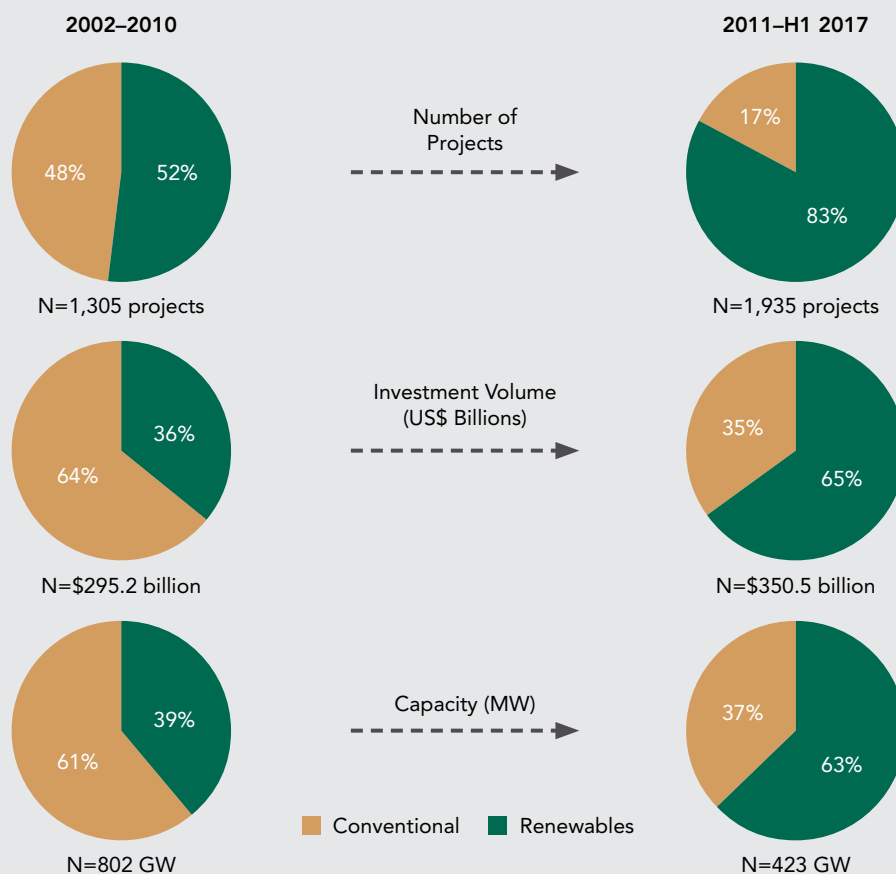
Breaking down renewable and conventional energy by the number of projects, investment volumes and capacity over two periods shows a clear trend towards environmentally friendly sources of energy (Figure 4). However, the share of renewables by capacity and investment volumes (63 and 65 percent) is much lower than the share by number of projects (83 percent), as renewable energy projects tend to be smaller.

From 2002 to 2010, PPI investment in conventional energy projects was US\$189.9 billion (64 percent of total energy investment), compared to US\$105.2 billion for renewable projects (36 percent of total energy investment). From 2010 to H1 2017, PPI investments in renewable energy projects more than doubled, to US\$224.8 billion (65 percent of total energy investment). Conventional energy projects, on the other hand, saw downsized PPI investments, to the tune of US\$125.7 billion (35 percent).

Although there are more renewable energy than conventional energy projects, the average project size and capacity is substantially lower for renewable energy projects. Conventional energy projects typically require a higher investment, a longer gestation period, and generate more capacity relative to renewable energy projects, which are faster to initiate and implement. Aside from hydropower projects, renewable energy projects have greater scalability in terms of capacity, and require lower initial investments.

FIGURE 4

Share of renewable versus conventional energy with private participation in EMDEs (2002 – H1 2017)

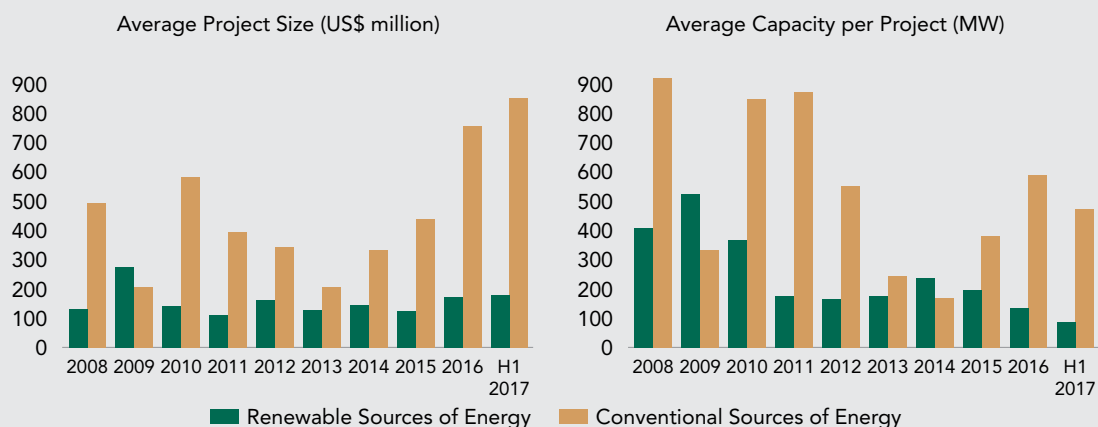


Source: PPI Database, World Bank, as of November 2017

From 2008 to H1 2017, the average investment size of conventional energy projects (US\$358 million) is 2.4 times that of renewable energy projects (US\$148 million). By capacity, conventional energy projects have had an average capacity of 513 MW over the same time period—about 2.5 times the average capacity of renewable energy projects (210 MW). Aside from the year 2009, over the last decade, conventional energy projects dominated the energy industry in terms of average capacity and average project sizes, even though renewable projects are more prolific. Excluding outliers (megaprojects with investment values of more than US\$1.0 billion), the average investment size of conventional energy projects fell by almost 20 percent, to US\$289 million, and that of renewable energy projects fell by 19 percent, to US\$120 million, still indicating that the average investment size of conventional energy is 2.4 times that of renewable energy projects. Similarly, by capacity, if we exclude outliers, the average capacity for renewable energy projects fell from 210 MW to 130 MW; for conventional energy projects, it fell from 513 MW to 350 MW, which is 2.7 times the average capacity for renewable energy projects.

FIGURE 5

Renewable- and conventional energy projects with private participation in EMDEs, by project size and project capacity



Source: PPI Database, World Bank, as of November 2017

From 2013 to H1 2017, the average project size of renewable energy remained consistent, whereas the average project size of conventional energy projects jumped from US\$203 million to US\$845 million. The average capacity for renewable projects was almost halved, from 170 MW to 80 MW, as solar energy projects that generally have lower capacities dominated the renewable space during this period; meanwhile, the average capacity for conventional energy projects almost doubled, from 240 MW to 460 MW.

3.1 GLOBAL ENERGY TRENDS AND COMPARISON OF PUBLIC AND PRIVATE CONTRIBUTIONS⁶

Figure 6 depicts the global⁷ trends in power-sector investment, along with how the total energy investment (including oil and gas) was financed in 2016. The upward trend in total global investment (public and private) in renewable energy is consistent with the upward trend in PPI investments in renewable energy sources in low and middle-income countries. A similar declining trend is observed for conventional energy investments, particularly after 2010, with renewables far exceeding conventional energy investments both globally and for PPI.

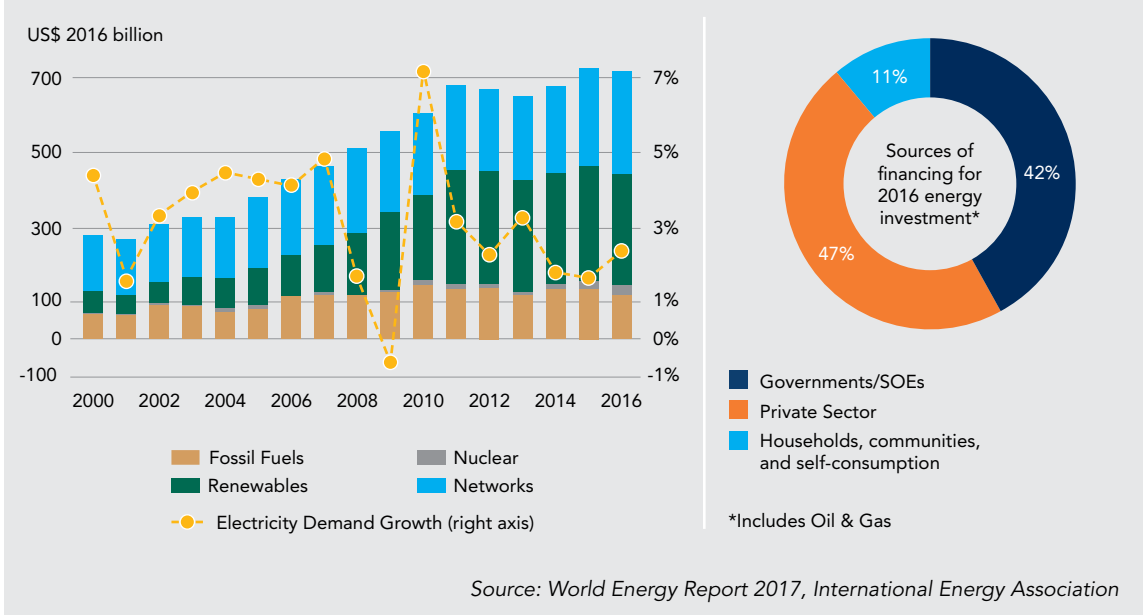
In the period of 2002 to 2010, global investments in renewables stood at approximately US\$920.0 billion. Such investment then doubled to US\$1.85 trillion during the period of 2011 to 2016. This is in tune with the increase in the renewable energy PPI investments in low and middle-income countries, which more than doubled from US\$105.2 billion in the period of 2002 to 2010, to US\$224.8 billion in the period of 2011 to H1 2017, indicating higher private participation in this space.

⁶ The source for non-PPI related information for this section is the World Energy Report 2017 by International Energy Association and [Global Landscape of Renewable Energy Finance](#) by IRENA.

⁷ In this section, global refers to trends observed across all countries, whether high-, middle- or low-income.

FIGURE 6

Global power sector investment and sources of financing for 2016 energy investments



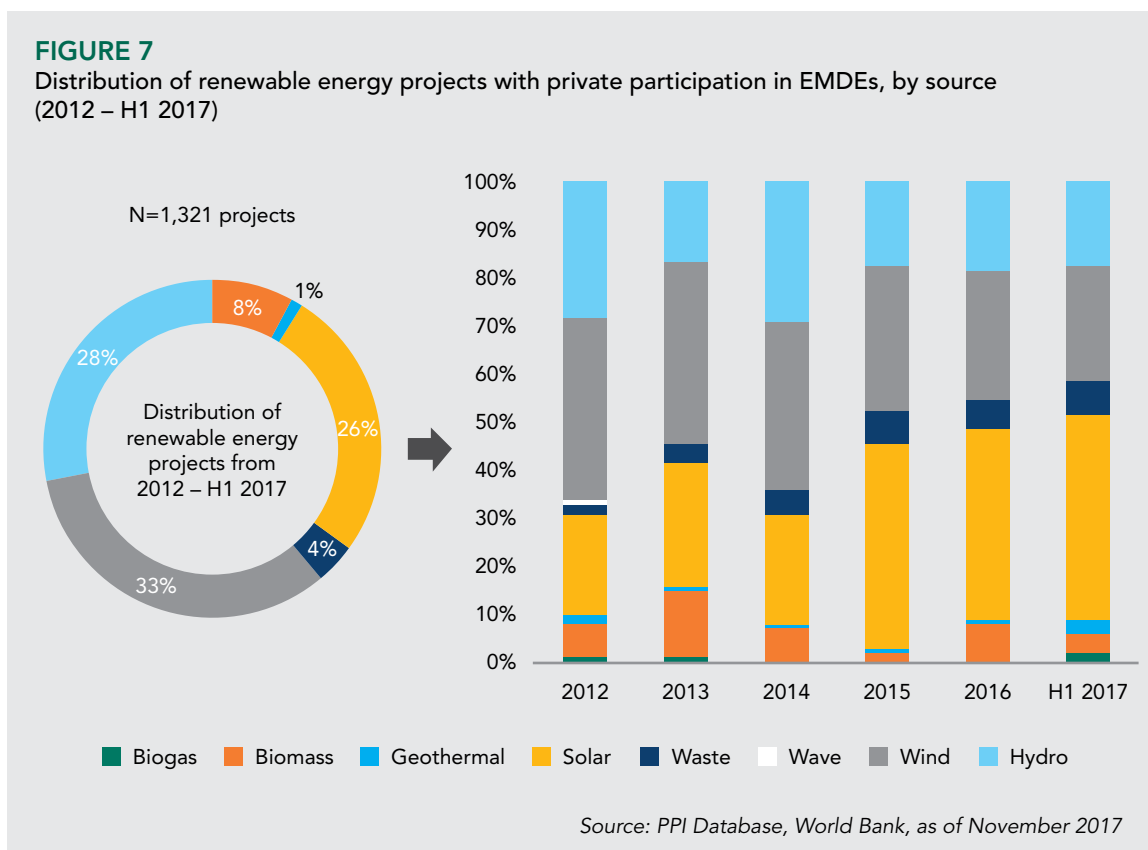
When it comes to total energy investments (including oil and gas) globally, the private sector contributed to most of the investment (47 percent), followed closely by the public sector and state-owned enterprises (42 percent). However, when it comes to renewable investments globally, private sources provided the bulk of investment (more than 90 percent) in 2016. The public sector plays a more active role in network investment and in upstream oil and gas spending, accounting for 70 percent and 44 percent (respectively) of spending in these areas in 2016. Also, in the case of subsidies, governments seem to continue favoring fossil-fuel consumption, with US\$325.0 billion worth of subsidies provided to fossil fuels, relative to only US\$150.0 billion to renewables in 2015.

3.2 RENEWABLE SOURCES OF ENERGY: TYPES, PROJECT SHARES, CAPACITY AND TRENDS

Figure 7 illustrates the total number and proportion of renewable energy projects undertaken by type (hydro, wind, solar, etc.) from 2012 to H1 2017. During this period, the largest contributors to renewable energy projects were wind and hydropower projects, accounting for 33 percent and 28 percent of all renewable energy projects, respectively. However, the shares of wind energy and hydropower projects are declining, while the share of solar energy projects is steadily increasing, having doubled from 21 percent in 2012 to 43 percent in H1 2017.

On average, due to economies of scale, global prices of photovoltaic modules fell by almost 80 percent since 2009, making solar energy projects a popular choice amongst investors. Also, contributing to a small extent is the fact that developing countries are slowly pairing battery storage with residential or commercial rooftop solar photovoltaic (PV), to avoid peak-demand charges by levelling load, and to manage power erraticism during nights or on cloudy days. Although batteries today are mostly used

for frequency control or other network-support services, and rarely for managing variability of PV and wind (because it is currently cheaper to do so with gas, etc.), by 2030, the installed costs of battery electricity storage systems are slated to fall by 50 to 60 percent. This would provide a further boost to renewables in the years to come.



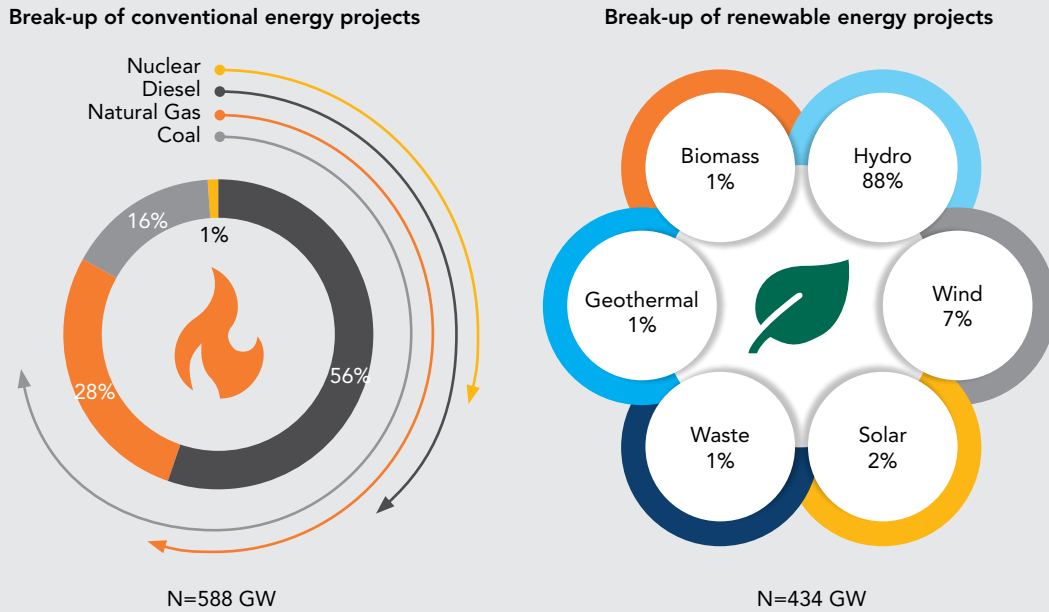
China has been a major player in the solar energy space—China accounted for 107 of the 368 (30 percent) of the solar energy projects undertaken from 2012 to H1 2017. However, although the number of solar energy projects seems large, the capacity of most of these projects is significantly lower relative to hydropower and wind energy projects.

3.2.1 Renewable Versus Conventional Energy Project Capacity

From 2002 to H1 2017, the total capacity for both renewable and conventional energy sources was split almost equally, with renewables accounting for 42 percent of the total capacity, and conventional energy sources accounting for the remaining 58 percent. Of the 42 percent of total capacity for which renewable energy projects account, 88 percent is captured by hydropower projects (Figure 8). The cumulative capacity for all hydropower projects stood at 385 GW, out of the total renewable energy capacity of 435 GW. This capacity exceeded the capacity of coal projects (327 GW) by 33 percent.

FIGURE 8

Conventional and renewable energy capacity (MW) by source, for projects with private participation in EMDEs (2002 – H1 2017)



Source: PPI Database, World Bank, as of November 2017

Wind energy projects captured 30 GW (seven percent) of total renewable energy capacity, with solar energy projects coming in a distant third, with 7.5 GW (two percent). Geothermal capacity gained traction, with higher capacity per project—it accounts for 5.7 GW (slightly more than one percent) of total renewables capacity.

Hydropower projects have an average capacity of 1.5 GW; wind energy projects have an average capacity of 47.3MW; and solar energy projects which have an average capacity of only 16.9MW.

Coal projects account for 327 GW (56 percent) of the conventional energy capacity added in the previous 15 years. Natural gas project capacity additions stood at 28 percent (167 GW) and diesel project capacity addition stood at 16 percent (93 GW).

3.2.2 Renewable versus Conventional Energy Price Trends⁸

The main drivers behind the strong emergence of renewable power has been cost reduction. Based on figure 9 below, which depicts the global weighted average levelized cost of energy (LCOE) for renewables compared to fossil fuels, it is evident that electricity from renewable sources is not more expensive than fossil fuels anymore. From 2010 to 2017, almost all renewable energy technology types (barring

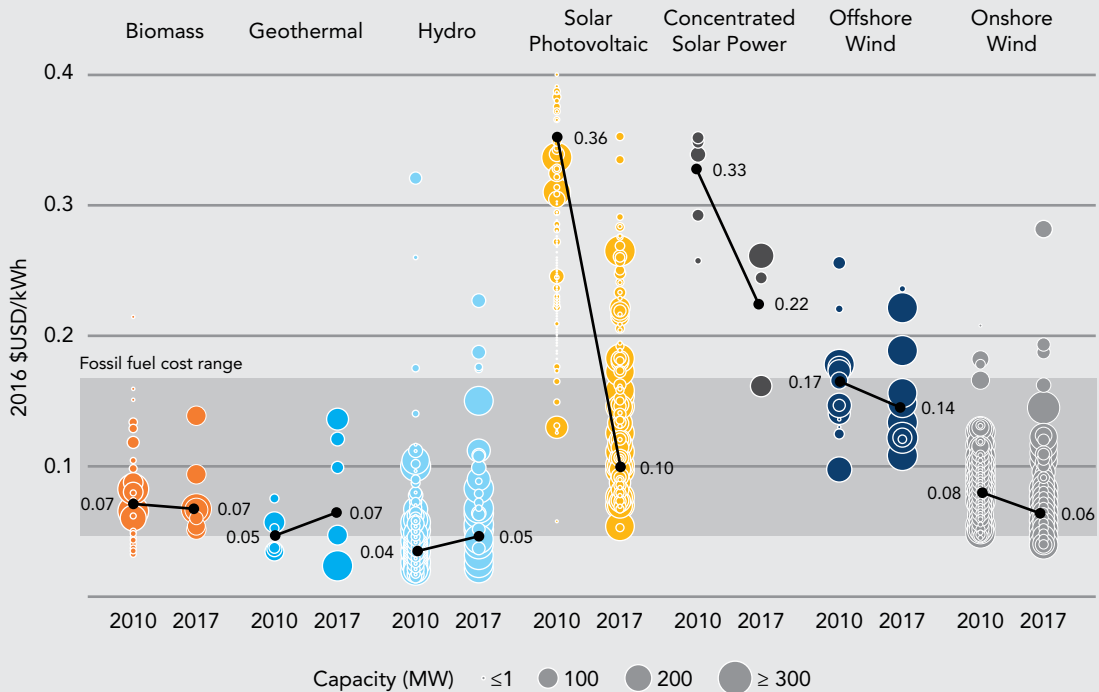
⁸ This section refers to global trends and not just PPI trends in EMDEs. The source of information and data for this section is the International Renewable Energy Agency (IRENA), specifically the “[Renewable Power Generation Costs in 2017](#)” and “[Electricity storage and renewables: Costs and markets to 2030](#)” reports.

concentrated solar power, or CSP) fall within the fossil-fuel cost range, and some are even lower. All geothermal and biogas projects undertaken are cheaper than average fossil-fuel costs; the bulk of on-shore wind, hydropower and solar PV projects are within the fossil-fuel cost range. With the further consolidation of costs in the renewables industry, it is expected that by 2020, electricity from renewables will be consistently within the fossil-fuel cost range and may even undercut fossil fuels.

Although the average LCOE of all renewable energy sources dropped in 2017 compared to the 2010 levels, the LCOE for hydropower went up marginally, from four to five cents/kWh, and that for geothermal went up from five to seven cents/kWh. During this period, the most remarkable drop was for solar PV, from 36 to 10 cents/kWh, as the prices of solar PV modules fell by more than 80 percent. The LCOE for wind projects also dropped by 23 percent, largely driven by a 40- to 60-percent fall in wind-turbine prices.

FIGURE 9

Global levelized cost of electricity (LCOE) from renewable power technologies compared to fossil fuels (2010 – 2017)



Note: The diameter of the circle represents the size of the project and its center is the value for the cost of each project on the Y axis. The thick lines are the global weighted average LCOE values for plants commissioned each year. The grey band represents the fossil-fuel power-generation cost range.

Source: IRENA Renewable Costs Database

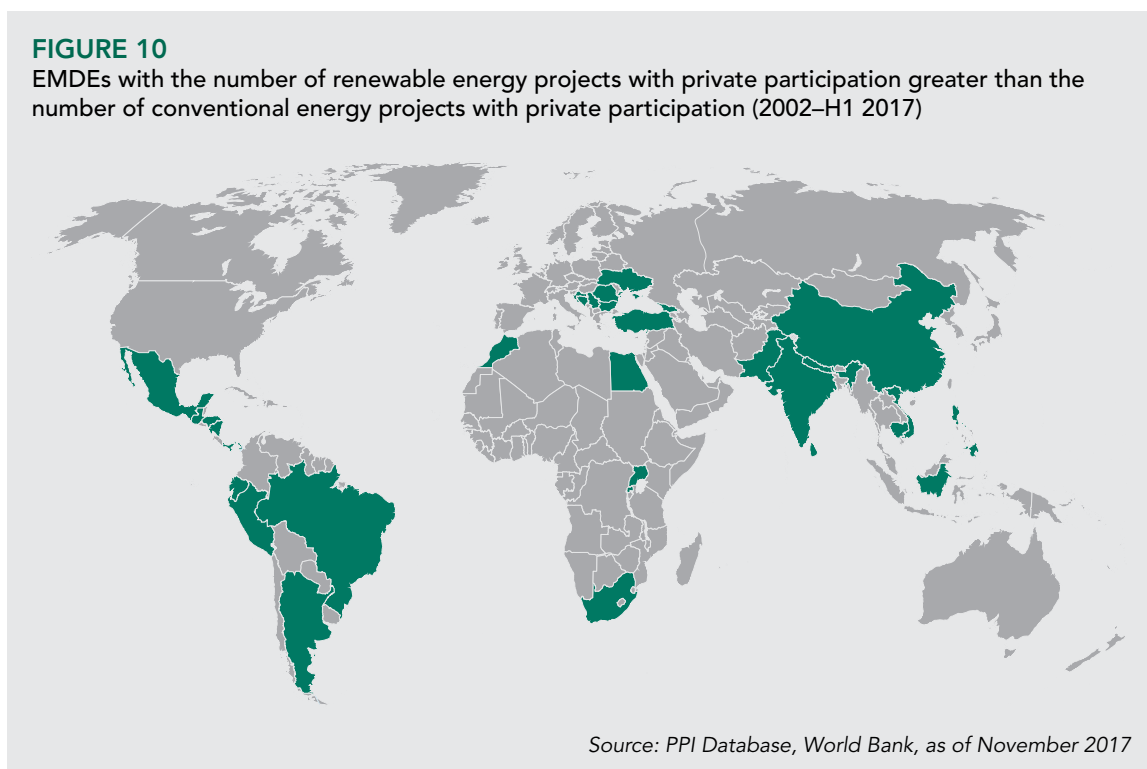
Hydropower has historically produced the lowest-cost electricity of any generation technology. However, from 2010 to 2017, the average LCOE for hydropower projects increased by about 25 percent. This was primarily due to more complex projects requiring higher civil-engineering and development costs.

Peru, India, China, Mexico and Chile are amongst the countries generating electricity from renewable energy sources at the lowest rates in the world.

3.3 REGIONAL AND COUNTRY-LEVEL ENERGY PPI

FIGURE 10

EMDEs with the number of renewable energy projects with private participation greater than the number of conventional energy projects with private participation (2002–H1 2017)



Source: PPI Database, World Bank, as of November 2017

In 33 countries, the share of renewable energy projects is higher than that of conventional energy projects (Figure 10). These countries may be further classified according to the extent to which renewable energy projects dominate:

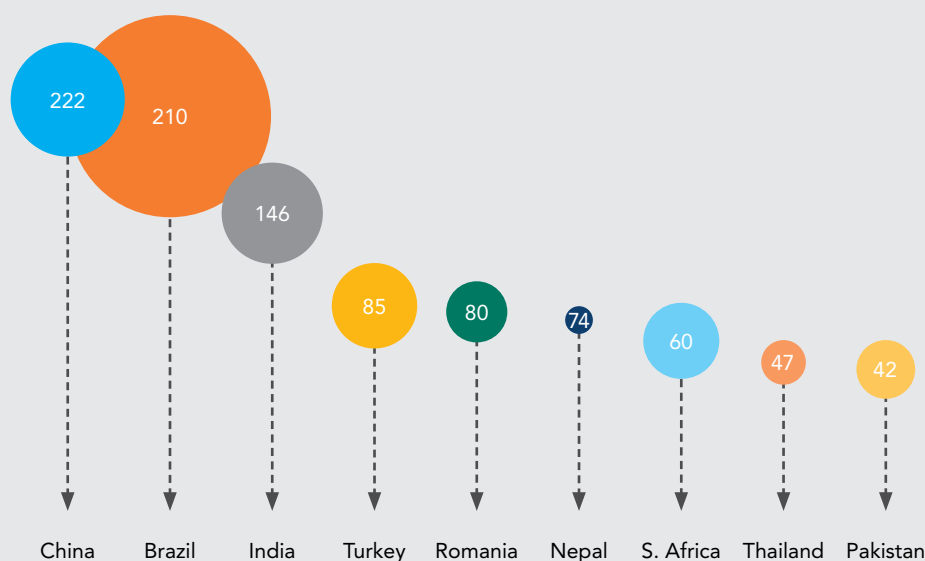
- 90 to 100 percent (7 countries): China, Laos, Nepal, Romania, Serbia, South Africa and Sri Lanka;
- 70 to 90 percent (15 countries): Armenia, Bosnia and Herzegovina, Brazil, Bulgaria, Ecuador, Egypt, Guatemala, Honduras, India, Jordan, Panama, Turkey, Uganda, Ukraine and Vietnam; and
- 50 to 70 percent (11 countries): Argentina, Cambodia, Indonesia, Mexico, Morocco, Nicaragua, Pakistan, Peru, the Philippines, Rwanda and Thailand.

In a few countries—such as Serbia, South Africa, Laos and China—almost all new energy projects being developed are renewable projects.

From 2012 to H1 2017, China and Brazil were comparable in terms of the number of renewable projects (Figure 11). India was third, with 146 renewable projects. Aside from Russia, all remaining BRIC countries lead the league table in terms of renewable energy projects. This makes sense, because each of these countries has a large landmass and a growing population with a constant need for energy. Amongst other notable countries, Turkey and Romania lead with 85 and 80 projects, respectively.

FIGURE 11

EMDEs with the highest number of renewable energy projects with private participation



Bubble size represents the size of investment and the numbers on the bubble denote number of renewable energy

Source: PPI Database, World Bank, as of November 2017

Brazil received the most investments for its 210 projects (US\$49.1 billion from 2012 to H1 2017). Consequently, its average investment per project was also the highest (US\$233 million).

China had the highest number of renewable energy projects (222), but the average project size (US\$68 million) was smaller than that of most of the top countries. This was primarily due to the focus on building smaller wind and solar energy plants in populated areas instead of large-scale plants.

Pakistan has the fewest projects; however, it had the third-highest average investment size (US\$178 million). This can be explained by a couple of very large (including the world's largest) solar power parks constructed as part of the China-Pakistan Economic Corridor in 2015.

Similarly, 60 projects were recorded in South Africa, but the average project size was quite high (US\$197 million). This can be attributed to five CSP projects that received investments of between US\$0.5 billion and US\$0.9 billion. Also, more than half of the projects (32) were recorded in 2012 as a result of the launch of the tendering process under South Africa's Renewable-Energy Independent Power Producer Procurement Program (REIPPPP) in 2011.

TABLE 1: ENERGY PPI INVESTMENTS AND AVERAGE PROJECT INVESTMENT SIZE

Country	Total PPI Investments (US\$ billions) 2012 – 2017	Average Project Size (US\$ millions)
Brazil	\$49.1	\$233
China	\$15.3	\$68
South Africa	\$11.8	\$197
India	\$10.0	\$69
Pakistan	\$7.5	\$178
Turkey	\$7.2	\$85
Romania	\$5.5	\$69
Thailand	\$2.9	\$61
Nepal	\$1.4	\$19

4. Land Transport

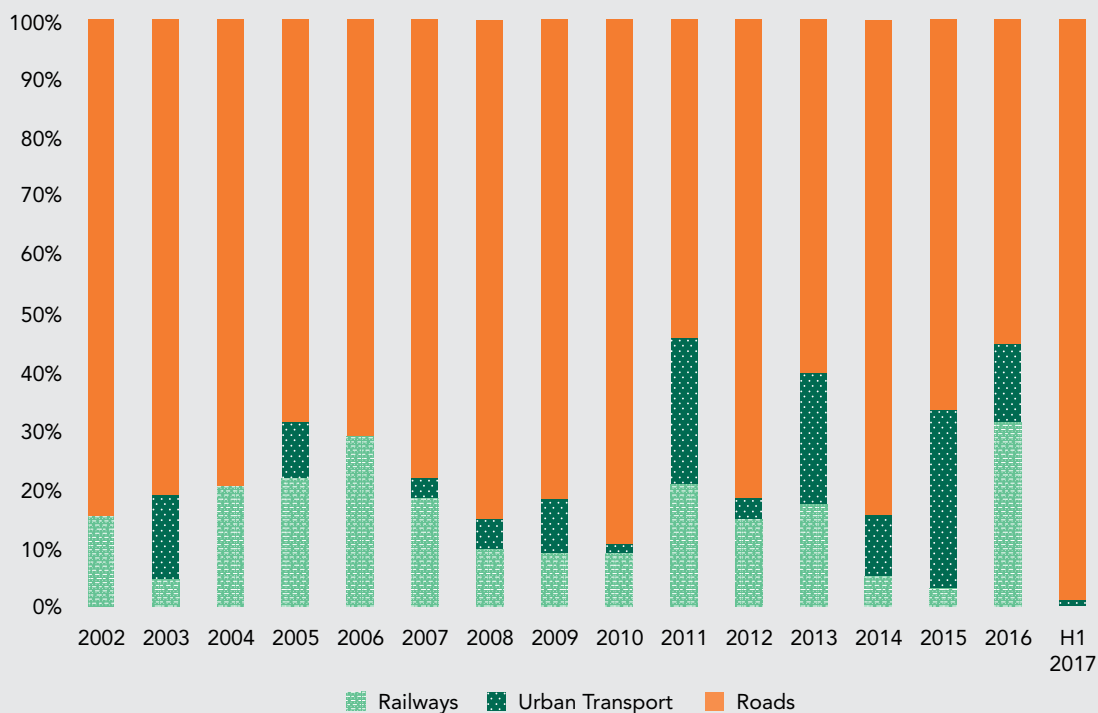
Land transport comprises three key structures—roads, railways and urban transport. Urban transport essentially includes light rail and local passenger-transport segments that cover shorter distances than what is typical of heavy rail. These include mass rapid transport (MRT) and light rail transit (LRT). LRTs act as a feeder service to MRT and traditional rail services, mostly connecting suburban areas to the main city and vice versa. The transport sector is important for our study, because it is responsible for 60 percent of global oil consumption, 27 percent of all energy use, and 23 percent of world CO₂ emissions (World Bank).

Low-carbon transport projects comprise heavy rail, MRT and LRT projects, because they take carbon-emitting trucks and other cargo carriers off the road and have the potential to promote reduced usage of cars. Also, for these modes of transport, the carbon emissions per unit distance traveled relative to the sheer volume of cargo carried and the number of passengers transported is significantly lower than that of road projects. Roads are not considered to be as climate-friendly as railways and urban transport, because each vehicle on the roads contributes to increased CO₂ emissions. Furthermore, direct and upstream emissions associated with raw materials (tar, asphalt and fly ash) used in the construction and maintenance of roads also contribute to higher CO₂ emissions.

Low-carbon projects have gained significant ground relative to road projects since 2011, although road projects still receive a majority of PPI investment funding (Figure 12). In 2011, low-carbon projects received 46 percent of land transport PPI investments, with railways contributing 21 percent and urban transport contributing 25 percent, respectively. Also, after 2010, urban-transport PPI investments increased significantly and have been garnering a double-digit share of total land-transport investments (except in 2012). Conversely, the share of road investments has been slightly lower after 2010, reaching an all-time low of 55 percent in 2016. PPI investments in railways also gained traction, except in 2014 and 2015, when projects captured five and three percent of PPI investments.

FIGURE 12

Share of railways, roads and urban transport projects with private participation in EMDEs, by investment volume (2002 – H1 2017)



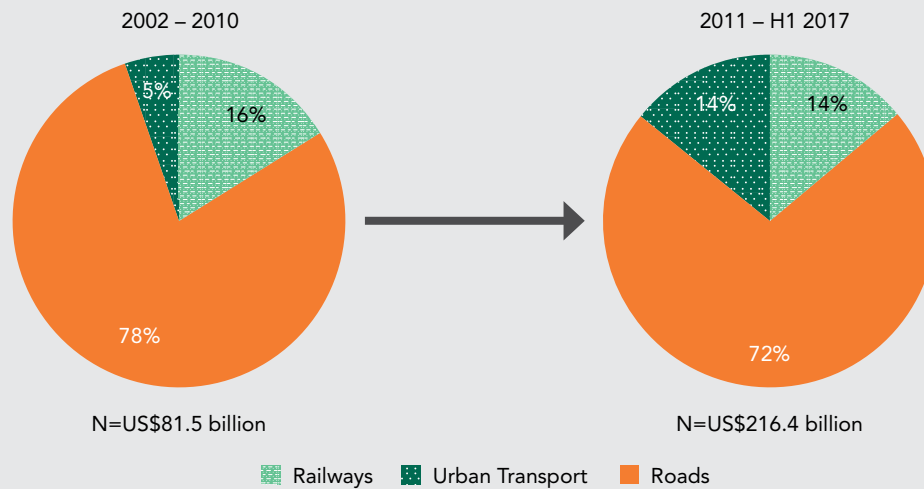
Source: PPI Database, World Bank, as of November 2017

Breaking down the PPI investments into two periods makes the trend more discernible (Figure 13). Road projects' share of PPI investments fell from 78 percent (in the period of 2002 to 2010) to 72 percent (in the period of 2011 to H1 2017). Urban transport's share of PPI investments almost tripled, from five to 14 percent, between those two periods, indicating a shift in developing countries to undertake more MRT/LRT projects. Railway projects saw a slight decline of two percent between the two periods.

Low-carbon projects form a small proportion (20 percent) of the total land-transport projects. The share of the number of low-carbon projects peaked at 33 percent in 2004; since then, the share has been declining in most years, reaching an all-time low of 11 percent in 2010. From 2013 to 2015, there was a revival, with 20 to 25 percent of projects falling into the low-carbon category.

FIGURE 13

Change in the share of railways, roads and urban transport investment volumes with private participation in EMDEs (2002 – H1 2017)



Source: PPI Database, World Bank, as of November 2017

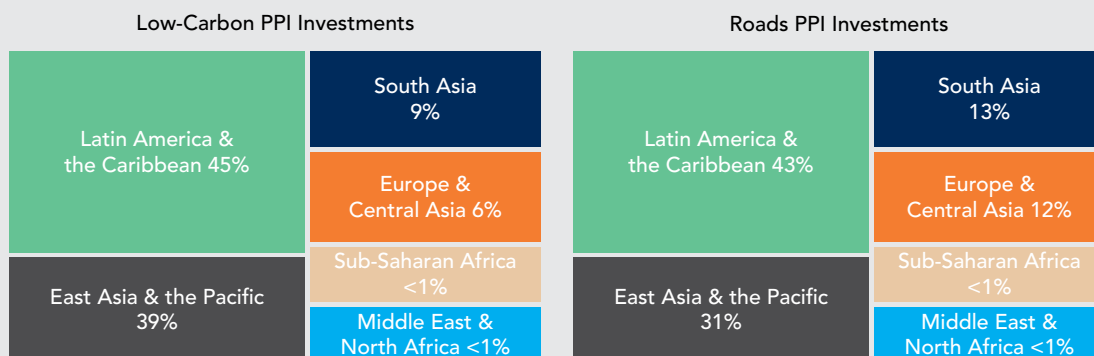
4.1 LAND-TRANSPORT PPI INVESTMENTS BY REGION

Total PPI investments in low-carbon land-transport projects in the six regions amounted to US\$85.3 billion, whereas the same figure for Roads PPI stood at US\$198.5 billion. Latin America and the Caribbean (LAC) received the highest amount of PPI investment in land transport from 2002 through H1 2017. It was the dominant region for both low-carbon land-transport PPI investments and roads investment, with 45 percent and 43 percent share, respectively (Figure 14). Peru and Brazil have the largest MRT and electric train projects. The largest PPI investment in roads in the region is in Mexico (US\$ 4.2 billion) and Brazil (which has four of the five largest roads investments, with a combined value of US\$11.1 billion).

East Asia and Pacific (EAP) shows a strong preference for low-carbon land-transport projects, capturing 39 percent of total PPI investments, valued at US\$32.8 billion. By comparison, roads PPI was lower, at 31 percent or US\$ 25.7 billion.

FIGURE 14

Regional distribution of low-carbon and roads investment volumes for projects with private participation in EMDEs (2002 – H1 2017)



Source: PPI Database, World Bank, as of November 2017

South Asia Region (SAR) still has a strong preference for road projects, capturing 31 percent of total road investments, whereas it only captures nine percent of low-carbon land-transport projects, at a cumulative PPI investment value of US\$7.9 billion. SAR has one of the lowest urbanization levels (35 percent), which could account for fewer urban transport and railway projects in the region. Road PPI investment in SAR is significantly higher (US\$62.2 billion), out of which India represents a significant share.

Europe and Central Asia (ECA), which accounts for six percent of low-carbon land-transport investments, has US\$5.4 billion worth of investments in low-carbon land-transport PPI. For roads, ECA has the lowest number of projects among all the regions, but the investment volume is sizeable, particularly due to some megaprojects in Turkey and Russian Federation. The top five road investments in the region are valued at US\$17.9 billion, accounting for 78 percent of the total road investment in the region. Turkey has the largest single PPI project, valued at almost US\$9.8 billion. Russia accounts for two of the top five projects, with a cumulative value of US\$5.9 billion.

The Middle East and North Africa (MENA) and Sub-Saharan Africa (SSA) regions accounted for less than one percent of PPI investments in low-carbon land-transport projects (US\$800 million). Similarly, these regions also account for less than one percent of the global road investment (US\$1.2 billion).

4.2 LAND-TRANSPORT PPI INVESTMENTS BY CAPACITY/ NETWORK LENGTH

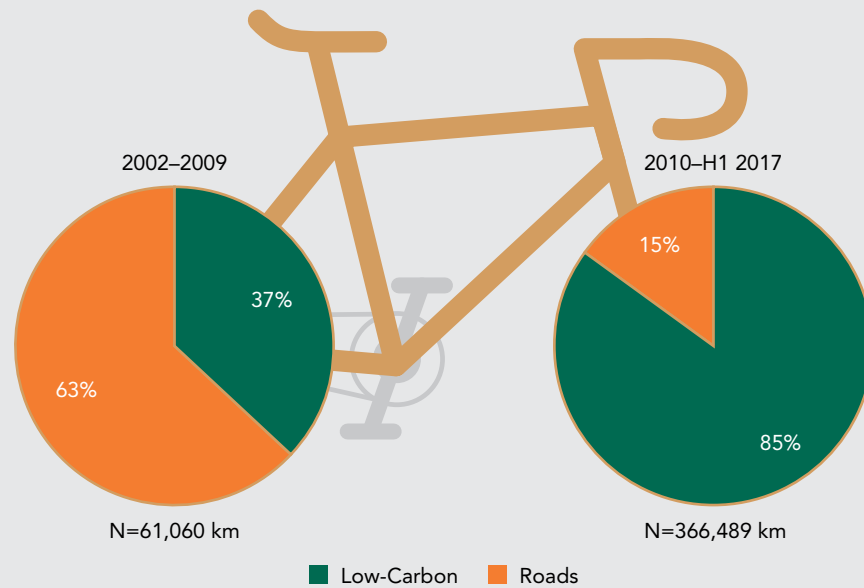
In this report, the capacity of land-transport projects is analyzed on the basis of the length of the network in kilometers rather than in volumes of cargo or in the number of passengers that can be moved during a period, because such information is not readily available for all projects.

Looking at the capacity (in kilometers) added during the two periods (Figure 15), we see that the capacity of low-carbon projects jumped significantly from 2010 to H1 2017. Whereas low-carbon capacity accounted for only 37 percent of total capacity from 2002 to 2009 period, it grew by more than 230

percent to reach 85.3 percent of total capacity during the 2010 to H1 2017 period. This was primarily due to significant capacity additions made in railway projects, where the total network length grew from 22,366 km during the 2002 to 2009 period to 312,665 km during the 2010 to H1 2017 period.

FIGURE 15

Change in the share of capacity (km) of low-carbon land-transport and road projects with private participation in EMDEs



Source: PPI Database, World Bank, as of November 2017

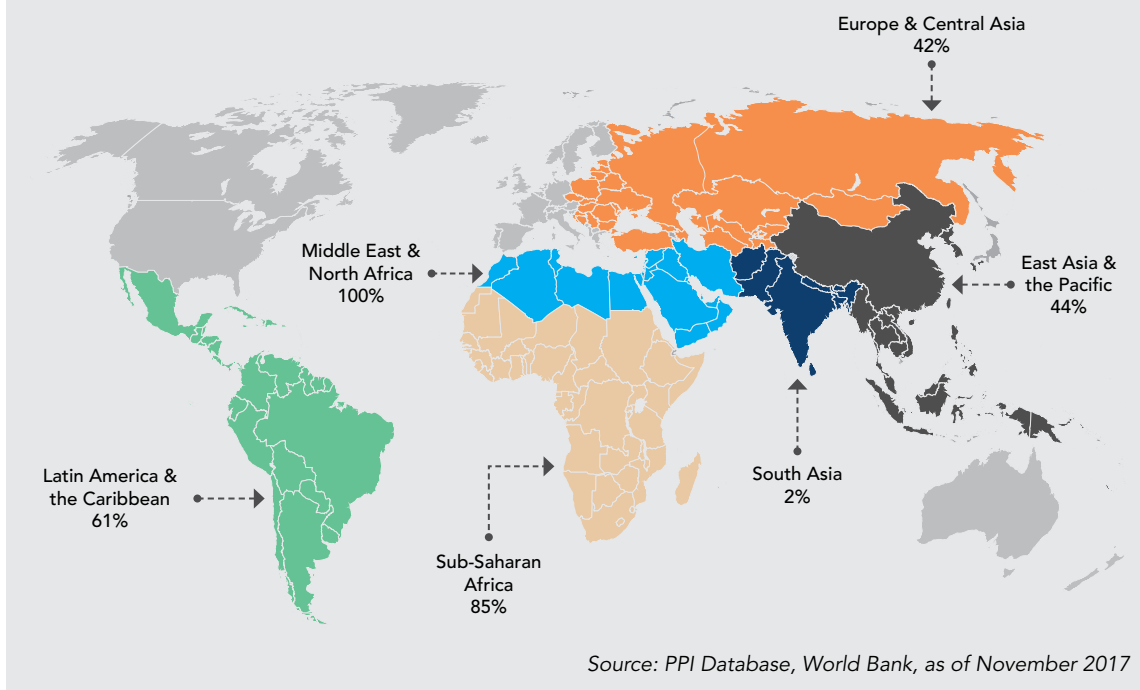
Although road projects also saw an increase in capacity between the two periods, it was insignificant compared to the increase of low-carbon land-transport projects. Road projects with private participation had a cumulative network length or capacity of 38,700 km during the 2002 to 2009 period, and this then increased by almost 50 percent to reach 53,824 km during the 2010 to H1 2017 period.

The regions in which the low-carbon land transport network length exceeds the network length of road projects are MENA (14 km, or 100 percent, of the land-transport network is low-carbon), SSA (13,800 km, or 85 percent, of the land-transport network is low-carbon) and LAC (81,332 km, or 61 percent, of the land-transport network is low-carbon). In these regions, most of the low-carbon network length is comprised of railways.

In EAP and ECA, the capacity or network length of road projects slightly exceeds that of the low-carbon projects—44 and 42 percent of the network length is in the form of low-carbon projects, respectively. In EAP, China leads the way, with railway and urban-transport projects connecting smaller cities and towns to the mainland, as well as railway projects connecting major cities. In ECA, Armenia and Russia have extensive railway networks being constructed with private participation.

FIGURE 16

Share of low-carbon network length in the total land-transport network length, by region, for projects with private participation in EMDEs (2002–H1 2017)



South Asia is the only region where the share of low-carbon project capacity or network length is abysmally low, at only two percent of the total. The reason could be the existence of a well-developed railway system since the colonial era, coupled with the mountainous terrain of North India, Pakistan and Afghanistan, which make railway projects expensive and time consuming to implement. In such cases, road projects make more sense because of their relatively lower costs.

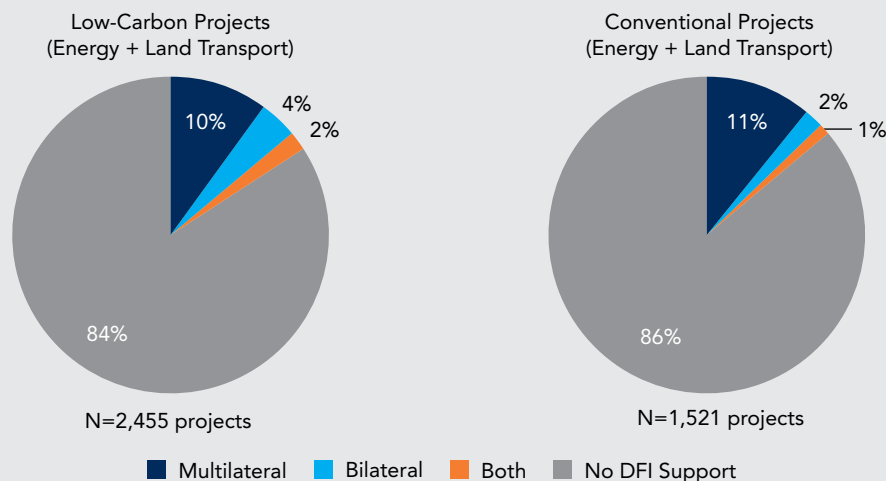
5. Development Finance Institution Support to Low-Carbon and Conventional PPI

Development finance institution (DFI) support includes support from both multilateral and bilateral institutions. In Figure 17, multilateral refers to projects that received only multilateral support; bilateral refers to projects that received only bilateral support; and both refers to projects that received support from both simultaneously. From 2002 to H1 2017, 16 percent of all low-carbon projects received DFI support, compared to 14 percent of all conventional projects receiving DFI support. During this pe-

riod, the number of low-carbon projects (401) that received DFI support also exceeded the number of conventional projects that received DFI support by a significant margin (214).

FIGURE 17

DFI support for low-carbon versus conventional projects with private participation in EMDEs, by number of projects (2002 – H1 2017)



Source: PPI Database, World Bank, as of November 2017

Within the low-carbon project category, renewable energy projects accounted for 95 percent of all such projects receiving DFI support, with 244 projects receiving multilateral support, 88 receiving bilateral support, and 60 receiving both forms of support. This is partially due to the fact that the number of renewable energy projects undertaken far outnumbered the number of railways and urban-transport projects during this period. Railway and urban-transport projects did not receive any bilateral support, whereas six railway projects and one urban-transport project received multilateral support.

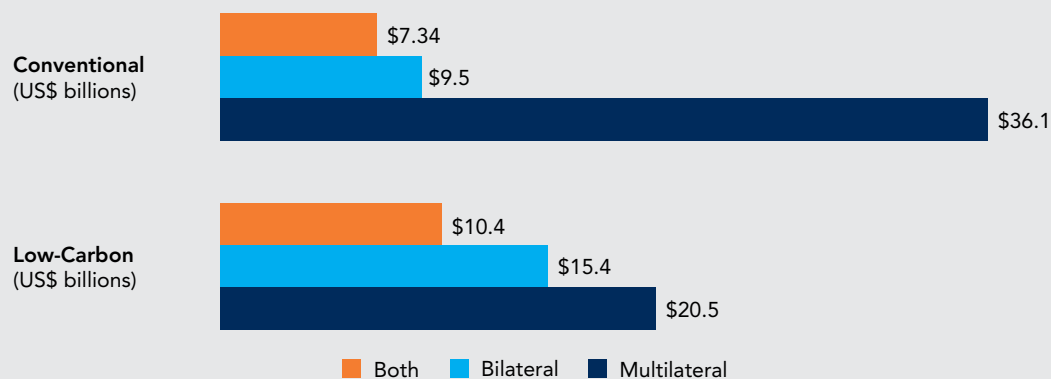
Within the conventional project category, conventional energy projects received the bulk of the assistance, accounting for an overwhelming 78 percent (166 projects) of the total projects (214) that received assistance. They also accounted for 79 percent (131 projects) of all multilateral projects that received DFI assistance (166 projects), whereas road projects accounted for the remaining 21 percent (35 projects). Conventional energy projects also accounted for 86 percent (25 projects) and 79 percent (15 projects) of the conventional projects that received bilateral and both forms of assistance.

Road projects received relatively less bilateral and joint support—only four road projects received bilateral support, and two received both forms of support.

Looking at DFI assistance by dollar value, the story changes completely. By number of projects, low-carbon projects received more DFI assistance, but by cumulative dollar value, DFI assistance was higher for non-low-carbon projects (Figure 18).

FIGURE 18

DFI support for low-carbon versus conventional projects with private participation in EMDEs, by investment value (2002 – H1 2017)



Source: PPI Database, World Bank, as of November 2017

Low-carbon projects received a cumulative US\$47.6 billion worth of assistance from 2002 to H1 2017. The same figure for conventional projects stood at US\$52.9 billion. However, the allocation of DFI assistance between renewable and conventional energy projects was almost equal, at US\$45.6 billion for renewable energy projects and US\$45.9 billion for conventional energy projects. The bulk of the US\$5.0 billion difference between low-carbon and conventional projects lies in the DFI assistance for land-transport projects. Railways and urban transport received only US\$2.0 billion in DFI support, whereas road projects received US\$7.0 billion.

The bulk of the support for low-carbon and conventional projects has been multilateral—US\$20.5 billion for low-carbon projects and US\$36.1 billion for conventional projects. Bilateral support for low-carbon projects (US\$15.4 billion) exceeds bilateral support for conventional projects (US\$9.5 billion).

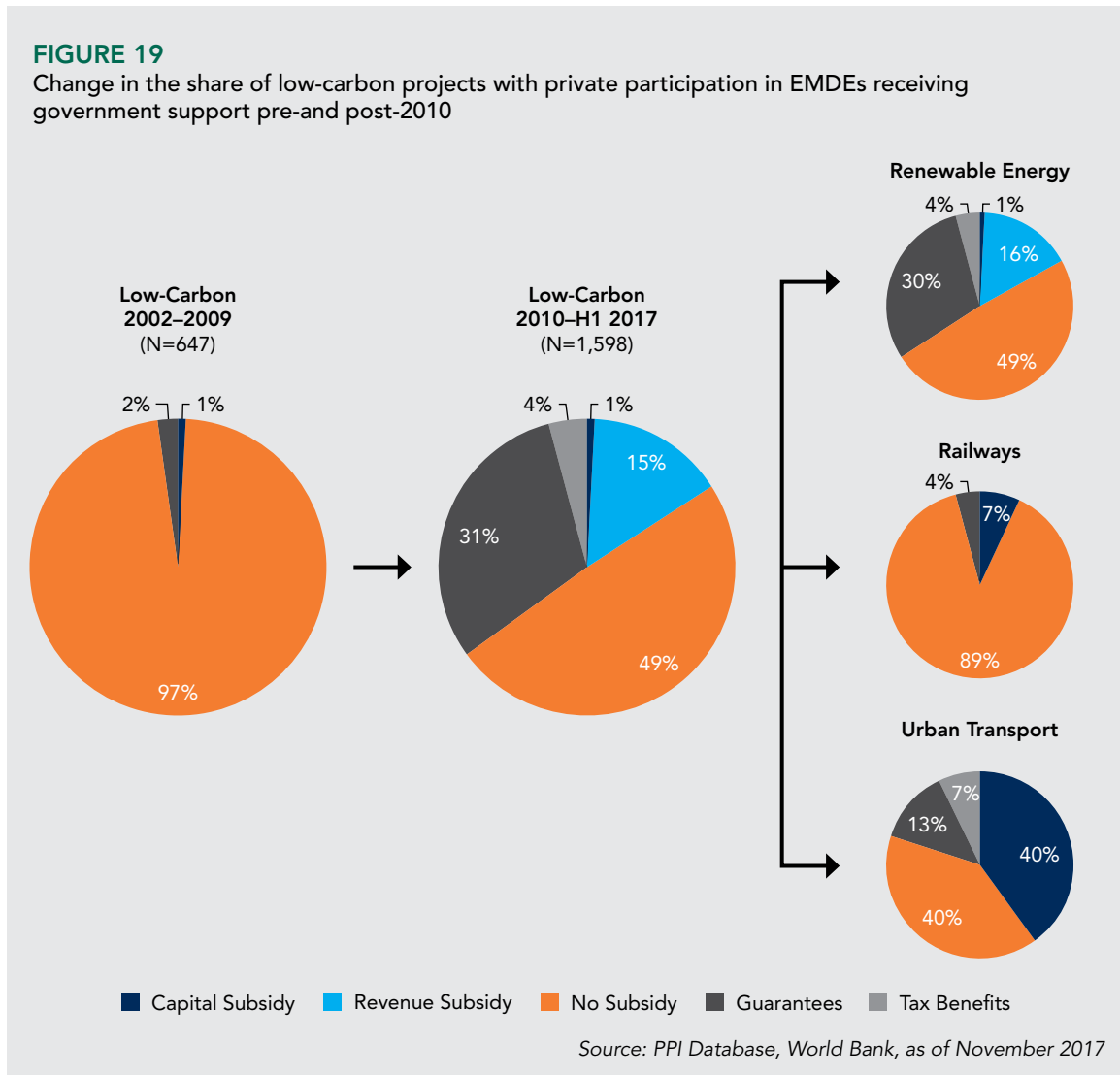
Renewable energy projects have a more even distribution of various forms of DFI assistance. Forty-three percent of the total DFI assistance for renewable energy projects comes from multilateral support, 34 percent from bilateral support, and 23 percent from both sources. More than two-thirds of DFI assistance for conventional energy projects comes from multilateral assistance, whereas 19 and 14 percent comes from bilateral and both sources, respectively.

6. Government Support to Low-Carbon and Conventional PPI

Government support is classified into two categories—direct and indirect. Direct government support includes government liabilities that directly cover project costs, either in cash or in-kind, and are certain to occur, such as capital subsidies, revenue subsidies, land, etc. Indirect government support is either in the form of contingent liabilities (liabilities that may not actually occur, because they are contingent

on a pre-determined event) or government policies that support investment. These include guarantees regarding such things as exchange rates, payments, revenues and debt, and tax breaks or benefits.

Government support to climate projects increased drastically, from only three percent of all low-carbon projects receiving government support to 51 percent of projects receiving government support. Favorable government policies, in the form of both direct and indirect government support, have been instrumental in the surge of low-carbon projects from 899 during the pre-2010 period to 1,915 in the post-2010 period.



Information on government support was available for 647 of 899 projects during the pre-2010 period and 1,598 of 1,915 projects during the post-2010 period. Further analysis and Figure 19 are based on the number of projects for which information was available.

Only seven projects received direct government support in the pre-2010 period (five of them in the form of capital subsidies, and two in the form of revenue subsidies) and 14 projects received indirect government support, in the form of guarantees. Low-carbon land-transport projects accounted for six of the seven projects that received direct government support, and only one renewable energy project (out of 535) received a revenue subsidy. However, 12 of the 14 projects receiving indirect government support were renewable energy projects.

The low-government-support scenario for low-carbon projects changed from 2010 to H1 2017, during which the number of low-carbon projects receiving government support jumped to 815, of which 800 were in the renewable energy (nine in urban transport and six in railways). Of the 800 renewable energy projects receiving government support, 522 received indirect government support, mostly in the form of payment guarantees; 234 received a revenue subsidy; and 14 were given a capital subsidy. It is noteworthy that the indirect government support in the form of payment guarantees for renewable energy projects increased from seven in the pre-2010 period to 422 in the post-2010 period, whereas it increased only from 21 to 92 for conventional energy projects.

Direct government support was largely nonexistent for conventional PPI projects, except for capital subsidies for road projects (Table 2). Thirty-one percent of road projects (90 projects) were given a capital subsidy in the pre-2010 period. This doubled to 180 projects (71 percent of total road projects) receiving such a subsidy in the post-2010 period. Revenue subsidies for roads remained similar—11 projects in the pre-2010 period, compared to 13 in the post-2010 period. Ninety-seven conventional energy projects received indirect government support in the form of guarantees in the post-2010 period, compared to 24 in the pre-2010 period.

TABLE 2: NUMBER OF CONVENTIONAL PPI PROJECTS RECEIVING GOVERNMENT SUPPORT					
	Capital Subsidy	Revenue Subsidy	In-Kind Subsidy	Guarantees	Tax Deductions
2002 – 2009					
Conventional Energy	4	1	0	24	0
Roads	90	11	0	10	1
2010 – H1 2017					
Conventional Energy	4	8	0	97	1
Roads	180	13	1	27	0

Table 3 provides a breakdown of the guarantee types provided by governments before and after 2010. Prior to 2010, the number of government guarantees was insignificant—only seven low-carbon projects received payment guarantees, and only one project each received revenue, debt, and exchange-rate guarantees. After 2010, government guarantees to renewable energy projects increased multi-fold, with a total of 422 renewable energy projects receiving payment guarantees and 19 receiving revenue guarantees. Although the number of guarantees issued to conventional energy projects also rose, it wasn't that significant. In fact, before 2010, three times as many conventional energy projects received payment guarantees as renewable energy projects, but after 2010, it dropped to just a fifth of the number for renewable energy projects. For railway and urban-transport projects, the number of guarantees in both periods was insignificant; however, the number of revenue guarantees for road projects jumped from nine to 19.

TABLE 3: NUMBER OF PROJECTS RECEIVING INDIRECT GOVERNMENT SUPPORT						
	Payment Guarantees		Revenue Guarantees		Others*	
	2002–2009	2010–2017	2002–2009	2010–2017	2002–2009	2010–2017
Low-Carbon PPI						
Renewable Energy	7	422	1	19	2	51
Railways	–	–	–	2	1	–
Urban Transport	–	–	1	2	–	1
Conventional PPI						
Conventional Energy	21	92	1	3	2	2
Roads	–	5	9	19	1	3

*Others include debt, exchange, tariff-rate and construction-cost guarantees

About the Private Participation in Infrastructure Projects Database

The Private Participation in Infrastructure Database is a product of the World Bank Group's Infrastructure, PPPs and Guarantees team. Its purpose is to identify and disseminate information on private participation in infrastructure projects in low- and middle-income countries. The database highlights the contractual arrangements used to attract private investment, the sources and destination of investment flows, and information on the main investors. The site currently provides information on more than 8,000 infrastructure projects dating from 1984 to 2017 H1. It contains over 50 fields per project record, including country, financial closure year, infrastructure services provided, type of private participation, technology, capacity, project location, contract duration, private sponsors, debt providers, and development bank support.

For more information, please visit: ppi.worldbank.org

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