CLEAN DEVELOPMENT MECHANISM

CDM-MP87-A11

Information note

Analysis of share and levelized cost of electricity generation of grid-connected solar photovoltaic technology

Version 01.0

United Nations
Framework Convention on
Climate Change

COVER NOTE

1. Procedural background

1. The Methodologies Panel (MP) at its eighty-fourth meeting (MP84) considered the update to "TOOL32: Positive lists of technologies" (TOOL32). The MP proposed to extend the validity of TOOL32 for one year while it completes the analysis of positive lists of technologies based on the most recent data available.

2. The Executive Board of the clean development mechanism (CDM) (hereinafter referred to as the Board) at its one-hundred and tenth meeting (EB110), based on the recommendation from MP84, agreed to extend the validity of the positive lists contained in TOOL32 for one year, i.e. up to 28 November 2022.

3. As per the Appendix of TOOL32, the MP shall reassess the validity of the positive lists included in this tool every three years. Such a reassessment shall be based on the review of relevant information on costs, share of renewable energy technologies, and other related information (e.g. regulations) pertaining to the technologies and conditions contained in the positive lists and comparable alternatives that are applicable to non-Annex I countries taking into account size thresholds. The reassessment will also prepare an analysis on the continuation or graduation of technologies contained in the positive list for consideration by the Board.

2. Purpose

4. The purpose of this information note is to inform the Board about the analysis conducted as per the guidance provided under paragraph 3 above.

3. Key issues and proposed solutions

3.1. Scope

5. The analysis is limited to the 126 non-Annex I countries[1] across Africa, Asia, Central America and the Caribbean, Middle East, Oceania and South America regions where the data related to electricity generation, grid-connected installed capacity and commercial lending rate are publicly available during the data vintage from 2017 to 2019.

6. This analysis focused on grid-connected renewable energy technologies included in TOOL32. TOOL32 also contains the positive list for waste handling and disposal, technology/measure used by households, communities and small and medium enterprises (SMEs), and off-grid renewable energy technologies besides the grid-connected renewable energy technologies. However, to be eligible to apply the positive list in the area of waste management or technology/measure used by households, communities and SMEs, a project participant or a coordinating and managing entity needs to submit

[1] Including 42 least developed countries, 27 small island developing States and 57 other developing countries.

evidence[2] to the validating designated operational entities confirming that the particular CDM activity qualifies under the positive list. In addition, the off-grid renewable energy technologies are still under an emerging stage. When compared with the installed capacity of the grid-connected renewable energy technologies, the global installed capacity of the off-grid renewable energy technologies is less than 0.5 per cent.[3] With the slow rate of change observed in these areas, the MP came to the opinion that the current analysis may be limited to grid-connected renewable energy generation.

7. The method used in this analysis is based on grid-connected installed capacity and total electricity generation of specific renewable energy (RE) technologies in different countries. The levelized cost of electricity generation (LCOE) of RE technologies and fossil fuel technologies predominantly used in non-Annex I countries have also been compared.

8. Further, the MP agreed that, consistent with the practice in the previous assessment conducted in 2018, a renewable energy technology included in the current positive list will only be considered in the analysis if its share, either based on grid-connected installed capacity or total electricity generation on global average basis, is greater than 3 per cent.[4] The IRENA database (IRENA 2021) that reported information for 2018 is considered for this purpose. The MP considered that lower share in the grid-connected electricity supply indicates that these technologies are facing financial or technological barriers in their implementation and thus qualify for automatic additionality.

9. Based on the information from IRENA 2021 cited above, of the renewable energy technologies currently included in the positive list in TOOL32, only grid-connected solar PV technology (hereinafter referred to as solar PV technology) exceeds the threshold set under paragraph 8 above. Therefore, this technology is further considered in the analysis.

3.2. Method used to estimate share and LCOE

10. The share of solar PV technology is calculated using an approach based on electricity generation and another one based on the total installed capacity for 126 non-Annex I countries and analysed by region.

11. The LCOE of commonly-used fossil fuel technologies (i.e. heavy fuel oil (HFO), natural gas and coal) is calculated for each of the 126 developing countries across the regions and is compared with the LCOE of solar PV technology. The LCOE of solar PV technology is calculated for three different scenarios for investment cost, which are based on minimum, maximum and weighted average[5] investment costs in the respective region, as referred from REN21, 2019 report.

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[2] Such a document may include a review of national regulations for waste handling and disposal, review of end-use of technology(ies) (e.g. biogas digestors used for cooking purpose), or national standards for energy efficient pump-sets.

[3] Refer to IRENA (2021), Renewable capacity statistics 2021 International Renewable Energy Agency (IRENA), Abu Dhabi available at < https://www.irena.org/publications/2021/March/Renewable-Capacity-Statistics-2021 >.

[4] A similar threshold was used for determining country-level positive list under microscale additionality tool (DNA submission route as per “procedure for submission and consideration of microscale renewable energy technologies for automatic additionality”).

[5] Based on data provided in International Renewable Energy Agency, Renewable Power Generation Costs in 2017 (2018).

3.3. Assumptions

12. The main assumptions are as follows:

    (a) The generation and installed capacity data for renewable energy technologies used for this analysis only include utility scale plants. For LCOE calculation for fossil fuel technologies, plants with economically viable capacities are considered, which are plants with installed capacity above 50 MW for natural gas-based power plants, 250 MW for coal-based power plants and 5 MW for HFO-based power plants;

    (b) Since no country-specific reliable information that is publicly available could be identified, the global average fossil fuel cost for recent three years at lower and higher threshold is considered to calculate fossil fuel LCOE for all 126 countries;

    (c) The LCOE calculation does not take into consideration:

        (i) fossil fuel subsidies, taxes, distribution costs on a country-by-country basis or at sub-national level;

        (ii) country-specific incentives such as subsidies, grants and feed-in tariffs, that are provided to the renewable energy technologies;

        (iii) transport costs of fuels and cost of deployment of renewable energy technologies which can be high in remote areas, specifically for landlocked countries;

    (d) The analysis does not make any differentiation for the sub-types of solar PV due to paucity of reliable and current data related to installed capacity, annual generation and capacity factors for the different types;

    (e) Country-specific commercial equity and debt lending rates are used to determine the weighted average cost of capital (WACC) that is used as the discount rate in the LCOE calculation;

    (f) Regional values for weighted average capacity factor,[6] global average values for plant lifetime, investment cost/kW, operations and maintenance (O&M) cost, and degradation factor for renewable energy technology installations are referred from literature sources (e.g. REN21, 2019 report, IRENA report[7]);

    (g) Investment cost is considered at three thresholds – minimum, maximum and weighted average – for renewable energy technologies per region except for China, India and Mexico, where country-specific values are available (referred from REN21, 2019 report).

[6] Refers to weighted average energy yield or utilization factor.

[7] The IRENA database on renewable energy costs contains 15,000 utility-scale renewable electricity generation projects and 5,600 power purchases agreement and tender results that provide new insights into trends in the costs and performance of renewables. The IRENA Renewable Costing Alliance (an alliance of companies, industry associations, governments and researchers) is helping to expand the database by sharing, confidentially, their data for real-world renewable energy projects.

3.4. Key findings

13. For 104 countries out of 126 countries (i.e. 83 per cent of countries), the share of solar PV technology is below 2 per cent when calculated based on the annual average electricity generation between 2017 and 2019. When the share is based on the annual average installed capacity between 2017 and 2019, the share of solar PV technology is less than 2 per cent for 82 countries (i.e. 65 per cent of countries). Further, it is noted the total installed capacity of grid-connected solar PV technology in 84 countries is less than or equal to 50 MW.

14. Therefore, as per prevailing conditions of the tool[8] and when 2017-2019 data vintage specified in paragraph 13 above is applied, solar PV technology will be automatically additional in 84 countries that includes 45 countries from Africa followed by 13 from Central America and the Caribbean, 9 from Asia, 7 from Oceania and 5 each from Middle East and from South America, and most of these (78 out of 84) countries either rely on HFO or natural gas-based technologies as major sources of electricity generation.

15. The share of solar PV based on annual generation as well as on installed capacity is highest in Oceania region, i.e. 4.59 per cent and 8.92 per cent, respectively. This is roughly four times the world average, which is 1.32 per cent and 2.89 per cent, respectively. Conversely, Asia has the lowest share of solar PV, i.e. 0.73 per cent on the basis of annual generation and on the basis of installed capacity Africa ranks lowest with 1.74 per cent.

16. Further, referring to the capacity additions over the three-year period from 2017 to 2019 and comparing them with the installed capacity of year 2016, it is noted that solar PV's share is ranging 13 to 17 per cent of the capacity addition in Africa, Central America and the Caribbean and South America, and Middle East, while in Asia and Oceania it is 57 per cent.

17. The solar PV technology is cost competitive in 84 per cent of countries that rely on HFO-based technologies or natural gas-based technologies for electricity generation. The magnitude of difference is dependent on characteristics of the particular renewable energy source and technology but also on the fossil-fuel mix prevalent in the country (e.g. domination of coal vs. oil or gas vs. coal could make a difference).[9]

4. Impacts

18. The analysis conducted will facilitate the decision-making by the Board with regard to revision of the positive lists of technologies for grid-connected renewable energy technologies.

5. Subsequent work and timelines

19. Based on the guidance received from the Board, the MP will revise the positive list of technologies as contained in TOOL32.

[8] The percentage share of total installed capacity of the specific technology in the total installed grid-connected electricity generation capacity in the host country is equal to or less than two per cent; or the total installed capacity of the technology in the host country is less than or equal to 50 MW.

[9] Granularity of the available data supported limited distinction among: (a) types of grid-connected solar PV technology and comparable fossil fuel-based technologies; and (b) applicable thresholds of the small-scale project activities, although it was found that investment cost of rooftop solar was up to three times the average capital cost of utility scale solar PV.

6. Recommendations to the Board

20. The MP recommends that the Board take note of the analysis and provide guidance for further work in this regard.

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1. Introduction

1. The Methodologies Panel (MP) at its eighty-fourth meeting (MP84) considered the update to "TOOL32: Positive lists of technologies" (TOOL32). The MP proposed to extend the validity of TOOL32 for one year while it completes the analysis of positive lists of technologies based on the most recent data available.

2. The Executive Board of the clean development mechanism (CDM) (hereinafter referred to as the Board) at its one-hundred and tenth meeting (EB110) based on the recommendation from MP84 agreed to extend the validity of the positive lists contained in TOOL32 for one year, i.e. up to 28 November 2022.

3. As per the Appendix of TOOL32, the MP shall reassess the validity of the positive lists included in this tool every three years. Such a reassessment shall be based on the review of relevant information on costs, share of renewable energy technologies and other related information (e.g. regulations) pertaining to the technologies and conditions contained in the positive lists and comparable alternatives that are applicable to non-Annex I countries taking into account size thresholds. The reassessment will also prepare an analysis on the continuation or graduation of technologies contained in the positive lists for consideration by the Board.

4. The MP prepared this information note considering representative and current information from a range of literature sources, taking into account different national circumstances. This information note presents an analysis of levelized cost of electricity generation (LCOE) and share of grid-connected solar photovoltaic (PV) (hereinafter referred to as solar PV technology) and comparable fossil fuel technologies that were predominately deployed in the non-Annex I countries[1] (also referred to as developing countries) across Africa, Asia, Central America and the Caribbean, Middle East, Oceania and South America regions.

2. Purpose

5. The purpose of this information note is to inform the Board about the analysis conducted for reassessment of the validity of the positive lists as per the guidance provided under paragraph 3 above.

[1] Analysis is conducted for 126 countries, including 42 least developed countries, 27 small island developing States and 57 other developing countries.

3. Definitions

6. For the purpose of this information note, the following definitions apply:

   (a) **Share[2] based on electricity generation (SEG)**: the ratio of the annual renewable electricity generation to the difference between gross annual total electricity generation and export;

   (b) **Share based on installed capacity (SIC)**: the ratio of the cumulative (total) renewable technology installed capacity to the cumulative (total) installed capacity of all power-generating sources;

   (c) **Levelized cost of electricity generation (LCOE)** – the average cost per unit of electricity generated by a given energy source, in USD/MWh, during the project lifetime (or contract) of any generation technology. The LCOE includes capital cost, fuel cost, fixed and variable costs of operation and maintenance (O&M), financial cost and a plant utilization factor, and excludes subsidies, incentives and system balancing cost associated with variable renewables and any system-wide cost-savings from the merit order effect.

4. Key issues and proposed solutions

4.1. Scope

7. The method proposed in the subsequent sub-sections will be used to determine share and LCOE of selected type(s) of grid-connected renewable energy technologies included in TOOL32 and comparable fossil fuel technologies, where these technologies are deployed in non-Annex I countries.

8. Currently, TOOL32 includes following large-scale grid-connected and isolated grid renewable energy technologies in the positive list:

   (a) Solar photovoltaic (PV) technologies;

   (b) Solar thermal electricity generation including Concentrating Solar Power (CSP);

   (c) Off-shore wind technologies;

   (d) Marine wave technologies;

   (e) Marine tidal technologies;

   (f) Ocean thermal technologies.

[2] For the purpose of this document, it is considered as the market share (i.e. the percentage of total market value) that the product captures. In literature, there is a different connotation for market penetration rate. For instance, as per Ansoff, I. H., 1957, “Strategies for diversification”; and as per Harvard Business Review, Vol. 35, No. 5, pp. 113-124, market share is the percentage of total market value that the product captures, while market penetration is the percentage of a product’s target market that the product captures in a period of time.

9. A specific technology listed in paragraph 8 above is defined as automatically additional if at the time of submission of project design document (PDD) any of the following conditions are met:

   (a) The percentage share of total installed capacity of the specific technology in the total installed grid-connected electricity generation capacity in the host country is equal to or less than two per cent; or

   (b) The total installed capacity of the technology in the host country is less than or equal to 50 MW.

10. Further, it includes the following small-scale grid-connected renewable electricity generation technologies:

   (a) Solar PV technologies;

   (b) Solar thermal electricity generation including concentrating solar Power (CSP);

   (c) Off-shore wind technologies;

   (d) Marine wave technologies;

   (e) Marine tidal technologies;

   (f) Building-integrated wind turbines or household rooftop wind turbines of a size up to 100 kW;

   (g) Biomass internal gasification combined cycle (BIGCC).

11. The analysis is limited to the 126 non-Annex I countries where the data related to electricity generation, grid-connected installed capacity and commercial lending rate are publicly available during the data vintage from 2017 to 2019.

12. Further, the MP agreed that, consistent with the practice in the previous assessment conducted in 2018, a renewable energy technology included in the current positive list will only be considered in the analysis if its share, either based on grid-connected installed capacity or total electricity generation on global average basis, is greater than 3 per cent.[3] The IRENA database (IRENA 2021) that reported information for the year 2018 is considered for this purpose. The MP considered that lower share in the grid-connected electricity supply indicates that these technologies are facing financial or technological barriers in their implementation and thus qualify for automatic additionality.

13. Based on the information from IRENA 2021 cited above, the share of grid-connected installed capacity of fossil fuel technologies is at 65 per cent, followed by 20 per cent share of hydro (including pumped storage). Solar PV and onshore wind have a share of 6 per cent each. Other renewable technologies such as Concentrated Solar Power (CSP), Geothermal, Bioenergy and Marine jointly make up less than 3 per cent. Refer to table 1 of Appendix 1 for more details.

14. Similarly, in terms of the share of total grid-connected electricity generation, fossil fuel technologies have 74 per cent share followed by 18 per cent share of hydro (including

[3] A similar threshold was used for determining country-level positive list under microscale tool (DNA submission route as per “procedure for submission and consideration of microscale renewable energy technologies for automatic additionality”).

pumped storage). Share is 4 per cent for onshore wind and 2 per cent for solar PV. Other renewable technologies such as CSP, Geothermal, Bioenergy and Marine jointly make up the remaining 2 per cent of the global electricity generation. Refer to table 2 of Appendix 1 for more details.

15. As solar PV is the only technology currently included in the positive list that exceeds the share of 3 per cent in installed capacity, **the analysis is conducted only for grid-connected Solar PV technology**.

16. The information note presents the analyses including the method and data sources used to calculate:

    (a) Share of solar PV technology based on total installed capacity and electricity generation; and

    (b) LCOE.

4.2. Method and data sources used to estimate share of solar PV technology and LCOE

17. The share of solar PV technology is calculated using country-specific data related to average grid-connected installed capacity and average annual generation. The data were sourced from IRENA's Query Tool.[4] Appendix 2 provides detailed country-specific information for three years from 2017 to 2019.

18. The LCOE is calculated for each country as the discounted lifetime costs of the commonly used fossil fuel generating technologies (i.e. coal, heavy fuel oil (HFO) and natural gas) and of the solar PV technology.

19. Appendix 3 of this information note details the methodology that is used to calculate share of solar PV technology and LCOE of fossil fuel and solar PV technology.

20. Appendix 4 provides details about various data parameters (e.g. global/regional average values for plant lifetime, investment cost/kW, O&M cost, degradation factor) that were used in this analysis.

21. The LCOE of commonly used fossil fuel technologies i.e. HFO, natural gas and coal, is calculated for each of the 126 developing countries across the regions, and it is compared with the LCOE of solar PV technology. The LCOE of solar PV technology is calculated for three different scenarios for investment cost, which are based on minimum, maximum and weighted average[5] investment cost in the respective region, as referred from REN21, 2019 report.

4.3. Assumptions

22. The following assumptions were made:

    (a) The generation and installed capacity data for renewable energy technologies used for this analysis only include utility scale data. For LCOE calculation for fossil

[4] Available at <http://pxweb.irena.org/pxweb/en/IRENASTAT>.

[5] Based on data provided in International Renewable Energy Agency, Renewable Power Generation Costs in 2017 (2018).

fuel technologies, plants with economically viable capacities are considered, which are plants with installed capacity above 50 MW for natural gas based power plants, 250 MW for coal-based power plants and 5 MW for HFO-based power plants;

(b) For simplification purposes, the gestation period of fossil fuel technologies and renewable energy technologies is not considered while calculating their share;

(c) As no country-specific information publicly available could be found, the global average fossil fuel cost for recent three years at lower and higher threshold is considered to calculate fossil fuel LCOE, as follows:[6]

(i) The HFO price is an average of Rotterdam oil product spot prices;

(ii) The natural gas price is an average natural gas import prices across Belgium, Germany, Japan, Spain and the United States of America; and

(iii) The coal price is the average of steam coal prices for electricity generation for the United States of America;

(d) No consideration is provided to fossil fuel subsidies, taxes, distribution costs on a country-by-country basis or at sub-national level;

(e) No consideration is provided to country-specific incentives such as subsidies, grants and feed-in-tariffs that are provided to the renewable energy technologies. Neither is consideration given to transport costs of fuels and cost of deployment of renewable energy technologies, which can be high in remoted areas, specifically for landlocked countries;

(f) The analysis does not make any differentiation for the sub-types of solar PV due to paucity of reliable and current data related to installed capacity, annual generation and capacity factors for different types;

(g) Country-specific commercial equity and debt lending rates were used to determine the weighted average cost of capital (WACC) that is used as the discount rate in the LCOE calculation;

(h) Regional values for weighted average capacity factor,[7] global average values for plant lifetime, investment cost/kW, O&M cost, and degradation factor for renewable energy technology installations are referred from literature sources (e.g. REN21, 2019 report and IRENA report);[8]

(i) Investment cost is considered at three thresholds (i.e. minimum, maximum and weighted average) for renewable energy technologies per region except for China,

[6] The prices are referred from “Key World Energy Statistics” as reported by IEA. It is also noted that fossil fuel prices were at their lowest during these years.

[7] Refers to energy yield or utilization factor.

[8] The IRENA database on renewable energy costs contains 15,000 utility-scale renewable electricity generation projects and 5,600 power purchase agreements and tender results that provide new insights into trends in the costs and performance of renewables. The IRENA Renewable Costing Alliance (an alliance of companies, industry associations, governments and researchers) is helping to expand the database by sharing, confidentially, their data for real-world renewable energy projects.

India and Mexico, where country-specific values are available (referred from REN21, 2019 report).

4.4. Results

4.4.1. Share of solar PV technology

23. The analysis includes data related to technology-wise annual generation and installed capacity of all grid-connected electricity generation technologies in 126 non-Annex I countries for the years 2017 to 2019. The data were used to calculate average annual generation and average installed capacity per technology per country over those three years. Based on this information, share of solar PV technology is determined. Table 3 and table 4 summarize the share of solar PV technology based on annual average electricity generation and on annual average installed capacity, respectively.

24. It is noted that the average share of solar PV in non-Annex I countries based on the annual average generation for the years 2017 to 2019 ranges between 0 and 14 per cent. It is also noted that 104 out of the 126 countries (83 per cent) have the share of solar PV technology below 2 per cent, while very few countries have more than 10 per cent generation from solar PV technology.

25. Thirty-nine (out of 42) least developed countries (LDCs), 20 (out of 27) small island developing states (SIDS) and 45 (out of 57) developing countries have the average share based on annual average generation for solar PV of less than 2 per cent. Refer to figures 1 and 2 and associated data under tables 1 and 2 of Appendix 2 for further details.

26. The MP also compared the above results with the previous analysis[9] it conducted in 2018 with data vintage of three years from 2014 to 2016 (hereinafter referred as previous analysis). It is noted that the percentage of countries having share of less than 2 per cent decreased from 93 per cent to 83 per cent. This indicates that share of solar PV technology in the grid-connected electricity generation has increased during recent years. For further details, please refer to table 1 of Appendix 6.

[9] This analysis was included in an information note agreed via electronic consultation by MP80 and presented to the Board for its consideration at EB104. The information note is available at <https://cdm.unfccc.int/Panels/meth/index.html>

Figure 1. Range of share of solar PV technology based on total grid-connected electricity generation

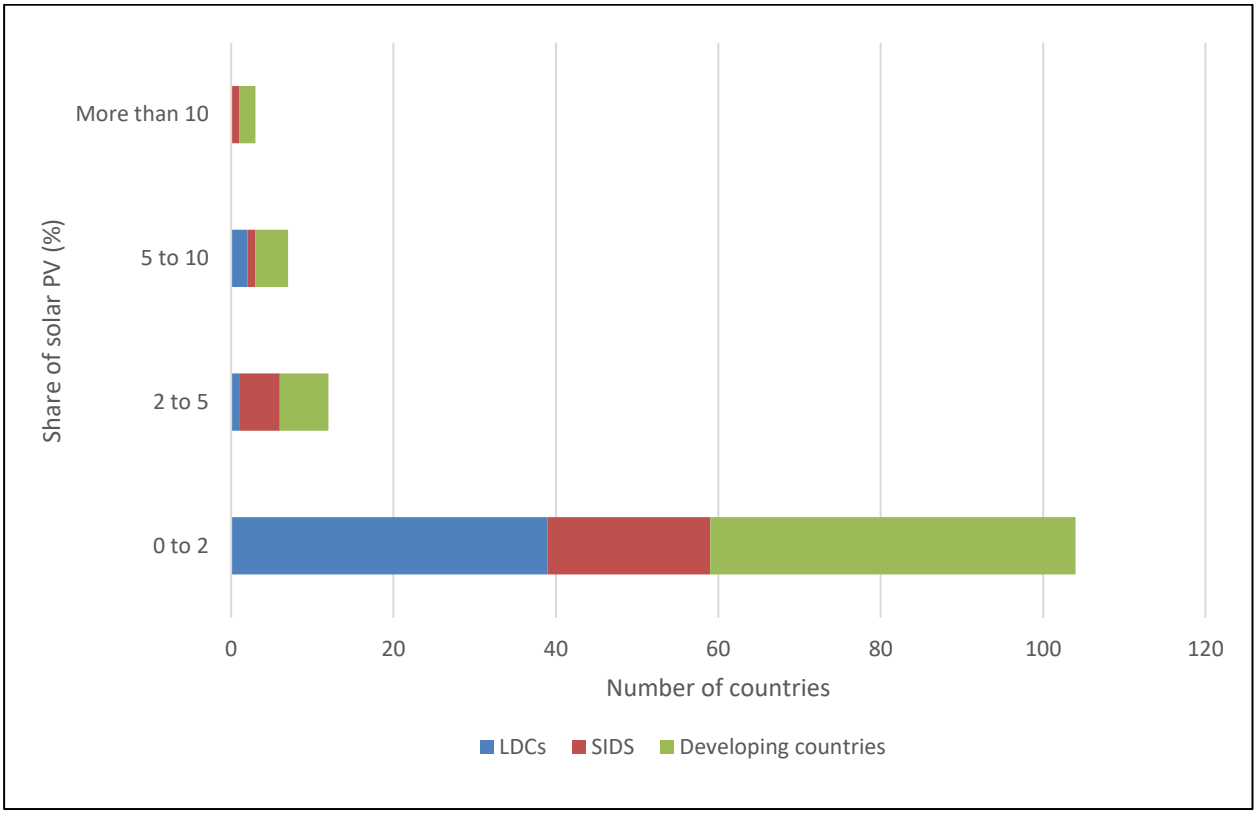
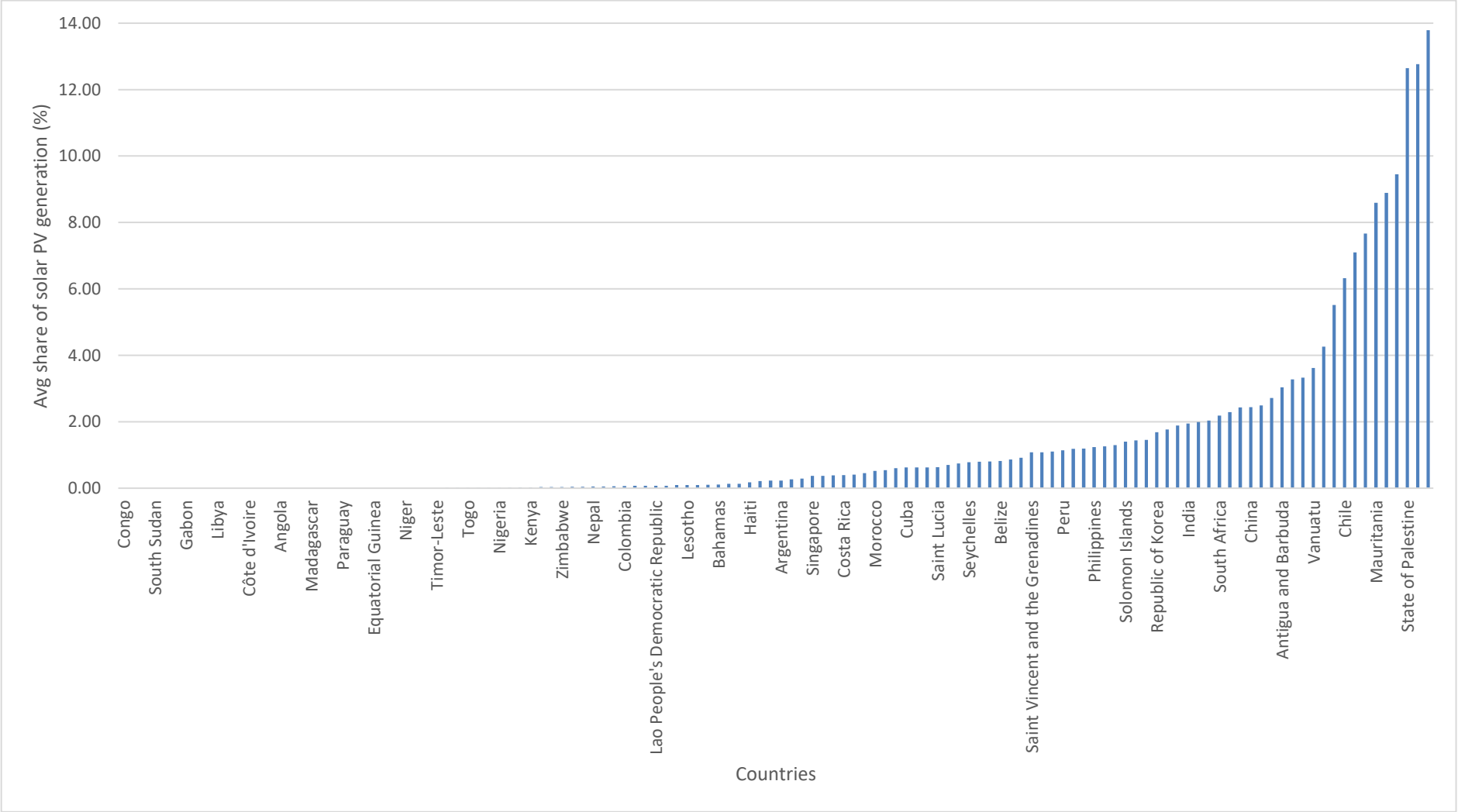


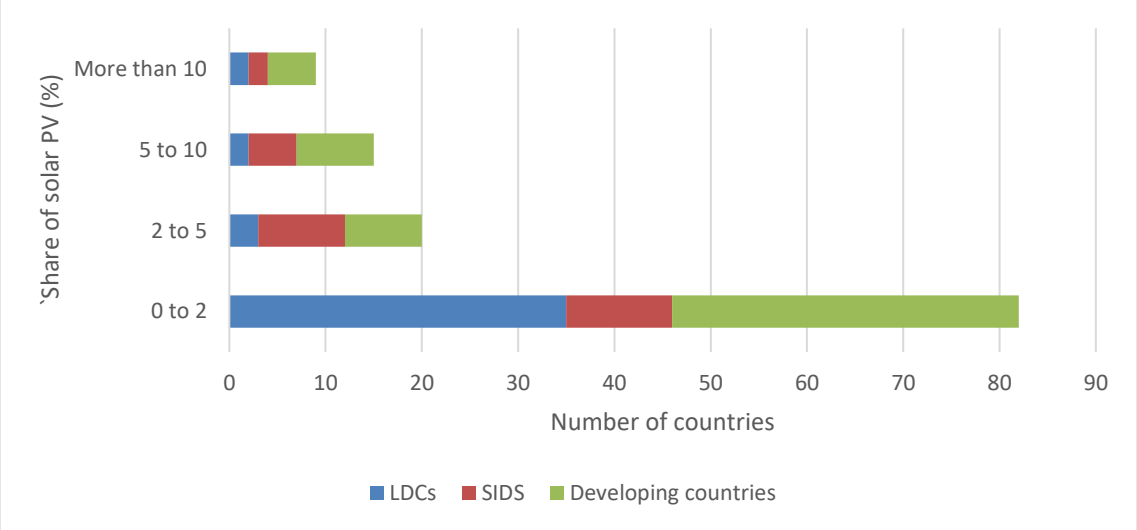
Figure 2. Share of average solar PV generation based on average grid generation in a country



27. In terms of installed capacity, the share of solar PV technology in non-Annex I countries based on the average figure for the years 2017 to 2019 ranges between 0 to 24 per cent and two-thirds of the countries have the share of solar PV technology below 2 per cent.

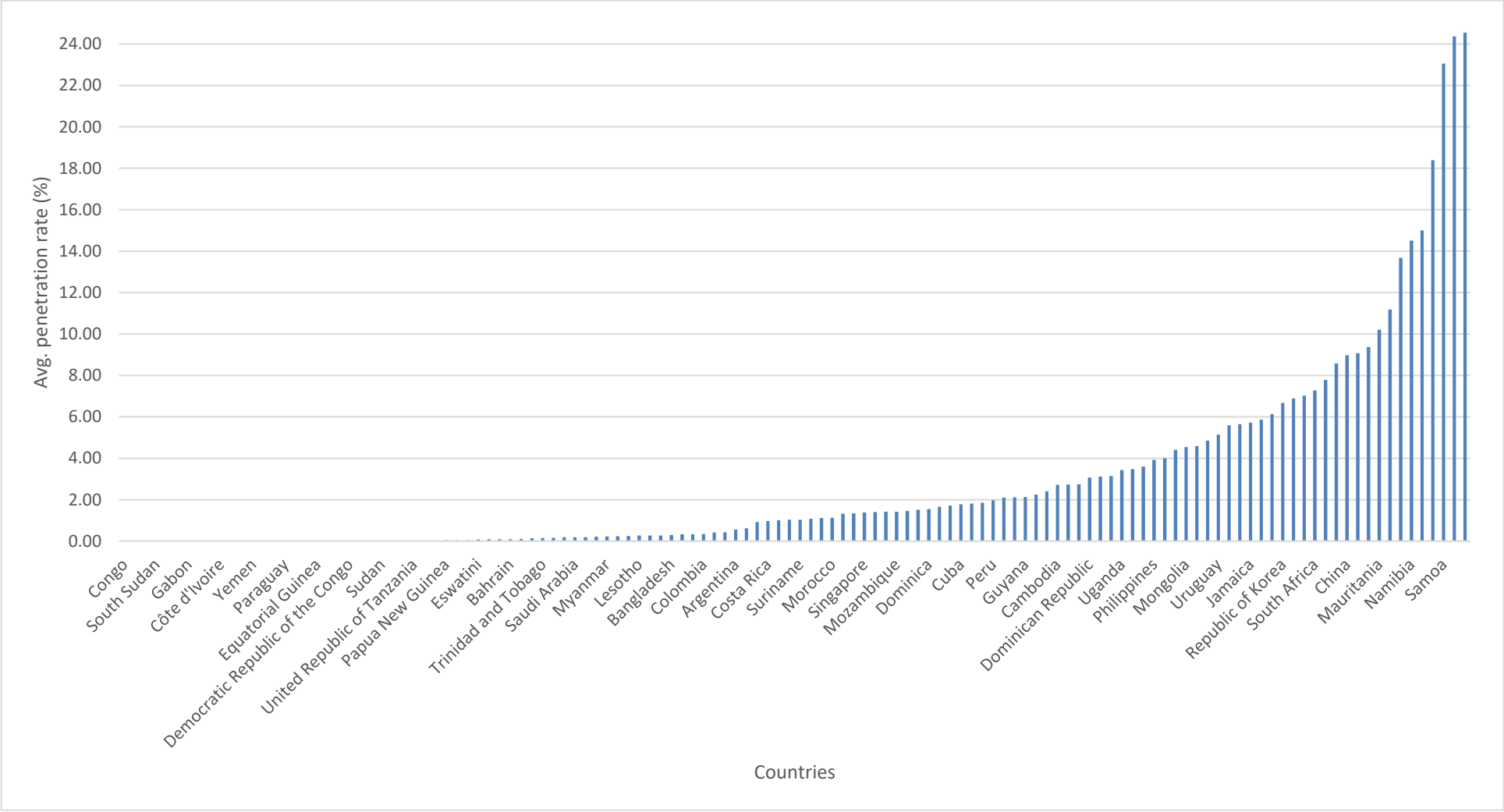
28. Furthermore, average share based on annual average generation for solar PV is less than 2 per cent for 82 (out of 126) countries, including 35 LDCs (out of 42), 11 SIDS (out of 27) and 36 developing countries (out of 57); the remaining 44 countries – 7 LDCs, 16 SIDS and 21 developing countries – have the average share above 2 per cent. Refer to figures 3 and 4 and associated data under tables 1 and 3 of Appendix 2 for further details.

Figure 3. Range of share of solar PV technology based on total grid-connected installed capacity



29. The comparison with the previous analysis shows that for share of solar PV technology based on total grid-connected installed capacity, the percentage of countries having share less than 2 per cent decreased from 73 per cent to 65 per cent. For further details, please refer to table 2 of Appendix 6.

Figure 4. Share of average solar PV installed capacity based on average grid-installed capacity in a country



30. Table 1 summarizes share of solar PV technology based on average annual electricity generation and on average installed capacity per region over 3 years from 2017 to 2019. Oceania region has the highest share of solar PV based on annual generation and based on installed capacity and as much as four times higher than the global average in both the generation and installed capacity. Asia has the lowest share of solar PV based on annual generation while Africa ranked lowest based on installed capacity.

Table 1. Comparison of share of solar PV technology by region

Region	Number of countries covered	Share (%) of solar PV technology	
		Based on annual generation	Based on installed capacity
Non-Annex I	126	1.32	2.89
Africa	52	0.89	1.74
Asia	22	0.73	2.43
Central America and the Caribbean	21	1.69	4.09
Middle East	12	1.99	4.01
Oceania	07	4.59	8.92
South America	12	1.09	2.01

31. The comparison with the previous analysis indicates that for non-Annex I countries, share of solar PV technology based on average annual electricity generation and on average installed capacity per region has increased from 0.73 per cent to 1.32 per cent and 1.42 per cent to 2.89 per cent, respectively. For further details, please refer to table 3 of Appendix 6.

4.4.2. Share of technologies in installed capacity additions: 2016-2019

32. The information related to increase in grid-connected installed capacity from 2016 to 2019 in the regions of Africa, Asia, Central America and the Caribbean and South America, Middle East and Oceania and in the specific countries having a dominant share of CDM projects i.e. Brazil, China, India and South Africa, as referred from Annex A of the World Energy Outlook, 2020 is analysed to study the share of solar PV technology and fossil fuel-based technologies in the capacity addition during the same period.

Table 2. Technology-wise share in the installed capacity of regional grids, 2016 to 2019

	Africa				Asia and Oceania				Central America and the Caribbean and South America				Middle East			
	2016	Avg. installed capacity over 2017- 2019	Capacity increase (GW)	% share in total increase	2016	Avg. installed capacity over 2017- 2019	Capacity increase (GW)	% share in total increase	2016	Avg. installed capacity over 2017- 2019	Capacity increase (GW)	% share in total increase	2016	Avg. installed capacity over 2017- 2019	Capacity increase (GW)	% share in total increase
Total capacity (GW)	210	242	32		2862	3110	248		333	361	28		309	330	21	
Coal	**45**	**49**	**4**	**11**	**1365**	**1451**	**86**	**35**	**13**	**13**	**0**	**1.19**	**0**	**0**	**0**	**0**
Oil	**41**	**43**	**2**	**5**	**119**	**100**	**-19**	**-8**	**48**	**49**	**1**	**4**	**88**	**93**	**5**	**25**
Gas	**82**	**102**	**20**	**61**	**367**	**368**	**1**	**1**	**61**	**67**	**6**	**21**	**203**	**216**	**13**	**61**
Nuclear	2	2	0	0	113	105	-8	-3	4	4	0	0	1	1	0	0
Renewables	40	47	7	22	898	1083	185	75	207	228	21	75	17	20	3	13
Hydro	32	35	3	10	517	542	25	10	170	180	10	36	16	17	1	3
Solar PV	**2**	**4**	**2**	**6**	**145**	**286**	**141**	**57**	**3**	**8**	**5**	**17**	**1**	**2**	**1**	**6**
Other RE*	6	8	2	6	236	293	57	23	34	41	7	23	0	1	1	3

** Other RE includes Bioenergy, On-shore wind, Geothermal, CSP and Marine-based technologies*

33. The data in table 2 indicate that comparing installed capacities in 2016 and average installed capacity over 2017-2019, gas-based electricity generation across Africa and Middle East makes up 61 per cent of capacity addition. In Central America and the Caribbean and South America, and Asia and Oceania regions, capacity addition is from renewables, mainly hydro and solar PV, respectively. It is noted that across the regions solar PV technology contributes 6 to 17 per cent in capacity additions except in Asia, where solar PV installations has contributed with a share up to 57 per cent. Overall, the data indicate that fossil fuel-based electricity generation still has major share in recent capacity additions in Africa and Middle East.

34. Further, solar PV has contributed 23 to 76 per cent in capacity additions under renewable energy category; the highest share of 76 per cent is from Asia while 23 per cent is from Central America and the Caribbean and South America.

35. The comparison with the previous analysis shows that solar PV technology's share in the capacity addition across the regions has increased. For example, in Africa it increased from 3 per cent to 6 per cent, in Asia and Oceania it increased from 23 per cent to 57 per cent, and in Central America and the Caribbean and South America it increased from 10 per cent to 17 per cent. The exception is in the Middle East region, where the share remained unchanged compared to the share during years 2014 to 2016. On the other hand, share of fossil fuel-based technologies is mixed: it increased from 66 per cent to 81 per cent in Africa and 17 per cent to 26 per cent in Central America and the Caribbean and South America region on account of increased share of natural gas-based technologies; and decreased from 49 per cent to 28 per cent in Asia and Oceania, and from 94 per cent to 86 per cent in the Middle East region. For further details, please refer to table 4 of Appendix 6.

36. The data related to capacity additions in 2016 and average capacity additions over years 2017 to 2019 in countries with a dominant share of CDM projects were also analysed as provided under table 3 below. It is noted that in recent years, except for Brazil, coal-based electricity generation has a major share, ranging from 33 to 71 per cent in capacity addition. In Brazil, hydro has a dominant share of around 64 per cent. Solar PV technology in these countries has a share ranging from 13 to 47 per cent.

37. The MP compared the above data in table 3 with the previous analysis and noted that the trend of increased share of solar PV technology in the capacity addition during years 2017 to 2019 is also followed at the country level; for example, in South Africa solar PV technology contributed 14 per cent in the capacity addition during years 2014 to 2016, which increased to 16 per cent during years 2017 to 2019. However, share of fossil fuel-based technologies increased in the South Africa from 57 per cent to 64 per cent and in Brazil from 0 per cent to 4 per cent, while it decreased in China and India from 37 per cent to 34 per cent and 51 per cent to 33 per cent, respectively. For further details, please refer to table 5 of Appendix 6.

Table 3. Technology-wise share in the installed capacity of major non-Annex I country grids, 2016 to 2019

	South Africa				Brazil				China				India			
	2016	Avg. installed capacity over 2017- 2019	Capacity increase (GW)	% share in total increase	2016	Avg. installed capacity over 2017- 2019	Capacity increase (GW)	% share in total increase	2016	Avg. installed capacity over 2017- 2019	Capacity increase (GW)	% share in total increase	2016	Avg. installed capacity over 2017- 2019	Capacity increase (GW)	% share in total increase
Total capacity (GW)	50	56	6		148	164	16		1 628	1 878	250		354	395	41	
Coal	**39**	**42**	**3**	**53**	**4**	**4**	**0**	**0**	**946**	**1 017**	**71**	**29**	**214**	**228**	**14**	**33**
Oil	**4**	**4**	**0**	**0**	**8**	**8**	**0**	**0**	**9**	**8**	**-1**	**0**	**8**	**8**	**0**	**0**
Gas	**0**	**1**	**1**	**11**	**12**	**13**	**1**	**4**	**68**	**81**	**13**	**5**	**29**	**29**	**0**	**0**
Nuclear	2	2	0	0	2	2	0	0	34	44	10	4	7	7	0	0
Renewables	5	8	3	47	122	137	15	94	571	727	156	62	96	124	28	69
Hydro	3	4	1	16	97	105	8	51	332	351	19	7	47	49	2	4
Solar PV	**1**	**2**	**1**	**16**	**0**	**2**	**2**	**13**	**78**	**170**	**92**	**37**	**9**	**28**	**19**	**47**
Other RE*	1	2	1	21	25	30	5	27	161	205	44	18	40	47	7	17

** Other RE includes Bioenergy, On-shore wind, Geothermal, CSP and Marine-based technologies*

4.4.3. LCOE calculation

38. Following the method listed under Appendix 3 and the data and sources listed under Appendix 3, LCOE of coal, HFO and natural gas-based electricity generation technologies, and solar PV technology for each of the 126 countries is calculated. Refer to Appendix 5 for detailed data of LCOE per technology per country.

4.4.3.1. Comparison with LCOE of coal-based technologies

39. The analysis is conducted for 25 countries that use coal-based electricity generation technology as one of the major technologies[19] together with HFO and or natural gas-based technologies. At regional level, this consists of 8 countries in Africa, 12 in Asia, 2 each in Middle East and South America and 1 in Central America and the Caribbean. Oceania region does not have any country where installed capacity of coal-based electricity generation is more than or equal to 30 per cent of the entire country's installed capacity, therefore, the region is excluded from the analysis.

40. Table 4 summarizes the LCOE of coal-based technologies and LCOE of solar PV technology at range of values for investment costs per region. It is noted that across all the regions, the LCOE of solar PV technology at lower-end investment cost is around 1.2 to 1.8 times higher than LCOE of coal-based technologies at higher threshold of fuel cost. However, at higher and weighted average estimate of investment cost, LCOE of solar PV is 1.8 to 4.6 times higher than LCOE of coal-based technologies at higher threshold of fuel cost. Therefore, at lower-end estimate of investment cost, solar PV is the preferred technology over coal-based technologies, while at higher-end estimate, coal-based technologies are preferred over solar PV technology. Refer to figure 5 for further details.

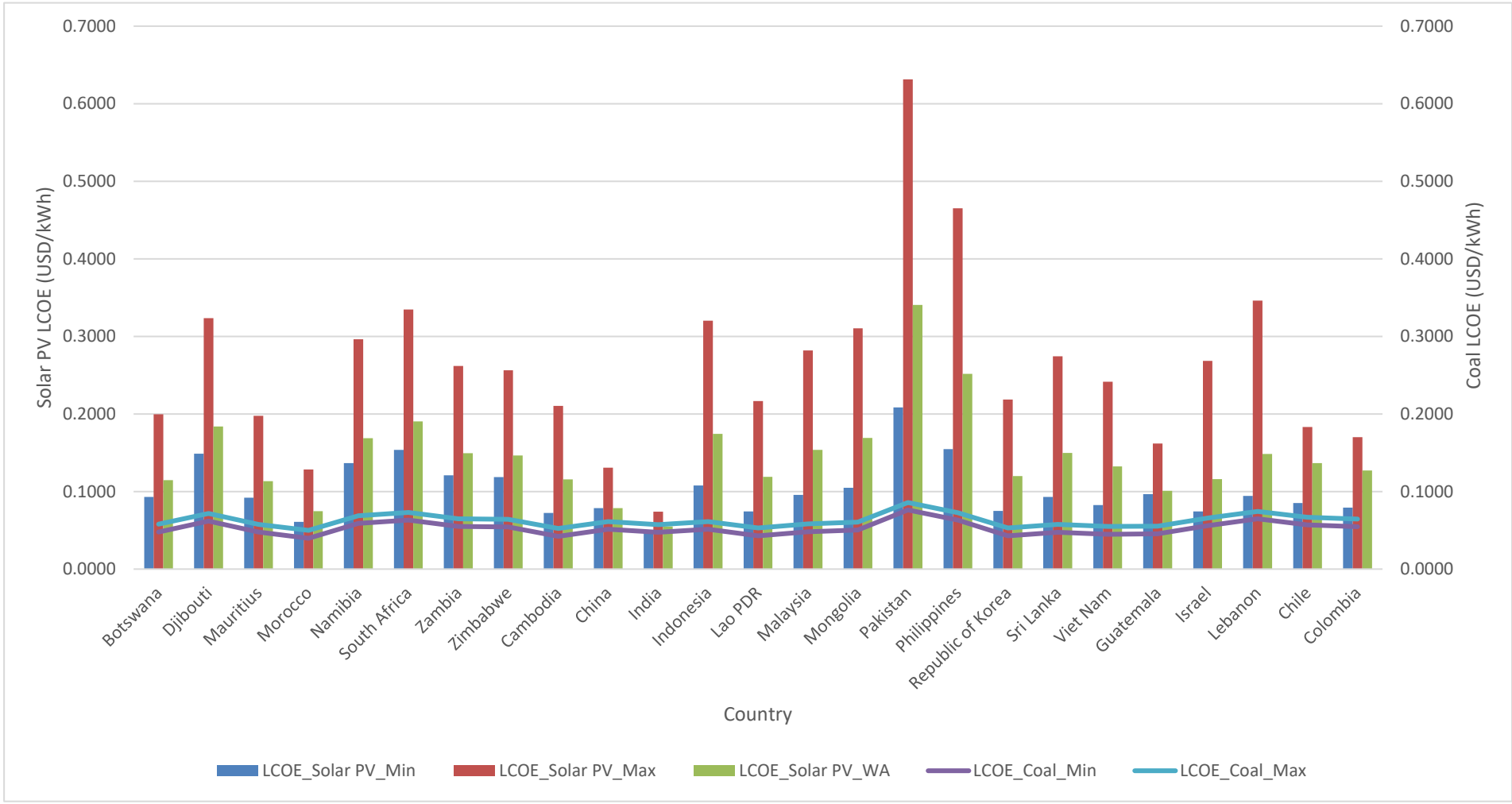
Table 4. Summary of LCOE of coal-based technologies and solar PV technology

Region	No. of countries (out of 126) using coal-based technologies	Region-based average LCOE (USD/kWh)				
		Coal_Min	Coal_Max	Solar PV_Min	Solar PV_Max	Solar PV_WA
Non-Annex I	25	0.0526	0.0625	0.1019	0.2601	0.1452
Africa	8	0.0536	0.0634	0.1156	0.2498	0.1427
Asia	12	0.0507	0.0606	0.0995	0.2813	0.1549
Central America and the Caribbean	1	0.0454	0.0554	0.0966	0.1617	0.1010
Middle East	2	0.0604	0.0701	0.0843	0.3073	0.1321
South America	2	0.0559	0.0657	0.0822	0.1767	0.1320

Min – Solar PV LCOE at minimum investment threshold; Max – Solar PV LCOE at maximum investment threshold; WA – Solar PV LCOE at weighted average investment threshold

[19] A fossil fuel-based technology is identified as a major technology for a country where it has more than or equal to 30 per cent share in installed capacity of fossil fuel-based electricity generation in the respective country.

Figure 5. Comparison of LCOE of coal-based technologies and solar PV technology



4.4.3.2. Comparison with LCOE of HFO-based technologies

41. The analysis is conducted for 81 countries that use HFO-based electricity generation technology as one of the major technologies together with coal and or natural gas-based technologies. At regional level, this consists of 35 countries in Africa, 19 in Central America and the Caribbean, 8 in Asia, 7 each in Oceania and South America, and 5 in Middle East.

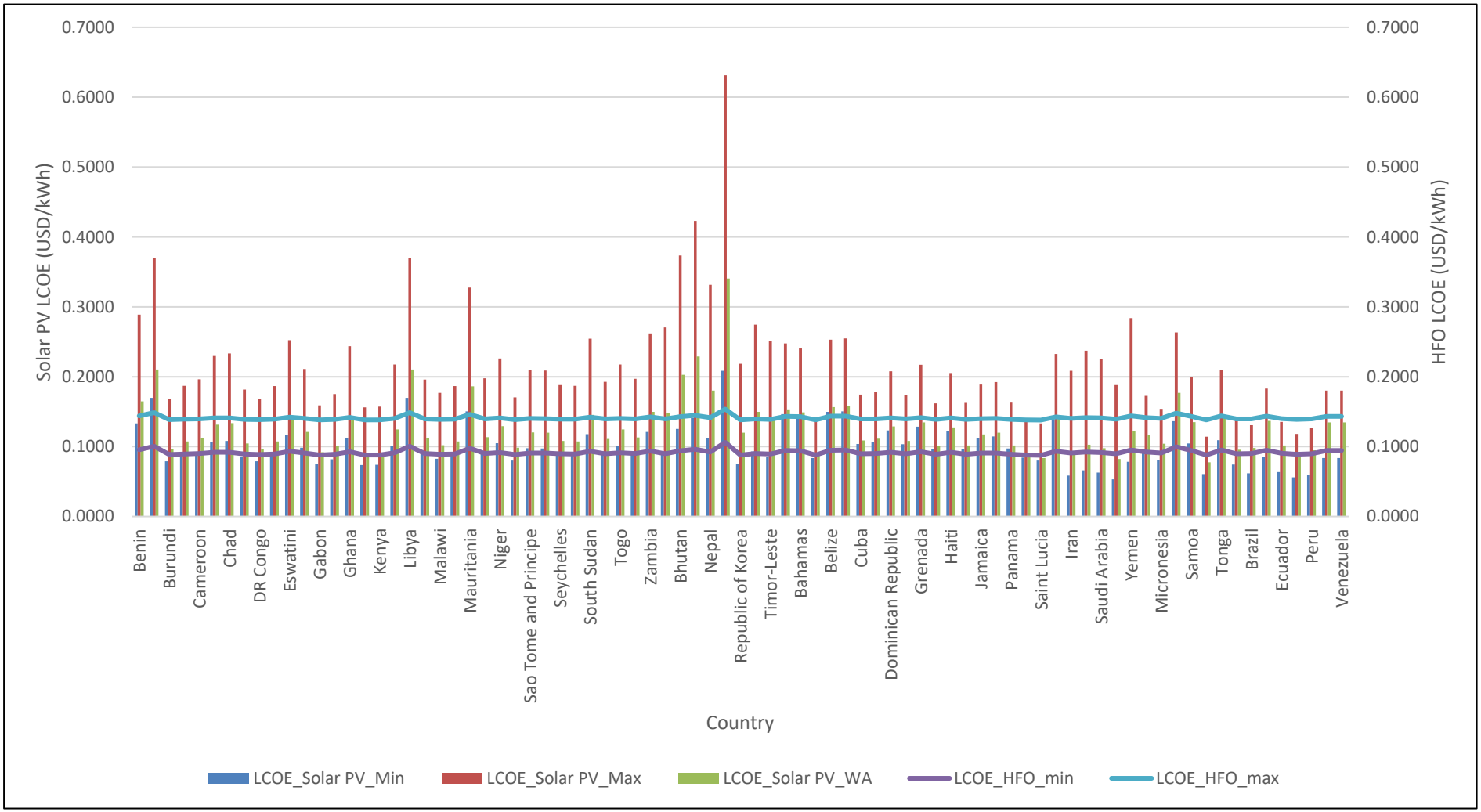
42. Table 5 summarizes the LCOE of HFO-based technologies and LCOE of solar PV technology at range of values for investment costs per region. It is noted that across all the regions, the LCOE of solar PV technology at lower-end investment cost is around 20 to 50 per cent less than LCOE of HFO-based technologies at higher threshold of fuel cost. Therefore, at lower-end estimate of investment cost, solar PV is the preferred technology over HFO-based technologies while at higher-end estimate, HFO-based technologies are preferred over solar PV technology. Refer to figure 6 for further details.

Table 5. Summary of LCOE of HFO-based technologies and solar PV technology

Region	No. of countries (out of 126) using coal-based technologies	Region-based average LCOE (USD/kWh)				
		HFO_Min	HFO_Max	Solar PV_Min	Solar PV_Max	Solar PV_WA
Non-Annex I	81	0.0916	0.1410	0.0998	0.2153	0.1265
Africa	35	0.0912	0.1406	0.1002	0.2157	0.1236
Asia	8	0.0932	0.1424	0.1165	0.3468	0.1884
Central America and the Caribbean	19	0.0911	0.1405	0.1147	0.1929	0.1200
Middle East	5	0.0919	0.1411	0.0637	0.2286	0.0991
Oceania	7	0.0929	0.1420	0.0937	0.1791	0.1209
South America	7	0.0919	0.1412	0.0705	0.1506	0.1127

Min – Solar PV LCOE at minimum investment threshold; Max – Solar PV LCOE at maximum investment threshold; WA – Solar PV LCOE at weighted average investment threshold

Figure 6. Comparison of LCOE of HFO-based technologies and solar PV technology



4.4.3.3. Comparison with LCOE of natural gas-based technologies

43. The analysis is conducted globally for 42 countries that use natural gas-based electricity generation technology as one of the major technologies together with coal and or HFO-based technologies. At regional level, it includes 15 countries in Africa, 10 in Middle East, 8 in South America, 6 in Asia, 2 in Central America and the Caribbean, and 1 in Oceania.

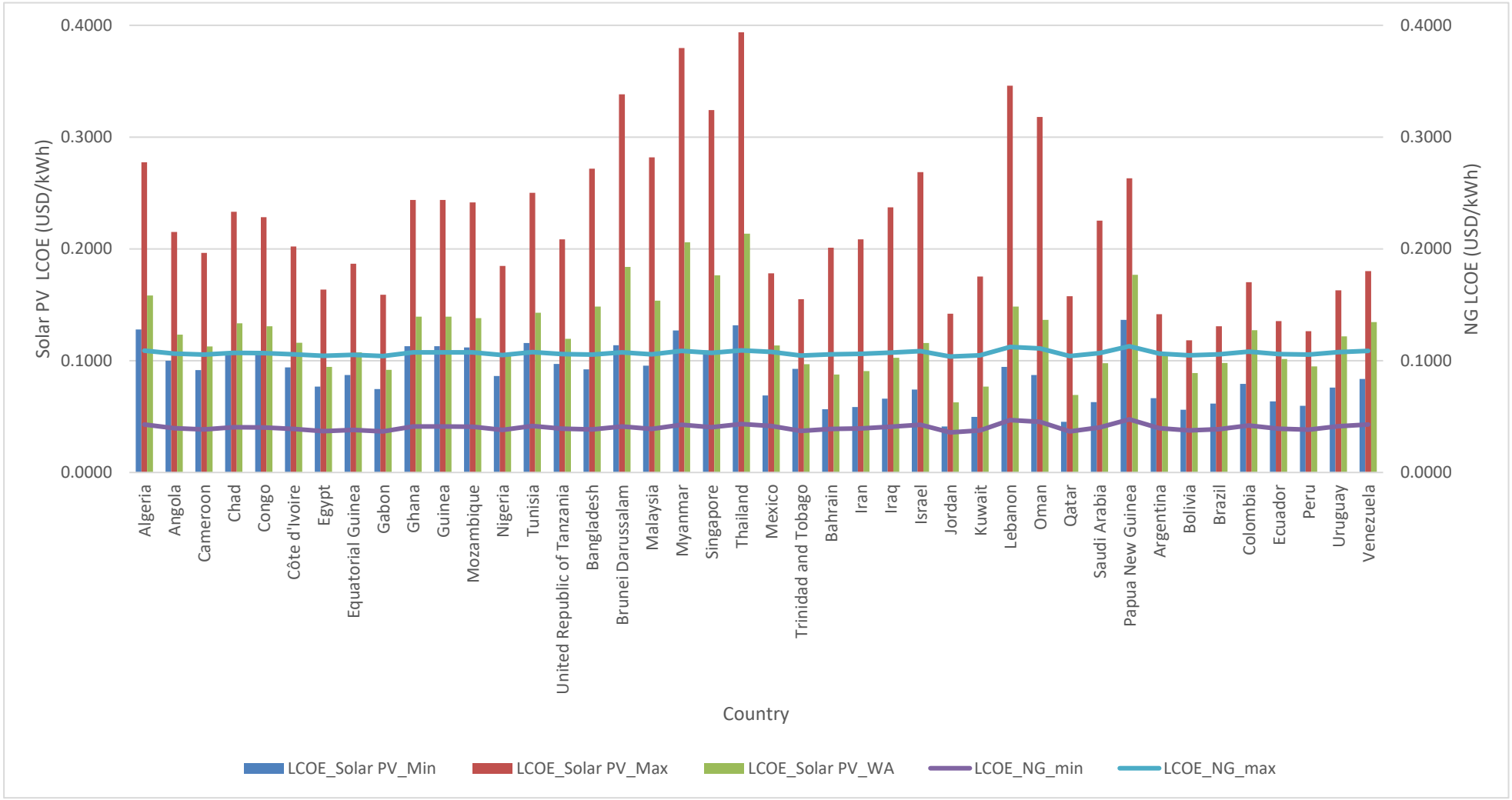
44. Table 6 summarizes LCOE of natural gas-based technologies and solar PV technology at range of values for investment costs per region. It is noted that across all the regions, LCOE of solar PV technology lower-end investment cost is around 10 to 40 per cent less than LCOE of natural gas-based technologies at higher threshold of fuel cost. Therefore, at lower-end estimate of investment cost, solar PV is the preferred technology over natural gas-based technologies, while at higher-end estimate, natural gas-based technologies are preferred over solar PV technology. Refer to figure 8 for further details.

Table 6. Summary of LCOE of natural gas-based technologies and solar PV technology

Region	No. of countries (out of 126) using coal-based technologies	Region-based average LCOE (USD/kWh)				
		NG_Min	NG_Max	Solar PV_Min	Solar PV_Max	Solar PV_WA
Non-Annex-I	42	0.0402	0.1068	0.0870	0.2206	0.1234
Africa	15	0.0396	0.1063	0.1002	0.2156	0.1236
Asia	6	0.0408	0.1072	0.1116	0.3316	0.1803
Central America and the Caribbean	2	0.0394	0.1062	0.0964	0.1706	0.1068
Middle East	10	0.0404	0.1070	0.0636	0.2280	0.0988
Oceania	1	0.0475	0.1129	0.1365	0.2633	0.1769
South America	8	0.0400	0.1066	0.0683	0.1457	0.1091

Min – Solar PV LCOE at minimum investment threshold; Max – Solar PV LCOE at maximum investment threshold; WA – Solar PV LCOE at weighted average investment threshold

Figure 7. Comparison of LCOE of natural gas-based technologies and solar PV technology



4.4.3.4. Summary of LCOE analysis

45. Table 7 summarizes the comparison of LCOE of fossil fuel-based technologies and LCOE of solar PV technology. At lower-end of investment estimate, solar PV is the cheapest option for electricity generation for 84 per cent of the countries that rely on HFO-based or natural gas-based technologies for electricity generation.

Table 7. Summary of comparison of LCOE of fossil fuel-based technologies and solar PV technology

Fossil fuel (FF)	Number of countries using FF as first choice for electricity generation[20]	Number of countries where		
		Solar PV_Min LCOE < FF LCOE_Max	Solar PV_Max LCOE < FF LCOE_Max	Solar PV_WA LCOE < FF LCOE_Max
Coal	18	1	0	1
HFO	70	70	6	62
Natural gas	36	31	0	15

4.5. Comparison with the other studies

46. The MP also compared the LCOE values for solar PV from the above analysis against the one estimated in the Renewables 2019 Global Status Report, published in 2019 (REN21) and in Renewable Power Generation Costs in 2019 (IRENA 2019). The comparison indicates that the LCOE values calculated in this information note are slightly higher but comparable to those estimated by REN21 and by IRENA 2019. The REN21 and IRENA 2019 calculated the LCOE with cost of capital (i.e.WACC) of 7.5 per cent for China and OECD countries and 10 per cent for the rest of the countries in the world. In this analysis, average country-specific WACC considered is around 12% with the range of 4.31 per cent to 31.54 per cent.

47. The LCOE values for solar PV in Asia were not included for comparison as REN21 provides separate LCOE value for China, India and for the rest of the Asia while this information note provides a unified value for the entire Asia region. Refer table 8 for further details.

Table 8. Summary of comparison of LCOE of solar PV technology as estimated in REN21 report and this information note

Region	Range of average LCOE (USD/kWh)			
	REN21		This info note	
	Min to Max	WA	Min to Max	WA
Africa	0.10 to 0.15	0.11	0.12 to 0.25	0.14
Central America and the Caribbean	0.10 to 0.20	0.105	0.097 to 0.16	0.10

[20] Lesotho and Paraguay are not included in the count as these countries rely on hydropower as the single largest source for electricity generation.

Region	Range of average LCOE (USD/kWh)			
	REN21		This info note	
	Min to Max	WA	Min to Max	WA
Middle East	0.05 to 0.21	0.090	0.084 to 0.31	0.13
South America	0.05 to 0.17	0.10	0.082 to 0.18	0.13

48. The comparison with the previous analysis reveals that for the non-Annex I countries, LCOE of solar PV technology at weighted average investment costshas decreased in the rage of 7 to 21 per cent, mainly due to increased capacity factor across the regions. Further, LCOE of fossil fuel-based technologies has seen a decrease up to 23 per cent mainly due to the corresponding decrease in the cost of the fossil fuels, except in case of natural gas-based technologies where increase by 60 per cent mainly due to corresponding increase in natural gas cost is seen. Refer to Appendix 6 for further details.

49. As per IRENA 2019, about 98 GW of newly installed systems have been commissioned during 2019, dominated by Asia region that contributed about 60 per cent of the added capacity. These new capacity additions were highest among all renewable energy technologies for the year.

50. As per IRENA 2019, in terms of global weighted average LCOE of solar PV there is 13 per cent year-on-year decrease from 2018. Similar trend is followed at country level, specifically for Brazil, China, India and South Africa there is decrease in the range of 6 to 16 per cent year-on-year basis. This highlights that solar PV technology is becoming cheaper and more competitive when compared with the fossil fuel-based technologies.

51. During COP26, [21] more than 23 countries including major coal users for example, Indonesia, Viet Nam, South Korea, Egypt, Nepal, Singapore and Chile have made their pledges to reduce their dependence on the coal-based technologies for electricity generation and to move away from future investments in these technologies and thereby committing to scaling up clean power and ensuring a just transition away from coal.

52. In addition, 20 countries including the United States of America and China together with major multi-lateral development banks, international financial institutions and major international lenders like HSBC, Fidelity International and Ethos pledged to end public financing for "unabated" fossil fuel projects implementing coal, HFO and natural gas-based technologies by the end of 2022.

53. As per Carbon Tracker report,[22] declining renewable energy costs and existing carbon and air pollutions regulations were already undermining coal-based technologies as the least -cost option for power generation. The report mentions that for some of the countries for example Bangladesh, Pakistan and South Korea, the coal-based technologies are costlier than new renewable energy-based technologies such as solar PV. Further, the report concludes that coal generation would become uneconomic in both absolute and relative terms by 2025 when investments in new renewable energy generation plants would beat

[21] Refer to <https://unfccc.int/news/end-of-coal-in-sight-at-cop26>

[22] Carbon Tracker, March 2020, How to waste over half a trillion dollars available at <https://carbontracker.org/reports/how-to-waste-over-half-a-trillion-dollars/>

new coal investments. The report also highlights that latest by 2030, the long run marginal cost of coal-based technologies will be higher than the LCOE of solar PV and wind technologies. This will make LCOE of these technologies cheaper than LCOE of coal-based technologies.

54. This highlights the future pathway in terms of energy transition towards clean energy alternatives such as renewable energy sources.

5. Limitations of the analysis

55. The MP would also like to highlight the limitations of this study, for example assumptions of the fossil fuel costs which are fluctuating beyond the normal ranges such as 10 or 20 per cent. It is noted that the fossil fuel cost today, as compared to data vintage period of 2017 to 2019 which is considered for this analysis, has increased by more than 20 to 30 per cent, for example, the average cost of HFO during 2017 to 2019 period was 0.46 USD/liter (i.e. around 73 USD/barrel) while the same as in January 2022 is around 0.60 USD/liter (i.e. around 95 USD/barrel).

56. Further, the difference in LCOE of solar PV between countries within the same region has to be interpreted with caution as the analysis only takes into account the country specific WACC values as discount rate and relies heavily on regional values for investment cost and capacity factor for solar PV. The same applies to LCOE of fossil fuel-based technologies.

57. The analysis is based on the data vintage from 2017 to 2019 and does not take into account future country policies or pledges towards clean energy transitions and predictions related to investment cost and LCOE of a certain electricity generation technology.

6. Key findings

58. For 104 countries out of 126 countries (i.e. 83 per cent of countries), the share of solar PV technology is below 2 per cent when calculated based on the annual average electricity generation between 2017 and 2019. When the share is based on the annual average installed capacity between 2017 and 2019, the share of solar PV technology is less than 2 per cent for 82 countries (i.e. 65 per cent of countries). Further, it is noted the installed capacity of grid-connected solar PV technology in 84 countries is less than or equal to 50 MW.

59. The MP noted that as per TOOL32 requirement a specific technology listed in the tool is defined as automatically additional if at the time of PDD submission any of the following conditions is met:

    (a) The percentage share of total installed capacity of the specific technology in the total installed grid connected power generation capacity in the host country is equal to or less than two per cent; or

    (b) The total installed capacity of the technology in the host country is less than or equal to 50 MW.

60. Noting the criteria as in paragraph 59 above and data vintage in paragraph 58 above, solar PV is technology will be automatically additional in 84 countries that includes 45 countries

from Africa, 9 from Asia, 13 from Central America and the Caribbean, 5 from Middle East, 7 from Oceania and 5 from South America. It is also noted that most of these (78 out of 84) countries either rely on HFO or natural gas-based technologies as major sources of electricity generation.

61. The share of solar PV based on annual generation as well as on installed capacity is highest in Oceania region, (i.e. 4.59 per cent and 8.92 per cent, respectively). This is roughly four times the world average, which is 1.32 per cent and 2.89 per cent, respectively. Conversely, Asia has the lowest share of solar PV, i.e. 0.73 per cent on the basis of annual generation and on the basis of installed capacity Africa ranks lowest with 1.74 per cent.

62. Further, referring to the capacity additions over the three-year period from 2017 to 2019 and comparing them with the installed capacity of 2016, it is noted that solar PV's share is ranging 13 to 17 per cent of the capacity addition in Africa, Central America and the Caribbean and South America, and Middle East, while in Asia and Oceania it is 57 per cent.

63. The LCOE is estimated based on a range of values for investment costs for solar PV and on a range of values for fossil fuel cost. The analysis reveals;

    (a) For 70 countries relying on HFO-based technologies as major sources of electricity generation, the LCOE of solar PV technology at lower-end investment estimate is around 20 to 50 per cent lower than the LCOE of HFO-based technologies at high-end investment estimate;

    (b) For 36 countries relying on natural gas-based technologies as major sources of electricity generation, the LCOE of solar PV technology at lower-end investment estimate is around 10 to 40 per cent lower than the LCOE of natural gas-based technologies at high-end investment estimate; and

    (c) For 18 countries relying on coal-based technologies as major sources of electricity generation, it is found that the LCOE of solar PV technology at lower-end investment estimate is higher than the LCOE of coal-based technologies at high-end investment estimate.

64. Solar PV technology is cost competitive in 84 per cent of countries that rely either on HFO-based technologies or natural gas-based technologies for electricity generation. The magnitude of difference is dependent on characteristics of the particular renewable energy source and technology but also on the fossil-fuel mix prevalent in the country (e.g. domination of coal vs. oil or gas vs. coal could make a difference).[23]

65. The analysis reveals that for a higher number of countries, solar PV technology is becoming a cost competitive option[24] for electricity generation than comparative fossil fuel-based technologies.

[23] Granularity of the available data supported limited distinction among: (a) types of grid-connected solar PV technology and comparable fossil fuel-based technologies; and (b) applicable thresholds of the small-scale project activities, although it was found that investment cost of rooftop solar was up to three times the average capital cost of utility scale solar PV.

[24] A review of methodologies from voluntary market mechanism indicates that the Gold Standard and Verra do not include solar PV under the positive list of technologies

7. Subsequent work and timelines

66. Based on the guidance received from the Board, the MP will address the positive list of technologies as contained in TOOL32.

8. Recommendation

67. The MP recommends that the Board take note of this information note and provide further guidance as necessary to the MP for further work in this regard.

9. References

(a) Carbon Tracker, March 2020, How to waste over half a trillion dollars available at <https://carbontracker.org/reports/how-to-waste-over-half-a-trillion-dollars/>

(b) CDM Methodological Tool, *TOOL09: Determining the baseline efficiency of thermal or electric energy generation systems*, *version 3.0*, available at <http://cdm.unfccc.int/Reference/tools/index.html>

(c) CDM Methodological Tool, *TOOL27: Investment Analysis, version 10.0*, available at <http://cdm.unfccc.int/Reference/tools/index.html>

(d) IEA, 2020, Electricity information, available at <https://www.iea.org/reports/electricity-information-overview>

(e) IEA, 2020, Projected Costs of Generating Electricity

(f) IEA, 2021, World Energy Investment

(g) IEA, 2020, World Energy Outlook, Annex A

(h) IRENA - International Renewable Energy Agency, Renewable Power Generation Costs in 2020, published in 2021

(i) IRENA, 2019, Renewable Power Generation Costs in 2019, available at <https://www.irena.org/publications/2020/Jun/Renewable-Power-Costs-in-2019>

(j) IRENA, 2021, Query tool - IRENA, available at <https://www.irena.org/Statistics/Download-Data>

(k) Lazard, 2020, *Lazard estimates, version 14*, available at <Lazard's Levelized Cost of Energy Analysis—Version 14.0>

(l) Ondraczek, J., Komendantova, N., Patt, A. WACC the dog: *The effect of financing costs on the levelized cost of solar PV power*. Renewable Energy Journal, 2015. Available from: <https://doi.org/10.1016/j.renene.2014.10.053>

(m) Organisation for Economic Co-operation and Development, et al. *Projected costs of generating electricity*. Paris: Organisation for Economic Co-operation and Development (OECD), International Energy Agency (IEA) and Nuclear Energy Agency (NEA), 2015. Available from: <https://www.oecd-nea.org/ndd/pubs/2015/7057-proj-costs-electricity-2015.pdf>

(n) REN21,2019, *Renewables 2019 Global status report*

(o) The World Bank, 2021, World Bank Lending interest rate. Available from: <https://data.worldbank.org/indicator/FR.INR.LEND?end=2020&start=2020&view=map>

Appendix 1. Data related to share of solar PV in non-Annex I country context

Table 1. Installed capacity of various electricity generation technologies (MW) for year 2018

Sr. No.	Technology	Installed capacity	% share in the global installed capacity	Is the technology included in the positive list under TOOL32
1	Fossil Fuel	2,374,142.16	65.05	No
2	Hydro	726,274.54	19.90	No
3	On-shore Wind	247,004.11	6.77	No
4	Solar PV	232,317.16	6.37	Yes
5	Bioenergy	42,920.55	1.18	No
6	Biogas and Municipal Solid Waste	8,138.38	0.22	Yes[1]
7	Geothermal	5,271.54	0.14	No
8	Off-shore Wind	4,768.20	0.13	Yes
9	CSP	1,735.76	0.05	Yes
10	Marine (tidal and wave)	259.72	0.01	Yes
11	Other Non-RE	6,801.07	0.19	No
	Total	3,649,633.18		

Source – IRENA database, 2021 (https://www.irena.org/Statistics/Download-Data)

Table 2. Electricity generation from various electricity generation technologies (GWh) for year 2018

Sr. No.	Technology	Electricity generation	% share in the global electricity generation	Is the technology included in the positive list under TOOL32
1	Fossil Fuel	10,069,865.25	73.87	No
2	Hydro	2,519,225.05	18.48	No
3	On-shore Wind	503,043.99	3.69	No
4	Solar PV	249,770.06	1.83	Yes
5	Bioenergy	170,812.95	1.25	No

[1] Electricity generation up to 10 MW is considered under positive list of TOOL32 under waste handling and disposal sector

Sr. No.	Technology	Electricity generation	% share in the global electricity generation	Is the technology included in the positive list under TOOL32
6	Biogas and Municipal Solid Waste	35,264.17	0.26	Yes[6]
7	Geothermal	32,956.54	0.24	No
8	Off-shore Wind	9,353.57	0.07	Yes
9	CSP	3,357.42	0.02	Yes
10	Marine (tidal and wave)	491.86	0.00	Yes
11	Other Non-RE	37,835.31	0.28	No
	Total	13,631,976.16		

Source – IRENA database, 2021 (https://www.irena.org/Statistics/Download-Data)

Appendix 2. Data related to share of solar PV

Table 1. Share of solar PV technology

Country	Region	LDC/SIDS	Annual average share of solar PV generation in % of annual average total generation over 2017 to 2019	Annual average share of solar PV installed capacity in % of annual average total grid-connected capacity over 2017 to 2019
Afghanistan	Asia	LDC	0.63	1.11
Algeria	Africa	N	0.00	0.00
Angola	Africa	LDC	0.00	0.00
Antigua and Barbuda	Central America and the Caribbean	SIDS	3.04	7.78
Argentina	South America	N	0.23	0.55
Bahamas	Central America and the Caribbean	SIDS	0.11	0.25
Bahrain	Middle East	SIDS	0.05	0.10
Bangladesh	Asia	LDC	0.10	0.29
Barbados	Central America and the Caribbean	SIDS	3.27	9.07
Belize	Central America and the Caribbean	SIDS	0.82	1.32
Benin	Africa	LDC	0.39	0.62
Bhutan	Asia	LDC	0.00	0.00
Bolivia (Plurinational State of)	South America	N	1.10	2.41
Botswana	Africa	N	0.06	0.23
Brazil	South America	N	0.60	1.66
Brunei Darussalam	Asia	N	0.04	0.14

Country	Region	LDC/SIDS	Annual average share of solar PV generation in % of annual average total generation over 2017 to 2019	Annual average share of solar PV installed capacity in % of annual average total grid-connected capacity over 2017 to 2019
Burkina Faso	Africa	LDC	4.26	9.37
Burundi	Africa	LDC	0.21	0.41
Cabo Verde	Africa	SIDS	1.89	3.60
Cambodia	Asia	LDC	0.81	2.72
Cameroon	Africa	N	0.00	0.00
Central African Republic	Africa	LDC	0.00	0.00
Chad	Africa	LDC	0.00	0.00
Chile	South America	N	6.33	8.57
China	Asia	N	2.44	8.98
Colombia	South America	N	0.06	0.34
Comoros	Africa	LDC	0.00	0.00
Congo	Africa	N	0.00	0.00
Costa Rica	Central America and the Caribbean	N	0.39	0.96
Côte d'Ivoire	Africa	N	0.00	0.00
Cuba	Central America and the Caribbean	SIDS	0.62	1.78
Democratic Republic of the Congo	Africa	LDC	0.00	0.00
Djibouti	Africa	LDC	0.00	0.00
Dominica	Central America and the Caribbean	SIDS	0.29	1.55
Dominican Republic	Central America and the Caribbean	SIDS	1.18	3.06
Ecuador	South America	N	0.13	0.33
Egypt	Africa	N	0.13	1.51

Country	Region	LDC/SIDS	Annual average share of solar PV generation in % of annual average total generation over 2017 to 2019	Annual average share of solar PV installed capacity in % of annual average total grid-connected capacity over 2017 to 2019
El Salvador	Central America and the Caribbean	N	5.52	11.18
Equatorial Guinea	Africa	N	0.00	0.00
Eswatini	Africa	N	0.03	0.07
Ethiopia	Africa	LDC	0.00	0.00
Fiji	Oceania	SIDS	0.54	1.40
Gabon	Africa	N	0.00	0.00
Gambia	Africa	LDC	0.07	0.18
Ghana	Africa	N	0.23	1.08
Grenada	Central America and the Caribbean	SIDS	1.45	4.85
Guatemala	Central America and the Caribbean	N	1.77	2.24
Guinea	Africa	LDC	0.01	0.01
Guinea-Bissau	Africa	LDC	0.00	0.00
Guyana	South America	SIDS	0.63	2.13
Haiti	Central America and the Caribbean	LDC	0.17	0.27
Honduras	Central America and the Caribbean	N	8.89	18.39
India	Asia	N	1.94	6.13
Indonesia	Asia	N	0.01	0.10
Iran (Islamic Republic of)	Middle East	N	0.09	0.33
Iraq	Middle East	N	0.37	0.43
Israel	Middle East	N	2.72	5.87
Jamaica	Central America and the Caribbean	SIDS	1.26	5.72

Country	Region	LDC/SIDS	Annual average share of solar PV generation in % of annual average total generation over 2017 to 2019	Annual average share of solar PV installed capacity in % of annual average total grid-connected capacity over 2017 to 2019
Jordan	Middle East	N	7.10	15.00
Kenya	Africa	N	0.02	1.41
Kuwait	Middle East	N	0.07	0.21
Lao People's Democratic Republic	Asia	LDC	0.07	0.27
Lebanon	Middle East	N	0.70	1.45
Lesotho	Africa	LDC	0.09	0.27
Liberia	Africa	LDC	0.00	0.00
Libya	Africa	N	0.00	0.00
Madagascar	Africa	LDC	0.00	1.71
Malawi	Africa	LDC	0.09	0.19
Malaysia	Asia	N	0.27	1.81
Maldives	Asia	SIDS	0.00	0.00
Mali	Africa	LDC	0.00	0.00
Mauritania	Africa	LDC	8.60	10.20
Mauritius	Africa	SIDS	2.29	7.02
Mexico	Central America and the Caribbean	N	1.20	3.14
Micronesia (Federated States of)	Oceania	SIDS	3.33	4.41
Mongolia	Asia	N	0.92	4.54
Morocco	Africa	N	0.52	1.13
Mozambique	Africa	LDC	0.00	1.42
Myanmar	Asia	LDC	0.00	0.22

Country	Region	LDC/SIDS	Annual average share of solar PV generation in % of annual average total generation over 2017 to 2019	Annual average share of solar PV installed capacity in % of annual average total grid-connected capacity over 2017 to 2019
Namibia	Africa	N	12.77	14.51
Nepal	Asia	LDC	0.05	0.16
Nicaragua	Central America and the Caribbean	N	0.46	0.92
Niger	Africa	LDC	0.00	1.35
Nigeria	Africa	N	0.01	0.01
Oman	Middle East	N	0.04	0.09
Pakistan	Asia	N	0.74	1.85
Panama	Central America and the Caribbean	N	2.03	4.58
Papua New Guinea	Oceania	SIDS	0.00	0.04
Paraguay	South America	N	0.00	0.00
Peru	South America	N	1.14	1.97
Philippines	Asia	N	1.24	3.92
Qatar	Middle East	N	0.02	0.05
Republic of Korea	Asia	N	1.68	6.67
Rwanda	Africa	LDC	1.99	5.58
Saint Kitts and Nevis	Central America and the Caribbean	SIDS	1.30	2.73
Saint Lucia	Central America and the Caribbean	SIDS	0.63	3.11
Saint Vincent and the Grenadines	Central America and the Caribbean	SIDS	1.08	2.75
Samoa	Oceania	SIDS	13.79	23.05
Sao Tome and Principe	Africa	LDC	0.00	0.00
Saudi Arabia	Middle East	N	0.08	0.18

Country	Region	LDC/SIDS	Annual average share of solar PV generation in % of annual average total generation over 2017 to 2019	Annual average share of solar PV installed capacity in % of annual average total grid-connected capacity over 2017 to 2019
Senegal	Africa	LDC	7.67	13.68
Seychelles	Africa	SIDS	0.79	2.12
Sierra Leone	Africa	LDC	0.00	0.04
Singapore	Asia	SIDS	0.37	1.37
Solomon Islands	Oceania	LDC	1.40	2.10
South Africa	Africa	N	2.18	7.27
South Sudan	Africa	LDC	0.00	0.00
Sri Lanka	Asia	N	1.44	4.00
State of Palestine	Middle East	N	12.65	24.37
Sudan	Africa	LDC	0.00	0.00
Suriname	South America	SIDS	0.41	1.03
Thailand	Asia	N	2.49	5.65
Timor-Leste	Asia	LDC	0.00	0.00
Togo	Africa	LDC	0.00	0.00
Tonga	Oceania	SIDS	9.45	24.55
Trinidad and Tobago	Central America and the Caribbean	SIDS	0.05	0.15
Tunisia	Africa	N	0.87	1.03
Uganda	Africa	LDC	1.08	3.43
United Republic of Tanzania	Africa	LDC	0.00	0.01
Uruguay	South America	N	2.44	5.14
Vanuatu	Oceania	SIDS	3.62	6.89

Country	Region	LDC/SIDS	Annual average share of solar PV generation in % of annual average total generation over 2017 to 2019	Annual average share of solar PV installed capacity in % of annual average total grid-connected capacity over 2017 to 2019
Venezuela (Bolivarian Republic of)	South America	N	0.00	0.00
Viet Nam	Asia	N	0.79	3.48
Yemen	Middle East	LDC	0.00	0.00
Zambia	Africa	LDC	0.01	1.00
Zimbabwe	Africa	N	0.04	0.09

LDC – Least developed country, SIDS – Small island developing state, N – Other developing countries not identified as LDC or SIDS as per United Nations.

Table 2. Range of share of solar PV technology in total grid connected electricity generation

Range (%)	Number of countries	Out of which LDCs	Out of which SIDS	Out of which other developing countries (non LDCs, SIDs)
0 to 2	104	39	20	45
2 to 5	12	1	5	6
5 to 10	7	2	1	4
More than 10	3	0	1	2
Total	126	42	27	57

Table 3. Range of share of solar PV technology in total grid connected installed capacity

Range (%)	Number of countries	Out of which LDCs	Out of which SIDS	Out of which developing countries (non LDCs, SIDs)
0 to 2	82	35	11	36
2 to 5	20	3	9	8
5 to 10	15	2	5	8
More than 10	9	2	2	5
Total	126	42	27	57

Appendix 3. Methodology

1. Methodology applied for conducting the analysis

1. The following methodology is applied for calculating LCOE and share of grid-connected renewable energy generation technologies.

1.1. Share of grid-connected solar PV technology

2. The following two approaches were used to calculate share of solar PV technology in a region or a country.

1.1.1. Share based on annual average electricity generation (SEG)

3. It is calculated using following equation:

$$SEG_{x,n,t} = \frac{S_{x,n,t}}{(G_{n,t} + Imp_{n,t}) - Exp_{n,t}} \quad \text{Equation (1)}$$

Where:

$SEG_{x,n,t}$	=	Share of a renewable energy technology *x*, based on its electricity generation in country *n*, period t
$S_{x,n,t}$	=	Annual renewable electricity *x* generated in country n, period t
$G_{n,t}$	=	Annual total electricity generated in country°*n*, period t
$Imp_{n,t}$	=	Annual total electricity import verified in country°*n*, period t
$Exp_{n,t}$	=	Annual total electricity export verified in country°*n*, period t

4. SEG refers to the share of renewable energy generation meeting domestic demand. This needs to be discussed further as the proposed equation would result in very conservative estimates for countries where RE is developed primarily because of export market. Share of renewable energy technology could be simply total electricity generation from specific RETs divided by total electricity generation (which already includes export) in the grid; a similar approach is used for determining 3 per cent share under microscale tool[1].

1.1.2. Share based on annual average installed capacity (SIC)

5. It is calculated using following equation:

$$SIC_{x,n,t} = \frac{REIC_{x,n,t}}{PIC_{n,t}} \quad \text{Equation (2)}$$

[1] DNA submission route as per “procedure for submission and consideration of microscale renewable energy technologies for automatic additionality”

Where:

$SIC_{x,n,t}$	=	Share of renewable energy technology *x* based on the technology installed capacity in country°*n*, period°*t*
$REIC_{x,n,t}$	=	Cumulative renewable technology°*x* installed capacity in country n, period t
$PIC_{n,t}$	=	Cumulative power installed capacity in country°*n*, period°*t*

6. Country-specific total electricity generation, generation from solar PV technology are is sourced from IRENA Query Tool.

1.2. Method and data sources proposed to use to estimate LCOE

1.2.1. Method

7. For the purpose of the analysis, LCOE of three commonly used fossil fuels – coal, heavy fuel oil (HFO) and natural gas – is compared with the LCOE of solar PV technology in 126 non-Annex I countries across the regions Africa, Asia, Central America and the Caribbean, Middle East, Oceania and South America.

8. Further, LCOE of solar PV technology is calculated using three different scenarios of investment cost – minimum, maximum and weighted average[2] investment cost – that is further based on weighted average capacity factor of the technology of each of the regions or a specific country if such value is available.

9. The LCOE can be described per equation (3) below:

$$\text{LCOE} = \frac{\text{Total Cost During the Project Life Cycle}}{\text{Total Electricity Production During the Project Life Cycle}} \left[\frac{\$}{MWh}\right] \qquad \text{Equation (3)}$$

10. The LCOE of solar PV technology for each country is calculated taking into account the weighted average capacity factor and the cost of capital, notably influenced by weighted average cost of capital (WACC) and comparing the result with the dominant fossil fuel technologies used in that particular technology.

11. Based on literature,[3] LCOE is calculated at a country level for an electricity generation technology. Although following equation (4) is commonly used to calculate LCOE for a plant, the same equation is used for a specific technology using global default values of

[2] Based on data provided in International Renewable Energy Agency, Renewable Power Generation Costs in 2020.

[3] Ondraczek, J., Komendantova, N. and Patt, A. WACC the dog: The effect of financing costs on the levelized cost of solar PV power. Renewable Energy Journal, 2015. Available from: <https://doi.org/10.1016/j.renene.2014.10.053>; and Organisation for Economic Co-operation and Development, et al. Projected costs of generating electricity. Paris: Organisation for Economic Co-operation and Development (OECD), International Energy Agency (IEA) and Nuclear Energy Agency (NEA), 2015. Available from: https://www.oecd-nea.org/ndd/pubs/2015/7057-proj-costs-electricity-2015.pdf.

economic lifespan, investment cost, O&M cost, decommissioning cost and annual degradation factor for the specific technology and country specific WACC values.

$$LCOE_n = \frac{\sum_{t=0}^{T}(I_t + O_t + D_t)/(1+r_n)^t}{\sum_{t=0}^{T} S_n(1-d)^t/(1+r_n)^t} \quad \text{Equation (4)}$$

Where:

$LCOE_n$	=	Levelized cost of electricity in country n
T	=	Economic lifespan of project
t	=	Year°t, (0, 1, 2, & n), where°t = 0 is the year of installation and start of operation
I_t	=	Initial investment cost in period°t
O_t	=	Operation and maintenance cost in period°t
D_t	=	Decommissioning cost in period°t
r_n	=	Discount rate in country°n
S_n	=	Rated energy output in country°n
d	=	Annual degradation factor for fossil fuel-based technologies or annual module degradation factor applicable for solar PV technology

12. The analysis does not include carbon price, as a majority of the non-Annex I countries do not have any carbon tax for fossil fuel.

13. In case of fossil fuel technologies, the cost of fuel is referred from average of spot prices from IEA.

14. It is noted that REN21 report provides minimum, maximum and weighted average values for total investment cost and weighted average capacity factor for renewable energy technologies.

1.2.1.1. Weighted Average Cost of Capital

15. The country-specific $WACC_n$ from Equation (5) is used as the input for the discount rate in country n (i.e. r_n) in Equation (4), enabling us to calculate the LCOE of Solar PV in each country.

16. For calculation of $WACC_n$, the following parameter values for developing countries is used as mentioned in TOOL27: Investment Analysis:

    (a) Share of equity and debt: 50/50;

    (b) Cost of Equity (K_{En}): default values;

    (c) Cost of Debt (K_{Dn}): data from the World Bank's database or from respective country's central bank on the commercial lending rates;

    (d) Estimated in real terms, no inflation is considered.

17. The cost of capital for technology and country-specific LCOE is determined as

$$WACC_n = \frac{E_n}{(E_n + D_n)} * k_{E_n} + \frac{D_n}{(E_n + D_n)} * k_{D_n}$$ Equation (5)

Where:

$WACC_n$	=	Weighted average cost of capital in country°*n*
E_n	=	Amount of equity used in financing project in country°*n*
k_{E_n}	=	Equity rate of return in country°*n*
D_n	=	Amount of debt used in financing project in country°*n*
k_{D_n}	=	Debt interest rate in country°*n*

18. Equity rate of return for a specific country is sourced from TOOL27: Investment Analysis while country-specific debt lending rate is sourced from the World Bank's database on lending interest rate. In cases where data from the World Bank are not available, data from of respective country's central bank are used.

1.2.2. Potential data sources referred for parameters used to calculate LCOE

19. Appendix 4 lists global and country-specific data along with their sources on investment cost of fossil fuel-based technologies and solar PV technology, cost of fuel, heat content of coal, gross efficiency of fossil fuel technologies, O&M cost for fossil fuel and solar PV technology, lifetime and degradation factor for fossil fuel-based technologies, and module degradation factor for solar PV technology.

Appendix 4. Data sources and assumptions used for fossil fuel LCOE analysis

1. Data sources for parameters used to calculate LCOE

1. Refer to table 1 for global and regional data used and its sources on investment cost of fossil fuel power generating technologies and solar PV technology, cost of fuel, heat content of coal, gross efficiency of fossil fuel technologies, O&M cost for fossil fuel and solar PV technology, lifetime and degradation factor for fossil fuel power generating technologies and solar PV technology.

Table 1. Data sources and assumptions used for fossil fuel analysis

Indicator	Value	Unit	Source
Global default values			
Heat content of coal	25	GJ/tonne	Projected costs of generating electricity, 2020
Cost of coal	69.20	USD/tonne	https://www.iea.org/reports/key-world-energy-statistics-2020/prices
Cost of Natural Gas	9.30	USD/MMBTU	https://www.iea.org/reports/key-world-energy-statistics-2020/prices
Cost of HFO	0.30	USD/liter	https://www.iea.org/reports/key-world-energy-statistics-2020/prices
Cost of coal (maximum threshold)	69.20	USD/tonne	https://www.iea.org/reports/key-world-energy-statistics-2020/prices
Cost of Natural Gas (maximum threshold)	9.50	USD/MMBTU	https://www.iea.org/reports/key-world-energy-statistics-2020/prices
Cost of HFO (maximum threshold)	0.46	USD/liter	https://www.iea.org/reports/key-world-energy-statistics-2020/prices
Gross efficiency of subcritical coal power plant	35	%	WEO_2016_PG_Assumptions_NPSand450_Scenario
Gross efficiency of natural gas-based power plant	38	%	WEO_2016_PG_Assumptions_NPSand450_Scenario
Gross efficiency of HFO based power plant	42	%	WEO_2016_PG_Assumptions_NPSand450_Scenario
Capacity factor of subcritical coal power plant	73	%	WEO_2016_PG_Assumptions_NPSand450_Scenario
Capacity factor of natural gas-based power plant	44	%	WEO_2016_PG_Assumptions_NPSand450_Scenario
Capacity factor of HFO based power plant	54	%	WEO_2016_PG_Assumptions_NPSand450_Scenario
Investment cost for coal-based power plant	1300	USD/kW	WEO_2016_PG_Assumptions_NPSand450_Scenario
Investment cost for natural gas-based power plant	400	USD/kW	WEO_2016_PG_Assumptions_NPSand450_Scenario
Investment cost for HFO based-power plant	650	USD/kW	WEO_2016_PG_Assumptions_NPSand450_Scenario
O& M costs for coal power plant	45	USD/kW	WEO_2016_PG_Assumptions_NPSand450_Scenario

Indicator	Value	Unit	Source
O& M costs for gas power plant	20	USD/kW	WEO_2016_PG_Assumptions_NPSand450_Scenario
O& M costs for HFO-based power plant	15	USD/kW	Saule Baurzhan and Glenn P. Jenkins - On-Grid Solar PV versus Diesel Electricity Generation in Sub-Saharan Africa: Economics and GHG Emissions, 2017
Lifetime of sub-critical coal power plant	40	years	Projected costs of generating electricity, 2020
Lifetime of natural gas-based power plant	30	years	Projected costs of generating electricity, 2020
Lifetime of HFO based power plant	25	years	Saule Baurzhan and Glenn P. Jenkins - On-Grid Solar PV versus Diesel Electricity Generation in Sub-Saharan Africa: Economics and GHG Emissions, 2017
Annual degradation factor - sub-critical coal power plant	0.6	per cent per year	Projected costs of generating electricity, 2020
Annual degradation factor - natural gas based power plant	0.6	per cent per year	Projected costs of generating electricity, 2020
Annual degradation factor - HFO based power plant	1	per cent per year	Projected costs of generating electricity, 2020
O& M cost for solar PV (conservative estimate for all non-OECD countries)	9	USD/kW/year	IRENA (2021), Renewable Power Generation Costs in 2020
Annual module degradation factor - Solar PV	0.5	per cent per year	Renewable Power Generation Costs in 2017 (IRENA)
Decommissioning cost for coal power plant	65	USD/kW	WEO_2016_PG_Assumptions_NPSand450_Scenario
Decommissioning cost for natural gas power plant	20	USD/kW	WEO_2016_PG_Assumptions_NPSand450_Scenario
Decommissioning cost for HFO power plant	32.5	USD/kW	WEO_2016_PG_Assumptions_NPSand450_Scenario
HFO consumed to produce 1 kWh	0.246	liter/kWh	Saule Baurzhan and Glenn P. Jenkins - On-Grid Solar PV versus Diesel Electricity Generation in Sub-Saharan Africa: Economics and GHG Emissions, 2017
Regional default values Africa			
Investment cost for solar PV for Africa_Minimum	1299	USD/kW	REN21. 2019. Renewables 2019 Global Status Report
Investment cost for solar PV for Africa_Maximum	2889	USD/kW	REN21. 2019. Renewables 2019 Global Status Report
Investment cost for solar PV for Africa_Weighted Average	1621	USD/kW	REN21. 2019. Renewables 2019 Global Status Report
Capacity factor for solar PV for Africa_Weighted Average	18	%	REN21. 2019. Renewables 2019 Global Status Report
Regional default values Asia			
Investment cost for solar PV for Asia_Minimum	1161	USD/kW	REN21. 2019. Renewables 2019 Global Status Report
Investment cost for solar PV for Asia_Maximum	3595	USD/kW	REN21. 2019. Renewables 2019 Global Status Report

Indicator	Value	Unit	Source
Investment cost for solar PV for Asia_Weighted Average	1921	USD/kW	REN21. 2019. Renewables 2019 Global Status Report
Investment cost for solar PV for China_Minimum	878	USD/kW	REN21. 2019. Renewables 2019 Global Status Report
Investment cost for solar PV for China_Maximum	1512	USD/kW	REN21. 2019. Renewables 2019 Global Status Report
Investment cost for solar PV for China_Weighted Average	879	USD/kW	REN21. 2019. Renewables 2019 Global Status Report
Investment cost for solar PV for India_Minimum	656	USD/kW	REN21. 2019. Renewables 2019 Global Status Report
Investment cost for solar PV for India_Maximum	1098	USD/kW	REN21. 2019. Renewables 2019 Global Status Report
Investment cost for solar PV for India_Weighted Average	793	USD/kW	REN21. 2019. Renewables 2019 Global Status Report
Capacity factor for solar PV for Asia_Weighted Average	16	%	REN21. 2019. Renewables 2019 Global Status Report
Capacity factor for solar PV for China_Weighted Average	17	%	REN21. 2019. Renewables 2019 Global Status Report
Capacity factor for solar PV for India_Weighted Average	19	%	REN21. 2019. Renewables 2019 Global Status Report
Regional default values Central America and the Caribbean			
Investment cost solar PV for Central America and the Caribbean_Minimum	1336	USD/kW	REN21. 2019. Renewables 2019 Global Status Report
Investment cost solar PV for Central America and the Caribbean_Maximum	2304	USD/kW	REN21. 2019. Renewables 2019 Global Status Report
Investment cost solar PV for Central America and the Caribbean_Weighted Average	1402	USD/kW	REN21. 2019. Renewables 2019 Global Status Report
Investment cost solar PV for Mexico_Minimum	916	USD/kW	REN21. 2019. Renewables 2019 Global Status Report
Investment cost solar PV for Mexico_Maximum	2481	USD/kW	REN21. 2019. Renewables 2019 Global Status Report
Investment cost solar PV for Mexico_Weighted Average	1557	USD/kW	REN21. 2019. Renewables 2019 Global Status Report
Capacity factor for solar PV for Central America and the Caribbean_Weighted Average	16	%	REN21. 2019. Renewables 2019 Global Status Report
Capacity factor for solar PV for Mexico_Weighted Average	22	%	REN21. 2019. Renewables 2019 Global Status Report
Regional default values Middle East			
Investment cost for solar PV for Middle East_Minimum	836	USD/kW	REN21. 2019. Renewables 2019 Global Status Report
Investment cost for solar PV for Middle East_Maximum	3195	USD/kW	REN21. 2019. Renewables 2019 Global Status Report
Investment cost for solar PV for Middle East_Weighted Average	1342	USD/kW	REN21. 2019. Renewables 2019 Global Status Report
Capacity factor for solar PV for Middle East_Weighted Average	20	%	REN21. 2019. Renewables 2019 Global Status Report

Indicator	Value	Unit	Source
Regional default values Oceania			
Investment cost for solar PV for Oceania_Minimum	1188	USD/kW	REN21. 2019. Renewables 2019 Global Status Report
Investment cost for solar PV for Oceania_Maximum	2336	USD/kW	REN21. 2019. Renewables 2019 Global Status Report
Investment cost for solar PV for Oceania_Weighted Average	1554	USD/kW	REN21. 2019. Renewables 2019 Global Status Report
Capacity factor for solar PV for Oceania_Weighted Average	20	%	REN21. 2019. Renewables 2019 Global Status Report
Regional default values South America			
Investment cost solar PV for South America_Minimum	936	USD/kW	REN21. 2019. Renewables 2019 Global Status Report
Investment cost solar PV for South America_Maximum	2086	USD/kW	REN21. 2019. Renewables 2019 Global Status Report
Investment cost solar PV for South America_Weighted Average	1542	USD/kW	REN21. 2019. Renewables 2019 Global Status Report
Capacity factor for solar PV for South America_Weighted Average	20	%	REN21. 2019. Renewables 2019 Global Status Report

Appendix 5. LCOE of fossil fuel generating technologies and Solar PV technology

Table 1. LCOE values for predominant fossil fuels used and solar PV technology

Country	Region	LDC/SIDS	LCOE_Solar PV (USD/kWh)			LCOE_Fossil Fuel (USD/kWh)		
			Minimum	Maximum	Weighted Average	Coal	HFO	Natural Gas
Afghanistan	Asia	LDC	0.0919	0.2706	0.1477	NA	0.0976	NA
Algeria	Africa	N	0.1280	0.2775	0.1583	NA	NA	0.1090
Angola	Africa	LDC	0.1000	0.2152	0.1233	NA	NA	0.1062
Antigua and Barbuda	Central America and the Caribbean	SIDS	0.1463	0.2474	0.1532	NA	0.1020	NA
Argentina	South America	N	0.0665	0.1416	0.1061	NA	NA	0.1063
Bahamas	Central America and the Caribbean	SIDS	0.1422	0.2404	0.1489	NA	0.1015	NA
Bahrain	Middle East	SIDS	0.0566	0.2011	0.0876	NA	NA	0.1057
Bangladesh	Asia	LDC	0.0923	0.2718	0.1484	NA	NA	0.1055
Barbados	Central America and the Caribbean	SIDS	0.0835	0.1392	0.0873	NA	0.0956	NA
Belize	Central America and the Caribbean	SIDS	0.1495	0.2530	0.1566	NA	0.1024	NA
Benin	Africa	LDC	0.1331	0.2888	0.1646	NA	0.1029	NA
Bhutan	Asia	LDC	0.1251	0.3735	0.2027	NA	0.1016	NA
Bolivia (Plurinational State of)	South America	N	0.0560	0.1183	0.0889	NA	NA	0.1049
Botswana	Africa	N	0.0930	0.1995	0.1146	0.0578	NA	NA
Brazil	South America	N	0.0616	0.1307	0.0980	NA	0.0978	0.1056
Brunei Darussalam	Asia	N	0.1138	0.3384	0.1839	NA	NA	0.1074
Burkina Faso	Africa	LDC	0.1697	0.3702	0.2103	NA	0.1080	NA

Country	Region	LDC/SIDS	LCOE_Solar PV (USD/kWh)			LCOE_Fossil Fuel (USD/kWh)		
			Minimum	Maximum	Weighted Average	Coal	HFO	Natural Gas
Burundi	Africa	LDC	0.0789	0.1682	0.0970	NA	0.0963	NA
Cabo Verde	Africa	SIDS	0.0873	0.1868	0.1074	NA	0.0972	NA
Cambodia	Asia	LDC	0.0725	0.2104	0.1156	0.0524	NA	NA
Cameroon	Africa	N	0.0916	0.1964	0.1128	NA	0.0977	0.1055
Central African Republic	Africa	LDC	0.1066	0.2298	0.1315	NA	0.0995	NA
Chad	Africa	LDC	0.1081	0.2332	0.1334	NA	0.0996	0.1070
Chile	South America	N	0.0851	0.1831	0.1368	0.0668	0.1023	NA
China	Asia	N	0.0785	0.1306	0.0786	0.0613	NA	NA
Colombia	South America	N	0.0793	0.1702	0.1272	0.0646	NA	0.1081
Comoros	Africa	LDC	0.0849	0.1815	0.1044	NA	0.0969	NA
Congo	Africa	N	0.1059	0.2284	0.1307	NA	NA	0.1068
Costa Rica	Central America and the Caribbean	N	0.1504	0.2546	0.1575	NA	0.1025	NA
Côte d'Ivoire	Africa	N	0.0941	0.2021	0.1160	NA	NA	0.1057
Cuba	Central America and the Caribbean	SIDS	0.1039	0.1743	0.1087	NA	0.0975	NA
Democratic Republic of the Congo	Africa	LDC	0.0789	0.1682	0.0970	NA	0.0963	NA
Djibouti	Africa	LDC	0.1486	0.3234	0.1840	0.0717	NA	NA
Dominica	Central America and the Caribbean	SIDS	0.1065	0.1788	0.1114	NA	0.0978	NA
Dominican Republic	Central America and the Caribbean	SIDS	0.1233	0.2077	0.1290	NA	0.0995	NA
Ecuador	South America	N	0.0637	0.1353	0.1014	NA	0.0982	0.1059
Egypt	Africa	N	0.0768	0.1636	0.0944	NA	NA	0.1043
El Salvador	Central America and the Caribbean	N	0.1034	0.1735	0.1082	NA	0.0975	NA

Country	Region	LDC/SIDS	LCOE_Solar PV (USD/kWh)			LCOE_Fossil Fuel (USD/kWh)		
			Minimum	Maximum	Weighted Average	Coal	HFO	Natural Gas
Equatorial Guinea	Africa	N	0.0872	0.1867	0.1073	NA	0.0972	0.1051
Eswatini	Africa	N	0.1166	0.2522	0.1441	NA	0.1007	NA
Ethiopia	Africa	LDC	0.0982	0.2112	0.1211	NA	0.0985	NA
Fiji	Oceania	SIDS	0.0904	0.1726	0.1166	NA	0.0998	NA
Gabon	Africa	N	0.0747	0.1589	0.0918	NA	0.0959	0.1042
Gambia	Africa	LDC	0.0819	0.1750	0.1008	NA	0.0966	NA
Ghana	Africa	N	0.1129	0.2438	0.1394	NA	0.1002	0.1074
Grenada	Central America and the Caribbean	SIDS	0.1286	0.2170	0.1346	NA	0.1001	NA
Guatemala	Central America and the Caribbean	N	0.0966	0.1617	0.1010	0.0554	0.0968	NA
Guinea	Africa	LDC	0.1129	0.2438	0.1394	NA	NA	0.1074
Guinea-Bissau	Africa	LDC	0.0735	0.1561	0.0902	NA	0.0957	NA
Guyana	South America	SIDS	0.0560	0.1182	0.0888	NA	0.0968	NA
Haiti	Central America and the Caribbean	LDC	0.1219	0.2054	0.1276	NA	0.0993	NA
Honduras	Central America and the Caribbean	N	0.0970	0.1624	0.1015	NA	0.0968	NA
India	Asia	N	0.0464	0.0738	0.0549	0.0573	NA	NA
Indonesia	Asia	N	0.1079	0.3203	0.1742	0.0612	NA	NA
Iran (Islamic Republic of)	Middle East	N	0.0585	0.2086	0.0907	NA	0.0984	0.1060
Iraq	Middle East	N	0.0660	0.2371	0.1027	NA	0.1000	0.1072
Israel	Middle East	N	0.0742	0.2686	0.1159	0.0658	NA	0.1086
Jamaica	Central America and the Caribbean	SIDS	0.1122	0.1886	0.1174	NA	0.0983	NA
Jordan	Middle East	N	0.0411	0.1420	0.0628	NA	NA	0.1037

Country	Region	LDC/SIDS	LCOE_Solar PV (USD/kWh)			LCOE_Fossil Fuel (USD/kWh)		
			Minimum	Maximum	Weighted Average	Coal	HFO	Natural Gas
Kenya	Africa	N	0.0739	0.1571	0.0908	NA	0.0958	NA
Kuwait	Middle East	N	0.0498	0.1754	0.0768	NA	NA	0.1048
Lao People's Democratic Republic	Asia	LDC	0.0745	0.2166	0.1189	0.0529	NA	NA
Lebanon	Middle East	N	0.0944	0.3461	0.1484	0.0744	NA	0.1123
Lesotho	Africa	LDC	0.0920	0.1973	0.1133	NA	NA	NA
Liberia	Africa	LDC	0.1010	0.2174	0.1245	NA	0.0988	NA
Libya	Africa	N	0.1697	0.3702	0.2103	NA	0.1080	NA
Madagascar	Africa	LDC	0.0914	0.1961	0.1126	NA	0.0977	NA
Malawi	Africa	LDC	0.0827	0.1768	0.1018	NA	0.0967	NA
Malaysia	Asia	N	0.0955	0.2818	0.1537	0.0581	NA	0.1057
Maldives	Asia	SIDS	0.1411	0.4230	0.2291	NA	0.1038	NA
Mali	Africa	LDC	0.0872	0.1866	0.1073	NA	0.0972	NA
Mauritania	Africa	LDC	0.1505	0.3275	0.1863	NA	0.1052	NA
Mauritius	Africa	SIDS	0.0921	0.1976	0.1135	0.0576	0.0977	NA
Mexico	Central America and the Caribbean	N	0.0688	0.1781	0.1136	NA	NA	0.1078
Micronesia (Federated States of)	Oceania	SIDS	0.0809	0.1540	0.1042	NA	0.0984	NA
Mongolia	Asia	N	0.1048	0.3105	0.1690	0.0604	NA	NA
Morocco	Africa	N	0.0610	0.1283	0.0746	0.0499	NA	NA
Mozambique	Africa	LDC	0.1118	0.2415	0.1381	NA	NA	0.1073
Myanmar	Asia	LDC	0.1271	0.3797	0.2060	NA	NA	0.1087
Namibia	Africa	N	0.1365	0.2964	0.1689	0.0687	NA	NA

Country	Region	LDC/SIDS	LCOE_Solar PV (USD/kWh)			LCOE_Fossil Fuel (USD/kWh)		
			Minimum	Maximum	Weighted Average	Coal	HFO	Natural Gas
Nepal	Asia	LDC	0.1115	0.3314	0.1802	NA	0.0999	NA
Nicaragua	Central America and the Caribbean	N	0.1144	0.1925	0.1197	NA	0.0986	NA
Niger	Africa	LDC	0.1048	0.2259	0.1294	NA	0.0992	NA
Nigeria	Africa	N	0.0864	0.1848	0.1063	NA	NA	0.1051
Oman	Middle East	N	0.0871	0.3180	0.1366	NA	NA	0.1109
Pakistan	Asia	N	0.2083	0.6315	0.3405	0.0858	0.1134	NA
Panama	Central America and the Caribbean	N	0.0973	0.1629	0.1017	NA	0.0969	NA
Papua New Guinea	Oceania	SIDS	0.1365	0.2633	0.1769	NA	0.1073	0.1129
Paraguay	South America	N	0.1104	0.2397	0.1785	NA	NA	NA
Peru	South America	N	0.0597	0.1265	0.0949	NA	0.0975	0.1054
Philippines	Asia	N	0.1547	0.4651	0.2516	0.0728	NA	NA
Qatar	Middle East	N	0.0452	0.1577	0.0693	NA	NA	0.1042
Republic of Korea	Asia	N	0.0751	0.2185	0.1199	0.0530	0.0958	NA
Rwanda	Africa	LDC	0.0800	0.1705	0.0983	NA	0.0964	NA
Saint Kitts and Nevis	Central America and the Caribbean	SIDS	0.0843	0.1405	0.0881	NA	0.0957	NA
Saint Lucia	Central America and the Caribbean	SIDS	0.0801	0.1332	0.0837	NA	0.0953	NA
Saint Vincent and the Grenadines	Central America and the Caribbean	SIDS	0.1375	0.2324	0.1440	NA	0.1010	NA
Samoa	Oceania	SIDS	0.1043	0.2000	0.1348	NA	0.1020	NA
Sao Tome and Principe	Africa	LDC	0.0975	0.2097	0.1202	NA	0.0984	NA
Saudi Arabia	Middle East	N	0.0629	0.2253	0.0977	NA	0.0993	0.1067
Senegal	Africa	LDC	0.0972	0.2089	0.1198	NA	0.0983	NA

Country	Region	LDC/SIDS	LCOE_Solar PV (USD/kWh)			LCOE_Fossil Fuel (USD/kWh)		
			Minimum	Maximum	Weighted Average	Coal	HFO	Natural Gas
Seychelles	Africa	SIDS	0.0878	0.1880	0.1081	NA	0.0973	NA
Sierra Leone	Africa	LDC	0.0873	0.1869	0.1075	NA	0.0972	NA
Singapore	Asia	SIDS	0.1092	0.3242	0.1763	NA	NA	0.1070
Solomon Islands	Oceania	LDC	0.0606	0.1140	0.0777	NA	0.0957	NA
South Africa	Africa	N	0.1538	0.3348	0.1904	0.0729	NA	NA
South Sudan	Africa	LDC	0.1176	0.2543	0.1453	NA	0.1008	NA
Sri Lanka	Asia	N	0.0931	0.2743	0.1497	0.0575	0.0977	NA
State of Palestine	Middle East	N	0.0532	0.1882	0.0821	NA	0.0973	NA
Sudan	Africa	LDC	0.0900	0.1928	0.1108	NA	0.0975	NA
Suriname	South America	SIDS	0.0838	0.1803	0.1347	NA	0.1021	NA
Thailand	Asia	N	0.1316	0.3938	0.2135	NA	NA	0.1092
Timor-Leste	Asia	LDC	0.0858	0.2516	0.1375	NA	0.0969	NA
Togo	Africa	LDC	0.1010	0.2173	0.1245	NA	0.0988	NA
Tonga	Oceania	SIDS	0.1090	0.2093	0.1410	NA	0.1027	NA
Trinidad and Tobago	Central America and the Caribbean	SIDS	0.0927	0.1550	0.0969	NA	NA	0.1046
Tunisia	Africa	N	0.1157	0.2501	0.1429	NA	NA	0.1077
Uganda	Africa	LDC	0.0919	0.1971	0.1132	NA	0.0977	NA
United Republic of Tanzania	Africa	LDC	0.0970	0.2086	0.1196	NA	NA	0.1060
Uruguay	South America	N	0.0761	0.1630	0.1219	NA	NA	0.1077
Vanuatu	Oceania	SIDS	0.0742	0.1407	0.0954	NA	0.0975	NA
Venezuela (Bolivarian Republic of)	South America	N	0.0837	0.1801	0.1345	NA	0.1020	0.1088

Country	Region	LDC/SIDS	LCOE_Solar PV (USD/kWh)			LCOE_Fossil Fuel (USD/kWh)		
			Minimum	Maximum	Weighted Average	Coal	HFO	Natural Gas
Viet Nam	Asia	N	0.0826	0.2417	0.1323	0.0549	NA	NA
Yemen	Middle East	LDC	0.0781	0.2836	0.1222	NA	0.1027	NA
Zambia	Africa	LDC	0.1210	0.2620	0.1496	0.0648	0.1013	NA
Zimbabwe	Africa	N	0.1185	0.2564	0.1464	0.0642	NA	NA

LDC – Least developed country, SIDS – Small island developing state, N – Other developing countries not identified as LDC or SIDS as per United Nations.
NA – The respective fossil fuel technology is not identified as a major fossil fuel technology for electricity generation in a particular country.

Appendix 6. Comparison with the previous analysis conducted in 2018

1. Following tables provides a comparison of the indicator used in the current analysis against the same indictors that were used in the previous analysis.

Table 1. Comparison of range of share of solar PV technology in total grid connected electricity generation during 2014 – 2016 and 2017 - 2019

Range (%)	Number of countries	
	2014 – 2016	2017 – 2019
0 to 2	90	104
2 to 5	4	12
5 to 10	2	7
More than 10	1	3
Total	97	126

Table 2. Comparison of range of share of solar PV technology in total grid connected installed capacity during 2014 – 2016 and 2017 - 2019

Range (%)	Number of countries	
	2014 – 2016	2017 – 2019
0 to 2	71	82
2 to 5	21	20
5 to 10	4	15
More than 10	1	9
Total	97	126

Table 3. Comparison of share of solar PV technology by region

Region	Number of countries covered		Share (%) of solar PV technology			
			Based on annual generation		Based on installed capacity	
	2014-2016	2017-2019	2014- 2016	2017- 2019	2014-2016	2017- 2019
All Non-Annex-I	97	126	0.73	1.32	1.42	2.89
Africa	39	52	0.92	0.89	1.65	1.74
Asia	23	22	0.56	0.73	1.06	2.43

Region	Number of countries covered		Share (%) of solar PV technology			
			Based on annual generation		Based on installed capacity	
	2014-2016	2017-2019	2014- 2016	2017- 2019	2014-2016	2017- 2019
Central America and the Caribbean	7	21	0.54	1.69	1.14	4.09
Middle East	12	11	0.82	1.99	0.82	4.01
Oceania	00	7	N/A	4.59	N/A	8.92
South America	16	12	0.85	1.09	1.74	2.01

Table 4. Technology-wise share in the installed capacity of regional grids, 2016 to 2019

	Africa				Asia and Oceania				Central America and the Caribbean and South America				Middle East			
	Capacity increase (GW)		% share in total increase		Capacity increase (GW)		% share in total increase		Capacity increase (GW)		% share in total increase		Capacity increase (GW)		% share in total increase	
	2014 - 2016	2017- 2019	2014 - 2016	2017- 2019	2014 - 2016	2017- 2019	2014 - 2016	2017- 2019	2014 - 2016	2017- 2019	2014 - 2016	2017- 2019	2014 - 2016	2017- 2019	2014 - 2016	2017- 2019
Total capacity (GW)	29	32			695	248			29	28			16	21		
Coal	2	4	7	11	83	86	12	35	1	0	3	1	0	0	0	0
Oil	5	2	17	5	48	-19	7	-8	2	1	7	4	1	5	6	25
Gas	12	20	41	61	209	1	30	1	2	6	7	21	14	13	88	61
Nuclear	0	0	0	0	51	-8	7	-3	0	0	0	0	0	0	0	0
Renewables	9	7	31	22	304	185	44	75	24	21	83	75	1	3	6	13
Hydro	6	3	21	10	81	25	12	10	13	10	45	36	0	1	0	3
Bioenergy	0	0	0	0	17	9	2	4	1	1	3	2	0	0	0	0.
On-shore wind	1	1	3	3	48	48	7	19	6	6	21	21	0	1	0	3
Geothermal	0	0	0	0	1	0	0	0	0	0	0	0	0	0	0	0
Solar PV	1	2	3	6	159	141	23	57	3	5	10	17	1	1	6	6

	Africa				Asia and Oceania				Central America and the Caribbean and South America				Middle East			
	Capacity increase (GW)		% share in total increase		Capacity increase (GW)		% share in total increase		Capacity increase (GW)		% share in total increase		Capacity increase (GW)		% share in total increase	
	2014 - 2016	2017- 2019	2014 - 2016	2017- 2019	2014 - 2016	2017- 2019	2014 - 2016	2017- 2019	2014 - 2016	2017- 2019	2014 - 2016	2017- 2019	2014 - 2016	2017- 2019	2014 - 2016	2017- 2019
CSP	1	1	3	3	0	0	0	0	0	0	0	0	0	0	0	0
Marine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 5. Technology-wise share in the installed capacity of regional grids, 2016 to 2019

	South Africa				Brazil				China				India			
	Capacity increase (GW)		% share in total increase		Capacity increase (GW)		% share in total increase		Capacity increase (GW)		% share in total increase		Capacity increase (GW)		% share in total increase	
	2014 - 2016	2017- 2019	2014 - 2016	2017- 2019	2014 - 2016	2017- 2019	2014 - 2016	2017- 2019	2014 - 2016	2017- 2019	2014 - 2016	2017- 2019	2014 - 2016	2017- 2019	2014 - 2016	2017- 2019
Total capacity (GW)	7	6			14	16			249	250			59	41		
Coal	3	3	43	53	0	0	0	0	81	71	33	29	30	14	51	33
Oil	1	0	14	0	0	0	0	0	0	-1	0	0	0	0	0	0
Gas	0	1	0	11	0	1	0	4	9	13	4	5	0	0	0	-1
Nuclear	0	0	0	0	0	0	0	0	8	10	3	4	1	0	2	0
Renewables	3	3	43	47	14	15	100	94	151	156	61	62	27	28	46	69
Hydro	2	1	29	16	8	8	57	51	24	19	10	7	2	2	3	4

	South Africa				Brazil				China				India			
	Capacity increase (GW)		% share in total increase		Capacity increase (GW)		% share in total increase		Capacity increase (GW)		% share in total increase		Capacity increase (GW)		% share in total increase	
	2014 - 2016	2017- 2019	2014 - 2016	2017- 2019	2014 - 2016	2017- 2019	2014 - 2016	2017- 2019	2014 - 2016	2017- 2019	2014 - 2016	2017- 2019	2014 - 2016	2017- 2019	2014 - 2016	2017- 2019
Bioenergy	0	0	0	0	1	1	7	4	4	7	2	3	3	1	5	2
On-shore wind	0	1	0	16	4	4	29	23	35	37	14	15	8	6	14	15
Geotherm al	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Solar PV	1	1	14	16	0	2	0	13	88	92	35	37	14	19	24	47
CSP	0	0	0	5	0	0	0	0	0	0	0	0	0	0	0	0
Marine	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Table 6. Summary of LCOE of coal-based technologies and solar PV technology

Region	**No. of countries using coal-based technologies**		**Region-based average LCOE (USD/kWh)**							
			Coal		**Solar PV**					
					Min		**Max**		**WA**	
	2014 - 2016	**2017 - 2019**	**2014 - 2016**	**2017 - 2019**	**2014 - 2016**	**2017 - 2019**	**2014 - 2016**	**2017 - 2019**	**2014 - 2016**	**2017 - 2019**
Non-Annex-I countries	38	25	0.066	0.062	0.076	0.102	0.341	0.260	0.155	0.145

Table 7. Summary of LCOE of HFO-based technologies and solar PV technology

Region	No. of countries using HFO-based technologies		Region-based average LCOE (USD/kWh)							
			HFO		Solar PV					
					Min		Max		WA	
	2014 - 2016	2017 - 2019	2014 - 2016	2017 - 2019	2014 - 2016	2017 - 2019	2014 - 2016	2017 - 2019	2014 - 2016	2017 - 2019
Non-Annex-I countries	54	81	0.153	0.099	0.080	0.099	0.167	0.215	0.101	0.126

Table 8. Summary of LCOE of natural gas-based technologies and solar PV technology

Region	No. of countries using natural gas-based technologies		Region-based average LCOE (USD/kWh)							
			Natural gas		Solar PV					
					Min		Max		WA	
	2014 - 2016	2017 - 2019	2014 - 2016	2017 - 2019	2014 - 2016	2017 - 2019	2014 - 2016	2017 - 2019	2014 - 2016	2017 - 2019
Non-Annex-I countries	50	42	0.067	0.107	0.075	0.087	0.333	0.221	0.155	0.123

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