Annex 13

INFORMATION NOTE ON THE EXTENSION OF SIMPLIFIED MODALITIES FOR THE DEMONSTRATION OF ADDITIONALITY OF SMALL-SCALE CDM PROJECT ACTIVITIES

(Version 02.0)

I. Background

1. Decision/CMP.7 "Encourages the Executive Board to extend the simplified modalities for the demonstration of additionality to a wider scope of project activities, inter alia energy efficiency project activities and renewable energy based electrification in areas without grid connection, and to develop simplified baseline methodologies for such project activities."

2. The Executive Board (hereinafter referred to as the Board) of the clean development mechanism (CDM) at its sixty-third meeting (see EB 63 report) requested an analysis of options and implications of including in the positive list off-grid electricity generation technologies and distributed energy generation activities that are automatically defined as additional, without further documentation of barriers in all non-Annex I countries.

3. At its sixty-seventh meeting, after taking into account a concept note prepared by the secretariat, the Board requested the secretariat to recommend a positive list of off-grid renewable electricity generation technologies and other isolated units/technologies of very small size in distributed location for automatic additionality. The positive list shall be part of a draft revision of the guidelines on demonstration of additionality of SSC project activities for consideration by the Board at its sixty-eighth meeting. The secretariat shall take into account the comments provided by the Board, in particular:

(a) Provide options and implications of extending the positive list to include isolated units of very small size in distributed location under the conditions that the end-users are households or communities or SMEs and the capacity of each unit is X% (e.g. 5%, 1.0%, 0.5%, 0.1%) of small-scale CDM thresholds. Include an analysis of options to simplify validation of these types of project activities;

(b) Include sensitivity analysis for the up-front cost of off-grid renewable energy technologies and comparable diesel generator technologies with the consideration of associated uncertainties;

(c) Provide an analysis of options to expand the list of technologies under the positive list to include emerging technologies, such as grid-connected small-scale vertical axis wind turbines;

(d) Provide an analysis of CDM impact on high upfront cost of off-grid technologies;

(e) Allow options for including energy efficiency activities in the positive list

II. Materials and methods

4. Implications of extending the positive list to include isolated units of very small size in distributed locations (hereinafter referred to as dispersed units project or DUP), particularly the influence of threshold chosen for units was assessed using the data from the CDM pipeline available from

UNFCCC sources complemented with data from the Institute for global environmental strategies (IGES) database.

5. An analysis of data from registered projects was also done. The reasons of rejection or request for review related to DUPs were analyzed. In particular, the following type of projects and POAs for household applications were considered:

(a) Biogas digester;

(b) Cookstoves ;

(c) CFLs;

(d) Solar water heater;

(e) Solar cooker ;

(f) Water purification.

6. To respond to specific request from the CMP.7 related to electrification using renewable energy sources, an analysis of rural electrification rates in particular electrification rates in LDCs is undertaken to explore options to simplify additionality demonstration when renewable energy is employed as the energy generation technology.

7. To respond to the request from the Board pertaining to off-grid electricity generation technologies in the positive list, an analysis of capital cost is also undertaken together with the levelized cost of unit energy generated from the off-grid renewable energy technologies taking into account current and future costs of those technologies. To select the technologies and sizes for the analysis, a comprehensive list of specific technologies for Rural Energy from REN 21 was compiled (REN21, 2011). Other sources such as ESMAP (2007) were used for a technical and economic assessment of off-grid, mini-grid and grid electrification. The data from ESMAP (2007) containing projections for specific technologies and sizes were used, and the costs data published by IRENA (2012) and IPCC (2011) was also used as reference, to validate the conclusions.

8. The analysis takes into account views presented by stakeholders through methodological submissions (e.g. via the commenting system for methodologies) and at coordination workshops such as the Sustainable Development Mechanisms Joint Coordination Workshop (SDM/JCW, 24-25 March 2012).

III. Analysis and recommendations

9. **DUPs:** Project design documents of a total of two hundred thirty-one (231) PoAs that are undergoing validation have been analyzed. Approximately 40% of those POAs are for DUPs. Percentage of PoAs qualifying automatic additionality based on the threshold for individual units is summarized in Table 1 below. It appears that the thresholds, whether chosen as 5% of the SSC threshold (750 kW) or 0.1% of the SSC threshold (15 kW), has a relatively minor influence on the percentage of projects that qualify; percentage of projects that qualify automatic additionality in the existing POA pipeline only drop by 6% even when the threshold for units is reduced by fifty time indicating that most of the POAs in the current pipeline comprise of very small units.

Table 1: Sensitivity analysis of thresholds for units

	5% of the SSC threshold (750 kW)	1% of the SSC threshold (150 kW)	0.5% of the SSC threshold (75 kW)	0.1% of the SSC threshold (15 kW)
Percentage of PoAs in the CDM pipeline that qualify automatic additionality	36%	34%	33%	30%

10. A total of fifty six (56) projects and eight (8) PoAs have been registered as of 31 May 2012 that are for DUPs for household applications such as biogas digester, cookstoves, CFLs, solar water heater, solar cooker, water purification. None of the projects or PoAs deploying technologies for household applications has been rejected so far. Very few projects have been requested for review and when the review was done it was on account of issues such as unclear monitoring plan, but none relate to additionality demonstration itself. The information is summarised in Table 2 below.

Table 2: DUPs in the registered CDM pipeline

Project type	No. of PAs registered	No. of PoAs registered	No. of PAs or PoAs that were rejected due to additionality	No. of PAs or PoAs that were requested for review due to additionality
Household biogas digester projects or PoAs	12	0	0	0
Household cookstove projects or PoAs	5	3	0	0
Household CFL distribution projects or PoAs	22	3	0	0[1]
Household solar water heater projects or PoAs	5	2	0	0
Household solar cooker projects or PoAs	11	0	0	0
Household water purification projects or PoAs	2	0	0	0
Total	**57**	**8**	**0**	**0**

11. It is recommended that projects for DUPs are included in the positive list under the conditions that the users of the technology/measure are households or communities or SMEs and where the size of each unit is no larger than [1%] [5%] of small-scale CDM thresholds.

12. **Simplified modalities for rural electrification projects:** The request from CMP7 to the Board made a particular reference to 'renewable energy based electrification in areas without grid connection' to extend the simplified modalities for the demonstration of additionality (see paragraph 1 above). Therefore this section explores options to include electrification technologies in the positive list of technologies.

[1] One CDM project (EB Ref 3452) was requested for review due to inconsistent use of the figures in the validation report and PDD versus the submitted spreadsheet. However, it was clarified and the project activity was registered in the end.

13. Rural electrification for the purpose of this document is defined as a project activity for supplying renewable electricity to facilities and energy consumers that do not have access to any electricity distribution system/network such as a national grid, regional grid.[2] Such electricity end-use facilities may include, but not limited to households; public buildings; and/or small, medium and micro enterprises (SMMEs). Electricity uses may include but not limited to interior lighting, street lighting, refrigeration, or agricultural water pumps.

14. In the literature (UNEP FI (2012), Szabó, S., et al (2011), Nguyen (2012), it is indicated that though some of the off-grid renewable energy technologies are cost competitive as compared to diesel generator based on life cycle assessment but due to high initial investment costs and/or presence of low energy prices (subsidized fossil fuel or electricity) in many developing countries renewable energy systems are financially not attractive compared to the baseline diesel generation technologies.[3] In other words, much of the competitiveness gains of renewable energy technologies are attributable to their relatively favourable OPEX profile (the level of ongoing operations-related expenditure), while in terms of CAPEX (up-front capital investment expenditure) renewable energy technologies tend to feature a higher level of capital intensity. However, the circumstances in many developing countries will mean that the CAPEX associated with different energy options will often play a more important role than the corresponding OPEX in financial assessment and decision-making processes. This will result in preferential treatment of technologies that are relatively low in CAPEX and relatively high in OPEX. Such circumstances in particular include a variety of investment-related risks (country, regulatory, commercial and market) that is more pronounced in developing countries. These risks will immediately increase the return expectations of investors and thus any project's cost of capital. This will discourage capital-intensive energy options and encourage less capital-intensive, conventional energy technologies. (UNEP FI, 2012)

15. In addition, the transaction costs associated with additionality demonstration through barrier analysis is considered a significant obstacle particularly for small-scale renewable energy projects[4] (see The World Bank (2012), Yadoo (2012), Pablo (2007), Pearson (2007). The data requirements at validation for additionality demonstration cause high upfront transaction costs and puts a significant burden on individual project developers, especially where such data is not readily available and accessible (e.g. in LDCs) (Alexandrina (2012)).

16. On the other hand it is seen that CDM project can contribute to cash-flow of the project while securing the loan upfront and ensuring sustainable operation of the plant. Also, it is evident from the PDDs that the CDM revenues from such projects are used to expand the electricity services to additional users which in the absence of CDM would not occur.

17. Regarding project sizes, considering all projects registered and at validation stage using approved methodologies relevant to rural electrification i.e. AMS-I.A. "Electricity generation by the user" and

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[2] The IEA (2011) estimates that in 2008, 1.5 billion people, or 22% of the world's population, had no access to electricity, of whom 85% live in rural areas.

[3] Diesel generators are commonly used to provide electricity for stand-alone and mini-grid application in developing countries and are thus a broadly applicable benchmark for off-grid electricity provision (Bazilian et al., 2012, V. Bovee, 2001, Schmidt S. et al., 2012).

[4] For example, Kharta et al. show that the baseline study costs for a 100kW hydro mini-grid can be 543% of CER value and 9% for a 10MW grid connected wind farm (at a CER price of 3$/tCO2). According to Castro et al (2011) , transaction costs for CDM project implementation are generally similar regardless of project size, which is a disadvantage to smaller sizes, where certain fixed costs are disproportionately greater than for larger projects. The same source argues the marginal contribution of carbon revenues (CER's) for small-scale renewable energy projects makes it difficult to prove financial additionality and to alleviate the additionality barrier.

AMS-I.F "Renewable energy generation for captive use and mini-grid" methodologies (83 projects until January 2012), more than 80% of the projects have the capacity equal or smaller than 5 MW. It is found that none of those larger than 5 MW project is located in a country with a rural electrification rate below 20%.

18. It is to be noted that there has been no CDM off-grid renewable energy projects that are rejected on the grounds related to additionality demonstration. In order to demonstrate barriers for project implementation (proof of additionality), many PDD's, cite the low electrification or the rural electrification rate in the host country or project area. These low rates are usually complimented with other barriers such as lack of capital and institutional capacity, limited technological availability, low return of capital for project developers, among others

19. Thus it is seen that low electrification rates present obvious barriers to projects, in order to simplify the procedure of demonstration of additionality of rural electrification projects, the adoption of a threshold rural electrification rates is suggested therefore when renewable energy is the project technology.

20. An overview of the effect of applying different thresholds is provided in Table 3. The threshold of 12%, suggested by the proponents of SSC-NM-073[5] , is the population weighted average rural electrification rate in all LDCs.

Table 3: National rural electrification rate thresholds, number and classification of the countries

Rural electrification rate	Number of countries within the threshold	Out of those that are LDC	Share of LDC out of total
5%	17	17	100%
10%	30	28	93.33%
12%	38	34	89.47%
15%	40	35	87.50%
20%	46	37	80.43%

21. Further it is noted that the rural electrification rates may be readily available via national or international sources for example IEA database on "Access to Energy" that is regularly updated may be referred to <http://www.iea.org/weo/electricity.asp>.

22. It is recommended that rural electrification projects with renewable energy sources in countries with rural electrification rates less than [20%] [10%] are included in the positive list of technologies.

23. **Simplified modalities for off-grid electricity generation technologies:** as discussed earlier upfront costs (e.g. capital costs of equipment together with CDM transaction costs) continue to be barriers for the deployment of renewable energy technologies, more so in the case of off-grid renewable energy technologies such as solar photovoltaic (PV), PV-wind hybrid systems, biomass gasifiers, micro or pico hydro systems, wind electricity or pumping systems. For the establishment of the grid-connected

[5] SSC-NM073 "Baseline methodology for electrification of rural communities" <http://cdm.unfccc.int/methodologies/SSCmethodologies/pnm/byref/SSC-NM073>.

renewable energy technologies to include in the positive list (EB 63, annex 24), the criterion used was the cost per energy unit of each technology (levelized cost).[6]

24. For comparison purposes, the cost of diesel generators of various sizes for which the renewable technologies serve as alternatives were used. As noted in the literature, diesel generators are commonly used to provide electricity for stand-alone and mini-grid applications in developing countries and are thus a broadly applicable benchmark for off-grid electricity provision (Bazilian et al., 2012, V. Bovee, 2001, Schmidt S. et al., 2012).

25. The analysis (see graphical illustrations in appendix 1) includes future price projections together with current and past prices, using values from the years 2005, 2010 and 2015. It is found that sizes of renewable energy technologies for off-grid applications are normally in the range of 300 W to 1,000 kW. It is found that the off-grid renewable energy technologies seem economically attractive in long term perspectives (levelized cost analysis) as compared to baseline fossil fuel technology. The upfront costs (capital costs) of technologies on the other hand are many times higher as compared to fossil fuel technology, i.e. diesel generators.

26. The generating costs of renewable technologies per unit of output are projected to continue to fall over the projection period (IEA, 2010a). The main reason is increased deployment, which accelerates technological progress and increases the economies of scale in manufacturing the associated equipment (learning rates). However, the costs of the more mature technologies, including geothermal and onshore wind power, do not change in some cases or change a little (< 5%) in other cases.

27. As discussed before transaction costs for CDM project implementation are similar regardless of project size in many areas, which is a disadvantage for smaller projects, where those fixed costs are disproportionately greater than for larger projects. It is also noted in the literature that the marginal contribution of carbon revenues (CERs) for small-scale renewable energy projects makes it difficult to prove financial additionality and to alleviate the additionality barrier (Castro et al. (2011, Pablo (2007), Pearson (2007))

28. For the renewable energy technologies covered in this analysis, in most cases the smaller the plant size, the higher the capital cost. In the case of capital costs, although for all technologies they drop over the years, in 2015 the renewable energy technologies still present higher upfront costs than diesel generators of comparable sizes. The analyses are based on the 2015 projected costs.

29. Thus when an upfront cost that is at least three to four times higher than that of a diesel generator of comparable size is used as the basis (see details in appendix 1), the following list of off-grid electricity generation technologies emerge as potential candidates for inclusion in the positive list.

(a) Micro/pico-hydro (with power plant size up to 100 kW);

(b) Micro/pico-wind turbine (up to 100 kW);

(c) PV-wind hybrid (up to 100 kW);

(d) Geothermal (up to 200 kW);

(e) Biomass gasification/biogas (up to 100 kW).

[6] Levelized cost is the cost of supplying a unit of energy over a system's lifetime that incorporates the initial investment, capital costs, and operating and maintenance costs including fuel costs.

30. It is also found that small/micro building-integrated wind turbines or household rooftop wind turbines of size up to 100 kW that can supply electricity to a grid may also be a potential candidate for including in the positive list. According to Freris (2008) and IRENA (2012), the difficulties facing the designers and manufacturers of such machines are substantial and the diseconomies of downsizing are such that the capital expenditures (e.g. cost/kW) of a small wind turbine is considerably more than for a typical size of grid connected wind turbines used in wind farms. Moreover the annual average wind speed in a typical urban environment is perhaps one half of that usually experienced in a good wind farm site and expected energy yield per kW capacity from the small wind turbine in these circumstances would be approximately one eight of that from its large scale counterpart and this ignores the substantial advantage of the higher wind speeds at the hub height of the large machines. Additionally, in urban locations potential wind turbulence due to the presence of buildings and trees makes such wind turbines less attractive.

Appendix 1

1. In Figure 1 and Figure 2, cost of electricity generation and upfront cost of installation of renewable energy technologies is compared to diesel alternative. Taking into account uncertainties on various assumptions on costs data, the technologies with upfront cost that is at least three times higher than that of diesel generator of comparable size is used as the basis of the list of off-grid electricity generation technologies that can be potentially included in the positive list.

(a) Micro/Pico-hydro (with power plant size up to 100 kW);

(b) Micro/Pico-Wind turbine (up to 100 kW);

(c) PV-Wind Hybrid (up to 100 kW);

(d) Geothermal (up to 200 kW);

(e) Biomass Gasification/Biogas (up to 100 kW).

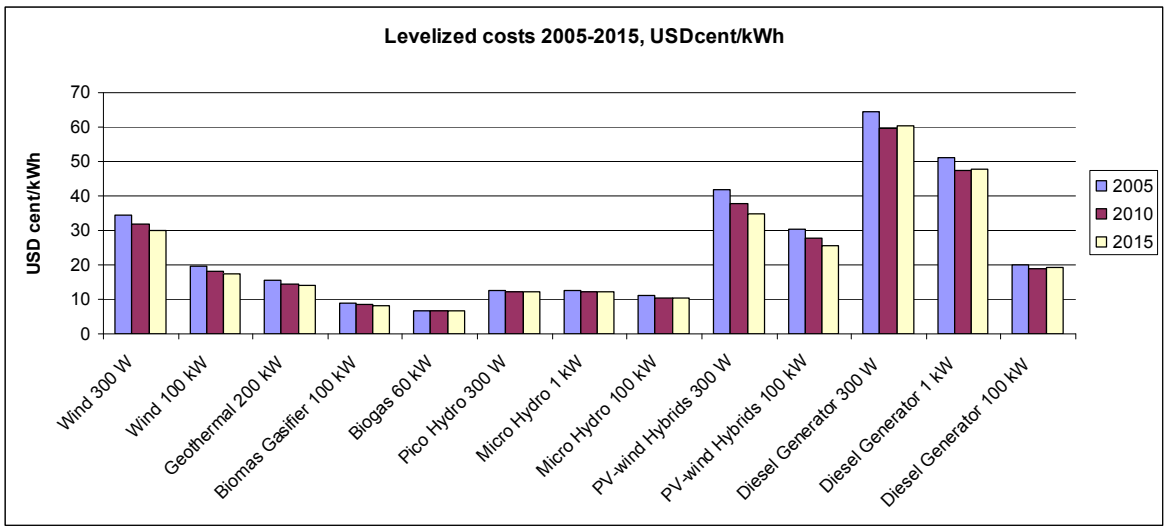

Figure 1: Levelized costs 2005-2015, USDcent/kWh

Source: Cost figures taken from ESMAP. Technological and Economic Assessment of Off-grid, Mini-grid and Grid Electrification technologies

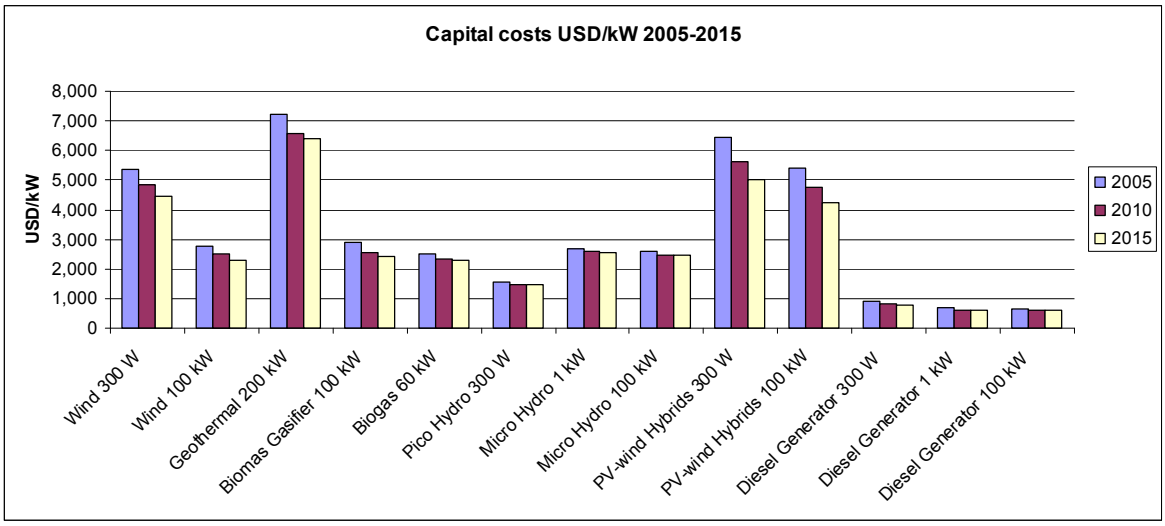

Figure 2: Capital costs USD/kW 2005-2015

Source: Cost figures taken from ESMAP. Technological and Economic Assessment of Off-grid, Mini-grid and Grid Electrification technologies

		Input data									Output data		
Resource	Technology	Typical size of the device (MW)[ii]	Investment cost (USD/kW)	O&M cost, fixed annual (USD/kW) and/or (non-feed) variable (US¢/kWh)	By-product revenue (US¢/kWh)[iii]	Feedstock cost (USD/GJ feed, HHV[iv])	Feedstock conversion efficiency[vi] (%)	Capacity factor (%)	Economic design lifetime (years)	References	LCOE[v] (US¢/kWh) Discount rate 3%	7%	10%
Bioenergy	Dedicated Biopower CFB[vii]	25–100	2,700–4,100[viii]	87 USD/kW and 0.40 US¢/kWh	n.a.[viii]	1.25–5.0[ix]	28	70–80	20	McGowin (2008)	6.1–13	6.9–15	7.9–16
	Dedicated Biopower Stoker[x]	See above	2,600–4,000[viii]	84 USD/kW and 0.34 US¢/kWh	n.a.[viii]	See above	27	See above	See above		5.6–13	6.7–15	7.7–16
	Dedicated Biopower (Stoker CHP[xi])	See above	2,800–4,200[viii]	86 USD/kW and 0.35 US¢/kWh	1.0[xii]	See above	24	See above	See above		5.1–13	6.3–15	7.3–17
	Co-firing: Co-feed	20–100	430–500[xiii]	12 USD/kW and 0.18 US¢/kWh	n.a.[viii]	See above	36	See above	See above	McGowin (2008)	2.0–5.9	2.2–6.2	2.3–6.4
	Co-firing: Separate Feed	See above	760–900[xiii]	18 USD/kW	n.a.[viii]	See above	36	See above	See above	Bain (2011)	2.3–6.3	2.6–6.7	2.9–7.1
	CHP (ORC[xiv])	0.65–1.6	6,500–9,800	59–80 USD/kW and 4.3–5.1 US¢/kWh	7.7[xv,xvi]	See above	14	55–68	See above	Obernberger et al. (2008)	8.6–26	12–32	15–37
	CHP (Steam Turbine)	2.5–10	4,100–6,200[xvii]	54 USD/kW and 3.5 US¢/kWh	5.4[xv, xviii]	See above	18	See above	See above		6.2–18	8.3–22	10–26
	CHP (Gasification ICE)[xix]	2.2–13	1,800–2,100	65–71 USD/kW and 1.1-1.9 US¢/kWh	1.0–4.5[xv, xx]	See above	28–30	See above	See above		2.1–11	3.0–13	3.8–14
Direct Solar Energy	PV (residential rooftop)	0.004–0.01	3,700–6,800[xxi]	19–110 USD/kW[xxii]	n.a.[viii]	n.a.[viii]	n.a.[viii]	12–20[xxiii]	20–30	see Section 3.8 and footnotes	12–53	18–71	23–86
	PV (commercial rooftop)	0.02–0.5	3,500–6,600[xxi]	18–100 USD/kW[xxii]	n.a.[viii]	n.a.[viii]	n.a.[viii]	See above	See above		11–52	17–69	22–83
	PV (utility scale, fixed tilt)	0.5–100[xxiv]	2,700–5,200[xxi]	14–69 USD/kW[xxii]	n.a.[viii]	n.a.[viii]	n.a.[viii]	15–21[xxiii]	See above		8.4–33	13–43	16–52
	PV (utility scale, one-axis)	0.5–100[xxiv]	3,100–6,200[xxi]	16–75 USD/kW[xxii]	n.a.[viii]	n.a.[viii]	n.a.[viii]	15–27[xxiii]	See above		7.4–39	11–52	15–62
	CSP	50–250[xxv]	6,000–7,300[xxvi]	60–82 USD/kW[xxvii]	n.a.[viii]	n.a.[viii]	n.a.[viii]	35–42[xxviii]	See above		11–19	16–25	20–31
Geothermal Energy	Geothermal energy (condensing-flash plants)	10–100	1,800–3,600[xxix]	150–190 USD/kW[xxx]	n.a.[viii]	n.a.[viii]	n.a.[viii]	60–90[xxxi]	25–30[xxxii]	see Section 4.7 and footnotes	3.1–8.4	3.8–11	4.5–13
	Geothermal energy (binary-cycle plants)	2–20	2,100–5,200[xxix]	See above	n.a.[viii]	n.a.[viii]	n.a.[viii]	See above	See above		3.3–11	4.1–14	4.9–17
Hydropower	All	<0.1 – >20,000[xxxiii]	1,000–3,000[xxxiv]	25–75 USD/kW[xxxv]	n.a.[viii]	n.a.[viii]	n.a.[viii]	30–60[xxxvi]	40–80[xxxvii]	see Chapter 5 and footnotes	1.1–7.8	1.8–11	2.4–15

		Input data									Output data		
Resource	Technology	Typical size of the device (MW)[ii]	Investment cost (USD/kW)	O&M cost, fixed annual (USD/kW) and/or (non-feed) variable (US¢/kWh)	By-product revenue (US¢/kWh)[iii]	Feedstock cost (USD/GJ$_{feed, HHV}$[iv])	Feedstock conversion efficiency$_{el}$ (%)	Capacity factor (%)	Economic design lifetime (years)	References	LCOE[v] (US¢/kWh) Discount rate 3%	7%	10%
Ocean Energy	Tidal Range[xxxviii]	<1 – >250[xxxix]	4,500–5,000[xxxvii]	100 USD/kW[xxxviii]	n.a.[viii]	n.a.[viii]	n.a.[viii]	22.5–28.5[xl]	40[xli, xxxviii]	see Section 6.7 and footnotes	12–16	18–24	23–32
Wind Energy	Wind energy (onshore, large turbines)	5–300[xlii]	1,200–2,100[xliii]	1.2–2.3 US¢/kWh	n.a.[viii]	n.a.[viii]	n.a.[viii]	20–40[xliv]	20[xlv]	see Chapter 7	3.5–10	4.4–14	5.2–17
	Wind energy (offshore, large turbines)	20–120[xlii]	3,200–5,000[xlvi]	2.0–4.0 US¢/kWh	n.a.[viii]	n.a.[viii]	n.a.[viii]	35–45[xlii]	See above		7.5–15	9.7–19	12–23

Figure 3: Levelized and capital cost IPCC

Source: IPCC Special report on Renewable Energy Sources and Climate Change Mitigation, 2011(Bruckner, Thomas et al. 2011)

Technology	Typical Characteristics		Typical Energy Costs (U.S. cents/kilowatt-hour)
Power Generation			
Large hydro	Plant size:	10 MW–18,000 MW	3–5
Small hydro	Plant size:	1–10 MW	5–12
On-shore wind	Turbine size:	1.5–3.5 MW; Rotor diameter: 60–100 meters	5–9
Off-shore wind	Turbine size:	1.5–5 MW; Rotor diameter: 70–125 meters	10–20
Biomass power	Plant size:	1–20 MW	5–12
Geothermal power	Plant size: Types:	1–100 MW; binary, single- and double-flash, natural steam	4–7
Solar PV (module)	Efficiency:	crystalline 12–19%; thin film 4–13%	-
Solar PV (concentrating)	Efficiency:	25%	-
Rooftop solar PV	Peak capacity:	2–5 kW_{peak}	17–34
Utility-scale solar PV	Peak capacity:	200 kW to 100 MW	15–30
Concentrating solar thermal power (CSP)	Plant size: Types:	50–500 MW (trough), 10–20 MW (tower) trough, tower, dish	14–18 (trough)
Hot Water/Heating/Cooling			
Biomass heating	Plant size:	1–20 MW_{th}	1–6
Solar hot water/heating	Size: Types:	2–5 m^2 (household); 20–200 m^2 (medium/multi-family); 0.5–2 MW_{th} (large/district heating); evacuated tube, flat-plate	2–20 (household) 1–15 (medium) 1–8 (large)
Geothermal heating	Plant capacity: Types:	1–10 MW_{th} heat pumps, cooling, direct use, chillers	0.5–2
Biofuels			
Ethanol	Feedstocks:	sugar cane, sugar beets, corn, cassava, sorghum, wheat (and cellulose in the future)	30–50 cents/liter (sugar) 60–80 cents/liter (corn) (gasoline equivalent)
Biodiesel	Feedstocks:	soy, rapeseed, mustard seed, palm, jatropha, waste vegetable oils, and animal fats	40–80 cents/liter (diesel equivalent)
Rural Energy			
Mini-hydro	Plant capacity:	100–1,000 kW	5–12
Micro-hydro	Plant capacity:	1–100 kW	7–30
Pico-hydro	Plant capacity:	0.1–1 kW	20–40
Biogas digester	Digester size:	6–8 m^3	n/a
Biomass gasifier	Size:	20–5,000 kW	8–12
Small wind turbine	Turbine size	3–100 kW	15–25
Household wind turbine	Turbine size:	0.1–3 kW	15–35
Village-scale mini-grid	System size:	10–1,000 kW	25–100
Solar home system	System size:	20–100 W	40–60

Figure 4: REN 21 Typical energy costs

Source: REN21. (Sawin , Janet L. et al. 2011)

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History of the document

Version	Date	Nature of revision(s)
02.0	2 July 2012	Published as an annex to the annotated agenda of EB68 Recommend to expand the positive list to include: (i) off-grid renewable electricity generation technologies; (ii) other isolated units/technologies of very small size in distributed location; (iii) grid connected household wind turbine; and (iv) rural electrification projects with renewable energy sources.
01.1	27 April 2012	Minor editorial change of footnote numbering for 7(e) & (f).
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