ARTICLE 6.4 MECHANISM

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Concept note

Guidelines for the implementation of methodological principles, approaches and methods for the establishment of baseline and additionality

Version 01.0

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1. Procedural background

1. Decision 3/CMA.3, paragraph 6 (d),[1] requests the Supervisory Body to elaborate and further develop recommendations, for consideration and adoption by the Conference of the Parties serving as the meeting of the Parties to the Paris Agreement (CMA) at its fourth session (November 2022), on the application of the requirements referred to in chapter V.B of the annex to that decision (titled 'Methodologies'). The relevant paragraphs are as follows:

33. Mechanism methodologies shall encourage ambition over time; encourage broad participation; be real, transparent, conservative, credible, below 'business as usual'; avoid leakage, where applicable; recognize suppressed demand; align to the long-term temperature goal of the Paris Agreement, contribute to the equitable sharing of mitigation benefits between the participating Parties; and, in respect of each participating Party, contribute to reducing emission levels in the host Party, and align with its NDC, if applicable, its long- term low GHG emission development strategy if it has submitted one and the long-term goals of the Paris Agreement.

34. Mechanism methodologies shall include relevant assumptions, parameters, data sources and key factors and take into account uncertainty, leakage, policies and measures, and relevant circumstances, including national, regional or local, social, economic, environmental and technological circumstances, and address reversals, where applicable.

35. Mechanism methodologies may be developed by activity participants, host Parties, stakeholders or the Supervisory Body. Mechanism methodologies shall be approved by the Supervisory Body where they meet the requirements of these rules, modalities and procedures and the requirements established by the Supervisory Body.

36. Each mechanism methodology shall require the application of one of the approach(es) below to setting the baseline, while taking into account any guidance by the Supervisory Body, and with justification for the appropriateness of the choices, including information on how the proposed baseline approach is consistent with paragraphs 33 and 35 above and recognizing that a host Party may determine a more ambitious level at its discretion:

(a) A performance-based approach, taking into account:

(i) Best available technologies that represent an economically feasible and environmentally sound course of action, where appropriate;

(ii) An ambitious benchmark approach where the baseline is set at least at the average emission level of the ***best performing comparable activities*** *providing* ***similar outputs and services*** *in a defined scope in similar social, economic, environmental and technological circumstances;*

(iii) An approach based on existing actual or historical emissions, adjusted downwards to ensure alignment with paragraph 33 above.

[1] See decision 3/CMA.3 contained in document FCCC/PA/CMA/2021/10/Add.1 available at: https://unfccc.int/documents/460950. The annex to the decision begins on page 29 (English language version).

37. Standardized baselines may be developed by the Supervisory Body at the request of the host Party or may be developed by the host Party and approved by the Supervisory Body. Standardized baselines shall be established at the highest possible level of aggregation in the relevant sector of the host Party and be consistent with paragraph 33 above.

38. Each mechanism methodology shall specify the approach to demonstrating the additionality of the activity. Additionality shall be demonstrated using a robust assessment that shows the activity would not have occurred in the absence of the incentives from the mechanism, taking into account all relevant national policies, including legislation, and representing mitigation that exceeds any mitigation that is required by law or regulation, and taking a conservative approach that avoids locking in levels of emissions, technologies or carbon-intensive practices incompatible with paragraph 33 above.

39. The Supervisory Body may apply simplified approaches for demonstration of additionality for any least developed country or small island developing State at the request of that Party, in accordance with requirements developed by the Supervisory Body.

2. Purpose

2. The purpose of this document is to identify and present issues that need guidance from the Supervisory Body regarding operationalising of the decisions included under the background above. In that regard, preliminary and non-exhaustive options in specific areas are presented only to kick start the discussion on the topic. Information and data from different sectors drawn from Clean Development Mechanism (CDM) and other mechanisms are included to facilitate the discussion of the SB.

3. Key issues

3. The methodological approaches for setting baselines and determining additionality are the key elements to be addressed in order to respond to the mandates listed in paragraph 1 above. Table 3 provide a snapshot of mandates for different methodological elements. This concept note first discusses the performance-based approach specified in paragraph 36 of the annex to decision 3/CMA.3 (reproduced in para. 1 above). It then delves into the methodological issues mentioned in paragraphs 33, 34, 37, 38 and 39 of the annex to that decision.

3.1. Performance-based approach for the baseline

3.1.1. Best available technology and ambitious benchmark

4. Paragraph 36 of the annex to decision 3/CMA.3 (see para. 1 above) ‘requires’ the application of ‘one’ of the approach(es) listed, whereas it seems to also allow a combination of approaches in stating ‘A performance based approach taking into account […].’. The Supervisory Body may wish to clarify if a combination of approaches is eligible or whether the three approaches are mutually exclusive.

5. While approaches in subparagraphs 36 (a) (ii) and 36 (a) (iii) refer to ‘emissions’, subparagraph 36 (a) (i) identifies ‘technologies’. When the latter is an electricity generation technology, the calculation of the emission intensity may be straightforward (e.g. 0.3 t

CO_2/MWh for an efficient natural gas power plant); in other cases, such as electromobility and thermal energy generation for cooking, the energy or electricity source seem to matter for the emissions. For example, with reference to Figure 4 in the appendix, the emission performance of a battery electric vehicle (BEV) would also depend on the grid emission factor of the electricity source (i.e. under some conditions emission intensity of a BEV would be close to zero if the grid were to be totally dominated by renewable sources; on the other hand it would be close to 200 gCO_2e/km if the grid were to be dominated by fossil fuel power plants such as coal power plants).

6. The benchmarking approaches in current methodologies for grid connected and off-grid renewable energy, buildings, transport, efficient appliances are detailed in the Appendix. A summary follows in paragraphs 7–16 below.

7. **Grid-connected renewable electricity generation**: When the electricity grid comprises many power plants in dispersed locations, the precise identification of the baseline power plants that are affected due to the renewable energy (RE) supplied by a project power plant will not be possible. Under the CDM, a combined margin (CM) approach evolved over the years to address the issue, which involved identifying affected power plants in the operating margin (OM) and the build margin (BM). In its simplest form, this included:

   (a) The OM as the cohort of existing power plants whose operation will be most affected (reduced) by the project;[2]

   (b) The BM as the cohort of the recent/prospective/future power plants whose construction and operation could be affected by the renewable energy project, based on an assessment of recent/planned/expected new generation capacity.

8. CDM rules also specified the weights of the OM and BM, which depend on the characteristics of the renewable energy project but also considered whether the project is operating in the first or subsequent crediting periods.

9. International Financial Institution Technical Working Group on Green House Gas Harmonisation, adopted a modified approach to CM, by using the International Energy Agency's (IEA) energy statistics database and World Energy Outlook (WEO) i.e. country specific CO_2 emissions were used for the OM whereas 'Stated Policy Scenario' of the latest WEO was used to construct the BM. The approach generally resulted in a more conservative estimation of country specific grid emission factors.

10. Another approach is to consider the share of various fuels used in grid-connected electricity generation. When natural gas is among the major fuels used, the most efficient natural gas-fired power plant supplying electricity to the national grid is chosen. This led to a conservative estimate of the grid emission factor, typically around 0.33 t CO_2/MWh (JCM, 2022).

11. **Off-grid renewable electricity generation:** As detailed under the CDM methodological tool "TOOL33: Default values for common parameters" (TOOL33), renewable electricity supplied to off-grid households was considered to comprise of two tranches. For the first

[2] In principle, the OM consists of generation from the power plants with the highest variable operating costs in the economic merit order dispatch of the electricity system. Natural gas and oil-based power plants have the highest variable operating costs, followed by coal. Hydropower, co-generation plants and other sources of power (including waste-to-energy and other renewables) are typically "must run" or low cost and, therefore, contribute to the OM only under special circumstances.

55 kWh/household/year, which is typically consumed for lighting applications, 2.72 kilograms kgCO_2/kWh of baseline emissions were assigned. The emission factor was estimated based on an annual consumption of kerosene in the households reported in literature (i.e. around 60 litres (L)/household/year), recognizing suppressed demand. For the electricity quantities that exceeded 55 kWh/household/year, typically to power household appliances, 0.8 kg CO_2/kWh was assigned. Literature on the field performance of diesel generators typically used for residential applications was considered to benchmark the performance.

12. Another approach is to estimate the emission factor of a baseline diesel power generator applying the default efficiency of 49 per cent, an efficiency level which is not attained by currently available diesel power generators on the market, but which has the potential to be achieved at some point in future, leading to a very conservative baseline estimate of 0.53 t CO_2/MWh (JCM, 2022).

13. **Clean cooking**: Referring to the section 'Benchmarking for distributed technologies' in the appendix, baseline estimation in the CDM and Gold Standard methodologies for clean cooking involved a number of different parameters that were benchmarked based on a variety of approaches. Under the CDM, baseline emissions for a cookstove are based on the efficiency of the baseline stoves, the historic amount of wood fuel it used and the extent to which the wood fuel is non-renewable, determined through literature sources, surveys or expert judgement.

14. **Mitigation in buildings**: As detailed in the appendix, besides the option to benchmark the performance of energy efficient buildings based on building operational data, other options such as energy efficiency certification schemes, building codes, standards, and labelling programmes (e.g. star ratings for appliances) have been included under the CDM to estimate the baseline emissions (i.e. usually top tiers of performance such as 1+ or A+ and above have been chosen as baseline). The $90^{th}/80^{th}$ percentile of units (e.g. appliances such as refrigerators) based on ranking of emission performance was also used in some cases.

15. **Mitigation in transport**: The upper bound of the 90 per cent confidence interval (i.e. average +1.645 times the standard deviation) determined from the monitoring reports of road-based or rail-based rapid transit projects, over a period in similar regions, were considered for benchmarking in a conservative manner.

16. **Energy efficiency**: Some methodologies have specified the luminous efficacy of the 'best available technology' for indoor light emitting diode (LED) lamps based on the specification of manufacturers with global presence (e.g. 77.2 lumens/watt (W) for LEDs between 1 to 20 W).

17. The above approaches are summarised in Table 1 below:

Table 1. Summary of performance-based approaches applied in current methodologies for grid connected RE, off grid RE, clean cooking, buildings, transport and energy efficiency

Technology	Performance-based approaches in current methodologies
Grid connected RE	• Displaced electricity production from plants connected to the grid with extra weightage for recent/prospective plants, for a reliable estimation of grid emission factor; • Use forecasted grid emissions under stated policy scenario of IEA for a more conservative estimate (a variation of the method above); • When natural gas (NG) is among the mix, choose the most efficient NG power plant (0.33 tCO_2/MWh).
Off grid RE	• 0.53 tCO_2/MWh as emission factor for diesel generation with a high 49% efficiency (i.e. an efficiency level not attained by generators on the market yet); • Benchmark residential kerosene consumption for lighting recognising suppress demand and diesel consumption for appliances; • Higher emission factor for first 55 kWh/household/year of renewable energy supply recognising that it may be displacing kerosene consumption.
Clean cooking	• Efficiency of traditional stoves benchmarked as per literature; • 0.5 tonnes of wood fuel consumed/person/year benchmarked as per CDM data and literature data; • Data available from literature varies in quality, pragmatic and conservative approaches applied to determine the default values.
Buildings	• Benchmarking performance of energy efficient lot of buildings based on operational data; • Utilise information from building energy efficiency certification schemes, building codes, standards, and labelling programmes (e.g. star ratings for appliances) – the baseline is set based on top tiers of performance such as 1+ or A+ and above; • $90^{th}/80^{th}$ percentile of units (e.g. refrigerator) chosen based on ranking of emission performance.
Transport	• Statistical method i.e. upper bound of the 90% confidence interval (i.e. average added by 1.645 times the standard deviation), determined from the monitoring reports of road-based or rail-based rapid transit projects, over a period in similar regions, to benchmark the GHG emissions per kilometre (e.g. per passenger kilometre).
Energy Efficiency	• Luminous efficacy of the 'best available technology' for indoor light emitting diode (LED) lamps based on the specification of manufacturers with global presence (e.g. 77.2 lumens/watt (W) for LEDs between 1 to 20 W).

3.1.2. Areas that need guidance from the Supervisory Body in relation to best available technology and ambitious benchmark

18. The Supervisory Body may wish to consider the above approaches and provide guidance regarding:

(a) Whether the approaches specified under paragraph 36 may be applied in combination where necessary;

(b) Which of the approaches that have been applied in existing methodologies may directly meet the requirements in paragraph 36 (a) (i) and/or 36 (a) (ii) and hence eligible to be considered;

(c) Which of the approaches that have been applied in existing methodologies do not currently meet the requirements in paragraph 36 (a) (i) and/or 36 (a) (ii) fully, but would be amenable to modifications to render them eligible;

(d) Which of the approaches that have been applied in existing methodologies are not suitable to be considered further;

(e) Any thresholds that should be applicable for using the benchmarks (e.g. percentage thresholds such as top 20 per cent, statistical methods such as one or two standard deviations deducted from the mean, and/or 80th or 90th percentile of ranked emission intensities). For the same technologies, the Supervisory Body may wish to specify whether less stringent benchmark percentiles should be applied for Least Developed Countries (LDCs) or Small Island Developing States (SIDS) to cater for their special circumstances;

(f) Any criteria that should be applicable to demonstrate the criteria ‘economically feasible’ (e.g. cost of ownership of the technology is less than 10 per cent of the household annual income) and that the baseline technology is ‘environmentally sound’ (e.g. technology is in line with national laws and regulations on environmental protection; technology does not belong to a negative list of technology such as electricity generation from coal);

(g) Any applicable vintage of data that should be considered (e.g. three years of data or at least one year of data where data gaps can be proven).

(h) How to address specificities of greenfield and retrofit project activities;

(i) Whether and how to consider benchmarking by industry associations and country level determination of best available technology (BAT) as detailed below.

19. **Benchmarking by industry associations**: The Supervisory Body may also wish to consider the benchmarking used by the industry associations and provide guidance regarding if and how they could be utilized for the purposes of baseline. Several sectoral associations such as the International Aluminium Institute, the Cement Sustainability Initiative, the World Steel Association and the Global Off-Grid Lighting Association[3] have collected data from their members and benchmarked the top performances, while respecting the confidential nature of some of the data supplied by their members.

[3] See GOGLA website located at: https://www.gogla.org/.

20. **Definition of best available technologies**: From the above discussion, it appears that both ‘best’ and ‘available’ are context-specific and there is no one-size-fits-all definition of best available technologies. The definitions of ‘available’ seem to range from accessibility of the technology to a specific user (e.g. cost of ownership of the technology relative to the income of the user), the technology being produced within the jurisdiction, and the technology being generally economically and technically viable in the jurisdiction. Thus, it may be desirable to determine accessibility by considering the costs and benefits of the technologies.

21. The Supervisory Body may also wish to consider developing a standard process for BAT determination involving the host country government, activity participants and other stakeholders, and the support structure of the Supervisory Body. Considering that such a determination may be time-consuming, the Supervisory Body may wish to discuss if such a process should remain optional for use by the stakeholders.

22. **Country-level determination of BAT**: Typically, where it was applied, BAT determination started with the collection of information on technologies through questionnaires and stakeholder meetings, and in some cases, data is also gathered though interviews and literature research. According to Organisation for Economic Co-operation and Development (OECD), the data gathering process is typically carried out by governmental environmental authorities or other ministries depending on the country, and by industry associations (OECD, 2018). In the subsequent evaluation process, both technical and environmental factors played an important role, and economic aspects were often also brought in. A BAT determination process then included multiple stakeholders such as government representatives, single industries, industry associations, non-governmental associations, and research institutes. This renders the process resource-intensive. The OECD also notes that some stakeholders are not willing to provide data on economic aspects of technologies. Countries without advanced monitoring systems face challenges in implementing such a process. Overall, it took one to six years to identify the BAT and finalize related documents, which stands in stark contrast with fast technological developments in some sectors.

3.1.3. Guidance needed by the Supervisory Body for setting the baseline based on existing actual or historical emissions adjusted downwards

23. For the approach in paragraph 36 (a) (iii), determination of actual or historical emissions, possibly using elements of existing methodologies, may be the first step. The SB may wish to specify any requirements that should be applicable for the data quality (e.g. vintage of data). Determination of an appropriate adjustment factor to discount the actual or historical emissions could be the next step. The Supervisory Body may also wish to provide guidance regarding applicable conditions, for example:

    (a) Period to be considered and whether the discount factor should be linear or can be staggered (e.g. linear or staggered discounting through the national Long-term Low Emission Developing Strategies (LT-LEDS) or Nationally Determined Contribution (NDC) period or the period until the host country anticipates achieving a net-zero target consistent with the Paris Agreement);

    (b) Whether discounting should be differentiated according to sectors if the necessary data is available;

3.2. Details on the requirements in 'Methodologies'

24. In relation to the requirement in paragraph 33 of the annex to decision 3/CMA.3 that methodologies "**shall encourage ambition over time**", a methodology could potentially trigger more ambition over time by including requirements for the baseline, project technology and additionality as follows:

(a) When using a programmatic approach, progressively including more efficient and less greenhouse gas-intensive project technologies/measures in the distribution plan (e.g. LED lights with 60 lm/W are distributed in year 1 or under component project activity 1, whereas in year 2 or component project activity 2, LED lights with 70 lm/W are distributed);

(b) By including an adjustment factor in the equations of the methodology to account for autonomous efficiency improvements of the baseline technology (e.g. it is assumed that the efficiency of the baseline refrigerators increases by *x* per cent every year);

(c) Installation of more equipment/measures using the same technology over a period (i.e. wider geographic coverage or greater penetration among the potential end users);

(d) Additional coverage of sectors over a period;

(e) More conservative and accurate estimation of emission reductions by increasingly adopting life cycle approaches over a period. Life cycle approaches often may involve supply chains extending to different sectors in a country or other country or even continents. As a result, there may be a need to develop capacity to collect reliable data over a period to conduct reliable life cycle assessments;

(f) Increasing the stringency of baselines during each renewal of the crediting period. For example, CDM methodologies for grid-connected electricity generation often specify a decreasing share of the OM grid emissions factor (i.e. existing power plants on the grid most impacted by the proposed project), while specifying an increasing share of the BM emission factor (i.e. recent or prospective power plants most impacted by the proposed project) at each renewal of the crediting period, often resulting in a more conservative grid emission factor;

(g) By incentivizing new low-emission technologies with very low penetration rates by designating them as 'first-of-its-kind' or 'automatically additional' and excluding technologies with high penetration rates by designating them as 'common practice' or 'business-as-usual';

(h) By making additional investments in adopting digital technologies, particularly for monitoring (e.g. Internet of Things technologies, blockchain technologies), thereby increasing the reliability of the estimates and reducing uncertainties.

25. Considering the range of options that may be available to meet the '**shall encourage ambition over time**' requirement, the Supervisory Body may wish to consider if further guidance should be provided for methodology development on this aspect or if the issue should be addressed on a case-by-case basis in the new methodologies that will be approved.

26. If the Supervisory Body wishes to adopt a more elaborate approach to specify concrete elements, it may wish to consider if paradigm shift potential or potential for scaling up and replication, innovation potential, and removal of barriers should be specified.[4]

27. In relation to the requirement in paragraph 33 of the annex to decision 3/CMA.3 that methodologies shall "**Encourage broad participation**": There may be several ways to encourage broad participation, including through broad sectoral coverage and the technological coverage of the methodologies. Experience under the CDM shows that conservative defaults for the monitoring parameters of the project technology and/or baseline technology in lieu of direct monitoring enabled reduced transaction costs for certain types of projects, thereby allowing underrepresented regions to participate. Such defaults may also help address data gaps that may prevail in some regions regarding baseline estimations, allowing for a prompt start for the projects (e.g. default 60 per cent methane content of biogas in small-scale CDM projects involving biogas generation as opposed to continuous monitoring allowed smaller projects to participate). Programmatic approaches under the CDM allowed for the aggregation of small and distributed technologies over a period. This allowed for broader participation through reduced transaction costs and uncertainty related to compliance with the CDM regulatory requirements. Broad participation may also imply that a broad range of stakeholders of the project participate and benefit from the project directly or indirectly. The Supervisory Body may wish to provide guidance on how this aspect should be included in the methodology.

28. In relation to the requirement in paragraph 33 of the annex to decision 3/CMA.3 that methodologies that shall be "**Below business as usual**": The Supervisory Body may wish to discuss if this demonstration is required at the activity level or at higher level. If a more macro level demonstration is required, the Supervisory Body may wish to provide guidance, perhaps by referring to the most recent Intergovernmental Panel on Climate Change (IPCC) literature such as the Sixth Assessment Report,[5] showing that a project's technology is a recommended technology and the avoided baseline technology is below business-as-usual. The Supervisory Body may wish to consider if scenarios developed by

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[4] This may include the elaboration of one or more elements from the list below in relation to technologies/measures that are being deployed:

- Paradigm shift potential or potential for scaling up and replication: Degree to which the proposed activity can catalyse impact beyond the proposed project or programme (i.e. potential for exporting key structural elements elsewhere within the same sector as well as to other sectors, regions or countries);
- Innovation potential: Opportunities for targeting innovative solutions and new market segments; and/or developing or adopting new technologies, business models, modal shifts and/or processes;
- Removal of the barriers: Degree to which the activity will change incentives for market participants by reducing costs and risks, thus eliminating barriers to the deployment of low-carbon solutions;
- Contribution to the regulatory frameworks and policies: Degree to which activity shifts incentives to mainstream climate change considerations in policies, regulatory frameworks and decision-making processes at national, regional and local levels, including private-sector decision-making.

[5] Available at: https://www.ipcc.ch/report/sixth-assessment-report-working-group-3/.

World Energy Model of the International Energy Agency[6] may also be considered for this purpose.

29. In relation to the requirement in paragraph 33 of the annex to decision 3/CMA.3 that methodologies shall "**Avoid leakage, where applicable**": Potential leakage emissions may be triggered by a methodology if it shifts the emissions-intensive technologies/measures in the baseline for continued use outside of the project boundary within the host country or outside of the host country. In some cases, the issue may be within the reasonable control of the project participant, but in other cases, such impacts may be difficult to identify. For example, when the proposed renewable energy generation project displaces a captive generation unit such as a diesel generation unit, it may be possible to track the shift of the existing units; however, the determination of impact of grid-connected renewable energy generation on the physical shift of existing grid-connected plants may be more difficult to determine. In some cases, it may be feasible to require the demonstration of dismantling/destruction of the baseline equipment (e.g. baseline cookstoves, baseline lighting equipment) or require the project to describe the built-in incentives to destroy the baseline inefficient equipment. Since feasible measures may be a sector-specific or region-specific issue, the Supervisory Body may wish to provide guidance on requirements that should be included in the methodology to allow the project participant to describe how this is met.

30. In relation to the requirement in paragraph 33 of the annex to decision 3/CMA.3 that methodologies shall "**Recognize suppressed demand**": Under the CDM, suppressed demand is recognized for the basic needs of lighting, water and energy.[7,8] If the technology and energy/fuel usage in that technology are segregated as separate issues, it may be feasible to address suppressed demand in some situations while still following the benchmarking requirements for the baseline technology. There will be a need to identify a minimum level of service and a reference technology that is use in the region that meets that level of service, as well as the resulting emissions that should be considered. The Supervisory Body may wish to provide guidance on whether the issue should be considered in specific methodologies such as those for clean cooking, safe drinking water supply or efficient lighting to displace the use of solid fuels or kerosene for lighting, or whether a general guideline on the issue should be developed.

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[6] *Net Zero Emissions by 2050 Scenario*: A scenario which sets out a narrow but achievable pathway for the global energy sector to achieve net zero CO_2 emissions by 2050; *Announced Policies Scenario*: A scenario which assumes that all climate commitments made by governments around the world, including NDCs and longer-term net zero targets, will be met in full and on time; *Stated Policies Scenario*: A scenario which reflects current policy settings based on a sector-by-sector assessment of the specific policies that are in place, as well as those that have been announced by governments around the world.

[7] Under the CDM, minimum service level is defined as a service level that can meet basic human needs. In some situations, this service level may not have been provided prior to the implementation of the CDM project activity, indicating suppressed demand with a consequent future emissions increase due to income effect, rebound effect or other technical factors such as limited availability of a service (e.g. connection to a very weak grid) or low quality of a service (e.g. aversion to pollution caused by kerosene lanterns). Further basic human needs are defined as physical and physiological needs such as basic housing, basic energy services (including lighting, cooking, drinking water supply and space heating), sanitation (waste treatment/disposal) and transportation.

[8] See "Guidelines on the consideration of suppressed demand in CDM methodologies" available at: https://cdm.unfccc.int/Reference/Guidclarif/meth/meth_guid41.pdf.

31. In relation to the requirement in paragraph 33 of the annex to decision 3/CMA.3 that methodologies shall "**Be real, transparent, conservative, credible**": For this purpose, the Supervisory Body may wish to consider whether concrete measures to exclude activities with weak demonstration of causality of emission reductions in relation to a technology/measure employed or implemented would be necessary. For example, a reduced level of activity due to reduced demand for services or goods may result in emission reductions that are not real, conservative or credible. It may be also necessary to consider 'when' the baseline emissions would have occurred to determine the real emission reductions. For example, organic waste deposited in a landfill will generate methane emissions over several decades. Accruing all the emission reductions upfront for a compost project that diverts waste from the landfill is not accurate. Instead, the emission reductions need to be determined by applying the IPCC first order decay model, which considers the rate of formation of methane from the waste deposited in a landfill. Similarly, behavioural change projects (e.g. training for bus drivers resulting in reduced fuel consumption from the bus) that do not include a technology change component would need a robust method to establish the causality of emission reduction. Until such a method becomes available, it may be necessary to take a cautious approach to determining the eligibility of such projects. The Supervisory Body may wish to provide guidance regarding concrete elements that should be included in the methodologies in this regard.

32. In relation to the requirement in paragraph 33 of the annex to decision 3/CMA.3 that methodologies shall "**Contribute to equitable sharing of mitigation benefits between participating Parties**": In some activities, mitigation is achieved entirely within the boundaries of the host country, for example renewable energy that displaces the use of a diesel generator to supply electricity for the domestic use of communities in the host country. In other cases, the value chain of the activity may extend to multiple countries, for example when biofuel produced in the host country is used in another country or green hydrogen produced in the host country is used in another country to achieve emission reductions in a steel plant. Existing methodologies require that either the producer or the consumer claim the emission reductions. The Supervisory Body may wish to provide guidance regarding concrete elements that should be included in the methodologies in this regard.

33. In relation to the requirement in paragraph 34 of the annex to decision 3/CMA.3 that methodologies shall "**Include relevant assumptions, parameters, data sources and key factors and take into account uncertainty, leakage, policies and measures, and relevant circumstances including national, regional or local, social, economic, environmental and technological circumstances and address reversals where applicable**": The Supervisory Body may wish to provide guidance regarding concrete elements that should be included in the methodologies in this regard.

34. In relation to the requirement in paragraph 33 of the annex to decision 3/CMA.3 that methodologies shall "**Align with long-term goals of the Paris Agreement**"/"**Align to the long-term temperature goals of the Paris Agreement**"; "**Align with the NDC of the host Party, if applicable, with a longer low-greenhouse gas emission development strategy**"; "**Reducing emissions levels in the host Party": ** The Supervisory Body may wish to provide guidance regarding concrete elements that should be included in the methodologies in this regard (e.g. where the activity is a project level activity, whether demonstrating that the project measures are consistent with the measures specified in the latest NDCs of the host Party would be an eligible means).

3.2.1. Summary of areas that need guidance from the Supervisory Body in relation to paragraph 33 of 34 of the annex to decision 3/CMA.3

35. The Supervisory Body may wish to provide guidance on overarching issues in paragraph 34 and 33 of the annex o decision 3/CMA.3 but also on specific issues described in other paragraphs of this section that are summarised in Table 2 below.

Table 2. Guidance needed from the Supervisory Body in relation to paragraph 33 of the annex to decision 3/CMA.3

Requirements in paragraph 33 of the annex to decision 3/CMA.3	Guidance needed from the SB to meet the requirements
Shall encourage ambition over time	• Should the issue be addressed on a case-by-case basis in the new methodologies/activities; • Should concrete requirements be included (e.g. show paradigm shift potential or potential for scaling up and replication, innovation potential, and removal of barriers);

Encourage broad participation	• Could the below approaches be used, what others could be included?
	  • broad sectoral coverage and the technological coverage of the methodologies;
	  • conservative defaults in lieu of direct monitoring;
	  • broad range of stakeholders of the project participate and benefit;
	  • programmatic approaches

Below business as usual	• Could the below approaches be used, what others could be included?
	  • Demonstrate at activity level or macro level;
	  • Use information in IPCC literature or use IEA scenarios.

Avoid leakage where possible	• Consider shift of pre project equipment or co-use of baseline equipment (e.g. stove stacking); • Dismantling/destruction of the baseline equipment; • Require demonstration on case by case basis.

Recognize suppressed demand	• Could the below approaches be used, what others could be included?
	  • Whether technology and energy/fuel usage in that technology may be segregated for the baseline to address suppressed demand for the fuel/energy while still following the benchmarking requirements for the baseline technology;
	  • Limit to basic needs of lighting, water and energy;
	  • How to determine minimum service level, reference technology in the baseline for that service level.

Requirements in paragraph 33 of the annex to decision 3/CMA.3	Guidance needed from the SB to meet the requirements
Be real, transparent, conservative, credible	• Could the below approaches be used, what others could be included? • Address issues related to causality of emission reductions in relation to a technology/measure (avoid reduced level of activity for reduced level of service), robust methods for behaviour change projects, consider when emissions would have happened in the baseline
Contribute to equitable sharing of mitigation benefits between participating Parties	• How to address the issue when the value chain of the activity may extend to multiple countries (e.g. green hydrogen, biofuels), what other issues could be covered?

3.3. Additionality

36. The Supervisory Body may wish to further consider if it would like to provide any guidance on the below aspects:

(a) In relation to additionality, should positive lists containing activity types deemed automatically additional be developed? Could criteria include penetration of technologies (e.g. 2.5 per cent of market penetration for products) and cost of technologies (e.g. life cycle cost of renewable electricity generation)?

(b) For the same technologies, the SB may wish to specify if less stringent benchmark percentiles should be applied for LDCs/SIDS to cater for their special circumstances;

(c) Should activity types that lead to a lock-in of current emissions levels, a prolongation of the lifetime of emissions-intensive technologies (for both new installations and refurbishments of existing installations) or the continuation of carbon-intensive practice under all possible circumstances based on an assessment LT-LEDS (where they are available) be classified as a negative list? If a negative list is to be developed, should it be developed on the basis of an IPCC report such as the Sixth Assessment Report, which implies that electricity generation from coal is a negative list. Besides, refurbishing of technologies based on oil and gas are excluded from IPCC scenarios which may merit inclusion in negative list.

3.4. Standardised Baselines

37. Standardized baselines (SBL) shall be established at the highest possible level of aggregation in the relevant sector of the host Party and be consistent with paragraph 33 above. Where the parameter of interest in the sector is homogeneous, highest level of aggregation, may be more easily achieved than otherwise.

38. The SB may wish to clarify:

(a) if the 'highest possible level of aggregation' refers to sectoral coverage of the standardised baseline whereas the results or the values of the SBL itself may remain disaggregated (e.g. for the building sector in a country SBL may specify different values for Specific CO_2 emission factor (tCO_2/m^2.year) depending on the climatic region, building age and building size (see for example values specified under the CDM for the building sector at https://cdm.unfccc.int/methodologies/standard_base/2015/sb146.html). Under the CDM, almost all SBLs were developed for parameters included in the approved methodologies and the SBL shall be used in conjunction with an approved methodology. For such an approach, the requirements in the paragraph 33 may have been complied with via the methodology otherwise separate guidelines may be required to comply with paragraph 33;

(b) If the SBLs may cover multiple countries (e.g. SBL for South African Power pool comprised 9 countries) and whether in that case are mandatorily applied in all the countries covered; and

(c) The default validity period of the SBL.

3.5. Other issues

39. The SB may also wish to provide guidance regarding if and when life cycle emissions be considered. The impacts of such consideration are illustrated in Figure 5 in the appendix in relation to the transport sector. Life cycle emissions approaches were generally not followed under the CDM with the understanding that baseline technologies would also incur such production-related or material-related emissions. However, as the operation emissions in different sectors such as building and transport dwindle, the share of emissions embedded in the materials grows, leading to a higher share of emissions from materials in the overall emissions.

40. Included in Table 3 is a matrix of methodological issues for visual presentation of connection among different issues.

Table 3. Methodological options available to address paragraphs 33-38

Requirement from paragraphs 33-38	Baseline	Additionality	Avoid Leakage	Monitoring	Standardized Baselines
Encourage ambition over time;	X	X	X		X
Encourage broad participation;	X	X		X (cost effective monitoring)	X
Be real, transparent, conservative, credible and below 'business as usual';	X			X (digital technologies)	X
Recognize suppressed demand;	X	X		X (reference approach)	X

Requirement from paragraphs 33-38	Baseline	Additionality	Avoid Leakage	Monitoring	Standardized Baselines
Contribute to the equitable sharing of mitigation benefits between the participating Parties;	X				X
Align with the long-term temperature goal of the Paris Agreement; In respect of each participating Party, contribute to reducing emission levels in the host Party, and align with its NDC, if applicable, its long-term low GHG emission development strategy, if it has submitted one, and the long-term goals of the Paris Agreement.	X	X			X
Include relevant assumptions, parameters, data sources, key factors; take into account uncertainty, leakage, policies and measures, relevant circumstances, Address reversals	X	X	X	X	X
Best available technology economically feasible environmentally sound	X	X			X

Requirement from paragraphs 33-38	Baseline	Additionality	Avoid Leakage	Monitoring	Standardized Baselines
average emission level of the best performing comparable activities providing similar outputs and services in a defined scope	X	X			X
existing actual or historical emissions, adjusted downwards to ensure alignment with paragraph 33	X			X	X
Established at the highest possible level of aggregation					X
Robust assessment that shows the activity would not have occurred in the absence of the incentives from the mechanism		X			
Taking into account all relevant national policies, including legislation, and representing mitigation that exceeds any mitigation that is required by law or regulation		X			
Taking a conservative approach that avoids locking in levels of emissions, technologies or carbon-intensive practices incompatible with paragraph 33 above		X			

Requirement from paragraphs 33-38	Baseline	Additionality	Avoid Leakage	Monitoring	Standardized Baselines
Simplified approaches for demonstration of additionality for any LDC or SIDS at the request of that Party		X			

4. Subsequent work and timelines

41. Based on the guidance from the Supervisory Body the secretariat will further work to develop the guidelines for methodological requirements and present it for the consideration of the SB at a future meeting;

42. The secretariat will also revise a sample number of CDM methodologies from key sectors such as energy, buildings, industry, transport, waste in conjunction with the above cited draft guidelines and present them for the consideration of the SB for illustration purposes. In doing so, where possible, small scale CDM methodologies that are used for the programmatic approaches will be prioritised.

5. Recommendations to the Supervisory Body

43. It is recommended that SB considers the concept note and provides guidance to the secretariat to develop the methodological guidelines and road test it with select set of CDM methodologies that are revised.

6. References

44. The list of references is as follows:

(a) Joint Crediting Mechanism (JCM) (2022), Available at: https://www.jcm.go.jp/methodologies/all, Accessed on 27 June 2022.

(b) I-AMT (2022). TOOL01 - Tool for the demonstration and assessment of additionality: Concept Note. Version April 2022, Perspectives Climate Research, Freiburg.

(c) II-AMT (2022). TOOL02 - Tool for robust baseline setting: Concept Note. Version April 2022, Perspectives Climate Research, Freiburg.

(d) Gold Standard (2022). VCM transition framework, Available at https://www.goldstandard.org/our-story/vcm-transition-framework. Accessed on 27 June 2022.

(e) Michaelowa, Axel and others (2022). Transforming existing carbon market methodologies for Article 6 market-based cooperation, Carbon Mechanisms Review, Vol. 10, 1, Spring 2022, pp. 17–23.

(f) Axel Michaelowa, Juliana Kessler, Aglaja Espelage, Hanna-Mari Ahonen (2021). Best available technology and benchmark baseline setting under the Article 6.4 mechanism. Discussion paper, Perspectives Climate Group.

(g) Wuppertal Institute for Climate, Environment and Energy (2021). Paris-proofing of baseline setting as a means for alignment with the Paris Agreement's long-term objectives, Carbon Mechanisms Review, Vol. 9, 3, Autumn 2021.

(h) Michaelowa, Axel and others (2020). CDM method transformation: updating and transforming CDM methods for use in an Article 6 context. Perspectives.

(i) IEA (2020). Global EV outlook report 2020, IEA.

(j) McKinsey (2020). The zero-carbon car: Abating material emissions is next on the agenda.

(k) OECD (2018): Best Available Techniques (BAT) for Preventing and Controlling Industrial Pollution, Activity 2: Approaches to Establishing Best Available Techniques Around the World, Environment, Health and Safety, Environment Directorate, OECD, Paris.

Appendix. Best available technology and benchmark approaches from the clean development mechanism and Joint Crediting Mechanism methodologies

1. Executive Summary

1.1. Performance benchmarking in existing methodologies

1. Benchmarking approaches to baseline-setting are not new and have been discussed over the last 20 years in the context of the clean development mechanism (CDM), joint implementation under the Kyoto Protocol, and the voluntary carbon market. A benchmark is a reference against which an output is compared. It is used to show how an entity/activity/technology generating the output performs against the reference. The value of the benchmark is influenced by the level of aggregation of the underlying data and whether the comparison group is determined based on institutions, activity types or technology types. Often a geographical area, jurisdiction, specific features of a technology, vintage of a technology and/or the size of an activity is considered. On most occasions, greenhouse gas (GHG) emissions per unit output is computed for uniform comparison, for example tonnes of carbon dioxide equivalent (tCO_2e) per unit of output, also called “emissions intensity”.

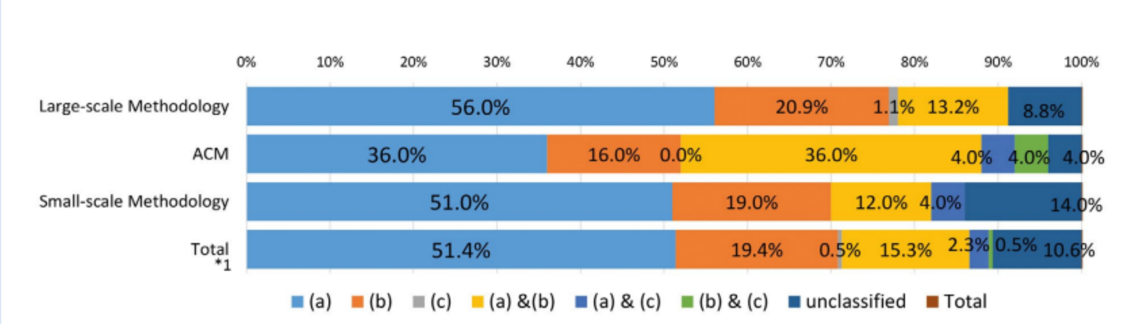
2. Paragraph 48 of CDM modalities and procedures provides three options to set the baselines, but no hierarchy for applying the options was indicated. As seen in figure 1 below, the option based on ‘existing actual or historical emissions’ was the one that was most used in the methodologies accounting for over 50 per cent of the usage. A performance-based approach to identify the top 20 per cent in the category was only occasionally used.

Figure 1. Application of baseline approaches under the CDM (source: Ministry of Environment, Japan, 2021 as cited in Wuppertal Institute for Climate, Environment and Energy, 2021)

a) Existing actual or historical emissions, as applicable

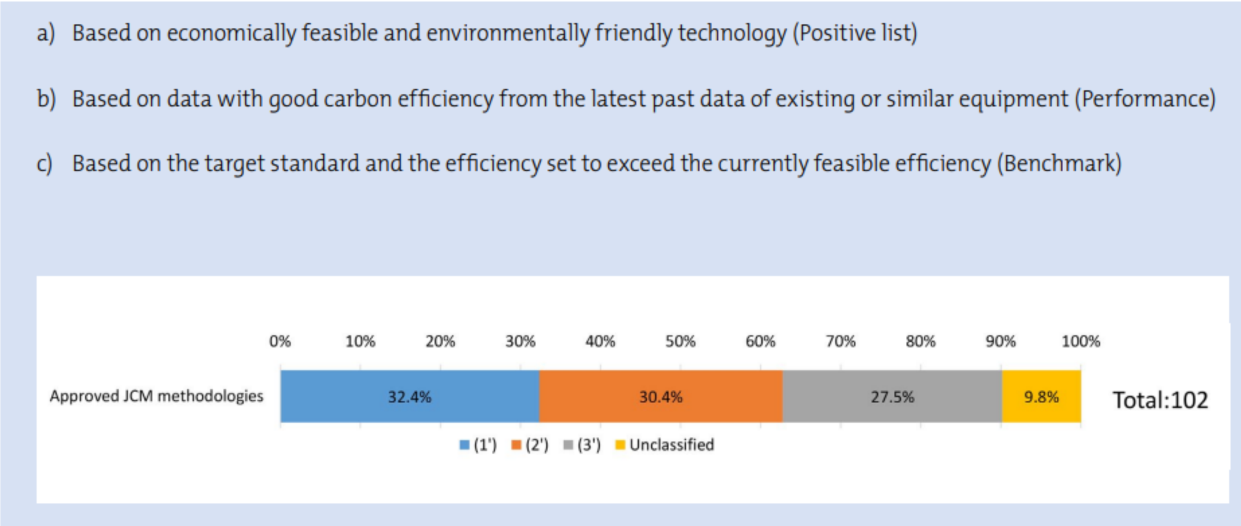
b) Emissions from a technology that represents an economically attractive course of action, taking into account barriers to investment

c) The average emissions of similar project activities undertaken in the previous five years, in similar social, economic, environmental and technological circumstances, and whose performance is among the top 20 per cent of their category.



3. Under Joint Crediting Mechanism (JCM), each approved methodology is developed in the context of the host Party, taking into account economically feasible and environmentally friendly technologies. Emission reductions to be credited are defined as the difference between "reference emissions" and project emissions. The reference emissions are calculated below business-as-usual emissions, which represent plausible emissions in providing the same outputs or service level of the proposed JCM project in the partner country. As seen in figure 2, in nearly a third of the JCM methodologies, the efficiencies are set to a target efficiency, exceeding the current efficiencies observed in the field.

Figure 2. Application of baseline approaches under the Joint Crediting Mechanism (Source: Ministry of Environment, Japan, 2021 as cited in Wuppertal Institute for Climate, Environment and Energy, 2021)



4. The application of benchmarking and best available technology approaches in the CDM and JCM methodologies is detailed below.

5. The standardized baseline for the building sector in the Republic of Korea benchmarked the top 20 per cent of building units based on a census of primary energy consumption per unit area (kilowatt-hour(kWh)/square metre (m^2)) of over 7 million building units. The resulting standardized baseline returned the top three tiers of performance reflected in the Korean Building Energy Efficiency Certification (BEEC): 1+++, 1++ and 1+. Although in this instance the benchmarking was done using the primary data, involving 5.7 million metering equipment and over 4 billion data points, it is seen that comparable results could be achieved by leveraging the data collected under BEEC (i.e. an average of 1+++ to 1+ buildings' performance could be considered to determine the benchmark).

6. In this regard, it can be argued that the reliability of data in the mandatory or voluntary standards and labelling programmes or star rating programmes could not be assured in all instances. However, it may be possible for regulators to establish an ex-ante or ex-post process where stakeholders could submit the data collection methodologies/processes and associated quality assurance procedures involved for the consideration of the regulators. Once such data collection procedure is approved, it may be possible to use the standards and labelling data for the purposes of benchmarking the performance to determine the baseline in the respective sector.

7. In this regard, it is worthwhile to note that CDM TOOL29 for the determination of a standardized baseline for energy-efficient refrigerators and air conditioners refers to 'Standards and labelling' databases in the host Party in order to identify the 90th or 80th percentile of baseline refrigerator units based on annual electricity consumption, or specific annual electricity consumption or energy efficiency index to conservatively determine the performance of the baseline refrigerator.

8. In the transport sector, the methodologies for bus rapid transit (BRT), mass rapid transit systems (MRTS) and high-speed rails leveraged the data from the CDM Project Design Document to benchmark the performance for the purposes of additionality. For example,

the performance of 37 BRT and/or MRTS projects across the world over the period of five years between 2009 to 2014 was used to estimate the emissions per passenger kilometre. The upper bound of the 90 per cent confidence interval (i.e. an average of +1.645 times the standard deviation) of the values reported by the project's documentation (i.e. CDM PDD, CDM Monitoring Report or annual report of the company managing the BRT/MRTS lines) was used for a conservative estimate. Such statistical methods, as above from the CDM experience, could also be useful to consider for the purposes of benchmarking using a conservative estimate of the baseline.

9. The CDM methodology for manufacturing energy-efficient refrigerators specified the lower of the two values to benchmark the performance of baseline refrigerators (i.e. the market benchmark), which is the specific electricity consumption of the top performing refrigerators in use in the market or the average historical specific electricity consumption of all refrigerators produced by the same manufacturers.

10. JCM methodologies use a consistent approach to determine the best available technology when it comes to renewable electricity generation in off-grid areas irrespective of the host Party of the emission reduction project activity. For example, the emission factor of a baseline diesel power generator is calculated by applying the default efficiency of 49 per cent, an efficiency level which is not attained by currently available diesel power generators on the market, leading to a very conservative baseline estimate of 0.53 tCO_2/megawatt-hour (MWh). When it comes to grid-connected renewable energy generation, when natural gas is among the major fuel mix for the grid-connected generators, JCM methodologies use the most efficient natural gas-fired power plant supplying electricity to the national grid with a conservative estimate of around 0.33 tCO_2/MWh.

11. The definition of grid accessible versus grid inaccessible areas in Kenya, accounting for the use of diesel generation during grid outage hours, is another novel approach used by the JCM methodologies. For the latter, a very conservative 2 per cent share of annual generation by diesel generators based on 'the shortest average annual time of power interruption during 2013 to 2016' was assumed. For efficient lighting activities, JCM methodologies specified the luminous efficacy of the 'best available technology' for indoor light emitting diode (LED) lamps based on manufacturers' specifications with global presence (e.g. 77.2 lumens (lm)/watt (W) for LEDs between 10 to 20 W). Other approaches applied in JCM methodologies include the use of standards and specifications for efficient and advanced technology drawn from developed country (e.g. Japan) and applied in a developing country for conservative baseline estimates.

1.2. Benchmarking for distributed activities

12. When it comes to distributed activities such as cooking, portable LED lights and solar home systems, there are additional complexities for benchmarking. Baseline fuel use such as wood fuel, charcoal and kerosene are poorly recorded as it is in great part processed and distributed by the informal sector. Estimates are often based on fuel preferences and per capita consumption averages, with occasional direct measurements to cross-check. Thus, the reliability and details of these estimates vary enormously from statistically sound surveys to the development and modelling of secondary data sources. There are also sectoral issues such as distinguishing residential use from non-residential consumption. Rural and urban distinction, units used (e.g. volume vs. weight), segment of the population covered (e.g. all of the population or wood fuel users among the population) and data vintages used also need consideration. Given the wide heterogeneity of consumption

estimates, in most cases the original values require some process of transformation (i.e. conversion to the common format using conversion factors and an assumed urban/rural fraction). After converting them into the common format, the values from the most suitable dataset that is “relevant, complete, consistent, reliable, current, accurate and objective” were approved as a standardized baseline in the case of standardized baselines that provided values for woody biomass consumption per person for household cookstoves in six countries in Africa.

13. CDM guidance for baseline stove efficiency allows to choose a value for efficiency based on a survey as below;

    (a) 0.1 for a three-stone fire using firewood (not charcoal), or a conventional device with no improved combustion air supply or flue gas ventilation (i.e. without a grate or a chimney);

    (b) 0.2 for other types of devices.

14. Of the 186 CDM monitoring reports for cookstove projects, 84 per cent have used default values (0.1 for baseline stoves without a chimney and grate and 0.2 for the rest), while 14 per cent used surveys and 2 per cent used literature.

15. The Clean Cooking Alliance developed the Clean Cooking Catalog[9] in 2013, which is a global database of cookstoves, fuels, fuel products, and performance data. It includes information on features and specifications, as well as on emissions, efficiency and safety based on laboratory and field-testing. The Catalog contains data from over 700 sets of test results, including both third party and self-reported data on performance and safety, which may be useful for benchmarking purposes.

Table 1. Thermal efficiency values of cookstoves reported in the Clean Cooking Catalog

Type of cookstove[10]	Number of stoves tested	Mean	Standard Deviation (SD)	Mean + SD
Three-stone fires using firewood	11	16.6	3.5	20.1
Traditional firewood stoves	9	22.1	7.8	29.9
Traditional charcoal stoves	4	21.8	3.2	25.0
Non-traditional firewood stoves	93	30.2	10.5	40.7
Non-traditional charcoal stoves	33	32.5	8.2	40.7

16. Based on an analysis of data from over 100 CDM projects, the global average value per capita of wood fuel consumption is 0.74 tonnes/capita/year, and one standard deviation is 0.39. Based on United Nations and Demographic and Health Surveys data, the global

[9] Available at: http://catalog.cleancookstoves.org/.

[10] For definitions of “traditional” and “non-traditional”, refer to: http://catalog.cleancookstoves.org/glossary#stove-characteristics.

average value per capita is 0.62 tonnes/capita/year (one standard deviation is 0.45 and the median is 0.5). A default wood fuel consumption of 0.5 tonnes/capita/year was conservatively benchmarked under the CDM.

17. Similarly, the CDM methodological tool TOOL33 specified that "For the first 55 kWh of electricity supplied to the user by the project electricity generating system in a given year, an emission factor of 2.72 kgCO_2/kWh (i.e. 2.72 tCO_2/MWh) may be used" and, based on information from a Lighting Africa study, was identified as the best available literature. The 2010 Lighting Africa study estimated 150 kilograms of CO_2 emissions per household per year based on a usage rate of 5 litre/month of kerosene (i.e. kerosene consumption in a household per year results in 2.5 kgCO_2/litre/household/year per 'bottom-of-pyramid household consumption of kerosene').

1.3. Benchmarking by industry associations

18. Sectoral industry associations often collect relevant data for benchmarking. For instance, in the aluminium sector, the major companies worldwide have formed the International Aluminium Institute. The Cement Sustainability Initiative, an industry initiative comprising major multinational cement producers, introduced the 'Getting the Numbers Right' exercise, which aims at gathering relevant data on existing technologies and creating a benchmarking system. The members of the World Steel Association (also known as 'worldsteel') collect industry-wide CO_2 data under its Climate Action programme. Data shared by companies will only be known to the company itself, worldsteel and the administrator of the data management system.

2. Sector wise details of benchmarking approaches used

2.1. Building sector

2.1.1. Standardized baseline for the building sector in the Republic of Korea (PSB0054)

19. The standardized baseline developed by the designated national authority (DNA) of the Republic of Korea determines the specific CO_2 emissions per m^2 of floor area for the top 20 per cent most efficient residential building units ($SE_{CO2,\ Top\text{-}20\%}$) when applying "TOOL31: Determination of standardized baselines for energy efficiency measures in residential, commercial and institutional buildings" (ver. 01.0).

20. Eighteen categories of buildings were identified by the DNA of the Republic of Korea based on the age of the building (new and existing), the floor area range and the climatic regions.

21. TOOL31 allows for the calculation of specific energy consumption (SE_{CO2}) of the top 20 per cent based on a sample of buildings. The DNA of the Republic of Korea, however, determined the top 20 per cent using a superior approach to data collection by including the whole population of residential building units (over 7 million building units, involving 5.7 million metering equipment and over 4 billion data points) instead of a sample.

22. The SE_{CO2} and top 20 per cent determined for each of the identified 18 building categories (separated based on floor area, climatic region and age of the building unit) were on the higher side of the BEEC, as seen in the figure below, leading to a very conservative estimate of the baseline.

Figure 3. Building Energy Efficiency Certification level and standardized baseline

BEEC Level	Required primary energy per unit area per year (kWh/m².year)	
	Residential buildings	Non-residential buildings
1+++	Less than 60	Less than 80
1++	60 - 90	80 - 140
1+	90 - 120	140 - 200
1	120 - 150	200 - 260
2	150 - 190	260 - 320
3	190 - 230	320 - 380
4	230 - 270	380 - 450
5	270 - 320	450 - 520
6	320 - 370	520 - 610
7	370 - 420	610 - 700

BEEC levels achieved by the 18 building categories (levels 1+++, 1++, 1+)

Mandatory BEEC level (level 1)

23. With regard to the $SE_{CO2,Top\text{-}20\%}$, six building categories were within the 1+++ BEEC level; six building categories were within the 1++ BEEC level; and six building categories were within the 1+ BEEC level, resulting in a baseline that averages the 1+, 1++ and 1+++ categories (i.e. much less than the 120 kWh/m^2 applicable to one category, leading to a very conservative baseline).

2.2. Transport sector

2.2.1. AM0031: Bus rapid transit system and ACM0016: Mass rapid transit projects

24. These methodologies provide a benchmarking approach for the demonstration of additionality. A proposed BRT or MRTS project shall demonstrate that the forecasted emissions from the project's BRT system is less than or equal to 50 grams (g) of CO2/passenger-kilometre (pkm) to demonstrate that project is additional. The benchmark was developed by analysing the performance of 37 BRT and/or MTRS projects across the world over a period of five years between 2009 to 2014. For light rail-based MRTS projects, the benchmark is 'forecasted emissions from the project's light rail transit (LRT) system is less than or equal to 0.1 kWh/pkm'. The benchmark was developed by analysing data between 2009 to 2014 from five LRT projects that were registered as CDM projects. The benchmark value for BRT and/or MRTS projects, including LRT projects, represents the upper bound of the 90 per cent confidence interval (i.e. an average of +1.645 times the standard deviation) of the values reported by the project's documentation (i.e. CDM PDD, CDM MR or annual report of the company managing the BRT/MRTS lines). The methodology includes the following guidance to determine the benchmark: "The benchmark for an existing system shall be calculated based on expected efficiency and fuel type of the project buses, annual number of passengers expected to travel and an average trip distance that these passengers are expected to travel when the system reaches its planned capacity, following a transport model such as ASIF model. A generic equation to calculate the GHG emissions per passenger km of transport system should read as follows:

GHG emissions = (***activity*** (per km) x ***modal share*** x ***energy intensity of the transport mode*** (CO_2/km) x ***carbon intensity of fuel*** (g/km))

2.2.2. AM0101: High speed passenger rail systems

25. The methodology provides a benchmark for additionality demonstration. The proposed high-speed rail (HSR) project shall demonstrate that the forecasted electricity consumption of the HSR project per passenger-kilometre is less than or equal to 0.08 kWh/pkm to demonstrate that the project is additional. The benchmark was developed by analysing operational data between 2009 and 2014 from seven rail companies that operate HSR systems across Asia and Europe. The proposed benchmark value for HSR projects represents the upper bound of the 90 per cent confidence interval (i.e. an average of +1.645 times the standard deviation) of the values reported by the annual report of the company managing the HSR lines.

2.3. Appliances: Refrigeration and air conditioning sector

2.3.1. AM0070: Manufacturing of energy-efficient domestic refrigerators

26. Baseline emissions are calculated based on benchmarks for the specific electricity consumption (in kWh/year*litre) of refrigerators in the baseline. A separate benchmark is established for each adjusted storage volume class j and refrigerator design (direct cooling or frost-free). The benchmark corresponds to the lower value between:

    (a) The specific electricity consumption of the top performing refrigerators in the market of the host country (market benchmark);

    (b) The average historical specific electricity consumption of the refrigerators produced by the manufacturer involved in the project activity (manufacturer benchmark).

27. The specific electricity consumption of the top performing refrigerators (market benchmark) is calculated as follows: The market benchmark is determined based on all refrigerators that were manufactured and sold in the host country. This should include refrigerators produced by the manufacturer involved in the project activity. Refrigerators produced for export shall be excluded. Project participants may choose whether or not refrigerators imported into the host country shall be included in the determination of the market benchmark. The choice should be documented in the CDM PDD and applied consistently for all years, all adjusted storage volume classes j, all models and all manufacturers and retailers.

28. The market benchmark is either determined (a) at the start of the project activity and is fixed for the crediting period; (b) until the applicable national or international standard to determine the model-specific rated electricity consumption and/or the adjusted storage volume is revised, whichever is earlier, or determined annually during the crediting period.

2.3.2. Benchmarking in CDM TOOL29 ‘Determination of standardized baselines for energy-efficient refrigerators and air-conditioners’

29. The approved tool states “The tool enables using different sources of data to address data gaps and cost effective data collection without compromising the environmental integrity of estimates, i.e standards and labelling databases” (e.g. Indian BEE Star, Brazil Procel, Korean Energy Management Corporation, China CNIS) and commercial marketing data

provided by specialized agencies (such as those provided by Nielsen Company, IMS Health, etc.)). Manufacturers' (industry) data is judiciously applied depending on the availability and quality of the data. For the 'Baseline electricity intensity factor (kWh/refrigerator/year) of volume class p, the TOOL29 provides the following three options:

(a) The 90th or 80th percentile of baseline refrigerator units of volume class p sold in the reference period sorted from highest to lowest annual electricity consumption (kWh/year);

(b) The 90th or 80th percentile of specific annual electricity consumption per unit volume of baseline refrigerator models of volume class q sorted from highest to the lowest specific annual electricity consumption in the reference period (kWh/litre/year);

(c) The 90th or 80th percentile of the Energy Efficiency Index of the baseline refrigerator models in the reference period sorted from highest to the lowest Energy Efficiency Index (number).

30. Only the values determined using national test standards or International Electrotechnical Commission 62552 or equivalent are eligible for use.

3. Distributed activities

3.1. Benchmarking emission factor for baseline kerosene usage

31. The literature compiled under Table 2 below shows a wide range of consumption patterns ranging from 3–30 litres of kerosene per month, amounting to 90–900 kg CO_2/household/year.

32. The 2010 Lighting Africa study,[11] which was more comprehensive than other studies cited, estimated 150 kg of CO_2 emissions per household per year based on a usage rate of five litres/month (i.e. kerosene consumption in a household per year results in 2.5 kg CO_2/litre/household/year) per bottom-of-pyramid household consumption of kerosene. The report stated that "…our estimate draws on Lighting Africa market research on off-grid populations in five African countries and equates to the use of one kerosene wick lamp, or two relatively more efficient kerosene hurricane lamps, for 3–4 hours daily".

Table 2. Household kerosene consumption according to various literature sources

Source	Coverage	Litres/year	kg CO_2/year
Mills (2005)	All developing countries	132	339
Lighting Africa (2010)	Review of 28 surveys from across the globe	60 (range: 36 to 360)	154 (92 to 920)
CDM project 2279: Rural Education for Development Society (REDS) CDM Photovoltaic Lighting Project	Rural India	131	336
CDM Project 2699: D.light Rural Lighting Project	Rural India	83.8	215

[11] Available at https://www.lightingafrica.org/wp-content/uploads/2016/07/Solar-Lighting-for-the-BOP-overview-of-an-emerging-mkt.pdf.

Source	Coverage	Litres/year	kg CO_2/year
Cambodia (UNDP 2008)	Rural households in Kampong Speu and Svay Rieng	15–23	38–59
CDM project from United Republic of Tanzania	Sumbawanga Region	36–60	92–154
Uganda (Harsdorff and Bamanyaki 2009)	Unelectrified rural households	38	97

33. CDM TOOL33 (Default values for common parameters) specified “For the first 55 kWh of electricity supplied to the user by the project electricity generating system in a given year, an emission factor of 2.72 kg CO_2/kWh (i.e. 2.72 t CO_2/MWh) may be used”, taking the Lighting Africa study cited above as the best available literature.

4. Joint Crediting Mechanism: Emission factor for grid and off-grid electricity

34. The emission factor of Viet Nam’s national grid is calculated as 0.333 t CO_2/MWh based on the most efficient natural gas-fired power plant supplying electricity to the national grid. The value is lower than the emission factor of the Viet Nam grid published by the Government of Viet Nam, which is 0.8154 t CO_2/MWh (combined margin, 2015). In addition, the emission factor of a diesel power generator is calculated by applying the default efficiency of 49 per cent, an efficiency level which is above the value of the world’s leading diesel power generator and set to 0.533 t CO_2/MWh of thermal.

4.1. Thailand, TH_AM001: Installation of Solar PV System

35. Most of the grid power is derived from natural gas in Thailand (around 70 per cent). The generation efficiency of major natural gas-fired power plants in Thailand ranges from 41 to 61 per cent. The emission factors of these plants are in the range of 0.477 to 0.319 t CO_2/MWh. The grid emission factor is set to be 0.319 t CO_2/MWh, which corresponds to the most efficient natural gas-fired power plant in Thailand (generation efficiency: 61.2 per cent).

4.2. Mongolia, MN_AM003: Installation of Solar PV System

36. This methodology applies the lowest emission factor of a coal-fired power plant supplying electricity to the national grid (0.797 t CO_2/MWh), which is lower than the combined margin grid emission factor (1.154 t CO_2/MWh) published by the Mongolian Government. The emission factor of a diesel power generator is calculated by applying the default efficiency of 49 per cent, as mentioned in paragraph 40 above.

4.3. Bangladesh, BD_AM002: Installation of Solar PV System

37. The emission factor of 0.376 t CO_2/MWh is applied, which is calculated based on the thermal efficiency **of the most efficient natural gas-fired power plant** supplying electricity to the national grid. The value is lower than the emission factor of the Bangladesh grid published by the Government of Bangladesh, which is 0.674 t CO_2/MWh (combined margin, 2011). The emission factor of a diesel power generator is calculated by applying the default efficiency of 49 per cent, as mentioned in paragraph 40 above.

4.4. Kenya, KE_AM001: Electrification of communities using Micro hydropower generation

38. There are **two types of reference scenarios** depending on the accessibility to the national electricity grid. When the project is executed in an area defined as a “grid-accessible area”, which is a village where at least one electricity consumer is connected to national electricity grid, but there are other electricity consumers who are not connected to national electricity grid on the day of validation, the reference scenario assumes emissions due to electricity supplied by the national electricity grid. When the project is executed in an area defined as a “grid-inaccessible area”, which is a village not classified as a “grid-accessible area” on the day of validation, the reference scenario assumes the emissions are due to electricity supplied by a diesel generation unit or kerosene lamps. In the case of a grid-accessible area, the grid emission factor of 0.5893 t CO_2/MWh, which is **the lowest value suggested by Kenya in 2014** for the standardized baseline of CDM project activities in the second and third crediting periods, is chosen to fulfil the net emission reduction requirement. Similarly, in the case of grid-inaccessible areas, the reference emissions are calculated in view of ensuring their conservativeness with an emission factor of 1.0 t CO_2/MWh for a diesel generation unit which is less than **the lowest value indicated in Table I.F.1 in CDM small-scale methodology AMS-I.F.** for the equivalent load factor of the micro hydropower generation unit of 30 kW.

4.5. Maldives, MV_AM001: Installation of energy-saving transmission lines in the Mongolian Grid

39. Almost all electricity in the Maldives is generated by diesel. Being an island country, almost all of the islands generated their own electricity, and all grids in the Maldives are isolated. Considering that power from other sources such as solar photovoltaic (PV) is very limited and is negligible, net emission reductions are ensured as follows: It is assumed that solar PV systems installed in the Maldives will replace grid electricity and/or captive electricity generated by the existing diesel generators, whose power generation efficiency is estimated to be around 35.4 per cent in Male, which leads to a CO_2 emission factor of 0.739 t CO_2/MWh.

40. However, applying such an emission factor derived from the existing diesel generators does not result in net emission reductions. Therefore, **the power generation efficiency of 49 per cent, which has not been achieved yet by the world’s leading diesel generators**, is employed in this methodology to ensure net emission reductions. The emission factor of grid and captive electricity is set to 0.533 t CO_2/MWh based on the power generation efficiency of 49 per cent.

4.6. Ethiopia, ET_AM003: Introduction of Biomass Combined Heat and Power Plant

41. The power source of the national grid of Ethiopia is almost 100 per cent renewable. However, power interruption is very common, and industries requiring continuous operation resort to captive diesel power generation. It is assumed that 2 per cent of the electricity generated from the biomass combined heat and power plant displaces electricity generated by **a captive diesel genset using the most efficient diesel power generator in the world**, and the balance displaces grid electricity, which is assumed to have an emission factor of zero. The 2 per cent corresponds to the percentage of time power was interrupted in the year; the **shortest average annual time of power interruption** occurred during the June 2013 to May 2016 period. **The most efficient diesel generator**

in the world of 0.533 t CO_2/MWh, which is derived from a generation efficiency of 49 per cent, is used as mentioned in paragraph 40 above.

4.7. Palau, PW_AM001: Displacement of Grid and Captive Genset Electricity by a Small-scale Solar PV System

42. It is assumed that solar PV systems installed in Palau will replace grid electricity and/or captive electricity generated by the existing diesel generators, whose power generation efficiency is estimated to be around 33–41 per cent, which leads to a CO_2 emission factor of 0.805–0.631 t CO_2/MWh.

43. The emission factor of grid and captive electricity is set to 0.533 t CO_2/MWh based on the power generation efficiency of 49 per cent mentioned in paragraph 40 above.

5. Joint Crediting Mechanism: Energy efficiency sector

5.1. VN_AM013: Energy saving by introduction of high-efficiency double suction volute pumps in water supply system

44. Pump efficiencies for high-efficiency double suction volute pumps are determined based on Japanese Industrial Standard JIS B 8322 “Double suction volute pumps” using the collected data of high-efficiency double suction volute pumps actually marketed in Japan. The application of those pump efficiencies as default values for reference pumps, taking into account pump efficiency commonly observed in Viet Nam, ensures the conservativeness and the net emission reductions in this methodology.

6. Joint Crediting Mechanism: Efficient lighting systems in Indonesia

45. The luminous efficiency of the <u>best available technology</u> for indoor LED lamps in Indonesia (according to **product catalogues, specification documents and/or the websites** of four major LED lighting manufacturers whose products are available globally):

    (a) 77.2 lm/W, for rated power consumption between 0 and 20 W;

    (b) 77.6 lm/W, for rated power consumption between 20 and 40 W;

    (c) 73.7 lm/W, for rated power consumption between 40 and 60 W;

    (d) 76.3 lm/W, for rated power consumption between 60 and 80 W;

    (e) 74.8 lm/W, for rated power consumption above 80 W.

46. The luminous efficiency of the <u>best available technology</u> for street LED lamps:

    (a) 115 lm/W (rated power consumption = 40 W);

    (b) 100 lm/W (rated power consumption = 90 W and 120 W).

6.1. Cambodia, KH_AM001: Installation of LED street lighting system with wireless network control

47. Reference emissions are calculated on the basis of the rated power consumption of project street lighting systems, the ratio of luminaire efficiency of project/reference lighting, the

operating hours of reference lighting systems, and the CO_2 emission factor of the electricity systems to which the lighting systems are connected.

48. In order to ensure net emission reductions, **a conservative default value is established for the luminaire efficiency of a reference lighting system, taking into account the highest luminaire efficiency out of high-pressure sodium lamps used on major arterial roads of Japan.**

7. Joint Crediting Mechanism: Transport sector (Indonesia)

49. The benchmark sourced from **catalogues published by three major Japanese bus manufacturers** (names of the companies not provided) that will provide the buses to the project in Indonesia:

(a) 6.5 kilometres/litre, if engine size is below 5.2 litres;

(b) 4.7 kilometres/litre, if the engine size is above 5.2 litres.

8. Accounting for GHG emissions on a life-cycle basis versus calculating well-to-wheel emissions in transport sector

50. When it comes to vehicles for transportation, well-to-wheel (WTW) comprises both well-to-tank (WTT) and tank-to-wheel (TTW) emissions. For oil, this would comprise extraction, refining and distribution; for biofuels: growing feedstock and transforming and transporting it to the fuel pump; for electricity: generating electricity, transmission and charging the vehicle; and for hydrogen: producing, transporting and dispensing the hydrogen to the vehicle. TTW (“tailpipe”) emissions come from the leakage of hydrocarbons in vehicle tanks and from fuel combustion. Therefore, TTW emissions are zero for electric vehicles and fuel cell vehicles.

51. Life cycle assessments take into account sourcing, altering and incorporating materials into the final product (i.e. the car, its engine and drivetrain, and/or battery/fuel cell), as well as the end-of-life (i.e. disposal, reuse and/or recycling).

52. Figure 4 illustrates the impact of emission factor of the electricity or fuel that is supplied to the vehicle for the net emissions per kilometre. It is seen that the emission performance of the battery electric vehicles, plug-in electric vehicles and fuel cell electric vehicles greatly varies as compared to hybrid electric vehicles and internal combustion engines on account of the grid emission factor of electricity or the emission footprints of hydro production. Figure 5 shows the projected contribution of embedded emissions from materials; it shows that the share of emissions from embedded materials will increase as the operations emissions are set to drop due to cleaner energy sources.

Figure 4. Range of passenger-kilometre emissions in electromobility (source: International Energy Agency Global EV Outlook 2020)

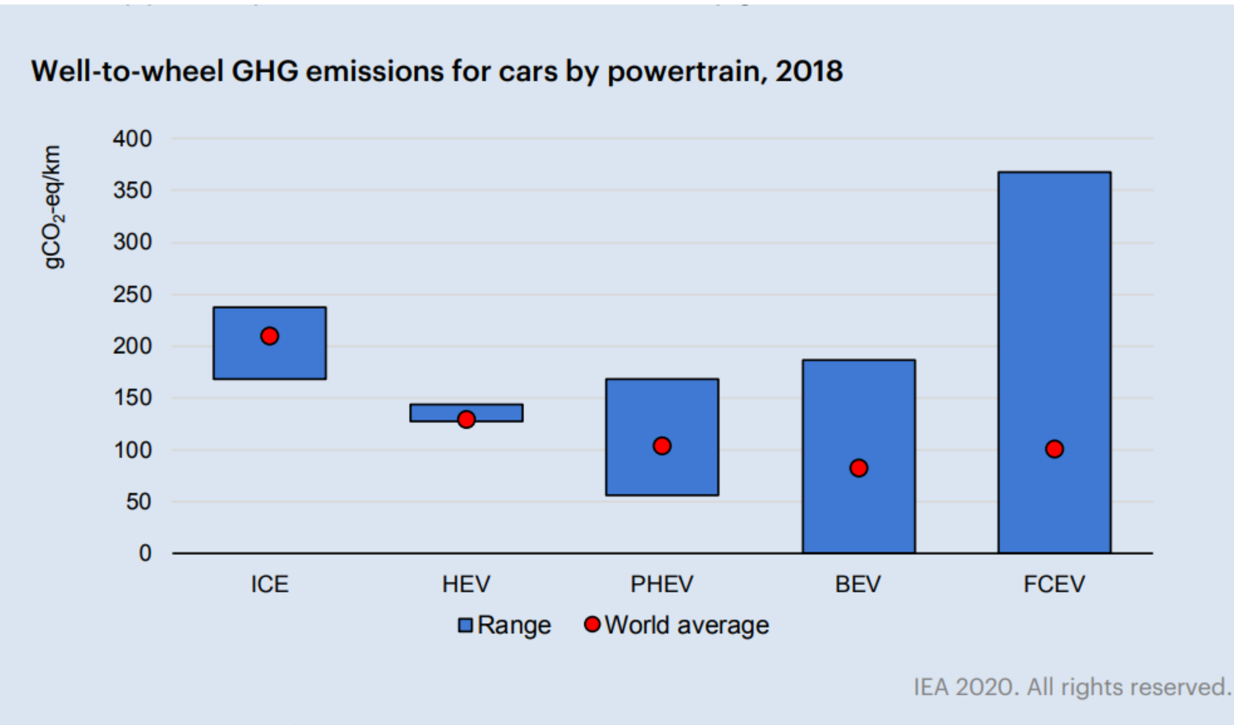
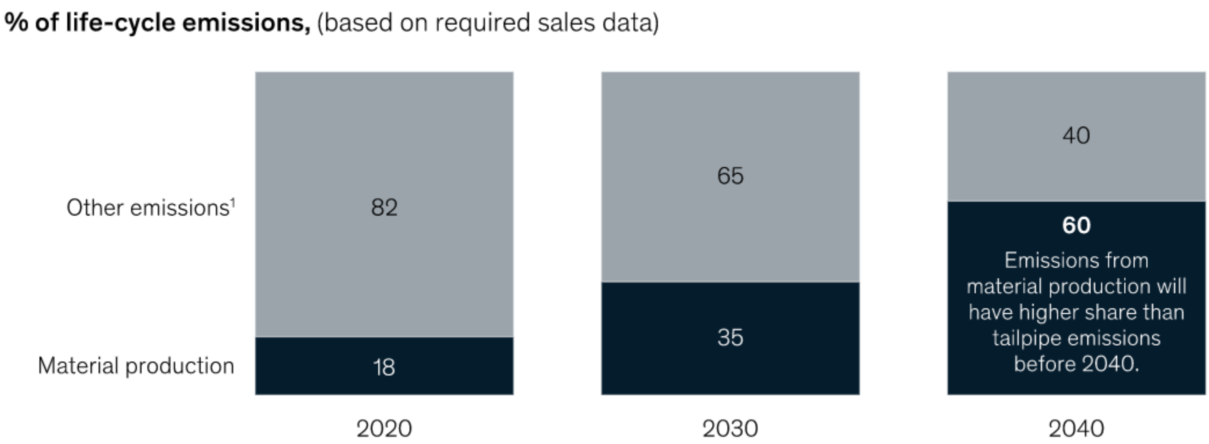


Figure 5. Emissions from material production (source: McKinsey, 2020)



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