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Gold Standard for the Global Goals

Methodology Concept

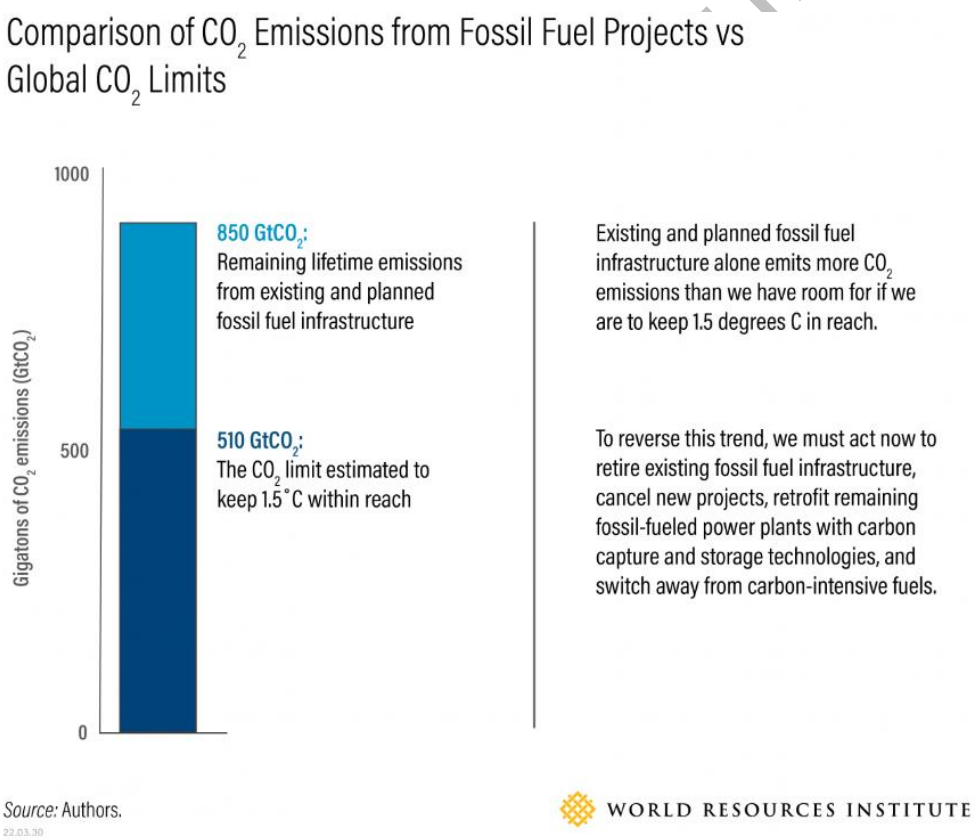
Early Phase-out of coal fired thermal power plants and their replacement with green-field renewable energy generation plants

1| TITLE OF THE PROPOSED METHODOLOGY:

Early Phase-out of coal fired thermal power plants and their replacement with green-field renewable energy generation plants.

2| DESCRIPTION OF THE PROPOSED METHODOLOGY CONCEPT:

Globally, coal fired thermal power plants are the major source of base power supply. But they are equally the largest source of GHG emissions with about 10 billion tCO_{2e} of the 55.3 billion tCO_{2e} released annually. Continuation of coal fired thermal power plants is therefore a big setback to the concerted global climate action and to the efforts targeted to meet earth's warming within 1.5ºC compared to that of the pre-industrial time. To limit warming to 2ºC or below, and without new builds, existing coal plants will need to retire 10 to 25 years earlier than the historical average operating lifetime.



Actions are being taken by various international and subnational actors, including national and subnational governments, public and private power companies, and financial institutions and pension funds that have committed not to fund new coal or coal-based infrastructure. Although these initial efforts are not yet sufficient in limiting warming to 1.5°C, and most have occurred in regions with older coal fleets, that provides insight into possible coal phaseout (well before their end-of-life) strategies (Spencer et al. 2018). Phase-out of operating coal fired thermal power plants is a priority action to significantly contain their impact on global warming and to accentuate

the positive impact of other climate actions currently underway or planned for the future.

Operating coal fired thermal power plants are commercial assets providing continuous economic gains to their stakeholders i.e. shareholders, investors, employees, contractors, vendors etc. who would be needed to be compensated to facilitate their accelerated phase-out in a way which is not only acceptable to the stakeholders but is also equitable. For example, a suitable compensation for early retirement could be derived and expressed in net present value (NPV) of the net gains expected to be generated through the remaining lifetime. Obviously, the net gains would depend on several factors including but not limited to - plant vintage and remaining lifetime and technical and financial operating parameters. However, to prevent any undue and unintended support to development of any new coal fired thermal power plants, the compensation provided to the stakeholders shall be mandatorily utilised for the development of new RE projects alone. For example, the compensation would flow to the stakeholders over a period of time (ideally spread over the remaining lifetime of baseline plant) and based on the quantity of electricity generated in the alternative RE project plant expressed as USD/kWh of RE power.

The above compensation can also be expressed as USD/tCO_{2e} avoided due to the phase-out of baseline plant. As is clear, the value will be guided by the method of determining tCO2e avoided or GHG emission reductions achieved. Refer to the details of baseline emission calculation methodology.

It is also possible that the RE technology chosen to be the alternative to the coal fired thermal power plant is not a common practice in the target area yet and faces barriers to implementation. These barriers may be a mix of financial, technical, capacity, market related and/or of policy & regulatory nature. To overcome these barriers, an additional revenue stream might be needed to support the implementation and to sustain the RE project commercially over the operational lifetime and in particular during the debt servicing years. Such financial support may be extended in the form of USD/kWh or USD/tCO_{2e}. In other cases, where RE technology is well established and is faced with no significant barriers, the project plant would not be provided any additional financial support.

3| TYPICAL PROJECT ACTIVITY:

The project activity is early phase-out (retirement) of an operating coal fired thermal power generation plant (baseline plant) and replacing it with a renewable energy generation plant of an equivalent capacity (project plant).

Energy, power and electricity are used interchangeably in the context of this methodology.

Since, electricity generation in coal fired power plants is highly carbon intensive, stopping those before their end-of-life and replacing with a RE source would result into direct GHG emission reductions which would otherwise continue to happen through the remaining life time of the baseline power plant.

Besides GHG emission reductions, phasing-out baseline plant would result in direct gains in terms of avoidance of emission of other air pollutants i.e. SOx, NOx, particulate matter, water savings, problems of safe disposal of flyash etc. Reduced used of coal would also reduce pressure on forests due to reduced requirement of coal mining leading to direct benefits in terms of biodiversity and ecological balance.

In the context of this methodology, a baseline plant would mean:

- The power plant operates on coal as a primary fuel with other fossil fuels used only as secondary fuels.
- The plant has a history of successful uninterrupted commercial operation of at least three years at the time of evaluation.
- The plant shall be free of any mandate for an early closure and is expected to run through its remaining life time. Or it can be determined that the mandate is not expected to be implemented in the foreseeable future.
- Historical techno-commercial operating data is available for projecting future commercial gains and baseline GHG emissions.
- Phase-out (retirement) means stopping the commercial operation of a power plant having a remaining lifetime of at least five years and dismantling/decommission it so that it cannot be commercially operated anytime in future.

In the context of this methodology, a project power plant would mean:

- A renewable energy (RE) generation plant
- RE here means energy generation using RE technology solutions commercially available in the region.
- Project plant is of an equivalent capacity to the baseline plant. Equivalent capacity here means capacity at a minimum electricity generation in kWh equal to that by the baseline plant.

4| DEMONSTRATION OF ADDITIONALITY:

The environmental integrity of the program measure will be determined by demonstration of the following:

Baseline plant:

- That the baseline plant has been under uninterrupted operation in the most recent three years

- That the baseline plant is not under any mandate to retire prior to its end-of-life or at least not earlier than five years.
- That the baseline plant remains commercially competitive under the prevailing market conditions, faces no operational challenges that might affect its normal operation and is expected to continue to operate for its remaining life-time.
- That the baseline plant's phase-out and its replacement with a new RE plant face barriers and need additional support to overcome the barriers. To demonstrate the financial additionality UNFCCC approved CDM Tools may be used. Further options will be explored during the full methodology development.

Project plant:

- The project plant may or may not be additional.
- In case the returns from the project plant are below the benchmark return and the project plant qualifies the additionality test, additional revenue can be sought to support it. To demonstrate the financial additionality UNFCCC approved CDM Tools may be used. Further options will be explored during the full methodology development.

5| QUANTIFICATION OF SDG CONTRIBUTIONS:

SDG 13: Climate action GHG emission reductions are calculated as the difference of baseline emissions, project emissions and leakage emissions. Since project plants would be RE based there would not be any project emissions. Considering that the methodology is applied to cases where the baseline plant is made redundant/inoperative with no possibility of power generation in future, the leakage emissions are also not applicable. So, the emission reductions would be equal to the baseline emissions. The baseline emissions shall be calculated as:

$$BE_y = EG_{PJ,y} \times EF_{BL,y}$$

Where;
BE_y = Baseline emissions in year y
$EG_{PJ,y}$ = Net electricity delivered by the project plant in year y
$EF_{BL,y}$ = Emission factor of power generation in the baseline plant calculated based on historical performance and adjusted with a factor

$$EF_{BL} = \frac{\sum FC_{i,y} \times NCV_i \times EF_{CO2,i}}{EG_{BL,y}}$$

Where;
$FC_{i,y}$ = Quantity of fossil fuel type i fired in the baseline plant in year y (mass or volume unit). This can be derived on the basis of historical fuel consumption in the baseline plant (average of three years). However, the limitation of this is that

low efficiency baseline plants would result into higher levels of emission reductions and in a way would be compensated higher compared to a better managed and better efficiency baseline plant. This would be counterproductive to compensate for low efficiency and poor operations. Therefore, historical performance shall be adjusted upward (so as to provide lower baseline emissions) using one of the below options.

Option 1: To take care of poor operating efficiency of the baseline plant as explained above, historical performance under this option is adjusted for best efficiency baseline plant operating in the region for the same technology type and vintage.

Option 2: Historical performance is adjusted to a higher level operating efficiency for the best efficiency plants which are financially viable and commercially available in the region. This would result into a more conservative baseline emission level.

In any case, the operating efficiency shall not be below the targets set out in the NDC of the host country if such targets are prescribed. It also means that baseline plants operating at a higher level of efficiency than the above will be rendered ineligible under this methodology.

NCV_i = Average net calorific value of fossil fuel type i (GJ / mass or volume unit)

$EF_{CO2,i}$ = Average CO2 emission factor of fossil fuel type i (tCO2 / GJ). This shall be derived either from national database or IPCC default values.

$EG_{BL,y}$ = Quantity of electricity generated in baseline plant in year y (MWh). This would be derived on the basis of historical level of electricity generation in the baseline plant (average of three years) adjusted for any expected reduction due to the declining plant's condition or due to the future market demand for thermal power in the region.

As per GS4GG Principles and Requirements, all projects shall demonstrate a clear, direct contribution to sustainable development, defined as making demonstrable, positive impacts on at least three Sustainable Development Goals (SDGs), one of which must be SDG 13.

The Project shall identify the potential SDG Impacts by comparing the Project Scenario to the Baseline Scenario. The SDG Impacts shall be demonstrated as making a positive effect beyond what would reasonably be expected to occur in the Baseline Scenario. The Project shall identify the relevant monitoring indicators and/or monitoring parameters and define the monitoring approach in the Project Design Document following GS4GG requirements.

Such projects are likely to contribute to the other SDGs, for example -

SDG3: Good health and well-being: Between 200,000 – 550,000 deaths have been attributed annually to coal-fired electricity in China, India, U.S., and Europe[1], the upper range of which is almost twice the deaths that have been attributed to COVID-19 as of June 30, 2020. Coal-fired electricity is also responsible for 13.1% of mercury emissions globally, exposures to which may have adverse effects on the nervous system, kidneys, and brain development.

SDG8 Decent Work and Economic Growth A study has shown that on average, US$1 million spending creates only 2.65 full-time-equivalent (FTE) jobs in fossil fuels but would create 7.49 or 7.72 FTE jobs in renewables and energy efficiency respectively[2]. However, renewable energy, energy storage, and related supply chain jobs may not be provided in the affected regions. Moreover, a portion of jobs in the renewable supply chain may not be created in the countries that use the energy but be centred in countries that export solar cells, advanced wind turbines, software, etc. Therefore, it is critical that

i. comprehensive social programme such as retirement compensation, and transition plans to retrain workers in coal-related industries to have the skills necessary to take advantage of the new jobs in the future is considered, and
ii. transition jobs be considered broadly, not just be in the renewable energy sector, but in the overall circular economy, and special efforts will be needed in the areas most severely impacted.

Other SDGs: A project activity may also have impact positive impact on other SDGs for example SDG 6: Clean Water and Sanitation due to reduced water demand.. The SDGs contributions are to be assessed as per the project level assessment.

6| SAFEGAURDING PRINCIPLES ASSESSMENT

Referring to the Gold Standard Safeguarding Principles & Requirements document – all Projects shall undertake an upfront assessment against the Gold Standard Safeguarding Principles and implement their Project in accordance with the stated requirements.

Coal power plants are steady sources of electricity at a relatively low operating cost over their decades-long lifetime. With both the coal mining industry and coal power plants being major employers, closing coal plants results in significant economic and

[1] World Economic Forum (2020), How to replace coal power with renewables in developing countries. https://www.weforum.org/agenda/2020/05/how-to-replace-coal-and-accelerate-the-energy-transition-in-developing-countries/

[2] European Commission. (January 14, 2020). "Financing the green transition: The European Green Deal Investment Plan and Just Transition Mechanism". https://ec.europa.eu/regional_policy/en/newsroom/news/2020/01/14-01-2020-financing-the-green-transition-the-european-green-deal-investment-plan-and-just-transition-mechanism

social hardships in the affected areas. Therefore, the project must design a transition plan to mitigate potential negative impact following the guiding principles such as International Labour Organization's Guidelines for a Just Transition[3]. Full methodology will include further Safeguarding requirements to ensure the projects applying the methodology include a robust mitigation plan following best practice approaches for a Just Transition.

7| MONITORING APPROACH

The key parameters that need to be fixed ex-ante are:

- Power generation capacity of the baseline plant in MW
- Historical power generation in the baseline plant in MWh
- Fuel type (s) combusted in the baseline plant
- Historical quantity of fuel combusted by type in the baseline plant in mass or volume unit
- Net calorific value of fuel by type in TJ/mass or volume unit of fuel
- Emission factor of fuel(s) by type in the baseline plant in tCO2/TJ of fuel energy
- Historical plant load factor of the baseline plant in percentage of plant capacity
- Historical fuel efficiency of the baseline plant in percentage of fuel energy used
- Remaining lifetime of the baseline plant
- Factor for efficiency adjustment of the baseline plant

The above parameters shall be based on at least three years of operational data of the baseline plant. The measurements shall be based on national/international measurement practices. The meters and/or instruments used in the measurements shall be tested and/or calibrated as per the local regulations or as prescribed by the manufacturer.

The key parameters that need to be monitored are:

- Net electricity delivered by the project plant

This shall be measured using energy meters installed at the project site. The measurement shall be continuous with at least monthly recording of data. The meters used for measurement shall be tested and/or calibrated at a frequency as mandated by local regulations or as prescribed by the manufacturer.

The generation data shall be crosschecked with the bills raised by the project developer to the buyer of the power.

[3] International Labour Organization 2015, Guidelines for a just transition towards environmentally sustainable economies and societies for all https://www.ilo.org/wcmsp5/groups/public/@ed_emp/@emp_ent/documents/publication/wcms_432859.pdf

8| OTHER:

There are different ways of how methodology could be used to enable early phase of coal power plant. A few illustrative examples have been presented below -

Case example 1:
Assuming that a coal fired thermal power plant **(baseline plant)** with following specifications is to be retired:

Baseline plant	**Value**	**Unit**	**Remarks**
Plant rated capacity	210	MW	Assumed
Historical plant load factor	70%	%	Assumed
Annual operating hours	7920	Hours	Calculated for 330 days per annum and 24 hour operation per day
Historical plant operating efficiency	20%	%	Assumed
Fuel type	Bituminous coal	-	Assumed
Fuel emission factor	94.6	tCO2/TJ	IPCC default
Fuel NCV	25.8	TJ/Gg	IPCC default
Remaining life time	5	years	Assumed. Credits are available for RL.
Gross power generated	1,164,240	MWh/annum	Calculated
Auxiliary power consumption	9%	%	Of gross power generation
Net power delivered	1,059,458	MWh/annum	Calculated
Fuel consumption	812,260	tonne/annum	Calculated
Adjustment in historical plant efficiency for conservative estimation			
Option 1	25%	%	Best efficiency of an operating plant of similar technology and vintage
Option 2	40%	%	Best efficiency of a plant which is financially viable and commercially available in the region
Option 3	35%	%	NDC target for efficiency of power generation
MAX of three options	40%	%	
Fuel consumption (adjusted)	406,130	tonne/annum	Calculated
Baseline emission factor	0.936	tCO2/MWh	Calculated

And, the **project plant** with following specification would replace the above baseline plant:

Project plant	**Unit**	**Value**	**Remarks**
Capacity	MW	302.36	Equivalent for same net power generation in the baseline plant
PLF	-	40.00%	-

Annual power generation	kWh	1,059,458,400	-
Project cost	USD	181,414,110	at USD 600,000/MW
Debt	-	80%	
Equity	-	20%	
Interest rate	-	8.0%	
Debt repayment period	year	10	
Benchmark rate of return on equity	-	14%	
O&M Cost	-	1%	of project cost
Escalation	-	5%	annual rate
Insurance	-	0.10%	of project cost
Project duration	year	25	
Baseline emissions	tCO2/a	991,234	

Estimate of **compensation budget**:

Parameter	Unit	Year 1	Year 2	Year 3	Year 4	Year 5
Net power delivered	MWh	1,059,458	1,059,458	1,059,458	1,059,458	1,059,458
Power tariff of baseline plant (5% annual escalation)	USD cents/kWh	3.75	3.94	4.13	4.34	4.56
Sale revenue	USD '000	39,730	41,716	43,802	45,992	48,292
Operating expenses (80% of gross revenue)	USD '000	31,784	33,373	35,042	36,794	38,633
Net income (pre-tax)	**USD '000**	**7,946**	**8,343**	**8,760**	**9,198**	**9,658**
Emission reductions	tCO2	991,234	991,234	991,234	991,234	991,234
ER price	**USD/tCO2**	**8.02**	**8.42**	**8.84**	**9.28**	**9.74**

- Terminal value of the baseline plant and decommissioning cost has not been accounted for.
- Cost of and revenue from the project plant has not been accounted for.

For a discount factor of 12%, the above ER price is levelized for a price of **6.32** USD/tCO_2.

Case example 2:

In cases where the project plant conforms to the additionality test, an additional revenue stream in the form of USD/kWh or tCO2e/kWh should be extended to meet the project requirements.

Year	O&M	Insurance	Return on Equity	Loan Repayment	Interest Charges	Estimated Tariff	Actual Tariff	Uncovered tariff

	USD cents/ kWh	USD cents/ kWh	USD cents/ kWh	USD cents/ kWh	USD cents/ kWh	USD cents/ kWh	USD cents/ kWh	USD cents / kWh	USD/E R
1	0.1712	0.0171	0.4795	0.9347	1.0683	2.6709	2.0000	0.6709	7.17
2	0.1798	0.0171	0.4795	1.0118	0.9913	2.6794	2.0000	0.6794	7.26
3	0.1888	0.0171	0.4795	1.0952	0.9079	2.6884	2.0000	0.6884	7.36
4	0.1982	0.0171	0.4795	1.1855	0.8176	2.6979	2.0000	0.6979	7.46
5	0.2081	0.0171	0.4795	1.2832	0.7199	2.7078	2.0000	0.7078	7.56
6	0.2185	0.0171	0.4795	1.3890	0.6141	2.7182	2.0000	0.7182	7.68
7	0.2295	0.0171	0.4795	1.5035	0.4996	2.7291	2.0000	0.7291	7.79
8	0.2409	0.0171	0.4795	1.6274	0.3756	2.7406	2.0000	0.7406	7.92
9	0.2530	0.0171	0.4795	1.7616	0.2415	2.7526	2.0000	0.7526	8.04
10	0.2656	0.0171	0.4795	1.9068	0.0963	2.7653	2.0000	0.7653	8.18
11	0.2789	0.0171	0.4795	-	-	0.7755	2.0000	-1.2245	-13.09
12	0.2929	0.0171	0.4795	-	-	0.7894	2.0000	-1.2106	-12.94
13	0.3075	0.0171	0.4795	-	-	0.8041	2.0000	-1.1959	-12.78
14	0.3229	0.0171	0.4795	-	-	0.8195	2.0000	-1.1805	-12.62
15	0.3390	0.0171	0.4795	-	-	0.8356	2.0000	-1.1644	-12.45
16	0.3560	0.0171	0.4795	-	-	0.8526	2.0000	-1.1474	-12.26
17	0.3738	0.0171	0.4795	-	-	0.8704	2.0000	-1.1296	-12.07
18	0.3925	0.0171	0.4795	-	-	0.8890	2.0000	-1.1110	-11.87
19	0.4121	0.0171	0.4795	-	-	0.9087	2.0000	-1.0913	-11.66
20	0.4327	0.0171	0.4795	-	-	0.9293	2.0000	-1.0707	-11.44
21	0.4543	0.0171	0.4795	-	-	0.9509	2.0000	-1.0491	-11.21
22	0.4770	0.0171	0.4795	-	-	0.9736	2.0000	-1.0264	-10.97
23	0.5009	0.0171	0.4795	-	-	0.9975	2.0000	-1.0025	-10.72
24	0.5259	0.0171	0.4795	-	-	1.0225	2.0000	-0.9775	-10.45
25	0.5522	0.0171	0.4795	-	-	1.0488	2.0000	-0.9512	-10.17
Levelized	**0.2374**	**0.0171**	**0.4795**	**0.9170**	**0.5260**	**2.1893**	**2.00**	**0.19**	**2.02**

*Discount factor of 12% is used.

So, the effective ER price should be **8.34** USD/tCO_2 for the remaining life of the baseline plant and **2.02** USD/tCO_2 for the remaining period assuming a typical 10 year crediting period for a GHG mitigation project.

Case example 3:

However, in another scenario where the project plant is financially compensated in the form of a tariff higher than the one estimated for a certain return on the capital deployed, ER price set above should be adjusted downward.

Year	O&M	Insurance	Return on Equity	Loan Repayment	Interest Charges	Desired Tariff	Actual Tariff	Uncovered tariff	
	USD cents/ kWh	USD cents/ kWh	USD cents/ kWh	USD cents/ kWh	USD cents/ kWh	USD cents/ kWh	USD cents/ kWh	USD cents/ kWh	USD/ER
1	0.1712	0.0171	0.4795	0.9347	1.0683	2.6709	2.7000	-0.0291	-0.31
2	0.1798	0.0171	0.4795	1.0118	0.9913	2.6794	2.7000	-0.0206	-0.22
3	0.1888	0.0171	0.4795	1.0952	0.9079	2.6884	2.7000	-0.0116	-0.12
4	0.1982	0.0171	0.4795	1.1855	0.8176	2.6979	2.7000	-0.0021	-0.02
5	0.2081	0.0171	0.4795	1.2832	0.7199	2.7078	2.7000	0.0078	0.08
6	0.2185	0.0171	0.4795	1.3890	0.6141	2.7182	2.7000	0.0182	0.19
7	0.2295	0.0171	0.4795	1.5035	0.4996	2.7291	2.7000	0.0291	0.31
8	0.2409	0.0171	0.4795	1.6274	0.3756	2.7406	2.7000	0.0406	0.43
9	0.2530	0.0171	0.4795	1.7616	0.2415	2.7526	2.7000	0.0526	0.56
10	0.2656	0.0171	0.4795	1.9068	0.0963	2.7653	2.7000	0.0653	0.70
11	0.2789	0.0171	0.4795	-	-	0.7755	2.7000	-1.9245	-20.57
12	0.2929	0.0171	0.4795	-	-	0.7894	2.7000	-1.9106	-20.42
13	0.3075	0.0171	0.4795	-	-	0.8041	2.7000	-1.8959	-20.26
14	0.3229	0.0171	0.4795	-	-	0.8195	2.7000	-1.8805	-20.10
15	0.3390	0.0171	0.4795	-	-	0.8356	2.7000	-1.8644	-19.93
16	0.3560	0.0171	0.4795	-	-	0.8526	2.7000	-1.8474	-19.75
17	0.3738	0.0171	0.4795	-	-	0.8704	2.7000	-1.8296	-19.56
18	0.3925	0.0171	0.4795	-	-	0.8890	2.7000	-1.8110	-19.36
19	0.4121	0.0171	0.4795	-	-	0.9087	2.7000	-1.7913	-19.15
20	0.4327	0.0171	0.4795	-	-	0.9293	2.7000	-1.7707	-18.93
21	0.4543	0.0171	0.4795	-	-	0.9509	2.7000	-1.7491	-18.69
22	0.4770	0.0171	0.4795	-	-	0.9736	2.7000	-1.7264	-18.45
23	0.5009	0.0171	0.4795	-	-	0.9975	2.7000	-1.7025	-18.20
24	0.5259	0.0171	0.4795	-	-	1.0225	2.7000	-1.6775	-17.93
25	0.5522	0.0171	0.4795	-	-	1.0488	2.7000	-1.6512	-17.65
Levelized	**0.2374**	**0.0171**	**0.4795**	**0.9170**	**0.5260**	**2.1893**	**2.70**	**(0.51)**	**(5.46)**

So, the effective ER price should be **0.86** USD/tCO_2 for remaining life of the baseline plant.