CDM: form for proposed new small scale methodologies (F-CDM-SSC-NM) (version 01)

(To be used for proposing a new small scale methodology in accordance with article 15 and 16 of the simplified modalities for small-scale CDM project activity categories. This form is not to be used in case of large scale methodologies).

Name of person/entity submitting this form:	C.B. Upasani/Hardik Desai
Title of the proposed small scale methodology:	Destruction of Hazardous Waste containing carbon using Plasma Technology and recovery of Energy (Thermal and/or Electrical) using Syngas generated.
Please suggest type to which the new proposed methodology (category) belongs to:	☐ Type I Renewable energy projects ☐ Type II Energy efficiency improvements X Type III Other project activities

Information for completing the form

For proposing a new small scale methodology all sections below should be completed. Approved small scale methodologies shall be used as a reference for language and structure used. If necessary, attach files or refer to sources of relevant information.

1. Technology/measure: please specify and provide reference to the exact technology/measure the proposed small scale methodology is applicable to and describe in detail the applicability conditions of the proposed methodology.

1) The technology covers the use of plasma Gasification technology for the destruction of Hazardous Waste (HW) containing carbon as an alternative to the use of incinerators. (AMS III.E covers biomass and/or other organic wastes left to decay). The technology produces several end products:

i. Syngas, which is then used as fuel to generate energy – in the form of steam and/or electricity;
ii. A vitrified matrix hat can be used for various construction-industry purposes, including road bed material and concrete aggregate; and/or
iii. For the recovery of metals and metal alloys from waste feedstocks.
iv. The syngas cleaning process also yields valuable chemicals – such as diluted sodium sulphide; a valuable chemical in certain chemical industries.

2) Plasma is a distinct phase of matter, separate from the traditional solids, liquids, and gases. It is often described as the fourth state of matter. It is the ionised (highly charged) state of matter where the electrons in the outer most shell of the atom have been removed from the atom to make it a charged particle and thus able to conduct electricity efficiently. It is a collection of charged particles that respond strongly and collectively to electromagnetic fields, taking the form of gas-like clouds or ion beams. Since the particles in plasma are electrically charged (generally by being stripped of electrons), it is frequently described as an "ionized gas."

3) The technology uses plasma-arc electrodes and/or torches to produce thermal plasmas.

i. Graphite electrodes or torches are the devices that converts electrical energy into thermal energy. They generate controlled plasma "fields" when a steady flow of gas is forced between electrodes with a high electrical current flowing between electrodes. This now ionized gas generates an intense heat in the form of an arc column or "plume" (Temperatures in excess of 5,000°C).
ii. Plasma-arc electrodes or torches create an ultra-high energy environment where the energy density is greater than the bonding energy between the elemental atoms that form molecules. When the molecules that form the waste are fed into the plasma field, the molecules are dissociated into their basic elemental atomic constituents. This

dissociation permanently and totally destroys the molecular compounds and their properties.

4) HW, when heated to a very high temperature in the controlled atmosphere of the reducing plasma reactor undergoes predictable physical and chemical changes. The plasma-arc electrodes or torches maintain the temperature of the plasma reactor at a uniformly high level (i.e. 1,000 to 1,500 deg C). This high temperature in the reactor prevents the formation of complex organic molecules and breaks down organics into a gas. The formation of dioxins or furans is nearly impossible inside the plasma reactor due to the unique process features, including high uniform temperatures and a lack of excess oxygen within the system and rapid quenching of the syngas as it leaves the plasma reactor.

i. The organic portion of the waste, depending on the composition of the waste stream, is broken into carbon, oxygen and hydrogen, essentially. Typically a controlled (stoichiometric) amount of oxygen (either in the form of steam or pure oxygen or both) can be added to reform the dissociated elements of the waste into the syngas, consisting mainly of Carbon Monoxide (CO) and Hydrogen (H_2).

ii. The inorganic constituents of the waste (other than carbon and oxygen) are melted (vitrified) into an environmentally safe, leach resistant, glass matrix and separately removed in an environmentally safe and sequestered safely. The carbon in the inorganic portion of the waste is also typically released to form syngas. The other portions are in the form of inert glass constituents, such as Silicates, Borosilicates, Calcium Oxide, Alumina or metals and metal alloys. These end-products from the process have beneficial commercial uses and thus the landfill requirements are reduced significantly, and if the glass matrix and metals are used in constructional material the landfill requirements can be negated completely.

5) HW containing carbon may be incinerated in the Generator's own premises (GP) or in a Centralized Common Incineration Plant nominated by the local regulatory authority for treating HW.

6) The applicable conditions are

i. The facility may be either new or replacing existing incineration technology for destruction of HW containing carbon. In case the facility is being set up where the regulatory environment compliance is weak, then the best technology in the region will form the baseline.

ii. New Facilities (Greenfield projects) and project activities involving replacing incinerators capacity additions compared to the baseline scenario are only eligible if they comply with the related and relevant requirements in the "General Guidelines to SSC CDM methodologies".

iii. The HW (in the baseline scenario) is either being destroyed in incinerators or disposed in a manner that is not conforming to the local regulations and law.

iv. The storage of the waste prior to destruction shall comply with local regulations, and shall ensure that there is no methane production during storage, prior to disposal.

v. The transportation of the HW and disposal of residues of incineration process of HW shall be in compliance with the local regulations.

vi. This syngas generated from the Plasma reactor is utilised for generation of electricity, hot water, liquid fuels and/or steam.

vii. Waste energy from the quenching of gases and the melt from the plasma reactor may or may not be trapped for use as a source of energy in another process.

viii. The solid inorganic residues are sequestered in compliance with the local regulations, in the baseline scenario. The landfill/sequestration may or may not be within the project boundary. It shall be ensured that the residues sequestered in a landfill do not contain any degradable organic carbon.

ix. The end-products produced by the Project Activity may have a commercial value. They are either consumed within the project boundary or sold commercially.

7) Measures are limited to those that result in aggregate emission reductions of less than or equal to 60 $ktCO_2$ equivalent annually.

8) Measures to avoid physical leakage of the syngas within the plasma gasification system shall also be adopted.

9) The energy generated in the project boundary is used in project activity and surplus energy exported, then the captive consumption (other than that for auxiliary power) plus electricity exported by project activity shall use corresponding category to Type I.

10) Part of the steam generated could be used in producing electricity and/or other project activities.

11) If the project activity replaces an existing incinerator, then last 3 years historical data prior to the project start date shall form the basis for determining the baseline emissions. For new projects or for replacement of old incinerators, this historical data shall be suitable amended by the emissions from the best practices from business as usual incinerator practice indigenous to the region where the project activity is being implemented, as certified by an independent laboratory or consultant with requisite experience using credible and appropriate process for certification. Based on Historical data, CO2 Emission factors per ton of waste incinerated shall be arrived.

12) If the project activity replaces an existing facility, then the incinerator will not move from the present location. Hence no leakage is to be accounted for.

13) For the electricity generated by project activity (less auxiliary power) and used for captive consumption or exported to the grid less imported from grid, the baseline emissions would be determined by using the "Tool to calculate the emission factor for an electricity system" multiplied by the net electricity exported to the grid. In case of a captive power plant, the appropriate emission factor for the captive power plant would be applied, as per Para 13 of AMS I.C.

14) The energy generated in form of steam and used for captive consumption or exported, would be determined by using the "tool to calculate the emission factor for an electricity system" multiplied by the net electricity exported to the grid. In case of a captive power plant, the appropriate emission factor for the captive power plant would be applied, as per Para 13 of AMS I.C.

2. Boundary: please specify the project boundary of the proposed methodology.
The project boundary are the physical, geographical sites: (a) Where the Plasma reactor and its associated subsystems are situated for the production of energy through the use of syngas and/or the waste heat in the hot gas/ molten melt quenching process. (b) Where the final residues of the plasma reactor may be beneficially utilized (c) Where the consumption of useful chemicals generated by the processes (if any) are utilized (d) And in the itineraries between them, where the transportation of wastes and residues
3. Baseline: please specify the baseline scenario and the way baseline emissions are calculated.

The baseline scenario is Destruction of HW containing carbon in an incinerator (Generator's premises or in Common Incinerator)

<u>Destruction of HW containing carbon in an incinerator.</u>

1. The process uses fossil fuel and electricity in the incineration process.
2. The residues from the process are sequestered in landfills as per the host country regulations.
3. The baseline emissions (BE_y) in year 'y' are, therefore

i. From the use of fossil fuels in the combustion process or for generating other thermal energy (such as for reducing the moisture of low calorific value (CV) wastes). The emissions from the conversion of embedded carbon in the HW are not accounted for, since it is the same in the baseline and project activity. ($BE_{FF,y}$).

ii. From the use of electricity in the incinerator and auxiliaries. ($BE_{elec,y}$).

iii. From the generation of electricity equivalent to the net electricity generated by the project activity by the grid or captive or combination. $BE_{EG,y}$.

iv. The transportation of the waste containing carbon to the incinerator and residues from the incineration process to the landfill, where the transportation uses fossil fuels for the motive power. (BE_{TWIy}) and ($BE_{TWO),y}$) respectively.

v. The use of other additives, such as activated carbon etc. $BE_{ADD,y}$.

4. Thus the baseline emissions may be expressed as

$$BE_{y} = BE_{FF,y} + BE_{EC,y} + BE_{EG,y} + BE_{TWI,y} + BE_{TWO,y} + BE_{ADD,y} \quad (1)$$

Where

$BE_{FF,y}$ is calculated using the annual emission from the fuel used in the baseline scenario. The fuel used will be the lowest carbon content fuel with the lowest cost available in the region where the project activity is located or the one used in the baseline scenario, if incineration exists. The efficiency of the incinerator will be the rated efficiency of the incinerator, as adjusted for age of the incinerator.

$BE_{EC,y}$ is calculated as per current version of 'Tool to calculate electricity consumption in baseline, project and/or leakage consumption from electricity consumption'.

$BE_{EG,y}$ is the energy (thermal, electrical or combination) that is being replaced by the generation of Syngas by the Project Activity. It will be calculated as per AMS I.C

$BE_{TWI,y}$ is calculated as the emissions from the transportation of the HW from the place of generation to the place of destruction.

$BE_{TWO,y}$ is calculated as the emissions from the transportation of the residues from the incineration process to the landfill. This is being considered since there will be significant reduction in the quantity of solid waste generation – vitrified solids and metal alloys from project activity instead of oxides and ash from incineration.

$$BE_{FF,y} = (Q_{NG,y} * EF_{NG,y}) + (Q_{Diesel,y} * EF_{Diesel}) + (Q_{NG\text{-}MEE,y} * EF_{NG}) \quad (2)$$

$Q_{i,y}$ is the quantity of fuel *i* consumed in year *y* in the incinerator and/or ancillary activities – such as, evaporation to concentrate liquid wastes tonnes/annum.

$EF_{i,y}$ is the emission factor of the fuel *i* consumed in year *y*. tCO_2e/tonne fuel.

Where the historical data is not used for reasons enunciated above, the quantity and the fuel used will be based on the manufacturer's specifications for baseline scenario solution or the actual consumption in the past year. The fuel used will be as per standard practice in the region or the least cost and lowest carbon content fuel available in the region identified in the PDD.

$$BE_{EC,y} = \sum kWh_{i,y} * EF_{grid,y} \div [1 - T_{Tech\ Loss}] \quad (3)$$

$kWh_{i,y}$ is the net electricity consumed in year *y* by the incinerator.

$EF_{Grid,y}$ is the emission factor for grid electricity *i* consumed in year *y*. tCO_2e/tonne fuel.

$$BE_{EG,y} = (kWh_{gen,y} - kWh_{cons,y}) * EF_{grid,y} \quad (4)$$

$kWh_{gen,,y}$ is the net electricity generated in year *y* by project activities.

$kWh_{Cons,,y}$ is the net electricity consumed in year *y*. by project activities.

$EF_{grid,y}$ is the emission factor for grid electricity consumed in year y, tCO_2e/tonne fuel

$$BE_{TWI,y} = D_{TWI,y} \times N_{TWI,y} \times EF_{per\,trip,} \quad (5)$$

Where

$BE_{TWI,y}$ is the emissions from the transportation of the HW from the place of generation to the place of destruction

$D_{TWI,y}$ is the distance in kms from the place of generation to the place of destruction in year y X 2.

$N_{TWI,y}$ is the number of trips per annum made by the transport vehicle for transportation of HW at the place of destruction and back in year y.

$EF_{per\,trip.u}$ is the per km emission factor from the use of fossil fuel as the transport fuel in tonnes CO_2e.

Note: This should generally be the same as the project scenario, unless the Project Activity is substituting an existing hazardous waste destruction process at a different location.

$$BE_{TWO,y} = D_{TWO,y} \times N_{TWO,y} \times EF_{per\,trip} \quad (6)$$

Where

$BE_{TWO,,y}$ is the emissions from the transportation of the residues from the incineration process to the landfill

$D_{TWO,y}$ is the distance in kms from the incinerator to the landfill for the waste residues from the incineration process in year *y* X 2

$N_{TWO,y}$ is the number of trips per annum made by transport vehicle for depositing the waste residue from the incineration process at the landfill site and back in year *y*.

$EF_{per\,trip}$ is the per km emission factor from the use of fossil fuel as the transport fuel.

$$BE_{ADD,y} = \sum_i Q_{i,y} \times EF_{i,y} \quad (7)$$

Where

$BE_{ADD,y}$ is the emissions from the use of additives in the processes in the baseline scenario

$Q_{i,y}$ is the quantity of additive *i* used in the incineration process in the baseline in year *y*

$EF_{i,y}$ is the emission factor for the additive used in year y. It will be calculated from the carbon content of the additive. Emission Factor of the additive will be calculated from the chemical equation for the emission of CO_2 from the breakup of the additive on heating/ reformulation post the plasma treatment.

Emission factor per ton of waste incinerated:

$$BE_{per\,ton} = BE_{y} / Q_{waste\,in\,ton,\,y} \quad (8)$$

Where;

BE per ton is the CO2 emission per ton of waste incinerated

BE y is the Total CO2 Emission per year

Q waste in ton, y is the Total waste incinerated per year

4. Leakage: please specify if leakage emissions can occur and how they should be calculated.

Inputs: There are no leakages, since the transportation of the HW would be the same in the baseline scenario too, for movement of the Industrial HW from the point of origin to point of destruction by incineration, unless the two solutions, viz. baseline scenario (Incineration) and the project activity are located in different industrial locations. Industrial locations are defined as the premises of an individual industry or an industrial estate.

Incinerator: If the project activity replaces an existing facility, then the incinerator may or may not move from the present location. In case the incinerator being replaced is moving to another location, where no incinerator was available, no leakage would be accounted for since, it is replacing a possible new incinerator. If an incinerator was available, then the replacement incinerator (that is, the one being replaced by the project activity) would be more efficient than the incinerator replaced. Therefore there is no net increase in the emissions of GHG gases, Hence no leakage is to be accounted for, even when the incinerator is moved to another location.

Residues: In case the boundary is restricted to the plant premises where the plasma waste destruction and recovery system is installed, then the transportation of the residues will result in leakage. The leakage will be calculated from the equation (9) below, when it is deleted modified from the emission reduction calculations.

5. Project activity emissions: please specify possible project activity emissions and how they should be calculated.

Project Emissions are equal to sum of Project activity emissions from the plasma waste destruction and recovery system and additives as well as transportation.

1. Project Emission PE_y
2. Project Activity PA_y
3. Transport Emissions of By Products $TR_{BP,y}$

$$PE_y = PA_y + BE_{ADD,y} + TR_{BP,y} \qquad (9)$$

Project Activity Emissions are two types – Positive emissions of GHG gases from

1. Consumption of carbon electrodes,
2. Consumption of Waste Activated Carbon

The consumption of electricity in the project activity is already accounted for in the baseline grid emissions, as the project activity is potentially a net exporter of electricity to the grid.

$$PA_y = (Q_{electrode,\,y} + Q_{act\ carbon,\,y}) * 44 \div 12 \qquad (10)$$

Where;

$Q_{electrode,y}$ is the quantity of carbon electrodes consumed in year *y* (tonnes/annum) in the project activity

$Q_{act\ carbon,y}$ is the quantity of activated carbon consumed in year y (tonnes/annum) in the project activity.

Any carbon containing residue left in the project activity is recycled back into the plasma reactor.

In addition, there are transport emissions related to the movement of vitrified material and metal. Since the quantity of the vitrified material and metal is less than the quantity of ash generated in the incinerator, the transport emissions are lower. The transport of the residues in the baseline have been accounted for in the baseline emissions, therefore the

$$PE_{,y} = D_{PE,y} \times N_{PE,y} \times EF_{per\ trip} \qquad (11)$$

PE_y is the emissions from the transportation of the vitrified material and recovered metals from the Project activity to the potential clients

$D_{PE,y}$ is the distance in kms from the project activity to the market for the vitrified material and metal from the project X 2 in year *y*

$N_{PE,y}$ is the number of trips per annum made by transport vehicle for transporting vitrified material and metal from the project to the potential clients and back in year *y*.

$EF_{per\ trip,y}$ is the per km emission factor from the use of fossil fuel as the transport fuel.

Emission factor per Ton of waste treated by Project:

$$PE_{per\ ton} = PE_y / Q_{waste\ in\ ton,\ y} \qquad (12)$$

Emission reduction is as given below;

$$ER\ Total_{,\ tons\ of\ CO2\ per\ year} = (BE_{Factor} - PE_{Factor})_{,\ ton\ of\ CO2/Ton\ of\ waste} * (Total\ waste\ treated\ by\ Project)_{,\ ton\ of\ waste/year} \qquad (13)$$

3. Monitoring: Please specify which parameters should be monitored and how they should be monitored.

The project activity will monitor the following parameters

(a) Quantity of each type of waste fed to the plasma reactor.
(b) Chemical analysis of each type of waste
(c) Temperature in the plasma reactor
(d) Parameters of steam generated.
(e) Gross Electricity generated
(f) Electricity imported from the grid
(g) Electricity exported to the grid.
(h) Consumption of additives and their analysis
(i) Fuel consumption and fuel efficiency of transportation equipment.
(j) Consumption of Graphite electrodes and analysis of carbon content of graphite

4. Project activity under a programme of activities: if the proposed methodology is also intended for application to a project activity under a programme of activities (CPA of PoA) guidance on consideration of leakage when applying to the CPA of PoA shall be provided.
There are no additional leakage points when considered under the Programme of Activities, as the individual project activities would be servicing an identified area.

Date you are delivering the contribution:	

Information to be completed by the secretariat	
F-CDM-SSC-NM doc id number	
Related to SSC-Submission number	
Date when the form was received at UNFCCC secretariat	