Adipic Acid Production Protocol V1.0

Public Comment Webinar
August 12, 2020

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Housekeeping

- All attendees are in listen-only mode
- Please submit any questions in the GoToWebinar question box
  - We will take questions at the end of the session (time permitting)
  - We will follow up via email to answer questions not addressed during the meeting
- The slides and a recording of the presentation will be posted online

Agenda

I. Introductions

II. Process Overview

III. Background

IV. Protocol Overview

V. Next Steps

INTRODUCTIONS

Introductions

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PROCESS OVERVIEW

Process Overview

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1. Internal research and scoping (*Summer 2019 – Winter 2020*)
2. Scoping meeting (*Sep 17, 2019*)
3. Issue paper (*Oct 4, 2019*)
4. Workgroup process (*Sep – Nov 2019*)
   – Formation (*Sep – Oct 2019*)
   – Meeting 1 (*October 8, 2019*)
   – Meeting 2 (*November 13, 2019*)
   – Meeting 3 (June 30, 2020)
5. Revisions based on workgroup feedback (*Nov 2019 – Aug 2020*)
6. 30-day public comment period (*Jul – Aug 2020*)
7. Revisions based on public comments (*Aug – Sep 2020*)
8. Presented to Board for adoption *(Sep 30, 2020)*

~12 months

BACKGROUND

Background

- Among the top 50 synthetic chemicals annually produced in the U.S. – largest use is in the manufacture of nylon 6,6
  - Nitrous oxide (N_2O) is generated and emitted as an unavoidable & unwanted byproduct
- Adipic acid N_2O abatement or control technology can be installed downstream of where the reaction occurs to treat the facility's off gas
- Currently 2 AAPs operating in U.S. – both U.S. AAPs are fitted with some N_2O abatement technology – though only 1 of the 2 U.S. AAPs is legally required to abate N_2O, based on facility-specific conditions
  - Significant potential exists to voluntarily abate further N_2O
  - Significant costs associated with voluntary abatement and little to no incentives

International Offset Projects History

Clean Development Mechanism (CDM): *Baseline Methodology for decomposition of N_2O from existing adipic acid production plants* (**CDM AM0021)**

- Projects install a catalytic or thermal N_2O destruction facility at an existing AAP
- **ISSUES: Caused production-shifting (i.e., "leakage"), leading to over-crediting and the generation of credits that were not real or additional**
  - **Set the baseline N_2O abatement emissions level at 0% (i.e., assumed no historical or current abatement), leading to high volume of credits ("CERs") as all abatement was credited**
  - **The value of the CERs exceeded the value of the adipic acid itself, creating perverse incentives to overproduce the product**
  - **Caused a substantial shift in worldwide adipic acid production, from non-CDM AAPs to CDM projects, resulting in an estimated 20% non-additional CERs**
- Led the EU to ban the use of these offsets from its carbon market

International Offset Projects History

Lessons Learned*,**:

- Most straightforward and efficient way to effectively reduce the risk for leakage is to set a baseline emission benchmark (i.e., emissions per adipic acid production)
  - Only emission reductions beyond the benchmark would be credited, i.e., multiply the amount of adipic acid production eligible for crediting with a baseline emission factor
  - Still provide considerable incentives for the industry to abate N_2O emissions (e.g., JI projects)
- JI projects show that very high levels of N_2O abatement can be, and have been, achieved by implementing additional abatement measures
  - Possibly even enable the elimination of nearly all N_2O emissions
- The carbon market provided incentives to innovate and implement highly effective N_2O abatement solutions

*Stockholm Environment Institute (2010). *Industrial N2O Projects Under the CDM: Adipic Acid – A Case of Carbon Leakage?*
**Öko-Institut (2016). *How additional is the Clean Development Mechanism?*

PROTOCOL OVERVIEW

Project Definition

Climate Action Reserve

1. The installation and operation of a new, previously uninstalled N_2O abatement technology; *and/or*
2. The enhancement of an existing control technology at a single adipic acid plant (AAP) …

that results in the reduction of N_2O emissions that would otherwise have been vented to the atmosphere

Enhancement

- The implementation of a capital investment to improve the N_2O abatement efficiency of an existing control technology compared to historical N_2O abatement efficiency levels

Projects may only be implemented at existing, relocated, or upgraded AAPs

Project Definition

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Approved N_2O Control Technologies

Abatement Type	Description	Example
Catalytic Destruction	Destroy N_2O using a catalyst – selective catalytic reduction (SCR) or non-selective catalytic reduction (NSCR)	Noble or precious metal catalysts
Thermal Destruction	Destroy N_2O using flame burners with pre-mixed CH_4 or natural gas	Thermal Reduction Units (TRUs)
Recycle to Nitric Acid	Recycle N_2O to create nitric acid by burning the gas at high temperatures with steam	Nitrogen recycling adiabatic reactor
Recycling / Utilization Technologies	Utilize N_2O as a reactant or input to produce other products	Using N_2O off gas as an oxidant to produce phenol from benzene

Other control technologies may also be permissible, pending review by and approval from the Reserve

Eligibility Rules

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I	**LOCATION**
	• U.S. and its tribal lands and territories
II	**START DATE**
	• Date on which production first commences after the installation and/or enhancement of specific N_2O control technology • No more than 12 months prior to project submission
III	**CREDITING PERIOD**
	• Ten years, with possible 2^{nd} crediting period
IV	**ADDITIONALITY**
	• Meet performance standard *and* exceed legal requirements
V	**REGULATORY COMPLIANCE**
	• Comply with all applicable laws

Performance Standard Test

Technology-specific threshold:

- Projects automatically pass the performance standard test by either installing a new approved N_2O control technology not previously installed at the AAP and/or enhancing an existing one to improve levels of N_2O abatement efficiency
- Both the installation of a technology completely new to the AAP and/or the installation of a redundant technology (e.g., a second TRU) are eligible
- e.g., Catalytic destruction, thermal destruction; recycling/utilization technologies

Financial barriers:

- New investments cost ~10.6 - 17.25 million USD*
- Increased operating costs ~1.33 to 2 million USD per year*

* Schneider et al., 2010. Industrial N2O Projects Under the CDM: Adipic Acid – A Case of Carbon Leakage? Stockholm Environment Institute. October 9, 2010; All currencies were converted from EURs to 2010 U.S. Dollars (USD) with an annual average conversion factor of 1.33.

Legal Requirement Test

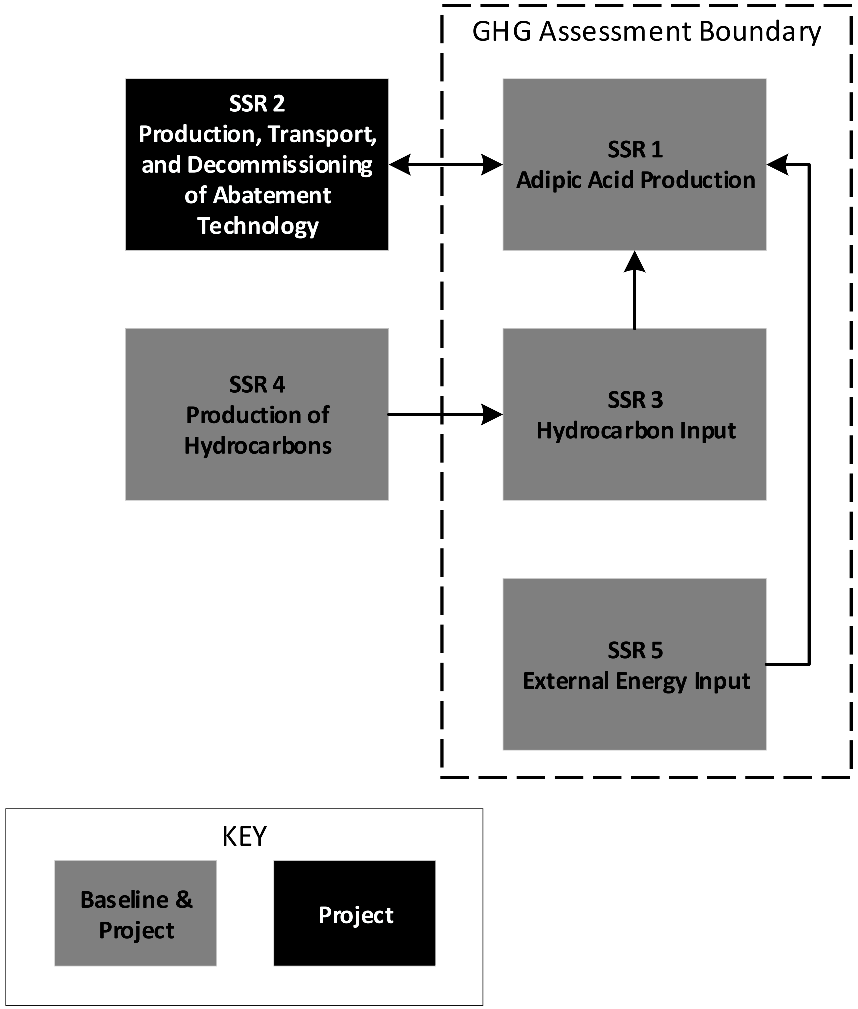
Projects pass the LRT when there are no legally binding mandates requiring the abatement of N_2O at the AAP project site

- The Reserve could identify *no existing* federal, state or local regulations that obligate *all* AAPs to abate N_2O emissions

Clean Air Act (CAA) Prevention of Significant Deterioration (PSD) and Title V Greenhouse Gas Tailoring Rule ("Tailoring Rule")

- When necessary, PSD permits for GHG emissions require an assessment of "best available control technology" (BACT), with the permitting authority ultimately mandating installation of a selected BACT
- If future PSD permits require installation of the same abatement technologies that are voluntarily deployed as part of this protocol, emissions may be reported (i.e., CRTs may be earned) up until ***the date*** that N_2O is legally required to be abated

Sources, Sinks, & Reservoirs (SSRs)



SSR 1

- N_2O emissions created and lost during adipic acid production

SSR 3

- CO_2 and/or CH_4 emissions from hydrocarbon use to enhance efficiency of the N2O abatement system (*if applicable*)

SSR 5

- Emissions from steam export, off gas utilization and heating, and fossil fuel/electricity use (*if applicable*)

Quantifying Baseline GHG Emissions

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Baseline GHG emissions are quantified using AAP-specific N_2O abatement efficiency (AE_{BL}) levels based on the quantity of N_2O in the off gas remaining after baseline voluntary N_2O abatement

- Ensures the baseline is conservative and representative of only the incremental emissions reduced beyond baseline voluntary abatement levels

For added flexibility, this protocol provides project developers with two options for setting the AAP-specific baseline N_2O AE_{BL}:

1. Static baseline N_2O AE_{BL} – *or* –
2. Dynamic baseline N_2O AE_{BL} that changes each reporting period based on historical maximum and minimum AEs, historical maximum and minimum adipic acid production levels, and current adipic acid production levels

Static Baseline Approach

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Static Baseline Abatement Efficiency ($AE_{BL,S}$)

- Calculate average annual AE over the static baseline look-back period
  - First calculate annual AE value for each baseline year, using all available data
  - Then calculate mean AE value over entire baseline period using annual AE values
  - Then introduce conservative bias eliminating any annual AE value beyond -2SD of mean over baseline period – replacing each removed annual AE with single highest annual AE from baseline period
  - Last, recalculate mean AE value over entire baseline period, using annual AE values

Baseline Look-Back Period

- The most recent calendar years of operation prior to project start date – dating back to 2015
  - Using data prior to 2015 is inappropriate due to significant structural changes in US adipic acid production industry in 2015
  - If start project in 2020, will be 5 years of baseline data
  - If start project in 2021, will be 6 years of baseline data, *etc*

Static Baseline Approach

Annual Baseline AE

- Percent of the AAP's N_2O emissions destroyed by the N_2O emission control unit in a given historical year within the static baseline look-back period
- Calculated by dividing the amount of N_2O reduced in a historical year (RE_{N2O}) by the total amount of N_2O emissions generated in the same historical year (TE_{N2O})

Relies on direct historical measurements using CEMS data

Quantifying Baseline GHG Emissions

Equation 5.2

$$BE = \left[\left(TE_{RP,N_2O} \times (1 - AE_{BL}) \right) + (HNO_{3\,Ratio} \times AA_{RP} \times 0.0025) \right] \times GWP_{N_2O} \times (1 - Ld)$$

Where,

BE = Baseline emissions in reporting period

$TE_{RP,N2O}$ = Total N_2O emissions in reporting period before any abatement

AE_{BL} = Baseline N_2O abatement efficiency

HNO_{3Ratio} = Ratio of nitric acid (HNO_3) to adipic acid

AA_{RP} = Adipic acid produced in reporting period

0.0025 = IPPC emission factor for N_2O emissions per HNO_3 produced

$GWPN_2O$ = global warming potential for N_2O (i.e., 298)

Ld = proportion of adipic acid production in reporting period due to leakage

Dynamic Baseline

In order for the baseline to be dynamically tied to the amount of actual N_2O emissions created by an AAP in a project reporting period, the AAP-specific baseline abatement efficiency ($AE_{BL,D}$) must be multiplied by total N_2O emissions in a given reporting period prior to any abatement ($TE_{RP,N2O}$)

$AE_{BL,D}$ is dependent on:

- Maximum and minimum baseline N_2O abatement efficiencies ($AE_{t,MAX}$ and $AE_{t,MIN}$, respectively) over the dynamic baseline look-back period;
- Maximum and minimum baseline amounts of adipic production ($AA_{t,MAX}$ and $AA_{t,MIN}$, respectively) over the dynamic baseline look-back period; and
- The amount of adipic acid production in a project reporting period (AA_{RP})

Dynamic baseline look-back period set using data back to 2015, same as static alternative (i.e. at least 5 years of baseline data starting in 2015)

Must demonstrate appropriate statistical correlation (ie min r^2 of 0.8)

Nitric Acid (HNO_3) Recovery Ratio

HNO_3 recovery is a function of N_2O conversion to NO, which is then converted to HNO_3 in the downstream process

Applies to recycling technologies that convert a portion of the N_2O in the exhaust to beneficial byproducts rather than simply oxidizing the N_2O to nitrogen (N_2) and oxygen (O_2) (conventional technology)

The calculation establishes a baseline average and project ratio of HNO_3 to adipic acid

The HNO_{3Ratio} is the average of HNO_3 to an average of adipic acid over the baseline look-back period less the ratio of HNO_3 to adipic acid in the reporting period:

$$HNO_{3_{Ratio}} = \frac{HNO_{3_{avg}}}{AA_{avg}} - \frac{HNO_{3_{RP}}}{AA_{RP}}$$

Mitigating Leakage

What do we mean by leakage?

- If greater production shifts to the project adipic acid facility, due to offset revenues, that can be considered leakage, and risks us crediting for N_2O destruction that would have occurred anyway at the facility from which such production shifted

3 Alternative approaches given to address leakage

- 1) Leakage assessment focusing on shifting production within corporate group
- 2) Leakage assessment focusing on shifting production when no corporate group
- 3) Production cap

Mitigating Leakage

1) Leakage assessment for corporate groups with multiple adipic acid producing facilities

- For project facility that's part of corporate group with multiple adipic acid production facilities
- Assess average annual factory loading of project AAP (% of facility-specific total production capacity being used) during baseline period relative to during each reporting period
- In any given reporting period, if factory loading decreases at other AAP controlled by group and increases at project AAP (or remaining steady at project AAP whilst dropping elsewhere) – by a statistically significant amount = leakage
- Reduce total baseline emissions in Equation 5.2 by % of increased production of adipic acid attributed to leakage

Mitigating Leakage

2) Leakage assessment for AAP not part of corporate group with multiple AAPs

- Seek Reserve approval for method to demonstrate no leakage occurred
- Method must be based on assessment of publicly available market data and a *reasonable explanation* – ie based on study of adipic acid demand in the U.S.
- Acceptance of such an alternative leakage assessment in one reporting period does not necessitate acceptance in any other future reporting period
- In any given reporting period, if adipic acid production increases – by a statistically significant amount – and Reserve does not accept explanation provided = leakage
- Reduce total baseline emissions in Equation 5.2 by % of increased production of adipic acid attributed to leakage

Mitigating Leakage

3) Production cap

- In any given reporting period, if adipic acid production increases – by a statistically significant amount – and first two options cannot be used = leakage
- Reduce total baseline emissions in Equation 5.2 to be no greater than CAA Title V permitted adipic acid production levels as at the project start date

Quantifying Project Emissions

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Equation 5.11

$$PE = PE_{N_2O} + PE_{HC} + PE_{EE}$$

Where,

PE = Total project emissions in reporting period

PE_{N2O} = Measured N_2O emissions in the off gas to project N_2O control units during the reporting period

PE_{HC} = GHG emissions from the use of hydrocarbons as a reducing agent or to reheat off gas during the reporting period (*if applicable*)

– CO_2 or CH_4 emissions

PE_{EE} = GHG emissions from external energy used to reheat the off gas during the reporting period (*if applicable*)

– E.g., steam export, off gas heating, fossil fuel/electricity use

Project Monitoring

Monitoring Plan

- Covers all aspects of monitoring and reporting; serves as the basis for verification

Initial Monitoring Requirements (6.1)

- Include CEMS installation and initial certification report in monitoring plan
  - Required per 40 CFR Appendix A to Part 75

Quality Assurance / Quality Control (QA/QC) (6.2)

- Implement and include CEMS QA/QC program written plan (e.g., testing frequency requirements) in monitoring plan
  - Required per 40 CFR Appendix B to Part 75

Missing Data Substitution (6.3)

- Follow the procedures for NO_X CEMS found in section 75.33 of 40 CFR Part 75

Monitoring Parameters (6.4)

- Table 6.1 contains the parameters necessary to calculate baseline and project emissions

Reporting Period and Verification Cycle

Reporting Period (RP)

- The length of time over which GHG emission reductions are periodically quantified and reported to the Reserve
- **An RP may exceed 12 months – this is the only case where more than 12 months of emission reductions may be verified**
- RPs must be contiguous; there must be no time gaps in reporting during the crediting period of a project once the initial RP has commenced

Verification Period

- The length of time over which GHG emission reductions are verified
- Projects must be verified **each reporting period**
  - Verified emission reduction reports on a sub-annual basis are acceptable
- One site visit to the AAP is required annually at a minimum

NEXT STEPS

Next Steps

1. Submit public comments by Aug 31, 2020

    Email comments, preferably in Word format, to policy@climateactionreserve.org

2. Revisions based on public comments (*Aug – Sep 2020*)
3. Board adoption *(Sep 30, 2020) TBD*

Key Contact

For questions about protocol development, the public comment process, or general assistance, please contact us at:

Policy@climateactionreserve.org