Adipic Acid Production Project Protocol V1.0

CLIMATE ACTION RESERVE

Workgroup Meeting 2
November 13, 2019

Purpose

- To present and solicit feedback from workgroup members on a *DRAFT* Adipic Acid Production Project Protocol Version 1.0 on a section by section basis

Housekeeping

- Workgroup members have the opportunity to actively participate throughout the meeting
- We will ask and take questions throughout the session
- All other attendees/observers are in listen-only mode
- Observers are free to submit questions in the GoToWebinar question box
- We will follow up via email to answer any questions not addressed during the meeting
- The slides and a recording of the presentation will be posted online

Agenda

I. 8:30 – 8:40 Introductions and Process Overview (< 10 min)

II. 8:40 – 9:45 Project Definition and Eligibility

III. 9:45 – 10:00 Break

IV. 10:00 – 11:15 Quantification

  a) GHG Assessment Boundary
  b) Baseline Emissions
  c) Leakage
  d) Project Emissions

V. 11:15 – 11:30 Break

VI. 11:30 – 12:15 Monitoring, Reporting, and Verification

VII. 12:15 – 12:30 Open Discussion and Next Steps

INTRODUCTIONS

Climate Action Reserve

Reserve Staff:

- Trevor Anderson, *Policy Manager*
  - Protocol development lead
- Heather Raven, *Senior Project Coordinator*
  - Development process coordinator
- Max DuBuisson, *Policy Director*
  - Protocol development support

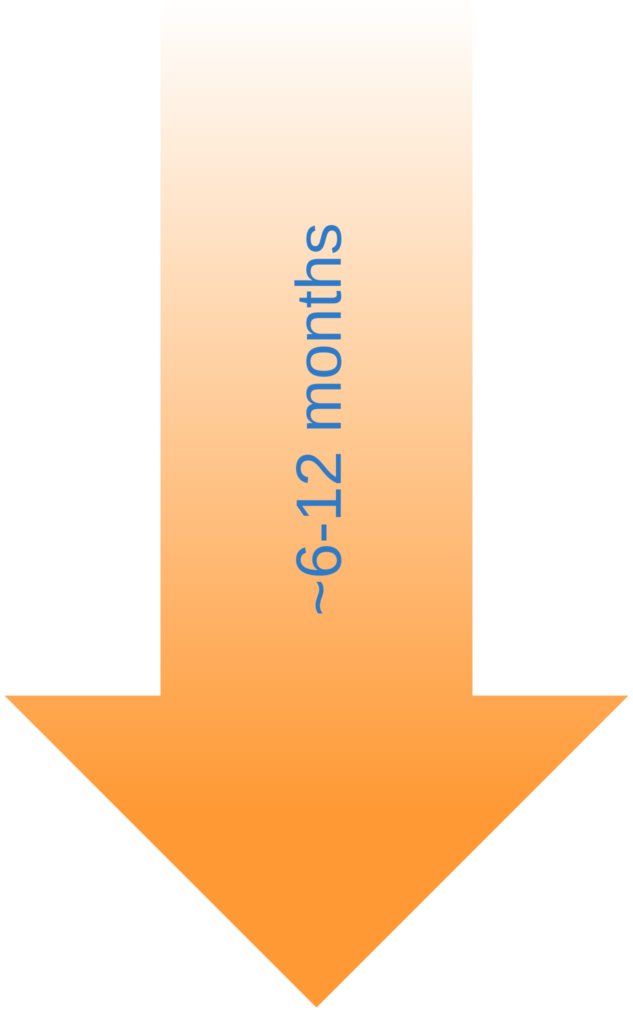
Workgroup Members

Name (alphabetical)	Organization
Seth Baruch	Carbonomics, LLC
Phillip Cunningham	Ruby Canyon Engineering, Inc
William Flederbach	ClimeCo Corporation
John McDougal	Element Markets
Lambert Schneider	Öko-Institut

PROCESS OVERVIEW

Protocol Development Timeline

1. Internal research and scoping (*completed*)
2. Reserve protocol drafting (*Sep – Dec 2019*)
   - Revisions based on workgroup feedback (*Oct – Nov 2019*)
   - Revisions based on public comments (*Dec 2019 – Jan 2020*)
3. Scoping meeting (*September 17, 2019*)
4. Issue paper (*October 4, 2019*)
5. Workgroup process (*Sep – Nov 2019*)
   - Formation (*Sep – Oct 2019*)
   - Meeting 1 (*October 8, 2019*)
   - Meeting 2 (*Today – November 13, 2019*)
6. 30-day public comment period (*Nov – Dec 2019*)
7. Board adoption *(January 22, 2020)*



DRAFT FOR WORKGROUP COMMENT

ADIPIC ACID PRODUCTION PROJECT PROTOCOL VERSION 1.0

Section 2

THE GHG REDUCTION PROJECT

2.2 Project Definition (1 of 3)

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

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

2.2 Project Definition (2 of 3)

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 in using reducing flame burners with pre-mixed CH_4 or natural gas	Thermal Reduction Units (TRUs)
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.
Recycle to Nitric Acid	Recycle N_2O to create nitric acid by burning the gas at high temperatures with steam	Nitrogen recycling adiabatic reactor

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

2.2 Project Definition (3 of 3)

Enhancement

- The retrofit, commissioning, and/or otherwise general modification of an existing technology that increases the abatement technology utilization rate (UR) compared to its historical usage (see Section 3.4.1)
- The UR (%) is simply defined as the percent of time the abatement technology is in use (Slide 19)
- *UR definition adopted from The GHG Protocol and IPCC Tier 2 methodology for "utilization factor"*

Any objections to or suggestions for improvement to proposed definition for "enhancement"?

Section 3

ELIGIBILITY

3.1 Location and 3.2 Start Date

Location

- Only projects located at AAPs in the United States (U.S.) and on U.S. tribal lands are eligible to register with the Reserve
  - *Since Workgroup Meeting 1, the Reserve has learned there are no existing AAPs operating in Canada or Mexico*

Start Date

- The date on which production first commences after the installation or enhancement of specific N_2O control technology
- To be eligible, the project must be submitted to the Reserve no more than 12 months after the project start date
  - *Should the Reserve allow projects with start dates 24 months prior to the protocol Effective Date?*

3.3 Crediting Period

The crediting period for projects under this protocol is ten years

- Begins at the project start date
- At the end of a project's first crediting period, project developers may apply for eligibility under a second crediting period
  – Must meet eligibility requirements of most current version of the protocol

The Reserve will issue CRTs for GHG reductions quantified and verified according to this protocol for a maximum of two ten-year crediting periods after the project start date, or until ***the date*** the project activity is required by law

3.4.1 Performance Standard Test (PST) (1 of 2)

Projects pass the PST by meeting a performance threshold representing installation and operation of a better than BAU N_2O control system

New Installations

- Automatically pass the PST by installing a new approved N_2O control technology not previously installed at the AAP
  - Catalytic destruction; Thermal destruction; Recycling / utilization technologies; Recycle to nitric acid; Other (see Table on slide 13)
- Both the installation of a technology completely new to the AAP and/or the installation of a redundant technology are eligible
- *Pass once* for the duration of the ten-year crediting period

3.4.1 Performance Standard Test (PST) (2 of 2)

Projects pass the PST by meeting a performance threshold representing installation and operation of a better than BAU N_2O control system

Enhancements

- Pass the PST when the project UR > the historical UR
- Utilization rate (UR) = # of days abatement technology is utilized / # of days of AAP operation
- Historical UR = average UR over 5-year baseline look-back period (Slide 25)
- Need to *pass each year* of the ten-year crediting period
- *Should the UR be based on operational days or on operational hours?*

3.4.2 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 AAPs to abate N_2O emissions

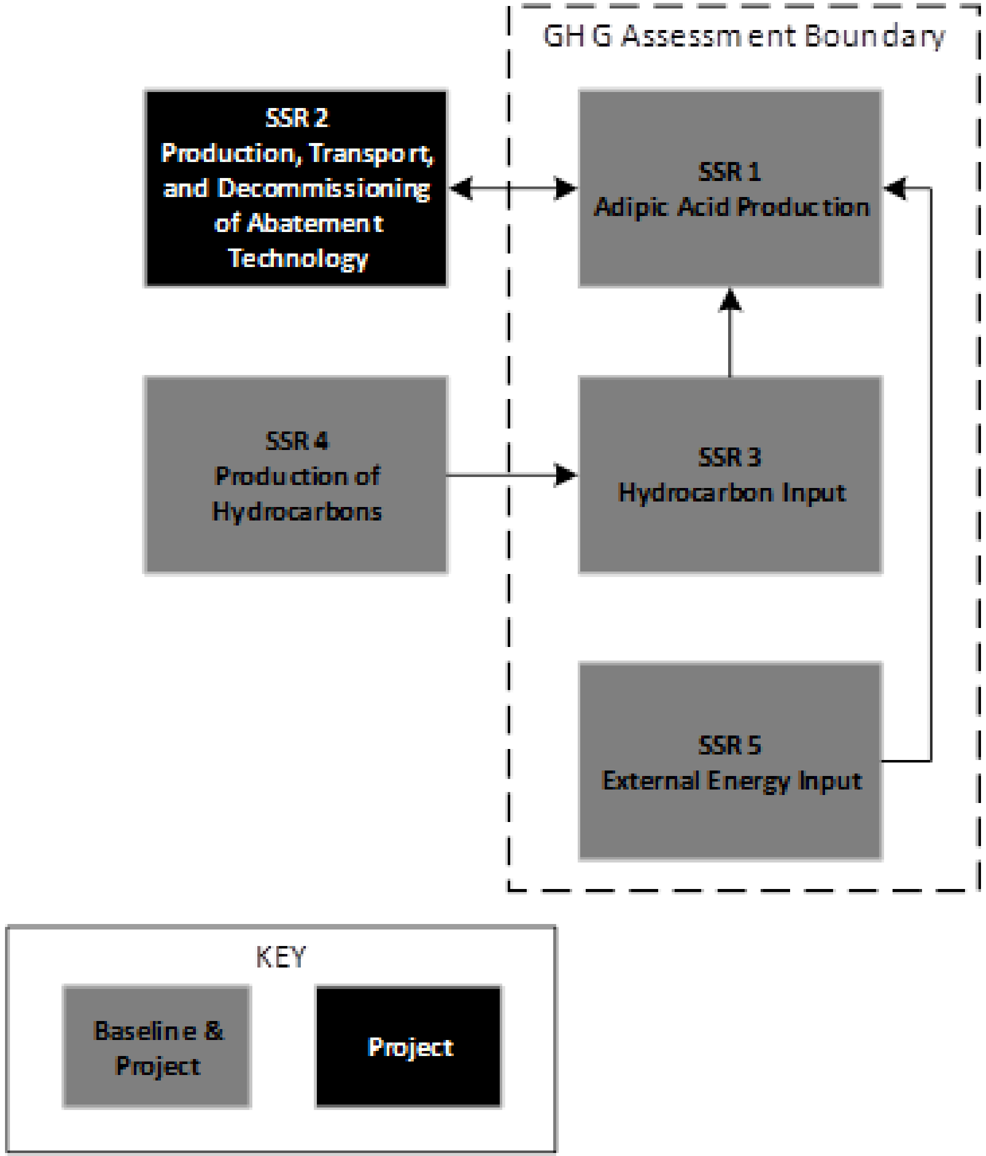
Clean Air Act (CAA) Prevention of Significant Deterioration (PSD) and Title V Greenhouse Gas Tailoring Rule ("Tailoring Rule")

- 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

Section 4

THE GHG ASSESSMENT BOUNDARY

GHG Assessment Boundary



SSR 1 – primary emission source

SSR 3 & 5 – *if applicable*

- Hydrocarbons (HC) can be used as a reducing agent, to reheat off gas to enhance the N_2O reduction efficiency, or simply as a combustion source for thermal treatment
- An external energy (EE) source may be used to adjust off gas temperatures at the inlet

SSR 2 & 4 – deemed insignificant

Does the Reserve need to consider including GHG emissions associated with the increased utilization of N_2O abatement technology (e.g., increases in energy use)?

Section 5

QUANTIFICATION

5 Quantification

Emission Reductions (ERs) = CRTs =

Baseline Emissions (BE) – Project Emissions (PE)

Baseline Emissions (BE) =

$$[(TE_{RP,N2O} \times (1 - AE_B)) + (\mathrm{HNO}_{3Ratio} \times AA_{RP} \times EF_{N2O})] \times GWP_{N2O}$$

Project Emissions (PE) = $PE_{N2O} + PE_{HC} + PE_{EE}$

5.1 Quantifying Baseline Emissions (1 of 7)

Baseline emissions (BE) represent the GHG emissions within the GHG Assessment Boundary that would have occurred in the absence of the project

- Based on the quantity of N_2O in the off gas before it enters the project abatement technology
- Must be quantified each project year (i.e., reporting period (RP)) on an *ex post* basis

Baseline Look-Back Period

- Five most recent years of operation prior to the project start date

Baseline N_2O Abatement Efficiency (AE_B)

- AAP-specific historical rate of N_2O abatement (%)

Dynamic Baseline

- AE_B is multiplied to measured annual project N_2O emissions prior to any project abatement to derive BE based on abatement levels that would have occurred in the absence of the project

5.1 Quantifying Baseline Emissions (2 of 7)

Climate Action Reserve

AAP-Specific Baseline N_2O Abatement Efficiency (AE_B)

- $AE_B = (RE_{B,N2O} / TE_{B,N2O}) \times 100$
- $RE_{B,N2O}$ = Measured N_2O reduced and destroyed by the N_2O control unit in year B of the 5-year baseline look-back period
  - Measures the amount of tail/off gas directed to each control unit and multiplies it by the efficiency of the respective N_2O control unit.
- $TE_{B,N2O}$ = Measured total N_2O emissions during year B of the 5-year baseline look-back period before any emissions control treatment
  - Uses direct measurements of the tail/off gas flow

5.1 Quantifying Baseline Emissions (3 of 7)

AAP-Specific Baseline N_2O Abatement Efficiency (AE_B)

- 3 scenarios to determine the correct AE value to use in BE calculations, depending on the amount of adipic acid produced in the project RP

1. **$AE_{B,MAX}$** = AE associated with year of maximum production in baseline ($AA_{B,MAX}$)
   – Use when project adipic acid production (AA_{RP}) $\geq AA_{B,MAX}$
2. **$AE_{B,MIN}$** = AE associated with year of minimum production in baseline ($AA_{B,MIN}$)
   – Use when $AA_{RP} \leq AA_{B,MIN}$
3. **$AE_{B,IN}$** = AE associated with production in between $AA_{B,MIN}$ and $AA_{B,MAX}$
   – Use when $AA_{B,MIN} < AA_{RP} < AA_{B,MAX}$
   – Calculate via simple linear regression analysis, bound by $AA_{B,MIN}$ and $AA_{B,MAX}$

5.1 Quantifying Baseline Emissions (4 of 7)

CLIMATE ACTION RESERVE

AAP-Specific Baseline N_2O Abatement Efficiency (AE_B)

Background and Rationale:

- U.S. AAPs have faced a trade-off between abating N_2O emissions voluntarily and abating NO_X emissions as legally mandated by the CAA
  - As adipic acid production increases, so do N_2O and NO_X emissions
  - However, this means a greater portion of the tail/off gas is sent to NO_X-SCR unit to meet the CAA legal requirements, resulting in greater NO_X abatement and less N_2O abatement.
  - As such, there is an inverse relationship between adipic acid production and N_2O abatement at AAPs; i.e., in years with greater adipic acid production, there is less N_2O abatement
  - In the absence of the project, it's likely for this relationship in the U.S. to hold true moving forward, and for the AE to be dependent on production values
  - For the protocol, the minimum and maximum AE_B values will be confined by maximum and minimum production values

5.1 Quantifying Baseline Emissions (5 of 7)

Baseline Nitric Acid Recovery Ratio (*if applicable*)

- Only 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 and oxygen (conventional technology)
- Calculation for the recovery of nitric acid (HNO_3) as a function of N_2O conversion to nitric oxide, which is then converted to HNO_3 in the downstream process.
- The calculation establishes a *ratio* of HNO_3 to adipic acid as an *average* of HNO_3 to an *average* of adipic acid over the 5-year baseline look-back period
- This ratio is then compared to the ratio of HNO_3 to adipic acid in the RP

5.1 Quantifying Baseline Emissions (6 of 7)

Mitigating Leakage

- To reduce the risk of production shifting (i.e., leakage), a cap (AA_{cap}) is applied on the max amount of adipic acid production allowable for crediting
  - The AA_{cap} for each AAP is set as the max adipic acid production limit allowed in the its CAA Title V Operating permit
  - If the AA_{RP} exceeds the AA_{cap}, the AA_{cap} value will be used as the AA_{RP} value in the applicable protocol equations
- AE_B value is floored by maximum baseline production values
  - i.e., it's not going to decrease if AA_{RP} surpasses maximum baseline production
- *Since Workgroup Meeting 1, the Reserve has learned the two U.S. companies have no international AAPs/ adipic acid production*

5.1 Quantifying Baseline Emissions (7 of 7)

In Sum:

$$BE = [(TE_{RP,N2O} \times (1 - AE_B)) + (\mathrm{HNO}_{3Ratio} \times AA_{RP} \times EF_{N2O}) \times GWP_{N2O}$$

- EF_{N2O} = IPCC EF for N_2O emissions per HNO_3 production = 0.0025
- GWP_{N2O} = Global warming potential for N_2O
  - Reserve currently uses IPCC Fourth Assessment Report values

5.2 Quantifying Project Emissions

Project emissions are actual GHG emissions that occur within the GHG Assessment Boundary as a result of the project activity

- Must be quantified every RP on an *ex post* basis

Project Emissions (PE) = $\boldsymbol{PE_{N2O} + PE_{HC} + PE_{EE}}$

PE from Off Gas (PE_{N2O})

- N_2O emissions not destroyed by abatement technology are measured and included

PE from Hydrocarbon Use (PE_{HC}) (*if applicable*)

- HC use leads to CO_2 and CH_4 emissions; projects may assert zero if $PE_{HC} < BE_{HC}$

PE from Off Gas Reheating (PE_{EE}) (*if applicable*)

- GHG emissions from an external energy source used to adjust off gas temperatures at the inlet of the N_2O control technology and the additional energy is not recovered

Section 6

MONITORING

6 Monitoring

Monitoring Plan

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

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

- Apply 40 CFR Part 75 (e.g., frequency of testing and data management)

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 prescribed monitoring parameters necessary to calculate baseline and project emissions

6.1 Monitoring Requirements

Continued Emissions Monitoring Systems (CEMS)

Direct measurements of the N_2O concentration in the tail gas/off gas and the flow rate of the tail gas/off gas shall be made using a CEMS

- CEMS are considered the industry standard for direct emissions monitoring and provide highly accurate and reliable data when installed and calibrated appropriately because they continuously measure a specific source
- AAPs are already required to have CEMS for NO_X emissions testing under the CAA (40 Code of Federal Regulations (CFR), Part 60)
- Implement CEMS upstream and downstream of N_2O abatement units to achieve real-time destruction efficiency data

Section 6

REPORTING

7.2 Record Keeping

System information the project developer should retain includes:

- All data inputs for the calculation of the project emission reductions, including all required sampled data
- Copies of all solid waste, air, water, and land use permits, Notices of Violations (NOVs), and any administrative or legal consent orders dating back at least five years prior to the project start date, and for each subsequent year of project operation
- Plant design information and diagrams/drawings of the AAP
- Diagram schemes showing the type of and detailed components of the N_2O control system and where it is or where it will be installed
- …
- *Anything missing that should be required?*

7.3 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
- 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
- A RP cannot exceed 12 months, and no more than 12 months of emission reductions can be verified at once, except during a project's initial verification

Verification Period

- The length of time over which GHG emission reductions are verified
- Although projects must be verified annually at a minimum, the Reserve will accept verified emission reduction reports on a sub-annual basis, should the project developer choose to have a sub-annual reporting period and verification schedule

Section 8

VERIFICATION

8.4 Core Verification Activities

Verification is a risk assessment and data sampling effort designed to ensure that the risk of reporting error is assessed and addressed through appropriate sampling, testing, and review

Verifying emission reduction estimates

The verification body (VB) investigates areas that have the greatest potential for material misstatements and confirms whether or not they have occurred

- Involves site visits to the AAP to ensure the systems on the ground correspond to and are consistent with data provided to the VB
- The VB recalculates a representative sample of the performance or emissions data for comparison with data reported by the project developer in order to double-check the calculations of GHG emission reductions

OPEN DISCUSSION – FEEDBACK AND SUGGESTIONS

NEXT STEPS

Next Steps

- Submit comments/feedback by ***COB Wednesday, 11/20***
- Protocol revisions by Reserve staff (pre-public comment)
- Public comment period – *November – December 2019*
  - Public comment webinar – *December 2019*
- Protocol revisions by Reserve staff (post-public comment)
- Submit protocol to Board – *January 2019*

Contact Information

Adipic Acid Production Project Protocol

Trevor Anderson, Policy Manager

tanderson@climateactionreserve.org