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Creating Greenhouse Gas Emissions Offsets by Reducing Nitrous Oxide (N_2O) Emissions in Agricultural Crop Production

Experience Developing and Implementing the World's First On-Farm N_2O Offset Project

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Technical Update, July 2014

EPRI Project Manager

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THE FOLLOWING ORGANIZATION, UNDER CONTRACT TO EPRI, PREPARED THIS REPORT:

Michigan State University

This is an EPRI Technical Update report. A Technical Update report is intended as an informal report of continuing research, a meeting, or a topical study. It is not a final EPRI technical report.

NOTE

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PRODUCT DESCRIPTION

This Electric Power Research Institute (EPRI) report describes the completion of a major component of the second phase (years four through seven, 2010–2014) of a two-phase, seven-year EPRI supplemental project. This EPRI-sponsored project investigated an innovative approach to developing large-scale, cost-effective greenhouse gas (GHG) emissions offsets by reducing nitrogen fertilizer use in agricultural crop production that potentially can be implemented across broad geographic areas of the United States and internationally. This can increase the breadth of offset options available to electric companies, and enable offset projects to be developed on agricultural lands owned by electric companies or located within an electric company's service territory.

This report focuses on the process of activating the scientific research completed in Phase 1 (2007–2009)[1] by developing, implementing, and obtaining offsets credits for a pilot GHG emissions offsets project developed by Michigan State University (MSU) and EPRI (the MSU-EPRI Offsets Project). The MSU-EPRI Offsets Project is the first agricultural N_2O emissions reduction project to apply the MSU-EPRI N_2O offsets methodology as validated by the American Carbon Registry (ACR) in July 2012.[2]

Objectives

- To validate a consistent version of the MSU-EPRI methodology under multiple different offsets standards operating in the United States and globally, including the ACR, Verified Carbon Standard, Climate Action Reserve, or other similar credible existing or evolving offsets standards (Part a)
- To develop and implement an MSU-EPRI Offsets Project that makes use of the MSU-EPRI methodology and that can be credited with GHG emissions offsets (Part b)

EPRI and MSU previously published an EPRI report[3] describing work completed for Phase 2 Part (a) of this project. This report describes the tasks and deliverables completed for Phase 2 Part (b) of the project.

Approach

Our approach for Phase 2 Part (b) was to identify a participating farmer and proceed to develop a GHG emissions offsets project that could be credited with GHG emissions offset credits using the ACR methodology, "Quantifying Nitrous Oxide (N_2O) Emissions Reductions from Reduced Use of Nitrogen Fertilizer on Agricultural Crops." The project team completed the following to develop and implement the agricultural N_2O offsets project described in this report:

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[1] For more information on Phase 1 of this project, refer to Developing Greenhouse Gas Emissions Offsets by Reducing Nitrous Oxide (N_2O) Emissions in Agricultural Crop Production: Final Project Report. EPRI, Palo Alto, CA: 2009. 1020546.

[2] Millar, N, G. P. Robertson, A. Diamant, R. J. Gehl, P. R. Grace, and J. P. Hoben. 2012. Methodology for Quantifying Nitrous Oxide (N_2O) Emissions Reductions by Reducing Nitrogen Fertilizer Use on Agricultural Crops. American Carbon Registry, Winrock International, Little Rock, Arkansas. Available online at: http://americancarbonregistry.org/carbon-accounting/carbon-accounting/methodology-for-n2o-emission-reductions-through-fertilizer-rate-reduction .

[3] Developing Greenhouse Gas Emissions Offsets by Reducing Nitrous Oxide (N_2O) Emissions in Agricultural Crop Production: Experience Validating a New GHG Offset Protocol. EPRI, Palo Alto, CA: 2013. 1023669.

- Holding discussions with MSU agricultural researchers and extension personnel to identify a suitable agricultural producer to participate in the project. In this case, we were seeking to work with a commercial corn farmer operating in Michigan.
- Meeting with the producer and their service provider to discuss options and requirements for participation.
- Obtaining access to relevant documentation and information to determine the project baseline.
- Holding discussions and obtaining confirmation of the on-farm project activities that would qualify for offset crediting.
- Coordinating with the producer and their service provider, MSU agricultural researchers, and MSU extension personnel to ensure that project activities were undertaken as and when required.
- Obtaining relevant documentation from the producer and their service provider to confirm project activities.
- Generating the project design document and other required documentation.
- Coordinating with an organization to act as a project account holder that would submit project documentation to an appropriate carbon offsets registry.
- Identifying a validation/verification body (VVB) to validate/verify the offsets project.
- Coordinating with the third-party project account holder and VVB to complete validation/verification of MSU-EPRI Offsets Project.
- Identifying and coordinating with an organization to purchase/retire project offsets.

Results

Phase 2 Part (b) has been completed successfully. The N_2O-based GHG offsets generated by the MSU-EPRI Offsets Project were issued to a third-party project account holder on June 3, 2014.[4]

This transaction represented the world's first trade of GHG emissions offsets derived solely and directly from agricultural N_2O emissions reductions. The Delta Institute paid participating farmer Myron Ortner for these offsets on June 12, 2014. On June 19, 2014, these offsets were purchased by the Climate Trust, a non-profit environmental organization, and are expected to be retired in July 2014. Other deliverables that the MSU-EPRI team completed during Phase 2 Part (b) are described in Chapter 2 of this document.

Applications, Value, and Use

The analysis, quantitative modeling, tools, and information developed in this project will help to broaden the GHG emissions offset options available to electric companies and others and can serve as a mechanism to develop and strengthen partnerships between electric companies and the agricultural communities they serve.

Keywords

Carbon offsets
GHG offsets
Greenhouse gas
Greenhouse gas mitigation
Nitrogen fertilizer
Nitrous oxide

[4] https://acr2.apx.com/mymodule/rpt/CertificateInfo.asp?ad=Prpt&RIID=331&ftType=PRO .

GLOSSARY OF TERMS

ACR	American Carbon Registry of Winrock International.
AFOLU	Agriculture, Forestry and Other Land Use. A broad category of eligible project activities that reduce GHG emissions and/or enhance GHG removals through changes in agriculture, forestry and land-use practices
Baseline Scenario	The project baseline is a counterfactual scenario that forecasts the likely stream of emissions or removals to occur if the project is not implemented, i.e., the "business as usual" case.
BAU	Business As Usual
BMP	Best management practices.
CAR	The Climate Action Reserve carbon offset registry (the Reserve). Previously the California Climate Action Registry (CCAR).
CCX	Chicago Climate Exchange. Voluntary, legally binding GHG reduction and trading system for emission sources and offset projects in North America between 2003 and 2010.
CO_2	Carbon Dioxide. A chemical compound comprising two oxygen atoms bonded to a single carbon atom. The primary GHG implicated in global warming with a designated 100-year GWP of 1.
CO_2eq / CO_2e	Carbon dioxide equivalent. A metric to compare GHGs based on their GWP relative to one metric ton of CO_2 over the same timeframe. The Intergovernmental Panel on Climate Change publishes GWP values for converting all GHGs to a CO_2e basis.
Crediting Period	The finite length of time during which a project can generate offsets for registration against its baseline.
ERT	Emission Reduction Ton. The ACR unit of exchange for tradable, project-based carbon offsets. One ERT is issued for each metric ton of verified CO_2e emission reductions or removals.
GHG	Greenhouse gas. Any gaseous compound that absorbs infrared radiation in the atmosphere and contributes to the warming of the atmosphere. Usually used to refer to the collection of all six types of GHGs regulated by the Kyoto Protocol - carbon dioxide (CO_2), nitrous oxide (N_2O), methane (CH_4), hydrofluorocarbons (HFCs), perfluorocarbons (PFCs), and sulfur hexafluoride (SF_6).
GHG Project Plan	An ACR term for a Project Design Document (PDD).
GWP	Global Warming Potential. The radiative warming caused by a molecule of gas relative to that of CO_2 for a defined period, usually 100 years. By convention CO_2 has a GWP of 1; N_2O has a GWP of 310.
ha	Hectare. A unit of surface area equal to 10,000 square meters or approximately 2.47 acres.
IPCC	Intergovernmental Panel on Climate Change. Body for the assessment of climate change, established by the United Nations Environment Programme (UNEP) and the World Meteorological Organization (WMO) to provide a scientific view on the current state of climate change and its potential environmental and socio-economic consequences.
KBS	The W.K. Kellogg Biological Station of Michigan State University. KBS is the largest off-campus facility of MSU, a National Science Foundation (NSF) Long-term Ecological Research (LTER), and Department of Energy (DOE) Great Lakes Bioenergy Research Center (GLBRC) site
Leakage	An increase in GHG emissions or decrease in sequestration outside project boundaries as a result of project implementation
Methodology	A systematic explanation of how a Project Proponent established the project baseline scenario(s), and estimates and monitors emissions reductions or removals by following scientific good practice
Monitoring	Continuous or periodic direct measurements and/or indirect assessment of GHG emissions, reductions, or other GHG data

MSU	Michigan State University.
MSU–EPRI Methodology	A GHG emissions offsets protocol that provides a way for farmers to obtain greenhouse gas emissions offset credits by reducing the amount of nitrogen used to fertilize agricultural crops.
MSU-EPRI Offsets Project	A first of its kind on-farm pilot N_2O offsets demonstration project that utilizes the framework of the MSU–EPRI Methodology to create greenhouse gas emissions offsets.
N	The chemical element nitrogen.
N_2O	Nitrous oxide is a chemical compound - an oxide of nitrogen. A greenhouse gas with a 100-year GWP of 310 as reported by IPCC Second Assessment Report (SAR). Although the IPCC has updated and will continue to update 100-year values, for reasons of fungibility carbon standard organizations currently require Project Proponents to use SAR values.
N_2O-N	The atomic mass of the nitrogen contained in the N_2O molecule.
NCR	North Central Region of the United States.
Nitrification / Denitrification	Nitrification is the microbial oxidation of NH_4^+ to NO_3^- during which N_2O can be produced as a byproduct. Denitrification is the microbial reduction of NO_3^- to N_2O and then possibly to N_2.
NRCS	Natural Resource Conservation Service of the USDA
Offset	A GHG emission reduction, sequestration or avoidance that typically is achieved outside of an organization's internal operations and outside the regulatory and geographic boundaries of any associated GHG cap-and-trade program. Typically, offsets are required to be real, additional, permanent and verified to qualify for use as a compliance instrument.
PDD	Project Design Document. A document that describes an offset project activity, satisfies eligibility requirements, identifies sources and sinks of GHG emissions, establishes project boundaries, describes the baseline scenario, defines how GHG quantification will be done and what methodologies, assumptions and data will be used, and provides details on a project's monitoring, reporting and verification procedures.
Project proponent	An individual or entity that undertakes, develops, and/or owns a project. This may include the project investor, designer, and/or owner of the lands/facilities on which project activities are conducted. The Project Proponent and landowner/facility owner may be different entities.
Reserve (the)	Alternative name for Climate Action Registry (CAR)
USDA	United States Department of Agriculture
Validation	Systematic, independent and documented process for the evaluation of a greenhouse gas assertion (GHG Project Plan at ACR) against agreed validation criteria (applicable requirements of a carbon standard, any relevant sector standard, and the applicable approved methodology).
VCS	Verified Carbon Standard.
VCSA	Verified Carbon Standard Association. Operates the VCS Program, comprised of the standard, methodology approval process, validation/verification body (VVB) accreditation process and registry system.
Verification	Systematic, independent, and documented process for the evaluation of a GHG assertion against specific criteria. The verification process is intended to assess the degree to which a project has correctly quantified net GHG reductions or removals per the validated PDD (GHG Project Plan at ACR), correctly utilizes methodologies and tools, and continues to meet applicable ongoing requirements of the carbon standard and sector-specific standard.
VVB	Validation/Verification Body. Auditors tasked with validating project descriptions and verifying actual emission reductions. VVBs must be qualified in a sectoral scope to gain eligibility for conducting a project validation or verification in that sectoral scope, as well as having to meet other eligibility requirements. Many VVBs are qualified to work on multiple sectoral scopes.

CONTENTS

LIST OF TABLES

1
EXECUTIVE SUMMARY

For the past seven years, Michigan State University (MSU) and the Electric Power Research Institute (EPRI) have collaborated on a research project to explore the potential to reduce nitrous oxide (N_2O) emissions by improving nitrogen management practices on croplands in the United States. During the first three years (Phase 1) of the collaboration, the project team conducted fundamental research to improve the scientific understanding of N_2O emissions based on the amount of nitrogen (N) fertilizer applied to grow corn. This work resulted in the publication of a number of peer-review scientific research articles[5,6,7] describing key findings and implications for crediting N_2O emissions reductions associated with reduced use of N fertilizer on croplands.

During Phase 2, the MSU-EPRI team developed an N_2O Offsets Methodology that has now been approved by the American Carbon Registry[8] (ACR) and the Verified Carbon Standard[9] (VCS) for use in their voluntary GHG emissions offsets programs. Major components of the MSU-EPRI Methodology also underpin the Nitrogen Management Project Protocol adopted by the Climate Action Reserve[10] (CAR-NMPP). These include quantitative tools for calculating N_2O emissions reductions and uncertainty in N_2O emissions reductions. The development of the N_2O Offsets Methodologies has been described in an earlier EPRI Technical Update.[11] In this report, we provide details on a first application of the methodology to a demonstration GHG emissions offset project in the so-called Agriculture, Forestry and Other Land Use (AFOLU) sector.

Nitrous oxide is a significant GHG that contributes to global climate change. Each ton of N_2O emitted to the atmosphere is equivalent to emitting approximately 300 metric tons of CO_2 because of N_2O's high Global Warming Potential (GWP). Consequently, GHG emission offset projects that reduce emissions of even small amounts of N_2O can have a disproportionately large effect on climate change. This sensitivity to small changes provides a strong impetus for including N_2O and the other non-CO_2 GHGs in the development of effective GHG mitigation strategies.

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[5] Millar, N., G. P. Robertson, P. R. Grace, R. J. Gehl, and J. P. Hoben. 2010. Nitrogen fertilizer management for nitrous oxide (N_2O) mitigation in intensive corn (Maize) production: an emissions reduction protocol for US Midwest agriculture. Mitigation and Adaptation Strategies for Global Change 15:185-204.

[6] Hoben, J. P., R. J. Gehl, N. Millar, P. R. Grace, and G. P. Robertson. 2011. Nonlinear nitrous oxide (N_2O) response to nitrogen fertilizer in on-farm corn crops of the US Midwest. Global Change Biology 17:1140–1152.

Grace, P. R., G. P. Robertson, N. Millar, M. Colunga-Garcia, B. Basso, and S. H. Gage. 2011. Fertilizer-derived N_2O emissions from maize production in the North Central Region of the USA: A regional estimate. Agricultural Systems 104:292–296.

[7] Shcherbak, I., N. Millar, and G. P. Robertson. 2014. Global metaanalysis of the nonlinear response of soil nitrous oxide (N_2O) emissions to fertilizer nitrogen. PNAS 111: 9199-9204.

[8] http://americancarbonregistry.org/carbon-accounting/carbon-accounting/methodology-for-n2o-emission-reductions-through-fertilizer-rate-reduction .

[9] http://www.v-c-s.org/news-events/news/new-methodology-approved-limiting-nitrogen-fertilizer .

[10] http://www.climateactionreserve.org/how/protocols/nitrogen-management/ .

[11] *Developing Greenhouse Gas Emissions Offsets by Reducing Nitrous Oxide (N_2O) Emissions in Agricultural Crop Production: Experience Validating a New GHG Offset Protocol*. EPRI, Palo Alto, CA: 2013. 1023669.

Nitrous oxide emissions reductions from crop production offers an approach that can generate large-scale and potentially cost-effective GHG emissions offsets that could be implemented across broad geographic areas of the U.S. and internationally. The estimated technical potential for reducing emissions of N_2O by reducing N fertilizer rate in the 12-state North Central Region of the U.S. that are eligible to use the MSU-EPRI protocol is approximately six million metric tons CO_2e per year (6 $MtCO_2e$/year). Economic analysis of "economy-wide" legislative proposals have concluded that GHG emissions offsets can play a key role in reducing the economic cost ($/ton CO_2) of achieving the GHG emissions reductions and have identified the agricultural sector to provide a key source of potential domestic GHG emission offsets.

The quantitative analysis, tools, and information developed in this project may broaden the GHG emissions offset options available to electric companies and other sectors of the U.S. and international economies, and may serve as a mechanism to develop and strengthen partnerships between electric companies and the agricultural communities they serve.

In this report, we describe the development of an N_2O-based emission reduction offset project that applies the MSU-EPRI Methodology. This project has been completed, and generated GHG emissions offsets for the participating farmer who voluntarily reduced the N fertilizer application rates on his farm in Tuscola County, Michigan. Although the number of offset credits generated by this demonstration project are very small, the project provides an important and successful proof-of-concept demonstration of the MSU-EPRI Offsets Methodology, and the process by which N_2O-based offset projects can be developed and deployed.

Major elements of this demonstration project included:

- Identifying a suitable project site;
- Identifying a willing farmer to participate in this project, and reduce the amount of N fertilizer applied to a suitable corn crop;
- Obtaining relevant information and data to develop an offset project design document;
- Coordinating with an offset project account holder to register the offset project; and,
- Coordinating with an independent consultancy to "validate" that the MSU-EPRI Offset Project was developed in accordance with the approved ACR offsets methodology, and "verify" the GHG emissions reductions resulting from implementation of the project.

2
INTRODUCTION

Below is a brief overview of Phase 2 of the EPRI Project "*Developing Greenhouse Gas Emissions Offsets by Reducing Nitrous Oxide (N_2O) Emissions.*" In October 2009, EPRI launched Phase 2 of the project to build directly upon Phase 1 research.

Phase 2 has two principal parts: (a) validation of an N_2O offsets methodology (i.e., the MSU–EPRI Methodology) on major carbon offset program "registries;" and, (b) implementation of an on-farm pilot N_2O offsets project (i.e., the MSU-EPRI Offsets Project) using the MSU–EPRI Methodology validated in part a of the project.

The two major objectives of Phase 2 were:

- To validate a consistent version of the MSU-EPRI Methodology under multiple different offsets standards and programs in the U.S. and globally, such as the ACR, VCS, CAR or other similar credible existing or evolving offsets standards (Part a); and,
- To develop and implement an MSU-EPRI Offsets Project that uses the MSU-EPRI Methodology, and which can be credited with GHG emissions offsets (Part b).

This document focuses on completion of Part (b) of this project. Part (a) was completed successfully in 2012 and 2013. A recent EPRI report is available that documents the three different versions of the MSU-EPRI N_2O Offsets Protocol, and our experience validating the protocol in three of the leading offset programs and standards operating today.[12] The MSU-EPRI N_2O Offsets Protocol is the only offsets methodology approved and adopted in whole or in part by all three leading voluntary offsets programs, including the ACR, CAR, and the VCS.

Additional Phase 2 project objectives included:

- To conduct a public-outreach workshop to inform and solicit feedback from public agencies, offset project developers, stakeholder groups and others.

  The EPRI Greenhouse Gas Offset Policy Dialogue, Workshop 11– Creating Nitrous Oxide (N_2O) Emissions Offsets in U.S. Agriculture – was held on Nov. 4 2011 in Washington DC; and,
- To conduct a technical workshop to explore future development of N_2O offsets protocols under existing and evolving GHG offsets protocols.

  The MSU team hosted a Nitrous Oxide Cropping Practices Workshop, February 7-9, 2012 in Fort Collins, CO in collaboration with the U.S. Department of Agriculture.

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[12] *Developing Greenhouse Gas Emissions Offsets by Reducing Nitrous Oxide (N_2O) Emissions in Agricultural Crop Production: Experience Validating a New Greenhouse Gas Emissions Offset Protocol*. EPRI, Palo Alto, CA: 2013. 1023669.

3
DEVELOPMENT AND IMPLEMENTATION OF THE MSU-EPRI OFFSETS PROJECT

Overview

In this section, we discuss the following components of the MSU-EPRI Offsets Project process, including:

- Discussions and meetings with MSU agricultural researchers and MSU extension personnel to identify a suitable agricultural crop producer to participate in the project.
- Meetings with the crop producer and their agronomic services provider to provide an overview the project and discuss options and requirements for participation.
- Obtaining access to relevant documentation and information from the participating crop producer and service provider to determine the project baseline.
- Discussing and confirming with the various stakeholders the on-farm project activities to be conducted to qualify for offset crediting.
- Coordination with the crop producer and their service provider, MSU agricultural researchers, and MSU extension personnel to ensure project activities were undertaken when and as required.

Identifying the project proponent

Preliminary discussions between the MSU-EPRI team and colleagues in the MSU Extension took place in July-August 2009 to identify an appropriate farmer who might be willing to participate in the MSU-EPRI Offsets Project. Some of the criteria the project team felt were essential for a crop producer to participate in the project included:

- Commercial long-term corn producer;13 and,
- Ability to prove land ownership or tenancy.

Other important criteria included:

- Previous positive interaction with MSU Extension;
- Openness to new environmental initiatives; and,
- Leader in local farming community.

Based upon these and other criteria, Mr. Myron Ortner of Tuscola County was identified as a potentially appropriate crop producer. Mr. Ortner had collaborated with MSU extension previously, including hosting a field trial to investigate N_2O emissions response to increasing N fertilizer rates. Data collected from his farm and similar trials on other farms throughout Michigan led to the development of a regional, non-linear relationship between N rate and N_2O

[13] To establish site baseline characteristics, information from at least three corn cropping years at one site were required prior to the start of a project.

emissions that underpins the MSU-EPRI Methodology. Details of this research can be found in Hoben et al. (2011).[14]

Stakeholder meetings

Mr. Ortner was contacted, and in-person meetings were arranged between him, his service provider[15] and members of the MSU-EPRI team and MSU Extension to discuss the MSU-EPRI Offsets Project. Both meetings were held near Reese Township in Tuscola County, Michigan. The first meeting was held on August 18, 2009, and the second on January 28, 2011. The agenda for the first meeting included:

- An overview of the MSU-EPRI project to all stakeholders;
- Discussion of eligible N management activities;
- Discussion of the data and information required for participation;
- Discussion of the potential advantages, disadvantages and outcomes of project participation; and,
- Identification of possible crop fields for the project site.

During the time between these two meetings, communications continued between the stakeholders. These included updates on the progress of the validation of the MSU-EPRI Methodology at the ACR, VCS, and CAR, further discussions on the choice of project site, and the provision of data and documentation to establish baseline estimates of N fertilizer rate and N_2O emissions at potential project sites.

The agenda for the second meeting included:

- Finalizing the project site;
- Specifying the project activities; and,
- Conveying the need for good communication between the stakeholders to ensure project activities would be conducted appropriately, and data and information would be collected and recorded appropriately.

Project activity

Application of N fertilizer at the project site took place on April 21, 2011. The N fertilizer was applied at a reduced rate as compared to the baseline N fertilizer rate. For the purposes of offset crediting and project registration details, the ACR program considers this date to be the project start date.

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[14] Hoben, J. P., R. J. Gehl, N. Millar, P. R. Grace, and G. P. Robertson. 2011. Nonlinear nitrous oxide (N_2O) response to nitrogen fertilizer in on-farm corn crops of the US Midwest. Global Change Biology 17:1140–1152.

[15] Star of the West Milling Company - organization that retains the producer's farm records and documentation http://www.staroftheWest.com/ .

4
THE PROJECT DESIGN DOCUMENT

Overview

In this section, we discuss the following components of the MSU-EPRI Offsets Project process:

- Obtaining relevant documentation from the crop producer and their service provider to confirm project (and baseline) activities; and,
- Creating the project design document (termed GHG Project Plan at ACR), and other required documentation for submission to the ACR.

Documentation

Following the application of N fertilizer to the project site in 2011, the service provider forwarded documentation describing the project activity, and also further information and documentation describing the baseline N management practices.

Other documentation, including soil maps, site details, and titles also were accessed from a number of sources. This information is presented in the Project Plan and Project Annexes documentation on the ACR Project Registry website.[16]

Project Design Document

Each of the carbon offset standards and programs (ACR, VCS, and CAR) has their own standardized forms and templates that are used by offset project developers to submit offset project information.[17,18,19] The MSU-EPRI Offsets Project documentation was submitted to the ACR by the Delta Institute, a third party accountholder, in October 2013. Further details of this collaboration and the project registration are described in Chapter 5.

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[16] https://acr2.apx.com/mymodule/reg/TabDocuments.asp?r=112&ad=Prpt&act=update&type=PRO&aProj=ipub&tablename=doc&id1=171 .

[17] ACR Template for GHG Project Plans: http://americancarbonregistry.org/carbon-accounting/tools-templates .

[18] VCS Project Description Template: http://v-c-s.org/program-documents .

[19] CAR NMPP Submittal Form: http://www.climateactionreserve.org/how/program/documents/ .

5
PROJECT REGISTRATION, VALIDATION, AND VERIFICATION

Overview

In this section we discuss the following components of the MSU-EPRI Offsets Project process:

- Identifying and coordinating with an organization to act as the Project Account Holder (Table 5-1) for submission of the MSU-EPRI Offsets Project documentation to an appropriate carbon offsets program / registry;
- Identifying a Validation and Verification Body (VVB) (Table 5-1) that could validate and verify the MSU-EPRI Offsets Project;
- Coordinating with the Project Account Holder and the VVB to complete validation and verification of MSU-EPRI Offsets Project; and,
- Identifying and coordinating with an organization (Table 5-1) to purchase the offset credits generated by the MSU-EPRI Offsets Project.

Table 5-1
Roles of the organizations involved during the registration and verification of the MSU-EPRI Offsets Project

Organization	Role
Michigan State University	Project Developer
Electric Power Research Institute	Project Funder and Developer
Delta Institute[20]	Project Account Holder
American Carbon Registry[21]	Carbon Offsets Program / Registry
Environmental Services Inc.[22]	Validation/ Verification Body (VVB)
The Climate Trust[23]	Offsets Purchaser

Project account holder

The MSU-EPRI team coordinated with the Delta Institute to help finalize preparation of the MSU-EPRI Offsets Project documentation that would be submitted to the appropriate carbon offset program for verification and validation. The MSU-EPRI team chose to collaborate to with the Delta Institute for several reasons, including their:

[20] http://www.delta-institute.org/ .
[21] http://americancarbonregistry.org/ .
[22] http://www.esinc.cc/ .
[23] http://www.climatetrust.org/ .

- Previous and ongoing role as an aggregator for conservation practices and GHG mitigation on agricultural land in Michigan and elsewhere across the U.S. Midwest;
- Engagement and familiarity with agricultural communities in Michigan and across the U.S. Midwest;
- Status as a project account holder with the ACR; and,
- Ongoing collaboration with MSU and other institutions on a USDA Conservation Innovation Grant (CIG)[24] that aims to create and bring GHG benefits to the market by promoting innovative nutrient management practices that reduce N_2O emissions.

More broadly, the choice of a third party to act as a Project Account Holder (rather than MSU assuming this role) was necessary because MSU did not have sufficient personnel available "in-house" to do take on this role.

Validation / verification body (VVB)

The MSU-EPRI team identified Environmental Services, Inc. (ESI) as a suitable VVB to verify the MSU-EPRI Offsets Project following submission to ACR. Some of the important criteria the project team used to select ESI for this role included:

- Accreditation as a VVB by ACR;
- Familiarity with the MSU-EPRI Methodology25;
- Previous positive interactions with the MSU-EPRI team; and,
- Competitive pricing for verification tasks.

Offsets registry

The MSU-EPRI team chose ACR as a suitable carbon offset program to submit the MSU-EPRI Offsets Project and create GHG offsets. Some of the important criteria used to make this determination included:

- The validated status for the MSU-EPRI Methodology at the ACR;[26]
- Delta Institute's standing as an active project account holder with ACR;
- Previous positive interactions with ACR staff; and,
- ACR is certified by the CA Air Resources Board as an approved Offset Project Registry that can facilitate the listing, reporting, and verification of compliance offset projects, and issue registry offset credits as part of California's statewide GHG cap-and-trade Program.[27]

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[24] http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/stelprdb1080175.pdf .

[25] ESI was one of two VVBs that validated the EPRI-MSU Methodology as part of the VCS methodology approval process.

[26] In late 2012, the MSU-EPRI project team decided to develop and submit this demonstration offset project to the ACR for registration. At this time, the MSU-EPRI Methodology was still undergoing validation at the VCS. The VCS version of the MSU-EPRI Methodology was approved in March 2013. While the CAR NMPP incorporates major components of MSU-EPRI Methodology, the project team decided not to implement this offset project with CAR as the team preferred to demonstrate use of a version of the methodology that was developed directly by the MSU-EPRI project team.

Offsets purchaser

With support from the MSU-EPRI team, the Delta Institute successfully secured an offset purchase obligation from The Climate Trust for offsets generated from the MSU-EPRI Offsets Project, and other future projects that use the MSU-EPRI Methodology. The contracting of ACR-issued offset credits called Emissions Reduction Tons (ERTs) for purchase or retirement takes place directly between a willing buyer and seller through so-called over-the-counter (OTC) transactions outside of the ACR Registry system. After a sale is completed, the counter-parties record the transfer of ownership or retirement of the ERTs within the Registry.

Project registration

A brief overview of the process and requirements for offset project registration at ACR is provided here. More detailed information can be found in ACR Operating Procedures[28] and ACR Project Standard[29] documents.

Prior to "registering" an offset project, the Project Proponent (or entity acting on behalf of the Project Proponent) who seeks to have carbon offsets[30] issued for the project must establish an account at ACR and pay the associated fees.[31]

To register the MSU-EPRI Offsets Project at the ACR, Delta Institute was required to:

- Submit an on-line offset Project Setup form containing information related to the characteristics of the project; and,
- Submit all documents identified as necessary by ACR.

Following submission, the following actions took place:

- ACR generated a project identification number (ACR 171);
- ACR sent a project screening report to Delta Institute with requests for revisions and clarifications to the project documents;
- Delta and MSU-EPRI revised and re-submitted project documents;
- ACR reviewed re-submission and certified the project;
- ESI was selected as the validation/verification body;
- Contracts and other documentation between ESI, ACR, and MSU were completed; and,32
- ESI started project validation/verification.

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[27] ACR utilizes APX "registry" technology. APX is an infrastructure provider for environmental markets (http://www.apx.com/).

[28] http://americancarbonregistry.org/membership/membership-list/acr-operating-procedures .

[29] http://americancarbonregistry.org/carbon-accounting/carbon-accounting/american-carbon-registry-standard-v2.0 .

[30] Known as Emission Reduction Tons (ERTs) at ACR.

[31] Account and other ACR fees found at: http://americancarbonregistry.org/membership/fee-schedule-may-2012 .

[32] For example, a Conflict-of-Interest (COI) form, purchase order #, and retainer fee from MSU.

Project validation/verification

A brief overview of project validation/verification as defined by ACR is given below. More detailed information is found in the ACR Validation and Verification Guideline document.[33]

Objectives of Validation

The overall goal of a third-party *validation* is to review impartially and objectively project documents against the requirements laid out in the relevant ACR standard and approved offsets methodology (i.e., the MSU-EPRI Methodology in this case). This includes validating the following elements of a proposed offset project:

- Project boundaries;
- Project baselines;
- Additionality;
- Quantification methodologies;
- Impermanence and risk mitigation;
- Leakage; and,
- Community and environmental impacts.

Objectives of Verification

The overall goal of third-party *verification* is to review impartially and objectively a project's claimed GHG emission reductions/removal enhancements against the relevant ACR standard and the relevant approved methodology (i.e., MSU-EPRI Methodology). This includes evaluating:

- Community and environmental impacts;
- Reported GHG baseline, project emissions and emission reductions;
- Leakage and impermanence risk assessment and mitigation;
- Significant changes to the project procedures or criteria since previous verification; and,
- Significant changes in the GHG project's baseline emissions and emission reductions since previous verification.

Validation / verification tasks and report

The validation and initial verification of the MSU-EPRI Offsets Project was conducted simultaneously. The end product of validation is a validation report, and the end product of verification is a verification statement and report. ACR accepts these documents as a combined submission and posts them publicly. The validation/verification report is a detailed description of the validation activities, verification activities, corrective actions, and conclusions. Further information on these reports and statements can be found in the ACR Validation and Verification Guideline (Chapters 7 and 12, respectively).[34]

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[33] http://americancarbonregistry.org/carbon-accounting/acr-v-v-guidelines-2012 .
[34] http://americancarbonregistry.org/carbon-accounting/acr-v-v-guidelines-2012 .

To accomplish these tasks, ESI personnel conducted a desk audit of the MSU-EPRI Offset Project documents, held conference call meetings with MSU-EPRI and Delta Institute personnel, and interviewed the participating crop producer via telephone.

ACR typically would require an ESI representative to visit and review the offset project site to meet a "reasonable level" of assurance. However, for this project the ACR provided a waiver for this requirement because of the following:

- The time period being validated / verified had passed (2011 growing season);
- No evidence of project site activity (N fertilizer rate reduction in 2011) was visually present.

The final project validation and verification report from ESI including timelines can be found on ACR's electronic registry.[35]

Offset issuance, purchase, and retirement

ACR formally issued offset credits to the Delta Institute for the MSU-EPRI Offsets Project on June 3, 2014.[36] This represented the first issuance anywhere in the world of GHG or "carbon" offsets derived solely and directly from agricultural N_2O emissions reductions.[37] The Delta Institute paid farmer Myron Ortner on June 12, 2014 for the offsets created by reducing the application of nitrogen fertilizer his project croplands. These offsets were purchased by the Climate Trust, a non-profit environmental organization based in Portland, OR on June 19, 2014, and are planned to be retired in July 2014.[38]

[35] https://acr2.apx.com/mymodule/reg/TabDocuments.asp?r=111&ad=Prpt&act=update&type=PRO&aProj=pub&tablename=doc&id1=171

[36] https://acr2.apx.com/mymodule/rpt/CertificateInfo.asp?ad=Prpt&RIID=331&ftType=PRO

[37] http://www.epri.com/Press-Releases/Pages/Greenhouse-Gas-Emissions-Offsets-Issued-in-First-Agricultural-Offsets-Transaction2.aspx

[38] http://www.deltanitrogen.org/wp-content/uploads/2014/06/First-Ag-Fertilizer-Offsets-Transaction-Rewards-Michigan-Farmer-061914-FINAL.pdf

6
KEY INSIGHTS AND LESSONS LEARNED

This section briefly highlights some key insights gained and lessons learned by the MSU-EPRI project team as we, our collaborators, and other stakeholders developed, implemented, registered, and validated and verified the MSU-EPRI Offsets Project.

The MSU-EPRI team's experiences working with the many stakeholders involved in this process has been positive. The issuance of the offsets associated with the MSU-EPRI Offsets Project represented the world's first trade of "carbon credits" derived from agricultural N_2O emissions reductions. Despite this success, we encountered several issues that could have broader, detrimental implications for the growth and success of future N management and N_2O mitigation offset projects. While some of these issues may partially reflect the small-scale nature and innovation of the MSU-EPRI Offsets Project, others transcend scale and novelty of this approach. We summarize these issues below under separate headings, but with the understanding that several of them are interlinked.

Economic Cost

The relatively high costs for validating/verifying new N_2O mitigation and other N management-related offsets projects is a strong disincentive that can be expected to discourage crop producers from participating in these types of voluntary activities. Only offset projects located on large aggregated parcels of land are likely to be able to generate the considerable volume of offsets (i.e., on the order of thousands of tons) needed to make a proposed project economically viable, particularly if validation costs remain high and carbon offset values remain low.

The direct cost to validate/verify the MSU-EPRI Offsets Project was approximately $10,000. This does not include the substantially greater cost in terms of MSU staff time and the producer's time dedicated to developing, implementing and helping guide the project through registration, validation and verification. This figure also does not include any financial and other costs associated with developing the underlying MSU-EPRI N_2O Offsets Methodology.

As with the MSU-EPRI Offsets Project team, many organizations that develop projects for the AFOLU sector do so in conjunction with the development of the methodology that underpins the project. Many methodology developers are also aggregators whose compensation will derive from trading GHG offset credits. As a result, these organizations often are willing to bear the financial cost of developing a new offset methodology and continuing to update it as needed. Public and non-profit institutions like MSU who are not be involved in credit trading directly, do not have a sustainable means (nor financial incentive) to cover the costs associated with new methodology development or revision.

Supporting Infrastructure

A small number of organizations still operate today as developers and aggregators of agricultural offset projects. However, with the failure of federal climate legislation to become law in 2009 and 2010 and the concomitant demise of the Chicago Climate Exchange (CCX) as a GHG reduction and trading system for agricultural emission sources and offset projects, a good deal of the infrastructure, communication, and trust built between the evolving carbon market

community and the farming community has eroded. This includes the role of several farmer's unions who previously had acted as offset project developers and aggregators. In addition, these farmer's unions offset handled project administration and documentation and arranged for third-party verification, thereby defraying much of the time, energy and costs that otherwise would have been borne by participating farmers. Without direct access to these types of organizations, large-scale aggregation and offset volume generation may be challenging to accomplish in the future.

Proliferation of Multiple N_2O Methodologies

Currently, there are two separate approved versions of the MSU-EPRI N_2O Methodology (i.e., ACR and VCS), and the CAR NMPP[39] that incorporates the MSU-EPRI approach to quantifying N_2O emissions. In addition, in 2010 the ACR itself developed and approved a further agricultural N_2O offset methodology based on the use of a "process-based" biogeochemical computer simulation model to estimate potential N_2O-based GHG offsets.[40]

The ACR and VCS agricultural N_2O offsets methodologies based on the MSU-EPRI Methodology share the same fundamental approach for calculating N_2O emissions reductions associated with reduced N fertilizer usage. However, there are important differences between these two versions of the MSU-EPRI Methodology which reflect several factors, including differences in the ACR and VCS program requirements, and the resolution of substantive issues addressed during the methodology approval process used by each of these programs. In addition, many of the key provisions of the MSU-EPRI Methodology are incorporated directly into the CAR NMPP, including the approach to quantifying N_2O emissions, but many other parts of the CAR NMPP differ substantially from the versions of the MSU-EPRI Methodology approved by the ACR and VCS. The key differences between all three of these methodologies are described in detail in a previous EPRI report.[41]

Because multiple different agricultural N_2O offsets methodologies now have been approved by these three voluntary offset programs, there may be uncertainty among farmers, offset developers and other parties regarding the choice and eligibility of a particular N_2O offset methodology for a particular set of circumstances. In addition, the proliferation of different N_2O methodologies could encourage offset developers, farmers and others to try to "cherry-pick" the version of the methodology that may be expected to provide them with the largest number of GHG offsets.

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[39] Nitrogen Management Project Protocol: Reducing Nitrous Oxide Emissions through Improved Nitrogen Management in Crop Production. Online at: http://www.climateactionreserve.org/how/protocols/nitrogen-management/ .

[40] See ACR methodology for "*N_2O Emissions Reductions from Changes in Fertilizer Management*" approved in 2010. Online at http://americancarbonregistry.org/carbon-accounting/carbon-accounting/emissions-reductions-through-changes-in-fertilizer-management .

[41] *Developing Greenhouse Gas Emissions Offsets by Reducing Nitrous Oxide (N_2O) Emissions in Agricultural Crop Production: Experience Validating a New GHG Offset Protocol*. EPRI, Palo Alto, CA: 2013. 1023669

Time Requirements

The time needed to develop and validate/verify a new offset project is long and includes multiple steps. In the case of the MSU-EPRI Offsets Project, the entire process took almost five years (Appendix A; Table A-1). The time elapsed from the start date of the project (April 2011) to offset issuance (June 2014) was a little over three years. Of course, the MSU-EPRI Offsets Project was a first-of-a-kind effort that can be expected to take considerably longer and cost more to implement than the deployment of the "n^{th}" offset project in the future. However, the relatively long time period may inhibit interested and qualified crop producers and offset project developers from trying to develop N_2O GHG abatement projects, and risks excluding projects due to eligibility criteria related to project start dates.

Moving from Demonstration to Deployment

It is our hope that developing the MSU-EPRI Offsets Methodology and successfully implementing the MSU-EPRI Offsets Project will help drive down the cost for crop producers and offset project developers to become engaged in projects to reduce N fertilizer use and agricultural N_2O emissions.

By developing the methodological foundation for creating N_2O offsets in agricultural crop production and demonstrating how to implement a real-world agricultural N_2O offset project, we hope we have set the stage for more widespread deployment of projects and activities that will reduce N fertilizer use and N_2O emissions.

7
NEXT STEPS & REMAINING CHALLENGES

Going forward, large-scale deployment of the MSU-EPRI Methodology faces a variety of near-term challenges and some opportunities, including:

- Offset project aggregators' interest in developing large-scale N_2O offsets projects.

  One positive development related to this challenge is the recent announcement by the Delta Institute and the Climate Trust of the launch of a large-scale Nitrogen Credit Trading program across 12 Midwestern states that is designed to build on and leverage the success of the MSU-EPRI Offsets Methodology and Offset Project;[42]
- The potential for offsets projects to be "stacked;" i.e., a situation in which two different kinds of environmental offsets may be generated by the same project activity and credited together, or "unbundled" and credited separately.

  One potential kind of offset "stack" that has been discussed among offset program observers is the potential to stack N_2O-based GHG emissions offsets with water quality credits for reduced nitrate generated by reducing N fertilizer application on agricultural lands. This approach now is being explored in conjunction with EPRI's Ohio River Basin Water Quality Trading Project[43];
- Site-specific research conducted in other regions of the U.S. and internationally that can help to enlarge the range of geographies and crops where "Tier 2" N_2O emissions calculation methodologies can be used to create GHG offsets; and,
- Potential adoption by the California Air Resources Board (ARB) of a "nitrogen management" compliance offset protocol for use in the State's mandatory GHG emissions GHG cap-and-trade program.

  If the ARB moves forward to develop a new nitrogen management protocol in the future, we hope the ARB will consider using the MSU-EPRI Methodology as a starting point for developing an agricultural N_2O compliance offsets protocol. In addition, we hope the ARB will consider recognizing one or more of the existing offset nitrogen management protocols as eligible to be used to create "early action" compliance offset credits.

Longer term success certainly will depend on a myriad of factors, including: (i) the potential for "covered entities" to use agricultural N_2O offsets for compliance with regulatory programs designed to reduce GHG emissions; (ii) the market price of carbon offset credits; (iii) the penetration of new and existing cost-effective agricultural technologies that may enable farmers to further reduce N fertilizer rates; and, (iv) the willingness of farmers to participate on a voluntary basis.

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[42] http://www.deltanitrogen.org/ .

[43] http://wqt.epri.com/ .

A

APPENDIX A – TIMELINE OF MSU-EPRI OFFSET PROJECT

Table A-1
Timeline of major events related to MSU-EPRI Offset Project development, implementation, registration and offset generation and retirement.

Event	Date
MSU/MSU Extension discussions to identify producer	July 2009
1st Producer and Stakeholder meeting	08/18/2009
2nd Producer and Stakeholder meeting	01/28/2011
MSU-EPRI Offsets Project start date	04/21/2011
MSU-EPRI Offsets Project crediting period	04/21/2011 – 4/21/2018
MSU-EPRI Methodology adopted by ACR	07/18/2012
MSU-EPRI Offsets Project issued project id by ACR	01/04/2013
MSU-EPRI Offsets Project documents (final) sent to ACR	10/16/2013
ACR project screening report to Delta Institute	11/21/2013
ACR certify MSU-EPRI Offsets Project	12/12/2013
ESI initial project call with MSU-EPRI/Delta Institute	01/16/2014
ESI final project call with MSU-EPRI/Delta Institute	04/30/2014
ESI submits validation/verification report to ACR	05/01/2014
ACR issues offsets to Delta Institute	06/03/2014
ACR issues check to Producer	06/12/2014
TCT purchases MSU-EPRI Offsets Project offsets	06/19/2014
TCT retires MSU-EPRI Offsets Project offsets	July 2014

B
APPENDIX B – EPRI PRESS RELEASE

EPRI | ELECTRIC POWER RESEARCH INSTITUTE

News Release

Greenhouse Gas Emissions Offsets Issued in First Agricultural Offsets Transaction

PALO ALTO, Calif. – (June 9, 2014) -- The Electric Power Research Institute (EPRI) announced today the first agricultural greenhouse gas emissions (GHG) offsets transaction based on validation and verification methodology developed by EPRI and Michigan State University (MSU). The methodology enables farmers to participate in emerging carbon markets by creating GHG offsets, which can be sold to other carbon market participants to meet GHG emission reduction targets or to achieve corporate sustainability goals.

The American Carbon Registry issued the offsets, called Emission Reduction Tons, to a Michigan farmer for voluntarily reducing nitrous oxide (N_2O) emissions by curbing the amount of nitrogen-based fertilizer used to grow corn. This project demonstrates that through improved nitrogen application efficiency farmers can reduce fertilizer use and GHG emissions without reducing crop yields, and be compensated for the GHG emissions reductions they create.

“Offsets are a potentially important tool for achieving GHG emission reduction targets, and this project shows that by connecting the agriculture industry with offset markets, farming practices can be a source for emissions reductions and tradable credits,” said Adam Diamant, technical executive at the Electric Power Research Institute and a co-author of the MSU-EPRI methodology.

The offsets generated by the farmer’s project are being purchased by The Climate Trust, an Oregon-based non-profit organization engaged in efforts to reduce GHG emissions and generate offsets. This also is the first offset project to be included in the new Nitrogen Credit Program created by the Delta Institute, a non-profit organization dedicated to creating and implementing market-driven solutions in the Great Lakes region. Working in partnership with The Climate Trust, the Delta Institute program uses the MSU-EPRI methodology across Illinois, Indiana, Iowa, Kansas, Michigan, Minnesota, Missouri, Nebraska, North Dakota, Ohio, South Dakota and Wisconsin.

Nitrogen fertilizers represent one of the largest sources of GHG emissions from agricultural production, resulting in significant emissions of N_2O, a GHG with approximately 300 times the global warming potential of carbon dioxide (CO_2). In 2012, N_2O emissions from cropland soils in the United States were approximately 195 million metric tons of CO_2 – equivalent (CO_2e), according to the U.S. Environmental Protection Agency’s 2014 National Greenhouse Gas Inventory, equivalent to the GHG emissions of approximately 41 million passenger vehicles annually.

"Farmers already manage fertilizer, but are often reluctant to further reduce its use because they fear doing so will curb crop yields," said Phil Robertson, co-author of the MSU-EPRI methodology and Michigan State University professor of plant, soil and microbial sciences. "Our research shows fertilizer use can be reduced to get N_2O emission reduction co-benefits while maintaining crop yields."

Corn is among the most intensive uses of nitrogen fertilizer and represents a significant opportunity for efficiencies that could reduce emissions. A large proportion of agricultural-related N_2O emissions in the United States stems from corn crops. The estimated technical potential of emission reductions using the MSU-EPRI methodology in the Midwest is approximately six million metric tons of CO_2e per year.

The science that underlies the offsets issued to the Michigan farmer represent results from 3 years of scientific research by MSU scientists, and more than 3 years of methodology development by EPRI and MSU. The research was conducted at the National Science Foundation's Kellogg Biological Station Long-term Ecological Research site and on commercial farms in Michigan.

The MSU-EPRI methodology, called *Methodology for Quantifying Nitrous Oxide (N_2O) Emissions Reductions from Reduced Use of Nitrogen Fertilizer on Agricultural Crops*, has been approved by the American Carbon Registry, and a similar version has been approved by the Verified Carbon Standard. Key aspects of this methodology also have been incorporated in a nitrogen management offset protocol approved by the Climate Action Reserve. Additional background information on the methodology is available for download from EPRI's website.

About EPRI

The Electric Power Research Institute, Inc. (EPRI, www.epri.com) conducts research and development relating to the generation, delivery and use of electricity for the benefit of the public. An independent, nonprofit organization, EPRI brings together its scientists and engineers as well as experts from academia and industry to help address challenges in electricity, including reliability, efficiency, affordability, health, safety and the environment. EPRI's members represent approximately 90 percent of the electricity generated and delivered in the United States, and international participation extends to more than 30 countries. EPRI's principal offices and laboratories are located in Palo Alto, CA; Charlotte, NC; Knoxville, TN; and Lenox, MA.

About Michigan State University

Michigan State University has been working to advance the common good in uncommon ways for more than 150 years. One of the top research universities in the world, MSU focuses its vast resources on creating solutions to some of the world's most pressing challenges, while providing life-changing opportunities to a diverse and inclusive academic community through more than 200 programs of study in 17 degree-granting colleges

The Electric Power Research Institute, Inc. (EPRI, www.epri.com) conducts research and development relating to the generation, delivery and use of electricity for the benefit of the public. An independent, nonprofit organization, EPRI brings together its scientists and engineers as well as experts from academia and industry to help address challenges in electricity, including reliability, efficiency, affordability, health, safety and the environment. EPRI also provides technology, policy and economic analyses to drive long-range research and development planning, and supports research in emerging technologies. EPRI's members represent approximately 90 percent of the electricity generated and delivered in the United States, and international participation extends to more than 30 countries. EPRI's principal offices and laboratories are located in Palo Alto, Calif.; Charlotte, N.C.; Knoxville, Tenn.; and Lenox, Mass.

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