

# Greenhouse Gas Management Roadmap

## Executive Summary

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**TRI-STATE**

THE POWER BEHIND YOUR  
LOCAL ELECTRIC CO-OP

A Touchstone Energy® Cooperative





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## Foreword

This Greenhouse Gas Management Roadmap is a status report for Tri-State Generation and Transmission Association, Inc. (“Tri-State” or “association”) as it continues to develop the information, data, tools and technologies necessary to position Tri-State to manage the risks associated with potential constraints on greenhouse gas (“GHG”) emissions while continuing to affordably and reliably meet the demand and energy requirements of its 44 Member-Systems.

Electric utilities face challenging times with significant economic, environmental, market and regulatory uncertainty. All sectors of the energy economy face similar challenges; however, each industry participant is in a different position relative to managing uncertainty.

To meet these challenges, Tri-State and its Members must plan for a number of future scenarios, including the potential of a GHG-constrained future. There are international, national, regional, state and local dimensions both influencing the evolution of this scenario and in attempting to respond to this scenario. For an energy company, a GHG-constrained scenario it is not the only scenario that must be planned for – others considerations include economic, technology, and fuel scenarios.

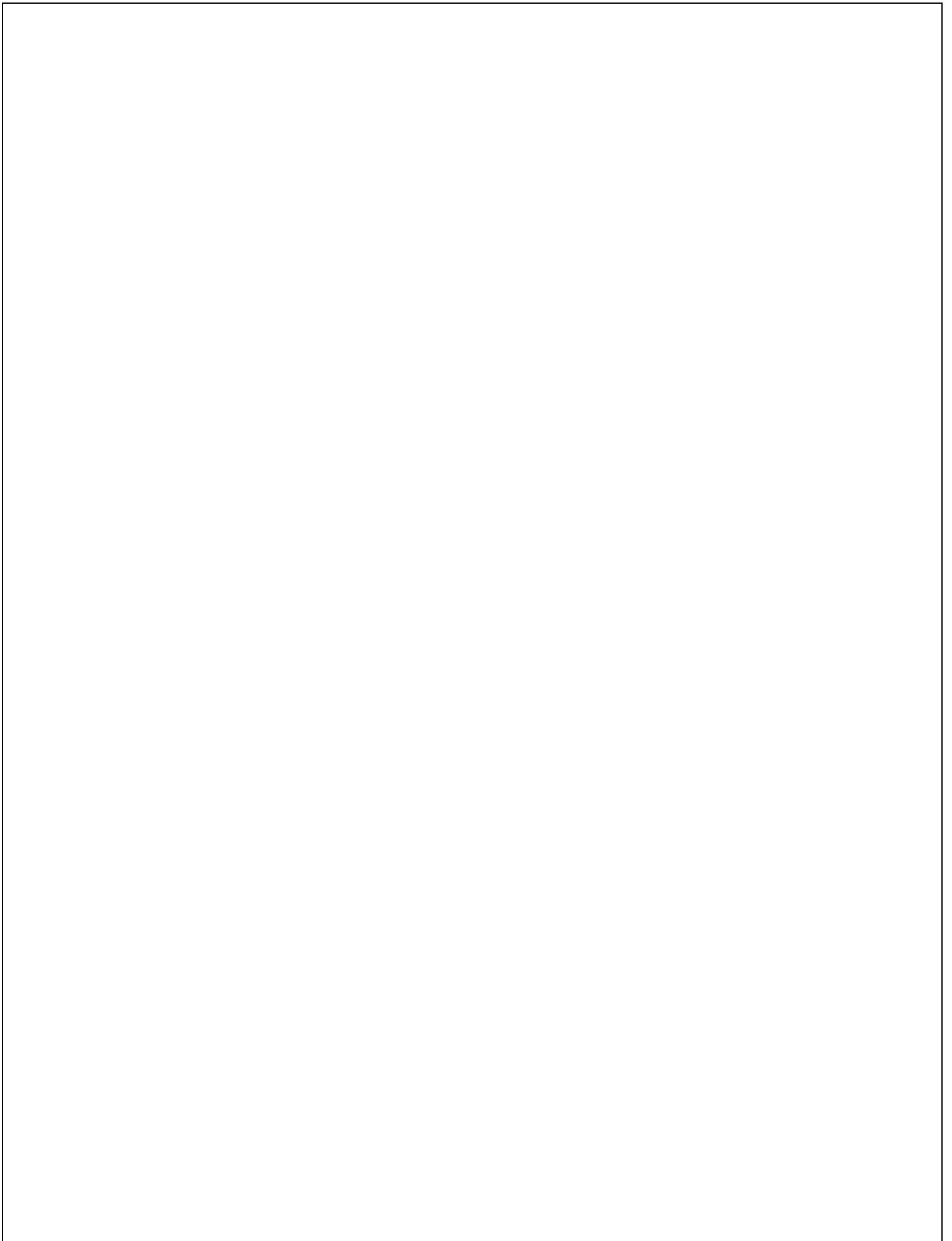
Tri-State believes a thorough review and analysis of GHG risk management options is required, and that implementing short-term actions or mechanisms could have significant economic ramifications on rural consumers if not implemented appropriately.

This Executive Summary identifies the specific activities, programs and initiatives that are unique to Tri-State and that will inform Tri-State, its Member-Systems, policymakers and stakeholders of the range of options for the association to manage its potential GHG emission risks in a GHG-constrained future.

Roadmap initiatives and programs span many areas of Tri-State’s operations, including energy efficiency, renewable energy, system efficiency, and research, development and demonstration, and resource planning. Roadmap programs are expected to have high potential for GHG management and are expected to reveal near-term opportunities and long-term strategies.

The outcomes from this Greenhouse Gas Management Roadmap will be incorporated, along with other risk factors, into Tri-State’s long-term resource planning evaluations.

In any case, Tri-State will consider the full range of tools, technologies and market opportunities to manage GHG emissions risk while continuing to maintain full compliance with all local, state and federal energy and environmental laws and regulations.



## What is the Greenhouse Gas Management Roadmap?

The Greenhouse Gas Management Roadmap (“Roadmap”) is a continuing process incorporating integrated studies and analysis to help Tri-State and its Members to better assess the potential to manage the risks associated with possible constraints on greenhouse gas (“GHG”) emissions.

Progress on the Roadmap will:

- Address roadblocks to effectively manage GHG emissions risk
- Enable the development of transformative tools and methodologies
- Fill defined knowledge gaps to support GHG risk management

## Roadmap progress

The Roadmap encompasses many efforts underway across Tri-State’s enterprise:

### Initiatives continue

	<b>Status</b>
√ Participation in policy and GHG reporting protocol development	Ongoing
√ Development of near-term resources to meet Member needs	Ongoing
√ Pursuit of utility- and community-scale renewable energy projects	Ongoing
√ Expansion of energy efficiency and DSM programs	Ongoing
√ System generation and transmission efficiency projects	Ongoing

### Key system studies commissioned

√ Energy Efficiency and Demand-Side Management Study	Launched 2Q/2009
√ CO <sub>2</sub> Footprint, Sequestration and Monetization Study	Launched 1Q/2009
√ Generation Technology Selection Study	Launched 1Q/2009

### Research, development and demonstration initiatives funded

√ Pre- and post-combustion CO <sub>2</sub> capture	Launched
√ CO <sub>2</sub> sequestration and offsets	Launched
√ Solar augmentation	Launched
√ Energy storage	Launched
√ Biological carbon capture	Launched
√ Transmission efficiency	Launched

### GHG management analysis and resource planning evaluation

√ GHG management analysis	Under development
- Long-term resource planning evaluation <sup>1</sup>	Ongoing
- Identification of long-term resource alternatives	Pending

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<sup>1</sup> Tri-State’s long-term resource planning evaluations will incorporate a wide range of uncertainties and risk factors, including potential risks from constraints on GHG emissions.

## Introduction

As a foundation of this Greenhouse Gas Management Roadmap, Tri-State and its Members recognize the potential risk of GHG constraints and seek appropriate federal policies to address GHG emissions. However, Tri-State has a significant interest in efforts that address GHG management in the states in which it operates. Tri-State serves power to its Colorado, Nebraska, New Mexico and Wyoming-based Member-Systems (“Members”), and has generation resources in Arizona, Colorado, New Mexico and Wyoming.

Tri-State will identify the potential to manage GHG emission risks that positions the association to meet the GHG emission reduction goals of the states in which it operates, as well as any federal goals. To put this risk in perspective:

- In 2005, Tri-State's total GHG emissions were estimated to be approximately 11.3 million metric tons CO<sub>2</sub> equivalent (CO<sub>2</sub>e).<sup>2,3</sup>
- 80 percent of Tri-State's total 2005 GHG emission level is approximately 9 million metric tons CO<sub>2</sub>e.
- In 2007, Tri-State's estimated total GHG emissions were approximately 14.5 million metric tons CO<sub>2</sub>e; these increased emissions were due to significant load growth on Tri-State's system.
- To reach a 20 percent reduction by 2020 goal, Tri-State would need to reduce GHG emissions by approximately 5.5 million metric tons CO<sub>2</sub>e from its total 2007 emissions level; this represents a nearly 38 percent reduction in total emissions.

This perspective illustrates the significant challenge that Tri-State faces managing GHG risks. Notwithstanding the current national and regional economic conditions, the demand for electricity continues to grow due to increasing economic development, population growth and consumer demand.

Accordingly, Tri-State's success, indeed the entire region's success in managing GHG emission risks, will be heavily dependent upon developing cost-effective new technologies and efficient ways to manage the growth of electricity consumption.

The Roadmap is a living document that identifies Tri-State's current efforts to manage risk. It will evolve into a plan detailing the specific steps that Tri-State will take to reach GHG emission reduction goals as Tri-State develops new capabilities and incorporates new technological developments. Tri-State understands the need to manage GHG risk and will, as always, be fully compliant with all legal requirements.

### State GHG policy development

Arizona, Colorado and New Mexico have developed climate action plans with state goals for GHG emissions reductions, and New Mexico and Arizona participate in the Western

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<sup>2</sup> In 2005, Tri-State's Craig 3 generating unit operated at about 86 percent capacity factor due to a major maintenance outage; the unit typically runs at an annual 90+ percent capacity factor.

<sup>3</sup> There are six greenhouse gases that have been identified by the International Panel on Climate Change. Each gas is assigned a global warming potential. This potential is used to convert total emissions to carbon dioxide (CO<sub>2</sub>) equivalent. For example, 1 ton of Methane = 21 tons CO<sub>2</sub> equivalent. A carbon dioxide equivalent is a quantity of GHG equal to 1 metric ton of CO<sub>2</sub>.

Climate Initiative<sup>4</sup> (“WCI”). The following table summarizes the goals of states Tri-State operates in and the WCI.

**State/Regional Climate Action Plan GHG Reduction Goals**

	<b>Baseline year</b>	<b>2012</b>	<b>2020</b>	<b>2040</b>	<b>2050</b>
Arizona	2000		2000 levels	50%	
Colorado	2005		20%		80%
New Mexico	2000	2000 levels	10%		75%
Western Climate Initiative (AZ and NM)	2005		15%		

In Arizona, Governor Janet Napolitano formed the Arizona Climate Change Advisory Group (“ACCAG”) in 2005 and signed an Executive Order in 2006 that accepted ACCAG’s Climate Change Action Plan and established state goals to reduce GHG. The state goals are to reduce emissions to the 2000 level by 2020 and 50 percent below the 2000 level emissions by 2040. The ACCAG plan identifies policy options for the energy supply industry that include increased utilization of renewable energy resources, implementation of net metering, energy conservation strategies, and implementation of a national or regional cap-and-trade program. The plan also includes options for agriculture and forestry, transportation and industrial sectors.

In Colorado, on April 22, 2008, Governor Bill Ritter signed Executive Order D 004 08 which established a long-term goal of an 80 percent reduction in Colorado's GHG emissions from 2005 levels by 2050. The Executive Order also established an interim goal of a 20 percent reduction from 2005 levels by 2020. Given that in 2005, 36 percent of carbon dioxide (“CO<sub>2</sub>”) emissions in Colorado were attributable to electricity production, the Executive Order recognized that "large utilities will have to weigh many approaches to achieve a 20 percent cut in emissions, including significant expansion of renewable energy sources and energy efficiency, investments in new clean coal technologies, retirement of old, inefficient coal-fired generating stations, purchases of carbon credits to offset emissions, and other strategies."

In New Mexico, Governor Bill Richardson formed the New Mexico Climate Change Advisory Group (“NMCCAG”) in 2005 and set GHG emission reduction targets for 2000 levels by 2012, 10 percent below 2000 levels by 2020, and 75 percent below 2000 levels by 2050. In 2006, Governor Richardson signed an Executive Order that accepted NMCCAG’s Climate Change Action Plan and 69 recommendations on how to meet the established targets.

The WCI has committed to reducing GHG emissions 15 percent below 2005 levels by 2020 through the development of a regional cap-and-trade program. The partners are Arizona, British Columbia, California, Manitoba, Montana, New Mexico, Ontario, Oregon, Quebec, Utah and Washington. Colorado, Wyoming and Kansas are observers, but have not joined the WCI. WCI released the final cap-and-trade program elements on September 23, 2008. States are now responsible for identifying necessary legislation and implementing the programs. Once legislative authority is established in each state, the cap-and-trade program is effective in 2012 for electric utility and industrial sectors.

<sup>4</sup> WCI is a group of seven western states and four Canadian provinces that have committed to reducing the emission of GHG through the development of a regional cap-and-trade program. The partners include Arizona and New Mexico.

## Tri-State's unique situation

Tri-State's unique structure, territory, function and system creates many challenges that do not generally apply to investor-owned or municipal utilities.

Tri-State is organized as a not-for-profit cooperative and is owned by its 44 Member distribution cooperatives and public power districts located in four states. Tri-State provides reliable electrical service to its Members at the lowest practical cost so that each Member may, in turn, distribute that electricity to its own retail member-consumers.

Tri-State and its Members serve electric demand and energy requirements in some of the most economically disadvantaged and least populated areas in the western United States – rural areas that investor-owned utilities historically were not interested in serving and that are more difficult and costly to serve. In these areas, access to affordable and reliable electric power is essential to the public welfare and economic prosperity of the communities served by Tri-State and its Members. As a result, Tri-State must carefully consider the costs associated with its GHG management efforts.

Tri-State operates as a wholesale power provider that generates, purchases, and transmits power to its 44 Members in Colorado, Nebraska, New Mexico and Wyoming, and with limited additional power deliveries into Arizona, Montana and Utah. Tri-State's function as an interstate, wholesale power provider makes it distinctly different from the region's vertically-integrated retail electric utilities. The lack of a retail relationship with the end-use consumer limits Tri-State's ability to interact directly with consumers to employ certain demand-side options to manage its GHG emission risks. Tri-State's multi-state service territory presents additional challenges. Three of the states in which Tri-State owns generation resources have their own climate action plans which have differing goals. Tri-State must consider how to balance the needs of its Members in each of the four states in which it operates while still working toward managing GHG risk in each of those states.

Tri-State operates an integrated, interconnected, interstate generation and transmission system which has its own capabilities and limitations. For example, there are transmission transfer limitations between the states in which Tri-State's Members are located and within Colorado as well. These transfer limitations have a profound effect on the evaluation of and opportunities to use various supply-side and demand-side options in managing GHG emissions risks. This reality requires Tri-State to evaluate not just its operations in any one state, but rather by its entire interconnected system in the context of available resources, load requirements, transmission constraints, unique Member needs and capabilities, and GHG management risks.

## Greenhouse gas reporting inventory initiatives



**The Climate Registry**

Tri-State is investigating with the states and federal government the appropriate protocol for developing a GHG inventory. Further, Tri-State is engaged in activities to understand inventory protocols and identify its own GHG emissions. There are a number of standard protocols available that are commonly used, including the Department of Energy 1605(b) voluntary program and the World Resources Institute protocol to calculate GHG, but to date, there is not one consistent method used in the U.S.

**Founding member of The Climate Registry**

Tri-State is a founding member of The Climate Registry, a nonprofit collaboration among North American states, provinces, territories and

Native Sovereign Nations that is working to develop consistent and transparent standards to calculate, verify and publicly report GHG emissions into a single registry. Tri-State participated in the team that developed TCR's General Reporting Protocol. Now TCR is developing a reporting protocol for the electric power sector. Tri-State is the only electric cooperative represented in the workgroup developing the sector-specific protocol and also volunteers for the technical expert panel that is critiquing the workgroup's products.

### **State reporting and federal reporting**

Tri-State is participating in the development of GHG reporting rules at the state level in New Mexico, Colorado and Arizona. In Colorado, pursuit of a GHG reporting rule was recently announced by the Colorado Department of Public Health and Environment in accordance with the Colorado Climate Action Plan and Governor Bill Ritter's Executive Order 004 08. Colorado has indicated that it will aim for consistency with The Climate Registry and rely on implementation of a federal program, rather than develop state-specific rules.

In New Mexico, a GHG reporting rule was promulgated in 2007 pursuant to Governor Bill Richardson's Executive Order 2006-69. The rule requires electric utilities to first report 2008 CO<sub>2</sub> emissions in June 2009. The rule in New Mexico allows optional use of The Climate Registry's reporting protocol. The New Mexico Environment Department intends to amend the rule to link to federal reporting requirements. In Arizona, the Department of Environmental Quality in 2008 opened a docket for development of a GHG reporting rule. Arizona intends to require reporting first in 2011 for 2010 emissions and to follow the Western Climate Initiative's reporting essentials, which are still under development.

### **Greenhouse gas emissions from Tri-State operations**

In 2005, Tri-State's total GHG emissions were estimated to be approximately 11.3 million metric tons CO<sub>2</sub> equivalent (CO<sub>2</sub>e). In 2007, Tri-State's estimated total GHG emissions were approximately 14.5 million metric tons CO<sub>2</sub>e; these increased emissions were due to significant load growth on Tri-State's system.

## **Near-term resource development**

In the near-term (next 3-5 years), Tri-State is counting on the expansion of its energy efficiency programs, investments in renewable energy and natural gas capacity to meet Member load growth, diversify its resource portfolio and manage risks, including those from GHG emissions. These efforts include:

- Developing a 30-megawatt, 500,000-panel solar photovoltaic power plant in northeastern New Mexico, with construction complete by December 2010.
- Announcing additional utility-scale renewable energy projects in mid-2009
- Incentivizing the development of local, community-based renewable energy projects, with approximately 10 MW of local projects under development.
- Contracting for 220 MW of natural gas-based capacity in eastern Colorado.
- Enhancing energy efficiency programs, including the addition of incentives for certain ENERGY STAR-rated appliances, "smart grid" and light-emitting diode ("LED") applications and low temperature heat pumps.
- Investing in efficiency improvements across Tri-State's generation and transmission facilities.

### 2008-2009 Energy Efficiency Credits Program Initiatives

Tri-State's Board of Director's recently expanded the program to include:

- **Premium efficiency electric motors and ENERGY STAR appliances:** Tri-State will continue to provide financial incentives for the purchase of premium efficiency electric motors and is expanding its rebate program for ENERGY STAR appliances, including dishwashers, washing machines and the recycling of refrigerators and freezers.
- **Energy efficiency kits:** Tri-State is providing 100 energy efficiency kits free to each of its members, plus a \$4.00 incentive payment for all additional kits purchased by members.
- **LED lighting:** Tri-State is providing financial incentives for installation of LED lights on commercial refrigeration units and for street lighting.
- **Low temperature heat pumps and energy efficient heating systems:** Tri-State is initiating a pilot program to pay half the cost of one low temperature heat pump for each of its member-systems and will fund the acquisition of advanced technology heating units for each of its members to test the effectiveness of the these units.
- **Heat pump water heaters:** Tri-State has worked the Electric Power Research Institute to research the commercial feasibility of water heater technologies based on heat pumps, and it is funding the deployment of up to six of these units for its members in 2009, with the program to expand in 2010.

## Efficiency and DSM initiatives

Tri-State and its Members are engaged in numerous programs to promote energy efficiency and demand-side management ("DSM"). Together, Tri-State and its Members work closely to structure cost-effective energy efficiency and DSM programs that meet the unique needs of rural consumers.

These programs, along with an end-use Energy Efficiency and Demand-Side Management Study, load management, smart grid and economic demand response programs, will be incorporated into Tri-State's resource planning evaluations.

Tri-State will also assign a GHG reduction potential value from energy efficiency and demand-side management programs for inclusion in the GHG risk management analysis in its resource planning evaluation.

Specific energy efficiency and DSM initiatives include:

### Energy Efficiency Credits Program enhancements

Tri-State continues to enhance its comprehensive Energy Efficiency Credits Program. First established in 1985, the EEC Program provides end-use consumers with financial incentives to promote the wise use of energy by installing more efficient lighting, appliances, heating and cooling systems, and high-efficiency motors in irrigation, commercial and industrial applications. Any Tri-State Member may choose to participate and may tailor the program to meet its specific goals. Most Members offer additional incentives to their customers, thereby further enhancing the effectiveness of the EEC program. In mid-2008, Tri-State made several EEC program changes to better meet the needs of consumers. In 2008, Tri-State paid-out in excess of \$1.8 million under the EEC Program, and since inception, the program has resulted in the reduction of approximately 73 MW in demand and saved 80,000 MWh in energy. As new energy-saving devices are marketed to consumers, Tri-State continues to widen EEC eligibility.

### Load management programs implemented

Tri-State is implementing an Emergency Load Management Program and has irrigation load control programs. Under the ELMP, Tri-State will pay Members or their end-use consumers for certain market services the participating load can provide by changing its power consumption behavior. While this program is initially intended to meet emergency or operational considerations, the ELMP will assist Tri-State in designing future DSM programs focused on consumer power consumption. Similarly, the irrigation load control programs provide incentives to Members that regulate irrigation loads at peak.

### **Smart grid programs progressing**

While Tri-State, as a wholesale power provider, does not enjoy the typical relationship with the end-use consumer which would facilitate application of various end-to-end "Smart Grid" opportunities, Tri-State is aggressively evaluating and implementing various "Smart Grid" technologies to improve energy analysis and use with its Members. Current projects include: Tri-State's Meter Data Management System (MDMS); an incentive program for Member "Smart Grid" pilot projects; and a program for joint opportunities with Members to take advantage of funding opportunities under the American Recovery and Reinvestment Act that would facilitate the deployment of "Smart Grid" technologies.

### **Economic Demand Response Program developing**

Tri-State is developing a strategy in various regions of its Members' service territories to implement an "Economic Demand Response Program." The Program's objective is demonstrating "end-to-end functionality" without Tri-State directly controlling the load on its Members' respective distribution systems. Furthermore, many Members have expressed interest in developing the capability to deliver to Tri-State "wholesale-equivalent" resources such as load reduction, load shifts or other supply-equivalent resources on a reliable basis, which can be called on to displace wholesale supply resources now being acquired by Tri-State. Tri-State is evaluating various regional approaches and the additional technology investments that may be required to achieve the desired load response and to demonstrate the capacity and energy savings.

### **Rate signals reviewed**

Rate signals are an important tool in promoting energy efficiency and managing GHG emissions. Tri-State, as a wholesale power provider, employs rate and load signals to its Members which can then be used with the Members' end-use consumers to encourage changes in consumption behavior. Tri-State's last rate structure change took effect on January 1, 2007. The 2007 rate structure allows each Member, rather than Tri-State, to focus on demand response programs as a whole. The rate structure calls for Members to optimize their Member Coincident Peak within Tri-State's peak periods and obtain demand charge reductions associated with such optimization. Thus, Members and their end-use consumers that can reduce their peak during Tri-State's highest cost-to-serve times will save on the demand charge. This constitutes a significant financial savings and offers significant GHG management potential. Based on two years of data, a number of Members and their end-use consumers have instituted programs to take advantage of the new rate and load signals. Tri-State will continue to review the effectiveness of the current rate structure and evaluate whether additional changes are appropriate.

### **Efficiency and DSM Roadmap actions**

Tri-State is taking the following actions on energy efficiency and demand-side management in the Greenhouse Gas Management Roadmap:

- Continue to enhance existing energy efficiency, DSM and load management programs and collect program data.
- Continue to pursue a range of smart grid opportunities and collect program data.
- Develop a demonstration strategy in various regions of Members' service territories to implement an "Economic Demand Response" program.
- Evaluate wholesale rate signals, objectives and desired Member-System and consumer actions to look at system optimization and potential efficiency gains.
- Assign GHG reduction values from all energy efficiency and demand-side management programs data for inclusion into GHG-risk management analysis.
- Incorporate energy efficiency and DSM GHG-risk management analysis into resource planning evaluation.

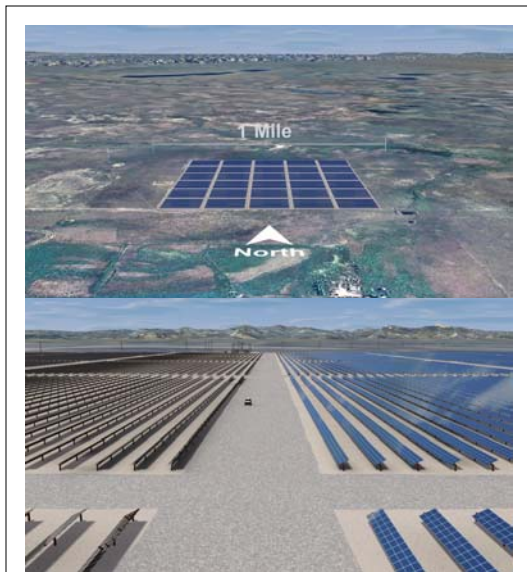
## Renewable energy initiatives

In a GHG-constrained scenario, renewable energy resources provide a significant opportunity to control the potential increase in GHG emissions associated with the growing demand for electrical power. Providing wholesale electric power to its membership from renewable energy is not a new concept for Tri-State. In fact, the association already provides 14 percent of its energy to its members from renewable resources, including renewable hydropower, wind and biomass.

Tri-State intends to employ renewable energy sources to diversify its portfolio that could control and ultimately to help slow the growth or intensity of GHG emissions associated with increasing load growth. Renewable energy initiatives will be evaluated in Tri-State's resource planning, in part for their GHG emission reduction potential. Tri-State will assign a GHG reduction value from renewable energy resources and programs for inclusion into resource planning evaluations.

Tri-State is committed to developing renewable energy sources both at the utility-scale and at the local, community-scale. Tri-State is taking a number of actions to diversify its generation resource portfolio and increase the percentage of renewable energy sources within its system. Specific renewable energy initiatives include:

### Cimarron I solar project



Computer-generated images of Tri-State's Cimarron I solar photovoltaic project under development in northeastern New Mexico. The 30-megawatt facility will serve the equivalent energy needs of 9,000 homes.

Tri-State is developing the 30-megawatt Cimarron I solar photovoltaic project in northeastern New Mexico. Cimarron I is the largest solar power project ever undertaken by a cooperative and one of the largest projects of its kind in the world.

Construction of the facility is scheduled to commence by April 2010, with the first portion of the system producing energy by August of that year. The plant is scheduled to be fully operational by the end of 2010.

The solar field will consist of 500,000 2' x 4' cadmium telluride ("CdTe") photovoltaic modules constructed with thin film semiconductor technology. First Solar is acting as the engineering, procurement and construction contractor and will monitor and maintain the facility. Tri-State has contracted to purchase the electricity output from the facility for a 25-year period.

CdTe photovoltaic technology is distinguished from other silicon-based photovoltaic technologies in featuring the

smallest carbon manufacturing footprint, when measured on a lifecycle basis. In addition, CdTe photovoltaic modules are believed to provide superior light absorption, resulting in higher power output compared to conventional silicon-based modules. This attribute of maximizing the absorption of light is important in maximizing the power produced under cloudy or diffuse light conditions, such as dawn and dusk.

### Utility-scale renewable energy projects

In connection with its 2007 Request for Proposals for renewable energy resources, Tri-State intends to announce an additional utility-scale renewable energy project in mid-2009. Tri-State plans in subsequent years to solicit proposals for and implement additional renewable energy projects to further diversify its resource portfolio and to meet renewable portfolio standards in a cost-effective manner.

### Local renewable energy programs

Tri-State has adopted a policy that provides financial support to its Members to develop local, community-based renewable energy projects. Tri-State will make performance payments to its Members for energy produced by a qualifying renewable energy project. In many instances, these payments benefit Tri-State's Members and the project developer by buying down the payback period for certain projects and helping make other projects financially feasible where it might not have been otherwise. To date, Tri-State has entered into three contracts with Members to develop local renewable energy projects totaling more than 10 MW.<sup>5</sup> A number of other Tri-State Members are evaluating projects including biomass, geothermal, micro-hydro, wind, solar and recovered energy technologies.

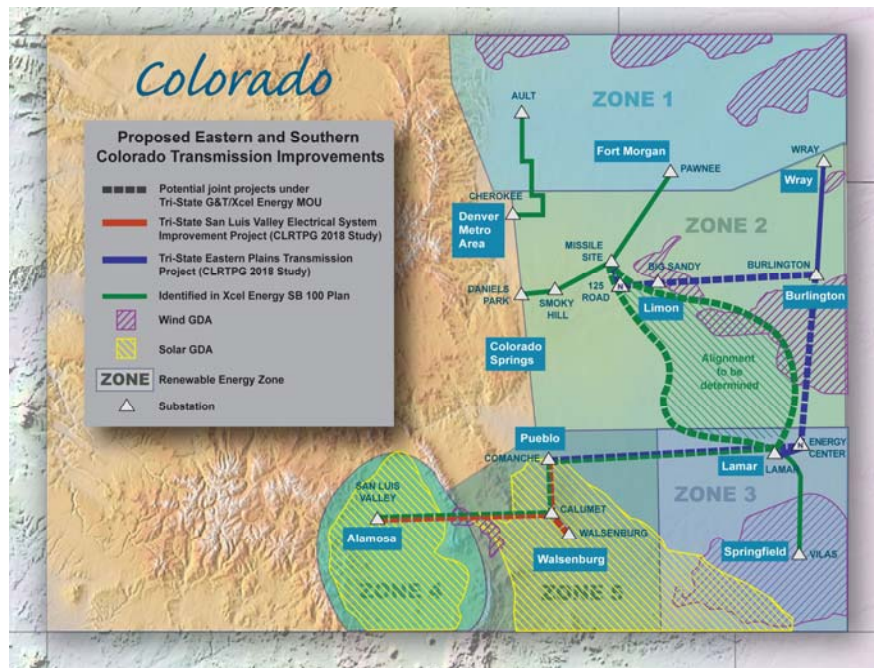
### Green Power Program

Tri-State continues to provide the opportunity for member-consumers of its 44 Members to participate in the Green Power Program. The program allows end-use consumers to buy green power at an additional, minimal monthly fee and to support the continued development of renewable energy resources. Beginning in 2008, the green power premium charged under the program was greatly reduced to track actual renewable energy credits market conditions. In 2008, Tri-State sold 78,294 MWh of renewable energy resources to its Members for their benefit and that of their member-consumers.

### Transmission development supporting renewables

Tri-State owns or has responsibility for more than 5,200 miles of transmission line across Colorado, Nebraska, New Mexico and Wyoming, and continues to invest in new and

improved transmission infrastructure to ensure dependable power delivery to its Members. Given the generally rural service territories of Tri-State's Members, Tri-State's investment in improved and expanded transmission infrastructure can offer transmission access opportunities that facilitate the development of new renewable energy sources. Such opportunities help alleviate transmission constraints and may improve the economical viability of many



<sup>5</sup> Including Highline Electric Association's recovered energy generation system located near Peetz, Colo.; La Plata Electric Association's steam turbine cogeneration facility near Ignacio, Colo.; and San Miguel Power Association's hydroelectric generation facility near Ouray, Colo.

renewable energy projects.

In 2008, Tri-State entered into a Memorandum of Understanding (“MOU”) with Xcel Energy’s Public Service Company of Colorado (“PSCo”) to jointly pursue transmission projects in southern Colorado. The projects identified in the MOU would strengthen southern and eastern Colorado’s power delivery infrastructure, serve growing electricity needs and provide for the interconnection of new energy resources.

On May 14, 2009, Tri-State and PSCo applied to the Colorado Public Utilities Commission for certificates of Public Convenience and Necessity for the first joint project under the MOU, the San Luis Valley-Calumet-Comanche Transmission Project. This new \$180 million transmission project supports electric system reliability and will facilitate the development of new solar electric generation in the San Luis Valley and southern Colorado. While the project will enhance Tri-State’s ability to provide reliable electric service to its Members in the project area, Tri-State is making a substantial investment in additional transmission capacity to accommodate new generation in the San Luis Valley.

In addition, Tri-State is a participant in the High Plains Express (“HPX”) transmission consortium. HPX includes western electric transmission owners, states and an independent transmission company that are participating in a study of a high-voltage backbone transmission system between Wyoming, Colorado, New Mexico and Arizona.

#### **National Renewable Cooperative Organization**

Tri-State is a founder of the National Renewable Cooperative Organization (“NRCO”), a national organization focused on the development and deployment of renewable energy resources by electric cooperatives. NRCO offers cooperatives a means to pool their resources, thereby putting cooperatives in a proactive position to take advantage of renewable resources in their regions. Tri-State serves on the NRCO Board of Directors. Tri-State’s participation in NRCO assists in the development of renewable energy projects within Tri-State’s Members’ service territories, particularly those to serve electric cooperatives across the country that have more expensive or lower producing renewable resources.



#### **Renewable energy Roadmap actions**

Tri-State is taking the following actions on renewable energy in the Greenhouse Gas Management Roadmap:

- Proceed with development of Cimarron I project to be commercially available in December 2010.
- Continue to evaluate and pursue utility-scale renewable energy projects.
- Continue to incentivize community-based renewable energy projects.
- Continue to expand voluntary Green Power Program.
- Expand transmission investments to support reliability, growth and renewable energy integration.
- Leverage participation in the National Renewable Cooperative Organization to promote renewable energy development in the Member-Systems’ service territories.
- Assign GHG reduction values from all renewable energy programs for inclusion into GHG-risk management analysis.
- Incorporate renewable energy GHG risk management analysis into resource planning evaluation.

## Key studies commissioned

Tri-State has commissioned third-party consultants to conduct several studies that will inform both Tri-State's resource planning and GHG management analysis.

### Energy Efficiency and Demand-Side Management Study

Tri-State is conducting a system-wide end-use study to determine the technical, economic, achievable and naturally occurring potential for energy efficiency and load management in the residential, commercial, irrigation and industrial customer classes over a period of 15 years (2010-2025). The study will analyze technologies, products and the potential of all practical energy efficiency and load management measures that can cost-effectively reduce or shift electricity use, and will identify and quantify new, emerging technology measures applicable to Tri-State and its Members' systems. The study is scheduled to be complete in the first quarter of 2010. Results will:

- Establish mechanisms to identify and evaluate opportunities for cost-effective energy efficiency and DSM.
- Identify programs and assess the benefits of implementing additional efficiency and DSM programs.

### CO<sub>2</sub> Footprint, Sequestration and Monetization Study

Tri-State has initiated a multifaceted evaluation to 1) identify CO<sub>2</sub> reductions from recent capital improvements and initiatives across its entire enterprise, including coal-based facilities, transmission facilities, corporate facilities and corporate fleet; 2) identify opportunities for projects and operating practices across its generation and transmission assets to reduce CO<sub>2</sub> emissions, considering a range of potential carbon costs; 3) evaluate the feasibility of CO<sub>2</sub> storage in underground geological formations at existing and future generation sites; and 4) potential feasibility and associated monetary benefits from injection of CO<sub>2</sub> into depleted oil fields for enhanced oil recovery and other CO<sub>2</sub> monetization opportunities. A contractor has been retained and is anticipated to deliver initial results in the 3rd quarter of 2009. Results will:

- Identify CO<sub>2</sub> reduction resulting from efficiency improvement projects completed at Tri-State's coal-based facilities, transmission facilities, corporate facilities and corporate fleet since 2005.
- Identify a list of potential for future projects and operating practices that could reduce CO<sub>2</sub> emissions from the above facilities.
- Identify potential at coal-based facilities for CO<sub>2</sub> storage and monetization.

### Generation Technology Selection Study

Tri-State has contracted for a study of generation technology options that could be applied to its southeast Colorado development site and other locations. The study will evaluate a wide-range of fuel and technology options available to meet Tri-State's long-term resource needs. The study includes a thorough risk analysis, including greenhouse gas emissions, costs, schedule and technology maturity. Renewables, natural gas, coal (including CO<sub>2</sub> capture technology) and nuclear technologies will be reviewed.

This effort, for which a contractor has been retained, is anticipated to deliver initial results in the 3rd quarter of 2009. Results will:

- Profile a wide range of generation technologies.
- Analyze the risk of technology options, including GHG emissions, financing, regulatory, legal, commodities and equipment, and technology maturity.
- Establish options for a 1,200 MW portfolio of new long-term generation options.

### Key studies Roadmap actions

Tri-State is taking the following actions on key studies in the Greenhouse Gas Management Roadmap:

- Complete the Energy Efficiency and Demand-Side Management Study; CO<sub>2</sub> Footprint, Sequestration and Monetization Study; and Generation Technology Selection Study.
- Provide inputs into Tri-State's resource planning evaluation and GHG risk management analysis.

## Investments in clean coal technology

At present, coal resources provide approximately 55 percent of the electric power generated on a national basis, and more than 70 percent of the electric power generated within the Tri-State system. As a wholesale power supply cooperative with significant fossil-fueled generation resources that are of relatively recent vintage and which operate at high capacity factors (85-95 percent of the time), the retirement of such resources or the reduction of their operating capacity would have a substantial impact on the cost of electricity that Tri-State provides to its Members and ultimately to their end-use consumers.

The continued use of coal, using advanced clean-coal technologies combined with sequestration, could ensure a reliable electricity supply well into the future. Tri-State is currently involved in a number of research, development and deployment projects focused on identifying high-value, clean coal technology solutions that can be utilized with existing and future generation resources. These projects include technologies that have the potential to either capture CO<sub>2</sub>, sequester CO<sub>2</sub> or advance coal-based generation technologies. Once commercial, Tri-State could employ these technologies to remove a large fraction (50-90 percent) of CO<sub>2</sub> from its coal-based power plant emissions.

### Pre-combustion CO<sub>2</sub> capture

Tri-State continues to investigate the potential development of a coal-based power plant that can address CO<sub>2</sub> emission in advance of electricity production. The leading technology to address pre-combustion CO<sub>2</sub> capture is integrated gasification combined-cycle ("IGCC"). In its evaluation of resource planning options, Tri-State continues to consider IGCC; however, there remain a number of issues that must be addressed before IGCC may be considered a viable resource choice.



Tri-State is participating in chilled ammonia post-combustion carbon capture pilot plant presently being tested at the WE Energies Pleasant Prairie Power Plant in Wisconsin.

### Post-combustion CO<sub>2</sub> capture

Tri-State is supporting two post-combustion CO<sub>2</sub> capture projects that offer a potential lower cost alternative to present technologies. If successful, these projects could offer opportunities to retrofit existing coal-based generating units. The alternative technologies being investigated by Tri-State are the Alstom chilled ammonia process and the PowerSpan ECO2 process.

Tri-State is co-funding two projects to evaluate the Alstom chilled ammonia process. The WE Energies Pleasant Prairie project began in March, 2008 and is scheduled to be completed in mid-2009. The results of this pilot plant

demonstration will be used to scale-up the design to a 30 MW electrical equivalent demonstration at the Mountaineer Station of American Electric Power located in Columbus, WV. This facility is under construction with operation start anticipated toward the end of 2009. This project will sequester the captured CO<sub>2</sub> into underground saline aquifers and is intended to continue for five years. Tri-State will invest \$1.5 million over three years in this project.

Tri-State is one of the largest members of Bismarck, N.D.-based Basin Electric Power Cooperative. Basin Electric, with Tri-State's financial support, is conducting a carbon capture demonstration project at the Antelope Valley power plant. The demonstration project will use the PowerSpan ECO2 process to treat 50 percent of a 120 MW slipstream of flue gas from one unit at the Antelope Valley power plant. Design of the PowerSpan ECO2 process is anticipated to begin in 2009 with operation scheduled to begin in 2012.

#### **Alternatives to post-combustion CO<sub>2</sub> removal**

The current technologies for post-combustion CO<sub>2</sub> removal, oxy-combustion and IGCC, could be bolstered by a low-cost and effective means to separate oxygen from air. Tri-State is funding a consortium-based project, supported by the U.S. Department of Energy ("DOE") and the Electric Power Research Institute ("EPRI"), evaluating various oxygen separation technologies. The feasibility of oxy-combustion, in which fuel is burned in nearly pure oxygen, critically depends on such a technology. The feasibility of IGCC generation, where coal is partially burned (e.g. gasified) to ultimately generate CO<sub>2</sub> and hydrogen, could be enhanced with such a technology. Tri-State is co-funding the development of ion transport membranes which could fill this need. This project has to-date delivered a pre-commercial pilot plant capable of generating oxygen at a rate of 5 tons/day. A three year follow-up program has been launched that will deliver a 150 ton per day membrane system. The results of this pilot plant will enable scale-up to commercial-size plants. The use of these generation options will enable eliminating the large majority of CO<sub>2</sub> from the combustion of coal.



In conjunction with these clean coal and carbon capture technology projects, Tri-State has launched several carbon storage and sequestration studies. Carbon storage is viewed by some observers to be of equal or greater importance to carbon capture but, in any event, must be developed in tandem with carbon capture so as to enable the effective use of clean coal technology for power generation. Tri-State's current activities are intended to explore and contribute to the technical, legal, jurisdictional and administrative challenges associated with carbon storage.

In addition to addressing such technical issues, Tri-State is involved in presenting the case of the industry to the federal government, regarding the need for public/private partnerships in managing the long-term risk of sequestration. This is accomplished through Tri-State's participation in both EPRI and the National Rural Electric Cooperative Association ("NRECA"). Both organizations have recently testified to both Congressional committees regarding the need for a well-defined legal and jurisdictional structure for sequestration, as well as the need for additional funding to resolve these technical uncertainties. Tri-State has also started a legal assessment of the issues within its states that will need to be addressed to allow for the long-term use and storage of CO<sub>2</sub>.

#### **Sequestration site assessment**

Tri-State has begun an assessment of candidate sequestration sites in its operating territory. This assessment will evaluate the CO<sub>2</sub> sequestration potential at Tri-State's coal and natural gas-based units, including the means to sequester CO<sub>2</sub> using geologic formations or other sinks, including enhanced oil recovery, enhanced natural gas recovery, or enhanced coal-bed methane operations. Factors to be considered will include: defining

the nearest and most accessible sites; the potential market for CO<sub>2</sub>; pipeline design and maintenance requirements; the wells to be drilled; storage capacity; leakage pathways; seismicity considerations; environmental impacts; permit requirements; capital and operating costs; and potential income from CO<sub>2</sub> sales. Finally, the assessment will also define the measurement, monitoring and verification needs, and the ultimate site closure requirements.



Tri-State is partnering with the Colorado Department of Public Health and Environment and Colorado State University to study land and soil in southeastern Colorado for its potential to sequester of carbon.

### **Colorado terrestrial sequestration project**

Tri-State has entered into an agreement with the State of Colorado and other partners, including Colorado State University (“CSU”), to illustrate the efficacy of an agricultural carbon credit program and the ability of eastern Colorado soils to sequester CO<sub>2</sub>.

Tri-State executed contracts with the owners of expired or expiring Conservation Reserve Program (“CRP”) lands in Baca County to ensure that the acres will continue to serve as carbon sequestering grasslands.

The demonstration project also offers the unique opportunity for CSU to do actual on-site soil sampling, which can then be compared to its modeling numbers. This will provide a better sense of the accuracy of CSU’s quantification methodologies before the overall program launch in the next couple of years.

### **Agricultural offsets**

Tri-State is involved in terrestrial sequestration through NRECA’s Cooperative Research Network (“CRN”) and EPRI projects. EPRI has an ongoing study to develop GHG emissions offsets by reducing nitrous oxide (N<sub>2</sub>O) in agricultural crop production. This project will investigate an innovative approach to developing large-scale, cost-effective GHG emissions offsets that could be implemented across broad geographic areas of the U.S. and internationally. The tools and information developed in this project will broaden the GHG emissions offset options available to electric companies, and can serve as a mechanism to develop and strengthen partnerships with the agricultural communities that they serve.

### **Clean coal technology Roadmap actions**

Tri-State is taking the following actions on clean coal technology in the Greenhouse Gas Management Roadmap:

- Continue funding and participation for multiple pre- and post-combustion carbon capture projects with EPRI, Basin Electric and other utilities to develop commercial clean coal technology.
- Participate in carbon sequestration research and studies, including terrestrial sequestration studies with the State of Colorado and CSU in southeastern Colorado.
- Assign a carbon reduction potential generated by the clean coal programs for inclusion into GHG risk management analysis.
- Incorporate clean coal GHG risk management analysis into resource planning evaluation.

## Efficiency and thermal improvements to existing facilities

Tri-State recognizes that one of the most significant opportunities for overall reductions in its direct GHG emissions lies in improvements to its existing facilities. As a result, Tri-State has undertaken significant steps to identify and pursue improved efficiencies within its existing generating fleet as well as in other parts of its overall system. These improvements to Tri-State's existing generation fleet and in other aspects of its integrated system have and will continue to yield direct reductions in Tri-State's total GHG emissions.

As part of the CO<sub>2</sub> Footprint, Sequestration and Monetization Study, Tri-State has begun a comprehensive system-wide study to evaluate CO<sub>2</sub> reduction opportunities in its generation plants, transmission assets, corporate facilities and fleet. The generation plant portion of the study will examine a variety of means to reduce CO<sub>2</sub> emissions including air preheaters, combustion systems, condensers, cooling systems and feedwater heaters. Initial results from this study are expected in the third quarter of 2009.

Tri-State is already making efficiency improvements, or evaluating opportunities, in its existing generation fleet, specifically:

### Craig Station

Consisting of three units totaling 1,340 MW of generating capacity – the plant in northwestern Colorado represents the largest single source of power and CO<sub>2</sub> emissions operated by Tri-State. Reducing coal consumption by even a modest percentage significantly lowers Tri-State's total CO<sub>2</sub> emissions. In 2005, Craig Station Unit 3 was retrofitted with a new steam turbine rotor. As a result, approximately 10 MW of additional power was obtained from the same flow of steam and fuel to generate the nameplate rating of 462 MW. This increase in generating capacity effectively comprises a 2 percent improvement in heat rate, and a corresponding reduction in CO<sub>2</sub> emissions. The Unit 3 steam path was further improved in 2009 by retrofitting an improved inner casing into the existing outer casing which will increase Unit 3 generation by 30 MW.

Craig Station Units 1 and 2 will undergo turbine rotor installation in Spring 2011 and 2013 that will provide an additional 10 MW at each unit of generating capacity without an increase in coal consumption. Based on the nameplate ratings of Units 1 and 2 of about 457 MW each, this turbine replacement comprises a thermal efficiency improvement of 2 percent and corresponding reduction in CO<sub>2</sub> emissions.

### Laramie River Station

Located in Wheatland, Wyoming, Laramie River Station is a three-unit, 1,692-megawatt, coal-fired electric generating facility that is part of the Missouri Basin Power Project. Tri-State owns a 24 percent capacity share of the plant. These units were retrofitted over the past three years with a new steam turbine rotors and approximately 40 MW of additional power was obtained from the same flow of steam.

### Escalante Station

Tri-State is evaluating the feasibility of installing new technology at the Escalante Station in northwest New Mexico that will measure and map the combustion zone reactions in the coal boiler to optimize combustion and result in improved efficiency and a corresponding reduction in CO<sub>2</sub> emissions. This technology uses a laser beam to penetrate the combustion zone and optimize performance through continuous adjustments. The system would measure oxygen, carbon monoxide, carbon dioxide and water to provide real time data and maps of the combustion zone which will enable operators to ensure balanced combustions as fuels and the boiler environment changes. If the application is successful at the Escalante Station, the technology could be installed at all Tri-State coal units.

### Transmission efficiency

In addition to these generation resource projects and studies Tri-State has also begun a system-wide evaluation of its transmission assets in the CO<sub>2</sub> Footprint, Sequestration and Monetization Study seeking options for improved efficiencies. The effort will inventory capital projects completed at existing transmission facilities, the attendant power factor or line loss improvement and the benefits related to GHG emission reductions. The project will identify options for future potential capital projects and changes in operating practices at existing transmission facilities that may result in increased efficiency from power factor improvements, reductions in line losses, or GHG emissions reductions. Initial results from this system-wide evaluation are expected in the third quarter of 2009.

### Efficiency and thermal improvements to existing facilities Roadmap actions

Tri-State is taking the following actions on system efficiency improvements in the Greenhouse Gas Management Roadmap:

- Complete CO<sub>2</sub> Footprint, Sequestration and Monetization Study, including analysis of generation and transmission efficiency potential.
- Identify options for implementation.
- Assign a GHG reduction potential generated by the programs for inclusion into resource planning modeling and GHG management analysis.

## Research, development and demonstration initiatives

Utilities seeking to reduce their GHG emissions must consider a number of strategies. Tri-State is investing in numerous innovative technologies and studies to identify additional means to reduce its GHG emissions and work toward GHG emission reduction goals. A full discussion of these various projects exceeds the scope of this Roadmap, however, a brief summary of each project is provided below.



Tri-State is hosting an EPRI study of a hybrid coal/concentrated solar power steam augmentation project at its Escalante Station power plant in New Mexico. The project could reduce emissions from coal-based power plants.

### Solar augmentation studies

Tri-State is participating in two projects investigating the use of solar energy to displace or supplement fossil fuel. Solar augmentation by concentrated solar power (“CSP”) is particularly attractive in that it enables utility-scale power generation without the barriers and cost of a new power station and can be deployed to existing generating assets. These projects focus on conventional coal-fired steam generators and on natural gas-fired combustion turbines equipped with heat recovery steam generators. By participating in these projects, Tri-State seeks to gain valuable experience with solar augmentation that may be adopted in its generation fleet.

Tri-State's 245 MW Escalante Station is the host facility for a project that involves introducing steam generated by a solar thermal field to the

conventional power plant's steam cycle to offset some of the fuel required to generate electricity and thereby reduce the facility's GHG emissions. The project will provide a conceptual design study, analyze options to retrofit the existing power plant and identify new plant design options.

Tri-State is also participating in a similar augmentation study for natural gas-fired units that will focus on high thermal efficiency, combined cycle generating units. This project began in mid-2008 and is anticipated to be complete in mid-2009.

#### **Concentrated solar power**

Tri-State partnered with EPRI and other regional power providers to evaluate the feasibility of a CSP project. The study consisted of a technical and economic feasibility assessment to site a 50-500 MW concentrated solar plant. Currently in the U.S. there are two utility-scale CSP plants - a 64 MW plant in Nevada and 310 MW plant in California. The project evaluated solar and weather patterns, transmission grid integration, access to water and natural gas, and a myriad of complex regulatory, social and cultural issues. The project assessment has been completed and Tri-State is using the study results to investigate the potential use of CSP in solar rich areas of Tri-State's system.

#### **Compressed air energy storage**

An important initiative by Tri-State that bridges both renewable and low carbon generating technologies is compressed air energy storage ("CAES"). Originally envisioned to "shave" peak load and for other forms of load management, CAES may also be used to promote penetration of renewable energy resources by providing storage. CAES could provide a better power storage option than advanced batteries or pumped hydro, as well as address issues such as intermittent power availability and load curve leveling. Tri-State is working to develop a CAES demonstration project in conjunction with EPRI in eastern Colorado. If successful in bringing this demonstration to fruition, Tri-State will gain experience in utilizing CAES within its generating system. The ability to successfully deploy CAES will enable Tri-State to leverage other investments in renewable energy resources.

#### **Biological carbon capture**

Tri-State, Sunflower Electric Power Corporation, and Greenfuel Technologies have worked together to fund the demonstration of the fuel production and environmental benefits of Greenfuel Technologies' algae reactor as part of a bioenergy center planned at Sunflower Electric's Holcomb Station in western Kansas. Tri-State's primary interest in the new bioenergy center is to prove that the algae technology can be used at coal-based power plants to mitigate CO<sub>2</sub> emissions. If successful, Tri-State could use this technology as a model to move forward with application to commercial-scale generating plants.

#### **Transmission efficiency research and development**

In addition to the system-wide evaluation of transmission assets previously discussed, Tri-State is also studying various means to maximize the efficiency and use of the electric transmission and distribution system. These include: development of static thermal conductor rating software which, among other benefits, will enable Tri-State to determine the best distribution of renewable energy sources within its system thereby maximizing their contribution to GHG emission reductions; evaluation of advanced composite transmission line conductors that may facilitate increased transmission capacity; probabilistic assessments of transmission expansion opportunities to better integrate wind resources.

#### **Research, development and demonstration Roadmap actions**

Tri-State is taking the following actions on RD&D in the Greenhouse Gas Management Roadmap:

- Continue support for a solar/coal hybrid solar augmentation study with EPRI at Tri-State's Escalante Station in New Mexico, and a solar/natural gas hybrid solar augmentation study with EPRI applicable to Tri-State's natural gas generating units.
- Continue evaluation of a concentrated solar power and energy storage feasibility study conducted with EPRI.
- Pursue a compressed air energy storage study with EPRI hosted by Tri-State in eastern Colorado.
- Continue to support biological carbon capture demonstration at Holcomb Station.

- Continue to research transmission efficiency opportunities.
- Assign a GHG reduction potential generated by the programs for inclusion into resource planning modeling and GHG management analysis.

## **Resource evaluation and GHG management analysis**

### **Greenhouse management analysis**

Tri-State is developing the technical tools and analytic capabilities to analyze and model the potential for GHG management and reductions from actions described in this roadmap. As the data from the work currently underway and described in this document is completed, that data will be utilized in a thorough GHG management analysis.

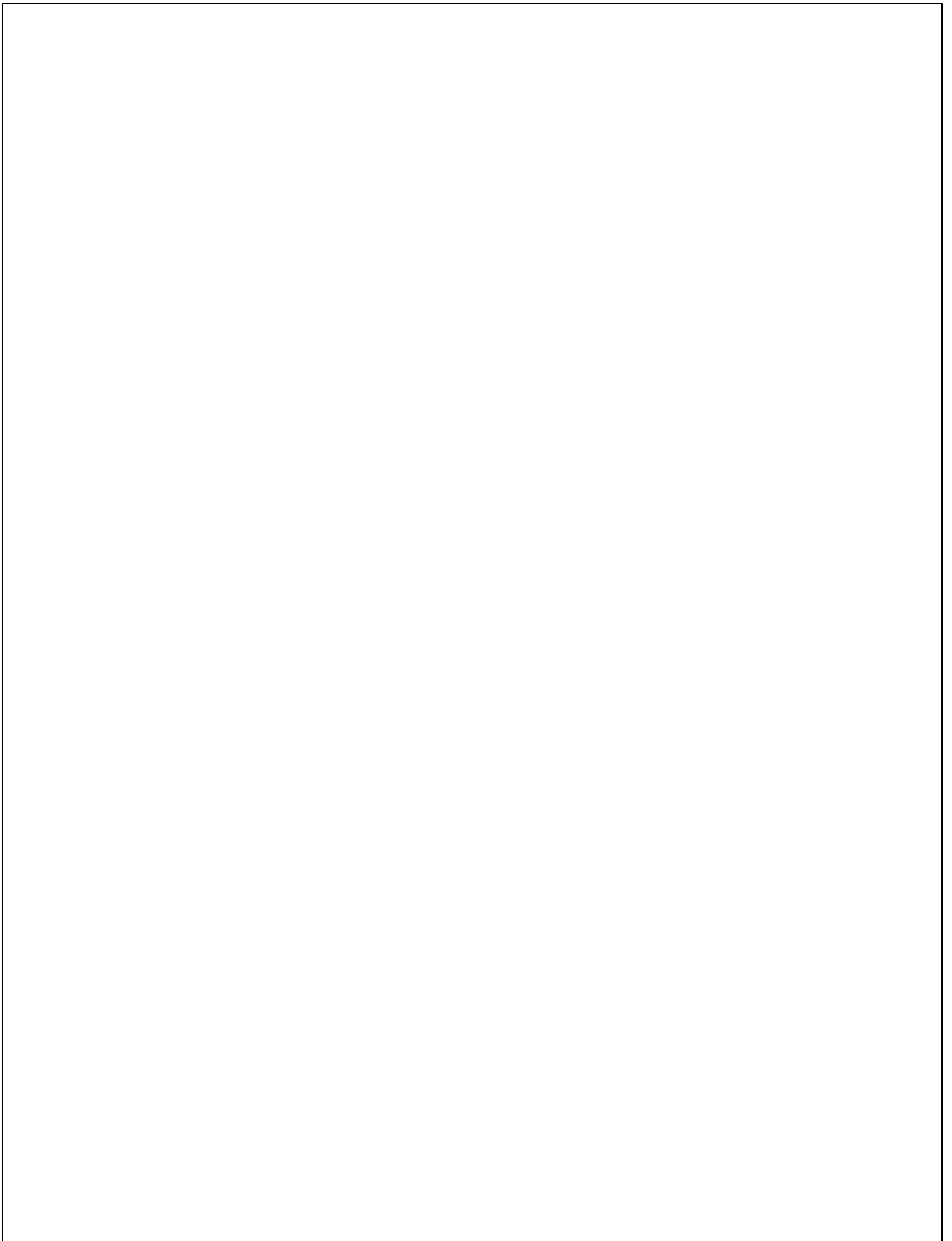
### **Resource planning evaluation**

In April 2009, Tri-State's Board of Directors announced that the association would reevaluate its long-term resource planning, including the continued evaluation of the risk associated with the regulation of GHG emissions. As part of the Roadmap, Tri-State will reevaluate its long-term resource planning, including the long-term resource development plan it announced in 2005 that included options for new coal-based generating units. Tri-State continues to preserve multiple long-term resource development options and has not committed to construct any specific resource.

### **Resource evaluation and GHG management analysis Roadmap actions**

Tri-State is taking the following actions on resource planning and GHG management analysis in the Greenhouse Gas Management Roadmap:

- Load resource data into testing and perfecting of new modeling tools to help inform resource planning decisions.
- Take into account the data that will be generated from uncertainties.
- Incorporate results from key studies, including Energy Efficiency and Demand-Side Management Study, CO<sub>2</sub> Footprint, Sequestration and Monetization Study, and Generation Technology Selection Study, research and development activities, and other policy, technology and market drivers.
- Develop resource planning alternatives.
- Perform analysis of GHG impacts of various resource planning alternatives.
- Load GHG management steps into resource modeling to assess the impacts on GHG footprint from resource planning and other activities.





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