

STAR Strategic Transmission and Renewables

A Vision of Colorado's Electric Power Sector to the Year 2050 A Report of the Colorado Governor's Energy Office



Executive Summary // Key Messages for Decision-Makers // December 2010



Governor's
Energy Office



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Strategic Transmission and Renewables (STAR): A Vision of Colorado's Electric Power Sector to the Year 2050 A Report of the Colorado Governor's Energy Office

Executive Summary // Key Messages for Decision-Makers

Introduction

The STAR report contains information and recommendations to address a multitude of challenges facing Colorado's electricity sector. The report updates previous work produced by the Governor's Office and the Governor's Energy Office, offering analyses of current issues and recommendations for actions to meet the long-term interest of Colorado's citizens.

The report provides current data and insights for an expanded discussion regarding additional steps the state should take regarding electric power. Views are presented regarding the optimal mix of demand-side and supply-side resources for consideration as Colorado plans the electricity sector policy landscape out to the year 2050.

The challenges and opportunities place a spotlight on how Colorado can build on its leadership position in the electricity sector through strategic planning. Other states are going through this exercise, and Colorado will benefit by identifying continuous improvements in policies and practices aimed at meeting the needs of our fast-growing population in an environmentally responsible and economically sustainable way.

An emphasis is placed on the importance of constraining what would otherwise be a costly increase in load growth. The established method to constrain load growth is to expand demand-side policies in both scope and scale, including extending demand side policies to utilities that have not yet adopted binding goals for energy efficiency.

Transformation of the electricity sector will help Colorado in many ways, including meeting Colorado's Climate Action Plan's (CAP) goal of reducing the electricity sector's carbon dioxide emissions by 80% by 2050 from a 2005 base. The STAR project conducted modeling that led to a series of recommendations to expand the state's utility-scale renewable and transmission infrastructures, coupled with growth of natural gas-fired generation capacity. Cleaner power generation lies at the heart of achieving the economic and environmental goals that constitute an optimum transformation.

Strategic decisions need to be made by today's policy-makers to ensure Colorado is set on a glide path toward a cleaner, more efficient energy portfolio that will benefit generations of Coloradans to come.

Topics and Recommendations

Well-known historical drivers have determined the structure of today's electricity sector. Given advances in technology, markets, and public policy, a concentrated focus on new drivers and structures is needed. In so doing, the state can craft policies to ensure responsible actions are taken to design a sustained, orderly development of Colorado's electricity sector out to the year 2050.

In sixteen chapters, this report covers a wide array of subjects, resulting in a series of recommendations on how Colorado can create a productive, reliable electricity sector that is economically and environmentally sustainable. The STAR report offers the following insights and recommendations on a wide variety of topics that can help inform the dialogue.

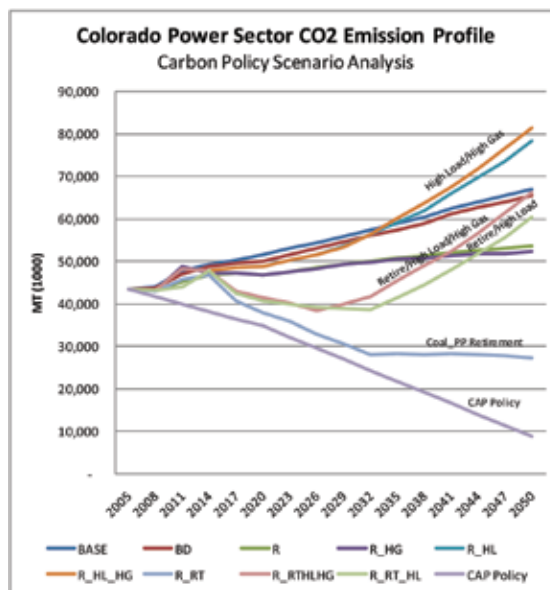
Chapter 1 - Modeling Colorado's Electric Power Sector

The STAR project produced a 38-page detailed modeling of Colorado's electricity sector out to the year 2050. Assumptions for load growth, fuel prices, cost and operating characteristics of new generation, renewable energy penetration levels and environmental compliance used in the modeling are conservative, transparent and defensible. The results indicate a variety of pathways for state electricity sector policy-makers to consider. The driving research question modeled was how Colorado can meet the CAP goal of an 80% reduction in carbon dioxide emissions by 2050 from a 2005 base. As the model results indicate, it can be achieved: furthermore, doing so will yield multiple benefits.

Colorado's population of 5 million is expected to grow to 9 million by 2050. A growing population coupled with a return to average historic levels of economic growth results in an imperative that new electric power infrastructure be planned and developed.

The modeling results in the need for five key actions to secure Colorado's strategic electric power sector: more energy efficiency, more utility-scale renewable energy, more high-voltage transmission, less coal-fired generation, and more natural gas-fired generation.

- First and foremost, the modeling reveals how essential it is, from economic and environmental perspectives, to moderate the load growth (assumed to grow at 1.7 per cent per year to 2050).
- The model selected utility-scale renewable energy as the preferred supply-side resource on the basis of its ability to reduce air pollution, reduce water consumption, and on the basis of being the least cost long-run resource, in large part because renewable energy does not incur fuel costs. However, there are operational limits on the penetration of variable renewable resources, and the model constrained the selection of renewable energy to conform to those operational limitations.
- It is well-understood that substantial new high-voltage transmission infrastructure is a linchpin issue that needs to be addressed to enable Colorado to deliver the renewable energy to the markets. Transmission is an enabler that achieves a variety of economic objectives over a very long time period



with comparatively minimal operation and maintenance expenses. As has been proven in Texas and elsewhere, the return on investment is fast, and transmission represents less than 10% of the customer's electric bill.

- The model analyzed Colorado's coal-fired generation fleet, and determined that if the CAP goals are to be met, coal units should be retired when they reach the age of 45. Should the units not be retired and replaced at age 45, Colorado's electricity sector will experience increasing operation and maintenance costs, and public health will be compromised.
- Of critical importance, the state must expand deployment of efficient natural gas-fired generation. The nation's natural gas supply has been expanded considerably in recent years, and price forecasts provide a greater confidence in price stability compared to the price volatility experienced over the past three decades. Gas-fired generation is particularly beneficial due to its unique ability to integrate variable renewable resources, while serving as a baseload resource. The model assumed that by 2017 research and development activities will result in commercially available natural gas advanced combined cycle plants with 90% carbon capture and sequestration. These plants were assumed to have a lower capacity cost and lower operating cost than new conventional coal-fired generating stations without carbon capture and sequestration.

Recommendations:

- Colorado's policy-makers should work to develop a future-oriented electricity sector policy landscape to leverage our state's strategic strengths (abundant renewables and natural gas) and to avoid our weaknesses (air and water constraints).
- Colorado policy-makers should review whether the "10% by 2020" renewable energy standard for rural electric associations and municipal utilities should be revised to match the state's "30% by 2020" standard for investor-owned utilities.

Chapter 2 - The Multiple Benefits of Demand-side Resources

Demand side resources include a broad array of techniques and technologies including utility-sponsored demand-side management, distributed generation, demand response, energy efficiency, and conservation. The STAR report provides detailed descriptions of the multiple benefits of these demand-side measures. Although a broad understanding exists that investments in demand side resources represent the most cost-effective approach to achieving strategic goals in the electricity sector, at present, Colorado's demand side resources policy framework only applies to investor owned utilities. The STAR modeling demonstrates that the existing scale of Colorado's demand side policy framework will achieve a disappointing reduction in carbon emissions, and current policies stop considerably short of achieving the economic and environmental benefits that energy efficiency can bring to the state.

Recommendations:

- Legislators should craft policy modifications to align all Colorado utilities' financial incentives with investments in demand side management.
- Legislators should increase demand side management targets enacted in HB07-1037.



Photo by Matt McClain

Chapter 3 - Addressing Climate Change and Water Issues through Renewable Energy

Colorado's world-class intellectual resources are expected to serve the essential function of expanding policy-makers' insights and analysis regarding climate change and other environmental challenges. Talented individuals and institutions in Colorado are well-positioned to maintain the state as a recognized leader in addressing energy and environmental issues, in large part, by planning the transformation of the electricity sector. In addition, Coloradans have an increasing awareness of the energy/water nexus that needs to be addressed in this semi-arid and drought-prone state.

The rapid expansion of utility-scale renewable energy in Colorado should be supported until its integration limits are reached. The STAR report describes this growth and discusses the economic and employment benefits that are expected to result.

Citizens and policy-makers who actively work to protect and enhance Colorado's environment, including the need to clean our air, secure clean water, protect wildlife, are urged to turn increasing attention to improve the electricity sector.

Recommendations:

- Colorado should expand the dialogue among scientists and policy-makers to create a future-oriented electricity sector strategy that positions Colorado to address climate change, economic opportunity, water scarcity, and other issues.
- Leadership from universities, research laboratories, the legislature, and utilities should further define the human and capital investments needed to improve the environmental performance of Colorado's electricity sector.





Chapter 4 - Recent Colorado Legislative Actions

During the tenure of Governor Bill Ritter (2007-2011), 57 bills relating to clean energy were signed into law. Two new state laws are particularly important in reshaping the state's electric power future. In March 2010 the governor signed HB10-1001, the renewable energy standard (RES). The act requires Colorado's investor owned utilities reach a minimum of 30 percent renewable electricity by 2020. Colorado's new standard is the nation's second highest, and the highest in the Rocky Mountain West. The act also established a production requirement for distributed generation that will provide a major economic boost to Colorado's solar industry.

In April 2010 the governor signed HB10-1365, the Clean Air-Clean Jobs Act, into law. The legislature passed the act in anticipation of federal Clean Air Act regulations that will require improved environmental performance in the electricity sector, particularly in Colorado's northern Front Range, which is in noncompliance with ground-level ozone standards. The act requires a reduction in nitrogen oxide emissions of 70 percent to 80 percent by December 2017 from coal-fired generation plants operated by Colorado investor-owned utilities, principally Public Service Company of Colorado (PSCo). For PSCo, the act calls for retiring the lesser of 900 MW of coal-fired electric generating capacity, or 50 percent of the company's coal-based capacity, in addition to those plants that PSCo was already planning to retire before January 1, 2015. The Public Utilities Commission (PUC) held hearings and has issued a final order that meets the provisions of the law.

Recommendation:

- Colorado should fully explore retiring other coal-fired generating stations after considering their age, environmental performance, in comparison to the economic and environmental benefits of displacing the coal units with natural gas-fired generation and other low-emitting resources.

Chapter 5 - Colorado's Transmission Infrastructure

Colorado's high voltage transmission infrastructure (defined as 230 kV and 345 kV) was developed over the decades to meet load growth. That aging infrastructure is now in need of substantial expansion to meet the needs of a state with five million residents, and a projected growth in population to over 9 million in 2050. New lines are also needed to deliver large blocks of renewable energy to the markets.

Transmission is the vital link to connect generation to loads. Colorado is preparing for the necessary major expansion in this infrastructure to improve the environment, and to meet the economic needs of a growing population.

Public Service Company of Colorado is the largest transmission owner and operator in Colorado. The second largest transmission owner and operator is Tri-State Generation and Transmission Association, Inc., a wholesale electric power supplier owned by 44 electric cooperatives. Western Area Power Administration markets and delivers reliable, cost-based hydroelectric power and related services within a 15-state region of the central and western United States, including Colorado. These three entities, their regulators and governing boards, are positioned to affirmatively address the strategic opportunities; however, further policy support is required.

A series of studies over the past decade have concluded that Colorado's transmission infrastructure is congested and undersized in voltage and capability. Policy-makers and utilities are responding with heightened attention to planning and permitting challenges that need resolution to deliver large blocks of renewable energy to load centers. Concrete and near-term actions are warranted to resolve these issues.

Recommendation:

- The state needs a continued flow of information and solid assurance that Colorado's utilities and regulators will strategically plan, permit, and build transmission infrastructure consistent with the need to deliver clean, reliable power to a growing population in a water-scarce state.



Chapter 6 - The Growing Importance of Natural Gas

Natural gas-fired generation has been a primary technology of choice by utilities across the country over the past several decades, and by every indication it will remain so. Like every energy source, natural gas has its environmental challenges. The natural gas industry has opportunities to address those environmental challenges while facilitating integration of renewable energy on to the grid.

With the technological advent of directional drilling and hydraulic fracturing, many credible sources consider the nation's shale gas reserves to be a 100 year domestic resource. Although uncertainties exist, this large national supply provides a growing confidence that electric utilities can increase their reliance on gas-fired generation to displace the aging fleet of coal-fired generation over the next twenty years, while increasing the integration of naturally variable renewable energy on to the grid.

Colorado is in the national spotlight for advancing the Clean Air-Clean Jobs Act policy framework that will replace old and inefficient coal-fired generation with natural gas plants. Residents throughout the state will be direct beneficiaries of cleaner air, reduced water borne pollutants, energy cost containment, economic development, the stabilization of carbon emissions, and less disruptive compliance with increasingly stringent federal pollution standards.

Recommendation:

- Colorado policy-makers should conduct a comprehensive benefit-cost analysis (including economic and environmental measurements) to review the age, performance, continuing operations and maintenance costs of the remaining coal-fired generation stations in the state. Such a review should include a determination of the opportunities for gas-fired generation and renewable energy (and the associated transmission and pipeline infrastructure requirements and policy guidance) to facilitate cleaner resources to replace retired coal-fired generation.

Chapter 7 - The Role of Balancing Authorities

Colorado can be viewed somewhat as an electric island that lacks sufficient transmission infrastructure to connect to adjacent markets. Because Colorado utilities are not part of a liquid electricity market characterized by a regional transmission organization or an independent system operator, the market is considerably different than the "organized" and central markets that serve the majority of U.S. electric customers. According to NREL and GE's May 2010 *Western Wind and Solar Integration Study*, better operation of the balancing authorities can achieve savings that reach into the billions of dollars through more effective integration of variable resources. Such mechanisms may include all or some aspects of dynamic scheduling, intra-balancing area scheduling at subhourly time steps, or other wide-area economic dispatch concepts that do not require actual physical balancing area consolidation.

Recommendation:

- To the extent possible, the Legislature and PUC should direct a move toward either physical or virtual consolidation of the state's two balancing authorities. Utilities should expand their work with key stakeholders to identify policy changes and modifications in practice which should be initiated to ensure maximization of system benefits from such consolidation.



Chapter 8 - Cost Recovery and Cost Allocation Challenges

“Cost recovery” describes how utilities receive reimbursement for capital costs expended. Cost recovery for transmission investments is often contentious because the regulatory process traditionally has a tendency to limit cost recovery to investments in near-term infrastructure. This results in forgoing more beneficial, higher-voltage, long-term investments. Too often, lower-voltage transmission is being planned when higher-voltage lines are needed to fully develop our vast renewable resources. These higher-voltage lines are crucial to successful implementation of a strategic vision of Colorado’s electricity sector to 2050 and beyond.

“Cost allocation” is a term used to describe how costs of a capital investment such as a transmission line will be allocated to entities that use the line or benefit from the line. Regulators are increasing their consideration of the cost allocation issues, and 2011 appears to be headed for an opportunity to address this particularly thorny issue.

Recommendation:

- Colorado policy-makers should strengthen their participation both the Federal Energy Regulatory Commission and the PUC to exercise their pivotal roles to minimize market uncertainties inhibiting the right-sizing of transmission lines directly traceable to cost allocation and cost recovery issues.

Chapter 9 - Federal Action and Inaction

The federal government is a critically important partner, setting rules and regulations that determine the economic and environmental performance of the electricity sector. Recent congressional efforts to address the need for a comprehensive approach to climate protection, energy independence, clean energy, and transmission development, have been either stopped or seriously compromised. While congressional progress has stalled, positive signals and developments have come from the Administration and the Federal Energy Regulatory Commission.

Many states, including Colorado, have stepped in to fill federal policy gaps by implementing their own environmental and energy policies. Although this provides greater clarity in a

particular state, the interdependency of the electric markets among neighboring states means regional solutions cannot be predicated on assessing the aggregate collection of individual state actions. If, and when it comes, coordinated federal action could address the fragmentation and uncertainty that characterizes the nation’s electricity sector.

Recommendations:

- Colorado executive and regulatory leadership should expand its existing interaction with the Western Governors’ Association’s (WGA) initiatives and other entities to ensure that federal executive, congressional, and agency leaders develop timely and effective state-federal policy frameworks to create a dynamic, clean, efficient, and renewable 21st century electricity sector.
- The return of a strong federal role in national transmission infrastructure development should be actively pursued by Colorado policy-makers. Transmission infrastructure investments have the opportunity to be substantially expanded if the Federal Energy Regulatory Commission pursues the cost allocation and renewable integration frameworks as articulated in their proposed rulemakings. State policy-makers are also encouraged to see what changes are required to ensure that the Western Area Power Administration expands strategic backbone transmission, or helps other utilities expand that backbone transmission.



Chapter 10 - Regional Planning Activities

In Colorado's region, two of the most important entities involved with regional planning are the WGA and the Western Electricity Coordinating Council (WECC). These organizations constitute the primary structures through which much of the transmission policy and technical coordination occurs. The WGA coordinates a wide variety of projects, focusing on issues related to the West. WECC is responsible for regional transmission planning, and the WGA conducts regional transmission planning policy and resource assessments in the Western Interconnection. The Regional Transmission Expansion Project (RTEP), funded by the Department of Energy, is a valuable undertaking expected to greatly improve the regional ability to plan for, and ultimately develop, new transmission.

Recommendation:

- Legislators and the PUC should fully engage in regional planning activities to ensure that the state benefits from economic development, energy, and environmental quality opportunities that are directly related to these activities.

Chapter 11 - The Feasibility of Exporting Colorado's Renewable Energy

Colorado is rich in utility-scale renewable resources- more than enough to meet its renewable energy standard. However, the state is transmission-constrained and geographically distant from large population centers that would, in concept, purchase Colorado's renewable energy exports. The largest potential markets for Colorado's renewable energy export sales are in Arizona, Nevada, and Southern California. These areas also have rich renewable resources and an equally strong interest in marketing their renewable energy. Although a conceptual export market opportunity may exist for Colorado to export its renewable resources, the target market states have a distinct advantage of being closer to the loads. A considerable amount of economic, land use and engineering analysis has been conducted by the High Plains Express and other entities to determine whether Colorado has an export opportunity. A key conclusion of this analysis is that high-voltage lines are needed, but they entail large capital outlays, and cost recovery and cost allocation issues constitute a risk that may not be taken absent improvements in state and federal policies.

Recommendation:

- Legislators and the PUC should maintain and strengthen their relationships with the High Plains Express, the Colorado Coordinated Planning Group, and other entities to represent Colorado's interest when analyzing opportunities for exporting Colorado's renewable energy.





Chapter 12 - Promising Transmission and Grid Technologies

A substantial range of new transmission and grid technologies are ready for deployment and are becoming commercially available. The STAR report describes a host of technologies that are either available, or are on the near horizon. These technologies include a wide array of smart grid technologies, storage technologies, electric vehicles, more efficient conductors, synchrophasors, and more.

As a general matter, electric utilities may be fully aware of these technologies; however, the lack of financial and regulatory incentives may be delaying their timely deployment. If Colorado is slow to adopt these technologies, the delays may diminish opportunities for the state to leverage many benefits that result from first-hand operational experience.

Recommendations:

- Colorado utilities should work with interested stakeholders and report to the legislature and the PUC with recommendations for policy and practice changes that will ensure that Colorado benefits by a more rapid introduction of new transmission and grid technologies.
- The Colorado General Assembly should carefully review the policy recommendations and roadmap for Smart Grid deployment contained in the 2011 Colorado Smart Grid Task Force Report.

Chapter 13 - Transmission Planning in Colorado

Responsibility for much of Colorado's transmission planning takes place under the auspices of the Colorado Coordinated Planning Group (CCPG) - a voluntary, joint, high-voltage transmission system planning forum operating within the WestConnect (southwestern states) footprint. CCPG and its subcommittees represent an effort primarily by utilities, and to a lesser degree by stakeholders, to move Colorado in the direction of unified transmission planning with a goal of single-system planning. Closer coordination between CCPG, key stakeholders, and the PUC is being explored as a central feature of a new commission rulemaking proceeding. Although transmission planning progress is moving forward, a greater sense of strategic purpose is needed to advance the state's electric power sector.

Recommendation:

- The PUC's rulemaking on transmission planning needs to ensure that Colorado policy-makers are certain that anticipated reforms will establish a context and planning landscape from which the commission can judge whether utilities' applications for certificates of public convenience and necessity are consistent with a strategic plan, and are in the broad public interest.

Chapter 14 - Integrating Renewable Energy into the Grid

As renewable energy provides higher percentages of a utility's generation portfolio, grid stability will be managed in new ways. Innovative techniques are being explored to maintain or enhance reliability while integrating larger amounts of renewable energy. Solutions are being tested across the United States following many years of improvements in Europe, with successful results that provide opportunities for increasing renewable resources in the coming years. Recent analyses demonstrate that it is operationally feasible to achieve a penetration of 35 percent renewables, provided that important changes are instituted to current operating procedures, including balancing authority reform, and deploying more storage and communications intelligence on the grid.

Recommendation:

- Colorado transmission-owning utilities should expand their interaction with regional and national stakeholders regarding adoption of new methods to integrate renewable energy, and report their findings to the legislature and the PUC.

Chapter 15 - Transmission Permitting Challenges

Many view transmission siting and permitting issues to be a more difficult challenge than transmission planning and financing. A growing understanding exists that Colorado's transmission permitting system may need to be more streamlined and better coordinated. Transmission siting and permitting must balance many interests, including concerns of property owners, environmental constraints, and local governments. Concerns from these constituents need to be addressed early in the transmission development process to mitigate chances for costly delays at the end of the process. Colorado has already experienced protracted litigation which has stymied expansion of the state's high-voltage transmission infrastructure and delayed transformation of the electricity sector.

Recommendation:

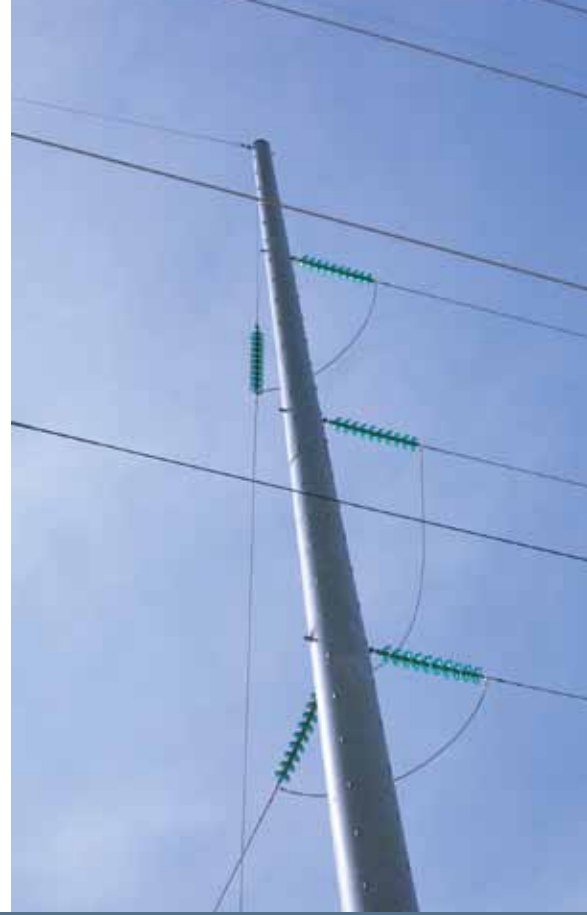
- Colorado policy-makers should consider whether the current legal structure for permitting transmission places the state at risk of slowing the transition to clean energy resources. If a substantial risk is determined, appropriate legislative solutions should be crafted.

Chapter 16 - The Potential for Independent Transmission Companies

Historically, virtually all high-voltage transmission built in the United States was planned, financed, designed, and constructed by electric utilities and federal hydroelectric marketing authorities. Relatively new arrivals in the market are independent transmission companies (ITCs), who now have a growing role in expanding and modernizing our nation's transmission infrastructure. Entry of ITCs will not resolve all of Colorado's transmission challenges, however opening the transmission enterprise to competition warrants investigation. States' utility statutory and regulatory structures have been identified by the ITCs as large considerations when selecting the states where they invest capital.

Recommendation:

- Further discussions should be explored to determine the rules and regulations under which ITCs could operate in Colorado. This could potentially be accomplished by amending the state's utility statute or amending certain PUC regulations.



The Colorado Governor's Energy Office's STAR Project has produced these elements:

- An Executive Summary and Key Messages for Decision-Makers
- The STAR Report
- The STAR Modeling of Colorado's Electric Power Sector
- A PowerPoint of the STAR Project

To access these documents, type "STAR Project" in the search box of GEO's Web site: www.rechargecolorado.com

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