NO SHORTCUTS TO CLEAN ENERGY
Why Colorado needs a proactive, long-term clean energy plan

by Joshua Epel and Michael Milligan

In view of Colorado's aggressive emissions and clean energy targets, Renewables for Colorado undertook an analysis of how energy planning needs to change to achieve these goals. Senior consultants Michael Milligan and Joshua Epel bring their expertise in grid integration and renewable energy policy to identify the issues and specific steps policymakers will need to consider as they lead the state's transition from fossil fuels to clean energy.

The Western states that have adopted aggressive climate goals share a dilemma. Achieving clean energy targets will require a detailed roadmap to plan and guide where renewable energy resources will be located, how they will be transmitted and who will pay for their development.

Colorado dramatically changed the policy and regulatory framework for how electricity is generated when it adopted the challenging goal of reducing greenhouse gas emissions from 2005 levels by 26% by 2025, 50% by 2030 and 90% by 2050. In addition, Governor Polis' Climate Action Plan calls for achieving 100% clean energy by 2040, joining a regional market, expanding the scope of the PUC, and evaluating transmission planning.

An evaluation of all the state's statutory changes by MJ Bradley and Associates concluded that Colorado's electric generating system can reach the state clean energy target of an 80 percent reduction by 2030 if it retires all existing coal facilities and replaces them with zero-emitting energy sources, or with an 80/20 percent mix of zero-emitting and natural gas resources. A recent study by GridLab and the University of California found that the United States could achieve a 90% carbon-free grid by 2035, but cautioned that strong policy and planning would be necessary to achieve this. The Western Resource Advocates state that "…we can't succeed if we just continue business as usual. We need – and Coloradans want – ambitious action that meets the urgency of the climate crisis we face."

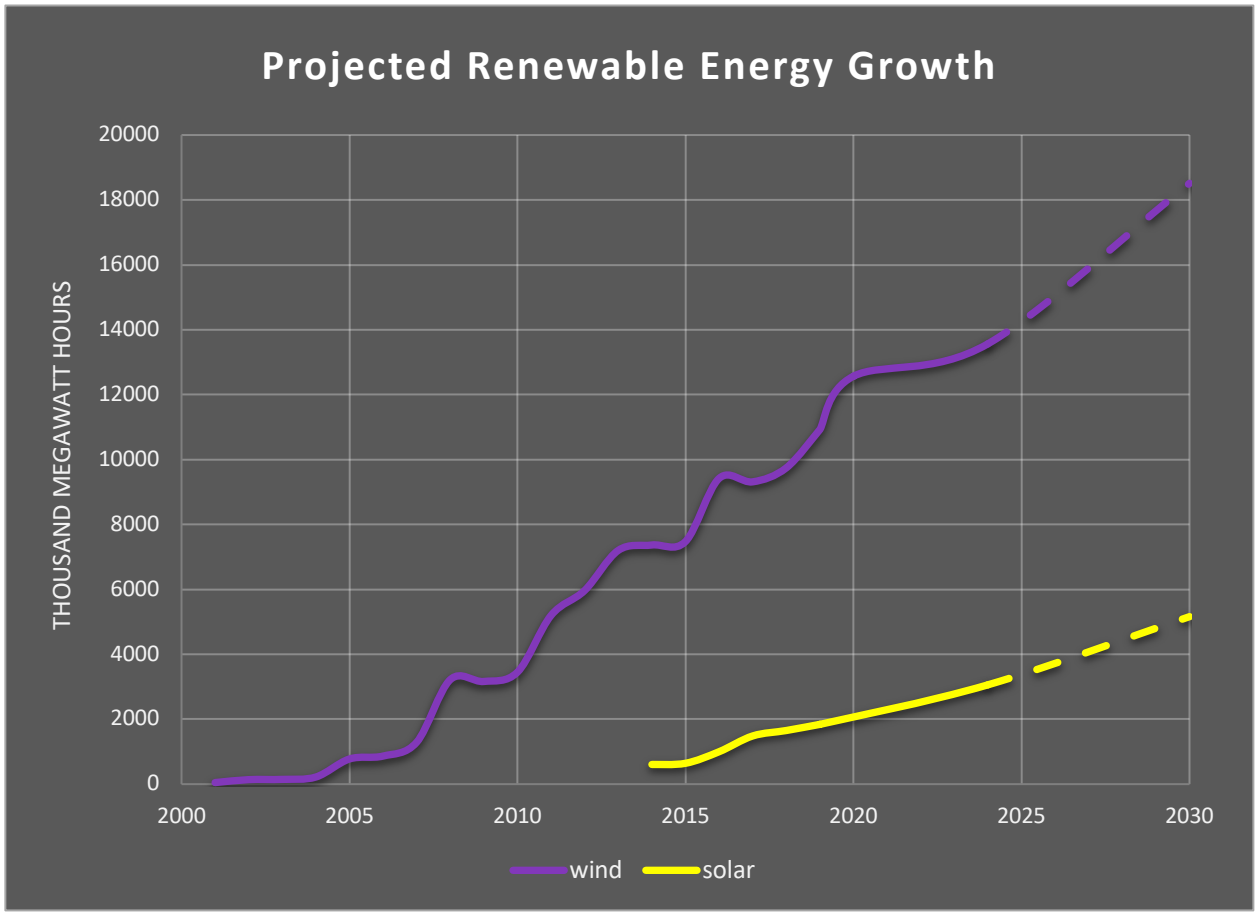
The question is, *how* does Colorado achieve these tectonic changes while ensuring the state maintains a reliable and affordable electric grid?

We have a long way to go to meet renewable capacity targets

Colorado has already achieved significant CO2 emissions reductions by retiring some of its coal-fired units. Colorado's key utilities – PSCO, Tri-state G&T, Platte River Power and Colorado Springs Utility – plan to shut down coal units totaling 2,640 MWs and replace them with 2,129 MWs of wind, 1,572 solar and 675 MWs of storage, and maintain roughly 380 MW of natural

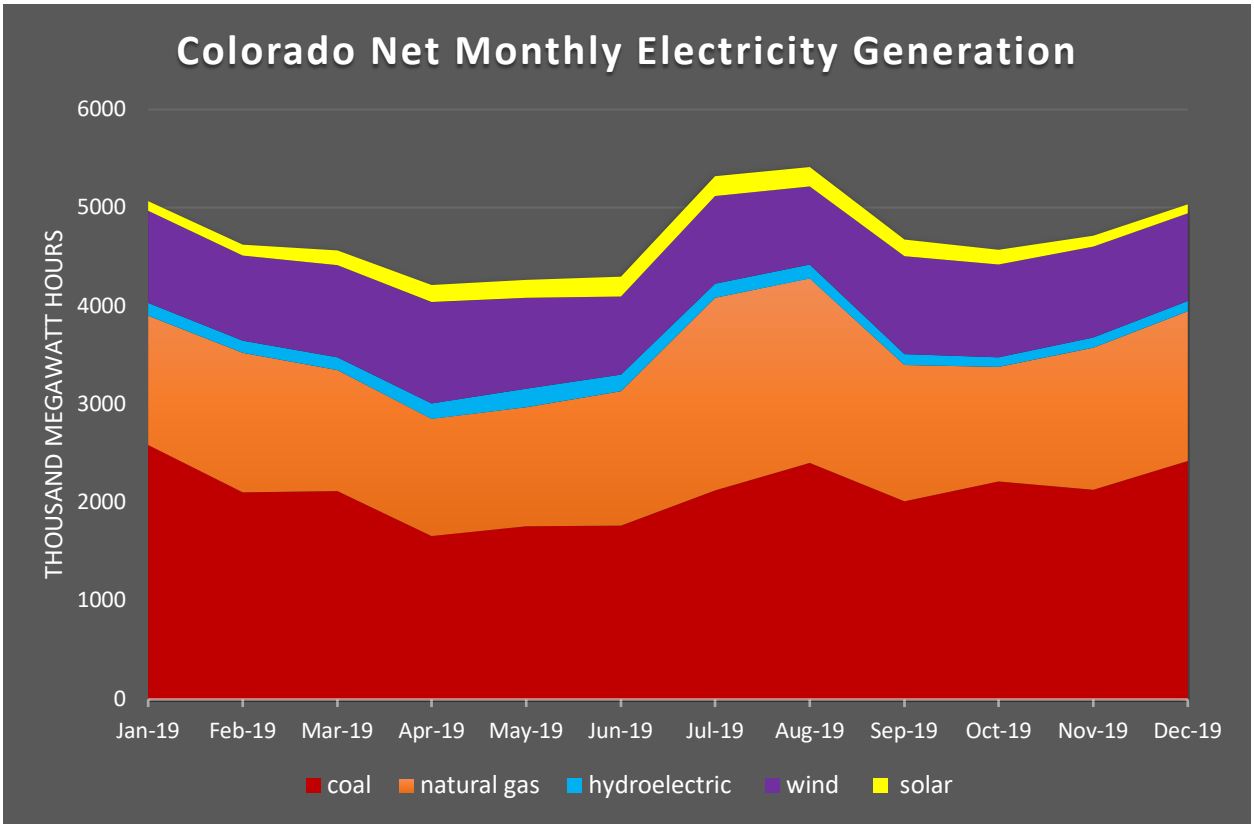
gas electricity generation capacity. Based on these scenarios, wind and solar energy generation are projected to grow to at least 170% and 280% of their 2019 levels by 2030, respectively.

Figure 1



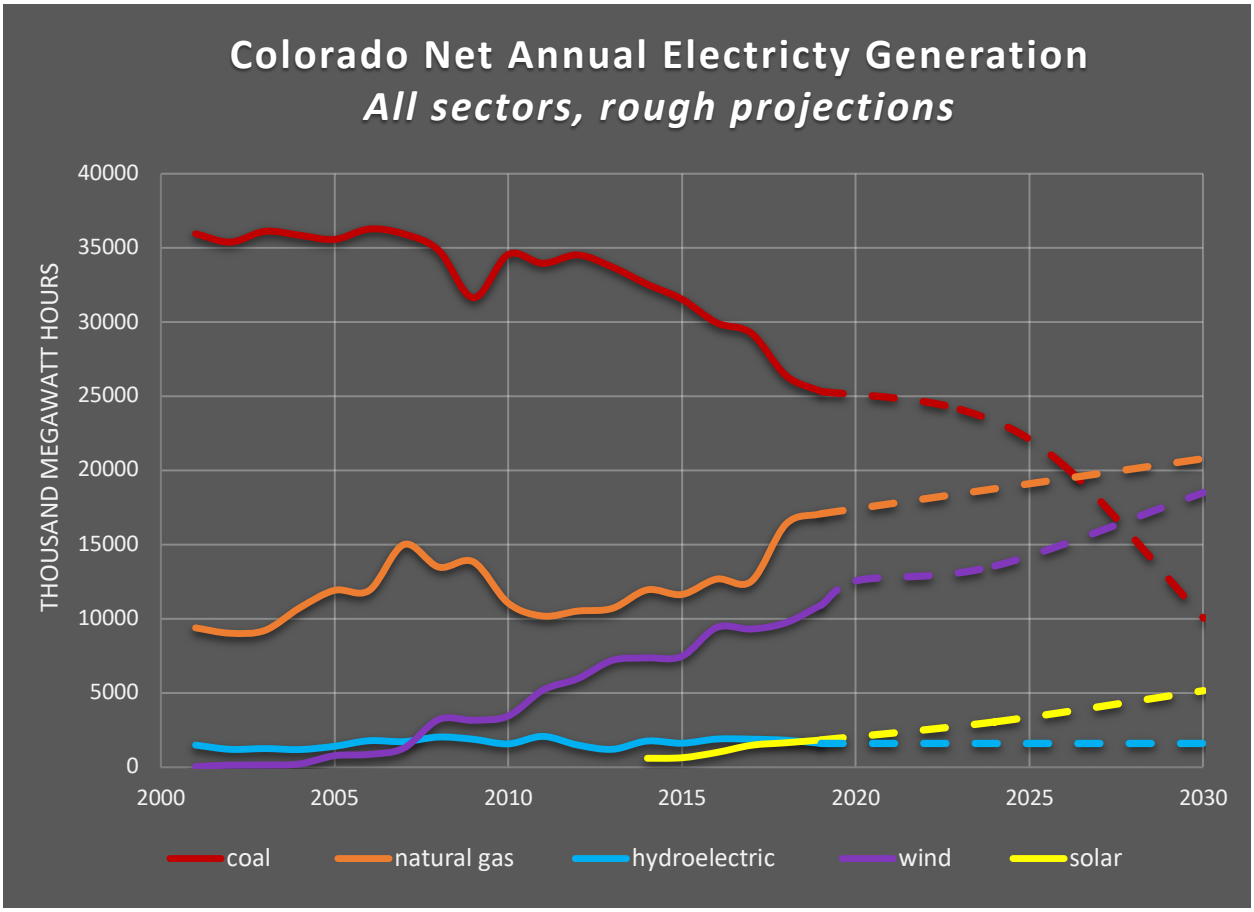
And yet, renewable energy currently accounts for a little less than 30% of Colorado's electricity generation (Figure 2).

Figure 2



Either fossil fuels will continue to fill the gap or more renewable energy will need to come onto the system than is currently projected. (Figure 3.)

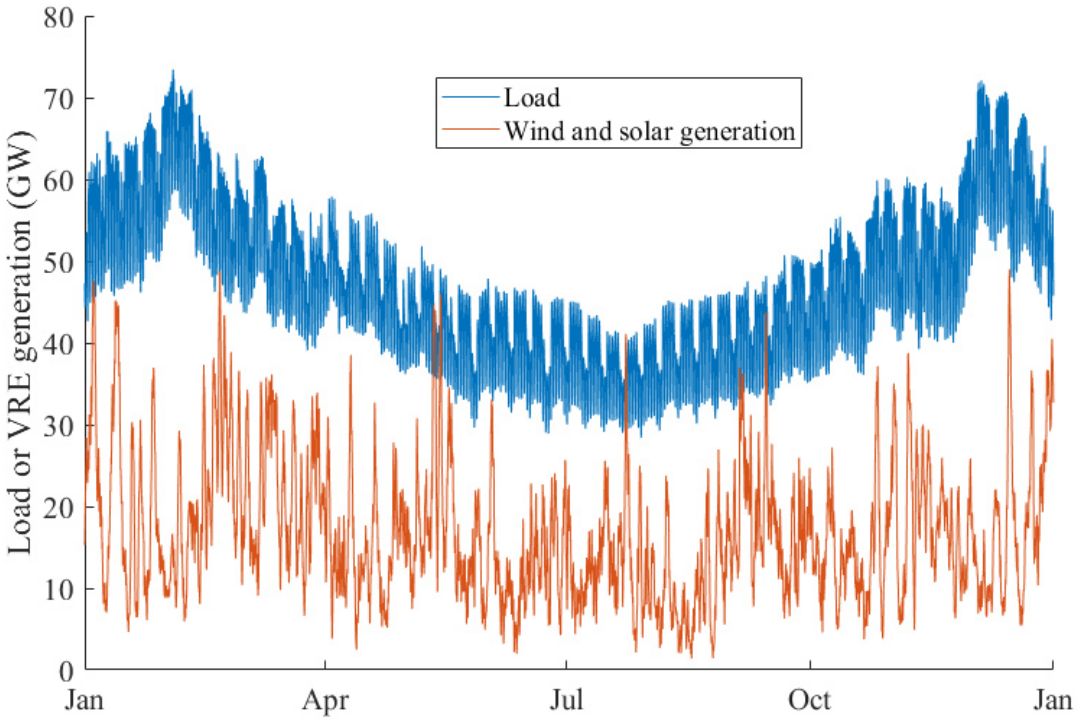
Figure 3



More renewables alone cannot fill the gap

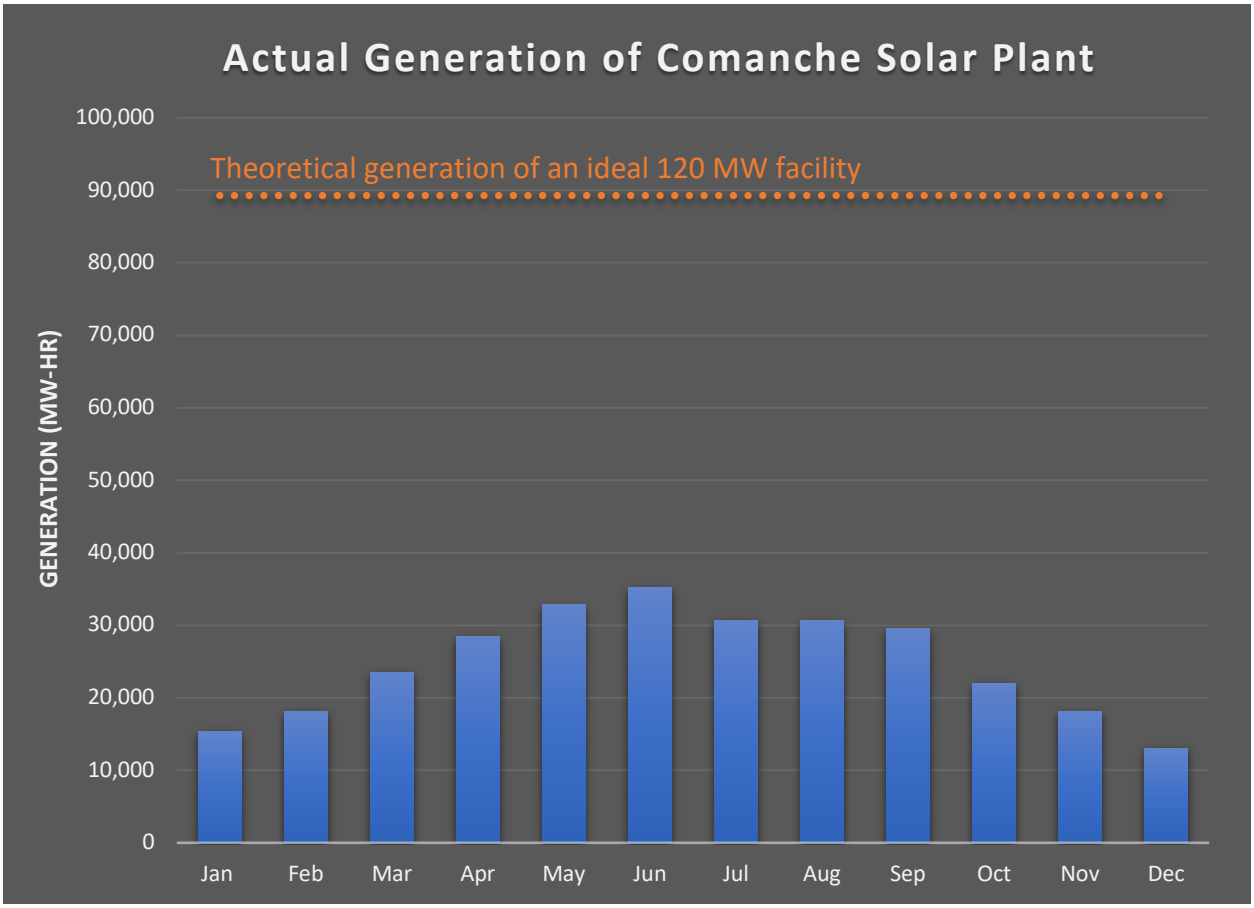
Renewable energy has three constraints that need to be factored into resource planning. The first is variability. In any given month, wind or solar power is not available to the grid when the wind is not blowing and the sun is not shining. Figure 4 illustrates the gap between available variable energy and the demand for electricity that must be met with other resources. This could potentially be done with some combination of storage, future hydrogen combustion turbines, resource diversity from neighboring utilities, or existing resources such as natural gas.

Figure 4



Second, a utility-scale solar energy facility provides only 20% of its potential capacity because of changes in the angle of the sun and length of the day. When this generation is included in integrated resource planning, the output from a utility scale solar facility can be factored into production. But generation from distributed solar facilities – rooftop and community solar gardens – is not currently included in resource planning, even as it receives taxpayer subsidies. This makes long-term planning difficult and can result in higher cost, less reliable renewable power. (Figure 5)

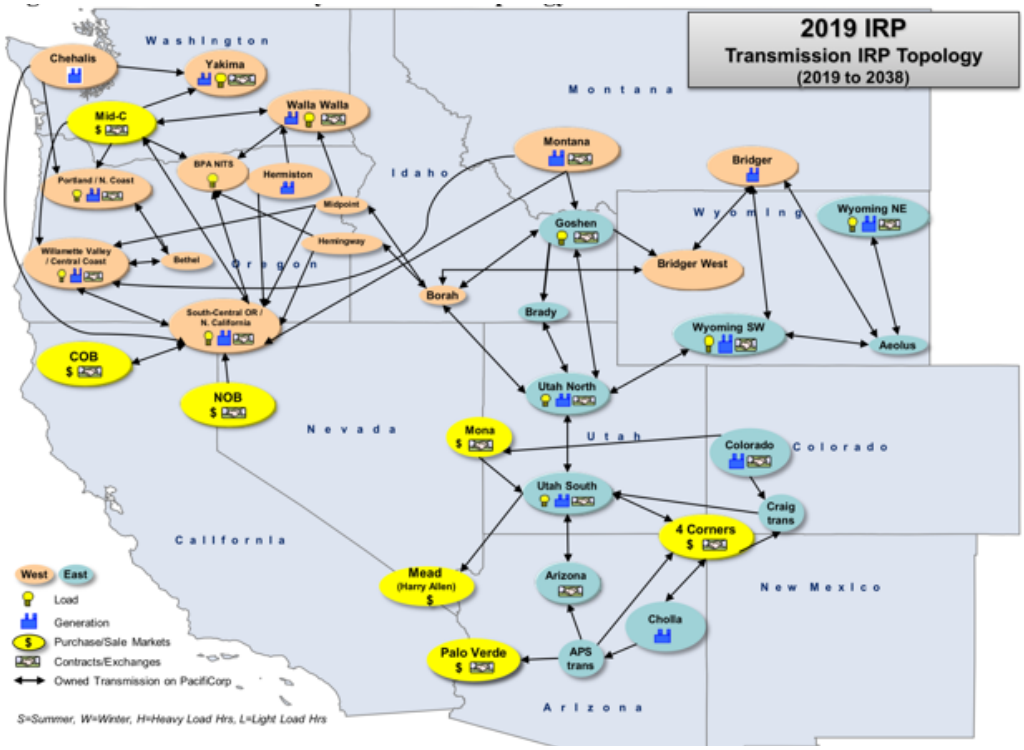
Figure 5



Solar energy at the largest utility scale facility in Pueblo, CO provides 15,000 MW-hr per month in winter and 32,000 MW-hr in the optimal summer season – the equivalent of 24 MW of energy in the summer and 36 MW of energy in the winter from a 120 MW rated facility.

A third problem is that when the location of wind and solar energy generation is not guided by grid requirements, it can result in redundant power in some areas and not enough power in others. Locating renewable facilities in resource-rich areas without considering how the energy will be transmitted and the grid will be balanced can drive up the cost of power without improving its reliability. Colorado has limited interconnection capabilities with neighboring states. (Figure 6)

Figure 6



The solution to all of these issues is comprehensive, long-term planning and coordination of renewable energy development.

Planning is key to achieving Colorado's clean energy roadmap

The first step in the planning process should be to conduct a comprehensive analysis of whether Colorado renewable energy resources can replace all of its fossil fuel generation reliably and affordably.

The PUC or General Assembly could contract for the use of NREL's ReEDS and Plexos models to determine whether current variable resources will allow the state to meet its clean energy goals. The modeling should also evaluate the role of other technologies, including lithium ion batteries and storage, large regional markets, and possibly future hydrogen-sourced resources can play to remedy the variability associated with renewable energy.

Guided by this analysis, the Colorado electric resource planning process should be expanded to evaluate each generating source based on its impact on grid reliability. The PUC should

evaluate the plans of all electricity generating resources in the state to determine if they can provide enough power with enough diversity by location and resource to avoid gaps in generation and transmission. Generators who receive or are seeking ratepayer support should be included in the resource planning process. Establishing a transparent, competitive market of all renewable generating sources is the only way the PUC can ensure long-term reliability and affordability as it works to meet clean energy targets.

The decision to enter a regional market or EIM should be guided by a regional framework that considers the impact of regional transmission on the grid. Recently, the state's key electricity generators entered into two distinct regional markets (Western Energy Imbalance Market and the Southwest Power Pool). The markets' different generation mixes and operating philosophies could create problems with transmission and reliability that can be avoided by a more proactive approach to regional participation.

In thinking about clean energy goals, Colorado policymakers should recognize that Colorado is not an electrical island. The state should work with other states to coordinate renewable resource development and transmission. An interregional transmission infrastructure would unlock the benefits of a diverse range of clean energy sources available throughout the West. It would link states and regions together to expand the supply of inexpensive electricity more broadly and smooth out the variability of renewable resources and demand. In addition, it would help improve system reliability and reduce generation capital investment costs.

A recent report by Wires and The Brattle Group, which looked at regional transmission schemes in the U.S. and Europe, found that having an interregional transmission infrastructure also allows generation to be built in the lowest cost locations, provides insurance against extreme weather, floods and wildfires, and creates trading opportunities for electricity across regional and interregional constraints. The 2035 Report shows an example of this, and the Seams Study, currently under review at the National Renewable Energy Laboratory, evaluates the economics and reliability of large DC transmission links between Eastern and Western Interconnections.

Finally, policymakers may need to accept that in the near-term, natural gas will likely play a role in grid reliability, at least until a more robust generation and transmission infrastructure is established. The planning process should include measures to reduce greenhouse gas emissions from the production, transmission and use of natural gas.

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Joshua B. Epel is a senior policy advisor for Renewables for Colorado, a nationally recognized energy expert and former Chairman of the Colorado Public Utilities Commission. He led the transformation of multiple sectors of the Colorado and U.S. economy, ranging from electric generation and transmission to oil and gas, telecommunications and transportation. Prior to his appointment to the Colorado Public Utilities Commission, Mr. Epel served as principal negotiator with the U.S. Environmental Protection Agency on the Clean Power Plan on behalf of

both Colorado and the National Association of Regulatory Commissioners and provides strategic counsel, consulting services and legal advice to domestic and international companies on advanced energy projects.

Michael Milligan is a senior technical advisor for Renewables for Colorado and recently retired as Principal Researcher at the National Renewable Energy Laboratory, with more than 25 years' experience in power systems and wind/solar power integration. He has authored/coauthored more than 220 articles and reports, and he has led/participated in numerous North American Electric Reliability Corporation (NERC), Western Electricity Coordinating Council (WECC), and IEEE Power and Energy Society working groups and committees. At NREL he received the H.M. Hubbard Award, for "two decades of grid integration analysis and leadership…, and for his selfless communication efforts to numerous decision makers, stakeholders, and grid engineers." In 2018 he was awarded the Lifetime Achievement Award by the Energy Systems Integration Group (esig.energy) for sustained contributions to wind and solar power system integration studies. His work at NREL influenced the formation of the Energy Imbalance Market in the Western Interconnection, and the Pilot Project on 05-Minute Scheduling in India. Formerly a key contributor to International Energy Agency Task 25, he is now an independent power system consultant, specializing in renewable integration, power system economics, and reliability.

Renewables for Colorado is a not-for-profit organization that works with renewable power producers and renewable energy advocates to provide energy expertise to policy leaders and the public on implementing state carbon reduction mandates and making the transition to 100% clean energy. The organization promotes the construction of large-scale and community solar and wind projects, competitive pricing, grid integrity and lower costs for consumers.

Graphic data sources:

Figure 1:

"U.S. Energy Information Administration - EIA - Independent Statistics and Analysis." Electricity Data Browser, 2020, www.eia.gov/electricity/data/browser/.
"COLORADO ENERGY PLAN SPRING 2020 UPDATE." Xcel Energy Information Sheet, 2020, www.xcelenergy.com/staticfiles/xe-responsive/Company/Rates & Regulations/Regulatory Filings/CO Recent Filings/Colorado Energy Plan 2020.pdf.

"Platte River to Retire Rawhide Unit 1 by 2030." Platte River Power Authority, 8 July 2020, www.prpa.org/media-releases/platte-river-to-retire-rawhide-unit-1-by-2030/.

Proctor, Darrell. "Colorado Utility Will Close Last Two Coal Plants." POWER Magazine, 26 June 2020, www.powermag.com/colorado-utility-will-close-last-two-coal-plants/.

"Renewable Energy: Tri-State Generation and Transmission Association, Inc." Tri, 2020, www.tristategt.org/renewable-energy.

Figure 2:
"U.S. Energy Information Administration - EIA - Independent Statistics and Analysis." Electricity Data Browser, 2020, www.eia.gov/electricity/data/browser/.

Figure 3:
"U.S. Energy Information Administration - EIA - Independent Statistics and Analysis." Electricity Data Browser, 2020, www.eia.gov/electricity/data/browser/.
"COLORADO ENERGY PLAN SPRING 2020 UPDATE." Xcel Energy Information Sheet, 2020, www.xcelenergy.com/staticfiles/xe-responsive/Company/Rates & Regulations/Regulatory Filings/CO Recent Filings/Colorado Energy Plan 2020.pdf.

"Platte River to Retire Rawhide Unit 1 by 2030." Platte River Power Authority, 8 July 2020, www.prpa.org/media-releases/platte-river-to-retire-rawhide-unit-1-by-2030/.

Proctor, Darrell. "Colorado Utility Will Close Last Two Coal Plants." POWER Magazine, 26 June 2020, www.powermag.com/colorado-utility-will-close-last-two-coal-plants/.

"Renewable Energy: Tri-State Generation and Transmission Association, Inc." Tri, 2020, www.tristategt.org/renewable-energy.

Figure 4:
WIREs Authors. "Tools to Assess Effects of Variable Renewable Energy Generation on Power/Energy Systems." Advanced Science News, 22 Nov. 2018, www.advancedsciencenews.com/tools-to-assess-effects-of-variable-renewable-energy-generation-on-power-energy-systems/.

Figure 5:
"Comanche Solar, Monthly". Electricity Data Browser. Energy Information Administration. Retrieved June 15, 2020.

Figure 6:
"2019 Integrated Resource Plan (IRP) Post-filing Public Input Meeting November 12, 2019". Slide 9. PacifiCorp. 2020, www.pacificorp.com/content/dam/pcorp/documents/en/pacificorp/energy/integrated-resource-plan/2019-irp/2019-irp-presentations-and-schedule/2019-11-12-General_Public_Meeting.pdf.