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NUCLEAR POWER AND THE FUTURE OF ENERGY IN COLORADO

AUTHORS: PAUL LUNDEEN & ERIK GAMM

ABOUT THE AUTHORS



Paul Lundeen

Paul Lundeen is CEO and President of American Excellence Foundation. AEF is a network of investors focused on expanding Free Enterprise, Liberty and Responsibility, and promoting Constitutional order. He recently retired from the Colorado State Senate as Minority leader, and served in the Colorado House, and on the State Board of Education.



Erik Gamm

Erik Gamm is a Senior Research Analyst with CSI. Erik joined CSI in 2019 and has led research for CSI reports covering the topics of taxation, education, workforce and health care. He graduated from the University of Michigan in 2020 with a Bachelor of Arts in Economics.

ABOUT COMMON SENSE INSTITUTE

Common Sense Institute is a non-partisan research organization dedicated to the protection and promotion of Colorado's economy. CSI is at the forefront of important discussions concerning the future of free enterprise and aims to have an impact on the issues that matter most to Coloradans. CSI's mission is to examine the fiscal impacts of policies, initiatives, and proposed laws so that Coloradans are educated and informed on issues impacting their lives. CSI employs rigorous research techniques and dynamic modeling to evaluate the potential impact of these measures on the economy and individual opportunity.

TEAMS & FELLOWS STATEMENT

CSI is committed to independent, in-depth research that examines the impacts of policies, initiatives, and proposed laws so that Coloradans are educated and informed on issues impacting their lives. CSI's commitment to institutional independence is rooted in the individual independence of our researchers, economists, and fellows. At the core of CSI's mission is a belief in the power of the free enterprise system. Our work explores ideas that protect and promote jobs and the economy, and the CSI team and fellows take part in this pursuit with academic freedom. Our team's work is informed by data-driven research and evidence. The views and opinions of fellows do not reflect the institutional views of CSI. CSI operates independently of any political party and does not take positions.

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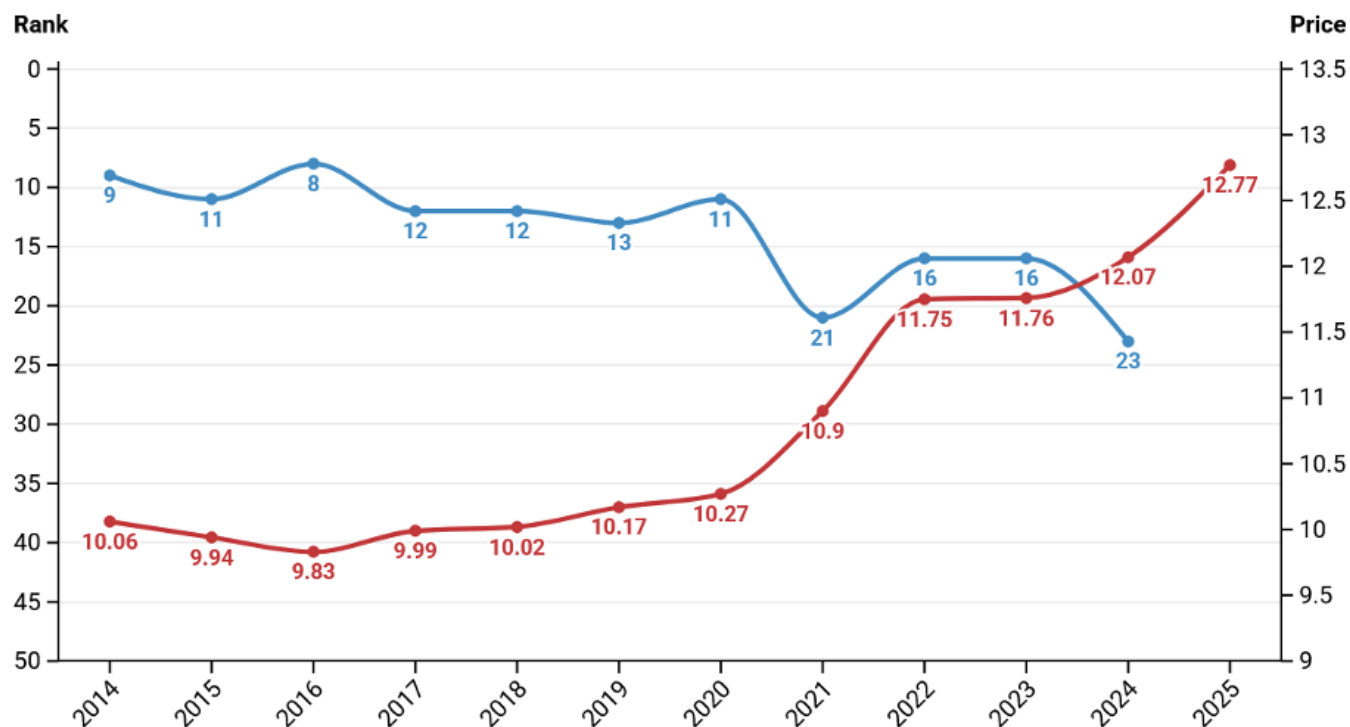
INTRODUCTION

Years of lawmaking and negotiation has settled the directional future of energy in Colorado: having been ordered to reduce emissions, overhaul infrastructure, and answer to much-intensified scrutiny, the state's electric utilities find themselves the vanguard of their government's campaign against fossil fuels and greenhouse gases. The innovation demanded of our electricity sector is an enterprise made all the more costly by artificiality and inflexibility—high ambition and short timelines, both better calibrated for the satisfaction of lawmakers than the allowance of technology, have already begun to manifest in measures of price and reliability. Previous CSI research based on the state government's own forecasts establishes that these problems are expected to worsen over time under prevailing strictures.ⁱ

FIGURE 1.

Colorado Grid Reliability Rank: 2014–2024

■ Price of electricity (¢/kWh) ■ Reliability rank



Within this framework, however, are opportunities to limit damages, reinforce Colorado's energy security, and even permanently benefit the state economy. Last year, albeit six years after the passage of Colorado's first statewide emissions-reduction targets, the state legislature enacted a bill that officially recognizes nuclear power as "clean energy" for the sake of meeting those goals. Although state regulations still disfavor nuclear energy in several concrete ways, there are many signs that Colorado, a state whose only nuclear power plant closed in 1989, is growing more amenable to the technology. Barring sudden and unforeseen advancements in renewable energies, this study finds that nuclear power, now having gained purchase in state law, is by far the least disruptive, most cost-effective, and most economically valuable means of supplying clean electricity capable of satisfying future demand and preserving the reliability of the grid.

KEY FINDINGS

Colorado's electricity demand is projected to more than double by 2050.

- State-contracted modeling projects annual demand of **120** million megawatt-hours in 2050, compared with **56.8** million in 2024, a 111% increase.
- These projections **exclude** potential new data-center demand, which could increase electricity needs further.

Nuclear power now qualifies as clean energy in Colorado, but it does not receive all the incentives available to renewable resources.

- HB25-1040 allows nuclear power to count toward the 2050 clean-energy target while excluding it from preferential property-tax valuation.

CSI estimates nuclear power would cost 21–24% less than a wind-and-solar mix when grid reliability costs are included.

- To supply 7 GW of additional average generation and support peak demand, modeled annual costs are **\$5.6–\$5.8** billion for nuclear, compared with **\$7.3** billion for a wind-and-solar mix, in 2026 dollars.

Nuclear power could limit electricity-price increases as Colorado's demand grows.

- CSI estimates retail prices of 16.8–17.2 cents per kilowatt-hour under its nuclear scenarios, compared with 19.7 cents for a wind-and-solar mix, in 2026 dollars.
- This price difference would equate to a household's monthly utility bill being **13%–15%** lower.

Nuclear generation would require substantially less land than a wind-and-solar mix under the report's assumptions.

- The 7 GW generation scenarios require an estimated 7.5 square miles for conventional nuclear plants or 0.5 square miles for small modular reactors, compared with 70.1 square miles for a wind-and-solar mix.

CSI's illustrative economic model projects stronger outcomes from conventional nuclear power than from a wind-and-solar mix.

- Through 2050, the nuclear scenario projects 18,800 additional jobs annually on average and \$244.7 billion in cumulative economic output. The wind-and-solar scenario projects 2,600 fewer jobs annually on average and \$22.5 billion less cumulative output.

NUCLEAR ENERGY IN STATE LAW

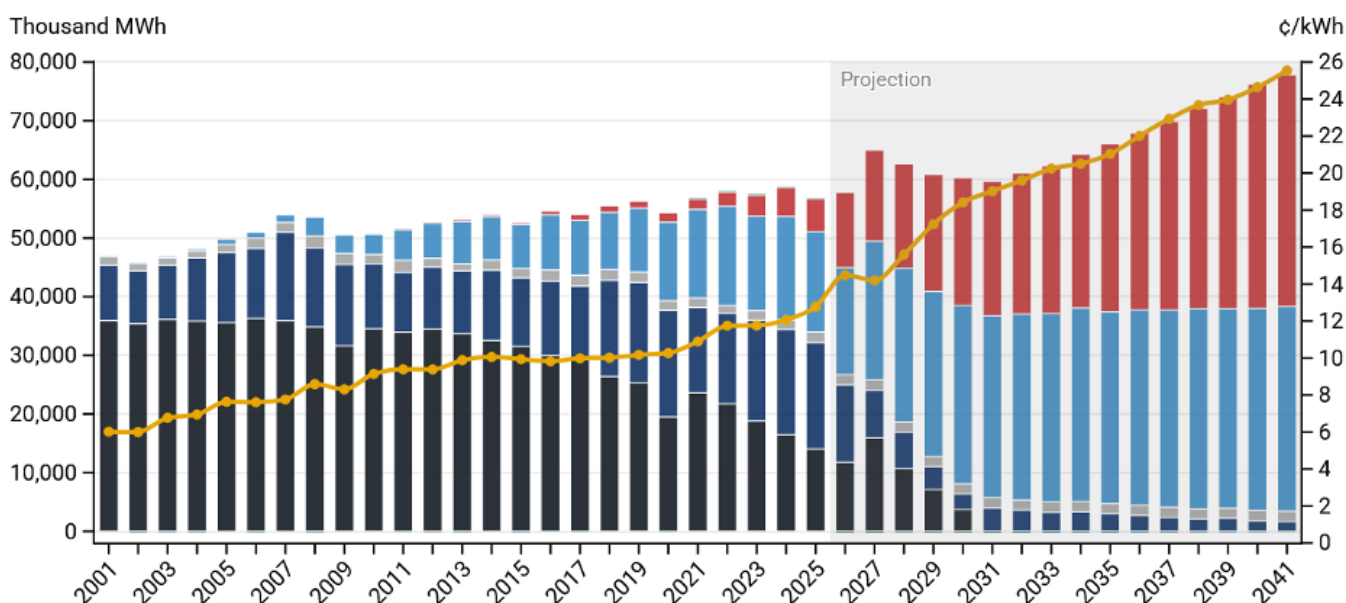
Colorado's statewide emissions-reduction targets, which have since been modified to require the state to achieve 100% carbon-neutrality by 2050, date to the passage of HB19-1261 in 2019. As the primary means of supplying energy to polluters and itself a major source of emissions, the utilities sector has been central to the state government's pursuit of its environmental goals ever since. What has come of this redoubled oversight is a mass of new laws and regulations that grant governments much more direct control over investor-owned utilities, including over how much capacity they can add, what infrastructure they're required to build, and what fuels they're allowed to use. Although a comprehensive treatment of utility compliance with state regulations would cover many more topics than even those, the sole focus of this report is the issue of zero-emissions fuels.

FIGURE 2.

Colorado's Electric Power Sector - Electricity Generation by Fuel Type

Projections based on a scenario developed by the Colorado Energy Office to meet state emissions-reduction laws for the electric power sector.

■ Historic price of electricity and projected rate (right axis) ■ Coal ■ Natural gas ■ Hydroelectric ■ Wind ■ Solar ■ Other*



Sources: EIA and CSI calculations based on costs in the "Pathways to Deep Decarbonization" report • * Petroleum, pumped storage, biomass, and other gases

The reclassification of nuclear power as a “clean energy resource” under HB25-1040 is an implicit acknowledgement that nuclear capacity might be necessary, in the long run, to control the costs of state environmental policy. It is also an important victory for supporters of nuclear energy, which, without privileges associated with the legal definition of “clean energy,” would have little chance of gaining any foothold in Colorado. Under their Clean Energy Plans, another product of statewide emissions-reduction targets, large utilities are required to source 100% of their electric generation from designated clean energy resources by 2050; grafting nuclear energy onto that list, therefore, enables utilities to consider its deployment to an extent that they could not before.^{ii,iii,iv}

Even moderate state-government projections forecast a rapid rise in Colorado’s electricity price under scenarios that exclude nuclear power; **still more dramatic increases are possible if demand, especially from advanced industries and data centers that some in Colorado want to attract, grows more quickly than expected.**

Still, despite being recognized as a reliable source of clean energy, nuclear power lacks certain other legal advantages that the state offers renewable resources like solar power and wind. In fact, state law precludes outright the full-scale adoption of nuclear energy, even though it produces no greenhouse-gas emissions, by requiring utilities to generate minimum shares of electricity from renewable resources. Below is an incomplete list of rules and incentives that favor renewable energy (defined in Colorado law to include solar, wind, geothermal, carbon-neutral biomass, and small hydroelectric resources) over clean but non-renewable sources like nuclear power.

TABLE 1.

Statewide Incentives for Renewable Energy Unavailable to Nuclear Power	
Renewable Energy Standard (RES) ^v	Minimum 30% of retail electricity sales from renewable generation for investor-owned utilities and lower minima for cooperative and municipal utilities
Installation rebates and metering ^{vi}	Utilities must offer rebates and credits for customer-sited solar panels and can recover costs through rate increases
Financial incentives under RES ^{vii}	Renewable-energy investments are eligible for bonus returns (up to 50% of their net economic benefit) and accelerated cost-recovery
Community-solar requirements ^{viii}	Utilities must provide 50MW of community solar through 2027 and offer recoverable credits to users
Distributed-generation interconnection rights ^{ix}	Customers using distributed generation of renewable energy have extra generation, consumption, storage, and export rights
Sales-tax exemption ^x	Equipment used to generate power from renewable energy is exempt from state sales and use taxes
Preferential property-tax valuation ^{xi}	Improvements on land used to generate clean electricity are partially exempt from valuation for the purpose of property taxation, but nuclear plants are explicitly ineligible

If lawmakers continue to grow more optimistic about the prospect of nuclear-powered electricity in Colorado, they should consider changing some of these policies to help equalize its treatment under state law.

MEETING STATE ENERGY TARGETS

The rest of this report concerns the practical, financial, and economic viability of deploying nuclear energy to help meet future electricity demand and honor the state’s environmental goals. In 2024, users in Colorado purchased 56.8 million megawatt-hours of electricity; state-contracted modeling forecasts roughly double that demand, 120 million, in 2050.^{xii,xiii} This means that utilities in 2050 will have to generate, at minimum, 7.2 gigawatts (GW) more in average actual capacity than they did in 2024 to meet consumers’ wants. For simplicity’s sake and to account for increases in demand since 2024, the scenarios to come in this study represent an even 7 GW of additional generation that electric utilities will need to supply in 2050, the year by which they’re also expected to have achieved net-zero emissions.

Different energy sources have different capacities to generate electricity relative to their theoretical potentials; “nameplate capacity” refers to the amount of electricity that a facility would generate by operating at full power across all hours while “capacity factor” measures how much electricity, under its particular circumstances, the equipment actually generates. To generate 7 GW of actual power, for example, a power plant with a capacity factor of 50% would need to be built at a nameplate capacity of 14 GW. Dispatchable resources like coal, natural gas, and nuclear energy typically command capacity factors close to 100%¹ while generation from intermittent sources like solar power and wind usually peaks below half of its nameplate capacity.

TABLE 2.

Capacity Factors of Selected Energy Sources		
	Capacity factor ²	Nameplate capacity required to generate 7 GW
Coal	85%	8.2 GW
Conventional nuclear	93%	7.5 GW
Solar power	30%	23.3 GW
Wind	41%	17.1 GW
Geothermal energy	90%	7.8 GW

¹ When used to supply baseload power

² Colorado-based or national estimates for equipment intended to operate at maximum year-round capacity; see the appendix for sources

Keeping the state's grid stable under higher demand, however, is not simply a matter of generation. Consumers use different amounts of power at different times throughout days, weeks, and years, and some electric power sources, like intermittent renewables, generate at levels that also vary over time. Electricity that cannot be used at the time of its generation must be stored, or else lost; preventing reliability problems like more frequent blackouts, therefore, requires building more than the minimum average capacity needed to equal average consumption and/or storing, at substantial expense, generation that goes unused upon its occurrence. According to the original Greenhouse Gas Roadmap, Colorado utilities will need to supply about 15.47 GW more peak-reliable electricity (including a required 16.3% allowance for stability) alongside their 7 GW of new average generation in 2050.^{xiv}

To account for this complication, this report calls upon Effective Load Carrying Capability (ELCC), which measures how much additional demand, as a share of a facility's nameplate capacity, the connected grid can tolerate after that facility's installation without weakening its reliability to deliver power at peak-demand times. A power plant with an ELCC of 50% and a nameplate capacity of 2 GW can safely satisfy 1 GW of peak demand regardless of its capacity factor. A plant's ELCC depends largely on how well its generation curve matches the grid's demand curve, so the marginal ELCC of intermittent sources diminishes as installed capacity rises.

In Colorado, where renewable energy penetration is already well above national and global averages, new generation from wind and solar power does especially little to improve the grid's reliability. Xcel Energy estimates that, within its Colorado territory, its next 1 GW of nameplate solar and wind capacity will have ELCCs of 21.1% and 19.4%, respectively, while any new capacity beyond 2 GW will register just 5.4% and 11.3%.^{xv} This means that generating 7 GW more from solar power and wind would increase the supply of reliable electricity at peak hours by just 1.5 GW and 2 GW, respectively.

TABLE 3.

ELCC of Selected Energy Sources			
	ELCC³	Nameplate capacity required to generate 7 GW	Total peak-reliable generation
Coal	85%	8.2 GW	7 GW
Conventional nuclear	95%	7.5 GW	7.2 GW
Solar power	6.3%	23.3 GW	1.5 GW
Wind	12%	17.1 GW	2 GW
Geothermal energy	95%	7.8 GW	7.4 GW

Nuclear power, which can run at a high capacity factor and has a very high ELCC, is the most potent and reliable source of clean energy that could realistically be deployed across all of Colorado. Geothermal energy has similar characteristics but is limited by geography and technology: the resource is most prevalent in small and rural parts of the state and would be extremely expensive in many cases to connect to population centers without major transmission losses.^{xvi,xvii} Intermittent renewables, though valuable as supplemental sources of electricity, are unreliable by nature; to meet future demand increases with them alone would require adding large amounts of storage to the grid.

One major advantage that fossil fuels have over renewable resources is that they can generate electricity with predictable timing and at consistent volumes. Nuclear energy shares these advantages without running afoul of state laws designed to limit utilities' environmental impacts.

3 Colorado-based or national estimates including diminishing returns for 7 GW of new generation from renewables; see the appendix for sources.

GENERATION AND SYSTEM COSTS

Nuclear energy's technological advantages cannot make it a singular solution to Colorado's electricity problems if its cost is prohibitive. In fact, intermittent resources comfortably outperform nuclear energy on many superficial measures of cost like LCOE; deeper and more comprehensive analysis, however, reveals these to be incomplete and often misleading. Accounting for generating potential, reliability, system costs, and land displacement, CSI finds that nuclear energy could meet future electricity demand in Colorado at a much lower price than that of intermittent renewables.

CSI's cost analysis compares six means of satisfying Colorado's projected total and peak electricity demand in 2050 with sources of clean energy approved for utility-scale use under state law. Five of these model the cost of one resource alone (conventional large-scale nuclear energy, small modular nuclear reactors (SMR), solar power, wind, and geothermal energy) while one represents an optimal mix of solar power and wind based on their respective ELCCs. See this report's appendix for a detailed list of each component's inputs and assumptions.

Capital Costs and Land Use

In general, the cost of building a nuclear power plant is much higher than that of building renewable-energy equipment. Even though solar power and wind require between two and three times as much nameplate capacity per unit of generation, the total capital cost of building 7 GW of new generation would be 77% higher for nuclear power than renewable energy under the mixed solar/wind scenario. Accounting for each technology's respective operating life, however, confirms that the annualized capital cost of nuclear generation is only modestly higher than those of renewable sources at a 5% real discount rate. The following graph shows inflation-adjusted costs of capital, annualized over each technology's lifespan, per GW of nameplate capacity, actual generation, and peak-reliable generation.

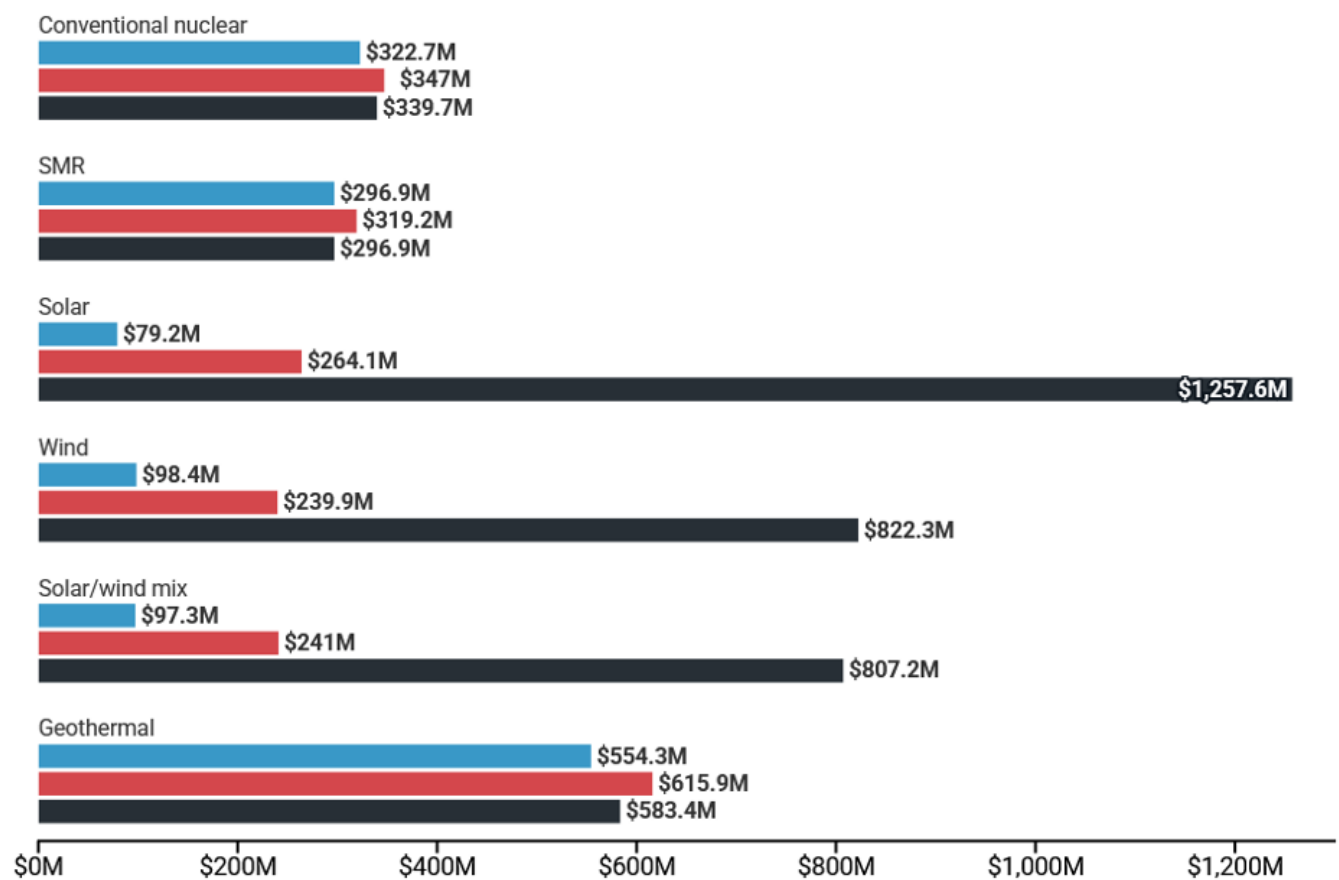
Nuclear energy's effective capital cost could be reduced even more by extending the average nuclear plant's technical life. Based on generalizations published by the National Laboratory of the Rockies (NLR), CSI assumes that nuclear-power facilities in Colorado would operate for 60 years, exactly twice as long as the expected lifespan of renewable-energy equipment.^{xviii} U.S. law, however, allows recertifications to extend the lives of nuclear plants to a maximum of 80 years; across the country, 25 total reactors have received approval for 80 years of operation under this provision.^{xix} Because technological advances have made such an accomplishment more feasible over time, **hypothetical future projects in Colorado appear to have good chances of reaching that milestone and registering capital costs lower than those of renewable technologies.**

FIGURE 3.

Annualized Capital Costs of Clean Energy Technologies

For 7 GW of new average generation atop Colorado's current mix

■ Cost per nameplate GW ■ Cost per actual GW ■ Cost per reliable GW



Nuclear energy's high capital cost per unit of capacity also belies its small physical footprint. Each GW of generation from nuclear power occupies 88% less space than an equivalent wind farm and 97% less space than an equivalent solar farm. Complications arising from comparative property values and opportunity costs render the issue of land-use beyond the scope of this report's cost analysis, but lawmakers should nonetheless consider differences in how much productive land different clean-energy technologies displace.

TABLE 4.

Land Displaced by 7 GW of Electric Generation			
	Nameplate capacity	Land use per nameplate GW (sq mi)	Total displaced land (sq mi)
Conventional nuclear	7.5 GW	1	7.5
SMR	7.5 GW	0.06	0.5
Solar power	23.3 GW	11.3	263.7
Wind	17.1 GW	3.6 ⁴	61.5
Solar/wind mix	17.3 GW	4	70.1
Geothermal energy	7.8 GW	0.94	7.3

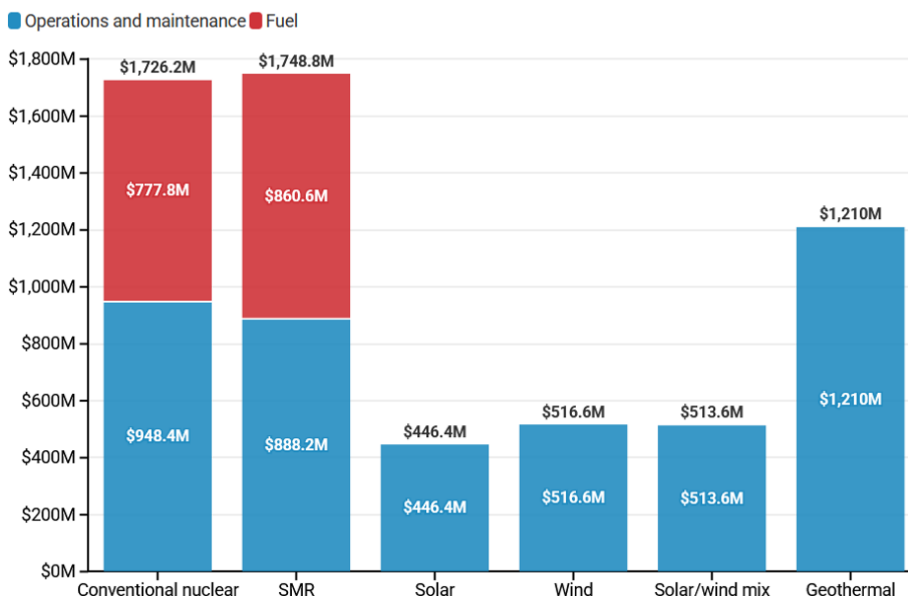
Operating, Maintenance, and Fuel Costs

Nuclear energy's variable costs are unambiguously higher than those of renewable sources. Operating and maintaining a nuclear power plant is a highly active and technical endeavor, but renewable-energy equipment requires only occasional upkeep after installation. Furthermore, whereas solar and wind farms are powered by inexhaustible natural phenomena, nuclear plants run on fuel, usually uranium, that must be commercially extracted, processed, purchased, and delivered. In total, the annual cost of generating 7 GW from nuclear fuels is roughly 3.4 times that of operating as much generation from a mixture of solar power and wind.

FIGURE 4.

Annual O&M and Fuel Costs of Clean Energy Technologies

For 7 GW of new average generation atop Colorado's current mix



4 Includes only land directly displaced by generating infrastructure, not full project dimensions

System Costs

The high underlying cost of generating electricity from nuclear energy is sweetened by its relatively low costs of capacity replacement, transmission, and balancing, all of which are spoils of high productivity and reliability. As a firm and dispatchable technology, it requires less accompanying storage capacity than renewables, can be built nearer to existing infrastructure, adds less nameplate capacity to connect to transmission systems, and generates virtually no forecasting error for grid operators to balance.

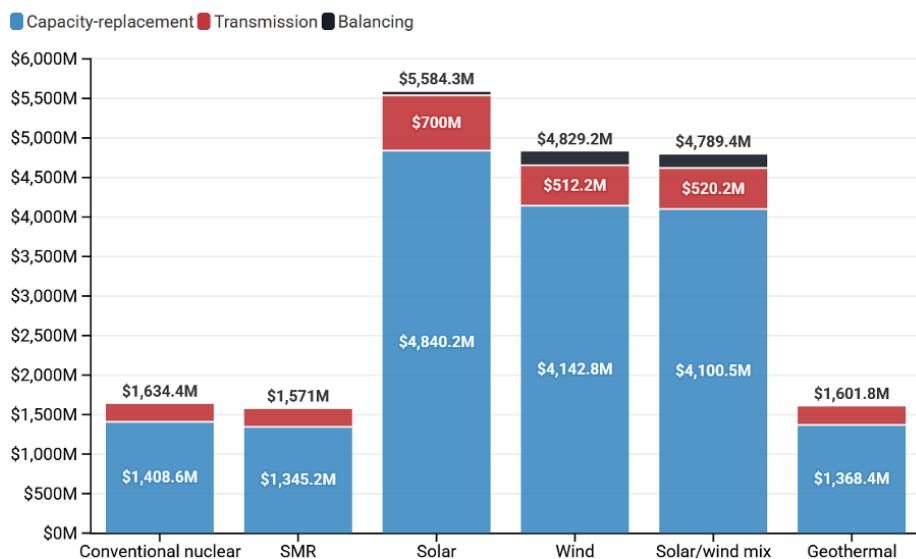
The cost of capacity replacement, represented alongside two other system costs in the graph below, is that of storing energy that cannot be used at the moment of its generation for use at times when immediate demand exceeds production. Intermittent sources, whose generation curves mismatch the grid's demand curve worse than do those of firm sources, require more and longer-term supplementary storage capacity to supply enough power for peak usage. Whereas nuclear energy could reliably account for demand swells with short-duration batteries and/or pumped storage, the inherent unpredictability of solar power and wind necessitate deploying more durable, and more expensive, storage mechanisms to the same end. This report conservatively assigns nuclear power and geothermal energy the same prospective average cost of capacity replacement as Xcel Energy's whole fleet and assigns renewable technologies the marginal cost of capacity replacement, according to NLR's 2024 baseline, of 8-hour batteries.^{xx,xxi} CSI finds that supplying peak-reliable power entirely through storage is less expensive than building some excess generating capacity in all six cases.

Because of a shortage of reliable data, this presentation of system costs is not exhaustive; in particular, it ignores the costs of curtailment and congestion alongside other minor matters. The instability of intermittent renewable energies should render them somewhat more expensive in these respects too, but the amounts are likely small and safe to exclude.

FIGURE 5.

Annual System Costs of Clean Energy Technologies

For 7 GW of new average generation atop Colorado's current mix



Firm resources' balancing costs are negligible and, lacking sufficient data, assumed to be zero for the sake of this study

Total Costs

The following table summarizes the combined annual cost, in 2026 dollars, of each clean-energy technology across all three cost categories.

TABLE 5.

Total Yearly Costs of 7 GW of New Reliable Generation from Clean Energy (2026 Dollars)				
	Annualized capital cost	O&M and Fuel costs	System costs	Total cost
Conventional nuclear	\$2,428,828,533	\$1,726,212,903	\$1,634,423,023	\$5,789,464,459
SMR	\$2,234,378,878	\$1,748,755,956	\$1,570,990,228	\$5,554,125,061
Solar power	\$1,848,686,352	\$446,385,223	\$5,584,343,812	\$8,405,992,403
Wind	\$1,679,423,602	\$516,558,059	\$4,829,161,143	\$7,379,755,433
Solar/wind mix	\$1,686,677,720	\$513,550,651	\$4,789,356,654	\$7,335,323,826
Geothermal energy	\$4,311,041,867	\$1,210,001,959	\$1,601,775,801	\$7,122,819,627

CSI's methodology finds that meeting Colorado's 2050 electricity demand (including its projected peak demand) with renewable energy would cost almost 1.3 times as much as it would to use conventional nuclear energy instead. If the same can be accomplished with small modular reactors, the cost of nuclear energy would be lower still. These savings would manifest in retail electricity prices by restraining their growth, expected to be extreme under mainstream projections, in proportion to nuclear energy's cost advantage over its alternatives.

ECONOMIC IMPACTS

A low cost of generation benefits both the utilities sector and general economic health. Because some amount of electric power is behind nearly every dollar of economic output in an advanced economy like Colorado's, nuclear energy's potential to control retail electricity prices otherwise facing rapid and inevitable long-term growth is of interest to every public and private industry in the state.

Based on pricing components reported in Xcel Energy's regulatory filings, CSI estimates that the cost of electric generation, encompassing the three cost categories identified in the previous section of this study, accounts for roughly 40% of the current retail price of electricity in Colorado.^{xxii,xxiii} The remaining 60% covers distribution costs and other matters unrelated to generation, like administrative expenses and profits. At full function, the additional nuclear and renewable generation required to meet 2050 demand would cost 9.4¢ and 12¢ per kilowatt-hour in 2026 dollars, respectively, and contribute those same amounts to the future price of electricity. As a result, assuming the same underlying real non-generation cost per unit of demand, deploying a mix of renewable-energy technology would provoke a 34.3% increase, adjusted for inflation, in the average retail electricity price (not including the cost of retiring and replacing existing fossil-fuel capacity) whereas choosing nuclear energy would raise the same by 23.3%.

TABLE 6.

Price Effects of New Generation and Storage (2026 dollars)			
	Generation/storage cost per kWh	Total retail price per kWh	Price-increase factor
Conventional nuclear	9.4¢	17.2¢	1.23
SMR	9.1¢	16.8¢	1.22
Solar power	13.7¢	21.4¢	1.42
Wind	12.0¢	19.8¢	1.35
Solar/wind mix	12.0¢	19.7¢	1.34
Geothermal energy	11.6¢	19.4¢	1.33

Alongside its relatively low effect on electricity prices among clean technologies, nuclear energy offers a promise of economic benefits through job creation. Because they require much more labor to operate and maintain, nuclear power plants employ far more workers than do solar and wind farms.^{xxiv} Storage capacity also creates jobs—about 60 per nameplate GW—but not enough to raise the employment impacts of renewable energy above those of nuclear power.^{xxv} Direct employment levels are unworthy proxies of economic impact when they belie high costs, poor productive efficiency, and/or overwhelming

negative externalities; nuclear power, however, is both more cost-effective and creates more jobs per gigawatt than renewable energy. The jobs it creates, too, pay relatively well within the utilities sector, suit a wide range of education levels, and could accommodate workers threatened by the gradual departure of heavy industry from Colorado.

TABLE 7.

Clean Electricity Jobs per 7 GW of Actual Generation ⁵			
	Plant jobs	Storage jobs	Total
Conventional nuclear	3,500	501	4,001
SMR	1,659	479	2,138
Solar power	252	842	1,094
Wind	560	808	1,368
Solar/wind mix	547	809	1,356
Geothermal energy	5,180	487	5,667

To represent the price and employment effects in terms of their comprehensive economic impact, CSI modeled its findings as fuel-cost increases and utility-sector employment growth in REMI Tax-PI, both starting at zero in 2026 and rising linearly to their full values in 2050.⁶ Because small modular reactors are still unproven as producers of utility-scale electricity, geothermal energy is unrealistic across most of Colorado, and the two renewable sources are better represented in combination than apart, the modeling excludes four of the original six scenarios. Below are the results of this exercise, which demonstrates the substantial economic advantage that conventional nuclear energy presents over intermittent renewables.

TABLE 8.

Economic Impacts of New Generation through 2050					
	Average yearly employment	Average yearly population	Total GDP	Total output	Total personal income
Nuclear energy	18,800	18,100	\$143.4B	\$244.7B	\$100.6B
Renewable energy	-2,600	-5,800	-\$12.9B	-\$22.5B	-\$6.3B

These results can be interpreted as gains/losses relative to a counterfactual case wherein widespread electrification does not occur, leaving Colorado's future electricity demand almost static through 2050 and prices to grow only at the rate of inflation.⁷ Because of this, the values in the table should be regarded as marks of direction and relative magnitude rather than precise expectations. Renewable energy can supply the future demand of an electrified state on its own, but its effect on the price of electricity would be severe enough to cause long-term economic harm. Nuclear energy, conversely, produces an ongoing employment effect large enough to overwhelm the damage caused by its lesser cost pressure and create, on balance, major economic benefits. None of these results reflect investment during planning and construction phases, but these are also likely to favor nuclear energy.

⁵ Includes only jobs that support ongoing operations, not pre-operation planning or construction

⁶ In practice, planning and construction of new generating capacity takes years, so operating costs and benefits would not start accruing immediately. These scenarios are illustrative, not precisely descriptive, and cumulative modeling results vary little across different starting years.

⁷ This characterization appears to best represent the modeling software's underlying assumptions, however realistic, about the future of Colorado's utilities sector.

CONCLUSION

As Colorado's electricity demand grows amid pressure from new advanced industries and large-scale electrification, the costs of state energy policy to households and businesses will continue to magnify. Although rapid price increases are nearly inevitable, this report finds that nuclear power could meet the state's future demand for reliable clean electricity at a lower total cost than renewable sources, which dominate the sector's current trajectory. Under the modeled assumptions, nuclear energy would cost 21–24% less annually, impose less upward pressure on electricity prices, and support better long-term economic outcomes. Its comparatively small physical footprint and the many jobs it can create further strengthen its potential value to Colorado.

Officially recognizing nuclear power as a source of clean energy was an important step, but state law continues to favor renewable resources through mandates and financial incentives. Those preferences narrow the options available to utilities facing rising demand and ambitious emissions requirements. Nuclear energy requires substantial upfront investment and the benefits estimated here are only prospective, as Colorado has not hosted a nuclear plant since 1989; still, this report's findings support evaluating nuclear power on its full economic and technological merits, not just its high initial costs. Leveling its treatment under state law with that of renewable resources would give electric utilities the chance to do just that, giving Colorado more flexibility to meet its environmental goals while preserving reliability and addressing affordability.

APPENDIX: INPUTS AND ASSUMPTIONS

Complete List of Inputs/Assumptions and Their Sources		
Item	Value	Source
Capacity factor: coal	85%	National Energy Technology Laboratory ^{xxvi}
Capacity factor: conventional nuclear/SMR	93%	NLR ^{xxvii}
Capacity factor: solar power	30%	NLR 2024 baseline
Capacity factor: wind	41%	Xcel Energy ^{xxviii}
Capacity factor: geothermal energy	90%	U.S. Department of Energy ^{xxix}
Peak demand increase through 2050	13.3 GW	Colorado Energy Office
Planning reserve margin	16.3%	Colorado Energy Office
ELCC: coal	85%	PJM ^{xxx}
ELCC: conventional nuclear	95%	PJM
ELCC: SMR	100%	Xcel Energy ^{xxxi}
Average ELCC: solar power	6.3%	Xcel Energy ^{xxxii}
Average ELCC: wind	12%	Xcel Energy
ELCC: geothermal energy	95%	Idaho Power Company ^{xxxiii}
Capital cost per nameplate GW ⁸ : conventional nuclear	\$6,471,000,000	NLR 2024 baseline
Capital cost per nameplate GW: SMR	\$6,417,000,000	NLR 2024 baseline
Capital cost per nameplate GW: solar power	\$1,070,000,000	NLR 2024 baseline
Capital cost per nameplate GW: wind	\$1,342,000,000	NLR 2024 baseline
Capital cost per nameplate GW: geothermal energy ⁹	\$6,737,000,000	NLR 2024 baseline
Brownfield credit ¹⁰ : conventional nuclear	20%	NLR ^{xxxiv}

8 2030 T1 and/or advanced where available; 2022 dollars

9 Simple average of all advanced types

10 Moderate; because of the abundance of decommissioned and decommissioning coal-fired power plants in Colorado, this report's cost model assumes that new nuclear plants would be built atop extant grid-connected infrastructure and benefit from some corresponding savings; this credit is applied exclusively to the overnight component of NLR's capital-cost estimates

Brownfield credit: SMR	26%	NLR
Location adjustment ¹¹ : conventional nuclear	0.98	EIA ^{xxxv}
Location adjustment: SMR	0.98	EIA
Location adjustment: solar power	0.99	EIA
Location adjustment: wind	0.98	EIA
Location adjustment: geothermal energy ¹²	1.1	EIA
Real financing rate	5% ¹³	Assumption based loosely on NLR 2024 baseline
Capital-cost repayment period	30 years	NLR ^{xxxvi}
Inflation adjustments	Varies by input	BLS CPI ^{xxxvii}
Technical life: conventional nuclear	60 years	NLR
Technical life: SMR	60 years	NLR
Technical life: solar power	30 years	NLR
Technical life: wind	30 years	NLR
Technical life: geothermal energy	30 years	NLR
Land use per nameplate GW ¹⁴ : conventional nuclear	1 sq mi	California Energy Commission ^{xxxviii}
Land use per nameplate GW: SMR	0.06 sq mi	NuScale Power ^{xxxix}
Land use per nameplate GW: solar power	11.3 sq mi	NLR ^{xl}
Land use per nameplate GW: wind	3.6 sq mi	NLR ^{xli}
Land use per nameplate GW: geothermal energy	0.94 sq mi	NLR
Yearly fixed O&M cost per nameplate GW ¹⁵ : conventional nuclear	\$126,000,000	NLR 2024 baseline
Yearly fixed O&M cost per nameplate GW: SMR	\$118,000,000	NLR 2024 baseline
Yearly O&M cost per nameplate GW: solar power	\$16,638,816	NLR 2024 baseline
Yearly O&M cost per nameplate GW: wind	\$26,314,454	NLR 2024 baseline
Yearly O&M cost per nameplate GW: geothermal energy	\$135,306,901	NLR 2024 baseline
Yearly fuel plus variable O&M cost per GW: conventional nuclear	\$96,643,736	NLR 2024 baseline
Yearly fuel plus variable O&M cost per GW: SMR	\$106,926,312	NLR 2024 baseline

11 Multiplicative adjustments to capital costs based on geographical and economic factors in Colorado

12 Adjustment for Las Vegas; no Colorado location described

13 Nuclear energy's high capital cost makes it highly sensitive to uncertainty about financing rates, but CSI's model finds that it presents an overall cost advantage over renewables under real discount rates not exceeding 12%.

14 Approximate

15 2030 T1 and/or advanced where available; 2022 dollars

Capacity-replacement cost per kW _y : firm sources	\$168.55	Xcel Energy ^{xlii}
Nameplate storage cost per kW _y : renewable sources	\$215	Approximation based on NLR 2024 baseline ¹⁶
Round-trip battery efficiency	85%	NLR 2024 baseline
Transmission-cost proxy ¹⁷ : cost	\$2,000,000,000	Xcel Energy ^{xlii}
Transmission-cost proxy: coverage	5 GW	Xcel Energy
Transmission-cost proxy: capital recovery factor	75%	Assumption
Integration/balancing cost per MWh: solar power	\$0.72	Xcel Energy ^{xlii}
Integration/balancing cost per MWh: wind	\$2.84	Xcel Energy
Share of average retail electricity price represented by modeled costs	39.4%	xlv, xvii
Operating jobs per GW: conventional nuclear	500	U.S. Department of Energy
Operating jobs per GW: SMR	237	U.S. Department of Energy
Operating jobs per GW: solar power	36	U.S. Department of Energy
Operating jobs per GW: wind	80	U.S. Department of Energy
Operating jobs per GW: geothermal energy	740	Geothermal Energy Association ^{xlvi}
Operating jobs per 1.5365 GW of battery storage	92	Indiana Office of Energy Development

¹⁶ Assumes sufficient capacity replacement via 8-hour batteries; the Colorado Energy Office's "Pathways to Deep Decarbonization in Colorado's Electric Sector by 2040" mixes 4-hour and 12-hour battery capacity for similar purposes. Insofar as this proxy underrepresents the risks of extended peaks and/or energy shortages, it may be an underestimate.

¹⁷ Values from an approved Colorado project used to calculate transmission costs of new actual generation for each energy source

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