Colorado Electrification and Decarbonization Study

Prepared By:

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Prepared For:

Community Energy

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Disclaimer:

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Study Scope

- Determine the change of the electricity system in Colorado between 2020 and 2040 when the coal-fired power plants are retired. Further, investigate the impact of the high electrification and decarbonization of the Colorado economy.
- Compute the retail rates for average customers.
- Estimate the electricity generation and installed capacity within Colorado. Preform the modeling at 5-minute, 3-km resolution for the entire period of transition.
- Estimate the total number of FTEs within the Colorado electricity sector.
- Ensure that Colorado does not heavily rely on neighboring states for imported electricity during the transition.
- Calculate the differences between three scenarios: BAU, Retire Coal and Deep Decarbonization.

Approach

- Use the WIS:dom® optimization model to transition the Colorado electricity grid from 2020 to 2040.

- Constrain the modeling to WECC and dispatch the system at 5-minute intervals with a 3-km resolution for power plants. Do not allow extensive transmission buildouts (interstate).

- Perform three scenarios:
  1) Keep all current Colorado coal-fired power plants active until 2040;
  2) WIS:dom® to retire coal-fired power plants, while the remainder of the electricity sector is economically evolved;
  3) WIS:dom® will simultaneously reduce emissions within the electricity sector and electrify transport, heating and other sectors.

- Compare the three scenarios to determine the effect of the coal-fired power plant retirements, electrification and decarbonization.

- The WIS:dom® modeling tracks the installed capacities, retirements, generation, transmission build out, costs, emissions, resource adequacy, capacity value, electrification, and other metrics.

Overall Results

- All three scenarios were stable and feasible for WIS:dom® to find solutions from 2020 to 2040 for Colorado. This suggests that Colorado has a diverse potential suite of technologies for electricity generation.

- The pathway where WIS:dom® retires the coal-fired power plants is cheaper than keeping them online. This implies that retiring all coal plants is economic with the 20 year time frame. Further, the electrification and decarbonization results in the lowest retail rates for electricity, because of the high growth in electricity demand and low-cost wind and solar generation capacity.

- The coal-fired generation is ***replaced by a mix of wind, solar and natural gas***. When electrification and decarbonization is occurring, the natural gas is also replaced with wind, solar and storage.

- Average retail rates decrease over time with all scenarios. The most expensive was keeping all coal to 2040. The least-cost was the one where electricity incorporates other sectors and decarbonizes.

- ***Cumulative economy-wide emissions are less than half compared with the economy in the BAU scenario***. Retiring coal accounts for a third of the GHG emission mitigation.

Overall Results

- It is, on average, ***$209 million lower cost per year to retire ALL the coal plants in Colorado by 2040*** compared with keeping them all running (without electrification).

- The cumulative savings from retiring the coal fleet by 2040 and electrifying the economy is ***$4,810 million*** by 2040. This saving is net of the $1,873 million used on clearing the outstanding debt and non-depreciation on the coal power plants.

- ***By retiring the coal power plants by 2040, Colorado electricity stops the emission of 331 million metric tons of CO_2***. Moreover, it would stop many other health-harming pollution from being emitted. **By retiring the coal plants and using electrification, while decarbonizing the electricity sector, Colorado stops the emission of 1,034 million metric tons of CO_2.**

- Electricity is provided, without fail, for all of Colorado (at 5-minute intervals) when the coal power plants are retired. Natural gas, wind, solar and storage can provide power for Colorado without baseload generation.

- Cost estimates are from the NREL ATB 2019 (https://atb.nrel.gov/electricity/data.html).

Overall Results

- Electrifying transportation **saves Coloradans $15.6 billion by 2040**. This equates to approximately $678 million annually and $611 per vehicle.

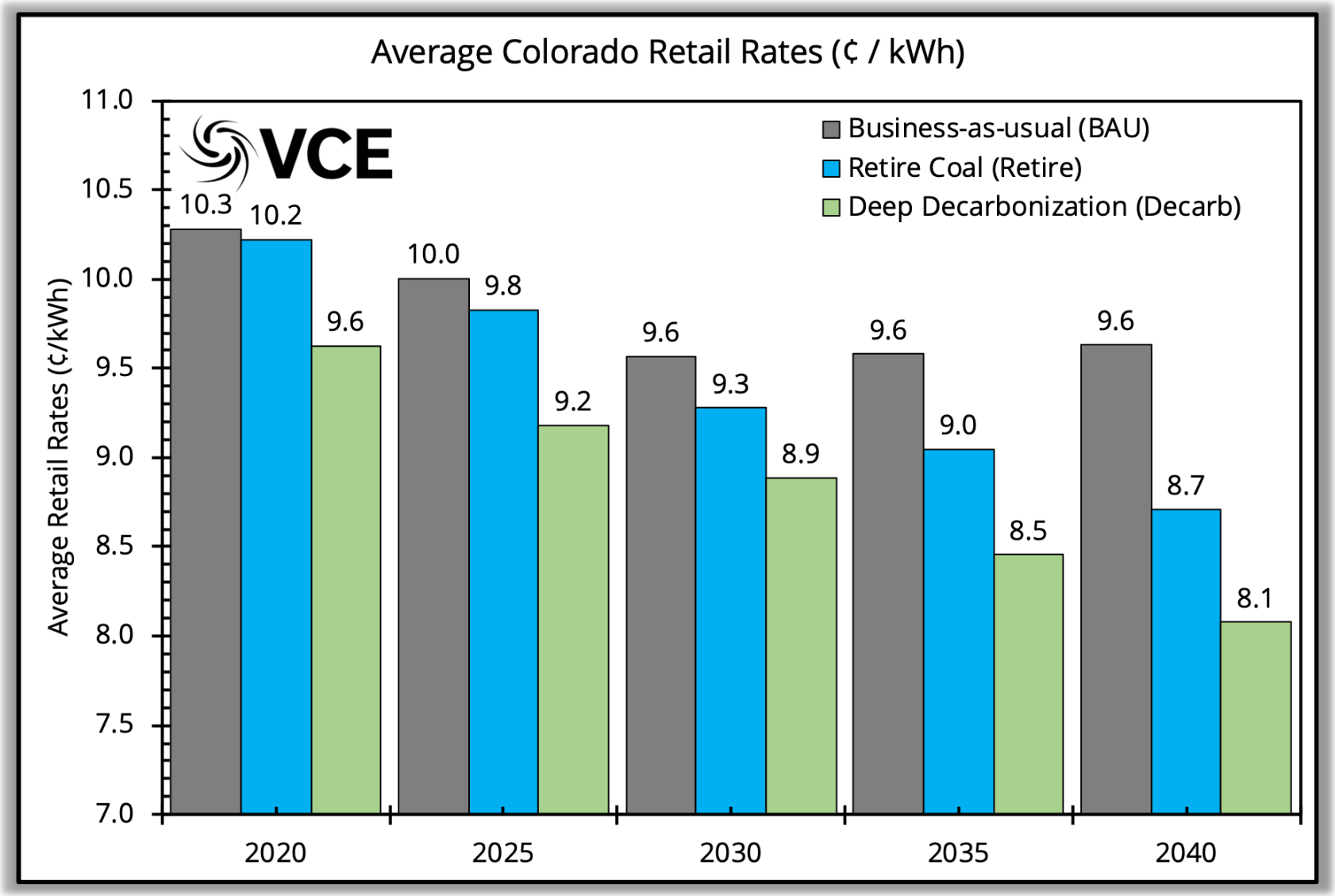
- Electrifying heating **saves Coloradans $9.7 billion by 2040**. This equates to approximately $424 million annually and $528 per heating customer.

- The reduction in electricity costs when electrifying and decarbonizing amount to $4.8 billion by 2040. Of that, $1.5 billion is invested in electrification, wind, solar and storage technologies. Thus, **a net saving of $3.3 billion**; or $97 per customer per year.

- ***Therefore, electrifying and decarbonizing benefits all Colorado customers in terms of electricity costs. More benefits are achieved if Coloradans electrify their transport (via an EV) and heating (via an ASHP).***

- WIS:dom® develops hydrogen facilities in Colorado to decarbonize some harder to reach sectors such as heavy trucking and some heating loads. By 2040, there is 200 MW capacity of electrolyzers to convert low-cost wind and solar to hydrogen.

Average Retail Rates



The deep decarbonization scenario (green) has the lowest electricity rates, such that those that do not electrify do not carry the burden of those that do.

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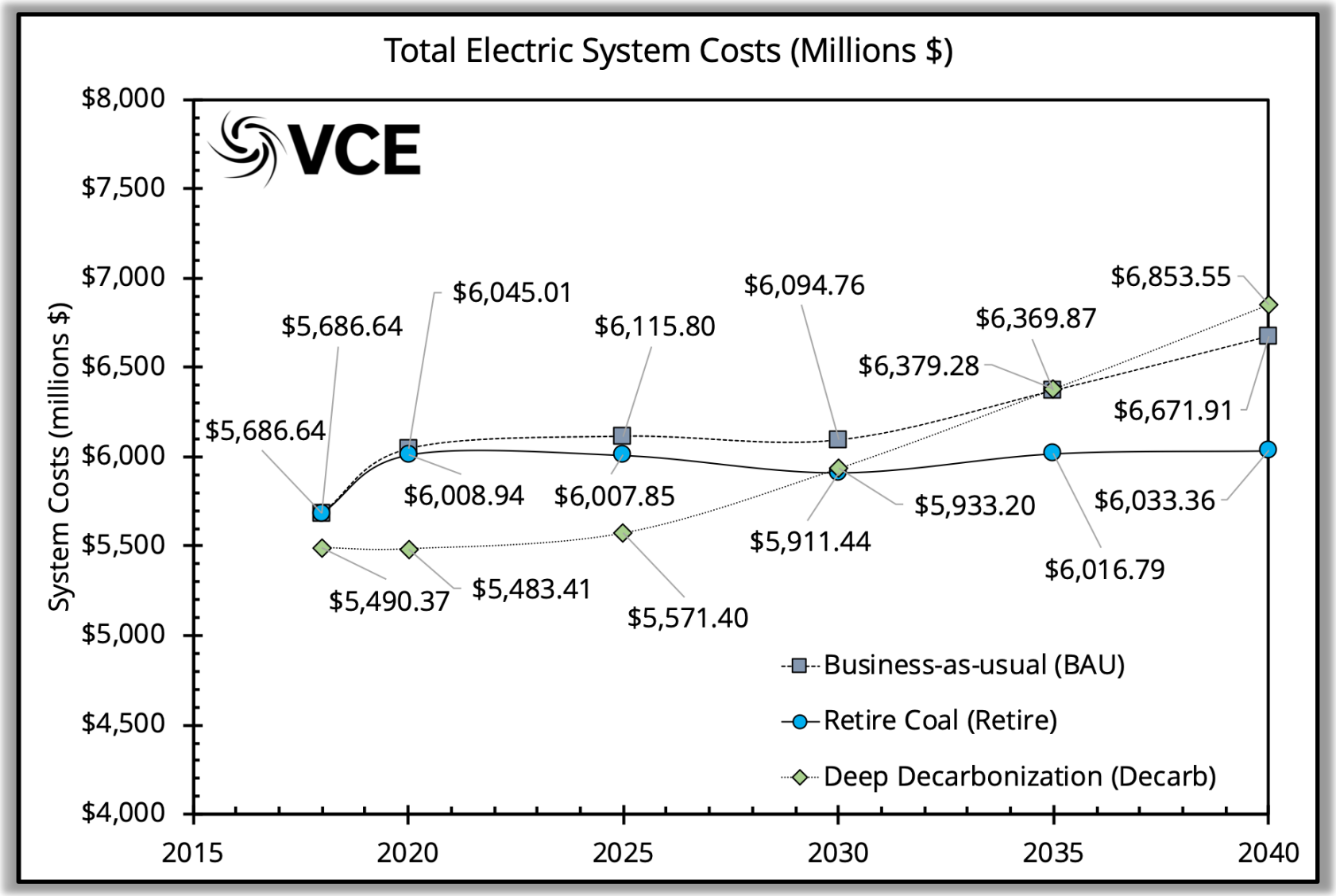
System Costs For Colorado Electricity Grid



Retiring coal in a gradual manner saves Coloradans $1.5 billion. The savings are used to accelerate clean energy in the deep decarbonization scenario that in turn leads to $4.8 billion in savings.

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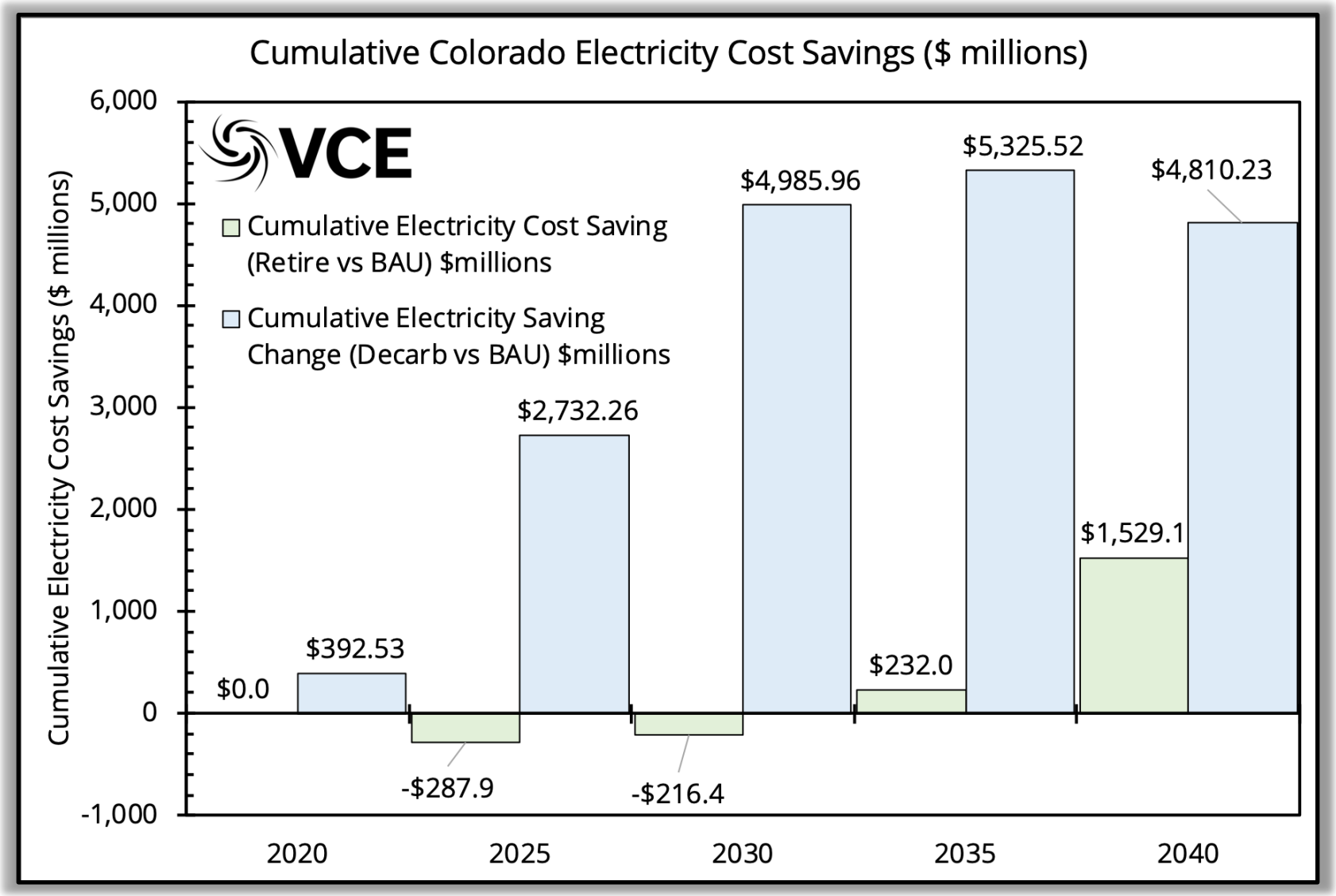
Electricity Savings from Coal BAU



The cumulative savings when retiring coal come later (green) when electrification and decarbonization is not done (blue)

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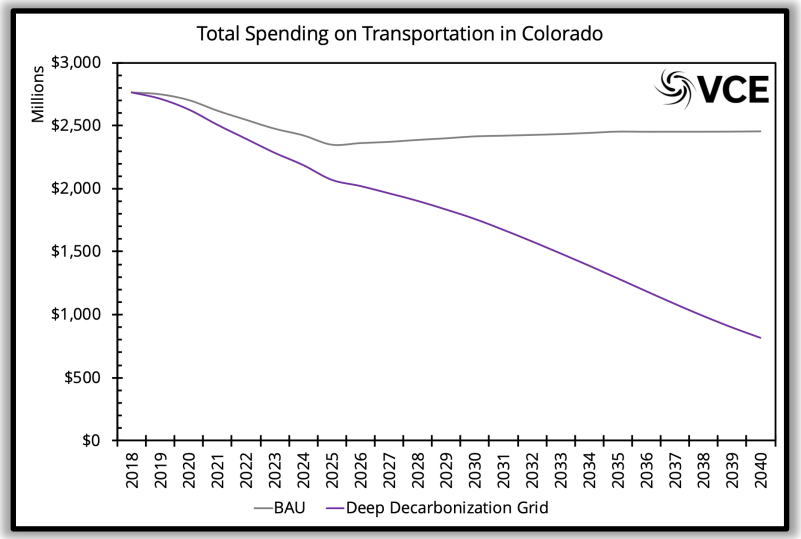
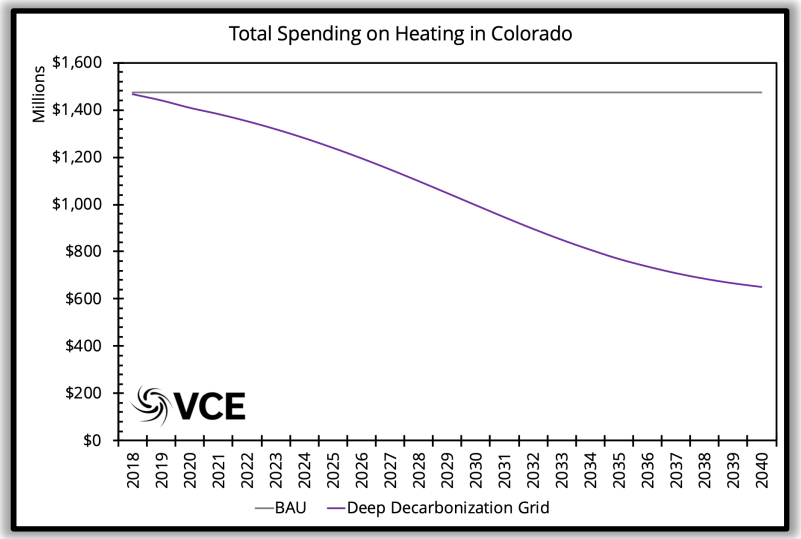
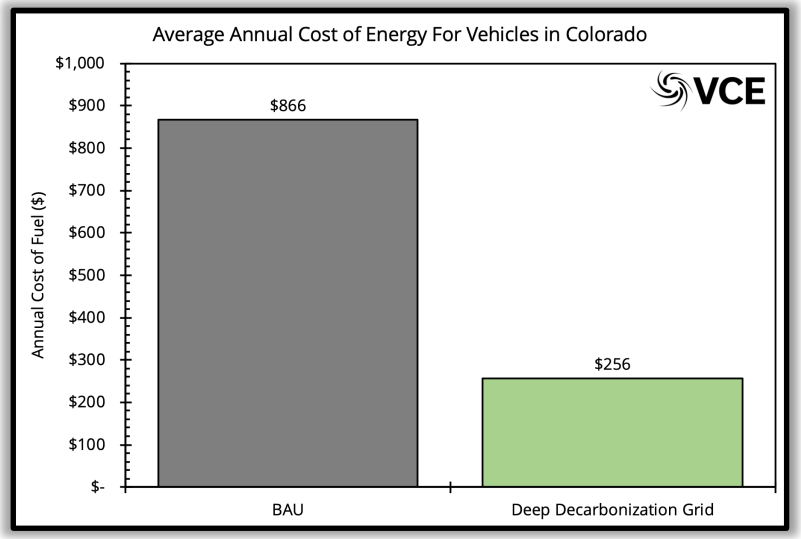
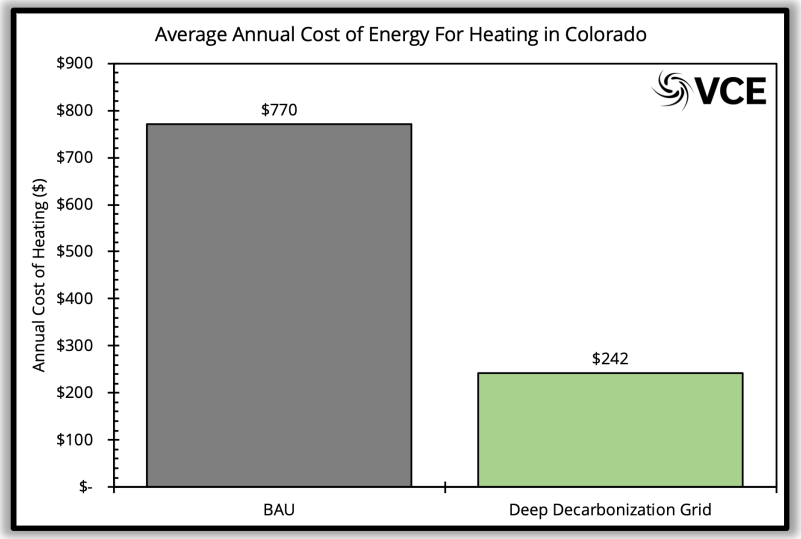
Transport & Heating Savings









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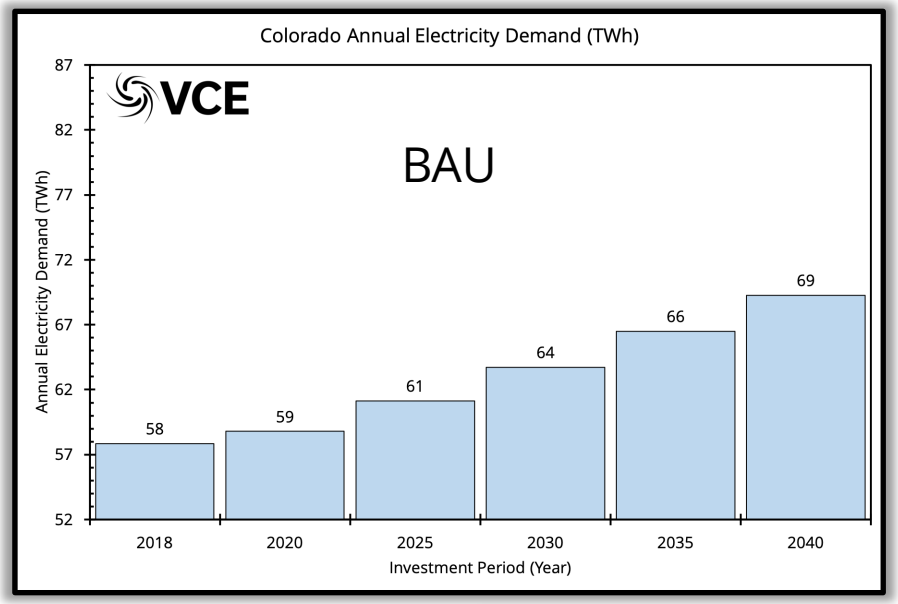
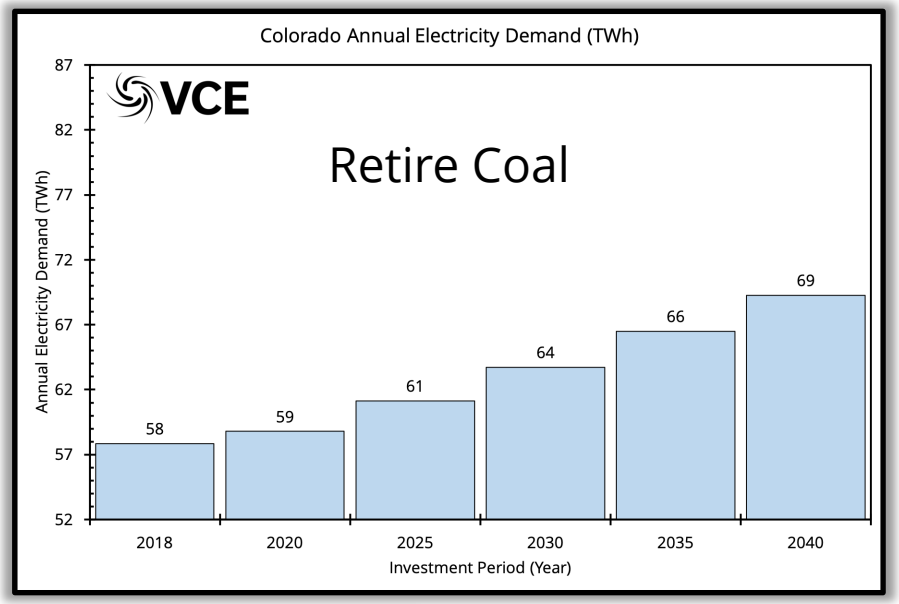
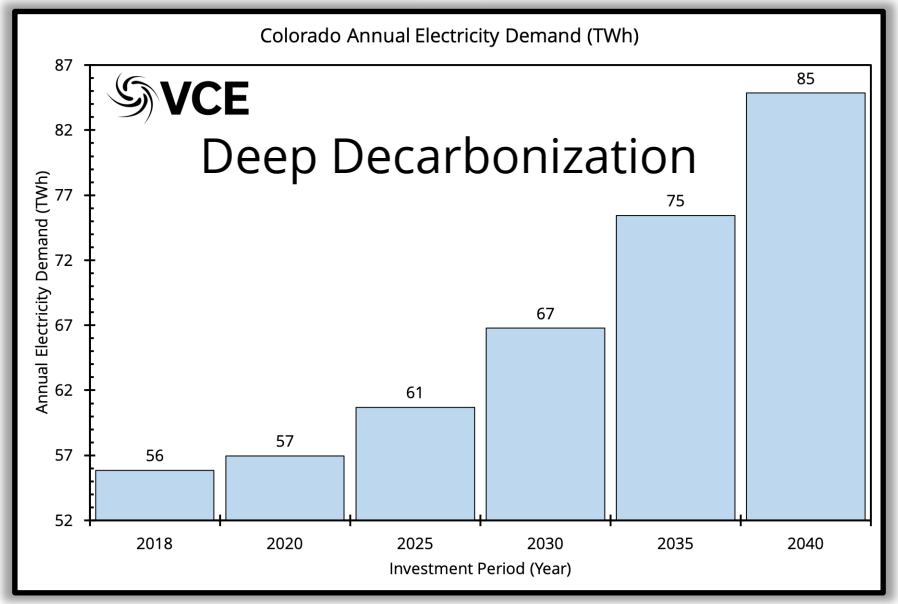
Electricity Demand







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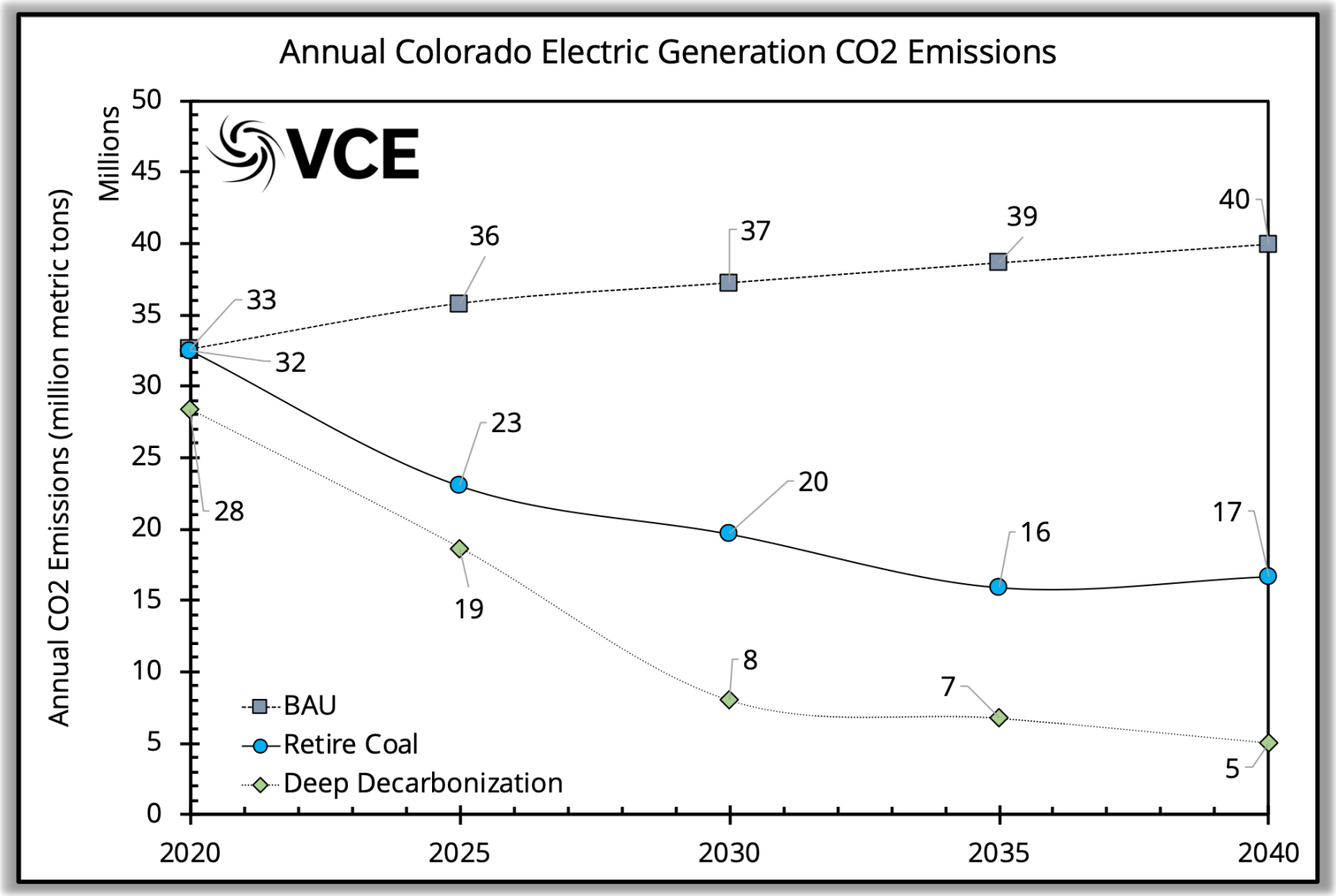
CO_2 Emissions From Colorado Electricity



The retirement of coal emits far less carbon dioxide and other health-harming pollutants. The deep decarbonization scenario emits the least, with fewer than 5mmT by 2040.

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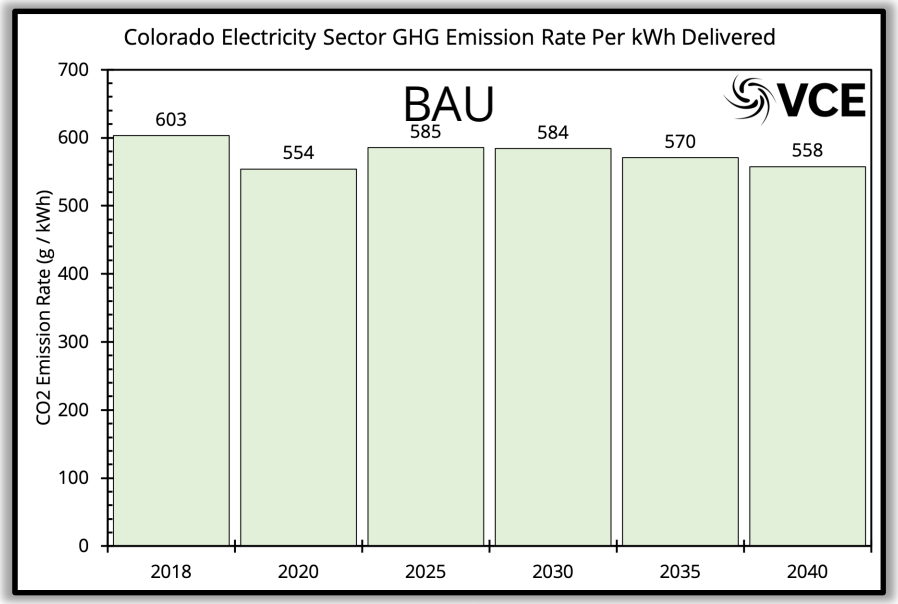
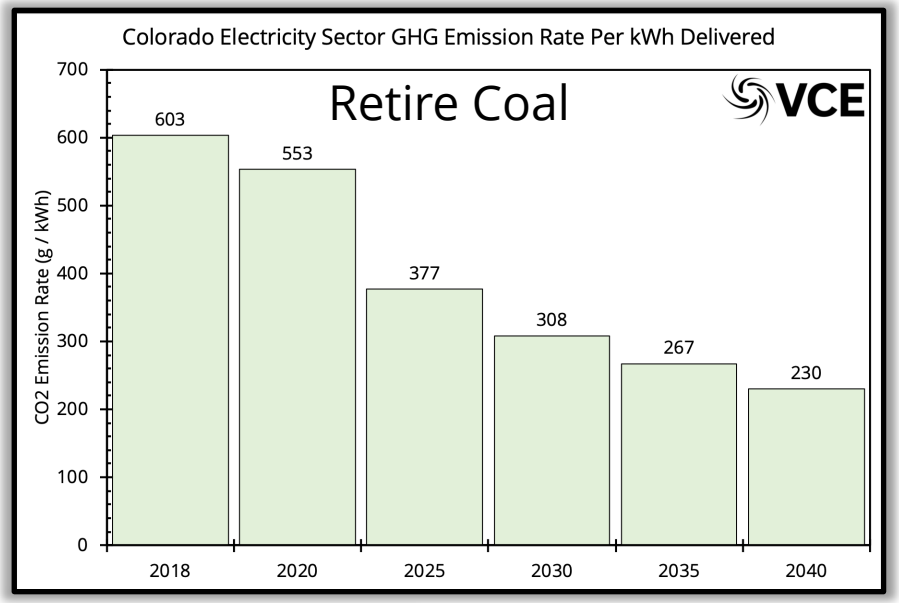
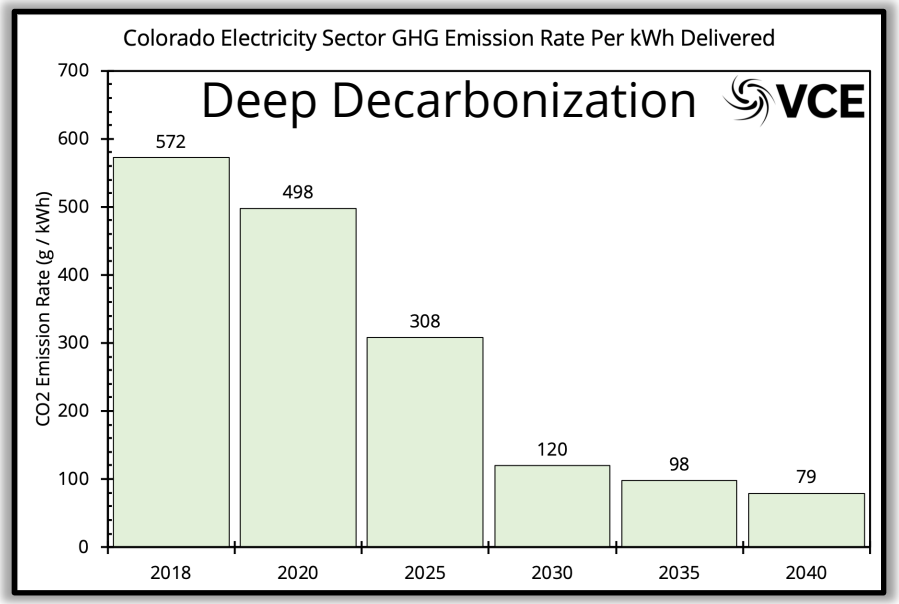
Electricity Carbon Intensity







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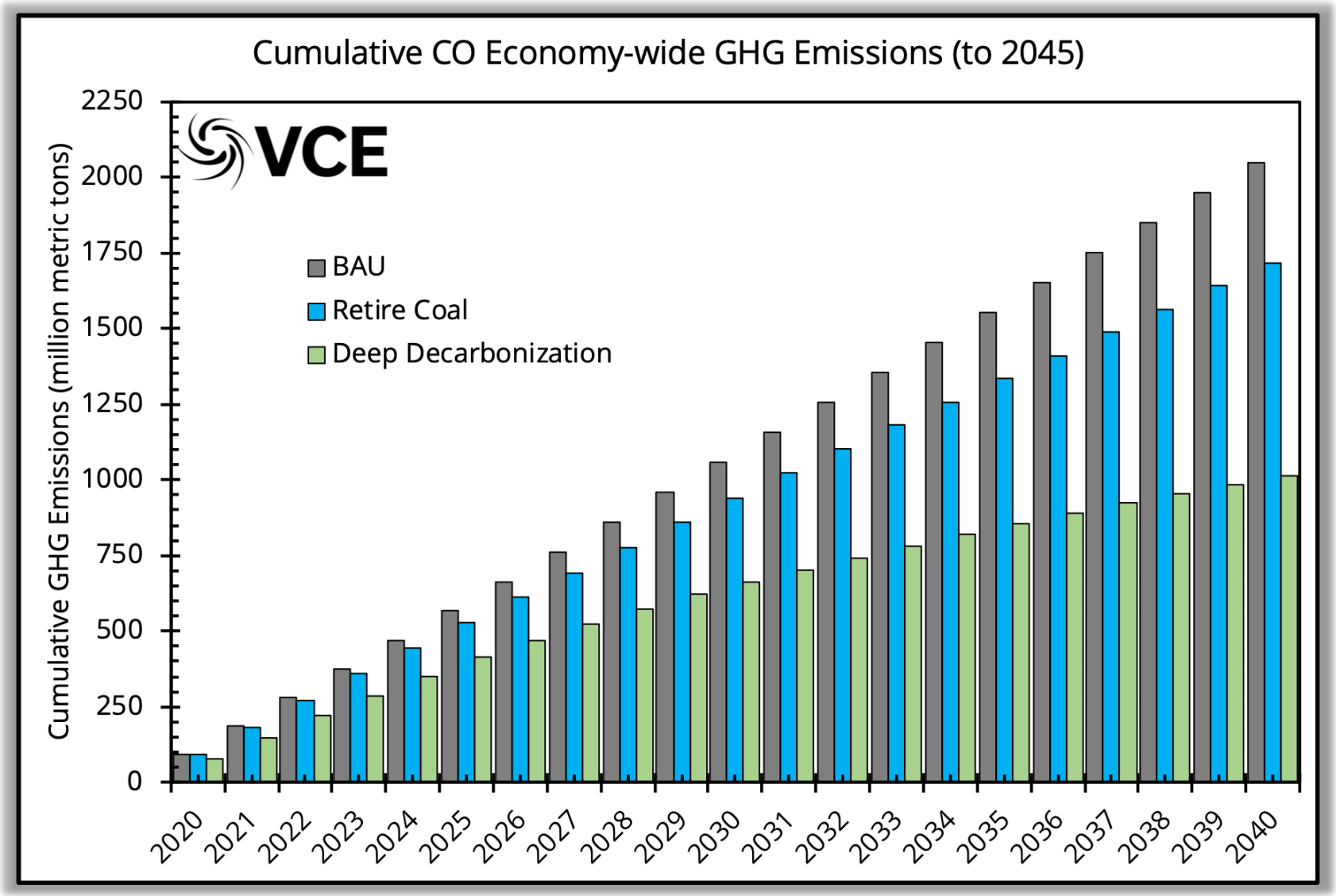
CO_2 Emissions From Colorado Economy



Carbon dioxide emissions fall by one third with the retirement of coal and fall a further two thirds under the deep decarbonization scenario.

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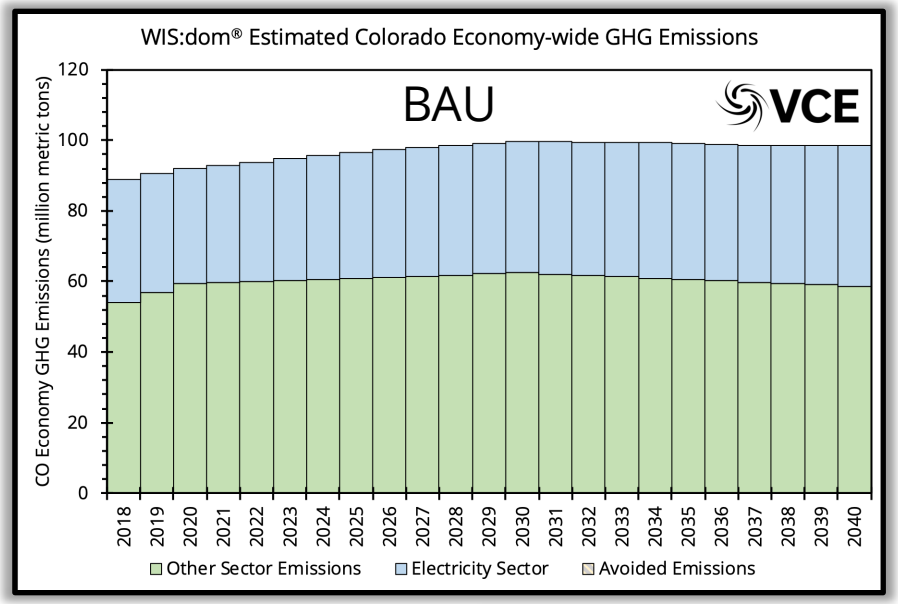
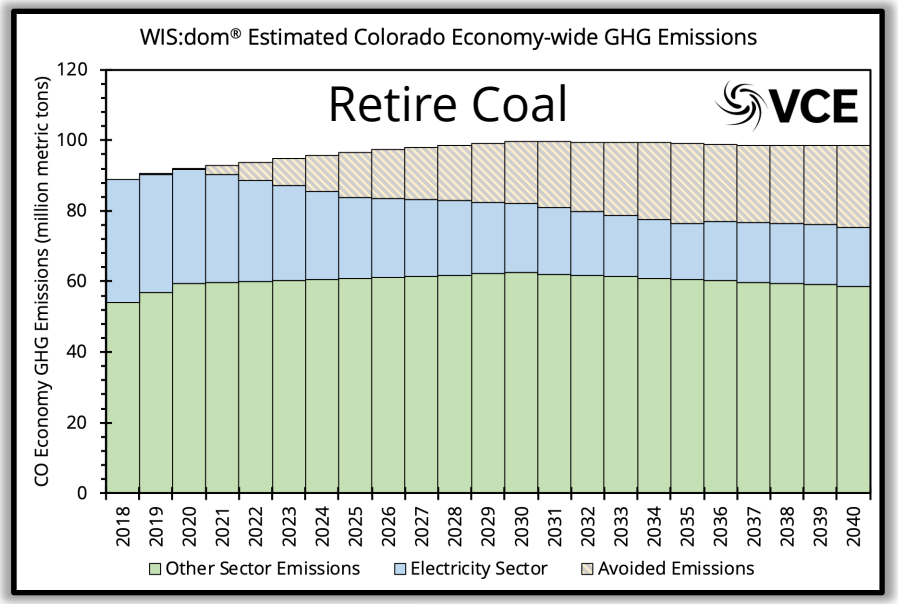
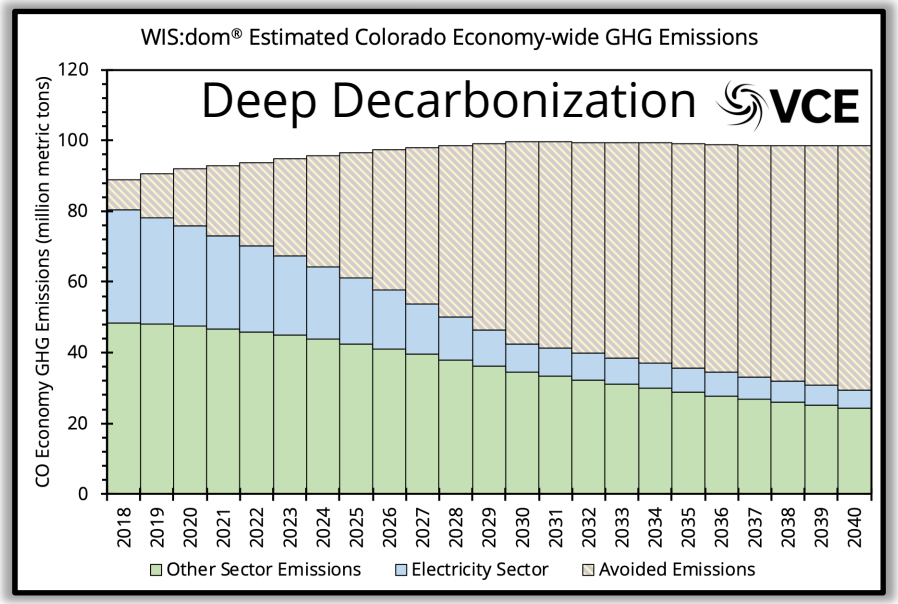
Economy-wide Emissions







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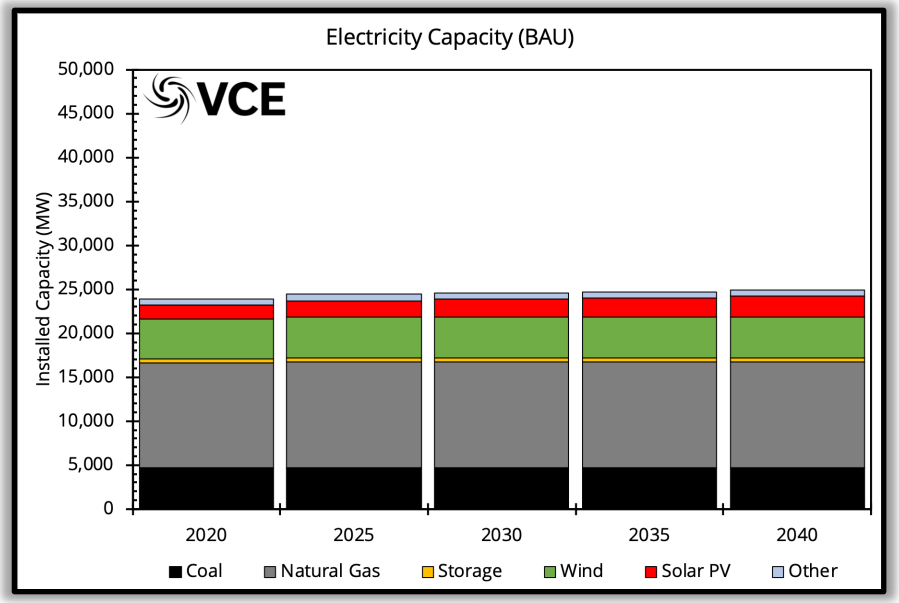
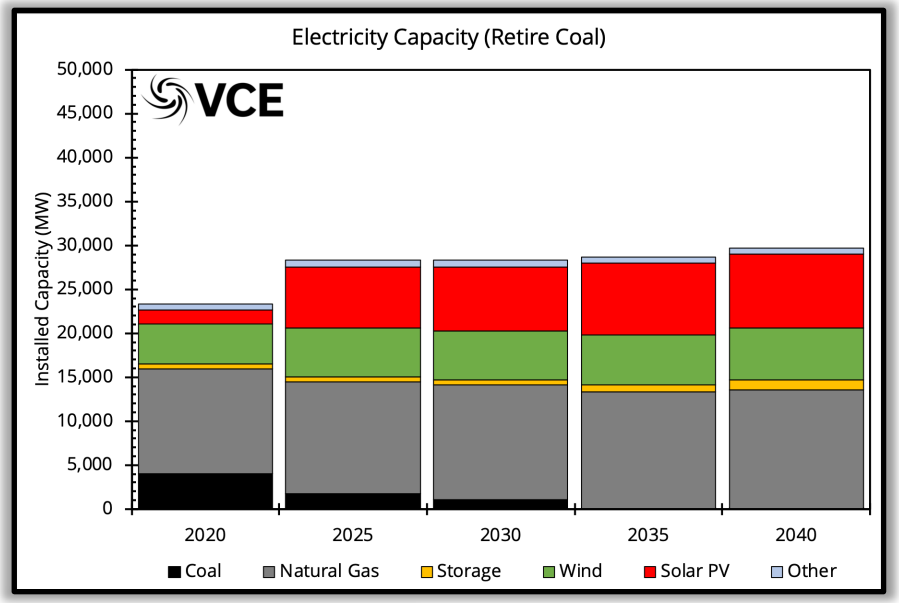
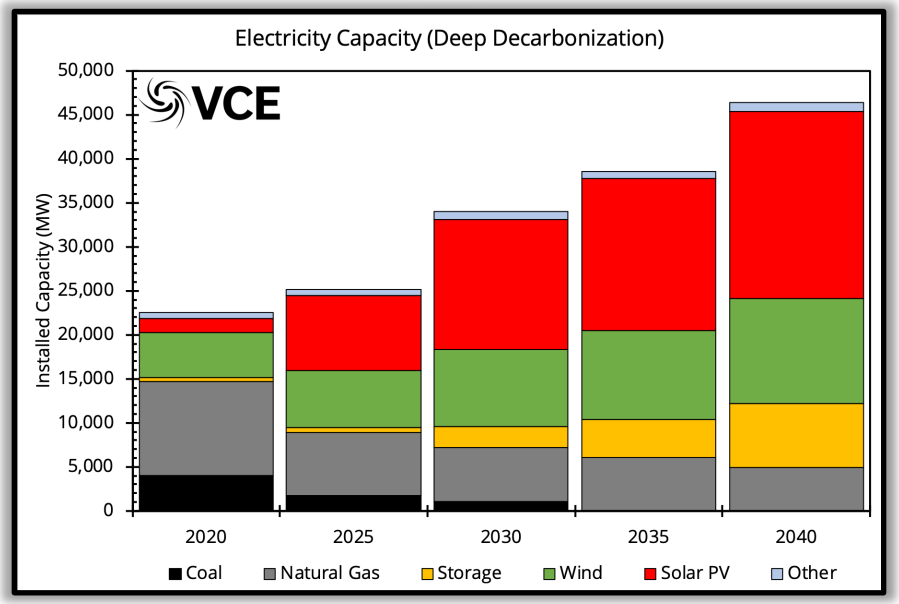
Installed Capacity For Each Scenario





The installed capacity in Colorado grows to replace the coal power plants when they are retired. Wind and solar are dominant in their increase in installed capacities. Natural gas also increases to provide flexible generation. For the deep decarbonization, solar and wind replace the natural gas



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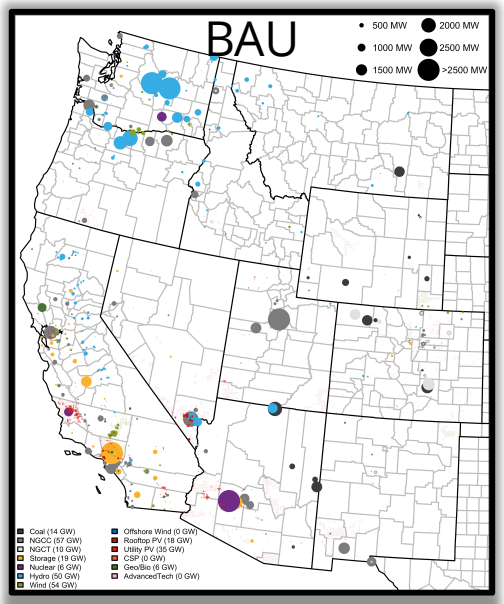
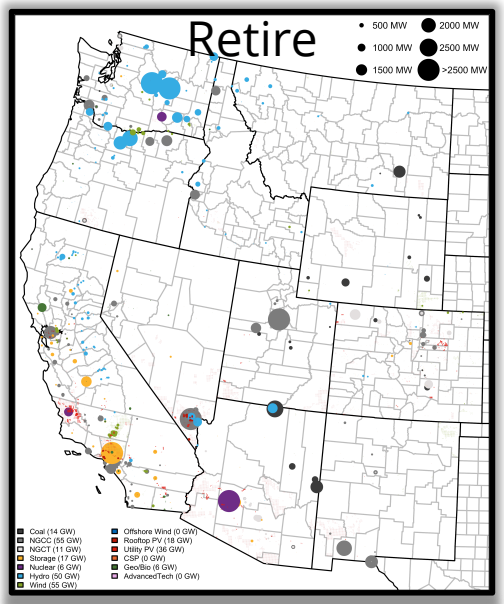
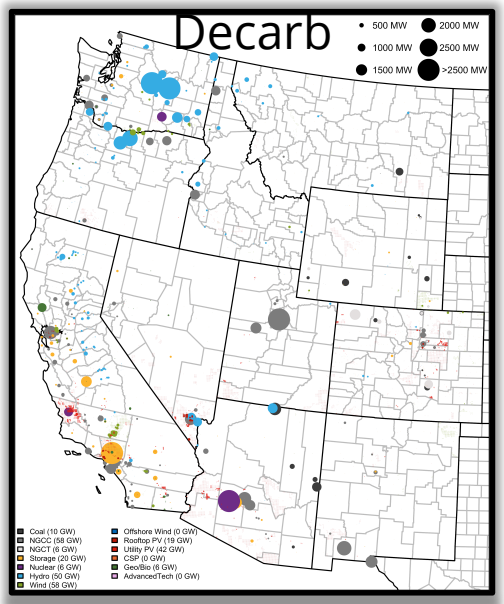
Installed Capacity For Each Scenario

2025

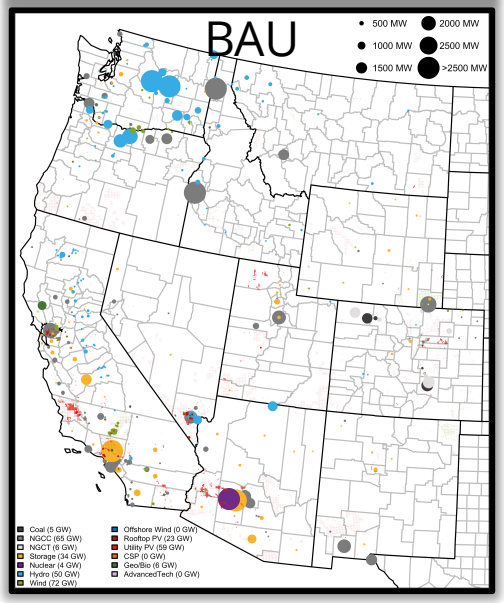


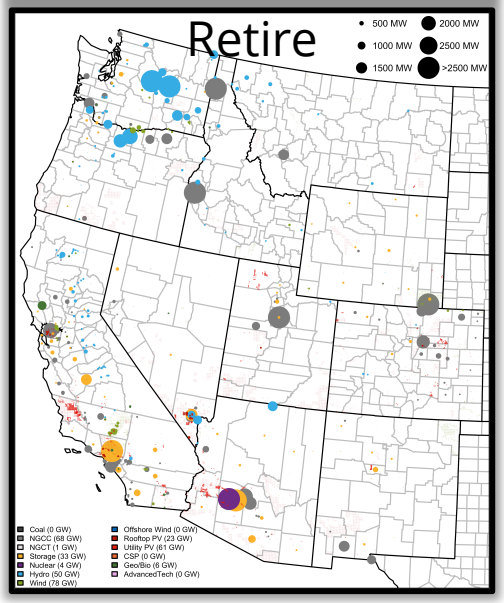


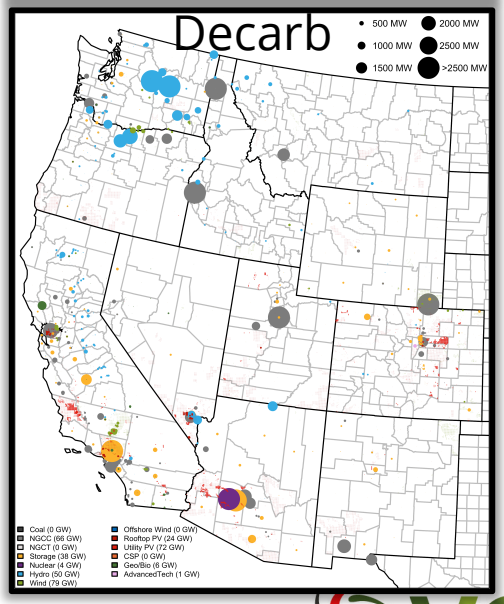


2025

2040







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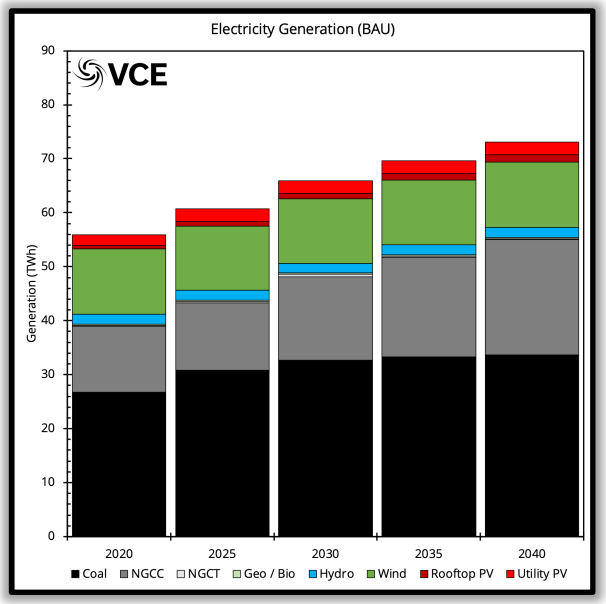
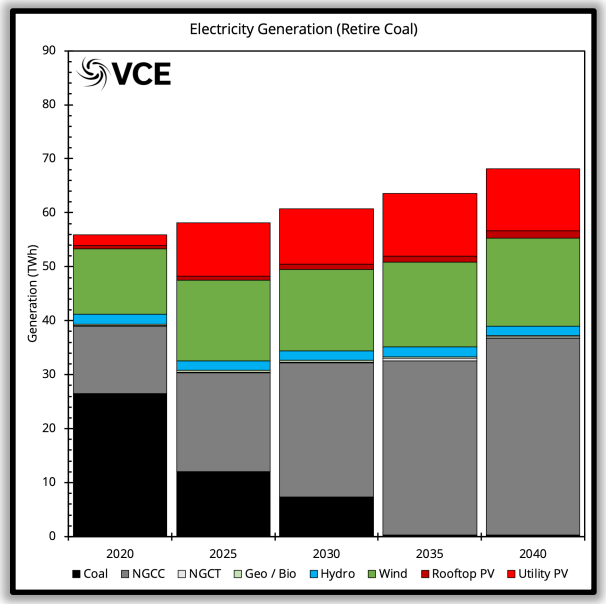
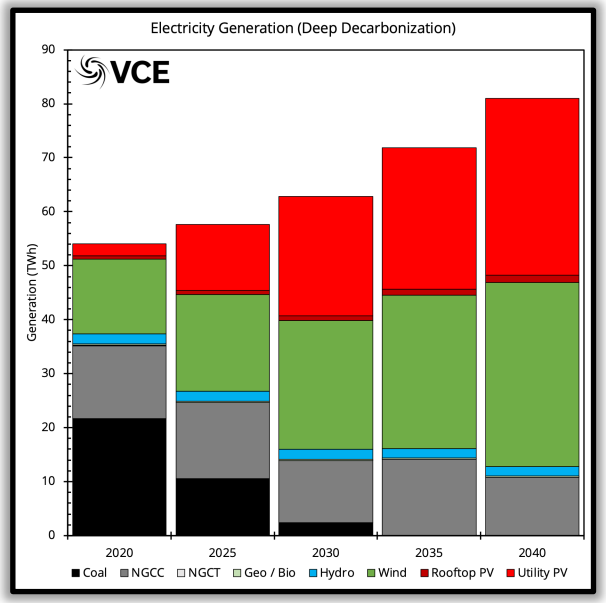
Electricity Generation For Each Scenario







The coal retirement generation is met with a combination of wind, solar and natural gas. Colorado has abundant resources and provides all the new generation from within State sites. Under the deep decarbonization natural gas is used to back up the wind and solar.

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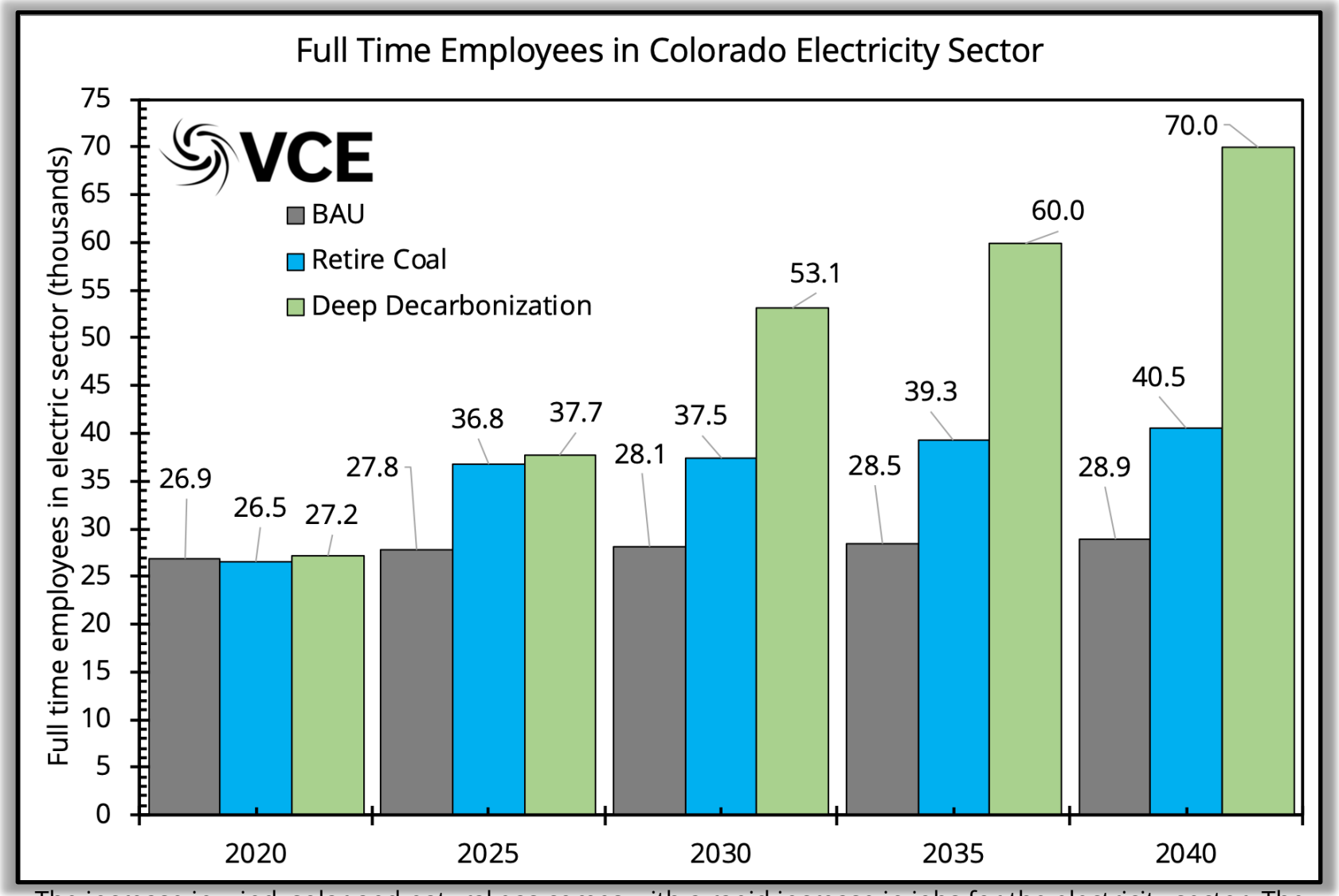
Employment For Colorado Electricity Sector



The increase in wind, solar and natural gas comes with a rapid increase in jobs for the electricity sector. The jobs provided are far greater than those lost through the retirement of the coal power plants.

Thank You

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