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FROM: Weld County, Garfield County, and the Western & Rural Local Governments
Coalition

DATE: November 12, 2020

SUBJECT: Colorado GHG Pollution Reduction Roadmap Public Comment

These comments to the Colorado GHG Pollution Reduction Roadmap (GHG Roadmap) are submitted on behalf of Weld County, Garfield County, and the Western & Rural Local Governments Coalition (collectively, the Counties). The Counties appreciate the opportunity to provide comment and for the extension provided. These comments have benefited from the input of Dr. Timothy J. Considine, a Distinguished Professor of Energy Economics at the School of Energy Resources at the University of Wyoming,¹ as well as from various scientists and engineers at Ramboll. This comment first addresses the Counties' economic concerns with the GHG Roadmap, next addresses technical concerns, and then briefly addresses legal and policy concerns.

1. Introduction

While the Counties laud the intent behind the GHG Roadmap and support the State's efforts to address climate change and reduce GHG emissions, the GHG Roadmap proposes intrusive intervention into the economy of Colorado without considering the costs of implementation nor the impacts on gross state product, employment, and income. More

¹ The views and findings expressed herein do not necessarily reflect those of the University of Wyoming.

specifically, the GHG Roadmap employs an accounting scheme that is fundamentally flawed and fails to capture the behavioral, economic and technological determinants of greenhouse gas (GHG) emissions. The effect of the recommendations will be economically devastating to the Counties and such a consequence should be accounted for and addressed in such an important policy document, as well as in any subsequent specific rulemakings undertaken in reliance upon the revised, final GHG Roadmap.

If Colorado pursues the unrealistic emission goals proposed in the GHG Roadmap, the likely result will be lower employment, income, and output in Colorado and an emigration of Colorado citizens to other states without such onerous emission targets.² Unilateral action by one state to reduce emissions without similar actions or commitments by other states and countries is unlikely to generate meaningful emission reductions nationally and perhaps even within Colorado given the influence of other states (and countries) on air quality in Colorado. In pursuing such a unilateral strategy, the State of Colorado risks incurring the costs of reducing greenhouse gas emissions without realizing global carbon emission reductions or their intended climate benefit.

The Counties recognize that Colorado is responding to political calls for “bold and decisive action;” however, the GHG Roadmap is aspirational, prescriptive, and inflexible. Instead, a more effective approach from an economic and environmental perspective is to pursue policies to reduce emissions iteratively and in full consideration of a given policy’s total costs and associated benefits. A more effective approach also adequately considers all manner of alternatives, evaluating relative costs and benefits. For example, policies to mitigate the associated impacts of climate change, such as forest fire prevention and water conservation, should also be considered as they may be particularly cost effective and impactful.

The GHG Roadmap prescribes solutions 30 years into the future based on uncertain or non-existent technologies, infrastructure, and resources. This is imprudent at best and it is highly unlikely such solutions will be viable years from now. Instead, the State should consider more iterative and adaptable approaches that rely on market forces to drive the most innovative, cost effective, and lasting solutions in lieu of what is currently outlined in the GHG Roadmap. Past

² The Counties also note that while the GHG emission targets are statutory, they are still targets, identified by the Legislature before any modeling or economic analysis was conducted. Any ultimate regulatory action codifying any target must still comply with the Colorado Administrative Procedures Act, including the requirements to evaluate alternatives and that any regulation have a rational costs-to-benefits relationship.

non-market attempts to address environmental issues, such as the US's failed past attempt to completely eliminate fossil fuels from the US energy portfolio, have failed due largely to the slow pace of technology, technologies' inability to keep pace with demand, and poor return on capital. Such lessons should be reflected in the final GHG Roadmap.

Colorado should pursue policies that achieve environmental benefit while also fostering a diverse and vibrant economy rather than pursuing a patchwork of standards and regulations driven by unrealistic goals set without significant input from impacted constituents. Enormous environmental progress has been achieved in the United States during the past 50 years. The path to an even cleaner energy future is unlikely to be achieved by overregulation. Experience has shown that economic and environmental progress is achieved when emission reduction goals are realistic, achievable, and market driven. The decentralized actions of millions of consumers and producers having the freedom to make their own decisions are the best means to achieving these ends, not the heavy hand of economy-wide state regulation.

Given the currently regulatory scheme in place, a focus moving forward on competition and reliance on market forces will be the most efficient and equitable means to achieving environmental ends. By shifting Colorado's energy supply towards non-fossil-fuel-generated electricity and away from end-use applications of low-carbon natural gas and petroleum fuels, the GHG Roadmap is vesting greater power in electric utilities that operate under rate of return regulations, which simply pass costs on to consumers and stifle lower-cost outcomes that competition would encourage. Many other states have deregulated their electric power generation sector and have established wholesale markets for electricity and in some cases markets for carbon permits or prices for carbon. *See* Christensen (2020)³. This approach stands in sharp contrast to the suite of standards and mandates implicit in the GHG Roadmap. Harnessing the flexibility and efficiency of market forces to achieve emissions reductions has worked in the past and will likely do so again in the future, if given a chance. The aspirational goals of the GHG Roadmap are unrealistic and if imposed rigidly could lead to a counterproductive economic decline while not materially contributing to global GHG emission reductions. Given the costs and technical challenges of reducing GHG emissions, a more

³ Christensen, E., B. Detterman, and K. Gruver, *FERC policy proposal may advance state efforts to price carbon emissions*, National Law Review, November 5, 2020 Vol. X, no. 310. Available at: <https://www.natlawreview.com/article/ferc-policy-proposal-may-advance-state-efforts-to-price-carbon-emissions>

gradual, market-based approach is the best path to ensure at least a modicum of economic growth and critical popular support that is so essential to environmental and economic success in the long-run.

2. Economic Concerns with the GHG Roadmap

a. Cost Effectiveness of the GHG Roadmap

The costs associated with implementing the suggestions of the GHG Roadmap are far higher than estimates of the costs that would result from emitting one additional ton of greenhouse gases into the atmosphere, known as the social cost of carbon, estimated to be realistic by the Obama Administration. As a result, there are more cost-effective ways to reduce emissions. This Section discusses why the costs of implementing HB-1216 are likely to be even higher than those estimated in the GHG Roadmap due to unrealistic assumptions, foremost among them the assumption of no constraints on the electricity distribution network and the presumption that implementing renewable gas targets is technically feasible and achievable. Additionally, the burdens of these higher costs and the presumed phase out of oil and gas production in Colorado will likely have disproportionately adverse impacts for income and employment in rural counties and will erode tax revenues for local government and special districts in these rural communities.

One major shortcoming of the GHG Roadmap is that there is not a clear discussion of its cost implications. To understand these costs, this Section computes the carbon abatement costs relating to the generation of electricity based upon the utility model results presented by the GHG Roadmap in their technical appendices.⁴ The cost of carbon abatement is defined as the additional costs in electricity divided by the emission savings estimated by the GHG contractor compared to their reference case. For example, the GHG Roadmap finds that under HB-1261 electricity costs increase by \$999 million in 2030 and CO₂ emissions would be 20.6 million tons lower compared to the reference case, which implies a carbon abatement cost of \$48 per ton. And according to the GHG Roadmap by 2040, electricity costs will increase by \$2.656 billion and emissions will fall by 21.1 million tons, again compared to the reference case. As a result, carbon abatement costs rise to \$126 per ton in 2040. Finally, as the 90 percent reduction goal is reached in 2050, electricity costs will increase by \$3.869 billion and emissions will fall by 14.37

⁴ The Counties note that additional costs would be required to implement recommendations in other sectors.

million tons compared to the reference case causing carbon abatement costs to increase to \$269 per ton. *See* Table 1.

Table 1: Carbon abatement costs from the GHG Roadmap⁵

Component	2030	2040	2050
Electricity costs in millions	\$999	\$2,656	\$3,869
Emission savings in million tons	(20.60)	(21.10)	(14.37)
Abatement Cost in \$ / MMT CO ₂ ⁶	\$48	\$126	\$269

The GHG Roadmap costs are compared to the social cost of carbon estimated by the USEPA (2017)⁷ during the Obama Administration in 2040 and 2050. *See* Figure 1. The social cost of carbon is the monetized measure of impact to society from the impacts of carbon emissions that adds the quantifiable costs and benefits of emitting a ton of carbon. This value can then be used to weigh the benefits of controlling emissions against costs of mitigating their impacts. The identified carbon abatement costs are much higher than the social cost of carbon because the GHG Roadmap has unrealistically ambitious goals to reduce greenhouse gas emissions. The widening gap between the abatement costs under HB-1261 and the social cost of carbon estimated in 2017 means that over time there are more cost-effective ways to either reduce emissions or mitigate their impacts.

While the carbon abatement cost of HB-1261 of \$48 in 2030 is slightly below the mid-range social cost of carbon of \$61, the gap widens considerably under the more ambitious targets after 2030. For example, the carbon abatement costs under HB-1261 are \$126 per ton in 2040 – more than 20% and 73% higher than the high and mid-range estimates for the social cost of carbon respectively. In 2050, the carbon abatement costs, once again based upon the GHG Roadmap’s own estimates, is more than three times higher than even the high estimate for the social cost of carbon. Based upon their own estimates, the GHG Roadmap is very expensive

⁵ These estimates are calculated based upon the results reported in the Excel spreadsheets on the GHG Roadmap website.

⁶ The Colorado Electricity Results Spreadsheet defines GHG emissions as “MMT CO₂.” It is unclear to the Counties as to whether methane is included in the electricity model. The social cost of carbon determinations outlined in this comment do not account for methane as methane was not specifically provided in the Spreadsheets.

⁷ US Environmental Protection Agency (2017), *The social cost of carbon: Estimating the benefits of reducing greenhouse gas emissions*. Available at: https://19january2017snapshot.epa.gov/climatechange/social-cost-carbon_.html

means to reduce GHG emissions. Moreover, the costs of the GHG Roadmap are likely to be much higher as Section (b) below demonstrates.

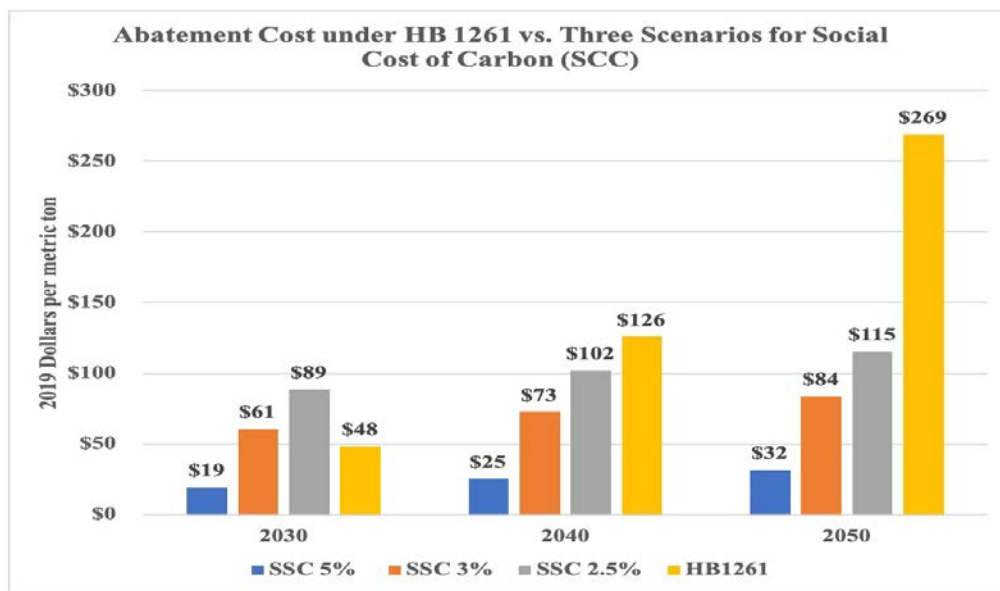


Figure 1: The social cost of carbon and carbon abatement costs under HB-1261

b. Why the GHG Roadmap Implementation Costs are Likely Much Higher than the estimates under the GHG Roadmap

The previous Section demonstrates that even using the GHG Roadmap’s own estimates, the costs of implementing the GHG Roadmap’s emission targets are much higher than estimates for the social cost of carbon. The analysis supporting the GHG Roadmap, however, makes several unrealistic assumptions that will likely lead to even higher implementation costs.

The first unrealistic assumption made by the GHG Roadmap is that there are no constraints on the electricity distribution network. This is not true now or for the foreseeable future. For example, Sahoo, et al. (2019)⁸ found that widespread adoption of electric vehicles will require significant investments to upgrade the electricity distribution network. The size and cost of these investments depends to a considerable extent on when consumers switch to electric vehicles. Sahoo et al. (2019) also note that consumers may have to change their behavior,

⁸ Sahoo, A, K. Mistry, and T. Baker (2019), *The costs of revving up the grid for electric vehicles*, Boston Consulting Group. Available at: <https://www.bcg.com/en-us/publications/2019/costs-revving-up-the-grid-for-electric-vehicles>.

shifting their charging of electric vehicles to avoid spikes in power consumption during peak demand periods.

The GHG Roadmap also assumes widespread adoption of heat pumps in the residential and commercial sectors. Based upon data from the Trane Corporation, heat pumps may not be technically feasible or cost effective in Colorado's cold climate, *see* Figure 2, especially in mountainous areas of the State. If this is true, then Colorado consumers may be forced to install electric furnaces, which are inefficient and very costly to operate. Moreover, this additional load would place further strain on electricity networks and threaten the reliability of the electricity grid.

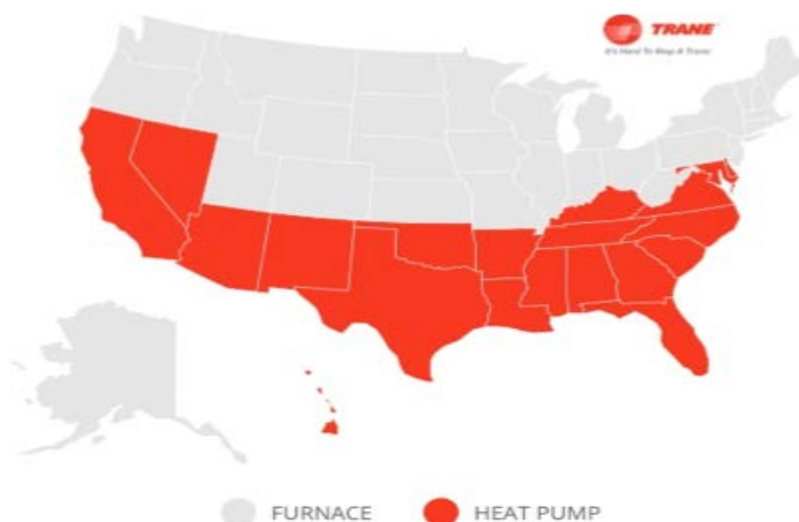


Figure 2: Heat pumps versus furnaces by region in the US

Another unrealistic assumption in the GHG Roadmap is that renewable gas targets are technically feasible. The current natural gas pipeline infrastructure is not compatible with hydrogen, which corrodes plain carbon steel pipe and requires expensive high-alloy steel pipe. To utilize hydrogen, an entirely new pipeline system would have to be installed, which is very costly and suffers from even greater regulatory barriers than the installation of natural gas transmission lines. Moreover, the potential supplies of replacement gas from biogenic sources, such as landfills, sewage treatments plants, and livestock feeding operations, are much less than the amount of natural gas currently consumed by homes and businesses in Colorado.

Further, the GHG Roadmap also does not estimate the significant installation and adjustments costs incurred by homeowners, landlords, and businesses to switch from natural gas,

propane, and other refined petroleum fuels to electricity. In addition, electricity is not necessarily the most efficient or effective end-use energy source. Many applications, such as residential heating, industrial/commercial steam production, and remote power applications are far more efficient using gas-fired sources than using electricity. These capital and operating costs are likely to be significant and are not included in the electricity rate base, which is the only sector modelled in the GHG Roadmap.

As previously illustrated and discussed above, using E3's own estimates for the additional costs for electricity and their estimated emission reductions under HB-1261, the carbon abatement costs are far higher than the costs of mitigation or the benefits from reducing emissions. This disparity between costs and benefits would be even wider if the direct costs for upgrades to the electricity grid, heat pumps, and electric furnaces, and renewable gas standards are added. Households and businesses pay for these costs and, as a result, would be forced to adjust their budgets and spending accordingly. These cost burdens will have very significant ramifications for the economy of Colorado.

c. Economic Impacts on Colorado's Economy

Higher energy costs act as a tax on households and businesses. As a consequence, consumer spending on non-energy goods and services must decline. Similarly, businesses adjust by either passing these costs on to customers or cutting costs, such as decreasing payrolls and supplies. These adjustments have indirect or multiplied effects via supply-chains on other sectors of the economy. Finally, these indirect effects induce changes in household income as employment and wages adjust to accommodate higher energy costs to achieve the emission reductions sought under the Roadmap. The E3 model does not account for these demand-side economic impacts.

There are significant oversights on the supply-side as well, involving the economic impacts from a dramatic reduction in projected fossil fuel production in the State of Colorado, which is implied by Figure 3, reproduced from the GHG Roadmap. The significant economic impacts from this decline in production are not estimated by the GHG Roadmap. Such a decline would lead to lower severance and mineral property tax income to local governments and special districts, especially in less economically diverse rural economies. Lower production activity and tax revenues would reduce employment and income in rural areas as well. These impacts are important and disproportionately impact rural communities. As such, they should be estimated

and addressed in the GHG Roadmap before rulemaking or legislation might be undertaken in reliance on the GHG Roadmap.

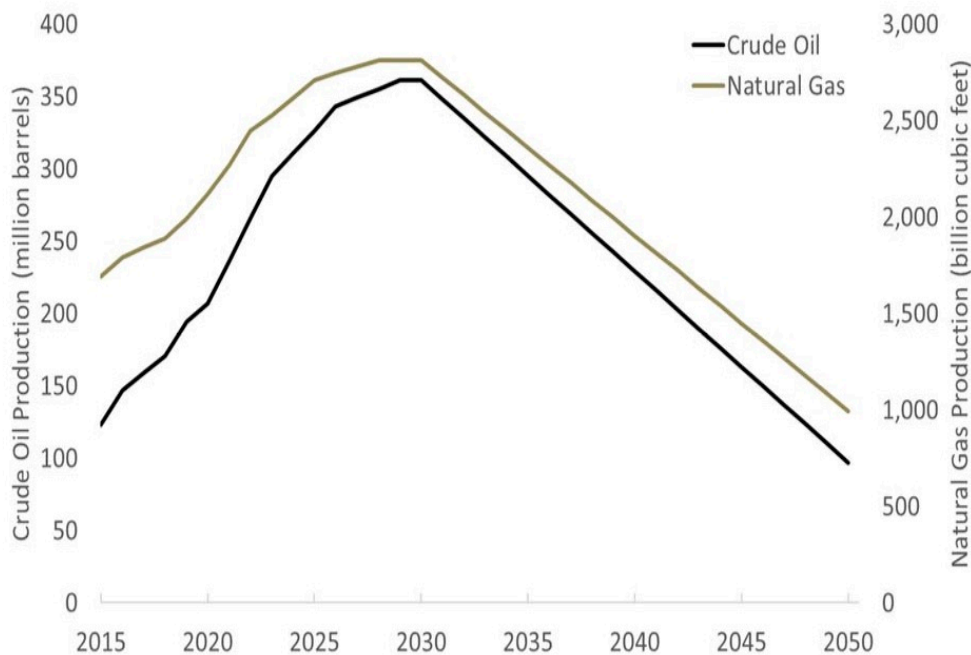


Figure 3: Colorado crude oil and natural production, 2015 - 2050

3. Technical Concerns with the Underlying Analysis in the GHG Roadmap

Notwithstanding the economic implications of the proposed GHG Roadmap, there are critical flaws with the GHG emissions models supporting the analysis used to inform the GHG Roadmap's recommendations. First, there are several concerns and limitations with the Colorado Statewide GHG Inventories for 2005 and 2015 which serve as the baseline for tracking emissions reductions for the GHG Roadmap against the targets established in HB-1261. Second, the E3 RESOLVE utility model, which is the main engine for driving the GHG Roadmap's recommendations for transitioning Colorado to electricity over all other forms of energy, makes oversimplified assumptions about the current and future operation of Colorado's electricity grid and the need for new infrastructure for renewable energy such as wind and solar. Finally, E3, CEO and CDPHE's overall approach to assessing the current and projected GHG emissions lacks transparency into the methods and the impacts of critical assumptions on the results of the GHG Roadmap. This limits the ability of policymakers and stakeholders to make informed

decisions about critical climate policies. The following sections will describe these critical flaws in more detail.

a. Limitations of the Colorado Statewide GHG Inventory

The State needs a robust baseline to make projections and decisions to meet State GHG goals. The GHG Roadmap relies on a baseline inventory, the Colorado Statewide Inventory (CSI) which is informed by the Colorado-specific Oil and Gas Inventory (O&G Inventory) and the EPA's State Inventory Tool (SIT) for other sectors. The Counties have significant concerns about the CSI and the inventories underlying it.

The SIT, which provides emission baselines for non-oil and gas sectors and informs the CSI, has significant limitations that compromise its precision and accuracy. Of particular note:

- The default emissions data in the SIT is generated from national data, not state or local data. The SIT default data uses emissions from the EPA Inventory of U.S. Greenhouse Gas Emissions and Sinks 1990-2018 Inventory Report (US GHG Inventory).⁹ From here, SIT allocates emissions data to states using estimates by sector. As a result, any data generated using the SIT is inherently imprecise and uncertain. However, the SIT default data does not quantify the uncertainty, making the data itself static and less reliable.
- The US GHG Inventory—the basis for the SIT—is incomplete because it does not account for all sectors. It also lags current emissions by 3-5 years (the most current data included is from 2015). As a result, reliance on this older data may be misplaced where affected sectors may have already implemented significant voluntary or mandate emissions controls (as is the case for the Colorado oil and gas industry).

The CSI more broadly also contains significant limitations compromising its efficacy as a baseline of emissions data. First, the CSI is informed by the O&G Inventory which was updated in 2005 and 2015 to incorporate more precise fugitive emissions data and to reduce previous uncertainty. In contrast, the GHG inventories from other sectors included in the CSI (e.g., electricity, buildings, transportation) were not updated to the same level of granularity. Instead, they merely rely on generalized state inventory data and the SIT assumptions, thereby making comparisons between oil and gas sector emissions and other sectors problematic. Second, the CSI also excludes emissions from certain sectors (such as biogas, industrial wastewater

⁹ Available at: <https://www.epa.gov/ghgemissions/inventory-us-greenhouse-gas-emissions-and-sinks>.

treatment, municipal waste-to-energy, and land use) due to insufficient data from these sectors, skewing the CSI towards sectors that have more data. This mean that sectors with robust data will bear the greater burden of deeper reductions than other sectors to make progress toward meeting the HB-1261 targets. Ultimately the GHG Roadmap makes recommendations assuming both significant accuracy of sector by sector emissions in the CSI and that it is appropriate to compare emissions between sectors. Yet the CSI contains inherent inaccuracies and does not quantify the uncertainty or quality of the data. Any recommendations based on CSI data in the GHG Roadmap should address that the CSI may overestimate or underestimate emissions and accordingly should make recommendations with some flexibility that account for potential inaccuracies of the underlying baseline data.

Third, the CSI has also not been externally verified by a third party. However, other state inventories, such as California and Minnesota, have had their emission data verified by a third party.¹⁰ The Counties believe that the CSI should be similarly verified in order to promote the transparency and validity of the CSI.

It is also important to note that the GHG Roadmap relies on the current CSI. However, Colorado GHG mandatory reporting, commencing in March 2021 as required by Colorado AQCC Regulation No. 22, could increase the accuracy and granularity of the forthcoming CSI and influence the required reductions to meet state goals. Ultimately, Colorado will soon have access to new and more precise GHG data, which will inevitably shift the baseline inventory and as such using only current CSI baseline data is unduly limiting. The GHG Roadmap should make recommendations that accommodate such additional and changing data.

Significant decisions that will affect the state economy for the next three decades are being contemplated based on the CSI. Given the critical importance the GHG baseline inventory in setting targets as well as identifying, evaluating, and selecting reduction strategies, the Counties believe that before the GHG Roadmap is finalized, the AQCC's GHG Subcommittee must address the significant concerns with the baseline inventory and prepare a more complete and transparent baseline inventory that properly discloses underlying methods and assumptions, and is adjusted for inherent uncertainty. From there, the GHG Roadmap recommendations will need to be revised in light of an updated, more accurate baseline. In its current form, the current

¹⁰ CDP, *2018-2019 Full States and Regions Dataset*. Available at <https://data.cdp.net/States-and-Regions/2018-2019-Full-States-and-Regions-Dataset/hmhn-9g99>.

baseline is insufficient to inform, let alone justify, the Roadmap’s recommendations which will differentially penalize certain sectors of Colorado’s economy.

b. Limitations to E3 RESOLVE Utility Modelling

One of the key recommendations of the GHG Roadmap is to “transform Colorado’s economy” from a portfolio of diverse energy assets to electricity as the only means to reduce GHG emissions by 2030 and 2050. This is a daunting task that would require monumental shifts in the Colorado economy. As we have stated above, this recommendation has large implications, likely by design, for the oil & gas sector—a core industry in the Counties that contribute significantly to their economic well-being. This transformation is simulated in the RESOLVE utility model, which attempts to use linear regression to select the optimal energy sources to meet specified requirements which, in this case, are the HB-1261 targets. The Counties have identified below their major concerns with this utility modeling approach undertaken by CDPHE’s contractor, E3.

First, the RESOLVE model is oversimplified and contains inappropriate assumptions. Specifically, the model represents Colorado as a single zone and assumes “the Colorado system is islanded without electricity traded and transferred between Colorado and other states *given the transmission capability between Colorado and other states is limited.*”¹¹ (Emphasis added). The model does not account for potential leakage from using lower cost energy sources from other states to meet demand. Further, it incorrectly does not account for the fact Colorado is a net importer of energy, and instead, only considers Colorado-based generation. However, EIA data¹² shows 9% and 7% of Colorado’s electricity supply was from net electricity imports in 2015 and 2018, respectively. Additionally, although the GHG Roadmap states that Colorado is islanded, the E3 model contradicts this and includes out of state electricity generation loads that are served by Colorado generators. By ignoring the out of state electricity imports in modeling Colorado emissions, the RESOLVE model overestimates the emissions from Colorado electricity generation and places a related, disproportionate burden on electricity generators to reduce carbon emissions.

¹¹ Available at: https://drive.google.com/file/d/1lok5it22y_Eh0Fip8ioT_BbPMC7zUJpZ/view.

¹² See EIA, *State Electricity Profiles*, Table 10 -Supply and disposition of electricity. Available at: https://www.eia.gov/electricity/state/colorado/state_tables.php.

Moreover, because the RESOLVE model only includes emissions for generators that are physically located in Colorado, it underestimates the generation capacity required to support Colorado's growth and shift to low carbon energy. The GHG Roadmap's assumptions about generation capacity should include all sources required to meet Colorado's electricity demands including imports. The emission estimates should also be adjusted to account for electrical imports. Doing so will improve the GHG Roadmap's forecasts of baseload requirements from natural gas, planning reserve margin (PRM)), and new infrastructure requirements.

The RESOLVE modeling of new infrastructure requirements for new energy sources is also oversimplified and falsely assumes there is no transmission or distribution constraint within the state. The GHG Roadmap notes that new infrastructure will "require careful land-use planning across the state," however, it is not clear if the physical and regulatory limitations of installing new infrastructure, such as requirements under the National Environmental Policy Act (NEPA), are considered. In fact, the GHG Roadmap does not consider any of the barriers to execute such an audacious change to infrastructure such as private land use agreements, permitting, and regulatory requirements under federal agencies such as the SEC, FERC, EPA, USACE, BLM, NPS, and many others. In addition, renewable energy sources such as solar and wind also require a significant amount of land area for implementation. Currently, the E3 RESOLVE model only constrains solar resources based on the solar potential (GW) and does not consider the physical requirements of installing the solar panels and wind turbines contemplated by the GHG Roadmap, leading to the following concerns:

- How has the Roadmap considered the practical limitations of implementing renewable energy, such as compliance and permit requirements, land availability, existing infrastructure?
- Is there enough land available that the State owns, can purchase, or co-use to meet the peak demand?
- Will there be enough land available beyond 2050 to expand renewable energy capacity as Colorado's population grows?

Moreover, the change in land use could increase lifecycle emissions from new infrastructure requirements depending on its current use that are not considered. For example, the modeling should consider: 1) the emissions from production, transportation, and installation of solar

panels, wind turbines, transmission lines, and pipelines, or 2) loss of biologic sequestration from forest or grasslands cleared for new production or infrastructure.

In addition, the RESOLVE model is myopic and urban-centric. The costs of new transmission upgrades for renewable resources are estimated based on the distance between the source of generation (which is likely rural) and the urban load center of Denver. The model fails to consider the costs to deliver electricity to other important load centers such as major urban centers on the Western slope or elsewhere in rural Colorado that provide critical income from tourism, agriculture, and energy production.

c. Concerns with the Overall Modelling Approach

The overall modeling approach by E3 and CDPHE lacks transparency which limits the ability of policymakers and stakeholders to make informed decisions about critical climate policies. To that end, The Counties have identified the following major issues with the overall modeling approach undertaken by E3, CEO, and CDPHE.

First, there is lack of transparency about the equations and assumptions of the PATHWAYS and RESOLVE models used by E3 to develop the GHG Roadmap. The modeling used by E3 to develop the Roadmap is completed with proprietary tools and only underlying inputs are disclosed, and not the algorithms used. This is problematic. Given the critical role the modeling may have in possibly justifying the recommendations of a final GHG Roadmap, it is extremely troubling that equations and algorithms are not available for evaluation and critique. Models are only as good as the assumptions made within them and without access to these assumptions the reliability and accuracy of the model cannot be assumed. Moreover, these proprietary tools were developed for California State Agencies and it is not clear if the overall modeling assumptions and results have been validated with a comparable model representing Colorado or by a third party. Even though the GHG Roadmap notes that some building and transportation data is validated using historical energy consumption data from the EIA National Energy Modeling System (NEMS), *see* GHG Roadmap Appendix C, page 1, this is entirely insufficient to validate the model, particularly as it applies to Colorado.

Second, neither the PATHWAYS nor RESOLVE model provide a scenario analysis on the sensitivity or uncertainty of the model's assumptions. Sensitivity and uncertainty analyses often show that there are multiple options for reaching an outcome. The optimal outcome in a model is often selected by narrow quantitative margins and can change based on different assumptions.

Thus, sensitivity analyses are a common and critical component of rigorous decision models. Without a sensitivity analysis, decision makers lack crucial information to understand under what conditions the optimal outcome changes and what key assumptions must be validated before implementing decisions.

Third, the model only includes direct GHG emissions from Colorado activities and does not include indirect emissions from upstream imported goods, upstream transportation, downstream transportation or use of Colorado goods outside of the state. Such failure to include the full scope ignores substantial carbon emissions that could result from implementing the Roadmap and misinforms policymakers and stakeholders. As such, implementation of the Roadmap could actually have little or no impact on emission reductions.

Fourth, in recent presentations to the AQCC's GHG Subcommittee on October 12, 2020¹³ and the AQCC on October 23, 2020¹⁴, CDPHE compared the models used in the GHG Roadmap to those developed by non-governmental organizations such as National Resources Defense Council (NRDC), Western Resources Advocates (WRA), Environmental Defense Fund (EDF) and Resources for the Future. The comparison revealed limitations to E3's modeling approach. This was especially true of the modelling for the Electric Power sector, where CDPHE and EDF/WRA's analyses assumed less emissions reductions were possible in the Electric Power Sector than the NRDC, E3, and NRDC models (see slide 24 of the October 23 slides Appendix). This example reveals that the models are just that—models—and should not be over relied upon as justification for recommendations. Rather, the modeling needs to be balanced with other compelling justifications such as economic impact and feasibility.

d. Other Technical Concerns with the GHG Roadmap

Beyond the overall concerns with the modelling approach, The Counties have other higher-level technical concerns with the GHG Roadmap.

First, the GHG Roadmap recommendations contain various assumptions that are far from certain. The recommendations do not account for this uncertainty which is a critical process flaw because understanding the uncertainty in assumptions is critical to how policymakers and

¹³ CDPHE, HB-1261 GHG Modeling and Strategy Comparison (October 12, 2020). Available at <https://drive.google.com/drive/folders/1c6BUPbOwdV9aYahlld65TvnhitQcTuQQ>.

¹⁴ CDPHE, AQCC Update on the Colorado GHG Pollution Reduction Roadmap (October 23, 2020). Available at https://drive.google.com/drive/folders/1_3QhvdBHMU3_1QWWEU4xP96-DahfOUQ7.

stakeholders will implement recommendations. The following assumptions should be explicitly addressed in the GHG Roadmap's recommendations:

- The “business as usual scenarios” in the GHG Roadmap (e.g., Reference and 2019 Action scenarios) rely on estimates of projections of the likelihood of certain legislation. These estimates could be under or overstated due to their likelihood of occurring and the State's ability to achieve policy measures; however, the GHG Roadmap does not include this uncertainty in its projections.
- Cost assumptions influence the available energy resources that are selected by the GHG Roadmap to meet emissions targets. These costs such as fuel prices vary regularly on the commodity market, but this variability is not considered. In addition, to meet 2050 emission goals and increased population and electrification goals, technologies that are more expensive than those in use or technologies that do not currently exist will need to be adopted to account for resource loading and dispatchable capacity (e.g., natural gas with or without CCS, bioenergy, use of renewables to produce hydrogen combined with hydrogen combustion, nuclear power, or a future long-duration energy storage technology). However, the probability that such technologies will be available or viable is not accounted for in the recommendations.
- The Roadmap includes assumptions based on country-level and state-specific data and assumptions instead of regional or local data, so it is hard to understand how the reduction measures and potential costs will impact local cities and counties. In addition, many smaller utilities rely on local, low-cost natural gas for all or the vast majority of their generation. Such investment in new electricity sources in rural communities could put a heavy cost burden on these communities or simply be unattainable. The Roadmap does not consider the disproportionate impacts on these communities which calls into question the viability of the recommendations.

Second, the GHG Roadmap only includes the direct GHG emissions associated with Colorado activities and anticipated reduction measures. To reduce the potential for unintended consequences or missed opportunities, the State should revise the GHG Roadmap to consider the following:

- Indirect carbon emissions across the value chain upstream and downstream of operations (e.g., emissions associated with materials, transportation, disposal)

- The full lifecycle costs of including capital costs and regulatory costs.
- The full lifecycle benefits of mitigation and resilience planning against future climate change related events, such as wildfires and droughts.

4. Legal and Policy Considerations

a. Insufficient Stakeholder Engagement

The GHG Roadmap would have significantly benefited from a more robust stakeholder engagement process. The fact that stakeholder engagement is and has been limited to written comments minimizes any meaningful impact stakeholders can have on a policy document which will lead to profound and material economic consequences for the state. While we recognize the GHG Roadmap is not a rulemaking proposal, it will set rulemaking priorities and would have benefited from the type of robust outreach contemplated by Colorado's Administrative Procedure Act.

Without robust stakeholder engagement the GHG Subcommittee was not able to adequately assess the complexities implicated in the recommendations, nor were the recommendations as nuanced as they could have and should have been. Had there been an opportunity for more robust stakeholder engagement, the GHG Roadmap could have, for example, better considered the role of technological innovation in emission reductions in the oil and gas industry. The GHG Roadmap, as drafted, fails to adequately consider and promote innovation in the industry, and instead solely focuses on encouraging further regulation of the industry. Though regulation may spur some level of technological innovation, there is a point at which regulation decreases the viability of production, causing operators to leave Colorado or shut down entirely rather than invest in meaningful innovation. The GHG Roadmap should have addressed this issue and set priorities to encourage innovation that would result in operating efficiencies that reduce environmental impacts including emissions. Such a recommendation would have provided the nuanced guidance regulators will need moving forward in their efforts to reduce GHG emissions.

For these reasons, the Counties recommend that the GHG Subcommittee not release a final version of the Roadmap until it provides an opportunity for more vigorous stakeholder engagement involving all major sectors of Colorado's economy likely to be affected by future efforts to make progress toward meeting HB-1261 targets.

b. Failure to Properly Contextualize Natural Gas

The natural gas industry has and continues to be a major economic driver in the state, even in the face of increasing regulation. The natural gas industry is one of the state's leading creators of jobs and state and local tax revenues and contributes significantly to the economy. The State has recognized the importance of the natural gas industry to the State's economic, fiscal, and environmental future, as evidenced in the passage of the Clean Air-Clean Jobs Act. The GHG Roadmap represents a substantial deviation from this important and historic milestone. Not only does the GHG Roadmap fail to acknowledge any benefit of the industry, its single-minded focus on curbing emissions will necessarily result in the diminishment of the natural gas industry without consideration of the potential cost to the economy and community at large. The Counties recommend that the GHG Subcommittee acknowledge the relationship between the natural gas industry and the State's economy and explicitly take this relationship into consideration in forming the recommendations related to emission reductions for this sector.

Relatedly, the GHG Roadmap did not adequately consider the relationship between the impact of its regulatory approach to oil and gas and the critical role of natural gas in the generation of electrical power. The GHG Roadmap will continue to decrease the viability of oil and gas operations in Colorado which will, in turn, curtail the amount of natural gas produced in Colorado. Yet, the GHG Roadmap continues to include natural gas as a baseload fuel in the electrical generation mix through 2050. Currently, natural gas accounts for 23% of electricity generation. In 2050 the GHG Roadmap assumes natural gas will account for 15% of electricity generation. However, given the focus on increasing regulation of the industry, it is entirely possible that there will not be enough operational capacity from Colorado operators to provide this baseload. Therefore, natural gas will necessarily be imported from other States or countries with less stringent regulations. As a result, any benefits Colorado gains from GHG emission reductions will be counteracted by GHG emissions associated with oil and gas production from the areas where the gas originated, a classic case of leakage. The Counties recommend that the GHG Subcommittee articulate the importance of the continued viability of the natural gas industry so that its electrical grid recommendations can be achievable, and the problem of leakage can be more specifically addressed.

5. Conclusion

While the GHG Roadmap is an admirable first step in addressing the critical issue of climate change, its ultimate recommendations are premature. The GHG Roadmap should honor the will of the legislature by laying out a process for achieving significant emission reductions by 2050, but the process must be informed by sophisticated, nuanced models and take into account the full complexity and broader context of Colorado's current energy economy, including the economic consequences of its recommendations.

Currently, the baseline emission inventory used by the GHG Roadmap inaccurately captures the current reality of Colorado, making any resulting recommendations inherently flawed. The Counties recommend that the GHG Subcommittee reconsider how it accounts for baseline emissions and adjust the related modeling and recommendations accordingly. The models informing the recommendations in the GHG Roadmap are equally problematic and the Counties recommend that the GHG Subcommittee have a third party validate the model using Colorado specific data. The models also need to be adjusted to account for actual generation capacity in Colorado and Colorado's importation of energy. Any adjusted modeling needs to more fully disclose assumptions and uncertainties so that policymakers can fully account for any limitations in the modeling as they attempt to implement suggestions.

But at a higher level, the GHG Subcommittee needs to base any recommendations not simply on modeling, which, as a tool, is inherently uncertain and cannot possibly accurately predict or account for changes impacting emissions between now and 2050. Instead, the final GHG Roadmap should additionally utilize a flexible, market-based approach to justify any ultimate recommendations. Such an approach must take into account the significant economic consequences of each specific recommendation and the recommendations in total, and in doing so specifically address the impact on rural versus urban counties. As currently drafted, the GHG Roadmap fails consider the costs of implementing its recommendations and does not address the inevitable, significant impact on state and county revenue and employment. Such an oversight reduces the viability of any recommendations and compromises the GHG Roadmap's ability to actually facilitate change. If the GHG Roadmap is revised to account for costs, the recommendations will be more achievable and grounded in the reality and complex context of Colorado.

The Counties also urge that the GHG Roadmap accurately quantify the cost of particular emission reductions relative to the social cost of carbon. Without robust economic, market-based analysis, the GHG Roadmap is less likely to achieve success or attain the public support necessary for real emission reductions. As currently drafted, the GHG Roadmap relies on a tremendous number of assumptions and uncertainties and as a result, all of the recommendations are likely untethered from the likely realities of the future. The Counties urge the GHG Subcommittee to revise the GHG Roadmap to address these significant shortcomings.