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MODELING SHOWS MINNESOTA'S CLIMATE POLICIES WILL CUT EMISSIONS 8 PERCENT, BUT ADDITIONAL POLICIES NEEDED TO LIMIT WARMING TO 1.5°C

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INTRODUCTION

In 2007, Minnesota adopted the Next Generation Energy Act, requiring 80 percent economy-wide greenhouse gas (GHG) emissions reductions below its 2005 baseline by 2050. While the state has made progress toward that goal in the interim, 14 years later Minnesota has reason to renew its climate action urgency.[1] The Minnesota Pollution Control Agency's December 2020 report to Governor Tim Walz noted "Minnesota failed to meet its 2015 goal...and the state is not on track to meet our future goals either."

New research using the Minnesota Energy Policy Simulator (EPS), developed by Energy Innovation and RMI, models emissions reductions from existing state policies and highlights pathways to help the state achieve interim and long-term emissions reductions necessary for a deep decarbonization pathway. These policy pathways would also generate jobs, strengthen the economy, and reduce negative health impacts associated with air pollution.

Recently proposed state policies—notably a statewide 100 percent by 2040 clean electricity standard—are critical for Minnesota to meet its climate goals. The recently proposed policy would reduce emissions 19 percent below the Reference Scenario emissions by 2040 as modeled in the Minnesota EPS, but the state must build upon these policies to align with global efforts to limit warming to 1.5° Celsius.

Implementing a full suite of policies across the agricultural, buildings, electricity, industrial, land, and transportation sectors can help Minnesota transition to a low-carbon economy. This 1.5°C Scenario would reduce statewide emissions more than 75 percent by 2050, create 16,000 additional job years in 2025 and 39,000 job years in 2050[2], and add $11 billion per year to the state's economy by 2050.

[i] Energy Innovation LLC https://energyinnovation.org
[ii] RMI https://rmi.org

Our analysis evaluates an illustrative policy bundle, including:

- Switching to 100 percent clean electricity
- Rapidly adopting of zero-emission cars and trucks, along with policies to facilitate reducing passenger vehicle miles traveled
- Requiring efficient, all-electric buildings and appliances with low embodied carbon
- Cutting fossil fuel use in manufacturing
- Reducing methane leaks throughout the natural gas supply system and waste management sectors
- Better managing land to capture more carbon

THE MINNESOTA ENERGY POLICY SIMULATOR

The Minnesota EPS is a free, open-source, peer-reviewed model developed by Energy Innovation and RMI that allows users to estimate impacts of climate and energy policies on emissions, the economy, and public health. The model uses publicly available data to estimate annual economic, emissions, public health, and infrastructure impacts of policies (along with how policies interact with one another) through 2050. EPS models have been developed for more than a dozen countries and several subnational regions, including California and Virginia. The Minnesota EPS is one of the first of 20 planned state-level EPS models that Energy Innovation and RMI are developing. A companion document explains the key data sources, assumptions, and calculation methodologies used in the EPS.

The Minnesota EPS is first and foremost an evaluation tool; it can provide a consistent, flexible framework to help policymakers and advocates assess a wide range of policy proposals in the state. Readers seeking deeper Minnesota decarbonization policy research can consult a range of studies across the agriculture, buildings, electricity, and transportation sectors.[iii]

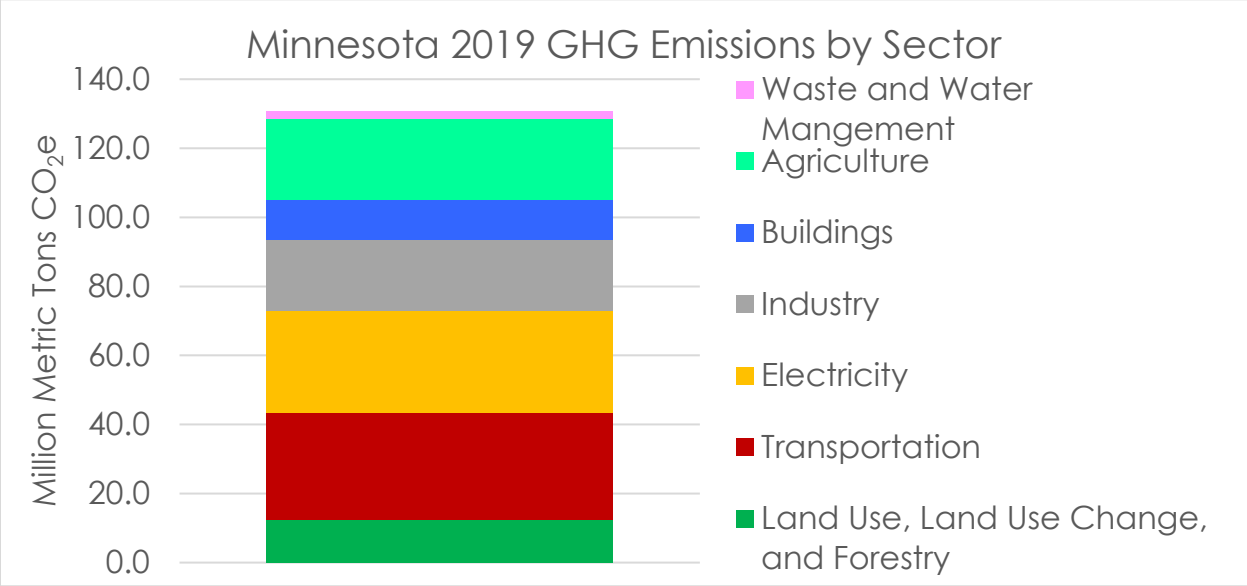
OVERVIEW OF MINNESOTA'S GHG EMISSIONS

The transportation and electricity sectors are the largest sources of greenhouse gas emissions in Minnesota (followed closely by agriculture), representing 65 percent of statewide emissions. Remaining emissions come from industry, land use, buildings, and waste management.[iv] While many U.S. states show negative land use sector emissions due to forest regrowth and other land

[iii] See for example: Minnesota's Smarter Grid," *Vibrant Clean Energy*, July 2018, https://www.vibrantcleanenergy.com/wp-content/uploads/2018/07/Minnesotas-SmarterGrid_FullReport.pdf; Clark, Tory, et al, "Minnesota Decarbonization Scenarios," *Energy+Environmental Economics*, June 2019, https://www.ethree.com/wp-content/uploads/2020/01/MN_PATHWAYS_Final-Report_2019-06-26.pdf; "Pathways to Decarbonizing Transportation in Minnesota," *Minnesota Department of Transportation*, August 2019, https://www.dot.state.mn.us/sustainability/docs/pathways-report-2019.pdf; "Driving Down Emissions in Minnesota," *Smart Growth America / Transportation for America*, October 2020, https://t4america.org/wp-content/uploads/2020/10/Driving-Down-Emissions-Minnesota-1.pdf; Ahlering, Marissa, et al, "Nature and Climate Solutions for Minnesota," *The Nature Conservancy,* 2021*,* https://assets.documentcloud.org/documents/20457231/report-nature-and-climate-mn_2021.pdf.

[iv] Note that the EPS includes emissions associated with cultivated histosols in the land use sector, while the Minnesota Pollution Control Agency's Greenhouse Gas Inventory includes cultivated histosols in the agriculture sector.

carbon uptake, Minnesota faces an added decarbonization challenge due to continued net emissions from agricultural soils including peatlands.



EMISSIONS FORECAST UNDER A BUSINESS-AS-USUAL SCENARIO

The Minnesota EPS includes a Business-As-Usual (BAU) Scenario for projected future emissions including existing enacted policy, building efficiency improvements forecast by national models, transportation fuel efficiency improvements set by the 2012 federal economy standards, economic adoption of electric vehicles, and clean electricity.[3] The Minnesota EPS also enables users to layer on Xcel Energy's recently proposed Integrated Resource Plan (IRP), labeled as the Reference Scenario. Xcel's IRP includes accelerated coal power retirement, new renewable energy and natural gas plants, additional demand response, extended lifetime of one of its nuclear plants, and additional building energy efficiency requirements.[v]

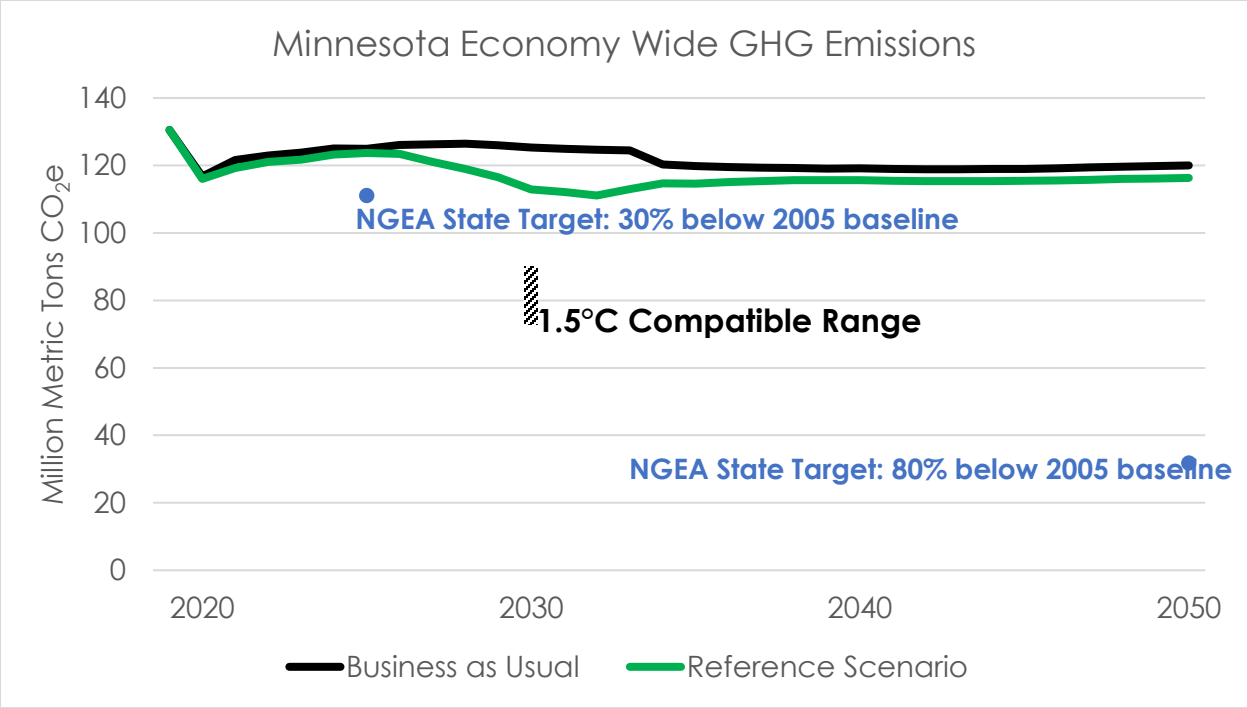
Minnesota's BAU Scenario emissions are expected to drop by about 8 percent from the 2019 baseline by 2050, primarily due to electric vehicles sales and projected changes in power composition.

THE GAP TO 1.5°C

The Minnesota EPS contains economy-wide emissions targets for 2025 and 2050 included in the Next Generation Economy Act to contextualize the state's projected emissions. In addition to state policy goals, the Minnesota EPS includes 2030 emissions target ranges consistent with limiting global warming to 1.5°C.[vi] Comparing Minnesota's Reference Scenario projections to the state's 2025 goals, as well as the 2030 1.5°C-compatible target range, shows a large gap.

[v] Policy documentation available here: https://github.com/Energy-Innovation/eps-minnesota/blob/master/MN%20Policy%20Assumptions_FINAL.pdf.

[vi] See the forthcoming Insight Brief from RMI on "Scaling United States climate ambitions to meet the science and arithmetic of 1.5°C warming." Targets are downscaled from the U.S. based on 2019 emissions shares.



Caption: Projected GHG emissions, net of land carbon uptake, in the Minnesota EPS in the BAU and Reference Scenarios (which also accounts for proposed actions within the Xcel IRP). The blue dot shows the state's 2025 target, and the gray hashed line shows the estimated 1.5°C-compatible target range.

RECENTLY PROPOSED CLIMATE ACTION

Minnesota's state legislators and Governor Tim Walz have proposed two climate policies to significantly reduce the state's future emissions: an accelerated Carbon-Free Electricity Standard and the new Clean Cars Minnesota rule.

The carbon-free electricity standards proposed in January 2021[4] could reduce Minnesota's electricity emissions to near zero by 2040, reduce economy-wide emissions 19 percent below Reference Scenario emissions, and reduce harmful air pollution, leading to 9,000 fewer asthma attacks by 2040.[vii]

The Clean Cars Minnesota rule will increase passenger vehicle fuel economy and require that 6-7.5 percent of new vehicles sold by 2025 are zero-emissions vehicles.[5] Policies like Clean Cars Minnesota are important foundational steps to jump-start electric vehicle availability and adoption, especially in states like Minnesota where electric vehicle options and adoption have been limited to-date.[6]

[vii] Modeled by adding policies to the Xcel IRP Reference Scenario including: 100% clean electricity by 2040, eliminate fossil fuel electricity imports, retire remaining non-peaker fossil fuel power plants, and add carbon capture and sequestration to remaining peaker natural gas plants.

POLICY OPTIONS FOR DEEP DECARBONIZATION

The Minnesota EPS includes a 1.5°C Scenario policy package that demonstrates a path to meet GHG emission reductions goals aligned with global efforts to limit climate change. This illustrative 1.5°C Scenario is adapted from a nationwide scenario developed by Energy Innovation.[7]

ELECTRICITY

Rapidly replacing fossil generation with clean electricity is key to deep decarbonization and provides the foundation for reducing emissions in other sectors. Minnesota has renewable portfolio standards that set initial targets for achieving 25-30 percent renewable energy and has proposed legislation to adopt 100 percent clean electricity.[viii] The 1.5°C Scenario includes several electricity sector policies, including a 100 percent clean electricity standard by 2035, early fossil fuel plant retirements, and reduced coal and natural gas electricity imports. The 1.5°C Scenario cuts electricity sector emissions 75 percent below BAU by 2030 and achieves near-zero electricity emissions by 2035.

Currently available technologies provide the core of a clean grid: wind, solar photovoltaic (PV), and batteries for daily load balancing, with transmission and flexible loads helping reduce costs. The Minnesota EPS 1.5°C Scenario adds a diverse portfolio including 10 gigawatts (GW) of solar by 2030 and 40 GW by 2050. This is complemented by Minnesota's growing wind power, which adds 9 more GW by 2030 and 22 GW by 2050. The new wind and solar is supported by increased transmission infrastructure, demand response, and flexible grid storage.

TRANSPORTATION

Transportation is the largest source of emissions in Minnesota and the U.S. as a whole, and decarbonizing passenger vehicles is critical to meeting climate goals. The Minnesota EPS 1.5°C Scenario builds on the Clean Cars Minnesota rule with a strong zero-emissions vehicle standard[ix] requiring new passenger car and SUV sales be 100 percent all-electric by 2035 and 100 percent zero-emission new freight truck sales by 2045. These standards align with California's transportation sector policies[8] and the multi-state Memorandum of Understanding[9] on zero-emissions medium- and heavy-duty vehicles, respectively. Implementing these measures would add 1.3 million on-road electric passenger vehicles by 2030, and nearly all on-road vehicles would be electric by 2050 as old vehicles are gradually replaced. Additional policies would likely be needed to achieve this outcome, such as building out charging infrastructure.

The 1.5°C Scenario also invests in alternatives to passenger car travel, with supportive land use and transportation policies to enable people to use public transit and walk and bike, reducing passenger car travel 20 percent by 2050. Such measures can be designed to provide broad economic and social benefits such as enhancing access to transportation and affordable

[viii] Minnesota's existing renewable energy standards are included in the BAU Scenario.

[ix] This is implemented in the model as an electric vehicle standard, but the same outcome could be achieved by a technology-neutral zero-emissions vehicle sales standard.

housing,[10] and would yield climate benefits beyond the direct emission reductions modeled in the Minnesota EPS.[x]

BUILDINGS

Minnesota's core buildings sector challenge is transitioning away from fossil fuel heating systems to clean electric equipment, as most homes in the state use gas or fuel oil for space and water heating.[11] Innovation with electric alternatives (air source heat pumps) has significantly expanded cold climate adoption, such as in Maine, which is targeting 100,000 heat pumps installed by 2025.[12] Envelope improvements, ground source heat pumps, and district heating may also be complements in a broad electrification strategy.[13] Building electrification is modeled in the Minnesota EPS with a sales standard that requires fully electric new building equipment sales by 2030. This would shift fossil fuel systems to electric heat pumps. Combined with building retrofits and additional appliance efficiency, these measures reduce buildings sector emissions 90 percent below BAU emissions by 2040.

INDUSTRY, AGRICULTURE, AND LAND

The industrial sector is key to Minnesota's economy, but policy opportunities exist to reduce emissions while maintaining the state's industrial strength. The 1.5°C Scenario includes policies to electrify and switch to hydrogen fuels, implement industrial carbon capture and sequestration, and increase efficiency. For non-energy combustion industrial emissions, the 1.5°C Scenario includes standards requiring methane leakage mitigation from the oil and gas industry, as well as water and waste management facilities. Appliance manufacturers must switch to refrigerants with low global warming potential, consistent with the Kigali Amendment to the Montreal Protocol.

Agriculture, forestry, and land use are significant emissions sources even in the 1.5°C Scenario. Policies required by that scenario include afforestation and reforestation, improved crop and soil management through methods such as no-till and nutrient management practices, and reduced livestock emissions through manure digesters and feed modification. We note that opportunities to increase Minnesota's carbon uptake in natural and working lands are not as well understood as opportunities in other sectors. In fact, because policy options in this sector are wide ranging and the science continues to evolve, this modeling reinforces the need for further research dedicated to enhancing carbon sequestration on natural and working lands.

AGGREGATE EMISSIONS IMPACTS

In total, the 1.5°C Scenario would reduce statewide emissions about 50 percent from the 2005 baseline by 2030 and more than 75 percent by 2050. A clean electricity standard, building electrification, electric vehicle sales, and industry fuel substitution measures have the greatest impact; early coal power plant retirements is also a key measure through 2030.

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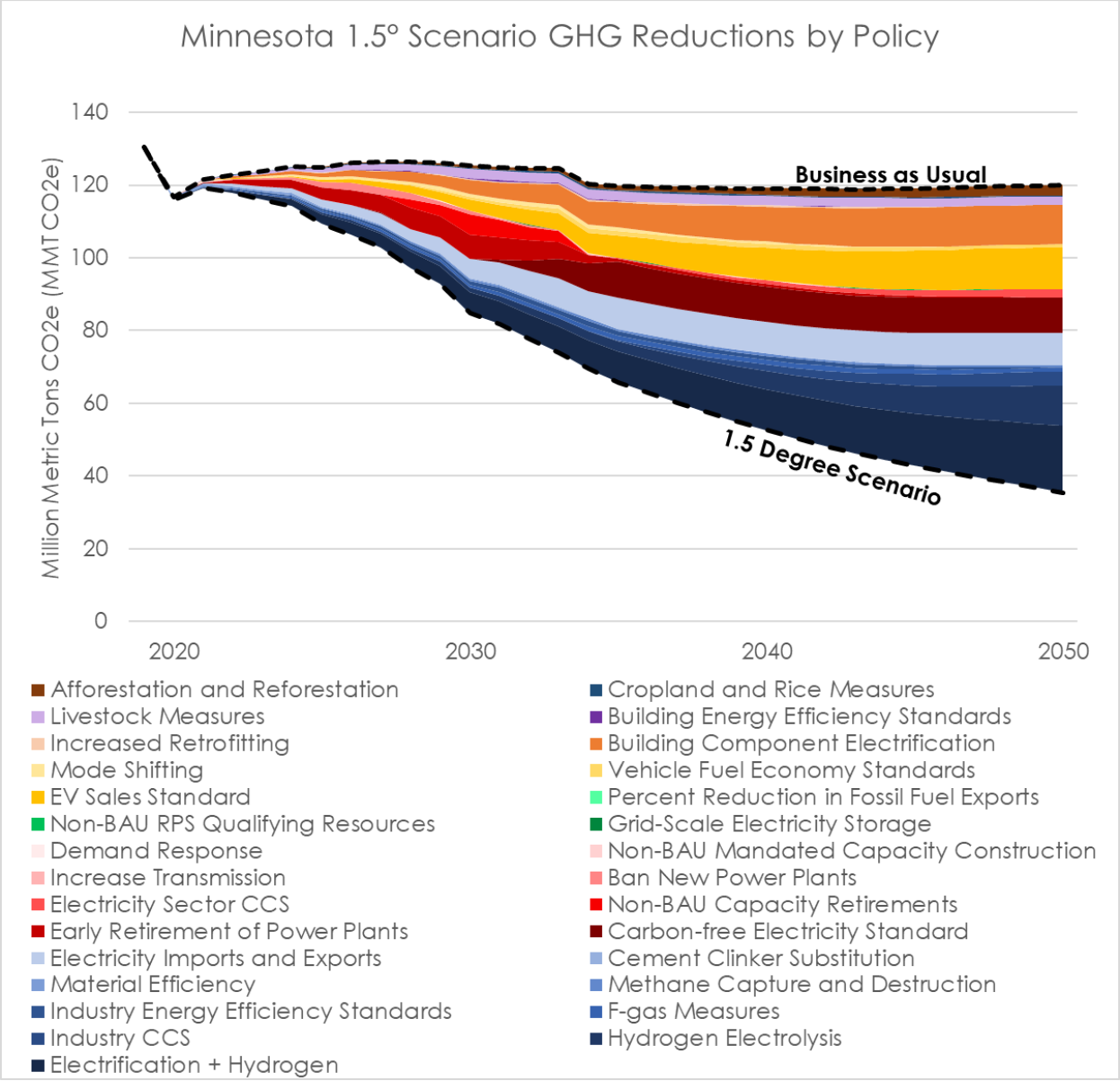
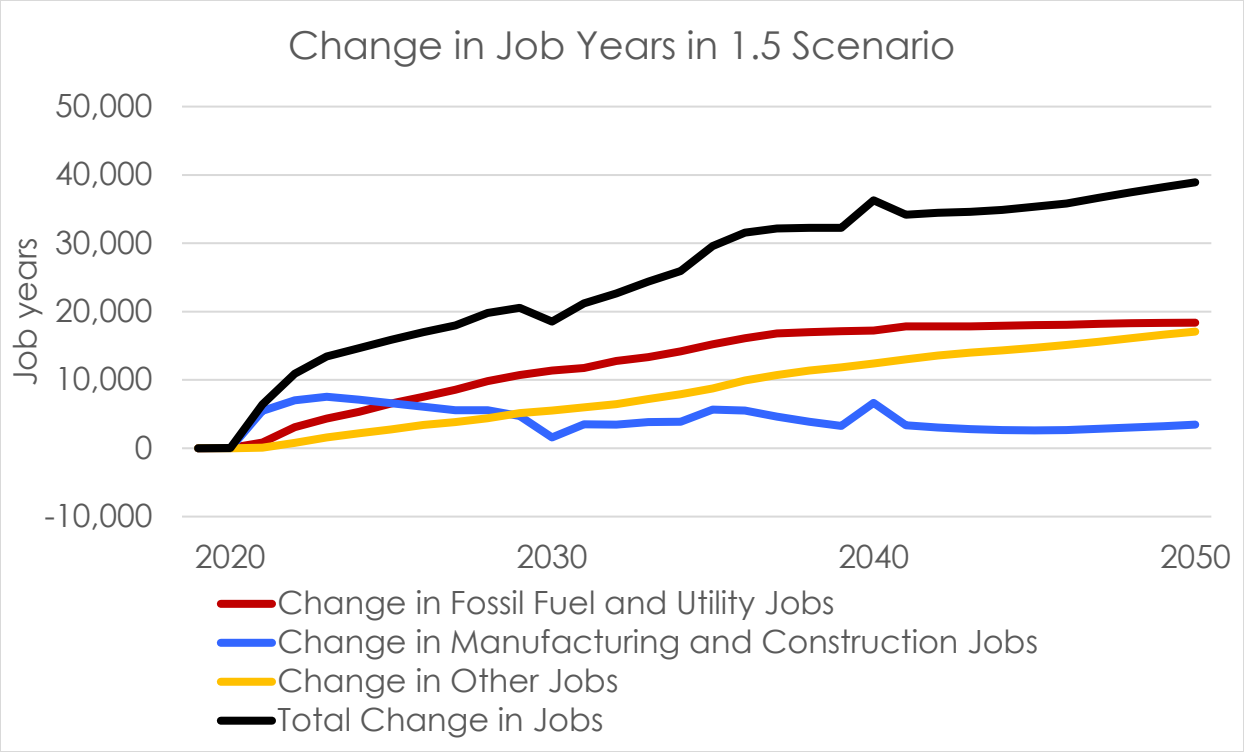
[x] See Jones, Christopher M, et al, "Carbon Footprint Planning: Quantifying Local and State Mitigation Opportunities for 700 California Cities," *Urban Planning* 3, 2 (2018): 35-51 DOI: 10.17645/up.v3i2.1218 & Milovanoff, A., et al, "Electrification of light-duty vehicle fleet alone will not meet mitigation targets," *Nature and Climate Change* 10 (2020): 1102–1107, https://doi.org/10.1038/s41558-020-00921-7



JOBS, GDP, AND HEALTH BENEFITS

Policies in the 1.5°C Scenario would require adding new solar and wind, retrofitting buildings, installing vehicle charging infrastructure, and more. The EPS projects these policies would yield 16,000 additional job-years in 2025 and 39,000 job-years in 2050.[xi] New investments and reuse of fossil fuel savings also help expand the state's economy $11 billion per year by 2050.

[xi] Read more at https://energyinnovation.org/2020/10/19/united-states-eps-3-0-update-adds-gdp-and-jobs-impacts-improved-public-health-metrics-and-more/.



The 1.5°C Scenario includes significant health benefits. These policies would avoid 700 premature deaths and 20,000 asthma incidents annually by 2050; including a conservative estimate of the benefits of reduced climate pollution[xii] and the U.S. Environmental Protection Agency's Value of a Statistical Life pushes the monetized health and other social benefits to $14 billion by 2050.

The economic benefits of the low-carbon transition are enormous and adopting these policies will place Minnesota among the country's clean energy leaders, ready to capture the significant benefits of a low-carbon future. While specific policies for Minnesota may vary from this illustrative package, the key decarbonization policy pathway is consistent across myriad studies. So too is the upside: carbon dioxide emission reductions, growth in GDP and jobs, and significant health benefits.

CONCLUSION

The Minnesota EPS provides one policy pathway to align state ambitions with the need to limit global warming to 1.5°C. While this policy pathway is ambitious, it is realistic and based upon policies that have been successfully implemented in other states and nations across the world; it would also generate large economic and health benefits. Steps taken by Minnesota's state

[xii] The Interagency Working Group estimate from 2016, from https://www.epa.gov/sites/production/files/2016-12/documents/sc_co2_tsd_august_2016.pdf. The central estimate of $42/ton in 2020 is used. Note that recent studies have suggested much higher possible ranges for the social cost of carbon, such as $187-805/ton in https://www.nature.com/articles/s41558-018-0282-y.

agencies and utilities have built momentum toward this clean energy future, and this analysis demonstrates possible policy pathways to reach the state's climate targets.

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[1] Kolash, Frank, "Climate Change Subcabinet update report," *Minnesota Pollution Control Agency,* December 2020, https://climate.state.mn.us/sites/climate-action/files/2021-01/ClimateChangeSubcabinetReport_2020_cc-mn3-01.pdf.

[2] A job year defined as one year of work for one person, for instance a new construction job that lasts five years is equal to five job-years. This is a more accurate measure than "job" because one job may last for five months or five years.

[3] Building efficiency improvement assumptions from NREL's: "Electrification Futures Study," *NREL,* 2017, https://www.nrel.gov/analysis/electrification-futures.html & Fuel efficiency improvements forecasted by EIA: "Annual Energy Outlook," *EIA,* 2020, https://www.eia.gov/outlooks/aeo/assumptions/pdf/summary.pdf.

[4] Eleff, Bob, "Renewable energy standards," *MN House Research,* January 2021, https://www.house.leg.state.mn.us/comm/docs/oQl-tnyDm0WfZcwB6dJOYQ.pdf

[5] "Statement of need and reasonableness Proposed Revisions to Minnesota Rules, chapter 7023 Adopting Vehicle Greenhouse Gas Emissions Standards (Clean Cars Minnesota)," *Minnesota Pollution Control Agency,* December 2020, https://www.pca.state.mn.us/sites/default/files/aq-rule4-10m.pdf

[6] Bjorhus, Jennifer, "Minnesota Pollution Control Agency to move forward on clean car rule," *Star Tribune,* December 2020, https://www.startribune.com/minnesota-pollution-control-agency-to-move-forward-on-clean-car-rule/573432451/

[7] Mahajan, Megan, et al, "Modeling the Climate Crisis Action Plan," *Energy Innovation,* June 2020, https://energyinnovation.org/wp-content/uploads/2020/07/Modeling-the-Climate-Crisis-Action-Plan_FOR-RELEASE.pdf

[8] "Zero-Emissions Vehicle Program," *California Air Resources Board,* 2021, https://ww2.arb.ca.gov/our-work/programs/zero-emission-vehicle-program

[9] "Multi-state Medium- and Heavy-duty Zero Emission Vehicle Memorandum of Understanding," *California Energy Commission,* 2020 https://www.energy.ca.gov/sites/default/files/2020-08/Multistate-Truck-ZEV-Governors-MOU-20200714_ADA.pdf

[10] Mangan, Emily, et al, "Driving Down Emissions," *Smart Growth America,* October 2020, https://t4america.org/wp-content/uploads/2020/10/Driving-Down-Emissions.pdf.

[11] Eleff, Bob, "Residential Space Heating Fuels in Minnesota," *Research Department, Minnesota House of Representatives,* January 2017, https://www.house.leg.state.mn.us/hrd/pubs/heatfuel.pdf.

[12] Michael Gartman and Amar Shah, "Heat Pumps: A Practical Solution for Cold Climates," *RMI,* December 2020, https://rmi.org/heat-pumps-a-practical-solution-for-cold-climates/.

[13] "Heating and Cooling Solutions," *Efficiency Maine,* 2021, https://www.efficiencymaine.com/heating-solutions/.