

SUPPLEMENTAL REPORT OF DR. PETER H. HOWARD, Ph.D. AND JASON A. SCHWARTZ, J.D.

Peter H. Howard and Jason A. Schwartz state and declare as follows:

1. Peter H. Howard and Jason A. Schwartz are, respectively, the Economics Director and the Legal Director at the Institute for Policy Integrity at New York University School of Law.¹ On October 8, 2018, we submitted an expert report calculating the climate benefits of Colorado’s proposed Low Emission Vehicle (LEV) Program. Our qualifications and relevant expertise are the same as stated in that October 8th submission. Our initial calculations of climate benefits were based on emissions reductions that a May 2018 White Paper commissioned by Environmental Defense Fund (the “Clean Car White Paper”) estimated that the proposed LEV program would achieve in the years 2030 and 2040. At the time of our original analysis, the emissions reduction estimates in the Air Quality Control Commission’s Initial Economic Impact Analysis were still preliminary and undergoing revision, and so we opted to base our calculations on the Clean Car White Paper. Our October report calculated that, assuming the proposed LEV program reduced about 2.5 million metric tons of carbon dioxide in the year 2030—along with about 2,500 metric tons of methane and about 6 metric tons of nitrous oxide—the climate benefits from those emissions reductions in 2030 would have a present value today of about \$108 million under the central estimates of the social cost of greenhouse gases (and about \$326 million under the high-impact estimates of the social cost of greenhouse gases). Our October report concluded that, given the magnitude of those annual climate benefits, the greenhouse gas reductions achieved by the proposed LEV program over the lifetime of affected vehicles would almost certainly deliver billions of dollars’ worth of cumulative climate benefits.

2. On November 15, 2018, the Colorado Air Pollution Control Division (Division) released a Final Economic Impact Analysis (FEIA). The FEIA estimates that the proposed LEV program will cumulatively reduce tailpipe carbon dioxide emissions² by between 29.67 million and 31.24 million short tons (depending on the assumption made about the rebound effect). Together with its underlying data, the FEIA now allows us to recalculate the LEV program’s cumulative climate benefits. To summarize our main findings, we now estimate that the proposed LEV program will generate at least between \$1.4 billion and \$4.3 billion worth of climate benefits from lifetime emissions reductions from Model Year

¹ This supplemental report does not purport to represent the views, if any, of New York University.

² The FEIA reports the figures as “carbon dioxide equivalent” tons of greenhouse gas emissions. AQCC, *Final Economic Impact Analysis—Proposed AQCC Regulation Number 20: Colorado Low Emission Automobile Regulation* at 21 (Nov. 15, 2018) [hereinafter FEIA]. However, carbon dioxide constitutes about 99% of tailpipe greenhouse gas emissions. EPA, *Light Duty Vehicle Emissions*, <https://www.epa.gov/greenvehicles/light-duty-vehicle-emissions>. Therefore, we make the simplifying assumption that all the tailpipe greenhouse gas emissions estimated by the FEIA are carbon dioxide emissions.

2022-2031 vehicles—and for several reasons discussed later, even these figures very likely are highly conservative underestimates of the program’s full climate benefits.

3. The difference in cumulative greenhouse gas reductions estimated by the FEIA under the no rebound assumption (31.24 million short tons) versus the 20% rebound assumption³ (29.67 million short tons) is only about 5%, and therefore the choice of rebound assumption does not significantly change the magnitude of estimated climate benefits.⁴ For simplicity, we will focus on the cumulative greenhouse gas reductions estimated under the 10% rebound assumption: 30.38 million short tons,⁵ which equals 27.56 million metric tons.⁶ The FEIA reports both cumulative reductions for the entire LEV program, as well as reductions that each individual model year of vehicles (MY 2022-2031) will achieve over its 11-year anticipated lifespan. To accurately monetize climate benefits, however, the specific emissions reductions for each calendar year are needed, as opposed to the reductions for each vehicle model year. Using the data underlying the FEIS, we can break out the estimated tailpipe emissions reductions achieved under the LEV program for each calendar year from 2022 through 2041 (with the calendar year 2041 being the end of the anticipated 11-year lifespan for model year 2031 vehicles). Those estimated tailpipe emissions reductions can then be combined with upstream reductions, as explained in the next paragraph.

4. The FEIA reports that its estimates include only tailpipe reductions and exclude “upstream emission reduction benefits associated with fuel production and refining in Colorado.”⁷ As explained in our October Expert Report, whether or not the upstream greenhouse gas reductions from fuel production and refining occur within Colorado or outside the state’s borders, the climate consequences will be the same. Greenhouse gases are global pollutants, and all upstream and downstream emissions should be counted. The upstream reduction in carbon dioxide emissions, which will result as the proposed LEV program reduces the need to fuel production and refining, can be approximated based on our October Expert Report and the data from the Clean Car White Paper. That data assumed that for every 100 metric tons of carbon dioxide eliminated from tailpipe emissions, about another 24.77 metric tons of carbon

³ A 20% rebound assumption is completely unsupported by the literature, whereas a 10% rebound assumption is grounded in the literature. *See* Comments from the Institute for Policy Integrity to NHTSA and EPA, on the Safer Affordable Fuel-Efficient Vehicle Rules for Model Years 2021-2026, at 100-125 (submitted Oct. 26, 2018), https://policyintegrity.org/documents/Emissions_Standards_EPA_NHTSA_Comments_Oct2018.pdf.

⁴ For example, using the central estimate of the social cost of greenhouse gases and the Division’s estimates of greenhouse gas reductions, we monetize \$1.41 billion in cumulative climate benefits under the 10% rebound assumption; under the no rebound assumption, the total would be \$1.45 billion, and under the 20% rebound assumption, the total would be \$1.37 billion. The differences are minor.

⁵ FEIA at 23.

⁶ Though the FEIA does not clarify, it is clear from the underlying data that the FEIA is reporting short tons. A short ton is 2000 pounds, whereas a metric ton is 2204.6 pounds. We use metric tons, because that is the unit used for calculating the social cost of greenhouse gases.

⁷ FEIA at 24.

dioxide are also reduced upstream from fuel production and refining. Applying this ratio here yields a conservative estimate of upstream emissions, since it only captures upstream carbon dioxide emissions and so does not reflect upstream reductions of potent methane and nitrous oxide emissions. Based on the underlying data from the FEIS and this upstream ratio, we calculate the following emissions reductions:

**Table S1: Tailpipe & Upstream Carbon Dioxide Reductions by Year
(under the 10% Rebound Assumption)**

| Year of Emission | Carbon Dioxide Reductions (metric tons) | Year (continued) | Carbon Dioxide Reductions (metric tons) |
|-------------------------|--|-------------------------|--|
| 2022 | 174,981 | 2032 | 3,202,673 |
| 2023 | 417,348 | 2033 | 2,954,238 |
| 2024 | 723,735 | 2034 | 2,659,417 |
| 2025 | 1,095,308 | 2035 | 2,319,658 |
| 2026 | 1,468,743 | 2036 | 1,957,770 |
| 2027 | 1,844,093 | 2037 | 1,597,134 |
| 2028 | 2,221,418 | 2038 | 1,237,788 |
| 2029 | 2,600,775 | 2039 | 879,772 |
| 2030 | 2,982,226 | 2040 | 879,772 |
| 2031 | 3,365,835 | 2041 | 167,886 |
| Total | | | 34,393,923 |

Annual emissions reductions seem to drop after the year 2031, because by that point model year 2022 vehicles are assumed to have retired and because the Division’s FEIA covers vehicles only from model years 2022 through 2031. However, to the extent that the proposed LEV program would continue to increase the efficiency of vehicles after model year 2031, these calculations of emissions reductions are significant underestimates. Indeed, rather than annual reductions dropping after 2031 and approaching zero by 2042, if the LEV program continued to increase vehicle efficiency relative to a baseline scenario, annual reductions would likely continue to increase from 2031 through 2041 and beyond.

5. As described at length in our October Expert Report, the climate benefits from these greenhouse gas reductions can be monetized using the federal Interagency Working Group (IWG)’s estimates of the social cost of greenhouse gases. We report results using both the IWG’s central estimates (calculated at a 3% discount rate), as well as the “high-impact” estimates (also calculated at a 3% discount rate). The monetized climate benefits for each year of emissions reductions are first presented as those benefits would be valued in the same calendar year when the reductions are achieved, and then the values are discounted back at a 3% rate and totaled to give the present value of those future benefits.

**Table S2: Monetized Climate Benefits of Carbon Dioxide Reductions from the LEV Program
(under the 10% Rebound Assumption, in 2017\$)**

| Year of Emission | Central Estimate | High-Impact Estimate | Year (continued) | Central Estimate | High-Impact Estimate |
|--|-------------------------|-----------------------------|-------------------------|-------------------------|-----------------------------|
| 2022 | \$8,895,095 | \$26,685,285 | 2032 | \$196,882,419 | \$598,219,658 |
| 2023 | \$21,709,113 | \$65,127,338 | 2033 | \$185,102,529 | \$562,292,587 |
| 2024 | \$38,501,954 | \$115,505,862 | 2034 | \$169,773,971 | \$515,609,838 |
| 2025 | \$59,564,188 | \$178,692,565 | 2035 | \$150,826,482 | \$460,706,346 |
| 2026 | \$81,608,345 | \$244,825,035 | 2036 | \$129,610,608 | \$395,775,250 |
| 2027 | \$104,644,189 | \$311,752,481 | 2037 | \$107,623,498 | \$328,534,890 |
| 2028 | \$128,681,848 | \$383,419,384 | 2038 | \$84,872,172 | \$259,006,456 |
| 2029 | \$150,657,185 | \$458,120,827 | 2039 | \$61,363,905 | \$187,211,915 |
| 2030 | \$176,279,408 | \$535,889,399 | 2040 | \$37,106,240 | \$113,174,032 |
| 2031 | \$202,933,571 | \$616,758,892 | 2041 | \$12,106,992 | \$36,916,401 |
| Total (undiscounted) | | | | \$2,108,743,712 | \$6,394,224,440 |
| Total Present Value (discounted at 3% to year 2018 value) | | | | \$1,407,354,344 | \$4,264,317,299 |

6. The LEV Program will generate at least between \$1.4 billion and \$4.3 billion in climate benefits over the lifetime of the vehicles. These values reflect benefits to agricultural output, property values, human health, ecosystem impacts, and other effects, as described in our October Expert Report. However, these values are also very likely severe underestimates of the LEV Program’s full climate benefits, for several key reasons:

- First, our estimation of upstream greenhouse gas reductions focused on carbon dioxide. In reality, significant upstream quantities of methane and nitrous oxide emissions would also be reduced under the LEV program. Methane and nitrous oxide are, pound for pound, more potent greenhouse gases than carbon dioxide. In our preliminary estimate of climate benefits presented in our October Expert Report, benefits from methane and nitrous oxide emissions reductions constituted about 3% of our total estimate of climate benefits. Such benefits are omitted from the calculations made in this supplement.
- Second, as a simplifying assumption, this analysis follows the FEIA and so does not capture emissions reductions from vehicles after model year 2031. In reality, the efficiency and emissions of subsequent model years will also be affected, thus increasing total emissions reductions, perhaps quite significantly. Additionally, if the Division’s assumption that vehicles retire after eleven years is an underestimate of vehicle lifespan, then our calculations may further be an underestimate for that reason as well.

- Finally, and most importantly, the IWG’s estimates of the social cost of greenhouse gases do not directly estimate many significant climate impacts, including catastrophic impacts, tipping points, ocean acidification, wildfires, biodiversity and habitat loss, impacts to labor productivity, national security impacts, and many more categories. These omissions are discussed in greater detail in our October Expert Report.

In summary, the proposed Colorado LEV Program is expected to deliver billions of dollars’ worth of climate benefits cumulatively.

We declare under penalty of perjury that the foregoing is true and correct to the best of our knowledge and belief.

Executed on November 13, 2018, in New York, New York.

/s/Peter H. Howard

Dr. Peter H. Howard, Ph.D.

Executed on November 13, 2018, in Denver, Colorado.

/s/Jason A. Schwartz

Jason A. Schwartz