Analysis: Calculating Near-Term and Long-Term U.S. Damages from U.S. Greenhouse Gas Transportation Sector Emissions

Rick Duke, Gigaton Strategies

16 September 2025

Near-term domestic damages that will be caused by U.S. transportation sector greenhouse gas emissions from 2025 – 2035 were calculated using the following methodology.

First, a quadratic relationship between historical cumulative transportation sector emissions since 1973 in billion metric tons (BMT) and annual percent damages to U.S. Gross Domestic Product (GDP) was developed using data provided by previous research, in consultation with the authors.[1] This data and quadratic fit are shown in Figure 1 below:

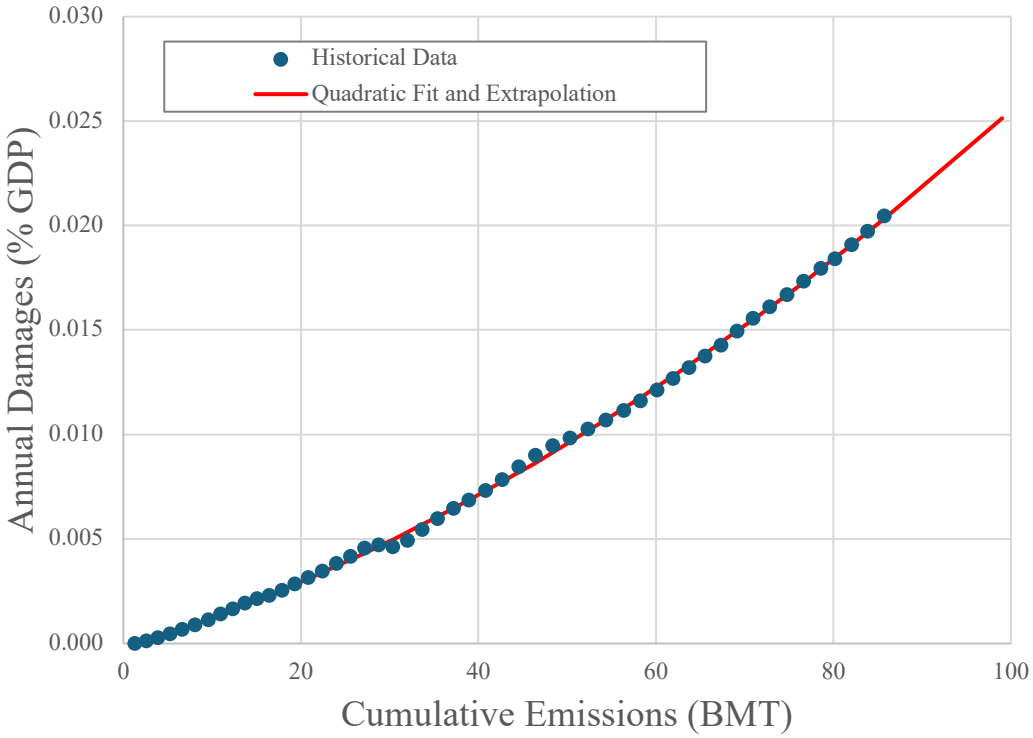

Figure 1: Relationship between damages in annual percent reduction in GDP and cumulative transportation sector emissions in billion metric tons since 1973 (blue dots), along with quadratic fit and extrapolation (red line).

[1] Justin S. Mankin, Alexander R. Gottlieb, and Christopher W. Callahan, *Climate damages to the U.S. economy from U.S. transportation emissions.* September 2025. https://zenodo.org/records/17080804.

The quadratic fit follows equation 1 as provided below:

$$\textbf{Eq. 1}: \quad \text{Damages (\% GDP)} = 1.23 \times 10^{-6}\left(\text{Cum. Em. (BMT)}\right)^2 + 1.34 \times 10^{-4}(\text{Cum. Em. (BMT)}) + -2.25 \times 10^{-4}$$

Future U.S. transportation sector emissions projections from two sources were used, as presented in Table 1.:

- **REPEAT Project**: projections assume the 2024 Multipollutant and Phase 3 HDV Rules are repealed and incorporate the current electric vehicle tax credit phase out schedule as modified by HR1 enacted on July 4th, 2025.[2]

- **Annual Energy Outlook 2025 (AEO 2025) Alternative Transportation Scenario**: projections assume 2024 Multipollutant and Phase 3 HDV Rules, along with other transportation sector regulations, are repealed. Electric vehicle tax credits remain in effect as they were before enactment of HR1.[3] Were the tax credits also removed the transportation emissions would likely be higher due to increased internal combustion vehicle sales relative to electric vehicle sales.

[2] Jenkins, J.D., Farbes, J., and Haley, B., "Impacts of the One Big Beautiful Bill on the US Energy Transition — Summary Report," REPEAT Project, Princeton, NJ (July 2025), *available at https://repeatproject.org/results.*
[3] U.S. Energy Information Administration. *Annual Energy Outlook 2025*. Alternative Transportation Case. Table 18 – Energy-Related Carbon Dioxide Emissions by Sector and Source. https://www.eia.gov/outlooks/aeo/tables_side_xls.php.

Table 1: Projected future U.S. transportation sector emissions 2025 – 2035.

Year	CO_2 Emissions (million metric tons)	
	REPEAT Project	AEO 2025 Alternative Transportation
2025	1,650	1,861
2026	1,610	1,857
2027	1,570	1,850
2028	1,523	1,845
2029	1,477	1,831
2030	1,430	1,813
2031	1,397	1,797
2032	1,363	1,778
2033	1,330	1,762
2034	1,330	1,744
2035	1,180	1,730

Both sets of modeled annual future emissions were converted into cumulative emissions since 1973 by adding them to the historical dataset maintained by the U.S. Energy Information Administration (EIA).[4] Using equation 1, both sets of data were converted to % reductions in GDP, and then into actual damages using projected future GDP from EIA's Annual Energy Outlook 2025[5] converted into 2024 dollar-year using GDP data provided by the Bureau of Economic Analysis.[6] Annual damages from 2025 – 2035 for were summed to calculate the total damages of $90.3 billion and $87.5 billion for both sources of future emissions projects, as reported in Table 2.

Table 2: Projected future cumulative damages from 2025 – 2035 due to both historical and projected 2025-2035 U.S. transportation sector emissions.

Scenario	Damages occurring in 2025-2035 (Billions $2024)	
	From historical and future emissions	Only from future emissions
No future emissions	$75.3	-
REPEAT Project	$87.5	$12.2
AEO 2025	$90.3	$14.9

[4] U.S. Energy Information Administration. *Monthly Energy Review*. Table 11.5 – Carbon Dioxide Emissions from Energy Consumption: Transportation Sector. https://www.eia.gov/totalenergy/data/monthly/pdf/sec11_8.pdf.
[5] U.S. Energy Information Administration. *Annual Energy Outlook 2025*. Reference Case. Table 20 – Macroeconomic Indicators. https://www.eia.gov/outlooks/aeo/tables_ref.php
[6] Bureau of Economic Analysis. *National Income and Product Accounts*. Table 1.1.3 Real Gross Domestic Product, Quantity Indexes. https://www.bea.gov/itable/national-gdp-and-personal-income

These damages include both damages occurring in 2025-2035 due to historical transportation sector emissions and projected transportation sector emissions from 2025-2035. To isolate only those 2025-2035 damages attributed to 2025-2035 transportation sector greenhouse gas emissions, a counterfactual no future emissions scenario was developed which assumed annual transportation sector emissions are zero 2025-2035 (i.e. cumulative transportation sector greenhouse gas emissions remain constant at the level they are as of the end of 2024). This resulted in 2025 – 2035 damages of $75.3 billion, solely attributed to historical emissions. Subtracting the historical $75.3 billion from the $90.3 billion calculated earlier results in $14.9 billion in damages attributable to 2025-2035 transportation sector greenhouse gas emissions under the AEO 2025 emission projections, as shown in Table 2. Using the REPEAT Project scenario results in $12.2 billion of damages attributable to 2025-2035 emissions.

Long term climate damages caused by U.S. transportation sector emissions from 2025 through 2050 used the same methodology described above, except only the AEO 2025 future emissions were used as the REPEAT Project emissions projections only go through 2035. The additional emissions 2036 – 2050 are in Table 2.

Table 3: Projected future U.S. transportation sector emissions 2036 – 2050.

Year	CO_2 Emissions (million metric tons)
	AEO 2025 Alternative Transportation
2036	1,717
2037	1,706
2038	1,694
2039	1,685
2040	1,679
2041	1,673
2042	1,667
2043	1,665
2044	1,659
2045	1,656
2046	1,650
2047	1,649
2048	1,646
2049	1,645
2050	1,645

Using total emissions from Table 1 and 3 covering 2025 through 2050 and following the same methodology described above, cumulative emissions were converted to future damages in both a no future emission scenario and the AEO 2025 scenario. Cumulative damages are presented in Table 4. In the no future emissions scenario, future damages from historical

emissions total $203.7 billion. The AEO 2025 scenario results in $300.0 billion in future damages. Taking the difference between these two gives the future damages attributed solely to 2025-2050 emissions from the U.S. transportation sector of $96.4 billion.

Table 4: Projected future cumulative damages from 2025 – 2050 due to both historical and projected 2025-2050 U.S. transportation sector emissions.

Scenario	Damages occurring in 2025-2050 (Billions $2024)	
	From historical and future emissions	Only from future emissions
No future emissions	$203.7	-
AEO 2025	$300.0	$96.4

Future damages (beyond 2050) that will be caused by those emissions (some of which will remain in the atmosphere for thousands to hundreds of thousands of years)[7] are not included in this estimate. Nor are damages from impacts (such as morbidity, wildfire smoke mortality, or macroeconomic effects) not included in the underlying damage analysis used in the original research. As such, the $12.2 to $14.9 billion in damages for 2025 – 2035 U.S. transportation sector emissions and $96.4 billion for 2025 – 2050 U.S. transportation sector emissions is a severe underestimate of the damages that will accrue to the United States from unabated transportation sector greenhouse gas emissions.

Both near-term, and long-term damage estimates are based on the relationship between cumulative emissions and annual damages captured in Equation 1 and based on historical data. The methodology used here relies on the expectation that the quadratic fit continues to capture the relationship between cumulative emissions and annual damages into the future.

[7] IPCC, 2021: Climate Change 2021: The Physical Science Basis. Contribution of Working Group I to the Sixth Assessment Report of the Intergovernmental Panel on Climate Change at 2237 [Masson-Delmotte, V., P. Zhai, A. Pirani, S.L. Connors, C. Péan, S. Berger, N. Caud, Y. Chen, L. Goldfarb, M.I. Gomis, M. Huang, K. Leitzell, E. Lonnoy, J.B.R. Matthews, T.K. Maycock, T. Waterfield, O. Yelekçi, R. Yu, and B. Zhou (eds.)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, 2391 pp. doi:10.1017/9781009157896.