Environmental Defense Fund

December 2023

U.S. Electric Vehicle Battery Manufacturing on Track to Meet Demand

The announced U.S. electric vehicle (EV) battery production capacity is more than on track to meet the projected demand for EV batteries that may occur under the Environmental Protection Agency's (EPA) proposed emission standards for light- medium- and heavy-duty vehicles with $92 billion of investment in batteries announced in the U.S.[i] **Over 1,000 gigawatt hours (GWh) per year** of U.S. battery production capacity has already been announced to come online by 2028 – enough to meet all of EPA's projected demand in 2030 and 85% of the projected demand in 2032.

Projected Demand for EV Batteries from EPA Proposed Standards

EDF used the EPA's projections for EV adoption and associated battery demand through 2030.[ii] Roughly 90% of the potential EV battery demand is from light-duty (passenger) vehicles. Potential demand for batteries in medium-duty vehicles (large pickup trucks and vans) and heavy-duty vehicles (delivery trucks, step vans, semi-trucks, buses, etc.) is much smaller.

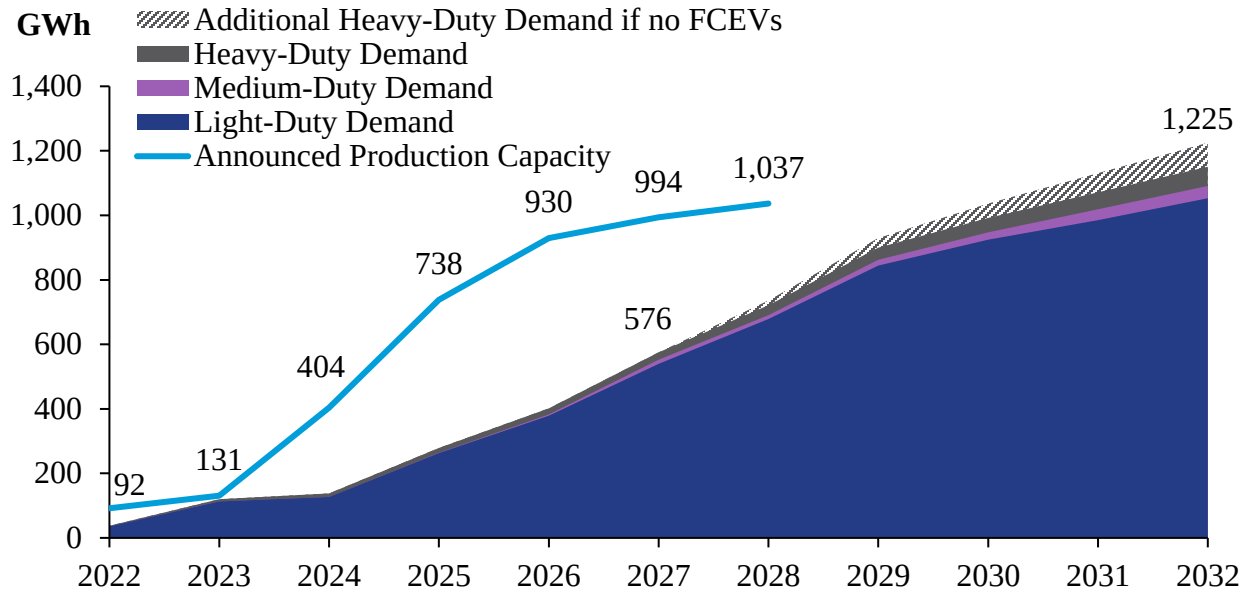

Figure 1: Projected U.S. EV Battery Demand and Announced Battery Production Capacity (2022-2032)

Figure 1 shows EPA projected battery demand by segment:

- Light-duty: 539 GWh per year in 2027 growing to 1,053 GWh per year by 2032.
- Medium-duty: 13 GWh per year in 2027 and only 38 GWh per year in 2032.
- Heavy-duty: 23 GWh per year in 2027 growing to between 59 GWh to 134 GWh per year in 2032, depending on whether heavy-duty EV adoption is met with a combination of fuel cell electric vehicles (FCEVs) and battery electric vehicles (BEVs) or solely BEVs (which would require more batteries). The additional batteries for an all-BEV compliance with EPA's heavy-duty proposal are labeled as "Additional Heavy-Duty Demand if no FCEVs".

Combined, **U.S. EV battery demand is projected to be 576 GWh per year in 2027 and 1,151 GWh – 1,225 GWh per year in 2032.** Even if heavy-duty EV battery demand increased twofold, overall battery demand would only increase to 1,359 GWh in 2032.

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Announced Battery Manufacturing Capacity in the U.S.

As shown by the blue line in Figure 1, based solely on announced EV battery manufacturing plants, the **U.S. will have an estimated capacity of 1,037 GWh per year by 2028**, consistent with projections made by other sources.[iii] This includes 45 battery manufacturing facilities with an average production capacity of 23 GWh per year. Table 1 shows states with the most announced battery production capacity. To estimate the nation's battery manufacturing capacity, EDF used publicly announced battery manufacturing plant information, including total monetary investment, battery capacity, and production start date.

Table 1: States with Highest Announced Battery Manufacturing

State	Number of Facilities	Battery Production (GWh)
Michigan	6	140
Georgia	5	136
Tennessee	3	128
Kentucky	4	119
Indiana	3	97
Ohio	2	75
South Carolina	5	67
Arizona	4	56
California	1	54
Illinois	1	40
Other	11	125
Total	45	1,037

The announced capacity for battery production outpaces EPA's projected demand through 2028, the last year for which any of the concrete current announcements project production will begin. Shifting consumer demand together with tax credits and incentives in the Inflation Reduction Act provide a strong case for battery manufacturers to build EV batteries in the U.S.

Even if construction delays shift production, there would still be enough battery supply. The average time between announcement and expected start of production for the battery facilities is 2.7 years, indicating that many of the facilities that would come online in 2027 and beyond have not yet been announced.

Plants Provide Capacity for Passenger EVs and Commercial EVs

As shown in Figure 1, EPA projects that roughly 90% of projected battery demand will power light-duty BEVs. While the relative demand for heavy-duty batteries is small, it will likely grow as demand for heavy-duty EVs grows. A recent announcement by Cummins, Daimler and PACCAR to build a joint battery plant in the U.S. indicates that heavy-duty manufacturers are already moving to supply this market.[iv]

There can also be significant sharing of vehicle batteries and components across light- and heavy-duty EVs, including cell modules.[v] For example, Tesla uses the same batteries for its electric semi-truck and Model Y passenger car.[vi] And many of the same battery chemistries are being used and explored for both vehicle segments, including Nickel Manganese Cobalt Oxide (NMC) and Lithium-Iron Phosphate (LFP).[vii viii]

Methodology

EPA's OMEGA2 model tracks fleetwide battery usage by model year. EDF used EPA's OMEGA2 model outputs for the light- and medium-duty runs for the proposed rule, *Multi-Pollutant Emissions Standards for Model Years 2027 and Later Light-Duty and Medium-Duty Vehicles*, to quantify the projected battery need. We summed the battery pack size for each vehicle by EPA's projected sales for a given year for all years between 2022 and 2032.

For the proposed heavy-duty rule, *Greenhouse Gas Emissions Standards for Heavy-Duty Vehicles—Phase 3*, EPA used the HD TRUCS model to project EV adoption, including number of vehicles and size of battery packs. EPA modeled two years, 2027 and 2032. EPA also included two types of EVs – battery electric vehicles (BEVs) and fuel cell electric vehicles (FCEVs). EDF multiplied the projected BEV adoption in 2027 and 2032 (in percentage terms) for each of the 101 vehicle categories in HD TRUCS by the annual sales and estimated battery pack size. HD TRUCS includes 2019 sales. To project HDV sales in later years, EDF assumed a 0.8% compound annual growth rate consistent with AEO2023.[ix] Heavy-duty

battery demand in 2022 was assumed to be 10% of the demand in 2027. The battery demand was linearly interpolated for the years between 2022, 2027 and 2032.

To account for a more conservative scenario in which the projected heavy-duty EV adoption might be met with all BEVs instead of a mix of BEVs and FCEVs as EPA projects, we calculated the battery demand if adoption projections are met entirely with BEVs. The largest group of vehicles projected to be FCEVs are sleeper cab tractors. EPA projects sleeper cab tractors would have very large battery packs, if BEVs were the chosen compliance path versus FCEVs, with the largest being more than 2 MWh per vehicle. EDF believes that EPA overestimates the battery pack size needed for many heavy-duty vehicles as explained in more detail in our comments,[x] but for purposes of this analysis, we used the EPA projected battery pack sizes. Assuming all heavy-duty EVs are BEVs results in the same 2027 battery demand because EPA does not project any FCEVs to be deployed then. Heavy-duty battery demand increases in 2030 to 90 GWh per year as a result of more BEVs, doubling EPA's projected demand for heavy-duty vehicles with BEVs and FCEVs of 45 GWh. This additional battery demand is labeled as "Additional Heavy-Duty Demand if no FCEVs" in Figure 1.

To determine the announced U.S. battery manufacturing capacity, EDF updated a previous analysis performed by WSP in August 2023 for EDF.[xi] EDF confirmed all plants produced batteries and not battery components to ensure no double counting. In cases where plans had changed for battery plants and the timelines for production were uncertain, the battery facilities were removed from the list. Some of the facilities like the North Carolina Toyota plant have announced investments ($13.9B) that would likely support much more battery production than they have announced (30GWh). Due to the conservative measures we took, this is likely an underestimate of the battery production capacity from already announced plants.

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[i] EPA's standards are technology neutral: vehicle manufacturers can use any combination of technologies they choose to reduce emissions from their vehicles. Likely the most cost-effective pathway is using ZEVs, as EPA modeled in its proposed rules.

[ii] *Multi-Pollutant Emissions Standards for Model Years 2027 and Later Light-Duty and Medium-Duty Vehicles*, 88 Fed. Reg. 29184 (May 5, 2023); *Greenhouse Gas Emissions Standards for Heavy-Duty Vehicles—Phase 3*, 88 Fed. Reg. 25926 (April 27, 2023).

[iii] A DOE estimate from January 2023 found 1,000 GWh of announced battery capacity expected to come online by 2030. https://www.energy.gov/eere/vehicles/articles/fotw-1271-january-2-2023-electric-vehicle-battery-manufacturing-capacity
Tech Crunch in August 2023 estimated 1,200 GWh per year of battery capacity by 2030. https://techcrunch.com/2023/08/16/tracking-the-ev-battery-factory-construction-boom-across-north-america/?guccounter=1&guce_referrer=aHR0cHM6Ly93d3cuZ29vZ2xlLmNvbS8&guce_referrer_sig=AQAAACQ3fpohOwikg91T2WLv1r2F04jRtHJDtRVn8x0POx4Nz9XSKaYfKo6VDeVTY9Qgtb2X1MT1iiNwW2Zsoi8Owel0pZeKtL-M6tKgad7jbJsInS3C6TGxfX9gTHeWX7ZbKQtH5gHEk79lt0NqGsUzWt73wa0_Vb7Xw2ulgzY15X22
In July 2023, Digi Times Asia estimated the announced battery capacity for 2030 was 900 GWh per year. https://www.digitimes.com/news/a20230726VL202/us-battery-electric-vehicle-meet-the-analyst.html

[iv] *Accelera by Cummins, Daimler Truck, and PACCAR form a joint venture to advance battery cell production in the United States*, Cummins Newsroom, (September 6, 2023), https://www.cummins.com/news/releases/2023/09/06/accelera-cummins-daimler-truck-and-paccar-form-joint-venture-advance.

[v] Vishnu Nair et al., *Medium and Heavy-Duty Electrification Costs for MY 2027- 2030*, Roush for EDF, (February 2, 2022), https://blogs.edf.org/climate411/wp-content/blogs.dir/7/files/2022/02/EDF-MDHD-Electrification-v1.6_20220209.pdf.

[vi] Mark Kane, *New Photo Reveals Resla Semi's Massive Battery System,* (January 25, 2023), https://insideevs.com/news/633133/photo-tesla-semi-battery-system/.

[vii] Nair et al., Medium and Heavy-Duty Electrification Costs for MY 2027- 2030.

[viii] *A Million-Mile Battery From China Could Power Your Electric Car*, Bloomberg News, (June 7, 2020), https://www.bloomberg.com/news/articles/2020-06-07/a-million-mile-battery-from-china-could-power-your-electric-car

[ix] U.S. Energy Information Administration's Annual Energy Outlook 2023, Table 49. Freight Transportation Energy Use, (March 2023), https://www.eia.gov/outlooks/aeo/supplement/excel/suptab_49.xlsx.

[x] Comments of the Environmental Defense Fund, EPA-HQ-OAR-2022-0985-1644, https://www.regulations.gov/comment/EPA-HQ-OAR-2022-0985-1644.

[xi] *U.S. Electric Vehicle Manufacturing Investments and Jobs: Characterizing the Impacts of the Inflation Reduction Act after 1 Year*, WSP for EDF, (August 2023), https://www.edf.org/sites/default/files/2023-08/EDF%20WSP%20EV%20report%208-16-23%20FINAL%20FINAL.pdf.