

Electrifying Long-Haul Trucking With Locally Generated Solar Energy

Final Project Technical Explanation

CP6581 Programming for GIS

By David Moss

Methodology

Can we electrify long-haul trucking using locally-generated solar energy?
To find out, this project tackled three key analyses in turn:



Road Network

How can we approximate the routing of freight across the US highway system?



Energy Requirements

How can we calculate how much energy is required to move freight in the US?



Solar Potential

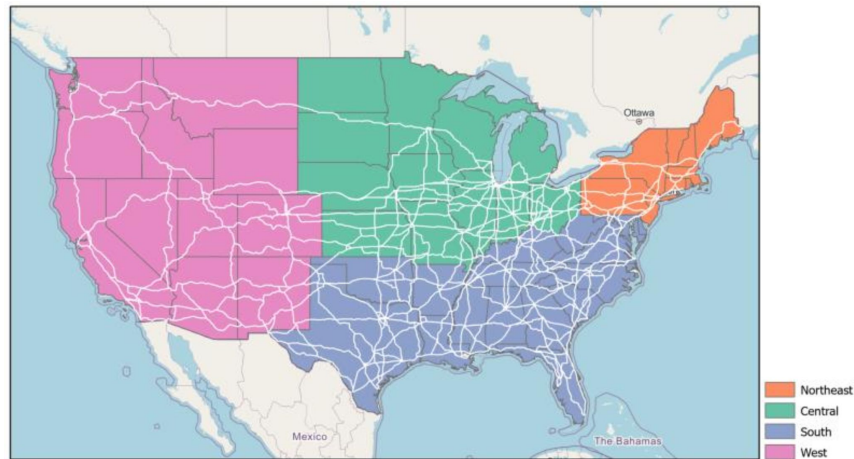
How can we estimate the amount of land it would take to power the energy for long-haul freight?

Road Network

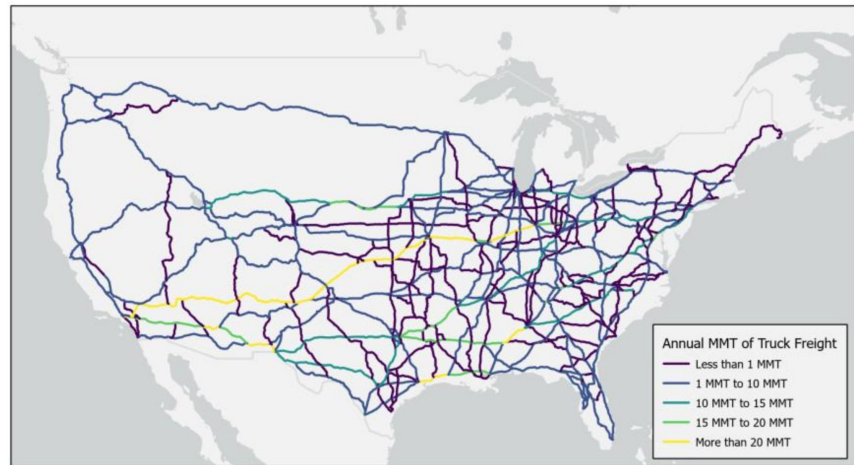
O-D freight flows data from the *Freight Analysis Framework* was **geocoded using Nominatim** from OpenStreetMap.

US Highways dataset was downloaded from Esri, then **planarized** (broken into segments where roads intersect to allow for transfers).

Shortest paths for each O-D were approximated with distance as a weight, then **overlined** so that freight on shared routes were summed together.



US Highway Network (white) and US Regions (Colors, key on right)



Annual MMT of Truck Freight by Highway Network Segment

Energy Requirements

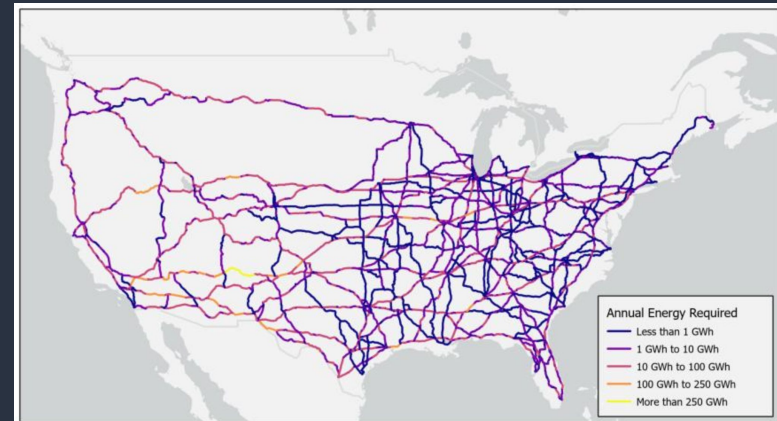
Knowing the amount of freight moving over each highway segment, the next step was to **calculate the number of trucks needed to haul that freight** using a representative electric vehicle currently available.

Then, **the kilowatt hours required to power all of those trucks over the distance of each segment** was approximated from the battery's range in these trucks.

The most energy-intensive segments of the highway system are those that **haul the most freight over the longest distance**.



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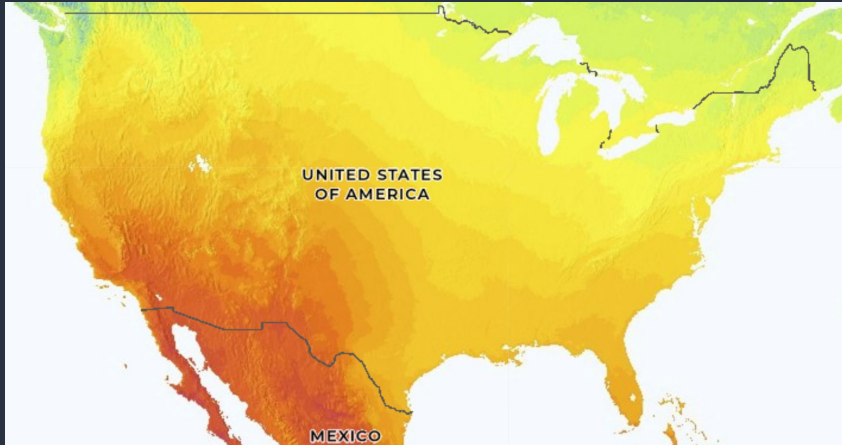


Annual GWh of Energy Required by Highway Network Segment

Solar Potential

Finally, the **area needed for solar panels** was calculated by dividing the kilowatt hours by the average global horizontal irradiance (GHI) around each segment.

The **area for battery storage** was estimated using the Hornsdale Power Reserve in Australia as a representative example for power-to-area.

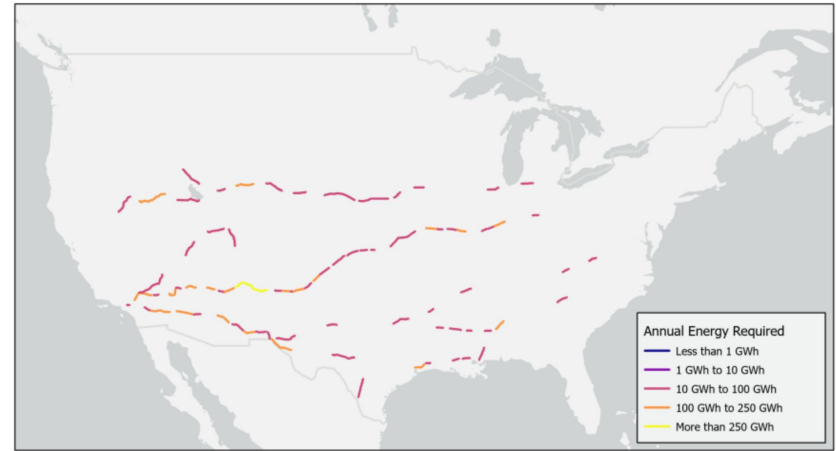


Findings

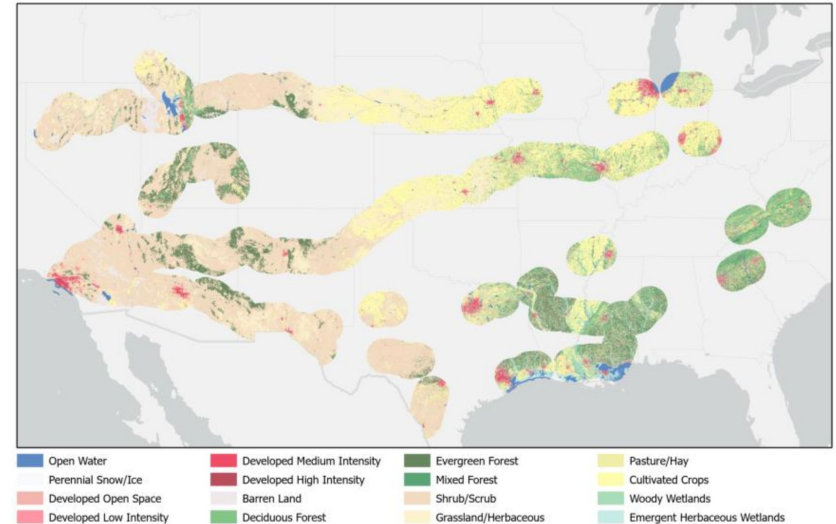
Long-haul trucking (> 1,000 miles) can easily be powered using locally generated solar energy, even in solar-poor areas such as New England and the Pacific NW.

Certain corridors, namely I-80, I-40 and I-44, and I-10 stand out as initial rollout locations due to high solar energy potential and large freight volumes.

This analysis should be complemented with another analysis using land cover data to determine areas suitable for solar panels.



Annual GWh of Energy Required for Top 100 Highway Network Segments



Thank You

Questions?

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