ASSESSING VEHICLE TECHNOLOGIES BENEFITS IN A TRANSPORTATION ENERGY ECOSYSTEM

Project ID # VAN035

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OBJECTIVES

- Evaluate the benefits of electrifying last mile deliveries and regional freight in the Altanta - Chattanooga region
- Estimate the associated electric demand on the grid

RELEVANCE

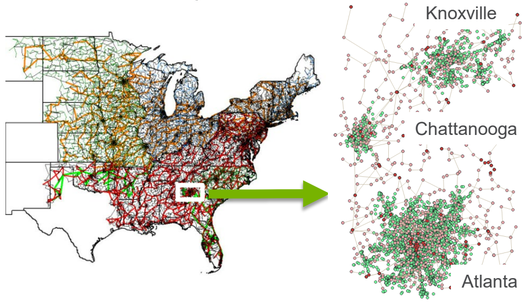
- VTO technology targets have historically been assessed for energy consumption and cost using US regulatory drive cycles. What are the benefits considering real world duty cycles in a given geographical area?
- What levels of grid update will be required to support upcoming and increasing levels of electrification?

PROJECT OVERVIEW

Timeline	Barriers Addressed
Start date: Oct. 2019 End date : Sep. 2022	• Lack of available data • Constant advances in technology • Complexity of freight operations • Computational models, design, and simulation methodologies
Budget	**Partners**
Total project : $900K FY22 : $300K Percent spent : 90%	• Vehicle Technologies Office • 21 Century Truck Partnership • Allison Transmission

APPROACH: GRID MODELING

- The electric grid system and data was extracted from the Eastern Interconnection of the U.S. Synthetic Grid (ACTIVSg70k) - 70,000 bus synthetic grid of eastern United States
- Filtered electrical nodes and lines were selected to represent the power grid model in Atlanta-Chattanooga area



The Eastern Interconnection of the U.S. Grid

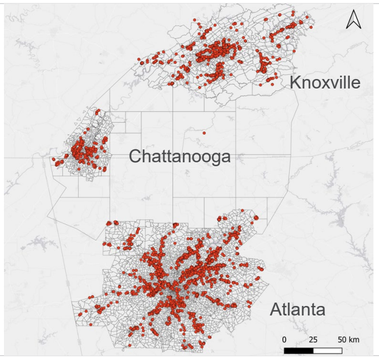
The Grid covering Atlanta-Chattanooga Region

The Atlanta- Chattanooga grid model:

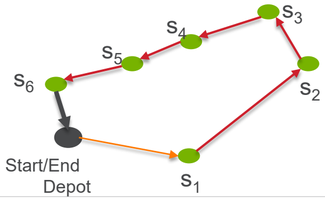
- 1,463 nodes
- 1,728 transmission lines
- 231 generators (red dots)
- 1,301 electricity demand nodes (light red and some dark red dots)
- 2,446 freight depots (green dots)
- 25,389 MW of generation capacity

APPROACH: FREIGHT MODELING

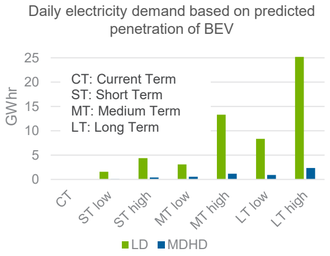
- Atlanta number of freight firms were used to estimate the number of depots
  - 13,000 Businesses (Source: Dun & Bradstreet)
  - Assuming that 20% of them have depots
- 2,446 depots distributed across 1,250 zones
- Fleet distribution based on Bureau of Transportation Statistics
  - 32% of trucks in fleet of less than 15
  - 68% of trucks in fleet of 15 or more
- 13 millions MDHD daily miles
- 265,000 MD tours
- 71,000 HD tours

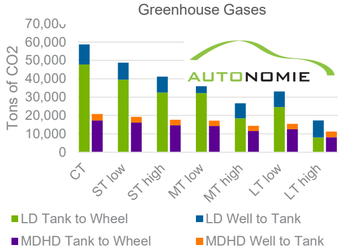


- Number of stops draw from a log-normal distribution
- Stops and VMT calibration based on multiple sources, including Vehicle Inventory and Use Survey (VIUS) and truck telematics data
- Medium-duty trucks' average daily VMT: 48.2
- Heavy-duty trucks' average daily VMT: 95.7



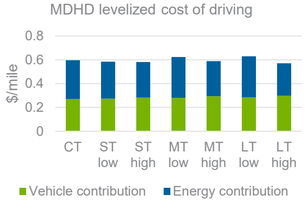
ACCOMPLISHMENTS: QUANTIFIED THE BENEFITS OF VTO TECHNOLOGIES IN THE ATLANTA – CHATTANOOGA REGION USING REAL WORLD DUTY CYCLES

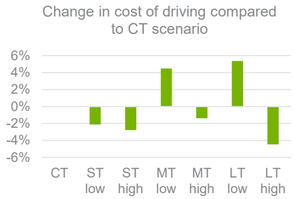




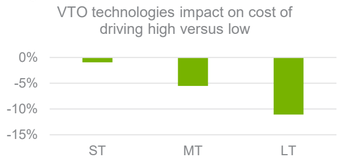
Low: Low levels of technology improvements - *High*: DOE VTO technology targets are met

- Vehicle powertrain distribution based on SMART 2.0 assumptions
- Electricity demand from LD far exceeds that of MDHD
- As electrification increases, the well to tank portion of GHGs increases
- As the rate of electrification is lower for MDHD compared to LD, the MDHD share of GHGs increases over time



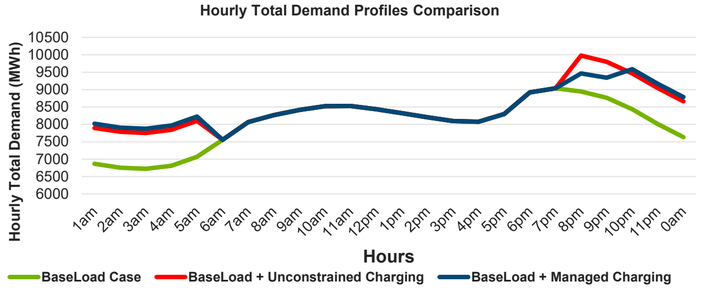


- The levelized cost of driving represents the cost of driving at the aggregate level taking into account all MD and HD trucks in the region. It considers the purchase price of the vehicles as well as the energy related costs (diesel or electricity).
- In the MT low and LT low scenarios, the cost of driving increases due to a high share of ICE powertrain and increase in diesel cost
- In the ST low and ST high scenarios, diesel cost has not increased significantly and technology progress allows for a reduction in energy consumption enough to generate a decrease in the cost of driving
- In the MT high and LT high cases, the increase in BEV penetration and technology improvement are large enough to overcome the impact of increased diesel cost.



At the aggregate level for the entire region, achieving VTO technology targets for MDHD trucks represents a 6% reduction in cost of driving in the short term and an 11% reduction in the long term.

ACCOMPLISHMENTS: QUANTIFIED THE GRID IMPACT OF FREIGHT ELECTRIFICATION



- This preliminary grid study only considers charging from freight and assumes 100% electrification.
- With unconstrained charging, the electric load is equally spread between 8 pm and 6 am and causes line congestion and high electricity prices in some areas.
- Shifting 50% of the charging load for the first 2 hours (8-10pm) to later hours (managed charging) avoids line congestion and hence reduces energy price.

Base load | Base load + unconstrained charging | Base load + managed charging

SUMMARY

- A freight model with truck tours was developed and calibrated for the Atlanta-Chattanooga region for delivery trucks and regional freight trucks
- A synthetic grid model was developed based on the Eastern Interconnection of the U.S. Grid
- Electricity demand at freight depots for different timeframes and technology achievement levels was quantified
- An aggregated cost of driving for MDHD trucks was defined

PROPOSED FUTURE RESEARCH

- Study the impact of cold and hot weather on electricity demand. Vehicle charging demand increases in a cold climate while the base load electricity demand increases in a hot climate
- Analyze charging schemes that can reduce line congestion and curtailment issues

Any proposed future work is subject to change based on funding levels

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