Overview
Reducing the dependence on fossil fuel is both a major national objective and essential to the long-term health of the national economy. Because transportation accounts for a large share of the demand for fossil-based fuels, shifting to electric vehicles (EVs) is core to reducing reliance on fossil fuels. This study examines the potential benefits that would emerge specifically in Connecticut (CT) from this shift and contrasts results with either flat or variable electricity rates.

Methods
The study draws on data of hybrid vehicles registered by CT residents to examine the rate of adoption of innovative vehicles within the state. Michigan's Detroit Edison Energy Data (DTE) early experience suggests that such an approach provides a good indication of the likely adoption of EVs. Annual cross-sectional data organized by CT zip codes (5 digits) provides the basis for estimating resident adoption of hybrids in each year between 2005 and 2009. CCEA drew on 2007 Internal Revenue Service (IRS) data by zip code to estimate average aggregate household income and the share of income tax filings in each zip code involving two people, from which CCEA then projected the ability of households to buy new vehicles. IRS data covered 275 of 281 CT zip codes used. The U.S. Census Bureau Longitudinal Employer-Households Dynamics (LEHD) provided additional data on residents' commuting distances to work from each of the zip codes above. The LEHD also provides data on the additional 89 zip codes.

These data facilitate estimating commuter cost differentials by type of vehicle under various conditions such as gasoline prices, electricity rates, paid and unpaid parking during the day, subsidies on vehicles, expected battery longevity and end-of-life vehicle values.

This approach allowed CCEA to estimate penetration effects relative to registered light vehicles by zip code under alternative electricity pricing schemes. DTE had found that if its electricity rates remained flat, transformers should be upgraded when market penetration of EVs reaches 5%. The study also analyses commuting patterns from Census data and then estimates concentrations of potential demand, including, affordability based on income benchmarks developed from IRS zip code data. These findings reveal how the rate of growth of hybrid adoptions has varied significantly among CT zip codes, which, with other Census and IRA indicators, facilitate long-term planning for gradual transmission capacity upgrades.

Allowing adoption rates of EVs to differ among zip codes dependent on the number of commuters, income, and distances travelled to work, facilitated estimating adopting rates for EVs to be charged off-peak by zip code and when transformers would need to be replaced. It also facilitated larger energy-cost savings among EV adopters, thereby generating larger economic impacts. Because base power is generated by nuclear energy and supplied via James Bay, recharging off-peak also has very different environmental impacts than would occur at flat rates.

Finally, CCEA used ArcMap 10 software to map the zip codes need to be upgraded and run a point density analysis to identify those towns where the highest number of zip codes are concentrated, thus providing a spatial perspective to the study.

Results
The study offers different results for both scenarios. Off-peak electricity rates are found to be integral to managing the dynamics associated with increased electricity demand derived from the adoption of EVs. Capping market penetration at 90%, EVs registration in CT will grow to 222,000 in 2022 and 1,198,000 in 2027. The initial requirement for to upgrade transformers will take 10 years to materialize under the current flat-rates system and 13 years under peak/off-peak rates. By 2022, under flat rates, transformer capacity constraints need to be redressed in 263 zip codes of the 341 residential ones tested. However, if peak/off-peak rates are introduced and recharging occurs during off-peak hours, only 50 zip codes need redressing. The towns with the highest concentration of zip codes that would need upgrade under off-peak rates in 2022. Other four groups of towns, including Greater Hartford area require attention in 2027. The reductions in emissions under both scenarios thanks to EVs adoption
are projected to reach 1.4 million CO\textsubscript{2} in 2022 (3.03\% of 2006 emissions) and 7.3 million in 2027 (15.84\% in 2006).

**Conclusions**

The initial off-peak loads based on nuclear and power from Bay Jones are relatively benign and low in GHGs emissions. If the current price regime of flat rates remains unchanged, the electricity generation system of the state will be put under stress sooner, with more towns affected. As such, the adoption of different electricity rates appear as a

**References**