Section 1: Overview

Electrification, or the switching from non-electric fuels to electricity at the point of final consumption, is a major emerging trend driven by the advancement of end-use electric technologies that are increasingly competitive and offer potential environmental and health benefits. Assessing the impacts of electrification on the energy system requires an understanding of how it might impact the amount and shape of electricity consumption, and how this electricity can be supplied. In particular, increased adoption of electric space heating could introduce new winter peaks in cold climates while transportation electrification introduces a new source of demand altogether, potentially very flexible. Moreover, electrification could shift the consumption of natural gas between sectors, thereby affecting the economics for natural gas-fired generation relative to other electricity generation options. Electrification could also amplify opportunities for demand-side flexibility such as through optimized vehicle charging or demand-side management in the buildings and industrial sectors. All of these factors, among others, will impact the evolution of the power system under a widespread electrified future, which, in turn, could have far-reaching affects on future energy costs and emissions.

Section 2: Research Approach

The Electrification Futures Study (EFS) is a collaborative research study designed to assess the impacts of widespread electrification in the United States. The study relies on a several modeling tools and technical experts to analyze future change in end-use electric technologies, the speed and extent of adoption of these technologies, corresponding changes to electricity consumption, and the evolution and operation of the future U.S. power system. Here, we present the latest research findings from the EFS, which includes electricity supply scenarios through 2050 for different electrification scenarios. The modeled scenarios are developed using the Regional Energy Deployment System (ReEDS) capacity expansion model, which finds the least-cost portfolio of generation, transmission, and storage using high-resolution optimization modeling.

Section 3: Research Results

Our scenarios indicate that electrification could drive U.S. annual electricity load to grow in excess of 1.6% per year through 2050, which is well below long-term historical rates, but is a departure from stagnate demand growth over the past decade and also reflects unprecedented year-to-year electricity demand increases in absolute terms. We find that these estimated electrification-driven growth could yield the following impacts on the U.S. electricity system:

- Electrification has the potential to accelerate and sustain deployment of new generation capacity and other power system infrastructure, particularly from natural gas-fired and renewable energy technologies.

- An increase in total power sector expenditures is expected with increased electrification but such expenditures can be mitigated by advancements in end-use electric technologies and relative electricity costs (in $/kWh) could decline.

- Electrification could result in net system-wide energy use and emissions reductions even as it results in greater power sector energy consumption and emissions.

- Electrification inherently increases the integration between U.S. economic sectors, and this integration can be further enhanced through demand-side flexibility, offering potential system-wide benefits.
Section 4: Further Research

Significant uncertainties are inherent in any projection of electricity and energy systems over a multi-decadal horizon. As electrification further integrates multiple economic sectors, complexities can be further compounded and future research is needed to understand the complexities. In particular, further research is needed in consumer choice modeling of technology adoption and the behavioral constraints and costs associated with demand-side flexibility. Future studies within the EFS will include analysis of systems operation under with highly electrified and flexible loads using unit commitment modeling, as well as an assessment of the impacts of electrification on the distribution system.

References

