Methodology for estimating the potential for household energy bill savings, by state

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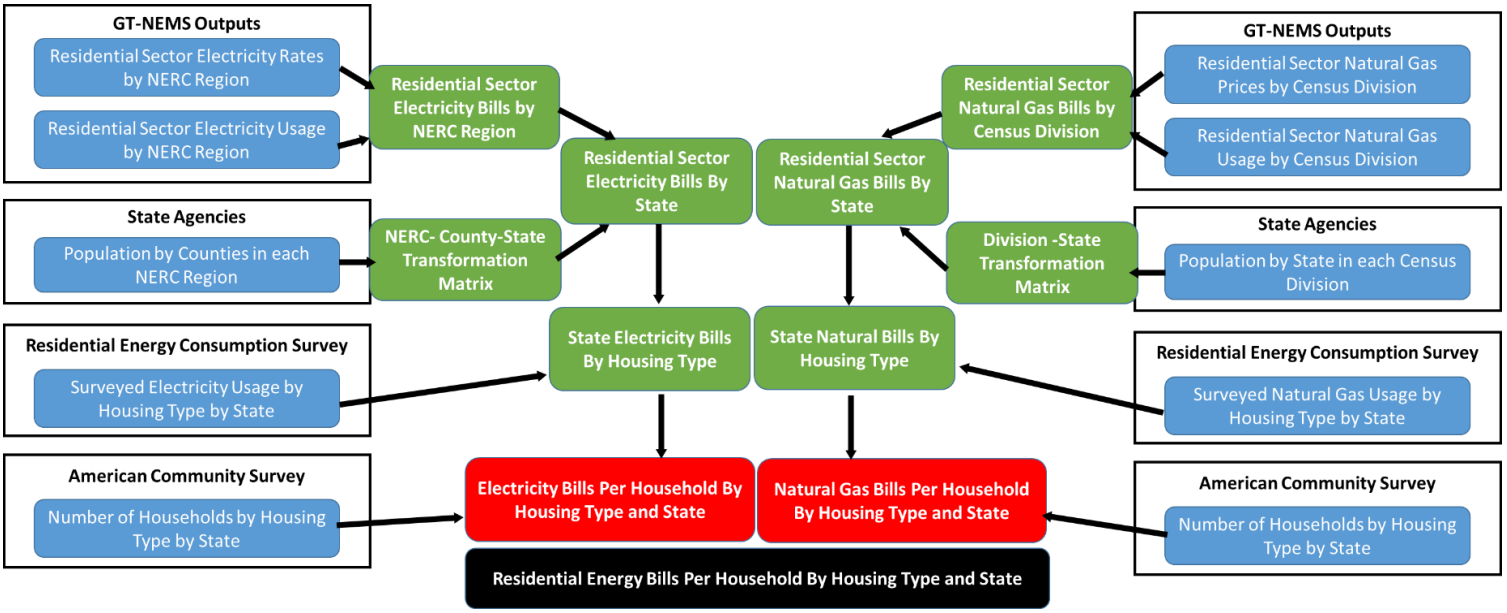
1. Brief Introduction and Logic Diagram

This document describes the methodology developed by the Georgia Institute of Technology's Climate and Energy Policy Lab to estimate the impact of clean power pathways on the utility bills of households. For an overview of the larger project, see the School of Public Policy working paper on "The Clean Power Plan and Beyond".

This methodology can be summarized in the following logic diagram. The blue boxes are data collected as input. While using these inputs, the green boxes characterize the steps and associated intermediate results. Finally, the red box illustrates how these steps conclude the final output, state level electricity bills per household by housing type.



Logic Diagram of the Methodology for Projecting Household Electricity Bills

The rest of this document further explains the data source and detailed process of projection.

2. Data Source

Four main data sources are necessary to forecast household utility bills for different housing types in each state. Firstly, electricity rates and usage by NERC region are collected from GT-NEMS outputs. Secondly, we apply the list of counties and their population in each NERC region developed by previous the School of Public Policy working paper on "Low-Carbon Electricity Pathways for the U.S. and the South: An Assessment of Costs and Options". What's more, two survey data are used: total usage by housing types by state from Residential Energy Consumption Survey, and number of households in each type by state from American Community Survey. The details of these data sources are listed in Table 1.

Table 1. Data Collected and Sources

Data	Source		Reference
Residential Sector Electricity Rates by NERC Region	GT-NEMS Outputs	Table 62 R1-R22 Line 108	GT-NEMS
Residential Sector Electricity Usage by NERC Region	GT-NEMS Outputs	Table 62 R1-R22 Line 63-67	GT-NEMS
Residential Sector Natural Gas Prices by Census division	GT-NEMS Outputs	Table 3 R1-R9 Line 5	GT-NEMS
Residential Sector Natural Gas Usage by Census division	GT-NEMS Outputs	Table 2 R1-R9 Line 7	GT-NEMS
Population by Counties in each Census division and NERC Region	State Agencies	Organized by CEPL	http://cepl.gatech.edu/drupal/node/88
Surveyed Electricity Usage by Housing Types by State	Residential Energy Consumption Survey 2009	Microdata	http://www.eia.gov/consumption/residential/data/2009/index.cfm?view=microdata
Surveyed Natural Gas Usage by Housing Types by State	Residential Energy Consumption Survey 2009	Microdata	http://www.eia.gov/consumption/residential/data/2009/index.cfm?view=microdata
Number of Households by Housing Type by State	American Community Survey 2010-2014	Table B25024 Line 1-51	http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_14_5YR_B25024&prodType=table

3. Detailed Descriptions of the Projection Process

3.1. Calculating Electricity Bills for NERC Regions and Natural Gas Bills for Census divisions

GT-NEMS (Georgia Tech - National Energy Modeling System) provides the data necessary for estimating household utility bills for the nine U.S. Census divisions. It also estimates residential electricity consumption and electricity prices by fuel type for smaller geographic units – the 22 North American Reliability Corporation (NERC) regions shown in Figure 2. While the GT-NEMS code incorporates population estimates for these regions in its macroeconomic model, it does not provide these population estimates as outputs. It also does not generate per capita utility bill estimates at the resolution of the 22 NERC regions. As a result, additional work by users of GT-NEMS is required to estimate utility bills on a per capita or per household basis at the scale of these NERC regions.

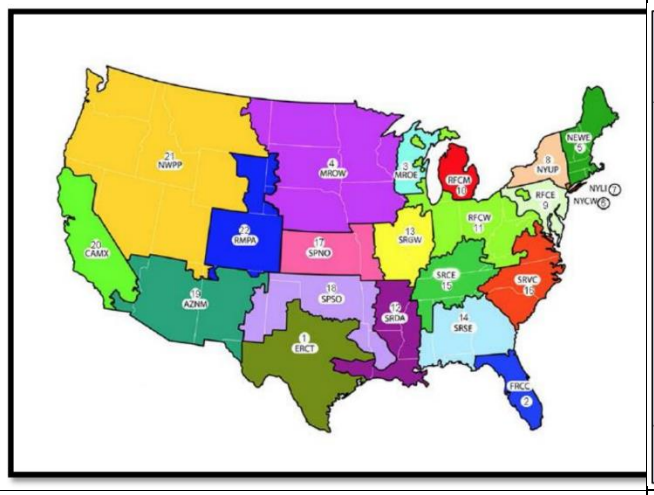


Figure 2. The Electricity Market Module's NERC Regions[1]

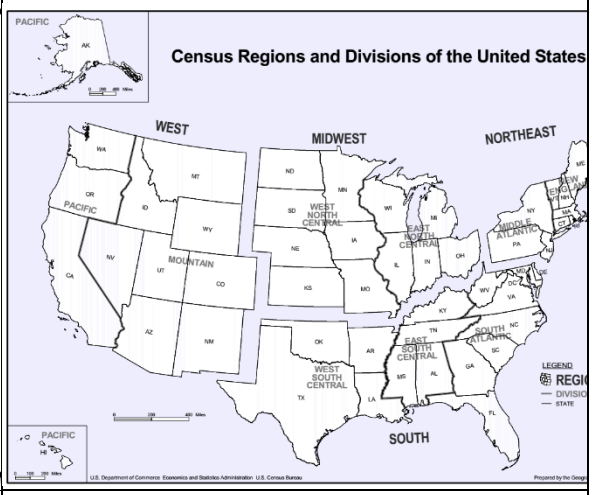


Figure 3. The Residential Module's Census divisions[2]

In GT-NEMS outputs, the electricity rates and consumption for residential sector are given by each NERC region. Thus, accordingly we can calculate the residential electricity bills for each NERC region.

However, in GT-NEMS outputs, the natural gas prices and usage by residential sector are recorded to Census divisions, which are shown in Figure 3. Census divisions are groupings of states and the District of Columbia that subdivide the United States for the presentation of census data. There are four Census divisions—Northeast, Midwest, South, and West. Each of the four Census divisions is divided into two or more census divisions[3]. Thus, accordingly we can calculate the residential natural gas bills for each Census division.

[1] U.S. Energy Information Administration. "*Analysis of the Impacts of the Clean Power Plan".* May, 2015. Figure 1, Page 6. http://www.eia.gov/analysis/requests/powerplants/cleanplan/pdf/powerplant.pdf. Accessed May 17, 2016.

[2] U.S. Census Bureau, "*Census divisions and Divisions of the United States",* https://www2.census.gov/geo/pdfs/maps-data/maps/reference/us_regdiv.pdf. Accessed May 17, 2016.

[3] U.S. Census Bureau, "*Geographic Terms and Concepts - Census Divisions and Census divisions",* https://www.census.gov/geo/reference/gtc/gtc_census_divreg.html. Accessed May 17, 2016

3.2. Building NERC Region-State and Census Division-State Transformation Matrix

While not a perfect method for downscaling to states, the 22 NERC regions can inform state statistics. The 22 NERC regions were developed and implemented by the Energy Information Administration in the Electricity Market Module (EMM) module of the *Annual Energy Outlook 2011*. They correspond to the North American Reliability Corporation regions in place in 2011. In some cases they are divided into sub-regions[4].

Some of the 22 regions correspond approximately to state territories, such as FRCC (Florida), ERCT (Texas), and CAMX (California). Others are aggregations of states, such as NEWE (New England), or are parts of states that can be aggregated (New York). Still others cut across state boundaries, reflecting the territories overseen by power coordinating entities or power marketing authorities such as the Northeast Power Coordinating Council and the Southeast Reliability Corporation. In some cases these are divided into the subregions served by entities such as utility holding companies. For example, the Georgia-Alabama NERC region is served by the Southern Company and is abbreviated SERC-Southeast or SRSE. Because of the influence these holding companies and power marketing authorities have over power planning, they provide useful insights into energy rates, consumption, and bills at the state level.

Therefore, to develop the NERC region to state transformation matrix, we link each counties and their population to NERC regions. This job has been done in previous working report "Low-Carbon Electricity Pathways for the U.S. and the South: An Assessment of Costs and Options"[5]. The details of linking counties to NERC regions are contained in the file NERC-to-CNTY CALC, which produced a table showing the NERC region location of each county. In addition, the aggregation of the 2010 population from counties and states to NERC regions is shown in the file named NERC_POP CALC, which can also be found at http://cepl.gatech.edu/drupal/node/88. Proportioning the population of each state in each NERC region, the transformation matrix is developed.

However, Census divisions are perfect downscaling to states. Thus, the transformation matrix will be much easier by weighing the estimated population of each state as a percentage of the total population in the corresponding Census divisions.

3.3. Transforming Electricity and Natural Gas Bills to State Level

With the transformation matrix, we proportion the residential electricity bills by NERC region into state level data, and proportion the residential natural gas bills from Census divisions into state level data. After the transformation, the residential electricity and natural gas bills by state are generated respectively.

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[4] U.S. Energy Information Administration. "*Analysis of the Impacts of the Clean Power Plan".* May, 2015. Page 6. http://www.eia.gov/analysis/requests/powerplants/cleanplan/pdf/powerplant.pdf. Accessed May 17, 2016.

[5] M. Brown, G. Kim and A. Smith. "Low-Carbon Electricity Pathways for the U.S. and the South: An Assessment of Costs and Options" July 2015. Appendix C, Page 52-55. http://www.cepl.gatech.edu/sites/default/files/attachments/Methodology_for_Bill_Calculations.pdf. Accessed May 17, 2016.

3.4. Separating State-Level Electricity and Natural Gas Bills to Different Housing Types

In each state, the energy bill is positive correlated to the energy usage. Respectively, natural gas bills are correlated to natural gas usage and electricity bills are correlated to household electricity usage. Thus, the electricity or natural gas usage for each housing type are part of the state-level electricity or natural gas bills by the proportion of the energy usage of particular housing type as to all housing types. According to the state-level usage data by housing type, the electricity and natural gas bills are separated into different housing type categories.

3.5. Identifying Electricity and Natural Gas Bills Per Household for Different Housing Unit Types

Finally, the electricity and natural gas bills per household for each housing type can be calculated by dividing the total bills of particular housing type by the number of households in this housing type categories in each state.

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