Energy Efficiency Investments in Public Housing: An Application of the U.S. EPA's Community Scale Energy Systems Model for New York City

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OBJECTIVE

- According to the United Nations, by 2050[1], almost 70% of the world population is expected to live in urban areas. This will present a tremendous challenge for cities in meeting their increased energy demand, and maintaining safety and integrity of natural resources such as water, land, and air.
  - New York City (NYC) has one of the oldest infrastructures in the U.S.
    → Requires expansion and upgrades over the coming decades
  - Building and transportation energy footprint of the city is significantly impacting air quality
    → Presents a public health issue
- The purpose of this project is to develop analytical technology evaluation tools for cities to address long-term planning questions related to sustainability, resilience, equity, and growth in the energy sector.
  - Cost and benefit analysis of various energy options
  - Tradeoffs among pathways to air quality attainment and emissions reduction
  - Multi-modal transportation, economy, air quality, and public health

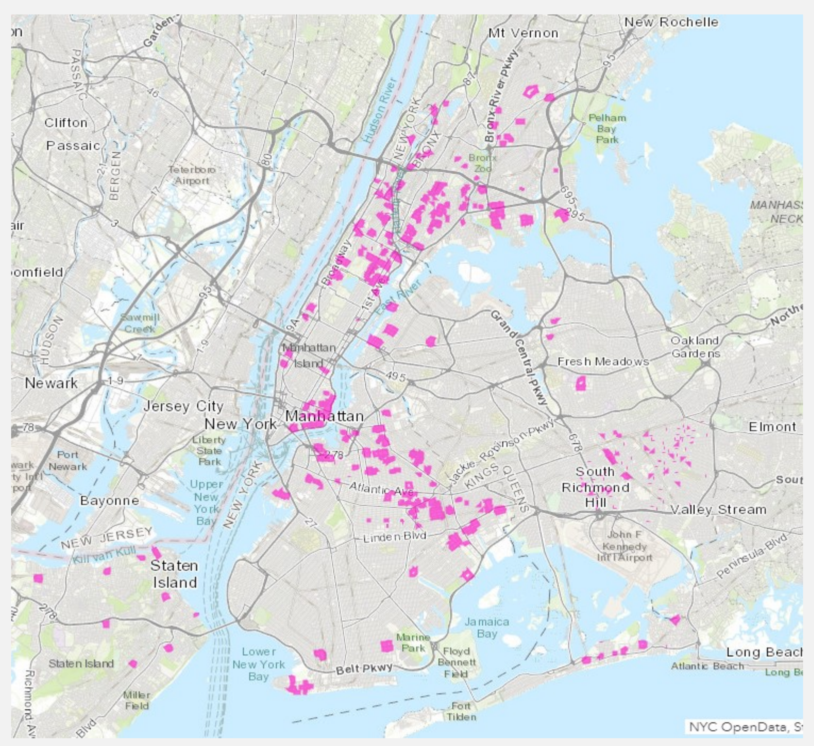

Figure 1. Public housing managed by NYCHA[2]

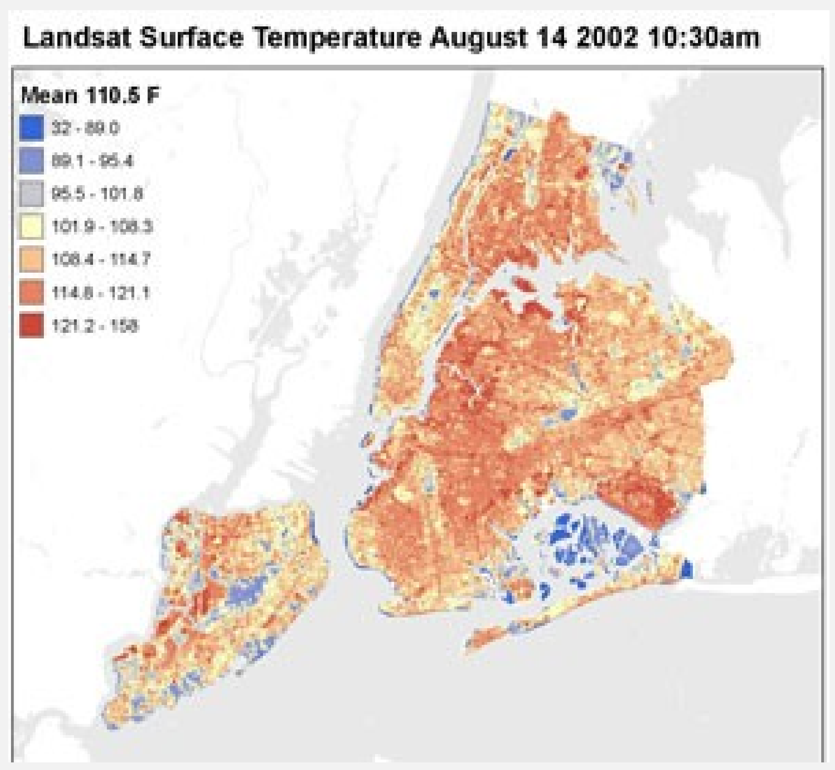

Figure 2. NASA Landsat surface temperature

BACKGROUND ON ENERGY SYSTEMS MODELING

- Identify strategies where multipollutant and multi-media impacts, and the unintended consequences of the evolution of energy systems, can be evaluated and compared.
- This knowledge can guide federal, state, and city governments to:
  - anticipate future environmental challenges so that they can be addressed proactively,
  - evaluate existing regulations over wide-ranging conditions, and
  - identify cost-effective strategies that meet energy demands and environmental goals.

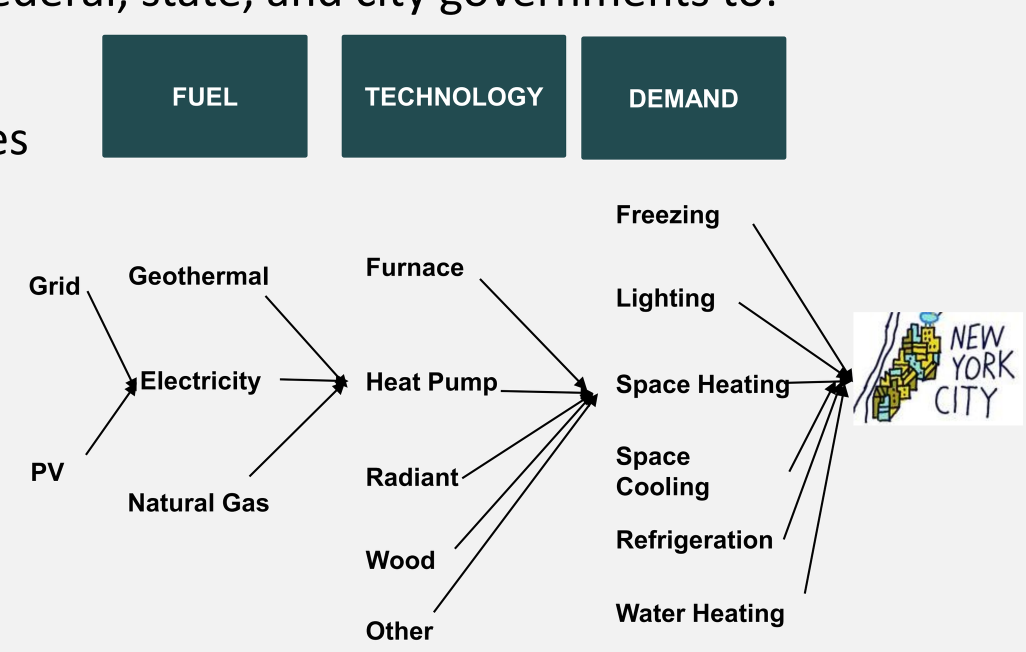

Figure 3. Detailed end-use demand characterization

MARKAL/TIMES ENERGY DATABASE FOR NEW YORK CITY

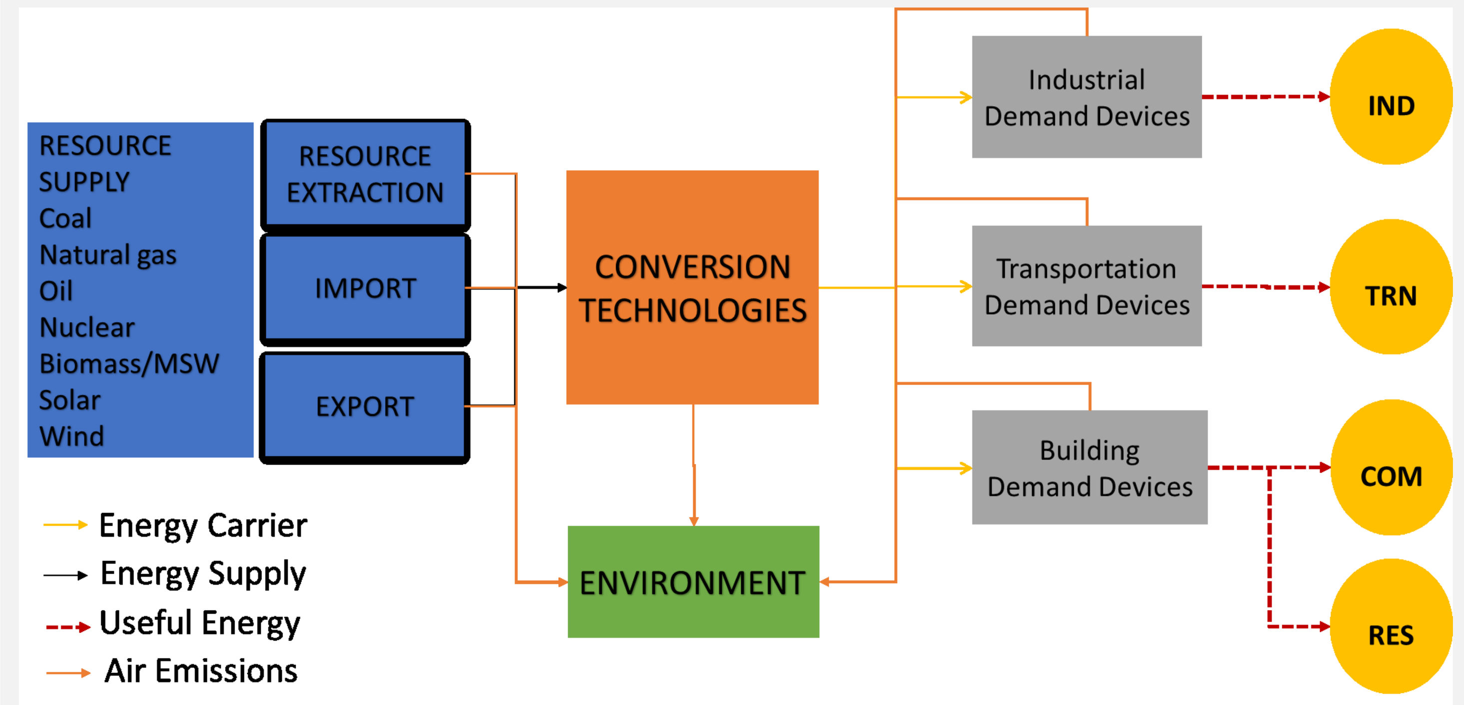

Figure 4. NYC_MARKAL model structure

Spatial resolution: Five boroughs of NYC and NY Electric Grid
Modeling horizon: 2010 to 2055 in five year increments
Outputs include fuel consumption, technology penetration, and air emissions (i.e., criteria pollutants, CO_2, CH_4, etc.).

- U.S. EPA has been developing publicly available technology databases[6,7] representing the energy system in nine U.S. Census Divisions and at a community scale (i.e., NYC) for use with the MARKAL/TIMES energy system optimization framework.
- Users include >50 organizations including ~25 U.S. Universities, DOE, NESCAUM, governmental and academic groups across 13 countries.

BUILDING SECTOR CHARACTERIZATION

- Existing building stock is categorized by type
  - Residential, multifamily, commercial, industrial.
  - Using Primary Land Use Tax Lot Output data from the NYC Department of City Planning
- The greenhouse gas inventory and other city provided data is utilized to calibrate the model to fuel consumption by end-use demand technology type in 2010.[3,4,5]
- In addition to greenhouse gases, criteria air pollutants such as NO_x, SO_2, and PM emissions from energy technologies are included in the database.

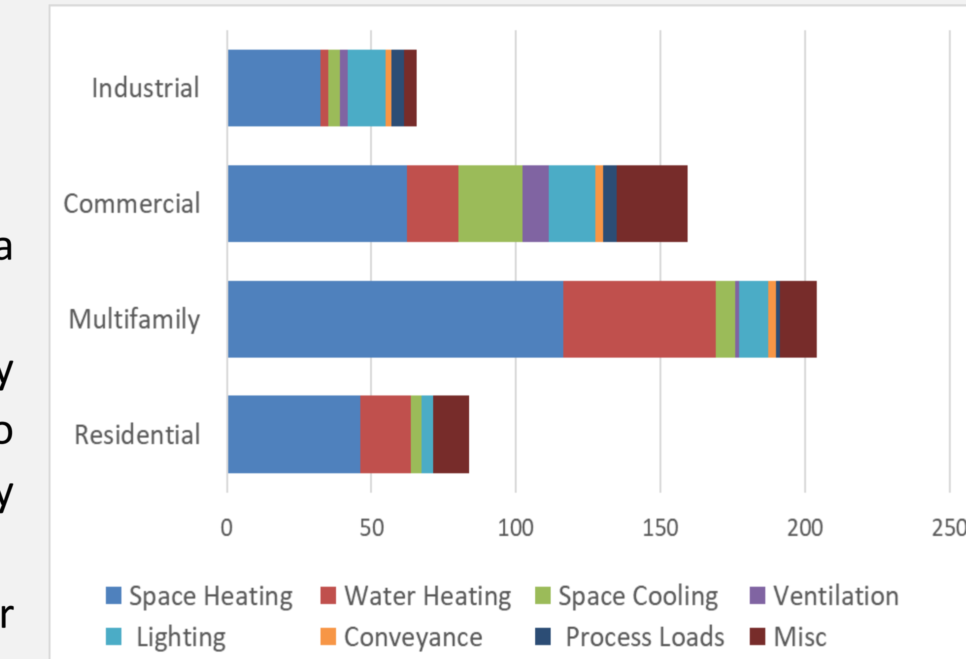

Figure 6. Energy consumption (PJ) in 2015 by end use[5]

SCENARIO FRAMEWORK

- Developed a matrix of four scenarios[8]
- Utilized expert opinion to identify underlying assumptions and describe the narratives
- Characterized the two key uncertainties in the decision framework for NYC that could impact how the city achieves its GHG reduction goals[9]
  - Speed demand technology decarbonization
  - Evolution of electric grid
- The goals of the scenario analysis are to:
  - Evaluate a portfolio of technologies meeting the city's goals in terms of resultant cost and air emissions

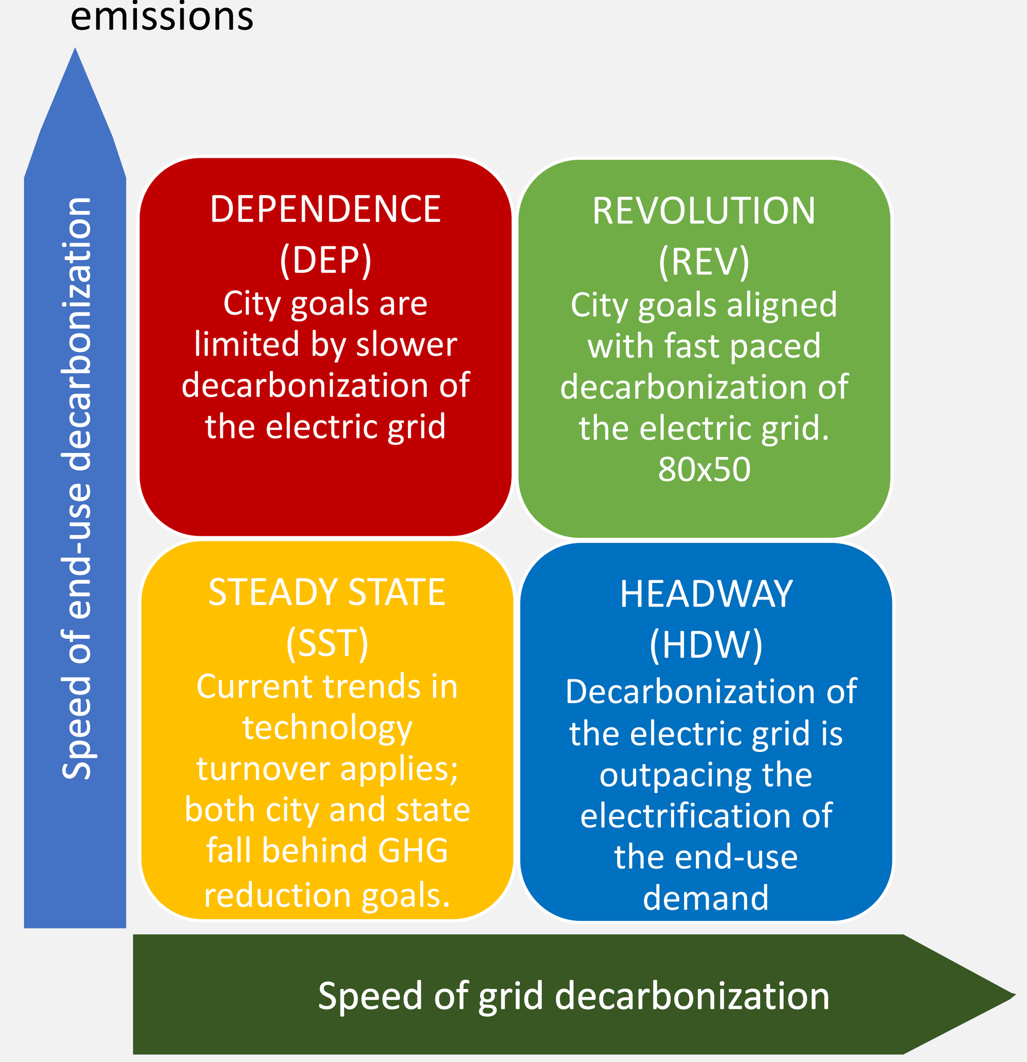

Figure 6. NYC emission reduction scenarios

ILLUSTRATIVE RESULTS

- SST is characterized as business as usual, and REV achieves 80% CO_2 emission reduction by 2050 from 2005 levels

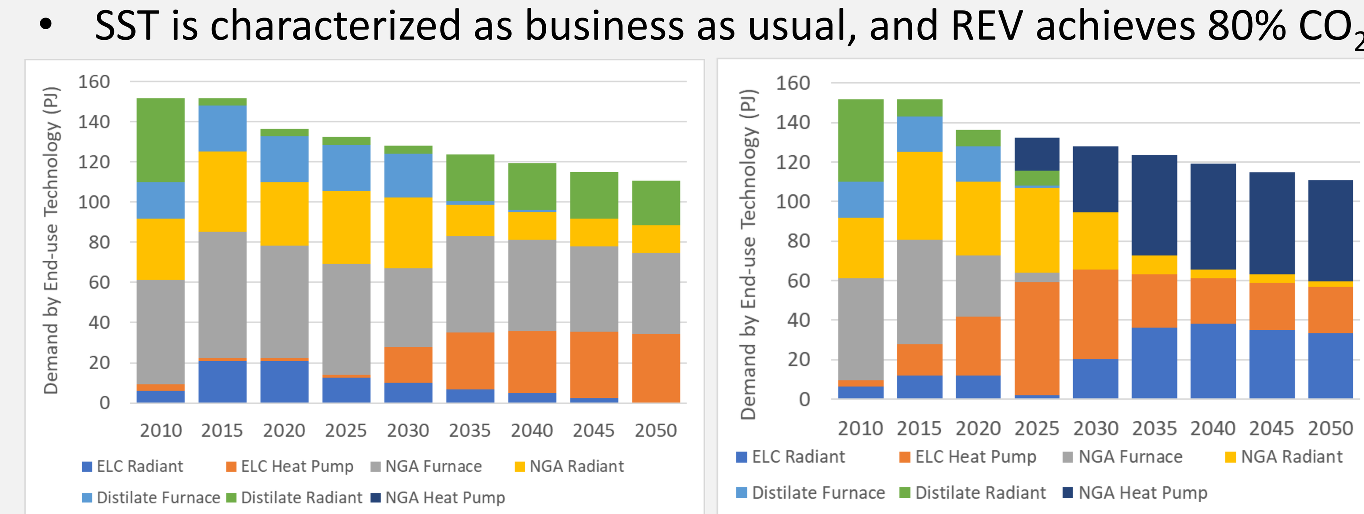

Figure 7. Residential space heating technology mix: **SST** (left) and **REV** (right)

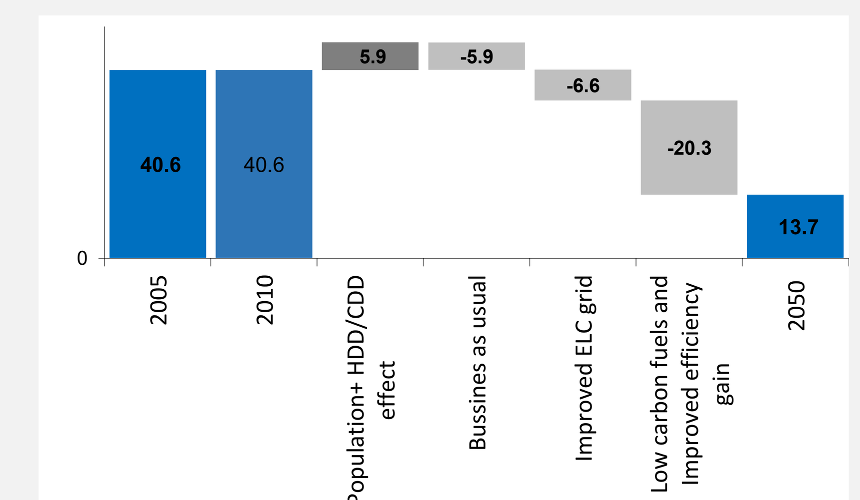

Figure 9. CO_2 reductions (Mt) in buildings under **REV**

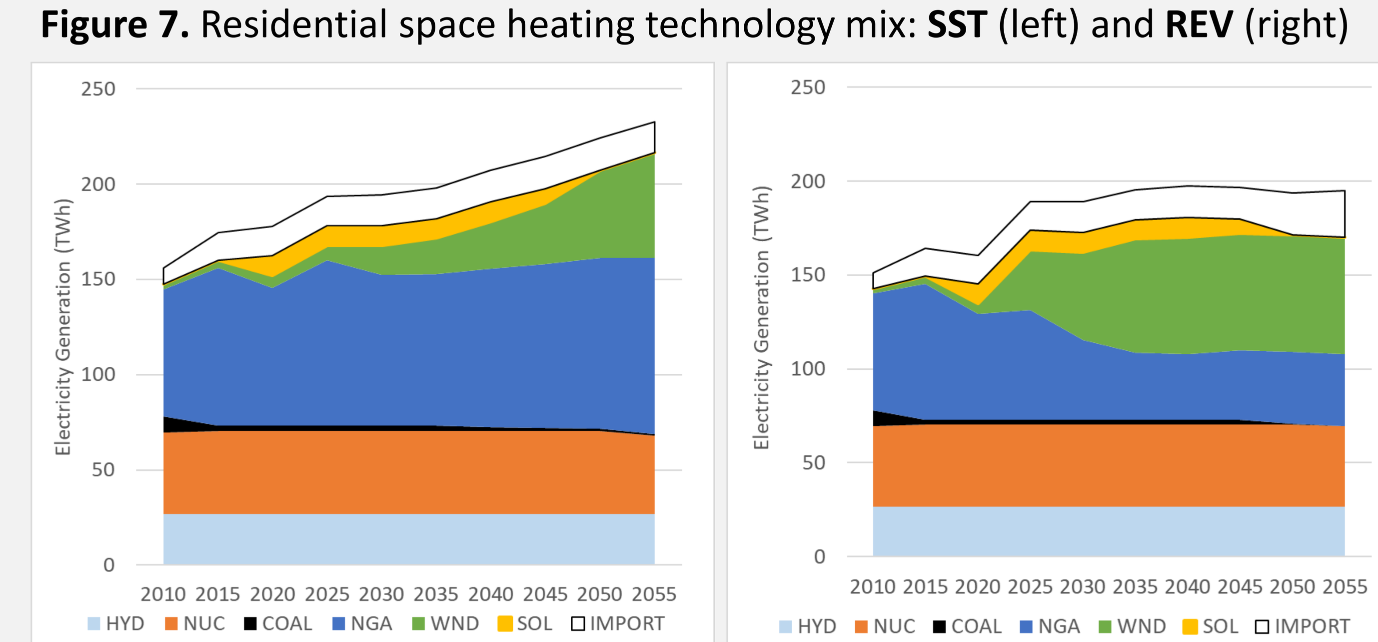

Figure 8. Electricity generation: **SST** (left) and **REV** (right)

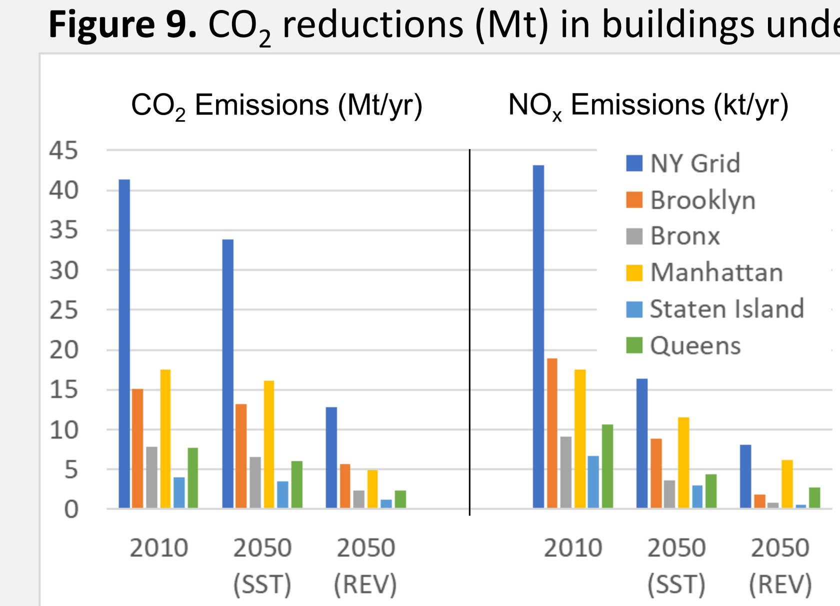

Figure 10. Grid and borough level CO_2 and NO_x

- The **REV** resulted in more renewables in the electric grid along with significant technology turnover to meet the building space heating end-use demand.
- To achieve the CO_2 reduction goals, model utilized energy efficient technologies as well as decarbonized the grid.
- With respect to **SST**, NO_x emissions are reduced further along with reductions in CO_2 emissions in the **REV**.

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