Cornell University

Challenges in energy and air quality modeling on the path to deep decarbonization

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NYSERDA
Supported

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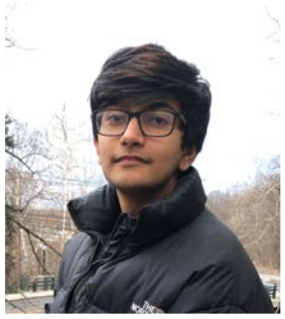

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Transformation of the New York Energy System (50x2030)

Supply

- 50% from renewable resources
  - 3 GW (6 GW) of solar
  - 2.4 GW (9 GW by 2035) of offshore wind
- Retirement of Indian point nuclear reactors
- 3 GW of energy storage

Demand

- 23% reduction in building energy consumption from 2012 levels
- 1 million electric vehicles
- Electrification of the heating sector: air- and ground-source heat pumps

Disclaimer

- Posing questions rather than answering questions
- Derived from own research experience
- Unintentionally self-serving!

Challenges in energy and air quality modeling

- Multi-sectoral
- Hyper-integration
- Hyper-local

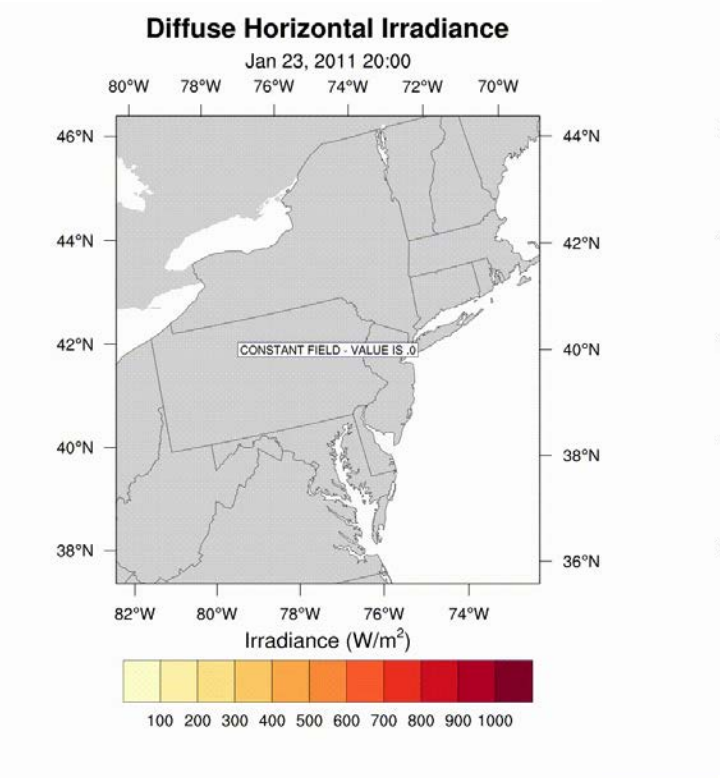
The “multi-sectoral” challenge

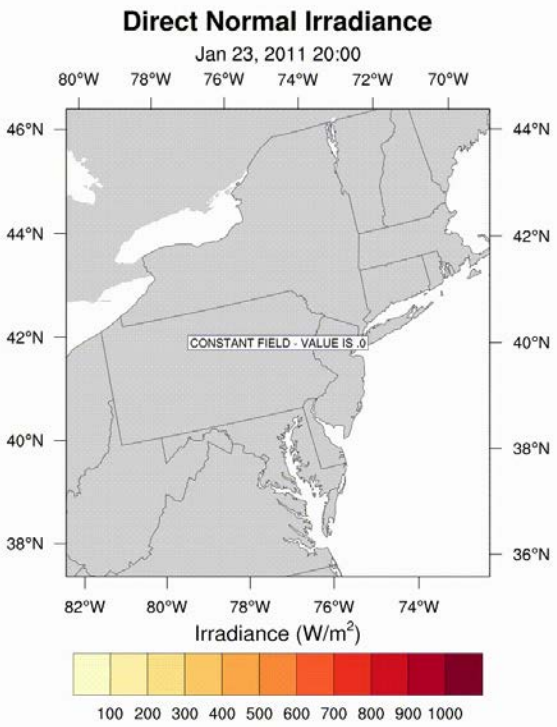
- Traditional approaches
  - Focus on individual energy initiatives
  - Evaluate their individual air quality and health impact
  - Assuming that the rest of the energy system remain unchanged
  - Generally sound for energy systems that do not experience significant changes
- However, the New York Energy System is experiencing radical transformation.
  - Both the supply and demand sides
- The “multi-sectoral” challenge
  - How should we develop future scenarios?
  - How can we evaluate the impact of individual energy initiatives?
  - Composite scenarios?

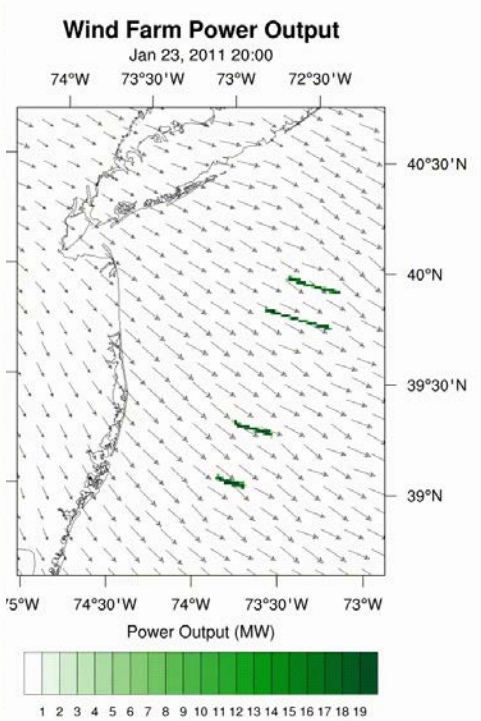
The “hyper-integration” challenge

- Traditionally the energy and air quality modeling communities are separated.
- Under high renewable energy penetration scenarios, *meteorology* drives:
  - Energy supply - Renewable energy generation (solar, onshore and offshore wind)
  - Energy demand - Heating and cooling
  - Environment - Air pollution transport
- Energy and atmospheric systems are “hyper” integrated.
- The “hyper-integration” challenge
  - Is the separation of energy and air quality modeling still a sound approach?
  - How can we keep the underlying assumptions consistent?
  - Follow the “you use it, you own it” principle
  - Power system models are mostly proprietary, while atmospheric models are mostly open sourced.

Towards a unified WRF – Solar and offshore wind







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Offshore wind farm modeling using WRF parameterization

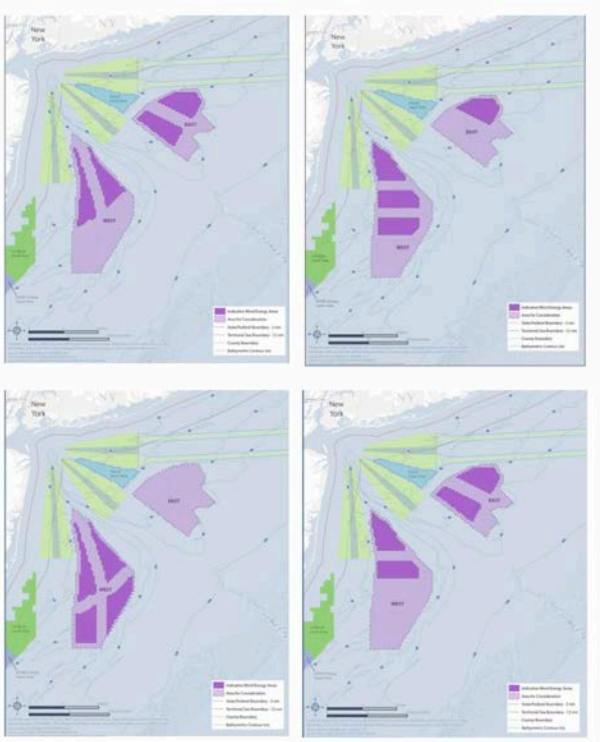
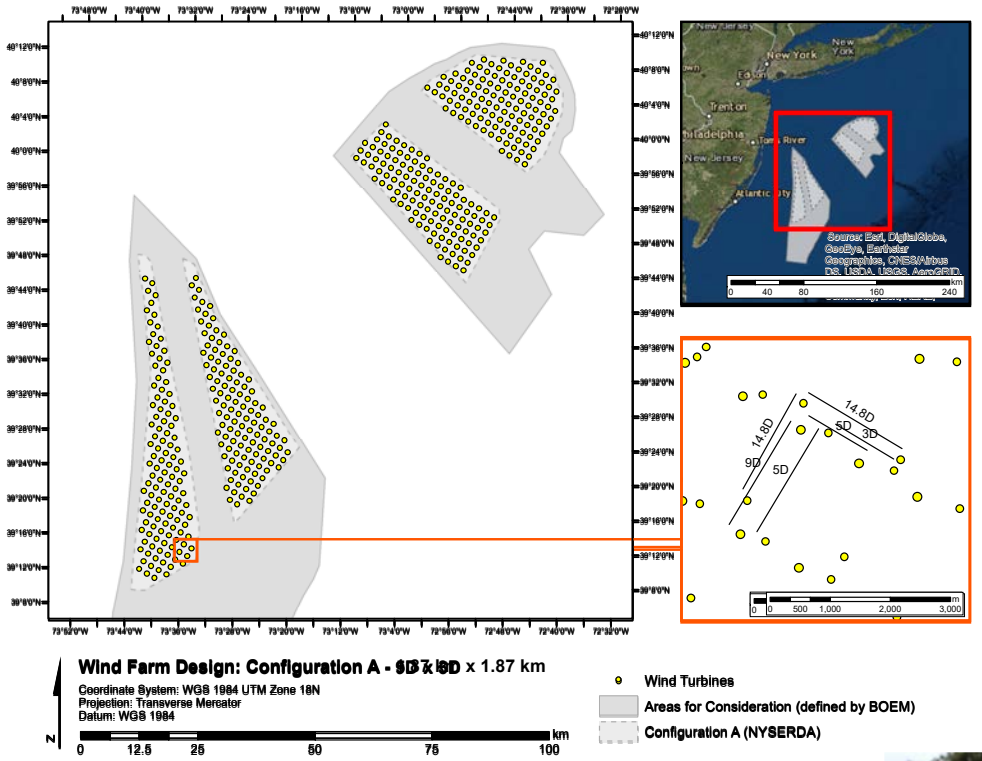


Figure 4: Indicative Wind Energy Area Configurations A (top left), B (top right), C (down left) and D (down right) defined by NYSERDA in its Report 17-25u.



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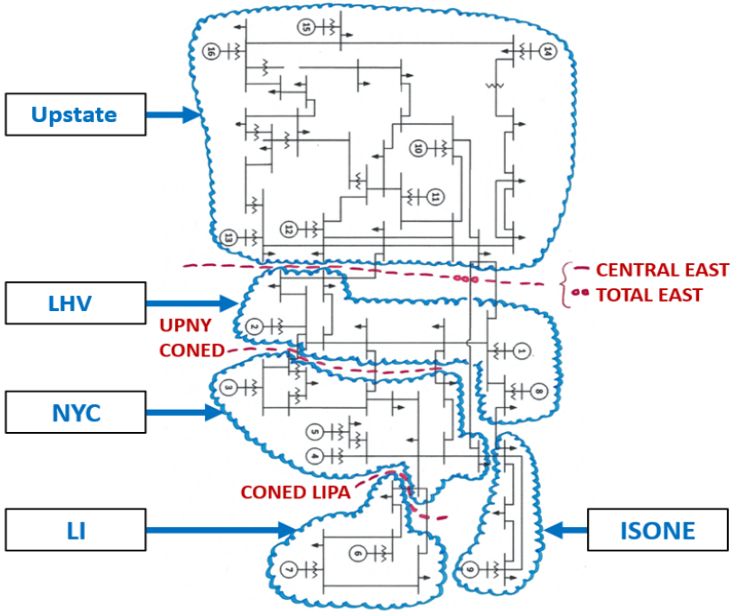
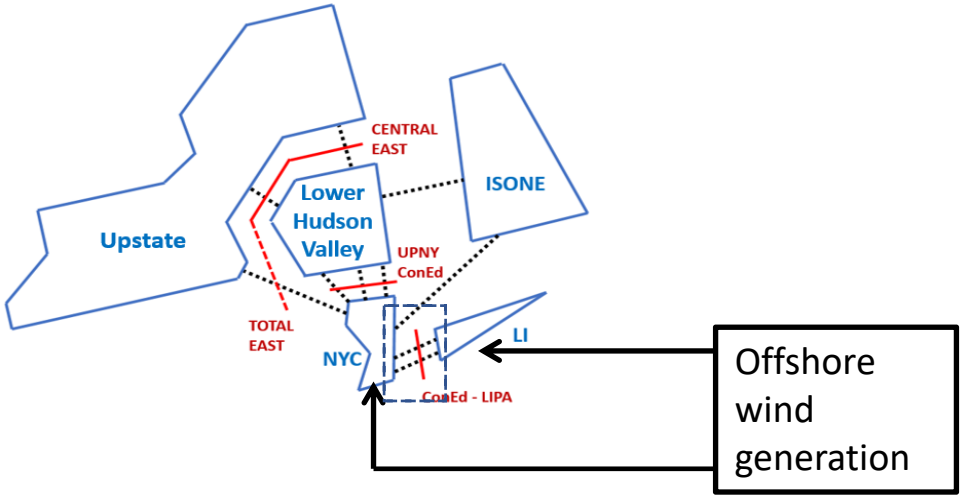
The NY Academic Model (NYAM)

- A reduced New York power system network model jointly developed by NYISO, RPI and Cornell.
- Undergoing revision by our research group, potentially available in the public domain





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The “hyper-local” challenge

- Traditionally, regional-scale modeling tools are employed to access air quality and health impact.
- We expect to see significant improvement in air quality at the neighborhood scale from clean energy initiatives, for example:
  - Offshore wind and energy storage -> Communities near peaking power plants
  - Electrified transportation -> Communities near highly trafficked corridors
  - Clean heat -> Communities with buildings burning dirty heat fuels
  - Microgrid -> Communities near low-stack, high-emitting sources
  - Many more, potentially around environmental justice (EJ) communities
- The “hyper-local” challenge
  - How can we capture those positive changes in air quality modeling/monitoring?
  - How do we quantify the health benefits?
  - Link with EJ communities programs?

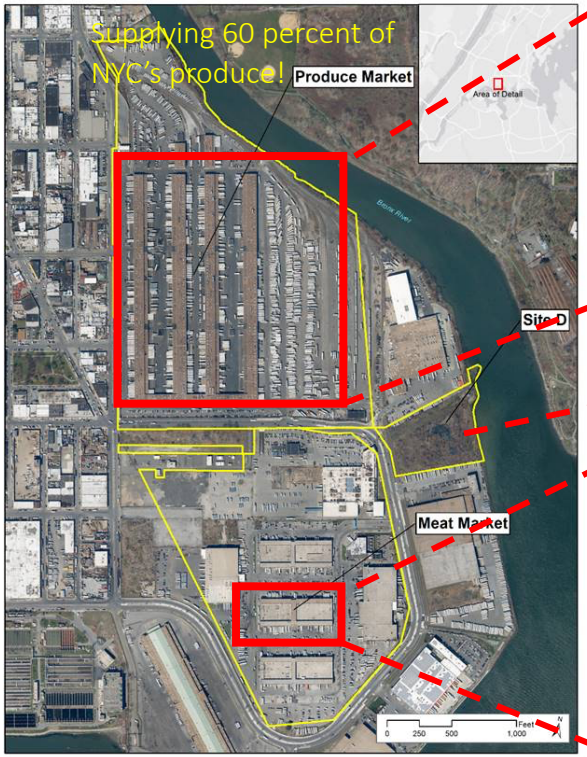
Tri-gen Microgrid by Combined Cooling, Heat and Power (CCHP)

- This is ongoing study on a project under active development;
- The analysis is solely based on publicly available information;
- The assumed emission factors and stack parameters are for academic exercise only;
- The views expressed in this presentation are those of the researchers.

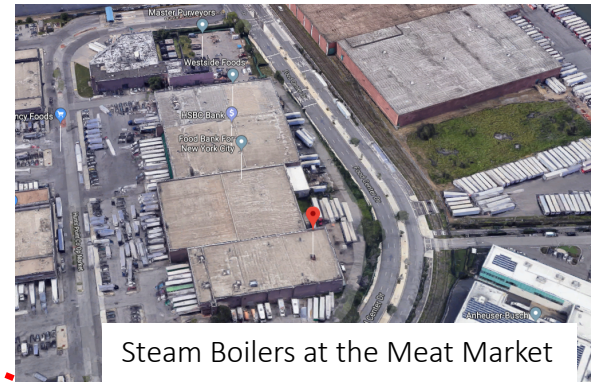
Emission factors:

- “Emissions of Transport Refrigeration Units with CARB Diesel, Gas-to-Liquid Diesel, and Emissions Control Devices”, NREL/CP-540-46598, May 2010
- Johnston Boiler Company, “PFTA 600-4” data sheet

Tri-gen Microgrid by Combined Cooling, Heat and Power (CCHP)



TRUs at the Produce Market



Steam Boilers at the Meat Market

- Provide cooling and electricity to the Produce Market
- Upgrade the power system to electrify the Transport Refrigeration Unit (TRU)

Proposed CCHP site, powering a microgrid

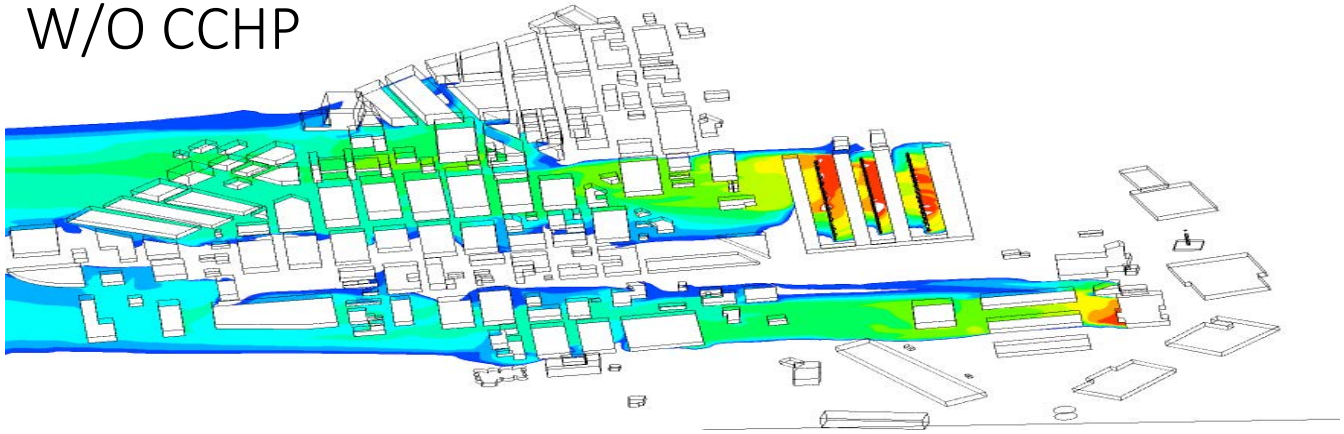
- Supply heating to the Meat Market

NYCEDC

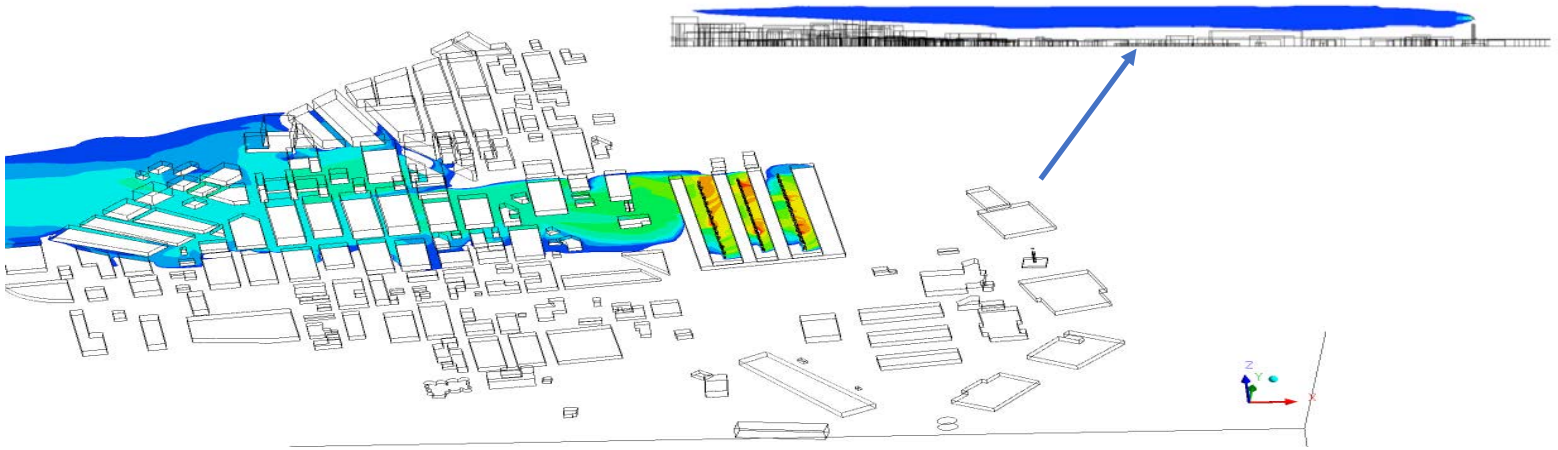
NEW YORK STATE OF OPPORTUNITY. NY Prize

CCHP Preliminary Results

W/O CCHP



With CCHP and 50% TRU electrification



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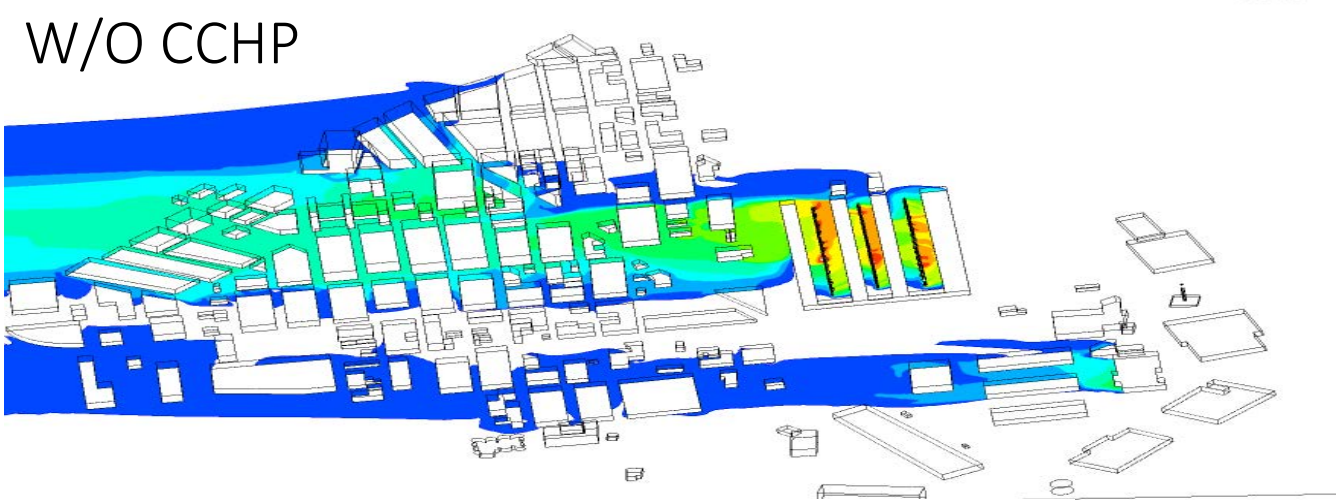
CCHP Preliminary Results

W/O CCHP



With CCHP and 50% truck electrification

Bo Yang

Community-level monitoring efforts