The Energy-Water Nexus (EWN): a New York City Pilot Study

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Presentation Outline

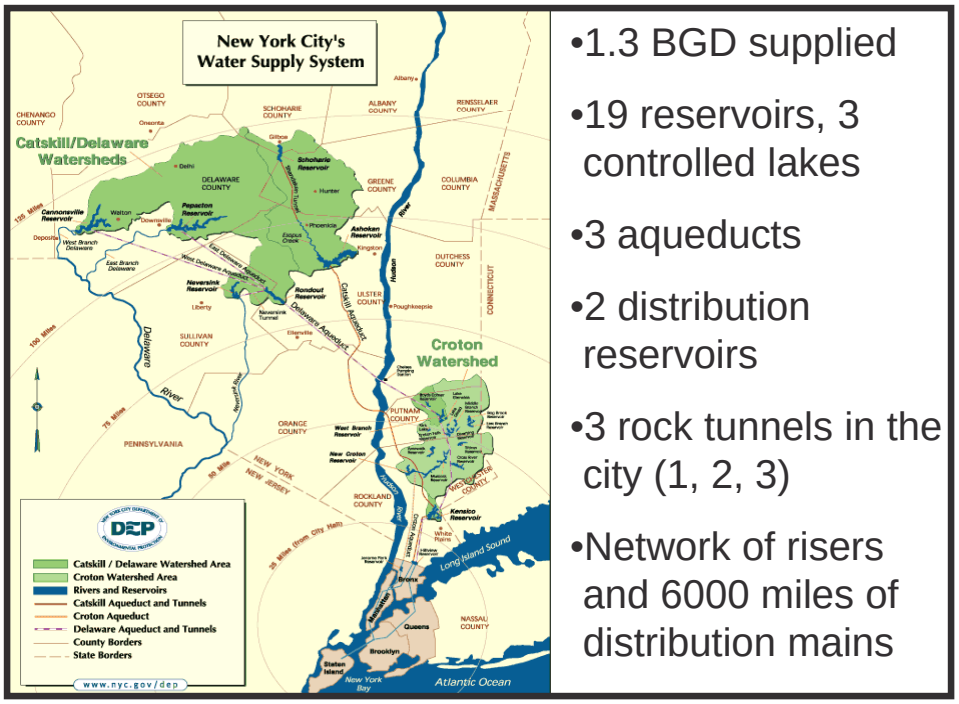
- Description of the BNL New York City Pilot Study
  - Area
  - Steering Committee
- MARKAL-Water Model
- Scenarios
- Results and Recommendations

New York City Pilot Study

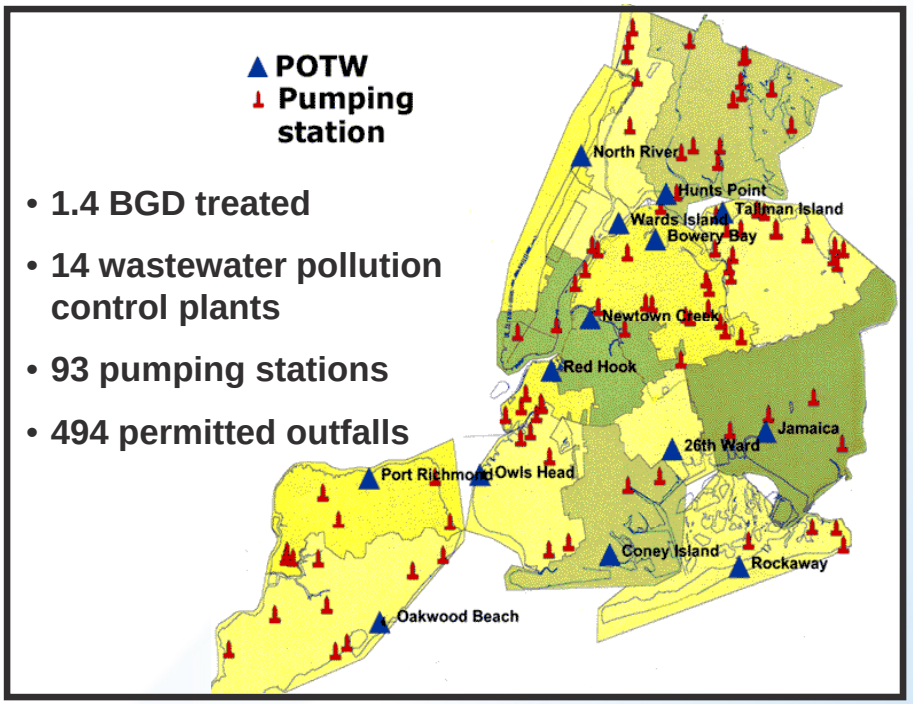
Goals:

- Determine the key energy-water planning issues for an urban area - New York City
- Develop and apply an integrated energy-water decision-support tool to facilitate urban energy-water planning
- Identify the activities and framework needed to achieve successful integrated energy-water planning
  - Challenges (regulatory/policy issues, data, necessary tools, programmatic issues, etc.)
  - Suggestions for steering committee establishment and the interactions and activities of the steering committee
  - Development and application of tools and methods

New York City Study Area



- 1.3 BGD supplied
- 19 reservoirs, 3 controlled lakes
- 3 aqueducts
- 2 distribution reservoirs
- 3 rock tunnels in the city (1, 2, 3)
- Network of risers and 6000 miles of distribution mains



- **1.4 BGD treated**
- **14 wastewater pollution control plants**
- **93 pumping stations**
- **494 permitted outfalls**

Area: 321 mi^2 (~ 830 km^2); Population: 8,213,839

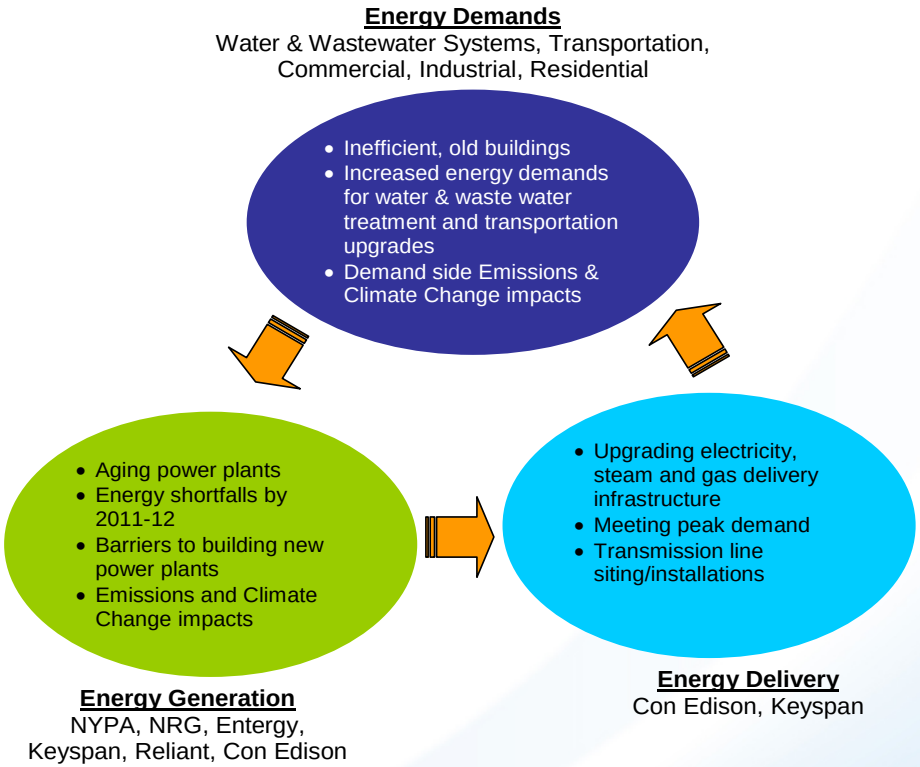
Energy Supply: Keyspan, Reliant Resources, NRG Energy, and NYPA

Distribution: Consolidated-Edison

Forecasted peak electricity demand 11,020 MW (80% in-City generation) 2003

By *2008*, *3,780 MW of new electricity resources needed*

Challenges Facing NYC Energy System

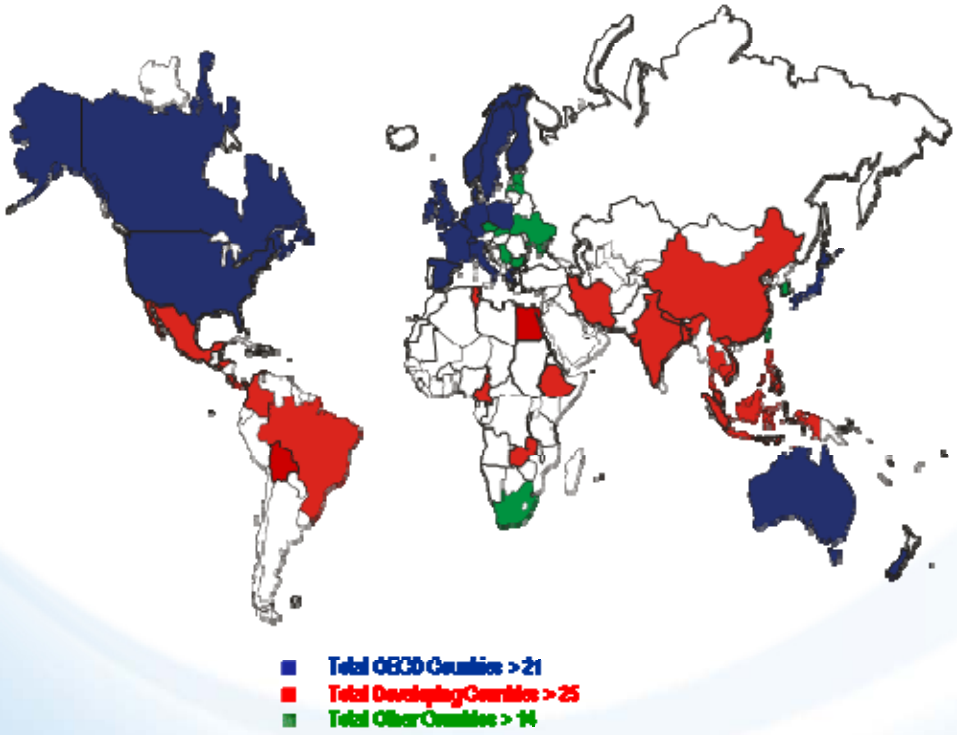


New York City Pilot Study Steering Committee Roles

- **Tasks and Activities**
  - Identify the energy-water issues for NYC
  - Guide the development of the integrated energy-water tool
  - *Assist* and guide BNL researchers in obtaining needed energy-water data and information
  - Select key energy-water strategies to be evaluated using the developed decision-support tool
  - Review final report
- **Comprised of a Diverse Group of Stakeholders**
  - Columbia University Professor/NASA GISS Researcher
  - USEPA Region 2 – Senior Energy Policy Advisor
  - Consulting Firm (HDR)
  - Water Environment Research Foundation
  - NYC Department of Environmental Protection
  - Energy Company in NYC (Consolidated Edison)

Decision Support Tool: MARKAL

- ***Developed at BNL*** in 1970s in collaboration with IEA (International Energy Agency) – continuously updated/validated
- ***Flexible*** and ***transparent*** framework with a ***well documented*** methodology

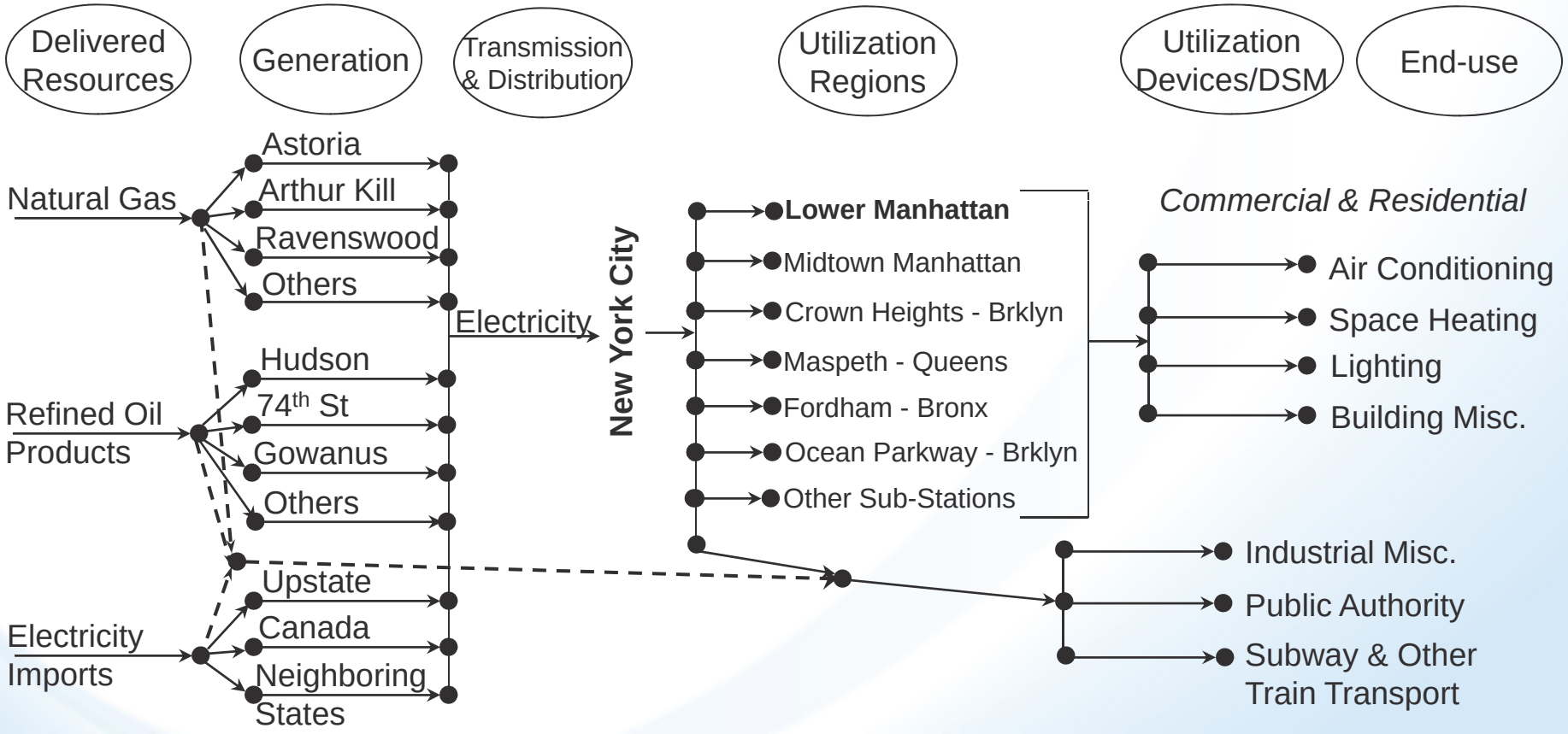


- ***Over 100 institutions*** in ***55 countries*** currently use it for energy systems analysis
- Use of MARKAL at ***U.S. DOE R&D policy decisions***
  - Applied R&D Programs (NE, EERE, FE & OE) – GPRA 1993
  - Office of Nuclear Energy – GNEP
  - Office of Policy and International Affairs
  - Hydrogen Economy
  - Energy-Water Nexus

MARKAL Model Basics

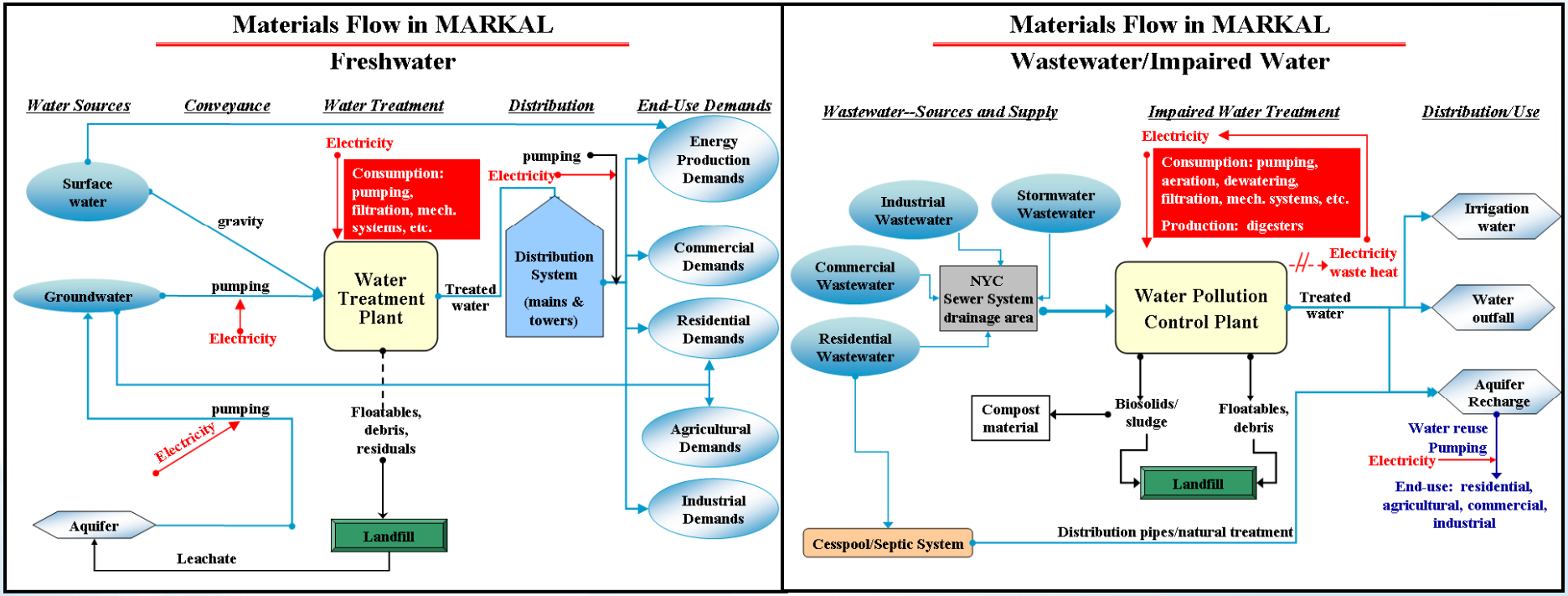
- Utilizes a state-of-the-art ***dynamic linear programming*** framework
- Provides a ***technology-rich*** basis for estimating energy dynamics ***over a multi-period horizon*** (2005-2050)
- Models ***environmental, technological*** and ***policy*** restrictions
- Generates ***least-cost*** energy path based on ***perfect foresight*** and ***life-cycle costs*** of technologies and competing alternatives (cradle-to-grave)
- Identifies the ***most cost-effective*** pattern of ***resource use*** and ***technology deployment*** over time

Reference Energy System



Modeling Water Systems

- Detailed fresh and wastewater flows and technologies



Leading NYC Energy and Water Planning Challenges

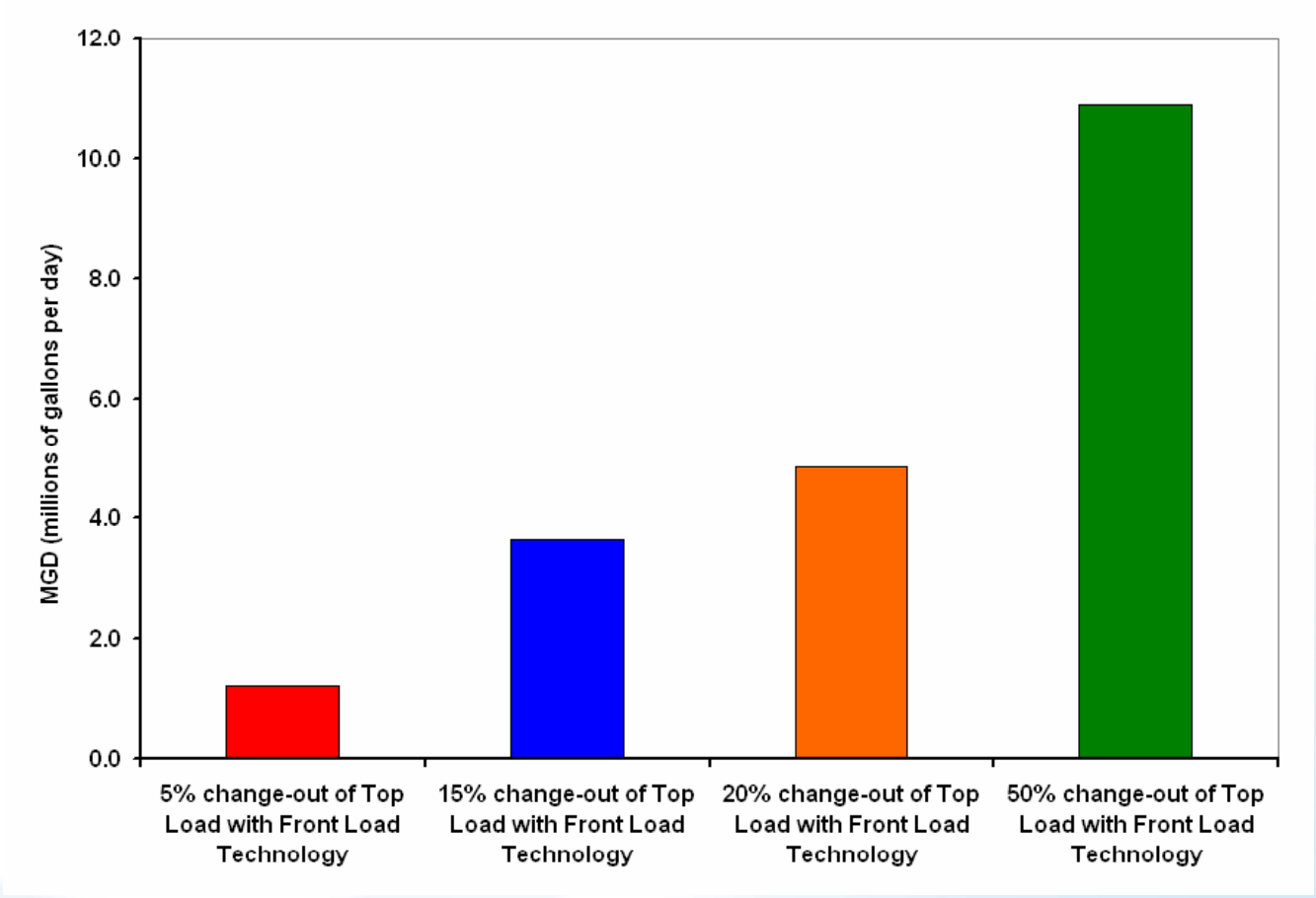
- Identified by the Steering Committee
- Reliable operation of drinking water and wastewater systems increases energy demands (UV treatment and Croton filtration plant)
- Enforcement of water conservation and assessment of the total benefits (e.g., water and energy savings)
- Evaluation of the impacts of climate change on energy and water systems
- Ensuring future energy and water supply security
- Planning for water withdrawals for steam production
- **City-wide integrated planning of energy and water systems**

Policy Options Analysis

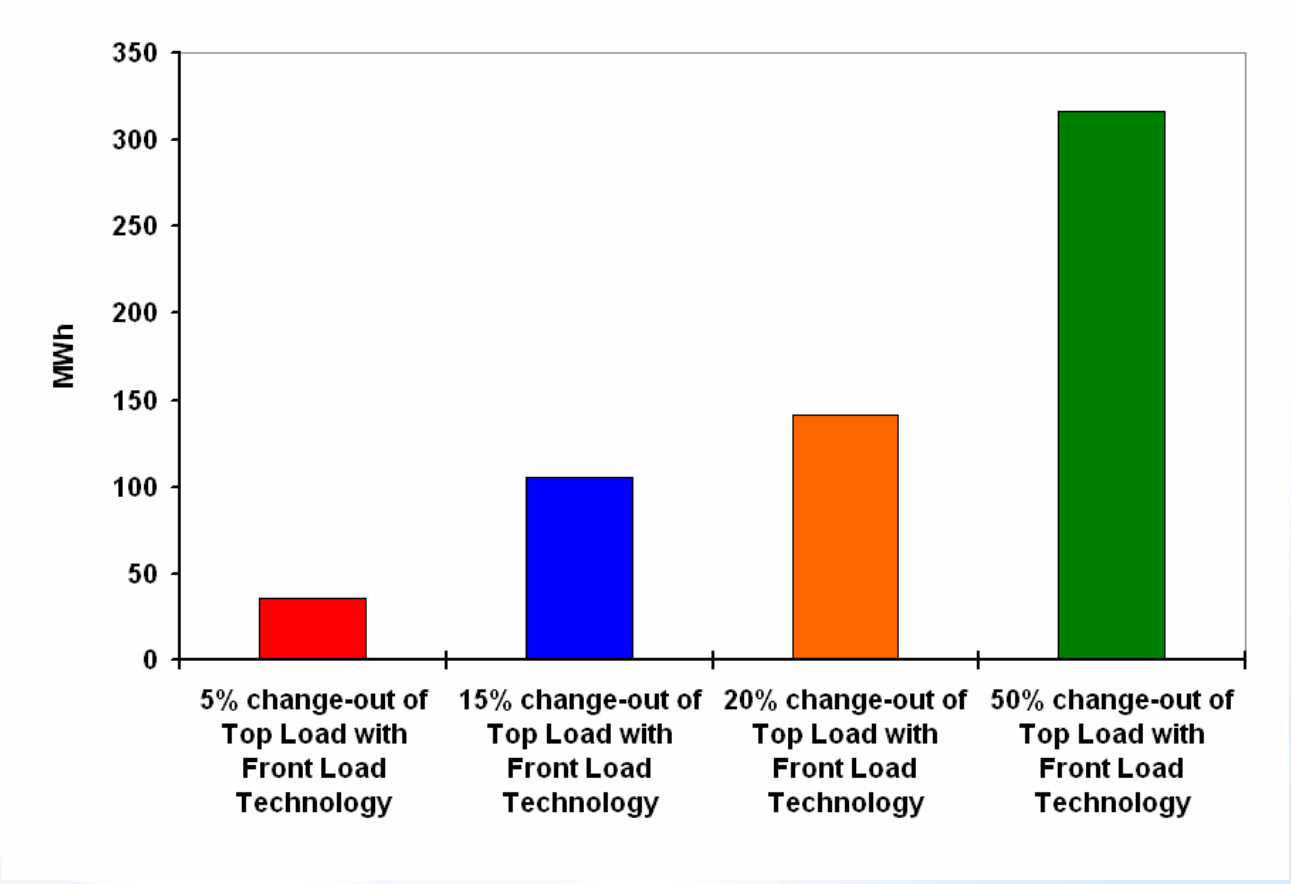
Several **energy-water integrated planning scenarios** were developed, based on issues identified by the steering committee.

- *Scenario 1:* Water-Efficient Appliances: Energy and Water Use Impacts
- *Scenario 2:* WasteWater Treatment: Deploying More Fuel Cells
- *Scenario 3:* New York City Water Supply: Impacts of Increased Energy Demands for New Treatment
- *Scenario 4:* New York City Steam Generation: Water Supply and Energy Impacts
- *Scenario 5:* Climate Change Models and Research: A Link with Energy and Water

Scenario 1
Water-Efficient Appliances



Scenario 1
Water-Efficient Appliances



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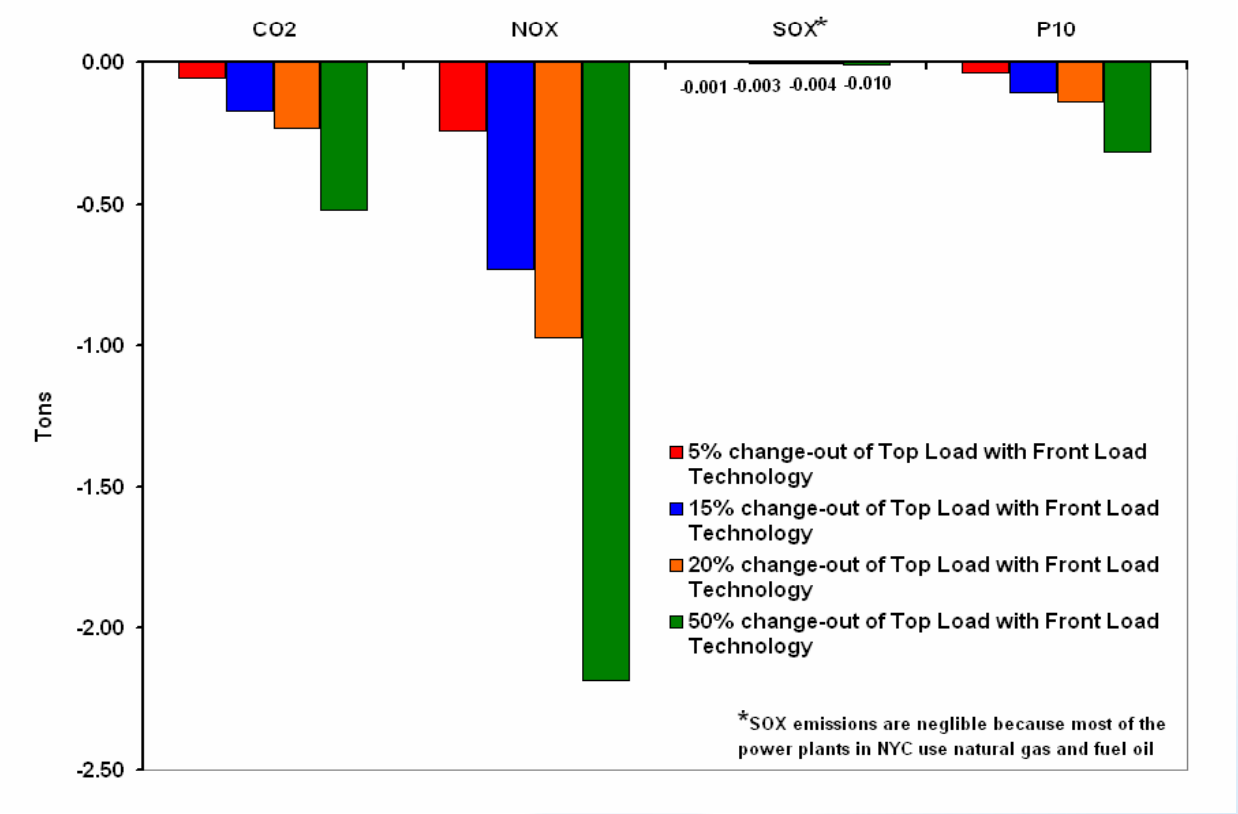
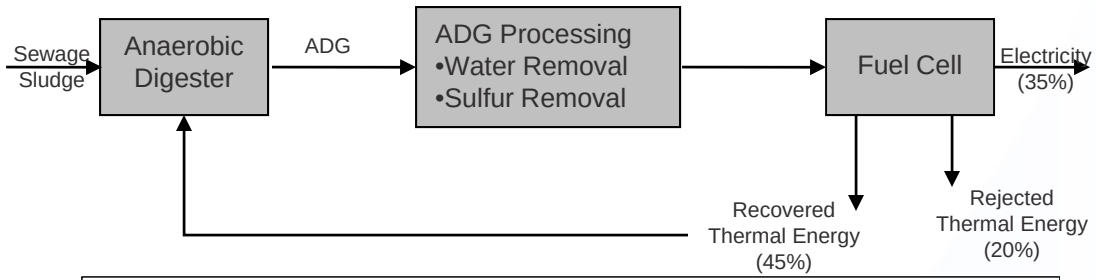
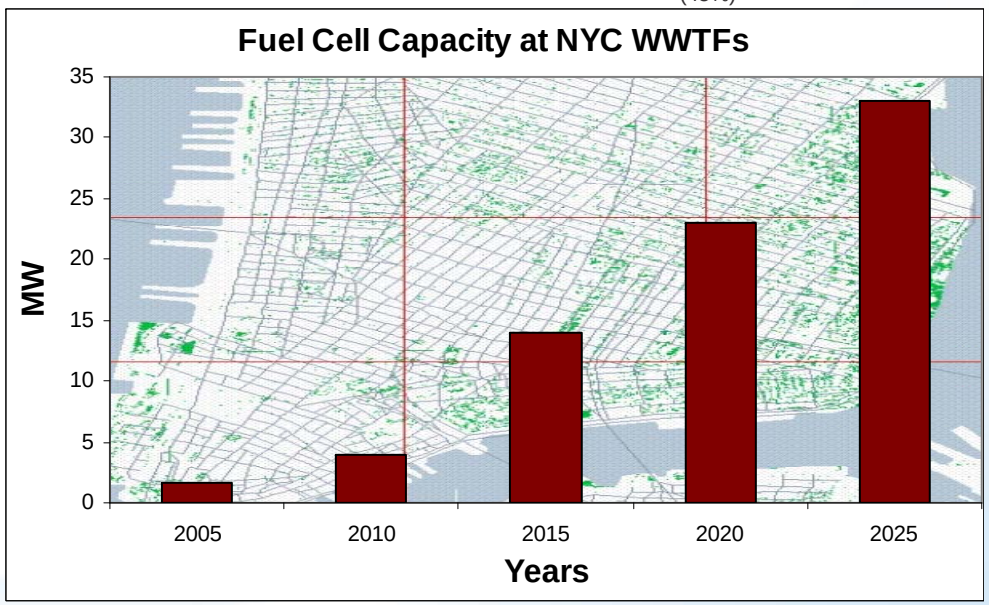
Water-Efficient Appliances

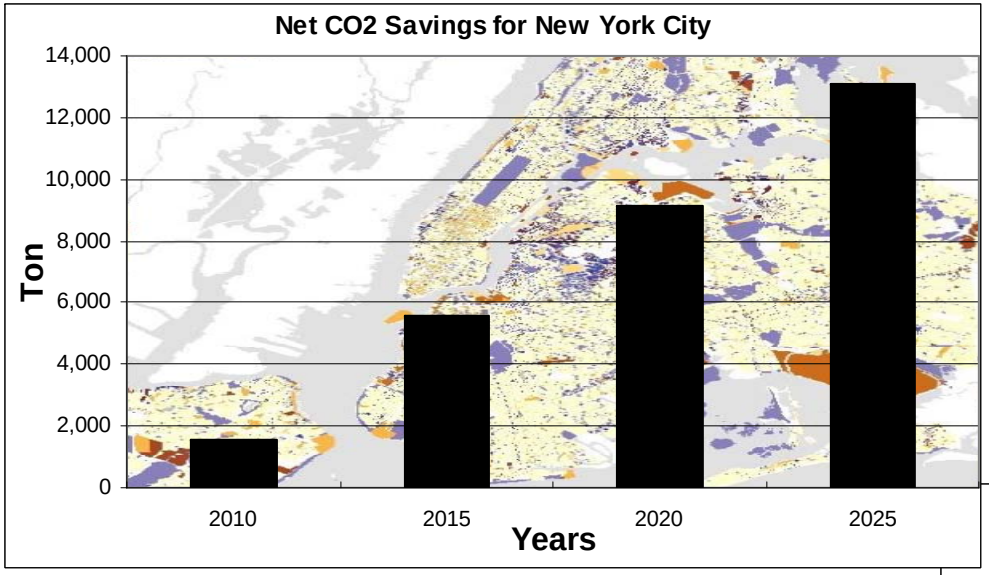


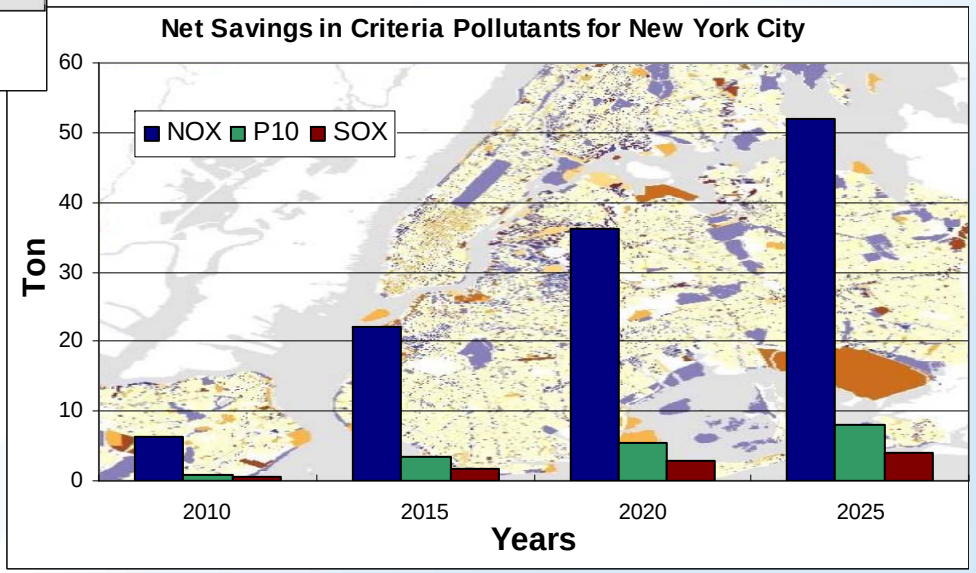
Scenario 2
Wastewater Treatment: Deploying More Fuel Cells





Scenario 2
Fuel Cells





New York City Pilot Study
Lessons Learned

- Steering Committee Composition and Roles Crucial to Success
- Existing Energy Studies and Decision Tools can be Modified to Include Water
- Linkages to Climate Models will be a Challenge