Smart *Energy* for Smart Cities

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Open Questions for Cities and Smart Grids

- Cost/benefit picture bright, but still unclear
- Early technology bets - Beta or VHS?
- Smart grid or smart energy system?
- The changing regulatory landscape

What are the benefits of Smart Grid for Cities?

- Value proposition assumes:
  - T&D efficiency gains
  - Improved reliability and power quality
  - Increased grid robustness and security
  - AMI & TOU pricing will enable expanded demand response and conservation
  - Improved capacity for renewables integration (central and distributed)
  - Integration of PHEVs and grid storage
  - Job creation

Research and Results to Date - *Smarter Grid May Reduce Electric System Waste*

- Costs of T&D sensing and automation > $720 million in 2010
  - Approx. 1.4 quadrillion Btu's lost in U.S. electric T&D ***EACH YEAR***
  - Approx. = 393,000,000 MWh or > 7.5 years of NYC electric consumption
- Benefits at the transmission level?
  - 2003 NE blackout: DOE estimates that wide-area measurement systems could have mitigated or even avoided the $4.5 billion in losses
- Benefits at the distribution level? Boulder's *SmartGridCity*
  - Xcel claims better grid awareness and control is improving local reliability and lowering utility response costs
- Benefits at distribution level? Improved Power Quality
  - Poor reliability and power quality cost $80-120 billion/yr
- Benefits at the distribution level? Clean DG penetration
  - DG on system extremely low = < 1.3% of total U.S. capacity
  - Future issue: who is in control of customer owned DG?

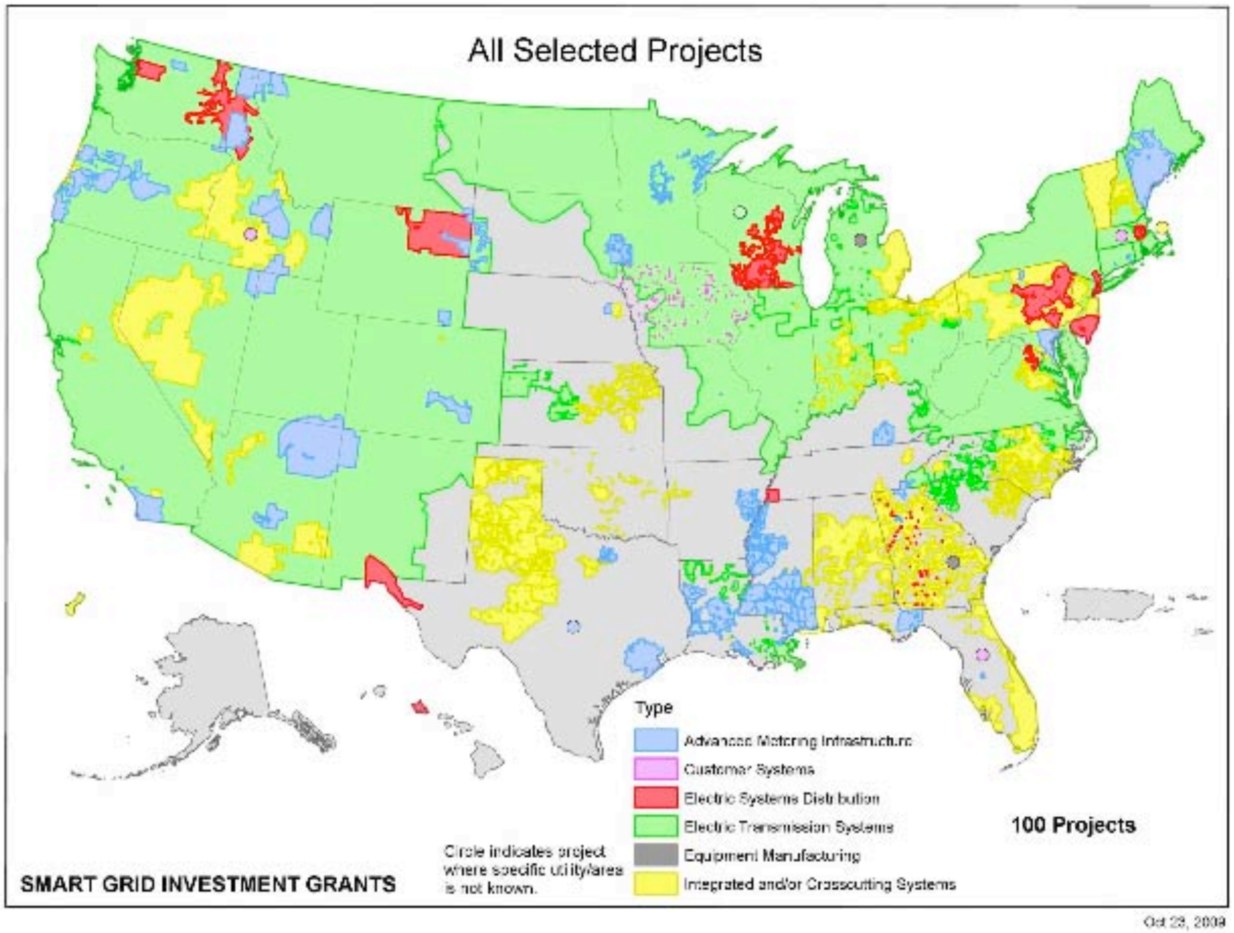
Research and Results to Date - *Smart Meters Need Smart Policies*

- Cost of new metering infrastructure = $27 - 40 billion
- Benefits *without smart policies*?
  - California utilities estimated distribution benefits would cover 60% of installed costs = need consumer demand response to make up rest
- Benefits *with smart policies*?
  - Westchester Co - Smart Homes Pilot Program - 146 participants, lower bills for 87%, *but 30% quit*
- Benefits *with smart policies & smart gadgets*? GridWise at PNNL
  - Customers with automated appliances & dynamic pricing saved 10% on bills and reduced peak by 15%
- But, today only 8% of U.S. energy customers have any form of time-based or incentive-based rates
- Environmental benefits? More a function of annual usage

Research and Results to Date - *Care Must Be Taken to Avoid Consumer Revolt and Political/Regulatory Backlash*

- 2005-2006: California utilities undertook dynamic pricing trials - found, on average, 13% peak demand reduction
- 2006: CPUC approved $1.7 billion for PG&E to install AMI, smart meters with a communications backbone
- 2008: PG&E requested an additional $800 million to replace 200,000 meters after discovering better technology
- 2008: City of San Francisco considered a law banning PG&E's smart meters and joined state consumer advocates to oppose rate recovery for PG&E's $800 million meter mistake
- 2009: PG&E's dynamic pricing pilot in Kern County, CA coincided with a general rate increase and monthly bills that were 2-3x's seasonally typical
- 2009: Residents filed class action law suit against utility and CPUC ordered an independent study of metering & billing accuracy

Federal Stimulus Results – *Utility Driven and Smart Grid "Backbone" Oriented*



Matching Grant Projects

- 400 applicants, 100 selected
- 43 states + D.C.
- Mostly AMI projects

Demonstration Projects

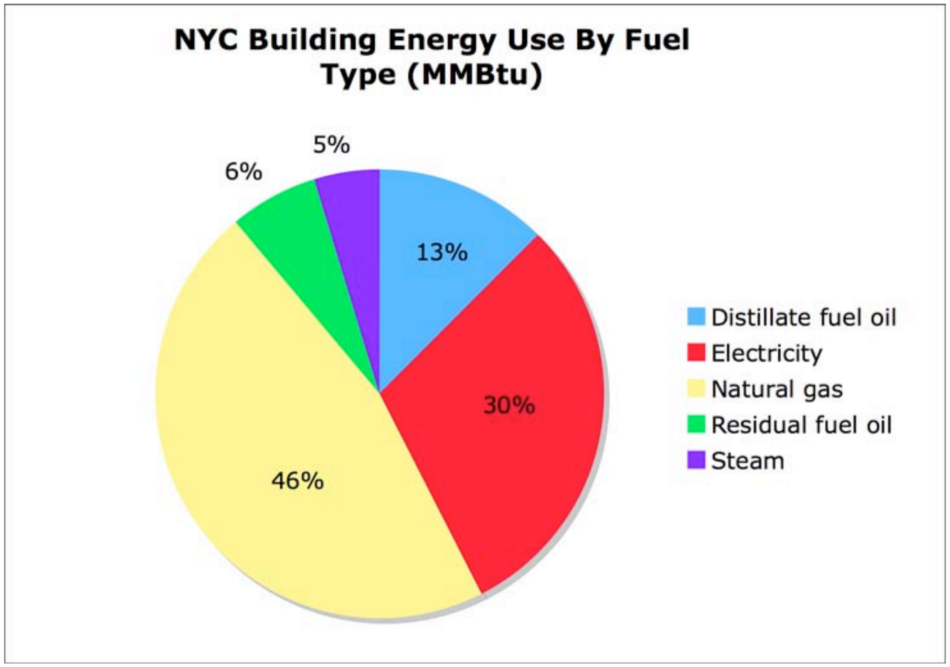
- 32 projects in 21 states
- $435 million for 16 "fully integrated" regional demonstrations in 21 states
- $185 million to support utility scale energy storage projects

Experience to Date - *Initial Impressions for Cities*

- Lessons
  - Cities will be the subjects of smart grid experiments, thus there are significant stakes involved
  - Modernizing T&D infrastructure could bring real benefits
  - Smart meters need smart policies, but it's still unclear if residential consumers will embrace dynamic pricing
  - Technology is evolving rapidly and standards still not in place, so deployment should be undertaken with great care to avoid stranded investments
  - Investments should be weighed against other more cost-effective measures
  - NEED TO THINK ABOUT ENTIRE ENERGY SYSTEM

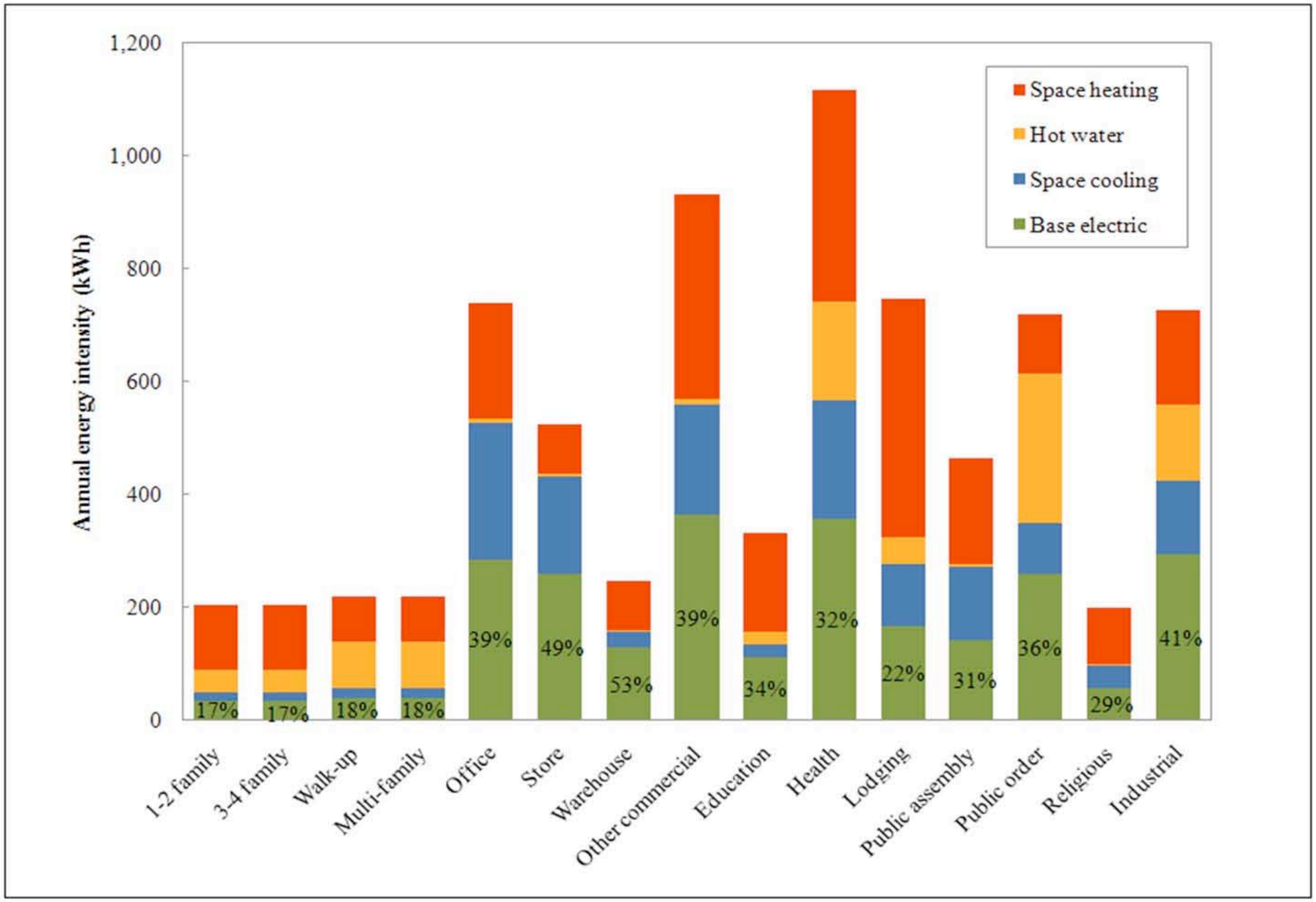
Building a Smarter Urban Energy System

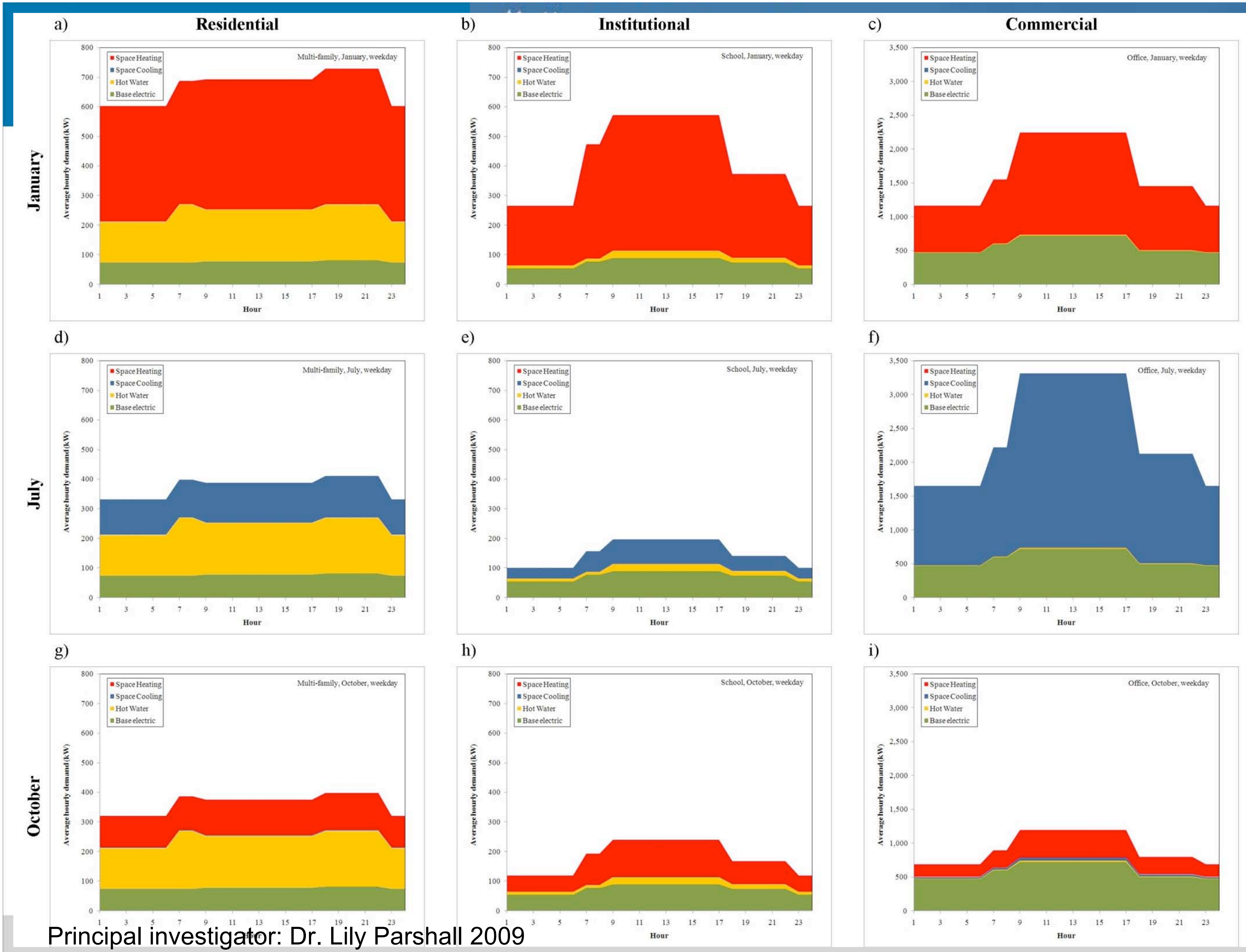
- Grid upgrades are important, especially if PHEVs take off
- But there are other elements to a smarter local energy system
- Only 30% of NYC building energy use is electric
- Thermal distribution - a proven winner - getting short end of the stick?



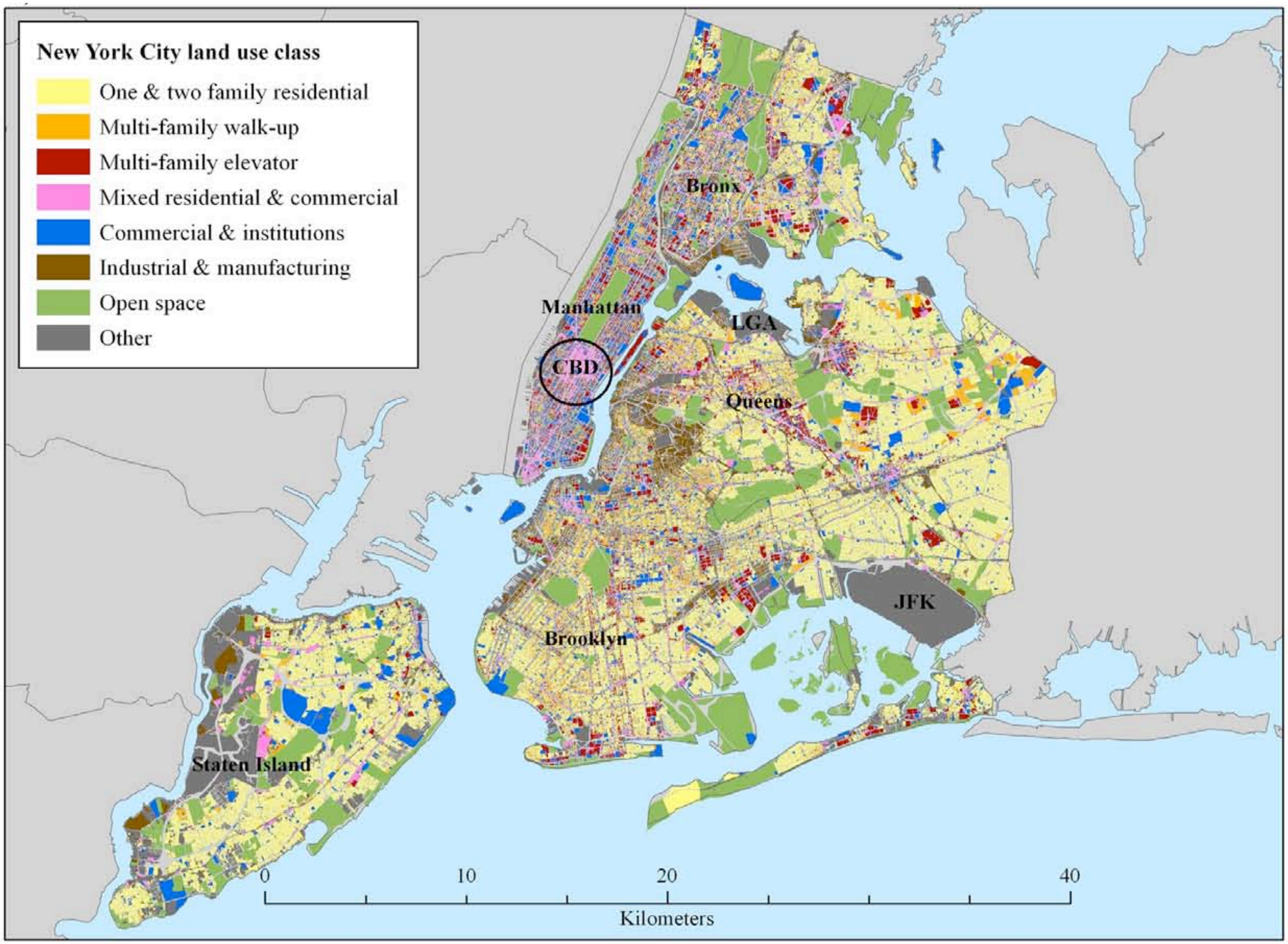
Source: NYC Inventory of GHG Emissions, Sept 2009

Energy demand in NYC by end use

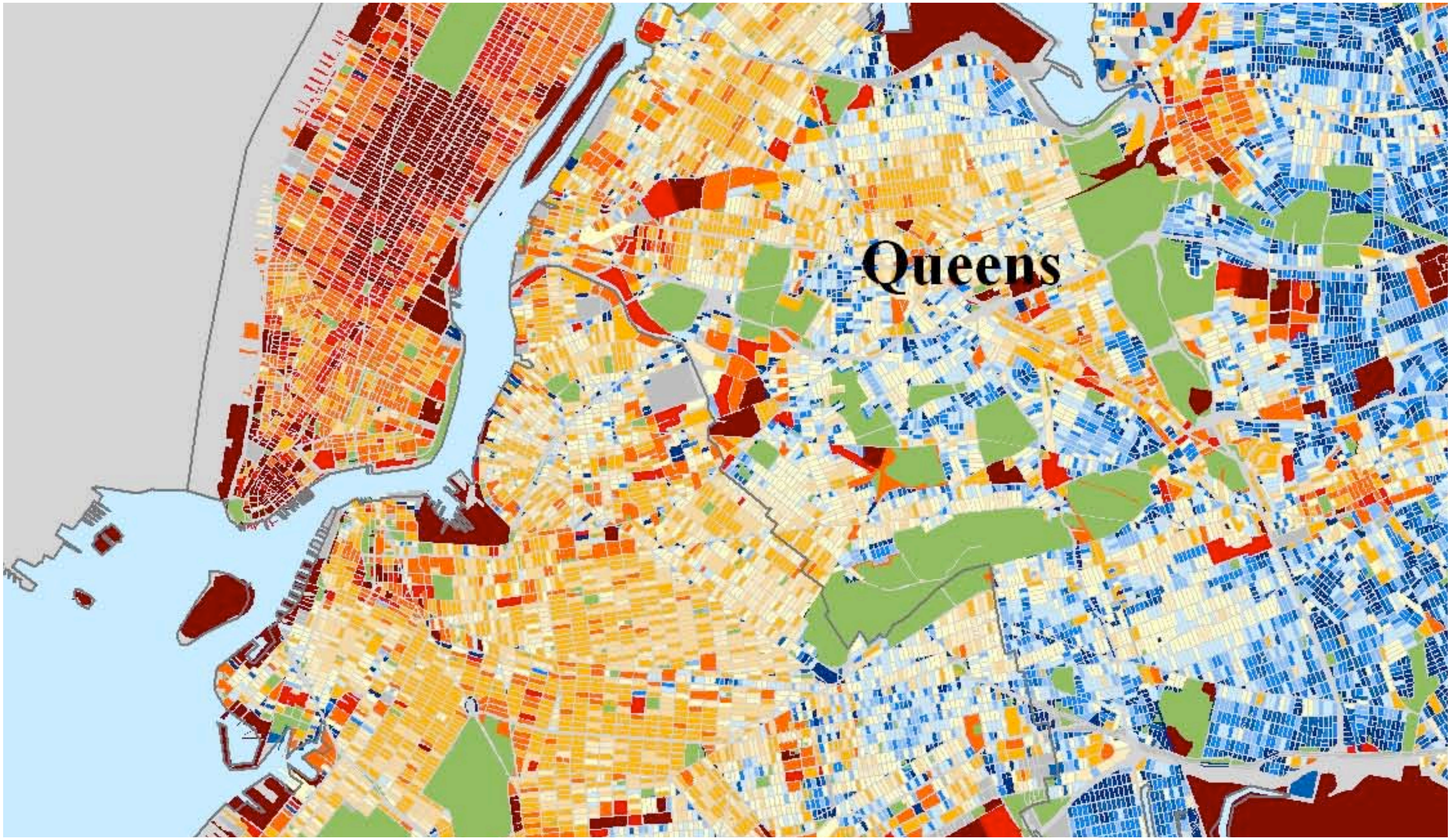




Principal investigator: Dr. Lily Parshall 2009


New York City land use class
One & two family residential
Multi-family walk-up
Multi-family elevator
Mixed residential & commercial
Commercial & institutions
Industrial & manufacturing
Open space
Other
Bronx
Manhattan
LGA
CBD
Queens
JFK
Brooklyn
Staten Island
0
10
20
40
Kilometers

Total annual energy demand (MWh), spatial resolution of map = city blocks



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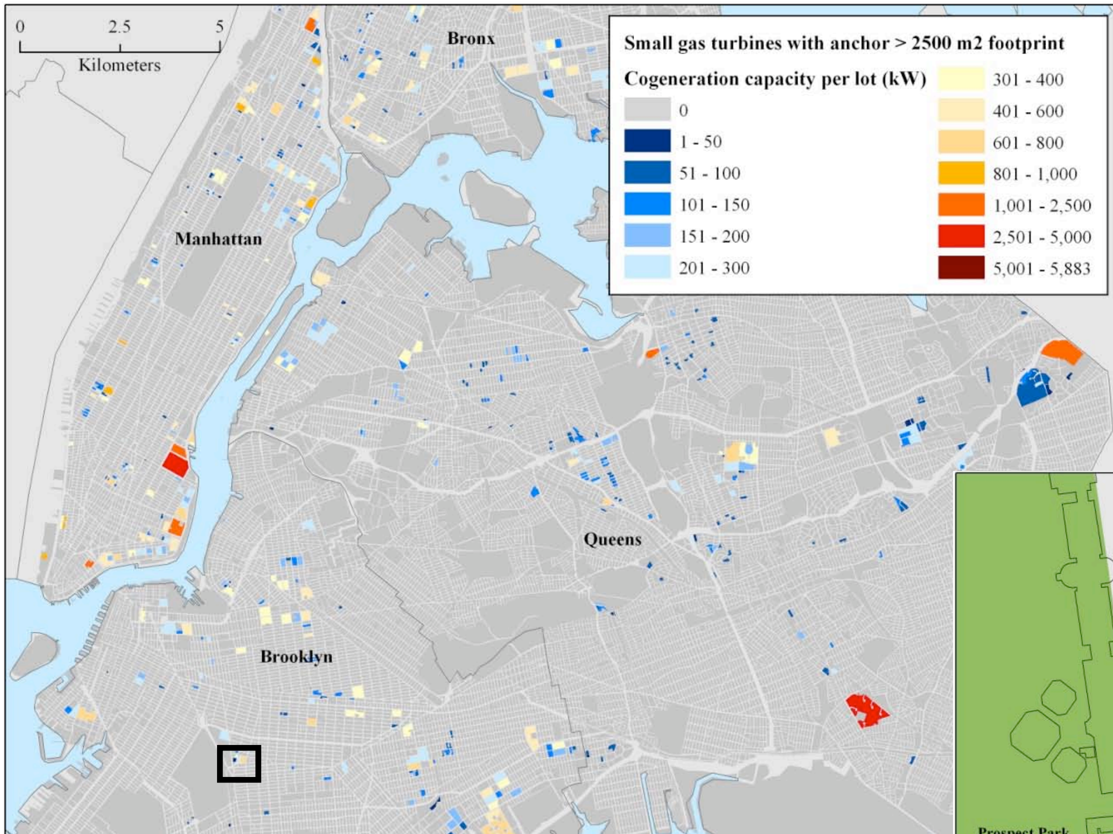
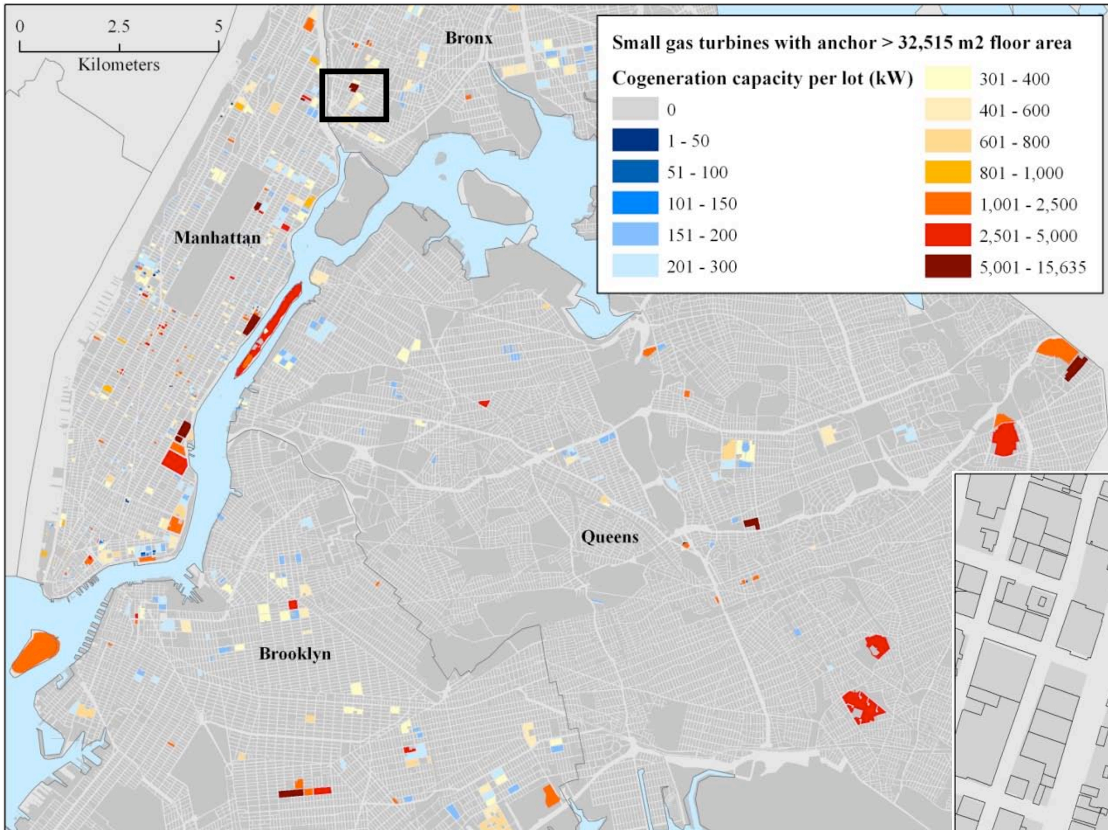


Example scenario 1

- Small gas turbines (<1 MW)
- Absorption chiller (COP=0.7)
- Large **building footprint** required (>2.5K square feet)

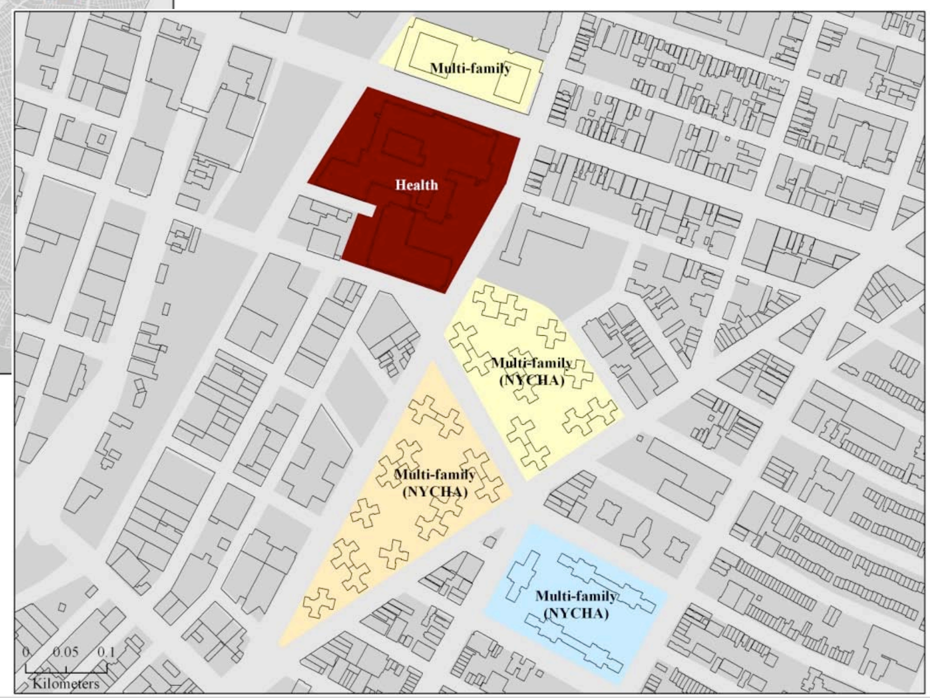
Results

- **709 MW** of total capacity identified, of which **96% multi-family**
- **7.9% reduction** in annual building CO_2 emissions



Example scenario 2

- Small gas turbines (<1 MW)
- Absorption chiller (COP=0.7)
- Large **building area** required (>350K square feet)



Results

- **660 MW** of total capacity identified, of which **98% multi-family**
- **6.8% reduction** in annual building CO_2 emissions

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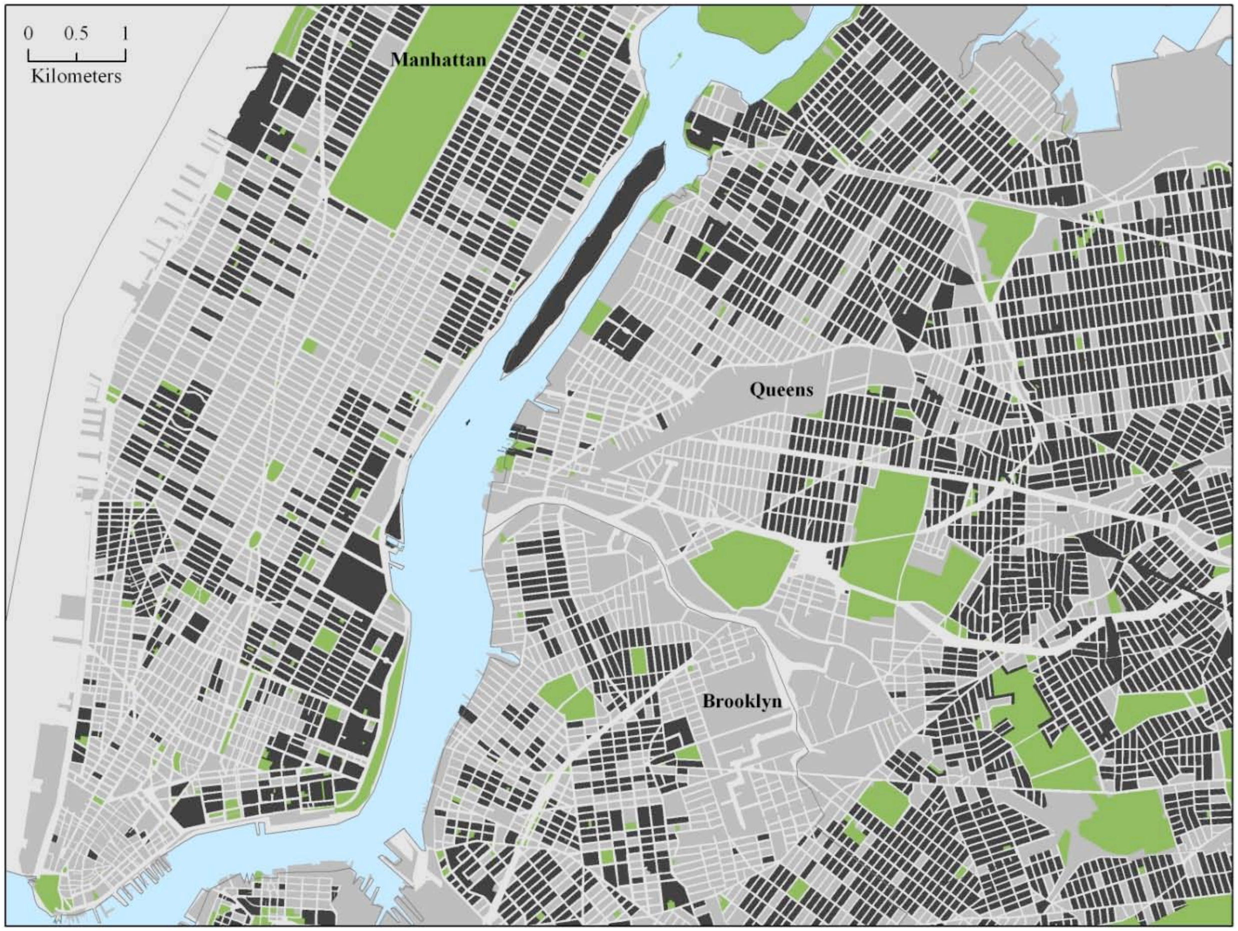

Example scenario 3

- **Block-scale** matches
- Much more dramatic benefits, but much larger challenges and physical disruptions
- Large gas turbines (~10 MW)
- Absorption chiller (COP=0.7)
- **8,876 MW** of total capacity
- Site supply in **residential neighborhoods**
- 39% multi-family, 52% low-density residential
- **72.2%** reduction in annual building CO_2 emissions

CEMTPP/Pace/CU Law Microgrid Regulatory and Policy Research Initiative

- Investigating the regulatory environment for microgrids in New York
  - Definition: *A small, integrated energy system of interconnected loads and distributed generation (producing electric, both electric and thermal, or thermal energy only), which can operate in parallel with the grid or in an intentional island mode.*
  - Microgrids ≠ solar panel or microturbine in a single building
  - Microgrids ≠ uncoordinated loads or generation resources
- Questions:
  - How can we deliver microgrids within the current regulatory framework?
  - How might we change current regulations to better accommodate microgrids?

Key Regulatory/Policy Considerations

- For electricity, wires competition could require fundamental paradigm shift > distribution no longer a natural monopoly?
- How regulators view microgrid will depend on how it is organized and the services it provides
  - If the microgrid infrastructure is utility-owned?
  - If the microgrid infrastructure is owned by a non-utility?
- Non-utility owned microgrids face several issues
  - Level of state oversight?
  - Customer rights?
  - Island or interconnect?
  - How to deal with utility stranded costs?

Current Regulatory and Status Takeaways

- Generally not on policy radar screen
  - California adopted a definition and has funded research and development
  - Connecticut adopted Energy Improvement District legislation
- Utility microgrids beginning to be examined in Smart Grid context
  - San Diego Gas & Electric Beach Cities Microgrid
- Most frequently cited barrier to non-utility microgrids is uncertainty regarding regulation as a "utility" (i.e., rate reviews, reporting reqs.)
- If microgrids do any of the following, regulatory treatment problematic
  - Serves multiple, unaffiliated customers OR residential customers
  - Crosses public streets occupied by incumbent utility
- Lack of economic incentives to pursue microgrids at a large scale

Important Questions for Cities and Smart Grids

SMART GRID TECHNOLOGY

- Will Smart Grid benefits justify the costs, or are there other things we should do first (e.g., EE)?
- What about the other 70% of in-city building energy use?

SMART GRID POLITICS

- How well will utility-led initiatives mesh with local government-led policy efforts?
- Do consumers really have an appetite for time varying or real-time pricing?
- Who should control the new smart infrastructure and data, particularly at the customer/smart meter level?
- Do regulators and policymakers have an appetite for microgrids and distribution-level competition?

=> Technological innovation must be matched by regulatory and market innovation/changes. What is being done to ensure these other important systems are keeping pace?

Thank you.

Questions?

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