FUEL CELL USERS PANEL

CASE STUDIES IN REAL ESTATE DEVELOPMENT
360 STATE STREET AND THE OCTAGON

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DOE HYDROGEN AND FUEL CELL
TECHNICAL ADVISORY COMMITTEE MEETING

JUNE 14, 2011

PRESENTATION OUTLINE

Introduction

Case Study I

360 State Street . New Haven, CT

Program and Green Objectives
Renewable Technologies Considered
Fuel Cell Analysis
Fuel Cells and Residential Development
Fuel Cells and Policy
Fuel Cell Installation and Operation
Fuel Cell Efficiency and Economics

Case Study II

The Octagon Apartments. New York, NY

Program and Green Objectives
Renewable Technologies Considered
Fuel Cell Analysis
Fuel Cell Installation
Fuel Cell Economics

Final Thoughts

The Future of Fuels Cells

360 State Street

New Urban Infill, Mixed-use,
Multi-family housing
Fuel Cell Installation
Fall 2008 - Fall 2010

Developer / Architect:
Becker + Becker

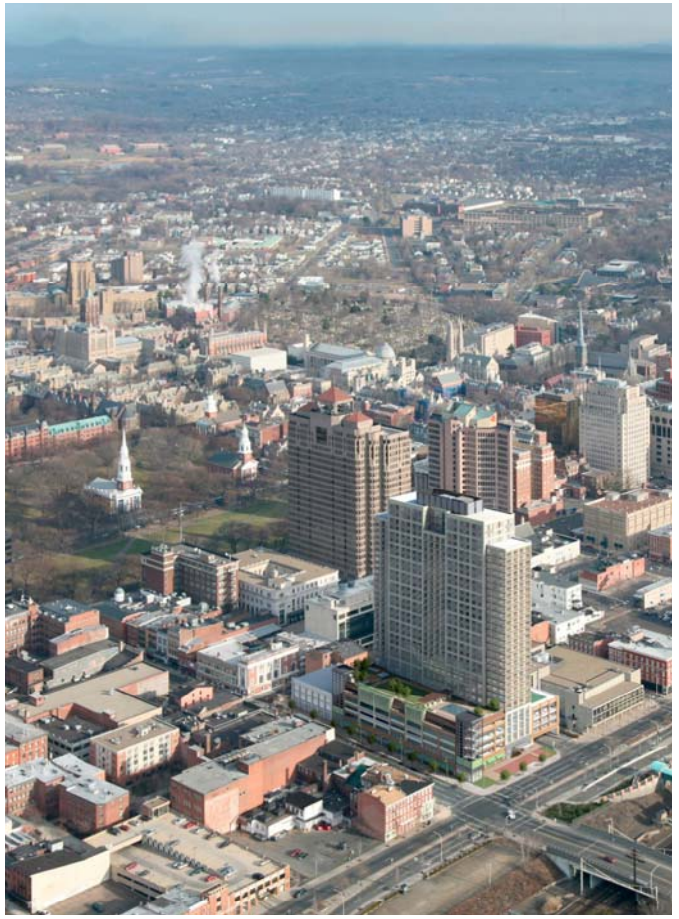
Investment Partner:
Bentall Kennedy | MEPT

MEP Engineers:
Cosentini Associates
LN Consulting

Green Building Consultants:
Atelier Ten
2nd Law
LN Consulting

DEVELOPMENT PROGRAM – 700,000 SF

360 STATE STREET
NEW HAVEN, CONNECTICUT



RESIDENTIAL

500 rental apartments | 50 affordable
Studios, 1 bedroom – 3 bedroom
Rent: $1,200 - $5,000

COMMERCIAL

30,000 SF retail and office,
community-owned food co-op, Elm City Market

PUBLIC PARKING

4 story structured parking garage for 500 cars,
Zipcars, electric car charging stations

COMMON AMENITIES

32,000 SF of amenities:
½ acre **Green Roof** and pool, art gallery, library, fitness center, yoga studio, theater, communal living room and kitchen, business center, children's playroom

SUSTAINABILITY – LEED® ND PLATINUM

360 STATE STREET
NEW HAVEN, CONNECTICUT

360 STATE STREET USES 50% LESS ENERGY THAN A BASELINE RESIDENTIAL BUILDING

82 Points Achieved — Possible Points: **106**

Certified 40 to 49 points | Silver 50 to 59 points | Gold 60 to 69 points | Platinum 80 or more points

26 Smart Location & Linkage — Possible Points: 30

Y	Prereq 1	Smart Location, Option 1	
Y	Prereq 2	Proximity to Water & Wastewater Infrastructure, Option 1	
Y	Prereq 3	Imperiled Species & Ecological Communities, No Species	
Y	Prereq 4	Wetland & Water Body Conservation, Option 1	
Y	Prereq 5	Agricultural Land Conservation, Option 2	
Y	Prereq 6	Floodplain Avoidance, Option 1	
2	Credit 1	Brownfields Redevelopment	2
1	Credit 2	High Priority Brownfields Redevelopment	1
8	Credit 3	Preferred Locations	10
8	Credit 4	Reduced Automobile Dependence, Options 1 & 3	8
1	Credit 5	Bicycle Network	1
3	Credit 6	Housing & Jobs Proximity, Option 1	3
1	Credit 7	School Proximity	1
1	Credit 8	Steep Slope Protection, Option 1	1
1	Credit 9	Site Design for Habitat or Wetland Conservation, Option 2	1
	Credit 10	Restoration of Habitat or Wetlands	1
	Credit 11	Conservation Management of Habitat or Wetlands	1

34 Neighborhood Pattern & Design — Possible Points: 39

Y	Prereq 1	Open Community	
Y	Prereq 2	Compact Development	
7	Credit 1	Compact Development	7
4	Credit 2	Diversity of Uses	4
3	Credit 3	Diversity of Housing Types	3
	Credit 4	Affordable Rental Housing	2
	Credit 5	Affordable For-Sale Housing	2
2	Credit 6	Reduced Parking Footprint	2
8	Credit 7	Walkable Streets	8
2	Credit 8	Street Network, Option 1	2
1	Credit 9	Transit Facilities	1
2	Credit 10	Transportation Demand Management, Options 2 & 3	2
	Credit 11	Access to Surrounding Vicinity	1
1	Credit 12	Access to Public Spaces	1
1	Credit 13	Access to Active Spaces, Option 1	1
1	Credit 14	Universal Accessibility	1
1	Credit 15	Community Outreach & Involvement	1
1	Credit 16	Local Food Production, Option 3	1

16 Green Construction & Technology — Possible Points: 31

Y	Prereq 1	Construction Activity Pollution Prevention	
	Credit 1	LEED Certified Green Buildings	3
3	Credit 2	Energy Efficiency in Buildings	3
1	Credit 3	Reduced Water Use, Option 1	3
	Credit 4	Building Reuse & Adaptive Reuse	2
	Credit 5	Reuse of Historic Buildings	1
1	Credit 6	Minimize Site Disturbance through Site Design, Option 1	1
1	Credit 7	Minimize Site Disturbance during Construction, Option 1	1
	Credit 8	Contaminant Reduction in Brownfields Remediation	1
5	Credit 9	Stormwater Management, Feb 2007 Version, Option 1	5
1	Credit 10	Heat Island Reduction, Option 1	1
	Credit 11	Solar Orientation	1
1	Credit 12	On-Site Energy Generation, Option 2	1
	Credit 13	On-Site Renewable Energy Sources	1
	Credit 14	District Heating & Cooling	1
	Credit 15	Infrastructure Energy Efficiency	1
	Credit 16	Wastewater Management	1
1	Credit 17	Recycled Content in Infrastructure	1
1	Credit 18	Construction Waste Management	1
1	Credit 19	Comprehensive Waste Management	1
	Credit 20	Light Pollution Reduction	1

6 Innovation & Design Process — Possible Points: 6

1	Credit 1.1	Innovation in Design: Exemplary Performance in SLLc6	1
1	Credit 1.2	Innovation in Design: Exemplary Performance in SLLc4	1
2	Credit 1.3	Innovation in Design: Exemplary Performance in GCTc12	1
1	Credit 1.4	Innovation in Design: Green Building Education	1
	Credit 1.5	Innovation in Design	1
1	Credit 2	LEED Accredited Professional	1

CASE STUDY I

RENEWABLES CONSIDERED

360 STATE STREET
NEW HAVEN, CONNECTICUT

360 STATE STREET
NEW HAVEN, CONNECTICUT

FUEL CELL ANALYSIS

- Base Load: 475 KW
- 24/7 demand for heat/hot water
- Financial Incentives:
  - Federal Fuel Cell Tax Credits
  - CT CEF Fuel Cell Grant
  - Fuel Cell Class I Renewable for RECs
  - Discounted DG gas rate

Fuel Cells and Residential Development

360 STATE STREET
New Haven, Connecticut

- 16.7 million multi-family housing units in the U.S.
- Consume 117 billion kWh of electricity per year (21% of US energy usage)
- 0.8% of electricity to multi-family housing is provided by renewable power

Source: EIA, 2009 RECS$_{UPDATE}$

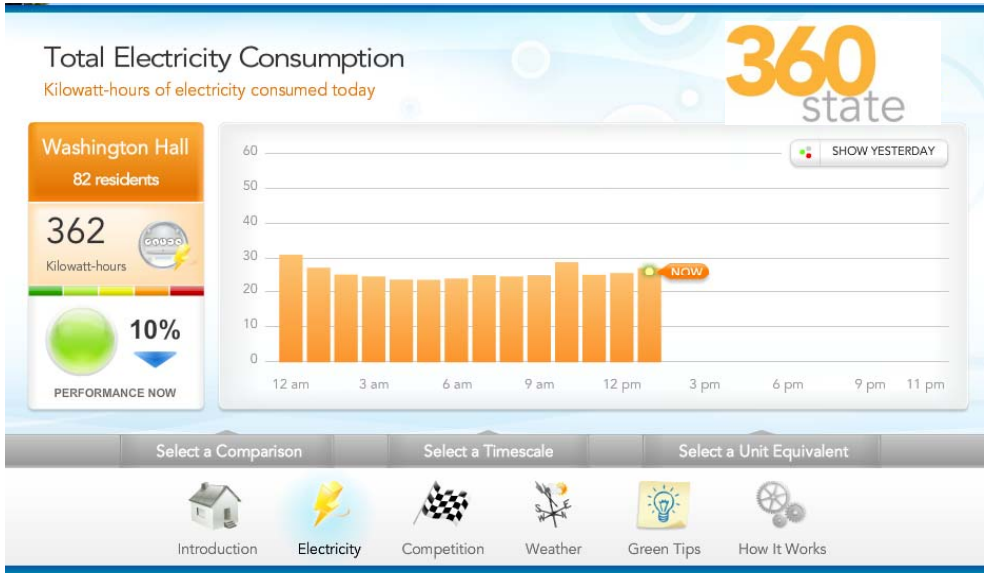
400 KW fuel cell provides 3.4 million kWh of electricity per year

35,000 fuel cells could take all multi-family buildings off the grid

FUEL CELLS AND POLICY

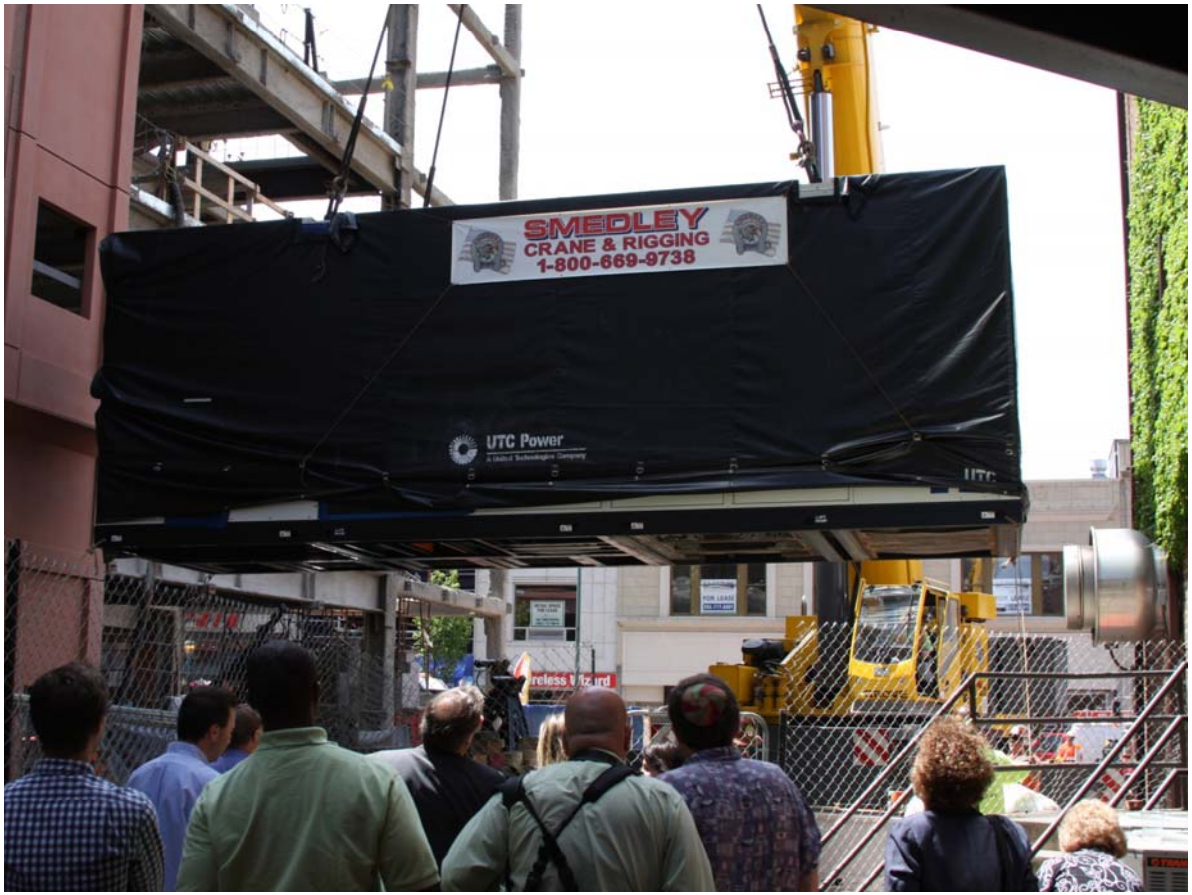
Regulations

- Submetering not permitted for residential development
- Net Metering permitted for meter connected to renewable source only
- Net Metering reimbursable rate at wholesale time of export rate



Fuel Cell Installation

360 STATE STREET
NEW HAVEN, CONNECTICUT



CASE STUDY I

Fuel Cell and CHP Operation

360 STATE STREET
New Haven, Connecticut

FUEL CELL EFFICIENCY

Electric Utilization: 65%

- Provide electric to all common and commercial areas: 65% of fuel cell's capacity
- Excess will go back to utility grid with reimbursement

Heat Utilization: 90%

- Waste heat will be used for domestic hot water heating, space heating, and pool heating. Excess heat is stored in thermal storage tanks

Fuel Cell life: 20 years with stack overhaul in year 10.

FUEL CELL ECONOMICS

Total Investment: $3,500,0000 (Fuel Cell Cost: $1,875,000)

Incentives:

- CT CEF Grant: $985,000
- Federal Tax Credit: $3,000/ kWh or 30% of install cost: $1,200,000
- REC sales, approximately $50,000 per year depending on REC market pricing
- DG natural gas rate- discount in CT removing distribution charges

Annual Avoided Energy Costs by Landlord + Sale: $295,000

Payback with incentives: 5 Years | without incentives: 13 Years

THE OCTAGON APARTMENTS

EXISTING
MULTI-FAMILY HOUSING
FUEL CELL INSTALLATION
2010-2011

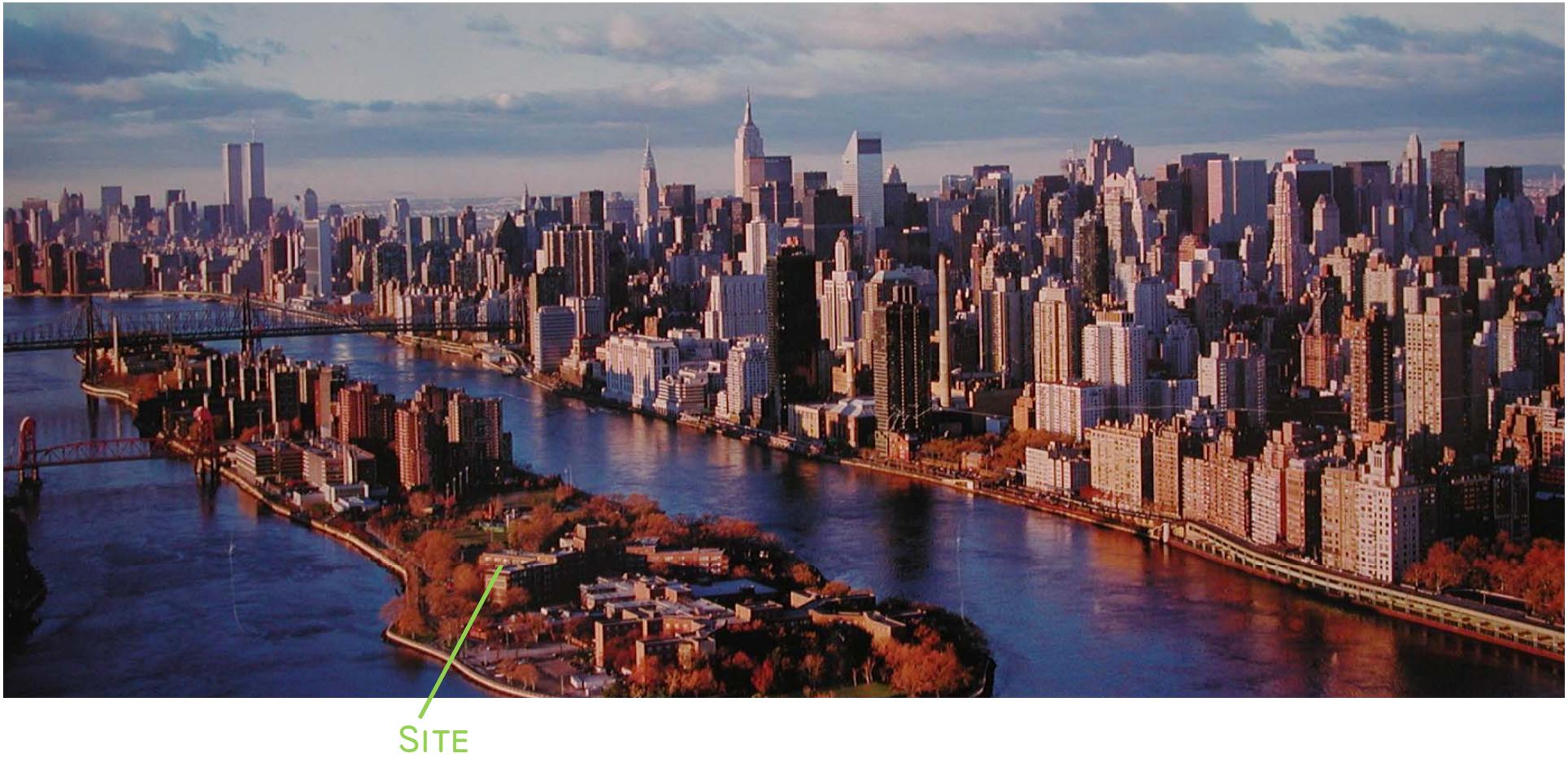
DEVELOPER/ARCHITECT:
BECKER + BECKER

INVESTMENT PARTNER:
KENNEDY ASSOCIATES | MEPT

ENGINEER:
LN CONSULTING

THE SITE – ROOSEVELT ISLAND, NYC

THE OCTAGON
NEW YORK, NEW YORK



CASE STUDY II

DEVELOPMENT – 550,000 SF | 500 UNITS

THE OCTAGON
NEW YORK, NEW YORK

BECKER + BECKER

SUSTAINABILITY – CERTIFIED LEED® SILVER

THE OCTAGON
NEW YORK, NEW YORK

THE OCTAGON USES 35% LESS ENERGY THAN A BASELINE RESIDENTIAL BUILDING AND WE CONTINUE TO MAKE IT GREENER

LEED-NC Version 2.1 Registered Project Checklist
Octagon Park Apartments, Roosevelt Island
888 Main Street, New York, NY 10044

Sustainable Sites — 14 Points

Yes	?	No			
Y			Prereq 1	**Erosion & Sedimentation Control**	Required
			Credit 1	**Site Selection**	1
1			Credit 2	**Development Density**	1
1			Credit 3	**Brownfield Redevelopment**	1
1			Credit 4.1	**Alternative Transportation**, Public Transportation Access	1
1			Credit 4.2	**Alternative Transportation**, Bicycle Storage & Changing Rooms	1
1			Credit 4.3	**Alternative Transportation**, Alternative Fuel Vehicles	1
1			Credit 4.4	**Alternative Transportation**, Parking Capacity and Carpooling	1
	?		Credit 5.1	**Reduced Site Disturbance**, Protect or Restore Open Space	1
1			Credit 5.2	**Reduced Site Disturbance**, Development Footprint	1
	?		Credit 6.1	**Stormwater Management**, Rate and Quantity	1
	?		Credit 6.2	**Stormwater Management**, Treatment	1
1			Credit 7.1	**Landscape & Exterior Design to Reduce Heat Islands**, Non-Roof	1
	?		Credit 7.2	**Landscape & Exterior Design to Reduce Heat Islands**, Roof	1
1			Credit 8	**Light Pollution Reduction**	1

Water Efficiency — 5 Points

Yes	?	No			
	?		Credit 1.1	**Water Efficient Landscaping**, Reduce by 50%	1
		1	Credit 1.2	**Water Efficient Landscaping**, No Potable Use or No Irrigation	1
		1	Credit 2	**Innovative Wastewater Technologies**	1
	?		Credit 3.1	**Water Use Reduction**, 20% Reduction	1
	?		Credit 3.2	**Water Use Reduction**, 30% Reduction	1

Energy & Atmosphere — 17 Points

Yes	?	No			
Y			Prereq 1	**Fundamental Building Systems Commissioning**	Required
Y			Prereq 2	**Minimum Energy Performance**	Required
Y			Prereq 3	**CFC Reduction in HVAC&R Equipment**	Required
3			Credit 1	**Optimize Energy Performance**	1 to 10
		1	Credit 2.1	**Renewable Energy**, 5%	1
		1	Credit 2.2	**Renewable Energy**, 10%	1
		1	Credit 2.3	**Renewable Energy**, 20%	1
1			Credit 3	**Additional Commissioning**	1
		1	Credit 4	**Ozone Depletion**	1
1			Credit 5	**Measurement & Verification**	1
	?		Credit 6	**Green Power**	1

continued...

Materials & Resources — 13 Points

Yes	?	No			
Y			Prereq 1	**Storage & Collection of Recyclables**	Required
		1	Credit 1.1	**Building Reuse**, Maintain 75% of Existing Shell	1
		1	Credit 1.2	**Building Reuse**, Maintain 100% of Shell	1
		1	Credit 1.3	**Building Reuse**, Maintain 100% Shell & 50% Non-Shell	1
1			Credit 2.1	**Construction Waste Management**, Divert 50%	1
	?		Credit 2.2	**Construction Waste Management**, Divert 75%	1
	1		Credit 3.1	**Resource Reuse**, Specify 5%	1
		1	Credit 3.2	**Resource Reuse**, Specify 10%	1
1			Credit 4.1	**Recycled Content**, Specify 5% (post-consumer + ½ post-industrial)	1
1			Credit 4.2	**Recycled Content**, Specify 10% (post-consumer + ½ post-industrial)	1
1			Credit 5.1	**Local/Regional Materials**, 20% Manufactured Locally	1
1			Credit 5.2	**Local/Regional Materials**, of 20% Above, 50% Harvested Locally	1
		1	Credit 6	**Rapidly Renewable Materials**	1
		1	Credit 7	**Certified Wood**	1

Indoor Environmental Quality — 15 Points

Yes	?	No			
			Prereq 1	**Minimum IAQ Performance**	Required
			Prereq 2	**Environmental Tobacco Smoke** (ETS) **Control**	Required
1			Credit 1	**Carbon Dioxide** (CO_2) **Monitoring**	1
1			Credit 2	**Ventilation Effectiveness**	1
1			Credit 3.1	**Construction IAQ Management Plan**, During Construction	1
1			Credit 3.2	**Construction IAQ Management Plan**, Before Occupancy	1
1			Credit 4.1	**Low-Emitting Materials**, Adhesives & Sealants	1
1			Credit 4.2	**Low-Emitting Materials**, Paints	1
1			Credit 4.3	**Low-Emitting Materials**, Carpet	1
1			Credit 4.4	**Low-Emitting Materials**, Composite Wood & Agrifiber	1
1			Credit 5	**Indoor Chemical & Pollutant Source Control**	1
1			Credit 6.1	**Controllability of Systems**, Perimeter	1
	?		Credit 6.2	**Controllability of Systems**, Non-Perimeter	1
1			Credit 7.1	**Thermal Comfort**, Comply with ASHRAE 55-1992	1
	?		Credit 7.2	**Thermal Comfort**, Permanent Monitoring System	1
1			Credit 8.1	**Daylight & Views**, Daylight 75% of Spaces	1
1			Credit 8.2	**Daylight & Views**, Views for 90% of Spaces	1

Innovation & Design Process — 5 Points

Yes	?	No			
1			Credit 1.1	**Innovation in Design**: AVAC Underground Garbage Removal System	1
			Credit 1.2	**Innovation in Design**: Provide Specific Title	1
			Credit 1.3	**Innovation in Design**: Provide Specific Title	1
			Credit 1.4	**Innovation in Design**: Provide Specific Title	1
1			Credit 2	**LEED™ Accredited Professional**	1

Yes	?	No		
34	11	12	**Project Totals** (pre-certification estimates)	69 Points

Certified 26-32 points **Silver** 33-38 points **Gold** 39-51 points **Platinum** 52-69 points

Renewable Power

The Octagon

New York, New York

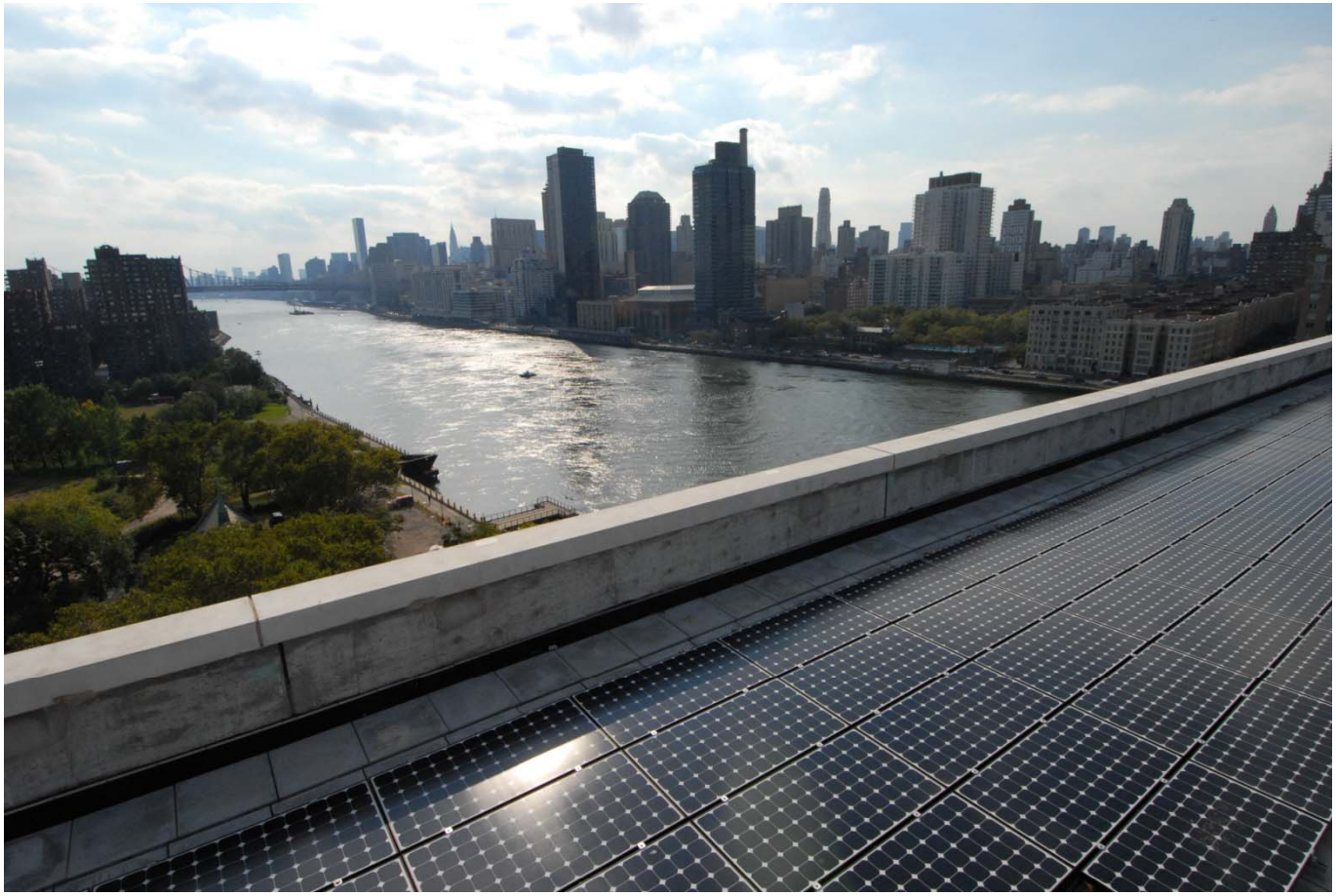


Image of the Octagon 50 KW Photovoltaic array – the Largest Array in New York City

CASE STUDY II

The Octagon
New York, New York

Fuel Cell Analysis

- Base Load: 600 KW
- 24/7 demand for heat/hot water
- Financial Incentives:
  - Federal Fuel Cell Tax Credits
  - NYSERDA DG CHP Demostration Program Grant
- Submetering permitted
- Construction/Design challenges with existing building

The Octagon
New York, New York

Fuel Cell Installation

- Installation: Fall 2010, 6 months
- Electric Utilization: 100%
  - •Provide electric to 500 residents and all common areas
  - •Excess will go back to utility grid, but without reimbursement
- Waste heat Utilization: 70%
- Waste heat will be used for domestic hot water heating and space heating
- Fuel Cell life: 20 years with stack overhaul in year 10

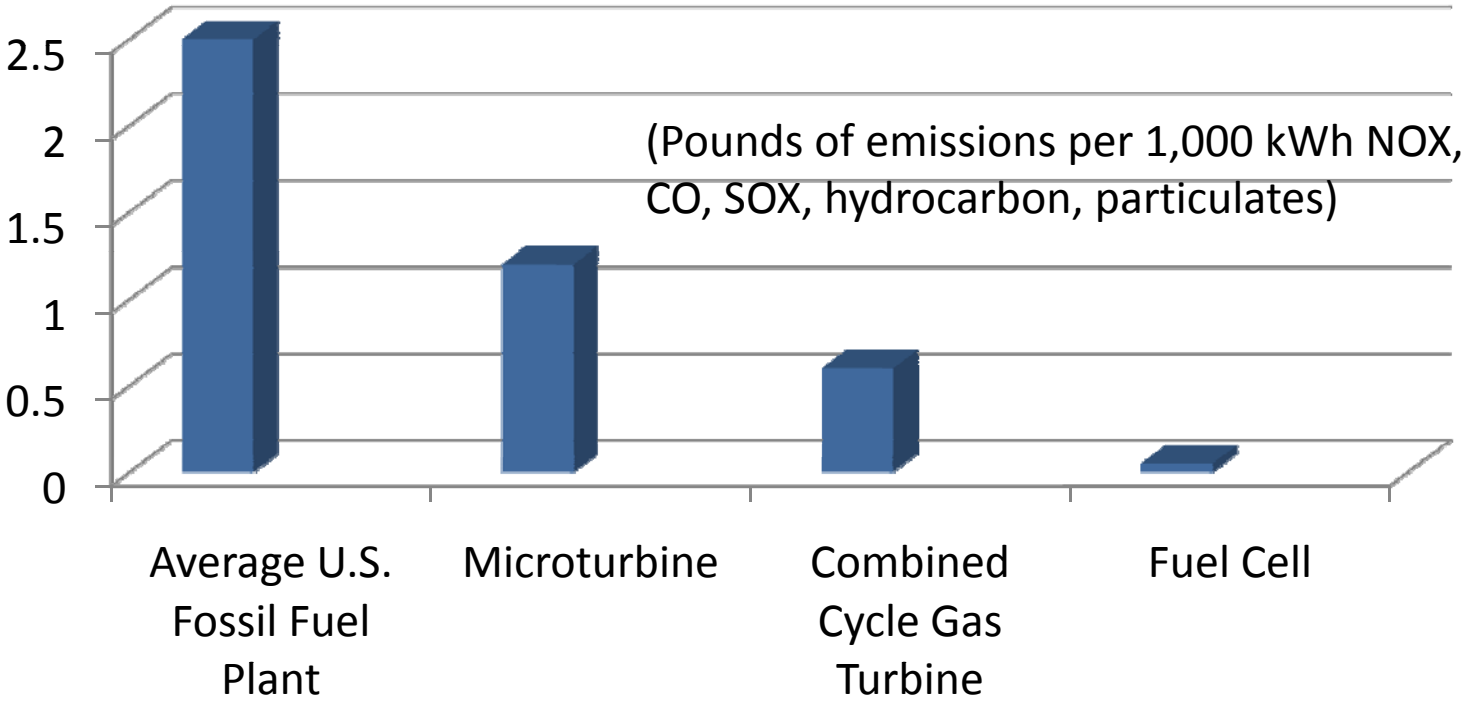
FUEL CELL ECONOMICS

- Total Install Cost: +$3,700,000
  - $2,175,000 for fuel cell unit + installation and existing system tie-in and upgrades
- Total Incentives: $2,200,000
  - NYSERDA Grant $1,200,000 upfront
  - Federal Tax Credit: $3,000/ kWh or 30% of install cost: $1,000,000
- Annual Energy Cost Savings: $221,500
- Payback without incentives: 14 Years (not including stack overhaul in Yr. 10)
- Payback with incentives: 5 Years

REDUCED EMISSIONS

Fuel cell creates 1 ounce of pollution per 1,000 kWh of electricity produced

Combustion generation creates 25 lbs of pollutants per 1,000 kWh of electricity produced



The Future of Fuel Cells

Powering the first 1,000 homes

360 State and the Octagon