



# **Open Windows**

## *Getting to Energy Efficiency in NYC Buildings*

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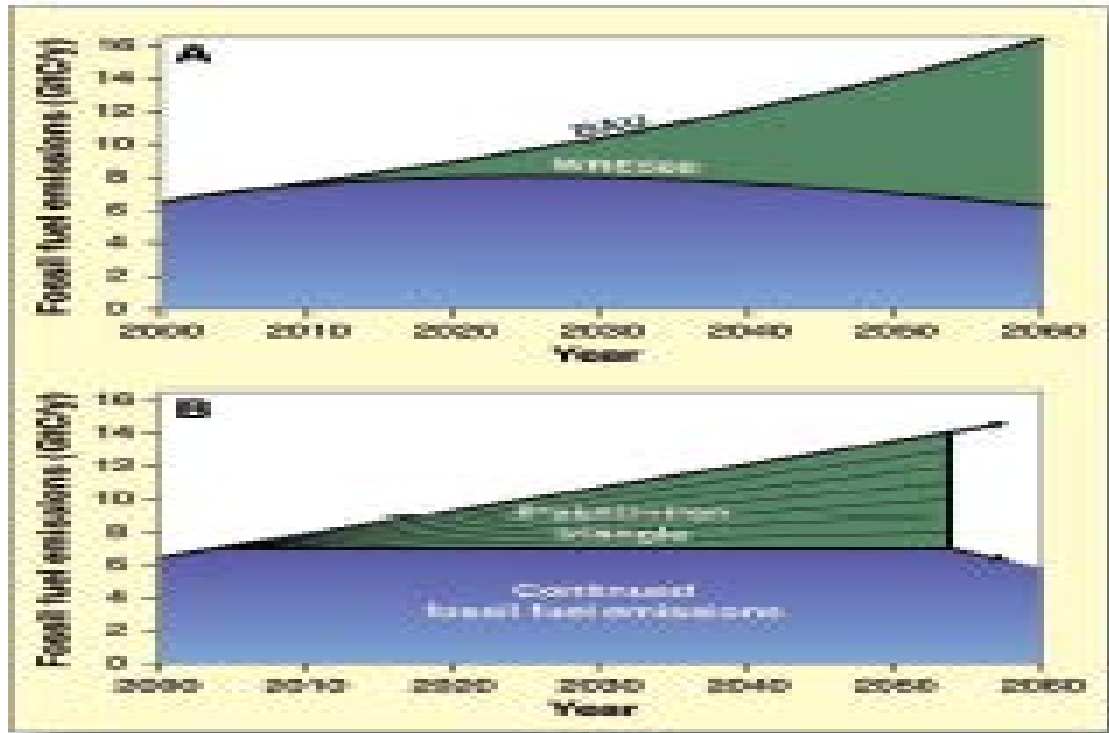




# The CUNY Building Performance Lab

- A serious\* perspective on operational challenges in building performance and energy efficiency in NYC
  - Industry collaboration with CUNY education and research
  - Workforce development for building operations
  - Seed-funded by NYSERDA
- serious -- *seasoned, somewhat skeptical; informed by experience and practical knowledge*

# Our Open Carbon Window: Sticking a wedge into it



- Robert Socolow, Princeton physicist
- Conceptualize the challenge
- Divide the wedge into manageable segments



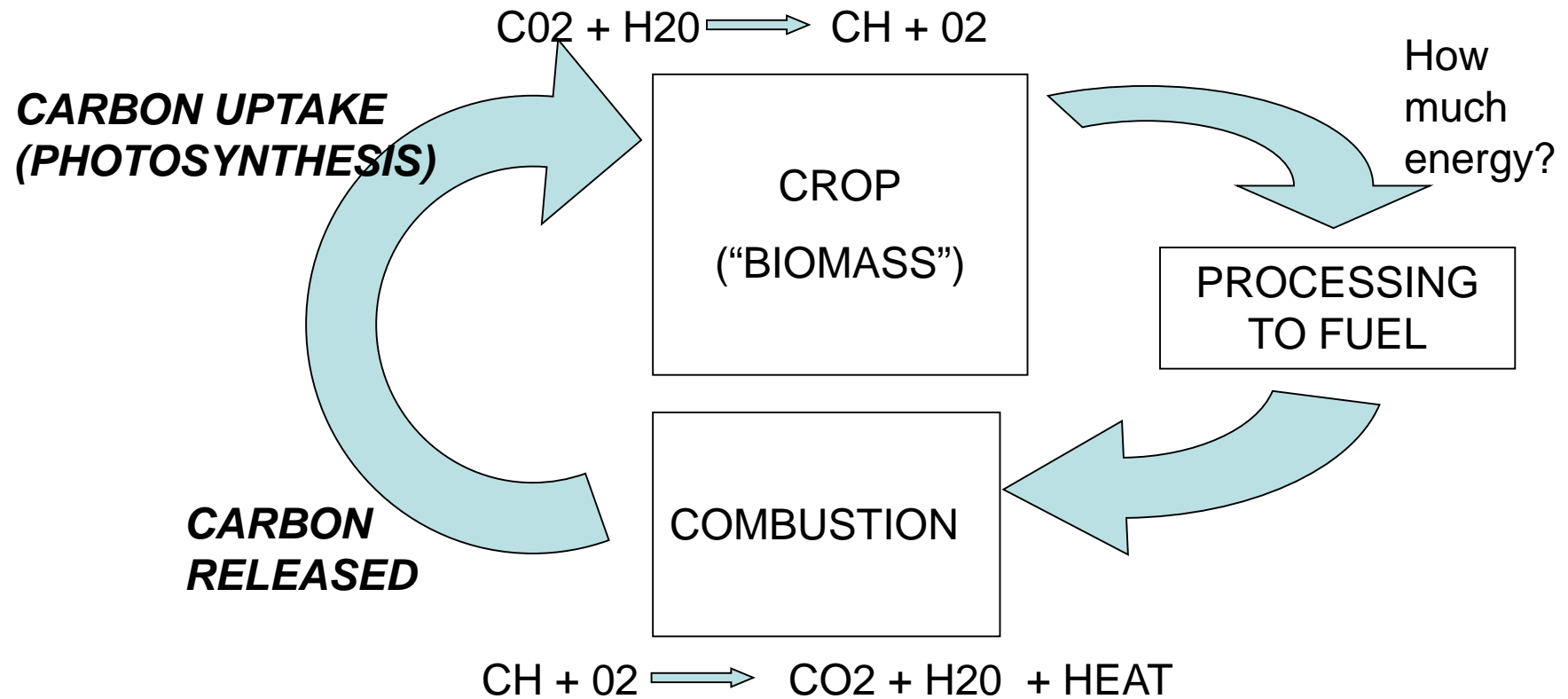
# Our Open Carbon Window: What *IS* the connection between carbon and energy use?



- Fossil and biomass fuels are CH molecules. Combustion produces and releases CO<sub>2</sub>.
- Biomass made by photosynthetic uptake of CO<sub>2</sub> from atmosphere, so its combustion is, to some extent, carbon neutral. Also the basis of “forestry-based sequestration.”

# Our open carbon window: Sticking a wedge into it

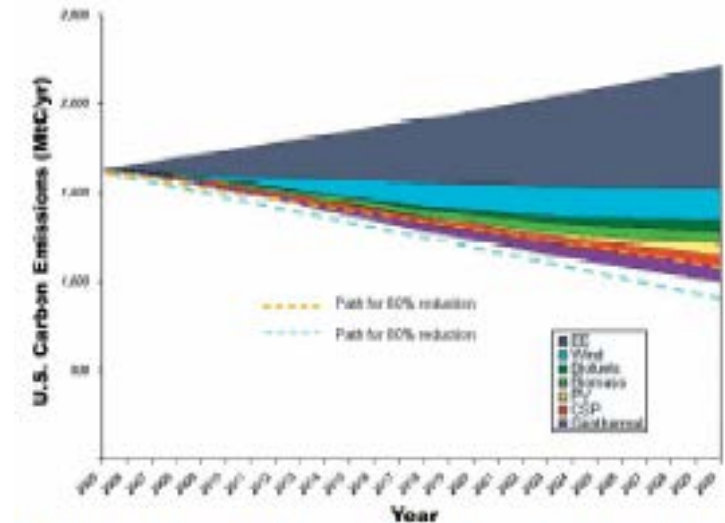
## The Biofuel Carbon Cycle



# Our open carbon window:


## Sticking a wedge into it - **Energy Efficiency**

- The largest “soft-path” wedge, by far
- Many technologies
- Many actions



**Table 1.**  
Potential carbon reductions (in MtC/yr in 2030) based on the middle of the range of carbon conversions.

Energy efficiency	688
Concentrating solar power	63
Photovoltaics	63
Wind	181
Biofuels	58
Biomass	75
Geothermal	83



# Our open carbon window: Sticking a wedge into it: Energy Efficiency

## How EE gets brought to market

- Codes
  - Effects new construction and building systems at points of major renovation
- Standards, regulatory or voluntary
  - Effects especially appliances, mass-market equipment
- Projects
  - Direct marketing of cost-effective measures

# The Bank Window



- Little work gets done without a source of money
- Energy Efficiency as the “Next Window” for investing in urban buildings ??



# The Bank Window

- Projects Line Up for Capital



- Capital Lines Up for Projects



# The Bank Window: Capital's EE Opportunity

- Technology & Equipment Investment
  - New technologies and industries that will mfr it
- Project Finance
  - Getting EE technologies applied and installed
- Carbon Trading
  - Certifying and securitizing the impacts of projects



# Capital's EE Opportunity

## Energy Project Finance

- High cost-effectiveness
  - 3-5 year simple paybacks = 20 - 30% ROI
- Multiple partners and cash flows
  - Owner - “shared-savings”, equipment benefits
  - Government, Utilities - incentives (subsidies)
  - Brokers and Traders
- Specialist firms to realize technical potential -- “ESCOs”
  - Energy Performance Contracts
  - Clinton Foundation model for C40 global large cities



# Capital's EE Opportunity Energy Project Finance

## How an Energy Performance Contract Works

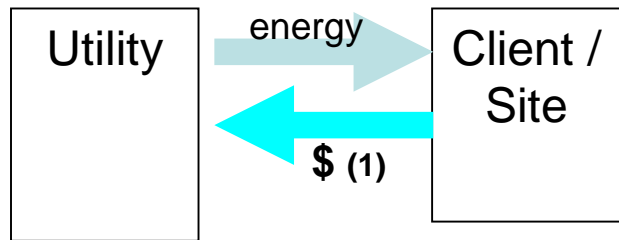
- Invest in goods & services for a site that will realize energy savings
- Site pays for project financing (loan or lease) with (a part of) energy savings for a specified contract period
- Purchasing a future stream of (avoided) energy payments
- Performance Guarantee

# Capital's EE Opportunity

## Energy Project Finance

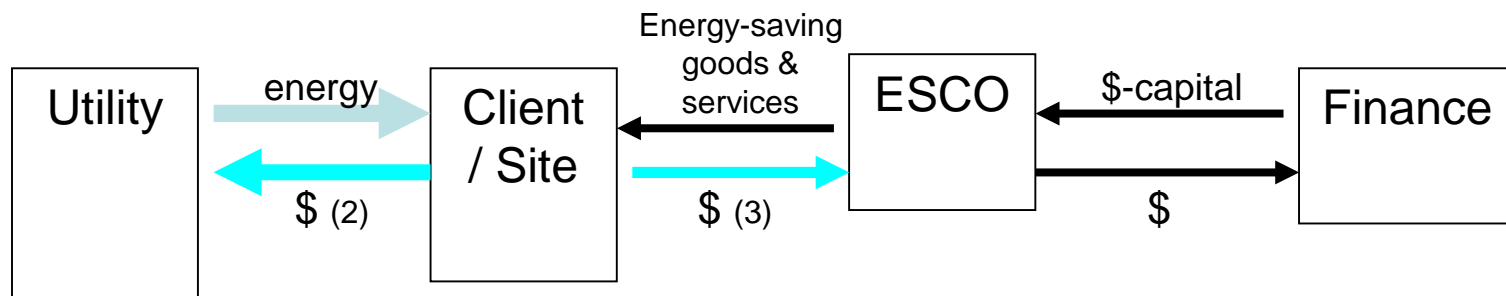
### How an Energy Performance Contract Works

#### Base Case (no EPC)



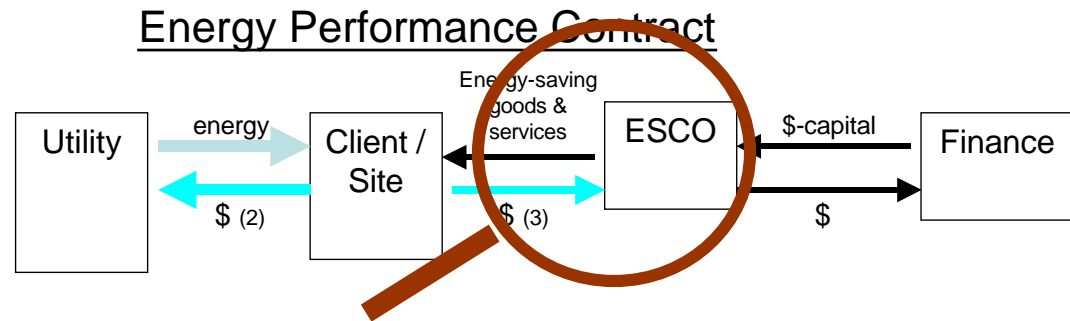
$$\$ (1) > \$ (2) + \$ (3)$$

#### Energy Performance Contract



# Capital's EE Opportunity

## Project Finance & Performance Contracts



## ESCO Performance Contract Process

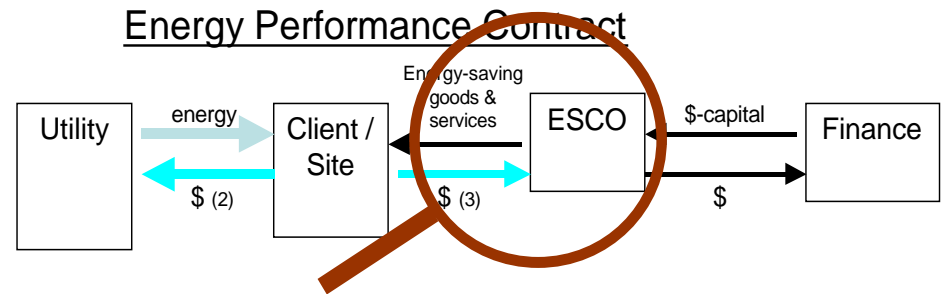
- Energy Audit – identify and quantify opportunities
- Finance & Contract
- Design & Install
- Operate (who?)
- **Monitor & Verify Performance - “IPMVP”**

# Capital's EE Opportunity

## Project Finance & Performance Contracts

### What Kinds of Work

- Lighting
- Mechanical (HVAC) systems
- Controls
- CHP, Cogeneration, Heat Recovery
- Building Shells
- Renewables for final step towards “net zero”





# NYC OPPORTUNITY (WINDOW OF)

## Key Facts

- 950,000 buildings
- \$10 billion annual energy
  - Almost 2/3 of cost is for electricity
  - But electricity only about 1/2 of Carbon  
(because of nuclear, hydro, coal, gas mix)

(facts courtesy of NYC Mayor's Office documents )



# NYC OPPORTUNITY (WINDOW OF)

## How is Energy Use Distributed?

Energy Usage by Building Type in New York City  
Percent of total energy in British Thermal Units (BTU)

### WHAT WE USE FOR ENERGY FOR

BUILDING TYPE	HEAT	HOTWATER	LIGHTING	APPLIANCES*	COOLING**	OTHER	TOTAL
1-4 family residential	7.6%	2.6%	1.7%	2.2%	0.6%	0.0%	14.7%
Multi-family residential	7.4%	7.4%	3.0%	3.9%	1.2%	0.0%	22.0%
Commercial	8.5%	2.8%	10.2%	4.5%	4.5%	0.9%	31.4%
Industrial	2.6%	2.1%	4.0%	3.3%	1.1%	0.2%	13.0%
Institutional/government	6.3%	4.0%	3.6%	1.7%	1.4%	0.9%	17.9%
<b>ALL TYPES</b>	<b>32.4%</b>	<b>18.9%</b>	<b>22.5%</b>	<b>15.6%</b>	<b>8.8%</b>	<b>2.0%</b>	<b>100%</b>

Source: Con Edison; KeySpan; U.S. Department of Energy;  
New York State Energy Research and Development Authority

\*Appliances include electronics and refrigerators as well as other appliances

\*\*Cooling includes ventilation as well as air conditioning

# NYC OPPORTUNITY (WINDOW OF) Projected Growth

- Not static picture
- Greatest growth in electricity

## NYC OPPORTUNITY (WINDOW OF)

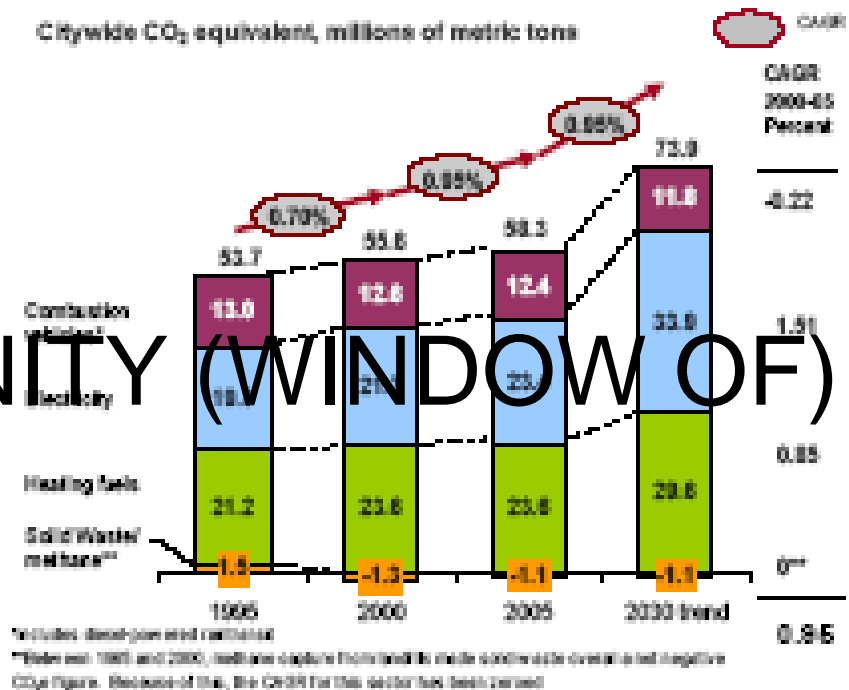


Figure 4. New York City citywide CO<sub>2</sub>e emissions, showing compound annual growth rates for combustion vehicles, electricity, and heating fuels. A 0.91 percent CAGR assumes business-as-usual conditions.

# NYC OPPORTUNITY (WINDOW OF) PlaNYC2030 “Wedge” targets

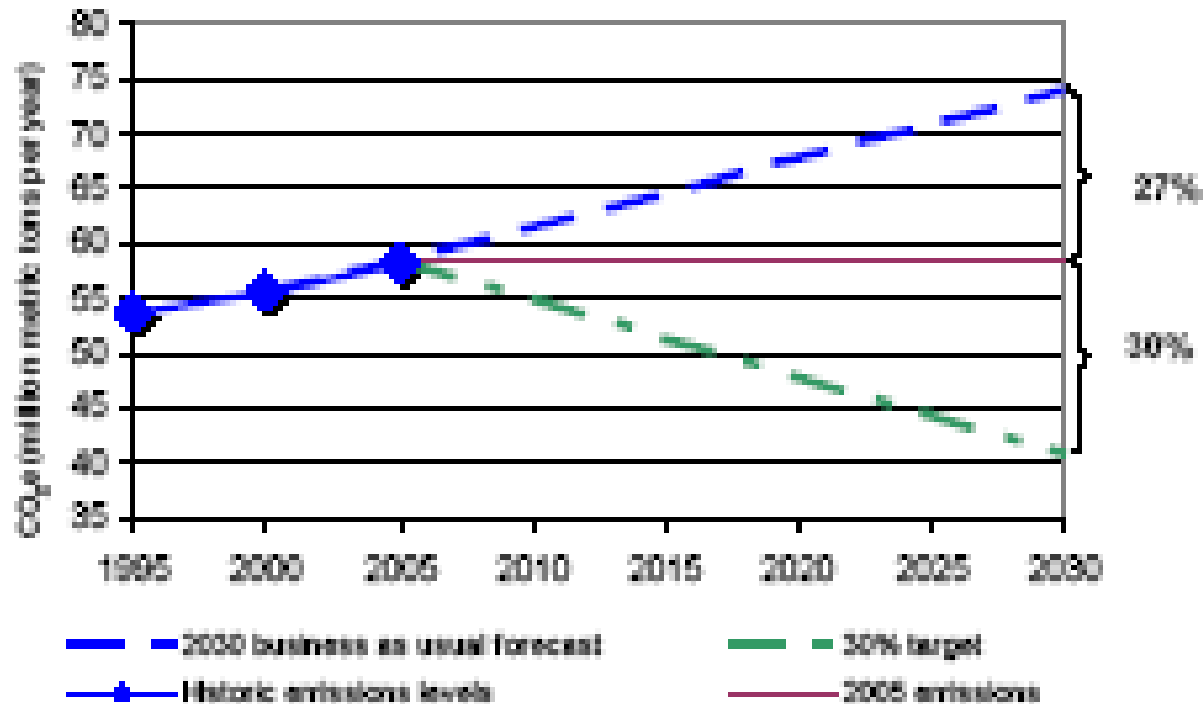


Figure 13. New York citywide CO<sub>2</sub>e emissions forecast and target.

# NYC OPPORTUNITY (WINDOW OF) Capital Requirement of the 2030 Wedge

*Some back-of-envelope projecting  
based on \$10 billion NYC annual energy expense*

30% savings at, say, a  
5-year overall  
average payback =  
\$15 billion market  
(capital required)

50% savings at, say, a  
10-year overall  
average payback =  
\$50 billion market  
(capital required)

Note, NYC proposing \$80 million/year program for its municipal properties, about 10% of overall NYC energy expense

# NYC OPPORTUNITY (WINDOW OF) PlaNYC2030 Sample Programs

**Key Areas for Targeted Energy Efficiency Initiatives**

Program	Description of Initiatives/Program Examples	Program Investment		Impact	
		Est. Program Cost	Est. Program Value	Estimated Program Savings (per building)	% Citywide Energy Savings Potential
1. <b>BOE INVESTMENT IN NEW YORK</b> (2009-2012)	city equipment to readily monitor - low reduction in heating and operations by code - achieved through sealed windows, lighting upgrades, and improved maintenance	\$50,000 (public school)	NA	7-8 yrs.	1.0%
	major challenges to monitor include a state agreement - ability to monitor the city government largely code - monitoring a state-commissioned assessment (energy audit/measure) - financial incentives/maintenance	\$50,000 (public school building)	\$100,000	10-15 yrs.	1.0%-1.5%
2. <b>COMMERCIAL &amp; INDUSTRIAL</b> Programs to date	in New York State on large commercial & industrial buildings (100,000 sq. ft.) - monitoring a state-commissioned assessment (energy audit/measure) - financially code, incentive/audit/energy - financial incentives/maintenance	\$500,000 (public school building)	\$100,000	10-15 yrs.	1.0%
	lighting systems brought up to energy code - financial incentives/maintenance	\$1,000 (public school)	\$10,000	10-15 yrs.	1.0%
3. <b>NEW CONSTRUCTION</b> Programs to date	in New York State on large residential buildings (100,000 sq. ft.) - monitoring a state-commissioned assessment (energy audit/measure) - financially code, incentive/audit/energy - financial incentives/maintenance	\$500,000 (public school building)	\$100,000	10-15 yrs.	1.0%
	large-scale residential programs targeted at all residential properties - financial incentives/maintenance	\$1,000-50,000	\$100	immediate	1.0%
4. <b>NEW CONSTRUCTION</b> (2009-2012) to date	new construction to meet energy code by code, incentive/audit/energy - monitoring a state-commissioned assessment (energy audit/measure) - financially code, incentive/audit/energy - financial incentives/maintenance	\$500,000 (public school building)	\$100,000	10-15 yrs.	0.5%
	energy incentives for higher energy savings investments/measure - financial incentives/maintenance	\$500,000	\$100,000	10-15 yrs.	0.5%
5. <b>APPLIANCES &amp; ELECTRONICS</b> Programs to date	incentives to high efficiency for appliances, electronics, and air conditioners - financial incentives/maintenance - incentive/audit/energy	\$500	\$100	immediate	1.0%
	work to state a national level for improved standards for appliances and electronics - financial incentives/maintenance - financial incentives/maintenance	NA	NA		0.5%

Source: NYC Mayor's Office of Energy, from PlaNYC 2030



“Open Windows” M.Bobker Presentation 8/4/07 to Governor’s Island series on NYC Sustainability

# NYC OPPORTUNITY (WINDOW OF)

If the \$\$ and the Projects are there,  
isn't EE a No-Brainer?

TWO WORDS:

**“OPERATIONAL RISK”**



# The Final Window for Today

## Operational Risk in Performance Contracts

- Is the project designed per intent?
- Is the project built as designed?
- Does the project perform as projected?
- Are savings maintained over time?
- Does anyone take the time to find out?

# The Final Window for Today

## Operational Risk in Performance Contracts

### THE STORY OF THE OPEN WINDOWS

- From late 1970's through 1980's, virtually all NYC apartment building windows replaced
- How many of them stay open in winter?
- Why?





# The Final Window for Today

## Operational Risk in Performance Contracts

### THE STORY OF VFD MOTOR CONTROLS



- Through the 1990's, hundreds of large pump and fans had variable speed controls added.
- How many of them are actually varying motor speeds?
- Why?



# The Final Window for Today

## Operational Risk in Performance Contracts

### HOW TO “KEEP THE WINDOWS CLOSED”?

- Understanding of adoptive behaviors in context of other priorities, metrics
  - Why do we chronically over-condition our buildings?
- Better feedback loops
  - better building conditions information
  - accountability for energy use
- Education and new skills



# The Final Window for Today

## Operational Risk in Performance Contracts

### HOW TO “KEEP THE WINDOWS CLOSED”?

- Must recognize the reality of operational “low-hanging fruit” and how to harvest it
  - important experience documents significant program enhancement and reliability
- Capital will fail without inclusion of these management and manpower elements

# Some extra slides on Carbon Markets

# What is the source of EE's perceived opportunity for capital?

- Derivative Market in Carbon
  - *Certified* carbon emissions reductions
  - Sell certificates -- additional source of revenues on top of energy savings
- Carbon Markets preferred to (carbon) tax
  - Kyoto Protocol - CDM
  - US - Local and Voluntary Markets
    - RGGI, Chicago CX

# Out the Window?

## Leakage & Hot Air in Carbon Markets

- Origin of the “hot air” concept under Kyoto trading – the case of Russia’s phantom CER’s
  - Illustrates “Baseline” as key. Difficulties in measuring energy reductions.
- Other kinds of “Leakage”
  - Additionality (free-ridership)
  - Persistence
- Certification Process