BRIGHT POWER

Panel:

Cost-Effective Transition to Electrified Heating & Cooling with Distributed Generation

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Today's Panelists

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Introduction

- Technology Overview and Use Case
- Case Studies
- Data Comparison
- Owner's Perspective
- Future Impacts of Policy

NYC & NYS Climate Goals

- In 2014, NYC committed itself to **reduce greenhouse gas emissions (GHG) 80% by 2050 (80 x 50)**
- The interim target to reduce GHG emissions 40% by 2030 (40 x 30)
- NYC has been taking steps to achieve that goal with new **investments in renewable energy, electric vehicles, and shifting away from fossil fuel-based energy sources.**
- New York State's Clean Energy Standard was revised this year, requiring **100% carbon-free electricity by 2040**. Last year, 29% of New York State's generation at both large- and small-scale facilities came from renewable sources.

1. New York City's Roadmap to 80 x 50
2. eia.gov/state/NY

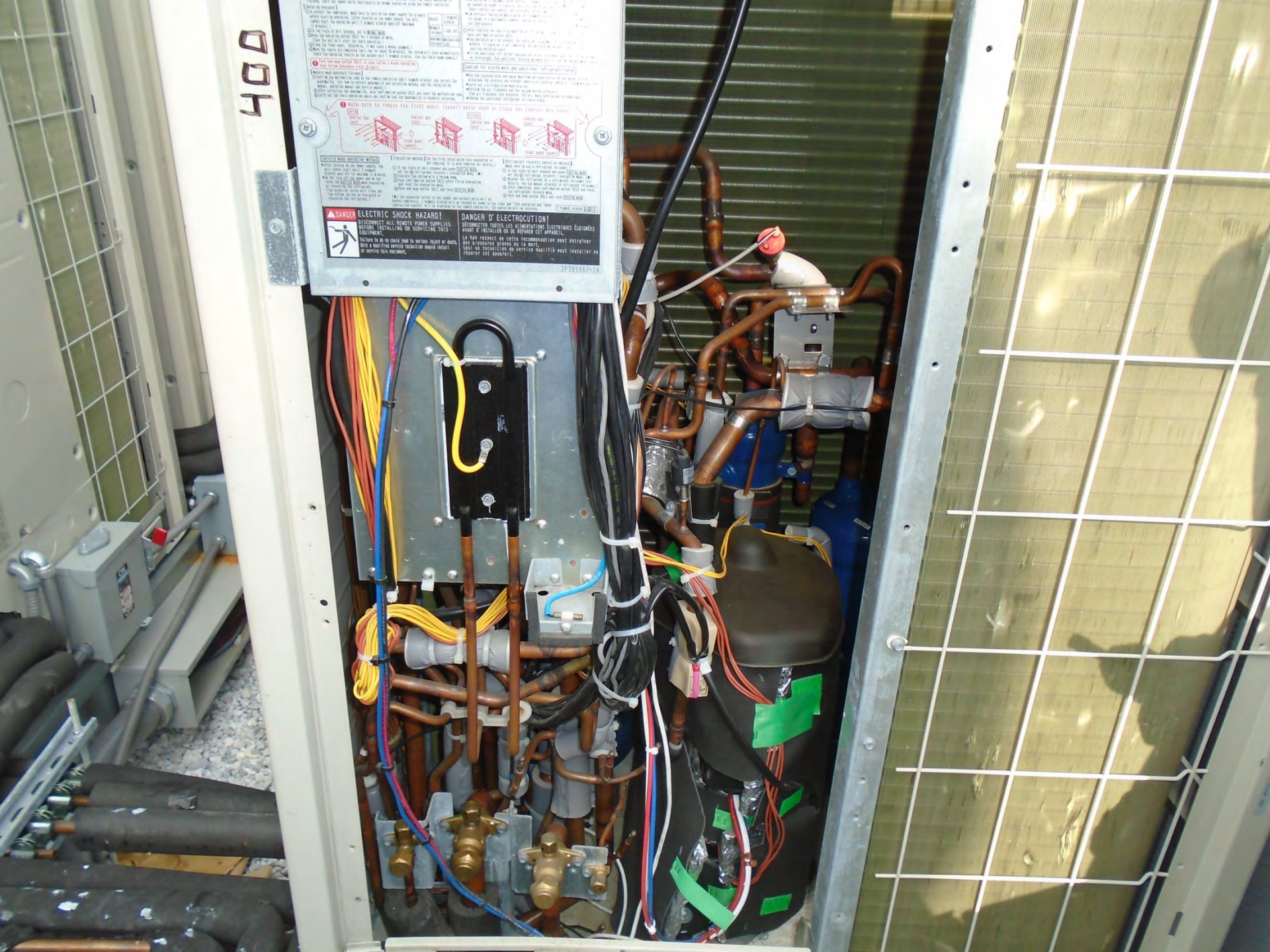
How Can We Achieve Our Climate Goals?

- Electric resistance heating + window or through-wall A/C
- Electric resistance PTAC
- Boiler/tower water source heat pump (not 100% electrified)
- Air-to-water heat pump
- **Air-to-air heat pump (mini-split, VRF)**
- Ground source heat pump (water-water, water-air)

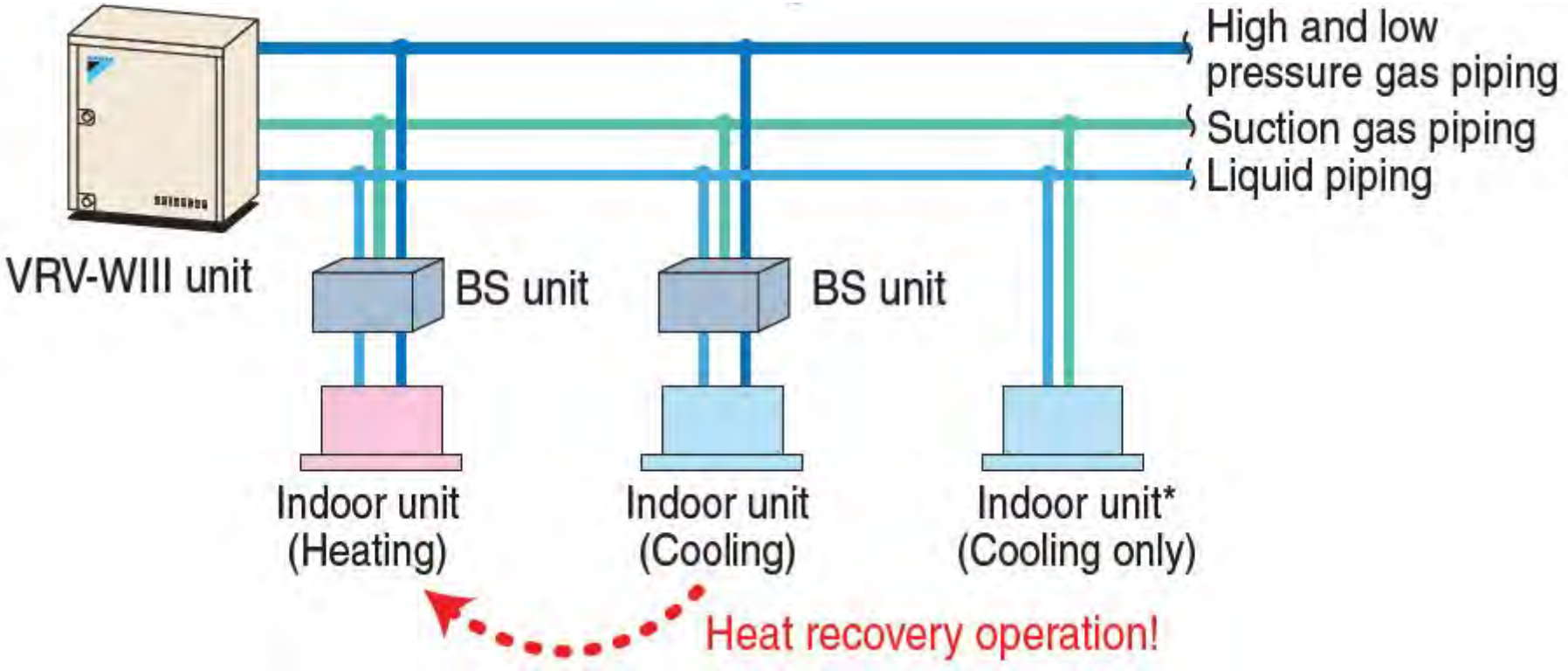
Variable Refrigerant Flow (VRFs)

- Typical refrigeration system / heat pump: fixed speed compressor, one outdoor coil, one indoor coil
- Mini-split: variable speed compressor, one outdoor coil, one indoor coil
- Multi-zone / VRV / VRF: variable speed compressor, one outdoor coil, many indoor coils


DAIKIN
VRV IV
INVERTER
R410A


400
DANGER ELECTRIC SHOCK HAZARD!
DISCONNECT ALL REMOTE POWER SUPPLIES BEFORE INSTALLING OR SERVICING THIS EQUIPMENT.
Failure to do so could lead to serious injury or death. Only a qualified service technician should install or service this equipment.
DANGER D' ELECTROCUTION!
DÉCONNECTER TOUTES LES ALIMENTATIONS ÉLECTRIQUES ÉLOIGNÉES AVANT D' INSTALLER OU DE RÉPARER CET APPAREIL.
Le non respect de cette recommandation peut entraîner des blessures graves ou la mort.
Seul un technicien de service qualifié peut installer ou réparer cet appareil.

VRFs Continued



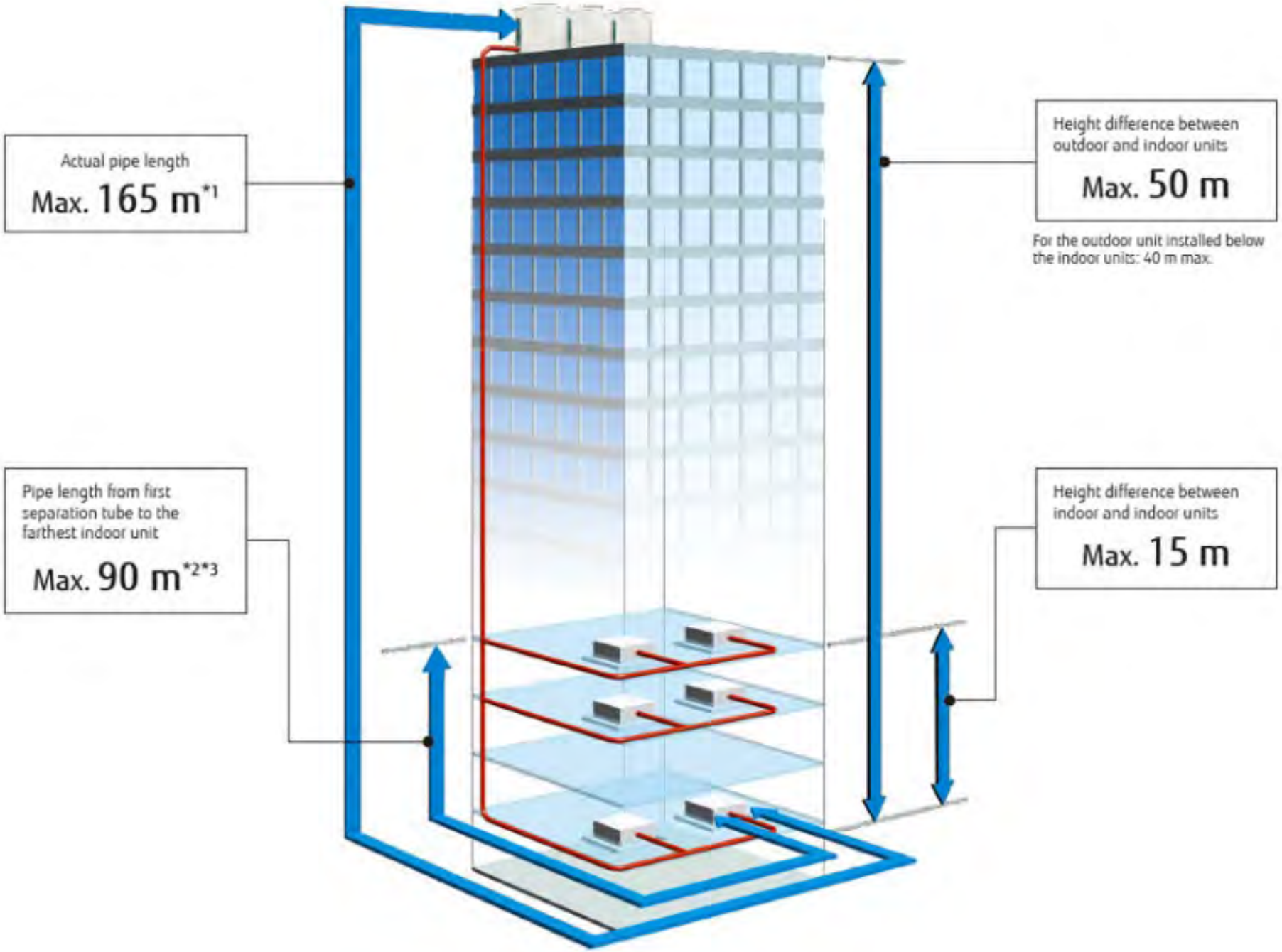
VRFs Continued

Circular Flow Cassette

Mini Duct

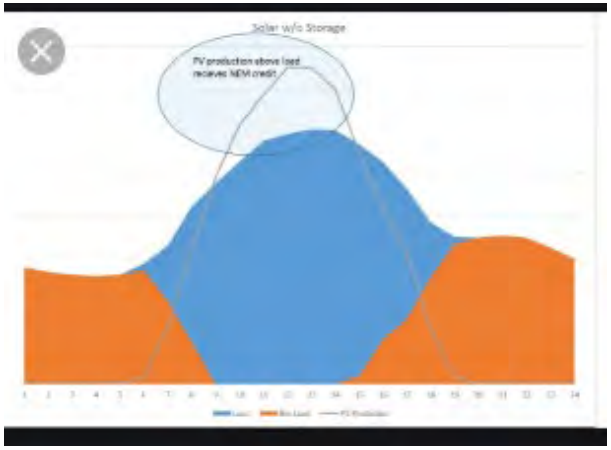
Compact Floor

Wall Mounted


Actual pipe length
Max. 165 m*1
Height difference between outdoor and indoor units
Max. 50 m
For the outdoor unit installed below the indoor units: 40 m max.
Pipe length from first separation tube to the farthest indoor unit
Max. 90 m*2*3
Height difference between indoor and indoor units
Max. 15 m

Urban Solar PV Systems

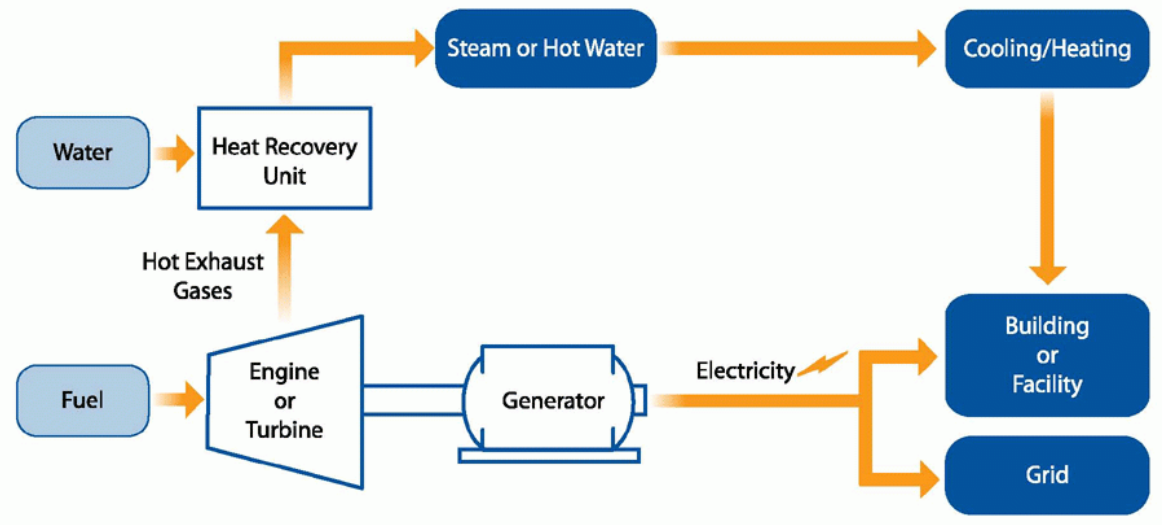
- Pergolas, Canopies, Tilted Planes, Vertical Walls, Ballasted Systems
- Behind the Meter, Remote Net Metering, Community Solar
- Offset kWh's consumed onsite via crediting or traditional displacement
- NYSERDA Incentives, Federal ITC, NYC PTA, MACRS, LIHTC



Examples of Urban Solar PV Projects

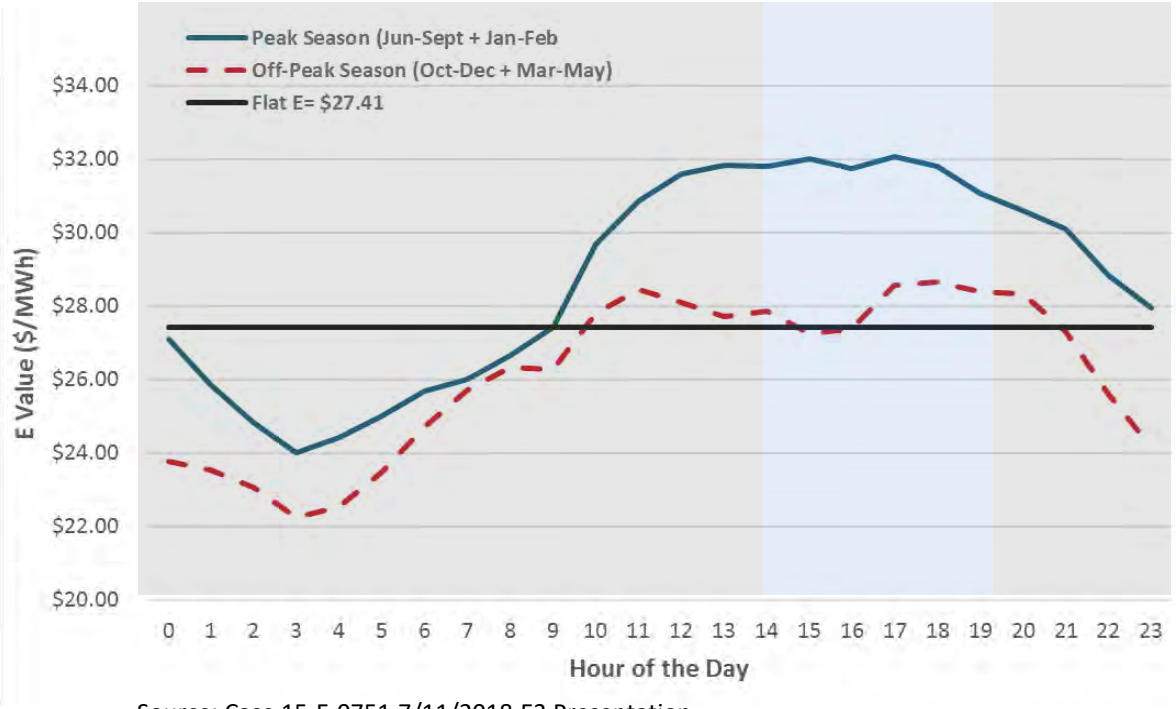
Micro Cogeneration Systems

- Modular Reciprocating Engines, Modular Microturbines
- Traditionally located behind the meter with thermal tie-in at DHW and Heating System Loops
- Offset kwhs, DHW and Hydronic heating system therms
- Federal ITC, MACRS, LIHTC



Future Technologies

- Energy Storage Systems (ESS) – not considered here but will play an important role
- Smart thermostats / controls / IOT
- Time value of carbon



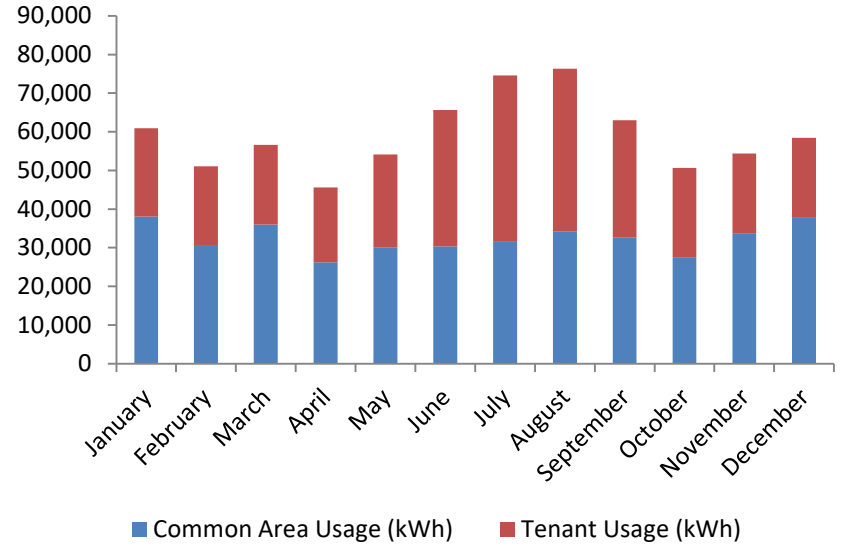
Source: Case 15-E-0751 7/11/2018 E3 Presentation

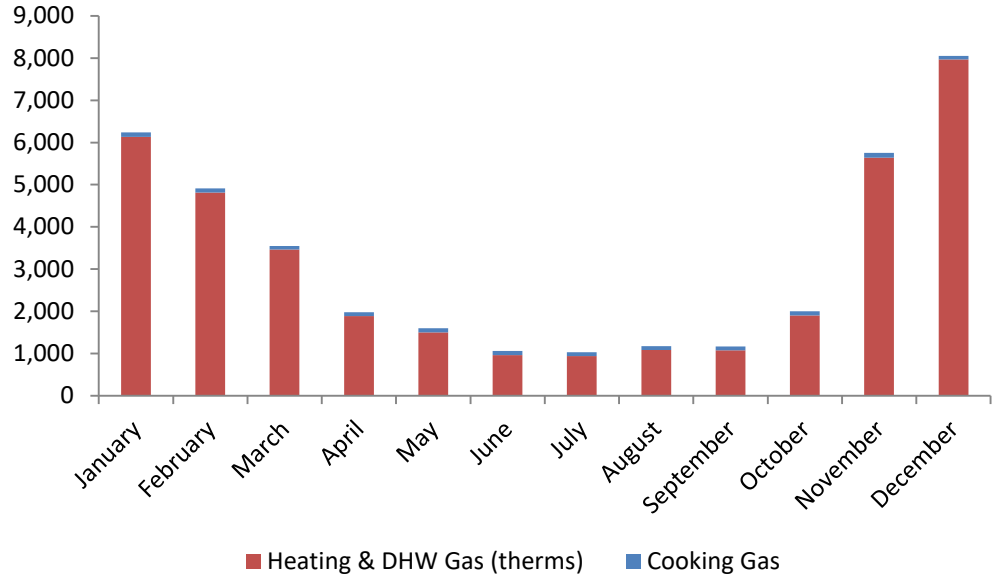
The Data

"Typical" New-ish NYC Multi-Family Building

- Roughly 10 years old
- Fairly high-percentage glazing, low-performance envelope
- Hydronic PTACs
- Some amenity spaces
- ~130,000 gross sqft
- 112 apartments
- 320 bedrooms

"Typical" Building Usage





Typical Multi-Family Building

Owner Energy Metrics and Costs

Energy End-Use	Energy	Unit	Cost	Unit
Cooling	4.5	Btu/sqft/CDD	$0.32	$/sqft/year
Heating	7.1	Btu/sqft/HDD	$0.37	$/sqft/year
Fossil Fuel Baseload	4.34	mmBtu/bedroom/year	$0.13	$/sqft/year
Electric Baseload	3361	kWh/unit/year	$0.55	$/sqft/year
Total Owner Energy	**59**	**kBtu/sqft/year**	**$1.38**	**$/sqft/year**

St. Augustine

- Roughly 1 year old
- High performance envelope
- VRF heating and cooling
- Some amenity spaces
- ~117,000 gross sqft
- 112 apartments
- 191 bedrooms
- 48 kW Solar PV system

Data: St. Augustine

Owner Energy Metrics and Costs

Energy End-Use	Energy	Unit	Cost	Unit
Cooling	2.40	Btu/sqft/CDD	$0.17	$/sqft/year
Heating	1.58	Btu/sqft/HDD	$0.39	$/sqft/year
Fossil Fuel Baseload	8.55	mmBtu/bedroom/year	$0.17	$/sqft/year
Electric Baseload (Net of PV)	1,831	kWh/unit/year	$0.33	$/sqft/year
Total Owner Energy	**30**	**kBtu/sqft/year**	**$1.06**	**$/sqft/year**

Park Avenue Green

Improvements

- Roughly 1 year old
- Passive House envelope
- VRF heating and cooling
- Some amenity spaces
- ~117,000 gross sqft
- 154 apartments
- 253 bedrooms
- 34 kW PV system
- 65 kW CHP system

Data: Park Avenue Green

Owner Energy Metrics and Costs

Energy End-Use	Energy	Unit	Cost	Unit
Cooling (VRF)*	-	Btu/sqft/CDD	-	$/sqft/year
Heating (VRF)*	-	Btu/sqft/HDD	-	$/sqft/year
Gas Heating (RTUs)	0.59	Btu/sqft/HDD	$0.03	$/sqft/year
Fossil Fuel Baseload (DWH Boilers)	0.04	mmBtu/bedroom/year	$0.001	$/sqft/year
Electric Baseload (Net of CHP)	2,070	kWh/unit/year	$0.64	$/sqft/year
CHP Gas	17,641	therms/year	$0.12	$/sqft/year
RNM Credits from PV System	41,582	kWh/year	($0.02)	$/sqft/year
Total Owner Energy	**21**	**kBtu/sqft/year**	**$0.78**	**$/sqft/year**

*All data are shown net of CHP production. CHP modulates to maintain minimum net import which is why heating and cooling metrics show as zero in a regression analysis.

Case Study Comparison

	"TYPICAL BUILDING"	St Augustine	Park Avenue Green
Fossil Fuel Baseload (Includes CHP)	$0.13	$0.17	$0.12
Electric Baseload + Seasonal Energy Cost (Net of DG)	$1.24	$0.89	$0.64
Total Owner Energy	**$1.38**	**$1.06**	**$0.78**

Note: All Units in Table are $/SqFt/Year

Construction Cost Premiums

Technology	Cost Premium ($/sqft)
VRF System Upgrade	5.0
PV System	.30
CHP System	1.8
Total	7.1

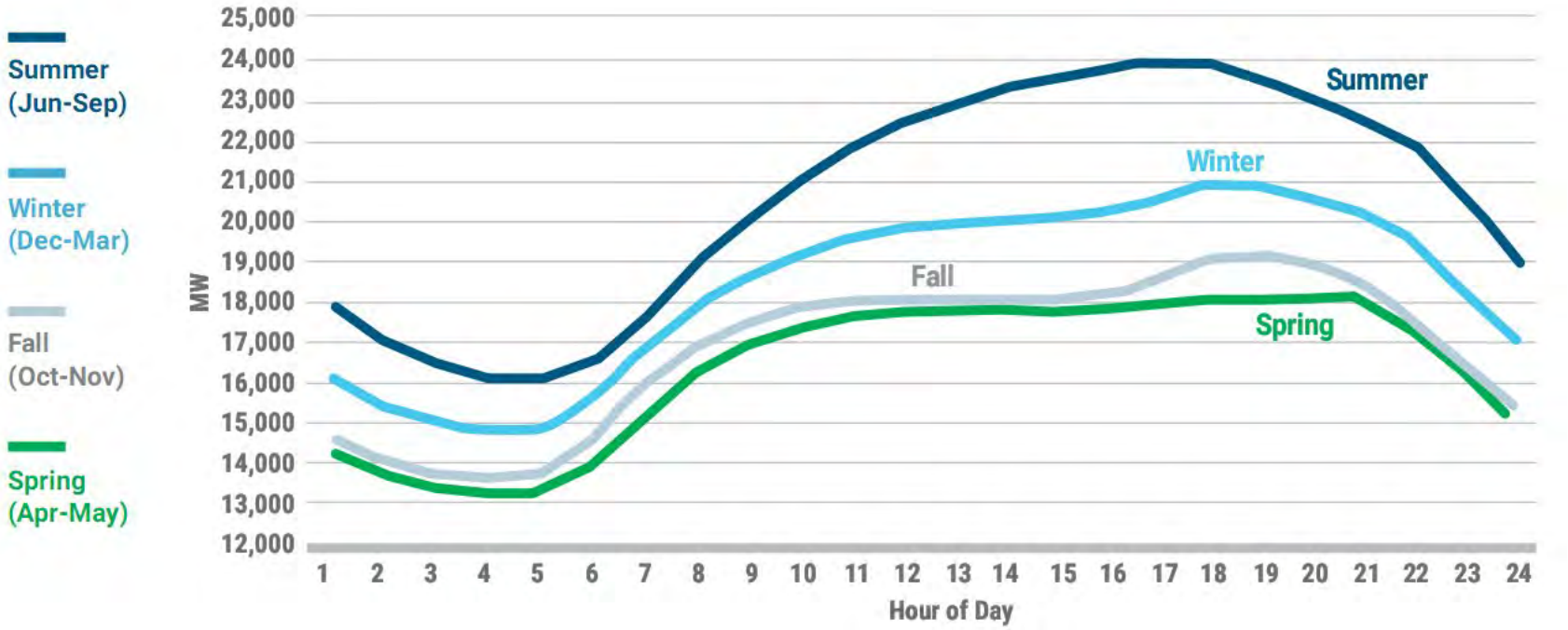
Note: Cost Premium is calculated based off additional cost for the described technology above the typical NYC building cost.

An Owner's Perspective

- Why VRFs?
- Why Cogen?
- Why PV?
- Goal : Passive House

Future Impacts of Policy

- Incentives
- LL97
- Rate changes
- Cleaner grid
- Different grid loading (EVs, electrified heating)



Source: NYISO Powertrends 2019

LL97 Impacts on Case Study Buildings: St. Augustine

2024-2029 Period			
Energy End-Use	**Electricity (kWh)**	**Gas (therms)**	**tCO2e**
Cooling	106,224	0	31
Heating	239,269	0	69
Fossil Fuel Baseload	0	16,336	87
Electric Baseload (Net of PV)	205,050	0	59
Total Owner Energy	550,542	16,336	246

Emissions	0.00210	tCO2e/sq ft
Emission Limit	0.00675	tCO2e/sq ft
Percent of Limit	**31%**	

2030-2034 Period			
Energy End-Use	**Electricity (kWh)**	**Gas (therms)**	**tCO2e**
Cooling	106,224	0	31
Heating	239,269	0	69
Fossil Fuel Baseload	0	16,336	87
Electric Baseload (Net of PV)	205,050	0	59
Total Owner Energy	550,542	16,336	246

Emissions	0.00210	tCO2e/sq ft
Emission Limit	0.00407	tCO2e/sq ft
Percent of Limit	**52%**	

LL97 Impacts on Case Study Buildings: Park Avenue Green

2024-2029 Period			
Energy End-Use	**Electricity (kWh)**	**Gas (therms)**	**tCO2e**
Cooling (VRF)	0	0	0
Heating (VRF)	0	0	0
Gas Heating (RTUs)	0	4,138	22
Fossil Fuel Baseload	0	95	1
Electric Baseload (Net of CHP)	318,800	0	92
Generator Gas	0	17,641	94
PV Generation	-41,582	0	-12
Total	277,218	21,873	196

Emissions	0.00123	tCO2e/sq ft
Emission Limit	0.00675	tCO2e/sq ft
Percent of Limit	**18%**	

LL97 Impacts on Case Study Building: Park Avenue Green

2030-2034 Period - CHP is On			
Energy End-Use	**Electricity (kWh)**	**Gas (therms)**	**tCO2e**
Cooling (VRF)	0	0	0
Heating (VRF)	0	0	0
Gas Heating (RTUs)	0	4,138	22
Fossil Fuel Baseload	0	95	1
Electric Baseload (Net of CHP)	318,800	0	39
Generator Gas	0	17,641	94
PV Generation	-41,582	0	-5
Total	277,218	21,873	150

Emissions	0.00094	tCO2e/sq ft
Emission Limit	0.00407	tCO2e/sq ft
Percent of Limit	**23%**	

2030-2034 Period - CHP is Off			
Energy End-Use	**Electricity (kWh)**	**Gas (therms)**	**tCO2e**
Cooling (VRF)	0	0	0
Heating (VRF)	0	0	0
Gas Heating (RTUs)	0	4,138	22
Fossil Fuel Baseload	0	95	1
Electric Baseload (Net of CHP)	548,691	0	67
Generator Gas	0	0	0
PV Generation	-41,582	0	-5
Total	507,109	4,232	84

Emissions	0.00053	tCO2e/sq ft
Emission Limit	0.00407	tCO2e/sq ft
Percent of Limit	**13%**	

How Are Developers Viewing the Future

- Motivation for Complete Building Envelopes
- Deters Cogen and other bridging technologies
- Gas Moratorium

Questions?

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