

NEEP VRF Market Strategies Report - Outline



- **Identification and Prioritization of Market Barriers and Opportunities**
- **VRF Market Characterization**
- **VRF Technology and Applications**
- **VRF Performance Metrics, Ratings and Standards**
- **Refrigerants in VRF Installations**
- **Regional Market Transformation Strategies**

NEEP VRF Workgroup – Identification and Prioritization of Market Barriers and Opportunities



VRF Market Development	VRF Technology & Performance
<ul style="list-style-type: none">● COST● MARKET ACTORS● MARKET INTERVENTIONS● MARKET SIZE● PROGRAM STRATEGIES● REGIONAL PROMOTION	<ul style="list-style-type: none">● DESIGN AND INSTALLATION● PERFORMANCE● STANDARDS & SAVINGS● REFRIGERANTS● TECHNOLOGY ASSESSMENT

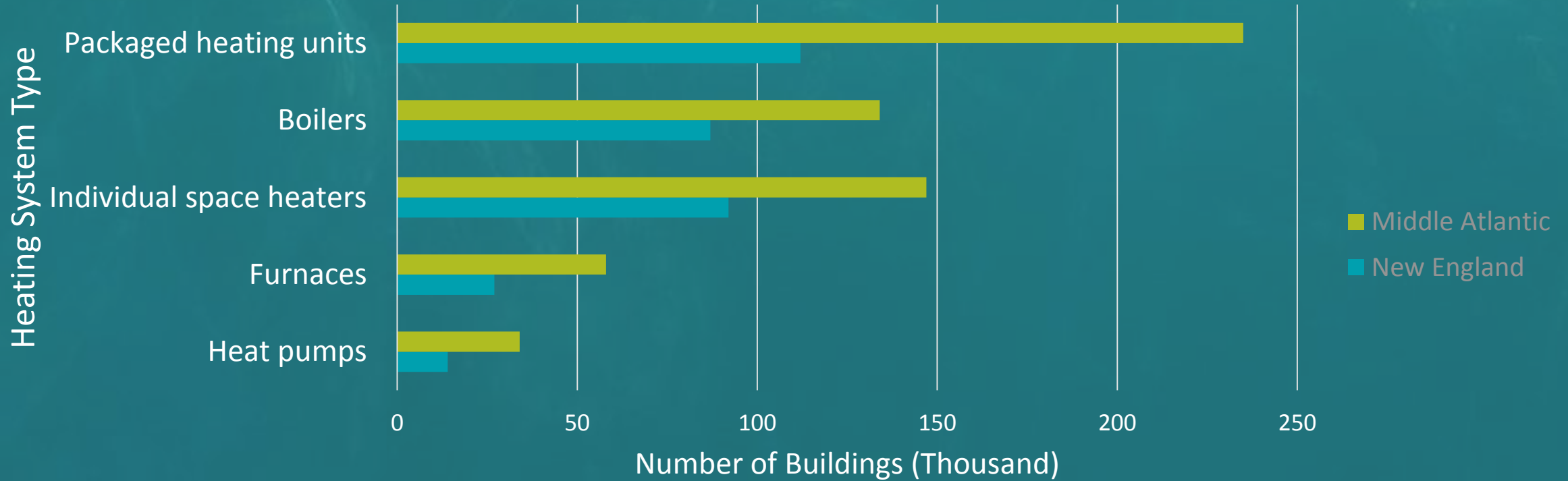
VRF Market Characterization (US and International)



- Europe and Asia market share of VRF ~ 80-90% of installed commercial HVAC systems
- Traditional US HVAC market – central, ducted, hot water – not refrigerant
- US VRF market share
 - ~6% but growing rapidly
 - Over 60,000 systems (500,000 tons)

VRF Market Characterization (Regional)

Commercial Heating System Type – Northeast and Mid-Atlantic (CBECS 2012)



- Upcoming Regional Data Sources: NYSERDA Commercial Baseline Study (2019), MA & RI VRF Programs

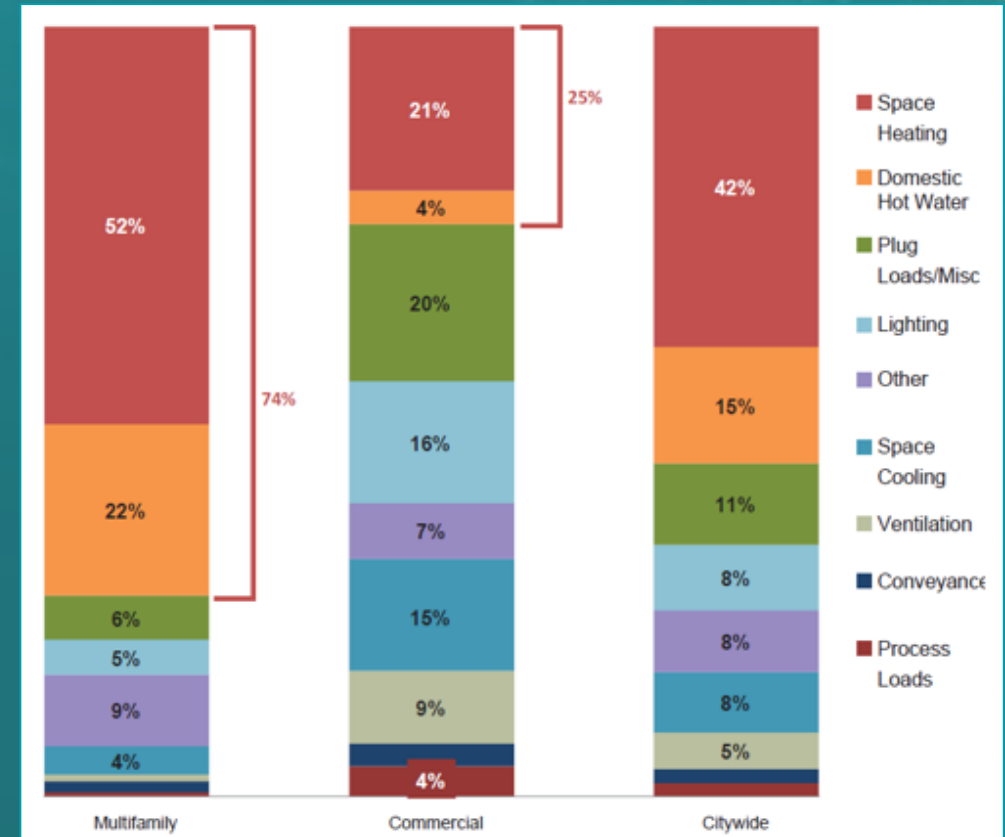
VRF Market Characterization (Regional)

NYC 80x50 Roadmap

- 80% reduction in GHG by 2050
- City buildings ~ 68% GHG emissions
- Target 82% emissions reductions in buildings
 - 70-75% renewable grid
 - Deep energy retrofit 100% buildings w/ 50-60% high efficiency electric heating

NYC buildings' heating, cooling and ventilation

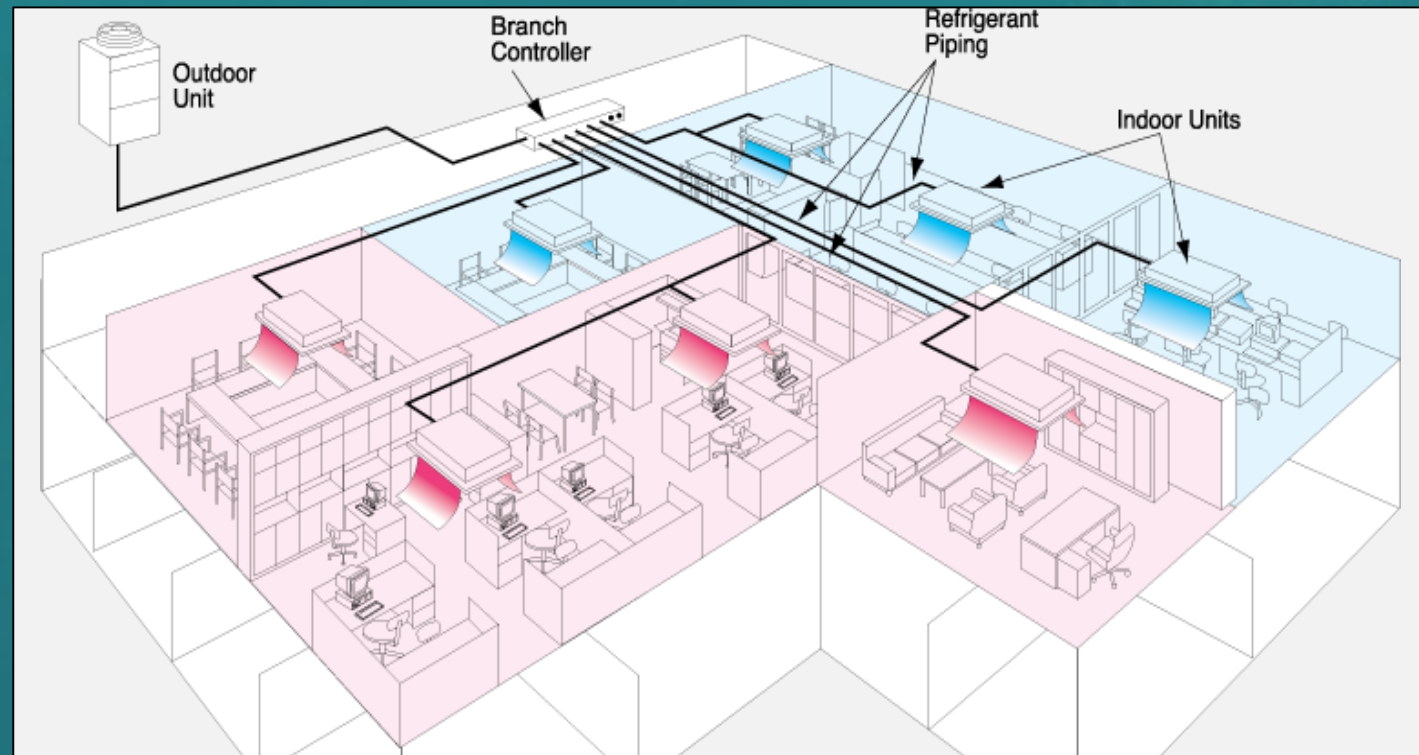
- Multifamily ~ 75% GHG emissions
- Commercial ~ 34% GHG emissions



New York City Building GHG Emissions by End Use

Source: NEEP NYC VRF In-Person Meeting Presentation (NYC Sustainability Office) – Dec 2019

- Comprehensive heating and cooling solution
- Variable capacity to meet diversely loaded zones
- Can transfer energy to heat & cool different zones
- Suited for comfort cooling applications
- Space savings



(Source: 2012 GSA VRF Systems Report / Mitsubishi)

VRF Performance Metrics, Ratings, and Standards



- **Minimum Efficiency Standard for VRF - ASHRAE Standard 90.1-2016 Table 6.8.1-10**
 - **Poor reflection of VRF part-load and cold-climate performance**
 - **DOE VRF multi-split air conditioners and heat pumps working group (Jan 2018)**

Equipment Type	Cooling Capacity	Heating Type	Minimum Energy Efficiency Criteria	
			Cooling Mode	Heating Mode
VRF Air-Cooled Heat Pump	≥ 65,000 Btu/h	w/o Heat Recovery	11.0 EER; 12.3 IEER	3.3 COP at 47°F
	< 135,000 Btu/h	w/ Heat Recovery	10.8 EER; 12.1 IEER	2.25 COP at 17°F
VRF Air-Cooled Heat Pump	≥ 135,000 Btu/h	w/o Heat Recovery	10.6 EER; 11.8 IEER	3.2 COP at 47°F
	< 240,000 Btu/h	w/ Heat Recovery	10.4 EER; 11.6 IEER	
VRF Air-Cooled Heat Pump	≥ 240,000 Btu/h	w/o Heat Recovery	9.5 EER; 10.6 IEER	2.05 COP at 17°F
		w/ Heat Recovery	9.3 EER; 10.4 IEER	

VRF Performance Metrics, Ratings, and Standards



Advanced specifications and criteria

State	Rebate Incentive	HPSF	EER	IEER	SEER	COP
<u>Massachusetts (Mass Save)</u>	For air cooled units ≥ 5.4 tons = \$125/ton		≥ 11.0	≥ 18.0		≥ 3.4
	For water cooled units ≥ 5.4 tons = \$125/ton		≥ 12.0	≥ 20.0		≥ 4.3
<u>Massachusetts (Clean Energy Center)</u> ⁵	For units without heat recovery ≥ 5.4 tons = \$800/ton	Must meet the minimum efficiency ratings established in the ANSI/ASHRAE/IES Standard 90.1-2016 Energy Standard for Buildings Except Low-Rise Residential Buildings				
	For units with heat recovery ≥ 5.4 tons = \$1,200/ton					
	For units without heat recovery < 5.4 tons = \$800/ton	≥ 10.0	≥ 11.0		≥ 17.0	
	For units with heat recovery < 5.4 tons = \$1,200/ton	≥ 10.0	≥ 11.0		≥ 17.0	

- ENERGY STAR, CEE
- Utility/State Efficiency Program Criteria
- Custom Building Energy Modeling

Refrigerants in VRF Installations

Factors in net CO2 impact of VRF

- VRF system performance
- Baseline fuel type and system performance
- Carbon content of electricity
- GWP of refrigerant
- Refrigerant leakage rate

REFRIGERANT	TYPE	ODP	GWP (100yr)
R-12	CFC	0.820	10,600
R-22	HCFC	0.034	1,700
R-404A	HFC	0	3,800
R-410A	HFC	0	2,000
R-290 (Propane)	Natural	0	~20
R-717 (Ammonia)	Natural	0	<1
R-744 (CO ₂)	Natural	0	1
HFO-1234yf	HFO	0	4

Source: Calm & Hourahan, 2001

NEEP VRF Market Transformation Strategy (Technical - # 1 & 2)



Increase reporting of VRF performance and costs to improve models for predicting cost-effectiveness, energy and GHG savings

- Evaluations and pre/post monitoring
- Field verification of performance
- Advance building energy modeling of VRF



Support improved test procedures and performance criteria/standards to enable the promotion of climate-appropriate VRF

- Assess opportunity for regional climate-specific performance reporting requirements and advanced criteria for VRF

NEEP VRF Market Transformation Strategy (Technical - # 3)



Develop a comprehensive regional strategy for addressing the climate and safety risks of refrigerants in VRF systems.

- Assess & verify leakage rates
- Develop best practices for VRF design & installations
- Evaluate and support low GWP refrigerants

NEEP VRF Market Transformation Strategy (Technical - # 7)



Promote integration of existing building management systems and advanced VRF controls to increase coordination and efficiency between building heating and cooling systems and other occupancy type controls.

- Invest in increased building operator training and integrated VRF and existing BEM design
- Support development of appropriate test procedures and standards to reflect real-world VRF operation

NEEP VRF Market Transformation Strategy (Market Development - #4)



Increase state policy support and program valuation of all energy savings and non-energy benefits of VRF

- Remove policy barriers to VRF and valuation of beneficial electrification
- Develop case studies & field monitoring of VRF installations in a diverse set of buildings (e.g. multifamily, office, etc.)



Increase HVAC workforce development and training on proper VRF design, installation and maintenance.

- Cooperative investment with industry to support the growth of a clean energy workforce
- Support standardized regional certifications / training for contractors installing VRF

NEEP VRF Market Transformation Strategy (Market Development - #5)



Increase HVAC workforce development and training on proper VRF design, installation and maintenance.

- Cooperative investment with industry to support the growth of a clean energy workforce
- Support standardized regional certifications / training for contractors installing VRF

NEEP VRF Market Transformation Strategy (Market Development - # 6)



Reduce incremental costs and increased VRF market transformation through robust, streamlined regional, state and efficiency program market promotional actions

- Develop incentives to value full electrification benefits (e.g. kWh, peak kW and carbon)
 - (New) 2019-2021 MassSave Plan embraces “Energy Optimization” as a fuel neutral focus holistically serving customers to reduce energy and costs while supporting state GHG targets
- Evaluate go-to-market strategies (midstream/downstream) to achieve desired outcomes (market adoption, affordable housing, data)
- Develop multi-year market transformation strategy for transition to low-carbon heating & cooling

Questions / Panel & Workgroup Discussion



Chris Badger

VEIC

Senior Energy Consultant

cbadger@veic.org