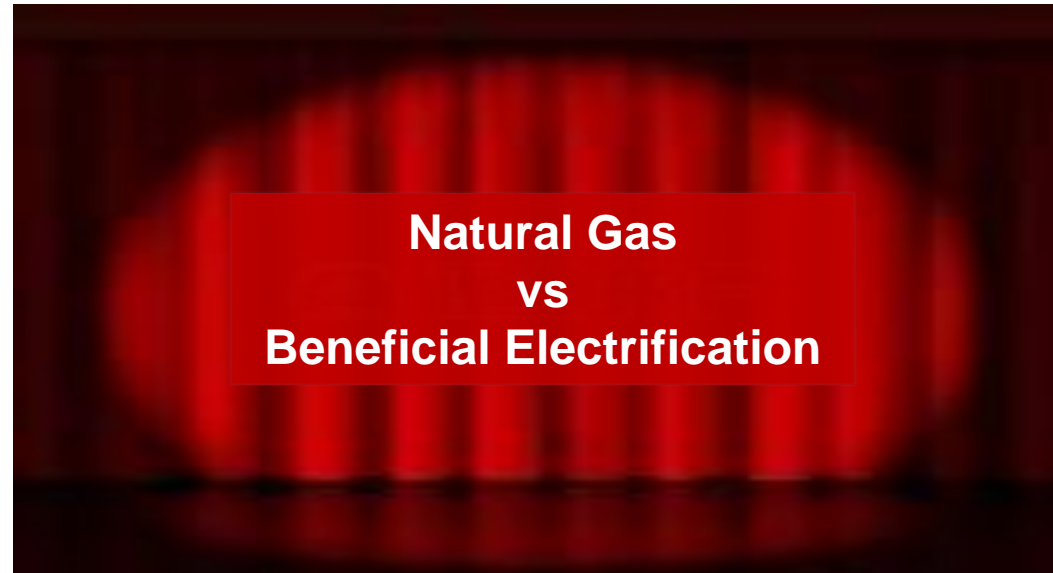


New York State Energy Transformation 1990-2050

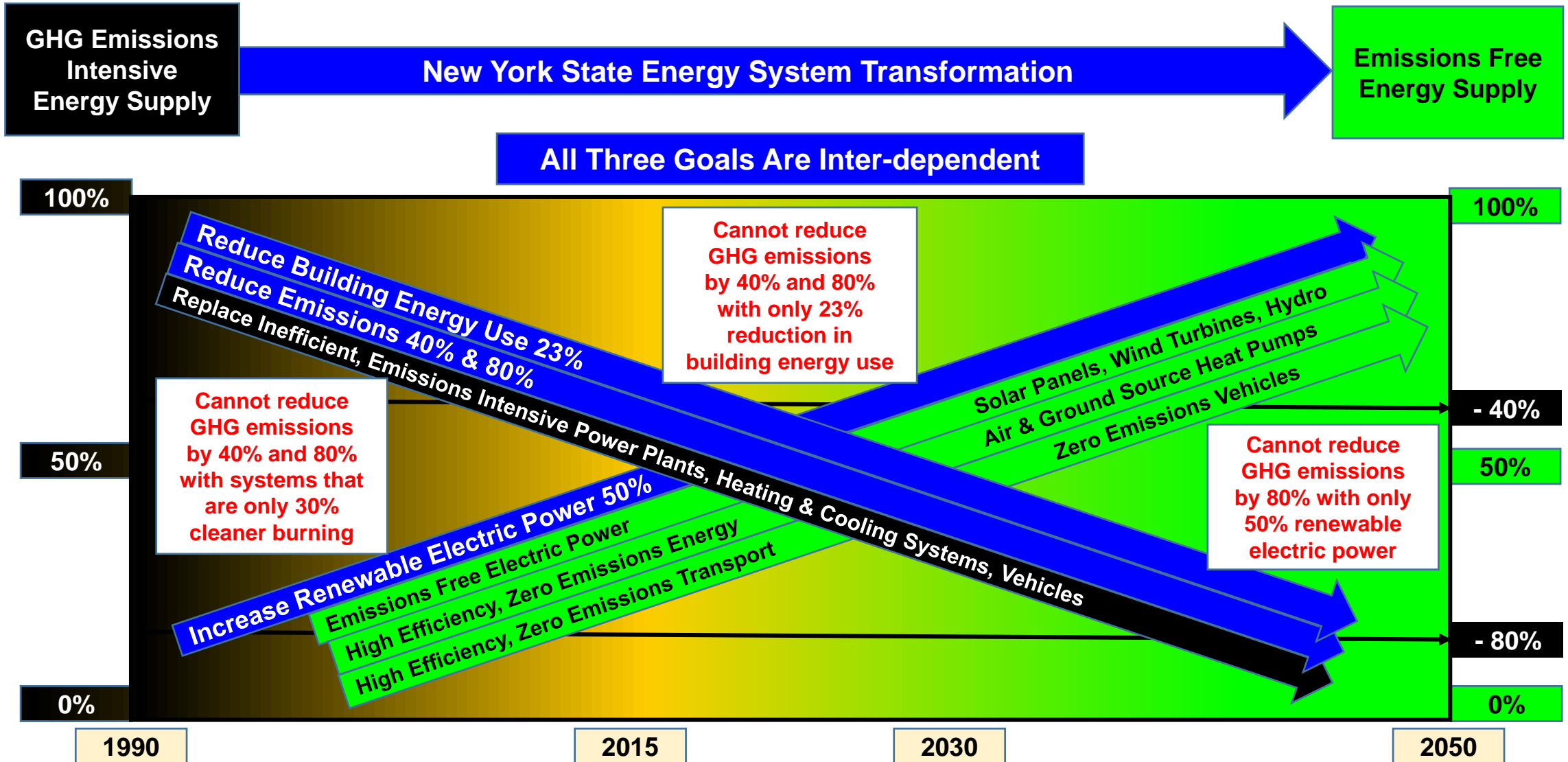
What is the Best Approach to Meet the
2015 New York State Energy Plan Goals?



Jerry Acton – Systems Engineer / Architect
Volunteer Systems Engineering Advisor -
Physicians, Scientists, and Engineers for Healthy Energy

New York State Energy Transformation 1990-2050

Transformation must comply with Laws of Physics



New York State Energy Transformation 1990-2050

What is the Best Approach to Meet the 2015 New York State Energy Plan Goals?

Goals

- Reduce GHG Emissions 40% by 2030, 80% by 2050
- Increase Renewable Electricity to 50% by 2030
- Reduce Buildings Energy Consumption by 23%
- and Reduce Overall Energy Costs

Can We Do Even Better ?

Natural Gas Strategy

VS

Beneficial Electrification

Harness Distributed Renewable Energy Using 21st Century Technologies:

- Solar, Wind, Water Energy
- Solar, Air, Water, Ground Thermal Energy
- Short Term and Long Term Energy Storage
- Intelligent Energy Grid

Leverage Zero Emissions Electricity

- Distribute Through Intelligent Grid
- Power Heat Needs
- Power Vehicles

Augment with Energy Use Reduction

- Products / Solutions
- Behavior Changes

Evaluation Criteria

RED FLAG
Does Not Meet Goals,
Critical Issues,
Flawed Solutions,
Way Behind Schedule
Re-evaluate Approach

CAUTION
Does Not Meet Some Goals,
Some Major Issues,
Some Inadequate Solutions,
Behind Schedule
Corrections Needed

ON TRACK
Meet All Goals,
Some Minor Issues,
Adequate Solutions,
On Schedule

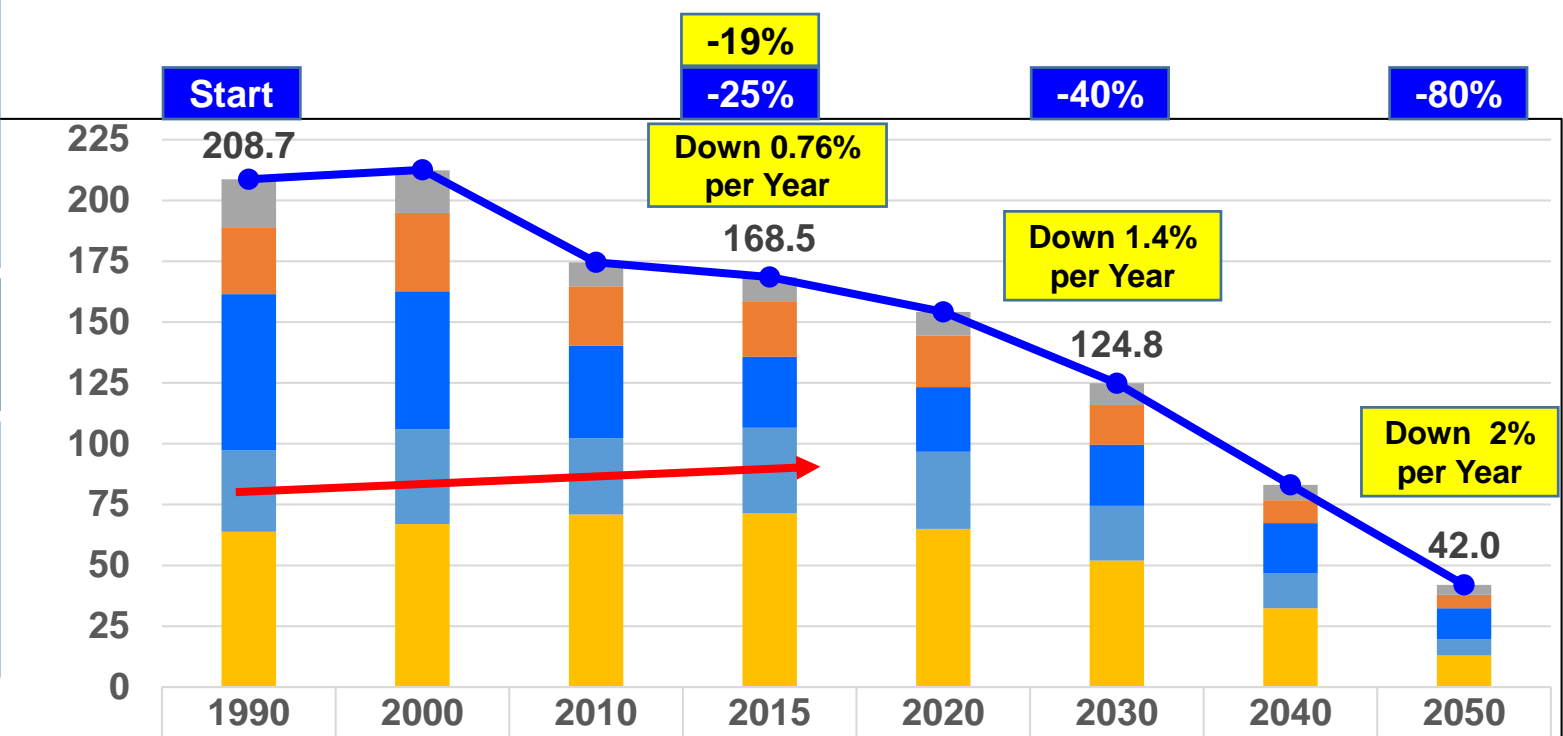
New York State Energy Transformation 1990-2050

Emission Reduction Targets by Sector

Electric Power and Industrial Sectors Ahead of Plan But Back Tracking with Natural Gas

Commercial Sector Behind Needed Pace

Residential and Transportation Sectors Need Significant Corrective Action



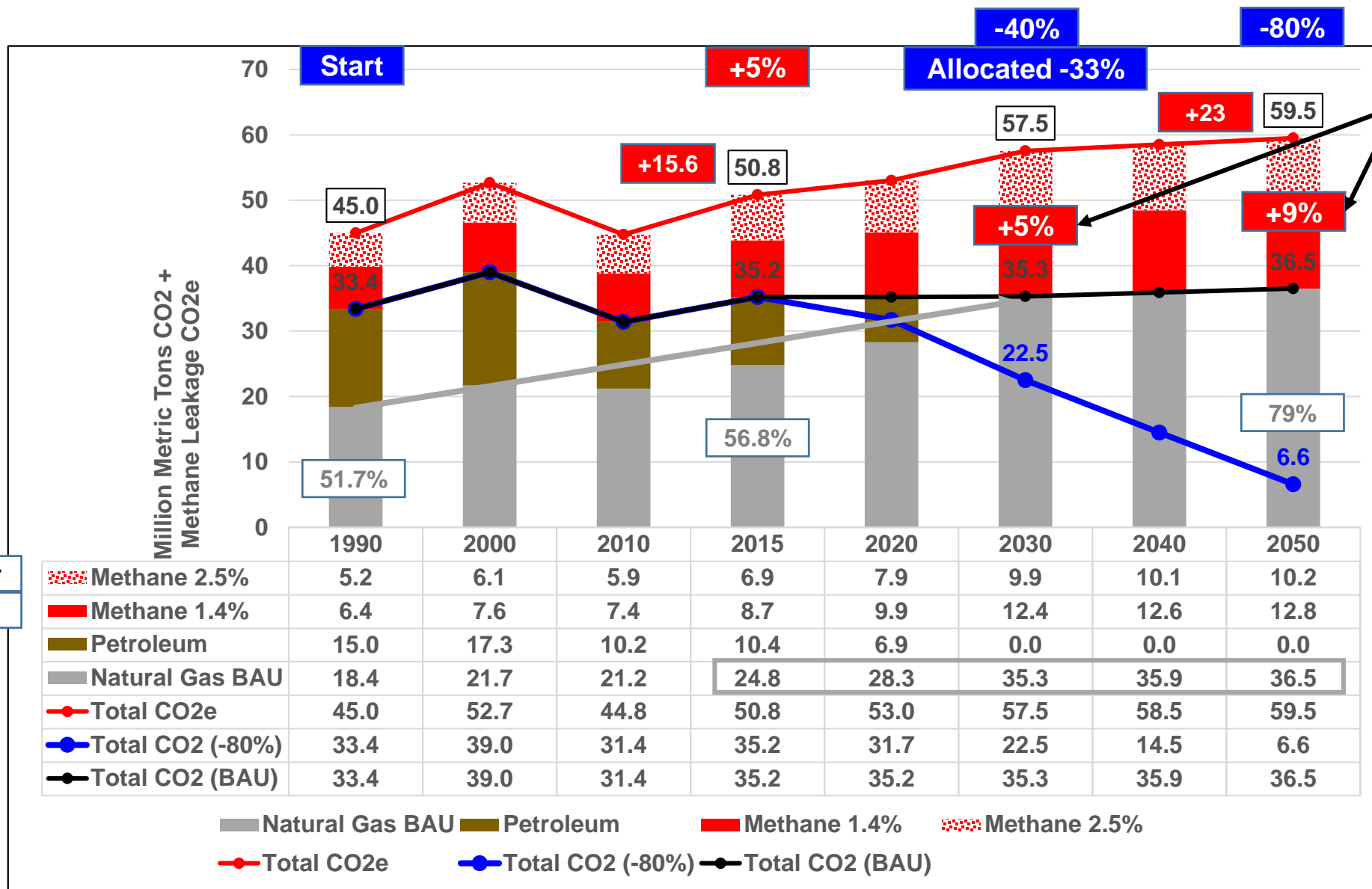
	1990	2000	2010	2015	2020	2030	2040	2050
Industrial	20.0	17.5	9.9	9.8	9.8	8.9	6.3	4.1
Commercial	27.2	32.2	24.3	22.8	21.1	16.3	9.4	5.5
Electric Power	64.2	56.7	38.1	29.2	26.6	25.1	20.5	12.8
Residential	33.5	39.0	31.4	35.2	31.7	22.5	14.5	6.6
Transportation	63.8	67.0	70.9	71.4	65.0	52.0	32.4	13.0
Total CO2 / Goal	208.7	212.6	174.6	168.5	154.2	124.8	83.1	42.0

- 51%
- 16%
- 55%
- +5%
- +12%

■ Transportation
 ■ Residential
 ■ Electric Power
■ Commercial
 ■ Industrial
● Total CO2 / Goal

Residential Sector Energy Transformation 1990-2050

Fuel Source Trends versus Reduction Targets



Natural Gas Approach Cannot Meet the 2030 or 2050 Emissions Reduction Goals

% of Housing Units

25 Year Trend Continues

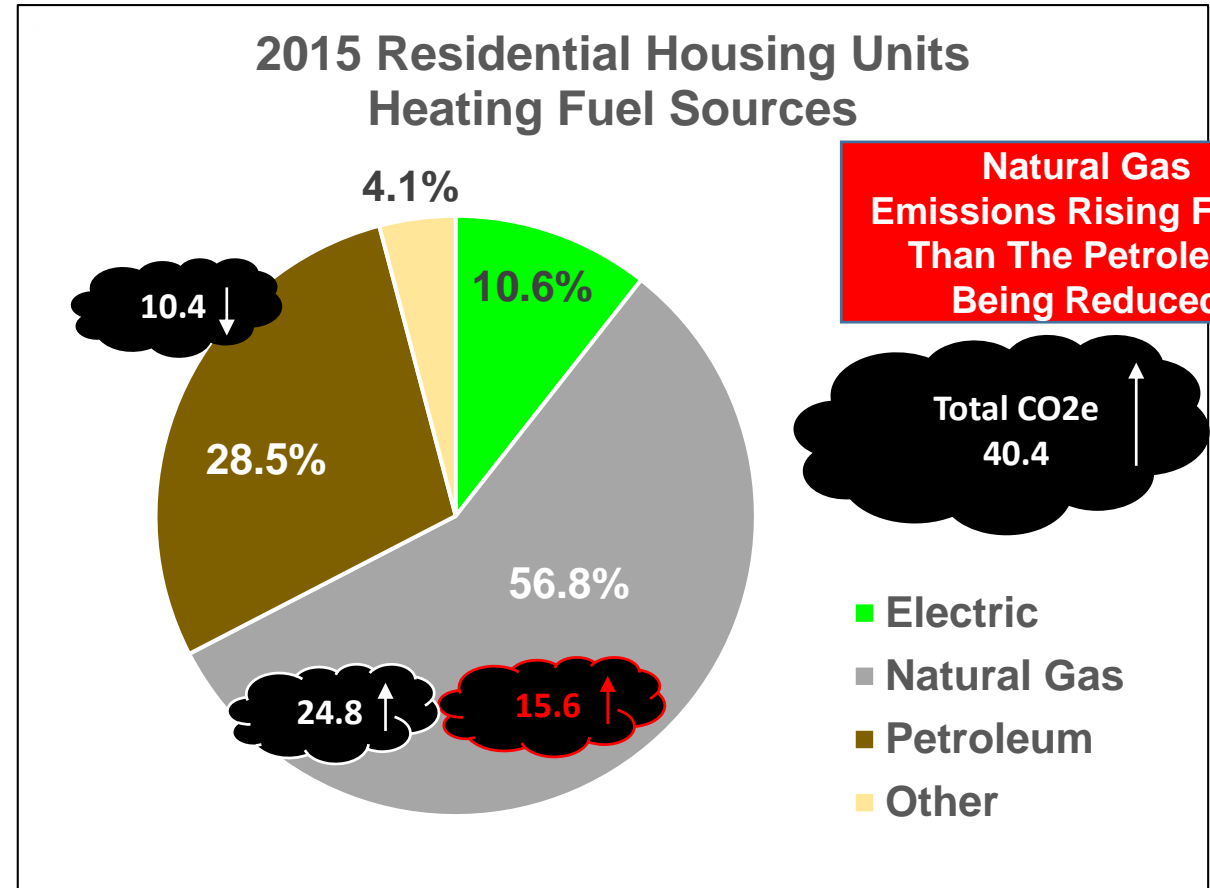
Natural Gas Heavily Advertised and Subsidized

- Replacing Petroleum 84% to Natural Gas 16% to Electric
- Maximum Natural Gas for New Construction
- Upgrade Old Natural Gas with New

Residential Sector Energy Transformation 1990-2050

Housing Units by Heating Fuel Source - 2015

Fuel Source	% of Housing Units	# of Housing Units
Electric	10.6%	766,772
Natural Gas	56.8%	4,108,738
Petroleum	28.5%	2,061,603
Other	4.1%	296,581
	Occupied	7,233,694
	Unoccupied	874,409
	Total	8,108,103



Natural Gas Emissions Rising Faster Than The Petroleum Being Reduced

Total CO2e 40.4

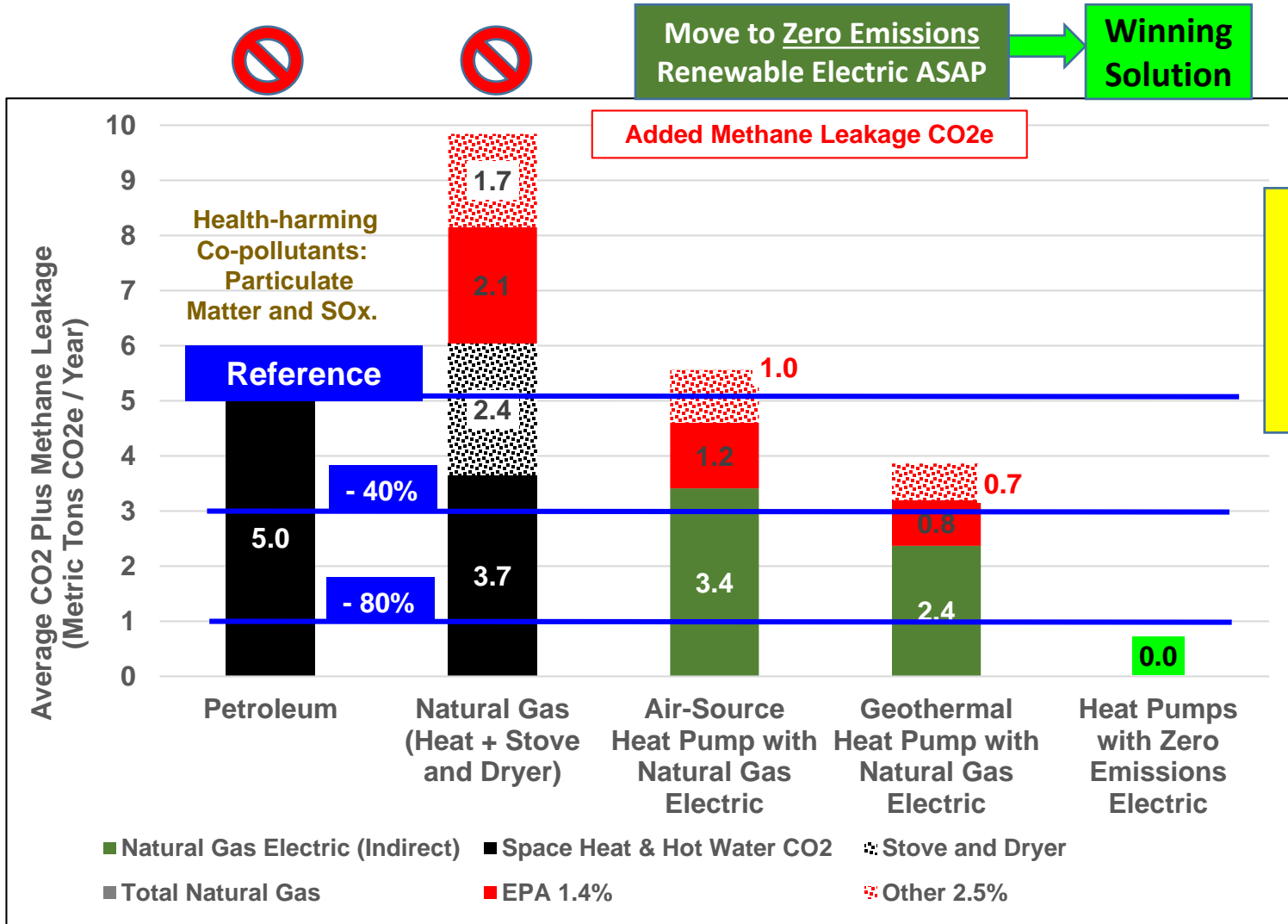
Million Metric Tons Methane Leakage CO2e

Million Metric Tons CO2

Subsidies and Advertising Are Encouraging Petroleum to Natural Gas Conversions

Residential Sector Energy Transformation 1990-2050

Space Heating and Hot Water – Yearly Emissions by Fuel Source - 2015



The More Complete Story About Residential Natural Gas Use

For Heating & Hot Water Natural Gas is 28% Cleaner Burning Than Petroleum or Wood

Add Stove and Dryer Use and Natural Gas Use CO2 Is 20% Higher Than Petroleum

Add Methane Leakage and Natural Gas Use CO2e Is 64% to 98% Higher Than Petroleum

Natural Gas Electric Is CO2 Emissions Intensive

Natural Gas Does Not Meet Emissions Reduction Goals

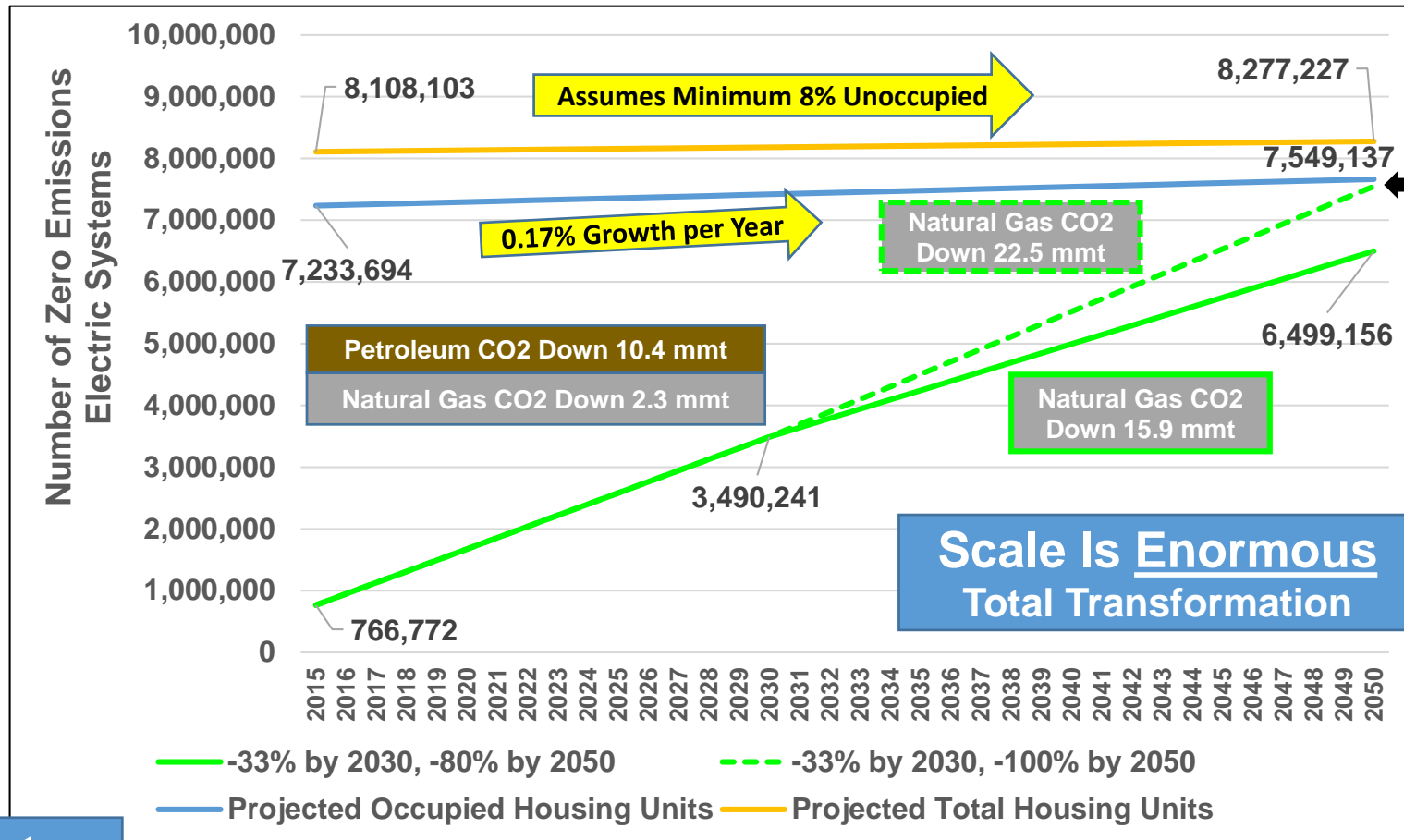
Yes	No
<input type="checkbox"/>	<input checked="" type="checkbox"/>
<input type="checkbox"/>	<input checked="" type="checkbox"/>

Phase Out Subsidies & Advertising for Natural Gas, Petroleum, & Wood They Cannot Meet Goals

Sources: EIA Data Browser & US Census Bureau
 2015 American Community Survey
 EPA Power Plants Data - 2012

Residential Sector Energy Transformation 1990-2050

Heat Pump Conversions to Meet Emissions Reduction Goals



No Reason to Slow Down
 Go for 98.5% Emissions reduction

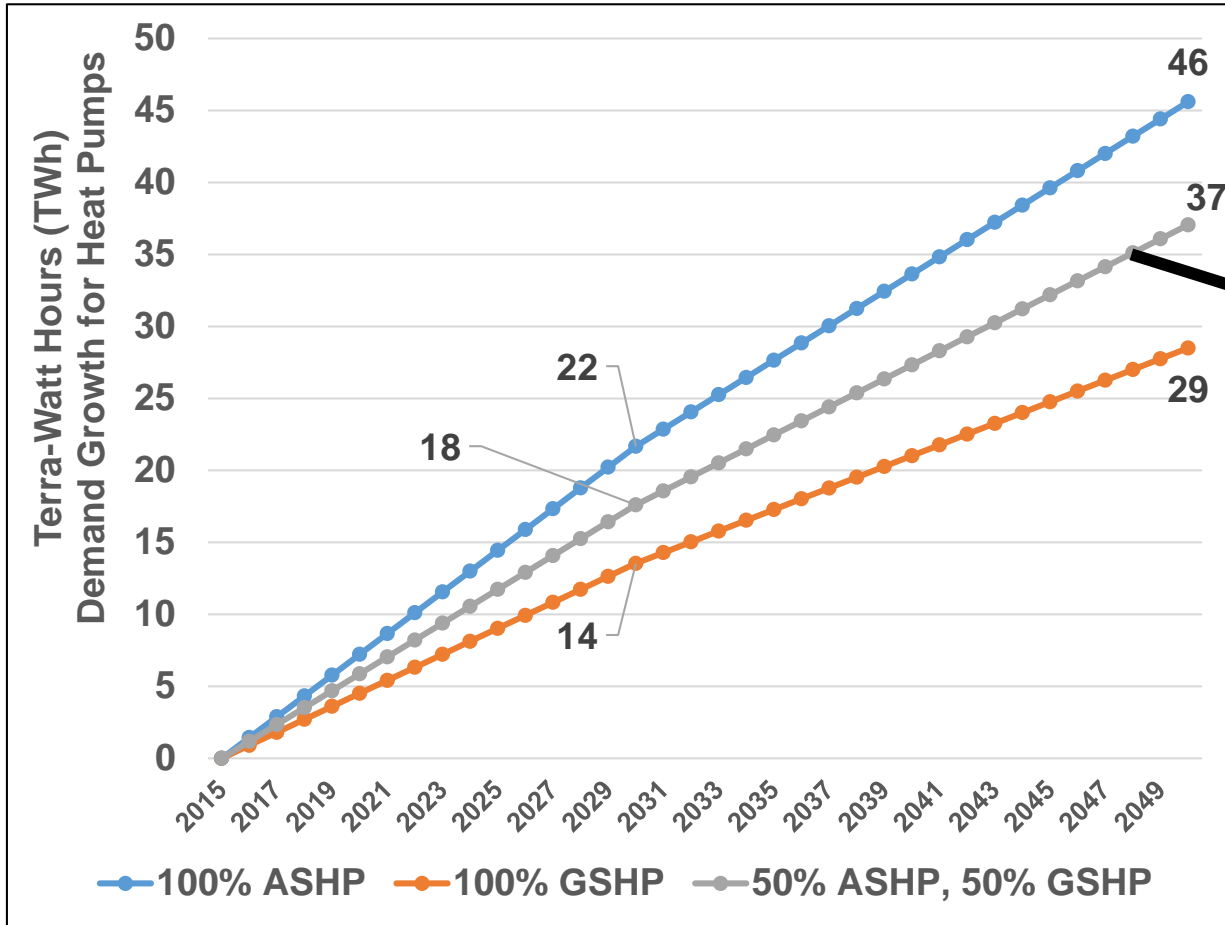
Pace Is Fast
 Heat Pump Conversions
 Must Be 13 to 22
 Times Greater Than
 the Past 25 Years

Conversions Pace	1990 - 2015	2015 - 2030 (-33%)	2030 - 2050 (-80%)	2030 - 2050 (-98.5%)
Total	202,429	2,723,470	3,008,915	4,058,896
Per Year	8,097	181,565	150,446	202,945
Per Month	675	15,130	12,537	16,912
Per Work Day (250)	32	726	602	812

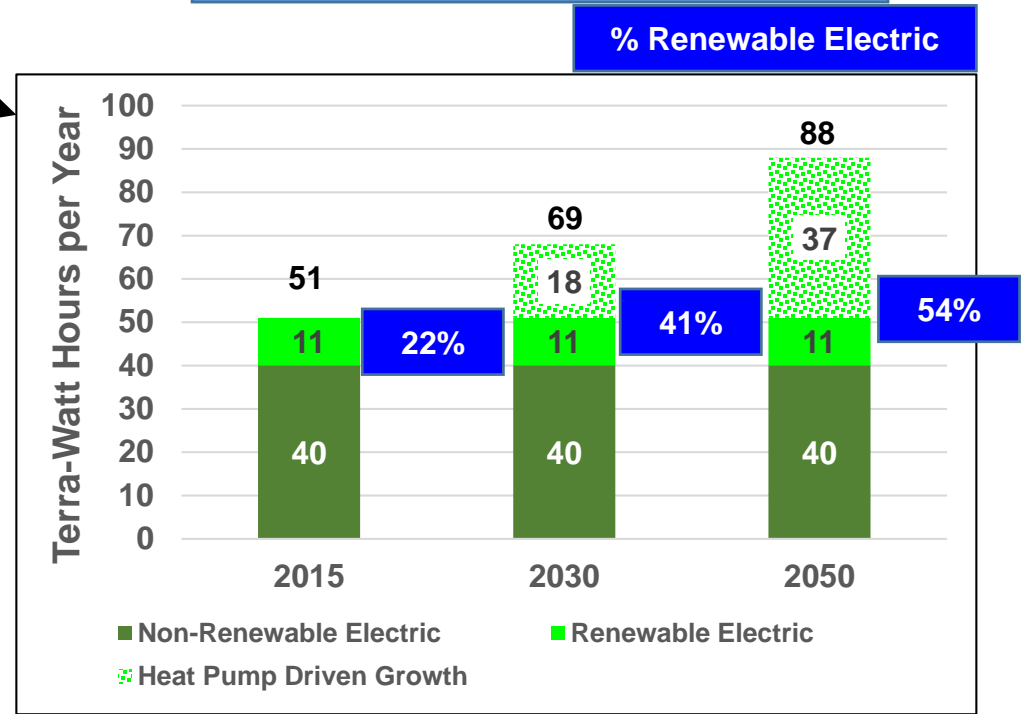
Residential Sector Energy Transformation 1990-2050

Additional Renewable Electricity Needed for Heat Pumps

Terra-Watt Hours per Year (TWh) 2015-2050

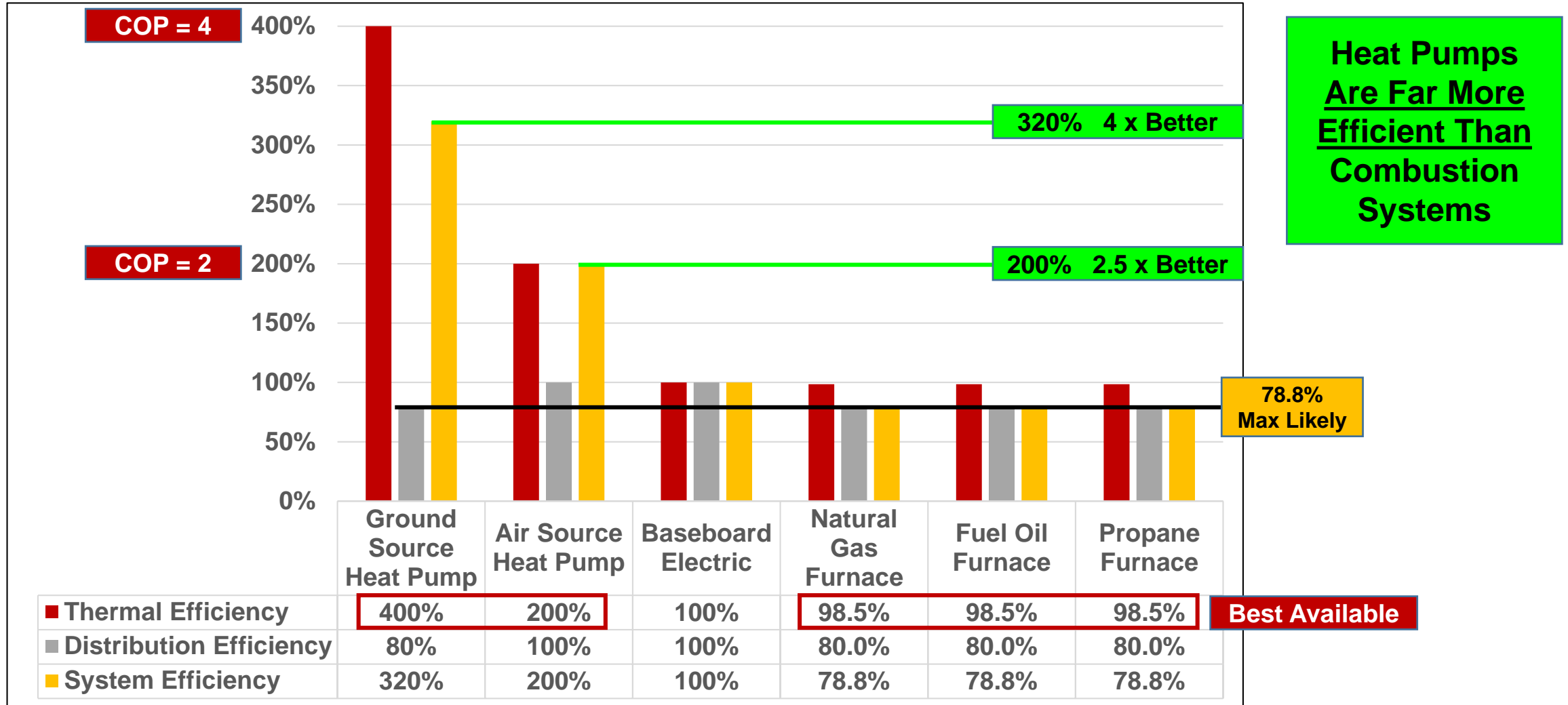


Assumption:
All Heat Pump Demand Growth
 is Met with Zero Emissions Electric



Residential Sector Energy Transformation 1990-2050

Housing Unit Heating Systems Efficiency



**Heat Pumps
Are Far More
Efficient Than
Combustion
Systems**

**78.8%
Max Likely**

Best Available

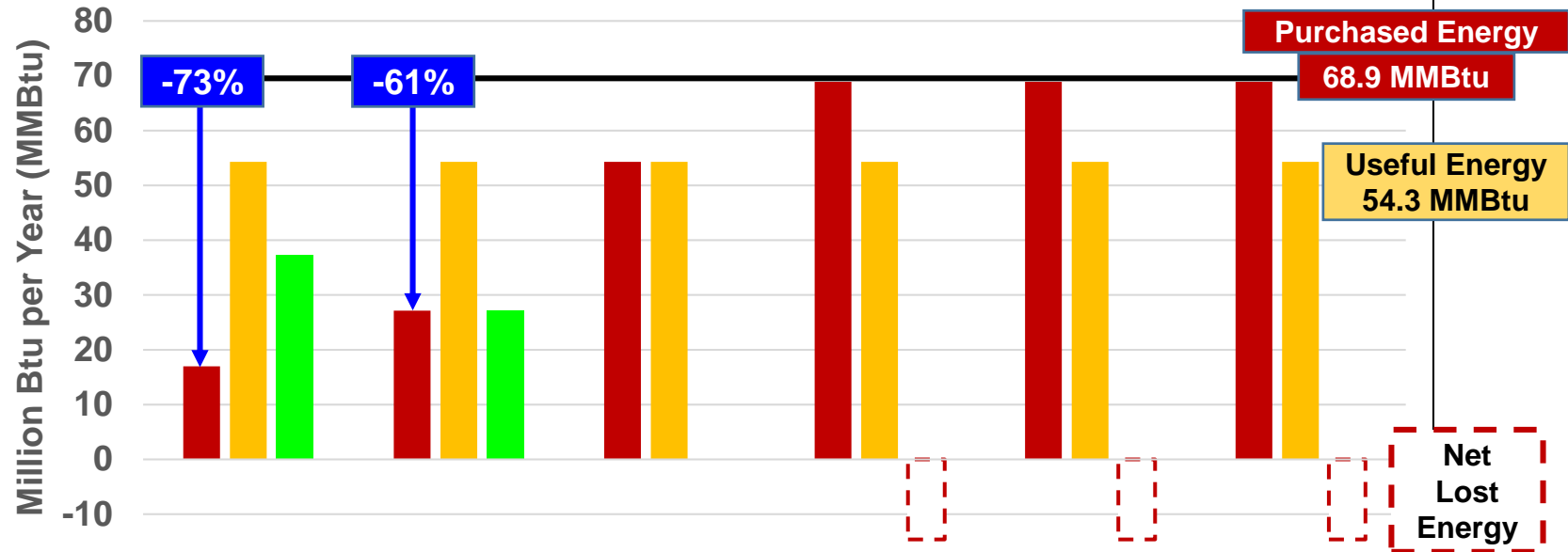
Residential Sector Energy Transformation 2015-2050

Housing Unit Average Yearly Heating Systems Energy Use

Reduce Building Energy Use by 23%

**Heat Pumps
Far Exceed 23%
Energy Use Reduction
For Housing Units**

Average Yearly Housing Unit Heating Energy Use Comparison

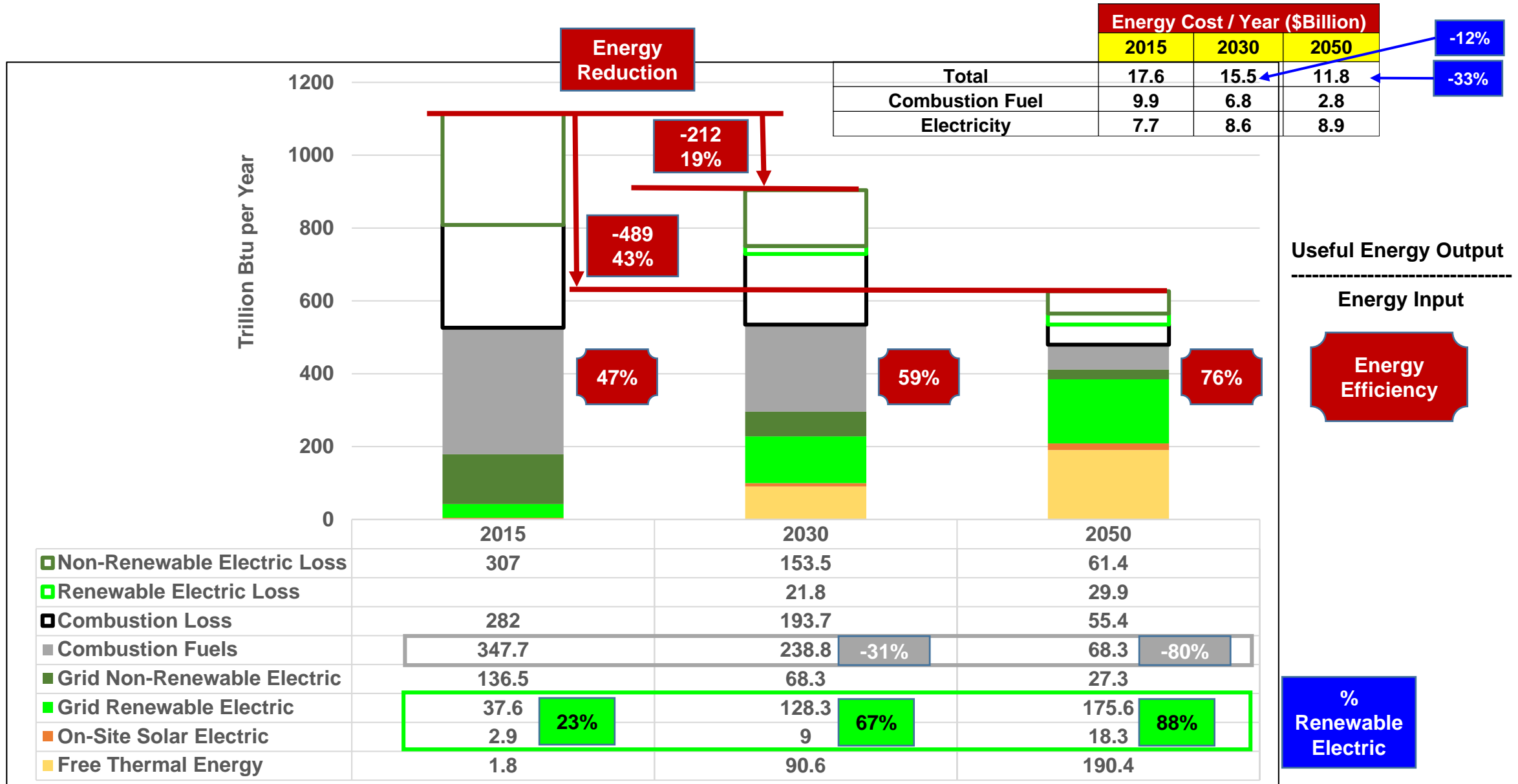


**Free
Air and Ground
Thermal Energy**

	Ground Source Heat Pump	Air Source Heat Pump	Baseboard Electric	Natural Gas Furnace	Fuel Oil Furnace	Propane Furnace
■ Average Input MMBtu / Yr	17.0	27.1	54.3	68.9	68.9	68.9
■ Average Output MMBtu / Year	54.3	54.3	54.3	54.3	54.3	54.3
□ Gain (+) / Loss (-)	37.3	27.1	0.0	-14.6	-14.6	-14.6

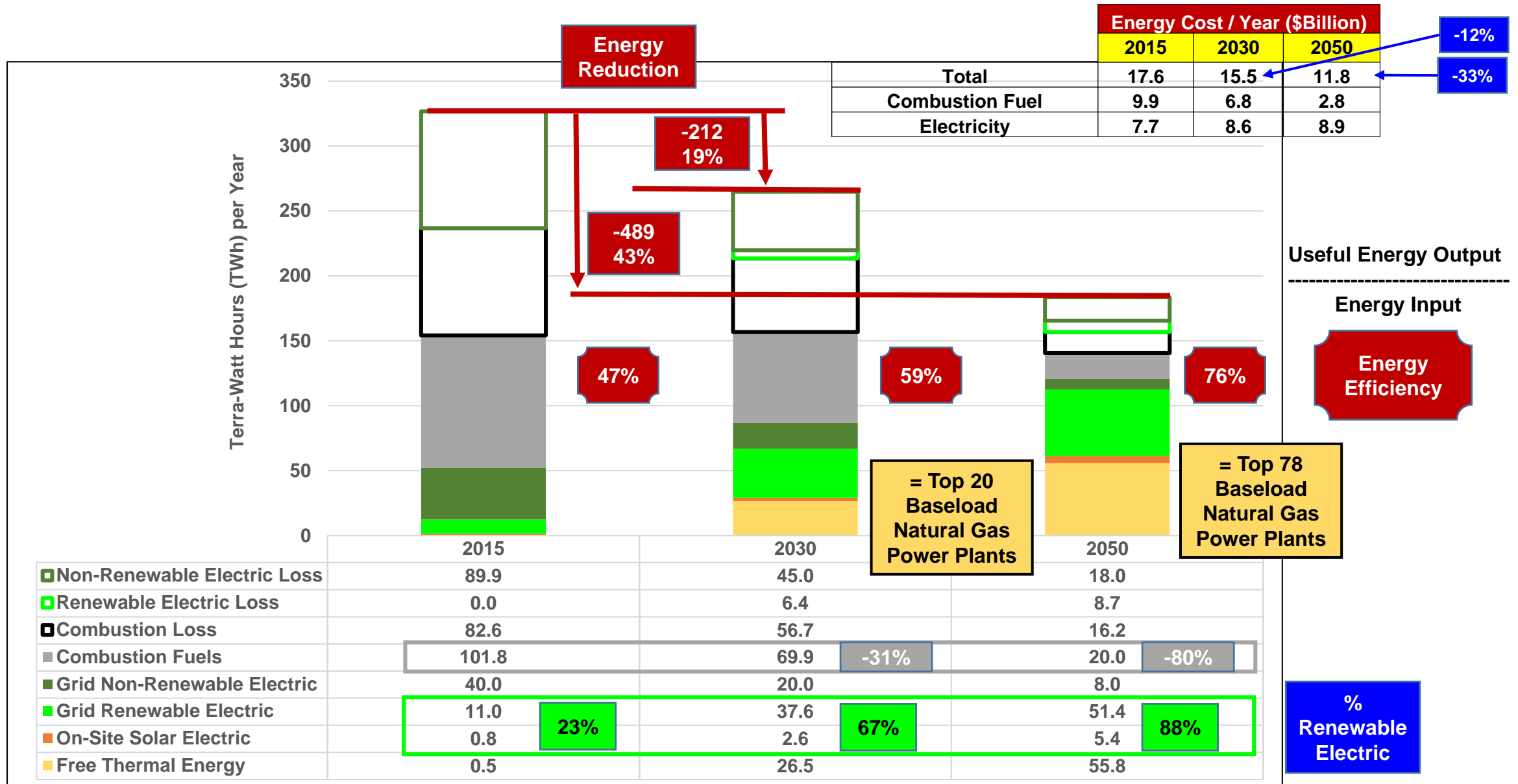
Residential Sector Energy Transformation 1990-2050

Residential Sector Energy Use – Trillion Btu (Tbtu) per Year 2015-2050



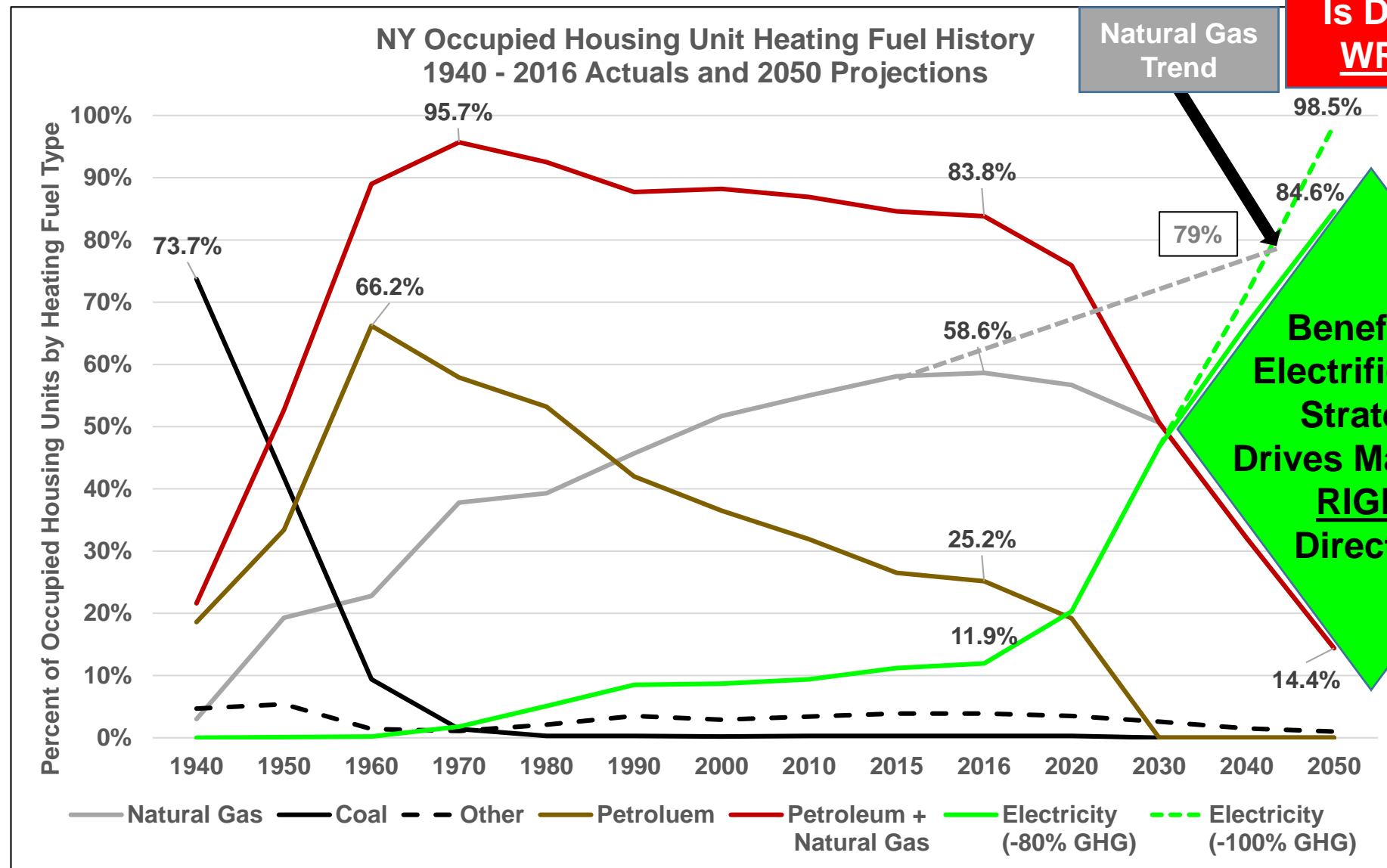
Residential Sector Energy Transformation 1990-2050

Residential Sector Energy Use – Terra-Watt Hours (TWh) per Year 2015-2050



Residential Sector Energy Transformation 1940-2050

Beneficial Electrification Is the Right Solution



Natural Gas Strategy Is Driving Market in WRONG Direction

Beneficial Electrification Strategy Drives Market in RIGHT Direction

New York State Energy Transformation 1990-2050

Which Path Best Meets the Goals?

		Meets None of the Goals		Meets and Exceeds All of the Goals			
State Energy Plan Goals		Natural Gas Strategy		Beneficial Electrification			
		Yes	No			Yes	No
• GHG Emissions Reduction	-40% by 2030	<input type="checkbox"/>	<input checked="" type="checkbox"/>	+5%	-33%	<input checked="" type="checkbox"/>	<input type="checkbox"/>
	-80% by 2050	<input type="checkbox"/>	<input checked="" type="checkbox"/>	+9%	-80%	<input checked="" type="checkbox"/>	<input type="checkbox"/>
• Renewable Electricity Generation	50% by 2030	<input type="checkbox"/>	<input checked="" type="checkbox"/>		-98.5%	<input checked="" type="checkbox"/>	<input type="checkbox"/>
					67%	<input checked="" type="checkbox"/>	<input type="checkbox"/>
• Reduced Buildings Energy Consumption	23%	<input type="checkbox"/>	<input checked="" type="checkbox"/>		88 %	<input checked="" type="checkbox"/>	<input type="checkbox"/>
				-19% by 2030		<input checked="" type="checkbox"/>	<input type="checkbox"/>
				-44% by 2050			
Can We Do Even Better ?		FAILING Solution STOP Subsidies & Advertising		RIGHT Solution INCREASE Subsidies & Advertising			
						\$\$\$ Energy Costs Down -12% by 2030 -33% by 2050 Energy Efficiency Up 59% by 2030 77% by 2050	

