Emissions Reductions for Residential and Commercial Buildings

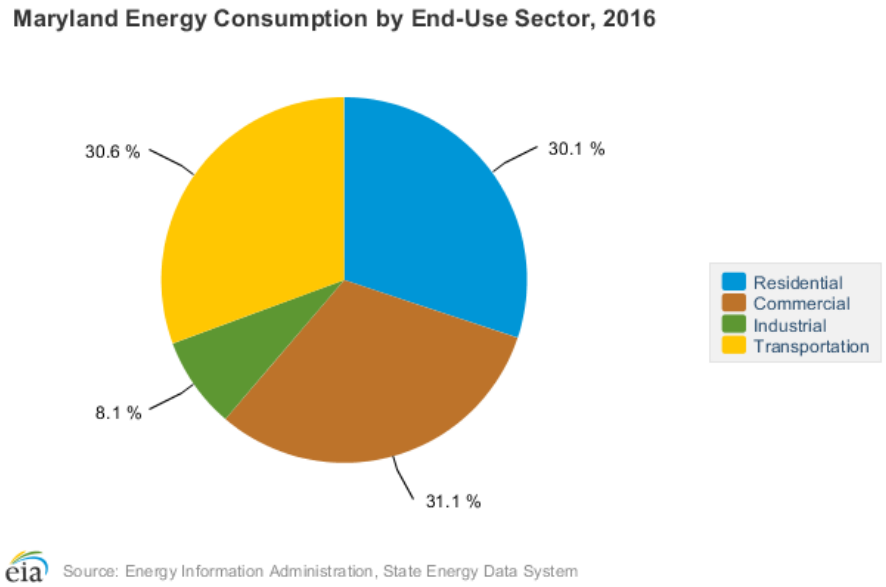
Recommendations for the Maryland Commission on Climate Change

Tuesday, April 16, 2019

Dr. Reinhard Radermacher
Minta Martin Professor, University of Maryland

Cara Martin
COO, Optimized Thermal Systems, Inc.

Building Energy Consumption in MD



- **MD consumed 226 million Btu per capita in 2016, ranked 10th lowest in the country.**
- **Residential and commercial buildings account for 61% of overall energy consumption; these sectors only account for 40% of the national average.**

2012 Values	US Average	Baltimore City Average
Annual Household Utility Cost	$2,000	$2,305.11

2012 Values	US Average	Baltimore City 50% Below Federal Poverty Level
Utility Expense as a Percent of Annual Household Income	3%	**32.2%**

More than **102,000** households in Maryland receive financial assistance to pay their utility bills, totaling over **$140 Million** in annual funding (Bardan et al., 2014).

What to Do?

- **Build tight:** well insulated, air-tight envelope
- **Ventilate right:** correct ventilation with heat/moisture recovery
- **High efficiency appliances** …including heat pumps
- **Use renewables** produced locally or elsewhere
- **Commission, Monitor,** ….again and again

Examples – Energiesprong

- Complete refurbishment within one week: envelope, windows, doors, heating cooling, hot-water, solar PV
- Tenant does not have to move out
- Financed through energy savings
- Develops entirely new industry

- 5000 renovations already successfully demonstrated in the Netherlands
- Total of 20,000 planned as pilot project
- Multiple projects planned with NYSERDA in NY State and elsewhere

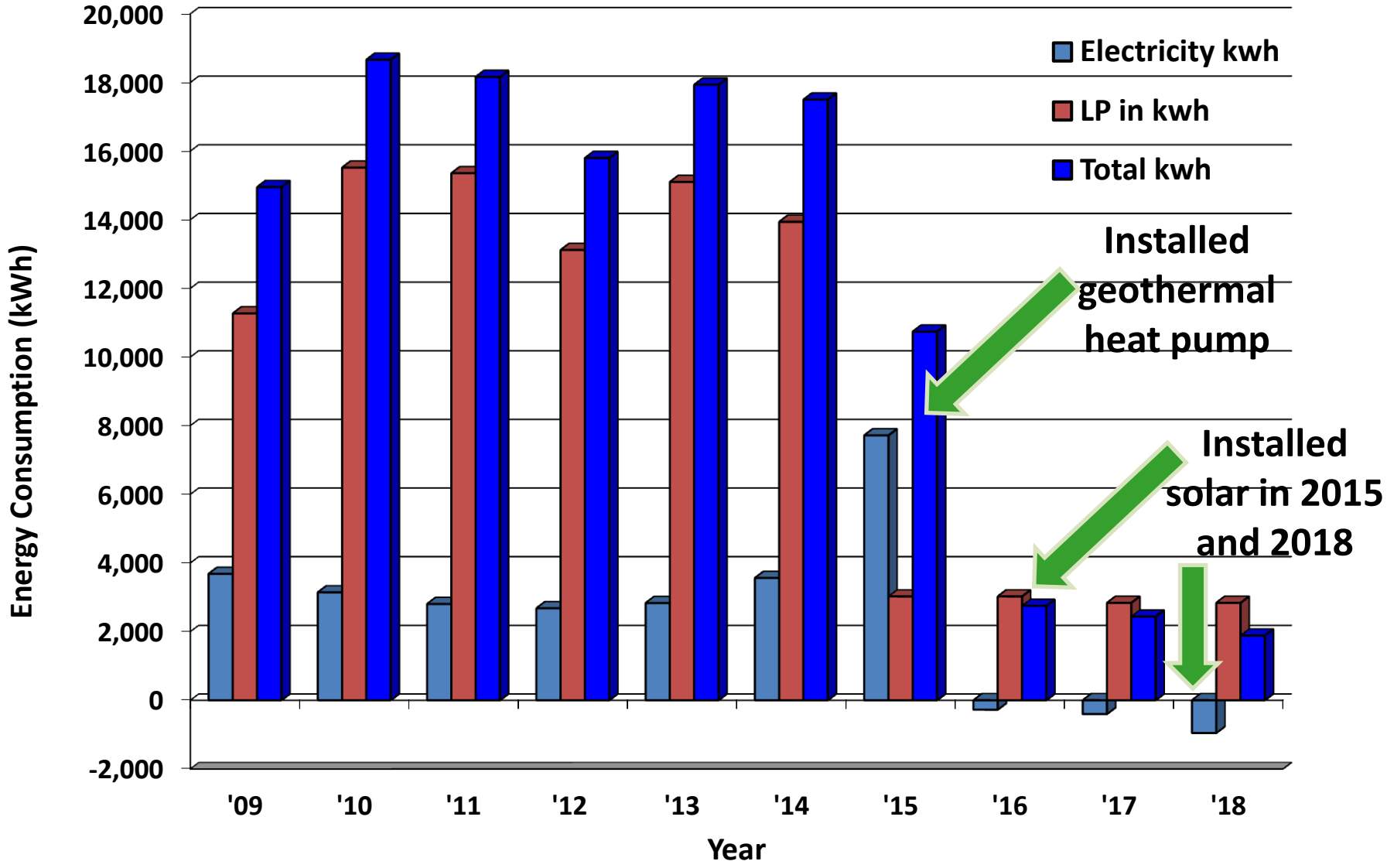
Benefits in Building Improvements

Any changes in programs or policies must produce sufficient benefits to overcome any burden imposed on the building owner

- **Benefits for the building owner will include:**
  - **Zero utility bills** (or greatly reduced)
  - **Return on investment revenue**
  - **More comfortable spaces to live and work – improved thermal comfort**
  - **Improved health, safety and indoor air quality (IAQ)**
  - **Productivity gains – reduced loss days at work and school**
  - **Increased property resilience / reduced risk in severe weather**
- **Benefits to the state will include:**
  - **Reductions in carbon footprint**
  - **Eliminated/Reduced subsidies to help families pay their bills**
  - **Variety of skilled jobs in MD:** engineering, manufacturing, commissioning, auditing, installation, eco-system of new jobs and companies
  - **Local industry, small businesses** (contractors)
  - **Increased infrastructure resilience**
  - **Less premature deaths from fossil fuel (in particular coal and oil) consumption**

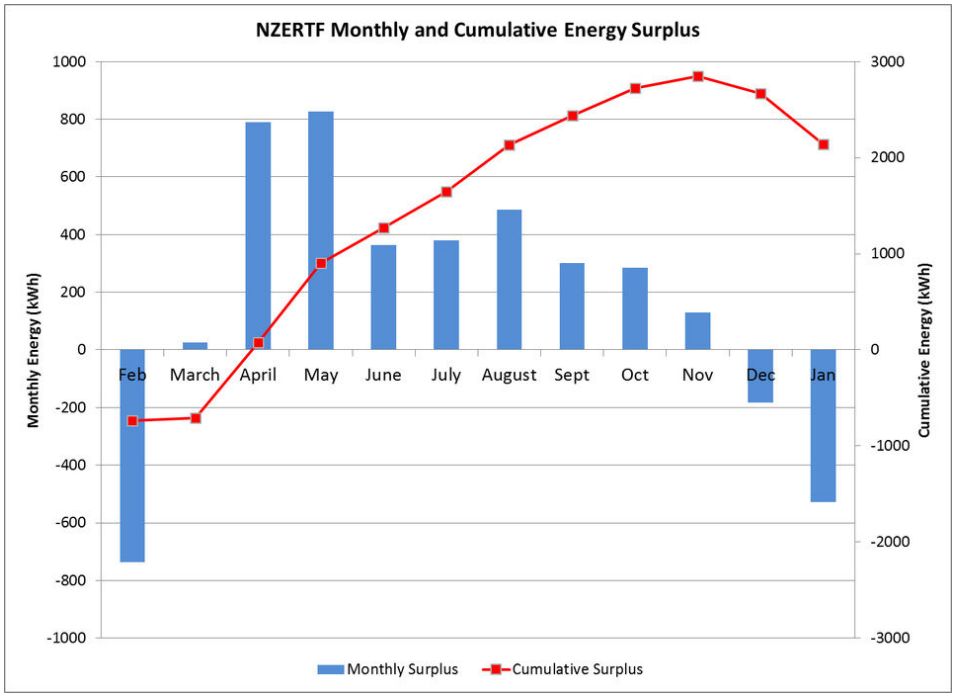
Success Stories

Examples – Private Residence



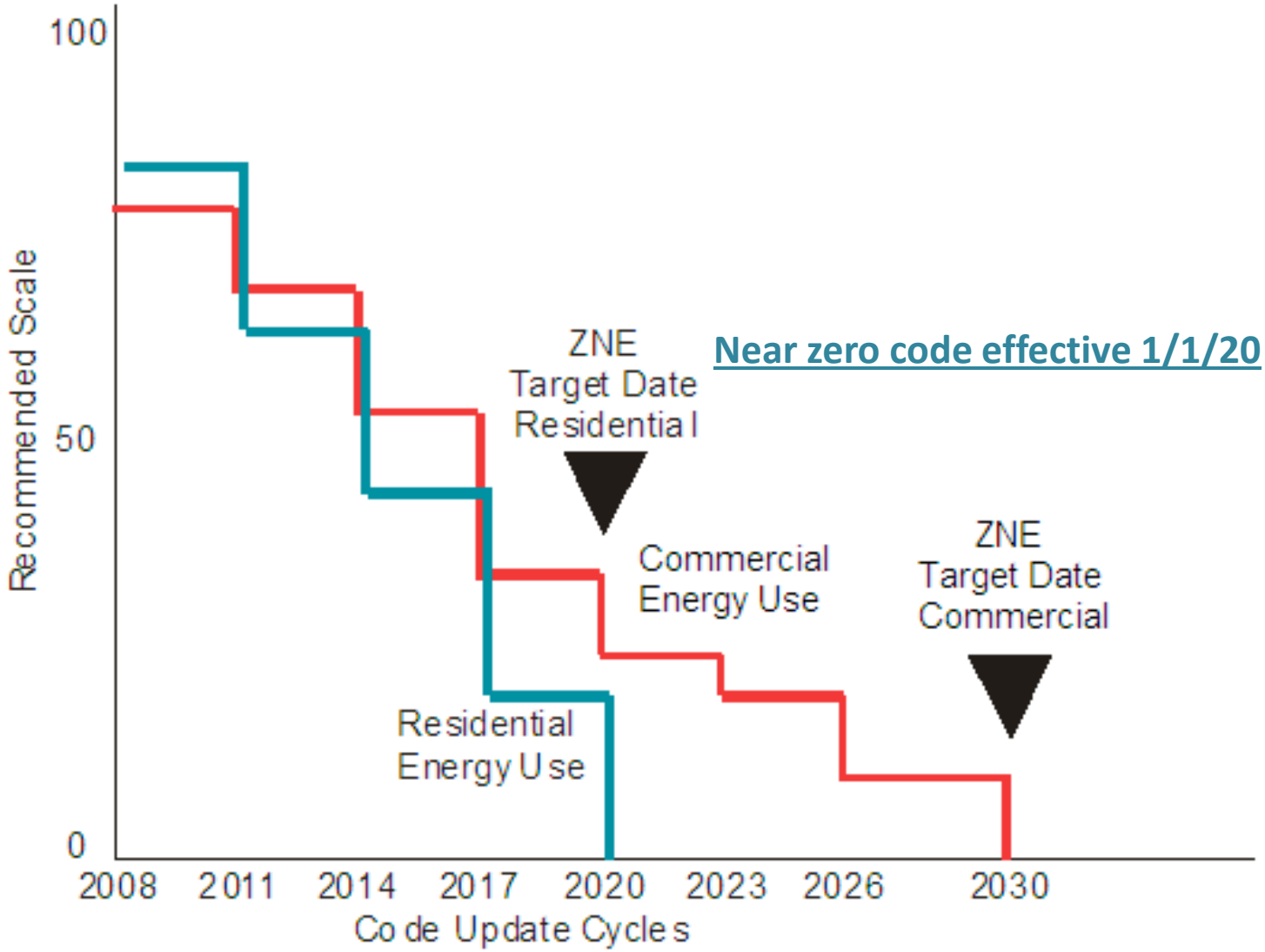
Net Zero Residential Energy Test Facility

Unique laboratory in Gaithersburg, MD. Net-zero energy home evaluating various technologies contributing to energy efficiency and very low energy consumption



https://www.nist.gov/el/net-zero-energy-residential-test-facility

CA Title 24 – 1st Zero Energy Codes Roadmap



Existing 2030 Challenge – AIA

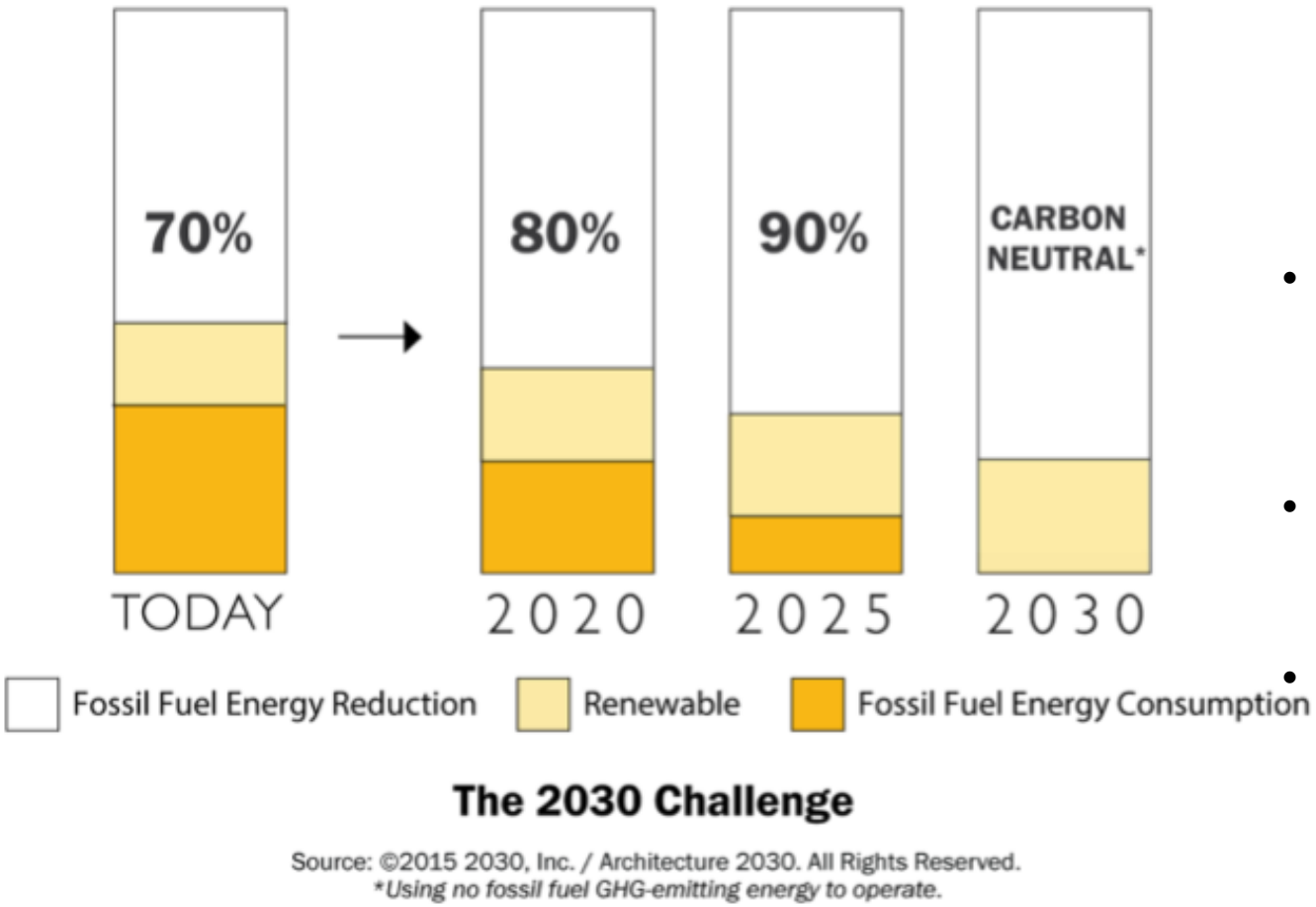


Figure 4. The 2030 Challenge: 2015 ("Today") and forthcoming targets

(Taken from Amann, July 2017)

- New buildings designed to energy performance standard 70% less than average for building type (2006 baseline)
- Equal amount of building area renovated each year to meet the same standard
- Standards increased in 2020 (80%) and 2025 (90%)
- Challenge accepted by individual design firms – over 525 have committed to date from across the country, the most coming from California (MD < 10)

(AIA, 2018)

Other States Committed to Zero Energy/Carbon

States	Cities
California: • Residential net zero new construction by 2020 • Commercial net zero new construction by 2030 • 80% GHG reduction by 2050 (1990 baseline) • Exploring use of Renewable Natural Gas/biofuels • Carbon neutrality by 2045 • Shift from zero net energy to zero net emissions	**Los Angeles**
New York: • 40% GHG reduction by 2030 (1990 baseline) • Building energy use reduction 23% by 2030 (2012 baseline)	**New York City**
Washington	**Seattle**
Massachusetts	**Cambridge:** • ZEB targets • 70% GHG emissions by 2040 – specific measures for improving existing building efficiency and zero net energy new construction
Vermont: • Supply 90% of state energy needs with renewables by 2050	**Montpelier:** • Working to become first zero net energy state capital
Illinois: • Future Energy Jobs Act: 4,300 MW new solar and wind installed in the state by 2030 • Solar Training Pipeline initiative	**Denver**

1. Buildings Emissions Target

In your professional opinion, what is an effective and achievable target for decreasing emissions from residential and/or commercial buildings in Maryland?

- **Buildings overall (including EmPOWER, energy programs, and innovation initiatives) accounted for 28% - nearly 1/3 of all emission reductions achieved to date.**
- **A similar, if not more aggressive emissions reduction goal for the building sector should be targeted moving forward. Such targets cannot be met, however, if more support, policies and funding are not provided.**

2. Emissions Reductions Mechanisms

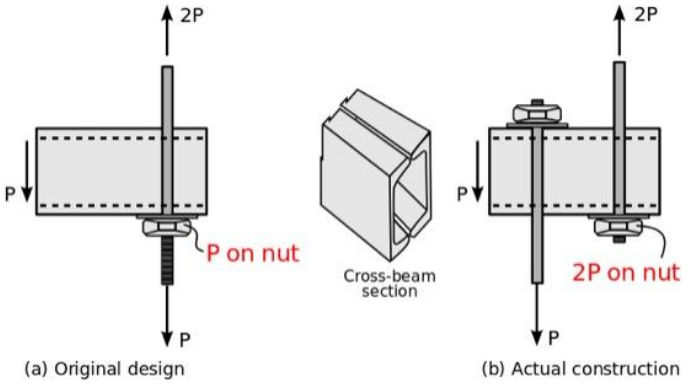
What specific mechanisms would you recommend for decreasing emissions from residential and commercial buildings to achieve this target?

- **Maximize the effectiveness of EmPOWER MD**
- **Streamline the PACE funding mechanism**
- **List buildings in Greenhouse Gas Reduction Act (GGRA)**
- **Allow opportunity for new technology**
- **Code review/update program**
- **Reassess energy generation sources and costs**
  - **What are the greatest emissions contributors and where is the biggest opportunity for reduction?**
- **Identify Major Funding Sectors**
- **Support job growth in the building sector in MD – training is key**
- **Support resilient building growth and development**

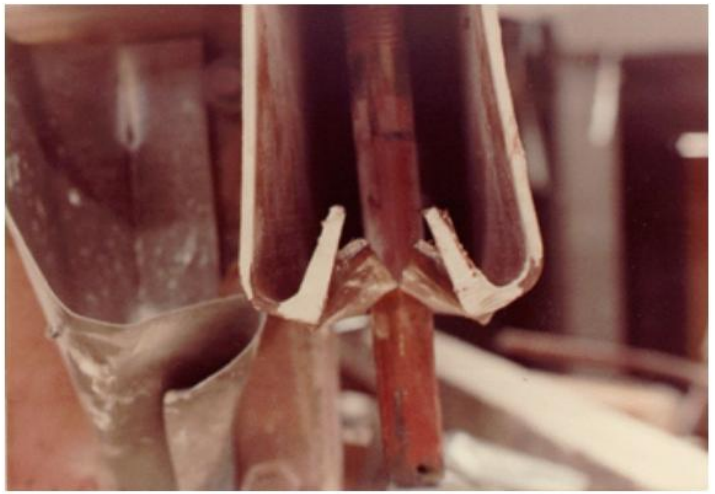
***Set goals and allow for multiple mechanisms to achieve desired emission reduction targets**

The Power of Intent and Redesign

- Hyatt Regency Walkway Collapse
- Kansas City, Hyatt Regency Crown Center, 1987
- 114 deaths, 216 fatalities



Changes in design, that were not properly evaluated, ultimately resulted in the bridge's failure



EmPOWER Maryland

- Align goals with overall GHG strategy
- Develop more robust Deep Energy Retrofit strategy
- Remove restrictions associated with demand side – peak load reduction
- Identify planned building projects; provide energy consultation for smart design decisions
- Incentives for engineering guidance services
- Loan capital for Passive House and/or Net Zero construction – new construction and retrofits
- Re-engage Home Performance Energy Star non-participating properties
- Include health benefits towards savings
- Consider useful life of the building, not just the energy equipment
- Greater incentives for HVAC efficiency upgrades
- Effective incentive structure for rental properties
- Increase code requirements to require multi-stage HVAC for new construction

Background

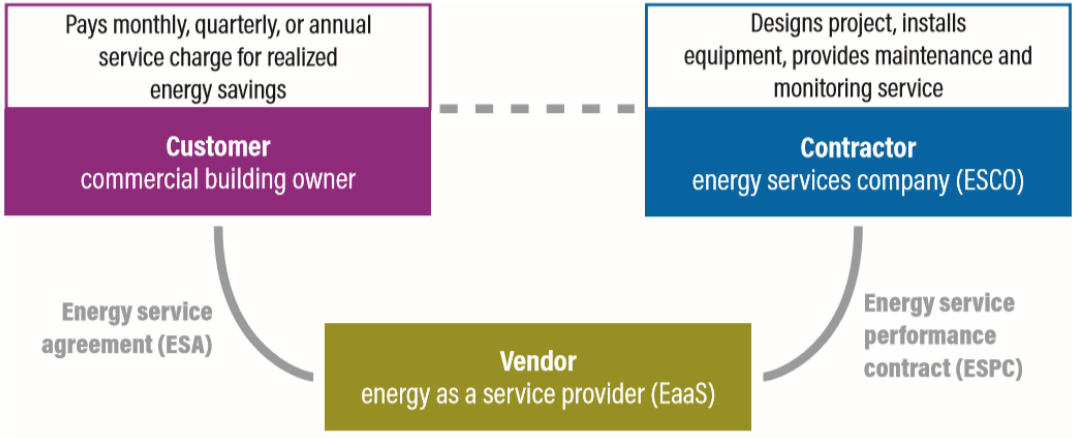
More Environmental Impact

Energy Source	Mortality per PWh elec.
Coal	10,000 – 170,000
Oil	36,000
Gas	4,000
Biomass	24,000
Solar Rooftop	440
Wind	150
Hydro	1400
Nuclear	90

http://iopscience.iop.org/article/10.1088/1748-9326/8/3/034005
https://en.wikipedia.org/wiki/Energy_accidents

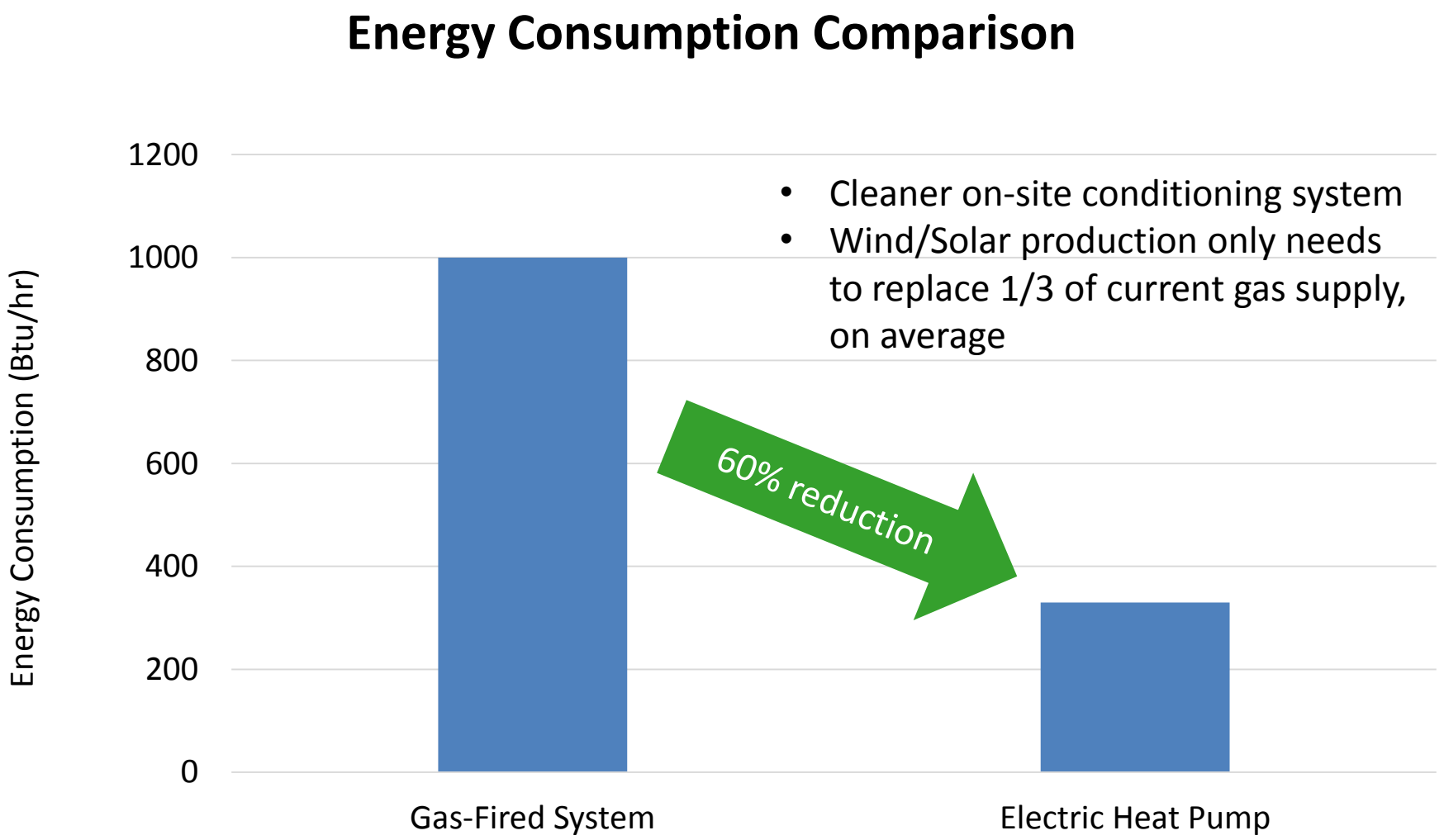
Implementation

- Measures have to work and deliver expected benefits
- Conduct auditing before and after
- Consider an 'Energy as a Service Provider Model' (ACEEE, 2019)
- Lessons learned from past projects (ACEEE, February 2019)
  - Need for building owner education and engagement
  - Targeting the right type of buildings for select upgrades
  - Assessing opportunities through targeted pilot programs



Energy as a Service (EaaS) structure (ACEEE, 2019)

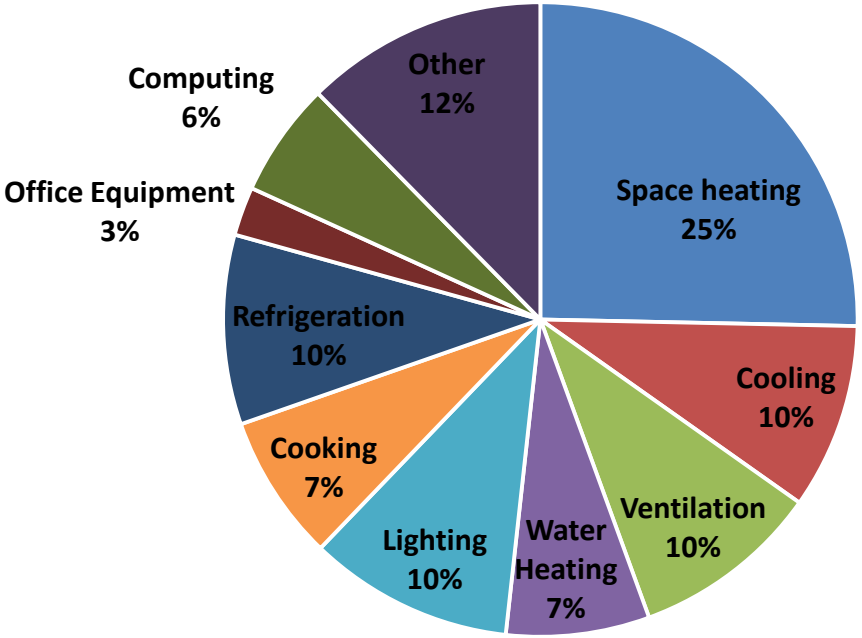
Implementation – Fuel Switching



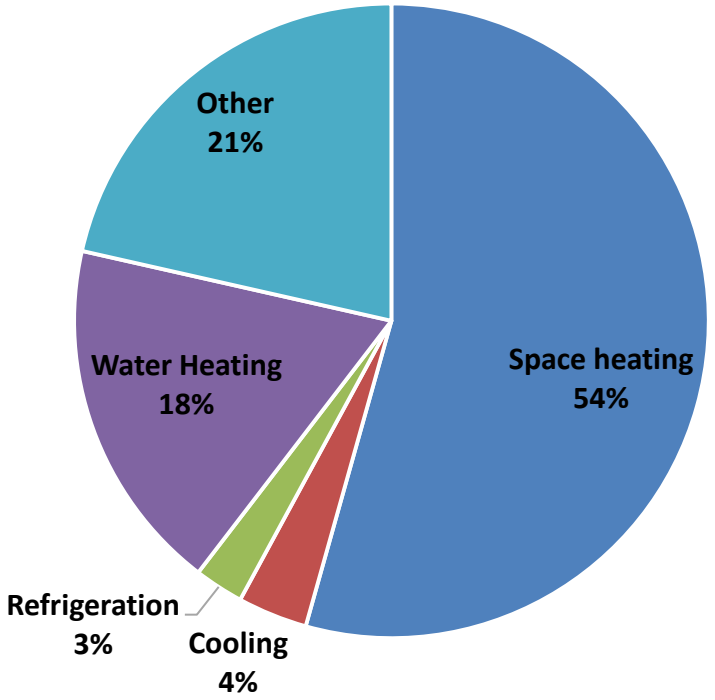
This includes high capacity and high-temperature heat pumps for industrial and commercial end-uses

How is Energy Used?

Energy Consumption by End Use for All U.S. Commercial Buildings (EIA, 2012)



Energy Consumption by End Use for Residential Buildings in the Mid-Atlantic (EIA, 2015)



References

AIA. 2018. 2030 By the Numbers: The 2017 Summary of the AIA 2030 Commitment. Published by AIA, November 2019. http://content.aia.org/sites/default/files/2018-11/2030-By-the-Numbers-2017v3.pdf

Amann, J. 2017. Unlocking Ultra-Low Energy Performance in Existing Buildings. An ACEEE White Paper. Published by ACEEE, July 2017. https://aceee.org/sites/default/files/ultra-low-energy-0717.pdf

American Council for an Energy-Efficient Economy (ACEEE). 2019. ACEEE Utility Multifamily Working Group Call. February 28, 2019.

ACEEE. 2019. Energy as a Service. Technical Brief. https://aceee.org/sites/default/files/eo-energy-as-service.pdf

Bardhan, A., Jaffee, D., Kroll, C., and Wallace, N. 2014. "Energy Efficiency Retrofits for U.S. Housing: Removing the Bottlenecks." *Regional Science and Urban Economics*, SI: Tribute to John Quigley, 47 (July): 45–60. https://doi.org/10.1016/j.regsciurbeco.2013.09.001.

NIST. 2019. Net-Zero Energy Residential Test Facility (NZERTF). Website accessed on March 26, 2019: https://www.nist.gov/el/net-zero-energy-residential-test-facility

Perry, C. 2018. Pathways to Zero Energy Buildings through Building Codes. An ACEEE White Paper. Published by ACEEE, October 2018. https://aceee.org/sites/default/files/zeb-codes.pdf