US Energy Policy Developments Towards NZEB

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Outline of Presentation

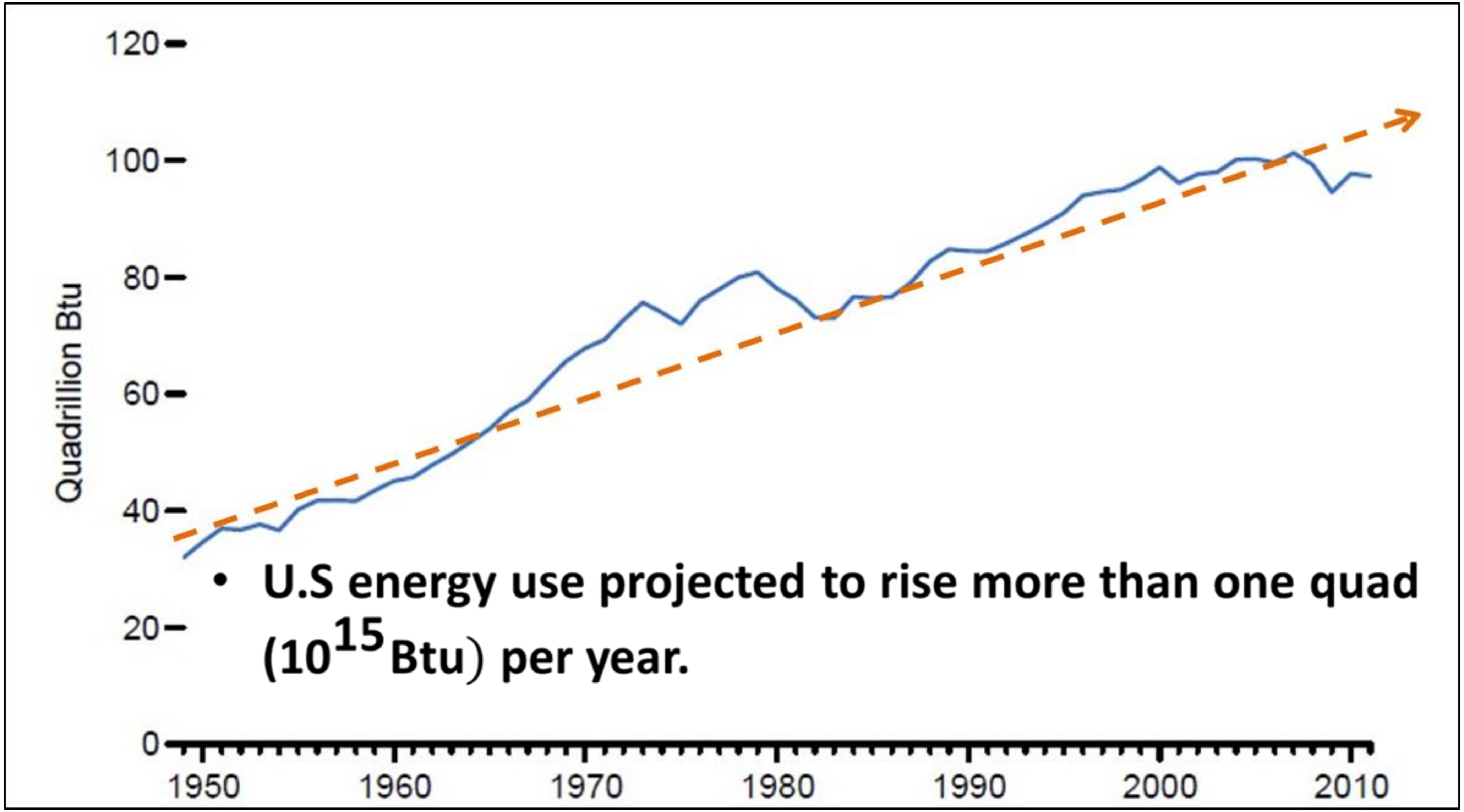
- *Energy Carriers and Energy Sources*
- *Background of Energy Use in the United States*
- *Goals Established by the Department of Energy (DOE)*
- *Strategy Employed (Energy Efficiency/Renewable Energy)*
- *Getting to Zero: The 2014 Status Report (New Buildings Institute)*
- *Statistics of the First 10 ZEBs in the United States*
- *Example ZEB in Kaupuni Village, Hawaii*
- *The California Experience*
- *Reducing Industrial Energy Intensity in the US (example SECIEER)*
- *Example EERE Projects Funded by DOE*
- *Conclusions*

Energy Carriers and Energy Sources

- **Energy Carriers: Examples include gasoline, hydrogen, electricity**

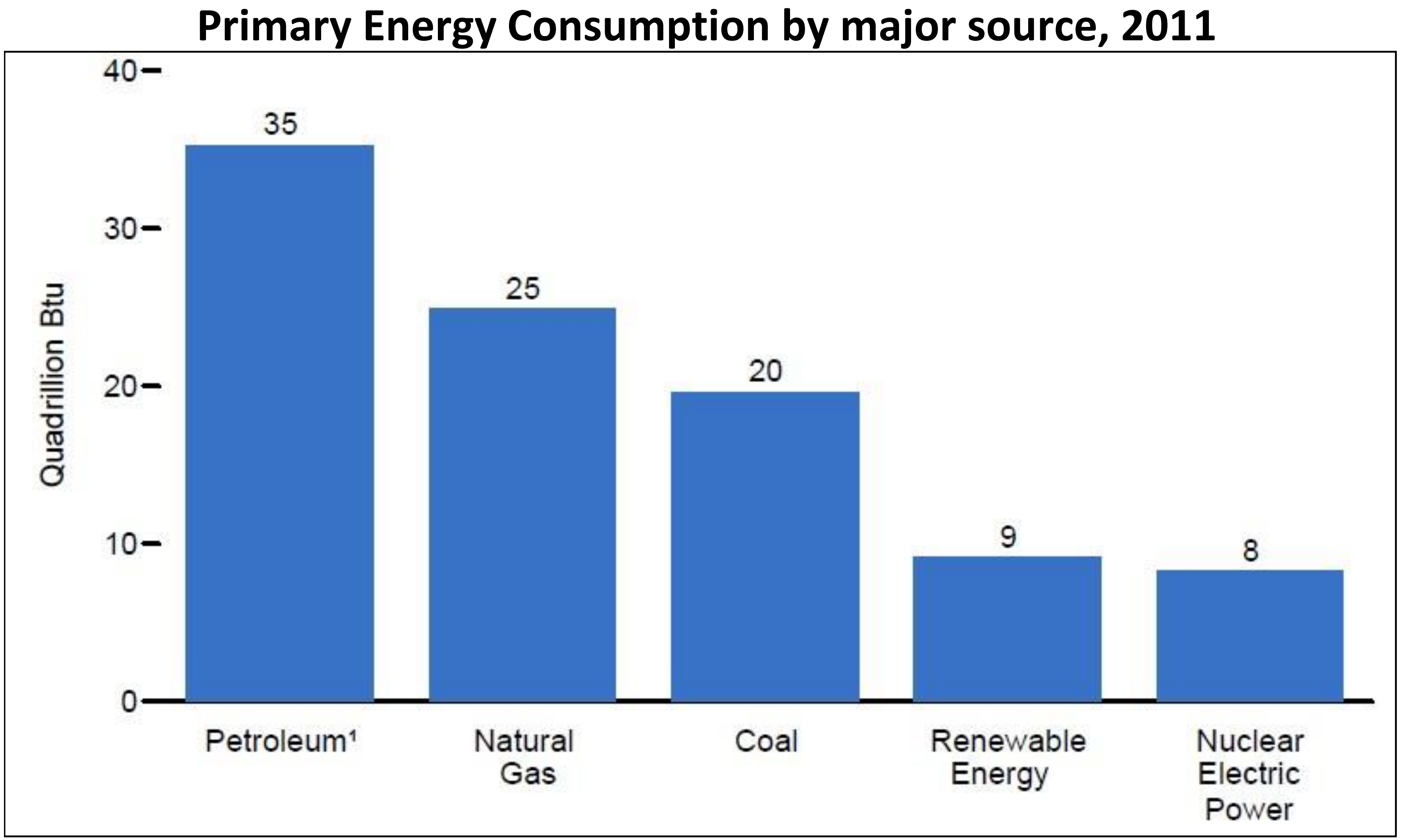
- **Energy Sources: Examples include solar energy, nuclear energy, coal, natural gas, oil**

US Projected Energy Consumption



- **U.S energy use projected to rise more than one quad (10^{15}Btu) per year.**

US Primary Energy Consumption by Major Source 2011



http://www.eia.gov/totalenergy/data/annual/pdf/aer.pdf

Fossil sources still dominate energy production

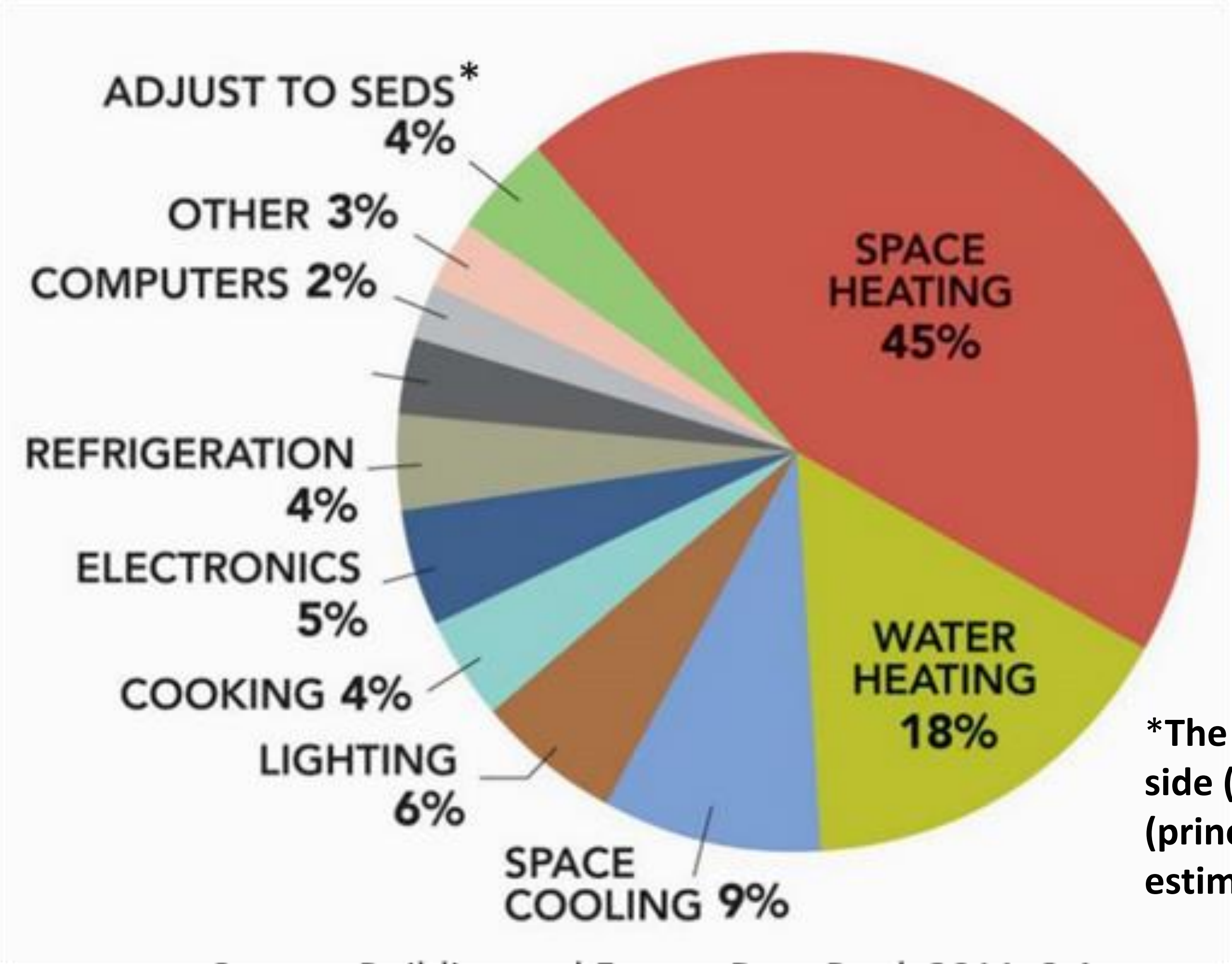
US Energy Use

- **Current and Future Building Consumption** Buildings in US use 40% of primary energy. Approximately 70% of the electricity in the United States.

- **Commercial Buildings** Primary energy consumption grew by 70% between 1980 and 2010. The Energy Information Administration (EIA) projects 22% growth between 2010 and 2035.

- **Residential Buildings** Homes built between 2000 and 2005 used 14% less than homes built in the 1980s. 40% less than homes built before 1950.

Areas of Building Energy Use: Commercial 2011



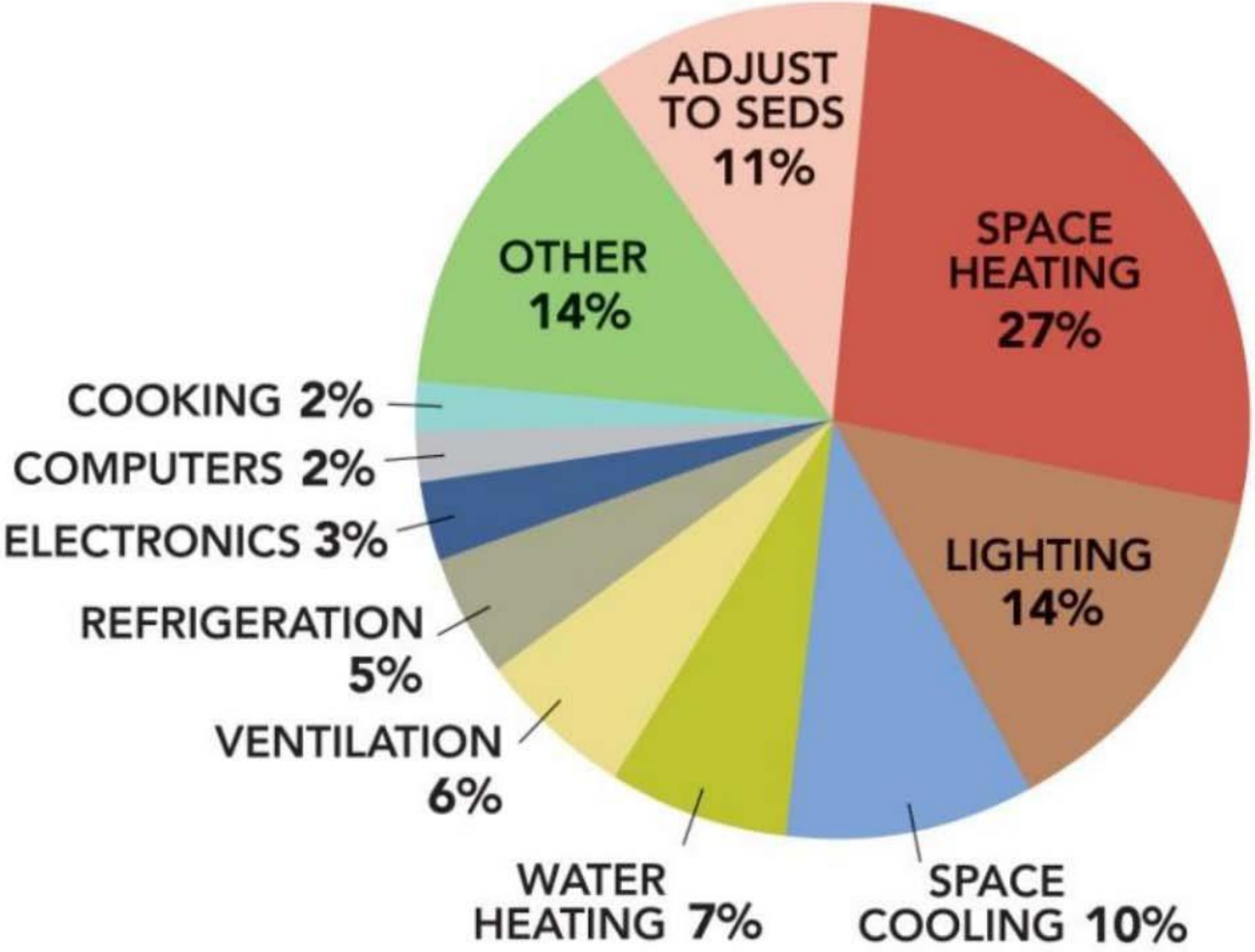
Source: Building and Energy Data Book 2011, 2-1

Regulated*: Lighting 14% Space Cooling 10% Space Heating 27% Ventilation 6% Water Heating 7% Refrigeration 5%

Unregulated*: Cooking 2% Computers 2% Electronics 3% Adjust to Seds 11% Other 14%

***The "Adjust to SEDS" is EIA's adjustment to reconcile supply-side (State Energy Data System,[SEDS]), and end-user (principally, the *Residential Energy Consumption Survey)* estimates of energy use.**

Areas of Building Energy Use: Residential 2010



Regulated*: Lighting 14% Space Cooling 10% Space Heating 27% Ventilation 6% Water Heating 7% Refrigeration 5%

Unregulated*: Cooking 2% Computers 2% Electronics 3% Adjust to Seds 11% Other 14%

***Regulated: Can be reduced by change schedule or control system.**
****Unregulated: Can't be..**

Most important Actions: Reduce Building Energy Use

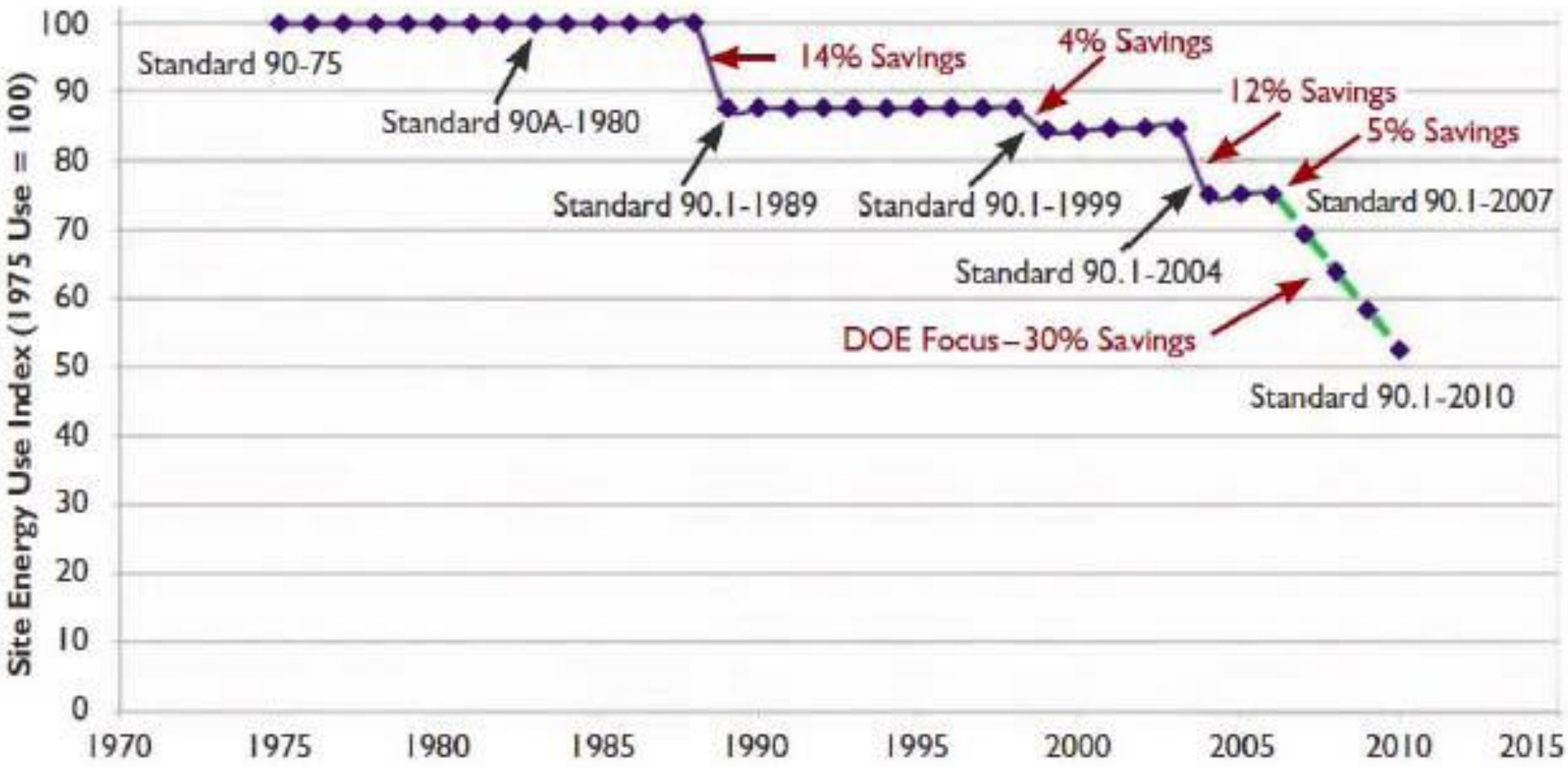
Apply and follow building codes, standards and programs

- **ASHRAE Building Codes** 90.1-2010
- 189.1-2009
- **International Energy Conservation Code (IECC)** Introduced in 1998.
- Latest is the 6th edition published in 2012.

- **EnergyStar:** Identify and promote energy–efficient products and buildings in order to reduce energy consumption and reduce pollution.
  - **Leadership in Energy & Environmental Design(LEED)** Promote Certification System to identify high-efficient performance buildings.
  - Provide technology training for high-performance buildings.

Most important Action: Reduce Building Energy Use

Trend of Code vs. Energy Savings



Source: Mark Halverson, PNNL

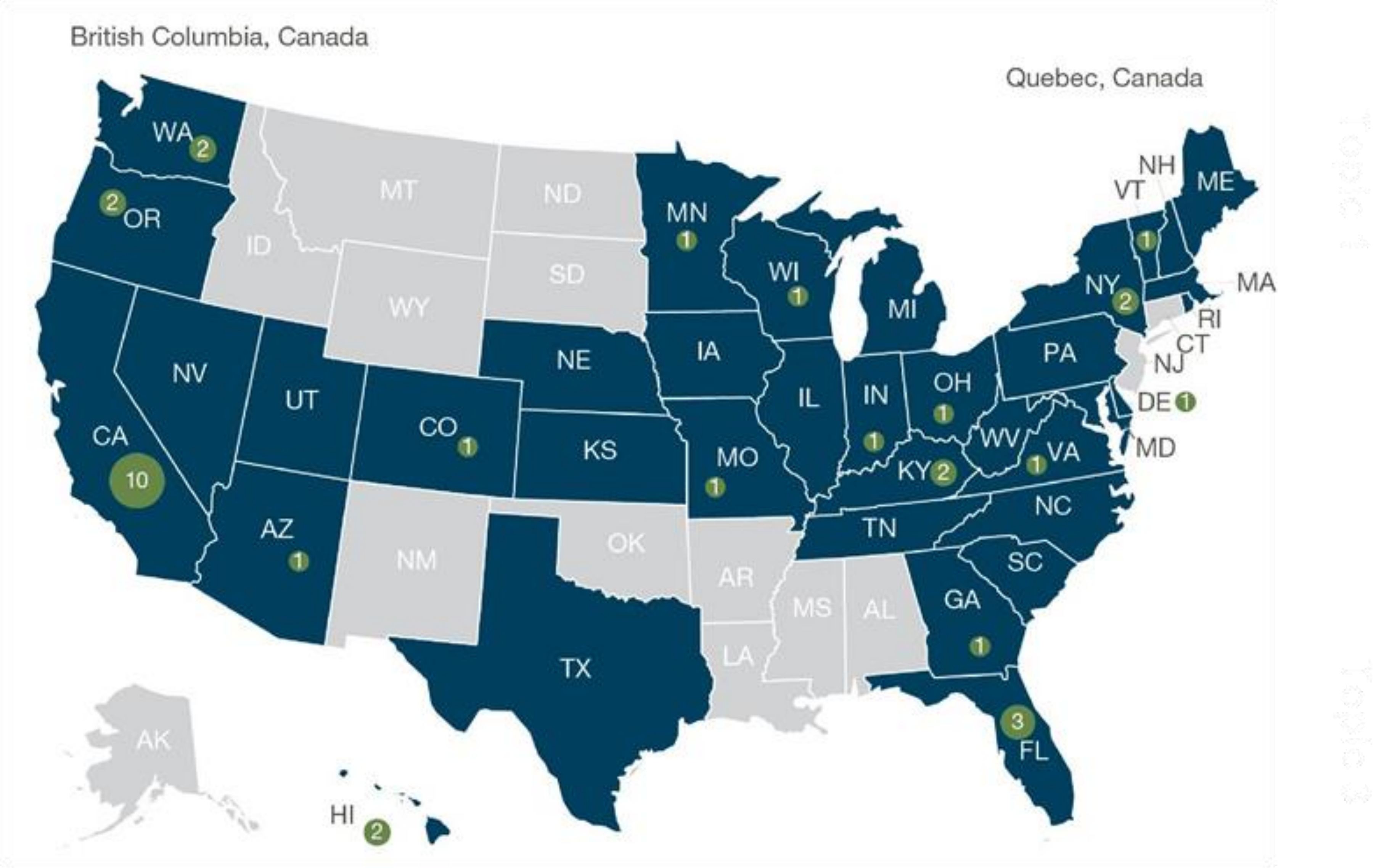
Goal established by DOE

- By 2015, Achieving a 50% reduction in whole-building energy use.
- By 2025, Maximum energy efficiency technology to achieve the 75% energy reduction .
- By 2025, create the technology and knowledge base for cost-effective **zero-energy** commercial buildings(ZEBs).

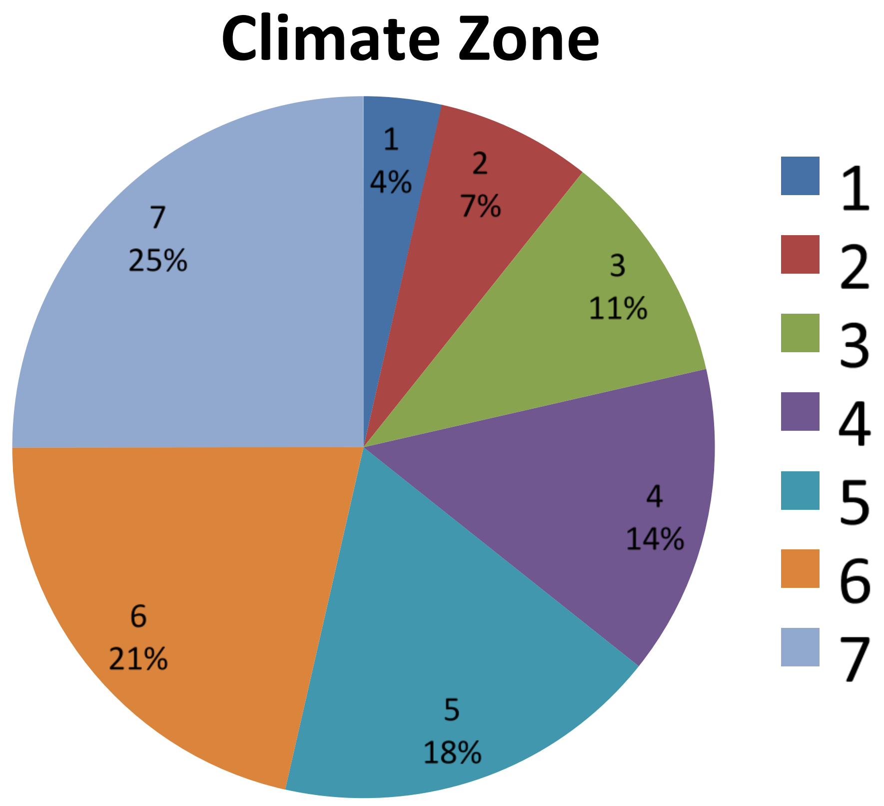
nbi new buildings institute

Getting to Zero: The 2014 Status Update

2014 Zero Status Update across the USA



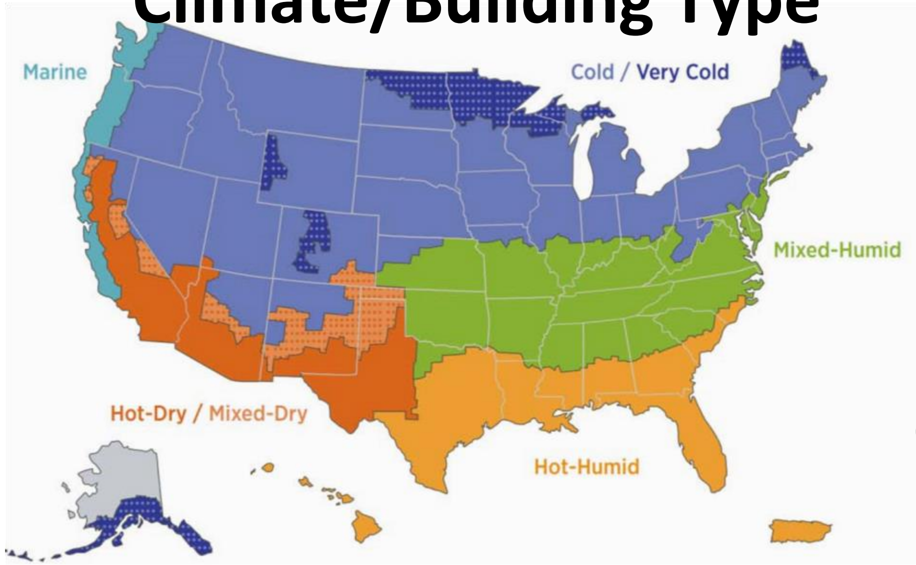
Currently, according to DOE Zero Buildings Database (126 buildings in the U.S.) , the distribution of net zero buildings by climate zones is:



Building America	IECC
Subarctic	Zone 8 (only found in Alaska)
Very Cold	Zone 7
Cold	Zones 5 and 6
Mixed-Humid	4A and 3A counties above warm-humid line
Mixed-Dry	Zone 4B
Hot-Humid	2A and 3A counties below warm-humid line
Hot-Dry	Zone 3B
Marine	All counties with a “C” moisture regime

Design Consideration

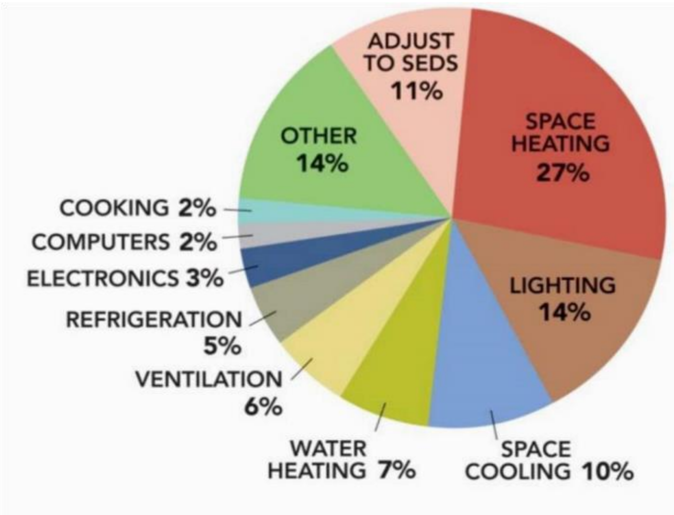
- **Climate/Building Type**



→ Cold
→ Warm
→Dry
→Tropical

- **Building energy use area**

→ Commercial
→ Residential
→ Other Types



Statistics of the 10 Pioneering ZEB Buildings in the USA

- **<u>Among 10 Net Zero Buildings</u>**
- **Location**: They are distributed in CA (Zone 3), VT (Zone 6), WI (Zone 6), OH (Zone 5), HI(Zone 1), MN(Zone 6). Cover both cold climate and warm climate.

- **Type Distribution** 6 commercial buildings
- 2 campus building
- 1 retail
- 1 Single-family residential

- **Area**: None of the 10 buildings are more than 14,000ft^2, the average is 5500ft^2.
- All are one-storied or two-storied.

Kaupuni Village, Hawaii, Zone 1

Features:

Single-family Residence

Affordable

Community

Climate: Hot Humid

- Average wind speed is 11.3m/s and uniform
- Annual percent of possible sunshine is 71%.
- Average Temperature
- Jan 72.9

Jun 79.4 →Heating/Cooling load is uniform during a year • Nov 77.2

Kaupuni Village, Hawaii, Zone 1

- **Renewable Energy**
- **High Efficiency Appliance**

Photovoltaic Panels

Hot Water Solar Panels

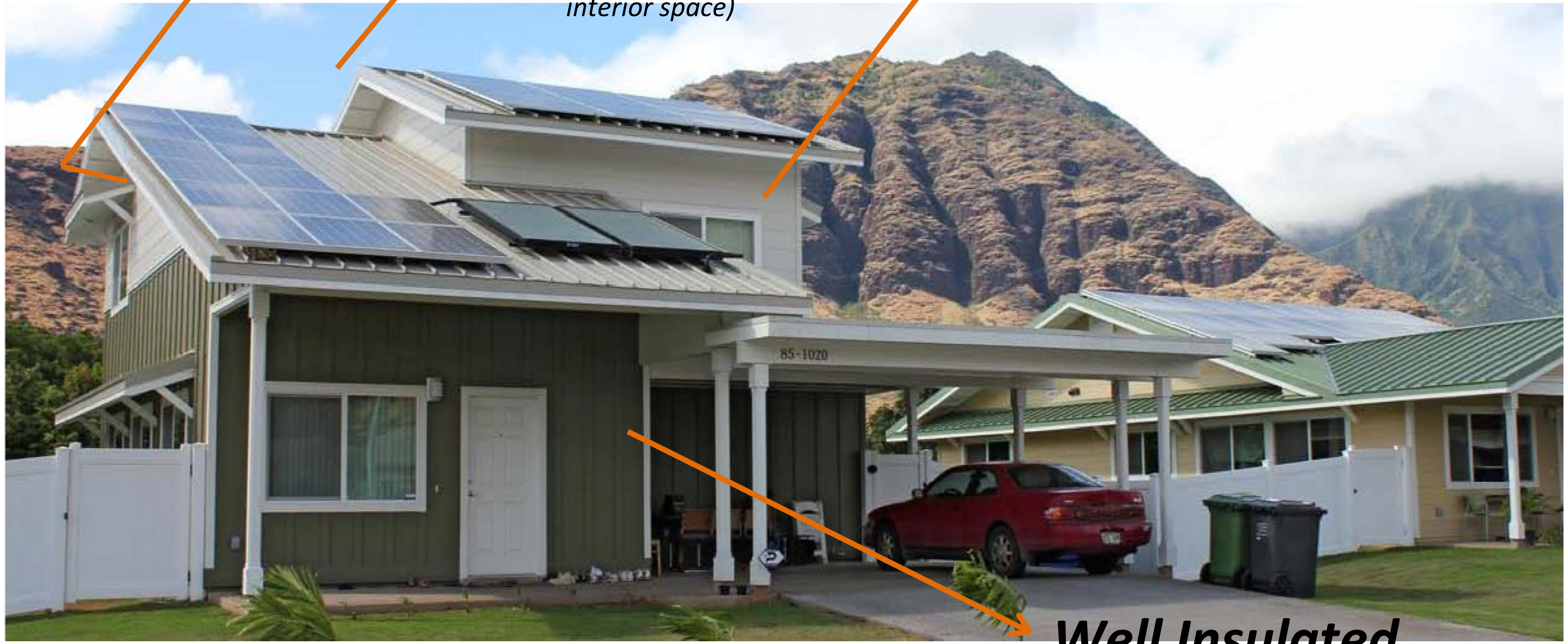
Kaupuni Village, Hawaii, Zone 1

Shaded High Performance Glazing

Solatube Lights

(Natural lights in interior space)

- *Well insulated*
- *Light Colored*
- *High Solar Reflect*



- **Insulation for Hot Humid Climate**

Well Insulated Exterior Wall

Student-built houses powered exclusively by the sun

The California Experience

California Experience (Cont.)

- California has a set a bold course to achieve statewide Zero Net Energy (ZNE) in the next two decades:
- All new residential construction will be ZNE by 2020 in California
- All new commercial construction will be ZNE by 2030
- 50% of existing commercial buildings in California will be retrofitted to ZNE by 2030

Example Projects Funded by the DOE (HVAC)

- Air-Source Integrated Heat Pumps (ASIHP)
- Cold Climate Heat Pump (CCHP)
- Next Generation Rooftop Unit (RTU)
- Residential Absorption Heat Pump
- Commercial Integrated Heat Pump with Thermal Storage
- Separate Sensible and Latent Cooling (SSLC)
- Membrane-Based Air-Conditioning System
- Novel Solar Absorption Cooling System to Reduce Peak Loads

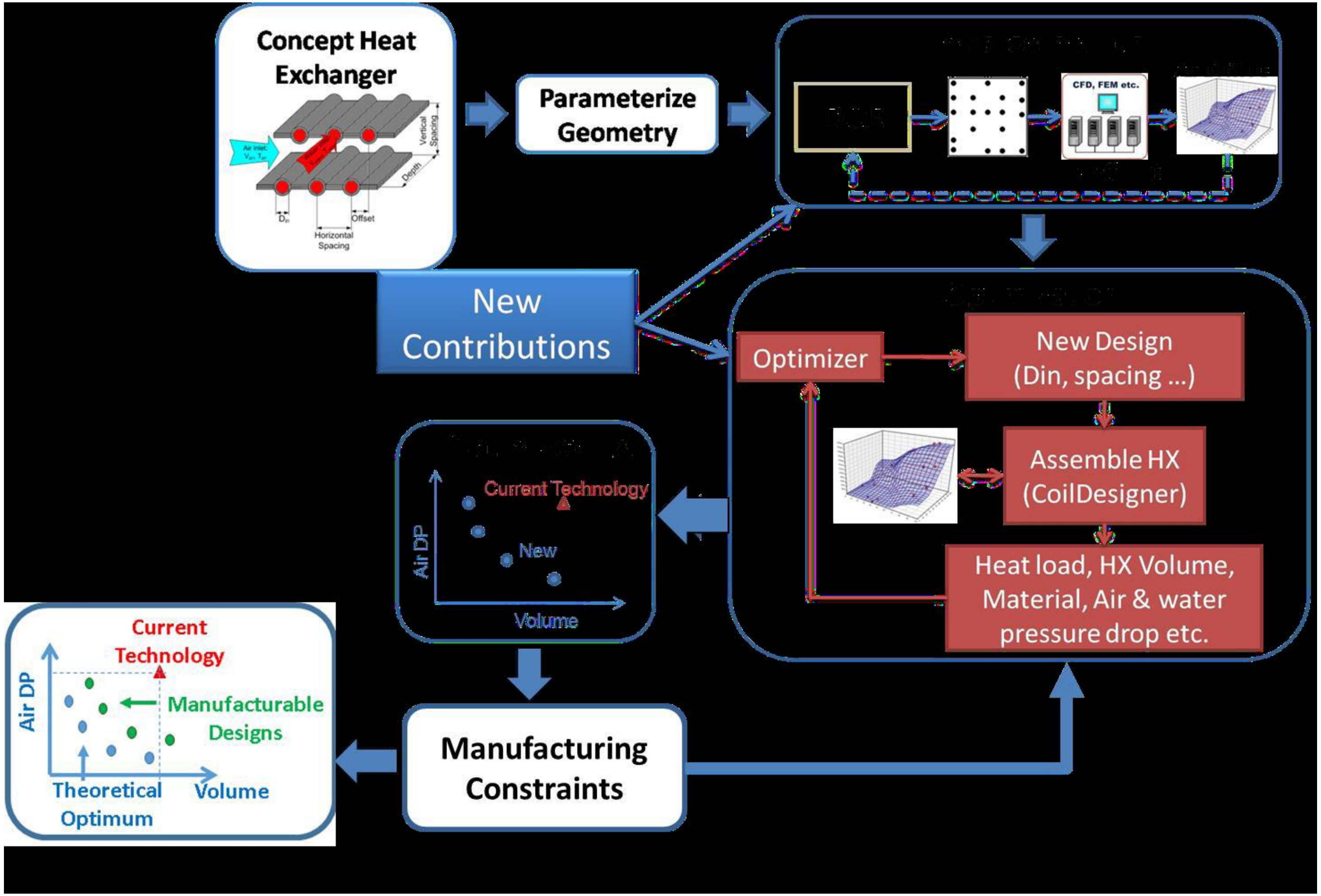
Example Projects Funded by the DOE (Water Heating)

- Adsorption Heat Pump Water Heater (HPWH)
- Commercial Absorption HPWH
- CO_2 HPWH
- Residential Absorption HPWH
- Combined Water Heater, Dehumidifier, and Evaporative Cooler (WHDEC)
- Commercial CO2 HPWH & Max Technical Efficiency Electric HPWH with Low-GWP Halogenated Refrigerant

Example of Energy Efficiency Projects currently Funded by DOE

- **Miniaturized Air-to-Refrigerant Heat Exchangers (UMD)**
- **Gas Heat Pumps for Building Space Heating (Stone Mountain Technologies)**
- **Highly Insulating Windows using Smart Automated Shading (LBNL)**
- **Dynamic Windows Program at NREL**
- **Dynamically Responsive IR Windows Coatings (PNNL)**
- **Next Generation Building Envelope Materials (ORNL)**
- **Building Integrated Heat and Moisture Exchangers**

Miniaturized Air-to-Refrigerant Heat Exchangers (UMD)

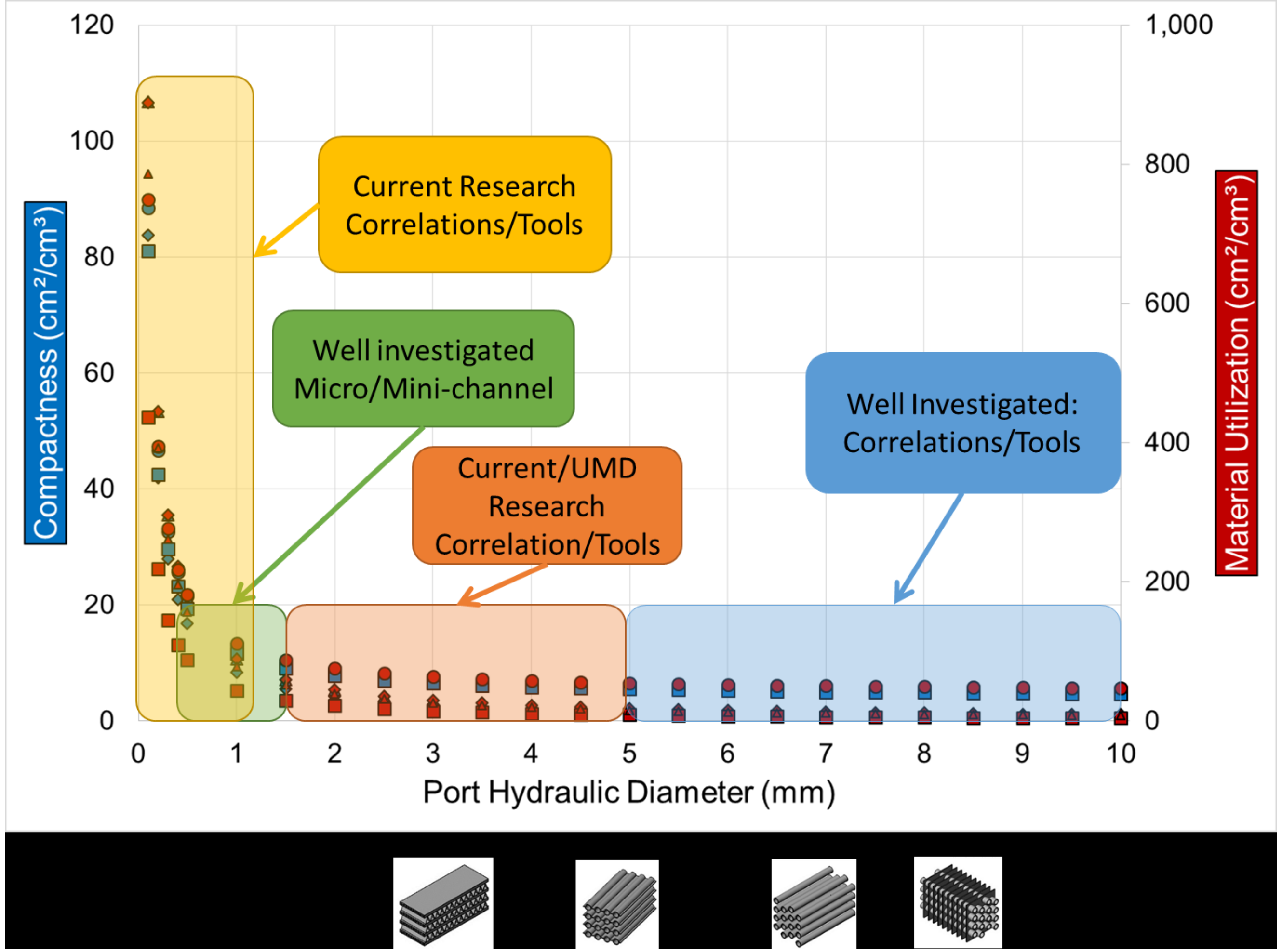


Miniaturized Air-to-Refrigerant Heat Exchangers (UMD)

- **Purpose**: Develop next generation heat exchangers for heat pumps and air-conditioners.
- **Performance Target**: Miniaturized air-to-refrigerant heat exchanger with at least 20% less volume, 20% less material and 20% more performance than current designs.
- **Market Target**: To be in production within five years.
- **Key Partners**:
  - **Oak Ridge National Laboratory**
  - **Luvata**
  - **International Copper Association**
  - **Wieland**
  - **Heat Transfer Technologies**

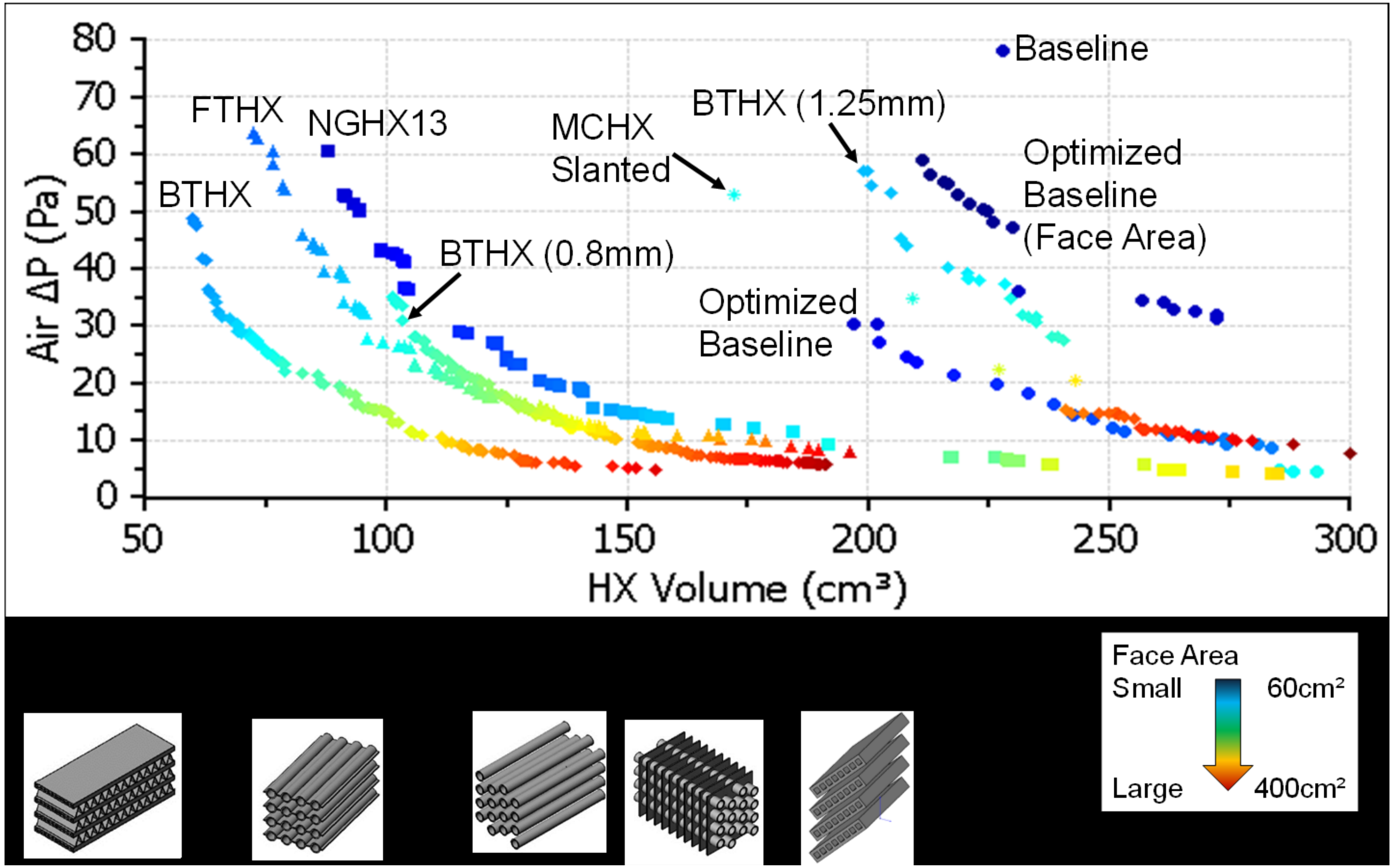
Miniaturized Air-to-Refrigerant Heat Exchangers (UMD)

Future of Heat Exchangers



Miniaturized Air-to-Refrigerant Heat Exchangers (UMD)

Where is the technology today?



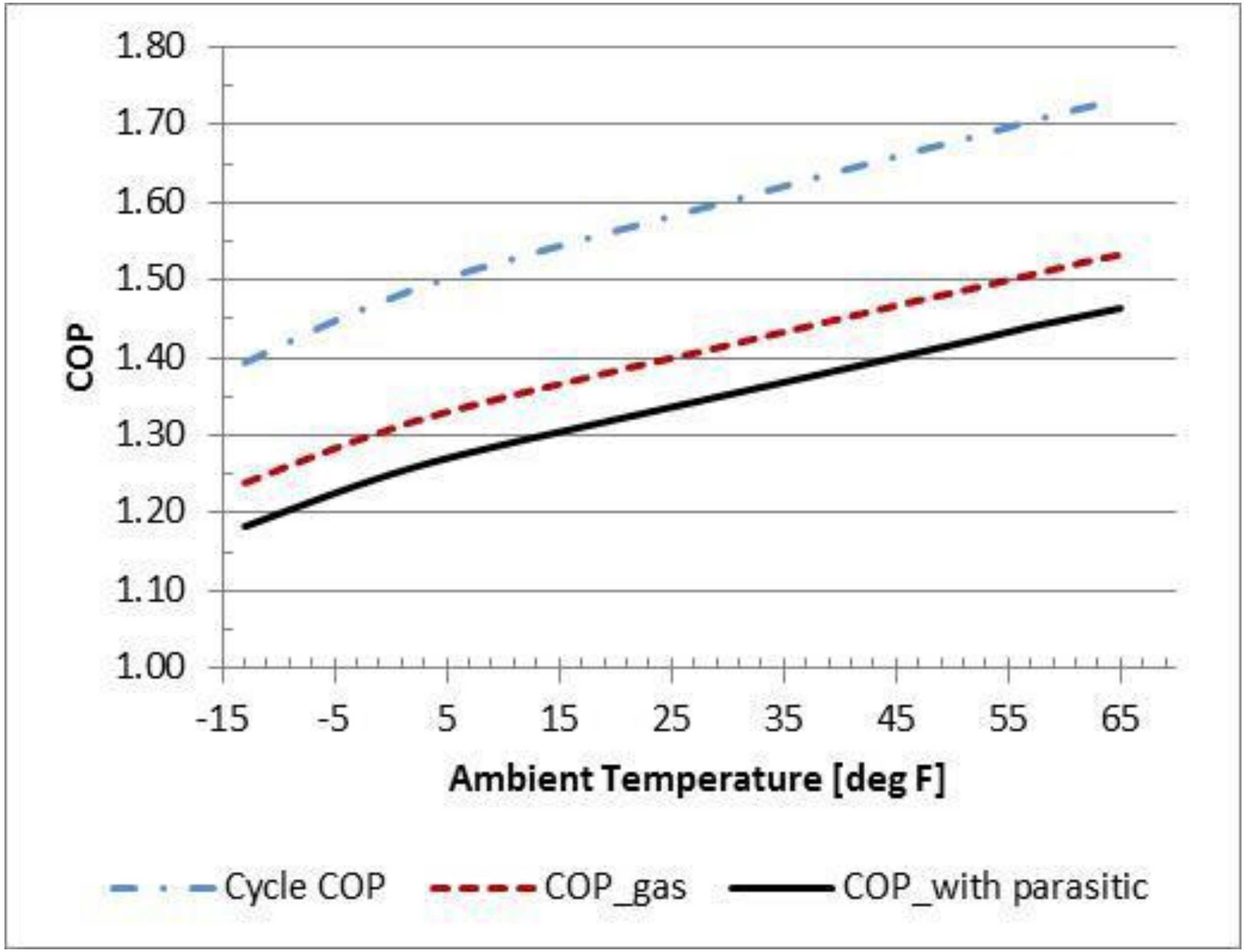
Low Cost Gas Heat Pump (SMTI)

Low Cost Gas Heat Pump (SMTI)

- **<u>Project Goal</u>:**
- **Develop and demonstrate a gas-fired absorption heat pump, with heating COP's greater than 1.0 at low ambient temps.**
- **Design simplicity and volume manufacturing requirements emphasized.**
- **Achieve a projected 2-5 year economic payback to drive market penetration is a higher priority than ultra-high efficiency.**

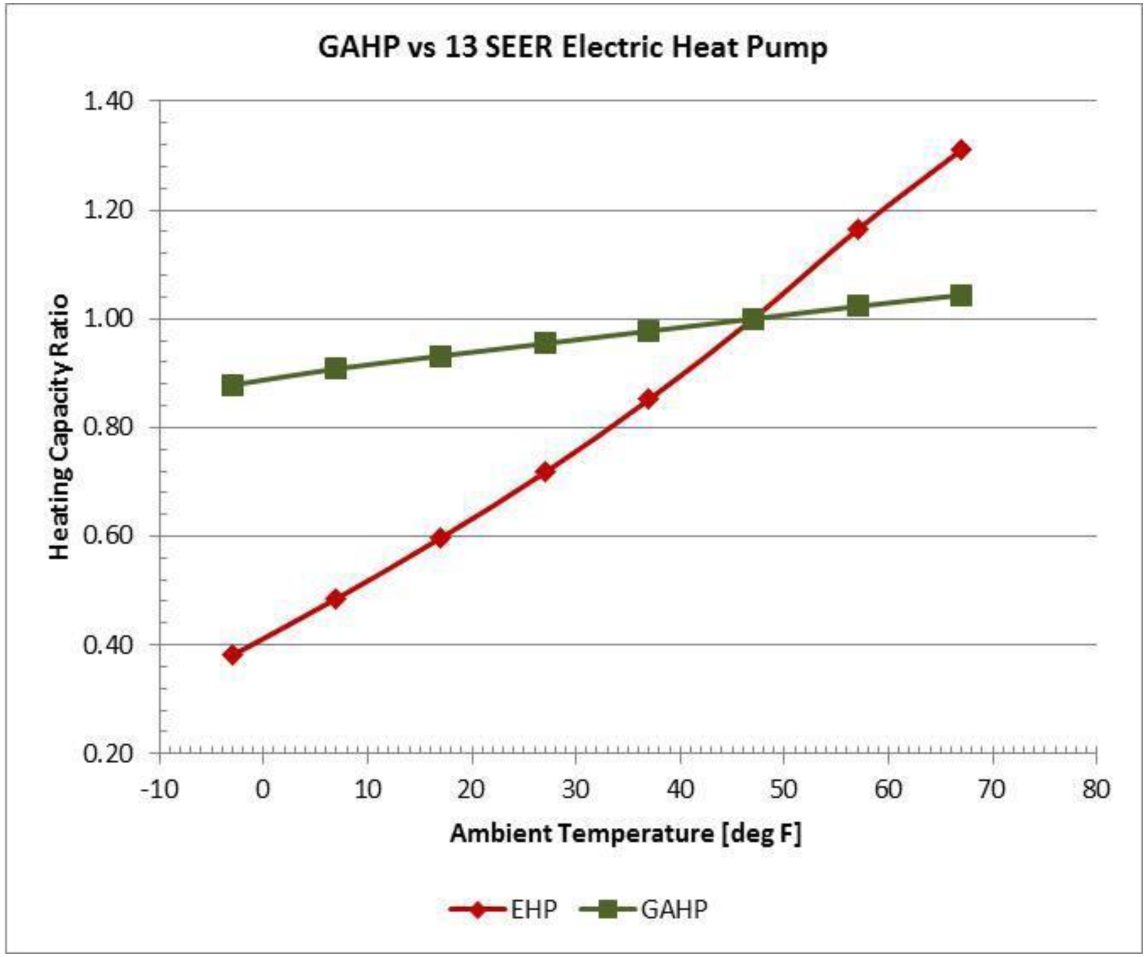
Low Cost Gas Heat Pump (SMTI)

Modeled and Target Performance

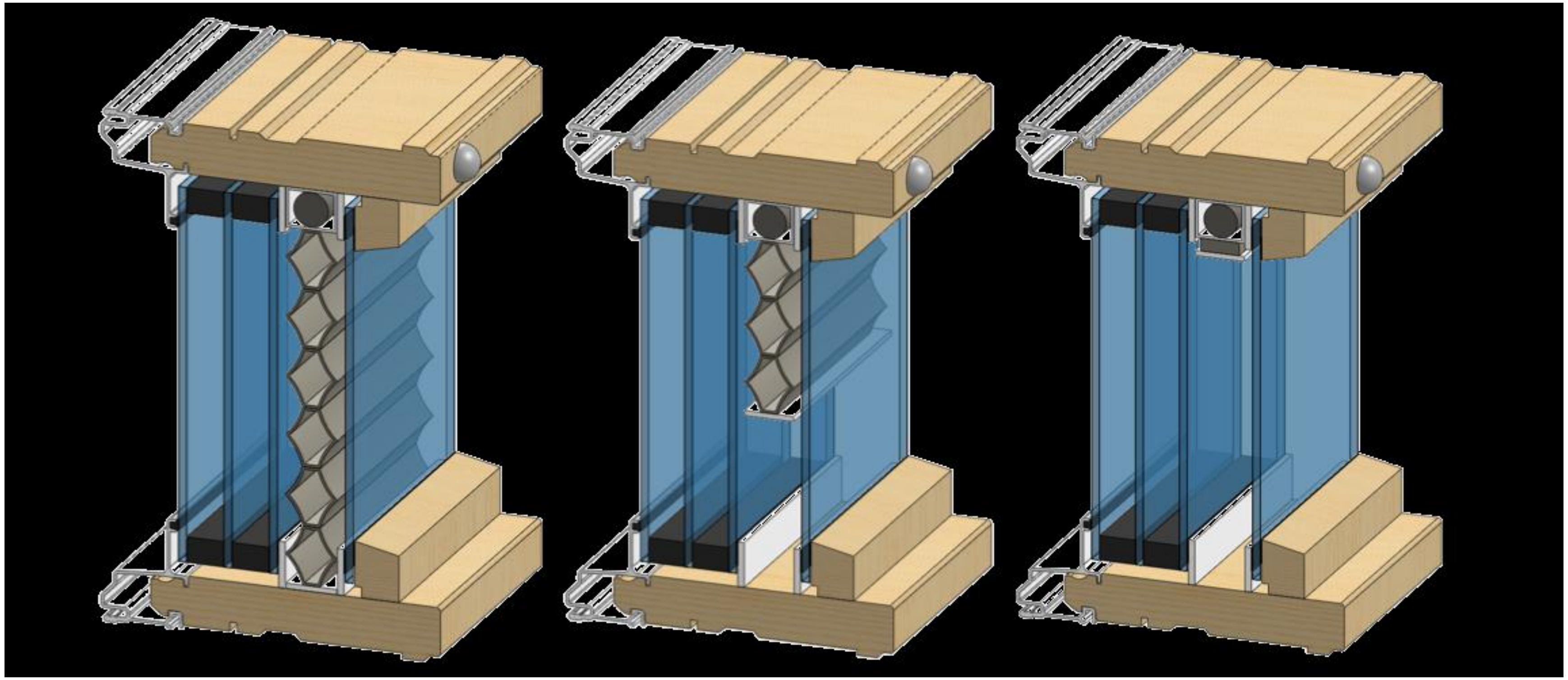


Low Cost Gas Heat Pump (SMTI)

Comparison toElectric Heat Pumps



Highly Insulating Windows with Smart Automated Shading (LBNL)

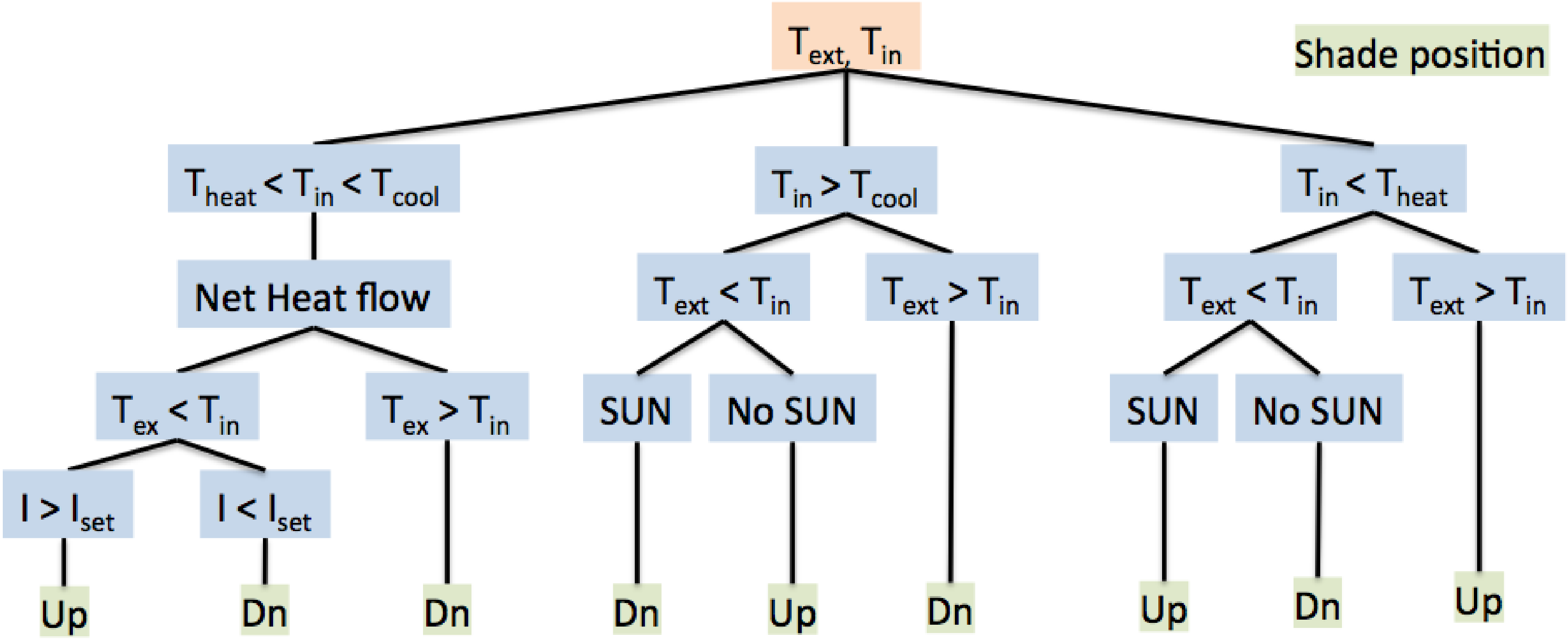


Highly Insulating Windows with Smart Automated Shading (LBNL)

- **Project Goal**:
- Create highly insulating windows with integrated sensors, control logic and motorized shades.
- The default control algorithm in these windows will minimize heating and cooling energy consumption by allowing solar gains when beneficial, and blocking solar gains at other times to reduce cooling loads.
- Optimize performance from links to utility meter, home automation, thermostat, internet data, etc.

Highly Insulating Windows with Smart Automated Shading (LBNL)

Algorithm



Highly Insulating Windows with Smart Automated Shading (LBNL)

- **The Smart Window has a number of integrated sensors:**
  - **Interior and exterior temperature sensors**
  - **Exterior solar irradiance sensor**
  - **Occupancy sensor**
- **Control algorithm evaluates if homes is in heating, cooling or neutral mode, and determines optimal shade position**
- **Override actions are aware of occupancy**

Conclusions

- **Effort is underway at finding a solution to the world energy problem**
- **Part of the effort is directed to establishing a permanent energy system by investigating renewables**
- **Another part of the effort is directed at finding better and more efficient ways of conserving available energy sources**
- **Examples of current efforts in both areas were given**

Conclusions

- **US is making steady but measured steps towards Zero Energy**
- **Significant progress has been made under the Obama Administration in the area of energy efficiency improvements in both the transportation and industrial/commercial sectors**
- **DOE is pursuing an aggressive policy in the area of energy efficiency and energy conservation**
- **Significant progress has been made in the area of environmental protection and sustainability (e.g. US engagement to curb greenhouse gases for the first time)**
- **Much more needs to be done**
- **California always leads by example**
- **It is possible that there would be policy shifts and set backs under successive administrations**