



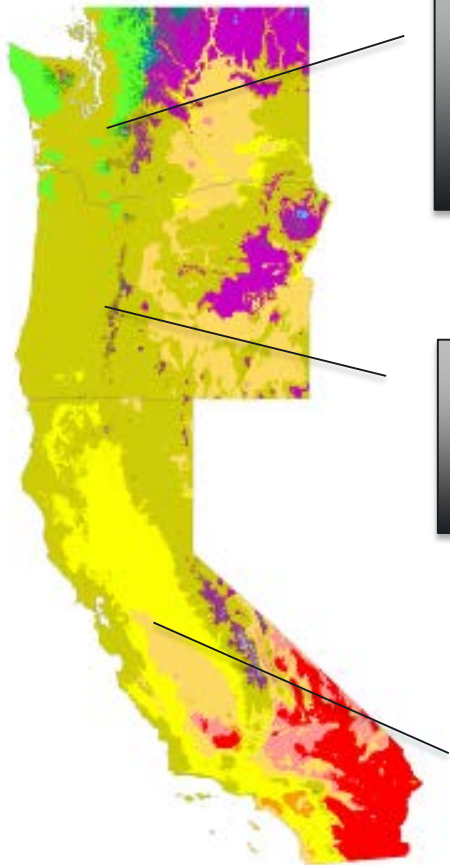
# Could Net Zero Homes Be in Your Future?

Matt Christie, Dan Wildenhaus, TRC

September 7, 2018



# Status of West Coast Net-Zero codes



IECC 2015+++, updating in 2019.  
WA legislature for zero-net-emissions homes by 2031.  
Essentially “Backdoor” ZNE-ready

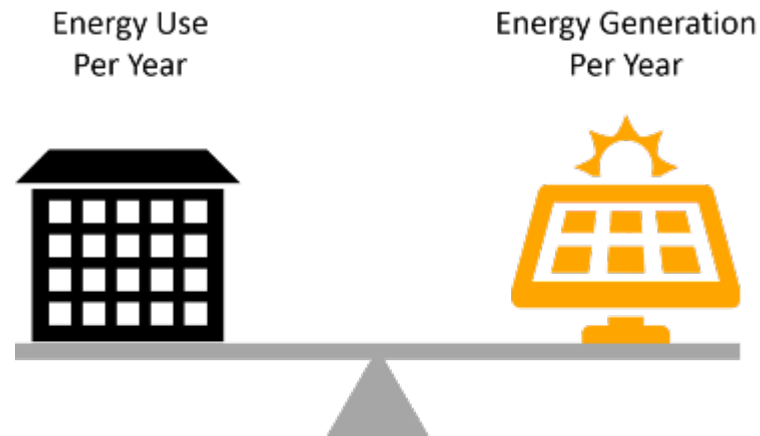
Executive Order 17-20  
directs agencies to achieve  
*Net Zero Ready* by 2023

2019 Title 24: “ZNE” Code  
- Solar required, covering  
all loads *except* heating  
and DHW

ZNE Municipal Reach  
Codes – Across the country;  
various levels and definitions –  
Bloomfield IA, Cambridge MA,  
Santa Monica, Palo Alto, Hayward  
CA, Boulder, Aspen, Lancaster CA,  
Boston, Burlington, Austin, Portland,  
Denver, Georgetown TX, Fort  
Collins CO, Montpelier VT,  
Vancouver BC, Las Vegas, Menlo  
Park CA, San Antonio TX, Seattle

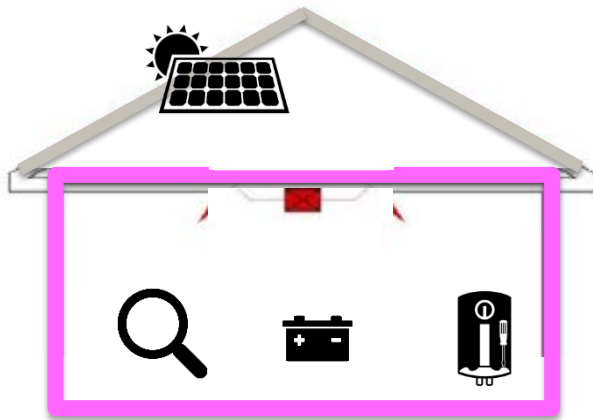
Model is used to estimate temperature (T) and construction (C) of building in °C  
Data source: Climate type calculated from data from PRISM Climate Group, Oregon State University, <http://prism.oregonstate.edu/>  
Data from US Census Bureau.

# Net Zero Code – Definitions get Complex



- How do you define **Energy**?
  - Dual-fuel, site-energy, source-energy, TDV (for CA), green-house emissions, marginal-use, what time horizon?
- How do you define **Use**?
  - Time of use, load shifting and shaping, electric vehicle charging, modeled vs. performance?
- How do you define **Generation**?
  - Solar-ready, on-site only, community-level, power-purchases, exceptions for solar-blocked buildings?

# All Definitions Push a Similar Construction Ethos

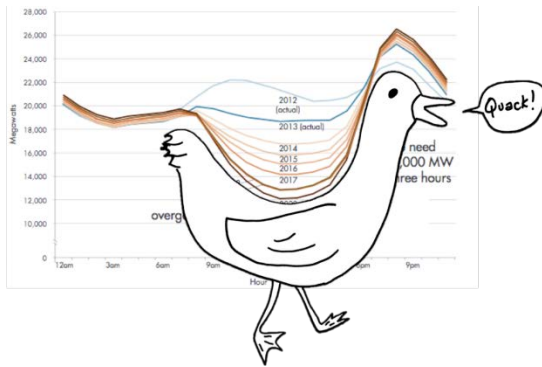


## Efficiency First:

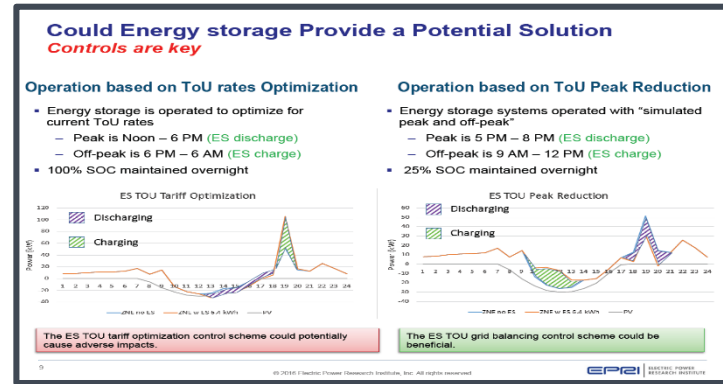
- Build a great envelope
- Install efficient equipment
- Use efficient distribution (ducts inside in particular)
- Leverage quality verifications
  - Then solar (maybe)
  - Then batteries (maybe)

# The "Now" Considerations Along with ZNE

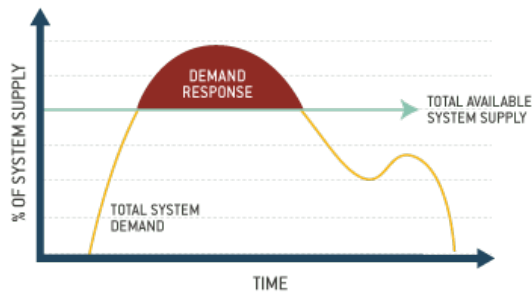
## Duck-curve mitigation



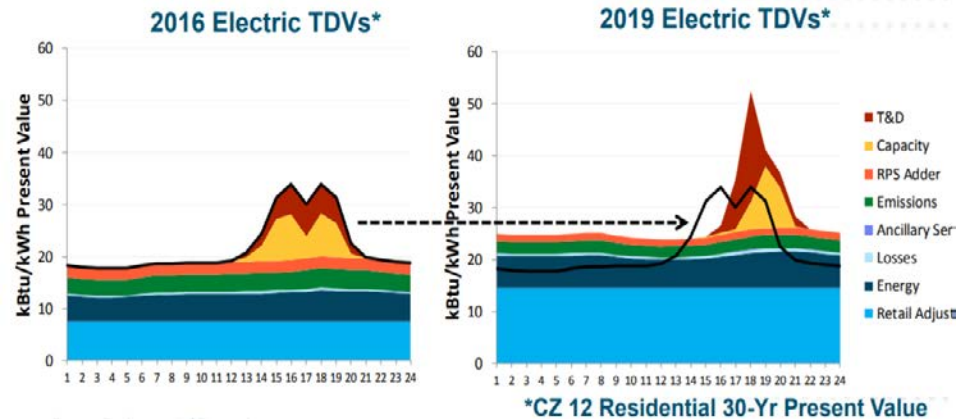
## Load-shifting with batteries



## Demand-response enablement



## Time-of-Use and Peak-use reductions



# The “Next” Considerations of ZNE

## Beneficial Electrification

- DHW
- Heating
- Cooking
- EV's



## Decarbonization

- Greenhouse gas emissions metrics, and hybrid metrics

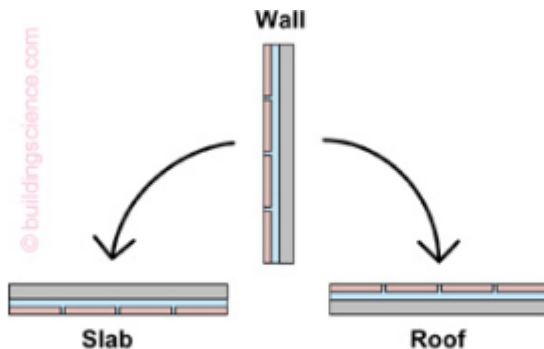


A photograph of two construction workers on a building site. The worker on the left is wearing a white hard hat and a light-colored shirt, pointing towards the wooden framing of a building. The worker on the right is wearing a blue shirt and jeans, holding a hammer and a tool bag. The background shows the wooden skeleton of a building under construction against a clear blue sky. An orange square is positioned to the left of the text overlay.

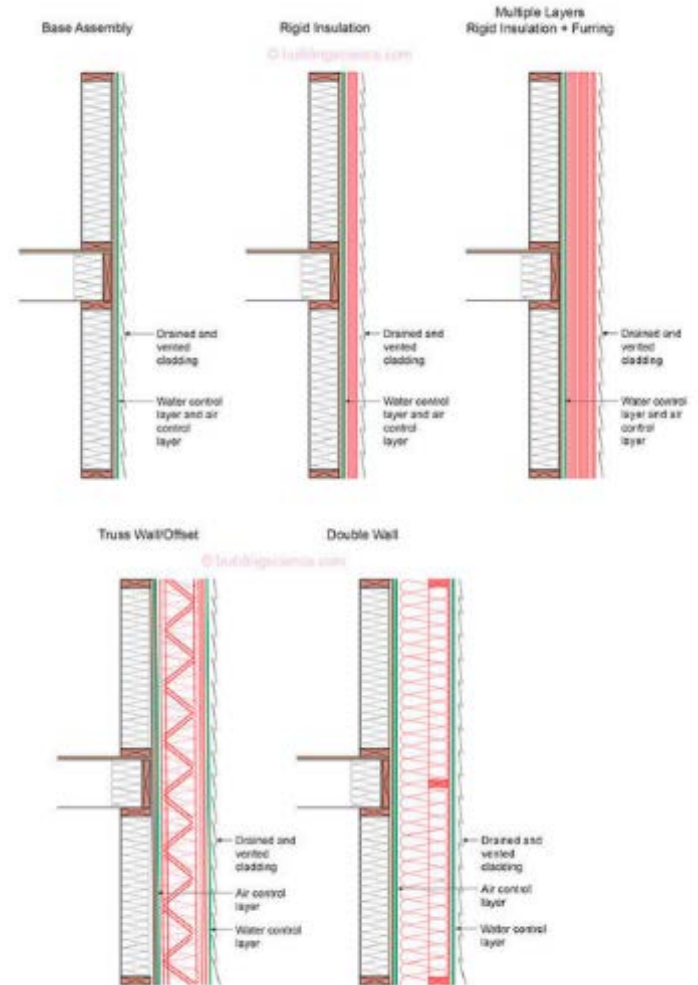
# Technologies to help get you there

# Technology to help get you there

What is the first rule of thumb for building Net Zero homes?



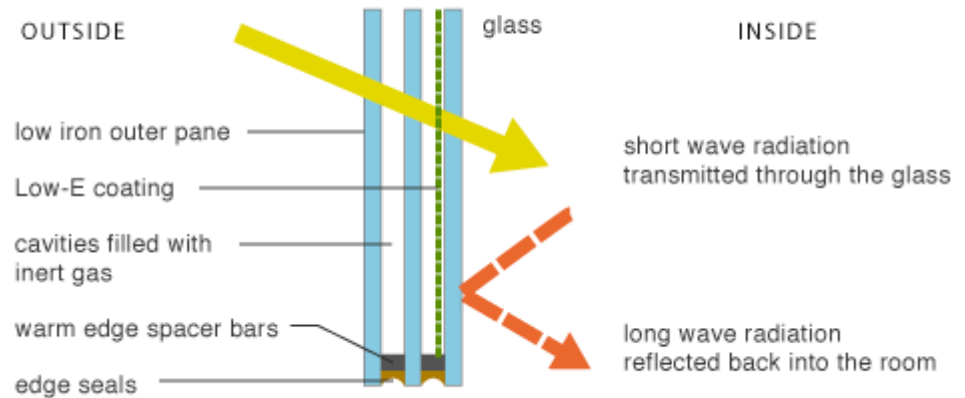
**A Wall is a Roof is a Slab**—The physics of walls, roofs and slabs are conceptually the same.





# Windows make or break your envelope

Window 15% of Wall Area	Wall R-Value with Windows w/Varied Wall Insulation Levels			
U-Value	R-0	R-18	R-39	R-60
0.30	R-5	R-11	R-15	R-17
0.20	R-5	R-13	R-19	R-23
0.15	R-5	R-14.5	R-23	R-28
0.10	R-5.5	R-16	R-27	R-34



**Sources:**

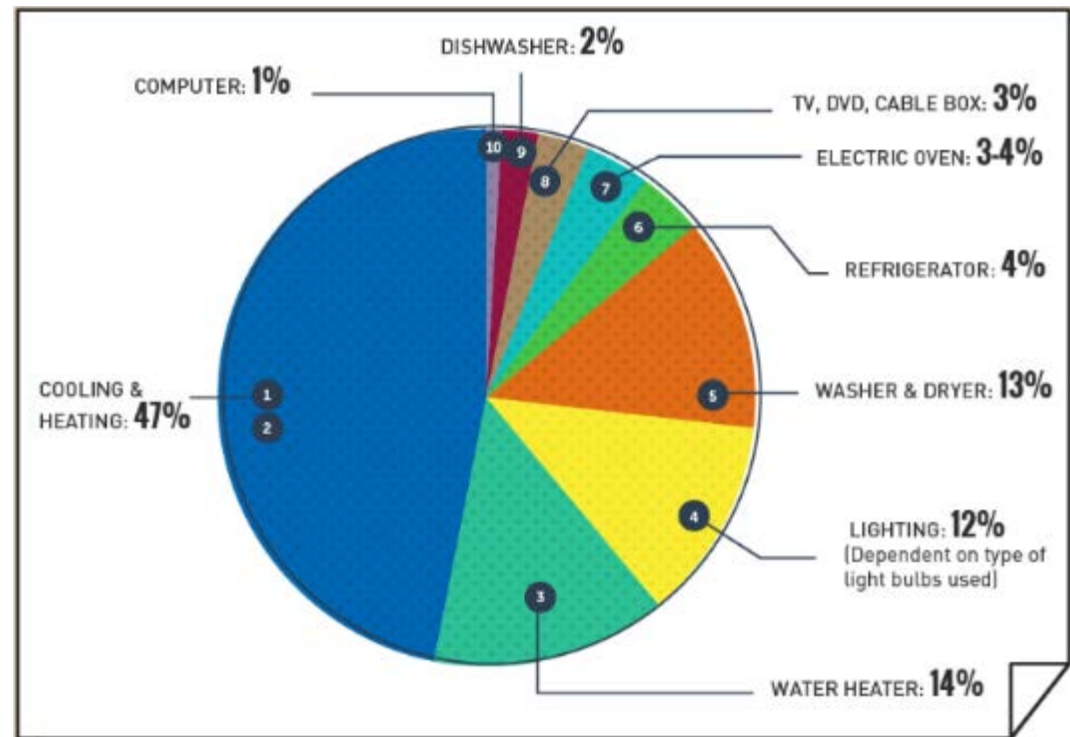
"Holes in the Wall: To Improve the Energy Performance of Walls, Look at the Total R-Value,"  
 Journal of Light Construction, February 2014;  
 Multi-Assembly R-Value / U-Value Calculator – Cascadia Windows and Doors;  
 Michael Blasnik Presentation, 2014 ACI Conference

# Then what is the second rule?

Improved mechanicals to reduce space conditioning and water heating.

Reducing lighting and appliance loads.

Improving homeowner energy use.



# Space conditioning



# Modern Mini-splits

## All inverter systems

- Variable refrigerant flow

## Ducted Systems

- Low profile - horizontal

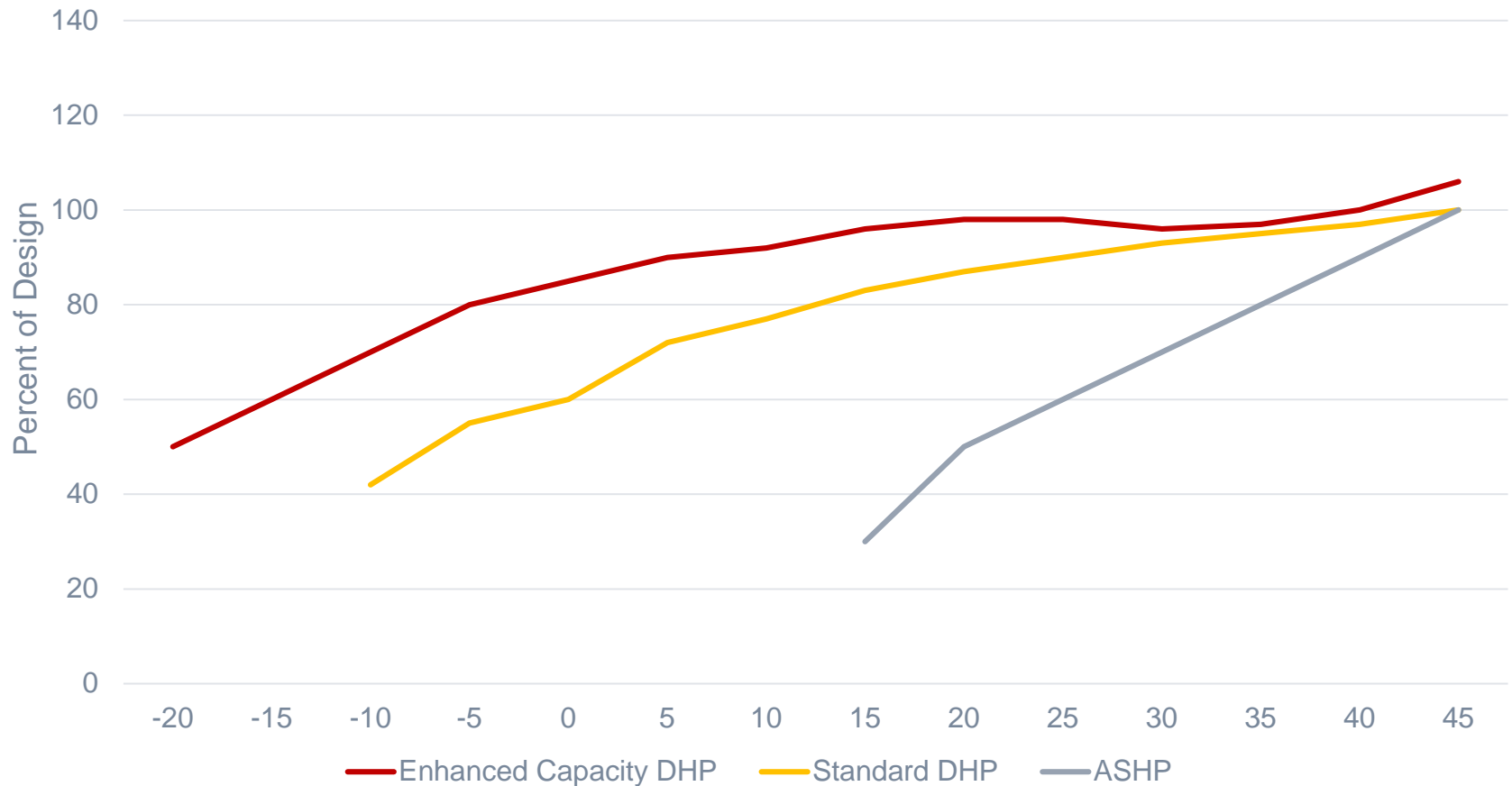
## Ductless Systems

- Wall Cassette
- Floor mount
- Ceiling Cassette



# Performance vs Outdoor Temperature

## Heat Pump Capacity & House Heating Need



# Water heating





# Performance comparisons

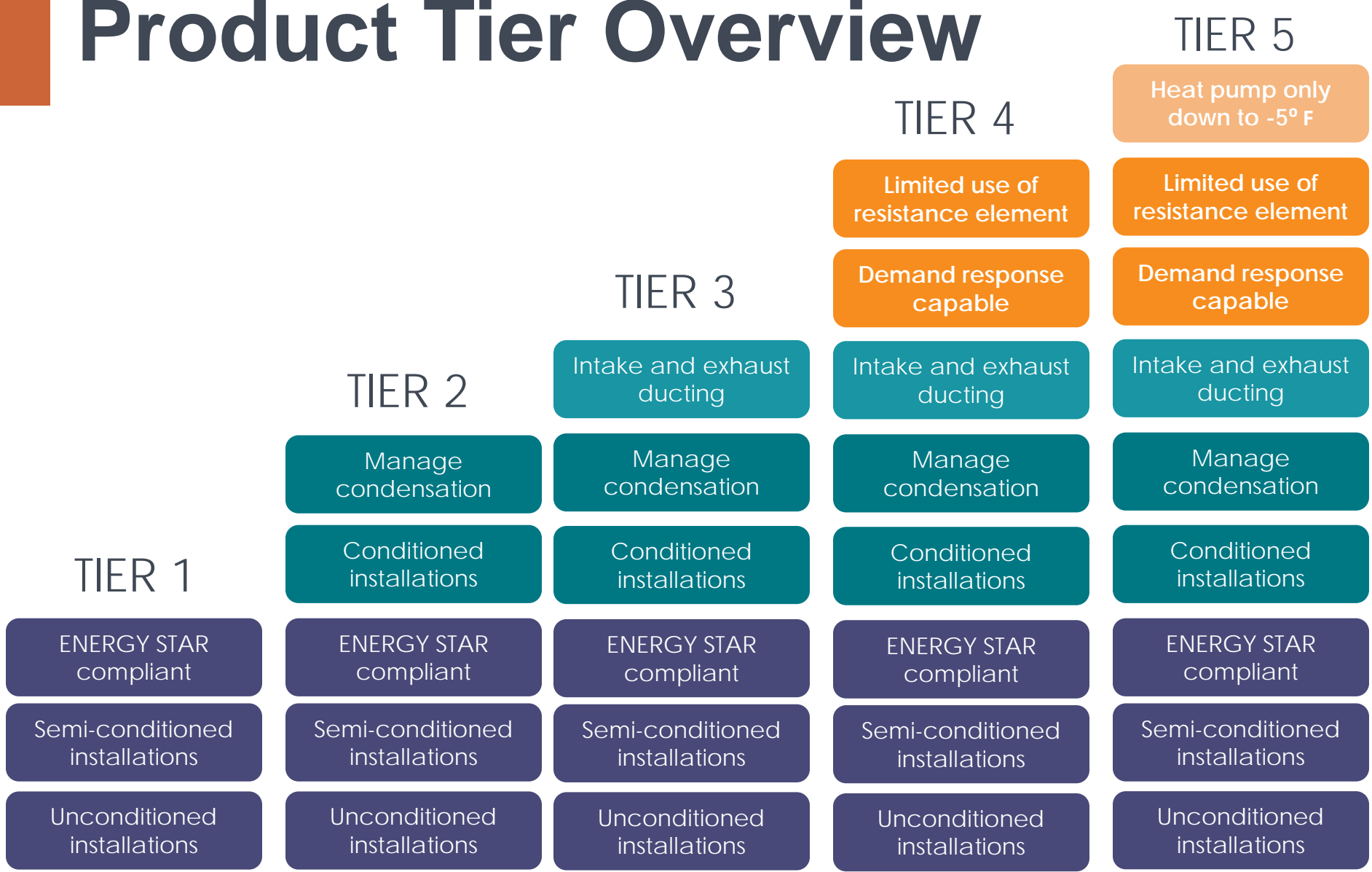
## WATER HEATER COMPARISON

50-Gallon standard  
electric water heater

50-Gallon electric heat  
pump water heater

<p><b>ENERGY STAR®</b> <i>Meets or exceeds ENERGY STAR specifications for energy efficiency.</i></p>	No	<b>Yes</b>
<p><b>UNIFORM ENERGY FACTOR</b> <i>Percentage of energy that is turned into hot water. The higher the number, the more efficient the unit and the less it will cost to operate.</i></p>	0.93-0.95	<b>3.24-3.70</b>
<p><b>FIRST HOUR RATING</b> <i>Number of gallons of water a fully heated water heater can deliver in the first hour of use.</i></p>	60-67	<b>66-70</b>
<p><b>RECOVERY RATE</b> <i>Amount of hot water, measured in gallons, a water heater is capable of providing in 1 hour, assuming 90 degree F increase.</i></p>	20-22	<b>29</b>

# Product Tier Overview



# HPWH vs. CO2 Heat Pump Water Heater



## HPWH

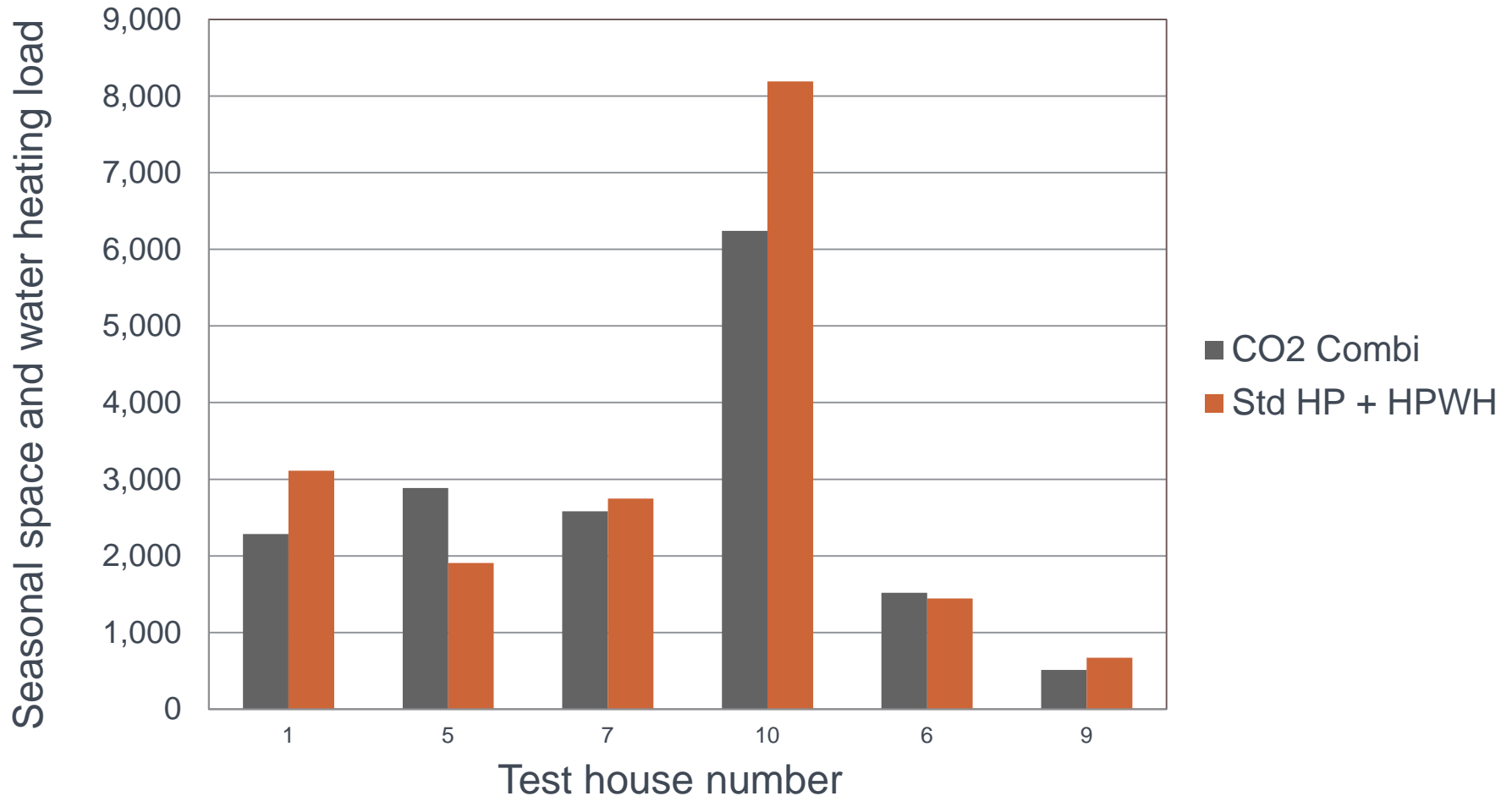
- Great for residential applications
- 0.55 kW Heat Pump
- 8.5 kW backup elements
- Energy Factor: 3.26
- Would cool the surrounding space

## CO2 HPWH

- Designed for residential, works for commercial
- 1.2 kW heat pump (more than twice as large as the standard HPWH)
- No backup elements, good -20 to 110
- Energy Factor: 3.84
- Split system



# Measured Combi & Simulated Standard HP Loads



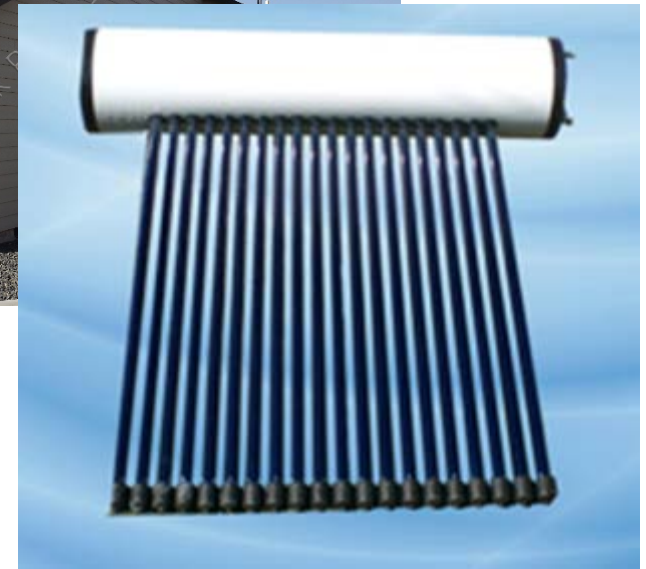
# Energy Savings

- 40% more efficient than an electric water heater and an electric furnace when configured with heat exchanger in air handler
- 55% more efficient than electric systems when configured with a radiant floor system
- PNNL final report published September 29, 2017
  - [See report here](#)



# Benefits of Solar Hot Water

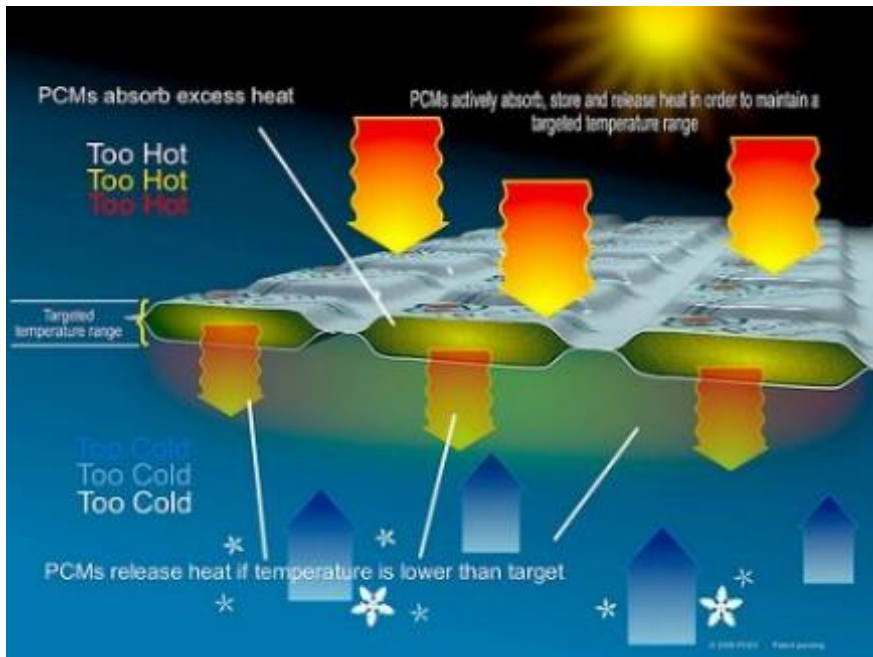
- Low Cost Panels
- UV Enhanced
- Silicon Fluid
- Proven Technology
- ROI
  - Similar to Solar PV
- Builders Embracing



A photograph of two construction workers on a building site. The worker on the left is wearing a white hard hat, a light-colored long-sleeved shirt, and dark pants, and is pointing towards the wooden framing of a building. The worker on the right is wearing a blue long-sleeved shirt, blue jeans, and a tan tool belt, and is holding a hammer. The background shows the wooden skeleton of a building under construction against a clear blue sky. In the foreground, there is a concrete floor with some wooden debris. A large, semi-transparent dark grey rectangle is overlaid on the center of the image, containing the text "What's coming next?". To the left of this rectangle is a solid orange square.

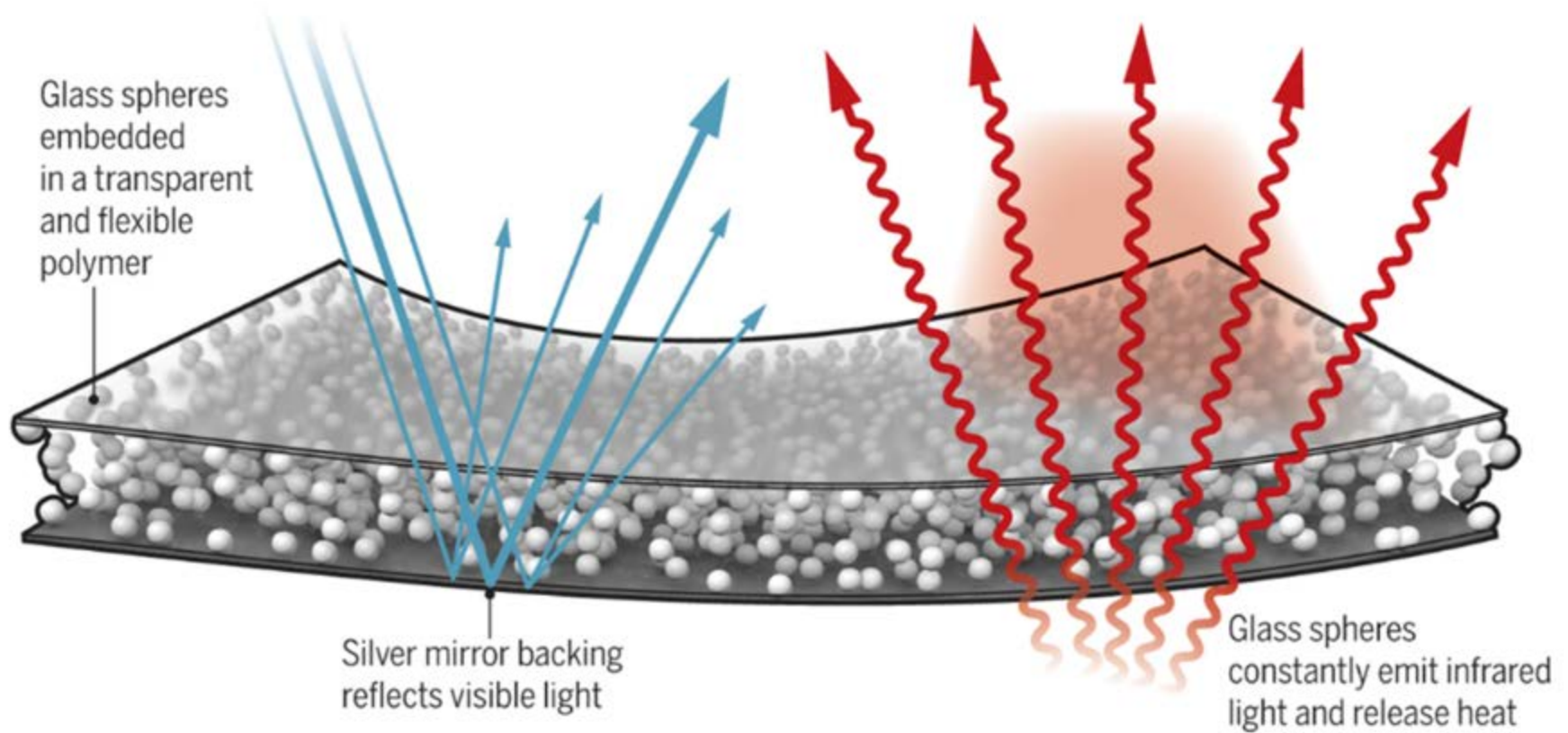
**What's coming next?**

# Phase change insulation





# Radiant Cooling





**What do we propose for  
demand response/DERs?**

# Smart Homes are a no brainer

- Low cost of entry\*
- High customer interest
- Possibility for energy efficiency and demand response



\*For homes with HEMs and Smart T-stats, batteries are not inexpensive!



# Pre-wire, plumb, frame, and ready homes for Solar



<https://www.silkroadenvironmental.com/products>

# Consider your water heaters

Tanks are nice thermal batteries

HPWHs are cutting edge and provide savings

Newest units come with smart controllers and apps

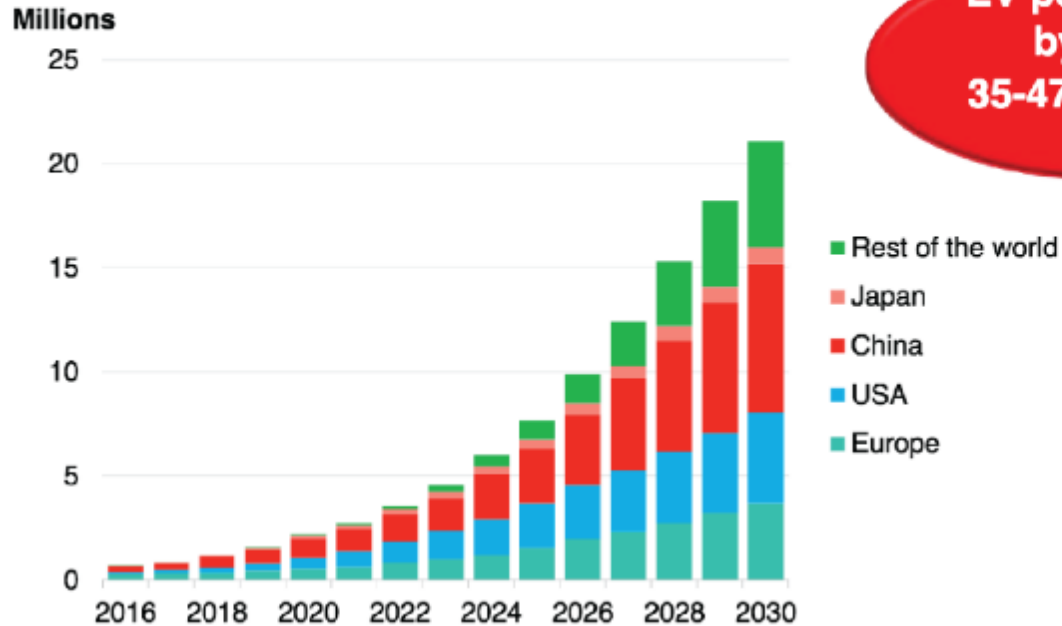


[http://www.rheem.com/products/water\\_heating/tank/hybrid/](http://www.rheem.com/products/water_heating/tank/hybrid/)

# Install or wire for charging stations

## The Rise of Electric Cars

BNEF sees more than 20 million sales by 2030



EV penetration  
by 2040  
35-47% of new  
cars





# Thank You

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