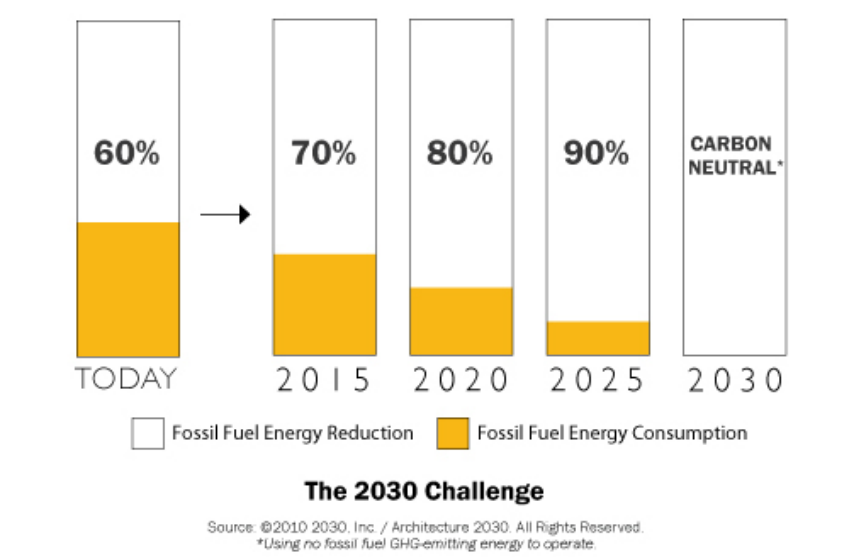
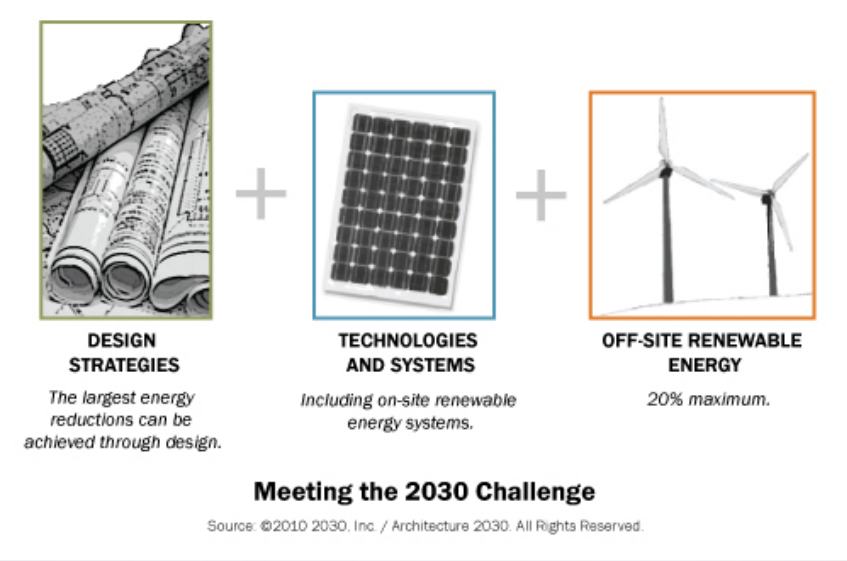
EARLY GENESIS OF ZNE

- DOE Building America - 2001
- DOE Solar Decathlon – 2002
- CEC PIER ZENH Research Program – 2004
- 2030 Challenge – Ed Mazria – 2007
  - http://architecture2030.org/2030_challenge/the_2030_challenge





WHY ZNE? CALIFORNIA POLICY CONTEXT

California Policy Context

» Legislation for Global Warming Solution

- AB 32, 2006 – ARB- GHG reduction goals (back to 1990 level by 2020)

» State Agency adopted goals

- Big Bold Energy Efficiency Initiative – CPUC - 2008
- California Energy Efficiency Strategic Plan – CPUC - 2009
- Integrated Energy Policy Report (IEPR) – CEC – 2009, 2011, 2013

Aspirational

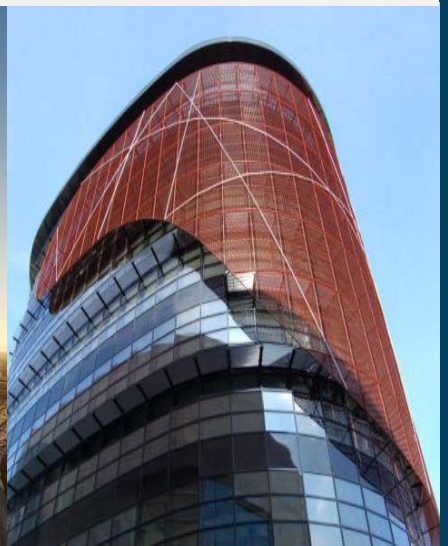
» Legislation for Renewable Energy

- 33% RPS by 2020 (2002 - SB1078, SB 2)
  http://www.cpuc.ca.gov/PUC/energy/Renewables/index.htm
  http://www.energy.ca.gov/portfolio/
- SB1 2006 – million solar roofs – CSI – solar incentives
  http://www.energy.ca.gov/sb1/index.html

Big Bold Energy Efficiency Strategies

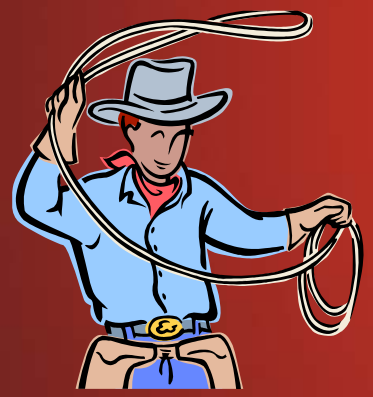
(1) All new residential construction in California will be zero net energy by 2020

(2) All new commercial construction in California will be zero net energy by 2030

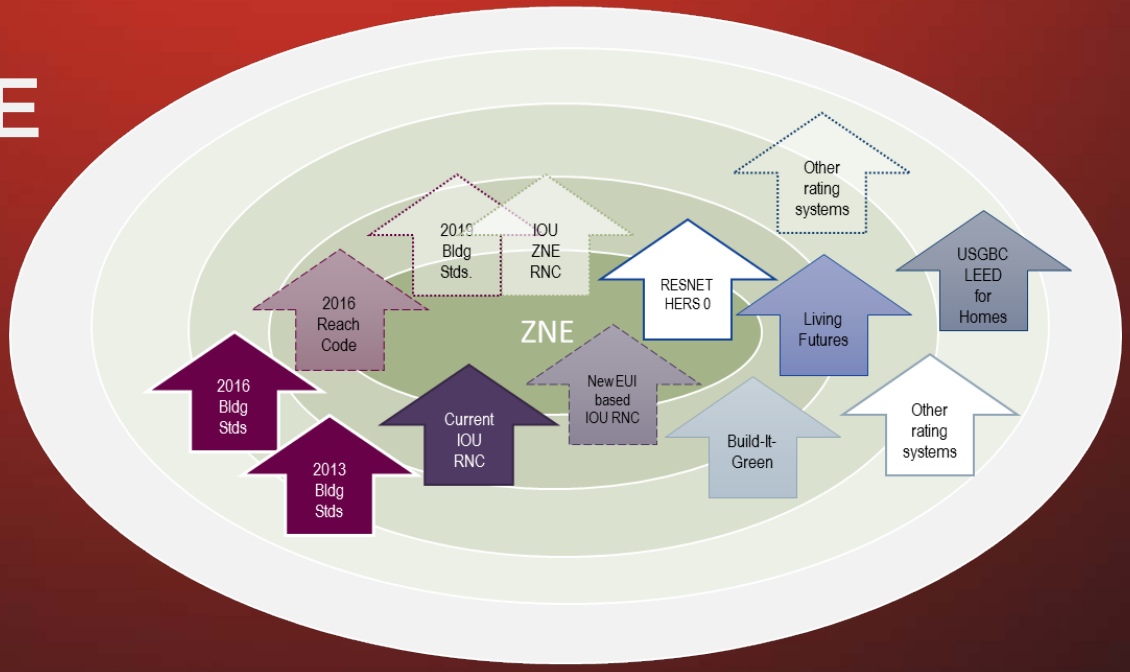


(3) Heating, Ventilation, and Air Conditioning (HVAC) industry will be transformed to ensure that its energy performance is optimal for California's climate

(4) All eligible low-income customers will be given the opportunity to participate in the low energy efficiency program by 2020



DEFINING ZNE

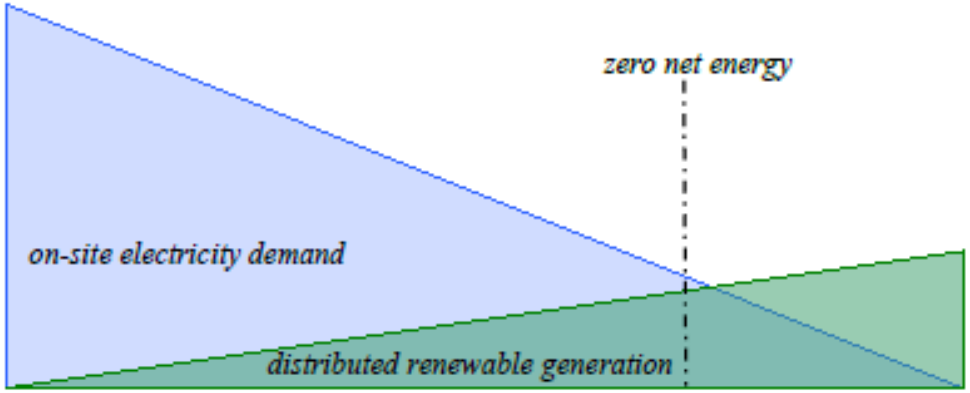


STRATEGIC PLAN DEFINITION

CPUC

WHAT IS ZERO NET ENERGY?

Zero net energy is a general term applied to a building with a net energy consumption of zero over a typical year. To cope with fluctuations in demand, zero energy buildings are typically envisioned as connected to the grid, exporting electricity to the grid when there is a surplus, and drawing electricity when not enough electricity is being produced.



- The amount of energy provided by on-site renewable energy sources is equal to the amount of energy used by the building.
- A ZNE building may also consider embodied energy – the quantity of energy required to manufacture and supply to the point of use, the materials utilized for its building.[29]

INTEGRATED ENERGY POLICY REPORT

CEC

- IEPR 2009
  - *A zero net energy building combines building energy efficiency design features and clean on-site or near site distributed generation of sufficient quantity on an annual basis to offset any residual purchases of electricity or natural gas from utility suppliers.*
- IEPR 2011
  - *…To maximize the alignment of ZNE with California energy system reliability and policy goals, the Energy Commission recommends the use of metrics that account for the societal value of energy, including the critical impact of avoiding peak demand and the value of avoided carbon emissions, and other energy system costs. These components are well-addressed in the time-dependent valuation of energy concept used by the Energy Commission for its efficiency standards and the CPUC for its valuation of efficiency program savings.*
- IEPR 2013
  - *The ZNE Code Building concept is that the building is designed with energy efficiency and on-site renewable energy production such that the net amount of the energy used over the course of a year, measured using the TDV metric, is equal to zero. A ZNE Code Building does not imply a building with zero utility costs.*

NREL TORCELLINI 2006 DEFINITIONS

- **Net Zero Site Energy:** A site ZEB produces at least as much energy as it uses in a year, when accounted for at the site.
- **Net Zero Source Energy:** A source ZEB produces at least as much energy as it uses in a year, when accounted for at the source. Source energy refers to the primary energy used to generate and deliver the energy to the site. To calculate a building's total source energy, imported and exported energy is multiplied by the appropriate site-to-source conversion multipliers.
- **Net Zero Energy Costs:** In a cost ZEB, the amount of money the utility pays the building owner for the energy the building exports to the grid is at least equal to the amount the owner pays the utility for the energy services and energy used over the year.
- **Net Zero Energy Emissions:** A net-zero emissions building produces at least as much emissions-free renewable energy as it uses from emissions-producing energy sources.

EUROPE - NZEB

- The European Union has adopted the Energy Performance of Buildings Directive which requires that “by 31 December 2020, all new buildings are nearly zero- energy buildings.” Net Zero buildings for the European Union are defined as follows (EU 2009):
  - *"… a net zero energy building is where, as a result of the very high level of energy efficiency of the building, the overall annual primary energy consumption is equal to or less than the energy production from renewable energy sources on site".*

- http://www.epbd-ca.eu/themes/nearly-zero-energy

CHALLENGE OF DEFINING ZNE

- ZNE site (implies more onsite PV to offset gas or all electric)
- ZNE source (implies fuel switch benefit between elect and gas)
- Zero cost (no utility bills)
- Grid Neutral (zero annual electric bill) – implies only electric offset
- Carbon Neutral (zero GHG impact) – implies all electric buildings
- Code/HERS II index = 0 implies TDV

- At Building level? What about Community level ZNE?

- ZNE equivalent for cases where Zero is not plausible – dense urban setting or heavily shaded sites
- What about fuel mix? Over sizing PV to offset gas? All electric buildings?

OPTIONS FOR ZNE

Regulator
Code
Mandatory
Modeled

Design

ZNE by Design

- TDV metric
- Needs to be cost effective (even for requiring solar)
- Asset rating with HERS II score = 0
- Enforceable

Market
Certification
Voluntary
Modeled

Build

ZNE Certified

- Site or Source Energy metric
- Asset rating - Assumes operation characteristics
- Disclaimer and Litigation
- Label/Brand value
- No or low extra cost

Owner/Operator
Performance monitoring
Voluntary
Actual

Operation

ZNE by Operation

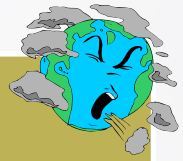
- Zero Utility Bills
- End user control (behavior)
- Financial motivation
- Fuel mixing
- No cost effectiveness test required

MOTIVATIONS FOR ZNE

At the building or community level

- Minimize impact on transmission and distribution grid
- Meet renewable generation RPS goals

Utility
Zero Grid impact



Policy/Regulators
Zero GHG

- Lower GHG emissions
- Avoid building new power plants
- Increase renewable energy on grid (RPS)

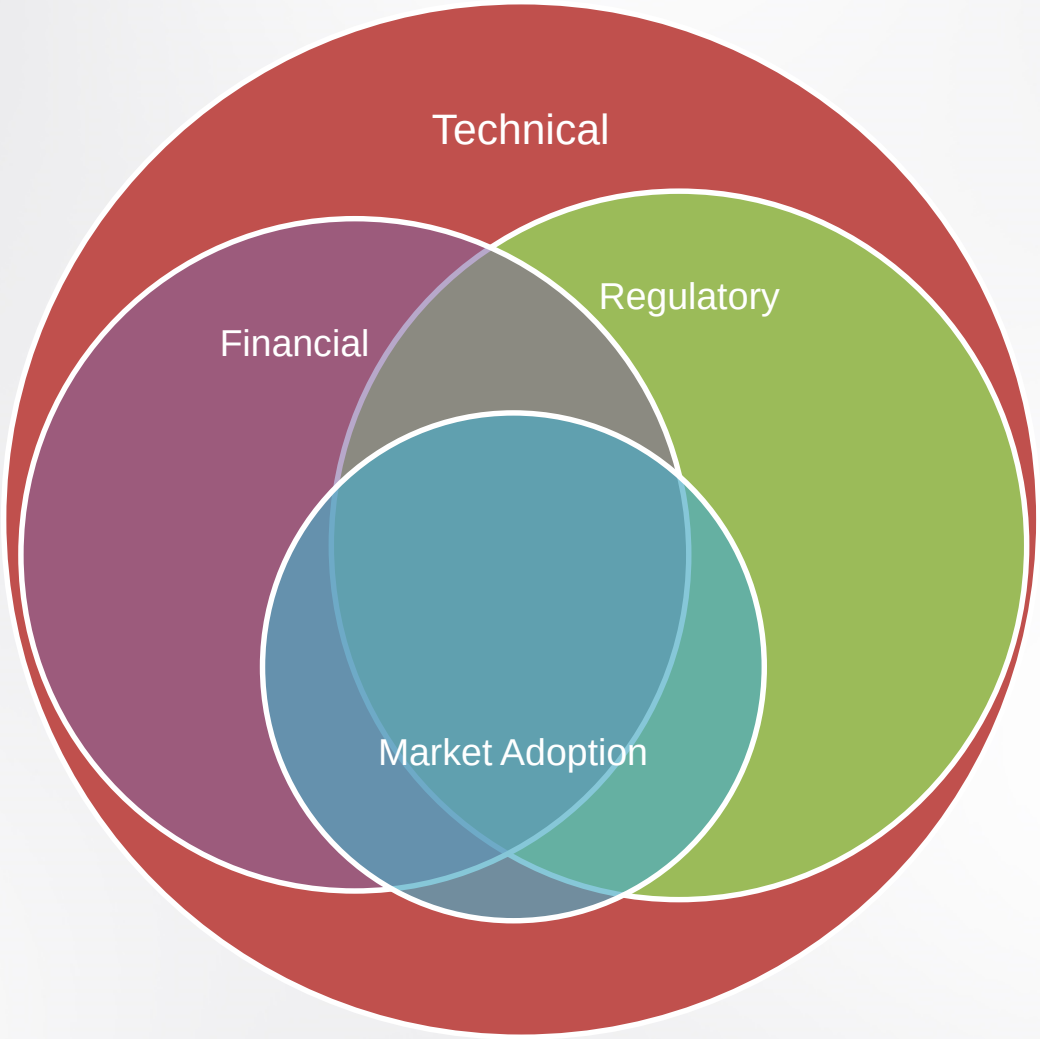
End user
Zero Bill

- Lower utility bills
- Lower carbon foot print

Net
0

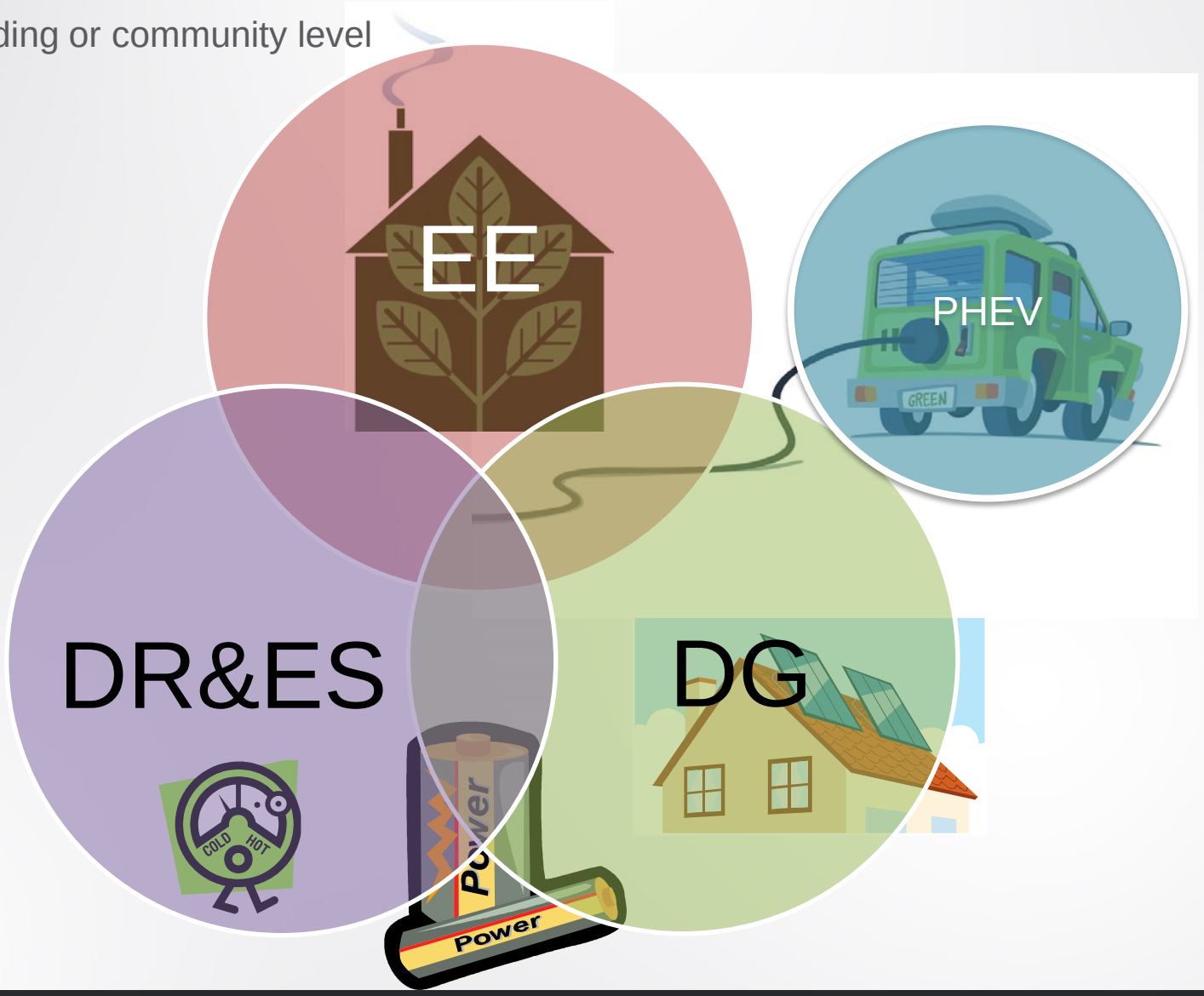
Builder/Developer
High Sales

ZNE SOLUTION SPACE



INTEGRATED DEMAND SIDE MANAGEMENT

At the building or community level



Demand Control Measures

Passive Measures

- Design orientation to minimize space conditioning needs
- Building envelope material characteristics
- Day-lighting – window design
- Natural ventilation – operable openings
- Integrated Building Design

Active Measures

- Appropriately sized and High efficiency HVAC equipment
- High efficiency water heating
- Ground source heat pumps and other such fuel efficient equipment
- Appropriate and High efficiency lighting

Control Measures

- Programmable thermostats
- DR - Communicating Thermostats
- Lighting controls
- Occupancy sensors
- Plug load controls

Distributed Energy Resources

Energy Generation

- Solar electric – BIPV
- Solar thermal – hot water
- Hybrid PVT, tri and quad generation

Energy Storage

- Electric battery storage
- Thermal storage