Emerging Technology: Key Trends and Opportunities

DAVID HEWITT

MAY 1, 2015

Review of Data from Three ET Areas

Pace of change for several markets and technologies, based on trend data developed by NEEA.

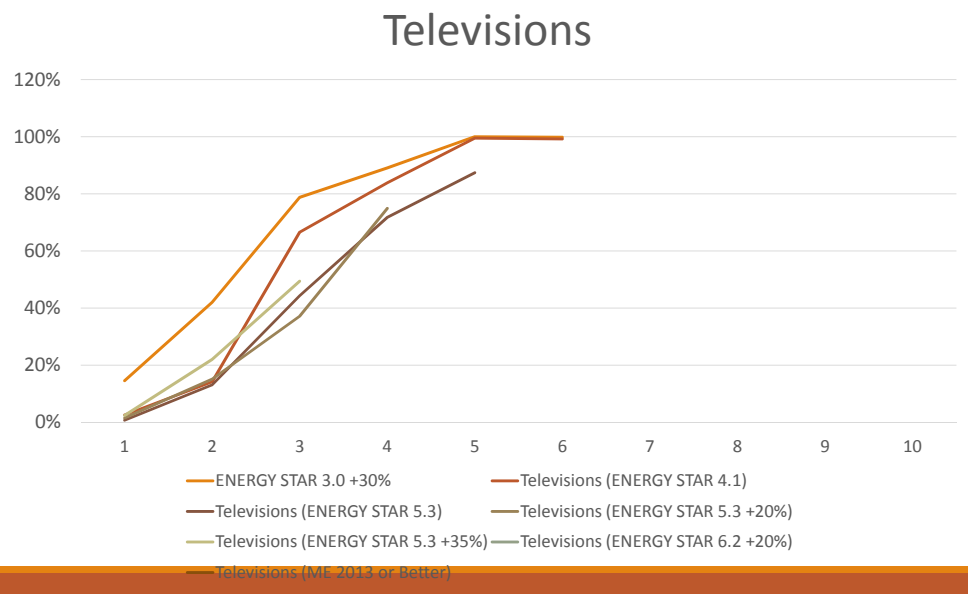
Continued changes to the pricing and scale of solar photovoltaic systems.

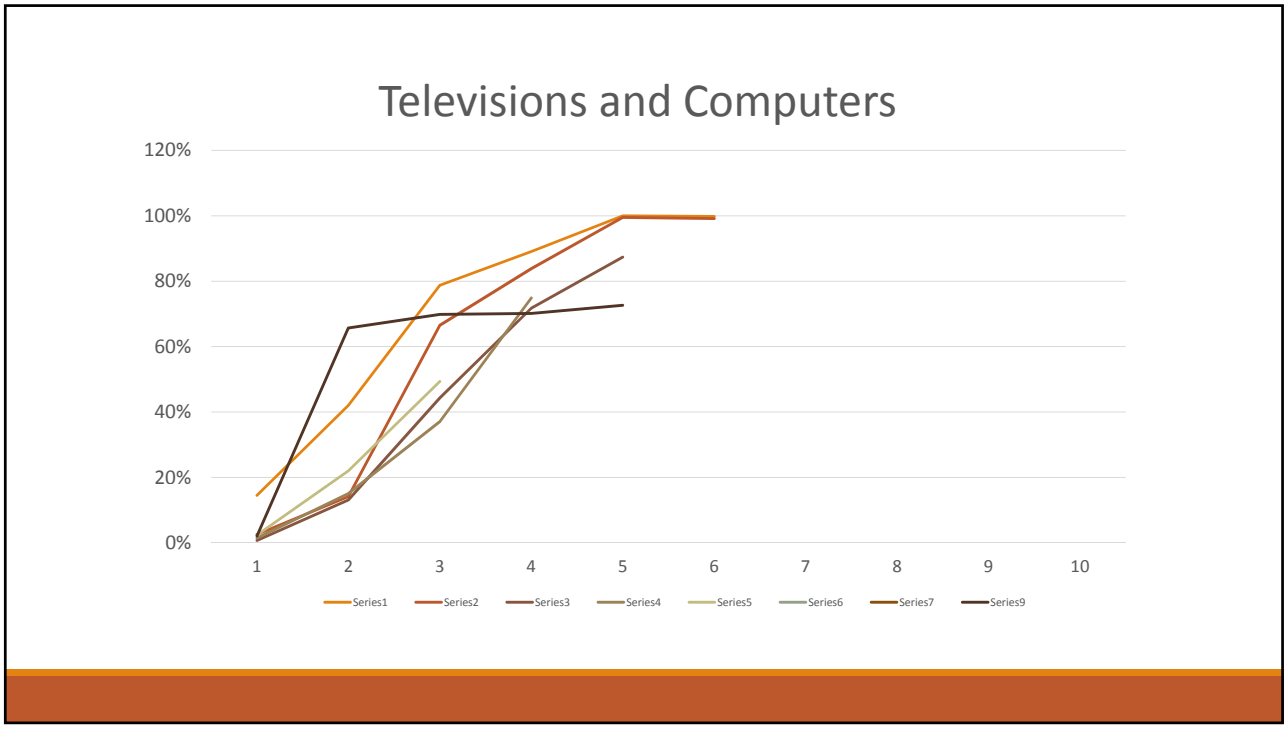
Opportunity in systems based approaches, as opposed to individual technologies, with an emphasis on Zero Net Energy design and construction.

Review of NEEA Data
(with many caveats)

NEEA data was analyzed for generalizable pace of change information for three technology types.

- Quick turn markets such as **consumer electronics** can transform very rapidly, **typically reaching market dominance in three to five years.**
- Incremental improvements to **appliances** are a well proven strategy which can **reach market dominance in five to seven years.**
- **Disruptive technology** refers to an enhanced or completely new technology that replaces and disrupts an existing technology, rendering it obsolete. After meeting market thresholds in terms of quality, price and manufacturing infrastructure, **reaching substantial market shares of sales will likely take ten years or more.**




Televisions and Computers
120%
100%
80%
60%
40%
20%
0%
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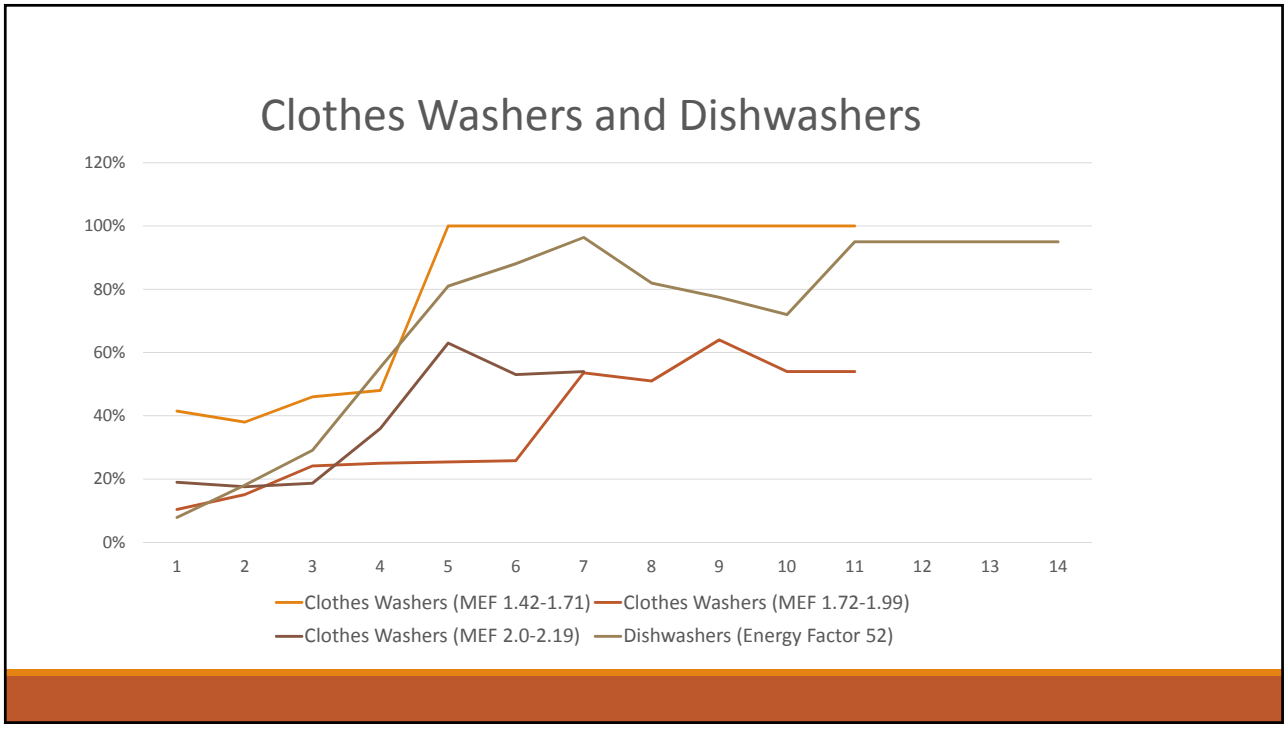
Series9


Clothes Washers and Dishwashers
120%
100%
80%
60%
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20%
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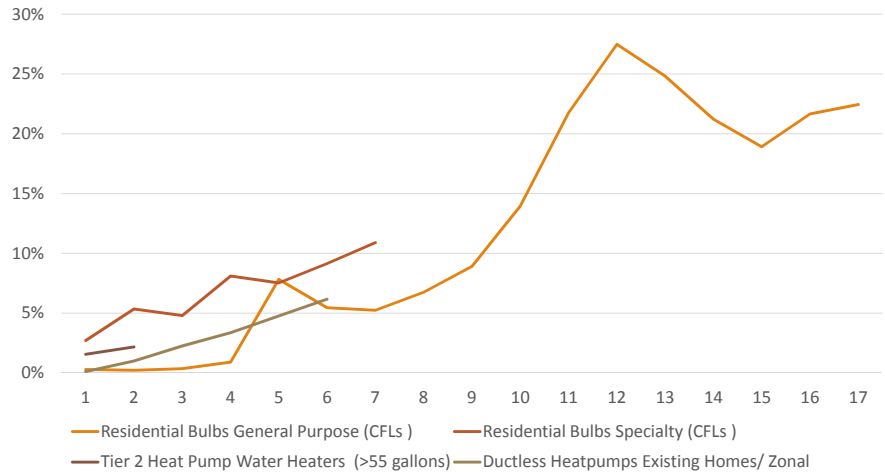
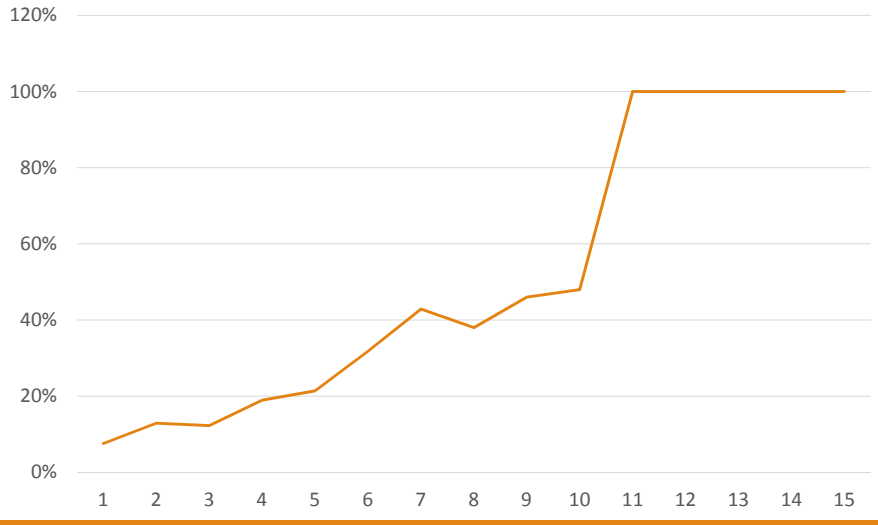
Clothes Washers (MEF 1.42-1.71)
Clothes Washers (MEF 1.72-1.99)
Clothes Washers (MEF 2.0-2.19)
Dishwashers (Energy Factor 52)

Disruptive Technology

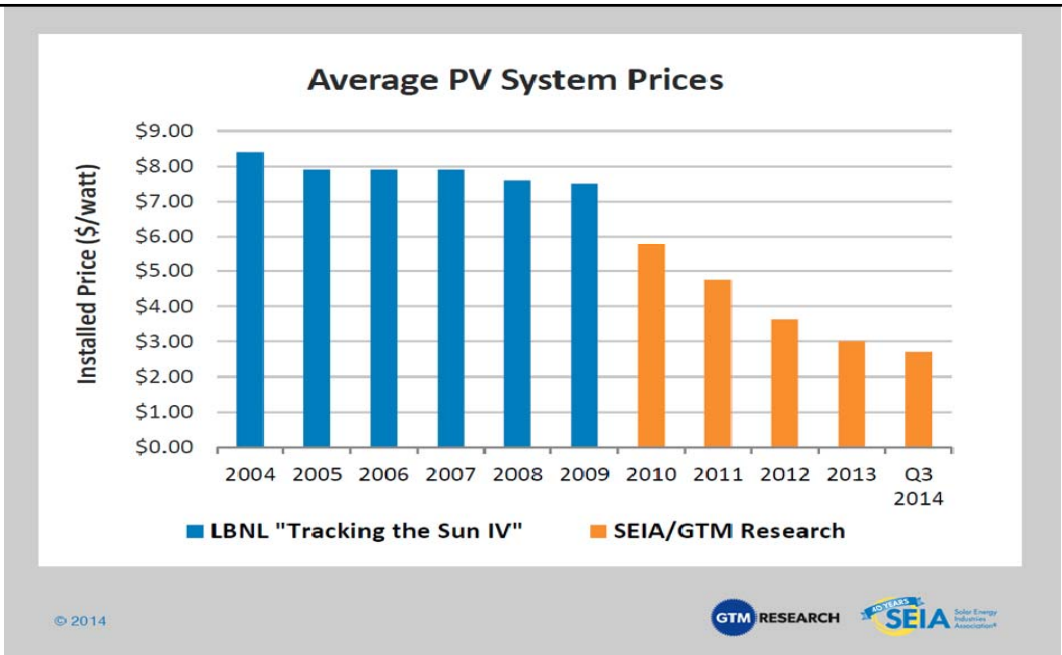


Clothes Washers (MEF 1.26-1.41)

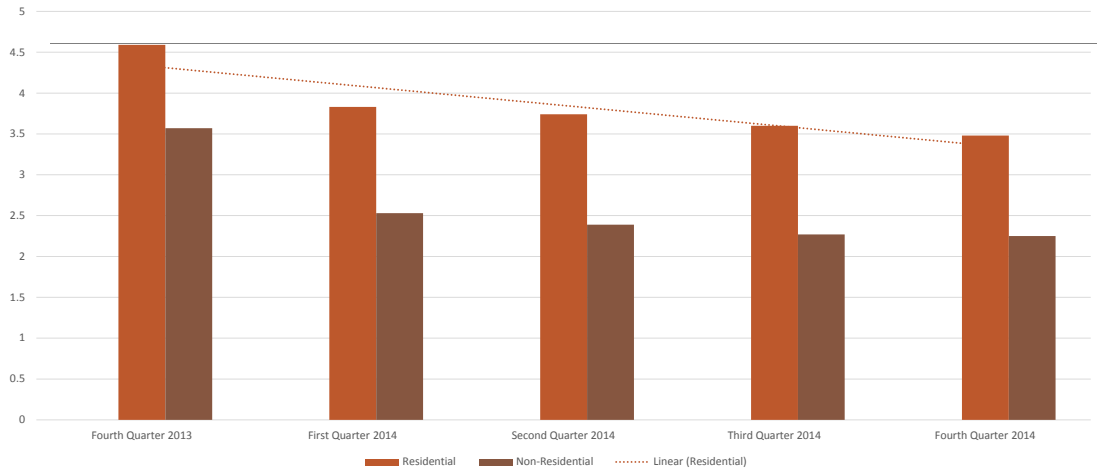


Costs and Scale of Solar PV

- The scale and pricing of PV has changed dramatically and continues to change.
- In terms of installed capacity, the amount of PV installed was twenty times greater in 2014 than it was in 2008, only six years earlier, and,
- The price has dropped by two-thirds.
- The industry has reached a high level of maturity with new business financing models and the development of a robust business infrastructure.
- Community-scale installations are becoming more common. Community scale installations offer economies of scale, a new ownership structure, and the ability to serve buildings with restricted on-site capabilities



Residential and Commercial/Community PV Costs



Demand-side PV installed costs have decreased to $3.48 per installed watt for residential and $2.25 for non-residential.

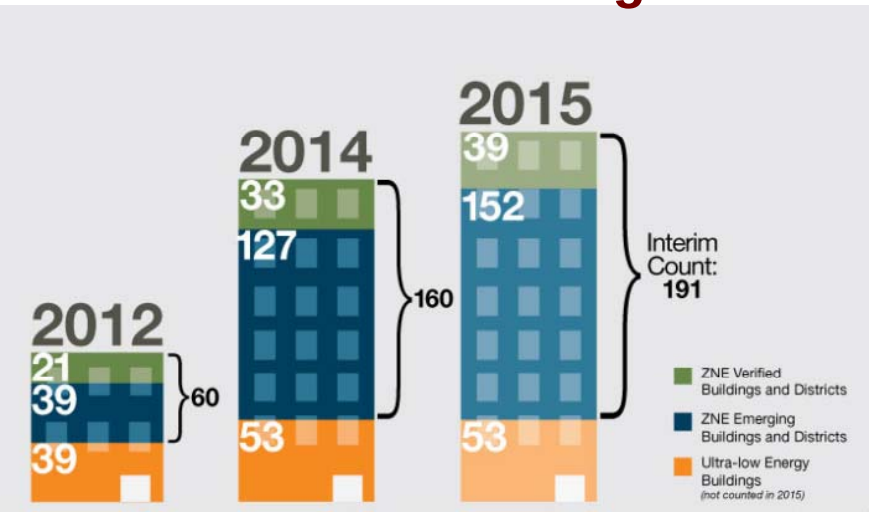
Community Scale PV Options

- PVs can be difficult to install or inappropriate for direct installation on many building due to shading, structural or ownership issues.
- A community scale system can benefit from economies of scale, be appropriately sited for optimal energy production and grid integration, and use a variety of financial or ownership models.
- There is an industry that has developed around these larger installations.
- A significant number of community scale solar installations are owned by public utilities and co-ops, while others are privately or collectively owned.
- The U.S. Department of Energy (DOE) SunShot Initiative recently provide $14 million to 15 awardees to identify business models and make solar more accessible and affordable.

Status of the ZNE Market

WITH THANKS TO CATHY HIGGINS AND NEW BUILDINGS INSTITUTE

Numbers Of ZNE Non-Res Buildings



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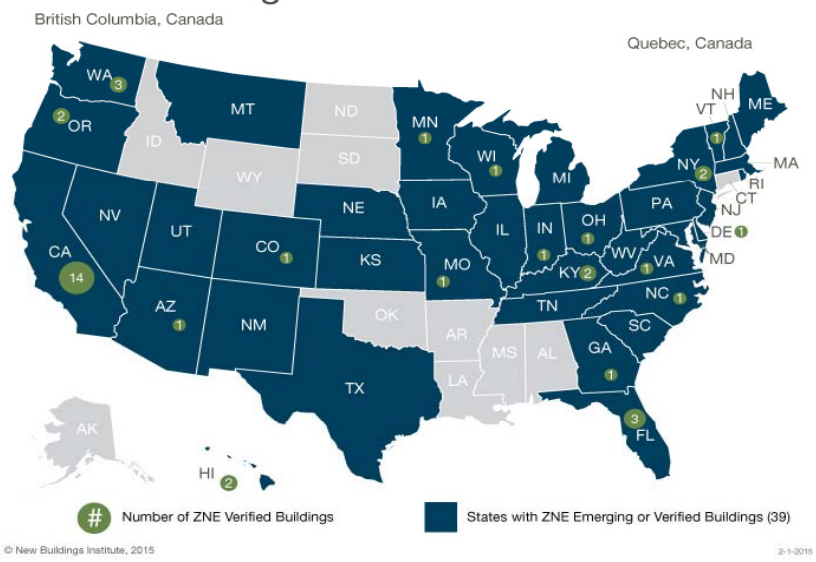
ZNE Building Locations in North America



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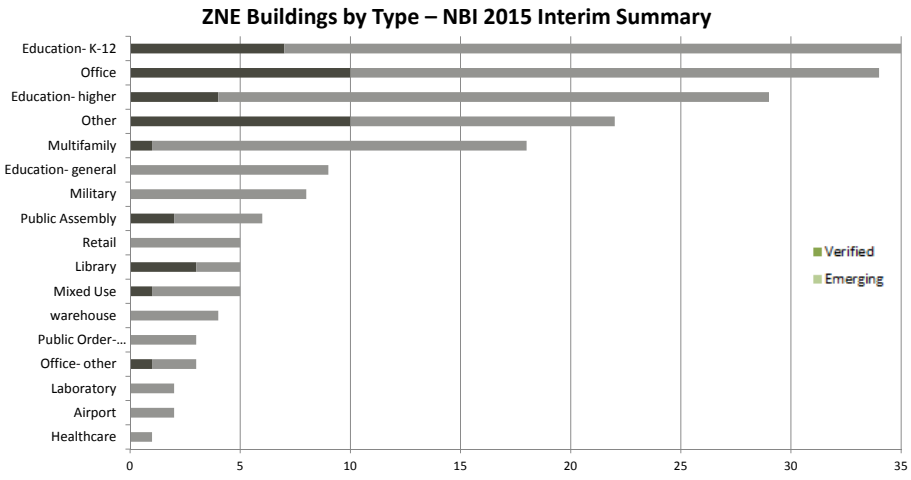
14 Building Types



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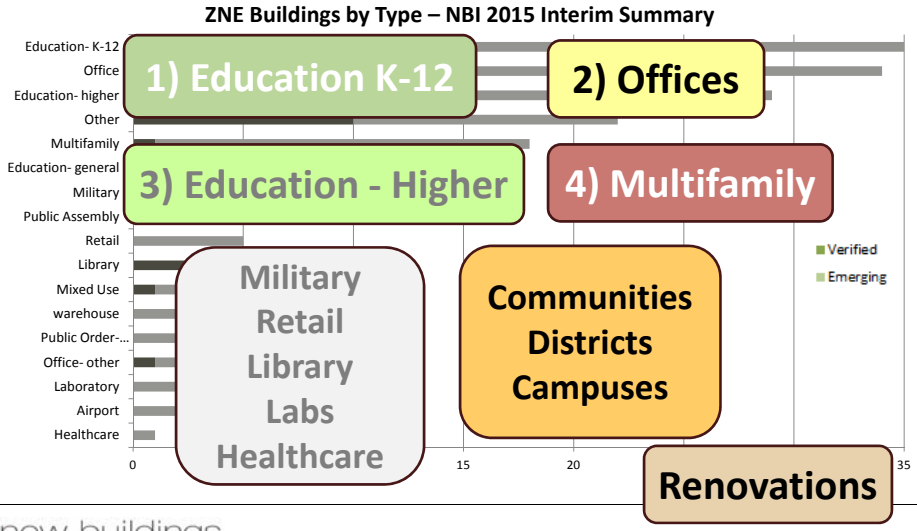
14 Building Types and Trends



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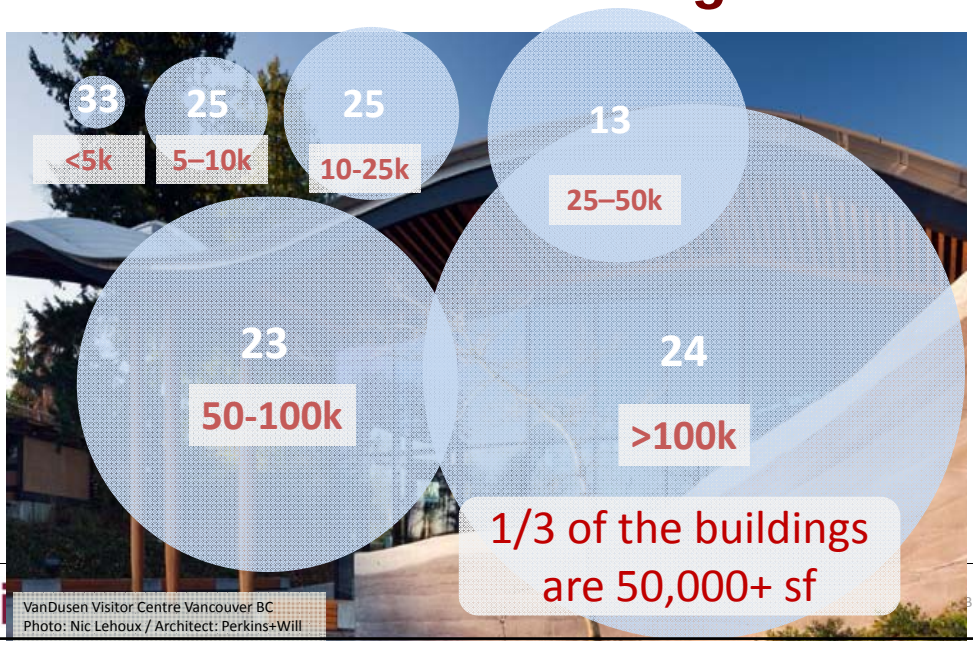
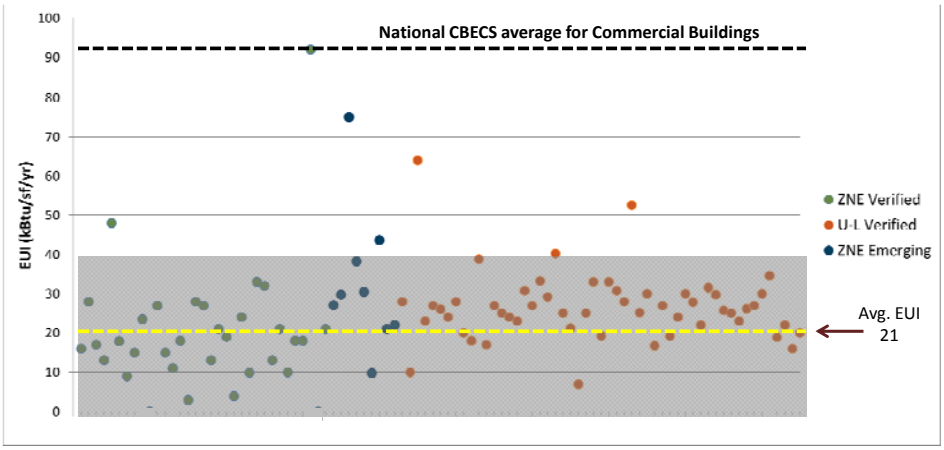
Size of ZNE Buildings



VanDusen Visitor Centre Vancouver BC
Photo: Nic Lehoux / Architect: Perkins+Will

Performance Range

(measured performance data)



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Non-Res Market Status

- ZEBs are technically feasible. ZEBs are more about careful and comprehensive design/construction than they are about new technology.
- The design and construction industry can deliver ZEBs. While the market is nascent, a number of firms have designed and constructed a wide variety of building types, sizes and designs that meet ZEB definitions throughout the U.S. and Canada.
- Costs is a complex issue for integrated building projects, however, a variety of ZEBs have been designed and built within normal cost parameters and the largest identifiable incremental cost – the PV system – has dropped dramatically in price over the last few years.

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Residential ZNE Market

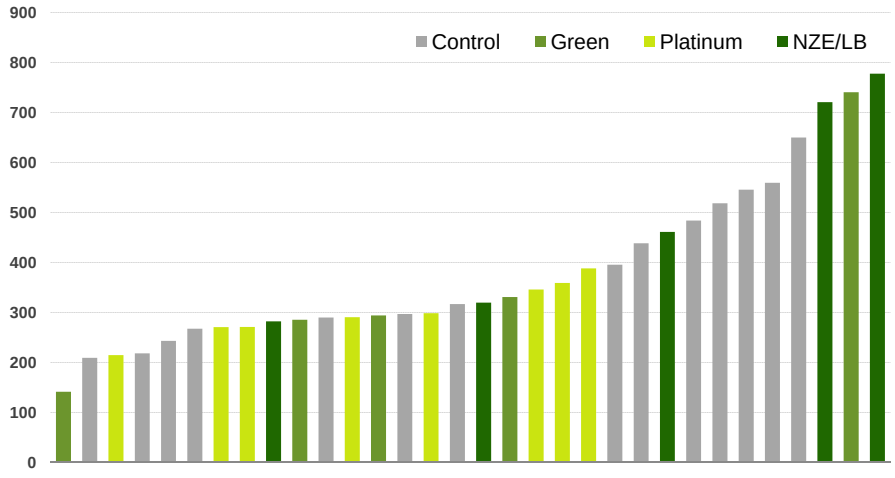
- Residential ZNEs have not been documented as well as non-residential buildings to this point and only limited national data is available. An informal estimate from U.S DOE staff is that there are 500 to 1,000 single family ZNEs nationally.
- DOE also noted that "Following the successful ENERGY STAR Certified Home program playbook, DOE Zero Energy Ready Home is making an impressive entry into the housing market. Within a year of the Zero Energy Ready Home launch in January 2013, there were nearly 8,000 homes committed by builder partners.
- A recent study in California identified only sixteen ZNE homes but over one thousand ZNE-ready and near ZNE homes in that state. The study found that over 50 builders have been active in ZNE homes in CA.

ZNE Cost Summary

- Both residential and commercial ZEBs have been built within standard construction budgets, and/or at the average cost of construction per square foot.
- Not everything that goes into the design and construction of a ZNE building adds costs. For example, reducing the amount of glazing increases the efficiency of a building while also reducing costs - it is a choice or trade-off.
- The integrated design process that drives the design of ZEBs can lead to a variety of trade-offs including, for example, not just a reduction in the HVAC equipment sizing, but a change to different equipment types and how heating and cooling are distributed.
- Adding a PV array to the building is a clear incremental cost, but there are two additional dynamics at work;
  - Installed PV costs continue to drop, which complicates use of historic data.
  - The customer may choose to buy into a community system.

low-rise office building

statistical analysis



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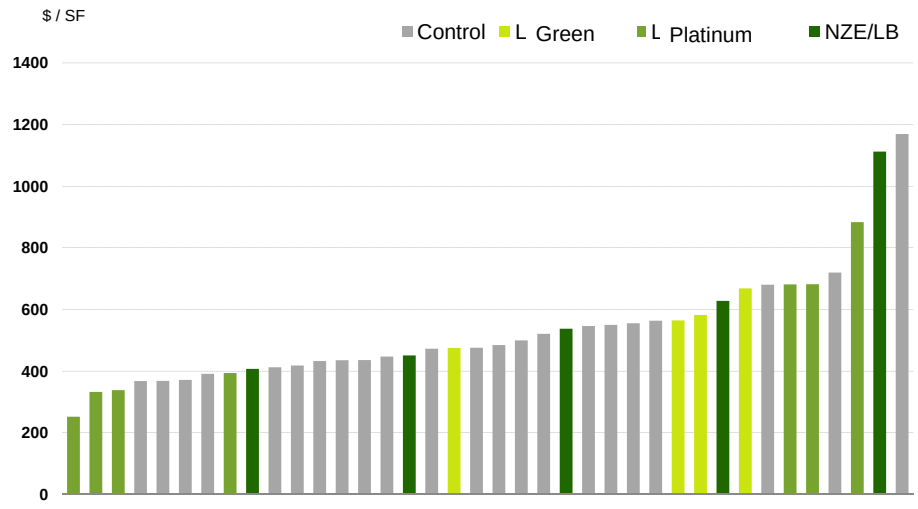
BUILDINGS MEASURED

LISA MATTHIESSEN, PETER MORRIS AND LAURA LESNIEWSKI

community centers

statistical analysis



BUILDINGS MEASURED

LISA MATTHIESSEN, PETER MORRIS AND LAURA LESNIEWSKI

Residential ZNE Costs

- The most recent cost estimates come from a study in California when high performance builders were asked for their estimate of the incremental cost of building a 2,500 square foot ZNE home compared to a Code-built home. Eleven of the builders interviewed provided incremental cost estimates with responses of 5%-15% or $15,000 to $50,000. (TRC)
- A 2012 based on case studies, noted that, “Residential buildings, which generally have a lower potential for “cost tradeoffs” common to high performance commercial buildings, are estimated to have incremental EEM costs on the order of $2-$8 per ft2 for a package of conventional EEMs, with current PV costs on the order of $4.50/ft2.” (Davis Energy Group)
- Updating these figures for reduction in the PV costs and applying to a 2,500 square foot house yield current cost estimates of $13,750 to $29,750 (5% to 10% on a $300,000 new home)

Questions/ Comments

THANK YOU