Emerging Approaches & Technologies For Net-Positive Design

Presented by Deborah A. Byrne

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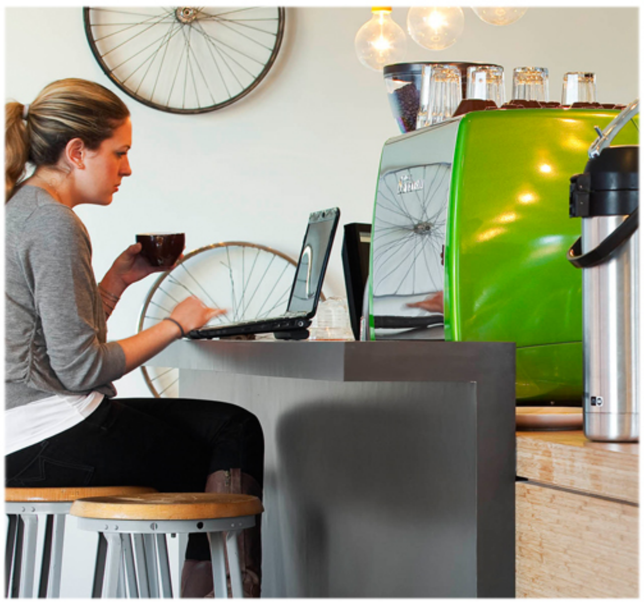



Benefits, Pit-falls, Risks & Market Misconceptions

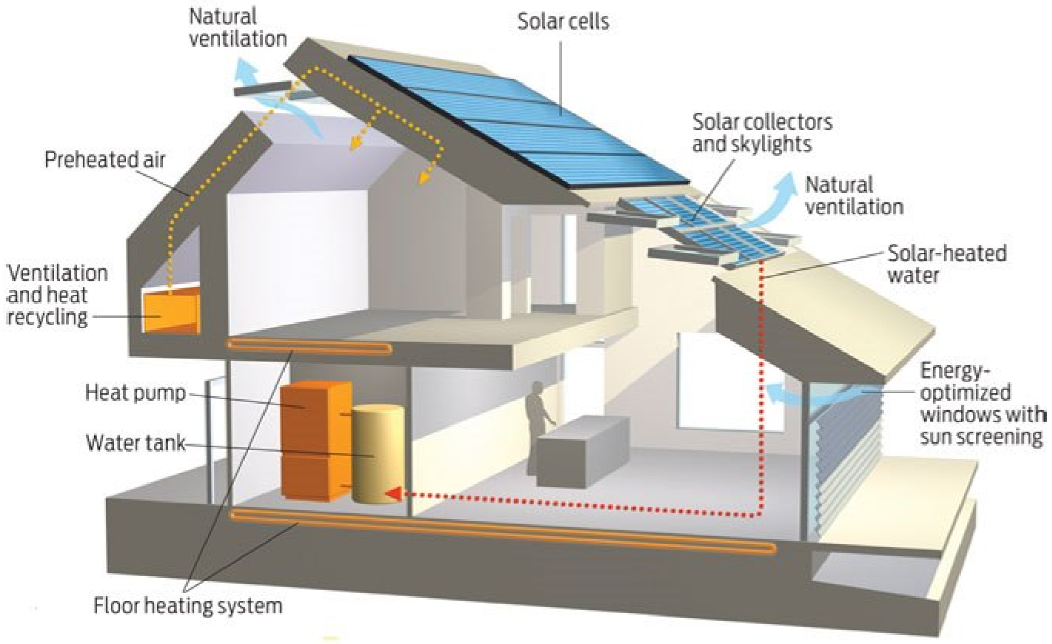
What is Net Zero Energy Building, NZEB?

- Living Building Challenge, Renewable Energy = Energy Used
- How to measure Net Energy?
- Energy Autonomous Buildings
- Grid Reliant Buildings

All Net Zero Energy and Energy Plus Buildings have one thing in common:

What is Net Zero Energy Building, NZEB?

➢ A BALANCED ENERGY BUDGET



** Courtesy of Ellen Kathrine Hansen, Architect*

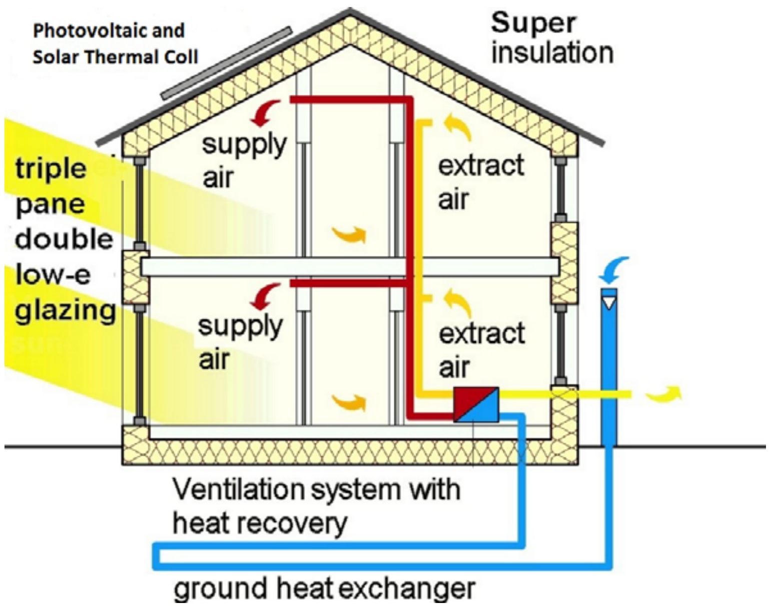
How to Achieve Net Zero Energy Building, NZEB?

- Address energy efficiency targets
- Account for local conditions
- NZEB without energy efficiency; difficult
- Study of existing commercial stock; reduce their energy by 60%
- Study other buildings; reduce their energy by 90%
- Building location, orientation and scale dictate generation possibilities
- Potential alternatives (CHP and CCHP)

How to Achieve Net Zero Energy Building, NZEB?

With these limiting factors the main focus of NZEB design should always be:

- A REDUCTION IN ENERGY DEMAND



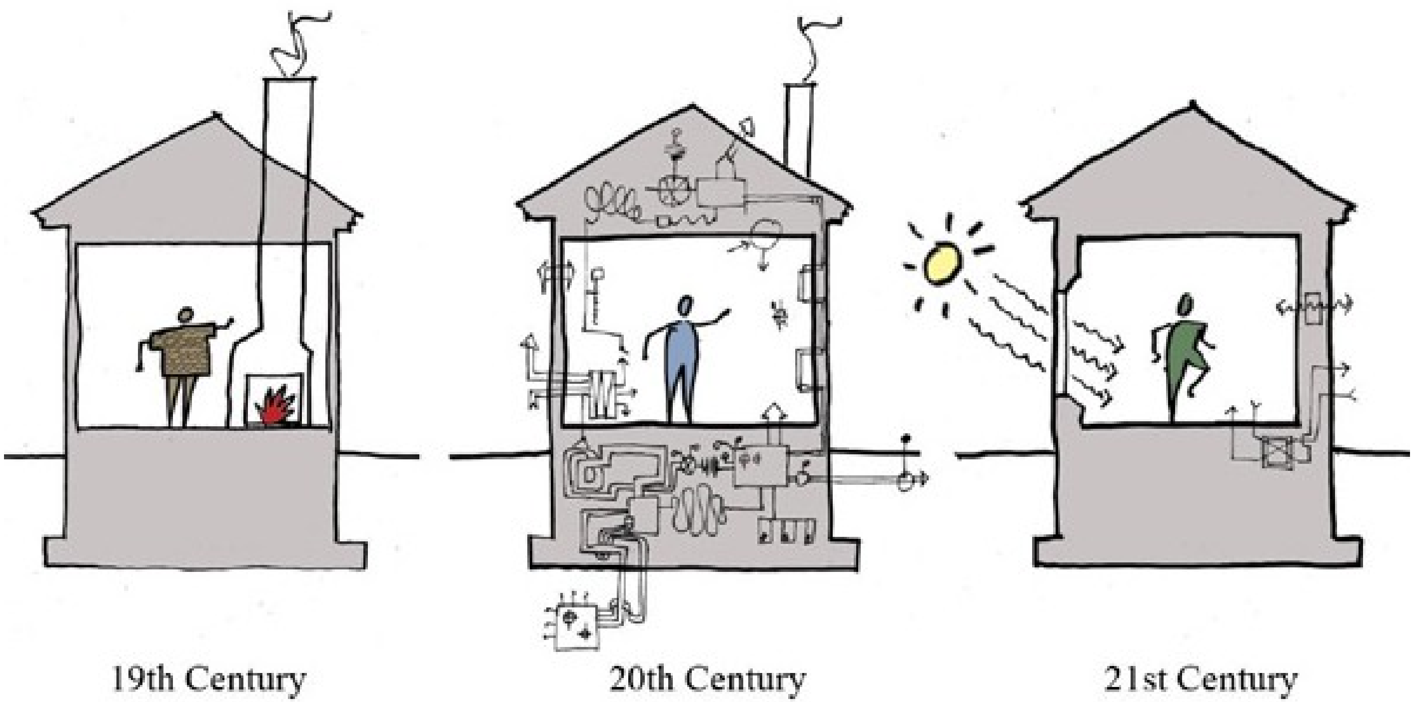
** Courtesy of Passive House Institute, Darmstadt*

NZEB/Energy Plus (E+) ≠ Low Energy

Net Energy/Energy Plus does not automatically result in the following:

- Lower Carbon Footprint
- Reduced Utility Fees
- Energy Earning Potential
- Reduced Operational Costs
- Reduced HVAC Capital Costs
- A Better Building
- A Cheaper Building
- A Healthier Building
- An Increase in the Rate of Return or Reduced Payback Period

Is NZEB the Same as Low Energy?



** Courtesy of Albert, Righter & Tittmann Architects* green reason

How to use a Low Energy Building to Achieve NZEB?

Low Energy with Renewables (LE++) = NZEB, E+

Low Energy Buildings automatically result in the following:

- Lower Carbon Footprint
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How to use a Low Energy Building to Achieve NZEB?

A 2953m2 College in Lower Saxony, Germany, with the entire roof covered in PV amounting to 172kWp

Air Tightness of n_{50} = 0.34ach

Total Energy Demand = 15 kWh /(m^2a)

Primary Energy = 94 kWh /(m^2a)

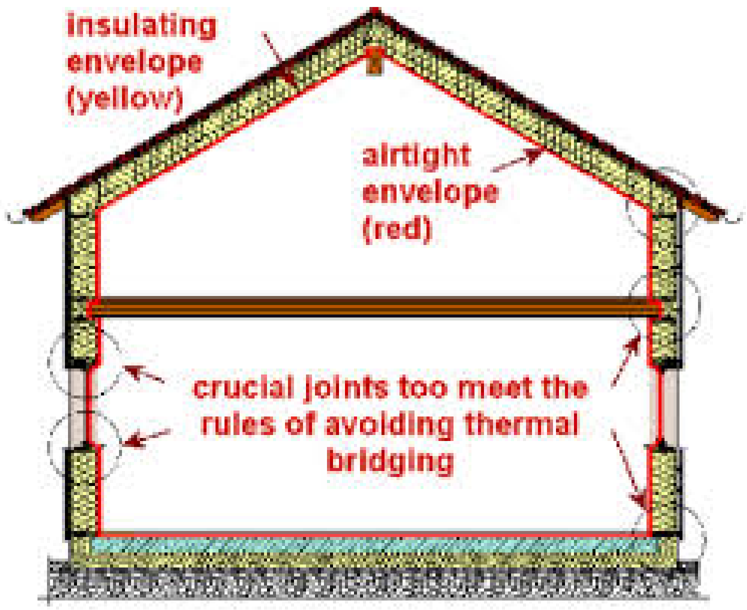
Energy Balanced, therefore NZEB

** Courtesy of Passive House Institute, Darmstadt*

Improving Minimum Accepted Building Standards

Building Envelope

- Air tightness
- Insulations
- Windows
- Breathability

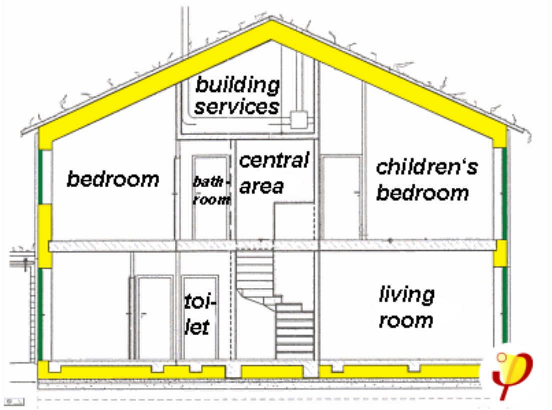


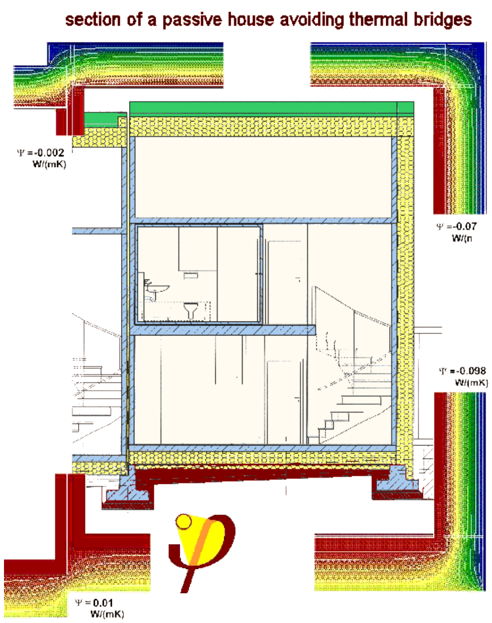
** Courtesy of Passive House Institute, Darmstadt*

Improving Minimum Accepted Building Standards

Considered Architecture

- Orientation
- Location/weather
- Shading
- Scale, compactness and logical layout
- Structural elements, thermal bridges



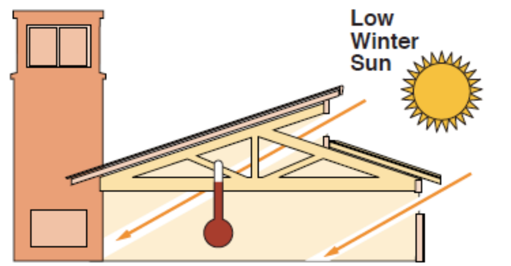


** Courtesy of Passive House Institute, Darmstadt*

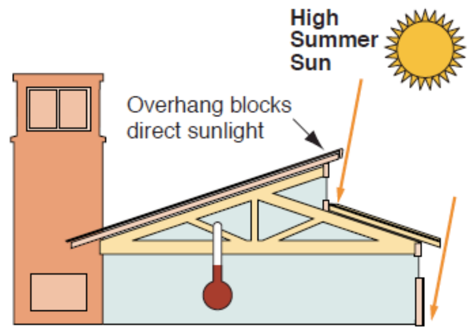
Improving Minimum Accepted Building Standards

Passive Strategies

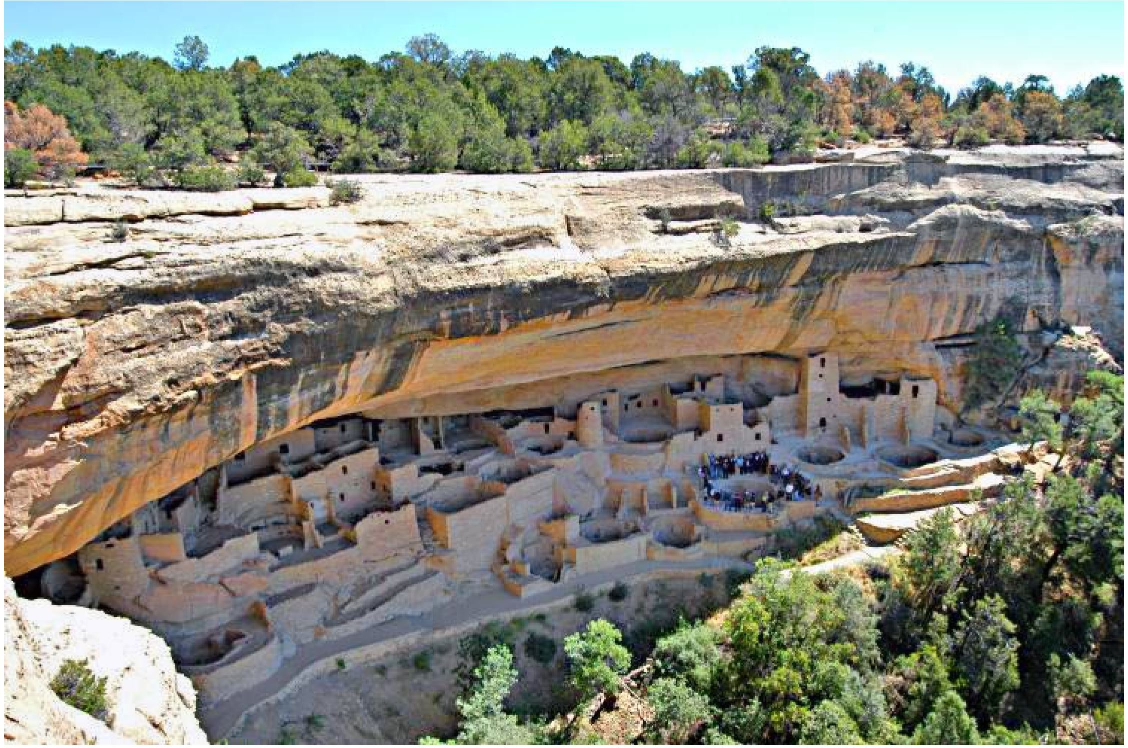
- Minimize losses and maximize gains
- Capture embodied energy
- Thermal mass
- Passive solar
- Phase change materials



South windows accept direct sunlight to light and warm the building interior



** Courtesy of greenpassivesolar.com/mesa-verde-cliff-dwellings*



Cliff Palace, Mesa Verda, Cliff Dwellings
Occupied up until 1300AD

**Courtesy of Wikipedia, Credit – Lorax*

The Passive House Standard as an Approach to NZEB

The Passive House Standard; reduce energy from heating/cooling by 90%.

- Minimum standards on all building components
- The Passive House Planning Package, PHPP
- Allowable Energy Demand is 15kWhr/m2.a (Heating/cooling)
- Allowable Total Primary Energy is 120kWhr/m2.a
- Very very low envelope U values
- Extremely Airtight <0.6 ach at n50
- Thermal Bridge free construction

PHI have spent many years scientifically re-evaluating and validating, these specifications and they have verified that:

- 15kWhr/m2.a is the Magic Number

Pitfalls

- Materials
- R value and U Value
- Airtightness testing
- Thermal Bridges
- Marketing material / technical specifications
- Airtight /breathable

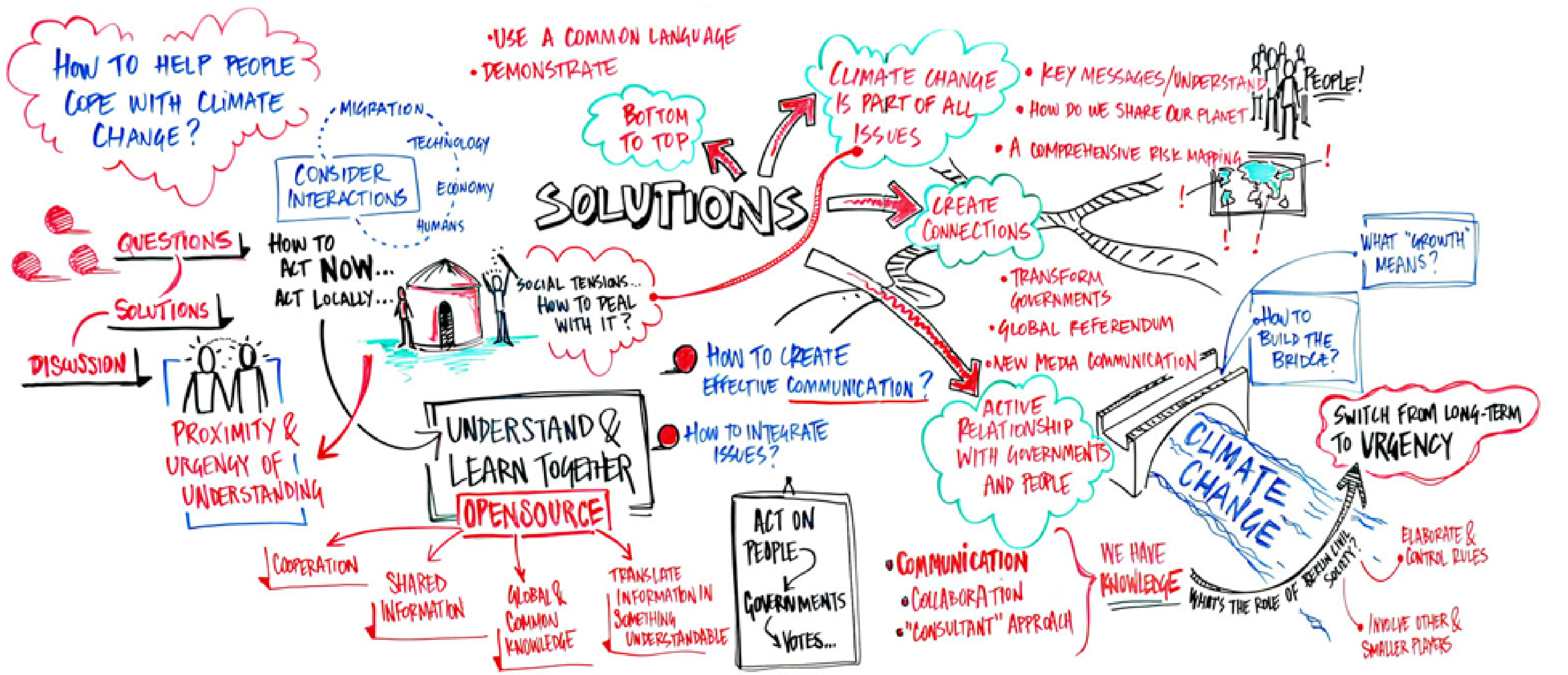
Risks

- The wrong team
- Education, Education, Education
- Coordination, Coordination, Coordination
- Project delays
- Budget
- Municipalities
- Commissioning deemed as an extra or a credit
- Poor contractor and design team relationships
- Aggressive contractor competitions

Risks to NZEB and E+ , beyond Passive:

- Grid limitations
- No on site storage for excess energy
- Tariff connections
- Tariff fee per unit
- Area available for generation, co-generation or tri-generation.

Answer: EVERYONE



** Courtesy of thevalueweb.org*

What are the Market Misconceptions that Prevent Us Doing Better?

- Availability of materials
- Price of energy
- Market demand / tenant requirements
- The fear of the new and other existing complex projects
- It's a "Fad" - Doubter
- Grid ready and tariff fee
- Assumed additional cost
- Assumed additional maintenance
- Potential Impact to Design
- Longevity of new materials
- The mentality that "this in not Europe"
- Change in typical volume to floor ratio, more compact designs
- Time, Cost, Quality
- Site location/ demographic
- Contractor experience
- That "Green" is a premium

What are the Benefits to Achieving NZEB/E+ Through PH Design?

- Future Proofed Building
- Healthy
- Comfort factor
- Cheaper operations
- No energy speculation necessary
- Lower maintenance
- Job creation
- Educated work force
- Lean building
- Revive market competition
- Informed and educated local government

Proof is in the Passive House Building

- When the Building Boom collapsed in Ireland the Industry diversified to incorporate low energy and passive house components as a minimum standard.
- This Irish Passive House was built almost entirely out of local Passive House components, sustaining and growing local jobs in an otherwise failing industry.

** Courtesy of Deborah Byrne, CPHD.*

What Emerging Technologies are there to Support LE/PH/NZEB/E+?

- Slim, Heat Protection Windows
- Thermally enhanced Façade system
- Electrochromatic Glazing
- Flexible Building Membranes
- Heat Technology: controls, low exergy, passive cooling and PCM, active air heat storage, decentralized heat pumps etc.
- Vacuum Insulations in: glazing, sandwich panels, precast concrete; second generation panels;

Emerging Technology

* Courtesy of raico.de/en/News

- The World's first Passive House Certified Curtain Walling System
- It complies with all the PHI's Standards for glazing thermal performance and air tightness and thermal bridge free constructions
- Everyday manufacturing companies are continuing to push the boundaries and improve performance

Who Cares?

Unless someone like you
cares a whole awful lot,
nothing is going to get better.
It's not.

Dr. Seuss

They Care….

Examples of Passive House/Low Energy and NZEB

Tesco's, Tramore, Co. Waterford, Ireland
World's First Passive House Supermarket with Generation

Air tightness n_{50} = 0.31/ach
Annual heating demand
15 kWh /m²·a according to PHPP

Primary energy requirement
758 kWh/m²·a according to PHPP

- The specific value of primary energy requirement is due to the mandatory conditions of use of a supermarket.
- The research on this issue of internal heat gains is still ongoing.
- Useable floor area = 3970m2
- Use of CO2-refrigerants,
- Solar photovoltaic panels,
- Wind turbine

** Courtesy of Passive House Institute Project Database*

Private Dwelling, Toronto, Ontario
NET ZERO ENERGY

- Over 4000sqft of living space
- Makes use of smart technology to monitor and control the home

- Generation = PV
- House currently trending as Net Energy after 12 months
- The building's performance is being monitored continuously so building operations can be optimized.
- Building uses passive principles and thermal mass to maintain heat in the property.
- Natural ventilation is maximized in the property

** Courtesy of Antonio Santini, Red Studio Architects, Toronto, ON*

Private Dwelling, Portland, Oregon, USA
Passive House with Generation, NZEB

- Certified Passive House, 123m2
- Boasting a 3.2 kW PV plant = NZEB
- **Air tightness** n_{50} = 0.28 /ach
- **Heating Energy Demand** 12kWh/m^2.a according to PHPP
- **Heating load** 10W/m^2 according to PHPP
- **Primary energy requirement** 82kWh/m^2.a on heating installation, domestic hot water, household electricity and auxiliary electricity calculated is according to PHPP

** Courtesy of Passive House Institute Project Database*

Private Prototype Dwelling, Viroqua, Wisconsin, USA
Passive House, NZEB

- **Air tightness** n_{50} = 0.51/ach
- **Annual heating demand** 12kWh/m^2.a according to PHPP
- **Primary energy** 104kWh/m^2.a on according to PHPP

- Newen House is a kit home, 83m2
- All models are 50% smaller than the average American home, while offering smart and efficient interior design solutions so it lives much bigger
- This 3 bedroom prototype is the large largest of the kit models
- Generation = PV, 2900 kwh/yr photovoltaic system for net zero site energy
- The project shows that ultra energy efficiency and healthy living can be simple and cost effective

** Courtesy of Passive House Institute Project Database*

Demonstration House, Fort St. John, British Columbia- Passive House, NZEB

- **Air tightness** n_{50} = 0.6/ach
- **Annual heating demand** 15kWh/m^2.a according to PHPP
- **Primary energy** 112kWh/m^2.a calculated is according to PHPP

- 1 1/2 storey, turnkey house, 176m2
- PV plant with unconfirmed energy yield of 3,500 kWh
- Year-round, 24/7, monitoring of energy consumption
- Canada's Northernmost Passive House
- Demonstration project for a cost-effective, precast solution in extreme temperatures of -40 ° C

** Courtesy of Passive House Institute Project Database*

World's First Certified Passive House Office Tower with Tri-generation, Vienna, Austria

- Office Tower, Wien, Vienna, Austria, 20984m2
- Optimum use of the existing site resources: cooling via the canal; use of waste heat from a nearby data center; geothermal and PV
- Tri-generation plant on biogas (CCHP)
- **Air tightness** n_{50} = 0.39/ach
- **Annual heating demand**14 kWh/m^2.a according to PHPP
- **Primary energy** 117kWh/m^2.a on heating installation, domestic hot water, household electricity and auxiliary electricity calculated according to PHPP

** Courtesy of Passive House Institute Project Database*

The End