Building America
U.S. Department of Energy
Research Toward Zero Energy Homes

Innovations & Emerging Technology

John Straube, Ph.D., P.Eng
Building Science Corp & University of Waterloo

www.buildingscience.com

Outline

- What are the trends
- What are possible emerging technologies

Predictions

- Are usually incorrect
- What follows are informed guesses … and hopes of a select number of changes

Future Transportation

- More train and mass transit
  - Already happening
- Plug-in hybrid
  - 100 mpg average
- Light weight vehicles
- Diesel and diesel hybrid
- Fuel cells?:
  - where is the Hydrogen

Competition Cars vs Buildings

- Chevy Volt (2010)
- Prius Plug-in (2010)
- European diesels are coming….
  - 2008 and on . . .
- Electrification of buildings will increase, but will compete with transport

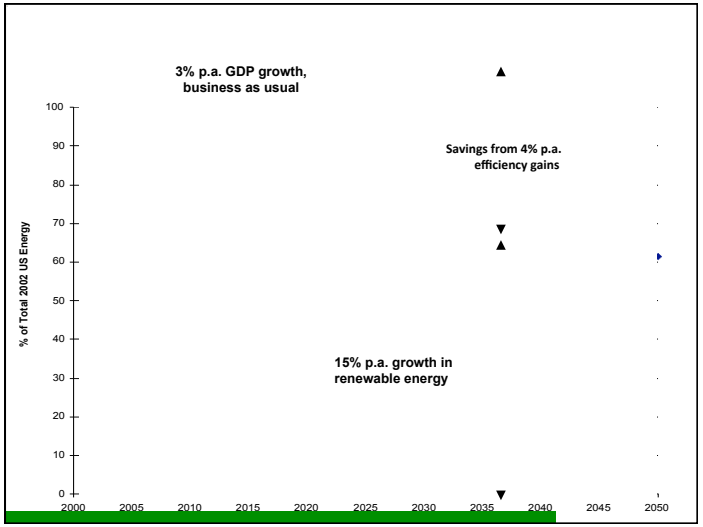
A new competitor for building energy

Efficient Enclosures & HVAC

- Airtight buildings require ventilation systems
  - Don't over ventilate. Quality≠Quantity
- Better windows, insulation and lighting
  - = Low heat gain
  - = dehumidification, less sensible cooling
- Thermal mass matters more
- Different HVAC systems can now be applied
  - Radiant cooling

Efficiency, Renewables, Retrofits

- Reducing energy wasted (efficiency) allows renewables to be economically and environmentally practical
  - Need to increase Energy Return on Investment
- Huge existing stock of buildings, means:
  - **Energy-efficient retrofits** must be part of any solution
- Both renewables and retrofit are needed!



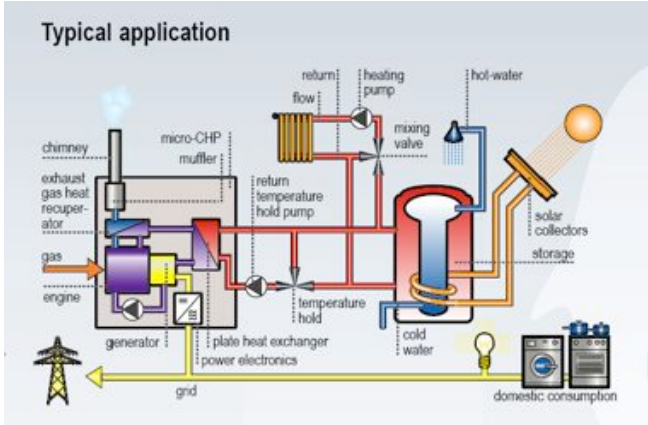
Renewables

- PV price is dropping, more silicon better prod.
- Installed cost likely under $5/W before 2012
- Large Wind installations increasing
  - No serious contenders for micro wind turbines on the horizon
- Sophisticated Biomass (wood pellets, etc) growing

Combined Heat Power-small

- Heat and power (roughly 3:1) on demand, 90% eff
- Capital cost (elec) Marathon EcoPower ($20K/4.7 kW)
  - $3 000- 20 000/kW
- Elec cost (if heat is free)
  - $0.10-0.25 kWh
- Difficult to match home/office needs
- Can provide base load or peaking
- Sterling cycle, microturbines, diesels, fuelcell
  - maintenance

Marathon EcoPower

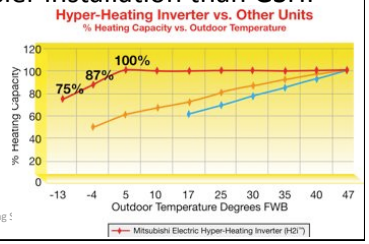


Mechanical systems

- Will get smaller and more efficient (right size)
- Tankless craze will mature to condensing boilers with microstorage
- Solar thermal costs are not dropping and storage costs $: PV soon may usurp

Low Temperature Heat Pumps

- New generation of air-to-air and air-to-water heat pumps
- COP over season of 2 to 3
- Much lower cost, easier installation than GSHP

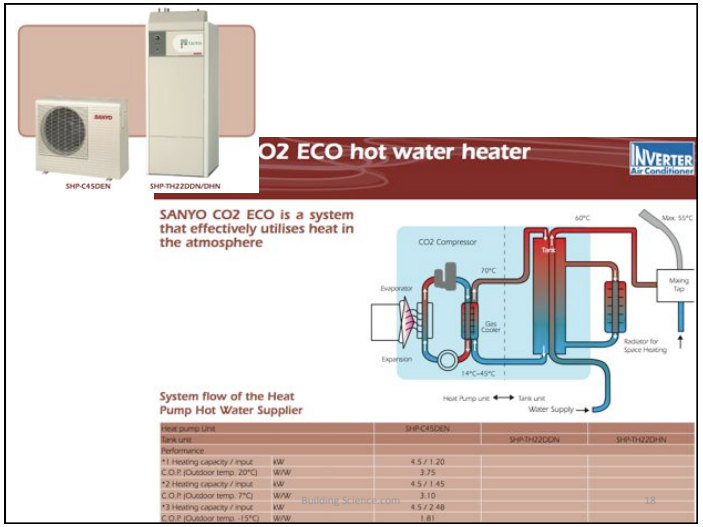


Integrated Heat Pumps

- Heat pumps that make hotwater as well as space heating
- Improve on electrical COP=1

CO2 Refrigerant

- New generation of compressors available to handle R744
- Higher COP
- less environmental impact
- Lower temperature operation (-40)



Enclosures

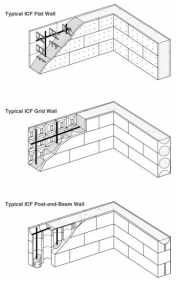
- We will start to do some of the stuff we know how to do on a wider scale
  - Insulating sheathing
  - Airtightness
  - Insulate basements
- More bio-based and recycled content

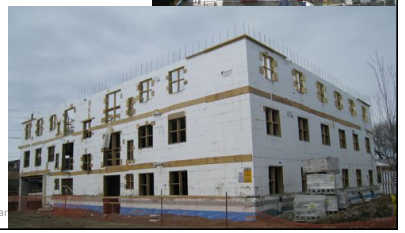
Enclosures

- Expansion of stressed skin panels (metal skins, fiber cement and OSB) and ICF
- More spray insulation
  - Fiberglass
  - Rockwool
  - Foams
- Wider range of spray foam:
  - ½ pcf, 2 pcf, and 0.8, 1.25, etc.

Insulated Concrete Fo

- Excellent enclosure system
- Concrete acts as air barrier
- No vapor barrier needed
- Expensive, but high performance





Building Science.com

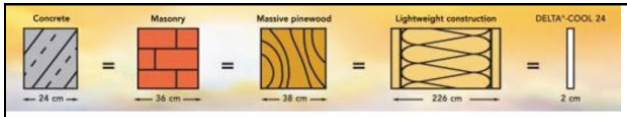
Insulation ar

Future products

- Vaccum panels: Depends on vacuum
  - R20-30/inch
  - VacuPor (Porextherm)
- Nanogel/aerogel
  - R12-20/inch
  - AspenAerogel

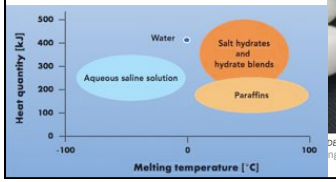
Building Science.com

Insulation and Thermal Bridges No. 23/65



terial thicknesses having a heat storage capacity of 5,700 kJ (10 °C temperature increase).

- Phase Change
- Water storage tanks cellulose insulation additive



DELTA®-COOL 24 is available in various forms of encapsulation.

ng Science.com 24

Windows

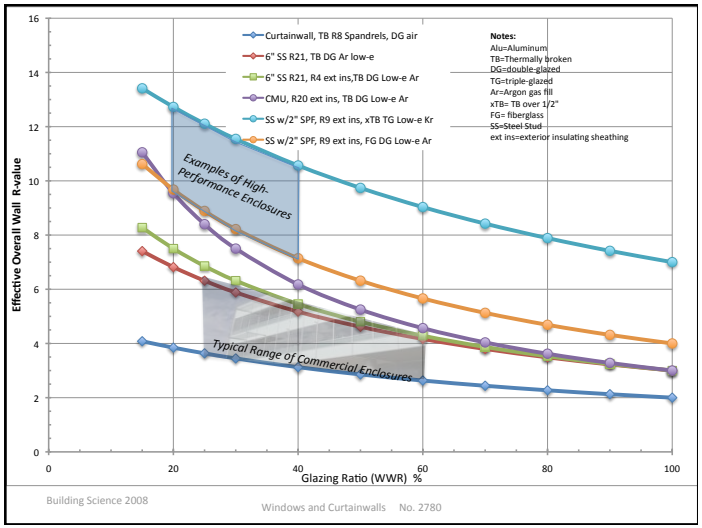
- R-value set to drop to ½ of current
- Triple glazing, heat mirror glazing get better
- Better frames and thermal breaks
- Price becoming more competitive

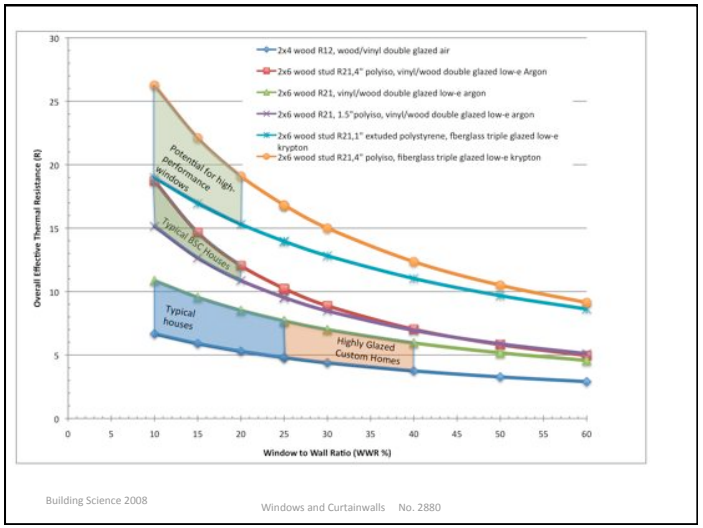
- Exterior shading becoming more important control solar heat gain

	Center of Glass (COG) Performance*				AlpenGlass+™	
Industry Leading Performance	U-Value	R-Value	SHGC	VT	Glazing	Fill
	0.05	20.00	0.29	0.44	Dual Pane, Triple Low Solar Heat Coefficient Film	Xenon
Premium Performance	U-Value	R-Value	SHGC	VT	Glazing	Fill
	0.07	14.29	0.24	0.43	Dual Pane, Dual Low Solar Heat Coefficient Film	Krypton
	0.11	9.09	0.51	0.65	Dual Pane, Dual High Solar Heat Coefficient Film	Krypton
High Performance	U-Value	R-Value	SHGC	VT	Glazing	Fill
	0.11	9.09	0.30	0.55	Dual Pane, Single Low Solar Heat Coefficient Film	Krypton
	0.19	5.26	0.60	0.73	Dual Pane, Single High Solar Heat Coefficient Film	Krypton

*Performance numbers are center-of-glass values based on LBNL Window 5.2 software.

Courtesy of ThermaProof Windows and AlpenGlass+





Thermal

- Critical for alu windows

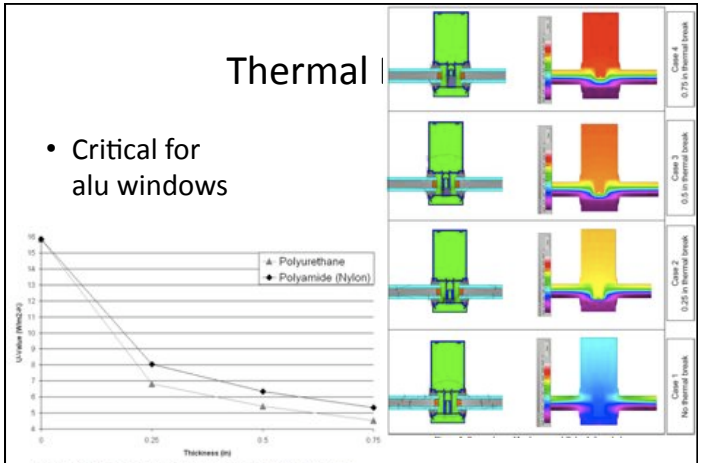
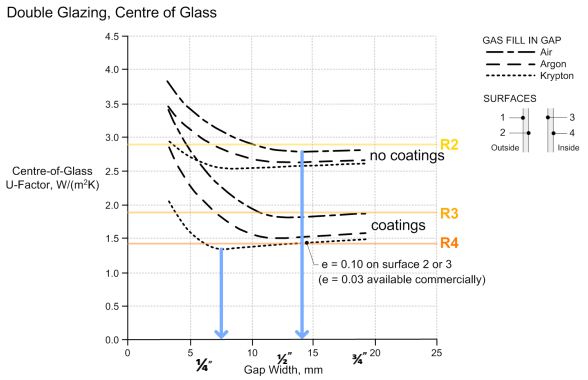


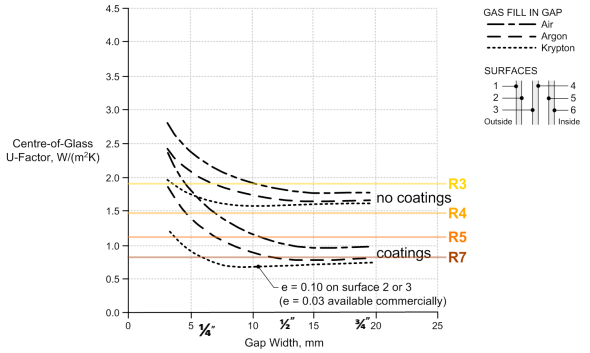
Figure 4: Frame U-Value vs. thermal break thickness.

30

Double IGU

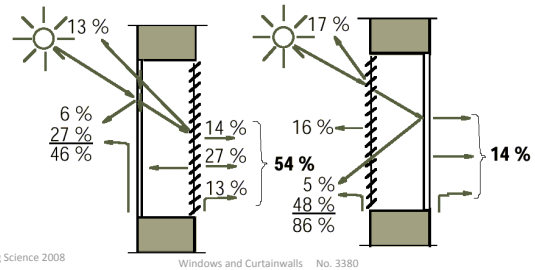


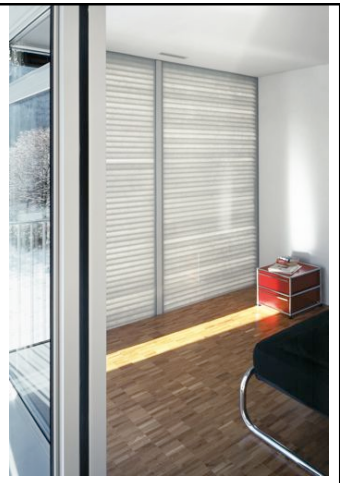
Triple IGU



Interior or Exterior Shade

- Exterior Shades always beat low SHGC
  - But the cost capital and maintenance
- Interior shades don't work well with good windows





Windows

- Vacuum panels
- Edge effects

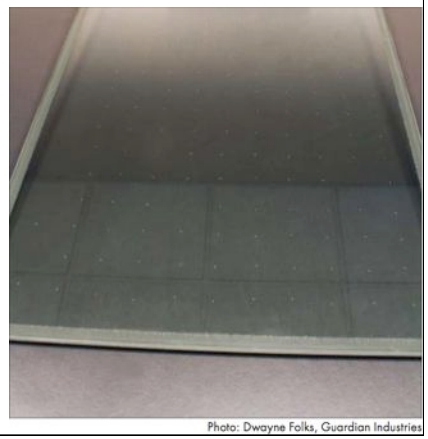


Photo: Dwayne Folks, Guardian Industries

Summary

- Few of these innovation are needed to solve climate crisis
- PV, heat pumps, plug-in hybrids are most likely to make it much easier to achieve clean, low resource future