Introduction to the session

E4: Energy - design and optimization of houses

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Assume: Energy design /optimization is a key part of sustainability, our goal is to have carbon neutral construction in 2030.

1. Look at sustainability (extract from Ed Lowans ‘presentation to BECOR)
2. Introduction to the session – paper on understanding of thermal bridges on the disk
Greening the Building Envelope

Ed Lowans

May 20 - 2008 Ottawa
Determine Feasibility First

What is the target?
Is it the right target?
Can it be achieved cost-effectively?
Does a next generation project require a next generation design team and technologies?

TD Centre
Toronto
The most value for the money

Savings for small initial cost

- Commissioning
- Use of daylight
- Self cleaning glazing
- Advanced building automation
- Pre-cooling e.g. geothermal
- Solar air preconditioning
- Solar Hot Water (third party financed) - leased
High Performance

To achieve these goals in cold climate will require next generation approaches:

- BIM will expand capabilities exponentially
- Distributed HVAC will displace central one
- Mechanical/envelope will converge
- Smart technologies will be used
- Integrated from appliance to grid
- Energy storage will be accounted for
- Systems will be third party financed/leased
Current Best Value

Ranked by energy savings potential (DOE)

- Radiant ceiling cooling
- Heat or energy recovery in ventilation (ERV/HRV)
- System /components diagnostics
- Dedicated outdoor air systems
- Brushless DC motors
- Smaller centrifugal compressors
High Performance BE

- A high performance BE is a pre-requisite for the next generation HVAC and lighting.
- High performance buildings dramatically reduce thermal loads accelerating the use of distributed mechanicals penetrating the envelope at (each) floor.
- The envelope will become a multi-functional element (HVAC, daylight, energy production).
- Integrated components will be modular, factory made and installed.
Envelopes will rely on next generation glazing and panels

- Aerogel technologies are already commercialised
- Partial vacuum insulation panels are already commercialized (refrigerators)
- Partial vacuum glazing is in the licensing stage for commercial production
- R20-50 thermal performance in airtight 1” thick walls
If this was a look at the future BE, where are we today?

- There is a gap between building science (predictability of performance) and building practice
- Construction is market driven and only in a crisis situation will use the knowledge
- Yet, the public momentum for the “green buildings” offers some hope of improvement
- This session will highlight the gap between R-value and field thermal performance as caused by multi-dimensional heat flow and air flows
Effect of thermal bridge depends on heat collecting layer
Temperature profiles measured in 1964

EPS + wood stud 20–50 mm

As above + cement board / drywall

As above + cement / porous fiberboard
Efficiency factor for thermal insulation in the cavity of 2x4” frame walls

<table>
<thead>
<tr>
<th>Class of ins., resistivity of insulation</th>
<th>k-factor of the cavity insulation</th>
<th>Nominal R-value of the wall</th>
<th>Mean R-value from 2D code</th>
<th>Percent reduction nominal R-value</th>
<th>Efficiency factor for thermal insulation</th>
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</thead>
<tbody>
<tr>
<td>3.15</td>
<td>0.32 (0.046)</td>
<td>12.85 (2.26)</td>
<td>11.39 (2.00)</td>
<td>11.3</td>
<td>0.89</td>
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<tr>
<td>3.55</td>
<td>0.28 (0.041)</td>
<td>14.25 (2.51)</td>
<td>12.35 (2.17)</td>
<td>13.3</td>
<td>0.87</td>
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<tr>
<td>3.75</td>
<td>0.27 (0.039)</td>
<td>14.95 (2.63)</td>
<td>12.81 (2.26)</td>
<td>14.3</td>
<td>0.86</td>
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<tr>
<td>4.0</td>
<td>0.25 (0.036)</td>
<td>15.83 (3.79)</td>
<td>13.38 (2.36)</td>
<td>15.5</td>
<td>0.85</td>
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<tr>
<td>5.0</td>
<td>0.20 (0.029)</td>
<td>19.33 (3.40)</td>
<td>15.48 (2.73)</td>
<td>19.9</td>
<td>0.80</td>
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<tr>
<td>6.0</td>
<td>0.17 (0.024)</td>
<td>22.83 (4.02)</td>
<td>17.38 (3.06)</td>
<td>23.9</td>
<td>0.76</td>
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</table>
### Efficiency for thermal insulation in the cavity of frame walls 2x4” with external insulation R5.6 & R9

<table>
<thead>
<tr>
<th>Class number (R-value / inch in the cavity)</th>
<th>Thermal resistance of external insulation</th>
<th>Nominal R-value in the center of the cavity</th>
<th>Mean R-value from 2D code</th>
<th>Percent reduction from nominal</th>
<th>Efficiency of the insulation</th>
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<tbody>
<tr>
<td>3.15 (21.8)</td>
<td>5.6 (1.0)</td>
<td>18.45 (3.25)</td>
<td>17.08 (3.01)</td>
<td>7.4</td>
<td>0.93</td>
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<td>9.0 (1.6)</td>
<td>21.85 (3.85)</td>
<td>20.49 (3.61)</td>
<td>6.2</td>
<td>0.94</td>
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<tr>
<td>3.75 (26.0)</td>
<td>5.6 (1.0)</td>
<td>20.55 (3.62)</td>
<td>18.55 (3.27)</td>
<td>9.7</td>
<td>0.90</td>
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<tr>
<td></td>
<td>9.0 (1.6)</td>
<td>23.95 (4.22)</td>
<td>21.98 (3.87)</td>
<td>8.2</td>
<td>0.92</td>
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<td>6.0 (41.6)</td>
<td>5.6 (1.0)</td>
<td>28.43 (5.00)</td>
<td>23.40 (4.12)</td>
<td>17.7</td>
<td>0.82</td>
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<td>9.0 (1.6)</td>
<td>31.83 (5.60)</td>
<td>26.90 (4.74)</td>
<td>15.5</td>
<td>0.85</td>
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