How Much Insulation is Too Much?
Context: How much Insulation?

- The wrong question
  - How much thermal control do I need?
- Insulation ≠ Thermal control
  - Thermal bridging
  - Air leakage
  - Thermal mass
- Minimum levels of thermal control needed
  - Comfort
  - Condensation
Approach

- Analyzed how people really make decisions on insulation?
- Critiques standard approaches
How much thermal control do I need?

- Depends on:
  - Climate zone
  - Assembly choice (e.g., ease of insulating, air sealing)
  - Indoor humidity
  - Energy costs, now and the future
  - Mechanical system choices and costs
  - Insulation costs
Standard Approach: decreasing benefit
Flaws with Standard Approach

- Compare future savings to current cost
- Little idea of future costs
  - Long track record of unpredictable future cost
- Cost of thermal control varies widely depending on
  - assembly design,
  - location, time,
  - contractor experience,
  - delivery method (tract, custom, retrofit)
- Difficult to even get close to similar costs for the same assembly
Assess Cost of Increasing Insulation

- Compare
  - Adding R7.5 to a 2x6 (R15) wall
  - Adding R60 to an R30 vented attic
- Same energy saved per square foot of area
- R60 blown cellulose often/usually cheaper than R7.5
- Consider cost difference if unvented roof
- Consider cost of windows going from R5 to R8.

How Much Insulation?

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Combined Air and Conduction Flow (70F indoors 0F outdoors)

- Heat Flow
- "w/0.1 cfm @0.3 in wg"
- "w/0.4 cfm @0.3 in wg"

2 lps/m² @ 75 Pa
Recommendations?

- Minimum: insulation level *and arrangement* to deliver comfort and durability
  - Should not fall below this level

- Too much? Upgrade in thermal control to save energy should in *no case* cost more than the cost to generate same energy using unsubsidized photovoltaic (eg most expensive energy)

- Lower cost of energy production could/should be used depending on goals
Avoiding over-insulation conserves financial resources for better alternatives

*Very little risk of over-insulation* in today's market
- Perhaps some PassivHaus designs

Bigger problem is poor heat flow control
- More insulation, fewer thermal bridges, more airtightness, better solar control