ASHRAE’s Cold Climate Design Guide

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Outline/Agenda

Things to Consider while Designing HVAC Systems for a Cold Climate…..

….Cold, Snow, Wind, Sun, Rain, condensation …

CCDG Topics

- Geographical Location
  - Remoteness
    - Operation and Maintenance
  - Construction Logistics
    - Barges
    - Ice Roads
    - Air Cargo
    - Working Conditions

…and Cities

ASHRAE Guide for Buildings in Cold Climates

- First Edition 2015
- ASHRAE Supervising Technical Committee
- MTG.CCDG Committee now operating
- Next edition 2018
- Next Cold Climate conference May 2018, Sweden

PRESS RELEASE

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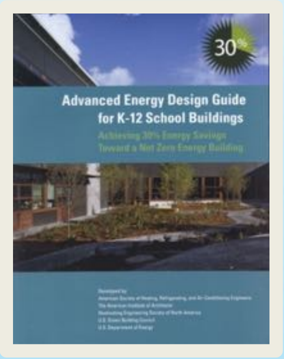
Cold Climate Challenges Addressed in New Publication from ASHRAE

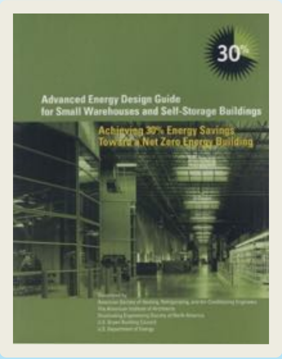
ATLANTA – Buildings in arctic and subarctic climates face not only challenges related to cold but also remoteness, limited utilities, permafrost and extreme temperature shifts. Designers must meet these challenges while keeping occupants comfortable andminimizing impact on the environment.

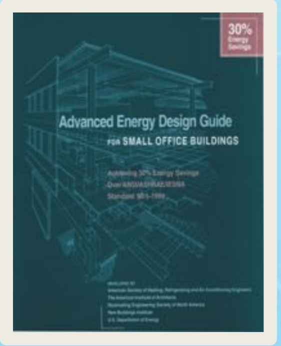
The newly published "Cold-Climate Buildings Design Guide" from ASHRAE provides information on the issues commonly faced by designers in these climates. The idea for the guide came from a working session held at the 7th International Cold-Climate Design Conference held in 2012 and co-sponsored by ASHRAE, SCANVAC and REHVA.

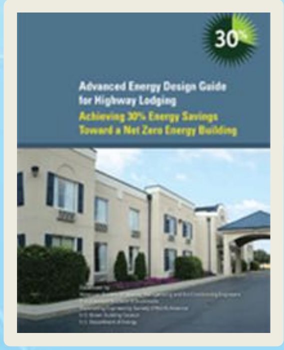
ASHRAE design guides – for example

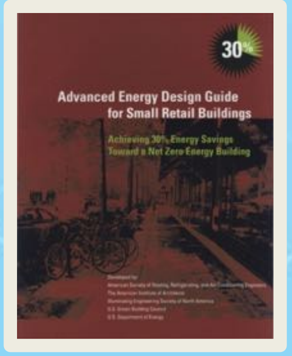
- ASHRAE *Advanced Energy Design Guides*:
  - Prescriptive path for achieving 30% energy efficiency over Standard 90.1-1999
  - **Not a code or standard**
  - Provides recommendations for achieving goal
  - AEDG for Small Office Buildings
  - AEDG for Small Retail Buildings
  - AEDG for K-12 School Buildings
  - AEDG for Small Warehouses and Self-Storage Buildings
  - AEDG for Highway Lodging

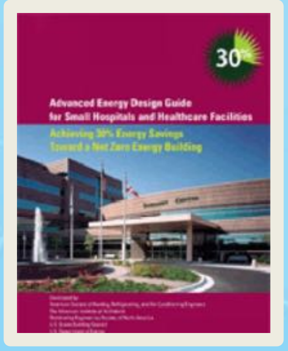












Cold Climate Buildings Design Guide

1. Cold Climates
2. Sustainability
3. Human comfort in the indoor environment
4. Utilities in buildings
5. Strategic design
6. Building HVAC design process
7. HVAC design calculations
8. Building Envelope
9. Design considerations
10. Control
11. Commissioning

Appendix : Case studies

- Institutional building Edmonton
- Snow and ice melting
- Commercial building, Albany
- Energy environment experiential learning project, Calgary
- Bullitt Centre, Seattle
- Walgreens Evanston
- Multipurpose Industrial facility, Bassano

UK is a cold country

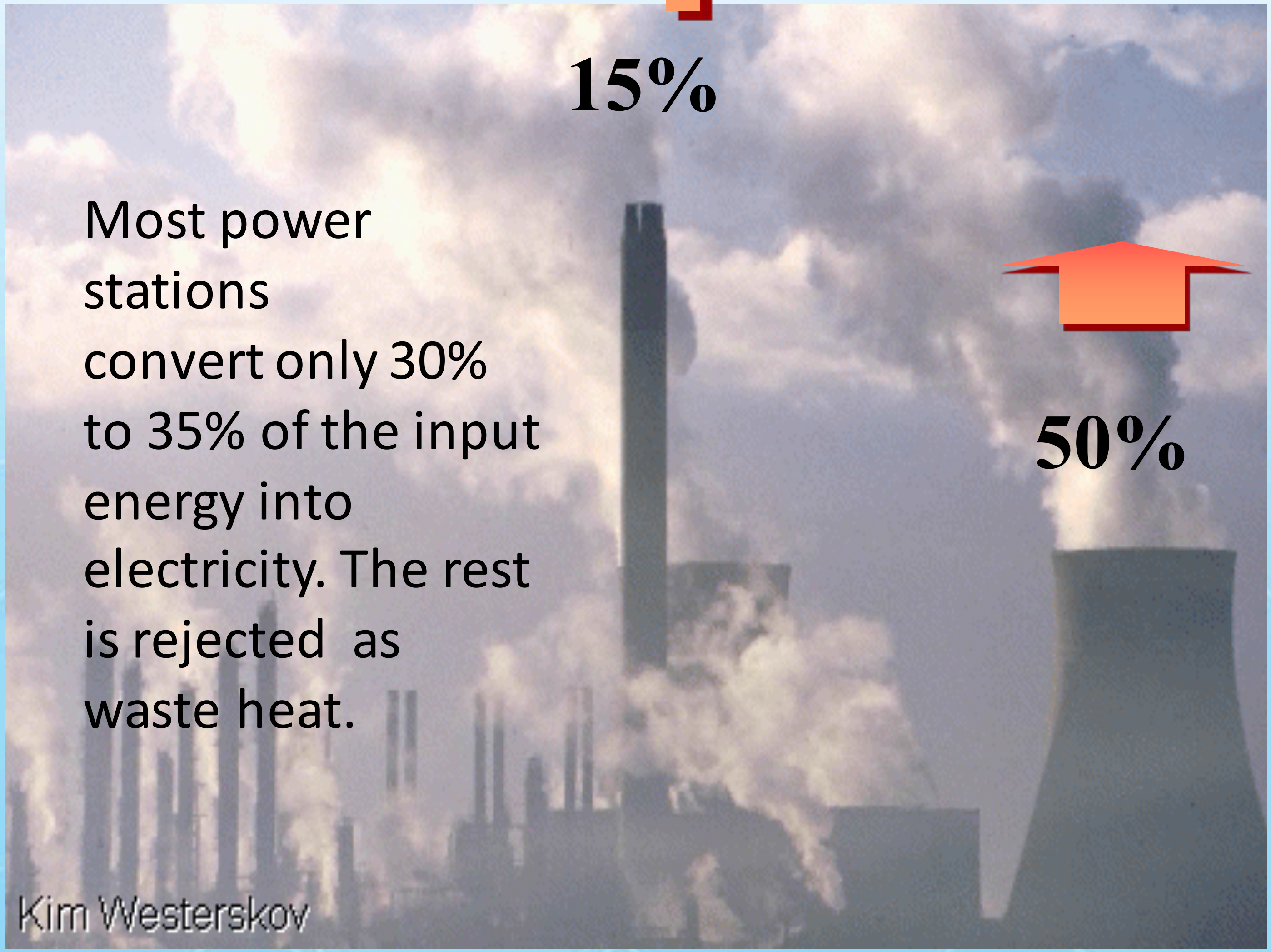
- Me - near where I live

UK is a cold country

- **In the UK the Provision of Heat Represents Over 40% of the Total Annual Energy Demand.**
- **The UK uses more energy for heating than for anything else such as………**

UK is a cold country

- **And yet we throw away more heat each year than we need**



15%

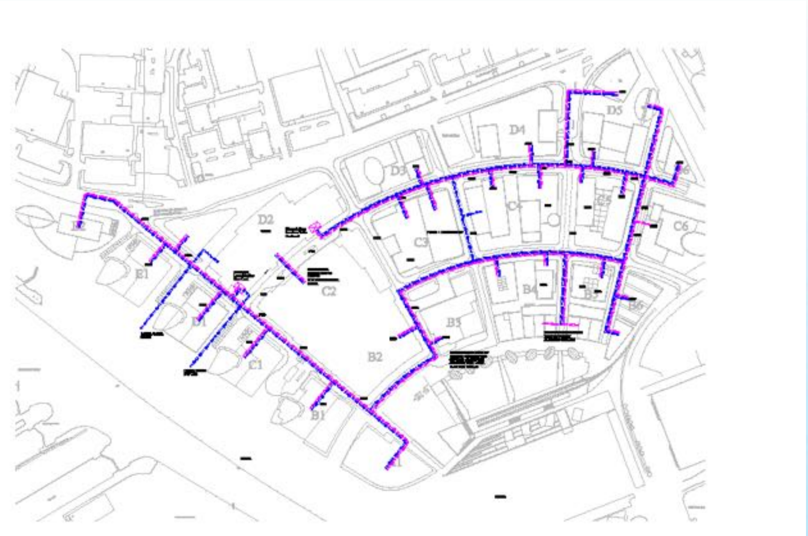
Most power stations convert only 30% to 35% of the input energy into electricity. The rest is rejected as waste heat.

50%

Wasted heat from UK Power stations

- UK wastes more heat from Power stations than it needs for heating
- Value of this waste heat – around £ 150 Billion per year.
- Produces over 160 Million tonnes CO_2

Missed opportunity – UK Power stations waste heat



- Developing heat networks capable of taking GW of heat
- Distance from Power stations to cities
- Disruption installing heat mains

Heathrow Airport shut due to cold in 2011

Snow travel chaos 'cost £280m a day'

•Transport Secretary Philip Hammond said it cost the UK economy 'about £280m a day'
•Heathrow suffered "enormous damage" to its reputation

•At a cost of….**a lot**. This affected flights worldwide – and upset many people

•BAA chief executive Colin Matthews - Heathrow "overwhelmed" after far more snow fell than the 2.4in 'it had planned for'.

•"There will always be disruption if we get 6in or 8in of snow," Mr Hammond said.

•Thousands of passengers were left stranded at the airport as 4,000 flights were cancelled over five days because of heavy snow before Christmas

Example of how heat networks save money

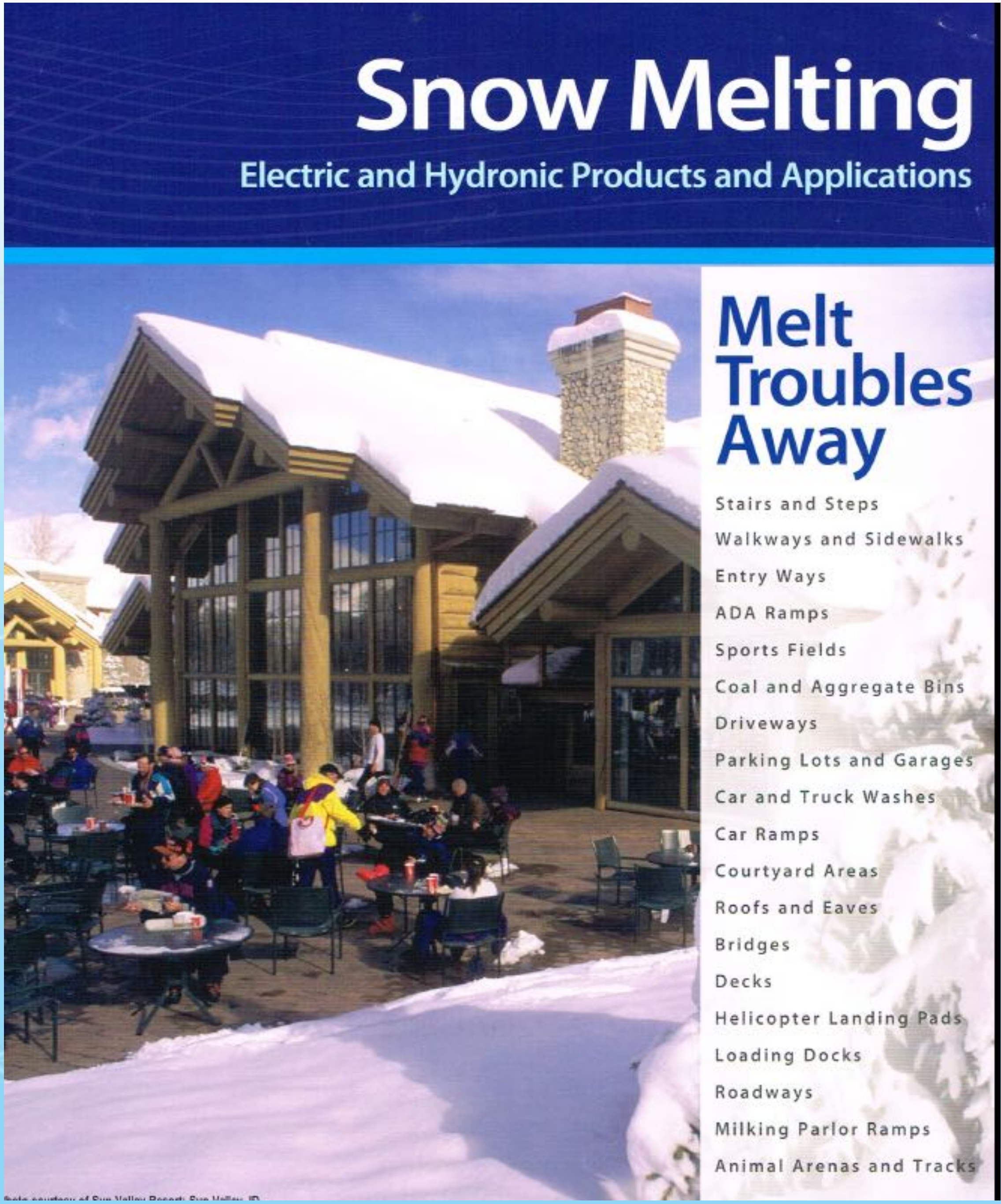
'Too much snow' grounded Heathrow Airport flights

- The snow cost BAA £20m at Heathrow

  In retrospect we should have had a plan for more snow than 6cm
- Operations at Heathrow almost came to halt before Christmas, with thousands of travellers jamming terminals.
- He said BAA had done "all we possibly could" for passengers
- But BAA could have installed ground slab heating using waste heat from the terminal cooling system and CHP plant

Planes stuck in snow

Low temperature waste heat into airport hardstandings – melts snow and gets rid of heat



Cost of heating airport hardstanding areas

At time of construction….

- Buried pipes in concrete = £ 2M
- Cost of heat system = £0 – use existing waste heat
- Cost of waste heat = £0

Payback time

- Airport losses = £208M/day = £145,000 per minute
- £2m investment to prevent losses would be recouped in 15 minutes

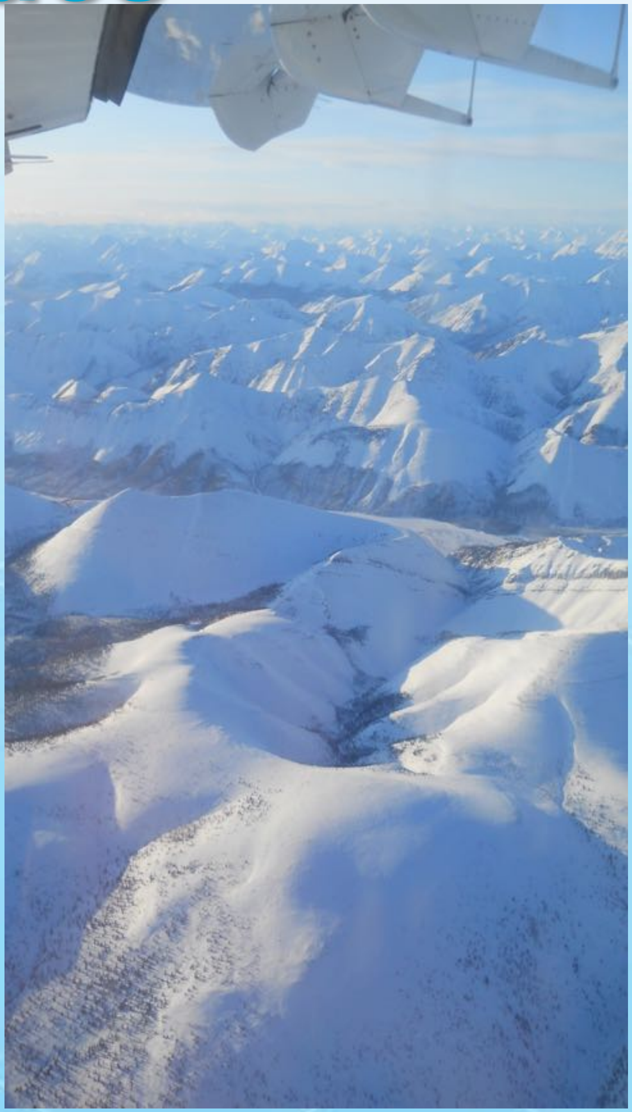
The Heathrow answer – is it right one???

Heathrow airport triples snow clearance fleet

- Heathrow airport has tripled the number of snow clearance vehicles to tackle severe winter weather.
- Operator BAA also has three times as many staff ready to clear snow compared with last year.
- BAA said it now has 185 snow clearance vehicles and has 468 staff per shift, compared to 117 last year
- BAA has invested £32.4m in 2012 to tackle severe weather
- BAA criticised following 2011 disruptions - report accused the operator of a breakdown in communication and lack of "preparedness" for the bad weather.
- After the publication of the Winter Resilience Enquiry Report, BAA promised to invest £50m to avoid facing disruptions on a similar scale.

Content Slides

- Cold regions present challenges in design, construction, operation and maintenance
- Make your project easy to build, operate and maintain!



Building Envelope Component

- Objectives of building envelope chapter of the Cold Climate Design Guide
  - Why the Envelope?
  - Interdependencies and Opportunities
  - Envelope Requirements
  - Envelope Design
  - Envelope Assembly Considerations

Why the Envelope?

Several objectives to meet in design;

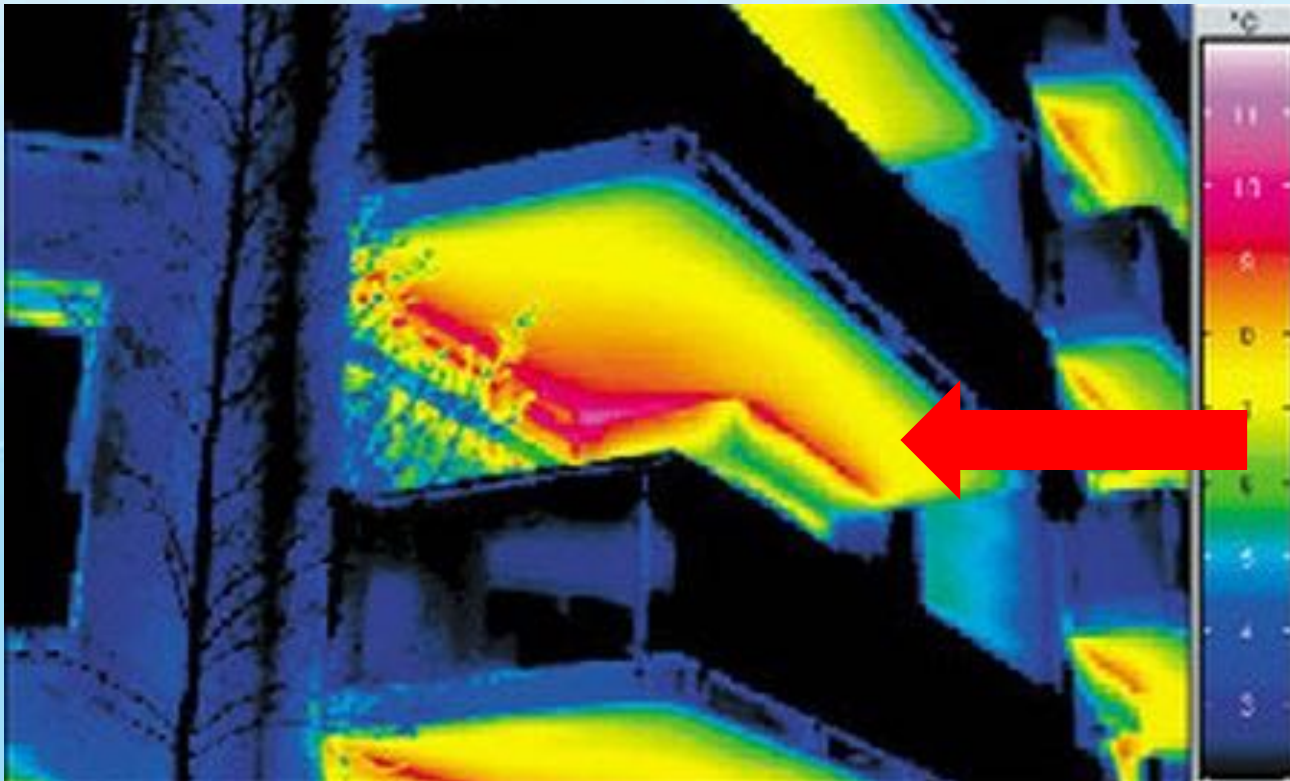
- Thermal control
- Water vapor control
- Precipitation control
- Durability and serviceability
- Human habitability and comfort

Envelope Design

- Step by step process on making envelope design decisions
  - Overall building design

Why maybe this isn't the best design solution for a cold climate…

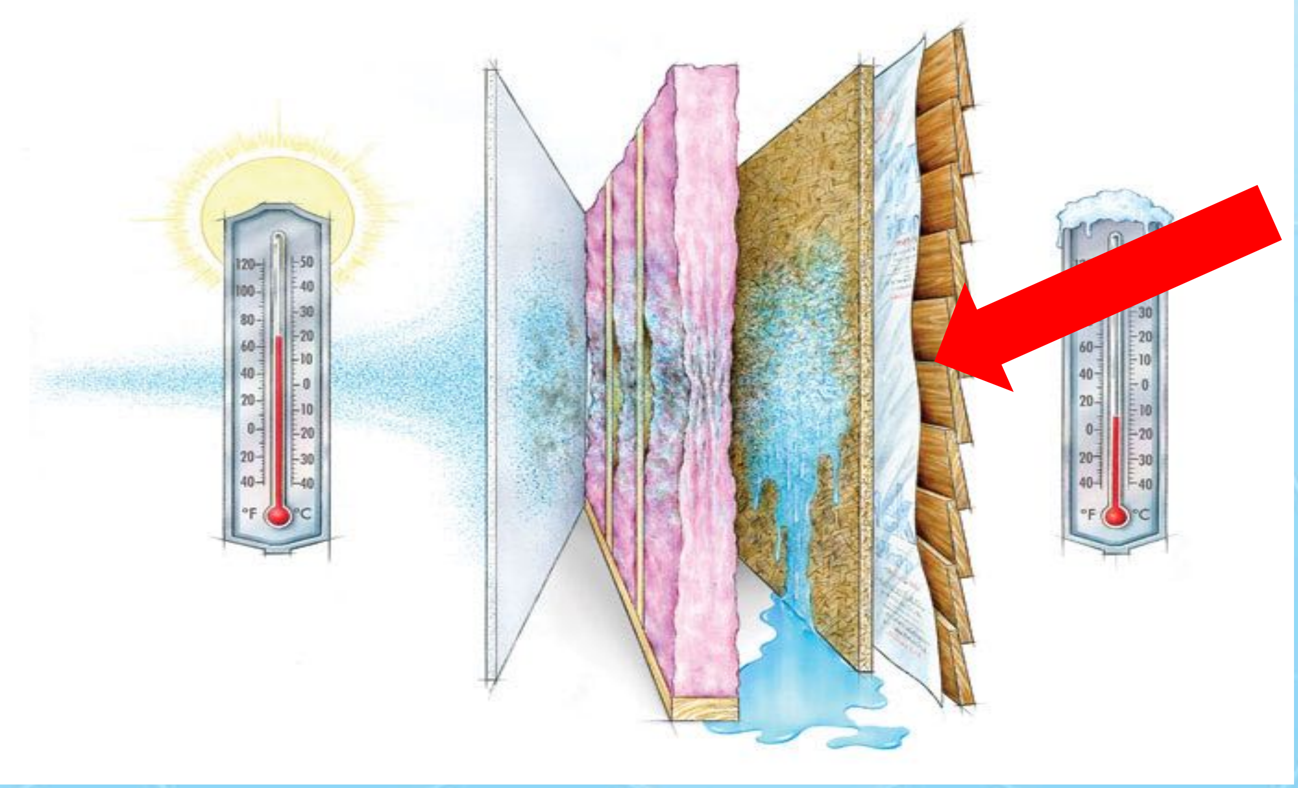
Passive heat loss via structure



Actual energy actually being lost!

Why the Envelope?

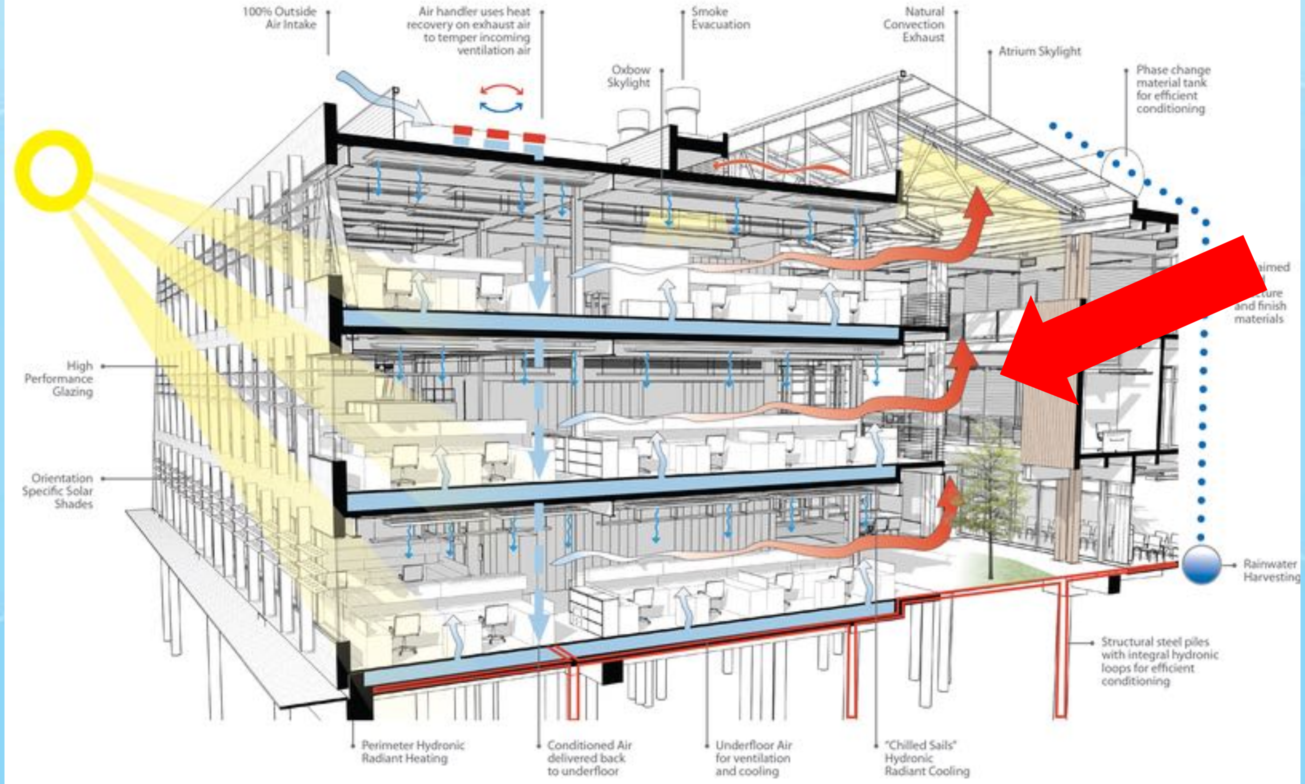
– Directly affects building durability



Lawyers, contractors, repairs – Oh my !

Envelope

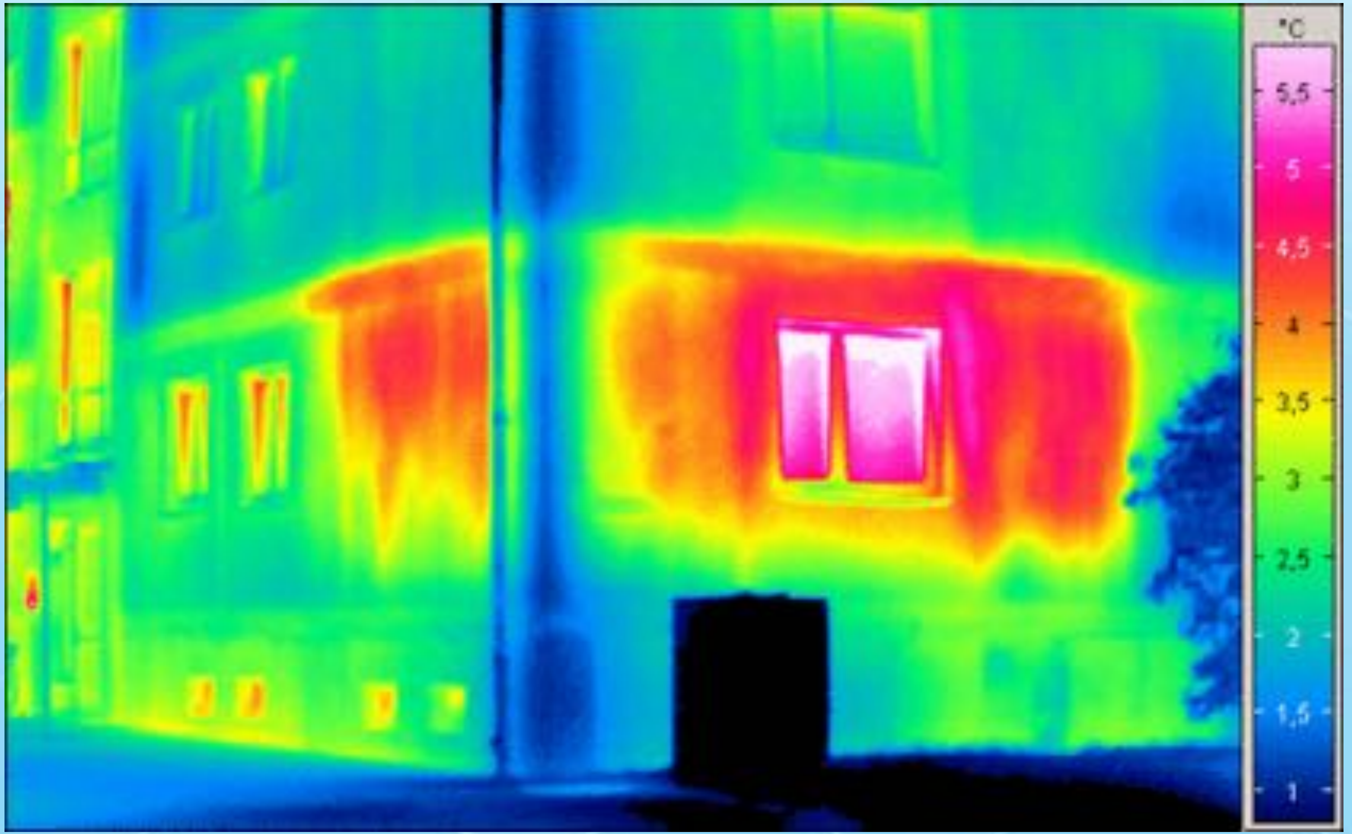
- Interdependencies and Opportunities
  - Intimately related to mechanical design



All these arrows can actually mean stuff…

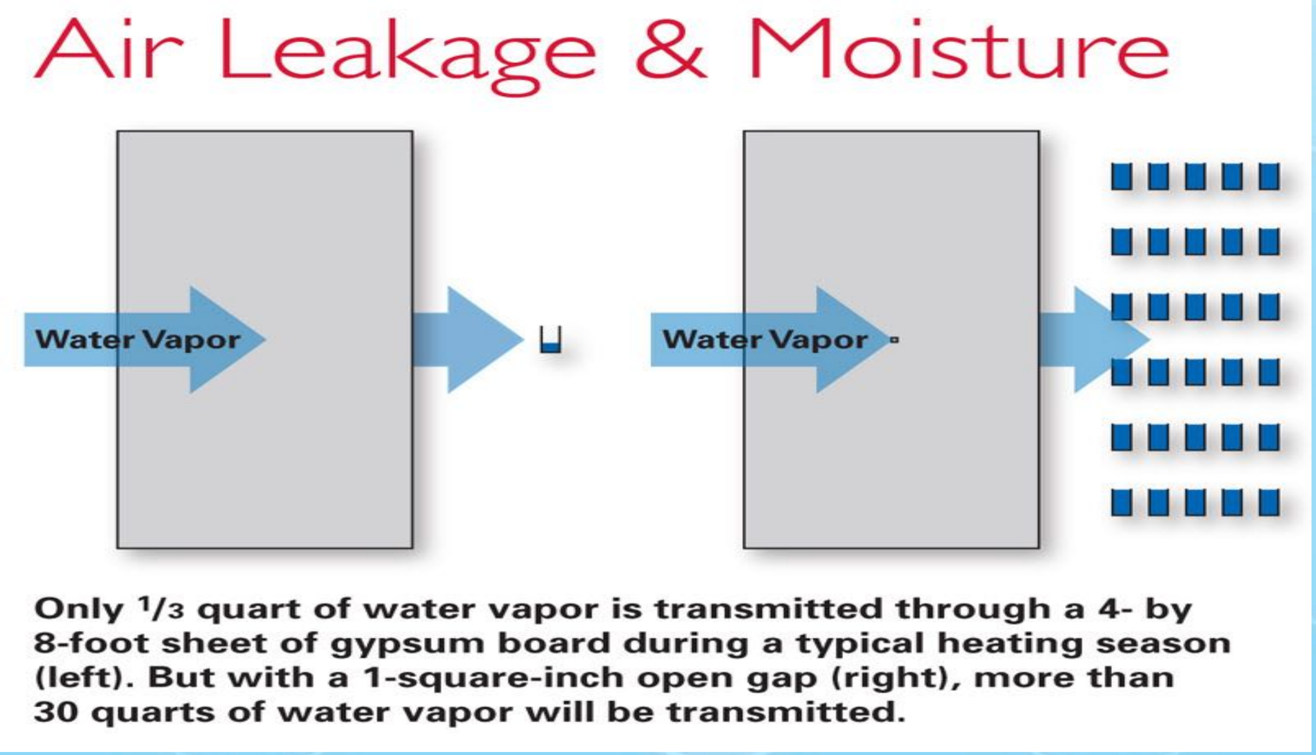
Envelope Requirements

- Thermal control: limit heat flow from the building



Water vapour

- Envelope Requirements
  - Water vapour control: limit water vapour deposition within the envelope



We cover both!

Water vapour control:

- limit water vapour condensation within the envelope

Content Slides

- Envelope Assembly Considerations

Strategic issues

Consider the outdoor conditions and the location.

- Are outside design conditions known? If not can they be found? Wind, humidity, elevation? Are 99% conditions adequate?
- local maintain or operator, remote access for internet troubleshooting or access by service company
- fuel choices, costs of fuels and electricity, transportation, cultural

Fuels – Biomass = Renewable Fuel Heat Plant

Slide courtesy Chris Gaul, NREL

Featuring Barnsley, Yorkshire

This building is heated with wood

Barnsley Metropolitan Borough Council became the first local authority in the country to adopt a biomass fuel heating policy.

Westgate Plaza development is the Council's ninth Econergy installation. This is an ongoing part of the regeneration of Barnsley where biomass boilers are helping achieve carbon targets well ahead of government targets.

A Froling Turbomat 500kW biomass boiler is installed in the basement with 3 x 5,000 litre buffer tanks. The

<u>Technical Summary</u>

High temperature combustion chamber with a conveyor grate.

- Clean, full combustion
- High degree of efficiency
- No cinder build-up
- Complete and thorough burning, even with wet fuel
- Very low emission levels (CO under 10 mg/MJ)
- Automatic ash removal

Life cycle costs

- Look at capital cost and life cycle cost. A better quality product may be much easier to maintain.

Heating

- Conserve what heat you have-insulate! Recover heat
- Can waste heat (from community power plant) or other facility be used/ trenching, piping and insulation costs may be prohibitive.
- Hydronic systems are more efficient and better for heating than air systems. The majority of heating loads will probably be in ventilation air.
- Heat pumps can be used in some cases but supplementary heating can be required.

Ventilation

- Minimizing outside air while maintaining adequate fresh air

Plant maintenance

- Locate where accessible and can be worked on in cold weather

Humidity control

- Watch humidification
- Avoid condensation and mould.

Content Slides

- Integrated design process is best.
- Need to work with architect to properly locate items (avoiding air entrainment of boiler gases, snow etc)

Conclusions

- Cold Climate Design Guide addresses all aspects of cold climate design
- Focuses on ‘why’ as much as ‘how’
- Shows how integrated design practice model maximizes savings and performance

Acknowledgements

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