BUILDING SCIENCE LIVE

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Custom High Performance: Achieving Low Carbon in Atypical Building Types

Steve Kemp, M.A.Sc., P.Eng., LEED AP BD+C, LEED Fellow
Principal, Senior Energy and Sustainability Specialist

Marine Sanchez, M.Eng., M.Sc., CPHD "Expert", PHI Certifier
Passive House Service Lead

Eric Catania, P.Eng., CPHD, PHI Certifier
Associate, Senior Energy and Sustainability Analyst

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- Some FAQs:
  - You will get a follow-up email regarding how to access the recording and a pdf of slides.
  - **If you need a completion certificate for self-reporting or EPP and/or AIA or AIBC credits**, please follow the link in the chat box to let us know.
- Please use chat for housekeeping questions.
- Please use Q&A box for questions for the speaker.
  - We will break at the end for questions.
  - Use upvote feature to let us know what you're most curious about!

More questions? Please contact us at events@learnbuildingscience.com.

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Steve Kemp

PRINCIPAL, SENIOR ENERGY AND SUSTAINABILITY SPECIALIST

As an energy & sustainability specialist, Steve drives energy- and carbon-related initiatives and explores avenues for growth within this emerging practice area.

Steve is renowned as one of Canada's top energy efficiency and carbon reduction experts. He works with architects and developers to lay the foundations for sustainable and high-performance buildings that mitigate climate change. He is skilled in numerous low carbon technologies, including geothermal energy, smart lighting control, solar power generation, solar thermal, energy recovery, and thermal storage.

Steve was part of the team that recently unveiled Mohawk College's Joyce Centre for Partnership & Innovation, the largest net-zero building in North America.

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Marine Sanchez

PASSIVE HOUSE SERVICE LEAD

As part of Canada's circle of highly experienced Passive House professionals, Marine leads RDH's Passive House consulting services across North-America, focusing on the delivery of large-scale institutional and mixed-use projects. Driven to make a positive impact with every project, she uses her passion and expertise to drive change in the industry to face the climate emergency.

In addition to her consulting work, Marine is dedicated to educating the industry about high-performance building practices, serving as an instructor since 2013.

She also supports various levels of government in implementing policies, acting as advisor on the City of Toronto's Climate Advisory Group. She serves on the International Passive House Conference's technical advisory committee, led by the Passive House Institute.

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Eric Catania

ASSOCIATE, SENIOR ENERGY AND SUSTAINABILITY ANALYST

Eric utilizes his passion for energy modeling and his background in integrated building design to improve the energy efficiency of buildings.

With over 10 years of experience, he specializes in the simulation and evaluation of energy efficiency measures and has experience in conducting energy audits and assessing facilities for retrofit potential. He has developed energy efficiency strategies for a variety of projects, including health care facilities, sporting complexes, and commercial and residential buildings that pose energy consumption challenges.

His ability to provide energy-focused building design solutions makes him an asset to any energy and sustainability project.

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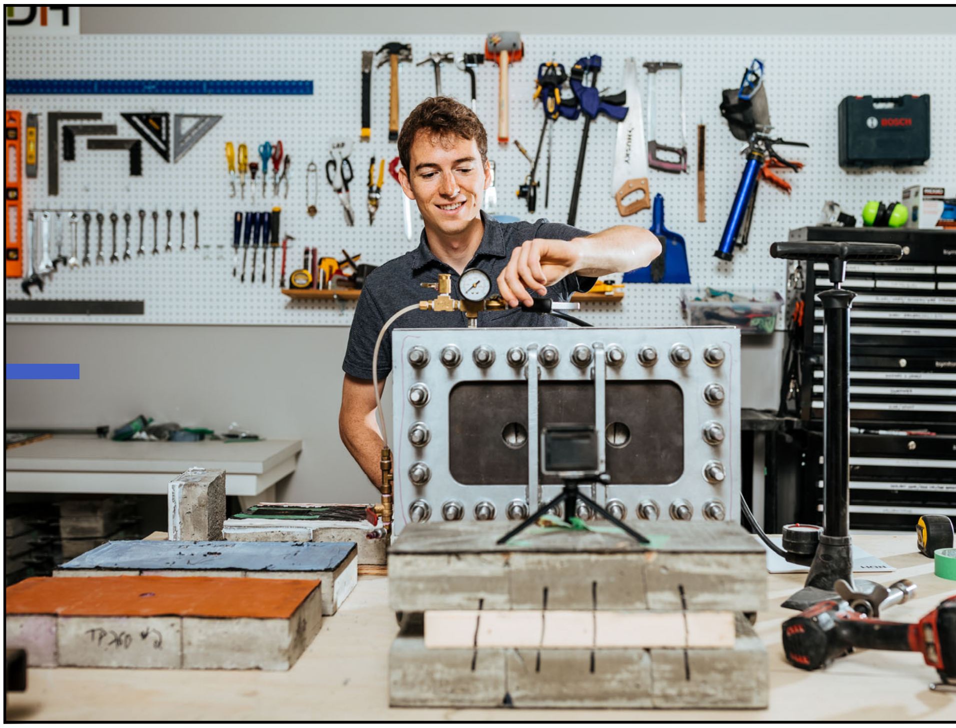

270+ staff

9 offices

Projects across North America

Focus on building science
& building enclosures

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Education for Professionals

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Agenda Slide

1. Approaches to Atypical Building Types
2. Commercial Kitchens
3. Hospitals SK0
4. Q&A

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Slide 9

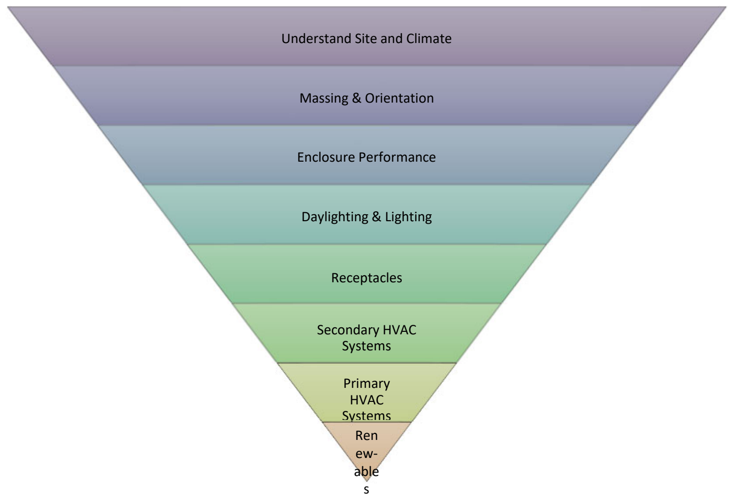
SK0 Remove. Wet labs are integrated into topic 1.
Steve Kemp, 2022-12-05T19:21:48.787

Slide 10

SK0 [@Natalie Michaelis] my slides (11 thru 18) are close to final.
Steve Kemp, 2022-12-05T19:22:34.812

General Approach to *Any* High-Performance Building

- Use of absolute targets (TEUI, TEDI, GHGI) – also known as Energy Budgets
- Use of bottom-up approach to energy/carbon accounting (budget management)
- Use energy “hierarchy”: reduce demand first + meet demand w/ energy-efficient systems second



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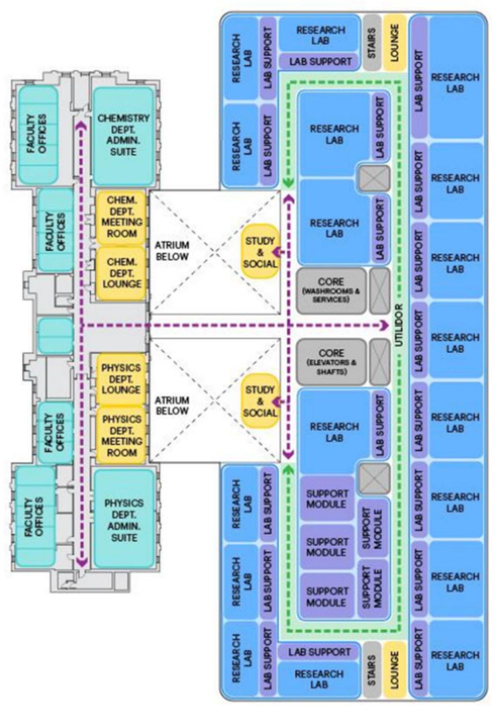
Atypical Building Types

- What is driving energy consumption
  - Are there underlying assumptions that need to be re-evaluated?
- Mitigate those demand
- Recover energy
- Supply energy efficiently

Nothing really changes, only what is driving the energy consumption….



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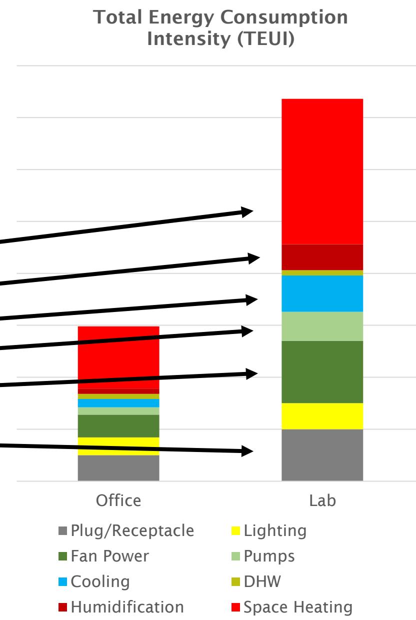
Laboratory Example: Where is energy being used (aka ***Looking for Elephants***)

- Climate Zone 5/6
- Laboratories have significantly more energy consumption for:
  - Space heating
  - Humidification
  - Space cooling
  - Pumps
  - Fans and
  - Receptacle loads…

Pretty much every load is higher than in offices



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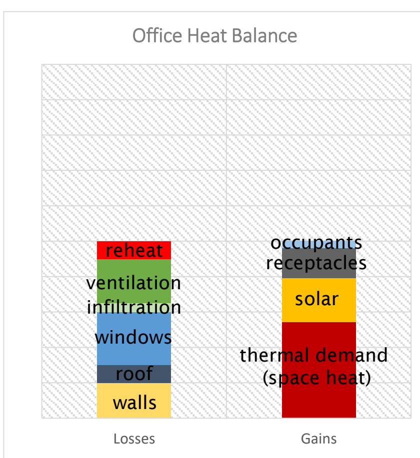
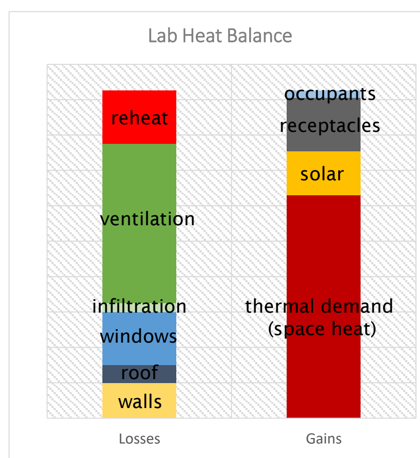
Heat Balance Comparison





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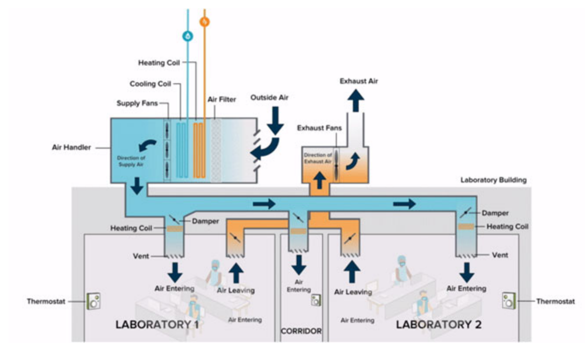
Laboratory Energy Demand:

- Exhaust requirements
  - General Lab 4-12 Air change to be exhausted per hour
  - Fume Hood, 1000 CFM design exhaust, 300 CFM when closed
- Is space exhaust driven by General Lab requirements, or Fume Hoods?
  - Some lab have high equipment heat loads too – exhaust driven by cooling
- Exhaust air energy recovery needs minimal leakage of exhaust air into outdoor air supply
- Summer humidity control introduces reheat to prevent overcooling space

Fume Hood
1,000 CFM each (design flow)
Annual Energy Consumption of a Single-Family Home



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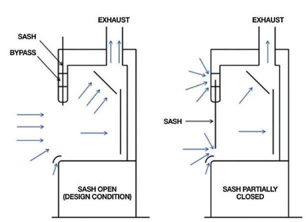
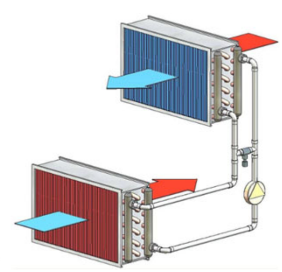
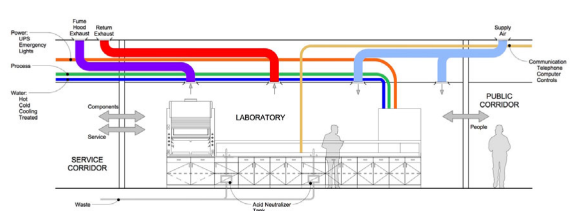
Energy Conservation Measure for Laboratories

- Programming needs
  - How many fumes hoods and labs are needed
  - Sharing of resources between departments
- Reduce exhaust requirements:
  - VAV fume hoods
  - Low flow fume hoods
  - Discuss general ACH risk with owner
  - Pollutant detection ventilation control
- Energy Recovery for Conditioning Make-up Air
  - Exhaust air energy recovery
  - Cascade “clean” exhaust air from non-lab spaces in building
  - On-site heat recovery chiller (reheat energy)
    - HRV Reheat arrangement for free re-heat (central plant option)







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Looking for Elephants

- → Commercial Kitchen
- → Acute Care Hospitals

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Photo credit: University of Victoria

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Predicted Use Understanding

- Predicted use (annual vs seasonal)
- Meal count (average meal per day)
- Meal type (hot vs cold meals)
- Kitchen operating hours + cooking profiles
- Kitchen equipment list
- Access to kitchen and dining spaces (out of hours)
- Ventilation system + zoning + controls
- Heating/Cooling system + zoning + controls
- DHW system

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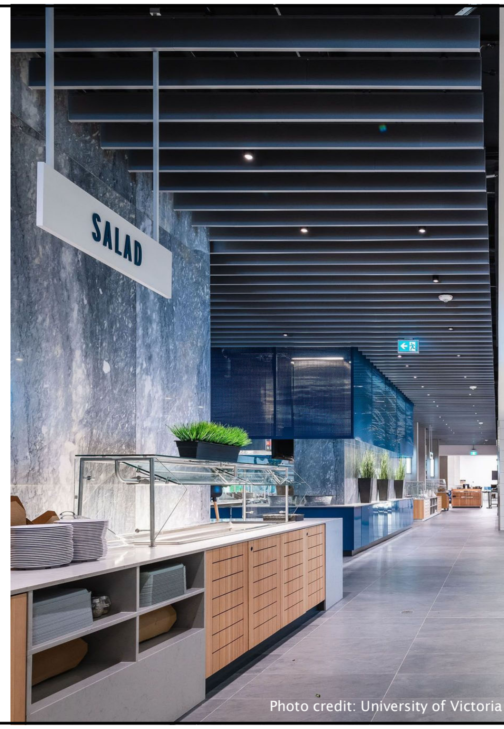

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Key Levers

1. Large exhaust requirements

2. Make-up air (MUA) to balance exhaust requirements + Preheat large amount of MUA = energy

3. Equipment energy demand

4. Domestic Hot Water demand

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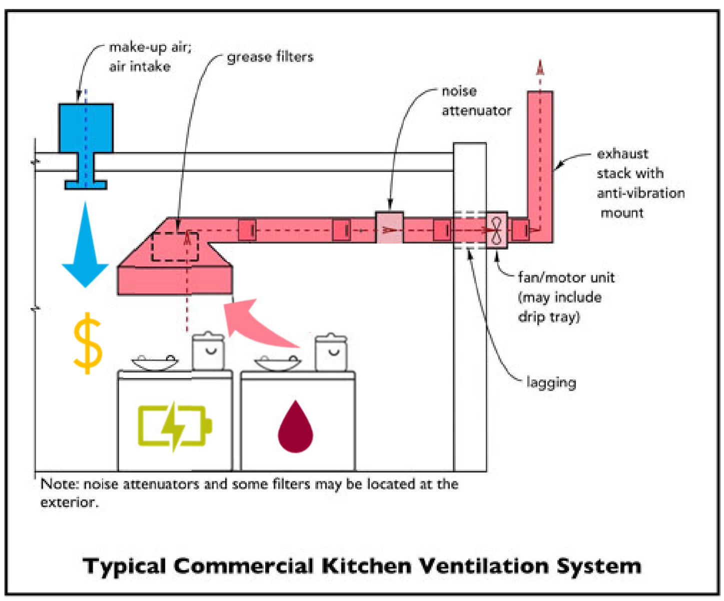

Typical Commercial Kitchen Ventilation System

Source: CJ Dustraction System

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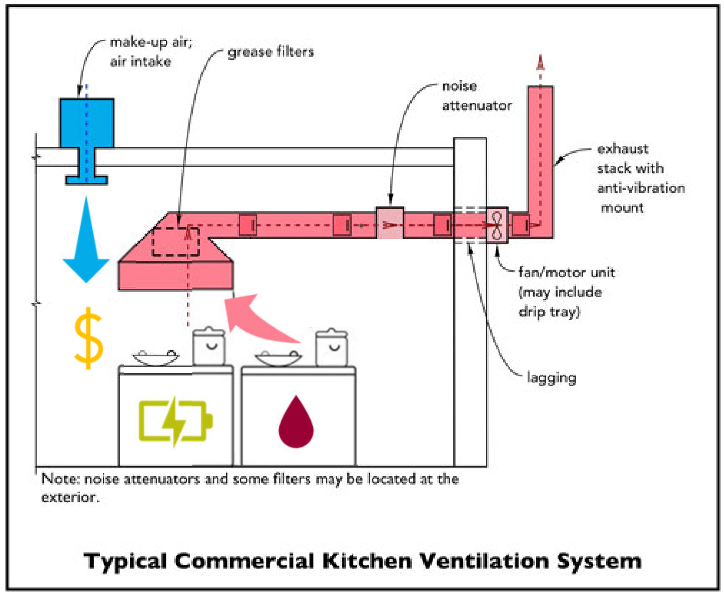
Solutions

1. Optimise kitchen design to reduce **exhaust requirements**
2. Reduce **conditioned make-up air** to balance exhaust
3. Efficient **kitchen equipment**
4. Reduce **Domestic Hot Water** demand
5. Use of **waste heat recovery**



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Source: CJ Dustraction System

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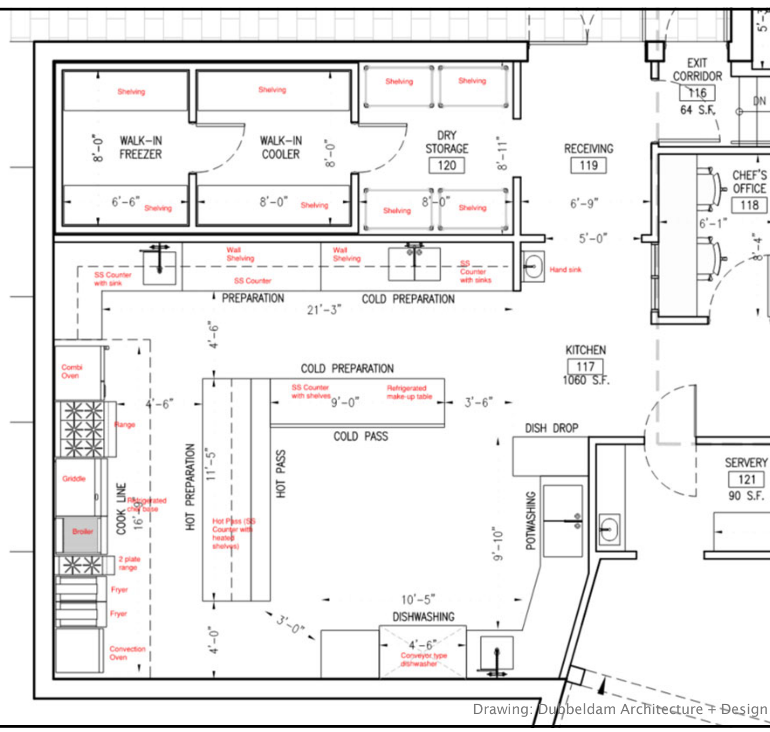
1. Kitchen Planning for min. exhaust

1. Grouping appliances with similar cooking schedules
2. Putting high-exhaust stations at the center of exhaust
3. Use of equipment with less heat production (induction cooktops)



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Drawing: Dubbeldam Architecture + Design

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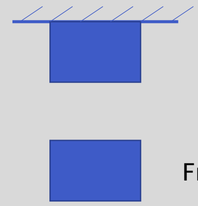
1. Kitchen Planning for min. exhaust

4. Removing island stations

Arrangement of Heat Source in Kitchen

(Plan section)



Placement on the wall

Free installation in the room

UTSC: (Island) pasta station

Island installation: **1472 cfm** exhaust

Wall installation: **800 cfm** exhaust

- 46%

Graph: Passive House Institute

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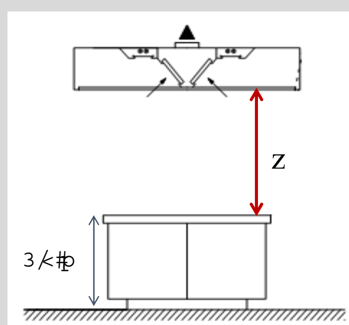
1. Kitchen Planning for min. exhaust

4. Removing island stations

5. Shielding exhaust hoods on 3 sides + adjust height of exhaust hood from cooking surface (the closer the better)

Height of Range Hood



Electric stove example

Z = **1.6m: 796 m3/hr** exhaust

Z = **1.2m: 620 m3/hr** exhaust

- 22%

Graph: Passive House Institute

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1. Kitchen Planning for min. exhaust

4. Removing island stations
5. Shielding exhaust hoods on 3 sides + adjust height of exhaust hood from cooking surface (the closer the better)
6. Use high-capture efficiency hoods (nozzles, air curtain)

26% cfm reduction

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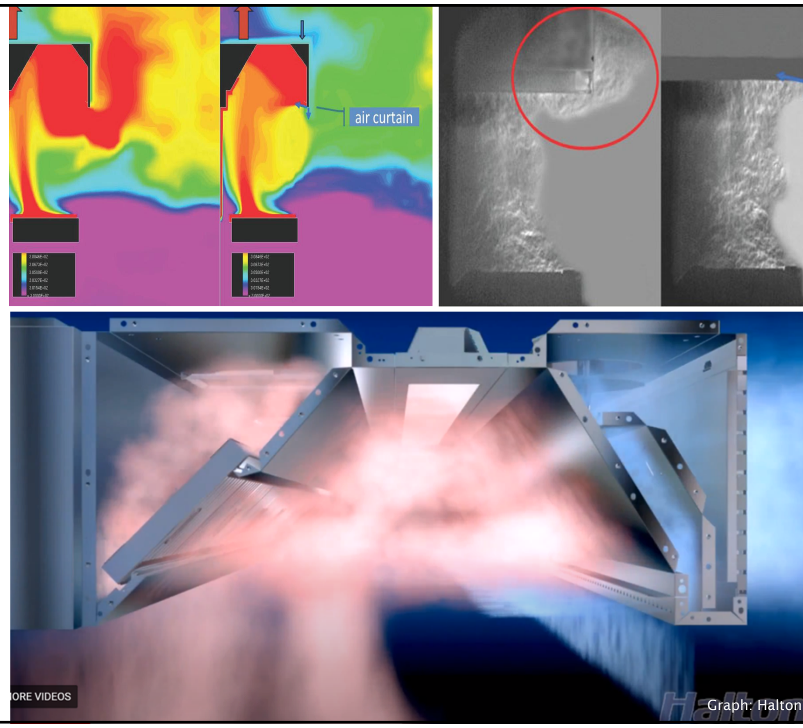

Graph: Halton

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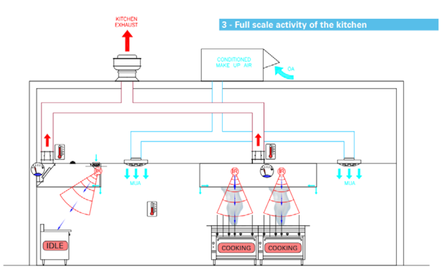
2. Demand Control Ventilation System

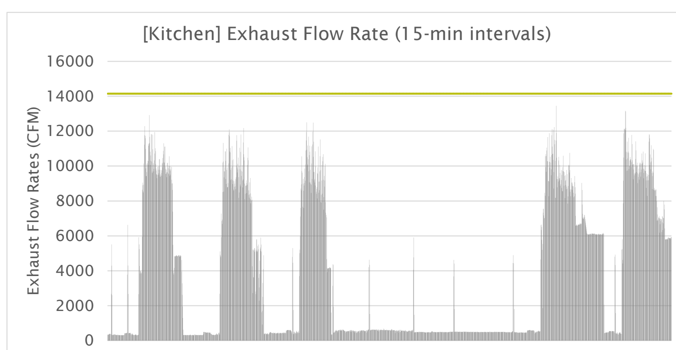
Use of "Demand Control Ventilation" (DCV)

DCV with algorithm based on:

→ Duct temperature sensors
→ Room temperature sensors
→ Infrared sensors

DCV control average* flow rate = 70% of max exhaust





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Graph (left): Halton Study*: Food Service Technology Centers, US Graph (right): RDH Building Science

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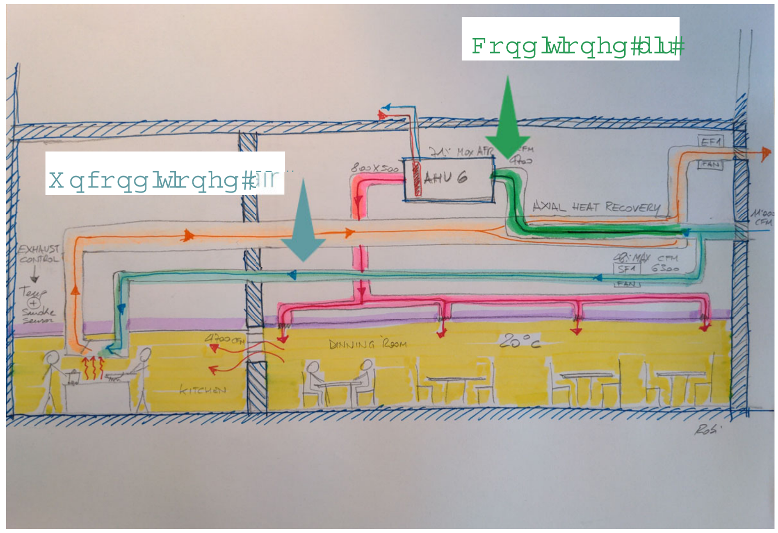
3. Use of Unconditioned Air

Split of make-up air between

- Conditioned air (people)
- Unconditioned air (directly to kitchen hood air curtain and extract)

Results

- Correct exhaust flow rate
- Reduced supply flow rate (energy budget "cost")



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Drawing: Passive House Institute (Roberto Iannetti)

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4. Heat Recovery Ventilation

Planning aspects

- Observe requirements for aerosol separation (Aerosols may condense in the duct and on components)
- Pay attention to **cleanability** of components and cleaning/inspection access requirements
- For operation in **summer**, kitchen ventilation systems with heat recovery to be equipped with a **bypass**

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Diagram: Reven

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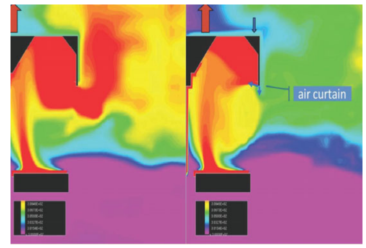
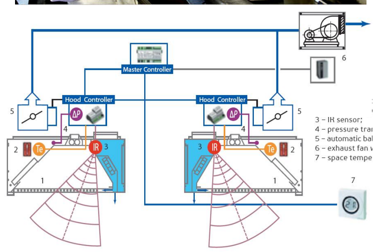
Kitchen Ventilation Design Efficiency Strategies

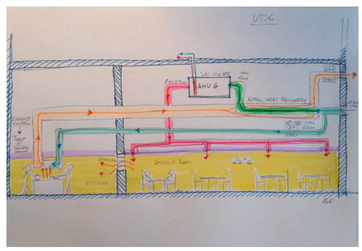
No.1: Equipment Grouping

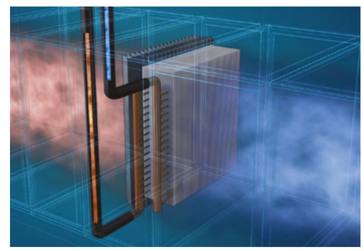
+ No Island Stations

+ High Capture Efficiency









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No.2: Demand Control Ventilation

No.3: Use of Unconditioned Air

No.4: Use of Heat Recovery

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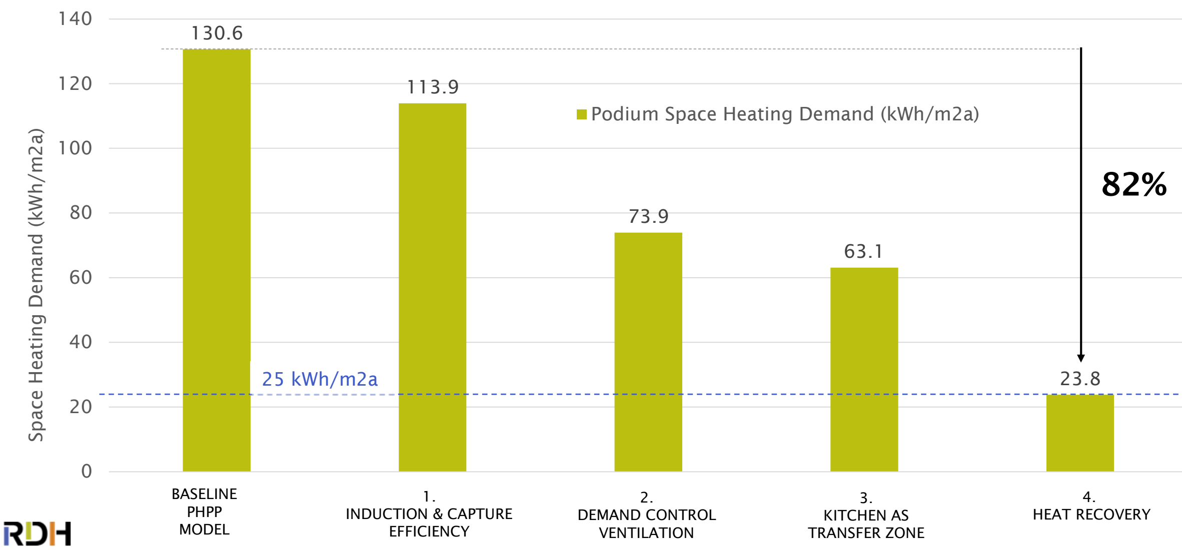
Impact of Kitchen Design Efficiency on Space Heating



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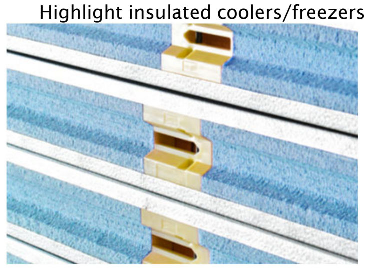
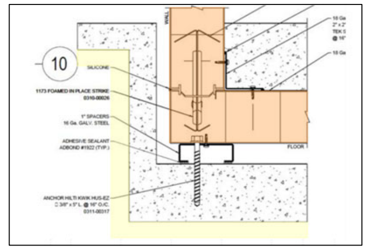
Kitchen Equipment

No open coolers

Highlight insulated coolers/freezers



Continuous insulation



Double set of airtight doors

Use of induction kitchen equipment

- Insulation - entire cabinet structure is foamed-in-place using a high density, polyurethane insulation that has zero ozone depletion potential (ODP) and zero global warming potential (GWP).
- "Low-E", double pane thermal insulated glass

Use of high-performance equipment

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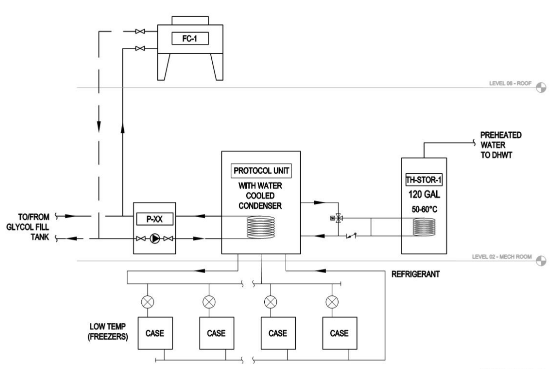
Waste Heat for DHW Pre-Heating

Equipment level

→ Dishwasher with wastewater heat recovery



Whole-Building Level

→ High temperature waste heat from refrigeration system

→ All refrigeration equipment installed on central compressor system

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Schematic: Integral Group

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Hospitals

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Differentiators

- Standards that increase ventilation and air flow minimums
- Strict indoor air temperature and relative humidity requirements
- Large process loads (e.g. MRIs, CTs, and sterilization)
- Continuous operation

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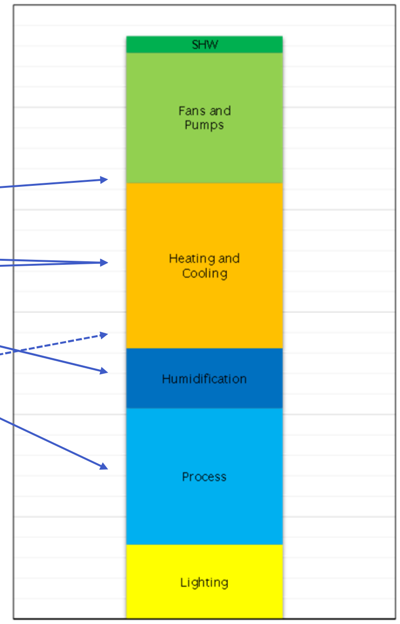
Where is the energy being used?

What are the elephants?

- Ventilation and air flow demands lead to:
  - Large fans to move air
  - High heating and cooling loads
  - Increased energy used for reheat
- RH requirements lead to large humidification loads
- Energy used by process loads and the cooling these loads demand



Typical Climate Zone 4C Hospital

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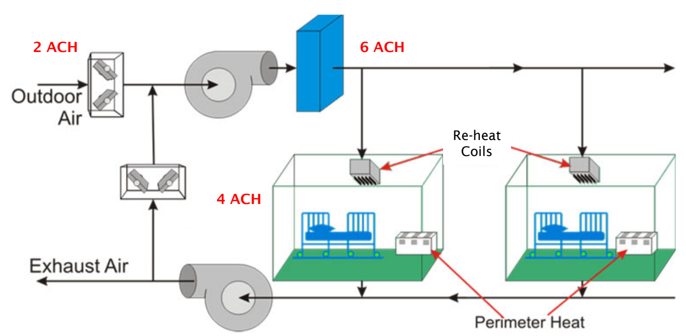
Standards for hospital HVAC design

- ASHRAE 170 / CSA Z317.2 define minimum total air changes per hour (ACH) and outdoor air ACH for each space type in the building.
- Examples of room requirements:
  - Patient Rooms: 6 ACH total, 2 ACH outdoor air
  - Operating Rooms: 20 ACH total, 6 ACH outdoor air
  - Procedure Room: 15 ACH total, 3 ACH outdoor air
- The volume of spaces drives flows rates



Patient Rooms: 6 ACH total, 2 ACH outdoor air

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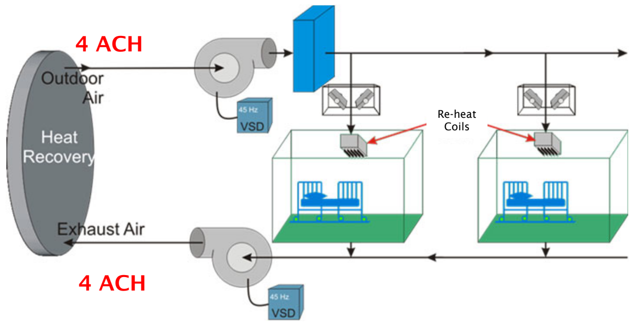
Reduce HVAC loads with heat recovery

- 100% Outdoor Air for Patient Rooms
  - 4 ACH total and outdoor air in lieu of 6 ACH total with 2 ACH outdoor air
- Air handler energy consumption reduced by **20%–30%** in cold climates
  - Reduces heating and cooling
- Smaller ductwork
  - lower floor-to-floor height or higher ceilings
- Lower capital cost
- Better infection control



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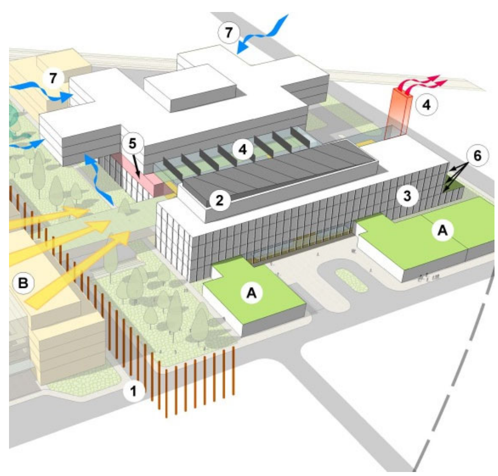
Reduce HVAC loads through planning

- Arrange rooms that may not need to comply with ASHRAE 170 / CSA Z317.2 in a separate area (or building):
  - Administration, lobbies
  - Offices
  - Training rooms
  - Cafeteria
- Design these spaces as typical space types (e.g. ASHRAE 62.1)



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ECO

Reduce heating & cooling with heat recovery chillers

- → Heat recovery chillers for 24/7 process cooling
- → Use heat recovery chillers to provide reheat to spaces
- → Depending on rate structure, heat pump chillers can be less expensive than gas heat
- → Can have much lower GHG emission than natural gas (depending on energy grid)

https://infrastructuredevelopment.ubc.ca/projects/life-sciences-centre-heat-recovery-chiller/

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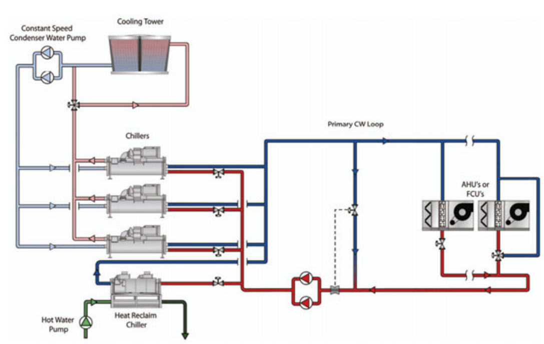
Reduce heating & cooling with heat recovery chillers

- → Designing for low temperature heating allows chillers to meet loads year round
- → Use high efficiency chillers for summer cooling
- → Look for "enhanced cooling" opportunities in design to provide additional heat from heat recovery chiller



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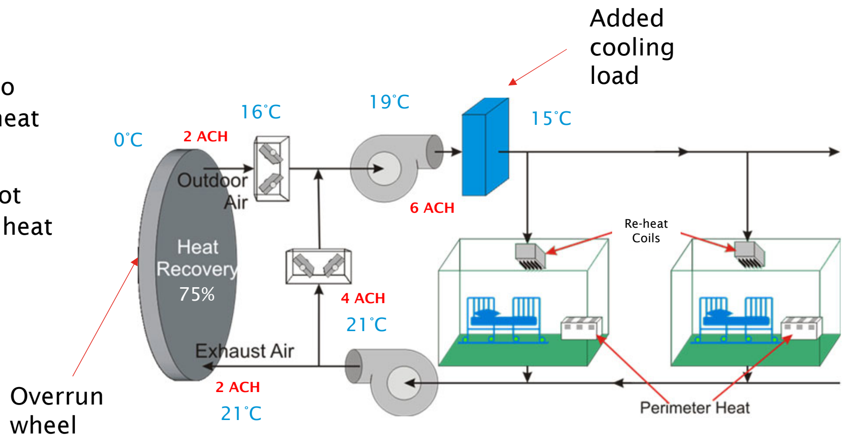
Slide 39

EC0 This slide could use a graphic
Eric Catania, 2022-12-08T14:45:46.146

Look for "enhanced cooling" opportunities

- Optimize HRV wheels to add a cooling load to heat recovery chillers
- Allows for additional hot water generation from heat recovery chillers



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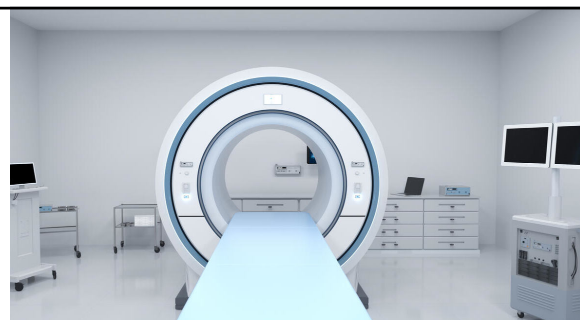
Process loads

- In high performance building these loads can be ~40% of overall energy use depending on climate zone
- Process loads include sterilization, plug loads (e.g. MRIs, CT, and X-Ray), and servers/IT equipment
- These introduce cooling loads in rooms that can benefit from using heat recovery chillers to cool them



https://uwaterloo.ca/news/media/mri-innovation-makes-cancerous-tissue-light-and-easier-see

https://www.hamiltonhealthsciences.ca/share/new-ct-scanner/

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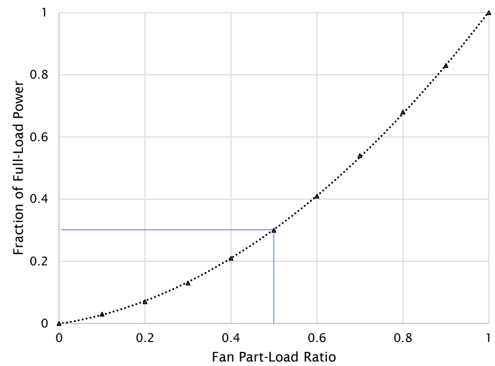
Reduce fan power

- Hospital standards include system redundancy requirements which may lead to multiple air handers serving the same space
- Running units in parallel can lead to significant reductions in fan energy
- Fans operating at 50% flow consume ~30% of full power



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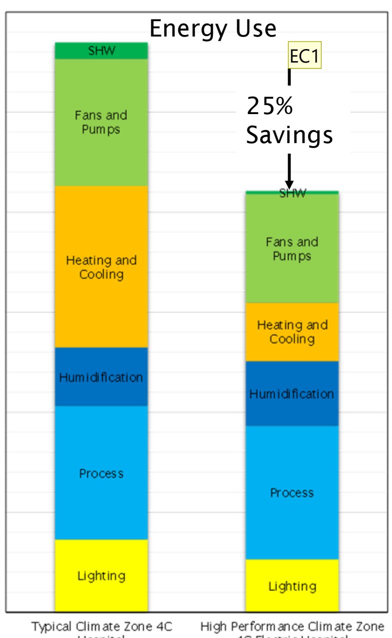
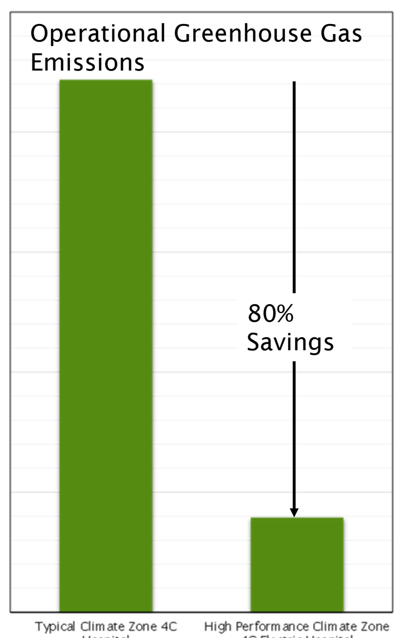
Energy efficiency and electrification

- Electrifying heating can have a significant impact on operational greenhouse gas emissions (depending on energy grid)
- Seek opportunities to electrify
  - Air Sourced Heat Pumps (ASHPs) for additional heating
  - Electric sterilizers
  - Electric humidification





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Slide 44

EC0 Schematic/Results
Eric Catania, 2022-12-08T15:24:46.345

EC1 GHG Charts?
Eric Catania, 2022-12-08T15:25:03.194

Takeaways – Hospitals

- Airflow and ventilation are the largest load in hospitals
- Heat recovery chillers can be used to reduce reliance on standard heating boilers
- Look for opportunities to enhance the potential for heat recovery chiller use
- Sequence fan systems to benefit from parallel units
- Electrify as much as possible

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Takeaways – Commercial Kitchen

Best Practice Commercial Kitchen Design Approaches

- Priority #1: **right-sized** ventilation (planning, then technology)
- Priority #2: use of **efficient** equipment (careful specification)
- Priority #3: reduced DHW demand (through use of **waste heat**)

Design Approaches to Commercial Kitchen

- **Need for deep client engagement & integrated design w/ consultants**
- Deep understanding of kitchen profiles (food preparation process & equipment use, ventilation requirements, occupancy)

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Overall Takeaways

1. Understand energy flows in your building
2. Find the energy Elephants
3. Challenge assumptions
4. Electrification, all grids in North America are decarbonizing over time

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