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BUILDING ENCLOSURE CONFERENCE

RESTON VA

2022

MAY 10-11

Future Ready Design Considerations for Building Enclosure Design

Paul Totten, PE, LEED AP

wsp

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Learning Objectives

- Be able to better assess the climate considerations for your building enclosure design.
- Comprehend where additional enclosure detailing and component considerations should be implemented.
- Evaluate what additional building science models may be prudent.
- Evaluate how climate change may impact construction schedules and risk for heightened built in moisture in some climate zones.

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Presentation Outline

- **Basic purpose of buildings**
- **Building types and considerations**
  - Existing vs. New assets
- **Overview of design considerations**
  - Climate change
  - *Durability and redundancy*
- **HVAC and pressure interaction with enclosure**
- **Examples of enclosure considerations**
- **Questions**

Purpose of Buildings

- **Provide shelter**
- **Separate and protect us from outside environment**
- **Life safety**
- **Building science considerations**
- **User experience**
- **Use type**
- **Minimizing impact while maintaining**

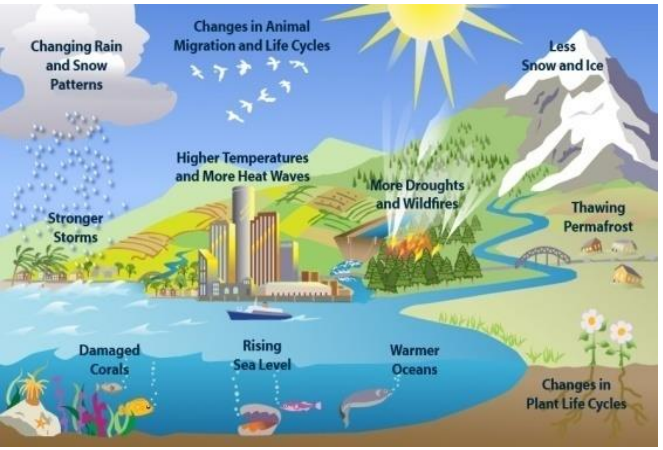
Building Examples and Types – Existing Assets

Building Examples and Types – New Assets

Impact of People

- **Materials made by people**
- **Designed by people**
- **Constructed by people**
- **Maintained by people**





Impact of Climate Change

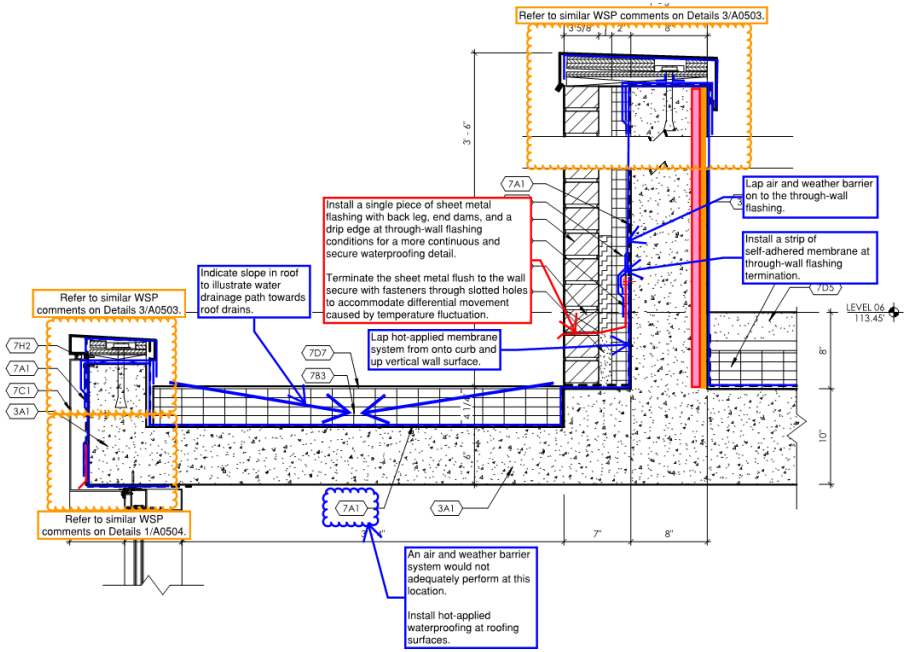
- **Change in type of precipitation events**
  - Increased volume/shorter duration
  - More severe storms/higher winds
  - Flooding
- **Solar considerations**
  - Increased radiation
  - Examine SHGC and window films
- **Need for improved durability, redundancy, and long-term planning of your asset(s)**

Asset Management Planning (AMP)

- **Existing building versus new construction**
- **If new construction, set asset management plan at completion of construction**
- **If existing, perform condition assessment and testing to develop asset management plan**
- **Set schedule and priority:**
  - Life safety
  - Maintenance cycles
  - Ease of doing multiple tasks simultaneously
  - Capital cost planning

New Construction

- **Importance of building enclosure commissioning (BECx)**
- **Design document reviews**
- **Coordinated submittals and shop drawings**
- **Architect/Consultants working with installers**
- **Systems manual, equivalent of O&M manual for the facade**
- **Apprenticeship programs**

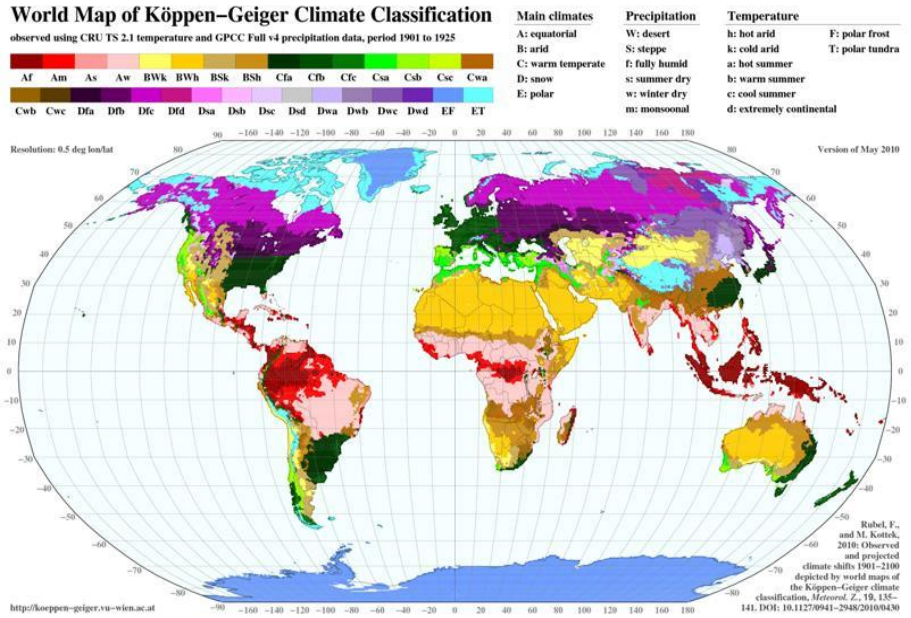


Existing Buildings

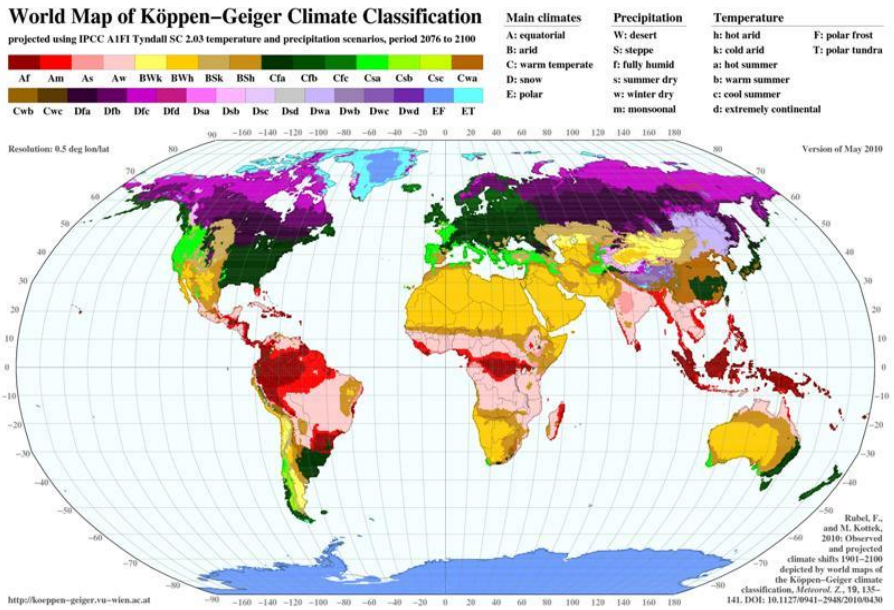
- **Document review – what has been done**
- **Visual and forensic survey – what does it look like, how does it perform**
- **Prioritization**
- **Asset Management Planning**

Climate Change

- World Map of Köppen-Geiger Climate Classification



1901-1925

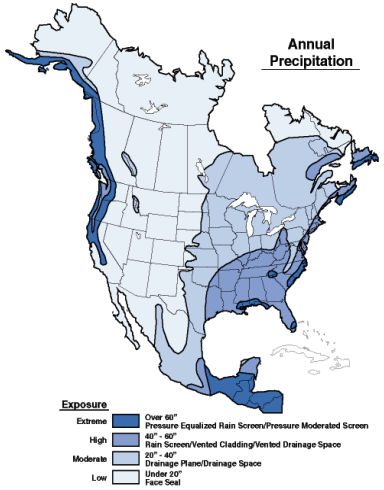


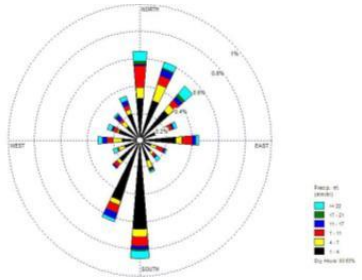
2076-2100

DC: Cfa Climate

Warm Temperate, Fully Humid, Hot Summer

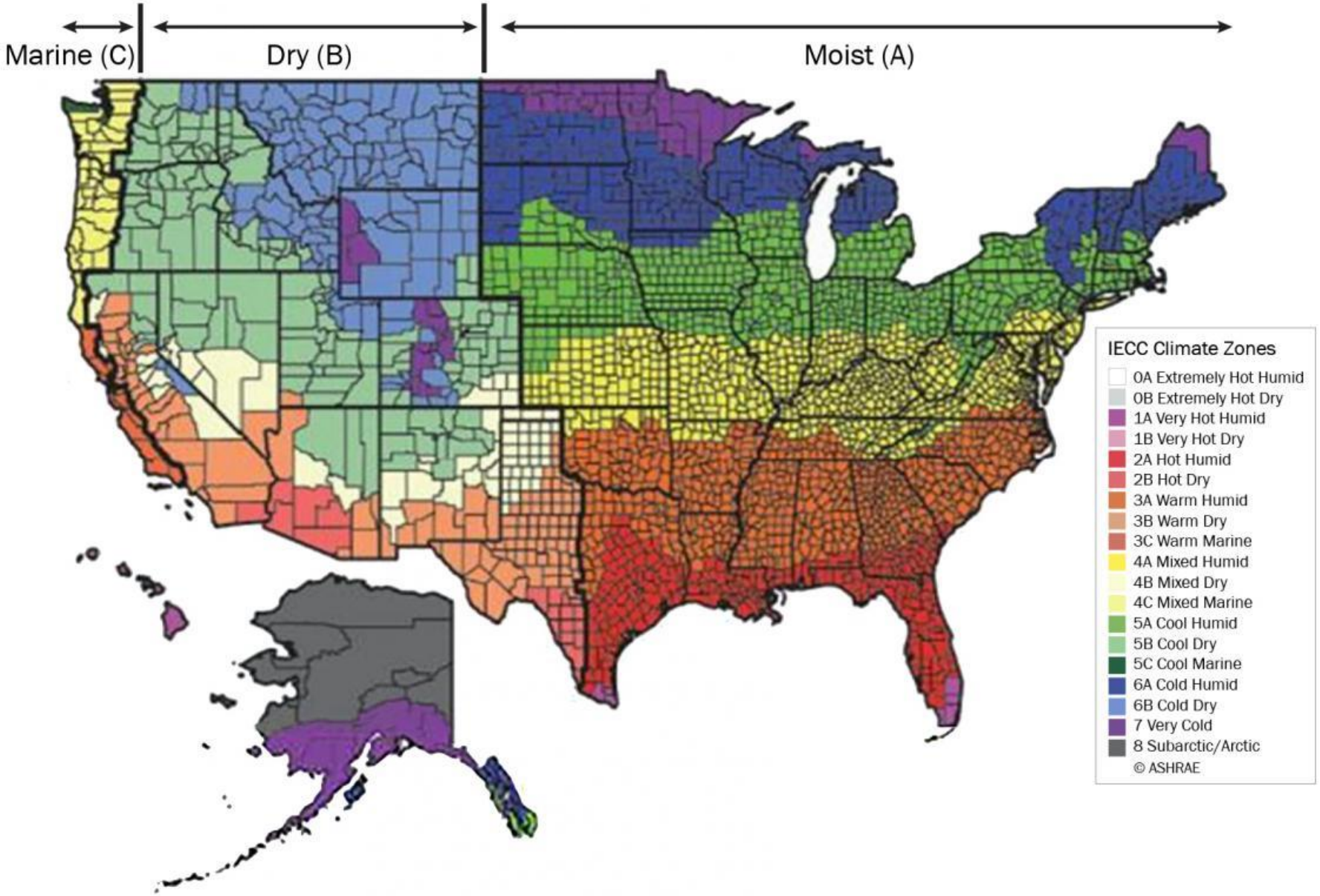
Importance of Climate Variation





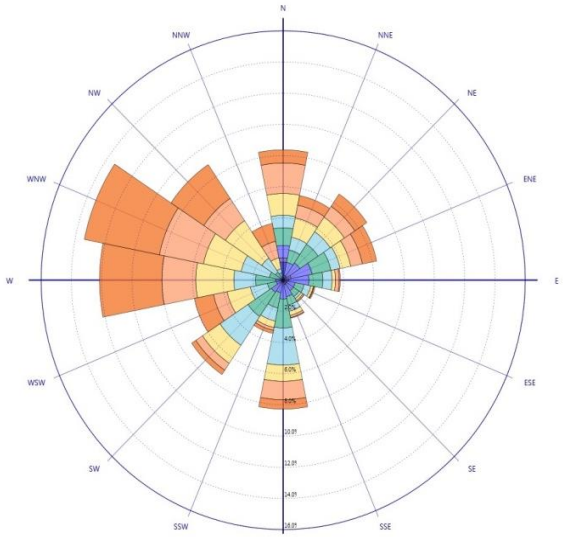
- Review of macro and micro climate
  - Understand the climate zone
  - Rain fall volume considerations
- Micro climate specific to your site
  - Review of site topography
  - Development density
  - Neighboring existing buildings and planned future development
- Existing building versus new construction
- Orientation of building and considerations by elevation

Climate Zones

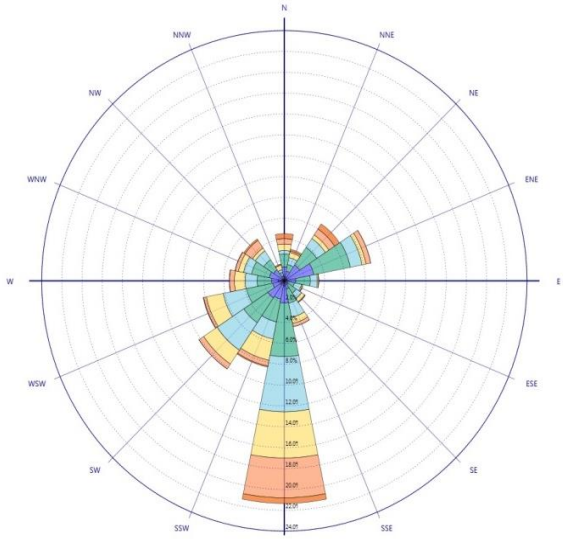


Seasonal Evaluation

Winter

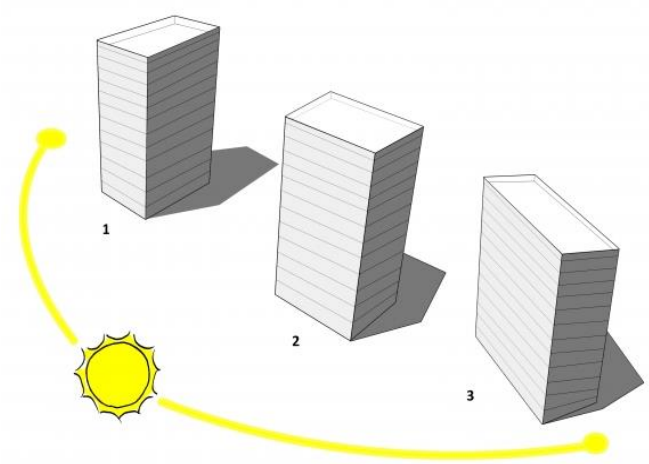


Summer

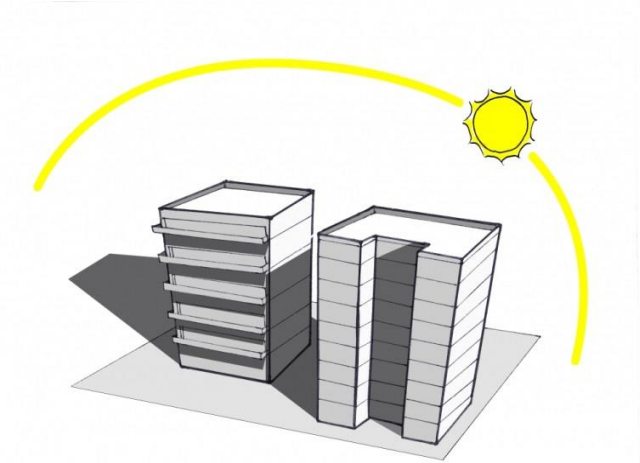


- Need to understand seasonal variations:
  - Short winter
  - Mold count and pollen count
  - Heavy rain in spring and summer
  - Similar heights of buildings in certain cities (Metro DC) and affect on wind flow
  - Wind flow variations
  - Heat gains
  - Exterior humidity levels

Building Design Considerations



SOURCE: http://sustainabilityworkshop.autodesk.com/buildings/building-massing-orientation



SOURCE: http://sustainabilityworkshop.autodesk.com/buildings/building-massing-orientation

- Orientation
- Floor plate – shape, depth
- Layout and type of mechanical systems
- Occupant comfort expectations – stretching the comfort zone

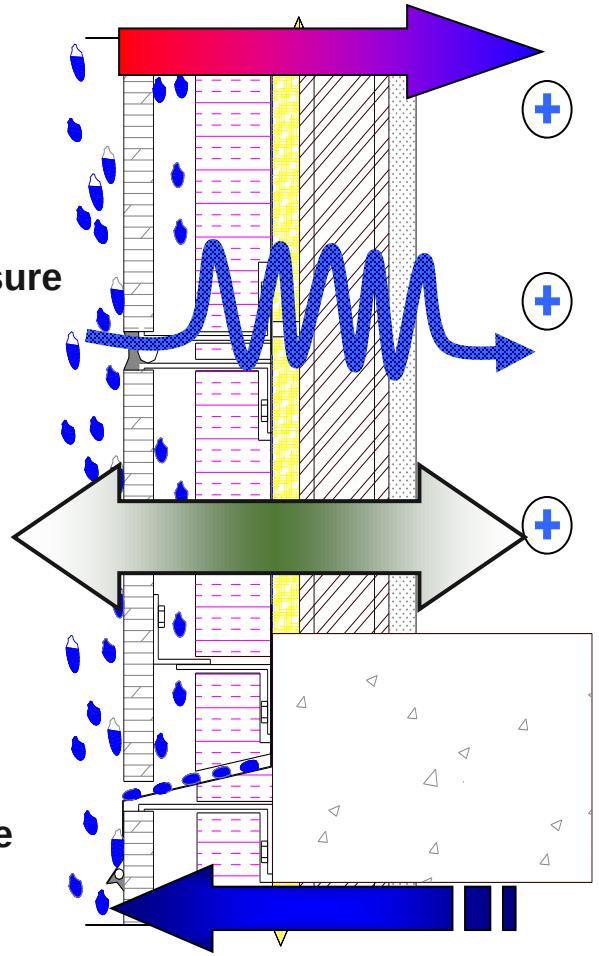
Heat, Air, & Moisture Transfer Principles

Warmer outdoor temperature

Higher vapor pressure (Higher RH)

Water drains along drainage planes and water redirected at flashings beyond exterior wall surface

Lower air pressure (ideal)



Cooler indoor temperature

Lower vapor pressure (Lower RH)

Cycling of air pressure due to wind, stack, or mechanical system variations

Positively pressurized building higher air pressure

Inverse direction for heating season for heat and vapor transfer

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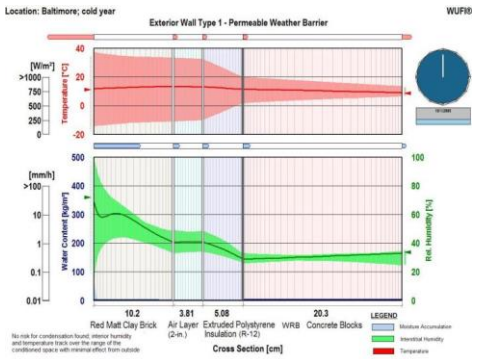
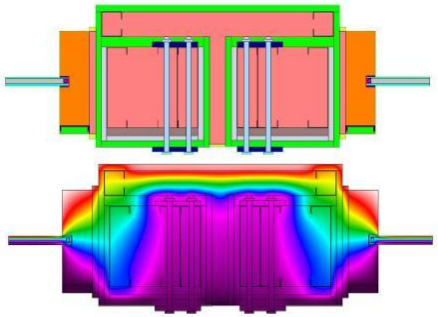
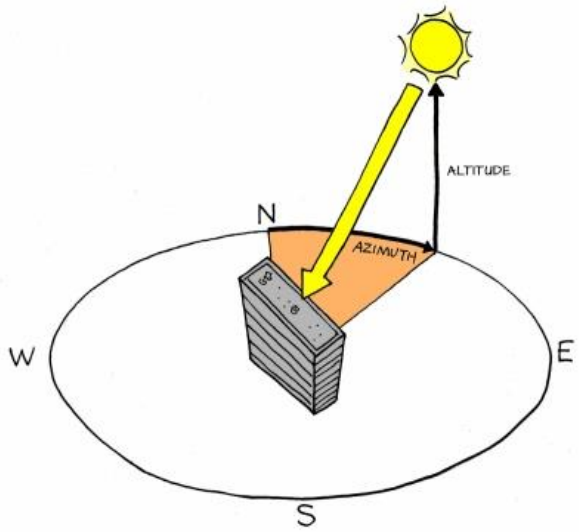
Initial Analysis





- Perform initial hygrothermal and thermal analysis during schematic design based on options for systems, orientation, etc.
- Conceptual energy analysis
- Not just present and historic climate data, but examine future prediction
- Design for adaptability
- System interaction
  - Mechanical with enclosure
  - Daylighting/lighting
  - Mechanical can drive the loads - ventilation

Temperature Considerations



SOURCE: http://sustainabilityworkshop.autodesk.com/buildings/solar-position

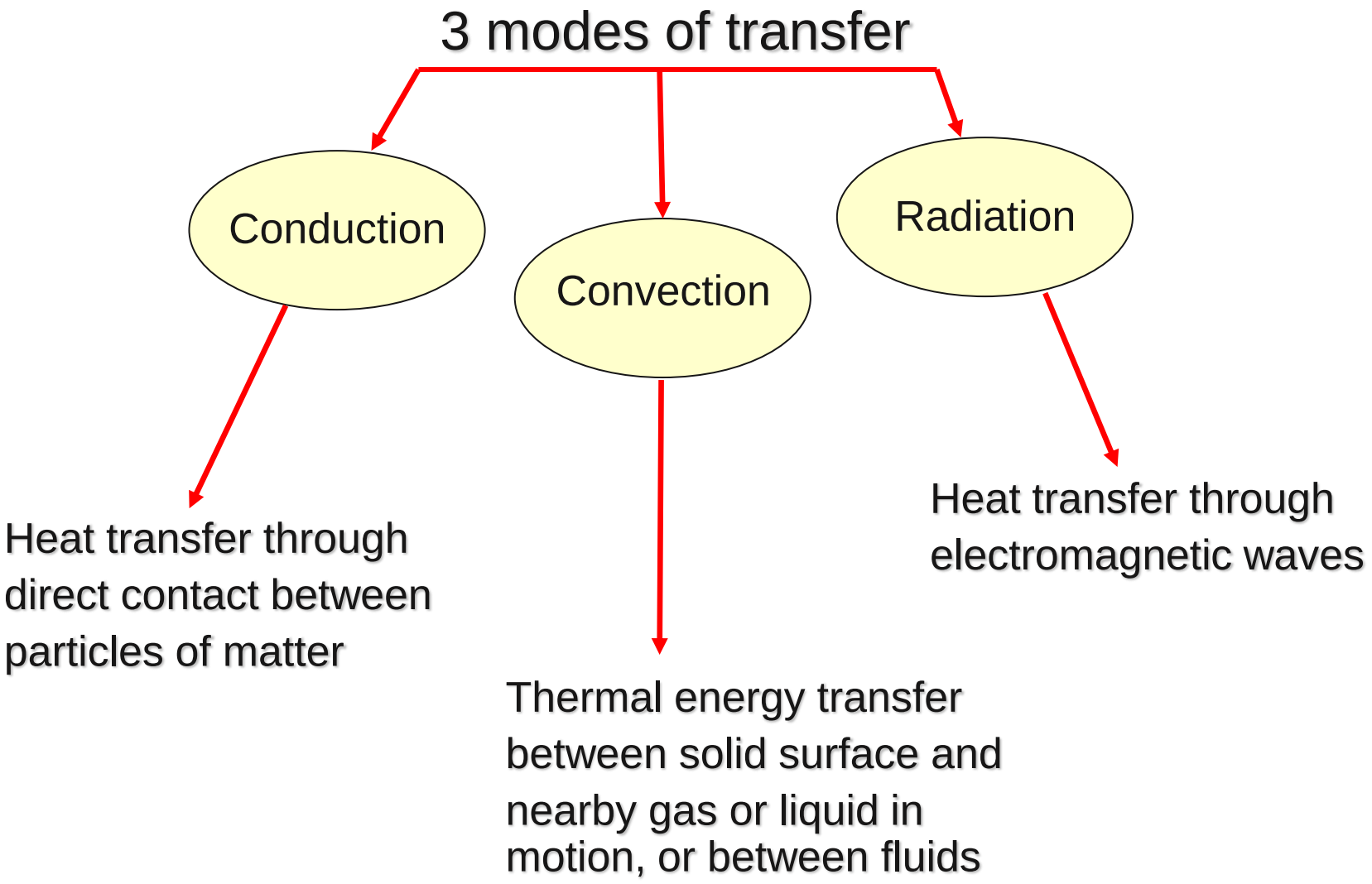
INCIDENT SOLAR RADIATION - Average Daily — New York Central Prk Obs Belv, USA — W/m²

Hr	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	15.2594	16.3422	0	0	0	0	0
18	0	0	0	20.5162	30.1162	34.6516	37.6782	23.9151	8.01574	0	0	0
	0	47.8764	45.2562	36.2752	51.507	56.5644	59.7385	44.9438	32.5852	13.6078	0	0
16	99.7517	126.088	139.851	77.431	71.8332	80.5094	75.5539	72.9254	82.4944	89.9916	89.4628	72.4797
	147.718	201.57	224.539	178.067	112.541	107.332	121.011	148.837	170.71	182.327	157.54	114.823
14	171.085	205.074	274.419	232.191	187.41	179.449	191.525	219.594	230.76	209.014	172.836	185.439
	279.964	336.974	325.122	316.401	225.078	219.815	243.011	281.171	280.965	229.617	203.148	209.866
12	170.401	275.084	292.961	246.355	230.516	230.134	228.714	241.856	242.34	324.579	268.864	237.835
	133.409	167.589	202.861	210.315	174.422	190.581	187.631	198.214	239.391	219.995	173.475	147.978
10	79.3008	130.855	108.277	158.254	203.247	200.136	203.194	157.644	156.529	158.502	105.719	77.8509
	50.2154	41.187	80.1259	178.958	128.575	130.855	130.331	132.114	98.3325	40.6744	97.5776	48.5689
08	0	14.4846	111.772	81.1856	82.1815	88.6367	86.8996	81.4501	70.8611	104	11.3328	0
	0	0	0	29.4274	42.3088	50.1165	44.1208	32.4433	23.3878	0	0	0
06	0	0	0	0	13.8069	18.4612	13.9167	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
04	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0
02	0	0	0	0	0	0	0	0	0	0	0	0
	0	0	0	0	0	0	0	0	0	0	0	0

W/m²
350
315
280
245
210
175
140
105
70
35
0

- Solar angle
- Solar radiation
- Interior conditions

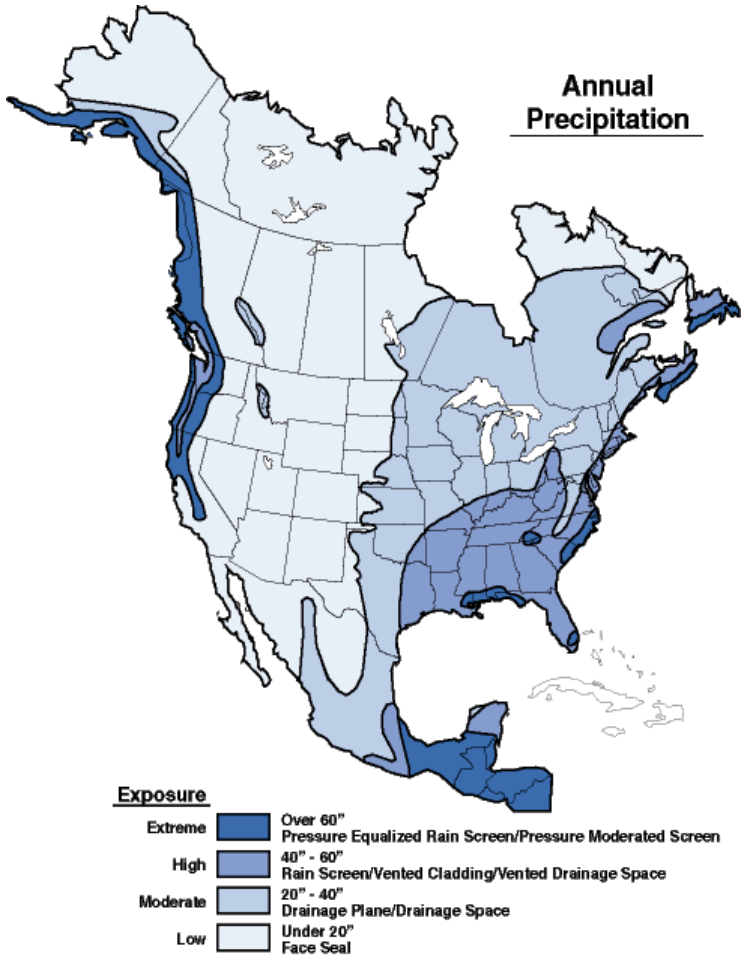
Heat Transfer Mechanisms



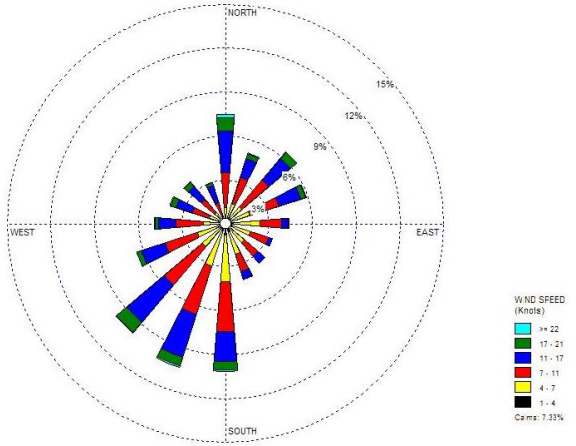
Rainfall Zones

Designing and building in a moderate to high rain fall zone*

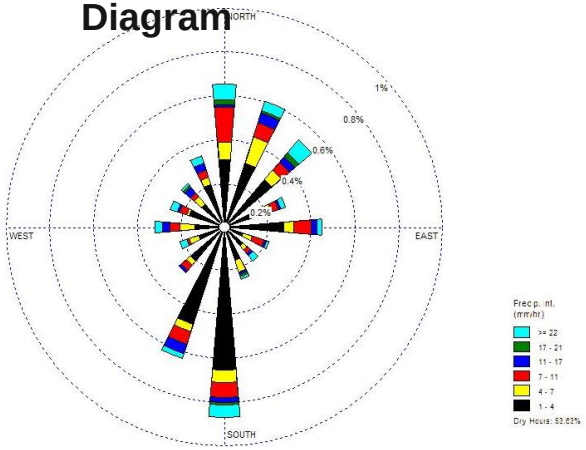
* Map and Zone Description per EEBA Builder's Guide



Wind Rose Diagram



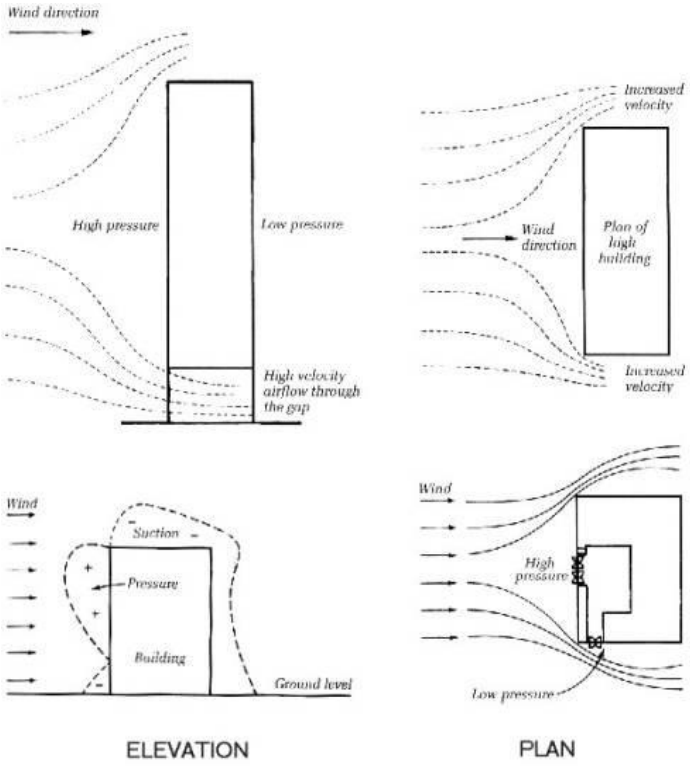
Rain Rose Diagram

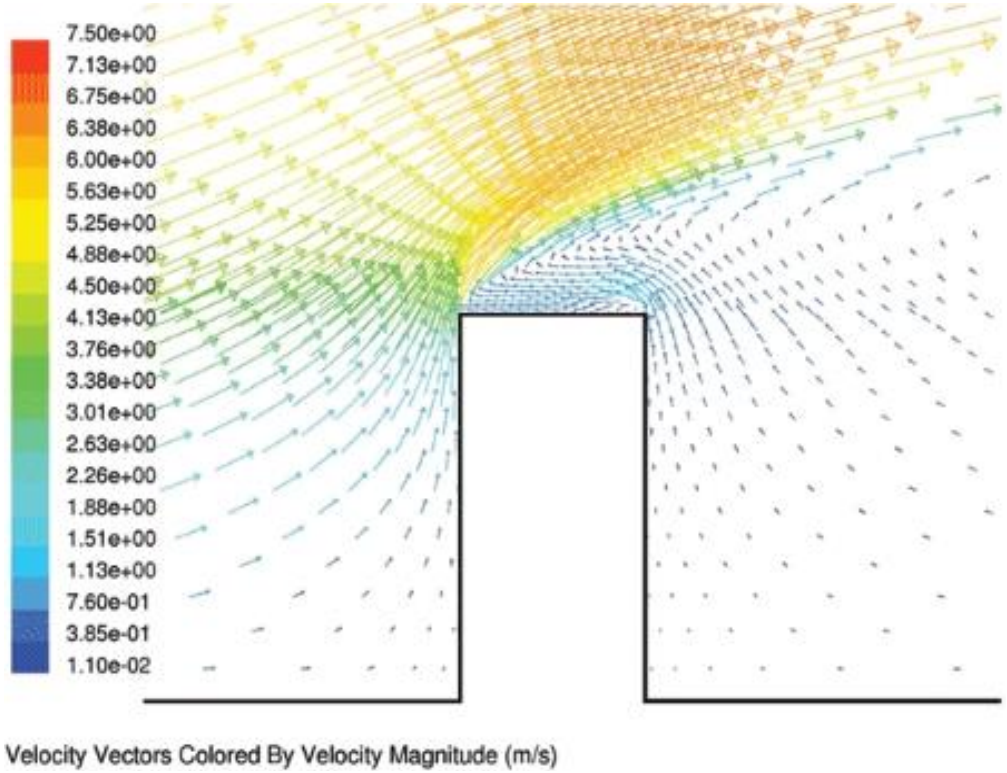


Wind

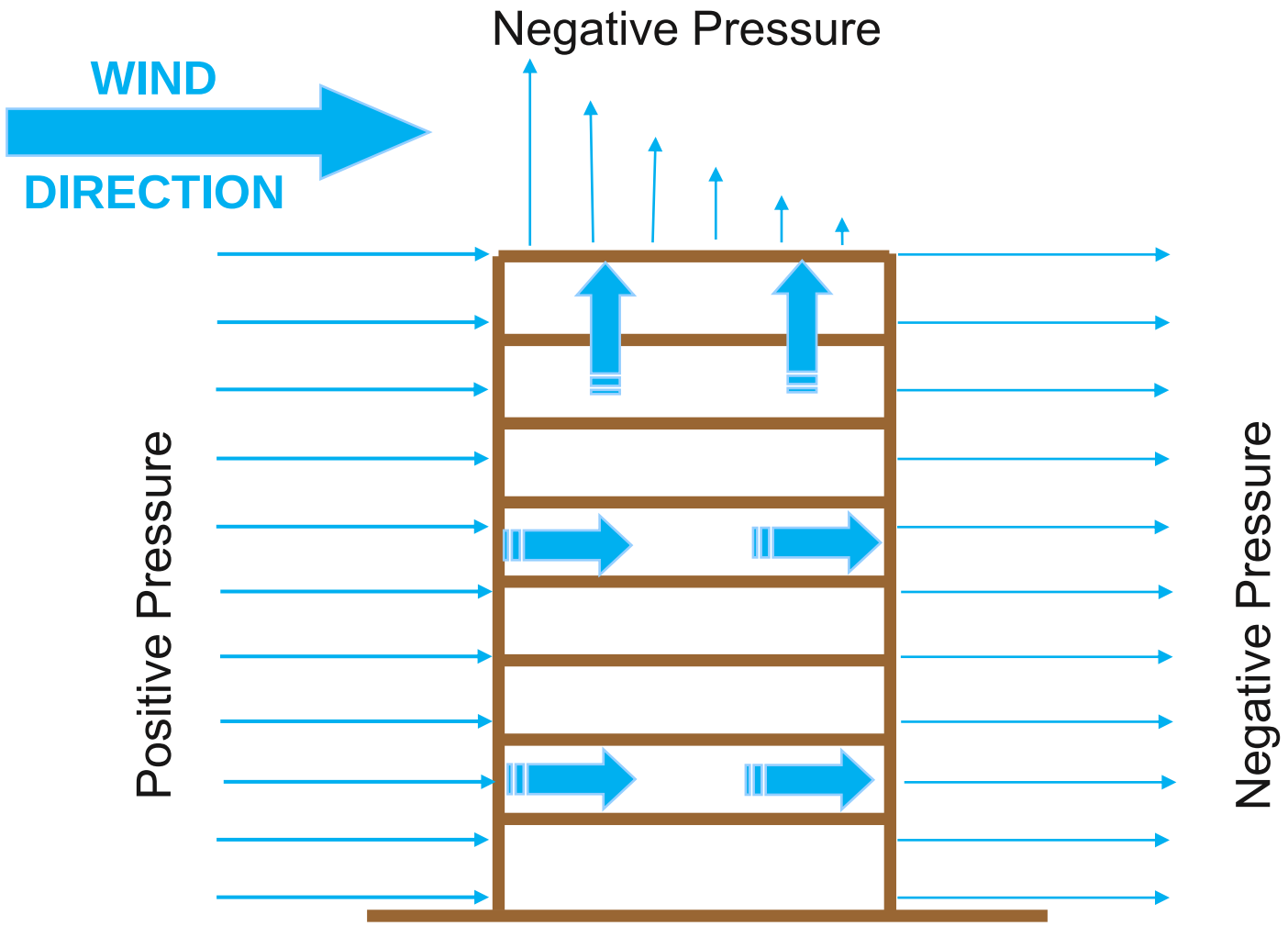
- Orientation
- Transport of Pollutants
- Orientation/location of fresh air intake

Wind Pressure

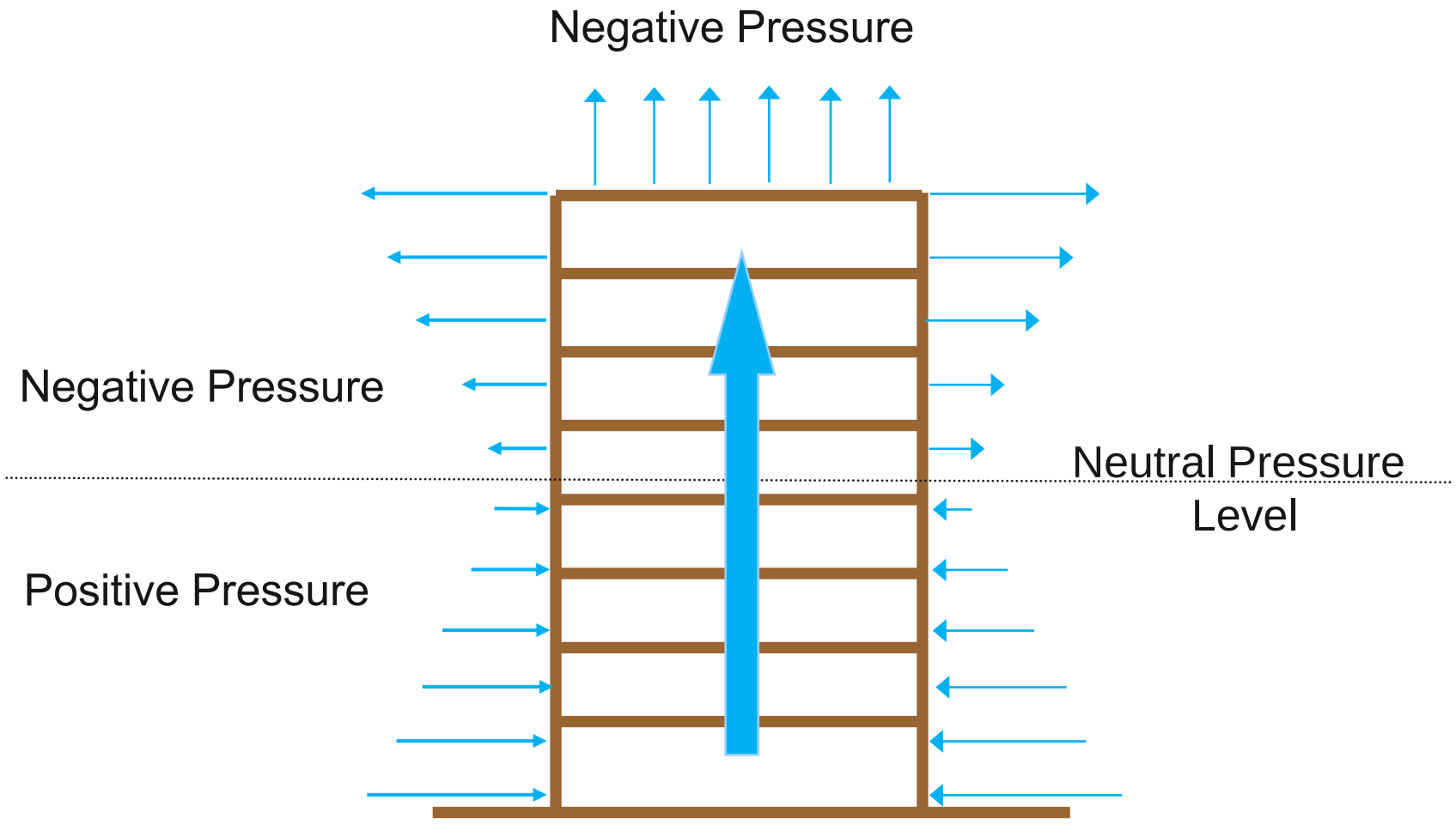




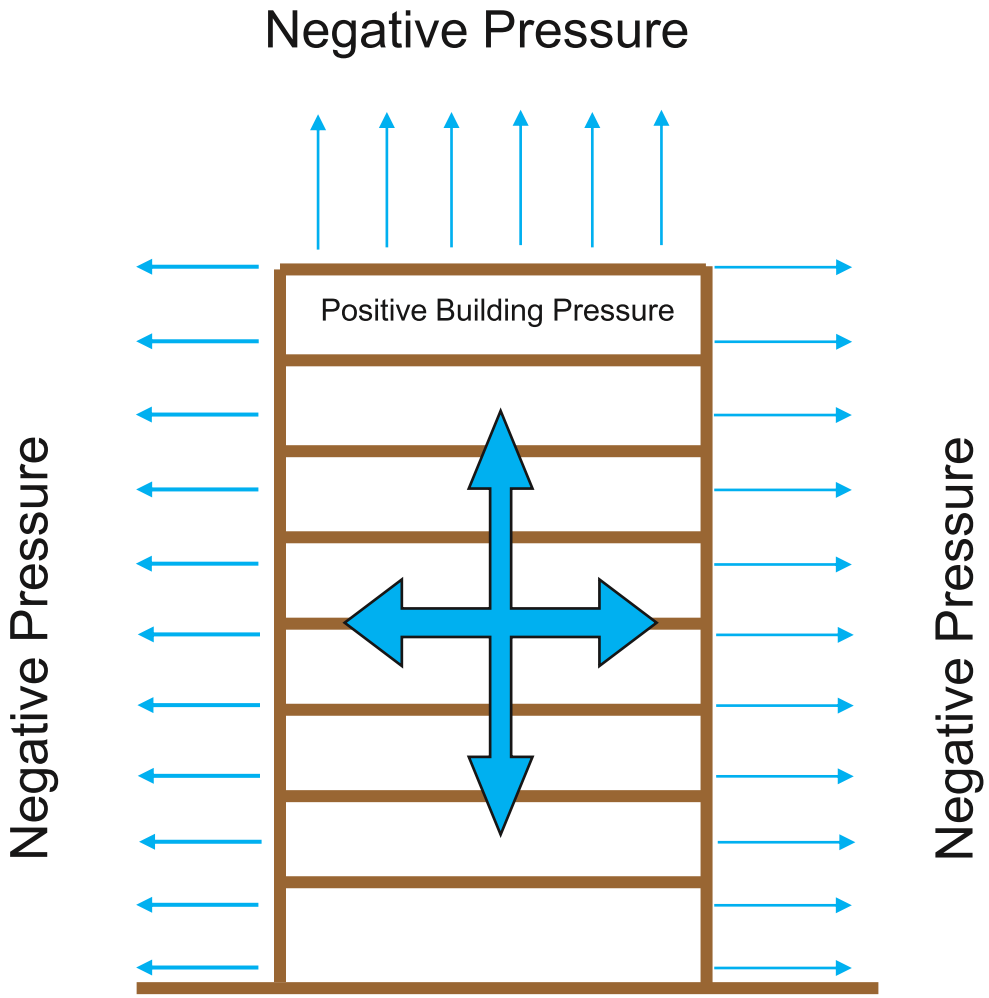
Wind Pressure



Stack Effect

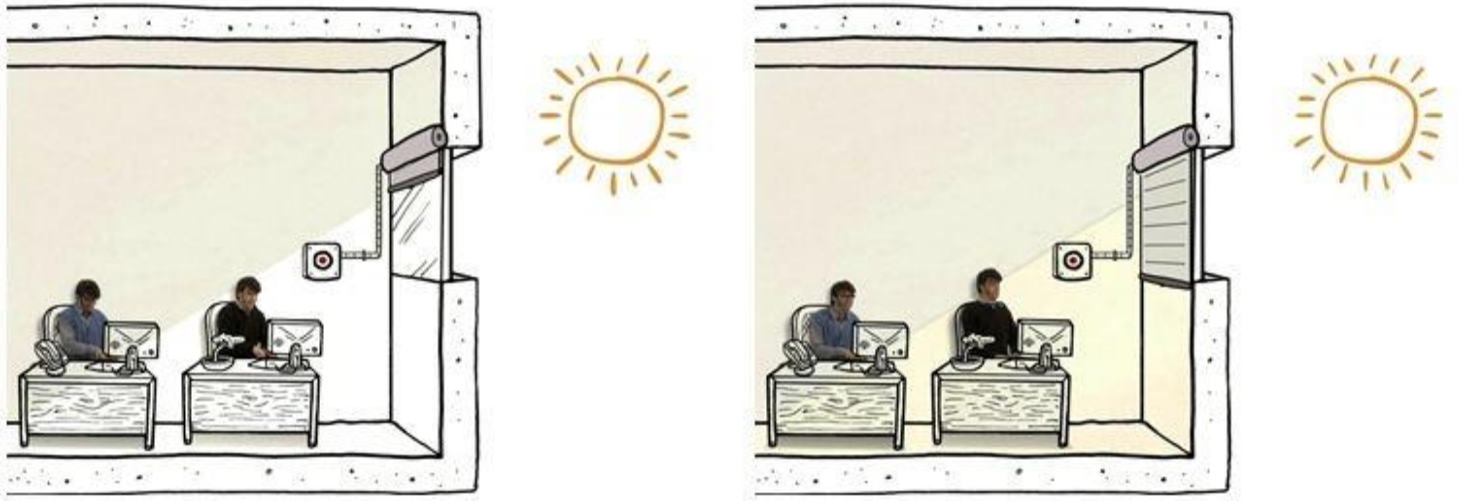


Mechanical Systems



Climate Responsive Building Design

- Responsiveness of systems
- Controls
- How it reacts to the environment



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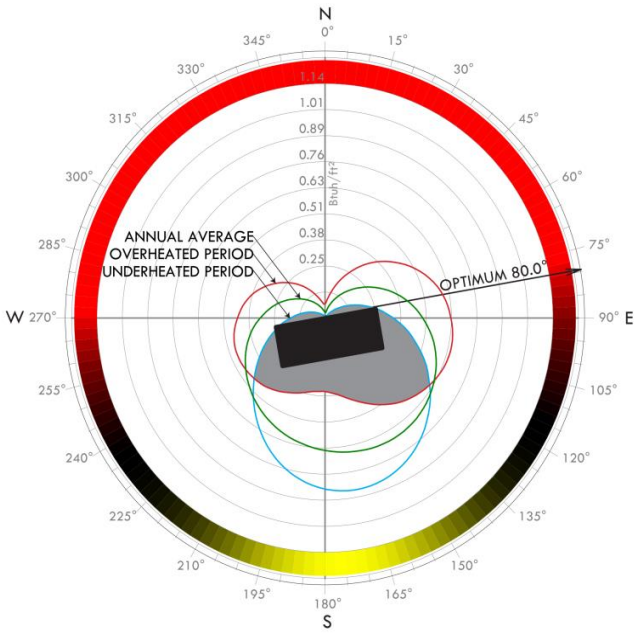
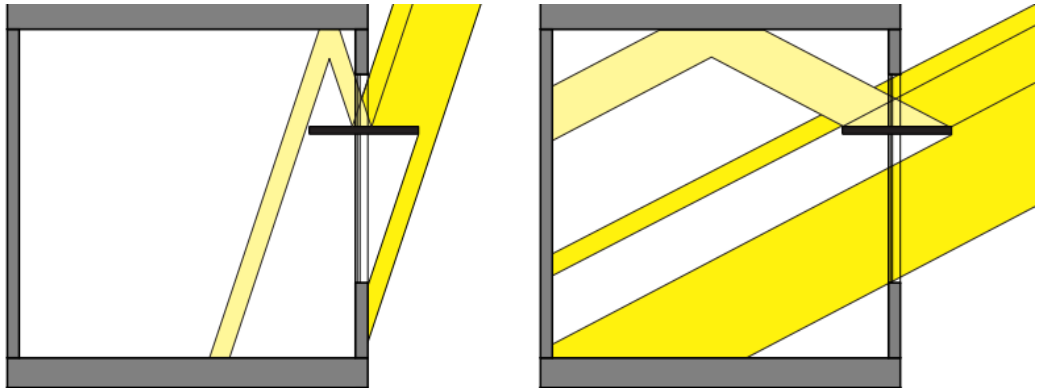
Passive Solar



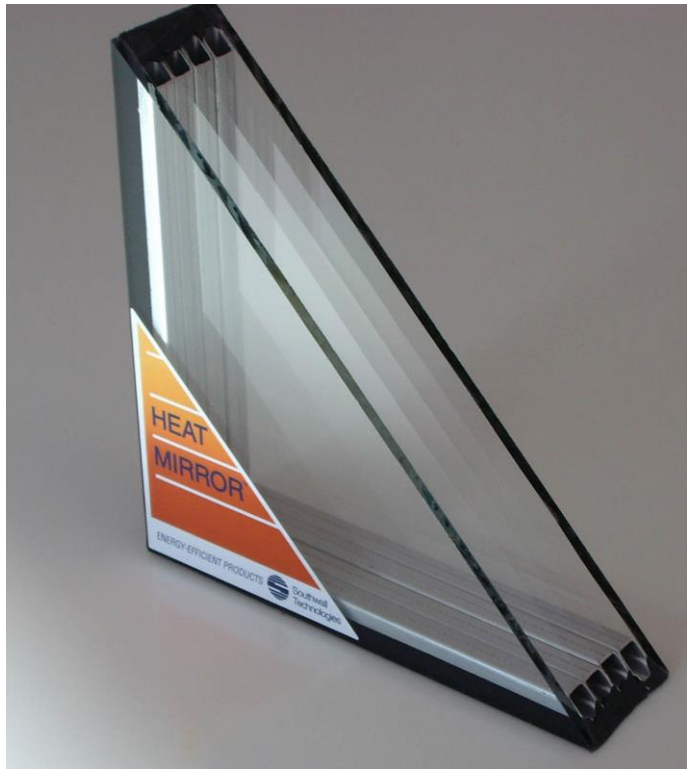
- Darkened materials
- Avoid overheating
- Building orientation
  - Shading due to adjacent development
  - Shading of neighboring spaces
- Glazing considerations
- Double skinned facades and the importance of distance between portions of skin and proper climate zone

Shading and Light Shelves

- Effect on passive solar gains
- Thermal bridging issues
- Angle, not just look
- Optimize by orientation
- Analyze site for other shading – trees, adjacent buildings



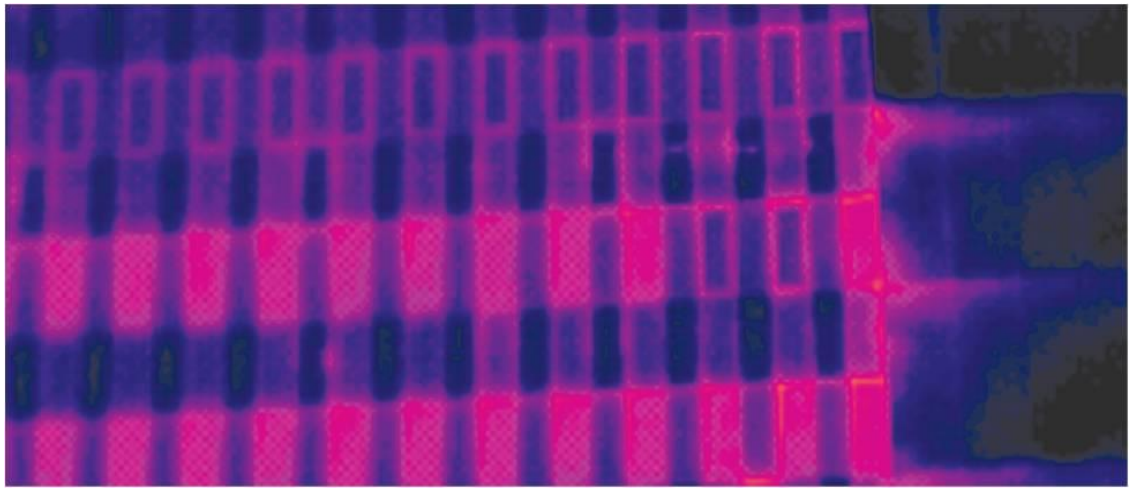
Glazing Systems



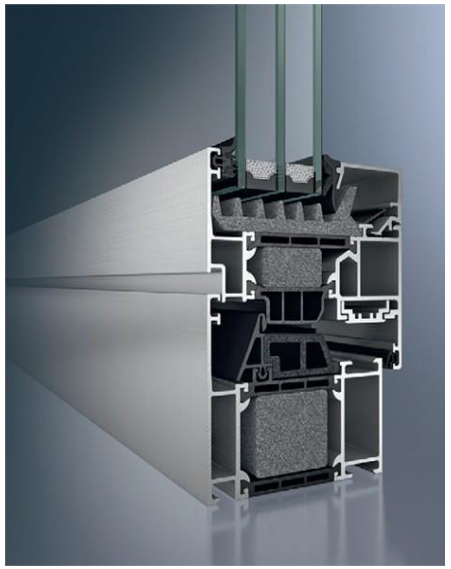
- Double versus triple glazed
- Heat mirror systems
- Low-e coatings
- Tint
- Glass type
- Low iron glass

Fenestration Systems

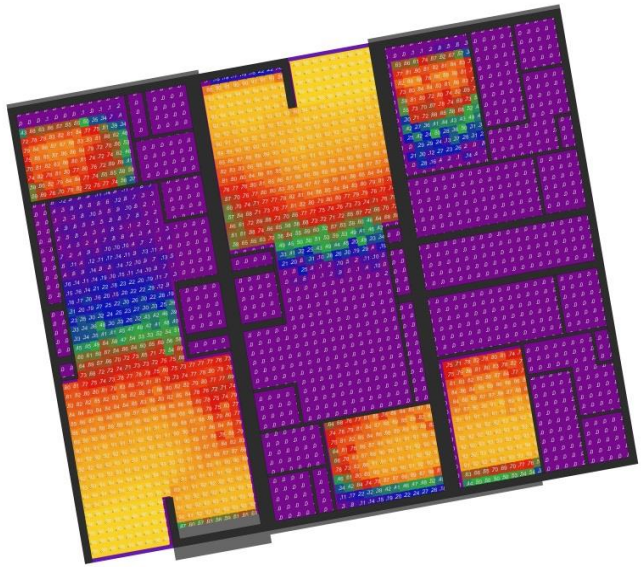
- Frame type
- Glazing type
- Glazing alignment with thermal barrier
- Passive heat fin considerations for glazing systems

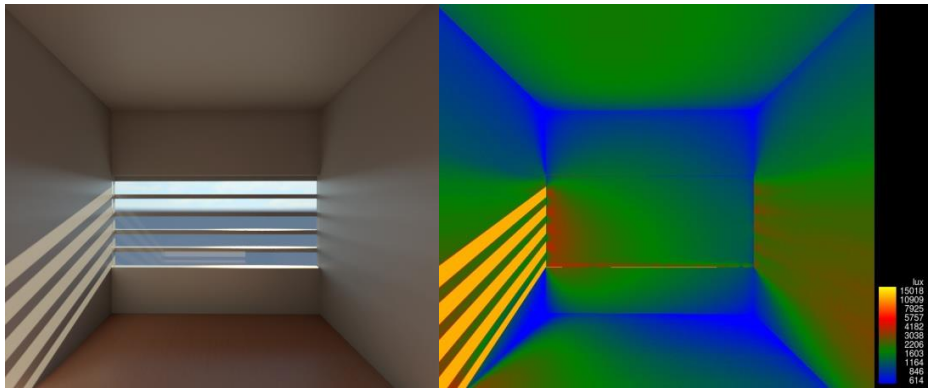


Design Considerations for Fenestration



- Thermal performance of fenestration product
  - Thermal breaks, glazing type, framing material
- Transition to adjacent structural components
- Transition to adjacent building enclosure components
- Location of mechanical heat/air supply relative to fenestration location
- Air leakage at the window perimeter
- Interior humidity levels





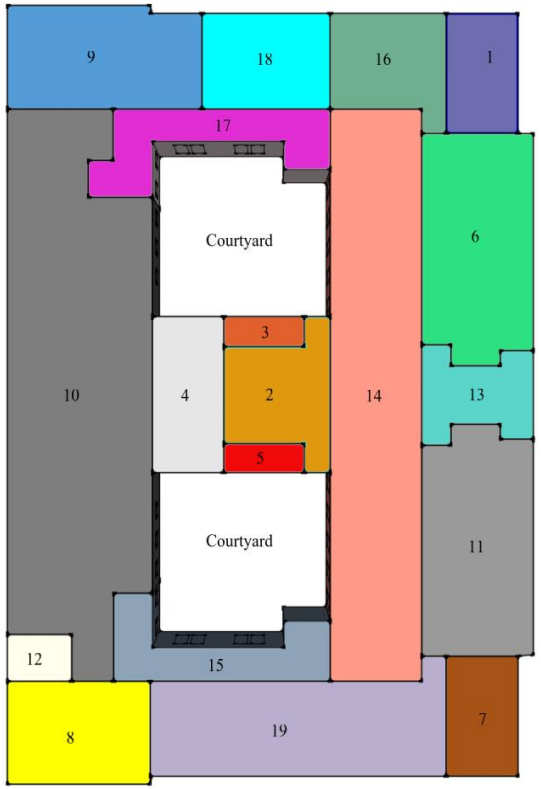
Daylighting

- Energy savings from heat transfer versus light transmission
- Fenestration positioning to optimize daylighting
- Daylighting savings
- Lighting system optimization
- Glare issues

Building Occupancy

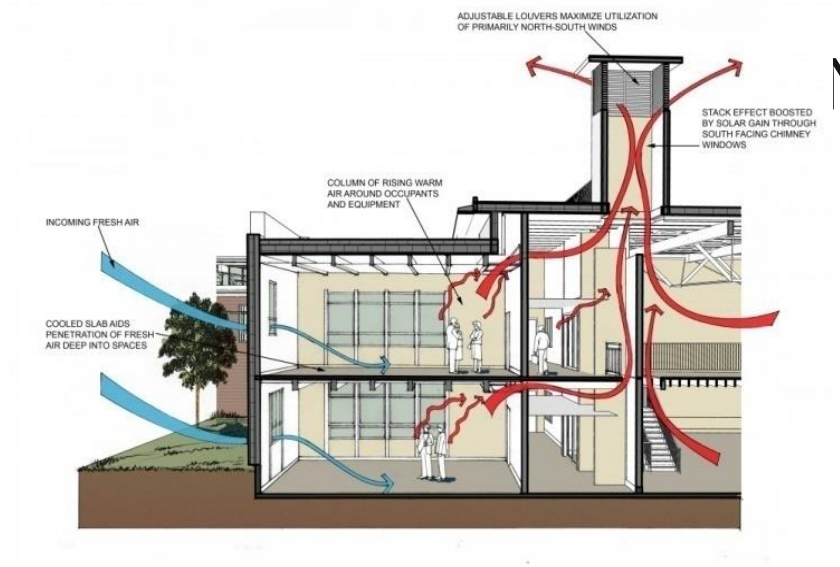
- Building type and use
  - Office space
  - Residential
  - Mixed use
  - Hospital/medical
  - Specialty building
- Full time versus partial day occupancy

Building Massing and Zoning



- Use of mass
- Zones based on use and orientation

Natural Ventilation

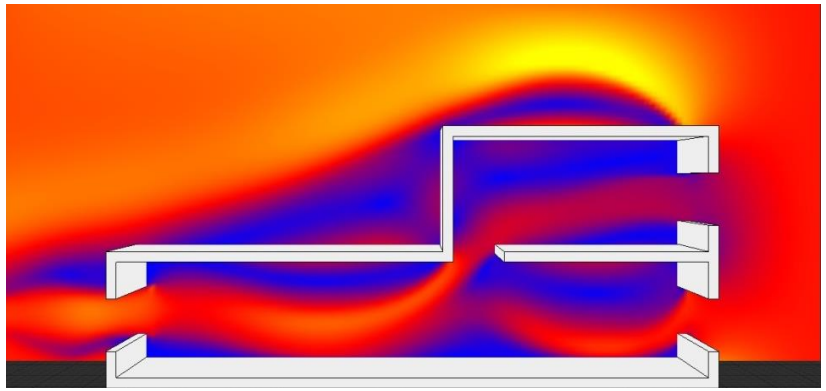


Natural ventilation

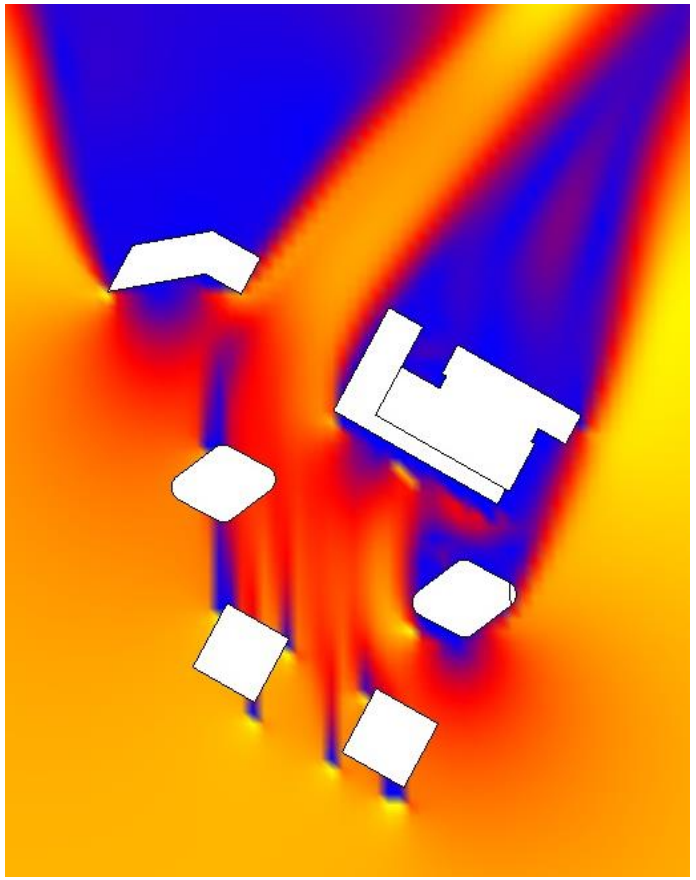
- Considerations for natural ventilation
- Stagnation of air and fresh air considerations
- Ventilation offset
- Solar chimneys

Natural Ventilation

- Does not always translate into fresh air
- Don’t rely on the magic/smart arrows
- Understand prevailing winds and wind flow
- Orientation
- Manual operation versus automation
- Effect on overall pressures
- Stack effect
- Natural combined with mechanical



Natural Ventilation



- Ventilation loads are some of the most energy intensive and thus costly
- Need to understand wind speed and interior layout
- Stack effect
- Occupant comfort considerations
- Pollutant evaluation
- Stagnation of air evaluation
- Solar chimneys

Climate Responsive Building Design

- Responsiveness of systems
- Controls
- How it reacts to the environment

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