# Living with the Old, Building for the New: Resilient Buildings

Local Solutions: Eastern Regional Climate Preparedness Conference

April 4, 2016

# Designing for Resilience

New Design Approaches for Buildings that are Core to Our Communities

## A Tale of Three Building Types

Image courtesy of ZGF, Inc.


Image courtesy of Perkins+Will


Image courtesy of GSBS Architects

# Designing for Resilience

New design approaches to buildings that are core to our communities

Resilience is: “the ability to prepare and plan for, absorb, recover from, or more successfully adapt to actual or potential adverse effects.”

National Research Council, 2012

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Most building codes and standards provide minimum performance for design-level hazard events…

But, don’t address preventing loss or ease of restoring building operations.

# Why these three building types?

- Critical to community
- Need to operate 24/7 (in whole or in part)
- 100 year buildings for good reason

Image courtesy of ZGF, Inc.


Image courtesy of Perkins+Will


Image courtesy of GSBS Architects

# Designing for Resilience

New design approaches to buildings that are core to our communities

## *Challenge:* new design fundamentals

**Engage** - support owner's exploration of risk through scientific data and information about community resilience readiness. Bring this and an understanding of the best resilience design strategies to the fore at the start of the design process.

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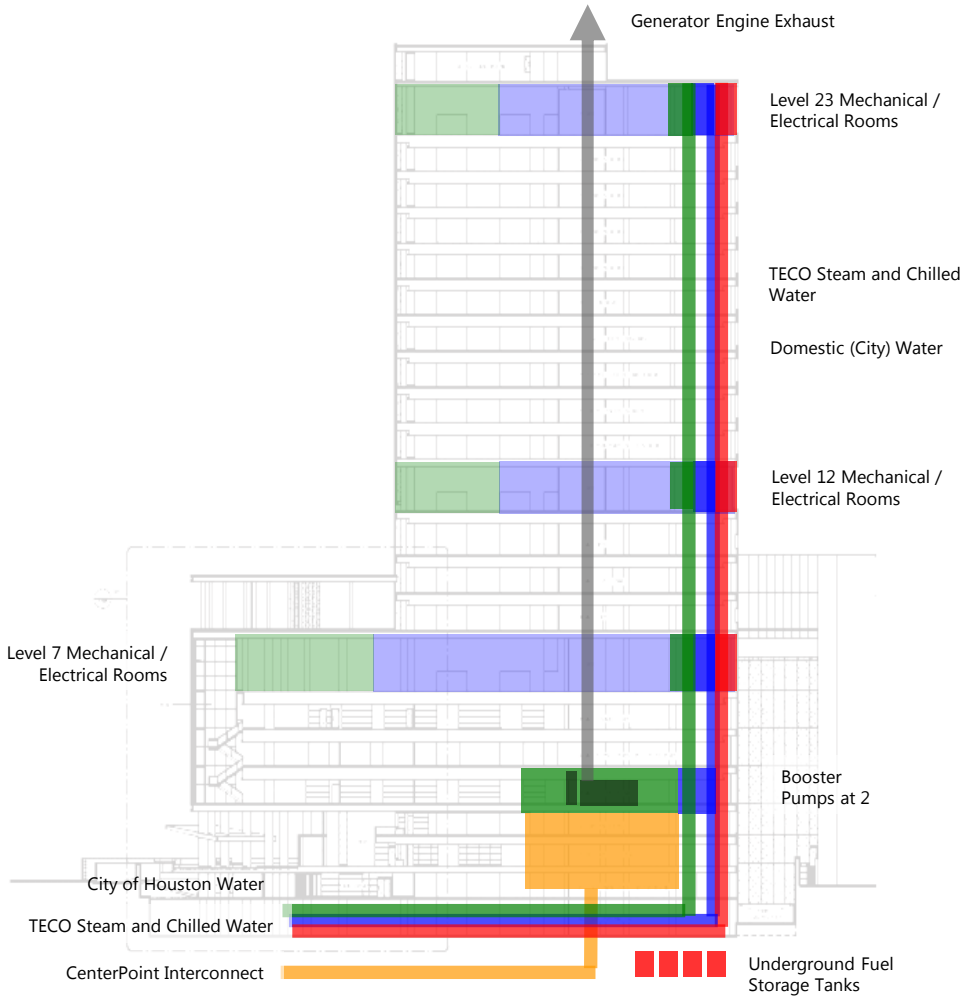
## *Challenge:* new design fundamentals

**Adapt** – design building systems that are calibrated to perform to predicted gradual changes in temperatures and weather pattern shifts.



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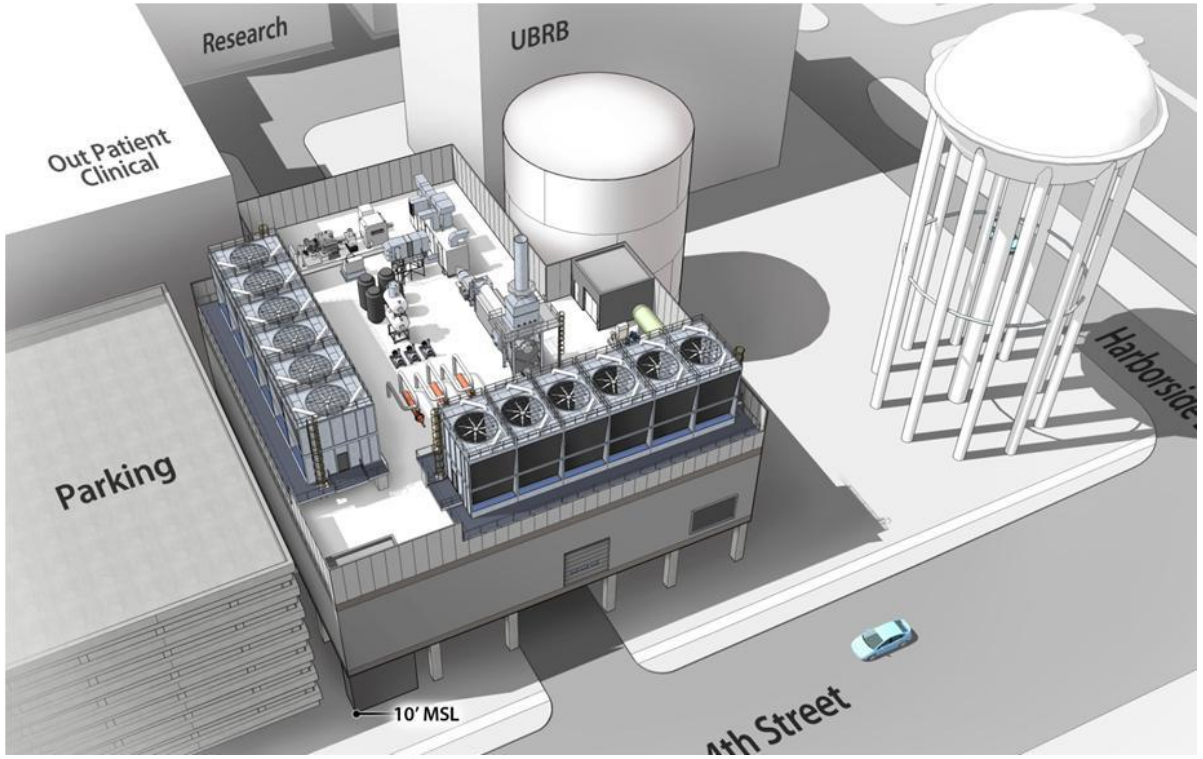
**Transcend** - as appropriate, exceed code requirements and design standards to address owner's resilience needs.



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## *Challenge:* new design fundamentals

**Sustain** – ensure that critical program will be sustained through extreme weather and other forms of disruptive events.

Image: Balance Photography

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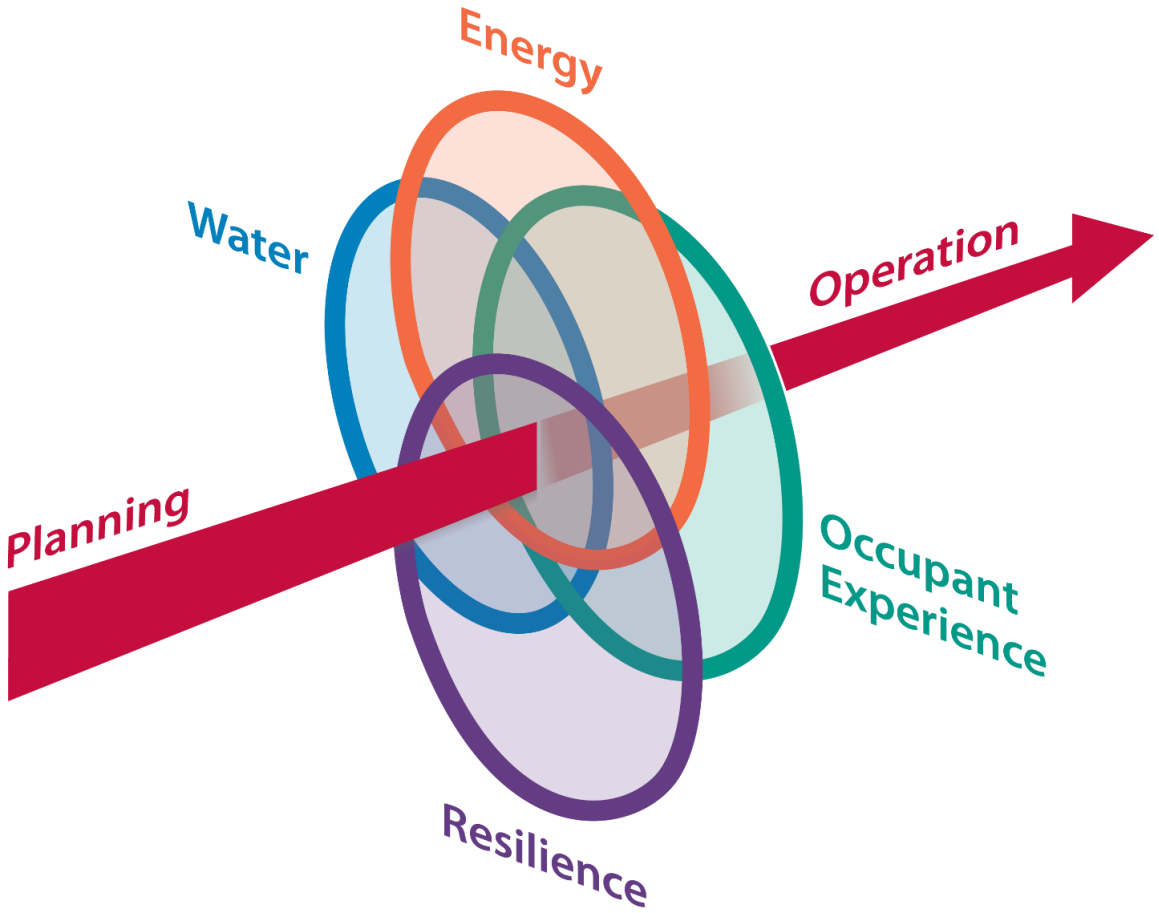
## *Challenge:* new design fundamentals

**Achieve** – accomplish resilience design without compromise to other core concerns of exceptional energy and water efficiency and a rich occupant experience.



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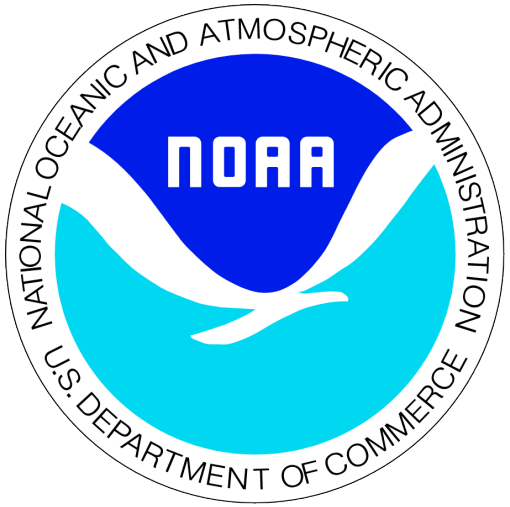
*Challenge:* expand owner's understanding of their project requirements

- Adaptation
  - Nature-based events
  - Human-generated events
- Mitigation







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*Challenge:* redraw the design starting line

- Hazard assessment
  - Assess and quantify nature-based and human risks
    - Relate to national, state, and local plans and standards
  - Identify relative priorities
- Identify design strategies for building system to respond to priority risks and to support expected gradual climate change
- Articulate project approach to emergency preparedness

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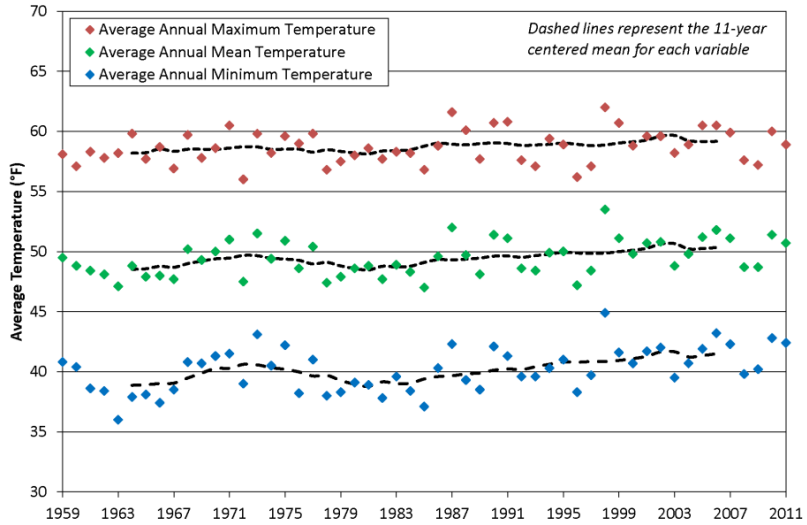
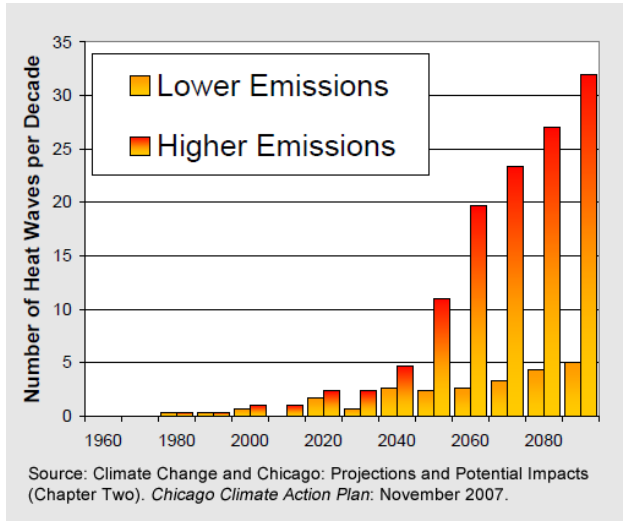
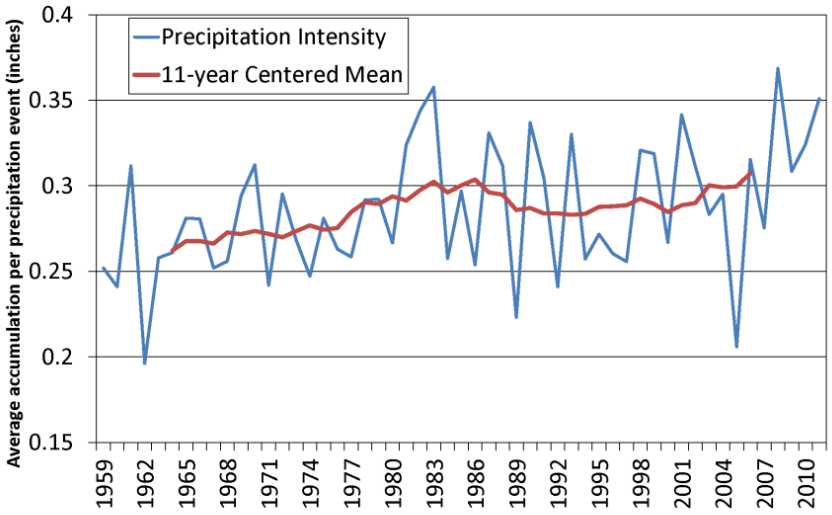
## *Challenge:* a new approach to energy modeling




Source: Midwestern Regional Climate Center




Source: Climate Change and Chicago: Projections and Potential Impacts (Chapter Two). *Chicago Climate Action Plan*: November 2007.




Source: Midwestern Regional Climate Center

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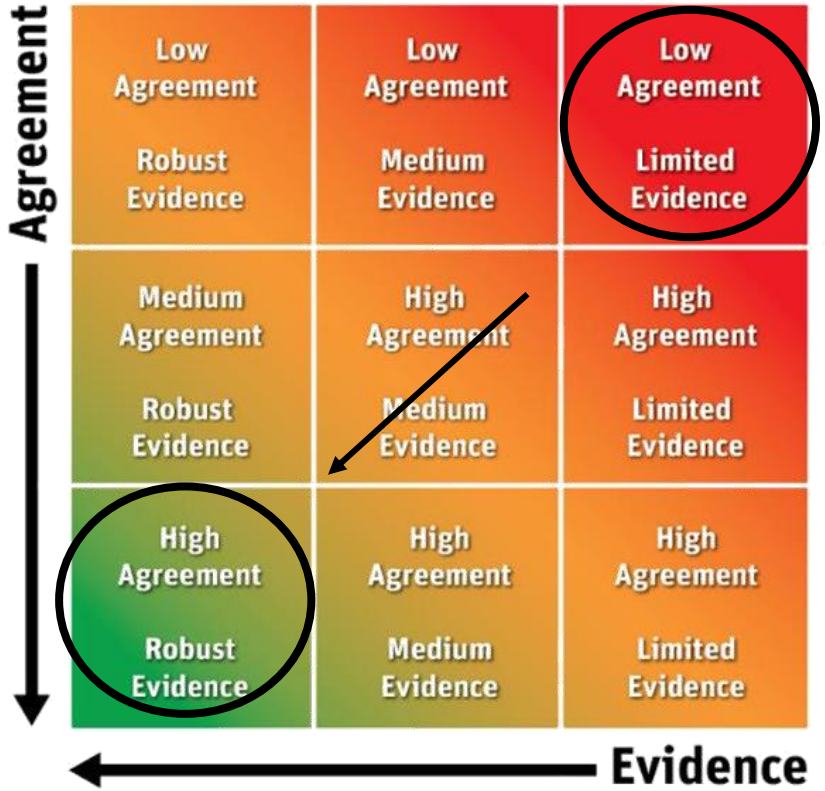
## *Challenge:* a changed approach to cost-benefit analysis

Expanded criteria for cost-benefit analysis

- Expected system resilience performance
- System capacity to protect building occupant needs
- System capacity to protect other precious resources and critical functions
- Opportunity for investment to also advance project's high performance design
- Cost premium (first and operational)



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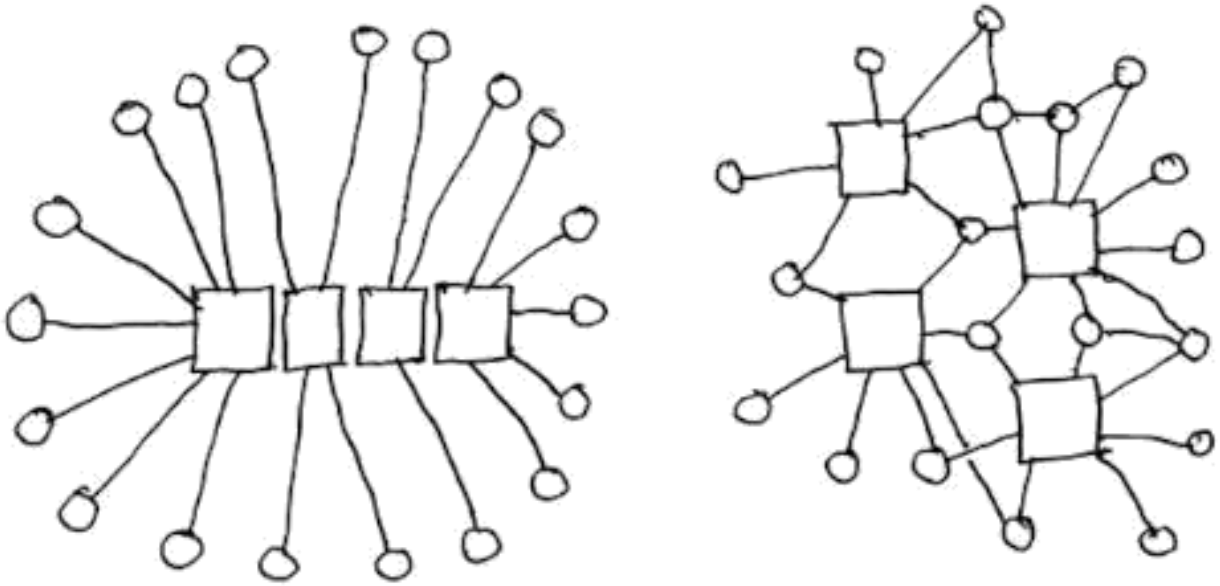
*Challenge:* new design fundamentals

Diverse and redundant systems to avoid “fracture critical” conditions



The Resilience Design Institute illustration of the concept of diverse and redundant systems

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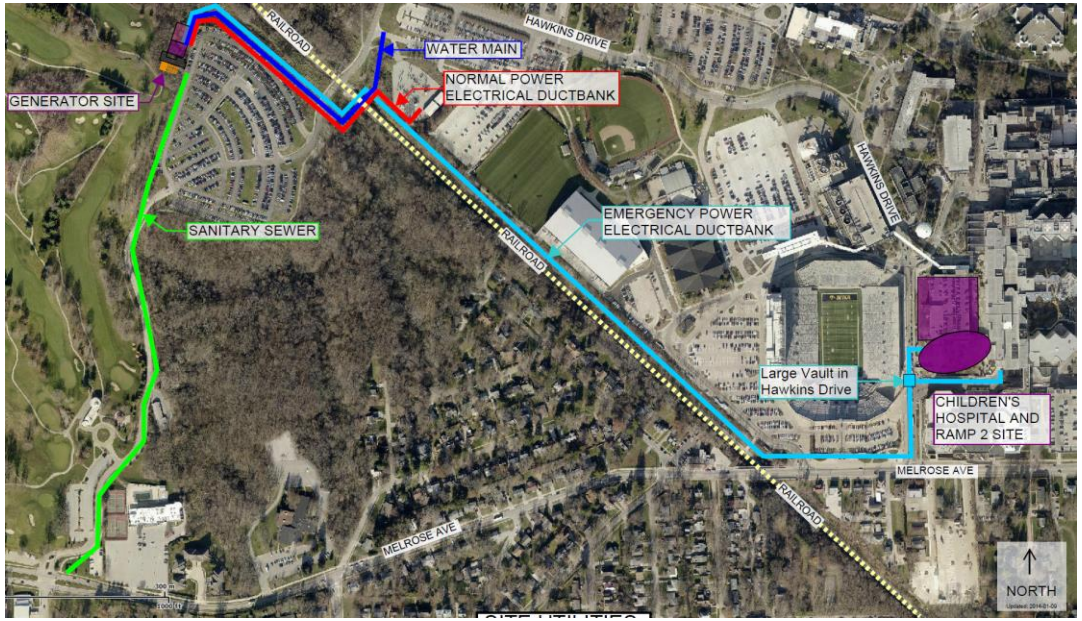
*Challenge:* new design fundamentals

- Assign space to support resilience
- Relate design fit to city infrastructure



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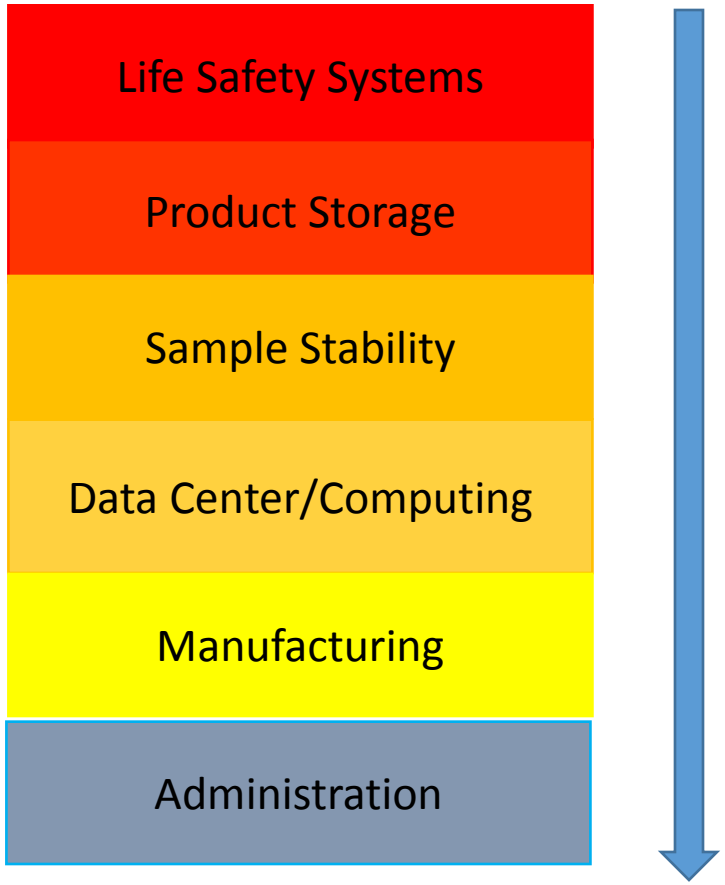
*Challenge:* new design fundamentals

Critical space approach



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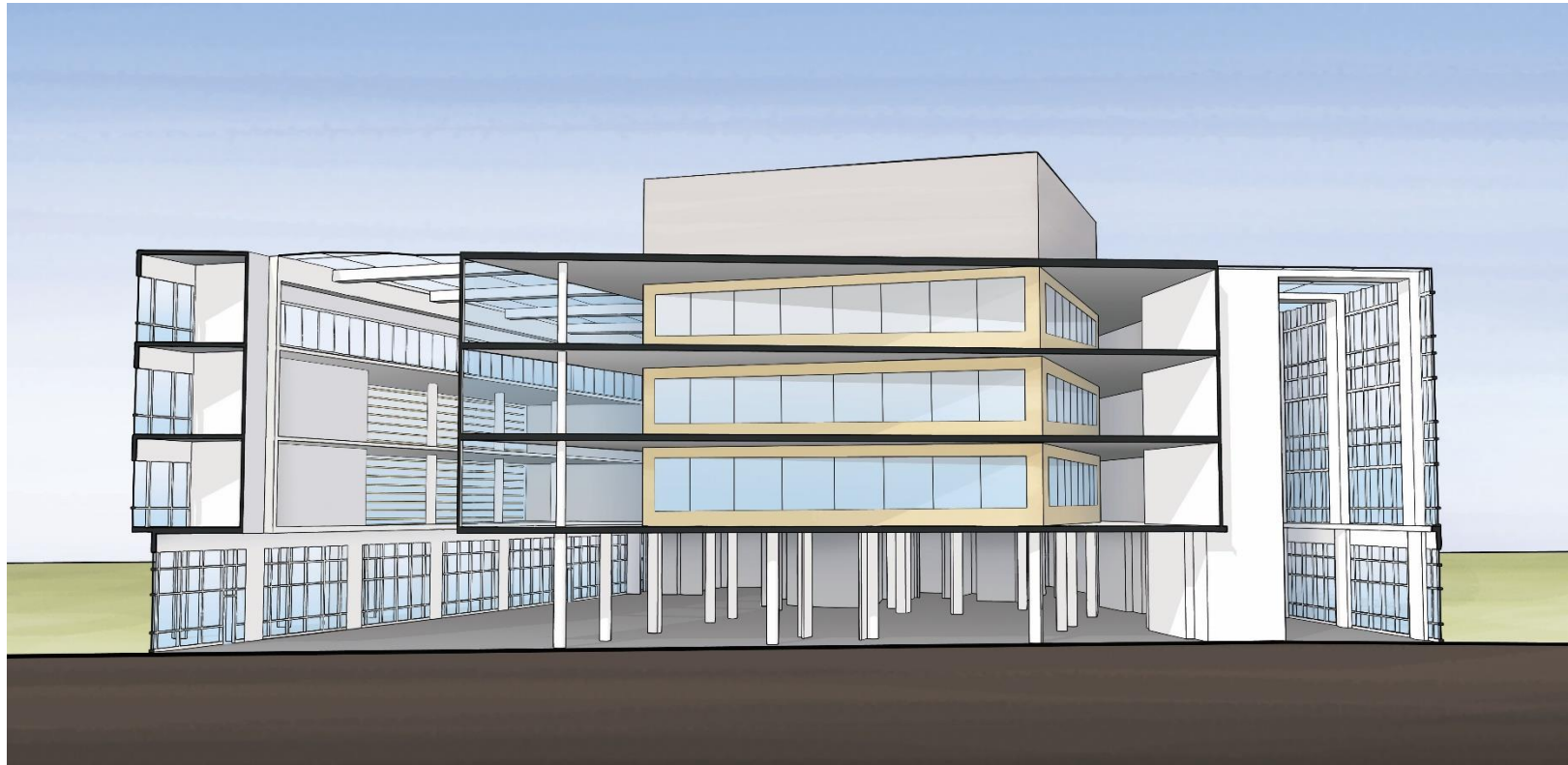

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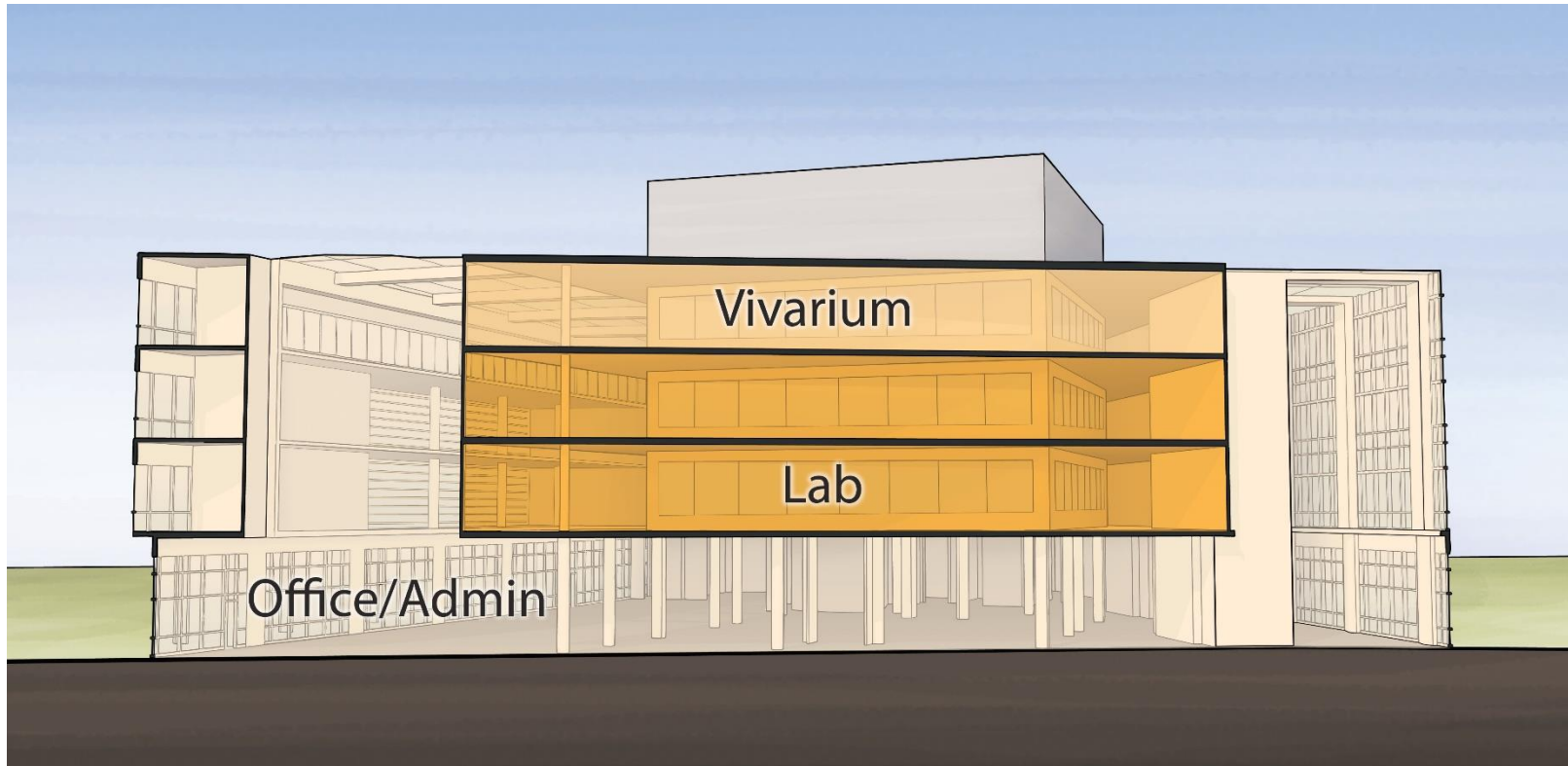
## Critical space approach

- Labs: N+1 and 50% emergency to power air pressurization and for critical equipment
- Vivarium: N+1 and 100% emergency power
- Office/admin: 50% redundancy and emergency power



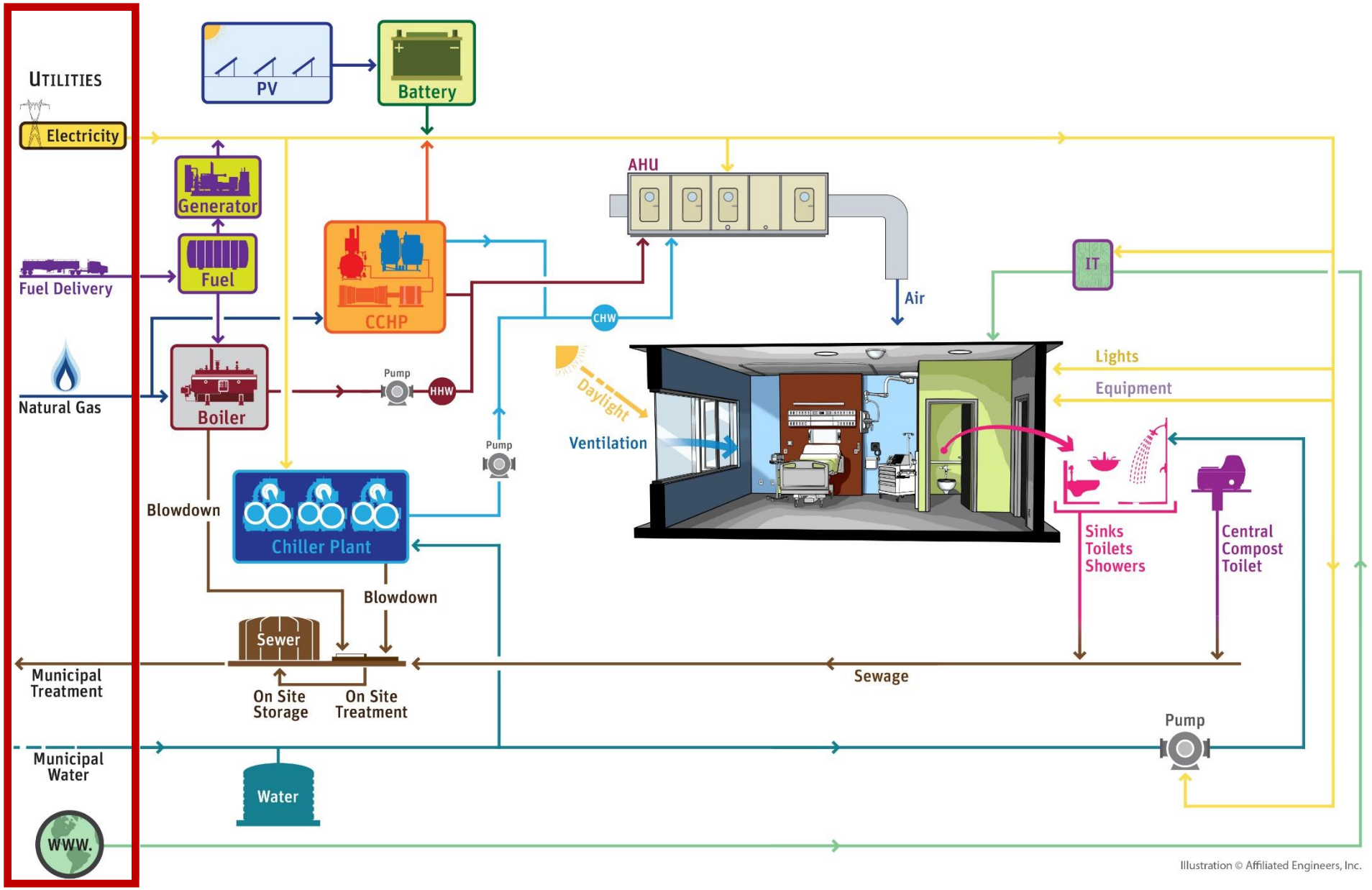
# Critical Space Approach Test: Maintain Hospital Room Occupancy

# Critical Space Approach Test: Maintain Patient Room Occupancy


# Critical Space Approach Test: Maintain Patient Room Occupancy

## Standard Operation

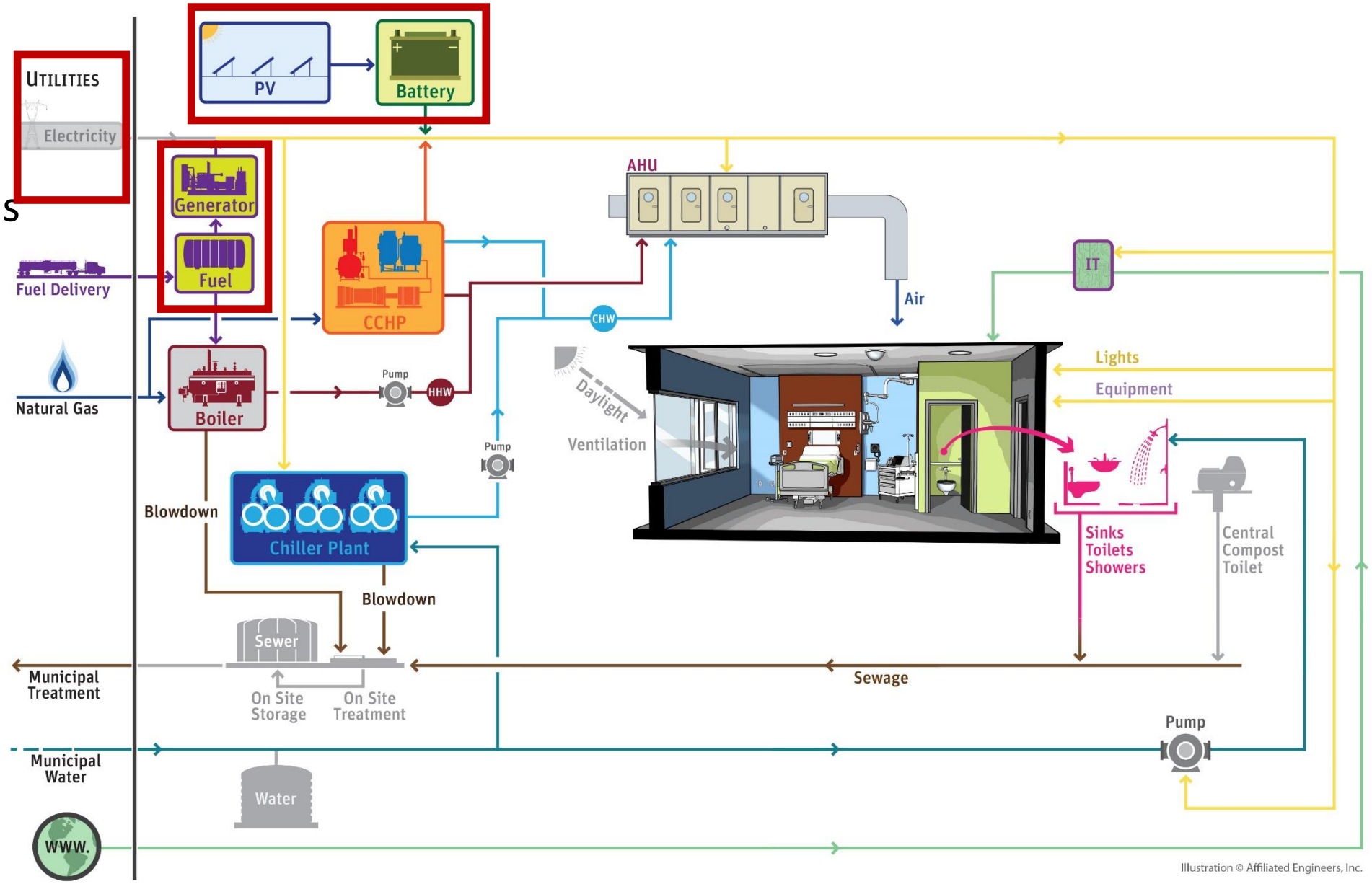
- Start with consideration of utility services



# Critical Space Approach Test: Maintain Patient Room Occupancy

<96 Hours: electric utility failure

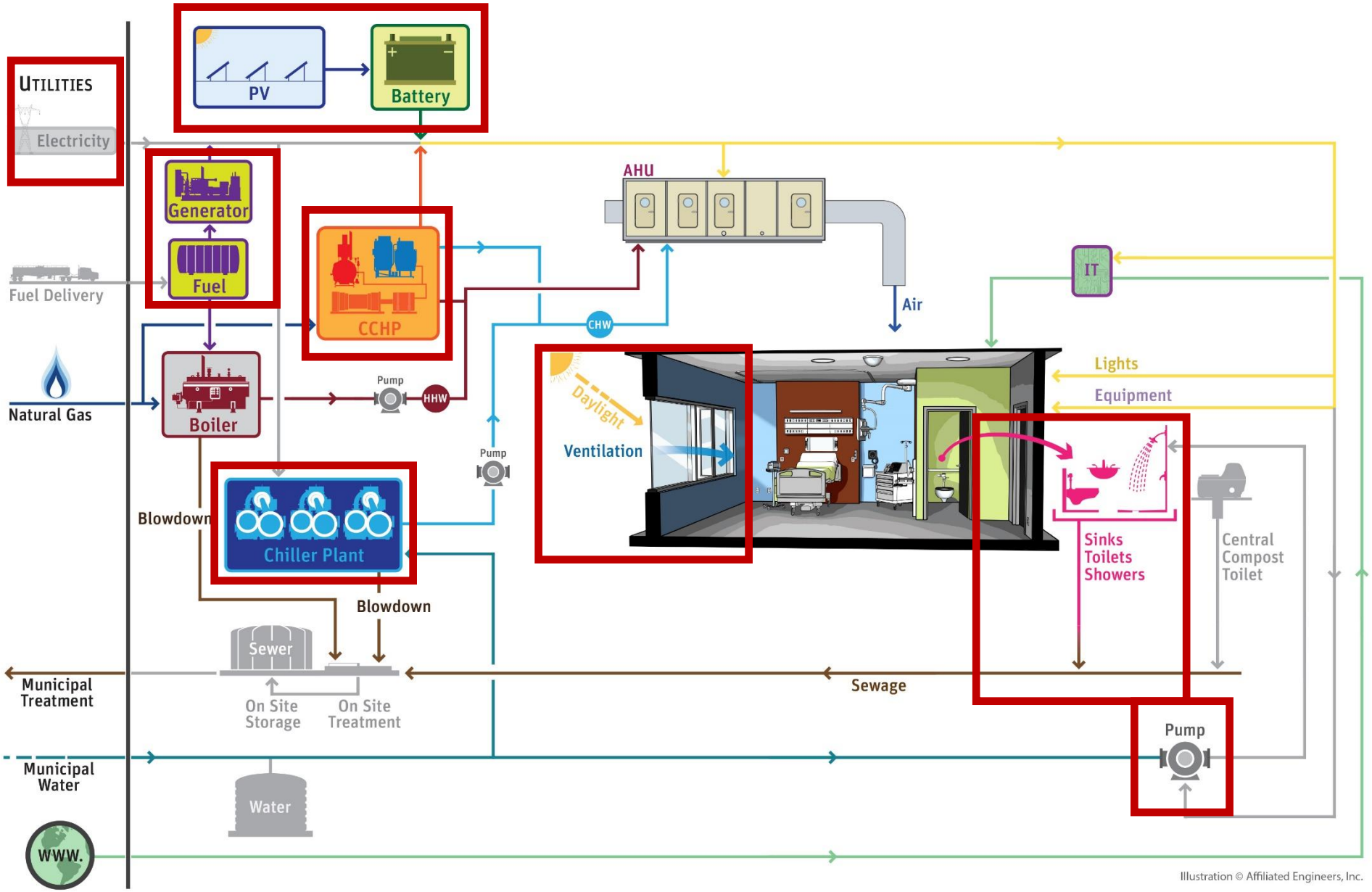
- Generator responds to provide continued electric power, enabling normal operation
- PV functions



# Critical Space Approach Test: Maintain Patient Room Occupancy

>96 Hours: electric utility failure

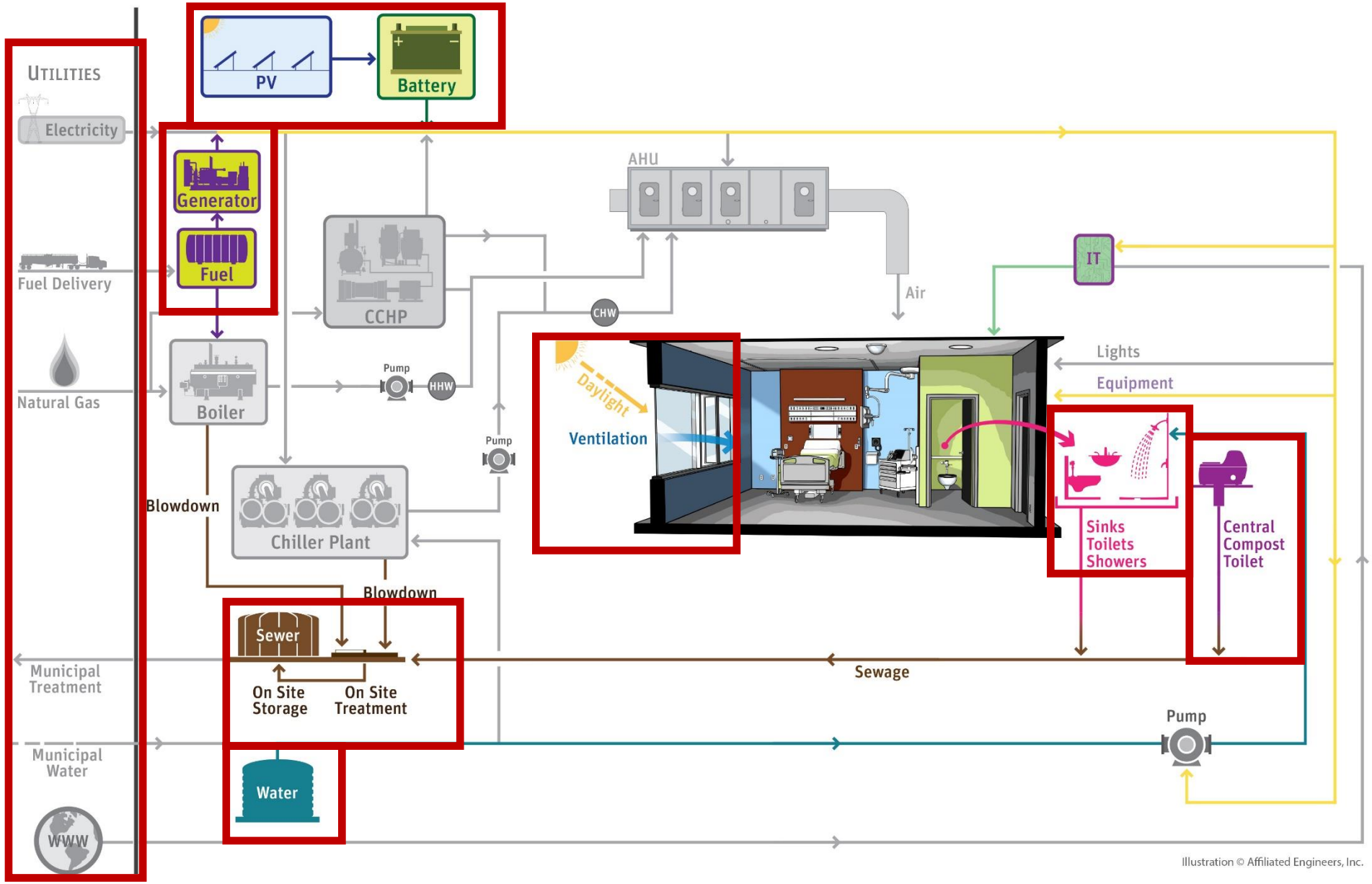
- PV functions
- Generator runs out of fuel
- Cogeneration provides partial power
- Steam turbine chiller cools critical needs
- Natural ventilation and lighting
- No water pumps



# Critical Space Approach Test: Maintain Patient Room Occupancy

Catastrophic Event: all utilities fail

- generator power with PV
- Load shed - ventilation, lighting, equipment
- Back-up water supply
- On-site sewage treatment



# Case Study: Children's & Women's Health Centre of BC

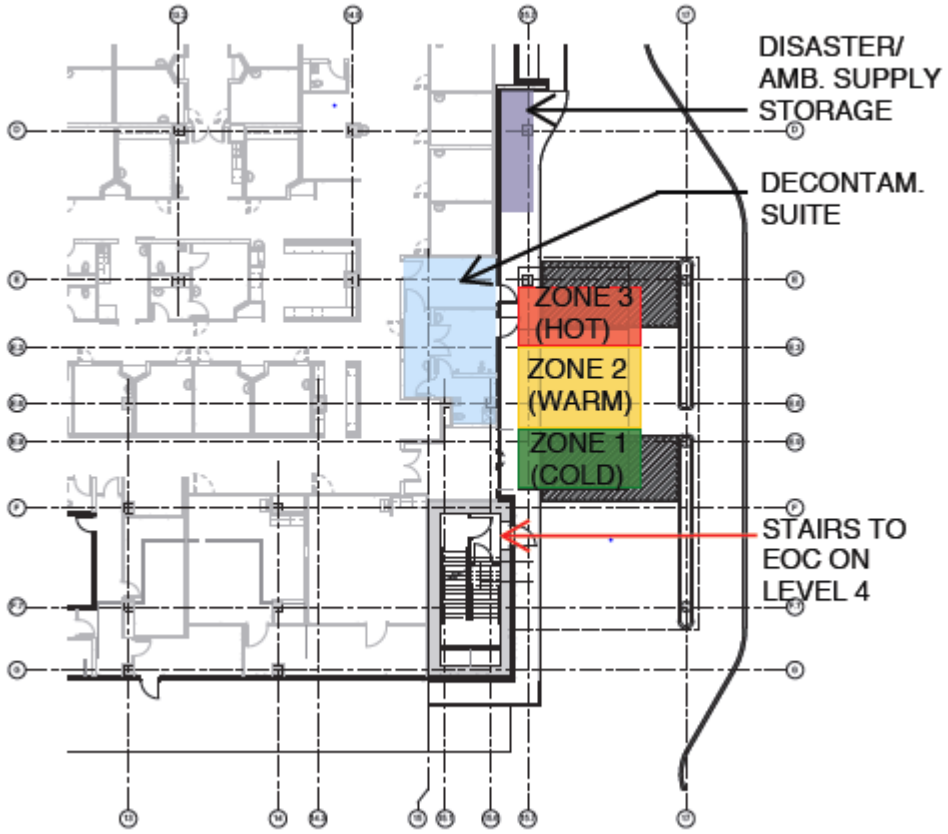
Classified by code as a "post disaster" facility

- Specific occupancy types: assembly, detention, care, high-hazard industry
- Buildings exceeding 6,458sf or 3-stories for major occupancy types


Image courtesy of ZGF, Inc.

# Case Study: Children's & Women's Health Centre of BC

- 650,00 sf
- Aspire for LEED Canada Gold designation
- Modeling, rather than prescriptive design path
- Program arrangement for disaster, including changed main access and functioning for ER, 6 pandemic outbreak spaces and ability to increase occupancy of many patient rooms



# Case Study: Children's & Women's Health Centre of BC

Redundancy with highly efficient normal operation

- Optimized façade and low-beam glazing systems
- Air source heat pumps boost efficiency, can also serve chilled water needs
- Heat recovery chillers and enhanced heat pump recovers systems serve about 80% of annual heating water and domestic hot water

Image courtesy of ZGF, Inc.

# Case Study: Children's & Women's Health Centre of BC

Redundancy with highly efficient normal operations

- District hot water,  steam in failure event
- Normal is mixed air, but 100% outdoor air in failure event
- Dual redundancy in electrical distribution system: generators and uninterruptable power sources
- Multiple connections to municipal utilities

HEATING HOT WATER SYSTEM DIAGRAM: