

Energy Resiliency

Whole System Approaches for new and old buildings

Thermal Energy Systems Resilience in Cold/Arctic Climates

January 22-23 2020

Fairbanks AK



Location in Canada

Key Points

- Whole System Design is the key to creating energy resiliency in both new and old buildings
- Can focus on buildings, but a facility wide view will generate more options and create greater resiliency (e.g. transport and buildings both use energy)
- Practically speaking all building energy loads are from existing buildings
- So definitely need revamped standards for new buildings, but the key to cost effective resiliency will be in energy retrofits.
- Need a new standards guide, but **really need a (re)design algorithm**
 - Start with the end use and end user and work backwards through the options to meet critical needs
- Distributed supply options are much more secure and resilient since they avoid single point of failure/attack challenges

We need to start with imagining what is possible and then design to it



Prior to 2008, the Empire State Building's performance was average compared to most U.S. office buildings.



Annual utility costs:

- \$11 million (\$4/sq. ft.)

Annual CO2 emissions:

- 25,000 metric tons (22 lbs/sq. ft.)

Annual energy use:

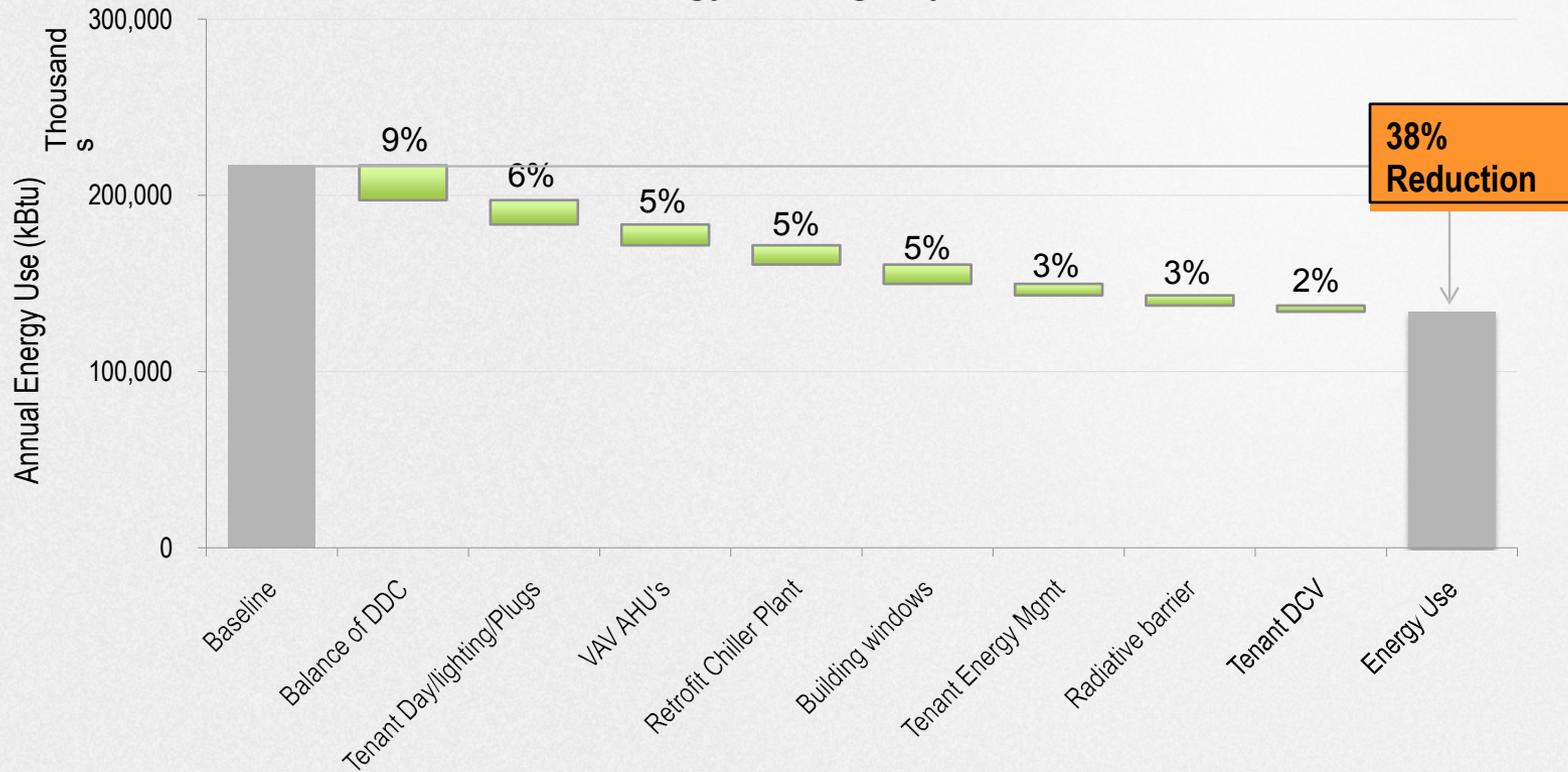
- 88 kBtu/sq. ft.

Peak electric demand:

- 9.5 MW (3.8 W/sq. ft. inc. HVAC)

A whole system retrofit saved >38% with a payback of 3.5 years

Annual Energy Savings by Measure



New Build: RMI Innovation Center Highlights



Achieves **net-positive energy** (only 200 buildings are NZE as of 2016)

The **highest performing** building in the **coldest climate zone** in the US even before PV

74% more efficient than the average office building in its climate

LEED Platinum certified, Passive House Certified, PHIUS+ Source Net Zero Project and meets Architecture 2030 goals

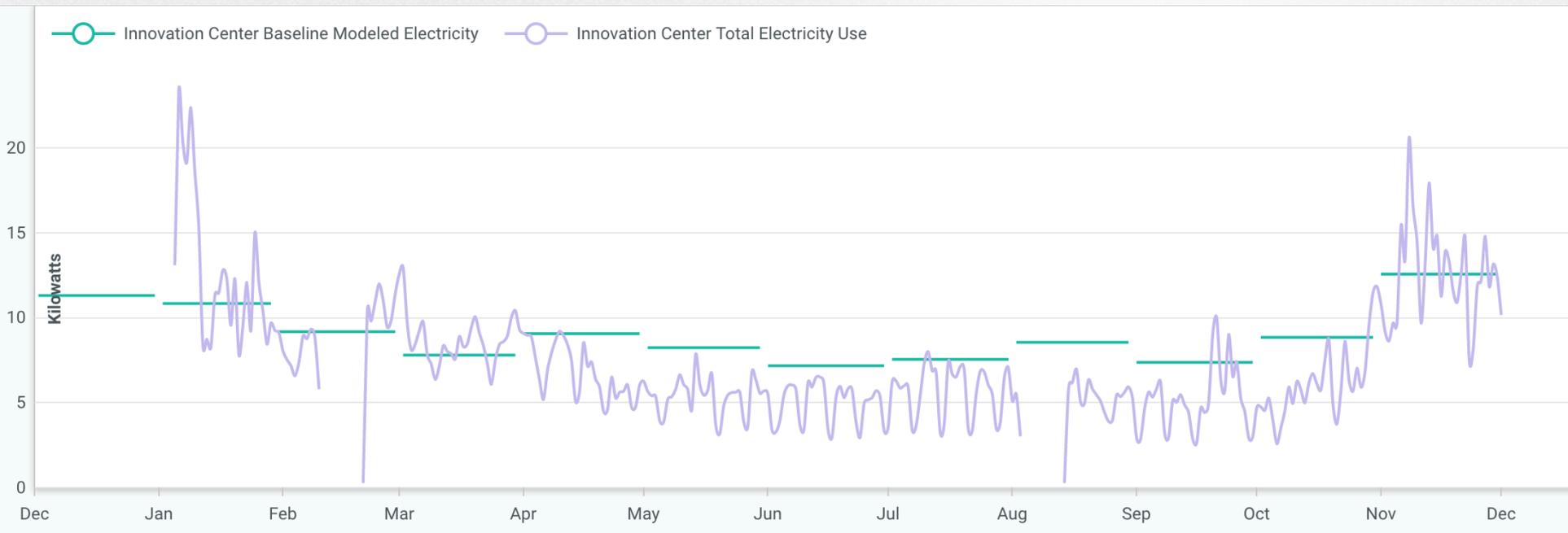
No cooling system and a small, distributed heating system with equivalent capacity of 1 mid sized home

Used emerging **Integrated Project Delivery (IPD)** contracting method



Energy performance: better than expected

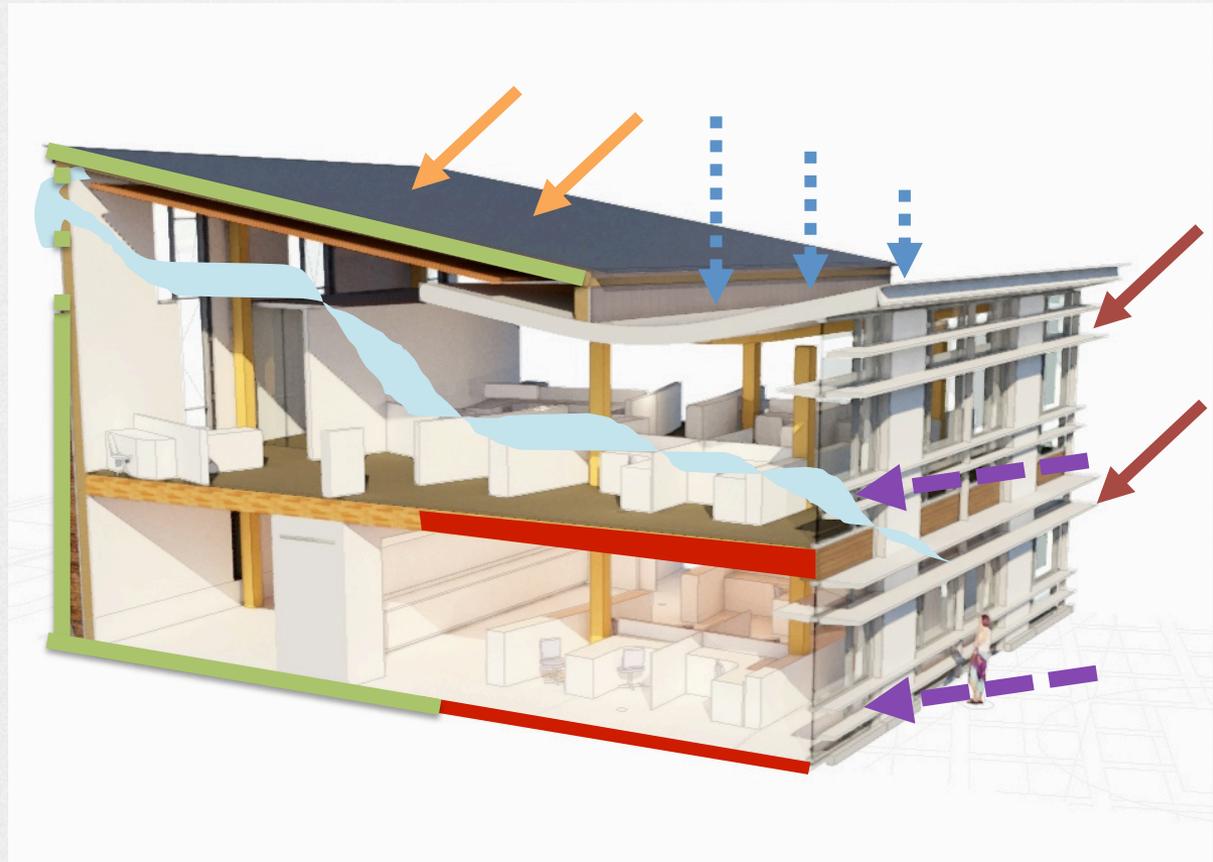
- EUI is trending at 15.9 kbtu/sqft/yr, lower than our modeled use (17.2 kbtu/sqft/yr)
- Operating at net positive energy



Passive features at-a-glance

'Like wearing a down coat and sunglasses'

- 1 Aggressively insulate
- 2 Create airtight weather barrier
- 3 Capture winter solar gain
- 4 Shade from summer heat
- 5 Engage thermal mass
- 6 Provide natural ventilation
- 7 Daylight the space and control glare
- 8 Collect solar energy



Passive performance: Aggressively insulate

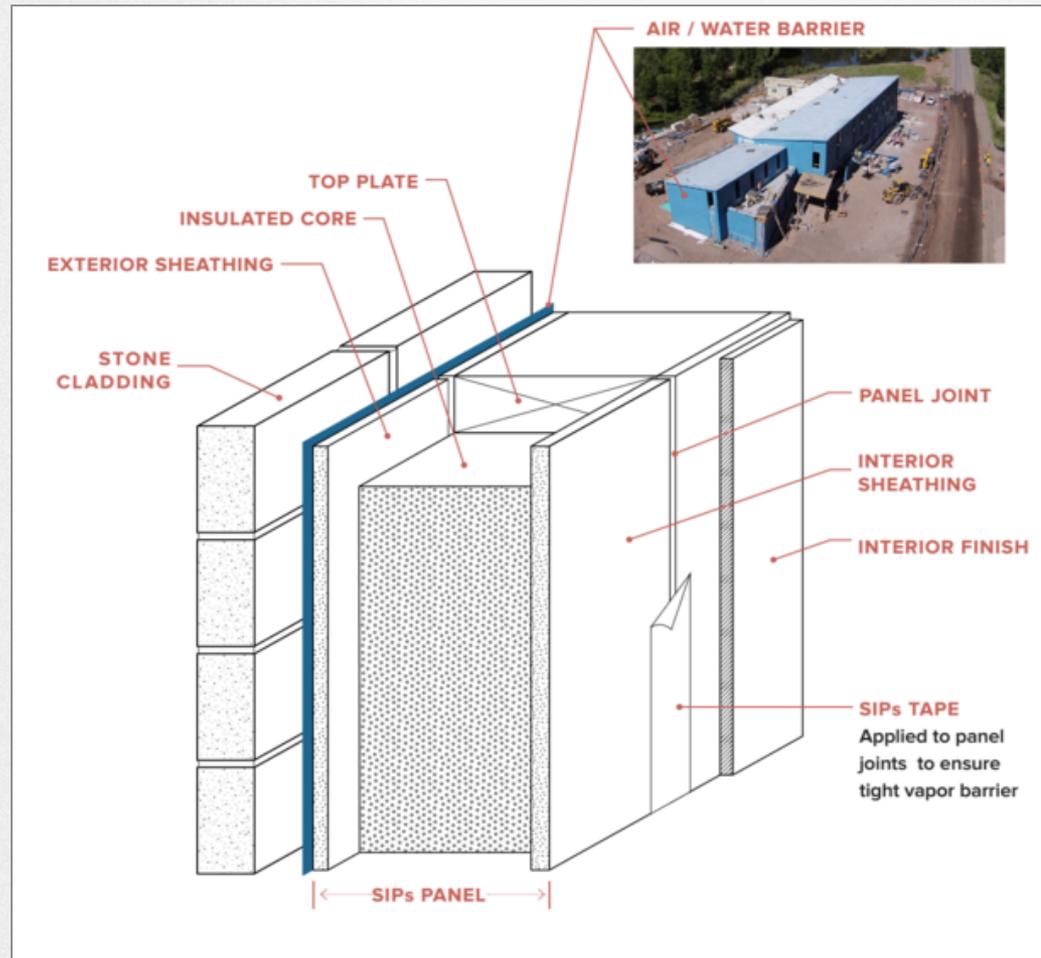
The Innovation Center has more than triple the code required levels of insulation

This is due to:

- **R-50 walls**, achieved with structural insulated (SIPs) panels
- **R-67 roof**
- **R-20** below slab
- **R-5.6** windows (with frame) overall (with a range of 4.8--7.1)

ANATOMY OF A SIP

SIPs provide the dual benefits of **insulation and airtightness**



Resilience

Durability and longevity were primary requirements for this 100-year building. Resilience influenced multiple components:

DESIGN

- Net-zero-energy reduces risk of electricity-price volatility
- Open office area is flexible and adaptable to evolving work styles and technologies
- Extra conduit in floors and walls allow for inexpensive adaptation to future IT and DC
- Modular heating and cooling systems expand easily to adapt to climate change

BUILDING MATERIALS

- Exterior stone and metal panels age well and ensure low maintenance costs
- Durable interior finishes include easily replaceable carpet tiles, concrete floors, painted walls, and acoustic fabric walls

SITE

- The site is more than one foot above the 500-year floodplain to avoid flooding that climate change may exacerbate
- The town of Basalt has entitled RMI to a 4,400 square foot addition, should it be needed

TECHNOLOGIES

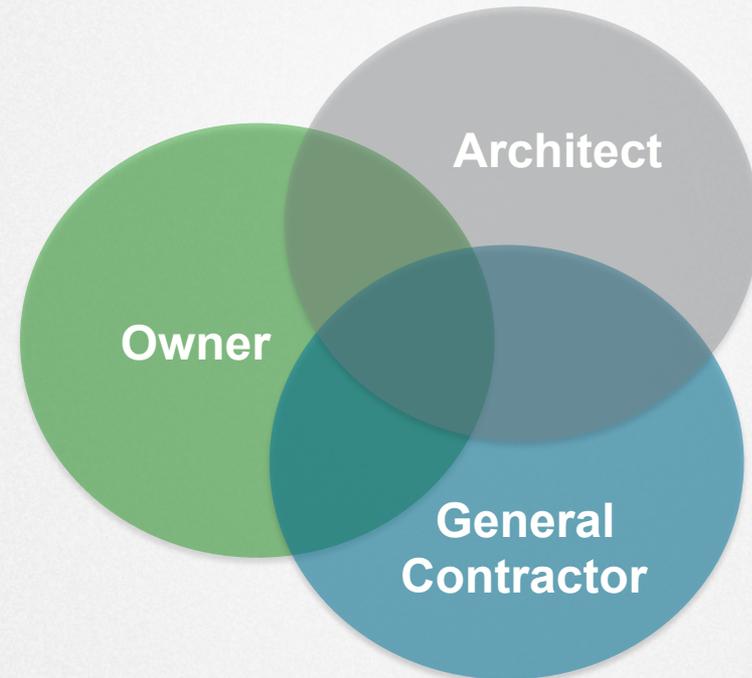
- Flexible and expandable battery system
- Available DC port
- Bi-directional EV charging infrastructure



Integrated project delivery (IPD)

Benefits of IPD

- Aligns motivations and incentives
- Builds highly collaborative design and construction process
- Financial risk mitigation for owner
- Financial reward for design/construction team



“The team was so cohesive, I couldn’t tell who was from what discipline. The architect, contractor, engineers were all speaking the same language...”

– Peter Boyer, RMI Trustee, reflecting about RMI design workshop