# How Rigorous Planning and Effective Design Help Hit Ultra-Low Energy Goals

**Getting to Zero National Forum**  
**April 18, 2018**

## Agenda

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Learning Objectives

1. Discuss the paramount role of integrative process and early goal-setting in achieving aggressive building and district-scale energy performance goals.

2. Illustrate how a proactive design strategy can ensure that a building designed today can support a district zero-energy vision.

3. Describe how a project team can address diverse and sometimes conflicting occupant-, building-, district-, and community-scale needs in the design and operations of a high-performance building.

4. Explain strategies to effectively communicate the value of high-performance buildings to occupants, the community, and the industry at large.
Energy Policy Vision: Fort Collins is a leader in the transition to sustainable and resilient local energy systems to serve the community's 2050 carbon neutral future.
This Design Development Energy Report (DDER) is a tool to assist the design team in making decisions to improve the energy performance of the Utility Administration Building design. As a participant in Fort Collins Utilities Integrated Design Assistance Program (IDAP), a goal of the project is to achieve a Target EUI (Energy Use Intensity) of 32.9 kBtu/SF/year, a 60% energy reduction below the regional median EUI of 82.3 for office buildings. At least 40% of this reduction must come from efficiency and the remaining 20% reduction can come from renewables. This goal aligns the project design with the Architecture 2030 Challenge. In addition, the project team has set a stretch goal of achieving an Energy Use Intensity of 20 kBtu/SF/year.

The project team intends to achieve a rating of 100 through EPA’s ENERGY STAR program and to certify the building. In accordance with a goal of attaining a Platinum rating through LEED for New Construction version 4, the project is targeting a minimum of 15 points for Optimize Energy Efficiency and 3 points for Renewable Energy Production.
ARCH | NEXUS SAC

LEED v4 Platinum Certified 4/20/17
LEED v4 Existing Buildings - Submitted
Living Building Challenge - Submitted
SEED Certification - Submitted
Energy Star Certification - Submitted
WELL - Registered

Reveal Label
JUST Certified Employee-Owned Company

ENR Best Green Project of the Year 2017

INSPIRATION
REGENERATION
STEWARDSHIP
LBC PETALS

PLACE 1
ENERGY 2
WATER 3
HEALTH + HAPPINESS 4
MATERIALS 5
EQUITY 6
BEAUTY 7
SITE CONTEXT

- Nature
- History
- Culture

SOLAR ACCESS
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PROJECT REQUIREMENTS

Space Types
- Office, Conference, Storage, Restroom (Locker/Shower), Breakroom, Mechanical Room, Print Area, Housekeeping, Recycling, Server Room, Bike Storage

Schedules
- 8-5 M-F

Site Design
- Existing Trees, Adjacent Buildings

Budget
- $300/SF for Good Quality Commercial Construction
- $150/SF for LBC

Energy Code Min/Max
- Do they really matter?

Goal: 30 kBtu/SF/yr
Brainstorm and Report

15:00

City District Design
On-Site Renewable Energy
Integrated Process
Low Energy Architecture
Energy Driven Planning
On-Site Renewable Energy
CLOSE BUILDING SPACING
SPACE LESS THAN OR EQUAL TO HEIGHT

SOLAR ACCESS TO SOUTH FACADE AND ROOF
SPACE 2.5 TO 2.75 TIMES THE HEIGHT

NETWORK OF VENTILATION CORRIDORS
VEGETATED MICROCLIMATES

DEEP COURTS PERPENDICULAR TO WIND
CROSS VENTILATION

SHADED WEST FACES

SUSTAINABILITY PATTERN LANGUAGE

SHADED WEST FACES

NEXT GENERATION ENERGY

SOLAR COURTS

NET ZERO ENERGY EUI ANALYSIS

100 kBtu/sf
30 kBtu/sf
20 kBtu/sf
15 kBtu/sf
60 kBtu/sf

PV GENERATION
BASELINE
TARGET (2 STORY)
TARGET (3 STORY)
TARGET (4 STORY)

ENERGY STORAGE
PV ROOFS
GEOTHERMAL WELL FIELD
SMART GRID Demand Response Energy Management
CONNECTED Grid
FortZED
ENERGY STORAGE

VEGETATED VENTILATION GRID

NET ZERO ENERGY EUI ANALYSIS

100 kBtu/sf
30 kBtu/sf
20 kBtu/sf
15 kBtu/sf
60 kBtu/sf

PV GENERATION
BASELINE
TARGET (2 STORY)
TARGET (3 STORY)
TARGET (4 STORY)
**MASSING ENERGY COMPARISON**

- **PASSIVE MASSING**
  - Cooling (Tons): 36
  - Heating (Tons): 49
  - kBtu/sf: 30

- **NZEB MASSING**
  - Cooling (Tons): 36
  - Heating (Tons): 41
  - kBtu/sf: 20

- **COMPACT MASSING**
  - Cooling (Tons): 57
  - Heating (Tons): 45
  - kBtu/sf: 36
**Wind Analysis**

- Wind shadows
- Leeward side
- Windward side

**Solar Analysis**

- North: Daylighting / Triple insulated glazing
- East + West: Minimize and shade glazing / 60' width or less
- Roof: Energy Generation / Toplighting
- South: Daylighting / Shaded view windows w/ 60° cutoff
Public Building Design Impacts

### Guiding Principles

- **World Class Leadership:** becomes a point of community pride in performance, innovation, and regenerative design that sets an example for the private sector in its reflection of Fort Collins' character and culture.

- **Vibrant Community Spaces:** contribute nature and ecology to the city while establishing places for public engagement that promote social and individual health.

- **Resilient Design:** lasting quality that is climate adaptive, accommodates growth, flexibility, and a universal community.

- **Intuitive Organization:** support and activate site connectivity externally and create a collaborative environment internally.

- **Enhance the Civic Heart:** physical embodiment of the city's mission and plan that meets immediate needs, establish a vision that can be invested in and realized.
86% better
than baseline

26.2 kbtu/sf

33% lower

Lighting Power Density than
ASHRAE 90.1 - 2010

R-28/R-30

Overall Wall/Roof Assembly
Occupant Productivity and Lessons Learned
32.9 Target

26.2 Actual 2017

Proposed Design End Use Distribution

- Internal Lighting
- Exterior Lighting
- Space Heating (Fossil Fuel)
- Space Heating
- Space Cooling
- Pumps
- Heat Rejection
- Fans Interior
- Service Water Heating (Fossil Fuel)
- Receptacle Equipment
EUI with solar (kBtu/sf/yr)
14.3 predicted
15.5 actual
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PROCESS

Choosing the Team
Design and Sustainability Charrettes
Community Engagement In Design
Daylight And Energy Modeling
Occupant Engagement - Inhabit

INTEGRATED TEAM
06  NET POSITIVE ENERGY

Target EUI 35-40 kBTU/sf/year given HVAC systems currently budgeted for this project. High performance building envelope. Mechanical VRF system with a DOAS unit for ventilation, supplemented with operable windows tied to HVAC controls. Alternate strategies include geothermal heat pumps and radiant floors. Target 0.6 W/sf for the installed indoor lighting supplemented with natural daylight through the use of Solatubes. All LED lighting indoors and out on sensor and/or daylight control. Solar hot water system and solar photovoltaic array. Sub-metering of energy end uses to enable verification of Net Positive Energy goal. Powerwall Tesla battery backs for back-up power. Natural ventilation strategies to conserve energy through thermal buoyancy with the use of solar chimneys is continuing to be studied through a CFD analysis.
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**NET POSITIVE ENERGY**

EUI 25.1  [36.1]  With PV -17.8  
170% + [105%]  
Carbon offsets
“Building reuse is the highest form of sustainability, yet the design constraints that come with reuse are very limiting in terms of energy use reduction...”

-Kenner Kingston
“...the answer to the reuse/energy conundrum is the occupant; while most buildings underperform predicted performance, our occupants are driving energy use down monthly.”

-Kenner Kingston
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SERVER LOAD

PLUG LOAD
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LIGHTING LOAD

PUMP LOAD
Engaged Occupants are using 26% Less Energy Than Expected in an Already High Performance Building
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Occupants into Inhabitants

- Education
- Action
- Reward
- (repeat)

TRANSFORM

How it works:

- Episodic Competitions
- Weekly “Learn & Earns”
- Short Quiz
- Unlock Actions
- Earn Individual & Team Points
- Dashboard Metrics
  - Points
  - kWh Saved
  - CO2 Avoided
  - Pounds of Waste Diverted
NET ZERO WATER

Rainwater to Irrigation
Greywater Capture
Composting Toilets
Rainwater to Potable? - Waiting
RAINWATER SUPPLY & WATER USAGE

[Graph showing rainfall, demand, and supply over months]

[Image of rainwater collection tanks]
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Q & A

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