



Zero Energy Districts

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Zero Energy Buildings (ZEBs)




Example ZEB Resources

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

A Common Definition for Zero Energy Buildings

September 2015

Prepared for the U.S. Department of Energy by
The National Institute of Building Sciences



NREL Research Support Facility, photo credit: Bill Gillies, NREL

NREL
NATIONAL RENEWABLE ENERGY LABORATORY



COST CONTROL STRATEGIES FOR ZERO ENERGY BUILDINGS

High-Performance Design and Construction on a Budget


NREL is a national laboratory of the U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, operated by the Alliance for Sustainable Energy, LLC.

U.S. DEPARTMENT OF ENERGY | Energy Efficiency & Renewable Energy

BUILDING TECHNOLOGIES PROGRAM


How-To Guide for Energy-Performance-Based Procurement

An Integrated Approach for Whole Building High Performance Specifications in Commercial Buildings





Zero Energy Districts (ZEDs)



“The district is the optimal scale to accelerate sustainability — small enough to innovate quickly and big enough to have a meaningful impact.” -EcoDistricts

Unlock new cost-effective energy savings:

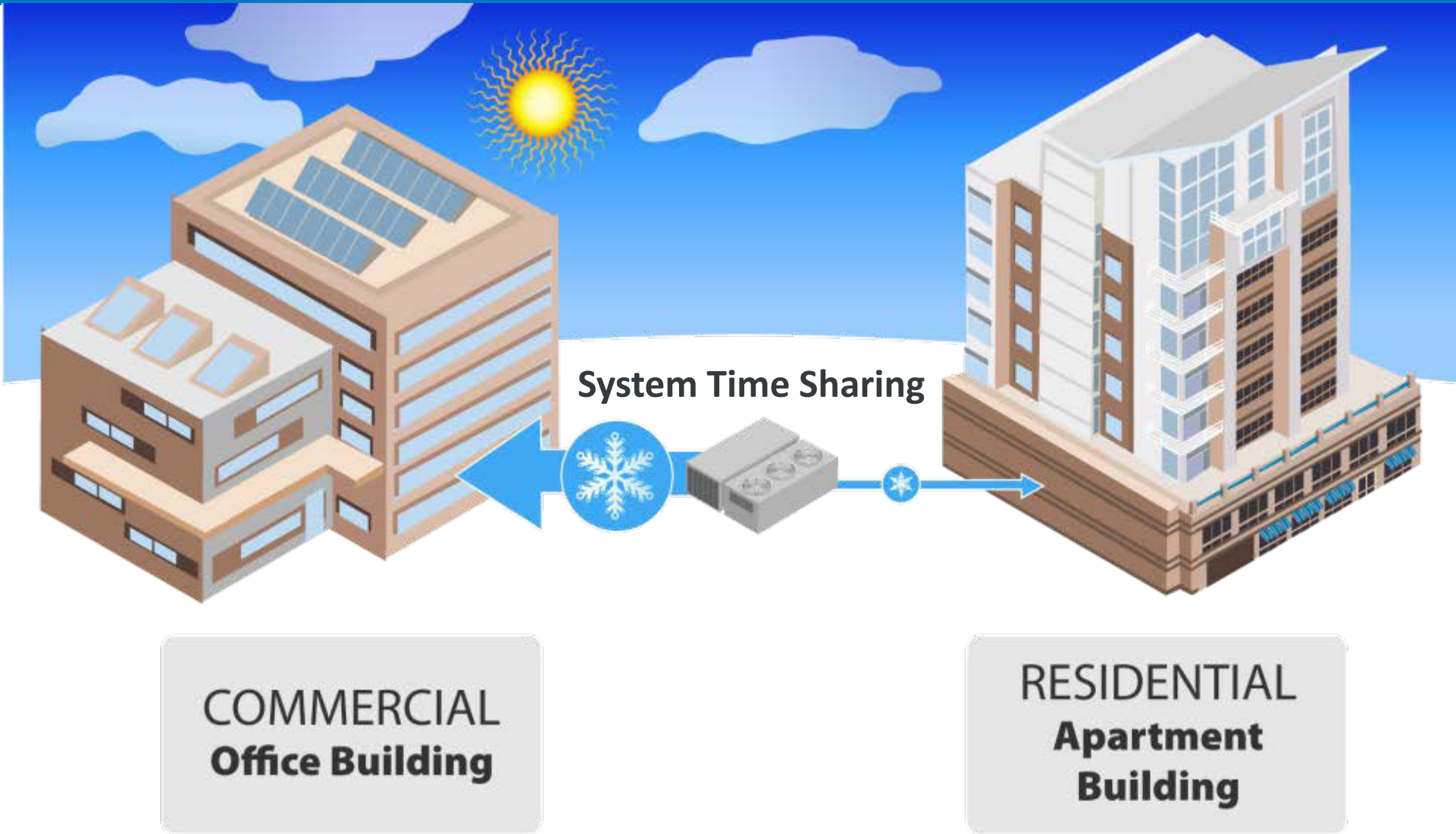
- Upfront planning
- Economies of scale
- Load diversity
- Waste heat capture

Testbeds for new:

- Technologies
- Utility programs



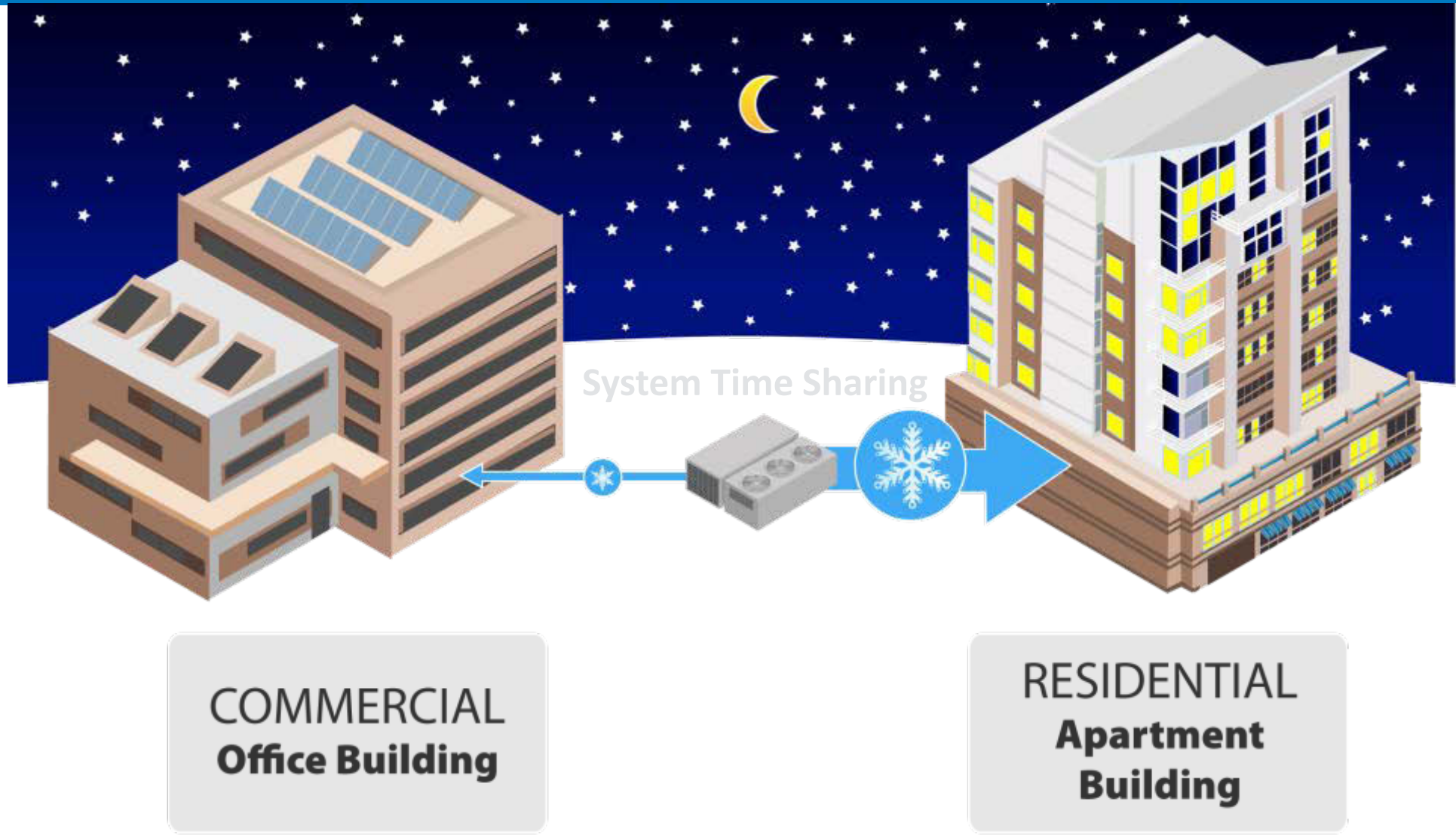
Why approach Zero Energy at larger scales?



**COMMERCIAL
Office Building**

**RESIDENTIAL
Apartment
Building**

Why approach Zero Energy at larger scales?

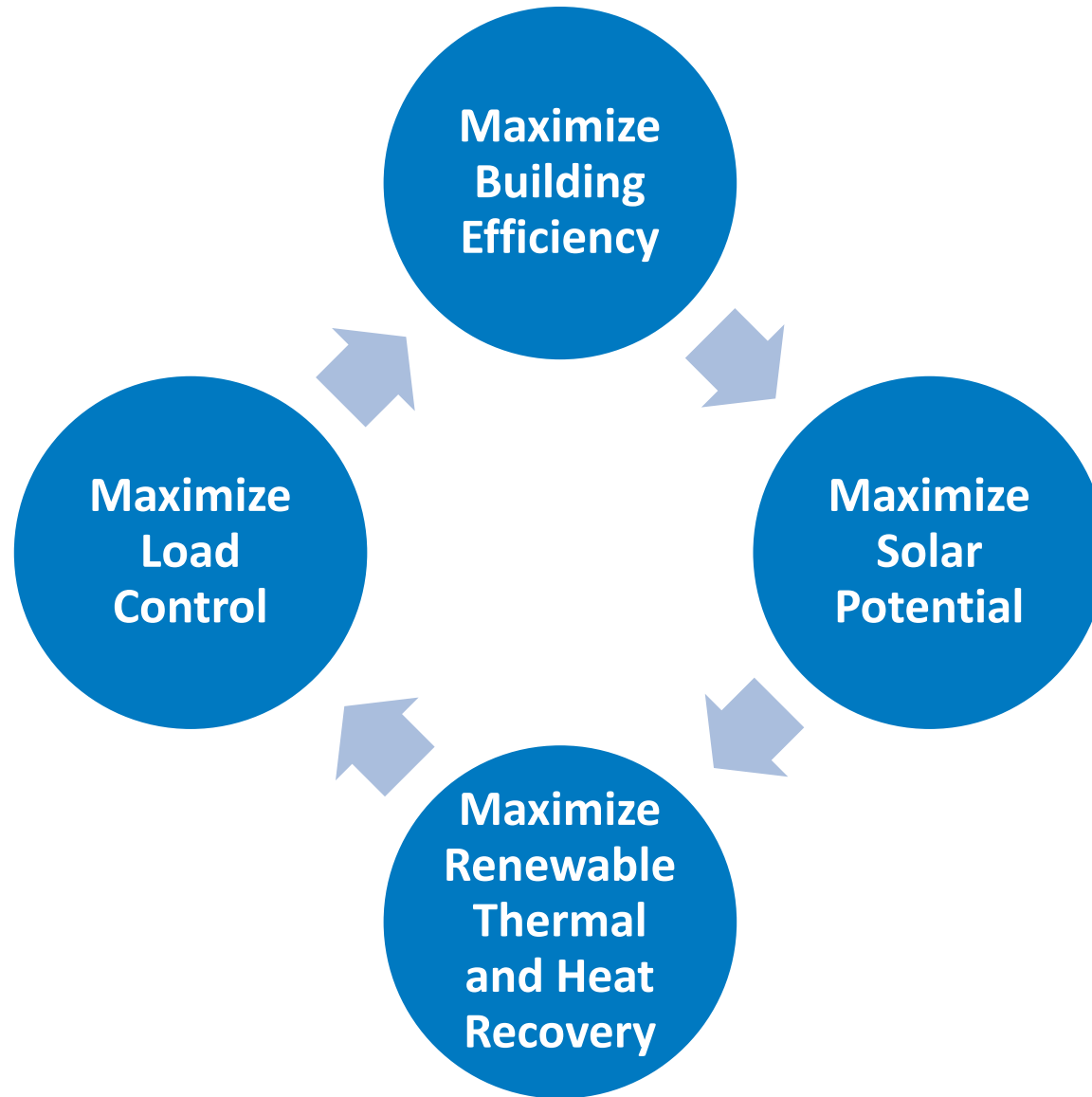


Better Buildings Zero Energy District Accelerator

- **Six district partners across U.S.**
 - Developing energy master plans with DOE/NREL/partner guidance
 - Identifying common barriers and innovative solutions
- **National partners:**
 - USGBC
 - EcoDistricts
 - Rocky Mountain Institute
 - Xcel Energy



Zero Energy District Design Principles



Maximize Building Efficiency



**Optimize
Orientation
and Natural
Lighting**

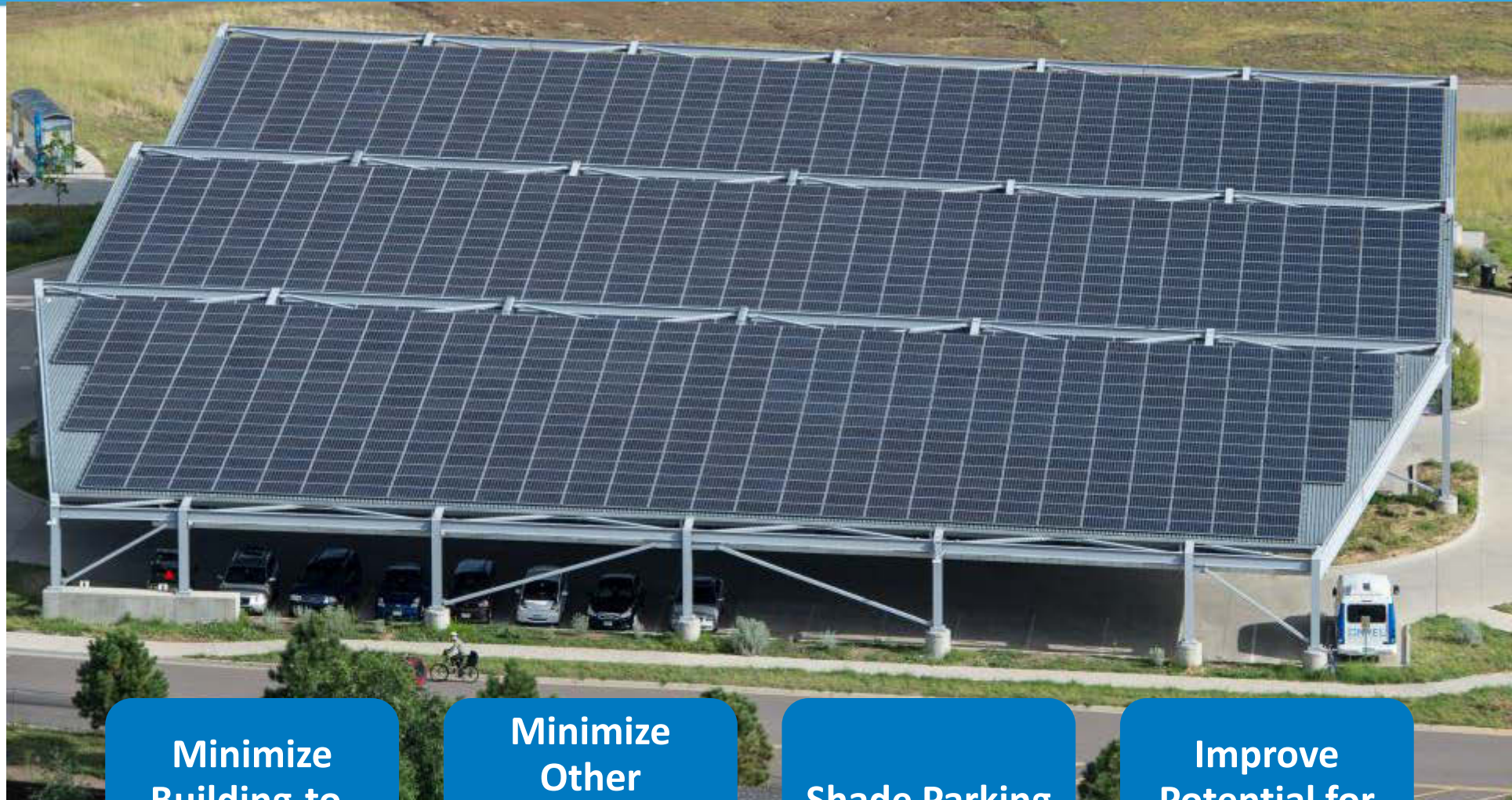
**Maximize
Enclosure
Efficiency**

**Minimize
Misc.
Electric
Loads**

**Install High
Efficiency
Lighting
and
Controls**

**Employ
District-
Connected
HVAC**

Maximize Solar Potential



**Minimize
Building-to-
Building
Shading**

**Minimize
Other
Systems that
Require Roof
Space**

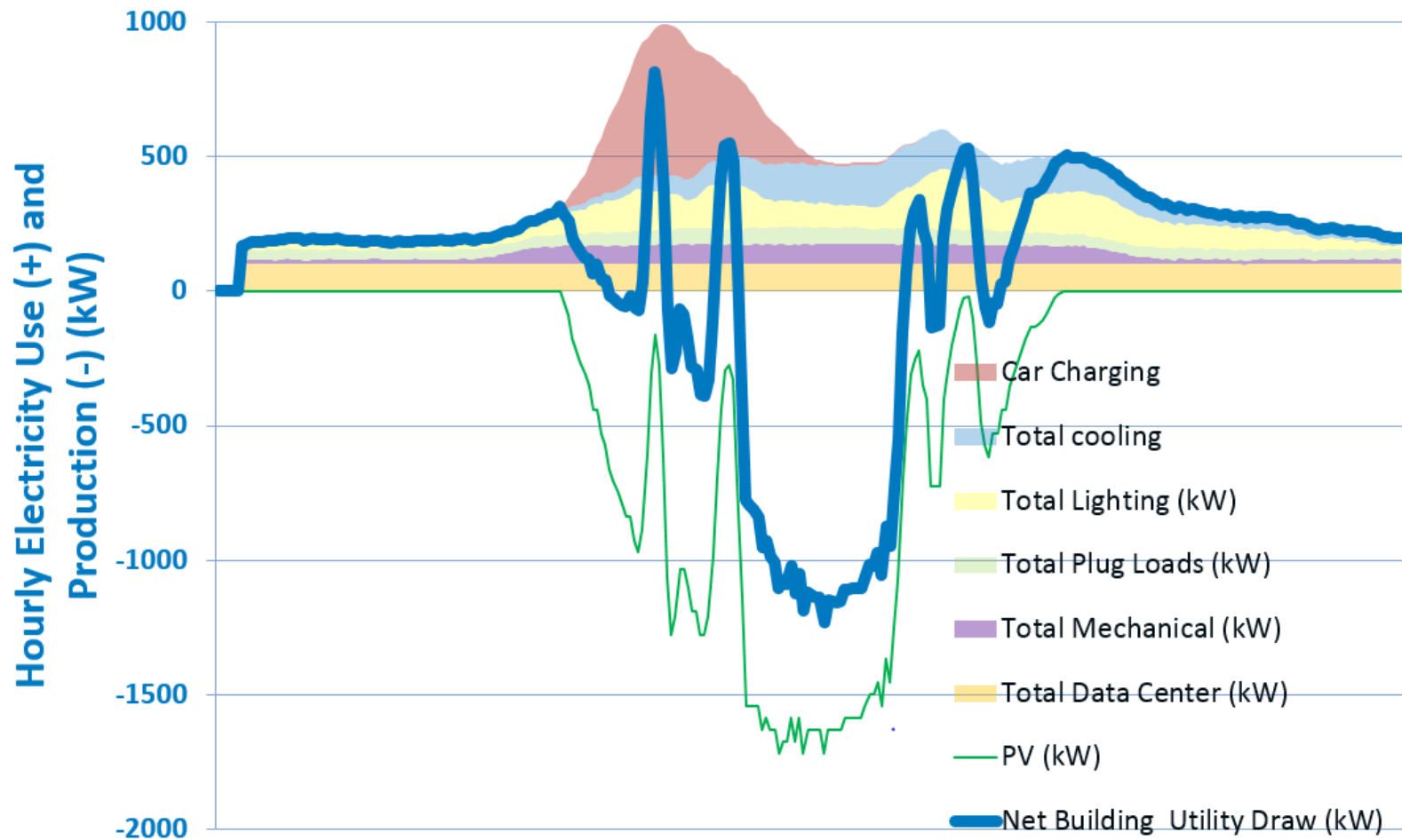
**Shade Parking
with PV**

**Improve
Potential for
Off-Grid
Resiliency**

Maximize Renewable Thermal Energy and Waste Heat Recovery



Maximize Load Control



Uncontrolled Load Profile for an Example Zero Energy Office Building



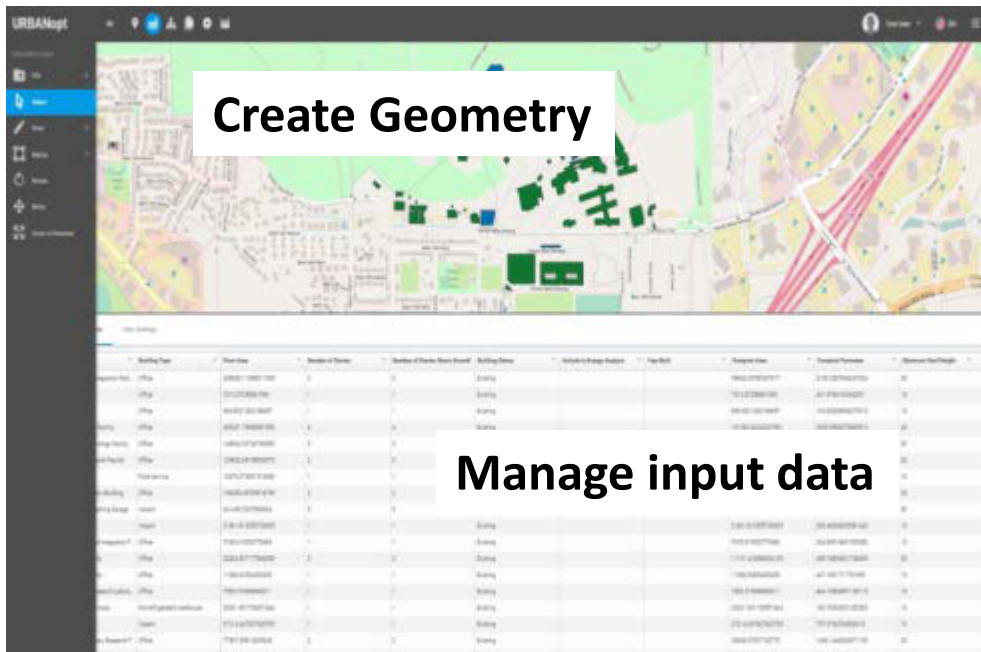
How much PV is needed? Where will it be located?



Does the density support a central district ground source heat pump system? Multiple smaller systems?

URBANopt

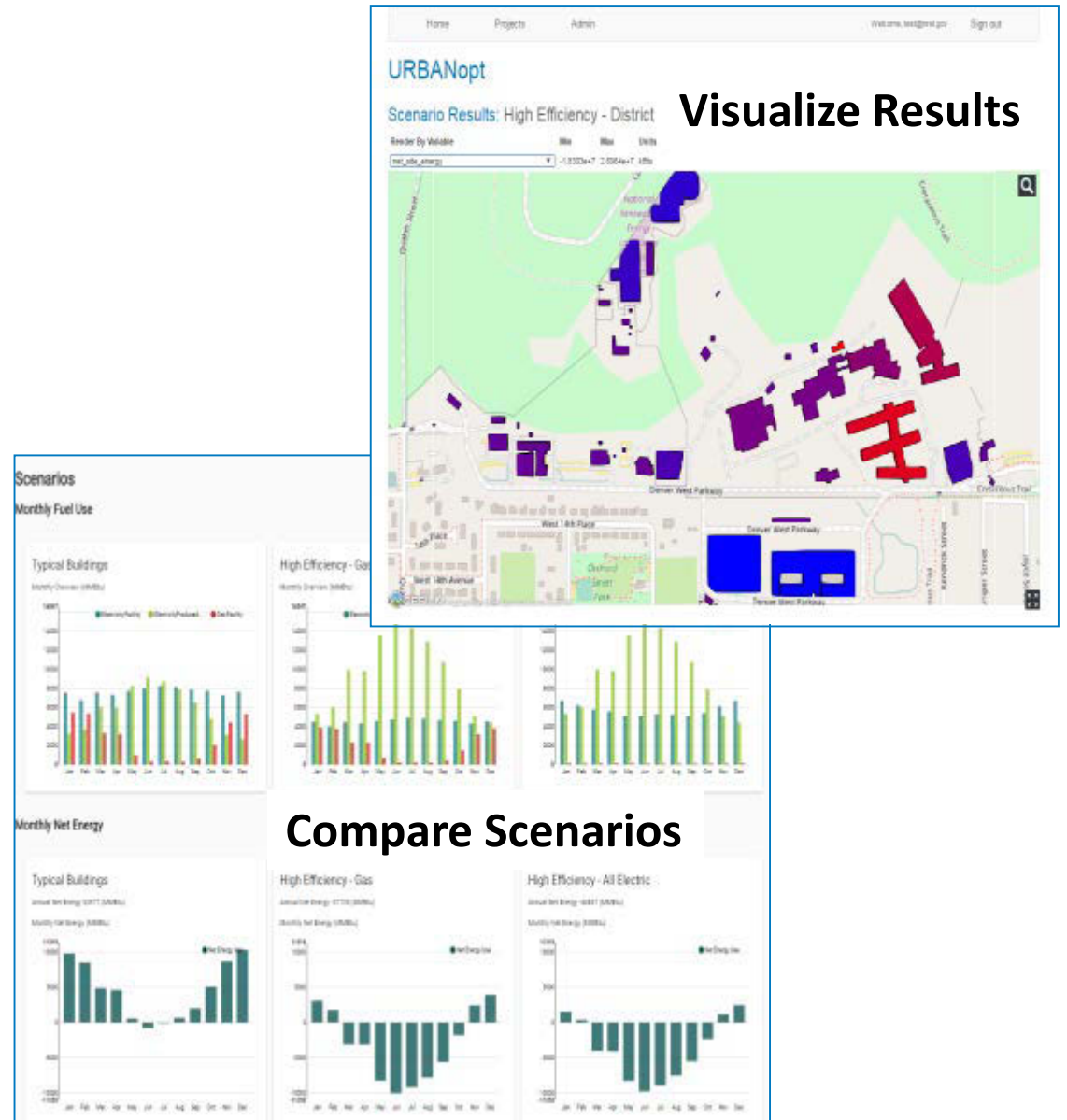
- Began as NREL LDRD, example application built on modeling framework
- Use with partners to validate the underlying modeling framework
- Demonstrate value of modeling framework to third-parties



Create Geometry

Manage input data

Building Type	Area (sqm)	Number of Stories	Number of Windows (per floor)	Building Volume	Number of Energy Zones	Top Wall	Roof Type	Roof U-Value	Roof Slope	Roof Orientation	Roof Pitch
Office	1000000000	10	100	1000000000	10	1000000000	1000000000	1000000000	1000000000	1000000000	1000000000
Office	1000000000	10	100	1000000000	10	1000000000	1000000000	1000000000	1000000000	1000000000	1000000000
Office	1000000000	10	100	1000000000	10	1000000000	1000000000	1000000000	1000000000	1000000000	1000000000
Office	1000000000	10	100	1000000000	10	1000000000	1000000000	1000000000	1000000000	1000000000	1000000000
Office	1000000000	10	100	1000000000	10	1000000000	1000000000	1000000000	1000000000	1000000000	1000000000
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Office	1000000000	10	100	1000000000	10	1000000000	1000000000	1000000000	1000000000	1000000000	1000000000
Office	1000000000	10	100	1000000000	10	1000000000	1000000000	1000000000	1000000000	1000000000	1000000000
Office	1000000000	10	100	1000000000	10	1000000000	1000000000	1000000000	1000000000	1000000000	1000000000



Visualize Results

Compare Scenarios

Scenarios

Monthly Fuel Use

Typical Buildings

High Efficiency - Gas

Monthly Net Energy

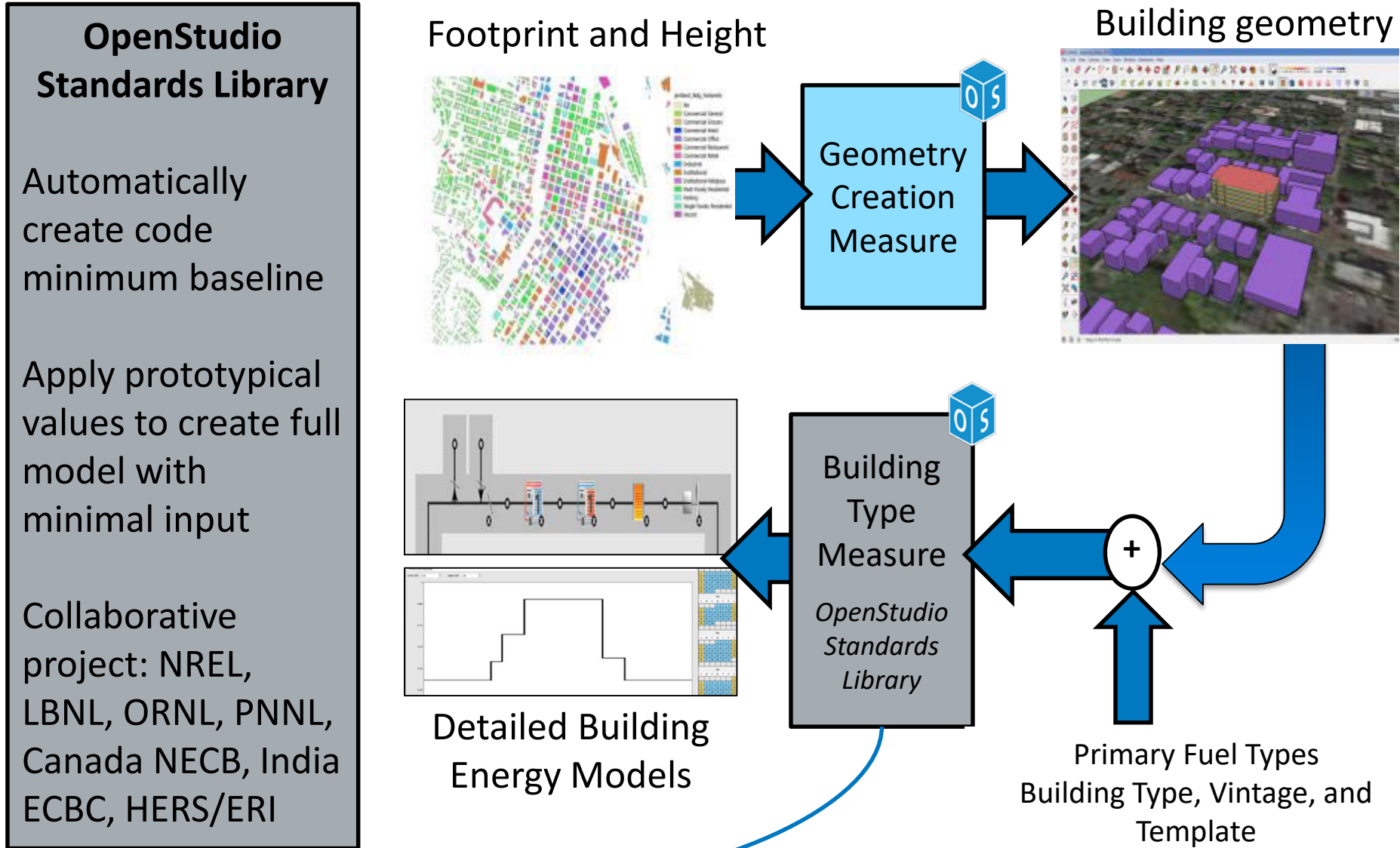
Typical Buildings

High Efficiency - Gas

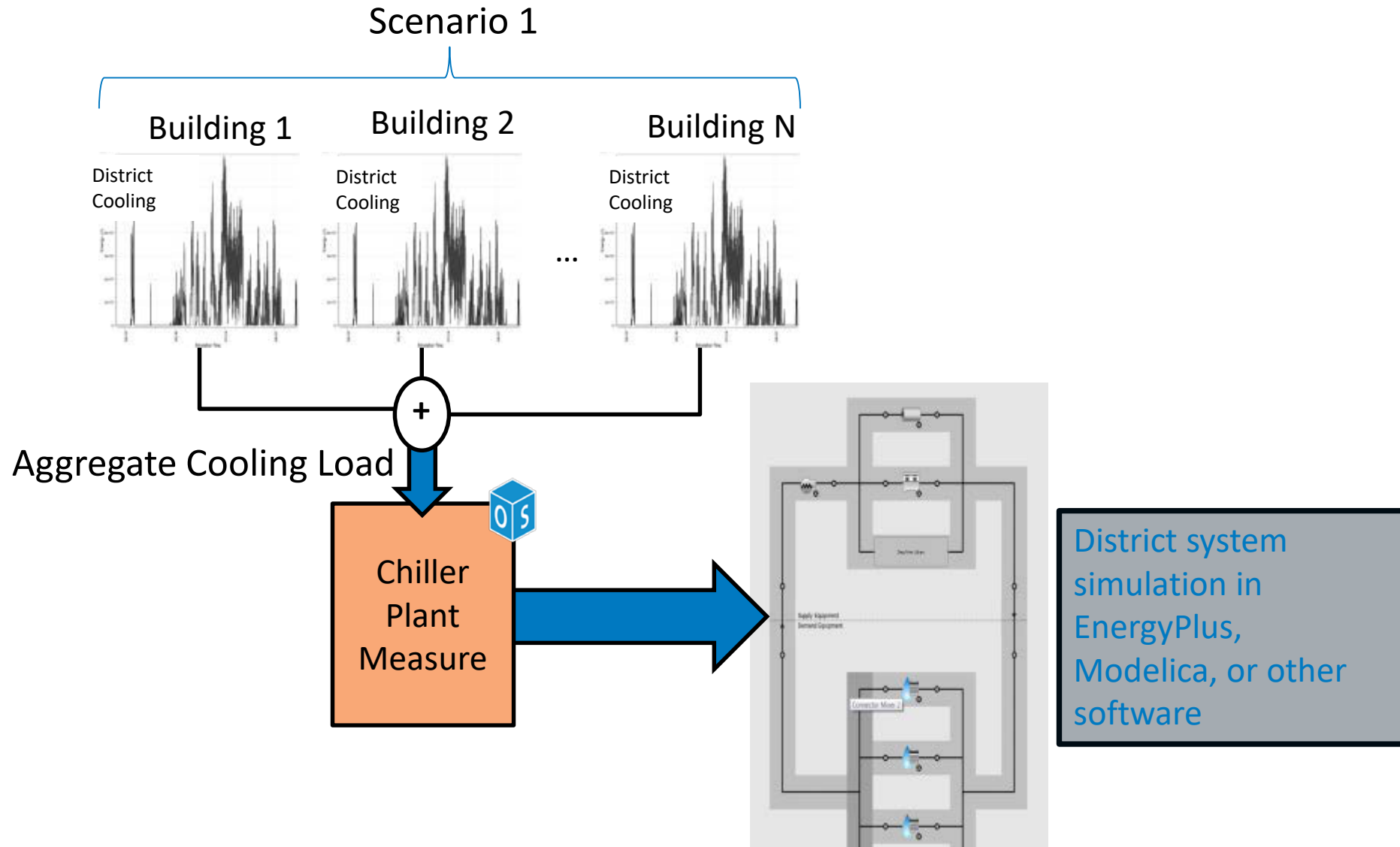
High Efficiency - All Electric

Scenario	Typical Buildings Monthly Fuel Use (kWh)	High Efficiency - Gas Monthly Fuel Use (kWh)	High Efficiency - All Electric Monthly Net Energy (kWh)
Typical Buildings	~1000	~1000	~1000
High Efficiency - Gas	~1000	~1000	~1000
High Efficiency - All Electric	~1000	~1000	~1000

OpenStudio Building Modeling



OpenStudio District System Modeling



Peña Station, Denver, CO

Goal: Design a net-zero energy development with much greater than 50% DER penetration, to achieve sustainability, reliability and affordability.

Technologies: Solar, smart inverters, storage, building efficiency, condenser heat recovery, district heating/cooling

Project Partners: Xcel Energy, Panasonic, L.C. Fulenwider Inc., City and County of Denver



Thank you!

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