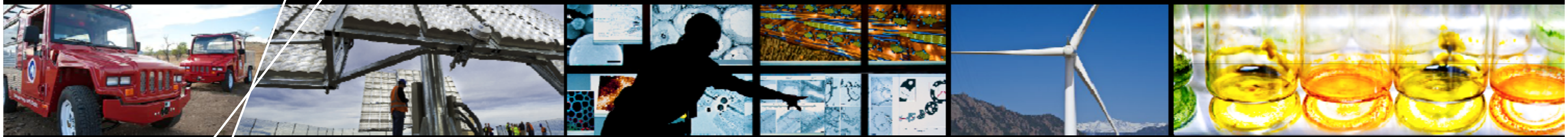
Defining and Including Energy Targets in the Contractual Process



NASA Net Zero Workshop

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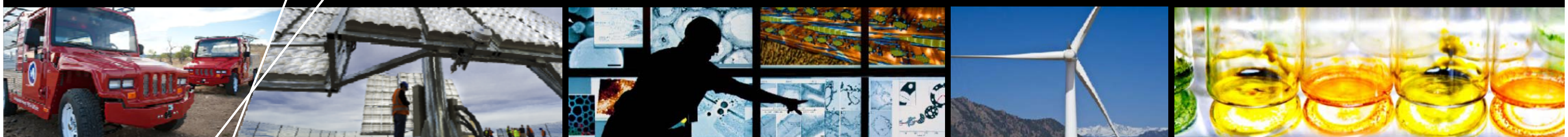
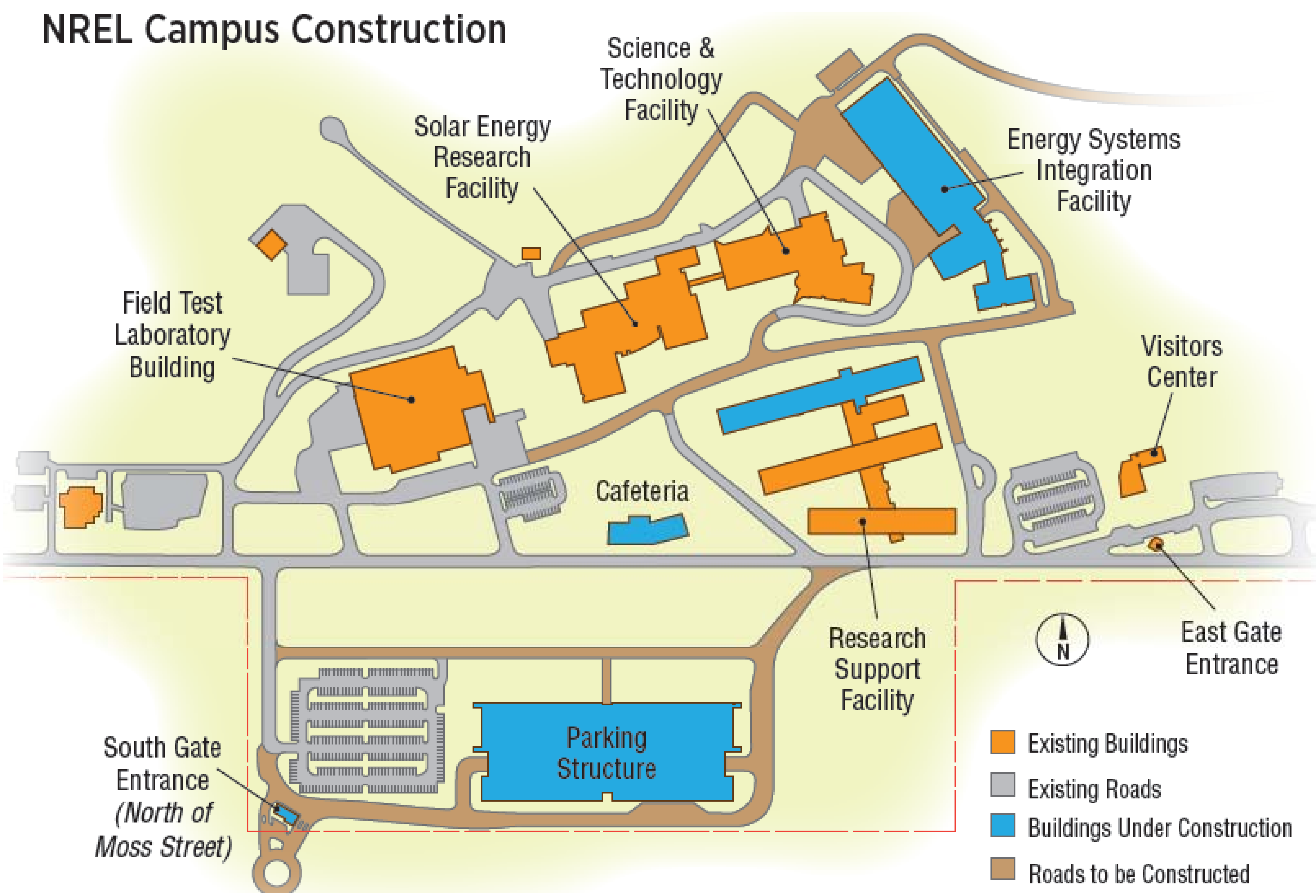


Incorporating Energy Goals into the Contractual Process on NREL s Campus

NREL Campus: Completed and Ongoing Construction



Energy Target Best Practices: NREL RSF I

- **Overview**
  - 220,000 ft^2 office building
  - 824 workstations
  - LEED Platinum
  - 35 kBtu/ft^2·yr
  - Net zero energy
  - \$254/ft^2

NREL Research Support Facility I

- **Energy Use Requirements**
  - 35 kBtu/ft^2·yr
  - 50% better than ASHRAE 90.1-2004

- **Best Practices**
  - Design-build, fixed price approach
  - Normalized energy targets included in request for proposal
  - Energy calculations and daylight modeling performed at each design phase
  - Energy targets incentivized in design-build contract
  - Passive strategies integrated into building form to reach energy target cost effectively

Energy Target Best Practices: NREL RSF II

- **Overview**
  - 140,000 ft^2 office wing
  - 550 workstations
  - LEED Platinum
  - 34.4 $kBtu/ft^2 \cdot yr$ (total RSF)
  - Net zero energy
  - $\$254/ft^2$

NREL Research Support Facility II

- **Energy Use Requirements**
  - 33 $kBtu/ft^2 \cdot yr$
  - 50% better than ASHRAE 90.1-2004

- **Best Practices**
  - Design-build, fixed price approach
  - Normalized energy targets included in request for proposal
  - Energy calculations and daylight modeling performed at each design phase
  - Energy targets incentivized in design-build contract
  - Passive strategies integrated into building form to reach energy target cost effectively

Energy Target Best Practices: NREL Parking Garage

- **Overview**
  - 1800 parking spaces
  - 160 kBtu per space, 90% more efficient than 90.1
  - LED lighting
  - Full daylighting
  - $14,172 per space, cost competitive with typical garages

NREL Parking Garage

- **Energy Use Requirements**
  - 175 kBtu per space

- **Best Practices**
  - Design-build, fixed price approach
  - Normalized energy targets included in request for proposal
  - Energy calculations and daylight modeling performed at each design phase
  - Energy targets incentivized in design-build contract
  - Daylighting and natural ventilation requirements drove building form (elongated shape, dual wing design)

Energy Target Best Practices: NREL SEB

- **Overview**
  - 1,500 ft^2 access control building
  - High performance envelope
  - Ground source heat pumps with radiant cooling and heating
  - Full daylighting
  - Net zero energy

NREL Site Entrance Building

- **Energy Use Requirements**
  - 9,300 kWh total use (initial)
  - 32 $kBtu/ft^2 \cdot yr$ (final)
  - Net zero energy

- **Best Practices**
  - Design-build, fixed price approach
  - Energy targets included in request for proposal (and modified in response to unknown loads)
  - Energy calculations and daylight modeling performed at each design phase
  - Energy targets incentivized in design-build contract

Energy Target Best Practices: NREL Cafeteria

- **Overview**
  - 12,000 ft^2 full-service dining facility
  - Accommodates 240 guests
  - Full daylighting in dining and servery areas
  - Variable volume exhaust system
  - LEED Gold

NREL Cafeteria

- **Energy Use Requirements**
  - Best-in-class equipment efficiencies

- **Best Practices**
  - Design-build, fixed price approach
  - System and equipment efficiency definitions included in request for proposal (in lieu of whole-building energy use goal)
  - Energy calculations and daylight modeling performed at each design phase
  - Performance goals incentivized in design-build contract
  - Passive strategies integrated into building form to reach energy target cost effectively

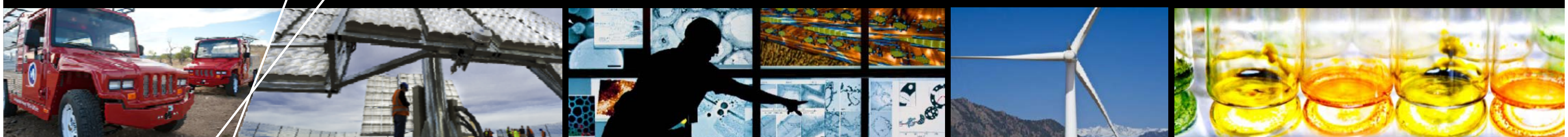
Energy Target Best Practices: NREL ESIF

- **Overview**
  - 182,500 ft^2 research and development facility (mixed office and lab space)
  - Accommodates 200 scientists
  - High performance data center
  - Heat recovery from data center
  - LEED Platinum

NREL Energy Systems Integration Facility

- **Energy Use Requirements**
  - 25 $kBtu/ft^2 \cdot yr$ for office areas, 30% better than 90.1-2007
  - Data center PUE of 1.06 and EUE of 0.6

- **Best Practices**
  - Design-build, fixed price approach
  - System and equipment efficiency definitions (for the data center) and space type-specific energy intensity targets (for the office space) included in request for proposal
  - Energy calculations and daylight modeling performed at each design phase
  - Performance goals incentivized in design-build contract
  - Data center heat recovery and daylighting requirements informed early massing decisions (east-west axis for office area and data center placement)



Best Practices Overview for Defining and Implementing Energy Targets

Performance Goal Considerations

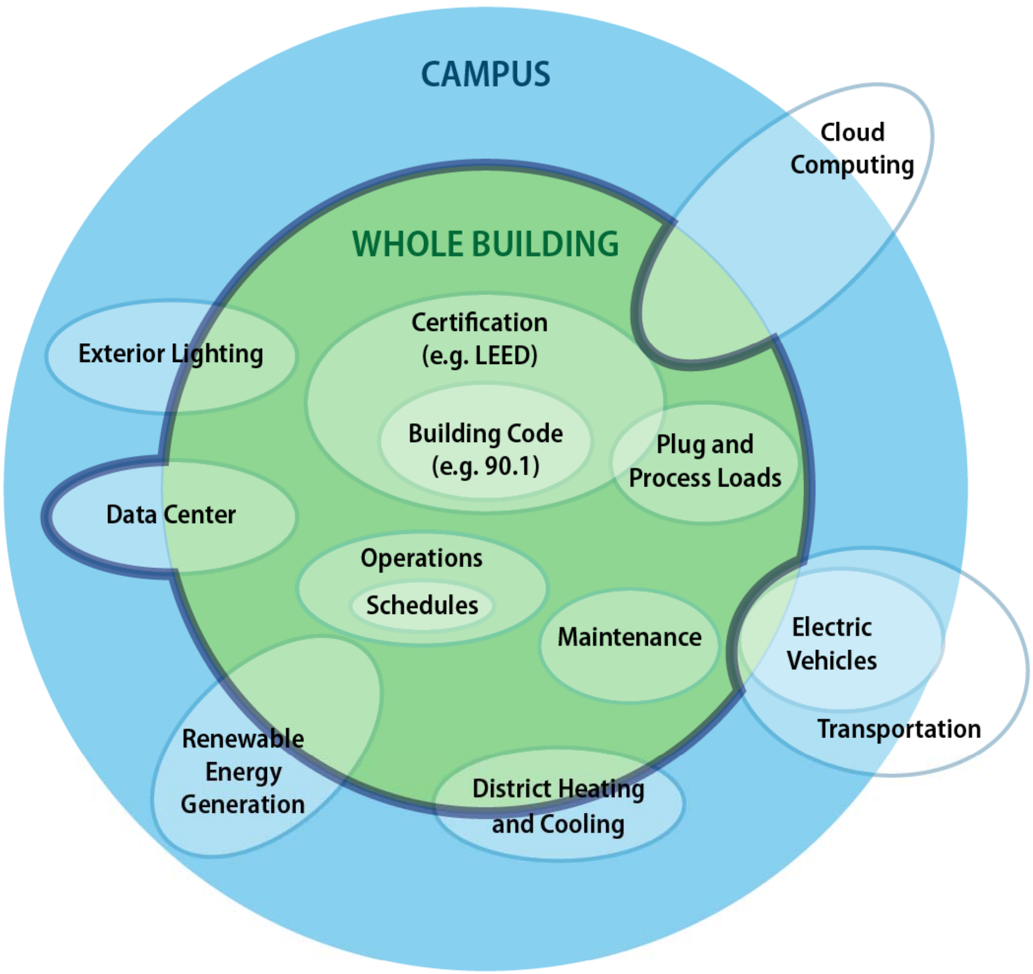
- **Goal setting is critical when striving for best-in-class efficiency performance**
- **Clear, measureable performance goals bring focus to the design process**
- **Many common goals require the definition of a theoretical baseline, requiring assumptions that do not necessarily reflect the reality of a project**

Benefits of Whole-Building, Absolute Targets

- **Clear goals without room for interpretation**
  - No interpretation of codes or standards or assumptions of typical design and use are required
- **Directly measureable**
  - Encourages and facilitates goal verification
  - Enables contractual inclusion of energy goals
- **Capture whole-building energy performance**
  - Encourages design team to carefully consider aspects of building performance that may be overlooked by codes or standards
- **Place focus on low-energy design**
  - Eliminate the need to develop a baseline
  - Project resources are applied to improving low-energy design

Defining Whole-Building Energy Use

- **Documentation of energy uses that fall outside the scope of codes and standards**
- **Defining the boundary of the site**
- **Site vs. campus**
  - Shared loads
  - Shared renewable energy generation
- **Link between building/campus and surrounding environment**
- **Considering water use. drainage and waste**



Tailoring Targets to Project Parameters

- **Define key project parameters (those that affect energy use)**
  - Building function
  - Climate
  - Plug and process loads
  - Hours of operation
  - Occupancy density and patterns
  - Designed level of service (comfort, indoor air quality, etc.)
  - Specialty space types
- **Seek out comparison data and target-setting recommendations according to key parameter definitions**
  - Improves the quality of comparison points
  - Results in more focused and better-informed targets
- **Use subsystem targets where appropriate**
  - Specialty space types may require separate analysis

Specifying Whole-Building, Absolute Energy Targets

1. **Define key project parameters**
   - All parameters that effect energy use
2. **Survey applicable resources**
   - Comparable industry best case studies
   - Portfolio data
   - Sector-level data (CBECS, Energy Star Target Finder, etc.)
   - Energy modeling results
3. **Specify energy target**
   - Select appropriate reference point (if desired)
   - Specify target that aligns with key parameter definitions, available resources, and project performance goals

Using Absolute Targets to Improve Energy Performance

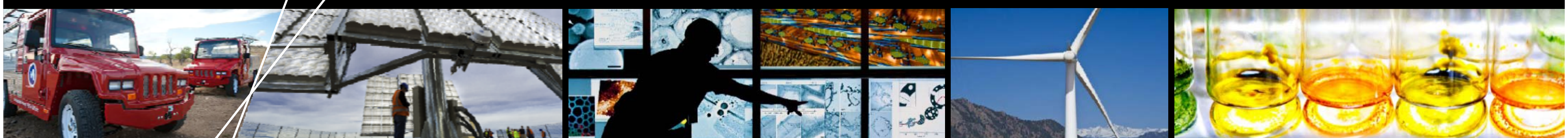
- **Team Selection**
  - Select design team according to ability to reach performance target within budget
  - Encourages prospective design team to identify innovative, cost-effective solutions, unrestricted by prescriptive requirements
- **Early Design**
  - Focus on whole-building energy use provides the opportunity to identify efficiency strategies for often-overlooked programmatic energy uses (space planning, equipment organization, operational schedules, etc.)
- **Construction**
  - Assess impact of change orders on the overall energy budget defined by the whole-building, absolute energy use target
- **As-Built**
  - Absolute targets inform the specification of end use energy budgets
- **As-Operated**
  - End use energy budgets inform the control sequence commissioning process
  - Reconcile differences between design and operation

50% AEDG Whole-Building Absolute Energy Use Targets

- **Advanced Energy Design Guides (AEDGs) provide cost-effective, industry-vetted recommendations for achieving performance that far exceeds the minimum requirements of commercial building codes (ASHRAE Standard 90.1)**
  - In addition to prescriptive design requirements, the 50% AEDGs for K-12 schools, medium- to big-box retail stores, and large hospitals provide whole-building, absolute energy targets that correspond to 50% site energy savings beyond ASHRAE 90.1-2004 and align with industry best practices for energy efficiency
  - AEDG absolute energy use targets embody industry design expertise and NREL's advanced energy modeling capabilities
  - Targets are provided for 16 climate zones, that encompass the range of weather conditions across the United States
  - In some cases, targets are broken down into suggested end use energy budgets (plug and process, lighting, and HVAC)

Best Practices: Whole-Building Absolute Energy Use Targets

- Use available resources to set targets that are aggressive and align with project-specific parameter definitions and budget
- Identification and understanding of all building energy uses is critical
- Better alignment between resources and project-specific parameter definitions allow for more aggressive targets
- Whole-building energy modeling can be used to evaluate unique strategies and considerations and integrated design concepts
- Discrepancies between design, construction, and operation should be tracked and evaluated for energy use implications
- End use energy budgets are valuable during commissioning and provide a means of evaluating system-level performance
- Absolute targets can be incorporated into design and construction contracts and incentivized to increase likelihood of project success



Backup Slides

Specifying Targets According to Industry Best Practice

- **Best practice performance should be identified and targeted where cost effective or otherwise justifiable**
- **Pros:**
  - Resultant targets are aggressive
- **Cons:**
  - Best practice projects that align with key parameter definitions cannot be identified or do not align with project budget
  - Projects that achieve the desired level of performance cannot be identified

Specifying Targets According to Portfolio Performance

- **Owners with a portfolio of buildings that share a prototypical design can leverage lessons learned from previous projects**
- **Portfolio data is invaluable to the target specification process**
- **Pros:**
  - Comparison projects have nearly identical project parameter definitions
  - Straightforward identification of poor performing buildings
- **Cons:**
  - Encourages perpetuation of status quo in design

Specifying Targets According to Sector-Level Data

- **Sector-level data can inform target setting in a broad sense and provide context for performance goals**
- **Pros:**
  - Relevant data is readily accessible (CBECS, Energy Star Target Finder, etc.)
  - Broad nature of data ensures high level applicability
- **Cons:**
  - Sector-level data cannot be benchmarked against project-specific parameter definitions

Specifying Targets Using Energy Simulation

- **Whole-building annual energy simulation allows for a comprehensive analysis of all project-specific parameters**
- **Pros:**
  - Maximum alignment with project parameter definitions
  - Enables evaluation of project-specific integrated design strategies
  - Results in most accurate prediction of project-specific operational energy use
- **Cons:**
  - Resource intensive
  - Quality of energy use predictions depend on simulation expertise

Applicability of Whole-Building, Absolute Targets

- **Targets may be difficult to define for buildings with mixed uses and/or specialty space types**
  - Lack of comparable resources available
  - Requires increased reliance on energy simulation
- **Operational parameters may be difficult to defines**
  - In some cases, occupant usage patterns may be unpredictable
  - Unpredictability may necessitate less aggressive targets