NREL Garage:
Incorporating Energy Goals

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Overview

• Energy use in parking garages
• Best-value procurement: RFP objectives
• Performance specifications: energy goals
• RFP goal substantiation
A parking structure typically uses 5%–20% the energy of its supported building(s)
Garage Objectives, Best Value Procurement

“Mission Critical,” top tier RFP language

• 1,500 net additional parking spaces for automobiles
• Comply with NREL requirements
• *Parking structure(s) maximize LEED™ points*
• Meet the budget and schedule
• Promote ease of mobility and campus circulation
• Integrate campus security
“Highly Desirable,” middle tier RFP language

- Minimize existing community impact
- 1,800 maximum parking spaces for automobiles
- Two-month early completion
- *Achieve energy goal for parking structure (175 kBtu/space/yr)*
- Minimize structure height
- *Maximize photovoltaic (PV) capacity capability*
- Life cycle cost efficiency (maximize)
- Shuttle stop is weather protected
- Promote carpooling and preferential high occupancy vehicle parking for a minimum 5% of spaces
- Incorporate recycling drop-off collection point
- Provide covered bicycle parking
- Provide industry-supported Electric Vehicle Supply Equipment (EVSE) for 2% of spaces immediately available on opening day
- Minimize operations and maintenance for snow and ice removal
Garage Objectives, Best Value Procurement

“If Possible,” bottom tier RFP language

• Three-month early completion date
• Provide infrastructure support to expand the industry-supported EVSE to accommodate up to 20% of the spaces without upgrading or modifying the electricity distribution system
• Parking management technology
• Motorcycle parking
Garage Objectives, Best Value Procurement

Qualitative Merit Criteria, RFP Language

3. Demonstrates an approach to obtaining energy goals and maximizing sustainability. (15 Points Maximum)
   a. Submission Requirements: Submit a narrative (10 page maximum) and LEED™ 2009 New Construction and Major Renovation project checklists (4 pages for each, site entrance building and the parking structure(s)) that demonstrates the approach to meeting the energy goals and maximizing sustainability for the proposed structure(s). In addition address the following Proposal Phase Substantiation Criteria in the narrative and/or checklists:
      • Performance Criteria, 111 Facility Performance, item A.4.h.1: LEED Checklist annotated to show specific credits to be achieved with brief description of how they will be achieved.
      • Performance Criteria, 111 Facility Performance, item F.2.a.1: Identification of method of calculation of energy efficiency to be employed.
      • Performance Criteria, B-Shell, item C.3.a.1: Identification of volumes relying on natural ventilation with description of ventilation concept and required building
      • Performance Criteria, C-Interiors, item B.4.d.1: Information on overall building configuration that will permit day lighting to levels specified.
   b. Evaluation factors:
      1. The narrative clearly demonstrates how the energy goals of 175 kBTU per parking space per year for the parking structure(s) and the annual energy consumption goal of 9,300 kWhr for the site entrance building can be obtained.
      2. The narrative and checklists will be evaluated to assess the reasonableness of the approach to maximizing LEED™ points to demonstrate sustainability of the project. Unsubstantiated claims will not be given credit.

Demonstrate approach to meeting the whole-building energy goal
Garage Objectives, Performance Specifications

Performance Criteria, RFP Language

As the facility must achieve a high level of energy efficiency consistent with NREL’s mission; the energy systems must use a maximum of 175 kBTU per parking space per year. Integration of natural lighting and ventilation systems are valued to the extent they support the energy efficiency requirements.

As the parking facility will be a 24/7 operation, safe environmental design (such as Crime Prevention Through Environmental Design (CPTED)) is essential for user comfort and a sense of personal security. Balancing energy consumption with a safe and secure environment will likely make use of motion-sensing lighting systems, or other energy saving designs that assure personal security.

Natural Light:

a. Daylighting: Provide ambient natural lighting in primary spaces that is of intensity adequate for essential tasks when measured on a typical overcast winter day in midafternoon.

... 

d. Substantiation:

1) Proposal: Information on overall building configuration that will permit daylighting to levels specified.

2) Design Development: Engineering calculations for representative spaces, predicting anticipated daylighting levels under specified conditions.

3) Construction Documents: Details of lighting control mechanisms.

4) Construction: Field test of lighting levels verifying compliance with performance requirements.

Whole-building energy goal

System-specific performance (worst-day daylighting requirement)

Substantiation requirement (daylighting)
Determining the Energy Goal

Must a new energy goal be determined? If so, follow the first five steps before drafting the RFP:

1. Identify occupant types, tasks, and demand profiles
2. Estimate daylight (or passive strategy) savings potential
3. Select a best-in-class lighting power density (LPD) (or base load) from case studies (or tools)
4. Add energy use for best-in-class security systems, elevators, parasitic loads, etc.
5. Add energy or cost credits for preferred solutions
6. Present goal to proposing teams for review
7. Require that the energy goal be substantiated throughout design, construction, and occupancy
Determining the Energy Goal

Step 1. Identify occupant types and tasks

IESNA Lighting Handbook, Ninth Edition

<table>
<thead>
<tr>
<th>Area</th>
<th>Time</th>
<th>Minimum Horizontal Illuminance (fc)</th>
<th>Uniformity Ratio (maximum: minimum)</th>
<th>Minimum Vertical Illuminance (fc)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Basic</td>
<td>–</td>
<td>1.0</td>
<td>10:1</td>
<td>0.5</td>
</tr>
<tr>
<td>Ramps</td>
<td>Day</td>
<td>2.0</td>
<td>10:1</td>
<td>1.0</td>
</tr>
<tr>
<td>Ramps</td>
<td>Night</td>
<td>1.0</td>
<td>10:1</td>
<td>0.5</td>
</tr>
<tr>
<td>Entrance</td>
<td>Day</td>
<td>50.0</td>
<td>10:1</td>
<td>25.0</td>
</tr>
<tr>
<td>Entrance</td>
<td>Night</td>
<td>1.0</td>
<td>10:1</td>
<td>0.5</td>
</tr>
<tr>
<td>Stairs</td>
<td></td>
<td>2.0</td>
<td>10:1</td>
<td>0.1</td>
</tr>
</tbody>
</table>
Step 1 (cont.) Identify occupant demand profiles

NREL Occupant Transition Profile for an Example Building, Typical Weekday

- Percentage of Peak Hour Entrance/Exits
- Hour of Day, MDT

- 100%
- 90%
- 80%
- 70%
- 60%
- 50%
- 40%
- 30%
- 20%
- 10%
- 0%
Determining the Energy Goal

Step 2. Estimate daylight savings potential (75% for a typical structure)

Step 3. Select an LPD

<table>
<thead>
<tr>
<th>Resource</th>
<th>LPD (W/ft²)</th>
<th>Average Illuminance (fc)</th>
<th>Typical Uniformity Ratio (maximum:minimum)</th>
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</thead>
<tbody>
<tr>
<td>Lowest LPD of reviewed literature and calculations</td>
<td>0.05</td>
<td>≤ 1.5</td>
<td>&lt;4:1</td>
</tr>
<tr>
<td>DOE High-Efficiency Parking Structure Lighting Specification range with maximum LPD allowance</td>
<td>0.05–0.18</td>
<td>1.5–5</td>
<td>7:1</td>
</tr>
<tr>
<td>ASHRAE Standard 90.1-2007 maximum LPD allowance</td>
<td>0.3</td>
<td>≥ 5</td>
<td>10:1</td>
</tr>
</tbody>
</table>
Determining the Energy Goal

Step 4. Add energy use for security systems, elevators, parasitic loads, etc.

Step 5. Add energy or cost credits for preferred solutions

*NREL parking structure energy goal: 175 kBtu/space/yr*

Step 6. Present goal to proposing teams for review

Step 7. Require that the energy goal be substantiated
Garage Objectives, Performance Specifications

Energy Appendix, RFP Language

- The whole building energy use will be measured at the building footprint. It includes all loads in the building: lighting, security cameras and other miscellaneous equipment connected through the building, such as transformers and control systems.
- All losses from transformers and inverters are considered part of this energy calculation. Use of direct current lighting that can use the 100,000 kWh PV allotment for the garage will be considered for a to-be-determined credit.
- Under this definition, PV on or through the building will be considered a supply side technology, and not count toward the 9300 kWh goal.
- Daylighting and natural ventilation are considered demand side technologies.
- Based on NREL occupancy data and a typical parking structure daylighting study, the EUI recommendation of 175 kBTU/parking space/year is based on:
  - 0.05 W/ft² LPD
  - 25% hours of operation for daytime hours (75% reduction on maximum LPD)
  - 25% hours of operation for nighttime hours (75% reduction on maximum LPD)
  - Full annual operating schedule
  - Approximately 0.10 kBTU/ft²/year controls allowance
  - 8.5’ x 19.5’ parking space
  - Transition area equals one and a half times and parking space area

With 1,500 or 1,800 spaces, the design will fit within the 100,000 kWh PV allotment for the structure.

Excluded loads from the energy goal include:
- Power for recharging stations
- Power for intermittent plug loads such as those incurred by power washing structure surfaces

Continuous load due to transformers required for the plug loads should be included when calculating the annual energy goal.

Energy goal calculation assumptions could be misinterpreted as requirements.
RFP Goal Substantiation

• Parking Spaces
  o 1,806 total spaces
  o 90 preferred spaces for carpooling and vanpooling, 90 preferred spaces for low-emitting vehicles, 36 electric vehicle charging stations

• Renewable Energy Ready
  o 1.4 MW PV (net zero energy for RSF complex)

• Energy Performance
  o 158 kBtu/space/yr, designed
  o 90% energy reduction versus ASHRAE Standard 90.1-2007
Energy Goal Substantiation

Daylight model results for one interior bay of the garage

Figure 22: Daylight levels in foot candles on February 4th at 2:00 PM under overcast sky conditions.

Daylighting calculations performed by Ambient Energy

Spreadsheets calculations use daylight model results for an annual lighting energy prediction

Annual energy calculations performed by ME Group
Energy Goal Substantiation

Baseline Energy Use (kBtu/space/yr, %) by End Use
- Elevators, 24.5, 1%
- Security, 46.3, 3%
- Lighting, 1,443, 93%
- Miscellaneous, 41.2, 3%

Predicted Energy Use (kBtu/space/yr, %) by End Use
- Lighting, 46, 29%
- Elevators, 24.5, 16%
- Security, 46.3, 29%
- Miscellaneous, 41.2, 26%

Predicted Energy Use Relative Size (compared to baseline energy use)

Calculations performed by ME Group