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<td>Evaluation</td>
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## Tolman Residence Hall

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<td>7.2</td>
</tr>
<tr>
<td>Roof and Shadow Analysis</td>
<td>7.3</td>
</tr>
<tr>
<td>Estimated Feasible kW</td>
<td>7.4</td>
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<tr>
<td>Evaluation</td>
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## Rait Residence Hall

<table>
<thead>
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<tr>
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<tr>
<td>Energy Usage Index</td>
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<td>Roof and Shadow Analysis</td>
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<tr>
<td>Estimated Feasible kW</td>
<td>8.4</td>
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<tr>
<td>Evaluation</td>
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</table>
Executive Summary
April 30, 2009

Mesa State College – Campus Wide Solar Initiative
Assessment No. 1

The purpose of this initial Assessment Phase was to rapidly access existing conditions for the following eight buildings, and identify those with the greatest potential for roof-top solar panel energy generation.

The buildings were reviewed based on the following factors:

1) Determine maximum feasible area for Solar Panels based on existing rooftop conditions and shadow studies.
2) Review of existing Roof System to determine general condition and life expectancy of the system.
3) Review of existing Structural Roof members to determine what available capacity each roof system has.
4) Assessment of existing electrical distribution systems and determine what capacity each service has.

Based on these initial assessments, the following buildings are recommended for the first phase of roof-top solar panel implementation:

1) Saunders Field House
   a. South Roof (1996 Addition)
2) Houston Hall
3) Monument Hall
4) Lowell Heiny Hall
5) Tolman Residence Hall
6) Rait Residence Hall

The following buildings were determined to need additional documentation or review, before being solar panel ready:

1) Saunders Field House
   a. North Roof (Original 1960’s Structure)
2) Tomlinson Library
3) Pinon Residence Hall
## SUMMARY MATRIX

<table>
<thead>
<tr>
<th>Building</th>
<th>Roof Structure</th>
<th>Roof Membrane Condition</th>
<th>Available Area for Solar PV</th>
<th>Possible kW</th>
<th>Energy Use Index²</th>
<th>Electrical Service kW Limit</th>
<th>PV Ready</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>1A</strong> Saunders Field House North Upper Roof</td>
<td>Sufficient Capacity 6 - 7 psf add/l capacity²</td>
<td>Roof Membrane near end of life-expectancy</td>
<td>25,330 sf</td>
<td>250 kW</td>
<td>62.29 EUI</td>
<td>219 kW</td>
<td></td>
</tr>
<tr>
<td><strong>1B</strong> Saunders Field House South Lower Roof</td>
<td>Sufficient Capacity 12 psf add/l capacity²</td>
<td>1996 - Roof Membrane in good condition</td>
<td>14,575 sf</td>
<td>145 kW</td>
<td></td>
<td>Sufficient Capacity (146 kW)</td>
<td>145 kW</td>
</tr>
<tr>
<td><strong>2</strong> Houston Hall</td>
<td>Sufficient Capacity 5 - 7 psf add/l capacity²</td>
<td>2003 - Roof Membrane in good condition</td>
<td>10,000 sf</td>
<td>100 kW</td>
<td>160.01 EUI</td>
<td>Sufficient Capacity (146 kW)</td>
<td>100 kW</td>
</tr>
<tr>
<td><strong>3</strong> Monument Hall</td>
<td>Sufficient Capacity 12 psf add/l capacity²</td>
<td>1996 - Roof Membrane in good condition</td>
<td>6,305 sf</td>
<td>63 kW</td>
<td>55.46 EUI</td>
<td>Sufficient Capacity (95 kW)</td>
<td>63 kW</td>
</tr>
<tr>
<td><strong>4</strong> Tomlinson Library</td>
<td>Sufficient Capacity 8 psf add/l capacity²</td>
<td>1985 Roof Membrane near end of life-expectancy</td>
<td>5,470 sf</td>
<td>54 kW</td>
<td>37.28 EUI</td>
<td>Sufficient Capacity (234 kW)</td>
<td></td>
</tr>
<tr>
<td><strong>5</strong> Lowell Heiny Hall</td>
<td>Sufficient Capacity 12 psf add/l capacity²</td>
<td>1993 - Roof Membrane in good condition</td>
<td>4,828 sf</td>
<td>48 kW</td>
<td>76.00 EUI</td>
<td>Sufficient Capacity (76 kW)</td>
<td>48 kW</td>
</tr>
<tr>
<td><strong>6</strong> Pinon Residence Hall</td>
<td>Sufficient Capacity 12 psf add/l capacity²</td>
<td>1989 Roof Membrane near end of life-expectancy</td>
<td>2,985 sf</td>
<td>29 kW</td>
<td>81.15 EUI</td>
<td>Sufficient Capacity (63 kW)</td>
<td></td>
</tr>
<tr>
<td><strong>7</strong> Tolman Residence Hall</td>
<td>Sufficient Capacity 12 psf add/l capacity²</td>
<td>Roof Membrane to be replaced in 2009</td>
<td>2,910 sf</td>
<td>29 kW</td>
<td>55.88 EUI</td>
<td>Sufficient Capacity (63 kW)</td>
<td>29 kW</td>
</tr>
<tr>
<td><strong>8</strong> Rait Residence Hall</td>
<td>Sufficient Capacity 12 psf add/l capacity²</td>
<td>Roof Membrane to be replaced in 2009</td>
<td>2,985 sf</td>
<td>29 kW</td>
<td>94.80 EUI</td>
<td>Sufficient Capacity (63 kW)</td>
<td>29 kW</td>
</tr>
</tbody>
</table>

**TOTAL** 414 kW

1. EUI Reference Benchmarks
   - 94 Assembly
   - 138 Library
   - 155 College Buildings
   - 102 Office > 50,000 GSF
   - 69/34 Residential

2. Capacity assumes existing stone ballast to be removed
Setbacks from Roof Edges:

In analyzing the available roof areas for PV arrays, information regarding required setbacks from roof edges with no parapets was collected.

Building codes require a minimum of a 10’ setback from roof edges without barriers (where the drop to the next surface is greater than 30”) to any equipment that has to be serviced. It was determined that PV modules/racks/other hardware associated with PV arrays are not considered to be equipment that requires service. In fact, servicing a junction box on the back of a PV Module will usually void manufacturers’ warranty as they are factory sealed. PV equipment that does require service and invokes the minimum 10’ setback include combiner boxes, disconnects, fuse boxes, inverters.

It was further determined in discussions with PV installation companies that PV modules are generally considered to be roofing materials and require no setback from roof edges in most jurisdictions. Some jurisdictions require that OSHA rules apply, requiring a 6’ setback from roof edges unless a guard rail is installed for fall protection.

Therefore the decision was made to allow for a minimum 6’ setback from roof edges to meet possible OSHA requirements, reduce mounting penetrations in eaves, and allow for a reduced sight line to the arrays (make the PV arrays less visible).

Type of PV Modules Used in Electrical Assessment:

There are several types of PV modules available, including but not limited to single crystal modules (aka mono-crystalline), poly-crystalline, amorphous, thin-film, building-integrated (from PV-imbedded glass to standing-seam metal roof panels), etc.

For the purposes of this initial feasibility assessment, the modules were assumed to be poly-crystalline (Sharp 216, Mitsubishi UD5, or similar).

After a determination is made whether the PV arrays will be ballasted, rack-mounted, micro-inverter type modules or other,
electrical design will be required to refine the estimate of available output capacity of the arrays.

**Building Energy Use Indices (EUIs):**

The metric used for assessing the relative energy use of a building is an Energy Use Index (EUI) in kBtus/SF/yr. Once the estimation of energy use per square foot is made from utility data, it can be adjusted for known weather conditions and then compared to national or state averages for buildings of a similar type. This can help identify particular buildings operating outside the normal range of energy use for further investigation.

In addition, further analysis of an EUI can show which systems if any within a building are responsible for higher than average use and target efforts to reduce the energy consumption.
**Assessment No. 1**  
*Mesa State College - Campus Wide Solar Initiative*

**Saunders Field House**  
*Energy Usage Index Analysis*

<table>
<thead>
<tr>
<th>Monthly Data</th>
<th>Saunders Field House</th>
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</thead>
<tbody>
<tr>
<td>GSF Area</td>
<td>125,877 GSF</td>
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<td></td>
<td><strong>Elec'.' - kWh</strong></td>
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<td>January-March</td>
<td>247,140</td>
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<td>April</td>
<td>65,904</td>
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<tr>
<td>May</td>
<td>61,785</td>
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<tr>
<td>June</td>
<td>74,142</td>
</tr>
<tr>
<td>July</td>
<td>98,856</td>
</tr>
<tr>
<td>August</td>
<td>94,737</td>
</tr>
<tr>
<td>September</td>
<td>74,142</td>
</tr>
<tr>
<td>October</td>
<td>82,380</td>
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<tr>
<td>November</td>
<td>82,380</td>
</tr>
<tr>
<td>December</td>
<td>82,380</td>
</tr>
<tr>
<td><strong>Annual Usage</strong></td>
<td><strong>963,846</strong></td>
</tr>
</tbody>
</table>

**Energy Usage Index, (EUI):**
- **963,846** Electric Use per year, kWh
- **56,742** Gas Use per year, CCF
- **125,877** Facility Size, GSF
- **62.29** EUI in kBtu/SF-yr.

**EUI Reference Benchmarks:**
- 94 Assembly
- 138 Library
- 155 College and University Buildings
- 102 Office > 50,000 GSF
- 69/64 Residential: with and without A/C

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**Notes:**

1. Electrical and Gas Usage for the months of January and February reflect the data obtained from the MSC Meter Usage Summary Report for the period between 1/1/2009 through 4/1/2009.

2. Electrical and Gas usage for the months of April through December have been extrapolated from the metered data on the basis of heating and cooling degree days for Grand Junction, Colorado.
SAUNDERS FIELD HOUSE - UPPER ROOF
1/32" = 1'-0"
SAUNDERS FIELD HOUSE - UPPER ROOF

A Useable Roof Area for Photovoltaic Systems 25,330 sf
B Estimated Feasible KW_{DC,STC} 250 KW
C Maximum Permitted by Electrical Capacity 219 KW
SAUNDERS FIELD HOUSE

Saunders Field House was categorized into two roof areas:
- The original 1960’s Building (Upper Roof) has action items before being PV Ready.
- The 1996 Addition (Lower Roof) is recommended to be PV Ready.

Existing Roof Condition and Recommendation:

Original 1960’s Building (Upper Roof): The Upper Roof at Saunders Field House is a Modified Bitumen System (MB). Mesa State College was not able to determine the age of the existing roof. Modified Bitumen Roof Systems have a typical lifespan of 18-25 years. Based on a visual inspection and walk-through with MSC Facilities, it was determined the MB Roof System is in the final stages of its life expectancy. It is recommended the Roof System be replaced before the installation of PV occurs.

1996 Addition (Lower Roof):

The Lower Roof at Saunders Field House is a Single Ply EPDM with Ballast System. Information received from Mesa State College indicates the age of the roof to be about 13 years. The roof system is the original assembly from when the building was constructed. Based on a typical lifespan of 20-30 years, this roof is sufficient for a PV installation.

A visual inspection with MSC Facilities determined there are no roof leaks or maintenance items that need to be addressed, on the Lower Roof.

Structural Evaluation:

Original 1960’s Structure: Long-Span Fabricated Steel Trusses with 2” Tectum Roof Deck.

Photovoltaic (PV) Assessment: The existing roof system has 6 to 7 pounds per square foot (psf) of additional capacity for a ballasted PV installation. A tilt-mount PV system would be difficult
to install without additional structural members or possible reinforcement of the existing structure.

1996 Addition: A combination of long span truss with steel wide-flange purlins and open web steel joist spanning between exterior and interior steel beams.

PV Assessment: The existing roof system supports a ballasted stone roof. Assuming the ballasted stone will be removed and replaced with a ballasted PV installation, the roof system has 12 psf of additional capacity. A tilt-mount PV system would be difficult to install without additional structural members or possible reinforcing of the existing structure.

Electrical Evaluation:

Saunders – Upper Roof: Limited by electrical capacity to maximum of 219 kW PV array. There is a set of questions to be answered before we can confirm a PV array of 219 kW can be installed on the upper roof.

1. 1-line diagram we have received does not match what was observed in the field. We need to confirm what service entrances to the building are going to be available and what final size transformer is going to be installed.
2. There is a question on Ground-fault Protection devices being rated to accept PV backfeed.
3. Room for additional fused disconnect for the PV needs to exist in Main Disconnect Panel.

If service entrance to existing building of 1200A is fed directly from the existing 15.5kV transformer and the new 1600A service is fed separately from the same transformer, there is capacity for 219 kW array on the upper roof.

Saunders – Lower Roof: 145 kW, limited by roof area
Electrical service capacity is sufficient for 146 kW array
Electrical Assumptions:

- 1200A service, 480V, 3φ, 4 W in existing building
- Maximum fused disconnect size is then 200A
- Inverter size is limited to 160A, 132.9 kW
- PV array max size is 146.2 kW
### Monthly Data

<table>
<thead>
<tr>
<th>Monthly Data</th>
<th>Houston Hall</th>
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<tr>
<td>GSF Area</td>
<td>71,250 GSF</td>
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<td>Elect'.' - kWh</td>
<td>306,699</td>
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<tr>
<td>Gas - CCF</td>
<td>28,516</td>
</tr>
<tr>
<td>January-March</td>
<td>306,699</td>
</tr>
<tr>
<td>April</td>
<td>81,786</td>
</tr>
<tr>
<td>May</td>
<td>76,675</td>
</tr>
<tr>
<td>June</td>
<td>92,010</td>
</tr>
<tr>
<td>July</td>
<td>122,680</td>
</tr>
<tr>
<td>August</td>
<td>117,568</td>
</tr>
<tr>
<td>September</td>
<td>92,010</td>
</tr>
<tr>
<td>October</td>
<td>102,233</td>
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<tr>
<td>November</td>
<td>102,233</td>
</tr>
<tr>
<td>December</td>
<td>102,233</td>
</tr>
<tr>
<td><strong>Annual Usage</strong></td>
<td><strong>1,196,126</strong></td>
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<tr>
<td><strong>160.01 EUI in kBtu/SF-yr.</strong></td>
<td></td>
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</tbody>
</table>

### Energy Usage Index, (EUI):

- Electric Use per year, kWh: 1,196,126
- Gas Use per year, CCF: 91,251
- Facility Size, GSF: 71,250

**EUI Reference Benchmarks:**

- 94 Assembly
- 138 Library
- 155 College and University Buildings
- 102 Office > 50,000 GSF

### Notes:

1. Electrical and Gas Usage for the months of January and February reflect the data obtained from the MSC Meter Usage Summary Report for the period between 1/1/2009 through 4/1/2009.

2. Electrical and Gas usage for the months of April through December have been extrapolated from the metered data on the basis of heating and cooling degree days for Grand Junction, Colorado.
A. Useable Roof Area for Photovoltaic Systems: 10,000 sf
B. Estimated Feasible $\text{KW}_{\text{DC STC}}$: 100 kW
Houston Hall is recommended to be PV Ready.

Existing Roof Condition and Recommendation

Houston Hall is a Single Ply Membrane EPDM System. Information received from Mesa State College indicate the age of the roof to be about 6 years. The roof was completely replaced in 2003. Based on a typical lifespan of 20-30 years, this roof is in its early stages and is sufficient for PV installation.

A visual inspection with MSC Facilities determined there are no roof leaks or maintenance items that need to be addressed.

Structural Evaluation

Original 1939 Structure: Sawn Wood 2x rafters at 16” and 4x and 6x rafters at 6’-0 spanning between exterior concrete masonry wall and steel fabricated truss.

PV Assessment: In all cases the framing indicates 5 to 7 psf of additional load capacity for a ballasted PV installation. A tilt-mount PV system is possible but will likely require additional reinforcing of the existing structure and/or additional structural members.

Electrical Evaluation

100 kW PV Array, limited by roof area

Electrical service capacity is sufficient for 146.2 kW array.

Electrical Assumptions:

- 1200A service, 480V, 3φ, 4 W in existing building
- Maximum fused disconnect size is then 200A
- Inverter size is limited to 160A, 132.9 kW
- PV array max size is 146.2 kW
Monument Residence Hall from South

Looking West

Monument Residence Hall from North
Assessment No. 1
Mesa State College - Campus Wide Solar Initiative

Monument Residence Hall
Energy Use Index Analysis

<table>
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<tr>
<td>GSF Area</td>
<td>46,695 GSF</td>
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<td><strong>Elec'l. - kWh</strong></td>
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<td>70,038</td>
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<tr>
<td>April</td>
<td>18,677</td>
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<tr>
<td>May</td>
<td>17,510</td>
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<tr>
<td>June</td>
<td>21,011</td>
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<td>July</td>
<td>28,015</td>
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<td>August</td>
<td>26,848</td>
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<td>September</td>
<td>21,011</td>
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<td>October</td>
<td>23,346</td>
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<tr>
<td>November</td>
<td>23,346</td>
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<tr>
<td>December</td>
<td>23,346</td>
</tr>
<tr>
<td><strong>Annual Usage</strong></td>
<td>273,148</td>
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</tbody>
</table>

| **Gas - CCF**    |                        |
| January-March    | 6,459                   |
| April            | 1,722                   |
| May              | 1,292                   |
| June             | 969                     |
| July             | 754                     |
| August           | 754                     |
| September        | 1,615                   |
| October          | 2,153                   |
| November         | 2,368                   |
| December         | 2,584                   |
| **Annual Usage** | 20,669                  |

**Energy Usage Index, (EUI):**

- 273,148 Electric Use per year, kWh
- 20,669 Gas Use per year, CCF
- 46,695 Facility Size, GSF
- **55.46** EUI in kBtu/SF-yr.

**EUI Reference Benchmarks:**
- 94 Assembly
- 138 Library
- 155 College and University Buildings
- 102 Office > 50,000 GSF
- 69/64 Residential: with and without A/C

**Notes:**

1. Electrical and Gas Usage for the months of January and February reflect the data obtained from the MSC Meter Usage Summary Report for the period between 1/1/2009 through 4/1/2009.

2. Electrical and Gas usage for the months of April through December have been extrapolated from the metered data on the basis of heating and cooling degree days for Grand Junction, Colorado.
MONUMENT RESIDENCE HALL

1/32" = 1'-0"

A  Useable Roof Area for Photovoltaic Systems  6,305 sf
B  Estimated Feasible KW_{DC STC}  63 kW
MONUMENT RESIDENCE HALL

Monument Residence Hall is recommended to be PV Ready.

Existing Roof Condition and Recommendation

Monument Residence Hall is a Single Ply Membrane EPDM System with a ballasted stone roof. Information received from Mesa State College indicate the age of the roof to be about 13 years. The roof system is the original assembly from when the building was constructed in 1996. Based on a typical lifespan of 20-30 years, this roof is sufficient for PV installation.

A visual inspection with MSC Facilities determined there are no roof leaks or maintenance items that need to be addressed.

Structural Evaluation

Original 1996 Structure: Open-web steel joist spanning between exterior bearing wall and interior steel girders.

PV Assessment: The existing roof system supports a ballasted stone roof. Assuming the ballasted stone will be removed and replaced with a ballasted PV installation, the roof system has 12 psf of additional capacity. A tilt-mount PV system would be difficult to install without additional structural members or possible reinforcement of the existing structure.

Electrical Evaluation

63 kW array, limited by roof area and electrical capacity
Electrical service capacity is sufficient for 63.3 kW array

Electrical Assumptions:

- 1600A service, 208V, 3ϕ, 4 W in existing building
- Maximum fused disconnect size is then 300A
- Inverter size is limited to 240A, 86.4 kW
- PV array max size is 95.0 kW
Assessment No. 1  
Mesa State College - Campus Wide Solar Initiative  
Tomlinson Library  
Energy Usage Index Analysis

<table>
<thead>
<tr>
<th>Monthly Data</th>
<th>Tomlinson Library</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSF Area</td>
<td>68,793 GSF</td>
</tr>
<tr>
<td>Elect' - kWh</td>
<td>751,511 kWh</td>
</tr>
<tr>
<td>Gas - CCF</td>
<td>0 CCF</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th></th>
<th>January-March</th>
<th>April</th>
<th>May</th>
<th>June</th>
<th>July</th>
<th>August</th>
<th>September</th>
<th>October</th>
<th>November</th>
<th>December</th>
<th>Annual Usage</th>
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<tbody>
<tr>
<td>GSF Area</td>
<td>68,793</td>
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<td></td>
<td></td>
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<td></td>
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<td></td>
<td>751,511</td>
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<tr>
<td>Elect'</td>
<td>181,087</td>
<td>54,326</td>
<td>48,290</td>
<td>60,362</td>
<td>72,435</td>
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<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>0</td>
</tr>
</tbody>
</table>

**EUI Reference Benchmarks:**
- 94 Assembly
- 138 Library
- 155 College and University Buildings
- 102 Office > 50,000 GSF
- 69/64 Residential: with and without A/C

**EUI in kBtu/SF-yr.**

37.28 kWh

**Notes:**
1. Electrical Usage for the months of January and February reflect the data obtained from the MSC Meter Usage Summary Report for the period between 1/1/2009 through 4/1/2009.
2. Electrical usage for the months of April through December have been extrapolated from the metered data on the basis of heating and cooling degree days for Grand Junction, Colorado.
A Useable Roof Area for Photovoltaic Systems 5,470 sf
B Estimated Feasible $K_{DC\, stc}$ 54 kW
A Useable Roof Area for Photovoltaic Systems  
B Estimated Feasible KW_{DC STC}  

5,470 sf  
54 KW
4 TOMLINSON LIBRARY

Tomlinson Library has action items before being PV Ready.

Existing Roof Condition and Recommendation

Tomlinson Library is a 3-Ply Built-up System. Information received from Mesa State College indicate the age of the roof to be about 24 years. The roof system is the original assembly from when the building was constructed in 1985. Based on a typical lifespan of 15-25 years, a roof replacement is recommended before a PV installation occurs.

Structural Evaluation


PV Assessment: The existing roof system has an additional capacity of 8 psf of additional load capacity for a ballasted PV installation. A tilt-mount PV installation is a possibility, but a better understanding of the racking system and its location would be required.

Electrical Evaluation

54 kW PV Array, limited by roof area
Electrical service capacity is sufficient for 219.2 kW array.

Electrical Assumptions:

- 1600A service, 480V, 3φ, 4 W in existing building
- Maximum fused disconnect size is then 300A
- Inverter size is limited to 240A, 199.3 kW
- PV array max size is 219.2 kW
Assessment No. 1
Mesa State College - Campus Wide Solar Initiative
Lowell Heiny Hall
Energy Use Index Analysis

Monthly Data

<table>
<thead>
<tr>
<th></th>
<th>Lowell Heiny Hall</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSF Area</td>
<td>41,238 GSF</td>
</tr>
</tbody>
</table>

**Elec'l. kWh** | **Gas - CCF**  
January-March   | 78,793  | 8,125  
April           | 21,011  | 2,167  
May             | 19,698  | 1,625  
June            | 23,638  | 1,219  
July            | 31,517  | 948    
August          | 30,204  | 948    
September       | 23,638  | 2,031  
October         | 26,264  | 2,708  
November        | 26,264  | 2,979  
December        | 26,264  | 3,250  
Annual Usage    | 307,293 | 26,000 |

Energy Usage Index, (EUI):

- 76.00 EUI in kBtu/SF-yr.

EUI Reference Benchmarks:
- 94 Assembly
- 138 Library
- 155 College and University Buildings
- 102 Office > 50,000 GSF

Notes:

1. Electrical and Gas Usage for the months of January and February reflect the data obtained from the MSC Meter Usage Summary Report for the period between 1/1/2009 through 4/1/2009.
2. Electrical and Gas usage for the months of April through December have been extrapolated from the metered data on the basis of heating and cooling degree days for Grand Junction, Colorado.
A  Useable Roof Area for Photovoltaic Systems  4,828 sf
B  Estimated Feasible KW_{DC \text{ STC}}  48 KW
Lowell Heiny is recommended to be PV Ready.

Existing Roof Condition and Recommendation

Lowell Heiny Hall is a Single Ply Membrane EPDM System with a ballasted stone roof. Information received from Mesa State College indicate the age of the roof to be about 16 years. The roof was replaced in 1993. Based on a typical lifespan of 20-30 years, this roof is sufficient for PV installation.

A visual inspection with MSC Facilities determined there are no roof leaks or maintenance items that need to be addressed.

Structural Evaluation

Original 1966 Structure: The low roof is an 8-inch thick post tensioned concrete lift slab. The upper roof is a 1 ½” deep 22 gauge roof deck on Penmetal 1000 J14 and J15 steel joist.

PV Assessment: The existing roof system supports a ballasted stone roof. Assuming the ballasted stone will be removed and replaced with a ballasted PV installation, the roof system has 12 psf of additional capacity. A tilt-mount PV system would be difficult to attach to the existing structure without the possibility of damaging the post tension strands. Furthermore, reinforcing the steel joist in the upper roof will require additional structural members or possible reinforcing of the existing structure.

Electrical Evaluation

48 kW PV Array, limited by roof area
Electrical service capacity is sufficient for 146 kW array.

Electrical Assumptions:
- 1200A service, 208, 3φ, 4 W in existing building
- Maximum fused disconnect size is then 200A
- Inverter size is limited to 160A, 57.6 kW
- PV array max size is 63.3 kW
<table>
<thead>
<tr>
<th>Monthly Data</th>
<th>Pinon Residence Hall</th>
</tr>
</thead>
<tbody>
<tr>
<td>GSF Area</td>
<td>42,507 GSF</td>
</tr>
<tr>
<td><strong>Elec’l. - kWh</strong></td>
<td><strong>Gas - CCF</strong></td>
</tr>
<tr>
<td>January-March</td>
<td>78,795</td>
</tr>
<tr>
<td>April</td>
<td>21,012</td>
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<tr>
<td>May</td>
<td>19,699</td>
</tr>
<tr>
<td>June</td>
<td>23,639</td>
</tr>
<tr>
<td>July</td>
<td>31,518</td>
</tr>
<tr>
<td>August</td>
<td>30,205</td>
</tr>
<tr>
<td>September</td>
<td>23,639</td>
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<tr>
<td>October</td>
<td>26,265</td>
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<td>November</td>
<td>26,265</td>
</tr>
<tr>
<td>December</td>
<td>26,265</td>
</tr>
<tr>
<td><strong>Annual Usage</strong></td>
<td><strong>307,301</strong></td>
</tr>
</tbody>
</table>

**Energy Usage Index, (EUI):**
- 307,301 Electric Use per year, kWh
- 29,933 Gas Use per year, CCF
- 42,507 Facility Size, GSF
- **81.15 EUI in kBtu/SF-yr.**

**EUI Reference Benchmarks:**
- 94 Assembly
- 138 Library
- 155 College and University Buildings
- 102 Office > 50,000 GSF
- 69/64 Residential: with and without A/C

**Notes:**
1. Electrical and Gas Usage for the months of January and February reflect the data obtained from the MSC Meter Usage Summary Report for the period between 1/1/2009 through 4/1/2009.
2. Electrical and Gas usage for the months of April through December have been extrapolated from the metered data on the basis of heating and cooling degree days for Grand Junction, Colorado.
PINON RESIDENCE HALL

Pinon Residence Hall has action items before being PV Ready.

Existing Roof Condition and Recommendation

Pinon Residence Hall is a Single Ply Membrane EPDM System with a Ballasted Stone Roof. Information received from Mesa State College indicate the age of the roof to be about 20 years. The roof was replaced in 1989. Based on a typical lifespan of 20-30 years, this roof is recommended to be replaced before a PV installation occurs.

A visual inspection with MSC Facilities determined there are no roof leaks or maintenance items that need to be addressed.

Structural Evaluation

Original 1966 Structure: The low roof is a 6-inch thick post tensioned concrete lift slab. The upper roof is a single span 6” deep metal deck.

PV Assessment: The existing low roof system supports a ballasted stone roof. Assuming the ballasted stone will be removed and replaced with a ballasted PV installation, the roof system has 12 psf of additional capacity. A tilt-mount PV system would be difficult to attach to the existing structure without the possibility of damaging the post tension strands. The upper roof has an 8 psf capacity for a ballasted PV installation. A tilt-mount system would be difficult to connect to the existing metal deck without additional framing.

Electrical Evaluation

29 kW PV Array, limited by roof area
Electrical service capacity is sufficient for 63.3 kW array.
Electrical Assumptions:
- 1000A service, 208V, 3φ, 4 W in existing building
- Maximum fused disconnect size is then 200A
- Inverter size is limited to 160A, 57.6 kW
- PV array max size is 63.3 kW
Monthly Data

<table>
<thead>
<tr>
<th></th>
<th>Tolman Residence Hall</th>
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</thead>
<tbody>
<tr>
<td>GSF Area</td>
<td>44,178 GSF</td>
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<tr>
<td><strong>Elec’l. - kWh</strong></td>
<td>77,738</td>
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<td><strong>Gas - CCF</strong></td>
<td>5,587</td>
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<tr>
<td>January-March</td>
<td>20,730 1,490</td>
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<tr>
<td>April</td>
<td>19,435 1,117</td>
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<tr>
<td>May</td>
<td>23,321 838</td>
</tr>
<tr>
<td>July</td>
<td>31,095 652</td>
</tr>
<tr>
<td>August</td>
<td>29,800 652</td>
</tr>
<tr>
<td>September</td>
<td>23,321 1,397</td>
</tr>
<tr>
<td>October</td>
<td>25,913 1,862</td>
</tr>
<tr>
<td>November</td>
<td>25,913 2,049</td>
</tr>
<tr>
<td>December</td>
<td>25,913 2,235</td>
</tr>
<tr>
<td><strong>Annual Usage</strong></td>
<td>303,178 17,878</td>
</tr>
</tbody>
</table>

EUI Reference Benchmarks:
- 94 Assembly
- 138 Library
- 155 College and University Buildings
- 102 Office > 50,000 GSF
- 69/64 Residential: with and without A/C

Notes:
1. Electrical and Gas Usage for the months of January and February reflect the data obtained from the MSC Meter Usage Summary Report for the period between 1/1/2009 through 4/1/2009.
2. Electrical and Gas usage for the months of April through December have been extrapolated from the metered data on the basis of heating and cooling degree days for Grand Junction, Colorado.
A  Useable Roof Area for Photovoltaic Systems  2,910 sf  
B  Estimated Feasible $K_{W_{DC \, STC}}$  29 kW
TOLMAN RESIDENCE HALL

Tolman Residence Hall was recommended to be PV Ready.

Existing Roof Condition and Recommendation

Tolman Residence Hall is a Single Ply Membrane EPDM System with a Ballasted Stone Roof. Mesa State has indicated this roof is scheduled and approved for replacement. Based on this info this Roof is sufficient for PV installation.

Structural Evaluation

Original 1966 Structure: The low roof is a 6-inch thick post tensioned concrete lift slab. The upper roof is a single span 6” deep metal deck.

PV Assessment: The existing low roof system supports a ballasted stone roof. Assuming the ballasted stone will be removed and replaced with a ballasted PV installation, the roof system has 12 psf of additional capacity. A tilt-mount PV system would be difficult to attach to the existing structure without the possibility of damaging the post tension strands. The upper roof has an 8 psf capacity for a ballasted PV installation. A tilt-mount system would be difficult to connect to the existing metal deck without additional framing.

Electrical Evaluation

29 kW PV Array, limited by roof area
Electrical service capacity is sufficient for 63.3 kW array.

Electrical Assumptions:

- 1000A service, 208V, 3φ, 4 W in existing building
- Maximum fused disconnect size is then 200A
- Inverter size is limited to 160A, 57.6 kW
- PV array max size is 63.3 kW
**Assessment No. 1**  
**Mesa State College - Campus Wide Solar Initiative**  
**Rait Hall Energy Usage Index Analysis**

<table>
<thead>
<tr>
<th>Monthly Data</th>
<th>Rait Hall</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>GSF Area</strong></td>
<td>42,883 GSF</td>
</tr>
<tr>
<td><strong>Elec'. - kWh</strong></td>
<td>313,225</td>
</tr>
<tr>
<td><strong>Gas - CCF</strong></td>
<td>42,883 Facility Size, GSF</td>
</tr>
</tbody>
</table>

**January-March**  
- **Elec'. - kWh**: 80,314
- **Gas - CCF**: 11,675

**April**  
- **Elec'. - kWh**: 21,417
- **Gas - CCF**: 3,113

**May**  
- **Elec'. - kWh**: 20,079
- **Gas - CCF**: 2,335

**June**  
- **Elec'. - kWh**: 24,094
- **Gas - CCF**: 1,751

**July**  
- **Elec'. - kWh**: 32,126
- **Gas - CCF**: 1,362

**August**  
- **Elec'. - kWh**: 30,787
- **Gas - CCF**: 1,362

**September**  
- **Elec'. - kWh**: 24,094
- **Gas - CCF**: 2,919

**October**  
- **Elec'. - kWh**: 26,771
- **Gas - CCF**: 3,892

**November**  
- **Elec'. - kWh**: 26,771
- **Gas - CCF**: 4,281

**December**  
- **Elec'. - kWh**: 26,771
- **Gas - CCF**: 4,670

**Annual Usage**  
- **Elec'. - kWh**: 313,225
- **Gas - CCF**: 37,360

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**Notes:**

1. Electrical and Gas Usage for the months of January and February reflect the data obtained from the MSC Meter Usage Summary Report for the period between 1/1/2009 through 4/1/2009.

2. Electrical and Gas usage for the months of April through December have been extrapolated from the metered data on the basis of heating and cooling degree days for Grand Junction, Colorado.
A  Useable Roof Area for Photovoltaic Systems  2,985 sf
B  Estimated Feasible $KW_{DC \, STC}$  29 kW
RAIT RESIDENCE HALL

Rait Residence Hall was recommended to be PV Ready.

Existing Roof Condition and Recommendation

Rait Residence Hall is a Single Ply Membrane EPDM System with a Ballasted Stone Roof. Mesa State has indicated this roof is scheduled and approved for replacement. Based on this info this Roof is sufficient for PV installation.

Structural Evaluation

Original 1966 Structure:  The low roof is a 6-inch thick post tensioned concrete lift slab. The upper roof is a single span 6” deep metal deck.

PV Assessment:  The existing low roof system supports a ballasted stone roof. Assuming the ballasted stone will be removed and replaced with a ballasted PV installation, the roof system has 12 psf of additional capacity. A tilt-mount PV system would be difficult to attach to the existing structure without the possibility of damaging the post tension strands. The upper roof has an 8 psf capacity for a ballasted PV installation. A tilt-mount system would be difficult to connect to the existing metal deck without additional framing.

Electrical Evaluation

29 kW PV Array, limited by roof area
Electrical service capacity is sufficient for 63.3 kW array.

Electrical Assumptions:

- 1000A service, 208V, 3φ, 4 W in existing building
- Maximum fused disconnect size is then 200A
- Inverter size is limited to 160A, 57.6 kW
- PV array max size is 63.3 kW