Sustainable Transit Facilities

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1. What Makes Transit Facilities Unique?
2. What Makes Transit Facilities Green?
3. Case Studies
4. Green Transit Best Practices
What makes transit facilities unique?
Sustainable Communities
Large and Remote Sites
Urban Heat Island, Access to Public Transit, Stormwater
Industrial Building Construction
Wall and Roof R-Values, Overhead Doors, Durability
Indoor Environmental Quality
Air Quality, Daylighting
Energy
Historically Daylit
Operations

Fueling Stations, Fuel Tanks, Wash Bays
Energy
Office vs. Maintenance Building Use
Workplace
A place for people - not just equipment
<table>
<thead>
<tr>
<th>Certification</th>
<th>Count</th>
</tr>
</thead>
<tbody>
<tr>
<td>LEED-NC</td>
<td>435</td>
</tr>
<tr>
<td>LEED-CS</td>
<td>29</td>
</tr>
<tr>
<td>LEED-EB</td>
<td>20</td>
</tr>
<tr>
<td>LEED-CI</td>
<td>10</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>494 (out of 28,062)</strong></td>
</tr>
</tbody>
</table>
California LEED Certified Projects

Gardena Transit Administration Facility
Gardena Municipal Bus Lines, Gardena, LEED NC Silver

MacArthur BART Transit Village MTCP, LLC, Oakland, LEED ND 1.0 Pilot Gold

Santa Clarita Transit Maintenance Facility,
City of Santa Clarita, Santa Clarita, LEED NC Gold

MTA Transportation Building DI, Los Angeles County Metropolitan, El Monte, LEED NC Gold
What makes transit facilities green?
Triple Bottom Line

- Environment
- People
- Economics
Design for One Earth
Establish Performance Based Targets

Energy
Carbon
Water
Materials / Waste
LEED Green Building Rating System

- Sustainable Sites
- Water Efficiency
- Energy & Atmosphere
- Materials & Resources
- Indoor Environmental Quality
- Innovation in Design
- Regional Priority
## LEED Green Building Rating System

<table>
<thead>
<tr>
<th>Building Type</th>
<th>Lifecycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Homes</td>
<td>Design</td>
</tr>
<tr>
<td>Neighborhood Development (in pilot)</td>
<td>Construction</td>
</tr>
<tr>
<td>Commercial Interiors</td>
<td>Operations</td>
</tr>
<tr>
<td>Core &amp; Shell</td>
<td></td>
</tr>
<tr>
<td>New Construction</td>
<td></td>
</tr>
<tr>
<td>Schools, Healthcare, Retail</td>
<td></td>
</tr>
<tr>
<td>Existing Buildings Operations &amp; Maintenance</td>
<td></td>
</tr>
</tbody>
</table>
LEED Green Building Rating System
LEED Green Building Rating System

1. Holistic Approach
2. Performance Based
3. Integrated Process
4. Third Party Verified
Procurement Methods
New Buildings, Major Renovations

Set Performance Objectives
• LEED
• Energy target
• Other green building targets

Integrate the Team
• Performance Based Design Build
• Integrated Project Delivery (IPD)
• Award Incentives
Existing Facilities

Energy Audits / Retrocommissioning

• Walk thru audit
• Detailed audit
• Retro or Re-commissioning
• Sustainability audit
Existing Facilities
Performance Contracting

Energy savings typically 15 – 30%
Existing Facilities

ENERGY STAR and LEED EBOM

• ENERGY STAR: energy bills, ventilation, lighting
• LEED-EBOM: utility bills, policies, procedures, maintenance, grounds, janitorial
CALIFORNIA
Incentives/Policies for Renewables & Efficiency

- See Federal Incentives
- See All Summaries
- See Residential Incentives Only

Financial Incentives

Green Building Incentive
- Marin County - Green Building Incentive Program
- San Bernardino County - Green Building Incentive
- San Diego County - Green Building Program
- Santa Monica - Building Permit Fee Waiver for Solar Projects
- Santa Monica - Expedited Permitting for Green Buildings

Industry Recruitment/Support
- Sales Tax Exemption for Alternative Energy Manufacturing Equipment

Leasing Program
- Santa Clara Water & Sewer - Solar Water Heating Program

Local Loan Program
- Palm Desert - Energy Independence Program
- San Francisco - GreenFinanceSF
- Sonoma County - Energy Independence Program
California will receive billions in Recovery Act funds to repair and improve our state’s transportation system, create jobs and stimulate economic growth. California will receive funds to rebuild and repair highways, local streets and roads, as well as numerous transit projects. California is also eligible to apply for billions in competitive funding for high speed and intercity rail, surface transportation projects, aviation and AMTRAK, new starts, transit, ferries and other programs; California is positioning itself to receive a large portion of funds for high speed rail, which will supplement the $10 billion voters approved in November 2008 to jumpstart high speed rail, create jobs and clean up the environment in California.

Governor Schwarzenegger is a strong advocate for infrastructure investment as it is one of the best ways to create and sustain jobs, stimulate economic development, and leave a legacy to support the financial well-being of the generations to come.

Transportation Funds Distribution Graph

- **Estimated**: $4,099.1
- **Awarded**: $3,739.1
- **Expended**: $699.9

Note: The above dollar amounts are in millions. The above graph depicts a snapshot of the distribution of federal recovery funds allocated to the state of California. The actual dollar amounts will vary as recovery dollars move from an estimate by the Federal Government to the actual amount awarded to California and eventually made available to the state.
Case Studies
VVTA
Hesperia, CA

Bus Administration, Operations, and Maintenance Facility
• Pursuing two LEED Golds
• 17% / 37% Energy cost savings in Admin vs Maint
• 40%+ indoor water savings
• 50%+ outdoor water savings
• 90%+ views
- Underfloor air distribution
- 1 MW photovoltaic system
- Stormwater management
- Native and xeric plants
• Pursuing 2 LEED Golds
• 35% / 41%+ energy cost savings in Shop-Warehouse vs Fleet-Maint.
• 40%/50%+ indoor/outdoor water usage savings
• 95%+ construction waste recycling
Central Platte Campus
Denver, CO

- Photovoltaics through a PPA
- Sawtooth roof design
- Evaporative cooling (no refrigerants)
- Heat recovery
TRANSPO
South Bend, IN

Bus Administration, Operations, and Maintenance Facility
Pursuing LEED Platinum
28% energy savings
30%+ water use reduction
75%+ construction waste diversion
- Ground source heat pumps
- Radiant slabs
- Brownfield remediation
- Bioremediation of stormwater
- Super insulated envelope
East Valley Bus Maintenance
Tempe, AZ

Bus Operations, and Maintenance Facility
East Valley Bus Maintenance
Tempe, AZ

- LEED-NC Gold (Office and Maintenance)
- 98% Construction waste diversion
- 53% Energy savings
- 30%+ Water use reduction
• Underfloor air delivery
• Daylighting / clerestories / sensors
• Dual flush WC / waterless urinals
• Operable windows
• Bus parking shade canopies
LA Metro Division 13
Los Angeles, CA

• Pursuing LEED Gold
• 50%+ Irrigation water reduction
• 30%+ water use reduction
• High indoor environmental quality
LA Metro Division 13
Los Angeles, CA

• Green roof
• Rainwater harvesting
• Public transportation access
• BIPV on façade
• Public use green fueling station
El Monte Station
El Monte, CA

• Pursuing LEED-NC Gold
• 57% water use reduction
• 21% energy savings
• 2% On-site Renewable Energy
El Monte Station
El Monte, CA

- Maximize open space (25%)
- Water efficient landscaping
- Vegetated walls for sound control
- Cool roofs / High albedo paving
Urban Heat Island

Cool Roofs, High Albedo Paving, Shading, Vegetation

- Cool Roofs
- Shade Canopies
- Shade Trees
- Pervious Paving
- High Albedo Paving
Stormwater Management

Bioswales, Constructed Wetlands, On-site Retention
Stormwater Management
Rainwater Harvest, Green Roof, Pervious Paving
Low Flow Fixtures, Water Re-use, Wash Bays

Source: Interclean

Source: Caroma
Green Materials

Recycled, Regional. Low Emitting, Certified Wood

- Recycled Content
- Regional Material
- Certified Wood
- Low VOC finishes
### Central Platte Campus

#### 4/16/2009

**LEED GOALS:**
- Recycled Content: 10-20%
- Regional Materials: 20%
- Rapidly Renewable: Up to 2.5%
- Certified Wood: 50% (of total wood)
- Low-Emitting: All
- Water Efficiency: 30%
- Energy Efficiency: 28%

#### SUSTAINABLE PROPERTIES

<table>
<thead>
<tr>
<th>SITE</th>
<th>RECYCLED CONTENT</th>
<th>REGIONAL</th>
<th>RAPIDLY RENEWABLE</th>
<th>CERTIFIED WOOD</th>
<th>LOW EMITTING</th>
<th>EFFICIENCY</th>
</tr>
</thead>
<tbody>
<tr>
<td>PAVING- ASPHALT</td>
<td>X</td>
<td>X</td>
<td></td>
<td></td>
<td></td>
<td></td>
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<tr>
<td>PAVING- CONCRETE</td>
<td>X</td>
<td>X</td>
<td></td>
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<tr>
<td>PAVING- DECOMPOSED GRANITE - CRUSH FINES</td>
<td>X</td>
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<tr>
<td>EROSION CONTROL</td>
<td>X</td>
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<tr>
<td>SITE FURNISHINGS- GENERAL</td>
<td>X</td>
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<tr>
<td>SITE FURNISHINGS- BIKE RACK</td>
<td>X</td>
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<td></td>
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</tr>
</tbody>
</table>

Regional and recycled content materials to be given preference.

20% flyash by weight in concrete. Recycled aggregate: up to 100% (Confirm with structural engineer). Source regionally.

Products available regionally to be given preference.

Regional and recycled content products to be given preference. Rapidly renewable products to be given preference when available regionally.

Highest recycled content to be given preference.

67-75% recycled content. Highest recycled content to be given preference.
Energy
California’s Climate

- Diversity of climate conditions
- Heating and cooling systems
- Building envelope strategies
Average Site EUI (kBtu/sf/year)

Vehicle Maintenance Buildings  27 to 101
Office Buildings     58 to 143
Storage Buildings    16 to 60

Source: National Renewable Energy Laboratory
Energy

Setting an Energy Goal

- Energy Star
- 2030 Challenge
Energy

Office vs. Maintenance Building Use

Admin/Operations Building
65 kBtu/sf/yr

vs.

Maintenance Building
120 kBtu/sf/yr
- Select lowest life cycle measures
- Optimize building prior to building footprint
- Select major mechanical systems

<table>
<thead>
<tr>
<th>EEM</th>
<th>Initial Cost</th>
<th>Life Cycle Cost (PV)</th>
<th>% Change</th>
</tr>
</thead>
<tbody>
<tr>
<td>E1 Daylighting Based Lighting Control</td>
<td>$12,450</td>
<td>$1,015,998</td>
<td>10.4%</td>
</tr>
<tr>
<td>E2 Occupancy Based Lighting Control</td>
<td>$9,000</td>
<td>$1,081,891</td>
<td>4.6%</td>
</tr>
<tr>
<td>M1 Evaporative Cooling</td>
<td>$20,400</td>
<td>$1,090,746</td>
<td>3.9%</td>
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<tr>
<td>Design Case</td>
<td>$0</td>
<td>$1,134,475</td>
<td>0.0%</td>
</tr>
<tr>
<td>A1d Shading: Boardroom</td>
<td>$4,320</td>
<td>$1,138,414</td>
<td>-0.3%</td>
</tr>
<tr>
<td>A2a Wall Insulation</td>
<td>$11,512</td>
<td>$1,138,562</td>
<td>-0.4%</td>
</tr>
<tr>
<td>A2b Roof Insulation</td>
<td>$26,406</td>
<td>$1,154,168</td>
<td>-1.7%</td>
</tr>
<tr>
<td>A3a Glazing: Solarban 70 XL</td>
<td>$22,995</td>
<td>$1,154,607</td>
<td>-1.8%</td>
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</tbody>
</table>
## Energy

### Building Envelope and Insulation

<table>
<thead>
<tr>
<th>Wall Type</th>
<th>Total R-Value</th>
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<tbody>
<tr>
<td>Baseline steel framed</td>
<td>11.9</td>
</tr>
<tr>
<td>Insulated stud wall</td>
<td>19.1</td>
</tr>
<tr>
<td>Un-insulated tilt up wall</td>
<td>1.7</td>
</tr>
<tr>
<td>Insulated tilt up wall</td>
<td>13.1</td>
</tr>
</tbody>
</table>

Source: Thermomass
Energy Daylighting

Source: Solatube

Source: Sunoptics
• Glazed bay doors
• Photosensors
• Multiple switches per bay
• Glazing per orientation and height
Energy Daylighting

Skylights or Solatubes

Clerestory / Roof Monitors
Energy Daylighting Modeling

- Optimize glazing type
- Optimize shading devices
- Optimize photosensors
- Optimize daylight strategy
- Destratification fans
- Air quality sensors
- Radiant heating / condensing boilers
- Heat recovery
- Evaporative cooling
• Low emitting alt fuel vehicles
• CNG energy management
• Biobased fuels
• Parking for alt vehicles
Energy
Maintenance Processes

- Highest efficient motors
- Variable speed drives
- Scheduling equipment

<table>
<thead>
<tr>
<th>Daily Occupancy</th>
<th>Hours Occupied</th>
</tr>
</thead>
<tbody>
<tr>
<td>5</td>
<td>4AM-1PM M-Sa</td>
</tr>
<tr>
<td>2</td>
<td>5:30AM-9PM M-Su</td>
</tr>
<tr>
<td>5</td>
<td>5PM-2AM M-Sa</td>
</tr>
<tr>
<td>6</td>
<td>7AM-5PM M-Sa</td>
</tr>
<tr>
<td>2</td>
<td>7AM-5PM M-Sa</td>
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<tr>
<td>1</td>
<td>7AM-5PM M-Sa</td>
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<td>7AM-7PM M-Sa</td>
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<tr>
<td>2</td>
<td>8AM-8PM Su</td>
</tr>
<tr>
<td>5</td>
<td>10AM-7PM M-Sa</td>
</tr>
<tr>
<td>8</td>
<td>8PM-5:30AM M-Su</td>
</tr>
</tbody>
</table>

Total 43

Maintenance Design Group
Renewable Energy
Transpired Solar Collector

Source: Solarwall
Renewable Energy Analysis

- Select renewables appropriate for the load
- Identify alt. funding sources
- Select the lowest life cycle

<table>
<thead>
<tr>
<th></th>
<th>SJIA Terminal A BaseCase</th>
<th>SJIA Terminal A Renewables</th>
</tr>
</thead>
<tbody>
<tr>
<td>Initial Cost ($)</td>
<td>$424,981</td>
<td>$148,677</td>
</tr>
<tr>
<td>Utility Incentive ($)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Tax Credit ($)</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Cost to SJIA after Incentives ($)</td>
<td>$424,981</td>
<td>$148,677</td>
</tr>
<tr>
<td>Utility Cost Savings ($/year)</td>
<td>$44,653.00</td>
<td>$17,918.75</td>
</tr>
<tr>
<td>O&amp;M Cost ($/year)</td>
<td>$1,062.45</td>
<td>$371.69</td>
</tr>
<tr>
<td>Internal Rate of Return</td>
<td>10.26%</td>
<td>11.80%</td>
</tr>
<tr>
<td>Simple Payback Period</td>
<td>9.7</td>
<td>8.5</td>
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<tr>
<td>Life Cycle Savings</td>
<td>$78,262.00</td>
<td>$156,817.24</td>
</tr>
<tr>
<td>Savings to Investment Ratio</td>
<td>1.1</td>
<td>2.1</td>
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</tbody>
</table>

Graph showing energy usage and cost savings for SJIA Terminal A with and without renewables.
Zero Energy Buildings
Low Energy and Renewable Energy

ZEBs produce as much energy as they consume over the course of a year.
Thank You!

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