Sustainable Rest Area Design and Operations

Photo Source: Vermont Department of Buildings and General Services

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One way in which State Departments of Transportation (DOTs) can modernize their rest areas while reducing operations and maintenance costs is by incorporating sustainable practices into rest area design and operations. Sustainability practices that DOTs have pursued at their rest areas include green building design, changing operations procedures, using on-site renewable energy, and tracking rest area performance and educating the public about sustainability. DOTs in Florida, North Carolina, Colorado, Georgia, and Vermont have constructed or renovated rest areas in ways that reduce energy usage and carbon emissions, minimize environmental impact, and in many cases save money.

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ACRONYMS AND ABBREVIATIONS

BGS	Vermont Department of Buildings and General Services
CDOT	Colorado Department of Transportation
CFR	Code of Federal Regulations
DOT	Department of Transportation
FDOT	Florida Department of Transportation
FHWA	Federal Highway Administration
FOUNDATION	The Ray C. Anderson Foundation
GDOT	Georgia DOT
HVAC	Heating, ventilation, and air conditioning
kW	Kilowatt
kWh	Kilowatt hour
LED	Light-emitting diode
LEED	Leadership in Energy and Environmental Design
LEED-EB	Leadership in Energy and Environmental Design – Existing Building
LEED-NC	Leadership in Energy and Environmental Design – New Construction
MMBTU	Million British Thermal Units
NCDOT	North Carolina Department of Transportation
PV	Photovoltaic

EXECUTIVE SUMMARY

Highway rest areas perform an important safety function by providing drivers with a place along the highway to stop and take a break. Many rest areas were constructed in the 1950s and 1960s as part of the development of the Interstate Highway System, and as a result, many are reaching the end of their useful life or are in need of renovations. One way in which State Departments of Transportation (DOTs) can modernize their rest areas while reducing operations and maintenance costs is by incorporating sustainable practices into rest area design and operations.

Sustainability strategies that DOTs can pursue at rest areas include green building design strategies such as daylighting, passive heating and cooling techniques, and choosing sustainable materials. They can also implement operations strategies that reduce energy and water usage, cut waste, and minimize environmental impacts. On-site renewable energy systems, including ones that use solar, wind, and geothermal resources, have been deployed at rest areas. DOTs can also track information about the rest area performance and provide educational information about sustainability to the public.

This report includes case studies of five DOTs that have implemented sustainability strategies at their rest areas. DOTs in Florida, North Carolina, Colorado, Georgia, and Vermont have constructed or renovated rest areas in ways that reduce energy usage and carbon emissions, minimize environmental impact, and in many cases save money.

1. INTRODUCTION

Rest areas provide places for drivers traveling along Interstate highways to stop and take a break without exiting the highway. They typically offer travelers facilities such as restrooms, picnic areas, and vending machines, as well as traveler information and tourism materials such as brochures about attractions in the state. While they are open to and benefit all travelers, rest areas are particularly important for truck drivers, who are mandated by Federal law to take breaks at least every eight hours.[1]

Some States use the terms "welcome center" or "information center" to refer to rest areas that have a particular focus on tourism. Throughout this report, the term "rest area" is used to refer to all of these facility types. "Service plazas" typically refer to rest areas that include commercial services, such as gas stations or restaurants, which in most cases are not allowed on Interstate highways (see Section 2).

Rest areas are usually built and operated by State departments of transportation (DOTs). Based on publicly-available, online information, there are at least 1,800 highway rest areas in the United States (including both Interstate Highway rest areas and those on other highways). Many rest areas were constructed in the 1950s and 1960s as part of the development of the Interstate Highway System, and as a result, many are reaching the end of their useful life or are in need of renovations. These aging facilities contribute to rising maintenance costs for DOTs, and in recent years, some DOTs have closed rest areas in attempts to cut costs. Since 2011, approximately 46 rest areas in 13 States have closed,[2] including several in Florida, Michigan, Ohio and South Dakota.[3] Budget proposals in other states have recommended eliminating rest areas in the near future and devoting resources to welcome centers near the State borders that focus on tourism.[4]

Travel on Interstate highways has continued to grow. The average annual amount of travel per Interstate lane-mile increased by 11 percent from 2000 to 2014, while overall vehicle miles traveled on Interstate highways increased over the same period by 14 percent, from 661 billion miles traveled annually to 751 billion miles.[5] Freight traffic has been increasing at an even faster rate. Travel by combination trucks on the Interstate Highway System increased by 29 percent between 2000 and 2014.[6] These figures highlight the continued need for rest areas despite the challenges DOTs face maintaining them.

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[1] Federal Motor Carrier Safety Administration (FMCSA). Summary of Hours of Service Regulations (2017). www.fmcsa.dot.gov/regulations/hours-service/summary-hours-service-regulations
[2] This count was done by the report authors and is based on publically available, online information.
[3] Bergal, Jenni. Why old-fashioned highway rest stops are disappearing. USA Today, April 1, 2017. www.usatoday.com/story/news/nation/2017/04/01/highway-rest-stops-disappearing/99868368/
[4] Cummings, Bill. State moves to close highway rest stops. CT Post, February 23, 2017. www.ctpost.com/local/article/State-moves-to-close-highway-rest-stops-10951937.php
[5] TRIP. The Interstate Highway System Turns 50: Challenges to Its Ability to Continue to Save Lives, Time and Money (2016). www.tripnet.org/docs/Interstate_Highway_System_TRIP_Report_June_2016.pdf
[6] Ibid

One way in which DOTs can modernize their rest areas while reducing operations and maintenance costs is by incorporating sustainable practices into rest area design and operations—a strategy that may cost more in the short term but that generally saves money in the long term through lower energy and water costs and less intensive maintenance needs. Including sustainable practices in rest area design and operations can also help DOTs meet energy savings goals or adhere to State green building policies.

Example Rest Area Resource Use

Few State DOTs publish information on resource usage and operations and maintenance costs for rest areas in a comprehensive or aggregated way. Michigan DOT, however, has made some data on resource use at its rest areas available to the public. According to the DOT, Michigan's 82 rest areas annually go through:

- 85,000 jumbo rolls of toilet paper;
- 9,000 gallons of hand soap;
- 200,000 trash bags; and
- 90 million gallons of water.

This report includes information on types of sustainable practices that DOTs could incorporate into their rest area design and operations. Section 2 discusses Federal and State policies that apply to rest areas and that influence the use of sustainable practices at rest areas. Section 3 provides an overview of the range of sustainability strategies that DOTs have implemented at rest areas to date, including green building design, sustainable operations strategies, use of renewable energy technologies, and education and tracking. Section 4 features five case studies from DOTs that have incorporated sustainability strategies into their rest areas. Section 5 discusses takeaways and themes from the case studies.

2. POLICY CONSIDERATIONS

23 Code of Federal Regulations (CFR) 752 defines a safety rest area as "a roadside facility safely removed from the traveled way with parking and such facilities for the motorist deemed necessary for his rest, relaxation, comfort and information needs." The regulation sets forth the permitted activities at rest areas along Interstate highways.[7] It states that the public may not be charged for goods and services at rest areas, except for telephone and articles dispensed by vending machines. Vending machines may sell food and drink, and other items that the State determines are appropriate. However, they may not sell petroleum products or motor vehicle replacement parts. States can also sell at their rest areas limited items that promote tourism in the State, such as books, DVDs, and other media. Commercial activity is allowed on some highways, including at rest areas, that were constructed prior to the Interstate Highway System as toll roads and later incorporated into the Interstate system.[8]

Recently, the Federal Highway Administration (FHWA) began to explore whether what is permitted to be sold in vending machines at rest areas should be changed. A Federal Register docket[9] that closed in December 2016 gathered public comments on what types of products should be permissible to be sold through vending machines, given that technology has changed since the regulations were written and that vending machines can now accept electronic payment and dispense a wide variety of products, not just food and drink. FHWA also asked the public for input on whether local agricultural products be considered media that promotes tourism, and therefore allowable to be sold at rest areas.[10] FHWA is continuing to consider the issue.

State policies can motivate DOTs to implement sustainable design or operations practices at rest areas. For example, many States have renewable portfolio standards that require them to use a certain amount of renewable energy by a specified date, or energy efficiency portfolio standards that require them to improve building efficiency. Such policies may apply to the State as a whole, or to State agencies or State-owned buildings in particular. Building design guidelines or standards may require that sustainable practices be incorporated into the construction or renovation of State buildings. Finally, many States have renewable energy incentives, such as net metering, renewable energy credits, or tax incentives, which can make renewable energy and energy efficiency at rest areas more cost-effective for DOTs.

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[7] Many States establish rest areas or service plazas with commercial activities on State highways or other non-Interstate highways. While the sustainability practices discussed in this report could be incorporated into those facilities, the regulations in 23 CFR 752 do not apply on non-Interstate highways.

[8] FHWA. Ask the Rambler: Why Does the Interstate System Include Toll Facilities? www.fhwa.dot.gov/infrastructure/tollroad.cfm

[9] Federal Register Docket number 2016-23269

[10] The Notice and comments received are available at: www.federalregister.gov/documents/2016/09/27/2016-23269/commercial-activities-on-interstate-rest-areas

3. SUSTAINABLE REST AREA ELEMENTS

Green building design and operations strategies have been deployed in a wide variety of building types. The sustainability strategies that can be incorporated into rest area design and operations are not significantly different from strategies that are incorporated into other types of buildings. However, several factors make rest areas unique and affect the types of sustainability strategies that can make the biggest impacts:

- Rest areas typically have large amounts of impervious surface due to their parking lots and access roads. Pavement material choice and type of landscaping can help manage water usage, stormwater runoff, and maintenance tasks such as mowing.
- Rest areas can require high volumes of water due to restroom use. Water conservation efforts and low-impact wastewater treatment strategies can help reduce water usage and manage water efficiently.
- Many rest areas have outdoor lighting that remains on at all times, or at least for significant portions of the night. As a result, energy use intensity, measured by energy usage per square foot per year, is likely higher for rest areas than for many other building types. Strategies to make lighting more efficient can help reduce rest area electricity use.
- Most rest area visitors only stay a short amount of time, reducing the need to provide all-day climate control as may be required in an office building. Strategies such as passive lighting, heating, and cooling can help ensure the short-term comfort of visitors while minimizing energy usage.
- Since most rest area visitors are seeking to take a break from driving, they may be open to reading educational and informational displays, which could include information about sustainability. (Displays would need to be directed toward pedestrians and away from the roadway, otherwise they could be considered advertising and subject to 23 United States Code 131).

These and other sustainability strategies that rest areas could pursue are discussed below and summarized in Table 1. Strategies are organized into four categories: green building design, sustainable operations, on-site renewable energy usage, and education and tracking.

Green Building Design

Whether constructing a new rest area or retrofitting an existing structure, DOTs can utilize building design strategies that help conserve energy and minimize environmental impact. Some green building design strategies include daylighting, passive heating and cooling techniques, and choosing sustainable materials.

Daylighting

In building design, daylighting techniques use natural light to illuminate interior spaces through the strategic placement of skylights and windows, allowing sunlight to enter without causing unwanted

heating or cooling. This technique is beneficial year-round, and conserves energy used for lighting by reducing the need for artificial light during daytime hours.

Passive Solar Techniques

Utilizing passive heating and cooling techniques at rest areas can aid in reducing their carbon footprints by lowering the amount of energy required to run heating and cooling systems. Passive heating and cooling, which can also help save money, is achieved through appropriate building designs incorporating large, south-facing windows[11] to capture sunlight. Heat from the sunlight is stored in building materials with high thermal masses, such as concrete, stone, brick, and tile, and then radiates back into the open space, warming the air. Mechanisms such as fans or blowers then distribute the heat throughout the structure. The south-facing windows must be unobstructed during the heating season to allow for increased sun exposure and heating, and must be adequately shaded in the cooling season to avoid overheating. Shading can be achieved through vegetation, awnings, or appropriately designed overhangs.[12]

Use of certain colored materials can also aid in passive heating and cooling, with darker colors used to absorb more heat. Lighter colored materials can be used for roofing to lower cooling costs. Nighttime ventilation, which involves opening windows at night to help the building cool off and closing them during the day to keep heat out, is another technique used for passive cooling.

Material Choice

Reusing materials from a preexisting structure for new construction is a straightforward method that DOTs can use to lessen the impact of their rest areas. Materials from original structures can also be used to retrofit structures or stored for maintenance use on new structures. Reusing construction materials reduces the volume of materials placed in landfills, preserves resources, and can lead to lower construction costs.[13] Materials and fixtures that are commonly able to be salvaged include sinks, toilets, light fixtures, windows, doors, dimensional lumber, bricks, and stones.[14]

Purchasing recycled materials or materials with recycled content may provide alternatives for DOTs when materials from old rest areas are unable to be reused. Some common materials with pre- or post-consumer recycled content include carpet and flooring, lumber, roofing, paint, asphalt, and concrete.[15]

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[11] The south-facing orientation applies in the Northern Hemisphere.
[12] US Department of Energy. "Passive Solar Home Design." www.energy.gov/energysaver/passive-solar-home-design
[13] US Environmental Protection Agency. "Best Practices for Reducing, Reusing, and Recycling Construction and Demolition (C&D) Materials." www.epa.gov/smm/best-practices-reducing-reusing-and-recycling-construction-and-demolition-cd-materials
[14] US Environmental Protection Agency. "Reuse and Recycling Opportunities and Demolition." www.epa.gov/large-scale-residential-demolition/reuse-and-recycling-opportunities-and-demolition
[15] US Green Building Council. "List of Common Recyclable Materials and Recycled-Content Building Products." www.usgbc.org/Docs/Archive/General/Docs5497.pdf

Sustainable Operations

DOTs have opportunities in the day-to-day operation of rest areas to pursue strategies that reduce energy and water usage, cut waste, and minimize environmental impacts. Several of these strategies depend on building design (e.g., electricity conservation through daylighting), but many of them can be implemented at any rest area, regardless of whether it is designed with green building techniques or not.

Energy Conservation

Reducing energy use at rest areas can help DOTs reduce carbon emissions and save money on electricity costs. Relevant strategies include using motion-activated lights so that lights are not on at times when visitation is low, and turning off interior lights and using natural light during certain daytime hours. Interior and exterior lights can be set to a timer so that they turn on when ambient light diminishes to a predefined level.

Using energy efficient lighting, such as light-emitting diode (LED) lights, can also help reduce electricity use. LED lightbulbs use 75–80 percent less energy and last 25 times longer than traditional incandescent bulbs.[16] LEDs are increasingly being deployed in commercial and industrial settings, such as street lights, parking garage lighting, and walkway and other outdoor lighting. Lights powered by solar cells can also be used in exterior areas.

Finally, DOTs can conserve energy by designing rest areas to minimize hot water usage. Rest areas in warm climates may not need to use hot water in their restrooms, and those in colder climates can opt to use hot water only in the winter. Water can also be heated using renewable energy technologies, such as solar hot water heaters or geothermal heat pumps.

Water Conservation

Rest areas can be designed to collect stormwater from their roofs or elsewhere on the site in cisterns or rain barrels. Collected water can be used onsite for irrigation or toilet flushing, among other activities.

Xeriscaping, or using plants that require no or minimal water, reduces the water required for landscaping (Figure 1). Knowledge of the local climate and typical rainfall patterns will help rest area managers decide which plants can minimize water and maintenance needs. Inside rest area buildings, water conservation strategies include

Figure 1: A trail around a rest area in Wilkes County, NC uses xeriscaping (Photo source: NCDOT).

[16] US Department of Energy. "LED Lighting." www.energy.gov/energysaver/led-lighting

waterless or low-flow toilets and installing faucets with sensors.

Waste Management

Reducing the amount of waste generated at rest areas not only reduces the site's environmental impact, but also reduces maintenance costs by minimizing the frequency at which trash has to be collected from the building. One strategy to reduce waste is to eliminate paper towels in rest rooms, and provide hand dryers instead.

Rest areas can also offer recycling, which reduces waste while allowing the DOT the option to sell the recycled materials. The cost savings for recycling depend on the price that the materials being recycled can obtain in the local recycling market. For example, recycling centers may pay for one material, such as aluminum cans, while also accepting other materials, perhaps paper and cardboard, for which they do not provide payment. DOTs interested in implementing a recycling system at their rest areas could do a cost benefit analysis, as the value of recyclables and the costs of waste disposal vary by location.

Other Strategies

Choosing environmentally-friendly, nontoxic cleaning products for rest area interiors and restrooms can help make rest areas healthier for visitors and workers while minimizing environmental impact. DOTs can also change their maintenance procedures to minimize mowing, saving both mowing equipment fuel usage and money from maintenance costs.

On-site Renewable Energy

Over recent years, some DOTs have installed solar, wind, and geothermal energy technologies at rest areas. Depending on site conditions, rest areas can be desirable locations to install renewable energy, due to the potential for the energy to be used onsite for electricity or hot water heating, without requiring interconnection to the electricity grid.

If the renewable energy project is grid-connected, it may be structured as a public private partnership, in which the DOT hires a contractor to install and operate the renewable energy system. With these arrangements, the DOT typically does not put down money for the project upfront, and agrees to buy the power at a guaranteed, long-term rate. The contractor is able to take advantage of Federal or State tax incentives for renewable energy. Net metering, in which a project is able to sell excess electricity back to the grid, can also help these renewable energy projects be economical.

Solar

Solar photovoltaic (PV) systems may be located on rooftops or other structures, ground-mounted (Figure 2), or on canopies over parking lots. At least 36 rest areas or service plazas have PV modules installed.[17] For example, the Michigan DOT has installed solar arrays at five of its rest areas. The projects have generated an average of nearly 20,000 kilowatt hours (kWh) of electricity per year since they became operational in late 2011.

The electricity generated from solar panels can be used on-site to power the rest area or for hot water heating, or in some cases can be fed into the grid to help offset the DOT's electricity costs. Solar panels are modular and scalable, so they can be used in a variety of settings, from providing electricity to an entire building to powering specific applications such as outdoor lights, variable message signs, or electric vehicle charging stations.

Figure 2: 75kW solar array at the Fair Haven Welcome Center in Vermont (Photo source: Vermont Agency of Transportation).

Wind

In areas where wind resources are strong, wind power can provide an additional renewable energy option for rest areas. While a large-scale wind turbine could be installed at a rest area with a significant amount of land area, DOTs can also consider smaller, vertical turbines that produce less energy but also require less space.

At least four States use or have tested wind turbines at their rest areas:

- The Texas DOT installed turbines at two sites: a 50 kilowatt (kW) turbine and a 10kW turbine, both atop 80-foot towers at rest areas in Gray and Culberson Counties, respectively.
- In 2008, the Montana DOT implemented a wind turbine pilot project at the Anaconda Rest Area. The project generated enough electricity to cover approximately 20 percent of the rest area's energy needs.
- The Conway Welcome Center in Missouri has two 1.2kW vertical turbines, which power lights in the Welcome Center.
- The Alburgh Welcome Center in Vermont has a 10kW turbine that was installed in 2004. The electricity generated is net-metered against the rest area's utility meter.

[17] This includes 23 locations in Connecticut, 5 in Michigan, and at least 1 each in Arizona, Colorado, Florida, Georgia, Massachusetts, North Carolina, Oregon, and Vermont.

Geothermal

Geothermal energy takes advantage of the fact that the upper portion of the earth's surface is typically a relatively constant temperature of between 50 and 60 degrees Fahrenheit. Heat pumps can be employed to access this resource and use it to heat or cool buildings. In the summer, heat from indoor air is exchanged for cooler air from a geothermal reservoir, while in the winter the reverse occurs and geothermal energy can be used to heat buildings.

Geothermal energy has been used for heating, cooling, and hot water heating at a handful of rest areas. For example, the Wilkes County rest area in North Carolina has a geothermal heat pump, which involves obtaining heating and cooling energy from 13 geothermal wells, 300 feet deep. Along with energy-efficient measures such as improved insulation, the geothermal system has reduced the energy consumption of the facility by a third.[18]

Education and Tracking

DOTs that have pursued sustainability strategies at their rest areas have the opportunity to track information about the rest area performance, and to provide educational information about sustainability to the public.

Tracking

Tracking various elements of sustainable rest area features, such as maintenance costs, energy generated, and energy and water usage, can assist DOTs in assessing the cost effectiveness of implementation, and in determining which methods to utilize in additional locations. Tracking metrics about sustainable methods can also aid DOTs in prioritizing rest area improvements and maintenance activities. Providing real-time displays of system performance in the rest areas or online dashboards can serve as an educational tool for the public, which will be able to learn about cost savings and environmental benefits from employing sustainable strategies.

Education

DOTs can use their rest areas' sustainable features to provide educational experiences for visitors. Since many visitors at rest areas want to take a break from driving to stretch their legs, they may be willing to engage with educational elements about the rest area's sustainable practices (Figure 3). For example, nine interpretive signs are located throughout the Wilkes County, NC rest area to explain various sustainable design features implemented at the facility. The rest area also includes a

[18] Innovative Design. *The Sustainable Northwest NC Rest Area & Visitor Center* [Brochure]. Raleigh, NC: Innovative Design (2014).

green trail with an additional 15 signs that face pedestrian visitors and provide them with information about the surrounding area, wildlife, and vegetation.

Signage can also be included to provide visitors with educational information about sustainable practices they can adopt. For example, DOTs can post signage informing visitors about the importance of water conservation or waste minimization, and listing strategies that they might adopt both at the rest area and in their own homes.

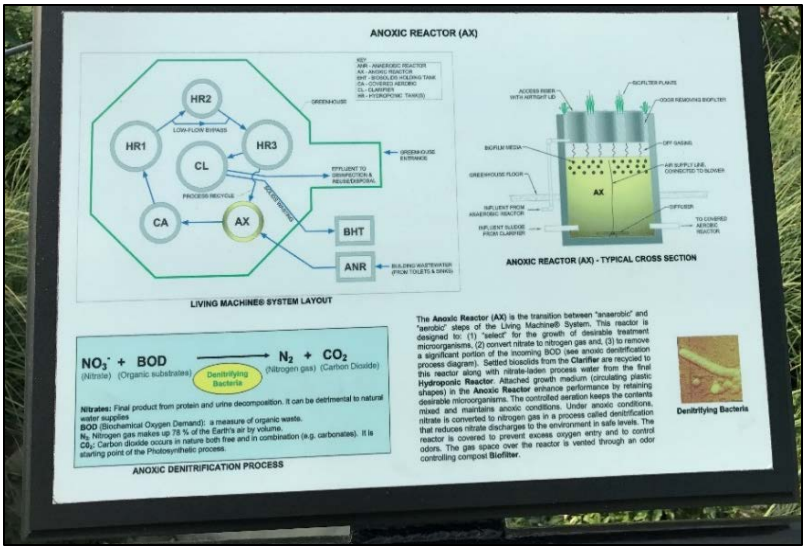

Figure 3: Educational signage at Vermont's Sharon Welcome Center explains the "Living Machine" system that uses natural processes to treat wastewater at the rest area (Source: Volpe Center).

Certifications

Various green building certifications are available for DOT rest areas. Planning a rest area construction or renovation with a certification in mind can help DOTs learn about potential sustainability strategies to include in their rest areas. Certification can also demonstrate to the public that the DOT is taking action to protect the environment. Leadership in Energy and Environmental Design (LEED) offers certifications for both New Construction (LEED-NC) and Existing Buildings (LEED-EB), and some DOTs have achieved LEED certifications for rest areas, including Florida and North Carolina. While obtaining certification can be expensive and time-consuming for DOTs, pursuing certification can also have long term benefits for the State. For example, lessons learned in the initial certification can be applied to subsequent rest area reconstruction and renovation projects to increase sustainability. Some States also set requirements that buildings be constructed according to the equivalent of LEED standards, but do not actually seek to become certified.

Other certifications are also available:

- Green Globes offers certifications for new construction and existing buildings. This certification system includes an online assessment tool and rating system for green building design that gets verified by a third party.
- Energy Star uses strict energy performance standards that have been set by the Environmental Protection Agency for certifications of existing buildings. Agencies seeking certification can enter appropriate data into the online tools, and if building performance is above a set threshold, the building is eligible for certification.
- WELL Building Standard offers certifications for new and existing buildings, and certifies projects through assessment, performance verifications, and on-site inspections and tests.

- The International Living Future Institute provides a zero energy certification focusing on net zero energy performance, and involves a third-party verification.
- Passive House Institute U.S. offers certifications for passive building designs.
- SITES offers certifications for new construction projects and existing sites built within the past two years, with a focus on sustainable landscaping.

Table 1: Summary of Rest Area Sustainability Strategies

Green building design	Sustainable operations	On-site renewable energy	Education and tracking
• Daylighting • Passive heating and cooling • Light-colored materials for roofing • Reused or recycled materials • Nighttime ventilation	• Motion-activated or timer-based lights • Energy efficient lighting • Minimize hot water usage • Rainwater collection for use on-site • Xeriscaping • Waterless toilets • Motion-activated faucets • Use hand dryers in rest rooms • Implement recycling • Non-toxic cleaning products • Minimize mowing	• Solar PV (rooftop, ground-mounted, or canopy) • Solar hot water heating • Wind • Geothermal	• Track energy and water usage and maintenance costs • Real-time displays of system performance • Educational signage for visitors • Pursue a green building certification

4. CASE STUDIES

A number of DOTs have incorporated sustainability practices at their rest areas, either through constructing new rest areas according to green building standards, renovating existing rest areas to be more efficient, adding renewable energy to their rest areas, or implementing more sustainable operations and maintenance strategies. The case studies below provide examples of five DOTs that have implemented sustainable design or operations practices at their rest areas.

Florida DOT

The Florida Department of Transportation (FDOT) operates 57 rest area facilities along the State's Interstate highways. They are typically situated in pairs on either side of the highway. For the last 20 years FDOT has been replacing or renovating 1 or 2 rest areas per year that have reached the end of their lifespan of approximately 30-35 years. FDOT strives to incorporate sustainable elements into all of its rest areas by using long-lasting materials and constructing rest areas that require minimal maintenance. Sustainability strategies that FDOT has pursued at its renovated or new rest areas include:

- Reducing energy required for lighting by using LED lights and daylighting with large windows and skylights.
- Using lighter-colored materials for roofs, white instead of black for example, to promote reflectivity and lower cooling costs.
- Where possible, installing wells and wastewater treatment on site to reduce the costs and impacts of connecting to the municipal water utility.
- Including generators onsite for use during power outages, which can also be used by emergency responders during emergency situations.
- One location, the Turkey Lake toll road service plaza, has solar panels that are used to power exterior lights.

In 2007, Florida's Governor signed an Executive Order requiring that the Department of Management Services adopt LEED-NC standards for all new buildings, and to adopt LEED-EB for all buildings operated by the Department.[19] Although these requirements did not directly apply to the DOT, the Executive Order motivated FDOT to consider LEED certification for its rest areas.

FDOT developed a pair of rest areas that achieved LEED gold certification along I-75 in Pasco County, a high-traffic area near Tampa. The existing facility had many maintenance issues and did not meet traffic loads, so FDOT decided to do a facility replacement rather than a renovation. The Pasco facilities incorporate a variety of sustainable strategies, including light-colored concrete, low-water landscaping (xeriscaping), swales and roof catchment to reduce runoff, daylighting, light sensors and LED lighting, use of low-flow toilets, and dedicated parking spaces for fuel-efficient vehicles.

FDOT is not pursuing LEED at other rest areas because of the cost of certification. Staff also found that it was difficult to achieve LEED points in certain topic areas, such as public transportation, since the site was by definition along a highway and not near public transit. However, FDOT continues to incorporate sustainability into all of its rest area renovations and reconstructions. It also uses relevant LEED criteria when planning and designing new rest areas, including criteria that relate to site design, parking, and building elements. Although FDOT does not track overall

[19] State of Florida Office of the Governor Executive Order Number 07-126: Establishing Climate Change Leadership by Example: Immediate Actions to Reduce Greenhouse Gas Emissions from Florida State Government. www.fsec.ucf.edu/en/media/enews/2007/pdf/07-126-actions.pdf

maintenance costs or energy usage at its renovated versus its old facilities, the rest area program manager noted anecdotally that building techniques that promote energy conservation may cost more upfront, but save money in the long run. FDOT district staff is starting to understand the potential for these cost savings, which is leading FDOT to continue to pursue rest area sustainability measures going forward.

North Carolina DOT

The North Carolina Department of Transportation (NCDOT) incorporates sustainable practices in rest area construction and renovation projects when possible. Currently there are 61 rest areas in North Carolina: 41 Interstate rest areas and 20 rest areas along non-Interstate primary routes. Three rest areas in the state are LEED certified. The Wilkes County rest area (Figure 4) is along a primary route, US-421, and opened in October 2009 as LEED Gold Certified. A pair of north- and southbound rest areas located on I-73/74 in Randolph County opened in January 2010 as LEED Silver Certified. All three of these rest areas were new site construction.

Figure 4: The rest area in Wilkes County, North Carolina is LEED Gold certified and opened in 2009 (Source: NCDOT).

The Wilkes Country rest area is 47 percent more efficient than minimum code-compliant rest area buildings. The site incorporates several sustainable design features, including geothermal heating and cooling, solar water heating, PVs, daylighting and passive solar energy, and rainwater harvesting. The 13 geothermal wells on site along with energy-efficient practices have reduced the building energy consumption by over 33 percent. Solar water heating has saved the equivalent of 5,242 kWh per year, and PV systems generate an additional 4,550 kWh per year, reducing the facility energy consumption by an additional four percent combined. Daylighting and passive solar energy techniques are beneficial year-round, and have helped reduce lighting and heating/cooling energy, saving an additional nine percent in energy consumption.

Rainwater is harvested onsite, and is used for toilet and urinal flushing, reducing stormwater runoff impacts and consumption of potable, municipal water. As of 2017, over 1 million gallons of

harvested rainwater have been used for flushing toilets. Over 90 percent of all construction waste was recycled, and over 50 percent of all wood products used in the building were Forest Stewardship Council certified. The site also includes a green trail for visitors and educational opportunities throughout the facility explaining with interpretive signage each sustainable design feature.[20]

Pursuing LEED certifications for the three rest areas was a learning experience for NCDOT, as LEED certified rest areas were found to cost approximately 30-40 percent more than standard rest area designs. While NCDOT is not currently pursuing additional LEED certifications for rest areas, it continues to incorporate cost effective sustainable designs and practices where possible. Through the development of the LEED certified rest areas, NCDOT determined which sustainable practices provided the best return on investment. Practices such as installing PV solar panels on roofs were found to be expensive and not provide sufficient returns given the limited number of panels that are typically able to be installed at sites. Therefore, NCDOT is not currently installing new solar panels at rest areas, although it may in future given that PV costs have decreased and the technologies improved since 2009. Other practices, such as solar hot water heating, geothermal energy, rainwater harvesting, daylighting, and recycling (providing trash and recycling receptacles at sites, and reusing materials for site renovations) were found to be cost effective sustainable design elements. NCDOT does suggest selectivity on sustainable design practices and consideration of site locations when determining which sustainable design practices will be most effective, as not all practices will work well at all sites.

NCDOT has faced some maintenance challenges at the LEED certified rest areas. For example, it encountered control systems issues with cisterns and geothermal pumps, and has historically had some difficulties finding qualified technicians for the specialized maintenance requirements for systems at rest areas in rural locations. NCDOT noted that this would likely not be an issue in urban areas and that as the technology becomes more widespread, more technicians who specialize in these types of systems would likely be available.

NCDOT opened a new rest area in January 2017, and another new rest area is currently under construction. While there are a few additional sites where NCDOT might consider building rest areas, no new rest area construction is currently planned due to funding constraints. Major renovations are underway at existing rest areas, with one rest area renovation under construction and two other renovations in the design phases. NCDOT plans to incorporate what it has learned thus far about sustainable practices where possible, including utilizing daylighting, recycling materials, and providing recycling receptacles on site.

Colorado DOT

Primarily motivated by State Executive Orders on reducing consumption of energy, water, and petroleum, and reducing greenhouse gas emissions, the Colorado Department of Transportation

[20] Innovative Design. *The Sustainable Northwest NC Rest Area & Visitor Center* [Brochure]. Raleigh, NC: Innovative Design (2014).

(CDOT) initiated a rest area sustainability study in 2010.[21] The study involved an analysis of sustainability at six Colorado rest areas chosen to reflect a variety of rest area sizes, styles, and geographic locations. Researchers evaluated rest areas to determine the sustainability of the rest area design, operation, and maintenance using scoring criteria that they developed based on LEED standards and goals outlined in the Executive Orders. The criteria included assessments on elements such as recycling activities, environmental and context sensitivity, site conditions, air and water quality, water and energy usage, community services provided, and innovation.

The study identified sustainability practices implemented at each site. For example, some sites reduced water consumption through the use of native vegetation or the use of low-flow toilets. Other sites reduced energy consumption and operating costs through energy-efficient lighting. Some minimized wildlife impacts by providing open spaces without fencing. Researchers also completed a carbon footprint analysis at each rest area to identify significant emissions sources and estimate emissions amounts. They identified truck idling as the largest contributor to the carbon footprint of the six rest areas, followed by electrical consumption used for lighting and heating.

The study also discusses opportunities to implement additional sustainability measures at these six rest areas. The researchers suggest that two of the studied rest areas have potential for harvesting water runoff from the structure roof, estimating an annual savings to CDOT of $450 to $800 depending on site conditions. Use of a trash compactor reduces the number of waste collection trips necessary to a site, thereby reducing labor costs and greenhouse gas emissions. Researchers estimated savings from the use of a trash compactor at one of the study rest area sites to be over $15,700 annually and have about a 4.5 year return on investment. The study also addresses the potential for alternative energy sources, including site appropriateness for both direct and passive solar energy, opportunities for wind energy use at rest areas in the plains regions, the potential for hydropower, and the use of geothermal heating, all of which would reduce the rest area greenhouse gas emissions and save CDOT financial resources long-term.

Table 2 shows recommendations specific to reducing fuel consumption, reducing energy consumption, reducing water consumption, and increasing site sustainability. CDOT has adopted some of these measures, such as using energy-efficient lighting and mulching lawn clippings. Further analyses were needed to determine the applicability and cost-effectiveness of other recommendations from the study. For example, CDOT conducted an additional study with CSU-Pueblo in 2015 on solar energy generation in the Highway Right of Way.[22]

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[21] Colorado Department of Transportation DTD Applied Research and Innovation Branch. *Assessment of Colorado Department of Transportation Rest Areas for Sustainability Improvements and Highway Corridors and Facilities for Alternative Energy Source Use* (Report No. CDOT-2011-3). (2011). www.codot.gov/programs/research/pdfs/2011/restareas/view

[22] Colorado Department of Transportation Applied Research and Innovation Branch. Potential Impacts of Solar Arrays on Highway Environment, Safety and Operations (Report No. CDOT-2015-08). (2015). www.codot.gov/programs/research/pdfs/2015-research-reports/solar-arrays/view

Table 2: Rest area sustainability recommendations from CDOT study

Reduce Fuel Consumption	Reduce Energy Consumption	Reduce Water Consumption	Increase Rest Area Sustainability
• Limit truck idling for extended periods • Provide truck electrification capabilities on site • Reduce mowing • Mulch lawn clippings • Reduce travel to and from the main CDOT maintenance facilities • Use biodiesel and/or electric power for maintenance vehicles • Provide preferred parking for alternative energy or hybrid cars	• Use energy-efficient bulbs • Shut off lights during daytime • Install skylights or solar tubes • Use motion-activated lighting in restrooms • Audit rest areas to reduce propane, natural gas, and electricity consumption • Minimize air conditioning use • Use solar powered lights for parking areas, walkways, and safety lighting • Deploy vending machines inside buildings • Optimize onsite waste treatment systems • Limit hot water use • Use Energy Star rated on-demand heating systems or solar heated water systems • Produce alternative energy • Use Energy Star rated hand dryers	• Minimize irrigation • Harvest rainwater and snowmelt • Conduct water conservation studies • Eliminate use of automatic flushing • Use waterless urinals • Post signage on water conservation • Use gray water for urinal/toilet flushing	• Maintain buffer zone between sites, herbicide use areas, and sensitive environmental areas • Use mechanical weeding techniques • Minimize fencing that can impede wildlife movement • Maintain habitat conditions • Use biodegradable, non-toxic, and low phosphorus chemicals and cleaning products • Use low VOC materials • Use recycled materials/reuse materials for maintenance • Implement on-site recycling program • Eliminate restroom paper towel use • Use groundwater infiltration or porous pavement • Reduce traction sand application in winters to reduce sediment loads

The Ray and Georgia DOT

In 2014, the Georgia legislature named an 18-mile stretch of Interstate 85 (I-85) in west Georgia in honor of the late Ray C. Anderson, a leader in industrial sustainability. To align with its goals of enhancing the environmental stewardship and sustainability, the Ray C. Anderson Foundation (Foundation) labeled the I-85 section "The Ray" to be a living laboratory for emerging innovations related to sustainable transportation. The Foundation set a goal for The Ray to become a "net zero" highway that eliminates all deaths, waste, and carbon emissions. It has partnered with the Georgia DOT (GDOT) and other stakeholders to test innovations along and at a visitor center on the highway segment.

Figure 5: Solar-powered EV charging station at the I-85 Visitor Information Center in West Georgia (Source: The Ray).

Several of the innovations tested by the Ray are located at the I-85 Visitor Information Center just over the border from Alabama. This includes a PV-powered electric vehicle charging station, which makes an important link in the EV-charging infrastructure between Montgomery, AL and Atlanta, GA. The "PV4EV" charger offers free power to electric vehicles, and is paid for by The Ray (Figure 5).

The Ray also developed the "Wattway," a drivable solar road, at the rest area parking lot (Figure 6). The technology involves an application of solar cells over the existing roadway; the project at the I-85 rest area is the first deployment of this technology outside of France. The Ray collaborated with the GDOT on the project, who permitted the project through an encroachment permit. The energy generated by the solar road helps to power the visitor center building. A representative from The Ray noted that the energy produced from the Wattway is significantly less than that generated from ground-mount solar panels. However, given that otherwise the parking lot would have a singular purpose and would not be generating any electricity, the technology begins to look attractive.

Figure 6: The Wattway solar roadway is located in the parking lot of the I-85 Visitor Information Center (Source: The Ray).

The Ray has also implemented an automatic, drive-through tire pressure check station at the rest area. Underinflated tires waste two billion gallons of fuel a year and are less safe than properly inflated tires. The tire check station is expected to reduce fuel usage

and tailpipe emissions and improve safety along The Ray. The rest area also includes a 7,000 square foot pollinator garden, the first of its kind in Georgia, which provides habitat for bees, butterflies, and other pollinators. Moving forward, The Ray will continue to test these and other innovations, and evaluate the potential of their deployment elsewhere in Georgia and around the country.

Vermont Department of Buildings and General Services

Vermont's Department of Buildings and General Services (BGS) manages the State's 27 rest areas. Guided by the 2016 State Energy Plan, which sets goals for the State government to reduce consumption and greenhouse gas emissions and increase renewable energy usage, BGS has been taking steps to make the rest areas more sustainable. BGS tracks energy usage for all State buildings using the Energy Star Portfolio Manager system. It ranks buildings based on building type (rest areas are their own category), energy usage, and cost of energy, which helps them prioritize areas for energy audits and implementing improvements. This analysis has shown that rest areas in Vermont have a high energy use intensity, primarily due to the large amount of continuously used outdoor lighting.

Consultants perform the energy audits at selected rest areas and recommend improvements. BGS decides which of the energy conservation strategies identified in the audit it will implement based on whether the strategy will last longer than the payback period. Energy efficiency improvements are funded through revolving loan funds, in which cost savings from the project are used to pay back the loans. This allows BGS to have a dedicated, upfront source of capital for energy conservation projects.

Strategies that BGS has pursued at rest areas include insulation, weather-stripping doors and windows, installing energy efficient pumps and heating, ventilation, and air condition (HVAC) controls, and installing sensors so that systems like lighting and restroom ventilation are being used only to the degree necessary for building occupancy. It has also replaced exterior lights with LED lights at several rest areas. With these projects, BGS has reduced its rest area energy usage by nearly 500 million British Thermal Units (MMBTU) per year and reduced energy costs by over $15,000 per year; after additional projects are implemented in late 2017 BGS expects to save approximately 1,000 MMBTU and $35,000 per year through 2022 (Figure 7).

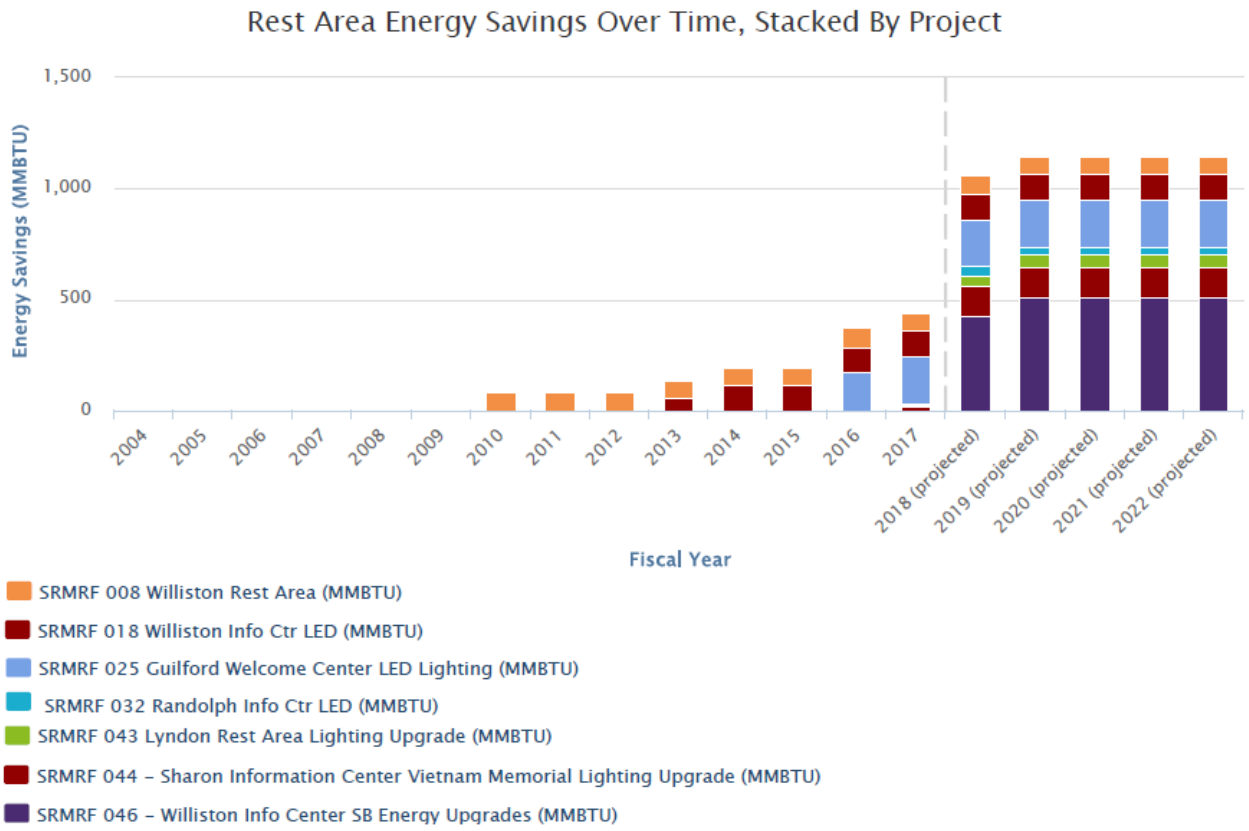

Figure 7: Measured and expected energy savings from Vermont's rest area energy efficiency projects (Source: Sustainable Endowment Institute's Green Revolving Investment Tracking System).

Vermont's net metering program offers opportunities for virtual net metering, or using solar produced in one location in the State to offset energy usage in a building elsewhere in the State. BGS has implemented solar projects throughout the State, and uses these to offset energy usage at rest areas. However, the BGS energy program manager noted that Vermont's net metering regulations may change, and restrictions may be placed on virtual net metering.

One of Vermont's rest areas has a unique, sustainable system for treating wastewater. The "Living Machine" at the Sharon Welcome Center along I-89 uses microorganisms, plants, and snails to treat wastewater from the Welcome Center (Figure 8). The rest area was originally constructed in the

1960s and by the early 2000s faced major issues with sewage drainage. The site is home to the Vermont Vietnam War Veteran's Memorial, which when it was installed in 1982 was the first Vietnam veteran's memorial in the country.[23] The State wanted to preserve the memorial while addressing the wastewater concerns at the rest area.

Figure 8: Interior of the Sharon Welcome Center's living machine, which treats wastewater for use flushing toilets at the welcome center, and includes educational signage for visitors (Source: Volpe Center).

The Living Machine, located in a greenhouse, uses a natural process in which plants and other microorganisms break down solids in wastewater. The wastewater is treated to a standard that allows the rest area to use it for toilet flushing. The system is sized to treat 6,000 gallons of average daily flow, and a maximum of 9,000 gallons of daily flow. The project manager noted that visitation has increased at the rest area, and the system often reaches its maximum. The system requires intensive maintenance, and is likely costlier than an in-ground septic system would be. However, the State sees the Living Machine as a way advance the science around environmentally-friendly wastewater management, educate the public, and boost the State's green image.

Moving forward, BGS is considering how to make all of the State's buildings, including rest areas, net zero energy or nearly net zero energy. This could include offsetting building energy usage with renewable energy produced elsewhere in the State. The agency is also working with the Vermont Agency of Transportation on implementing electric vehicle chargers at strategic locations to reduce range anxiety, and implementing right-of-way solar projects.

[23] Zezima, Katie. "Vermont Blends 'Green' Flush Toilets and a Greenhouse." New York Times. August 31, 2005. www.nytimes.com/2005/08/31/us/vermont-blends-green-flush-toilets-and-a-greenhouse.html

5. CONCLUSIONS

There are variety of ways in which DOTs can pursue sustainability practices at their rest areas, from retrofitting rest areas to have green building design elements, to changing operations strategies, to installing renewable energy on site. Implementing sustainability strategies at rest areas can help DOTs save money in the long-term, as well as reduce their environmental impacts.

The following section discusses lessons learned from the case studies.

- *Funding*. Interviewees expressed that finding upfront funding to pursue sustainability projects at rest areas is challenging. Even if these strategies save money in the long-term, with limited budgets it is difficult to justify spending more than the bare minimum necessary to renovate or construct a rest area. At least one State, Vermont, has addressed this by using a revolving loan fund to pay for energy conservation projects. With an initial source of funding, it has been able to pay for improvements at numerous rest areas, since the fund is paid back with savings from the energy conservation measures.
- *Policy*. State policy can motivate or mandate DOTs to pursue sustainability strategies at rest areas. Policies such as State green building standards, energy reduction goals for State agencies, and incentives for renewable energy have encouraged DOTs to incorporate sustainability into their rest area design and operations.
- *Certifications.* Several States have pursued green building certifications for their rest areas. These certifications provided DOTs with recognition for their sustainability efforts as well as ideas of strategies to pursue, but were found to be costly and time-intensive.
- *Operations*. Many sustainability strategies allow DOTs to save money on their operations costs. Energy and water conservation strategies, renewable energy, and low-impact landscaping strategies are often cost-effective strategies in the long term.
- *Maintenance.* Some sustainability strategies may reduce maintenance needs, such as installing native plants that require minimal watering and mowing. In other cases, sustainability strategies may increase maintenance needs or costs. For example, maintaining renewable energy or building energy management systems may require specialized skills or training that DOT maintenance staff need to obtain or contract out.

As DOTs continue to renovate or construct rest areas, they can turn to sustainability strategies to cut costs, reduce environmental impact, meet State environmental goals and policies, and improve the visitor experience. Site-specific considerations such as climate, site size, visitation, budget, and State policy can help DOTs determine which strategies may be most feasible for them.

APPENDIX A: POINTS OF CONTACT

Agency	Point of Contact
Colorado Department of Transportation	Bryan Roeder
Florida Department of Transportation	Dean Perkins
North Carolina Department of Transportation	Jimmy Parrish Jennifer Pitts
The Ray C. Anderson Foundation	Allie Kelly
Vermont Department of Buildings and General Services	Dan Edson Merle Miller

APPENDIX B: INTERVIEW GUIDE

Concept

Can you tell us about the rest areas that incorporate green building design, or other sustainable rest area practices that your agency has implemented?

a. At how many rest areas? When were they developed?
b. New rest area or modifications to existing rest area?

How did the idea come about? What were the motivations for pursuing a sustainable rest area?

a. Who/what did you look to for ideas (other states, other green buildings in the state, etc.)?
b. Are there any state laws or guidelines that encourage the construction of sustainable rest areas (e.g., energy reduction targets, green building guidelines)?
c. Why did you decide to put the sustainable rest area in this particular location?
    i. Did you consider suitability for renewable energy when selecting the site?

Rest area elements

What green/sustainable elements did you incorporate into the rest area?

Did you use a sustainability rating or certification system (e.g., LEED) when designing the rest area?

Does the project include on-site renewable energy? If so:

a. Where is the electricity generated used? Onsite?
b. Who owns/operates the renewable energy facility?

Have you calculated the energy usage/carbon footprint of the rest area?

a. How? What methodology did you use?
b. How does this compare to that of a traditional rest area?

Cost/financing

How did you estimate the cost of the project?

a. Was a life-cycle analysis done? If so, how soon do you expect to recoup the capital and operations/maintenance costs?
b. Did the initial cost estimates reflect reality? If not, what changed?

How was the project financed?

a. If there is a renewable energy system, was that financed differently from the rest of the project?

Operations/maintenance

How do operations and maintenance of the rest area differ from that of traditional rest areas?

a. Anything unexpected?
b. Have maintenance costs increased or decreased?
c. Additional/different work for maintenance staff? If so, what was the learning curve like?

Stakeholders/public involvement

What stakeholders (internal and external) have been involved?

What is the public perception of the project?

Did you do any public outreach related to the project?

Best Practices / Lessons Learned
What have you learned? What advice would you give other transportation agencies seeking to implement a similar project?

What challenges did you run into, and how did you overcome them?

Does your agency have plans for additional sustainable rest areas?

Referrals
Any contacts in other states?