Case Study of Deep Portage Learning Center's Sustainable Energy Initiative


Dale Yerger, Steven Gang, Norm Moody and Jim Ballenthin

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In 2011 Deep Portage turned on its first solar electric array with a rated capacity of 8 DC kilowatts and an electricity generating wind turbine with a rated capacity of 10 DC kilowatts, both producing carbon-free clean energy. Getting “turned on” to clean energy is one of the initiatives that makes Deep Portage stand out as a leader in energy efficiency and environmental responsibility. By the end of 2015 Deep Portage had expanded its electricity clean energy from the original 18 kW to 58kW, which has resulted in clean electric power generation rising from 5,755 kWh in 2011 to 57,284 kWh in 2015. In addition Deep Portage purchases “green credits” valued at 226,800 kWh annually of clean energy. In 2015, through its own solar electricity and purchase of “green credits,” 100% of Deep Portage’s electric energy was “green” and it contributed to the grid an additional 61,810 kWh of fossil carbon-free clean energy.

Deep Portage is not a newcomer when it comes to environmental responsibility. Being located in central Cass County, near Hackensack, Minnesota, it is situated in the heart of county, state and federal forest lands and is surrounded by some of the most pristine lakes and waters in the United States. Its mission of providing “Experiences and Knowledge That Create an Environmentally Literate Citizenry” is lived out every day. It is a place where community, education, and the environment come together. It is a place where a high priority is placed on the use of energy which has minimal adverse impacts on the health of the air, water and soil upon which all life depends.

Clean electric energy is not the only initiative that Deep Portage has pursued in getting “turned on” to **fossil carbon-free** clean energy. Beginning with 2009 it has added three high efficiency wood gasification boilers with a capacity of 1.17 million BTUH for space heating and heating of domestic hot water, two high efficiency fireplace inserts, two hot air solar furnaces, and a 300 evacuated tube solar array for domestic hot water. It also has converted most lighting to high efficiency LEDs, upgraded many electric motors and compressors to high efficiency models, and replaced many windows and doors with high U-value rated units.

The results of these initiatives in 2015 are a reduction of 123,161 pounds of carbon (2.15 lbs/kW-eia) which would have been emitted by coal generated electricity, a further reduction of 487,620 pounds of carbon as a result of purchased green credits, and a further reduction of 391,707 pounds of carbon (epa-12.43 lbs/gal) as a result of reducing propane consumption from 35,000 to 3,487 gallons annually. Wood for heating, an average of about 100 cords per year, produces no fossil carbon and is purchased locally at market rates from suppliers who harvest from sustainably managed forest lands. **Total 2015 fossil carbon reductions: 1,002,488 lbs. Total 2015 energy cost savings: $36,500.**

Consistent with its mission to bring together community, education, and the environment, Deep Portage has committed itself as much as reasonably possible to obtain the materials, labor, and supplies for its conservation and sustainable energy initiatives from local sources, thereby providing jobs, supporting local families and businesses, and **contributing to county, school district, and township revenues.**
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<tr>
<th>Year</th>
<th>Grid Energy Used Net kWh</th>
<th>PV Energy Generated kWh</th>
<th>Electricity Fossil-free kWh</th>
<th>Propane Gallons</th>
<th>Wood Cords Average</th>
<th>Total Cost $$$</th>
<th>Deep Portage Industry Average</th>
</tr>
</thead>
<tbody>
<tr>
<td>2003</td>
<td>271,470</td>
<td>0</td>
<td>0</td>
<td>--</td>
<td>--</td>
<td>--</td>
<td></td>
</tr>
<tr>
<td>2008</td>
<td>251,707</td>
<td>0</td>
<td>226,800 kWh</td>
<td>29,612</td>
<td>--</td>
<td>$69,800</td>
<td>$0.52 / $1.30</td>
</tr>
<tr>
<td>2011</td>
<td>223,609</td>
<td>5,755</td>
<td>232,555 kWh</td>
<td>10,153</td>
<td>100</td>
<td>$43,100</td>
<td>46,091 / 51,000</td>
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<tr>
<td>2012</td>
<td>191,682</td>
<td>14,831</td>
<td>241,631 kWh</td>
<td>2,593</td>
<td>100</td>
<td>$43,500</td>
<td></td>
</tr>
<tr>
<td>2013</td>
<td>188,891</td>
<td>35,075</td>
<td>261,875 kWh</td>
<td>3,054</td>
<td>100</td>
<td>$49,000</td>
<td></td>
</tr>
<tr>
<td>2014</td>
<td>181,811</td>
<td>39,781</td>
<td>266,851 kWh</td>
<td>2,781</td>
<td>100</td>
<td>$46,700</td>
<td></td>
</tr>
<tr>
<td>2015</td>
<td>164,990</td>
<td>57,284</td>
<td>284,084 kWh</td>
<td>3,487</td>
<td>100</td>
<td>$33,300</td>
<td></td>
</tr>
</tbody>
</table>

* includes 226,800 kWh purchased “green credits”

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**Deep Portage Industry Average**

<table>
<thead>
<tr>
<th>Year</th>
<th>Deep Portage Per Sq Ft</th>
<th>Industry Average Per Sq Ft</th>
</tr>
</thead>
<tbody>
<tr>
<td>2015</td>
<td>$0.52</td>
<td>$1.30</td>
</tr>
<tr>
<td>2015</td>
<td>46,091</td>
<td>51,000</td>
</tr>
</tbody>
</table>

**Calculation:**

$33,300 / 64,370 \text{ sq ft} = $0.52 / \text{ sq ft}$

3000 gallons of propane = 91,333 btu/gal x 3000 = 318,478,171 btu  
222,274 kWh total electric = 3,412 btu/kw x 222,274 = 758,400,000 btu  
100 cords wood = 18,900,000 btu/cord x 100 = 1,890,000,000 btu  
Total = 2,966,878,000 btu / 64,370 sq ft = 46,091 btu / sq ft

**Sources:**

Xcel Energy (Cost per square foot for full service hotels)  
US-EIA (BTU/sq ft for lodging and food service businesses)
02/01/2016

Deep Portage Electricity Use

<table>
<thead>
<tr>
<th>Base Year kWh</th>
<th>2003 kWh</th>
<th>2008 kWh</th>
<th>2009 kWh</th>
<th>2010 kWh</th>
<th>2011 kWh</th>
<th>2012 kWh</th>
<th>2013 kWh</th>
<th>2014 kWh</th>
<th>2015 kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>Grid Use kWh</td>
<td>271470</td>
<td>251707</td>
<td>256344</td>
<td>256002</td>
<td>225937</td>
<td>197655</td>
<td>197383</td>
<td>197785</td>
<td>187492</td>
</tr>
<tr>
<td>PV Produced</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>5755</td>
<td>14831</td>
<td>35075</td>
<td>39781</td>
<td>57284</td>
</tr>
<tr>
<td>PV Sold</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3238</td>
<td>5973</td>
<td>8492</td>
<td>15974</td>
<td>22502</td>
</tr>
<tr>
<td>PV Used</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>0</td>
<td>3427</td>
<td>8858</td>
<td>26583</td>
<td>23087</td>
<td>34782</td>
</tr>
</tbody>
</table>

| Total Use kWh (PV+Grid Use) | 271470 | 251707 | 256344 | 256002 | 229364 | 206513 | 223966 | 221592 | 222274 |
| Net Grid Use kWh (Grid Use - PV sold) | 271470 | 251707 | 256344 | 256002 | 223609 | 191682 | 188891 | 181811 | 164990 |
| Green Credits kWh | 0 | 226800 | 226800 | 226800 | 226800 | -3191 | -35118 | -44889 | -51810 |

Little if any energy improvements or energy conservation: E3 parking area lights added; 10 heat/cool room units added. E3 wood boilers added. Switched T12 to T8 incandescent to CFL LEDs, motors and compressors; B+B PV 12kw and Classroom PV 9kw; solar hot water, two solar hot air space heaters, window and door upgrades, 2 convection ovens added. Electric upgrades - E4 wood boiler added; two fireplace inserts added. Rooftop PV 11.5kw; Rooftop PV 6.5kw; Suniva PV 14.04kw; ten K PV 6.15kw switch T8 to LED Great Room AC, kitchen booster hw heater.
I. Deep Portage Facilities – 64,370 Square Feet

- A 54,000 square foot Resources Heritage Center with two great halls, a climbing wall, library, classrooms, theater, two kitchens and food services, and overnight accommodations for up to 175 persons. This center also includes an electric booster hot water heater serving one of the kitchens, one supplemental electric hot water heater for domestic hot water, two high efficiency wood fireplaces which provide supplemental heat for the great halls, 10 PTAC heat/cool units for bedrooms, 12 Energy Star electric air conditioners for bedrooms, one electric mini-split heat pump for supplemental heat and air conditioning, and two solar hot air furnaces which provide supplemental heat for two classrooms. Primary space heating and domestic hot water provided by the woody biomass boiler systems in Energy 3 and a 300 tube evacuated tube solar hot water system.

- A 6,000 square foot Interpretive Center which houses a museum, resident lodging, and bookstore. The Interpretive Center also includes two LP forced air furnaces (not currently used, retained as backup units) and an electric domestic hot water heater, together with heat exchangers for domestic hot water and forced hot air provided by the woody biomass boiler in Energy 4.

- A 1,960 square foot log cabin used for classroom and staff residence and heated by electricity with LP backup.

These facilities also are provided with hot water for space heating and domestic hot water from four energy centers:

- Energy 1: 390 square feet of conditioned* space which houses four LP hot water boilers for space heating, one LP domestic hot water heater, one BoilerMate indirect domestic hot water heater served by the woody biomass hot water boilers in Energy 3, a 1,000 gallon domestic hot water storage tank, and a solar hot water heat exchanger unit which provide domestic hot water from a solar evacuated tube hot water system. The four LP hot water boilers for space heating are not currently used and are retained as backup units for the woody biomass and solar hot water heating systems.

- Energy 2: 555 square feet of conditioned space which houses two LP hot water boilers for space heating, two unit heaters; one BoilerMate indirect hot water heater(s) served by the woody biomass hot water boilers in Energy 3. The two LP hot water boilers for space heating are not currently used and are retained as backup units for the woody biomass and solar hot water heating systems.

- Energy 3: 1,300 square feet of conditioned space which houses a maintenance facility and two woody biomass hot water boilers including 3,200 gallons of integrated hot water storage plus 4,000 gallons of separate hot water storage.

- Energy 4: 165 square feet of conditioned space which houses one woody biomass hot water boiler plus 1,650 gallons of separate hot water storage.

* conditioned: heated and/or cooled
II. Major Energy Improvements

Energy Use and Facilities Before Improvements and Solar/wind Energy Installations
29,612 gallons of propane (2008)
271,470 kWh of electricity (2003)

Energy Use and Facilities After Improvements and Solar/wind Energy Installations
3,487 gallons of propane (2015)
164,990 kWh of electricity (2015)
100 cords of wood annual average

October 2009: Wood Gasification Boilers – Energy 3 (serving Resources Heritage Center)
Wood Gun E500 (pressurized, closed system; 4,000 gallons hot water storage) – produces continuous average output at a rate of 500,000 btu/hour; manufactured in Pennsylvania; cost $30,000, funded by DEED Minnesota grant and Deep Portage Foundation.

Garn WHS 3200 (non-pressurized, open system with heat exchanger; 3,200 gallons integrated hot water storage) – produces continuous average output at a rate of 500,000 btu/hour for up to about 18 hours, cleaning then required; manufactured in Minnesota; cost $30,000, funded by DEED Minnesota grant and Deep Portage Foundation.

Total project cost: $350,000 ($60,000 in equipment; $290,000 in engineering design, installation and building); designed and installed by Minnesota contractors.

October 2011: Wood Gasification Boiler – Interpretive Center
Froling FHG Turbo (pressurized, closed system, with 1,650 gallons hot water storage) – rated at 170,000 btu/hour; boiler manufactured in Austria and hot water storage tank manufactured in Minnesota; total project cost $42,000 (boiler, storage tank, building, design and installation); sold by Tarm Biomass of Lyme, New Hampshire; designed and installed by Jerry Lilyerd, Sun Energy, of Mora, MN; funded by Deep Portage Foundation.

March 2012: Fireplace Inserts (Great Hall and Dining Hall, Resources Heritage Center)
Two Regency High Efficiency Fireplace inserts – 75% efficiency rating; total project cost $10,000; sold and installed by Wilkening Fireplace, Walker, MN; funded by Deep Portage Foundation.

July 2011: Wind Turbine – Maintenance Yard
Ventura Wind Turbine, 10 kW rating, manufactured in Minnesota; total project cost $76,000; funded by LCCMR of Minnesota; installed by Residential Wind Power, New York Mills, MN.

2006: Solar Electricity (PV) – Maintenance Yard
660 watt off-grid system to power a classroom; total project cost $5,000; funded by Deep Portage Foundation.

November 2011: Solar Electricity (PV) – Maintenance Yard
2,000 watt grid-tied system; total project cost $11,000; funded by Deep Portage Foundation and by a gift from Bud Smith (long time Board member and instrumental in promoting solar PV at Deep Portage).
June 2011: Solar Electricity (PV) – Solar Classroom
8,000 watt grid-tied system, ground mount, bifacial array; constructed to provide an outdoor solar classroom for teaching solar energy; made in USA components; total project cost $88,000; designed and installed by RReal of Pine River, MN; funded by a grant from the U.S. Department of Energy.

October 2012, May 2013: Solar Electricity (PV) – Great Hall Rooftop
11,500 plus 6,500 watt grid-tied systems; U.S. made solar panels; total project cost $61,500; designed by Brad Burritt of Empowered Energy Systems, Hotchkiss, CO, and installed by Brad Burritt, Trosen Electric of Hackensack, MN, and Deep Portage staff; funded by Deep Portage Foundation.

June 2011: Solar Hot Air Furnaces
Two solar hot air furnaces, one in each of two classrooms, to provide supplemental heat; meet about 40% of the daytime heat needs of the classrooms; total project cost $5,500; designed, manufactured and installed by RReal of Pine River, MN; funded by Deep Portage Foundation.

August 2011: Solar Evacuated Tube Hot Water
A 300 tube array that heats domestic hot water and meets about 80% of hot water needs May - September; up to 700 gallons of hot water per day; 75,000 btu/hour rating; racking made in Minnesota and tubes meet Buy USA standards; total project cost $86,000; designed by Cinco Solar and installed by KMI of Brainerd, MN; funded by LCCMR Minnesota.

June 2014: Solar Electricity (PV) – Ground Mount
14,400 watt grid-tied system, ground mount; Suniva panels; designed by Brad Burritt of Empowered Energy Systems, Hotchkiss, CO, and installed by Brad Burritt, Trosen Electric of Hackensack, MN, and Deep Portage staff; total project $49,600 Deep Portage Foundation.

June 2015: Solar Electricity (PV) – Ground Mount
6,150 watt grid-tied system, ground mount; tenK panels (made in Minnesota); designed by RReal of Pine River, MN and installed by RReal and by Trosen Electric of Hackensack, MN; total project cost $33,000 funded $25,000 by LCCMR Minnesota and $8,000 Deep Portage Foundation.
III. Benefits to the Community and to Deep Portage

• Benefits to the Community

Consistent with its mission to “Provide Experiences and Knowledge That Create an Environmentally Literate Citizenry,” the outstanding benefit of the Sustainable Energy Initiative of Deep Portage to the community is showing by example leadership in energy efficiency and environmental responsibility. Deep Portage is visited annually by 9,000 - 10,000 visitors. Students benefit from environmental learning programs, from classroom to hands-on projects and tours of the energy facilities. Visiting adults benefit from tours of the energy facilities. The general public benefits from Deep Portage’s website and published information and data on its green energy facilities.

The wood which Deep Portage burns in its gasification boilers comes from forest lands managed by Cass County, the State of Minnesota, and the US Forest Service, and all of these forest lands are sustainably managed for timber production, wildlife habitat, and public recreation. This provides jobs for loggers and firewood cutters, supports local families and the local economy, and provides tax revenues to the public treasury. In addition, the wood products harvested from county forests provide revenues to the county, which in turn shares part of that revenue with school districts and townships, thereby reducing local property tax burdens.

The Sustainable Energy Initiative of Deep Portage has allowed it to slash its carbon footprint, both through direct reductions in use of fossil fuels and through purchase of green credits. Net carbon kWh have fallen from 271,470 kWh in 2003 to a negative 61,810 kWh in 2015. The result is cleaner air, water and soil for all of us.

• Benefits to Deep Portage

The Sustainable Energy Initiative of Deep Portage has greatly reduced its costs of energy, which is dramatically shown by Chart 3: Energy Cost. Total energy costs have fallen from nearly $70,000 in 2008 to just over $33,000 in 2015. While some of the cost savings may be economy and market related, the fact remains that Deep Portage has reduced its total electricity usage from 271,470 kWh in 2003 to 222,274 kWh in 2015, a reduction of 18%, and of this only 164,990 kWh is net grid power.

The effect on Deep Portage is both greater stability in its energy costs and freeing of resources for the educational mission of Deep Portage. Deep Portage has been able to increase its scholarship funding for students who cannot otherwise afford to come to Deep Portage, and Deep Portage has been able to budget its operations based on more stable and predictable energy costs.

Most importantly, the benefit to Deep Portage includes both “talking the talk” and “walking the walk” of energy conservation. There is no divergence between the stated Mission of Deep Portage and how Deep Portage expresses that mission in its day-to-day operations.
IV. Conclusion

Deep Portage’s Sustainable Energy Initiative is a direct outgrowth of its Mission, something to which Deep Portage is committed to fulfilling. The Mission motivates all staff to aspire to a better future. It also inspires all staff to make that better future a present reality. It then moves each staff person to turn that inspiration into action.

A story is told of two travelers who, having come from opposite directions, meet at the top of a very high hill. After a period of silence, one says to the other, “I have many friends who came to this hill, and seeing how high it was, did several things. Some just turned around and went away. Others dreamed about the site they might see if they traveled to the top. Yet others wished for an easy way to get to the top. None took the first step.” The second traveler says, “I understand. When I came to this hill I made a plan to get to the top, and then one step after the other followed that plan, and here I am with you.” The first traveler nodded his head “Yes.” And then they both continued their journey to the next hill.

Deep Portage is ready to move to the next hill – further reductions in energy usage and conservation, and increased share of total energy from fossil carbon-free energy sources.