ABSTRACT

This paper investigates the role that renewable energy could play to promote economic and ecological sustainability in the Northern Forest region. The link between renewable energy development and land conservation has not been well established in the literature. This paper begins to establish this link. Several opportunities are identified in which renewable energy development could effectively address some of the key issues threatening the long-run sustainability of the Northern Forest region.

The paper concludes that renewable energy development could enhance the value of forested land, thereby reducing the pressure on landowners to harvest timber unsustainably or to sell-off large tracts of land for development purposes. In addition, renewable energy development could provide an opportunity to strengthen and diversify the rural, resource-based economies of the region.

1. INTRODUCTION

The Northern Forest region encompasses a 26 million-acre forest that spans from eastern Maine through the northern portions of New Hampshire, Vermont, and New York states (see figure 1). This region is the largest expanse of continuously forested land in the United States. The one million inhabitants of this region depend on forest resources for employment and a way of life. In addition, the Northern Forest region provides benefits to society as a whole in the form of vital wildlife habitat, watershed protection, recreation, and scenic beauty (Phillips, 1993). One factor that makes this region unique, is the fact that approximately 86% of the region is privately owned. Furthermore, almost one-half of all private land is in the hands of a few large industrial land owners that, in addition to owning the land, manufacture wood products like lumber and paper (Carr, 1994).

1.1 Problems Facing the Northern Forest Region

In 1988, this region first became know as the Northern Forest when Congress commissioned the U.S. Forest Service, in conjunction with the four states, to conduct the Northern Forest Lands Study (NFLS). This study was undertaken to assess potential impacts associated with a variety of changes occurring in the region. The original impetus for the NFLS was the sale of one million acres of forested land in the region by Diamond International Corporation to real estate speculators. This event ignited fears that the traditional land-use and ownership patterns in the region where at risk.

Fig. 1: The Northern Forest region
Since the NFLS, a variety of different special interest groups have been working on many different Northern Forest issues. Much of the work to date has focused on identifying ways in which timber extraction and recreation can co-exist in the region while assuring both long-run ecological and economic sustainability. The pressures of development and land fragmentation are great; nearly 70 million people live within an 8 hour drive of the Northern Forest region (Harper et al., 1990). There continues to be large tracts of forested land for sale in the region and concern is rising over the ecological impacts of recreation and certain timber cutting practices. The challenges facing the region revolve around finding uses for the forest that provide a secure economic base for the residents of the region while also maintaining the region’s ecological integrity and aesthetic character.

1.2 Renewable Energy in the Northern Forest Region

Renewable energy has always played an important role in the Northern Forest region. Figure 2 presents the percentage of total primary energy use that comes from hydroelectricity and biofuels in the four Northern Forest states. For decades, the abundant rivers and streams in the region have provided inexpensive energy for sawmills and paper mills. In addition, wood has been used extensively as a source of fuel for heating homes and generating electricity.

![Fig. 2: Percentage of primary energy consumed from hydroelectricity and biofuels](Source: U.S. Department of Energy’s Energy Information Administration)

Literally hundreds of hydroelectric facilities are scattered throughout the Northern Forest region. For example, Maine has over 100 hydroelectric facilities scattered throughout the State ranging in size from a fraction of a megawatt (MW) to over 78 MWs. In addition, a number of biomass facilities can be found throughout the region. In Vermont, there are two major biomass facilities, for a total of 74 MW of peak output. However, there has been very little development of wind and solar energy technologies in the region.

2. RENEWABLE ENERGY DEVELOPMENT AND LAND CONSERVATION

Existing renewable energy sources and the development of new sources could be utilized to promote sustainability in the Northern Forest region. This section explores the role that renewable energy could play to enhance the value of the forested land in the region, thereby maintaining current land-use and ownership patterns, and diversify the local economies.

Newly deregulated electricity markets in New England and New York will likely create new markets for wind and biomass generated electricity. Although it is difficult to estimate the demand for “green” power in the region, it will likely increase for two reasons. First, several states in New England have adopted renewable portfolio standards (RPS) which mandate that a certain percentage of all energy sold within the state must come from renewable sources. Second, customer choice may create an additional demand for renewables as certain customers opt for “green” power. Renewable energy generated in the Northern Forest region could be marketed at a premium to environmentally conscious consumers in the region.

In addition, this section of the paper explores opportunities for a number of decentralized energy technologies, such as photovoltaics, to enhance and support the extensive transmission and distribution system servicing this low-population density area. Finally, opportunities to achieve land conservation objectives as part of the hydroelectric dam relicensing process are discussed.

2.1 Wind Power Development in the Northern Forest Region

A significant wind resource can be found in the mountainous terrain of all four Northern Forest states. In fact, class 5 and 6 wind resources, the second and third highest wind resource classes, can be found in both northern New Hampshire and Maine (See figures 3 and 4) (Elliot et al., 1986). Much of the land with a good wind resource in these areas is owned by large industrial landowners. To date, however, very little of this valuable wind resource has been harnessed.

In the mid-western United States, wind power development has enhanced the value of the farmland where a significant wind resource exists. Similarly, the value of land in the Northern Forest would be enhanced if the wind resource was harnessed for power production. Typically, the
landowner receives lease payments equal to between 1.5% and 4% of the revenues generated from the sale of the wind power (Lee, 1999 and Tennis, 1999). As a result, the value to the landowner depends on the particular project under consideration.

To calculate the per acre value to the landowner from leasing their land for wind power development, the following data is required: acreage for the access roads, wind towers, and transmission lines, expected annual kWh production from project, expected retail price of electricity, and percent of total revenues to landowner as lease payment. The per acre value is then calculated using the following equation.

\[ AR = \frac{\text{kWh} \times \text{RP} \times \%\text{TR}}{\text{TA}} \]

where,
AR = Annual revenue to landowner ($/acre)
\( k\text{Wh} \) = Annual kWh production of the wind project
\( RP \) = Retail price of electricity ($/kWh)
\%TR = Percent of total revenue going to landowner as lease payment
 TA = Total acreage used for project.

One existing wind power facility in Searsburg, Vermont can be used to estimate the potential revenue flow to the landowner from wind power development. The facility includes eleven 550 kilowatt wind turbines which produce, in an average wind year, 14 million kWhs. The total land cleared for the project was 35 acres for access roads, wind turbine towers, and transmission lines (Green Mountain Power, 1998). The land is being leased from a private landowner engaged in timber production on the land. The potential revenues to the landowner are very sensitive to the percent of revenues dedicated to the lease payment and the expected retail price of electricity. Table 1 provides estimates of the per acre value to the landowner given a range of assumptions on these two key variables.

<table>
<thead>
<tr>
<th>% of revenues</th>
<th>Retail Cost of Electricity</th>
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<tr>
<td></td>
<td>5¢/kWh</td>
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<tr>
<td>1%</td>
<td>$200</td>
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<tr>
<td>2%</td>
<td>$400</td>
</tr>
<tr>
<td>3%</td>
<td>$600</td>
</tr>
<tr>
<td>4%</td>
<td>$800</td>
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Over an extended time horizon, an acre of forested land in the northeast provides $4/acre to $5/acre per year (Degeus,
An increase in the demand for biomass material in the

1999). The table above indicates that the value per acre to
the landowner from leasing their land for wind power
development far exceed the value to the landowner from
timber production. Furthermore, the land area that is most
suitable for wind power development along mountainous
ridge lines would not typically have valuable timber. In
addition, access roads to the wind towers must be built and
maintained as part of the wind development project. These
roads can serve the landowner’s timber harvesting efforts as
well, thus reducing the cost of building roads to gain access
to valuable timber stands.

2.2 Opportunities for Biomass in the Northern Forest

Biomass (plant matter) can be utilized as a fuel, like coal or
natural gas, to generate electricity. This material is
produced in the forest at the time of the harvest, and at mills
and manufacturing facilities where the wood is converted
into final consumer products (Hall et al., 1993). While
there is a significant amount of electricity in the region
produced utilizing biomass, the annual available supply far
exceeds current usage (Kropelin, 1999). In Vermont, for
example, the Vermont Agency of Natural Resources
estimates that annual growth in the forests of Vermont is
195 million cubic feet, while only 83 million cubic feet is
harvested annually (Vermont Agency of Natural Resources,
1999). Thus, it would be conceivable to double the annual
harvest and still not exceed the growth rate of Vermont’s
forests. As discussed above, electric utility deregulation in
the region may create new markets for “green” energy, such
as biomass generated electricity, especially if the power can
be marketed at a premium to environmentally conscious
consumers.

Technological improvements may allow biomass generated
electricity to become economically competitive with
traditional fossil fuel generated electricity, thus drawing
upon the plentiful biomass resources available in the
Northern Forest region. In particular, a new biomass
gasification technology is being tested at a facility in
Burlington, Vermont; the McNeil biomass generating
station is the first industrial scale-up of Batelle Columbus
Laboratory's biomass gasification process. The process
converts wood and other organic material into a gaseous,
energy intensive fuel source that can be used in a high
efficiency gas turbine. This process can improve biomass
conversion efficiencies from 25% to 35% or more (Moon,
1995). This increase in efficiency would significantly
improve the economics of biomass energy production. In
fact, one study estimated the cost of producing electricity
from the biomass gasification process to be approximately
$0.047/kWh, well below the current cost of biomass
generated electricity (Paisley, 1997).

An increase in the demand for biomass material in the
Northern Forest region would contribute to fostering
sustainability in the Northern Forest. The wood used for
biomass electricity production typically comes from low
quality trees and the tree tops from timber harvests. This
allows landowners to generate revenues from the sale of
undesirable tree species cut during thinning, part of a timber
stand improvement strategy (TSI). Although the potential
revenues to the landowner are modest ($12/acre to
$50/acre), the landowner increases the value of the stand
through TSI. Without a market for the low-grade tree
species obtained from thinning, the landowner is less likely
to perform TSI. Thus, increased markets for biomass
material will promote sustainable harvesting practices. In
addition, the waste from the wood products industry could
be a source of additional biomass material that would
otherwise contribute to the solid waste stream.

2.3 Distributed Energy Technologies in the Northern
Forest

Approximately one million people live in the 26 million
acres that comprise the Northern Forest region. This results
in a relatively low population density within the region. In
fact, the people per square mile in the Northern Forest is
roughly half of that found in the rest of the United States
and approximately one quarter of the population density of
the four Northern Forest states (e.g., 37 people per square
mile in the Northern Forest region versus 70 people per
square mile in the United States and 216 people per square
mile in the four Northern Forest states) (Carr, 1994).

This low population density requires an expansive
transmission and distribution (T&D) system to provide
power to the numerous Northern Forest communities. As a
result, the T&D infrastructure is vulnerable to frequent and
extended outages, similar to what occurred during the ice
storm of 1998. In discussions with residents of the town of
Newcomb, New York in the Adirondack State Park, they
commented that they experience power outages on a regular
basis. Also, some homeowners may find it cost prohibitive
to connect to the electric grid if the nearest power line is not
relatively close to their property.

Small-scale renewable energy systems could effectively be
used to support the regions expansive T&D infrastructure
and provide power for remote locations. When the
distributed benefits of placing small-scale, distributed
technologies within the T&D system are captured, the
economics of renewable energy technologies are

1 The payment to the landowner for biomass material is
estimated at between $0.50/ton to $2.00/ton. The average
number of tons per acre is 25. These figures were obtained
through conversations with Bill Kropelin, chief forester for
the McNeil biomass facility in Burlington, Vermont.
2.4 Dam Relicensing and Land Conservation

Many residences of the Northern Forest region have found that small-scale renewable energy systems offer a cost-effective alternative to connecting to the power grid. An effort should be made to systematically evaluate the economics of small-scale renewable energy systems as an alternative to extending the power grid. The abundant state and national forests should also consider these alternatives for their remote power needs.

The role of hydroelectricity in a land conservation strategy revolves primarily around the issue of dam relicensing. All hydroelectric dams must receive a license to operate from the Federal Regulatory Commission (FERC). Originally, these licenses were given for a 50-year period. Many facilities in the region are coming up for relicensing. As part of the public process, conservation concessions can be gained as a condition for allowing a private entity to benefit from a public resource. In fact, the Conservation Law Foundation (CLF) and other parties entered into a comprehensive settlement with the New England Power Company regarding the relicensing of its dams in the upper Connecticut River Valley in New Hampshire and Vermont. According to CLF, the settlement will provide more than $30 million in environmental and recreational improvements, and protect 11,000 acres of land from development (Conservation Law Foundation, 1999). Similar settlements are occurring throughout the Northern Forest region contributing to an overall conservation strategy.

3. CONCLUSIONS

Deregulation of the electric utility sector in New England and New York will create new markets for renewable energy, through both renewable energy portfolio standards and consumer preferences for “green” energy options. The Northern Forest region contains a significant untapped supply of renewable energy resources. In particular, wind and biomass resources are abundant in the region and have been largely untapped. The development of these resources could help to achieve conservation objectives in the region by addressing some of the most pressing issues threatening the long-run sustainability of the region. In particular, the development of wind and biomass power could provide an additional stream of revenues to large industrial landowners in the region alleviating the pressure to harvest timber unsustainably or sell their landholdings for development purposes.

Renewables can also play a role in the region to support the expansive T&D infrastructure and provide remote power. Small-scale renewable energy systems, like photovoltaics, could help to enhance the overall integrity of the region’s T&D system. The relicensing of hydroelectric facilities offers an opportunity to gain conservation concessions as a condition for issuing a new license. Future analyses of these issues should assess the region’s transmission capacity to determine the technological and economic barriers associated with delivering the renewable energy generated in the Northern Forest to the New England and New York. Although it is likely that additional renewable energy development in the region will help to stimulate and diversify the region’s economy, future analyses should attempt to estimate the economic and employment benefits to the Northern Forest from additional renewable energy development in the region.

4. ACKNOWLEDGMENTS

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5. WORKS CITED

(2) Conservation Law Foundation. 1999. Information
obtained from their world wide web site www.clf.com.

Boston, MA: Conservation Law Foundation.


