

**Environment and Natural Resources Trust Fund  
2015 Request for Proposals (RFP)**

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**Project Title:**

**ENRTF ID: 112-E**

In-Woods Biomass Drying to Increase Energy Value

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**Category:** E. Air Quality, Climate Change, and Renewable Energy

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**Total Project Budget:** \$ 194,550

**Proposed Project Time Period for the Funding Requested:** 2 years, July 2015 - June 2017

**Summary:**

Evaluating impacts of in-woods biomass drying techniques to reduce moisture content, which increases energy value, decreases air emissions and biomass requirements, and increases competitiveness with fossil fuel heating and electricity.

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**Name:** Dennis Becker

**Sponsoring Organization:** U of MN

**Address:** 1530 Cleveland Ave N, 115 Green Hall  
St. Paul MN 55108

**Telephone Number:** (612) 624-7286

**Email** drbecker@umn.edu

**Web Address** http://www.forestry.umn.edu/People/Becker/

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**Location**

**Region:** Statewide

**County Name:** Statewide

**City / Township:**

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**Alternate Text for Visual:**

Pictures of example in-woods biomass piles with paper covers

_____ Funding Priorities	_____ Multiple Benefits	_____ Outcomes	_____ Knowledge Base
_____ Extent of Impact	_____ Innovation	_____ Scientific/Tech Basis	_____ Urgency
_____ Capacity Readiness	_____ Leverage	_____ TOTAL	



**Environment and Natural Resources Trust Fund (ENRTF)**

**2015 Main Proposal**

**Project Title:** In-Woods Biomass Drying to Increase Energy Value

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**I. PROJECT STATEMENT**

The use of forest biomass for wood energy has great potential to provide a renewable, clean source of energy while investing in rural economies. But not all biomass is created equal. In Minnesota and most of the United States, biomass is collected and delivered wet (green) to processing facilities at time of harvest. High moisture content reduces boiler efficiency, which reduces the energy value compared to dried biomass. The consequence of wet biomass is higher air emissions, more biomass needed from within a supply region, increased transport costs and emissions, and overall increased production costs, which decreases competitiveness with fossil fuels. Decreased competitiveness results in a lower rate of displacement of propane and heating oil, thus limiting the potential environmental and economic benefits of wood energy in Minnesota.

The extent to which in-woods drying increases biomass energy value through improved boiler efficiency could significantly reduce carbon emissions and particulates, feedstock demand within a supply region, and transport costs and emissions per unit of energy generated. The potential environmental and human health benefits from this simple innovation are potentially substantial. It would also make wood energy more competitive with fossil fuels. But the magnitude of benefits and applicability to Minnesota is unknown. Research is needed to quantify the effects of in-woods drying on delivered energy value, and to evaluate market impacts and the willingness of industry to purchase biomass on an energy content basis (Btu) as opposed to a wet basis (green tons).

The overall goal of this project is to improve the energy value of forest biomass. Our objective is to quantify the net benefits of in-woods drying by measuring change in (a) boiler and transport emissions; (b) biomass needed to generate an equivalent amount of energy output; (c) ecological impacts from prolonged storage of biomass on the harvest landing; (d) cost of wood energy production and displacement of fossil fuels (\$/MMBtu); and (e) the willingness of forest landowners, loggers, haulers, and utilities to adopt alternative feedstock logistic and procurement practices. We will accomplish this by establishing a series of field trials on public and private forests managed by the Minnesota Department of Natural Resources, Minnesota Power, Fond du Lac Band of Lake Superior Chippewa, UPM-Blandin, and the University of Minnesota Cloquet Forestry Center. Findings of the two-year project will provide evidence about the benefits of in-woods drying in Minnesota, which is necessary for industry to pursue market innovations and to increase sustainability of wood energy production.

**II. PROJECT ACTIVITIES AND OUTCOMES**

**Activity 1:** Establish Field Trials, Harvest and Chip Biomass, Measure Moisture Content **Budget: \$52,000**

We will establish five replicated trials with four biomass piles per trial on public and private forests. Moisture content and chip quality will be quantified for two piles left uncovered and two piles covered with BioWrap paper on each site. Effect of pile position, size, aspect, and tree species will be evaluated. Moisture content will be measured at initial harvest, six months post-harvest, and time of final chipping (9-12 months post-harvest).

<b>Outcome</b>	<b>Completion Date</b>
1. Initial harvest operations, biomass piling, and moisture content sampling	January 2016
2. Chip quality testing, and re-measurement of pile moisture content	July 2016
3. Final chipping, re-measurement of moisture content, deliver chips to energy company	December 2016

**Activity 2:** Evaluate Environmental Benefits (air emissions, biomass requirements, soils) **Budget: \$82,550**

We will measure change in boiler efficiency (Btu’s generated) and air emissions (particulates, carbon) by level of biomass moisture content. We will calculate the amount of biomass needed from within a defined supply radius to produce an equivalent amount of energy output. We will measure the ecological effects of on-site storage on soil properties, regeneration, and plant communities. This includes assessment of site-preparation activities to mitigate impacts, and consequences for Minnesota’s Forest Management Guidelines.



Outcome	Completion Date
1. Measure criteria pollutants from biomass combusted at different moisture levels	December 2016
2. Calculate the amount of biomass needed to produced equivalent energy outputs (Btu's)	April 2017
2. Impacts of prolonged storage on soils and plant communities quantified	September 2016
3. Effects of mitigation practices quantified and incorporated into Forest Mgt. Guidelines	April 2017

**Activity 3: Evaluate Implementation Barriers to In-Woods Biomass Drying**

**Budget: \$60,000**

We will use the results to evaluate impacts on logging and trucking operations and willingness to sell biomass on an energy content basis. We will evaluate changes in chip quality, fuel purchasing, and contracting to optimize value-chain efficiency. We will also evaluate the change in wood energy production costs (\$/MMBtu), and estimate the amount of fossil fuel production that could be offset by increased wood energy competitiveness.

Outcome	Completion Date
1. Interview loggers, haulers, and purchaser(s) on project costs, barriers, and benefits	December 2016
2. Incorporate study findings into logger education/training, and Itasca Community College power generation continuing education (EngT1803-Renwable Energy 3-Woody Biofuel)	April 2017
3. Final report of activity results completed	June 2017

**III. PROJECT STRATEGY**

**A. Project Team/Partners**

Project Partners Receiving Funds:

- Dr. Dennis Becker (UMN Forest Resources): Project PI, coordinating data collection and analysis
- Brad Jones (Itasca Community College): Data collection oversight and analysis
- Dr. Robert Slesak (Minnesota Forest Resources Council): Provide analysis of site-level ecological impacts
- Dr. Charlie Blinn (UMN Forest Extension): Solicit logger input; provide logger training and outreach
- Dave Chura (MN Logger Education Program): Solicit logger input; provide logger training and outreach
- John Gephart & Tony Schram (North Shore Forest Products): Biomass piling and equipment operation

Project Partners Not Receiving Funds:

- Matthew Radzak (Minnesota Power): Provide forest land for trials; purchase biomass under existing contracts; no grant funds used to purchase biomass or to compensate landowners.
- Kevin Bergstrand (Minnesota DNR): Provide forest land for trials; coordinate logging crews
- Bruno Zaga & Steve Olsen (Fond du Lac Band): Provide logging crews and forest land for trials
- Cheryl Adams & Jim Marshall (UPM-Blandin): Provide forest land for trials; coordinate logging crews
- Mike Reinikainen (University of Minnesota, Cloquet Forestry Center): Provide forest land for trials
- Tomas Johannesson (Forestry Research Institute of Sweden): Develop data collection protocol
- Christopher Walden (Swedish Energy Agency): Provide external funds for Skogforsk involvement

**B. Project Impact and Long-Term Strategy**

This project is part of a long-term strategy to increase wood energy production and improve sustainability. It builds on efforts to reduce reliance on propane and heating oil in Minnesota including recent USDA funding to establish a MN Statewide Wood Energy Team. It also builds on efforts to create local wood energy capacity (LCCMR #156-F3+4, Supporting Community-Driven Sustainable Bioenergy Projects), and links actions to the *2013 MOU on Sweden-Minnesota Bioenergy Cooperation*. Project partners represent a significant share of biomass procurement; their involvement is expected facilitate adoption of in-woods drying in operational settings.

**C. Timeline Requirements**

The 2-year project period is needed to coordinate and implement field trials, dry biomass on-site for 9-12 months, evaluate findings, and incorporate the results into logger education training programs, feedstock procurement recommendations, and the Minnesota's Forest Management Guidelines.

## 2015 Detailed Project Budget

**Project Title:** In-Woods Biomass Drying to Increase Energy Value

### IV. TOTAL ENRTF REQUEST BUDGET: 2 years

<b>BUDGET ITEM</b>	<b>AMOUNT</b>
<b>Personnel:</b>	
Dr. Dennis Becker, Project Manager (75% salary, 25% benefits): 9% FTE for 24 months	\$ 20,000
Dr. Charles Blinn, education and outreach (74% salary; 26% benefits); 6% FTE for 12 months	\$ 10,000
1 University of Minnesota Research Associate, data collection and analysis (60% salary, 40% benefits); 50% FTE for 15 months	\$ 43,000
<b>Contracts:</b>	
Professional logging services (5 logging sites x \$6,000/site); payment to contractors for extra time and equipment needed to move biomass to landings and to pile biomass as requested for research; no payment for feedstock	\$ 30,000
Minnesota Logger Education Program: Conduct logger outreach and user interviews, and develop training curriculum (\$7,200 = 240 hrs @ \$30/hr; \$3,300 meeting rooms, supplies, and field tours; \$2,500 videography/editing; and \$2,000 travel)	\$ 15,000
Itasca Community College: Conduct biomass field sampling, moisture and energy content testing and estimation of boiler emissions. Includes salary and fringe for Co-PI Dr. Brad Jones (20% FTE for 24 months); salary and fringe for 4 students to collect and analyze data; and travel (mileage, lodging, meals, etc.) for co-PI and students to data gathering sites and trainings.	\$ 50,500
<b>Equipment/Tools/Supplies:</b>	
Chip screens for material quality testing	\$ 1,000
BioWrap paper covers (\$700/roll + freight x 10 rolls): covering for biomass piles to achieve reduction in moisture content (see Supplemental Attachment)	\$ 7,000
Freezer for sample storage, chain saw maintenance, sampling supplies, etc.	\$ 2,550
<b>Travel:</b>	
University of Minnesota: (~7,500 miles), lodging, and meals for travel to data gathering sites and trainings	\$ 5,500
<b>Additional Budget Items:</b>	
Lab services from an environmental testing company for real time air emissions testing (~1,000/sample x 10 samples)	\$ 10,000
<b>TOTAL ENVIRONMENT AND NATURAL RESOURCES TRUST FUND \$ REQUEST =</b>	<b>\$ 194,550</b>

### V. OTHER FUNDS

<b>SOURCE OF FUNDS</b>	<b>AMOUNT</b>	<b>Status</b>
<b>Other Non-State \$ To Be Applied To Project During Project Period:</b>		
Blandin Foundation grant to Itasca Community College for moisture testing equipment	\$ 11,300	Secured
USDA cash grant to Itasca Community College for moisture testing equipment	\$ 10,000	Secured
Swedish Energy Agency to secure Skogforsk (Forest Research Institute of Sweden) participation in project design, training	\$ 30,000	Pending
<b>Other State \$ To Be Applied To Project During Project Period:</b>		
Itasca Community College contribution of time and equipment	\$ 9,130	Secured
<b>In-kind Services To Be Applied To Project During Project Period:</b>		
Minnesota Power: coordinate loggers, provide forest sites, moisture content testing	\$ 10,000	Secured
UPM-Blandin: coordinate loggers, provide forest sites	\$ 10,400	Secured
Minnesota Logger Education Training Program contribution of time and resources towards logger training and outreach	\$ 4,750	Secured
Skogforsk (Forest Research Institute of Sweden) contribution of time and reduced rate towards project design, training	\$ 20,000	Secured
<b>Funding History:</b>		
Fond du Lac Band secured Skogforsk services with tribal funds to initiate 2014 trials	\$ 25,000	Secured
<b>Remaining \$ From Current ENRTF Appropriation:</b>	NA	

**PROJECT TITLE:** In-Woods Biomass Drying to Increase Energy Value



**Figure 1.** Biomass pile with paper cover in Östersund, Sweden after nine months drying (September 2013).



**Figure 2.** Skogforsk—Forest Research Institute of Sweden researcher providing training to Fond du Lac Band loggers on biomass piling and storage techniques (January 2014).

## DENNIS R. BECKER

Associate Professor, Department of Forest Resources, University of Minnesota  
1530 Cleveland Ave N., St Paul, MN 55108-6112; 612-624-7286 (w); E-mail: [drbecker@umn.edu](mailto:drbecker@umn.edu)

- Expertise** Forest and related natural resource policy research focuses on policy development and evaluation, resource assessment, and analysis of social and economic impacts pertaining to wood utilization, carbon accounting, environmental review, and community energy systems. Geographic focus in Minnesota and Lake States, western United States, and Scandinavia.
- Education** Ph.D. University of Idaho, Moscow, ID (2002) – Natural Resource Sciences  
M.S. Michigan State University, East Lansing, MI (1997) – Recreation & Tourism Resources  
B.S. Kansas State University, Manhattan, KS (1992) – Park Resource Management
- Appointments** Associate Professor, Forest Resources, University of Minnesota, St Paul, MN (9/2011-present)  
Assistant Professor, Forest Resources, University of Minnesota, St Paul, MN (6/2005-8/2011)  
Post Doc, USDA Forest Service, Pacific Northwest Research Station, Portland, OR (2002-2005)
- Leadership** Current Chair of the Society of American Foresters National Committee on Forest Policy;  
Board of Directors, Biomass Thermal Energy Council; Major Coordinator for the University of Minnesota Environmental Science, Policy and Management undergraduate program (ESPM)
- Recent Awards** Fulbright Fellow, US Dept of State (2013); H.T. Morse Distinguished Faculty, University of Minnesota (2012); University of Idaho Alumni Award (2010); Outstanding College Advisor, University of Minnesota (2010); CFANS Teacher of the Year, University of Minnesota (2009)
- Selected Presentations** 47 total invited presentations and keynote speeches given since 2005; 1 White House-USDA, 3 US Senate and House, and 4 state legislative briefings given on forest carbon accounting, wood energy development, and forest sustainability; 4 international invitations
- Recent Grants** Total: \$3,158,713; PI: \$1,527,479
- Selected Publications:** 31 total referred articles; 3 referred chapters; 33 technical reports  
Sagor, E.; Becker, D.R. 2014. Personal networks and private forestry in Minnesota. *J Env Mgt.* 132:145-154.  
Becker, D.R.; Eryilmaz, D.; Klapperich, J.J.; Kilgore, M.A. 2013. Social availability of residual woody biomass from non-industrial private woodlands in Minnesota and Wisconsin. *Biomass & Bioenergy* 56:82-91.  
Kueper, A.; Sagor, E.; Becker, D.R. 2013. Learning from landowners: Exploring peer exchange in the private landowner community through organizational case studies. *Society & Natural Resources* 26(2):1-19.  
Domke, G.M.; Becker, D.R.; D'Amato, A.W.; Ek, A.R., C.W. Woodall. 2012. Carbon emissions associated with the procurement and utilization of forest residues for energy in MN. *Biomass & Bioenergy* 36(1):141-150.  
Ma, Z.; Becker, D.R.; Kilgore, M.A. 2012. Barriers and opportunities for effective cumulative impact assessment in state environmental review in the United States. *J of Environmental Planning & Mgt*, 55(7):961-978.  
Becker, D.R.; McCaffrey, S.; Abbas, D.; Halvorsen, K.E., Jakes, P.; Moseley, C. 2011. The conventional wisdoms of woody biomass utilization. *Journal of Forestry*, 109(4):208-218.  
Becker, D.R.; Moseley, C.; Lee, C. 2011. A supply chain analysis framework for assessing state-level forest biomass utilization policies in the United States. *Biomass & Bioenergy*, 35(4):1429-1439.  
Becker, D.R.; Larson, D; Lowell, E.C. 2009. Financial considerations of policy options to enhance biomass utilization for reducing wildfire hazards. *For Policy and Economics* 11(8):628-635.  
Becker, D.R.; Nechodom, M.; Barnett, A.; Mason, T.; Lowell, E.; Graham, D.; Shelly, J. 2009. Assessing the role of federal community assistance programs to develop biomass utilization capacity in the western United States. *Forest Policy and Economics* 11(2):141-148.  
Becker, D.R.; Skog, K.; Hellman, A.; Halvorsen, K.E.; Mace, T. 2009. An outlook for sustainable forest bioenergy production in the Lake States. *Energy Policy* 37(12):5687-5693.  
Lowell, E.C.; Becker, D.R.; Larson, D.; Rummer, R.; Wadleigh, L. 2008. An integrated approach to evaluating the economic costs of wildfire hazard reduction in the southwest United States. *Forest Science* 54(3):273-283.