System-of-systems interfacing issues: a threat to western bioenergy availability Jeffrey Richardson², Kurt Spies¹, Steve Rigdon², Sara York¹, Rodney Cawston², and Daniel Schwartz¹ the role of life cycle assessment (LCA) Joyce Smith Cooper¹ **Bioresource-Based Energy for Sustainable Societies Program** Colleges of ¹Engineering and ²Forest Resources

Traffic

More.

100 mi

Satellite

Ter

Map

Western Governors Bioenergy Surveys

- 10 GW capacity at ¢8/kWh
 by 2015, if used for electricity
- Great for meeting renewable portfolio standards and renewable energy credits
- Uncompensated benefits from reduced fire risk, reduced air pollution, reduced GHG_e is worth >¢11/kWh



Biomass Task Force Report, Jan. 2006

Western Governors Bioenergy Surveys

- 8.3B gallons of gas (equiv) at
 \$2.40/gge by 2015 using
 different conversion methods
- Can provide 55% of the renewable fuel standard in the Energy Independence and Security Act by 2015
- Includes grains, oil seeds, and lignocellulosic biomass

Strategic assessment of bioenergy in the West, Sept. 2008



WGA analysis ignores key issues

WGA treats all the same 3 different management objectives 3 diff thinning/harvest regimes 3 diff bearers of fire costs 3 diff sets of laws and customs 2 definitions of "renewable power"

Google - Imagery @200

Ter

Scale, cost, and societal benefits of bioenergy are affected by these differences

100 mi

Biomass availability is set by interactions in

- Social Systems
 - values of land owners
 - political boundaries
- Technical Systems
 - transportation logistics
 - process technology
- Economic Systems
 - competing markets for the biomass
 - cost vs. competing renewables (e.g., I-937 mandates)
- Environmental Systems
 - more natural fire regimes
 - carbon credits

- more resilient to insects
- invasives removal

Tribal energy design projects probe these interactions

- laws and policy

- existing infrastructure

Tribal energy partnership 1: Yakama Nation

Yakama Power/Yakama Forest Products/Grant Co. PUD

- Sawmill residues (negligible transportation)
- Mill kilns require heat (combined heat & power)
- Satisfy I-937 renewables (15% by 2020)
- Tax structure on tribal lands

Interfacing Issues (not resolvable at resolution of WGA)

- Biomass from off-tribal lands (USFS, State, Private...)
- Supply stability linked to size of capital investment
- Employment and capital utilization
- Reduction in GHG emissions...

How many MWs can be reliably fueled with biomass?

First Bio-Energy IGERT Cohort (January, 2008)



Base-case: Yakama Reservation and Yakima Co.



Developing an inventory of Forest Residues





Transportation Model Overview

- Computes over the road costs on a distance (mainly fuel and equipment costs) and time (mainly labor costs)basis.
- Roads are classified into four categories to determine time
- ArcGIS Network Analysis is used to compute distances and times
- Other costs and limits are mostly derived from Polagye, et al. (2007), and Western Governors reports (2006, 2008).



Driving Mileage (Round Trip)







Beyond base-case: Interfacing

- Off reservation biomass has many implications
 - Federal forests are unhealthy (need thinning for fire, bugs)
 - Urban residues must comply with I-937
 - Extra employment opportunities (~4.9 jobs/MW)



USFS Stewardship Contracts, 2003-7

Beyond base-case: Interfacing

- Off reservation biomass has many implications
 - Federal forests are unhealthy (need thinning for fire, bugs)
 - Urban residues must comply with I-937
 - Extra employment opportunities (~4.9 jobs/MW)
- Life Cycle Assessment (Joyce Cooper)
 - Contributions to climate change
 - Effects of land/water use change
 - Energy return on energy invested
 - Employment shifts
 - Possible impact of technology innovations

