RESOURCE CRITERIA APPROVED BY WREZ TECHNICAL COMMITTEE AT ITS OCTOBER 2008 MEETING

ZONE IDENTIFICATION AND TECHNICAL ANALYSIS WORK GROUP

WESTERN RENEWABLE ENERGY ZONES PROJECT

Biomass Criteria Table and Definition

This matrix reflects criteria used to develop maps showing the availability of biomass resources potentially applicable to renewable energy zones (REZs). Biomass resource maps will be overlaid onto REZ maps identified using wind, solar, and geothermal data to determine the level of biomass resource capacity within a REZ. The availability of biomass itself will not be used to define a REZ. The purpose of a candidate study area is to focus the WREZ analysis on those parts of the Western Interconnection with renewable energy resources that are large enough and concentrated enough to economically justify an extra-high voltage (EHV) transmission line and will likely cross state boundaries and require regional coordination. The WREZ project does not supersede or negate state renewable energy initiatives, but is intended to provide a foundation for interstate collaboration on commercial delivery of renewable energy. Resources outside the proposed zones will be identified in this study, but they will not be considered in the supply curve analysis as they are developable as in-state resources and do not depend on regional collaboration.

BIOMASS	
	Status
Base Resource Maps	Draft maps previously provided
Criteria for identifying resources in Candidate Study Areas	
Treatment of biomass in REZ identification	Biomass feedstocks can be transported to a power plant site. As a result, project locations depend much less on the location of the feedstock resources than other technologies assessed in WREZ. As a result of this siting flexibility, biomass projects will be added to REZs created for other location-dependent resources.
Resource categories included (see detailed definitions)	• Agricultural residues • Forest residues • Primary mill residues • Secondary mill residues Urban wood residues (urban wood waste, tree service waste, C&D waste)
Resource categories NOT included (reasons in parentheses)	• Municipal solid waste (location in urban centers not conducive to REZ sites and limited suitability for state RPS compliance) • Dedicated energy (currently limited resource/unknown potential) • Manure (moisture content/limited resource/small generation per site) • Vegetable crops (limited resource) • Liquid food processing wastes (moisture content)
Estimation of amount available for electricity generation (see detailed definitions)	One third of technically available resource.
Unit of analysis	Biomass power availability will be determined on the county level.
Exclusions	Do not affect resource availability because plants can be flexibly sited

Definition of Biomass Resources for WREZ

The main data set that will be used to define biomass power capacity in WREZ areas is from research performed by NREL. Definitions for the major categories of biomass considered in this analysis are used as the starting point for the specific areas that will be considered for WREZ applications. Additional resources identified by the stakeholders will supplement this analysis and are included below.

Greater detail for each category will be included if available from the developers of the data sets.

Agricultural residues are defined as the residues from production of the following crops

- Corn
- Wheat
- Soybeans
- Cotton
- Sorghum
- Barley
- Oats
- Rice
- Rye
- Canola
- Beans
- Peas
- Peanuts
- Potatoes
- Safflower
- Sunflower
- Sugarcane
- Flaxseed

Provided that appropriate data can be obtained, orchard and vineyard residues will be included from state agricultural data and the USDA. Vegetable crop residues (very limited resource in the West) and liquid food processing waste (such as cheese whey, and beverage residues do to their high moisture content) will be excluded, consistent with KSU analysis. Solid food processing waste, such as nut shells, stone fruit pits, cotton gin waste, and rice hulls, will be included.

Forest residues are defined as logging residues and other removals. These include material already utilized as well as material that is disposed as waste. Logging residues are the unused portions of trees cut by logging (tops and branches) and left to be burned or decay in the woods. Other removals include trees removed as a part of thinning projects, land clearings, and forest health uses that are not directly associated with round wood product harvests.

Additional resources that will be included consist of pine beetle infested and killed wood in British Columbia, Colorado, and Arizona. Information on these resources will be obtained as necessary from the BC Ministry of Natural Resources and the USFS. In addition, the removal of pinon pine and juniper from grasslands will also be included as necessary. Data for this resource is likely available from USDA estimates. Finally, green waste sites located in forest communities on USFS land will also be included if significant and if data is available.

Primary mill residues include wood materials and bark generated at manufacturing plants (primary wood-using mills) when round wood products are processed into primary wood products. Among the materials included in this category are the following

- Slabs
- Edgings
- Trimmings
- Sawdust
- Veneer clippings and cores
- Paper pulp screenings.

Secondary mill residues include wood scraps and sawdust generated by the following types of businesses

- Pallet companies
- Woodworking companies
- Truss manufacturers
- Wood container/pallet manufacturers
- Lumber, plywood, millwork and wood panel wholesale companies.

Urban wood waste includes the following three categories:

1) Wood disposed of in municipal solid waste (MSW) and handled by MSW haulers such as household yard waste, clean construction debris, household remodeling scrap, municipal and utility tree trimmings, and wooden shipping containers (other than pallets) disposed of by retail and grocery stores. This includes clean wood residues and green waste that is sorted out of a raw MSW stream. It does not include plastics and tires.
2) Wood waste from the tree service industry, which is generally in the form of mulch (75%) and firewood (25%) from tree trimming activities
3) Wood waste from the construction and demolition industries such as clean construction debris, wood cleared from land before construction, and wood mixed in with other types of debris generated during demolition.

Virgin recycled paper fibers are not included. Industrial wastes are included if the waste stream contains any clean wood that is separated from MSW.

Items Not Included

Based on stakeholder discussions and previous Black & Veatch research, the following potential sources will be excluded from consideration. Footnotes will be made in the report regarding potential.

- MSW (location in urban centers not conducive to REZ sites and limited suitability for state RPS compliance)
- Dedicated energy crops (these are currently limited and of an undeterminable size)
- Manure (moisture content too high, limited resource, and lack of need for transmission due to small generation potential per site)
- Vegetable crops (resource is limited)
- Liquid food processing wastes (moisture content is too high)

Availability of Biomass for Power Generation

Once the gross amount of biomass available is reduced to take into account material necessary for soil quality, animal consumption, terrain accessibility, and collection inefficiencies, an amount of material that is "technically" available is derived. A "technical" estimate is made in recent work performed by both NREL and the CEC. This needs to be further broken down into how this technically available biomass may be utilized. According to the EIA, the main categories for biomass utilization are the following:

- Industrial Usage (~60%, including co-gen)
- Power (~18%)
- Residential and Commercial Use (~19%)
- Transportation Fuels (~3%)

The main purpose of industrial, residential, and commercial use is for heat and not power. 80 percent of the industrial usage is for heat. This is a simple, inexpensive way to use available residues. The growth of any of these sectors could expand demand for biomass. As an example, the Renewable Fuel Standard dictates that 16 billion gallons of cellulosic ethanol be used by 2022. Using a 75 gallon/BDT conversion factor and representative production by Petroleum Area Defense District (PADD) demand, this would mean that 44 million BDTs of biomass would be required just to meet cellulosic ethanol demand in the Western US. Depending on the data source used, this could consume 50 percent or more of the technically available biomass potential.

Allocating the power generation from biomass in the industrial sector to power only, 30 percent of the biomass utilized today goes to the production of power. In discussions with stakeholders as part of the RETI process, Black & Veatch used an estimate that one-third of the available biomass, consistent with the amounts used today, could be utilized for power. While some areas of utilization may increase (such as transportation fuels), others may have limited growth (such as residential use). This estimate is also supported by NREL due to competing thermal and pelletizing demand. Maintaining a one-third estimate for biomass utilization to power takes into account potential utilization in other sectors due to policy mandates, GHG reduction strategies, and increases in the cost of alternate fuels.

Geothermal Criteria Table and Definition

This matrix reflects criteria used to develop maps showing the availability of geothermal resources potentially applicable to renewable energy zones (REZs). The geothermal maps that result will show both general areas and specific locations of developable geothermal resources and/or commercial interest. These maps will be overlaid with similar maps showing wind, solar and biomass resources to select candidate study areas. The purpose of a candidate study area is to focus the WREZ analysis on those parts of the Western Interconnection with renewable energy resources that are large enough and concentrated enough to economically justify an extra-high voltage (EHV) transmission line and will likely cross state boundaries and require regional coordination. The WREZ project does not supersede or negate state renewable energy initiatives, but is intended to provide a foundation for interstate collaboration on commercial delivery of renewable energy. Resources outside the proposed zones will be identified in this study, but they will not be considered in the supply curve analysis. It will be assumed that they are developable as in-state resources and do not depend on regional collaboration. Candidate study areas are precursors to identification of more defined REZs.

Geothermal	
Resource Maps	
Geothermal CSA Identification	1) Existing and "commercial interest" hydrothermal projects and sites from prior WGA geothermal task force report and other reports 2) USGS identified geothermal systems map 3) Map of all existing geothermal leases on federal lands.
Total Geothermal Resource Identification	1) EGS heat map at 5.5km depth Available on google earth at http://www.google.org/egs/index.html Derived from 2004 MIT Report: **The Future of Geothermal Energy**: Impact of Enhanced Geothermal Systems (EGS) on the United States in the 21st Century (http://geothermal.inel.gov/) 2) BHT Map (oil and gas co-production sites) from Southern Methodist University 3) Map of known direct use and geothermal heat pump sites (as small power potential and direct use) possibly from Oregon Institute of Technology or DOE.
Criteria for identifying resources in Candidate Study Areas	
Treatment of geothermal in REZ identification	Geothermal resources are distributed throughout the WREZ study area. In some cases, these resource areas are large enough and/or occur in high enough spatial density to justify the creation of a REZ. In other cases, geothermal projects may be smaller scale and/or so dispersed that they will be considered part of a REZ only if they are included within the boundaries of a REZ created to take advantage of multiple types of renewable resources.
Geothermal Resource Identification criteria	• Discovered conventional geothermal resources (i.e. hydrothermal) will be used to identify REZs based on commercial interest and discovered potential, where, for example, project investment , land leasing or prospecting is already known to have occurred. • Undiscovered conventional resources will be included in REZs when they occur in REZs created for other technologies. They will be quantified if possible, and if not, their presence will be noted using the USGS geothermal favorability map. • Various maps will be used to identify high-quality geothermal resource areas for EGS, co-production (BHT maps), direct use and small power resources.
Exclusions	Resource maps screened using the environmental exclusions applied to wind and solar.

WREZ Geothermal Assessment Overview

In the last 8 years, newly refined "heat flow" mapping techniques, technological advances and publication of comprehensive studies indicate that geothermal resources have the potential to generate renewable energy in the next 10-20 years on par with the estimates other advanced renewable technologies. Based on updated research there may be geothermal energy potential available on the order of a hundred thousand MW or more in the Western Interconnection.

Input from the private sector, research institutions and government agencies, was used to compile a resource map and MW power production table that shows the varied and significant potential for use of geothermal resources to meet western states' energy demand, RPS goals and climate change emission reduction targets.

Recent resource assessments for renewable energy transmission planning are targeting conventional geothermal resources with a high degree of resource certainty, specifically those with known development activity, but their remains a gap in identifying hidden "hydrothermal" resources which may be considerable. WREZ will use the available analyses of conventional resources in identifying geothermal projects for zone identification and transmission planning purposes.

In the geothermal resource assessment, WREZ has included what are traditionally considered utility-scale conventional resource areas (i.e. hydrothermal and mapped and quantified the potential of several other uses and technologies.) While it cannot identify hidden resources, it also does include Enhanced Geothermal Systems (EGS), known direct-use sites (which are also small power opportunities), and co-production opportunities in oil and gas fields using available data. These "layers" have all been mapped as part of the WREZ process.

WREZ has also included all historic and current federal lands leased for development and geothermal lease application data from the Bureau of Land Management (BLM) as a map overlay, including new 2008 lease sales. This data is an excellent representation of commercial interest, and shows a historic increase in leasing activity in geothermal areas for 2008 in Nevada alone of $28.2 million for a total of 105,211 leased acres.

For WREZ, these geothermal resource areas have been identified from a variety of public domain information sources including government assessments of geothermal potential, research papers and maps created by universities and national labs, industry publications and press releases, leasing records, and direct responses from geothermal developers to solicitations for information. After reviewing the assessment data, WREZ will determine which states have geothermal resources of sufficient size to warrant further consideration for zone identification and transmission planning. Based on existing data, WREZ will be able to differentiate between uses for geothermal resources, and while it may be determined that smaller scale uses do not need large-scale interstate transmission solutions, it is important to recognize that recent trend indicate that new geothermal power development on a large, utility scale is being preceded by small-scale development, sometimes distributed generation (eg Wyoming, Alaska, New Mexico, Idaho). By examining the mozaic of available information in context of current

development trends, this approach can provide the most accurate means of identifying resources for specific transmission lines, and avoid the historic problem of underestimating the overall potentially available geothermal resources.

In order to ensure a return on investment in transmission planning, the economic viability of the renewable energy technology must be used as a "screen" for transmission planning purposes. The limiting factor in utilizing the true "commercial" potential of geothermal energy is, at this point, largely a question of investment choices in resource development. In other words, just like wind and solar, we know the resource is there in abundance, but how much are we going to invest in R&D and project development to actually utilize the resource on at least a scale that will (at least) ensure the success of RPS standards? Based on the quality of geothermal resources in the WREZ planning area, it is likely that various technologies will become more commercially available and widely deployed as new entrants invest in resources exploration and project development.

For example, Enhanced Geothermal Systems (EGS) enable the utilization of geothermal resources for power that have traditionally been considered uneconomical to develop. EGS produces heat and electricity by harnessing the energy from hot rock deep below the earth's surface, expanding the potential of traditional geothermal energy by orders of magnitude. Several research projects are underway in the US, Europe and Australia to determine the most effective methods of water use and heat recovery. The project at Soultz-sous-Forêts in France is one of several small projects already producing about power from EGS resources, and other projects in Europe, Australia and the United States are expected to begin generating power within the next several years. Another market development that signals a growing interest in this technology is Google.org's $10 million investment in an EGS project in the Pacific Northwest, new drilling technology and more refined resource assessments as well as the recent agreement of GE to partner with Google in pursuing rapid expansion of this technology.

Significant utility-scale EGS development may be 10 years or more from widespread commercial deployment, but the recent infusion of interest and investment will lead to near term development and its pace cannot be accurately predicted at this point in time. It's eventual pace of development may be determined by how fast cost-reductions follow from added experience in the development and operational aspects of EGS projects. Estimates by MIT of near-term development of EGS sites, however, show economic potential within the range of other advanced technologies, ranging from 10 cents/kWhr to about $1/kWhr depending mostly upon the depth of the resource. This would indicate that prime EGS opportunities should be defined as part of the WREZ process, since their cost and timing may well be within the idealized goals for new renewable development.

Finally, the overall WREZ economic and transmission planning process will necessarily examine the commercial viability of different technologies in different zones. This will presumably drive transmission planning and investment across the Western Interconnection. In looking at different economic viability measurements, geothermal energy technologies can and should receive consideration for their system-wide advantages that help stabilize the grid by providing very reliable baseload, capacity power as part of an ever-increasing renewables mix.

Hydroelectric Power Criteria Table

This matrix reflects criteria used to develop maps showing the availability of hydroelectric resources potentially applicable to renewable energy zones (REZs). Hydro resource maps will be overlaid onto REZ maps identified using wind, solar, and geothermal data to determine the level of hydro resource capacity within a REZ. The availability of hydropower itself will not be used to define a REZ. The purpose of a candidate study area is to focus the WREZ analysis on those parts of the Western Interconnection with renewable energy resources that are large enough and concentrated enough to economically justify an extra-high voltage (EHV) transmission line and will likely cross state boundaries and require regional coordination. The WREZ project does not supersede or negate state renewable energy initiatives, but is intended to provide a foundation for interstate collaboration on commercial delivery of renewable energy. Resources outside the proposed zones will be identified in this study, but they will not be considered in the supply curve analysis as they are developable as in-state resources and do not depend on regional collaboration. Candidate study areas are precursors to identification of more defined REZs.

HYDRO	
	Status **Additional Issues/REZ perspective**
Base Resource Maps	Draft available on WGA Mercator site
Criteria for identifying resources in Candidate Study Areas	
Treatment of hydro in REZ identification	Potential hydro projects are distributed throughout the western US. As a result of these characteristics, REZ's will not be created specifically for hydro projects. Instead, hydro projects will be included in a REZ if they are located within the boundaries of a REZ created to serve other resources.
US hydro resources considered (see "Hydro definition and criteriav3.doc")	1. Incremental hydropower 2. New hydropower at existing non-powered dams 3. Irrigation power
Canadian resources	1. All hydroelectric power will be included in Canada, given that it meets all applicable provincial and federal standards. 2. Hydroelectric power in Canada **will** be used to define REZs because it is much more spatially concentrated than in the US.
Mexico resources excluded	No large resource available in Mexico
INL environmental data	Will be passed on to Environment and Lands group for review

Definition of United States Hydroelectric Resources Analyzed

The proposed definition for hydro in WREZ for the US incorporates language from the proposed SB3335 and existing IRS code for the Production Tax Credit (PTC). The purpose of this definition is not to define what is renewable, but what resource will be reviewed for purposes of inclusion in a WREZ. In the simplest form, hydro, for purposes of the WREZ project is retrofitting existing diversions and impoundments with no change in water deliveries. To clarify:

1. Incremental hydropower
2. New hydropower at existing non-powered dams
3. Irrigation power
4. New hydropower at existing diversions or other impoundments

Given the distributed nature of hydro, it is unlikely that hydro will be of sufficient scale to warrant creation of a renewable energy zone and will have little impact on transmission siting issues. However, there may be hydro projects within a study area that can enhance and stabilize proposed renewable energy generation. For those projects within a study area, the hydro projects will be screened for land use, environmental and economic potential when projects fall into a Candidate Study Area.

The final report will detail all exclusions and note that the resource is not defined as 'non-renewable'. Furthermore, hydro projects/resources that fall outside of the zones, the resource potential and benefits will be identified.

The definition below will be used for US hydro resources. It is based on proposed and existing legislation in the US Federal Renewable Energy Production Tax Credit. This language has been negotiated between National Hydro Association and numerous environmental NGOs.

1) Incremental hydropower –
    a. Incremental production from an existing hydropower production facility that is attributable to efficiency improvements or additions of capacity determined by using the same water flow information used to determine an historic average annual hydropower production baseline for such facility.
2) New hydropower developed at existing non-powered dams
    a. The hydroelectric project is operated so that the water surface elevation at any given location and time that would have occurred in the absence of the hydroelectric project is maintained, subject to any license requirements imposed under applicable law that change the water surface elevation for the purpose of improving water quality of the affected waterway.
    b. The hydroelectric project installed on a non-hydroelectric dam or other impoundment that is licensed or permitted by the Federal Energy Regulatory Commission, the Bureau of Reclamation, or other agency as specified by Federal legislation or applicable agency rule making, and meets all other applicable environmental, licensing and regulatory requirements.

c. The non-hydroelectric dam was placed in service for flood control, navigation or water supply purposes and did not produce hydroelectric power.

3) New irrigation hydropower –
   a. Free flowing water in an irrigation system, canal or other man-made channel, including projects that utilize non-mechanical structures to accelerate the flow of water for electric power production purposes.

4) New hydropower at other existing diversions and impoundments:

   a. New hydropower at existing diversions and impoundments, not identified above, that has little or no incremental environmental impact (e.g., municipal water systems, pressure reducing valves, or other energy dissipating features).

Solar – Thermal and PV

This matrix reflects criteria used to develop maps showing the availability of solar resources potentially applicable to renewable energy zones (REZs). These maps will be overlaid with similar maps showing wind, biomass, geothermal, and small hydroelectric resources to select candidate study areas. The purpose of a candidate study area is to focus the WREZ analysis on those parts of the Western Interconnection with renewable energy resources that are large enough and concentrated enough to economically justify an extra-high voltage (EHV) transmission line and will likely cross state boundaries and require regional coordination. The WREZ project does not supersede or negate state renewable energy initiatives, but is intended to provide a foundation for interstate collaboration on commercial delivery of renewable energy. Resources outside the proposed zones will be indentified in this study, but they will not be considered in the supply curve analysis as they are developable as in-state resources and do not depend on regional collaboration. Candidate study areas are precursors to identification of more defined REZs.

SOLAR THERMAL	
Base Resource Maps	NREL Climatological Solar Radiation Model (40 km by 40 km grid using historical data from)
Criteria for developing Candidate Study Area	
Insolation Screen	> 6kWh /m^2/day (supplemented with 5kWh/m^2/day in REZs)
Maximum Terrain Slope	5%*
Exclusions	Wetlands/water bodies Mines (surface) Urban areas Airports

*Varying technologies are developable on slopes up to 5%. The ZITA group may identify more rigorous slope criteria for narrowing candidate study areas down to smaller REZs. Slope will also be accounted for in the REZ supply curves, to the extent that slope affects a project's levelized cost of energy.

Wind

This matrix reflects criteria used to develop maps showing the availability of wing resources potentially applicable to renewable energy zones (REZs). These maps will be overlaid with similar maps showing solar, biomass, geothermal, and small hydroelectric resources to select candidate study areas. The purpose of a candidate study area is to focus the WREZ analysis on those parts of the Western Interconnection with renewable energy resources that are large enough and concentrated enough to economically justify an extra-high voltage (EHV) transmission line and will likely cross state boundaries and require regional coordination. The WREZ project does not supersede or negate state renewable energy initiatives, but is intended to provide a foundation for interstate collaboration on commercial delivery of renewable energy. Resources outside the proposed zones will be indentified in this study, but they will not be considered in the supply curve analysis as they are developable as in-state resources and do not depend on regional collaboration. Candidate study areas are precursors to identification of more defined REZs.

WIND	
Data Source	**NREL Wind Speed Maps at 50 meters and 1 km x 1 km, annual data. Criteria listed below refines the base resource data to show the greatest potential wind resource available for development.**
Criteria for creating Candidate Study Area Map	**Agreement**
Wind Class	Class 4. Class 3 wind may be used to supplement class 4 in certain areas
Slope	20% (industry standard)
Buffer	No buffer needed