



Regional Sustained Hydro Peaking Capacity Analysis

Phase 1 Final Report

October 19, 2008

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I. Summary of Contract Requirements and Schedule

BPA Contract 00038556 was awarded to Don Long Services on July 8, 2008 with an effective date of July 14, 2008. The Pacific Northwest Resource Adequacy Forum (Forum) has been tasked with developing an early warning system to let the Region know when a generation insufficiency might be looming 3 to 5 years out. This contract is a part of that task.

Phase 1 of the contract calls for the Contractor to contact each hydro utility's representative to ascertain whether sustained hydro peaking analyses are available for its projects, or can easily be run for the projects for the defined water conditions (i.e. flows & storage assumptions), or will require the development of a model (preferably a simple spreadsheet model). Based on these discussions, the Contractor will develop a detailed work plan, cost estimate and schedule for Phase II. In addition, the Contractor will develop a preliminary plan for a repeatable process to allow for calculation of the regional sustained hydro peaking capacity analysis on a periodic basis. The deliverable of Phase 1 was originally due on or before September 12, 2008. Because of difficulties in obtaining information from some utilities, the Phase I deliverable deadline was extended to October 19, 2008.

II. Status of Contacts with Utility Representatives

Some contact has been made with every utility listed in Section B.3 of the Statement of Work. Of those, ten of the fourteen utilities have submitted the information I requested to complete the survey.

Written responsive submittals have not been received from PPL Montana, PacifiCorp, Seattle, and Puget. PacifiCorp and Puget have verbally agreed to participate, but have not responded in writing to me. Seattle and PPL Montana have not committed to participate at all in the study.

Several utilities have indicated that they will need a non-disclosure agreement. Avista does not wish to disclose to other utilities the plant discharge of any of its projects. These discharges may be helpful to downstream utilities in better modeling their own systems. PacifiCorp has not agreed to make its studies available to the consultant for verification that their methodology is consistent with that outlined in this study proposal.

III. Projects for which Regional Model will be used.

None of the utilities who have responded so far have completed any peaking capability studies that meet the criteria called for in this Sustained Peaking Capability Analysis. PGE has completed sustained peaking capability studies using a simplified approach. The following table summarizes the projects that will be modeled by their owners and those that will be modeled by the Regional Model. It also identifies projects for which the project owner has not yet indicated whether they will participate in the Regional Sustained Hydro Peaking Capacity Analysis. For workload estimating purposes, it is assumed that the Regional Model will be used for those projects.

**Table 1. Pacific Northwest Hydro Projects
Sustained Hydro Peaking Capacity Study Status of Contacts**

NAME	OWNER	Status of contact with utility	Utility will model	Use Regional Model	Use Regional Model with simplifying assumptions	No response -- assume Regional Model	No response -- assume Regional Model with simplifying assumptions
Cabinet Gorge	Avista Corp	Responded	X				
Post Falls	Avista Corp		X				
Noxon Rapids	Avista Corp		X				
Little Falls	Avista Corp		X				
Long Lake	Avista Corp		X				
Monroe Street	Avista Corp		X				
Nine Mile	Avista Corp		X				
Upper Falls	Avista Corp		X				
TOTAL HYDRO							
Chelan	Chelan PUD	Responded		X			
Rock Island	Chelan PUD			X			
Rocky Reach	Chelan PUD			X			
TOTAL HYDRO							
Yelm	Centralia City	No contact attempted				X	
Wells	Douglas Co PUD	Responded		X			
Carmen	EWEB	Responded	X				
Leaburg	EWEB					X	
Stone Creek	EWEB					X	
Trail Bridge	EWEB					X	

NAME	OWNER	Status of contact with utility	Utility will model	Use Regional Model	Use Regional Model with simplifying assumptions	No response -- assume Regional Model	No response -- assume Regional Model with simplifying assumptions
Walterville TOTAL HYDRO	EWEB				X		
Felt	Fall River REA	No contact attempted			X		
Priest Rapids Wanapum TOTAL HYDRO	Grant Co PUD Grant Co PUD	Responded		X X			
American Falls Bliss Brownlee CJ Strike Hells Canyon Lower Malad Lower Salmon Milner Oxbow Shoshone Falls Swan Falls Thousnd Springs Twin Falls Upper Malad Upper Salmon TOTAL HYDRO	Idaho Power Co Idaho Power Co Idaho Power Co Idaho Power Co Idaho Power Co Idaho Power Co Idaho Power Co Idaho Power Co Idaho Power Co Idaho Power Co Idaho Power Co Idaho Power Co Idaho Power Co Idaho Power Co Idaho Power Co	Responded	X X X X X X X X X X X X X X X				

NAME	OWNER	Status of contact with utility	Utility will model	Use Regional Model	Use Regional Model with simplifying assumptions	No response - assume Regional Model	No response -- assume Regional Model with simplifying assumptions	
Elwha	US Interior Dept	BPA will model	X					
Glines Canyon	US Interior Dept		X					
TOTAL HYDRO								
Cowlitz Falls	Lewis Co PUD	No contact attempted		X				
Black Eagle	PPL Montana	Has not agreed to participate in study						X
Cochrane	PPL Montana					X		
Hauser Lake	PPL Montana						X	
Holter	PPL Montana					X		
Kerr	PPL Montana					X		
Madison	PPL Montana						X	
Morony	PPL Montana					X		
Mystic Lake	PPL Montana						X	
Rainbow	PPL Montana					X		
Ryan	PPL Montana					X		
Thompson Falls	PPL Montana					X		
TOTAL HYDRO								
		Responded verbally to BPA, but won't supply details of study to consultant						
Copco 1	PacifiCorp		X					
Copco 2	PacifiCorp		X					
Irongate	PacifiCorp		X					
East Side	PacifiCorp		X					
John Boyle	PacifiCorp		X					

NAME	OWNER	Status of contact with utility	Utility will model	Use Regional Model	Use Regional Model with simplifying assumptions	No response - assume Regional Model	No response -- assume Regional Model with simplifying assumptions
Ashton	PacifiCorp		X				
Cove	PacifiCorp		X				
Grace	PacifiCorp		X				
Oneida	PacifiCorp		X				
Soda	PacifiCorp		X				
Clearwater	PacifiCorp		X				
Fish Creek	PacifiCorp		X				
Lemolo 1	PacifiCorp		X				
Lemolo 2	PacifiCorp		X				
Slide Creek	PacifiCorp		X				
Soda Springs	PacifiCorp		X				
Toketee	PacifiCorp		X				
Powerdale	PacifiCorp		X				
Prospect 1	PacifiCorp		X				
Prospect 2	PacifiCorp		X				
Prospect 3	PacifiCorp		X				
Prospect 4	PacifiCorp		X				
Bend Power	PacifiCorp		X				
Cline Falls	PacifiCorp		X				
Eagle Point	PacifiCorp		X				
Wallowa Falls	PacifiCorp		X				
Big Fork	PacifiCorp		X				
Condit	PacifiCorp		X				
Merwin	PacifiCorp		X				
Swift 1	PacifiCorp		X				
TOTAL HYDRO							

NAME	OWNER	Status of contact with utility	Utility will model	Use Regional Model	Use Regional Model with simplifying assumptions	No response - assume Regional Model	No response -- assume Regional Model with simplifying assumptions
Box Canyon	Pend Oreille PUD	No contact attempted		X			
Bull Run #1	City of Portland	No contact attempted		X			
Bull Run #2	City of Portland				X		
TOTAL HYDRO							
Provided simplified analysis							
Bull Run	PGE		X				
Faraday	PGE		X				
North Fork	PGE		X				
Oak Grove	PGE		X				
Oregon City	PGE		X				
Pelton	PGE		X				
River Mill	PGE		X				
Round Butte	PGE		X				
TOTAL HYDRO							
Tentative response. Awaiting written confirmation							
Electron	PSE		X				
Nooksack	PSE		X				
Snoqualmie1&2	PSE		X				
Lower Baker	PSE		X				
Upper Baker	PSE		X				
TOTAL HYDRO							

NAME	OWNER	Status of contact with utility	Utility will model	Use Regional Model	Use Regional Model with simplifying assumptions	No response - assume Regional Model	No response -- assume Regional Model with simplifying assumptions
Boundary	City of Seattle	No decision yet. Have expressed concerns about participating.				X	
Cedar Falls	City of Seattle					X	
Newhalem Cr	City of Seattle						X
Diablo	City of Seattle					X	
Gorge	City of Seattle					X	
Ross	City of Seattle					X	
TOTAL HYDRO							
HM Jackson	Snohomish PUD	No contact attempted			X		
Alder	City of Tacoma	Responded	X				
Cushman 1	City of Tacoma		X				
Cushman 2	City of Tacoma		X				
LaGrande	City of Tacoma		X				
Mayfield	City of Tacoma		X				
Mossyrock	City of Tacoma		X				
Wynoochee	Tacoma/Aberd.		X				
TOTAL HYDRO							
Moyie Falls (3)	Bonnors Ferry	No contact attempted				X	
L. Packwood	Energy NW	No contact attempted			X		
Idaho Falls (3)	City of Idaho Falls	No contact attempted			X		

NAME	OWNER	Status of contact with utility	Utility will model	Use Regional Model	Use Regional Model with simplifying assumptions	No response - assume Regional Model	No response -- assume Regional Model with simplifying assumptions
Twin Falls	Twin Falls Hydro	No contact attempted		X			
Pelton Rereg	Warm Spr Tribe	No contact attempted			X		
FCRPS HYDRO	Corps of Engineers/ Bureau of Reclamation	Responded	X				
Count (other than FCRPS)			76	13	9	12	5

IV. Phase II Detailed Work Plan.

A. Obtain approval by BPA and the Council of Phase II approach. Before Phase II is initiated, the work plan, cost estimate and schedule developed by the Contractor in Phase I will be reviewed by BPA and the Council to be sure that the suggested Phase II approach is reasonable. The Forum will also have an opportunity to review and comment on these documents. Before proceeding with Phase II, some changes to the Phase II approach may be negotiated with the Contractor. Once BPA and the Council have approved the Phase II work plan, cost estimate and schedule, as revised through negotiation, then the Contractor will implement this work plan.

B. Develop a model for determining sustained peaking capability (preferably a simple spreadsheet model)

The Contractor will develop a model in the form of a spreadsheet template that will approximate the operation of each utility's hydro facilities during sustained peaking conditions. The hydro facilities for each utility will be modeled as an independent system, except that, where available, the inflow from the upstream projects owned by other utilities will be an input. There will be six cases run for each utility: summer and winter load shapes applied to critical, adverse and average water conditions.

The model shall be designed to allow for the following inputs for each project and utility:

1. Generation vs flow and head
2. Minimum and maximum forebay
3. Allowable storage draft for peaking (at a minimum, this should be the period average storage draft from the seasonal regulation period used in the study.)
4. Minimum discharge
5. Non-power discharge
6. Reservoir content vs forebay and flow
7. Tailwater vs flow and downstream forebay
8. Side inflow below upstream project(s)
9. Water delay time and damping factor from upstream project(s)
10. Other non-power constraints
11. Utility's normal temperature summer load shape and normal temperature winter load shape. Each of these two load shapes will be 3 consecutive days of load by hour, including the normal peak day and the 2 days before, surrounding or after which are the next highest peak days. For example, if the utility's peak day is normally Wednesday, the 3 days could be Monday – Wednesday, Tuesday – Thursday, or Wednesday – Friday, whichever results in the highest total load.
12. Utility's owned or contractual resources other than hydro for each hour of each case

13. "Reasonable" purchases to be assumed during off-peak and shoulder hours. The test of "reasonable" purchases assumptions is that in aggregate, these should not exceed regional market purchases (both in- and out-of region) assumed to be available to the PNW in the PNW Energy Adequacy Standard.

The Contractor will develop a worksheet template that allows each project to be modeled using the inputs listed above. The template will model 72 hours of operation of the utility's hydro system.

In addition to the detailed model outlined above, the Contractor will develop a simplified spreadsheet template for "smaller" hydro projects. These are generally assumed to be projects with a nameplate capacity of 20 MW or less. Generally, these projects will operate either such that daily peak generation equals daily average generation or such that discharge matches the discharge of the upstream project. In either case, modeling of reservoir effects will be unnecessary.

The spreadsheet model for each utility will include a worksheet for each of the utility's hydro projects and a worksheet for calculating the residual load and allocating it among the projects. It is envisioned that the allocation to each project will be done by either specifying a percentage of the residual load, a maximum and minimum generation to be shaped in the same shape as the residual load, or a manually entered allocation. The spreadsheet will calculate generation, discharge, forebay elevation, and tailwater elevation for each project and report whether or not all power and non-power constraints have been met.

C. Gather project data for projects for which the regional model will be used and studies from utilities who are doing their own modeling

At the same time that the model is being developed, the Contractor will gather the data for those projects that are going to use the regional model. Where data is not available, the Contractor will document assumptions made.

1. Obtain purchase assumptions from all utilities, whether they are using regional model or their own model. The statement of work calls for the Contractor to "check whether purchase assumptions in aggregate for the Region are consistent with the assumptions in the PNW Resource Adequacy Standard." In order to perform this check, all utilities, whether doing their own sustained peaking studies or having the regional model determine their sustained peaking capacity, need to supply their purchase assumptions to the Contractor. The Contractor will report only the aggregate regional purchases on an hourly basis.

2. Run model for selected projects. The spreadsheet model will first compute the starting energy load for each utility as the average hydro generation at each of the utility's projects from the seasonal regulation period used in the study, plus the energy component of the utility's owned or contractual resources other than hydro, plus the energy component of "reasonable" purchases. This energy will then be shaped to the utility's normal temperature load shape. The model will then compute the residual hourly hydro load of the utility as that normal temperature load minus the utility's hourly owned or contractual resources other than hydro, minus hourly "reasonable" purchases. A base case

test will be made to ensure that the residual load can be allocated among the utility's projects in a manner that does not violate any power or non-power constraints.

The normal temperature hourly loads will then be incrementally increased or decreased by a constant factor and a new residual load calculated. The model will continually increment or decrement the normal temperature load, compute the residual load and allocate the load to the utility's hydro projects until the point is reached where the load cannot be increased without violating power or non-power constraints at all hydro projects.

3. Fill in Technical Exhibit D.1 for all projects. Based on the results of the model runs or data supplied by utilities, hourly hydro generation will be summed for the highest 6 load hours each day over the 3 days, which define the sustained-peak period, and divide by 18 for each hydro project or utility system under the three hydrological conditions. This sum is then entered into Exhibit D.1 as the 18 hour sustained peaking capacity. The highest one hour generation of the 18 hours will also be entered into Exhibit D.1.

4. Present results to the Forum. The Contractor will present the sustained hydro peaking analyses to the Forum for the six cases run for each utility. The Forum will be requested to concur with the following approach for estimating regional sustained hydro peaking capacity:

- a. Use the sum of the sustained hydro peaking capacities of the Region's hydro projects under critical hydrological conditions as the firm hydro capacity component under the Standard.
- b. Calculate the incremental hydro capacity component by subtracting this firm hydro capacity component from the sum of the sustained hydro peaking capacities of the Region's hydro projects under the adverse hydrological condition as defined in this contract.

If the Forum does not concur with using the adverse value of sustained hydro peaking capacity, the contractor will meet with BPA and Council staff to define a Phase III work plan for this effort.

D. Aggregate purchase assumptions for all utilities. The Contractor will aggregate the purchase assumptions used for each utility and check whether they are in aggregate for the Region consistent with the assumptions in the PNW Resource Adequacy Standard. The Contractor will provide feedback to the Forum as to whether the purchase assumptions to support the sustained hydro peaking capacity operation, in aggregate, are realistic and supportable.

E. Prepare a description of the final methodology to allow the analysis to be a repeatable process. After concurrence with the approach described above for estimating regional sustained hydro peaking capacity, the Contractor will prepare a detailed description of the final methodology used in the model. The report will be submitted to BPA for approval.

V. Phase II Cost Estimate. Following are cost estimates for each of the anticipated tasks in Phase II. Cost estimates assume that all reports will be submitted electronically. If required, printing will be charged at cost plus 5%. If more than 4 trips are required, expenses will be charged at actual cost plus 5%.

A. Develop model	\$20,000
B. Gather data from utilities	\$24,000
C. Estimate data for utilities not participating	\$34,000
D. Perform modeling	\$41,000
E. Check results of studies performed by utilities	\$16,000
F. Complete Technical Exhibit D.1.	\$3,000
G. Check aggregate purchase assumptions	\$4,000
H. Present results to the Forum	\$4,000
I. Prepare description of the final methodology	\$6,000
J. Estimated travel expense	\$2,600
Total estimated cost of Phase II	\$152,600

VI. Phase II Schedule.

A. Develop model	1/1/2009 – 5/26/2009
B. Gather data from utilities	1/1/2009 – 5/26/2009
C. Estimate data for utilities not participating	1/1/2009 – 5/26/2009
D. Perform modeling	5/27/2009 – 8/11/2009
E. Check results of studies performed by utilities	8/12/2009 – 9/10/2009
F. Complete Technical Exhibit D.1	9/11/2009 – 9/23/2009
G. Check aggregate purchase assumptions	9/11/2009 – 9/23/2009
H. Present results to the Forum	9/24/2009 – 9/30/2009
I. Prepare description of final methodology	9/24/2009 – 10/11/2009

VII. Preliminary plan for a repeatable process to allow for calculation of the regional sustained hydro peaking capacity on a periodic basis.

A preliminary plan for a repeatable process to allow for calculation of the regional sustained hydro peaking capacity on a periodic basis is suggested below:

- A. Obtain agreement from all regional utilities that they will participate in determining the regional sustained peaking capacity.
- B. Encourage all utilities to use the spreadsheet model developed by the Contractor.
- C. Provide training to utilities on use of the spreadsheet model
- D. Perform regional analysis at least once every three years to reflect potential changes in load shapes, owned or contractual resources other than hydro and purchases.