

Bill Bradbury
Chair
Oregon

Henry Lorenzen
Oregon

W. Bill Booth
Idaho

James A. Yost
Idaho



Northwest Power and Conservation Council

Jennifer Anders
Vice Chair
Montana

Pat Smith
Montana

Tom Karier
Washington

Phil Rockefeller
Washington

November 16, 2014

MEMORANDUM

TO: Interested Parties

FROM: Council Staff

SUBJECT: Council's Regional Hydropower Potential Scoping Study

In August 2014, the Council released a request for proposals for a regional hydropower scoping study. The Council selected a proposal by the Northwest Hydroelectric Association (NWEHA) to perform the work with the assistance of several subcontractors. The contractor has submitted its final report to the Council – see <http://www.nwccouncil.org/energy/grac/hydro>. The results of this study will be discussed at the November 19th Generating Resources Advisory Committee (GRAC) as well as the December 9th Council Meeting.

The Council's objective for this study was to gain a better understanding of Northwest potential for new hydropower development and for upgrades to existing units, and the costs associated with that potential development. The Council's last major assessment of hydropower potential was conducted during the development of its Fourth Power Plan in 1994. Since then there have been numerous regional and national studies identifying large amounts of hydropower potential. However, these studies considerations of costs, transmission constraints, environmental constraints (including the areas protected from new hydropower development as part of the Council's fish and wildlife program) and other constraints were not clearly stated. (See the background below.) The scope of the Council's study was to review and analyze these existing reports and determine if a **realistic, reasonable** assumption for hydropower potential could be determined from that work. If a realistic, reasonable potential could not be derived, the contractor was asked to recommend next steps to develop a hydropower supply curve for the Northwest.

In developing a resource strategy for the regional power plan, the Council identifies and assesses various generating resources and technology alternatives. Assumptions based on cost, availability, regional potential, and technical specifications are developed for each resource. Those assumptions are discussed and vetted by the GRAC and are

also subject to review and comment by the region's stakeholders and public at large during the development of the Council's power plan.

The results of this study, along with other sources and advisory committee input, will be used by the Council in its analysis of regional hydropower potential as part of its development of the draft Seventh Power Plan.

Background

In April 2014, the Department of Energy (DOE) released a hydropower potential assessment that identified almost 85 gigawatts of developable hydropower in new stream reaches in the United States. The largest potential was found to be in the Pacific Northwest with about 25 gigawatts identified. To put this number in perspective, the region's current hydropower nameplate capacity is around 33 gigawatts.

The DOE assessment is the latest of several studies assessing hydropower potential that have been performed at the national and regional level over the past decade. The existing studies vary in scope, objective and methodology. For example, while the 2014 DOE study focused on new stream reaches, other studies have looked at potential at existing non-powered dams, upgrades at existing hydropower facilities, and varying size, site or region-specific assessments. In addition, studies used different parameters and screens to narrow down and define hydropower potential. For example, some studies may exclude hydropower potential located solely within the region's Protected Areas, while other studies may also exclude areas in federally designated wilderness and protected areas, and other studies apparently ignored (or were not aware of) the protected areas altogether.

As a result, there is a wide range of estimates of hydropower potential for the Pacific Northwest. In addition, existing estimates are often based on physical potential and may not take into account environmental impacts or cost-effectiveness.

Potential Hydropower

Anticipated 2015-2035

November
2014

Non-Powered Dams						Capacity	Generation	
FERC No	Study #	Date	Developer	State	Project Information	River	MW	MWh
Identified in Survey and FERC Applications								
Tongue River Dam	P-14602	N/A	State of Montana, DNR	MT	Add capacity	Ruby	2.200	7,344.0
Gibson Dam	P-12478	2016	Tollhouse Energy/Greenfield I.	MT	New project at existing dam	Sun	15.000	43,217.0
Mason Dam	P-12686	N/A	Baker County	OR	New project at existing dam	Powder	3.400	8,100.0
Pinto Dam	P-14380	2019	GCHPA*	WA	New project at existing dam	Columbia	2.929	9,700.0
Warm Springs Dam Hydro	P-13570	N/A	Warm Springs Irrigation District	OR	New project at existing dam	Malheur	2.700	7,442.0
Studies A-1, A-2, A-3 & FERC Applications								
McKay Dam	P-14205	N/A	McKay Dam Hydropower	OR	New project at existing dam	Umatilla	3.000	7,400.0
Howard A. Hanson Dam	P-14594	N/A	Howard A. Hanson Power, LLC	WA	New project at existing dam	Green	5.000	26,000.0
Scootney Wasteway	P-14352	2019	GCHPA	WA	New project at existing dam	Columbia	1.100	1,480.0
Easton Diversion Dam	P-13850	N/A	Qualified Hydro 15 LLC	WA	New project at existing dam	Yakima	1.200	5,000.0
Blue River Dam	P-14381	N/A	Qualified Hydro 15 LLC	OR	New project at existing dam	Blue	20.630	32,565.3
NON-POWERED DAMS POTENTIAL						10 Projects:	57.159	148,248.3
Conduit Exemptions & Hydrokinetic Projects								
Studies B-1 and B-2	B-2	N/A	Various irrigation districts	OR	4 Conduit projects	Deschutes	5.317	21,508.0
Study B-3	B-3	N/A	Various irrigation districts	OR	2 Conduit projects	Deschutes	1.579	6,172.0
Study B-5	B-5	N/A	Various canal sites	NW	111 Conduit projects	NW Rivers	34.000	116,596.77
Survey Responses	SR	N/A	Various canal/pipeline sites	NW	15 Conduit projects	NW Rivers	14.627	47,918.0
Hydrokinetic Demo Project	SR	2015	Hydrokinetic unit in canal	WA	1 Hydrokinetic conduit project	Yakima	0.01	N/A
FERC apps. Issued	FERC	N/A	Approved projects/canals	NW	7 Conduit projects	NW Rivers	2.099	6,433.0
FERC approved NOIs	FERC	N/A	Approved projects/canals	NW	3 Conduit projects	NW Rivers	6.065	27,480.0
CONDUIT EXEMPTIONS AND HYDROKINETIC PROJECTS						143 Projects:	63.697	226,107.8
Pumped Storage Projects								
John Day Pool	C-2	N/A	Klickitat PUD	WA	Pumped storage	Columbia	1,000.000	15,000.0
Swan Lake	C-2	N/A	EDF Renewable Energy	OR	Pumped storage	Klamath	600.000	10,000.0
Banks Lake	SR	2019	*Grand Coulee Hydroelectric Power Agency (GCHPA)	WA	Pumped storage	Columbia	1,040.000	8,084.0
PUMPED STORAGE PROJECTS							2,640.000	33,084.0

SR: Survey

S-14

Table A

Tidal and Wave Energy

Potential Hydropower

Anticipated 2015-2035

November
2014

No identified projects at this time

General Assessments					Capacity Generation			
FERC No	Study #	Date	Developer	State	Project Information	River	MW	MWh
Identified in Survey and FERC Applications								
Various canal or small reservoir	E-3	N/A	Various irrigation districts	OR	30 Conduit exemptions	Oregon Rivers	20.630	5,852.0
Oak Springs	SR	N/A	Oregon Dept. Fish/Wildlife	OR	Exemption at existing diversion	Deschutes	0.085	15.0
Unidentified Location	SR	N/A	Portland General Electric	OR	New traditional project	Clackamas	2.800	22,210.0
Identified in FERC Applications only								
Go with the Flow	P-14538	FERC	Go with the Flow Hydropower	OR	Traditional hydro exemption	Umatilla	1.200	
Weiser-Galloway	P14608	FERC	Idaho Water Resources Board	ID	Traditional hydro project	Weiser	60.000	365,000.0
Two Girls Creek	P-14626	FERC	Green Volt Hydro Inc.	OR	Traditional hydro	Two Girls Creek	5.000	36,870.0
GENERAL ASSESSMENTS							89.7	429,947.0

Upgrades

These projects were identified in the survey:

Blind report as requested	SR	2020	Unidentified utility	WA	Add equipment	NW	7.000	N/A
Box Canyon Dam	P-2042	2017	Pend Oreille PUD	WA	Add equipment	Pend Oreille	30.000	1,300,000.0
North Wasco PUD Plant	P-7076	2018	North Wasco PUD	OR	Add capacity at Dalles Dam	Columbia	5.000	3,800.0
Shoshone Falls	P-2778	2022	Idaho Power Company	ID	Add capacity	Snake	52.000	N/A
Blind report as requested	SR	2015	Unidentified utility	WA	Add energy	NW	0.000	2,000.0
Grand Coulee Dam	SR	2018+	Bureau of Reclamation	WA	Add units 19-21	Columbia	200.000	N/A
Boundary Dam	SR	2015-2035	Seattle City Light	WA	Add equipment	Pend Oreille	40.000	100,000.0
Packwood Lake Hydro	SR	2015	Energy Northwest	WA	Add energy	Cowlitz	0.000	5,808.0
Black Canyon Dam	SR	2018	Bureau of Reclamation	ID	Add third unit	Payette	12.000	N/A
Hungry Horse Dam	SR	2019+	Bureau of Reclamation	MT	Replace turbines/efficiency	Flathead	0.000	N/A
Lower Baker	SR	N/A	Puget Sound Energy	WA	New powerhouse		30.000	N/A
Little Falls	SR	2015-2018	Avista Corporation	WA	4 new units	Spokane	4.000	17,520.0
Nine Mile	SR	2015	Avista Corporation	WA	Upgrade	Spokane	8.000	35,040.0
Palisades Dam	SR	2016	Bureau of Reclamation	ID	Replace turbines +7.5 efficiency	Snake	0.000	N/A
14 Projects:							388.000	1,464,168.0
TOTAL OF ALL PROJECTS OF EACH TECHNOLOGY:							3,238.56	2,301,555.10



Council's Regional Hydropower Potential Scoping Study: Results and Next Steps

Gillian Charles
Peter Paquet
December 9, 2014

 Northwest Power and Conservation Council  SEVENTH NORTHWEST POWER PLAN

Why hydropower and why now?

- Last major regional hydropower potential assessment undertaken in the Fourth Power Plan
- Sixth Power Plan identified need for an updated assessment
- Many national and regional studies performed over past decade identifying large sums of potential in the Pacific Northwest

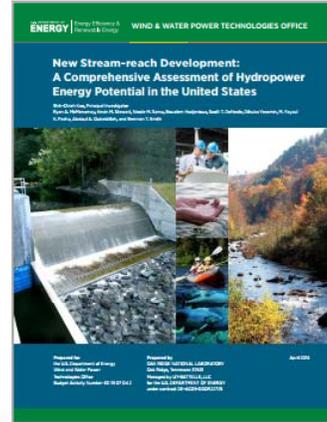


 Northwest Power and Conservation Council 2  SEVENTH NORTHWEST POWER PLAN

Latest Hydropower Potential Study Creating a Buzz

2014 DOE study on undeveloped stream reaches

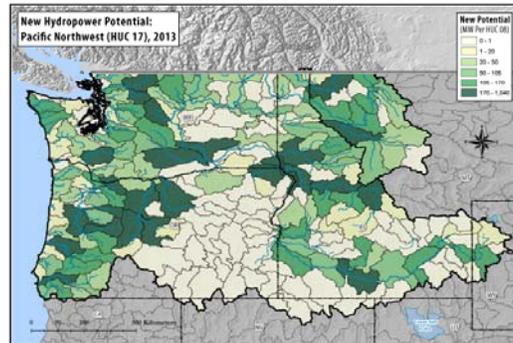
- 84.7 GW undeveloped hydropower capacity in the US
- Highest potential found in the PNW (~25 GW)



New Stream-reach Development (NSD) Potential by Subbasin for the United States



Study identified ~25GW new stream potential in the PNW



- ~ 16 GW Potential in undeveloped stream reaches >1 MW
- ~ 9 GW Potential in undeveloped stream reaches <1 MW
- ~33 GW Current existing hydropower in the PNW

Overlap with Fish and Wildlife

- Protected areas are designated streams and wildlife habitats that are protected from hydroelectric development
- Council recently amended its Fish and Wildlife Program (October 2014)
 - Amendment reinstates exemption process that allows petitioners to demonstrate the *exceptional benefits* to fish and wildlife of a potential project in a protected area

History

March 2012 – Information gathering session

September 2013 – GRAC Hydropower subgroup meeting

June 2014 – Presentation to Power Committee on staff proposal for study

July/August 2014 – Release of RFP and selection of contractor

August → November 2014 – Study duration

November 2014 – GRAC hydropower mtg

BACKGROUND

COUNCIL'S HYDROPOWER POTENTIAL SCOPING STUDY

Objective

- Hire consultant to review inventory of recent studies and reports, characterize parameters used to determine potential, and draw conclusions
- Determine if ***realistic, reasonable*** assumption for hydropower potential in the PNW can be drawn from the various reports
 - Focus on new stream reaches, opportunities at existing non-powered dams, and upgrades at existing hydropower facilities

Questions Asked

- Can a reasonable physical potential of energy and capacity be drawn for the PNW from the existing studies?
 - Does this potential integrate the Protected Areas?
- Is there enough information available to apply cost assumptions to the technical potential?
- If a supply curve (potential and cost) cannot be derived, what approach is recommended as a potential next step?

Council's Intent

- How does this inform our analysis and the development of the draft Seventh Power Plan?
- Council staff issued a memo describing objective of report
 - Report will be **one** of the resources used in our analysis of hydropower potential for the Plan
 - Report is not a direct input into the Plan
 - Further analysis is needed to digest results and decide what next steps of analysis need to be performed

Deliverables

- Final report – NWA and team
 - Presentation
 - Addendum – US DOE 2014 new stream reach mapping project
 - Comments from BEF
-
- All materials are available on the Council's website -
<http://www.nwcouncil.org/energy/grac/hydro/>

Categories of Studies Reviewed

- **Projects at existing unpowered dams**
- **Conduit and kinetic projects**
- **Pumped storage**
- **Tidal and wave energy**
- **General generation project assessments**
 - **New stream reach**
 - **Small hydro**
 - **Irrigation**

Parameters to Review Studies

- **Objective of study**
- **Model used to develop study**
- **Approach – how review was conducted, # sites**
- **Cost**
- **Capacity and energy estimates**
- **Site specific restrictions or environmental attributes**
 - **Council's protected areas**
 - **Protected lands (national/state parks)**
 - **Fish and wildlife species**
 - **Wild and Scenic Rivers**
 - **Water quality and quantity**
 - **Transmission access**
- **Potential in the Pacific Northwest**

In Addition...

- Survey of utilities and developers to assess pending projects
- Review of existing FERC applications
- Models/databases/tools
- Legislation and rulemaking
- Map overlay between the 2014 US DOE study and the Council's protected areas

RESULTS

COUNCIL'S HYDROPOWER POTENTIAL SCOPING STUDY

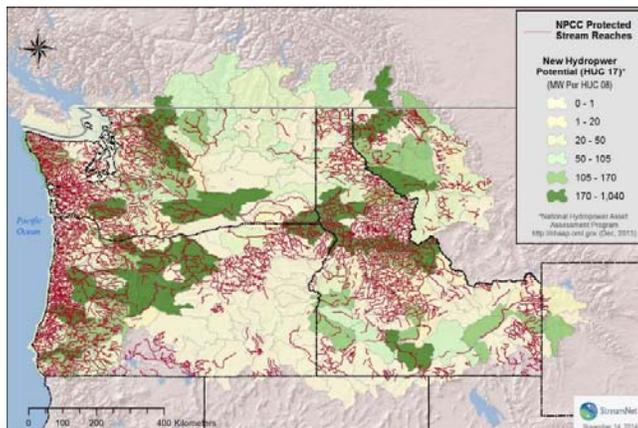
Is there enough information in the existing studies to determine hydropower potential and cost in the PNW over the next 20 years?

- **Criteria used to develop each study varies in quality and specifics → very difficult to piece together in consistent way**
 - Supply curve based on existing information alone is not possible without further analysis
- **However, contractor identified realistic potential (capacity) based on site-specific locations, projects in the licensing process, and utility commitments**

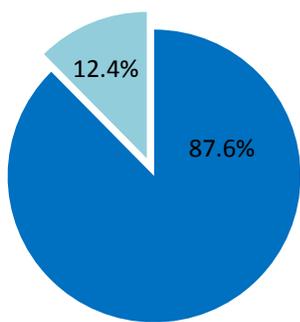
2014 US DOE Study and Protected Areas Mapping (1)

- **StreamNet worked with Oak Ridge National Laboratory**
- **ORNL provided GIS overlays for sites greater than 1 MW = ~16,000 MW**
 - Remaining 9,000 MW not analyzed for overlap with protected areas
- **StreamNet produced an overlay map of the ~16,000MW potential and the protected areas**

2014 US DOE Study and Protected Areas Mapping (2)



Only 12% of potential identified in DOE study (>1MW) not in protected areas



■ In Protected Areas
■ Outside of Protected Areas

Capacity	
PNW Potential	25,226 MW
> 1 MW	15,996 MW
In Protected Areas	14,006 MW
Outside Protected Areas	1,990 MW
< 1 MW	9,230 MW

“Realistic, Reasonable” Hydropower Potential (2015-2035)

Category	Capacity (MW)	Energy (MWh)
Non-powered Dams	57	148,248
Conduit and Hydrokinetic	64	226,107
Pumped Storage	2,640	33,084
General Assessments	90	429,947
Upgrades to Existing Projects	388	1,461,168
Total:	3,239	2,298,554

The contractor did not include any of the potential identified in the US DOE study as realistic and reasonable because it is not site-specific and requires further analysis.

Potential Costs*

Technology Type	Average cost per kW of capacity
Non-powered dams	~ \$3000/kW
Conduit	~ \$5,000/kW - \$7,500/kW
Pumped Storage	~ \$1,800/kW - \$3,500/kW
Tidal and Wave	n/a
General Assessments	~ 3,000/kW - \$9,000/kW

* Costs are based on estimates from the various studies; thus, they tend to be site-specific and vary drastically in the parameters used to develop cost estimates.

Next Steps

- **Staff proposal: Analyze hydropower as a secondary resource**
 - Does not appear to be enough potential for inclusion in the RPM, but enough for a resource analysis of cost and potential for inclusion in the Seventh Power Plan
- **Analyze pumped storage potential in more detail for Seventh Power Plan**
 - GRAC discussion planned for future meeting

Thank You Contributors

- Northwest Hydroelectric Association
- HDR, Inc.
- MWH Global
- Black & Veatch
- Bonneville Environmental Foundation
- StreamNet
- Oak Ridge National Laboratory
- Generating Resources Advisory Committee (GRAC)