Hydropower Resource Assessment at Non-Powered USACE Sites

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Site Selection:

- Potential sites are selected using the screening from the Oak Ridge National Laboratory's (ORNL) study: *An Assessment of Energy Potential at Non-Powered Dams in the United States*

- The study identified 419 USACE non-powered USACE dams

- This number was reduced to 223 sites using the following screening:

    1. Generate less than 1 MW.
    2. Have a Federal Energy Regulatory Commission (FERC) license.
    3. Obvious hindrances in developing hydropower.

Site Selection:

Distribution of USACE Sites with Potential Power Capability by Division and FERC Status

Division	Total Projects Identified	FERC Preliminary or Pending Preliminary Permit		No FERC Permits	
		Total Number	Percentage of Total	Total Number	Percent of Total
Great Lakes & Ohio River (LRD)	71	40	56%	31	44%
Mississippi Valley (MVD)	50	28	56%	22	44%
Southwestern (SWD)	39	7	18%	32	82%
North Atlantic (NAD)	21	2	10%	19	90%
South Atlantic (SAD)	19	8	42%	11	58%
Northwestern (NWD)	12	5	42%	7	58%
South Pacific (SPD)	11	2	18%	9	82%
USACE Total	223	92	41%	131	59%

Data Quality:

•Data call was made for all 223 sites for at least three years of :

- daily flow
- daily head(forebay-tailwater elevation)

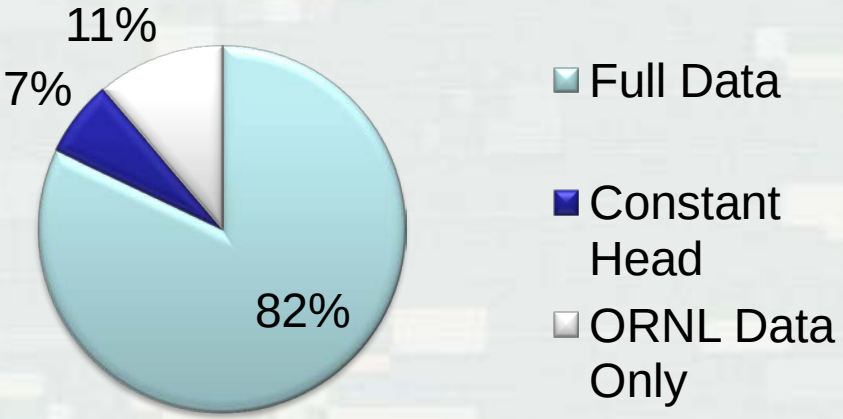
• Data Quality was defined by 3 categories:

1. **Full Data**: At least three years of daily head and flow values were available

2. **Constant Head**: At least three years of daily flow values were available. Constant head values from ORNL study were used

3. **ORNL Data Only:** No additional data was available. Constant head and monthly average flows from ORNL study were used

Data Quality Distribution



Methodology: Potential Capacity Estimates

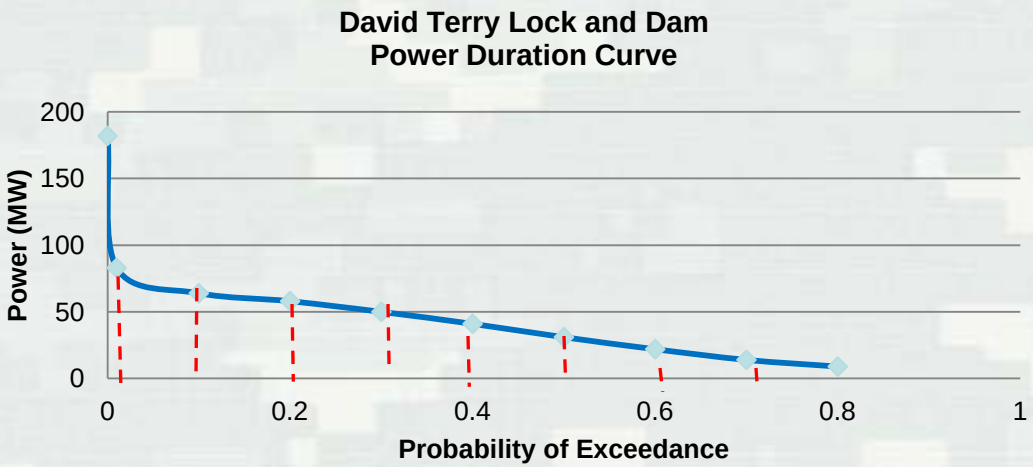
- Capacity values are determined from a power duration curve developed using a sites observed head and flow values. (This assumes current operations)

- Both capacity and generation are calculated using the power equation, assuming a 85% efficiency

- A sites potential capacity is defined as the capacity associated with the 1% probability of exceedance.

- A benefit-cost ratio is calculated for selected capacity values

- A sites feasible capacity is defined as the maximum capacity with a benefit-cost ratio greater than 1.



Exceedance Probability	1%	10%	20%	30%	40%	50%	60%	70%	80%
Capacity (MW)	83	64	58	50	41	31	22	14	9

Methodology: Benefits and Costs Estimates

Benefit Estimates:

1) Electricity Values:
   Monthly energy values were forecast using the EIA long term generation forecast and shaped using monthly state retail prices

2) Avoided Emissions:
   Avoided greenhouse gas emissions were calculated using elecricity market modules (EMM) estimates from eGrid.

3) State and Federal Performance Renewable Energy Incentives:
   - Database of State Incentives for Renewables and Efficiency (DSIRE) did not report any state incentives.
   - An analysis was performed on the effect of the expiring Federal incentive.

Cost Estimates:

Construction costs + O&M costs:

Updated and indexed to 2012 dollars using:

- INEEL , *Estimation of Economic Parameters of US Hydropower Resources*
- *BOR, Hydropower Resource Assessment at existing Reclamation facilities*

Methodology: Feasibility

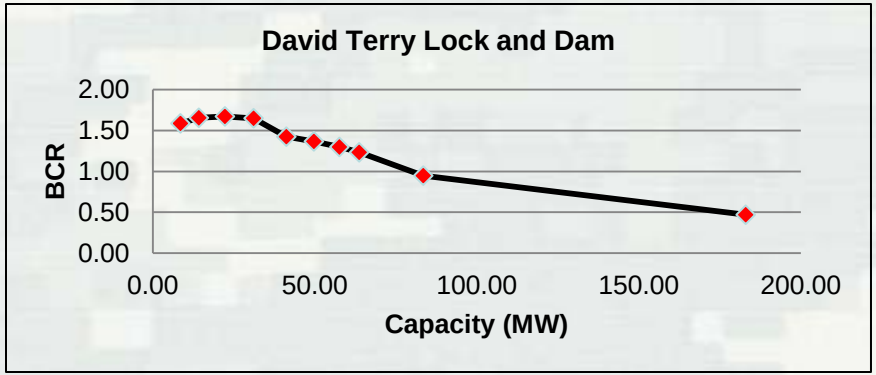
To determine economic feasibility:

Benefit-cost Ratio (BCR): Ratio of the present value of the benefits over the present value of the cost. Present value of benefits and cost was calculated using the federal discount rate of 3.75%

Internal Rate of Return (IRR): The discount rate at which the present of the cost equals the present value of benefits.

Range of Feasibility: Defines the range of capacity that results in a BCR greater than 1.

Optimal Feasible Capacity: Defines the capacity with the highest BCR greater than 1.

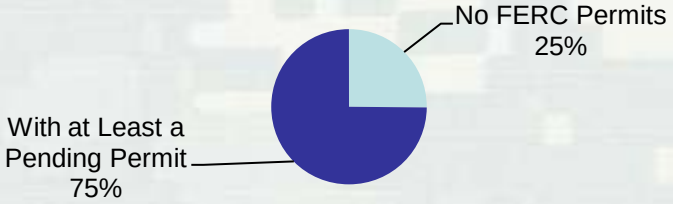


	Power Duration Exceedance Probability	Max Cap (MW)	BCR	IRR	
	1%	83.46	0.95	3.30%	
	10%	63.68	1.23	5.60%	Feasible Range
	20%	57.57	1.3	6.00%	
	30%	49.7	1.37	6.50%	
	40%	41.2	1.42	6.90%	
	50%	31.09	1.65	8.40%	
Optimal Feasible Capacity	60%	22.24	1.67	8.60%	
	70%	14.19	1.65	8.50%	
	80%	8.52	1.59	8.00%	

Results: Potential and Feasible Capacity

Division	Number of Plants	Potential Capacity (MW)	Feasible Capacity (MW)	Percent of Potential Capacity Assumed Feasible
LRD	71	1961.50	898.16	46%
MVD	50	1568.22	939.75	60%
NAD	21	288.07	63.49	22%
NWD	12	348.74	50.63	15%
SAD	19	671.92	324.51	48%
SPD	11	116.29	112.71	97%
SWD	39	1301.67	429.27	33%
USACE Total	223	6256.43	2818.54	45%

FERC Status of Estimated Feasible New Hydropower Capacity (2,818 MW)



Results: Top Plants without FERC Licenses

Top 10 Non-powered USACE Sites with no FERC Permits Ranked by BCR

Ranking	Plant	Plant_ID	Division	District	Data Confidence	Feasible Capacity (MW)	Estimated BCR
1	SANTA ROSA DAM	SPD-10	SPD	SPA	ORNL Data	3.61	2.42
2	NORTH FORK DAM	SPD-8	SPD	SPK	ORNL Data	4.12	2.21
3	COCHITI LAKE	SPD-3	SPD	SPA	ORNL Data	11.66	1.97
4	BLUESTONE DAM	LRD-9	LRD	LRH	Full Data	31.09	1.69
5	BUCHANAN DAM	SPD-2	SPD	SPK	ORNL Data	2.98	1.68
6	CLAIBORNE LOCK AND DAM	SAD-5	SAD	SAM	Full Data	38.05	1.61
7	BOLIVAR DAM	LRD-10	LRD	LRH	Constant Head	8.98	1.32
8	HIDDEN DAM	SPD-5	SPD	SPK	ORNL Data	2.48	1.29
10	BLUE MARSH DAM	NAD-4	NAD	NAP	Full Data	2.46	1.29

FERC status obtained from spreadsheets downloaded from FERC website 4/10/2013

Results: Energy Price Forecast

Analysis was performed on best and worst case scenario based on the EIA's high and low generation cost estimate for each state. The baseline was based on the actual EIA forecast.

Maximum Capacity Values (MW) with Different Electricity Prices			
Division	Baseline	Worst Case Scenario Lowest Projected Prices	Best Case Scenario Highest Projected Prices
LRD	898.16	653.84	964.42
MVD	939.75	747.96	1024.31
NAD	63.49	43.53	106.59
NWD	50.63	43.44	63.31
SAD	324.51	290.7	326.42
SPD	112.71	102.09	112.71
SWD	429.27	352.63	567.75
USACE Total	2,818.54	2,234.18	3,165.52

Results: Effect of Federal Renewable Performance Incentive:

An analysis was done with and without the federal renewable performance incentive to quantify the change in feasible capacity.

	With Federal Benefits		Without Federal Benefits		Difference (with-without)	
Division	Total Maximum Feasible Capacity (MW)	Total CDE Avoided (billion lbs.)	Total Maximum Feasible Capacity (MW)	Total CDE Avoided (billion lbs.)	Total Maximum Feasible Capacity (MW)	Total CDE Avoided (billion lbs.)
LRD	955.33	7.51	898.16	7.35	57.16	0.16
MVD	987.33	8.22	939.75	7.93	51.37	0.28
NAD	66.05	0.34	63.49	0.34	2.56	0.01
NWD	62.39	0.36	50.63	0.31	11.75	0.05
SAD	374.24	2.25	324.51	2.14	49.73	0.12
SPD	112.71	0.59	112.71	0.59	0.00	0.00
SWD	434.19	2.28	429.27	2.25	4.92	0.03
Total	**2992.24**	**21.55**	**2818.54**	**20.91**	**177.49**	**0.64**