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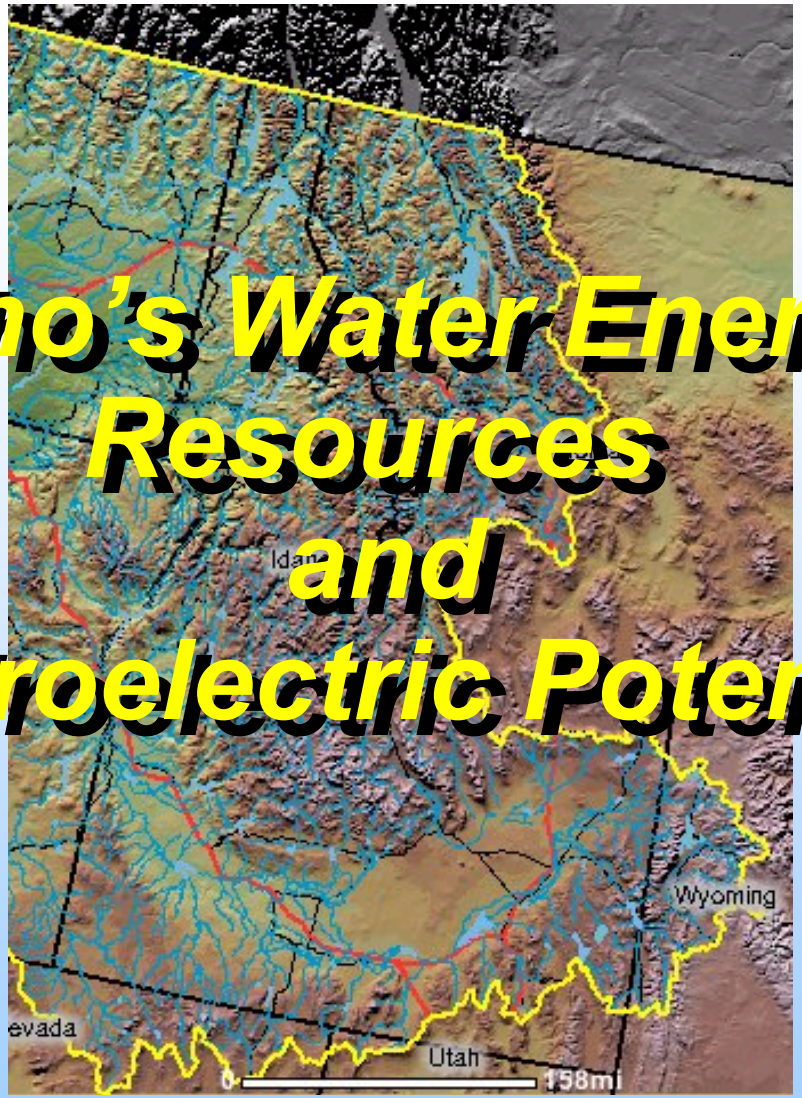
Idaho's Water Energy Resources and Hydroelectric Potential

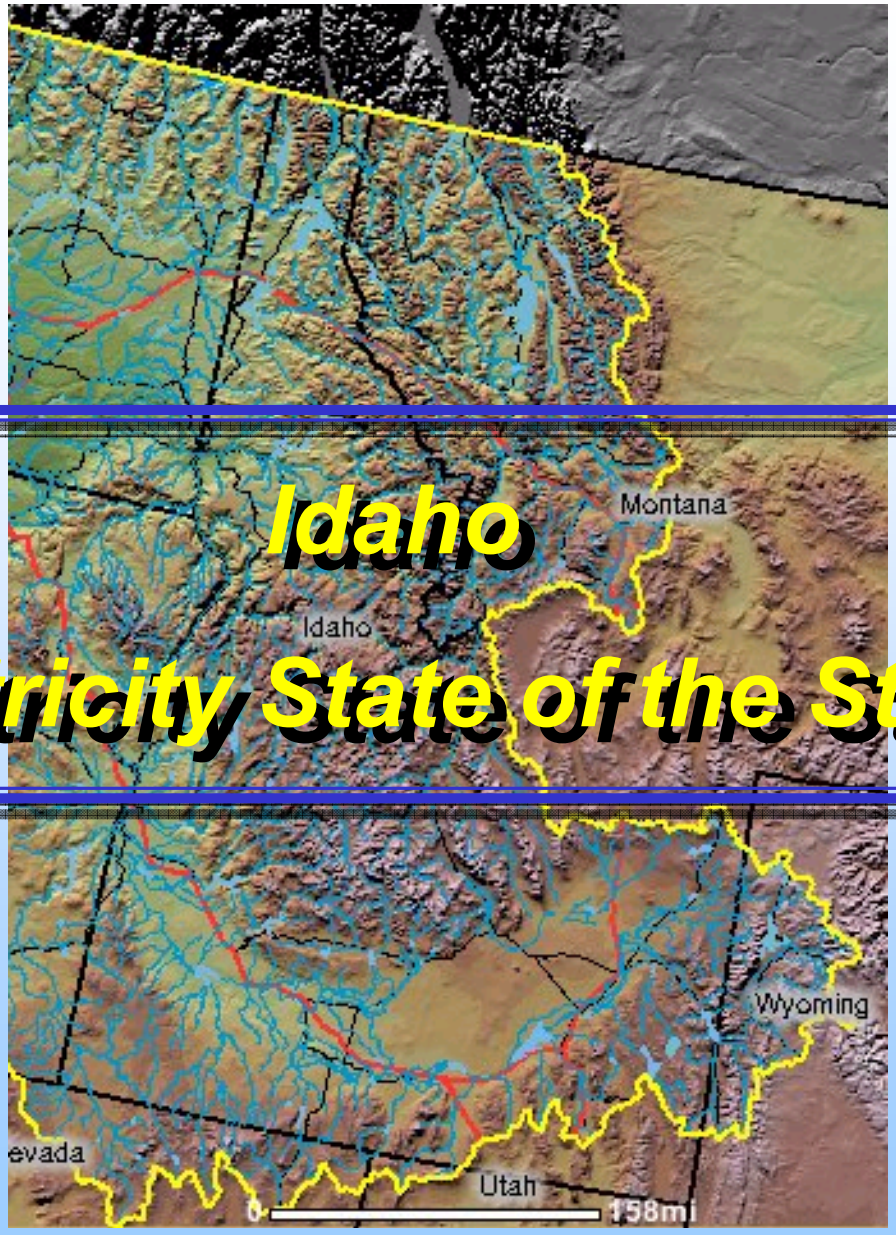


Douglas G. Hall, Program Manager
INL Hydropower Program

August 2006

Topics

- *Idaho electricity state of the state*
  - *Energy sources, production, and consumption*
  - *Hydroelectric plants and generation*
- *Basic natural stream resource assessment*
  - *Resource spatial distribution*
  - *Resource gross power potential*
- *Feasibility assessment*
  - *Feasible potential projects*
  - *Project realistic power potential*
- *Development opportunities & costs*
- *Virtual Hydropower Prospector – a GIS application*
  - *Water energy resource site & feasible project locator*
  - *Preliminary feasibility assessment tool*



Idaho Electricity State of the State

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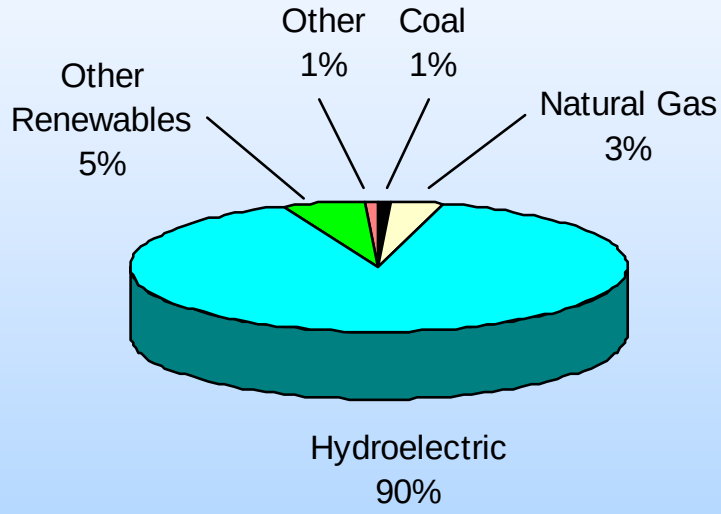
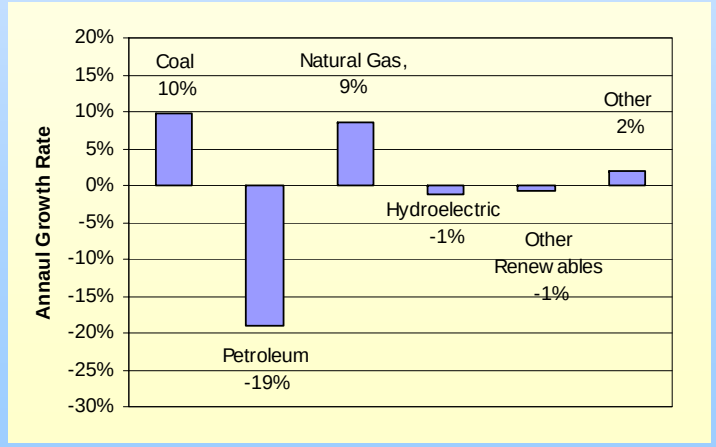
Idaho Electricity State of the State

- ***Electricity consumption*: 21 billion kilowatthours***
- ***Electricity production*: 10 billion kilowatthours***
- ***Electricity Sources*:***



- ***Trends by source*:***
  (1993-2002)



- ***Average 2004 retail price** of electricity: 5¢/kWh***

  (2nd lowest in the nation)

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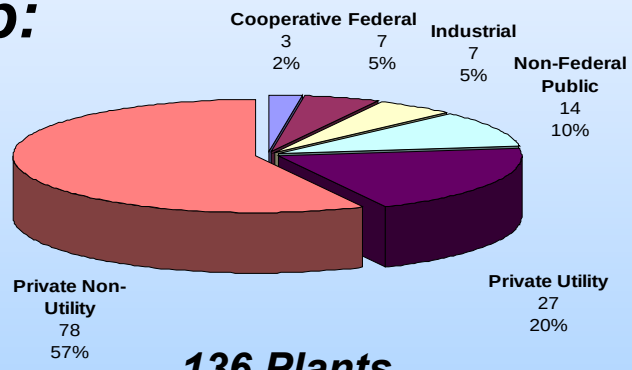
* EIA, *State Energy Profiles 2002*
** EIA, *Electric Power Annual 2004*

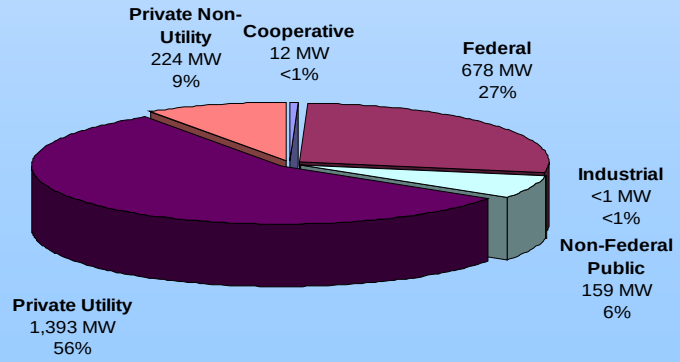
Idaho Hydroelectric Plants

- *Hydroelectric plants: 136*
- *Total plant capacity: 2,468 MW*
- *Total annual average power: 1,300 MWa*
- *Average annual generation: 11 billion kilowatthours*
- *Plant ownership:*



136 Plants

- *Capacity ownership:*



2,468 MW

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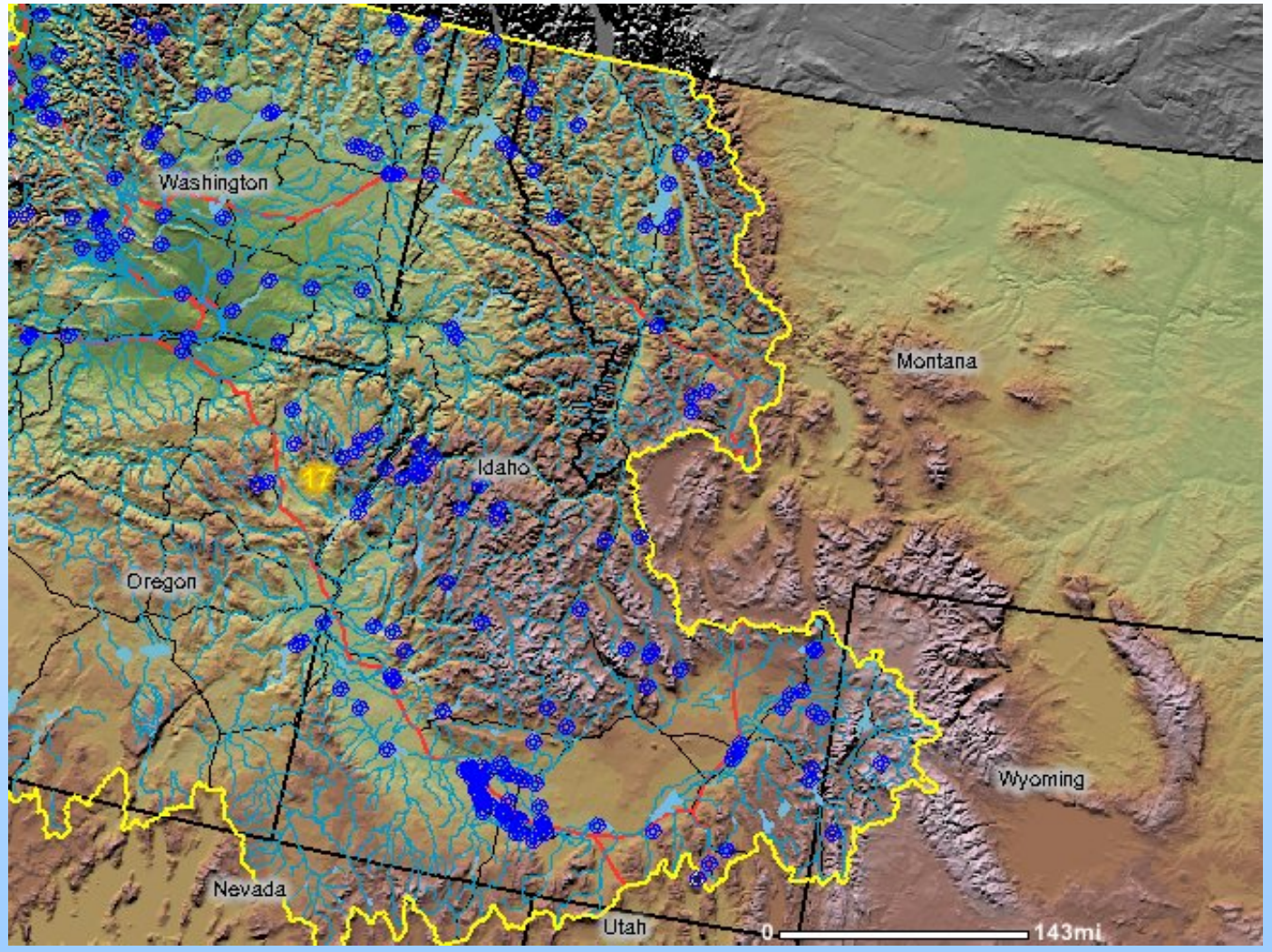
Idaho's hydroelectric plants



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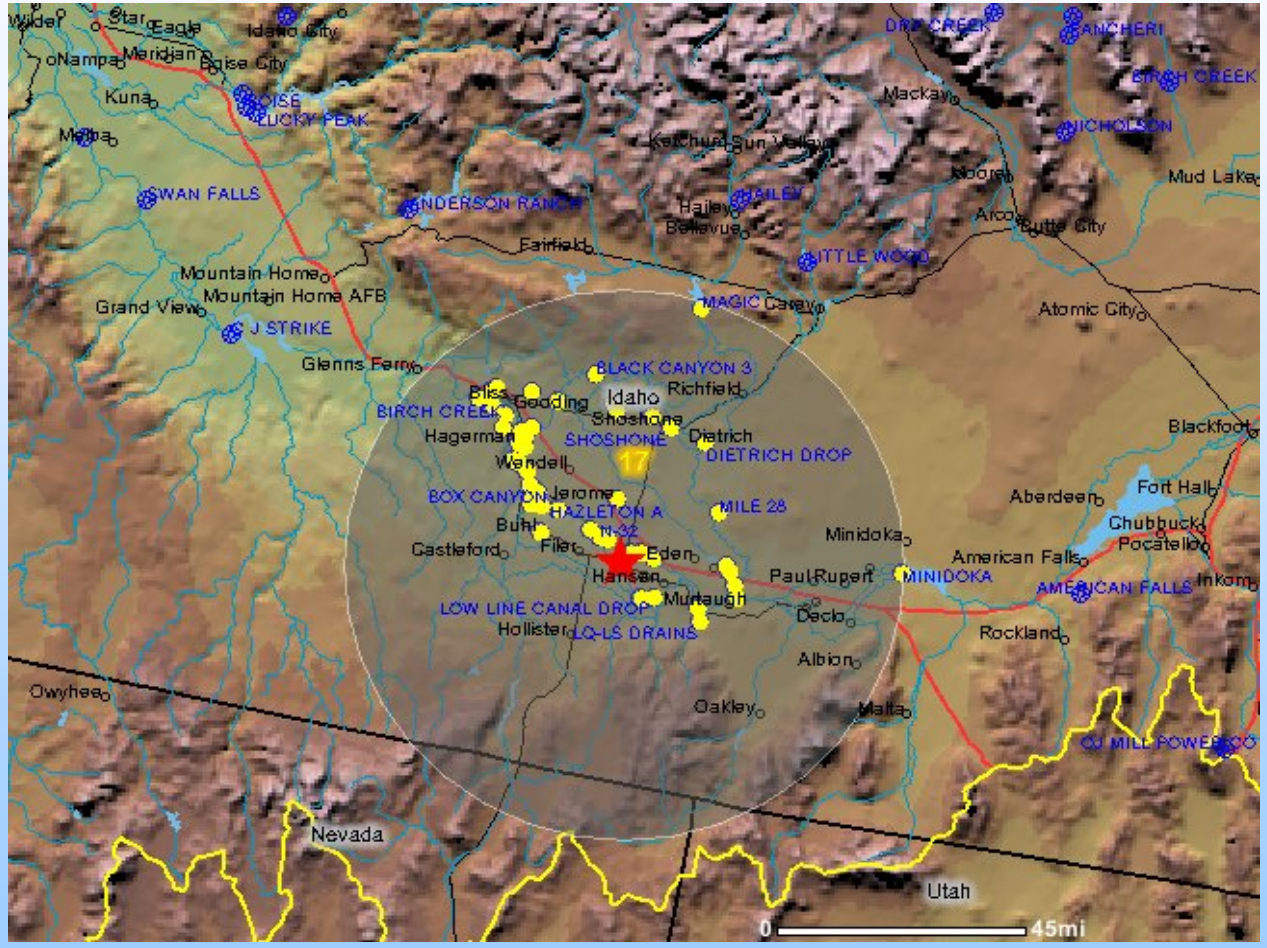
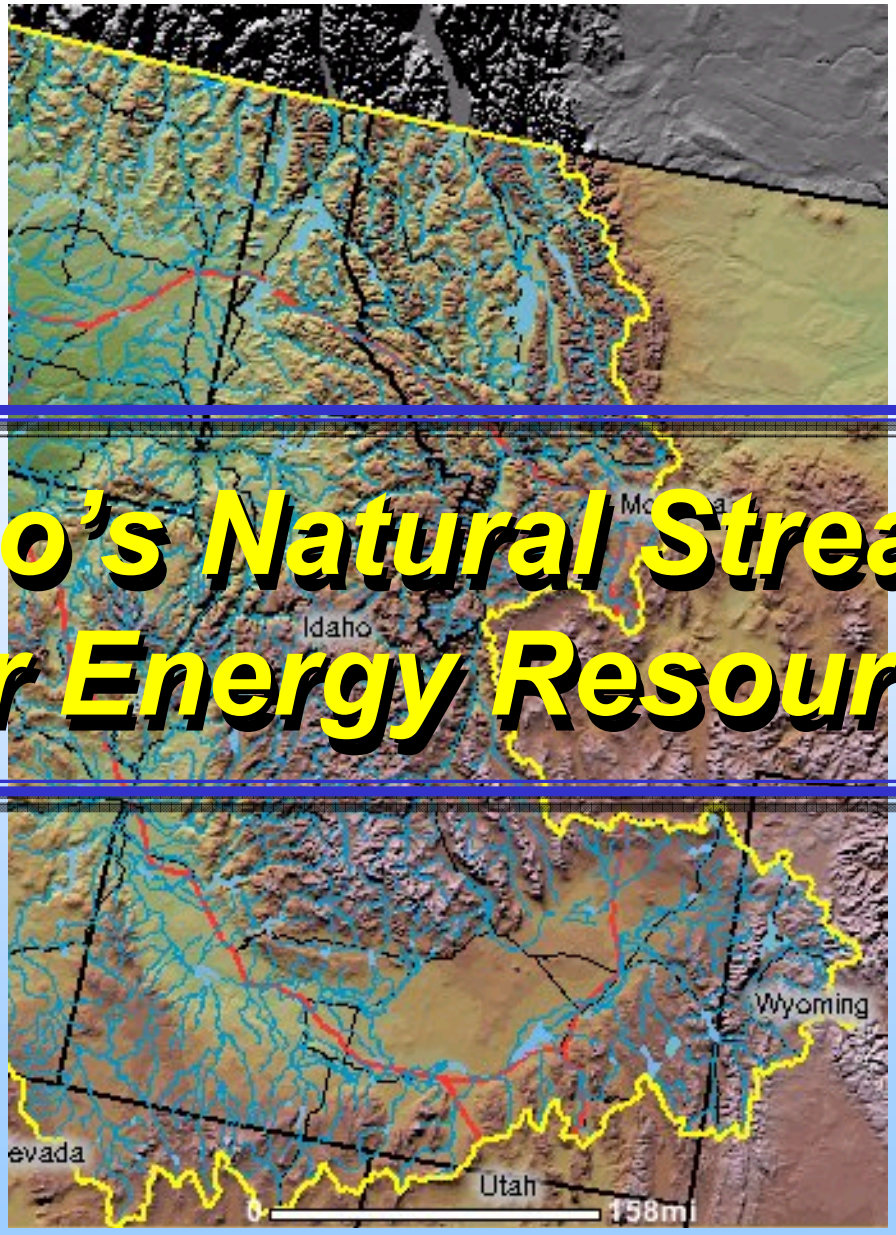
61 hydroelectric plants within 50 mi. of Twin Falls, ID



Milner: 59 MW

Birch Ck: 30 kW

Idaho's Natural Stream Water Energy Resources



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Hydropower 101

Power ≈ hydraulic head x water flow rate

Capacity – the maximum plant power rating (MW)

Annual Average Power – average rate at which electricity is generated during a year (MWa)

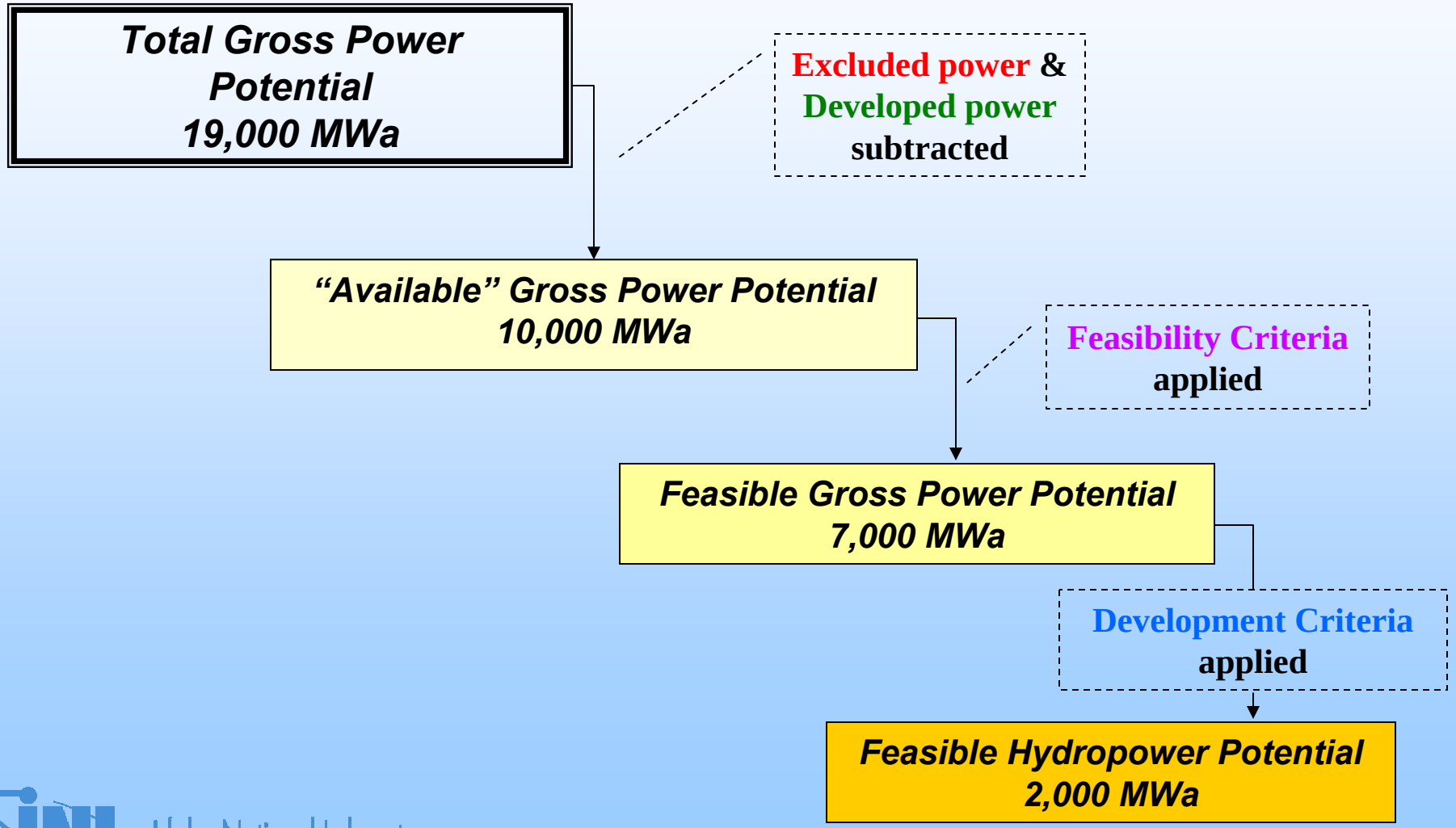
Generation (MWh) = capacity factor x capacity x 8760hrs

OR

Generation (MWh) = annual average power x 8760hrs

Typical capacity factor = 0.5

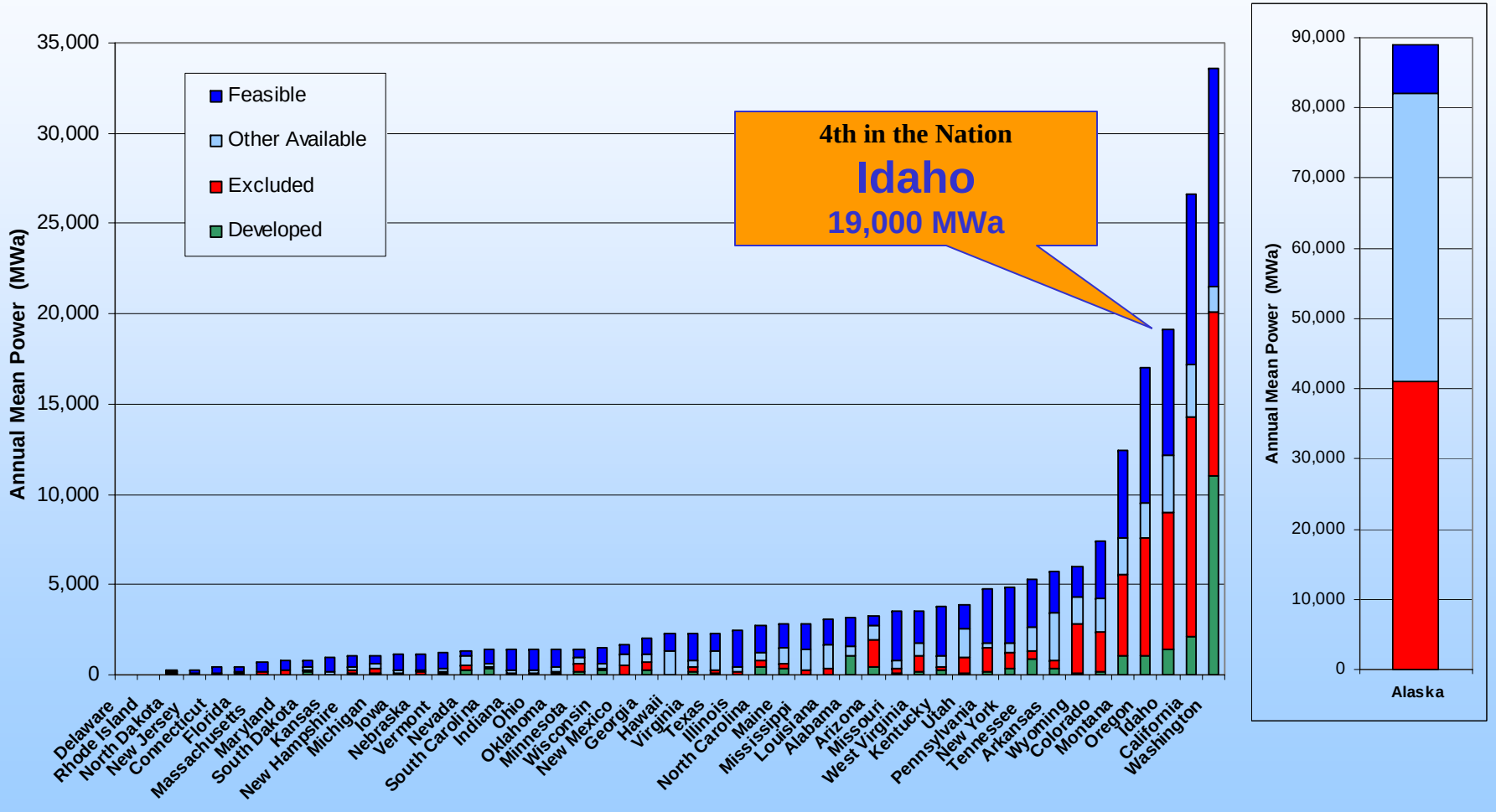
State gross power potential to feasible hydropower potential



Assessment methodology

- ***Power potential of every stream reach in the state estimated***
  - ***Reach hydraulic heads (elevation difference start to finish) provided by digital elevation models***
  - ***Reach annual mean flow rates estimated using regression equations based on stream gages***
  - ***Combination of reach hydraulic head and flow rate yields gross power potential***
- ***Zones where development unlikely identified using GIS***
  - ***Federal exclusion zones***
  - ***Environmental exclusion zones***
- ***Developed reaches identified by matching existing plants and reaches using GIS***

Gross power potential by state and power category



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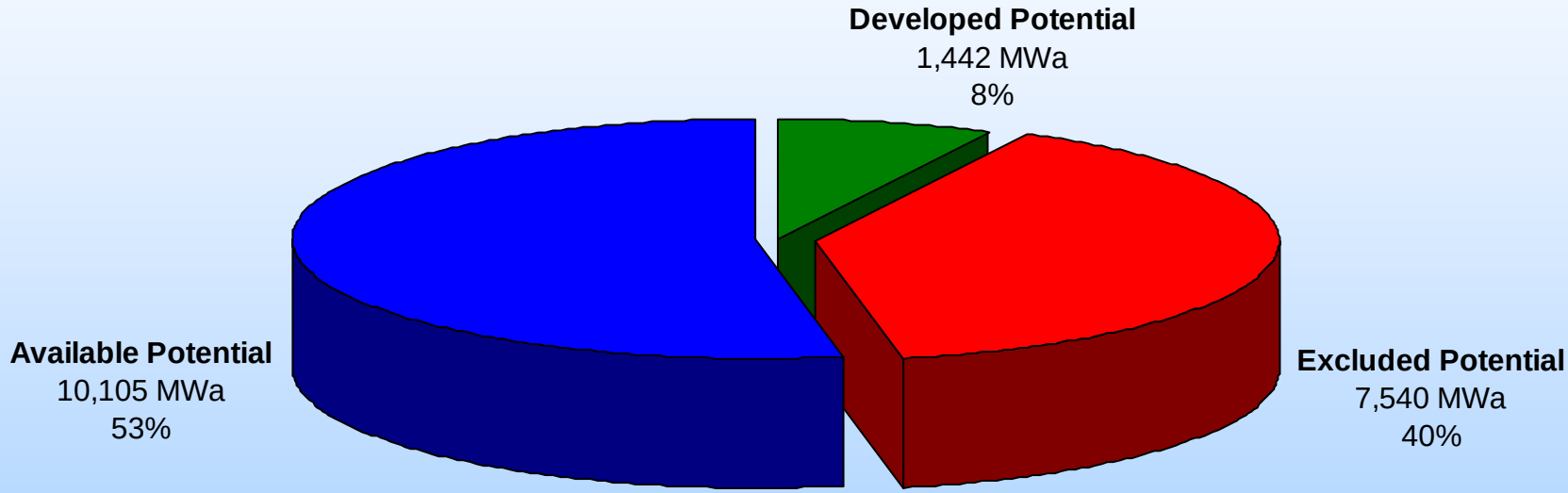
Power category distribution of Idaho water energy resources



Total Resource Potential
19,088 MWa

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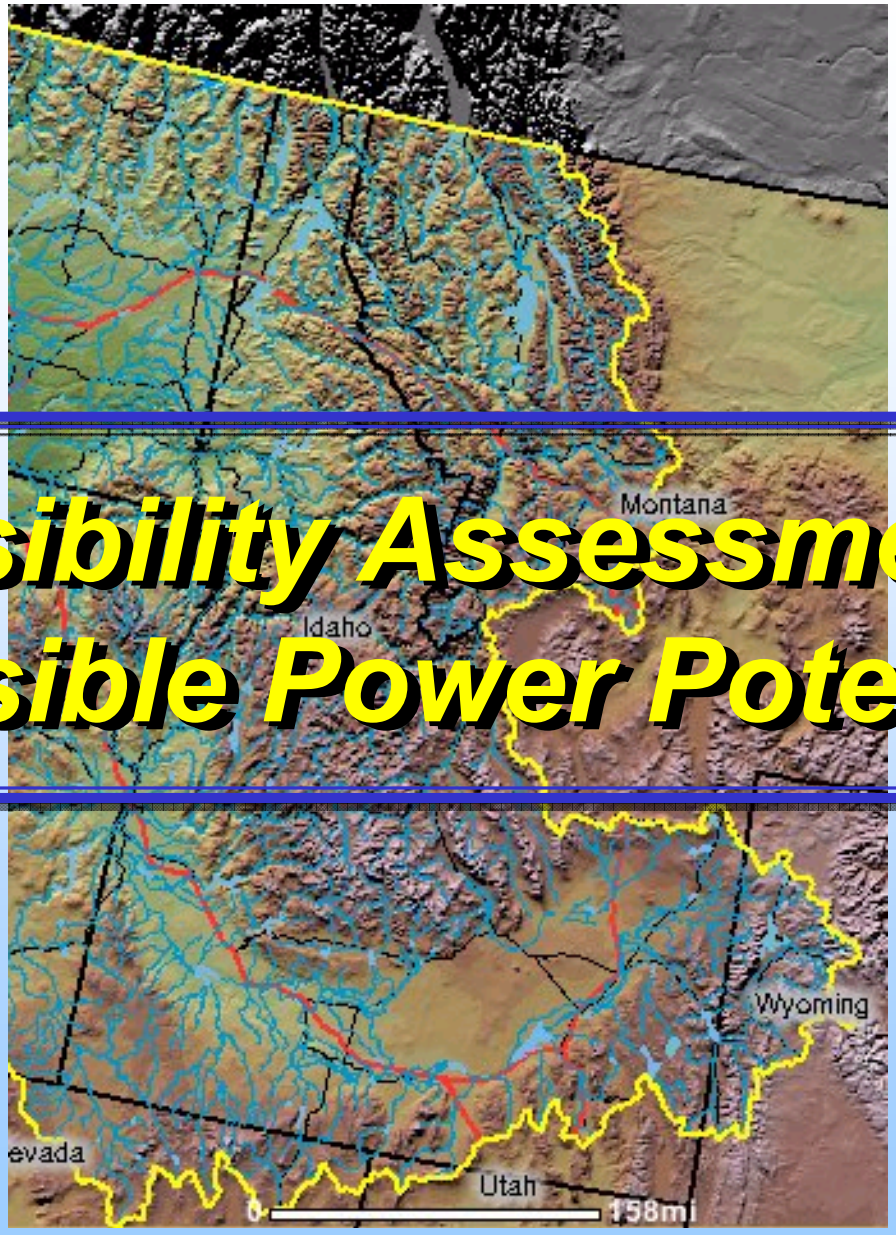
Feasibility Assessment – Feasible Power Potential



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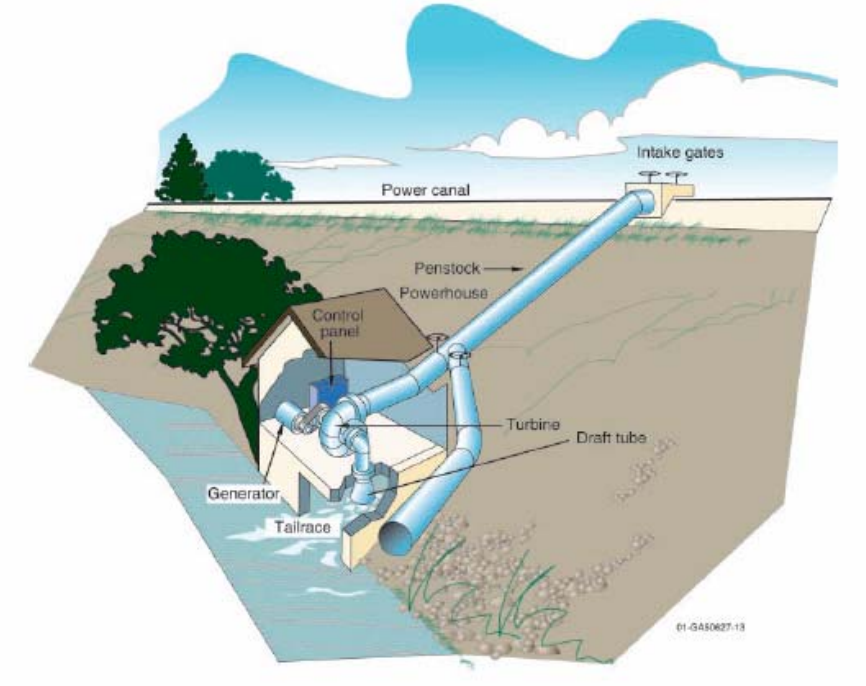
Feasibility criteria

- *Not previously developed*
- *Development not improbable*
  - *Not in federal exclusion zone*
  - *Not in environmental exclusion zone*
- *Site assessibility – within 1 mile of a road*
- *Load or tranmission proximity*
  - *Within 1 mile of either* **OR**
    - *Power line*
    - *Substation*
    - *Power plant*

Within the 90th percentile of distances of hydro plants in the same power class to a city or populated area boundary in the hydrologic region

Site development configurations



Artist's Conception of Canal Offtake Project

Tazimina Project Alaska

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Environmental benefits & desirable features

- *Emissions-free generation*
- *Power predicability*
- *New dam not required*
- *Reservoir is not created*
- *Main stream channel is not obstructed*
- *Small plant footprint*
- *Minimal visual impact*
- *Long plant life (30 to 50yrs or more)*

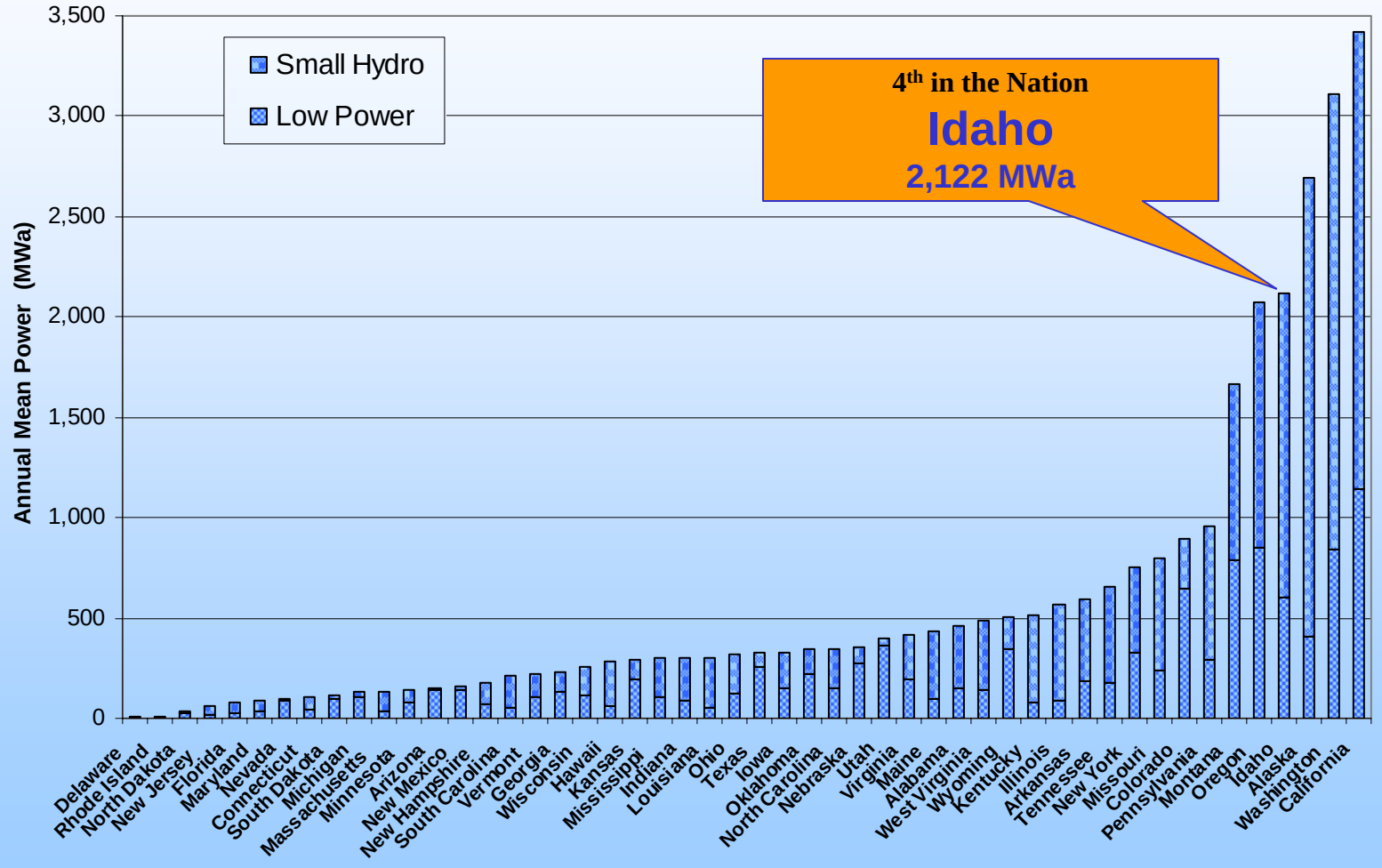
Project development criteria

- ***Working stream flow** – the lesser of:*
  - *Half the reach flow rate*

    OR
  - *Sufficient flow rate to produce 30 MW*

- ***Working hydraulic head** – penstock length*
  - *Upper limit set by existing projects*
  - *Search algorithm found optimal location for minimum length penstock to capture maximum hydraulic head*

Feasible hydropower potential by state and power category



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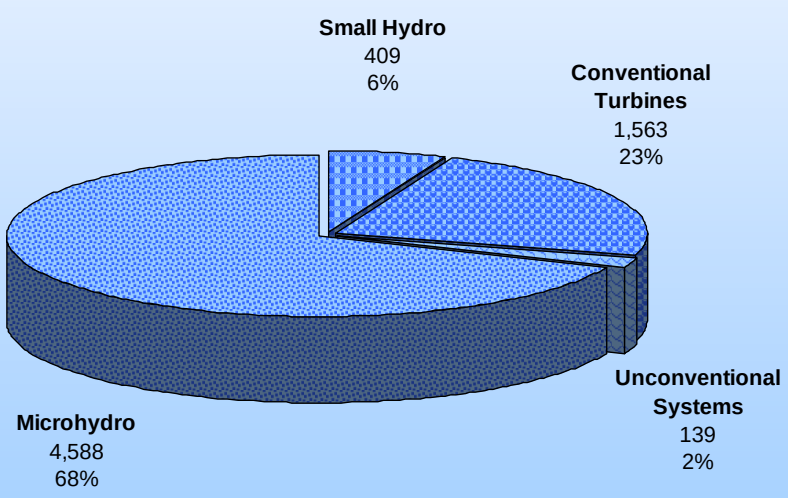
Idaho potential projects by power & technology classes

- ***Feasible projects having hydropower potential ≥ 10 kW***

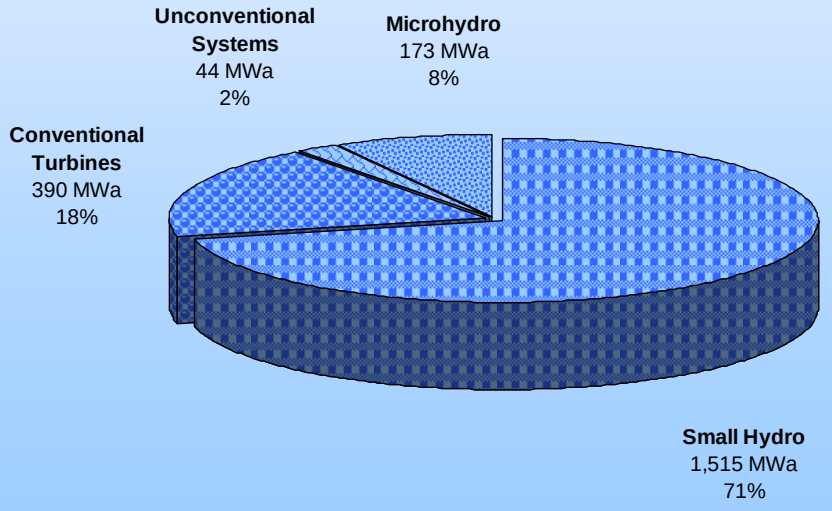
6,700 potential projects
Feasible hydropower potential: 2,000 MWa



Total Feasible Projects
6,699

Small hydro: >1 MW & ≤ 30 MW

Low power: < 1 MW



Total Feasible Project Hydropower Potential
2,122 MWa

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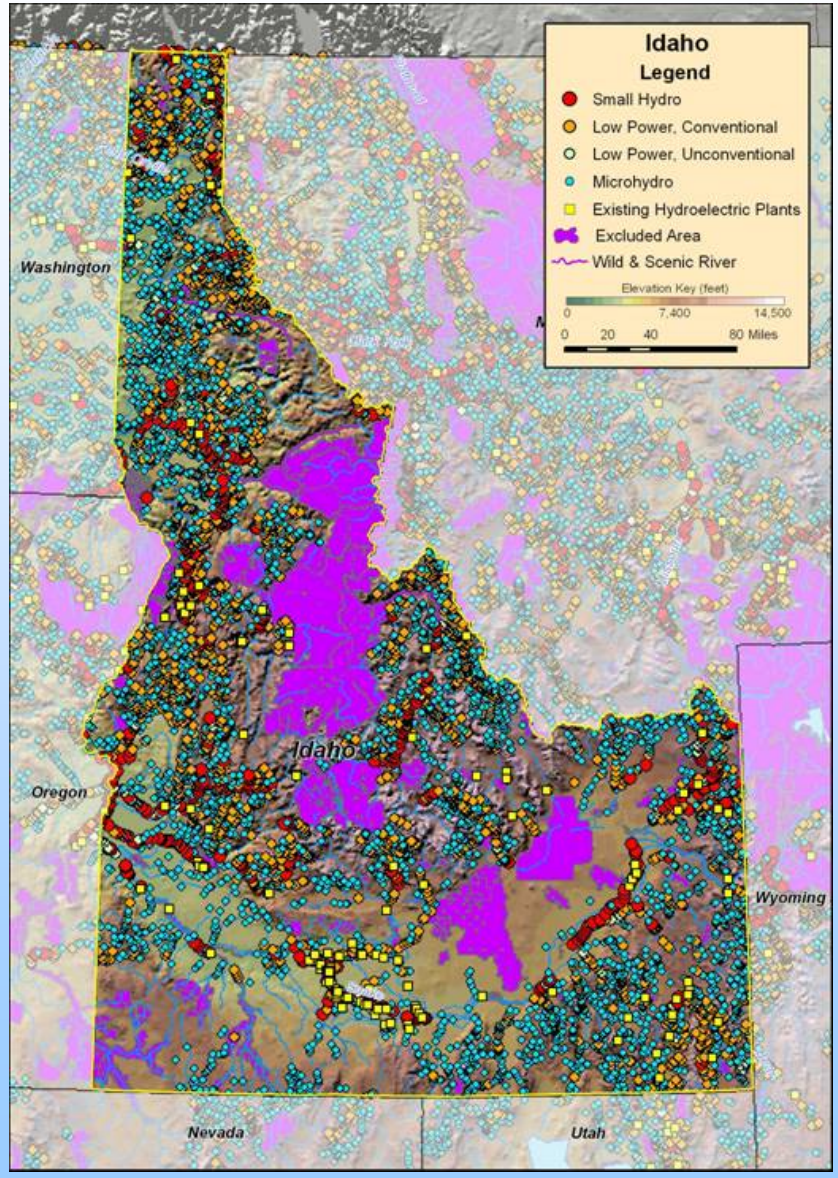
Idaho's low power & small hydro potential projects

Power Class	Power Potential (MWa)
Total Potential	**2,122**
Small Hydro	**1,515**
Low Power	**607**
Conventional Turbines	390
Unconventional Systems	44
Microhydro	173



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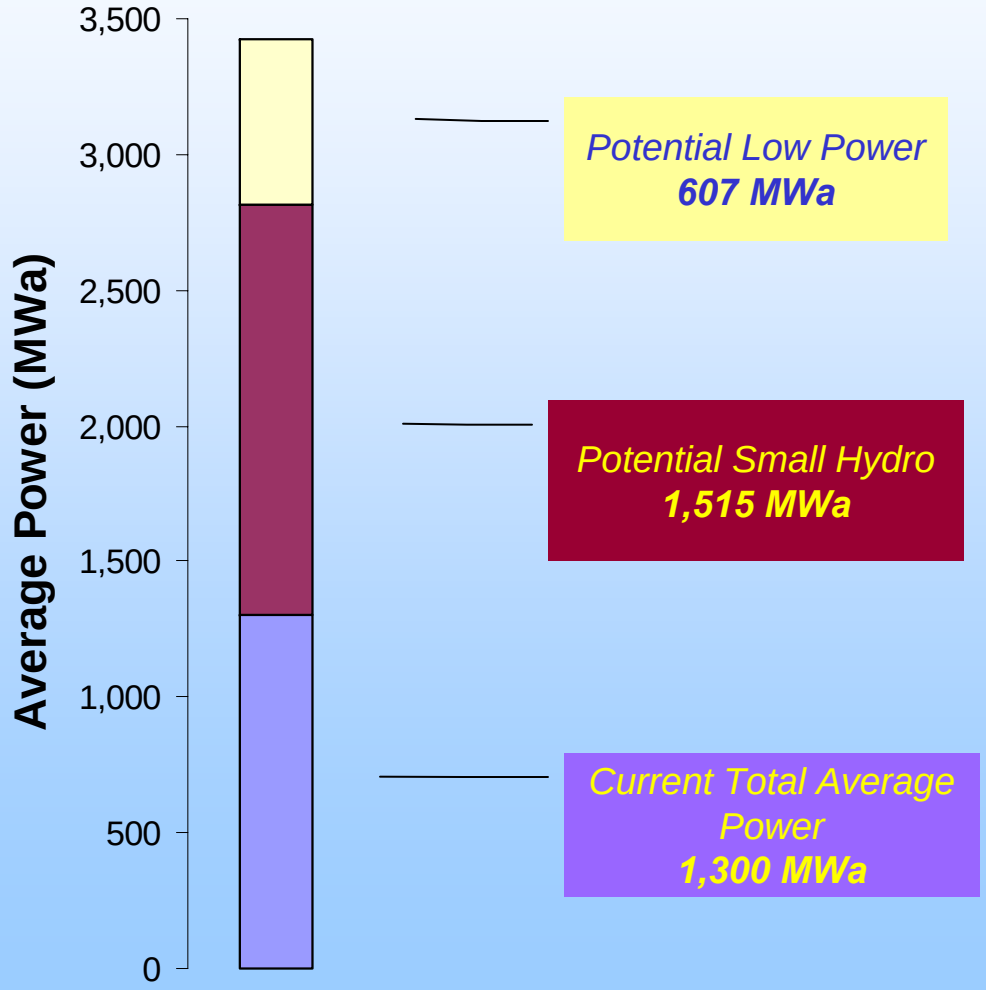
Idaho hydroelectric growth potential from new low power and small hydro plants

Annual Hydroelectric Generation w/ New Low Power & Small Hydro
30 x 10^9 kWh

Annual Hydroelectric Generation w/ New Small Hydro
24 x 10^9 kWh

Idaho Annual Consumption
21 x 10^9 kWh

Current Annual Hydroelectric Generation
11 x 10^9 kWh



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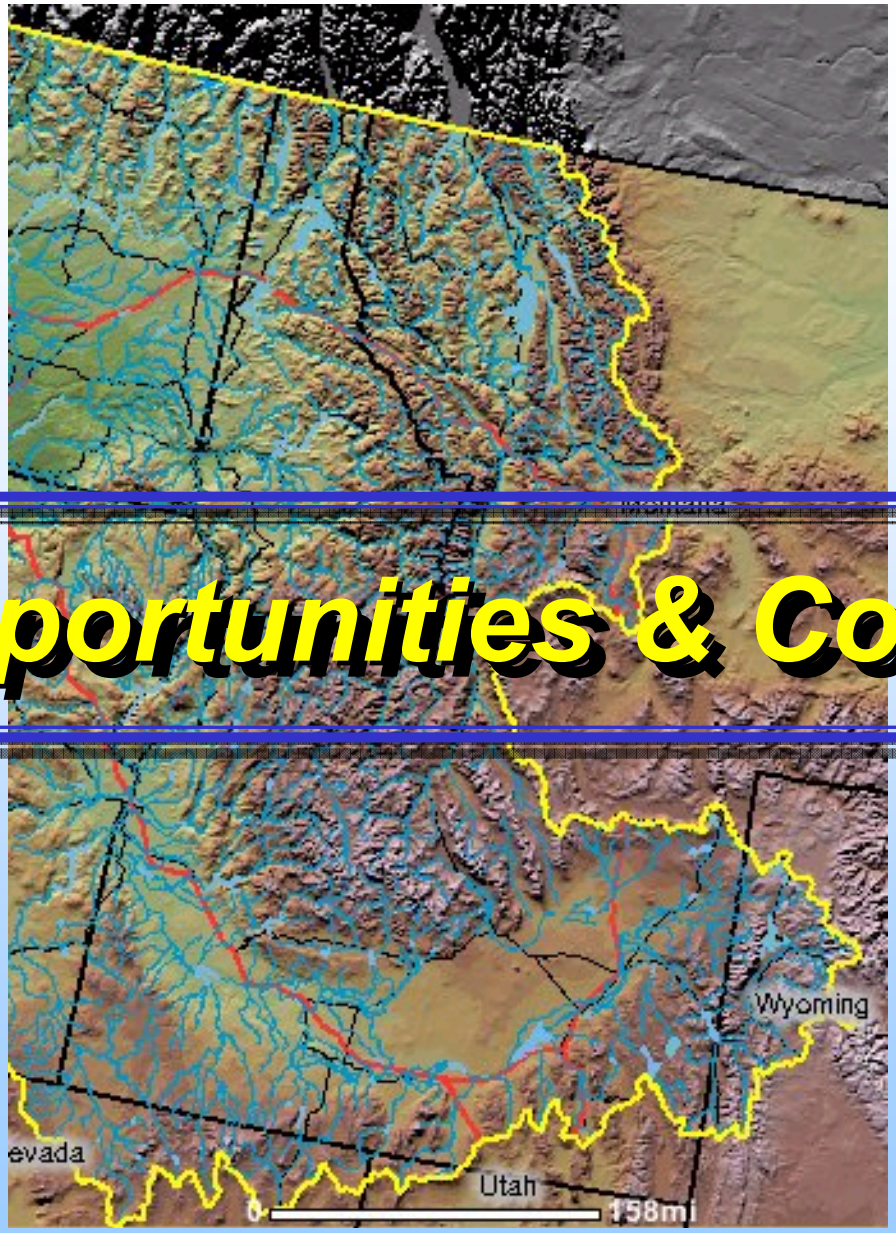

Opportunities & Costs

Powerhouse additions to existing dams – possibly low hanging fruit

- ✓ ***Minimal additional environmental impact***
- ✓ ***Less time and cost to license***
- ✓ ***Lower unit development cost ($/kW)***

Estimated development costs for three types of capacity increase opportunities

- ***INL developed cost estimating tools based on historical cost data***
- ***Cost estimating tools applied to Idaho capacity increase opportunties > 1 MW assessed in 1990's***

Type of Site	Number of Projects	Total Capacity (MW)	Median Unit Cost To Develop Sites (2002$/kW)	Median Unit Cost To Develop Site Capacity (2002$/kW)
Undeveloped site	74	1,264	$3,831	$2,791
Powerhouse Addition to Existing Dam	51	518	$2,063	$1,370
Capacity Increase at Existing Hydroelectric Plant	7	726	$1,265	$469
All	**132**	**2,509**	**$2,894**	**$2,523**

Unassessed

More Idaho water energy resources

- *Natural stream locations for hydrokinetic technologies*
- *Constructed waterways – canals & aquaducts*
- *Municipal water supply systems*
- *Effluent streams*
  - *Water treatment plants*
  - *Power plants*
  - *Industrial plants*

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Virtual Hydropower Prospector

- *Geographic Information System (GIS) tool on the Internet*
- *Idaho National Laboratory developed and served (http://hydropower.inl.gov/prospector/)*
- *No special software or licenses required to use*
- *Displays 500,000 water energy resource sites and 130,000 feasible project sites throughout the U.S.*
- *Displays context features needed to perform preliminary feasibility assessments*
- *Provides tools for locating and selecting features of interest*
- *Goes beyond geographic location and provides attribute information about selected features*

Region Selector

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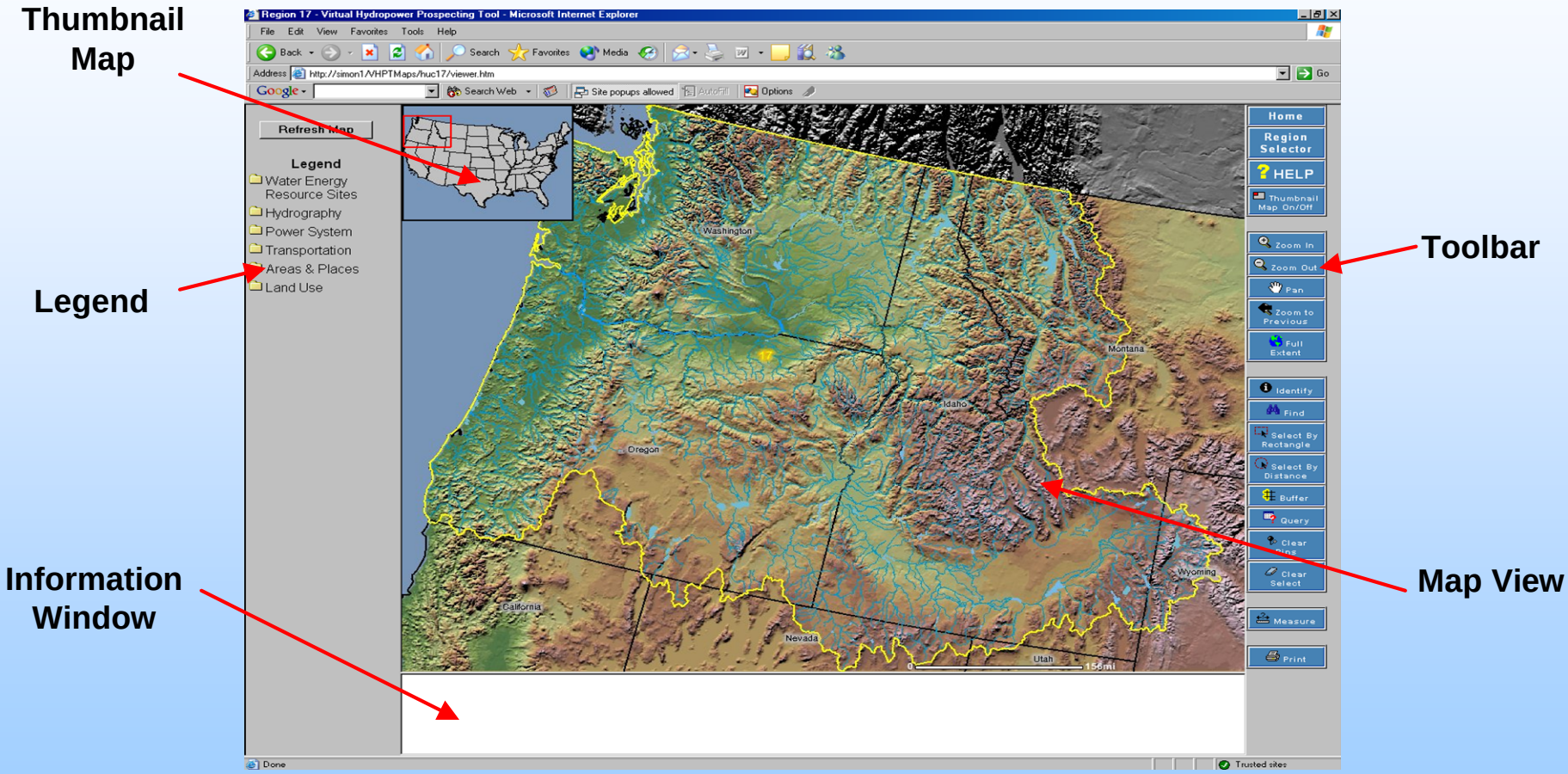
VHP Desktop


Thumbnail Map
Legend
Information Window
Toolbar
Map View
Region 17 - Virtual Hydropower Prospecting Tool - Microsoft Internet Explorer
Refresh Map
Legend
Water Energy Resource Sites
Hydrography
Power System
Transportation
Areas & Places
Land Use
Washington
Montana
Idaho
Oregon
California
Nevada
Utah
Wyoming
Home
Region Selector
HELP
Thumbnail Map On/Off
Zoom In
Zoom Out
Pan
Zoom to Previous
Full Extent
Identify
Find
Select By Rectangle
Select By Distance
Buffer
Query
Clear Select
Measure
Print

Features displayed

- *Water energy features*
  - *Water energy resource sites (500,000 sites)*
  - *Feasible potential projects (130,000 sites)*
- *Hydrography (5 feature sets)*
- *Power system*
  - *Hydro plants*
  - *Other plants*
  - *Power lines*
  - *Substations*
- *Transporation*
  - *Roads*
  - *Railroads*
- *Areas & places*
  - *Cities*
  - *Populated areas*
  - *County boundaries*
  - *State boundaries*
  - *Hydrologic region boundaries*
- *Land Use*
  - *Excluded areas*
    - *Federally designated*
    - *Environmentally sensitive*
  - *Bureau of Indian Affairs (BIA)*
  - *Bureau of Land Management (BLM)*
  - *Bureau of Reclamation (BOR)*
  - *Department of Defense (DOD)*
  - *U.S. Forest Service (FS)*
  - *U.S. Fish & Wildlife Service (FWS)*
  - *U.S. National Park Service (NP)*

Conclusions

- ***Idaho has a history of hydroelectric generation*** ***which now allows it to enjoy the among the lowest electricity rates in the country***
- ***Over 50% of the Idaho's water energy resources*** ***have not been developed and are not in development exclusion zones***
- ***Idaho could significantly increase hydroelectric generation*** ***using undeveloped sites, existing dams, equipment upgrades, non-traditional resources, and new technology***
- ***Costs of new hydroelectric plants are competitive*** ***considering environmental benefits, attractive features, and long life***
- ***Virtual Hydropower Prospector*** ***provides all hydropower stakeholders with a tool to evaluate new hydropower development***

Access to references and VHP

- **Access:** http://hydropower.inl.gov/
- **References:** (Resource Assessment link)
  - Feasibility Assessment of the Water Energy Resources of the United States for New Low Power and Small Hydro Classes of Hydroelectric Plants, DOE-ID-11263, January 2006.
  - Water Energy Resources of the United States with Emphasis on Low Head/Low Power Resources, DOE/ID-11111, April 2004.
  - Estimation of Economic Parameters of U.S. Hydroelectric Resources, INEEL/EXT-03-00662, June 2003.
  - U.S. Hydropower Resource Assessment Final Report, DOE/ID-10430.2, December 1998.
- **VHP:** Virtual Hydropower Prospector link

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