OAK RIDGE NATIONAL LABORATORY

MANAGED BY UT-BATTELLE FOR THE DEPARTMENT OF ENERGY

State of Alaska Hydropower Capacity Potential

Speaker: Boualem Hadjerioua

Tribal Hydropower Forum
September 21, 2016
Anchorage, Alaska

OAK RIDGE National Laboratory

U.S. DEPARTMENT OF ENERGY

UT-BATTELLE

Discussion Points

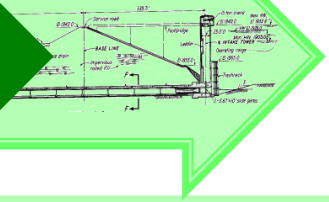
- **National scale NSD Assessment**
  - NSD Objectives and Methodology
  - Regional Results
  - Example – New England (Region 1)
- **Alaska NSD Assessment**
  - Data Collection and Initial Screening
  - Project Screening Methodology
  - Existing Hydropower in Alaska
  - Feasible NSD Potential Results
  - Total Undeveloped NSD Potential Results

DOE/ORNL NSD Overview

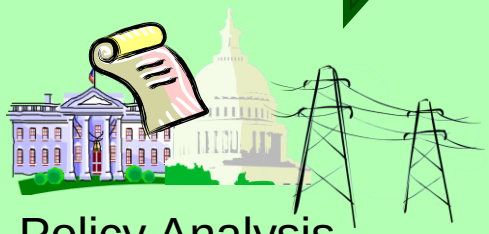
- NSD – hydropower New Stream-reach Development resource assessment
- Identify new hydropower potential from undeveloped U.S. stream-reaches
  - **AK, HI, and lower 48 states**
  - **Focus on opportunities > 1MW capacity**
  - **Target for run-of-river projects**
  - **Estimate potential capacity (MW), monthly energy (MWh), inundated area (acre), and reservoir storage (acre-ft)**
  - **Provide comprehensive environmental attributes**
  - **Support the future deployment studies**
  - **Site-specific raw data available but not appropriate for preliminary permitting, engineering design or investment decisions.**

Energy–Water Assessment & Development

Scale & Complexity

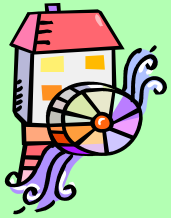


Users & Uses



Policy Analysis
Research Programming
Transmission Planning

Environmental Planning
Generation Planning
Project Developers



Site-Specific Feasibility
Technology Deployment
Project Developers

Clarity & Resolution

Modeling & Remote Sensing — **Increasing Detail, Decreasing Uncertainty** — ***Site-Specific Assessment***

Roles

Government → **Industry**

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METHODOLOGY

National Geo-spatial Datasets

Data Type	Data Source	Note
Watershed Boundary	Watershed Boundary Dataset, NRCS	
River Geometry, Mean Annual Flow, Existing Water Bodies	National Hydrography Dataset Plus (NHDPlus), EPA/USGS	3 million flowlines (NHDPlus version 1)
Existing Dams	National Inventory of Dams (NID), USACE	84,000 dams
Existing Hydropower Plants	National Hydropower Asset Assessment Program (NHAAP), ORNL	
Topography	National Elevation Dataset (NED), USGS	10-meter resolution
Daily Flow Time Series	National Water Information System (NWIS), USGS	22,000 stations
Monthly Runoff Time Series	WaterWatch Runoff, USGS	Unit runoff for each HUC08
Flood Zone	Flood Insurance Study (FIS), FEMA	100-year flood elevation is used as the hydraulic head
Environmental Attributes	Critical Habitats, Wild and Scenic River, Conservation Lands, Water Use, and others	

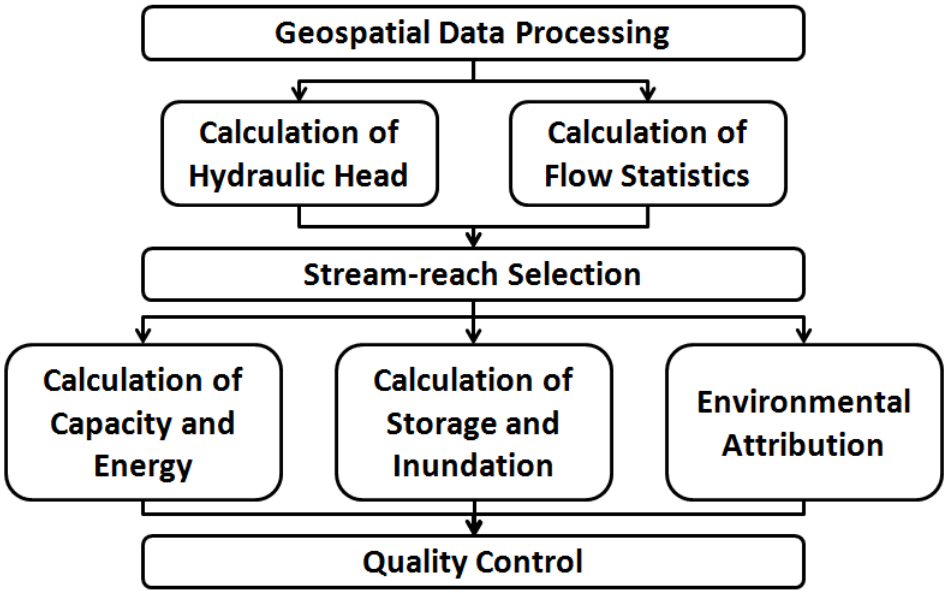
National scale NSD:
Objectives and Methodology

Main Objectives:

- Identification of stream reaches with potential for development
- Calculation of potential hydropower capacity, energy, reservoir storage, and inundation
- Detailed geospatial integration of environmental data with NSD assessment results.

Methodology:

Lower 48 States



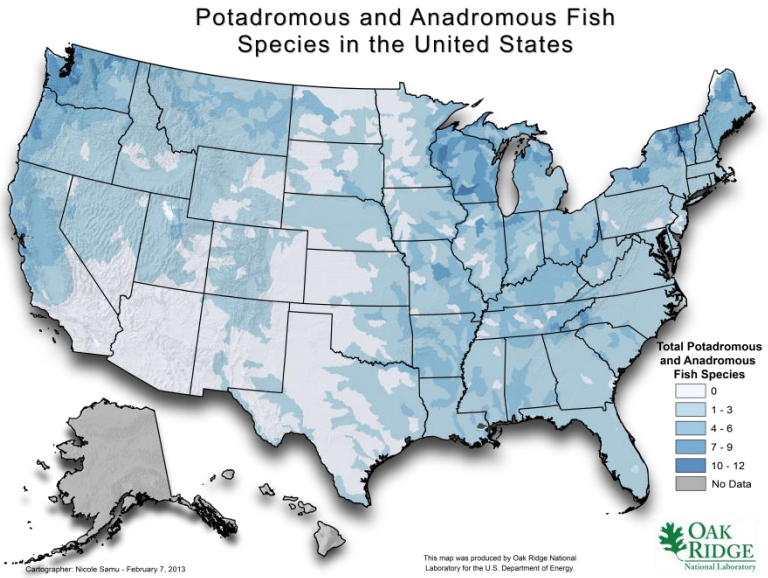
Alaska and Hawaii Assessments

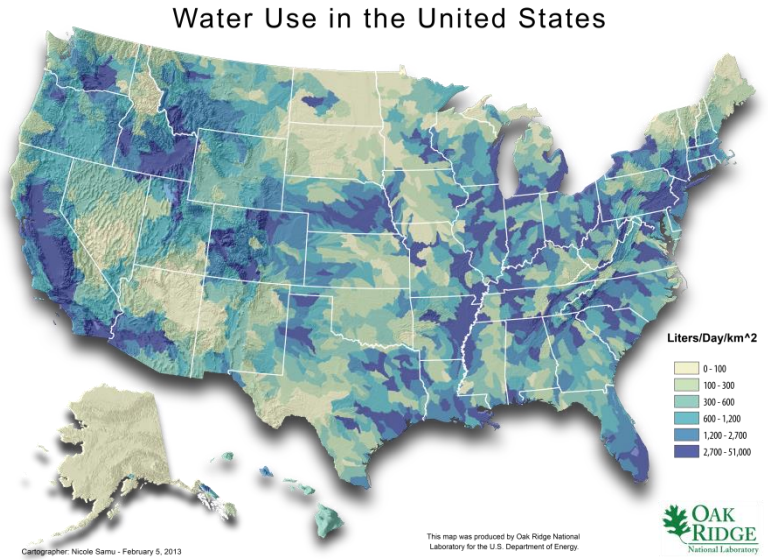
- Lack full NHDPlus coverage
- Use existing information from hydropower reports
  - reconnaissance/feasibility/design-level

Examples of Environmental Data

National Scale Layers

Environmental Layers	Descriptions
Ecological	
ESA Critical Habitats	Spatial coverage of critical habitats for species listed under the Endangered Species Act (1973).
Fish Species of Concern	Spatial distribution of fish species listed under ESA or ranked under IUCN
Fish Traits of Concern	Spatial distribution of fish characteristics potentially vulnerable to hydropower development
Protected Lands	
GAP Protected Lands	Stewardship coverage of conservation lands across US
US Wild and Scenic Rivers	River segments listed under the Wild and Scenic Rivers Act
Landscape Development	
EPA Waters Database	Provides water quality information previously available from independent and disparate sources
National Fish Habitat Action Plan (NFHAP)	Nationwide database of fish habitat quality delineated by National Hydrography Data (NHD) plus catchments. Includes land use, dams, road crossings and habitat quality metrics.
USGS Water Use Estimates for the United States	Provide estimates of total consumptive water usage in various categories
Recreation/Aesthetics	
Fishing and Boating Access	Point locations of boat ramps and fishing access locations
American Whitewater National Whitewater Inventory	Recreational boating launch and takeout access points along waterbodies
Geology.com Waterfalls	US waterfall point locations





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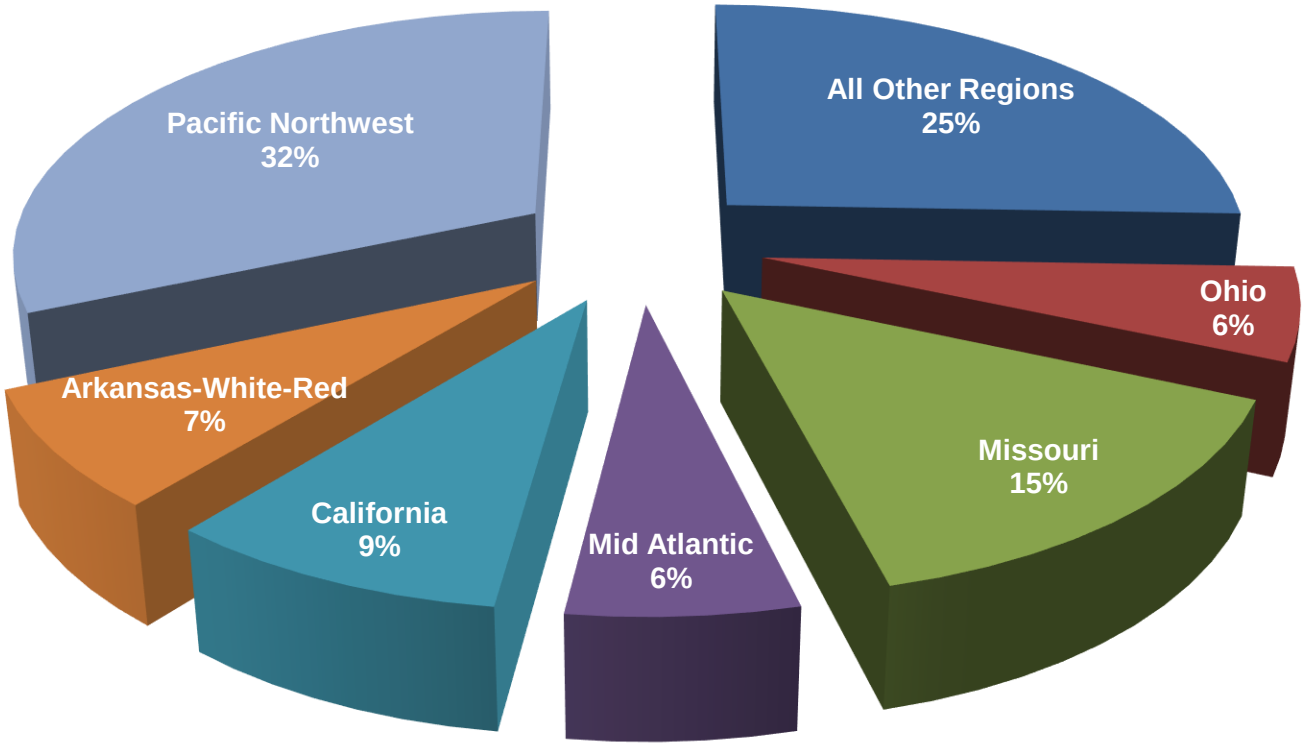
RESULTS

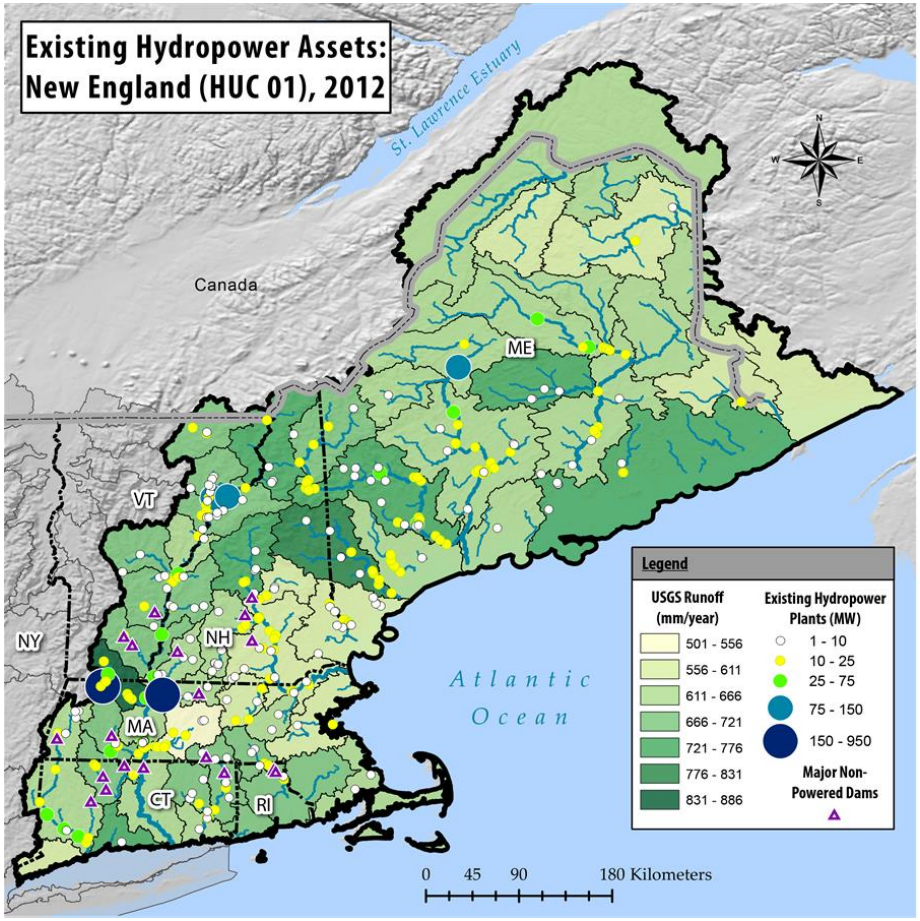
NSD Provisional Resource Estimate

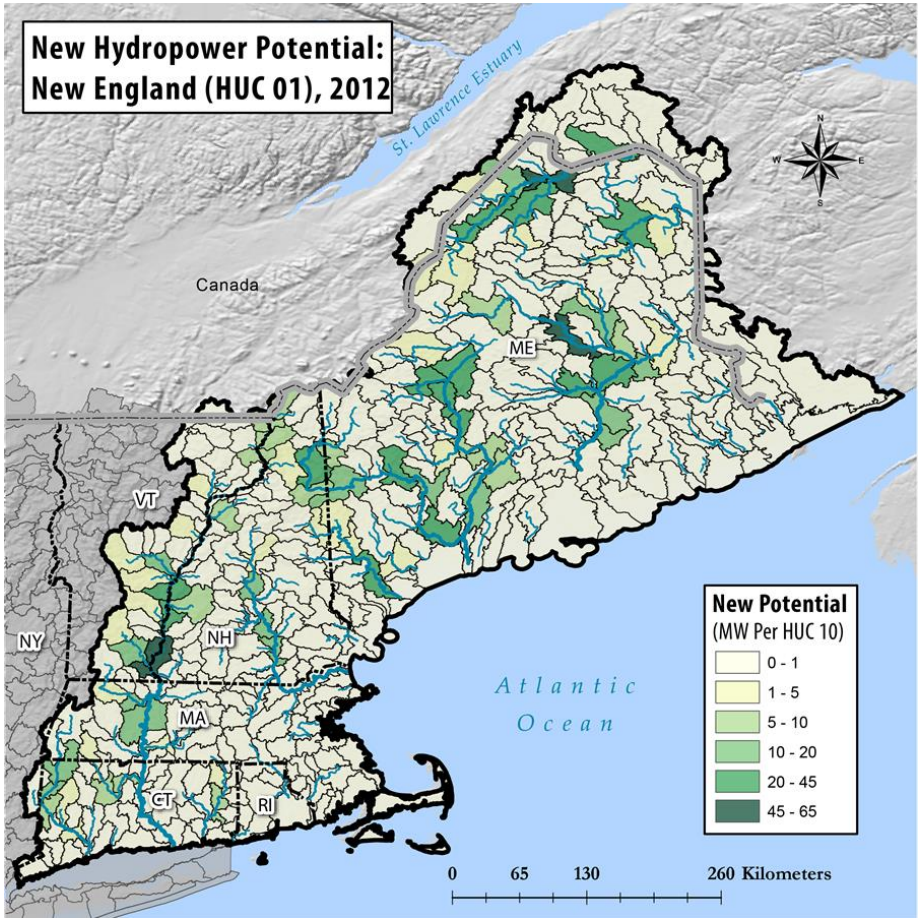


	Stream-reach (>1MW)	Stream-reach (<1MW)
Potential Capacity	51.5 GW	28.4 GW
Potential Energy	302 TWh	157 TWh
Mean Capacity Factor	65 %	62 %

*Plot and totals do not include Alaska and Hawaii

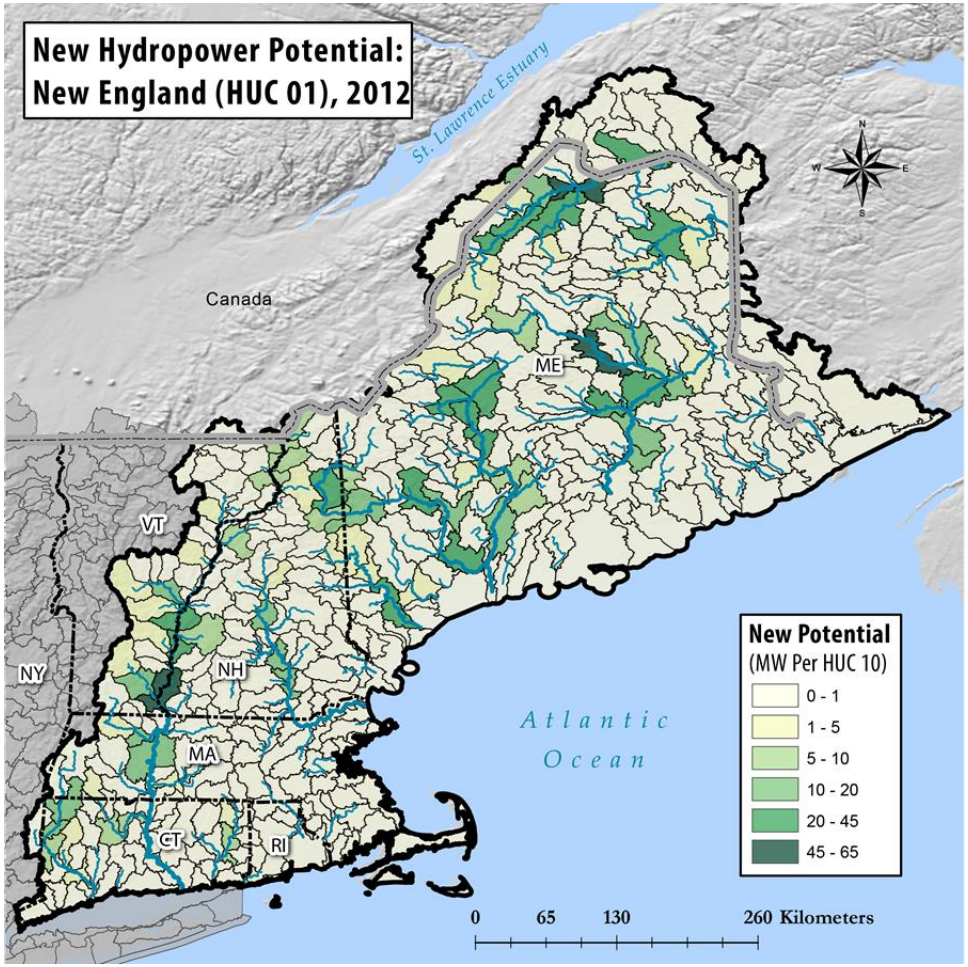
NSD Potential – New England (Region 1)

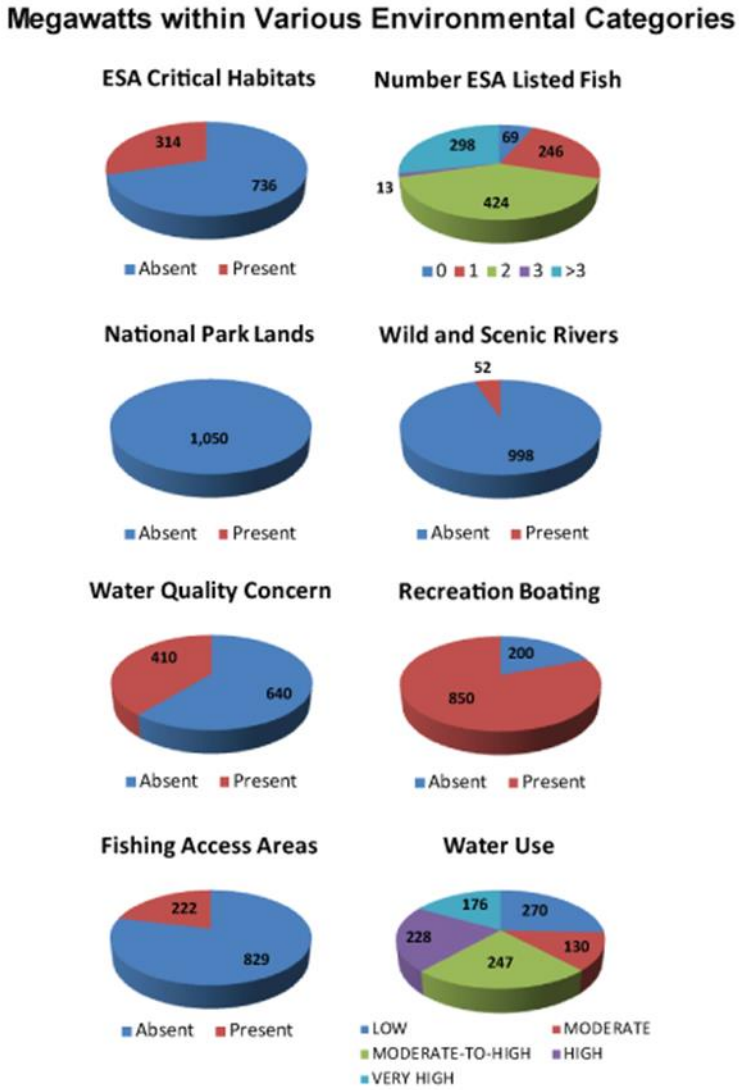




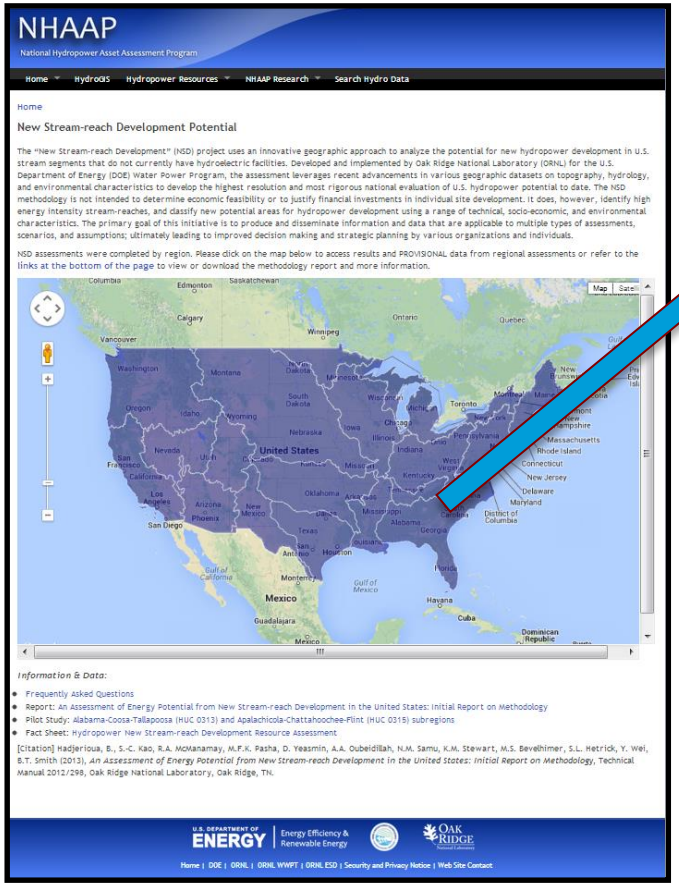
	Stream-reach (>1 MW)	Stream-reach (<1 MW)
Potential Capacity	1.05 GW	1.09 GW
Potential Energy	6.16 TWh	6.27 TWh

Environmental Attributes – Region 1



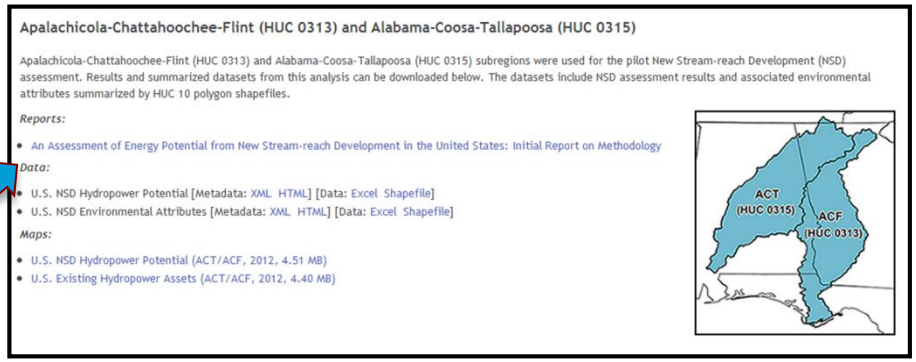


Product Dissemination via DOE/ORNL NHAAP Website



National Hydropower Asset Assessment Program (NHAAP)
http://nhaap.ornl.gov/nsd

Regional Results



- **Clickable NSD Availability Map**
- **NSD Methodology Report**
- **Webpages for each hydrologic region**
  - **Maps for existing hydro, non-powered dams, and NSD potential**
  - **Public data package in both GIS and xls formats**
  - **Detailed data will be provided upon further request**
- **Final nationwide Summary Report**

Alaska New Site Development Assessment & Results

Collaborative Effort:

- **Oak Ridge National Laboratory- U.S. Department of Energy**
- **Alaska Energy Authority**
- **US Army Corps of Engineers**

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ALASKA ENERGY AUTHORITY

US Army Corps of Engineers®

Recognition

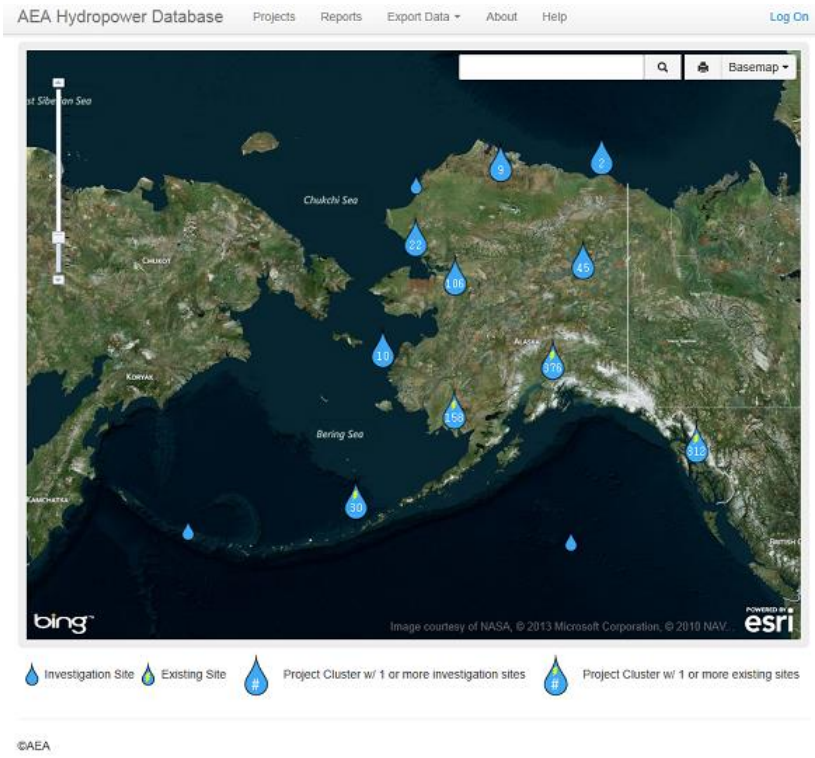
State of Alaska:

- **Alaska Energy Authority (AEA)**
  - **Doug Ott, Hydroelectric Program manager**
  - **Audrey Alstrom**
- **US Army Corps of Engineers (USACE) Anchorage Office:**
  - **Crane Johnson**

http://nhaap.ornl.gov/nsd

Alaska NSD Assessment:
Data Collection and Initial Screening

- Data source
  - Alaska Energy Authority Hydropower Database
- 2,200 potential projects from 404 reports:
  - Contains duplicate, missing capacity, unfeasible, and non-hydro references
- 15 projects (2011-2013)

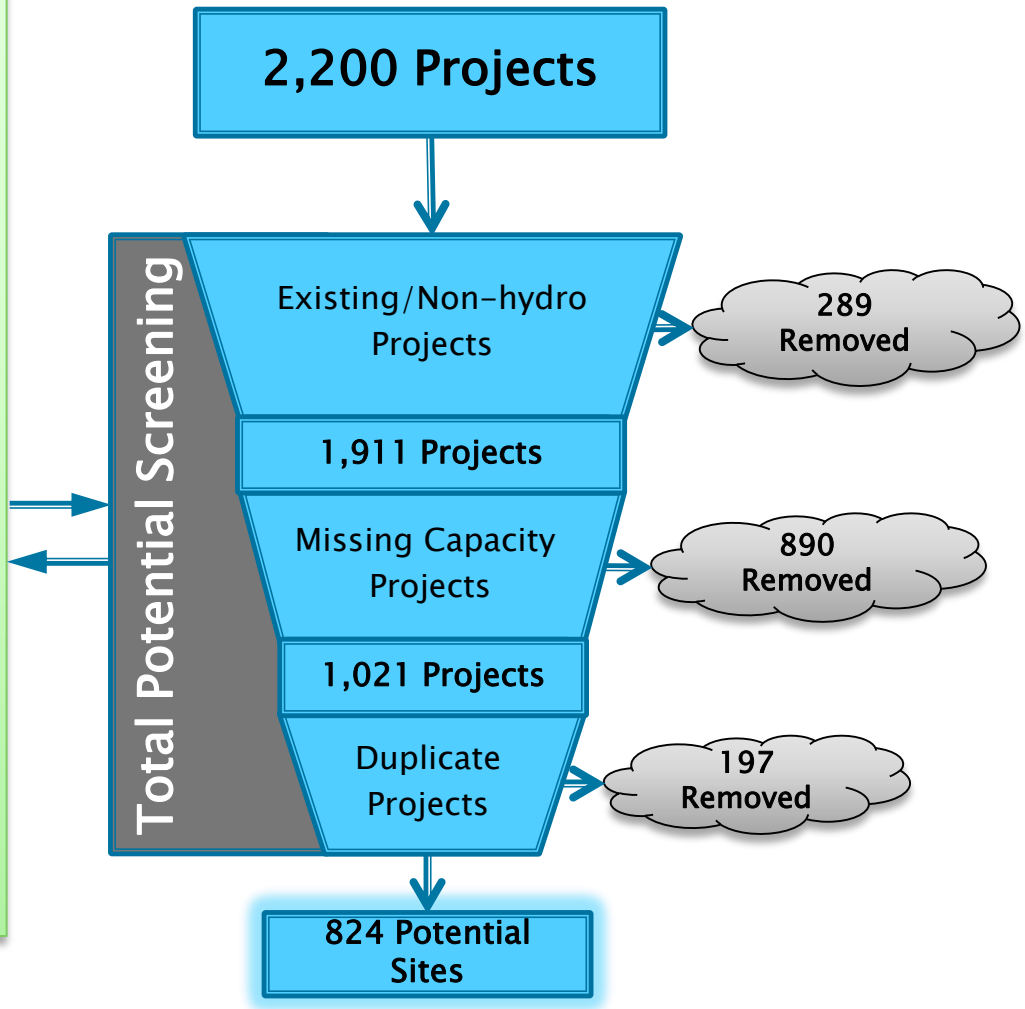


Goal:

- Identify projects in the database that are feasible with consideration of New Stream-reach Development assessment criteria.
- Determine the total NSD potential without feasibility restrictions to identify true stream potential.

Alaska NSD Screening Methodology:
Total Undeveloped Potential

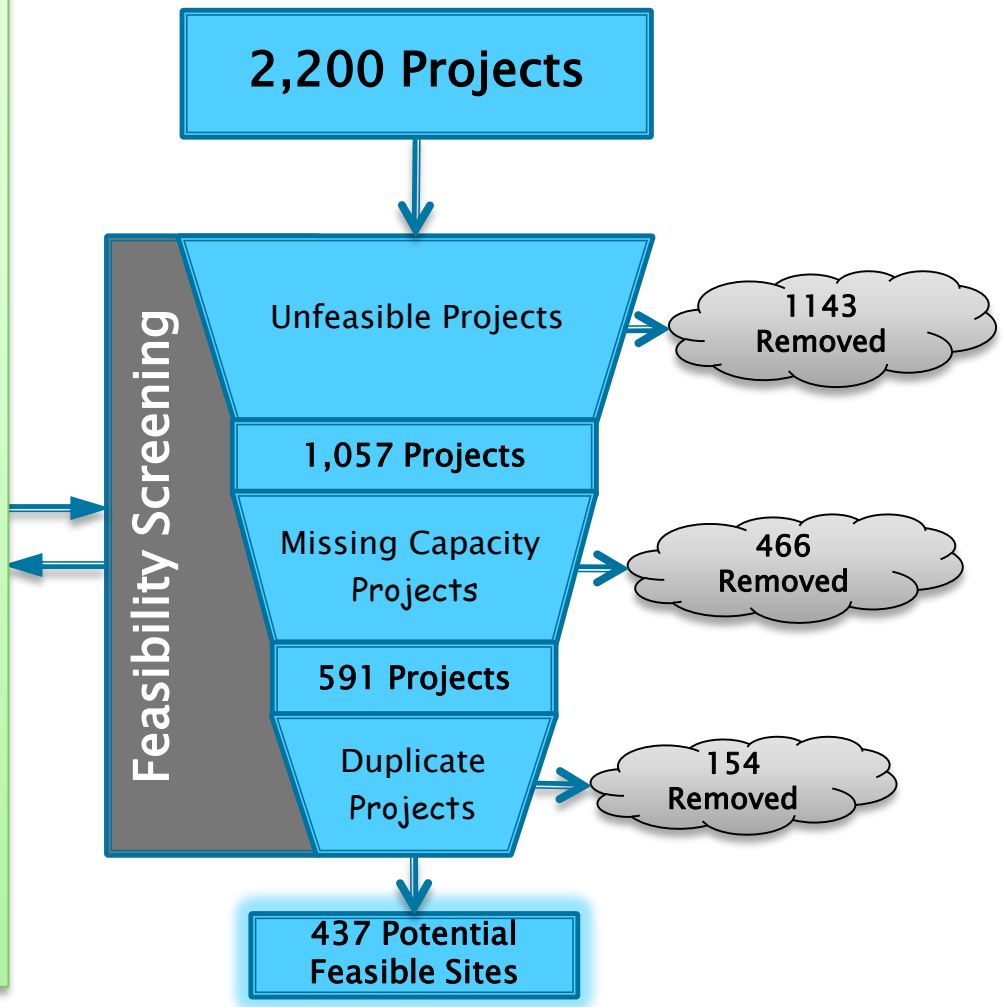
- Remove existing/non-hydro projects based on following criteria:
  - Existing/active development
  - Previously existing hydropower
  - Non-hydro reference
- Remove missing capacity projects
  - Check source reports for verification
- One project selected from duplicates based on various criteria, generally including:
  - Project feasibility
  - Report type (level of effort)
  - Report date published



Alaska NSD Screening Methodology:

Screening: Feasible Potential

- Remove unfeasible projects based on the following criteria:
  - Too large for rural development
  - Land compatibility issues
  - Environmental concerns
  - Negative evaluation in original report
  - Too remote
  - Existing/active development
  - Not a hydro reference
  - Other
- Remove missing capacity projects
  - Check source reports for verification
- One project selected from duplicates based on various criteria, generally including:
  - Project feasibility
  - Report type (level of effort)
  - Report date published



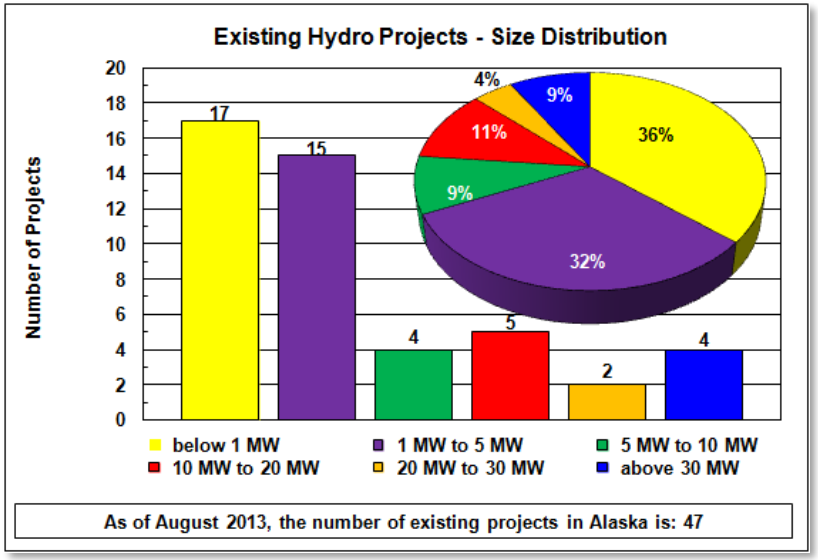
Existing Hydropower in Alaska

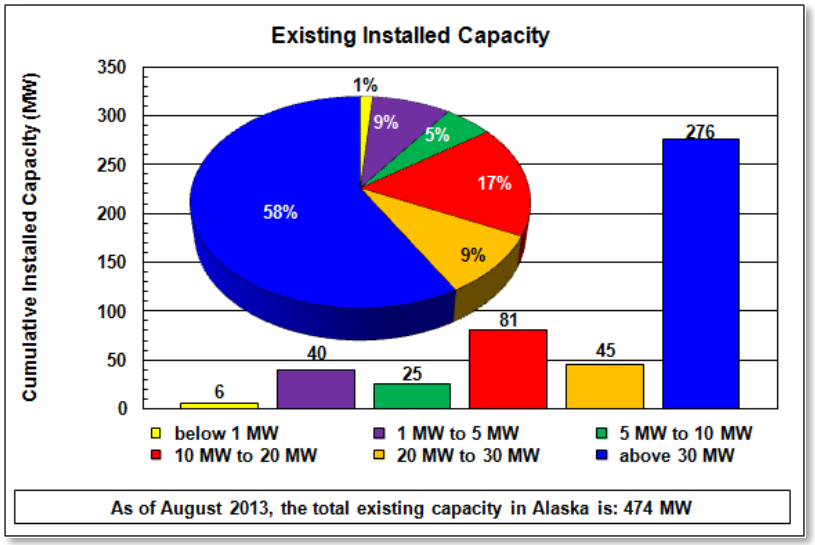
Alaska's Average Electrical Energy Make-up, 2011				
Oil	Gas	Coal	Hydro	Wind
15.6%	57.8%	5.9%	20.3%	0.3%

- 20% of Alaska's electrical energy comes from hydropower
- 68% of sites have a capacity below 5 MW
- 58% of total capacity is from 4 sites with greater than 30 MW capacity

Number of Existing Projects: 47

Total Installed Capacity: 474 MW



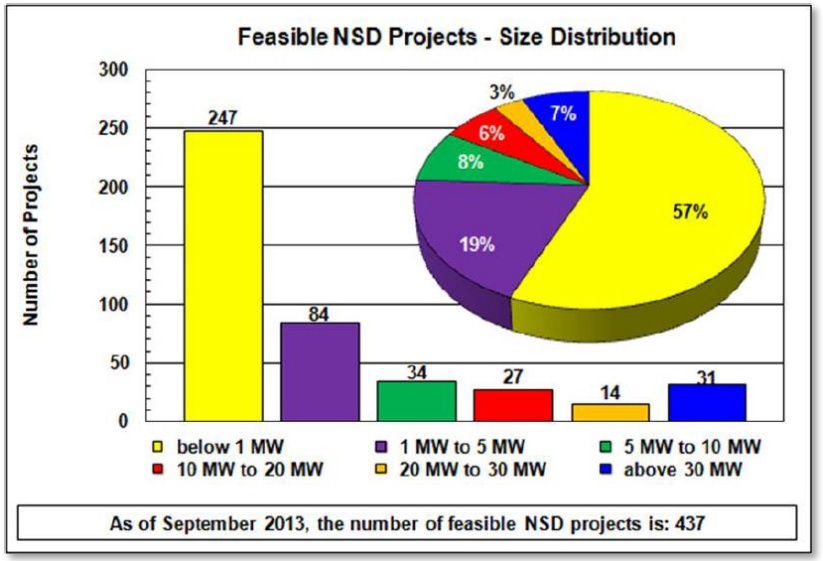


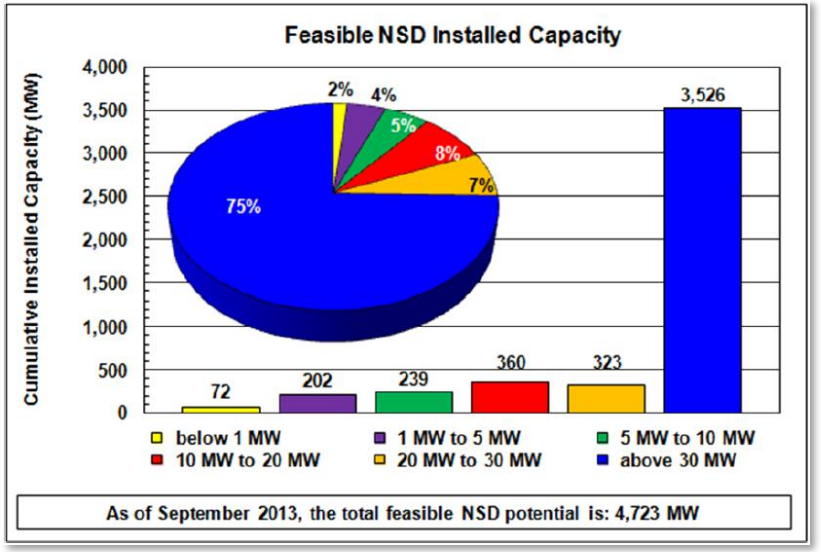
Alaska NSD Results:
Feasible Potential

- Does not include projects considered unfeasible due to economic, environmental, cultural, or land use restrictions.
- 76% of sites have a capacity less than 5 MW.
- 31 sites with a capacity above 30 MW comprise 75% of Alaska's potential.

Number of Feasible Projects: 437

Total Feasible Potential: 4.723 GW





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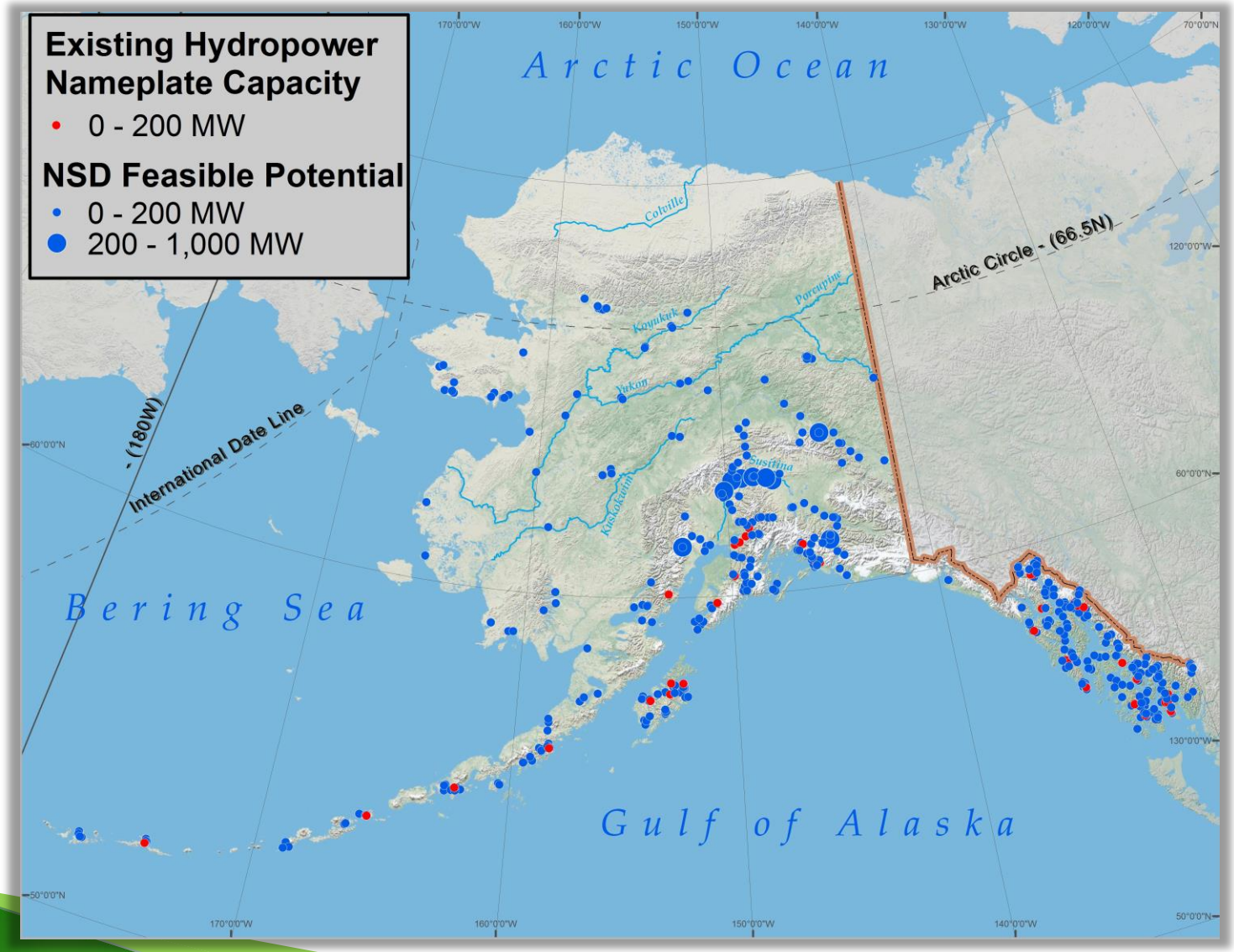
Alaska Hydropower:
Existing and Feasible NSD Sites



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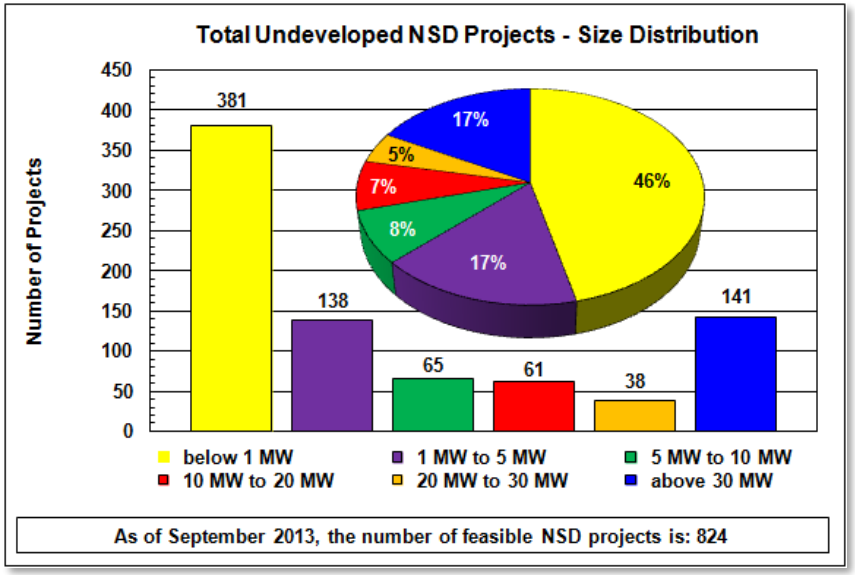
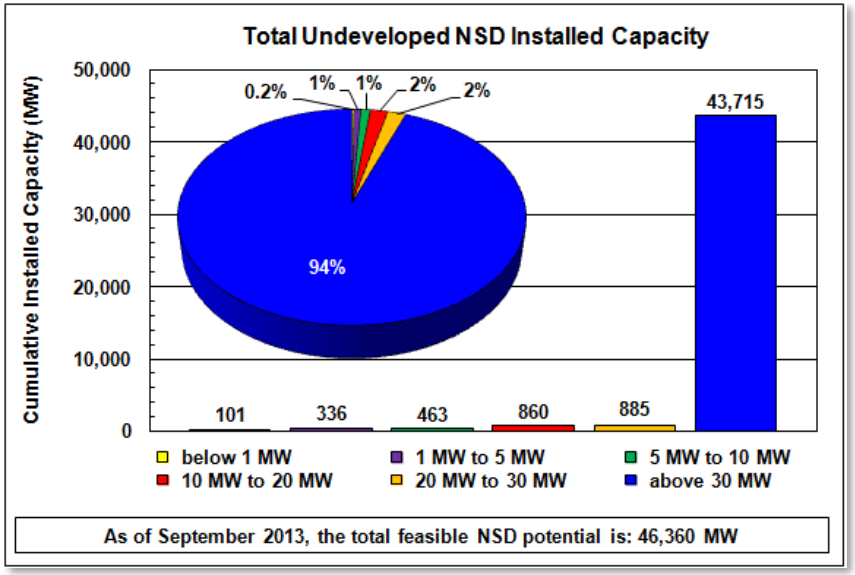
Alaska NSD Results:
Total Undeveloped Potential

- Includes projects considered unfeasible today.
- 63% of sites have a capacity less than 5 MW.
- 141 potential sites with a capacity above 30 MW comprise 94% of Alaska's potential.
- Much of the capacity comes from large potential sites on the Yukon and Copper rivers.

Number of Potential Projects: 824

Total Potential: 46.36 GW





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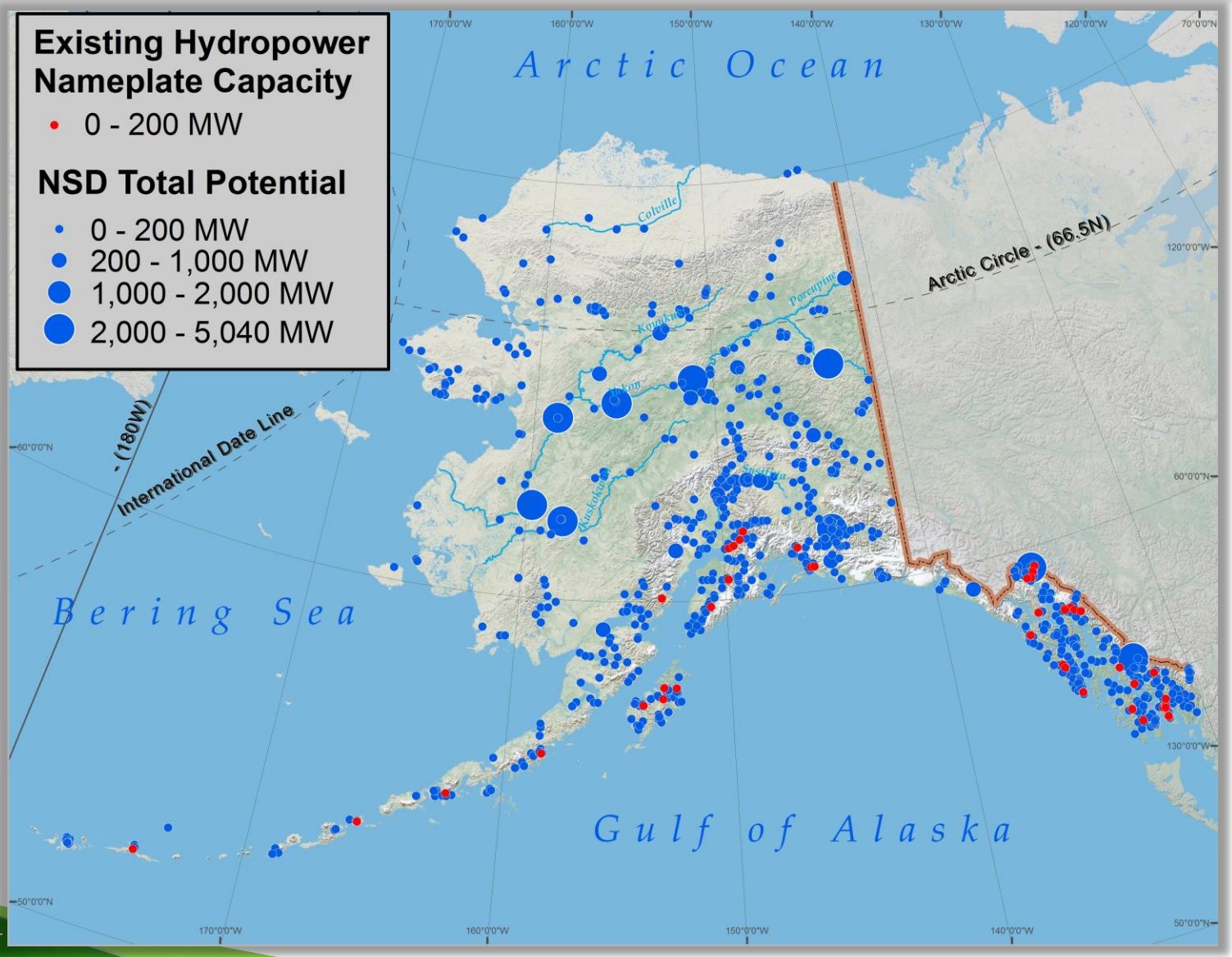
Alaska Hydropower:
Existing and Total Undeveloped NSD Sites



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Takeaway Messages

- DOE/ORNL will publish a hydropower resource potential dataset and findings of unprecedented spatial, temporal, and functional detail in 2013.
  - Hydropower feasibility and design will always require site-specific assessment that is outside the scope of this effort.
  - The methodology and results are reviewed by a panel of industry, agency, and NGO experts engaged at the beginning of the effort.
  - Energy (MWh) and capacity (MW) estimates are dependent on industry guidance for assumptions of powerhouse flow capacity as a function of hydrology.
  - Due to the updated data sources and refined assessment approach, the findings could be different comparing to the pervious assessment. Further discussion will be provided in the following reports.

National Scale NSD:
More Information

- **NSD home page:** http://nhaap.ornl.gov/nsd

- **Methodology Report:** "AN ASSESSMENT OF ENERGY POTENTIAL FROM NEW STREAM-REACH DEVELOPMENT IN THE UNITED STATES INITIAL REPORT ON METHODOLOGY" B. Hadjerioua, et al.
  - LINK: http://nhaap.ornl.gov/sites/default/files/NSD_Methodology_Report.pdf

Thank you
Questions?

Thank you for your attention

Presenter Contact information for:

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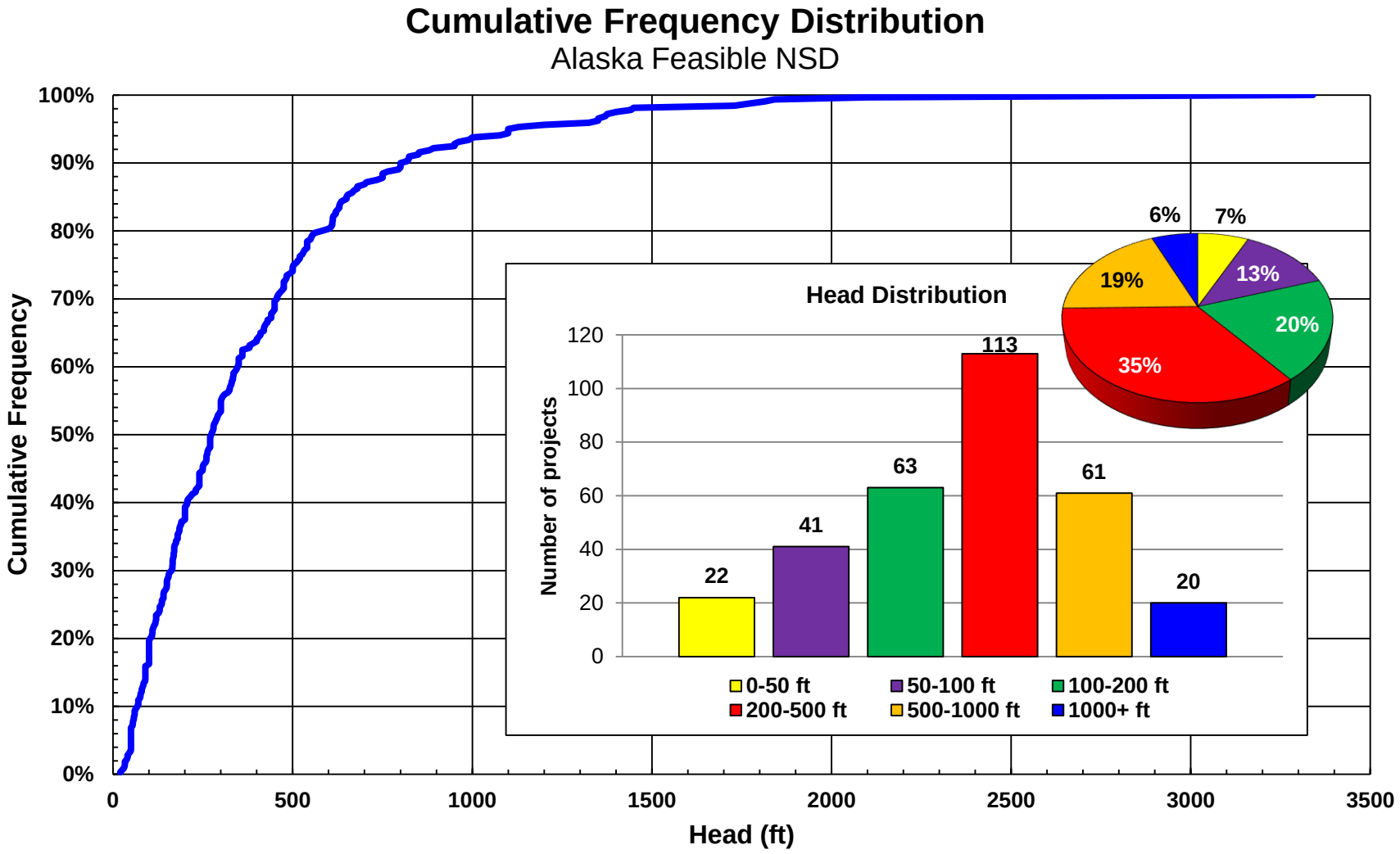
BACK UP SLIDES

Some statistics about Alaska assessment

Feasible Projects

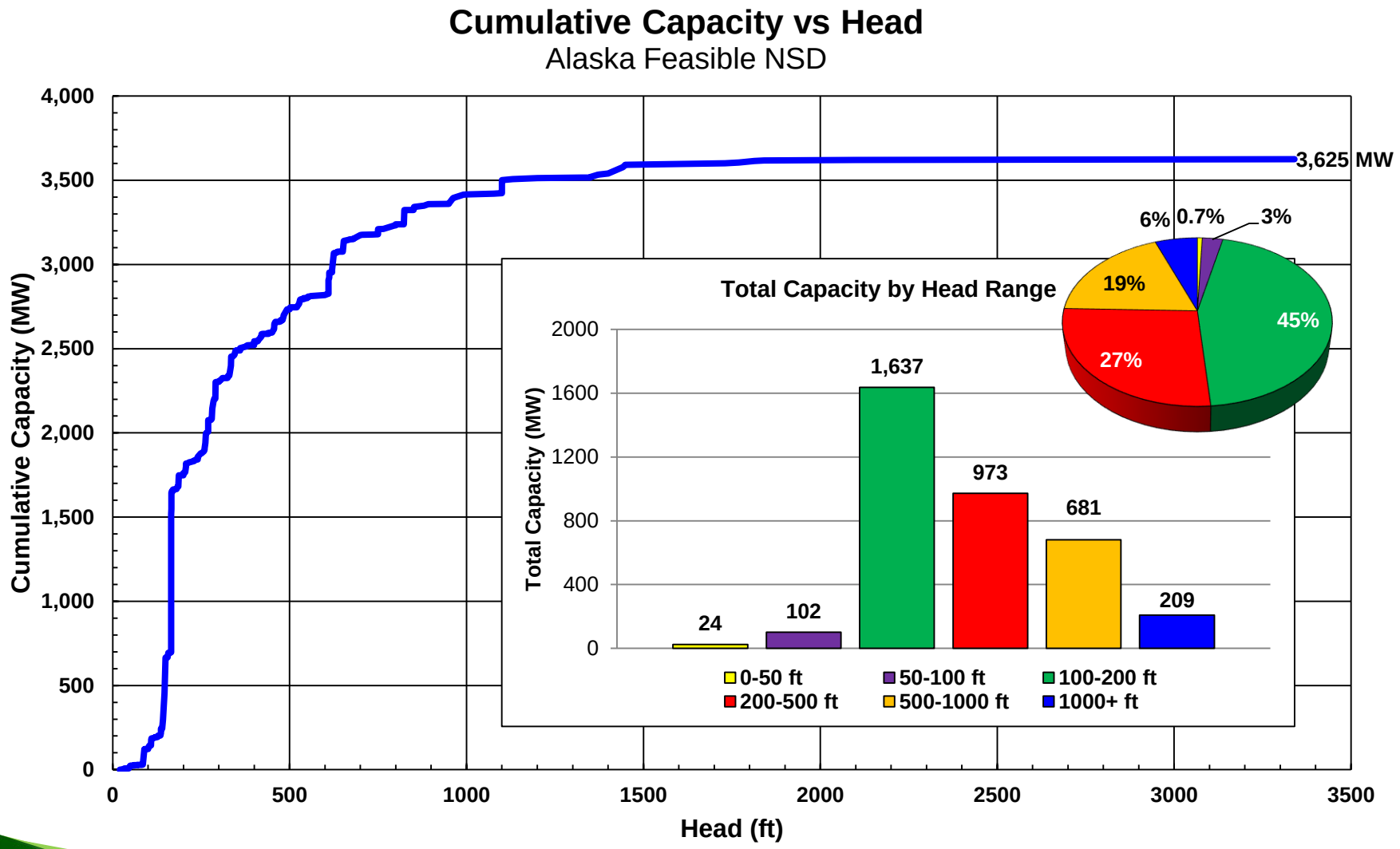
Project Head Distribution



Note: out of the 437 feasible NSD sites, only 320 (73.2%) contain information for project head

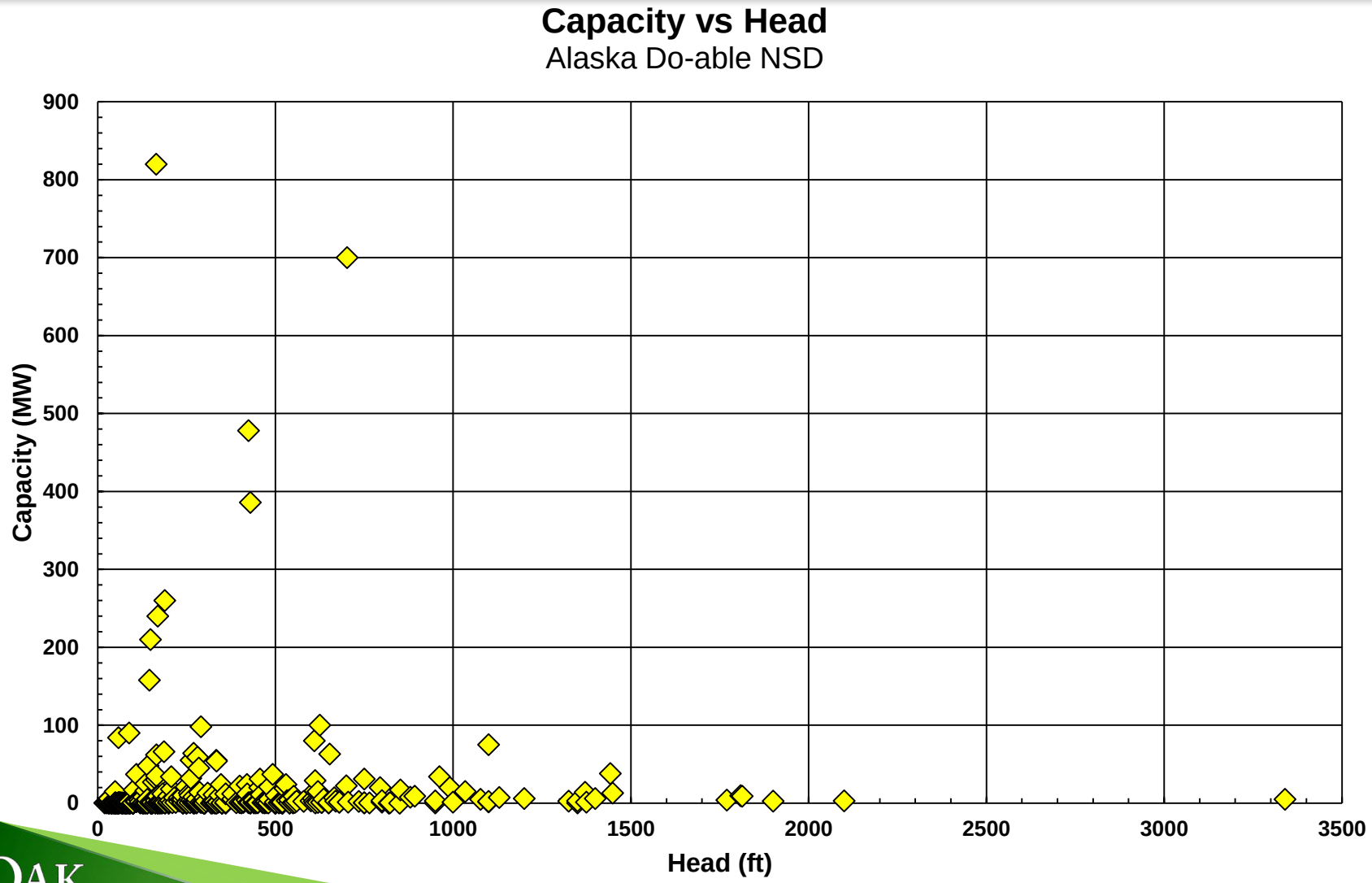
Feasible Projects

Capacity-Head Distribution



Note: out of the 437 feasible NSD sites, only 320 (73.2%) contain information for project head

Feasible Projects
Capacity vs Head



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