

Utilizing Micro Hydro Opportunities

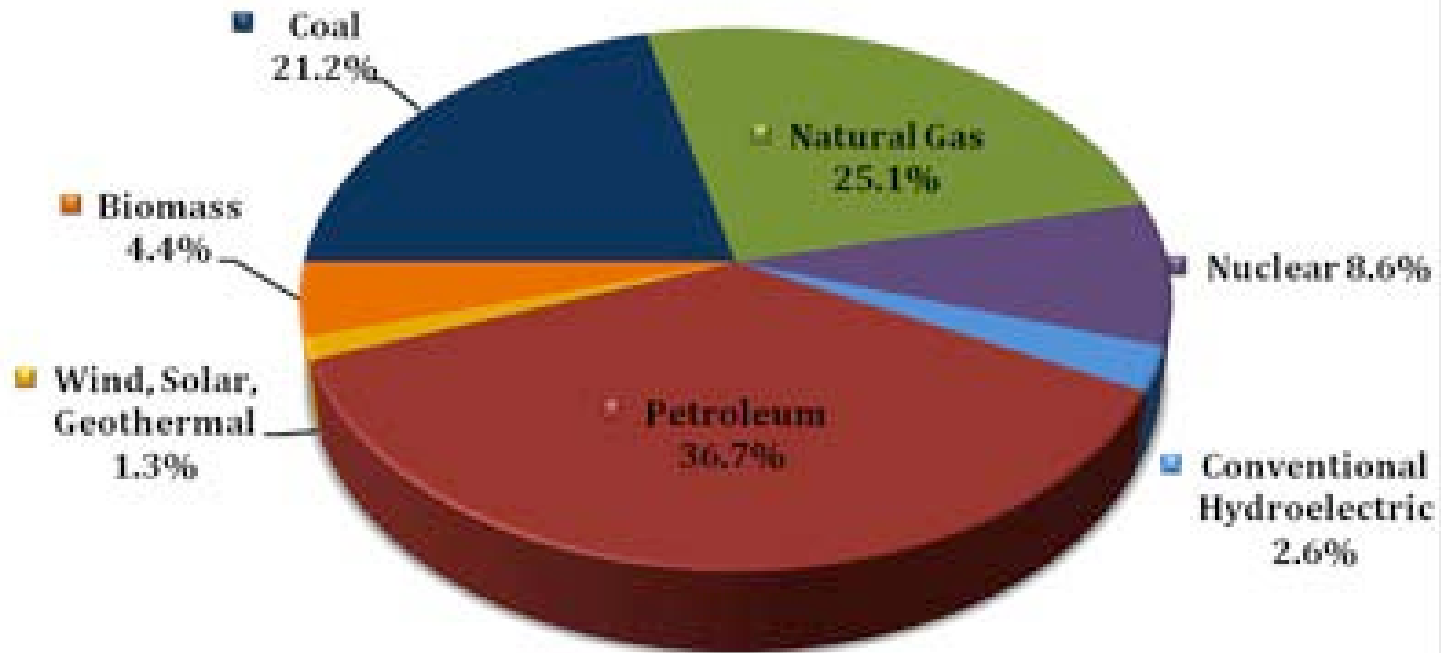
Defining Hydropower Development for the Future



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Hydropower's Relative Importance

US Energy Consumption by Source 2010



Source: EIA, *Monthly Energy Review*, March 2011, Table 1.3 Primary Energy Consumption by Source (Quadrillion Btu), 7, <http://www.eia.doe.gov/emen/mer/pdf/mer.pdf>.

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How Does Drought Impact Hydropower?

Power = Height of Water * Flow Amount * Gravity



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Average Family of 4 Water Consumption:

7,300 Gallons per month for sinks, showers, toilets, etc.

22,300 Gallons per month for food production

39,800 Gallons per month for power

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The Water Cost of Power

Power Sources Measured in Gallons per MWh*

7. Wind	1
5. PV Solar	2
5. Geothermal	2
4. Natural Gas	1,512
3. Nuclear	2,995
2. Coal	7,143
1. Hydropower	29.920!

* 1 MWh powers an average household of 4 for a month 2010 Census data

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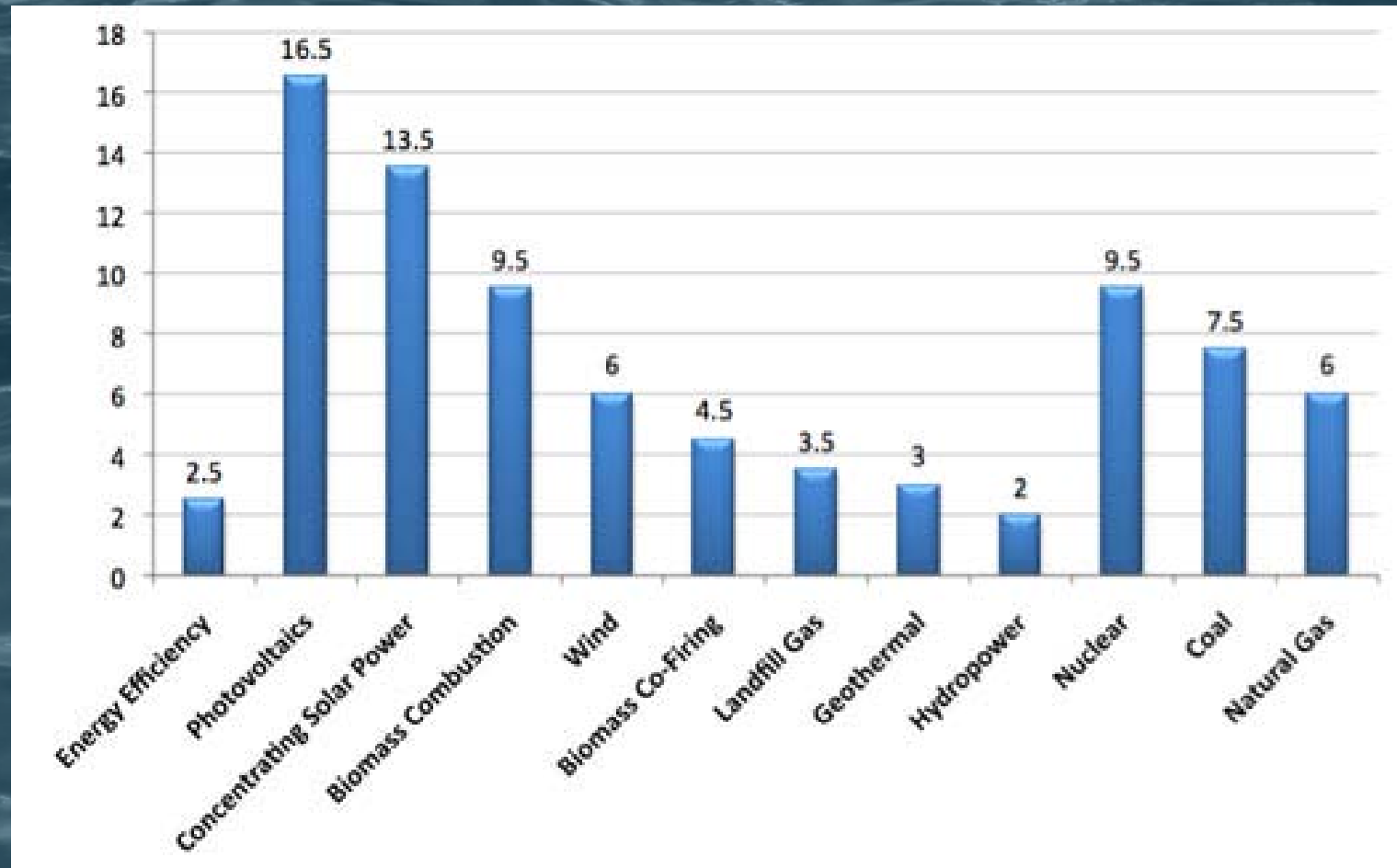
Why? ...Evaporation



Net evaporation in Colorado can be between 2 and 3 feet over the entire water surface in a year!

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Then Why Hydro?



Assumes Federal & state incentives. CSP assumes trough technology. Natural gas price of \$4.57/MMBTU.

Source: Navigant Consulting, Inc. 2010

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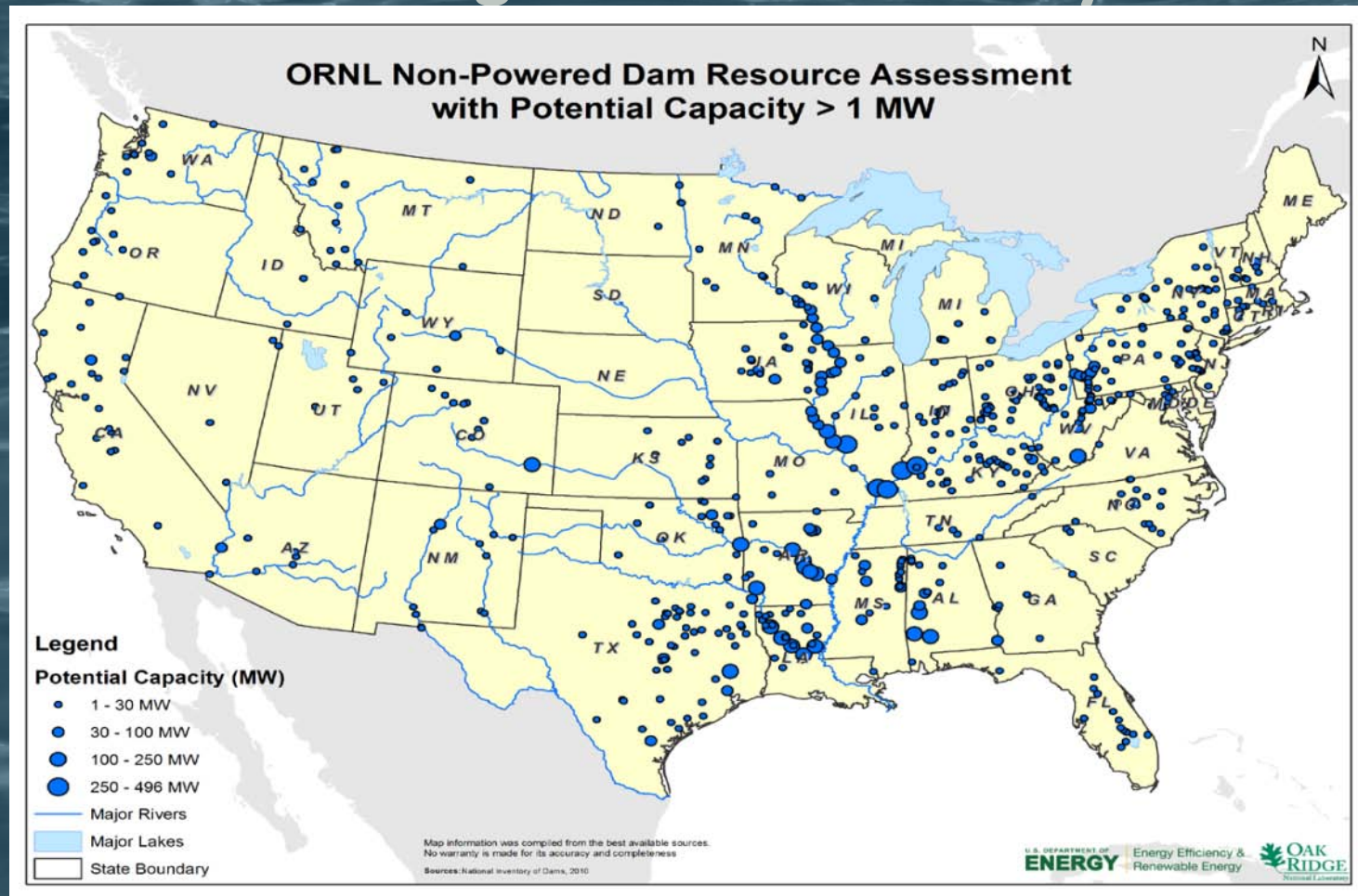
Can Hydropower Use Less Water?

- Decommission “wide” water inefficient hydro electric dams
- Upgrade existing hydropower turbines with more efficient turbines
- Fit existing reservoirs and diversion structures that are built for other uses with hydropower
- Small hydropower applications in conduits – canals and pipelines
- Design flexibility into the project – don’t maximize the flow and height of water.



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Only 3% of the nation's 80,000
dams generate electricity.



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Colorado's Streamlined Permitting Pilot Program

- Federal surveys have identified potential of about 700 MW in Colorado
- Most of the projects in the Pilot Program did not come from the surveys.... HOW MUCH MORE?

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21st Century Hydropower; A New Paradigm

- Use existing structures
- Pair with other uses
- Consider other river values beginning in the pre-feasibility phase
- Maximizing generation not always best option for project
- Engage interested stakeholders prior to project design

