

# Hydropower Optimization

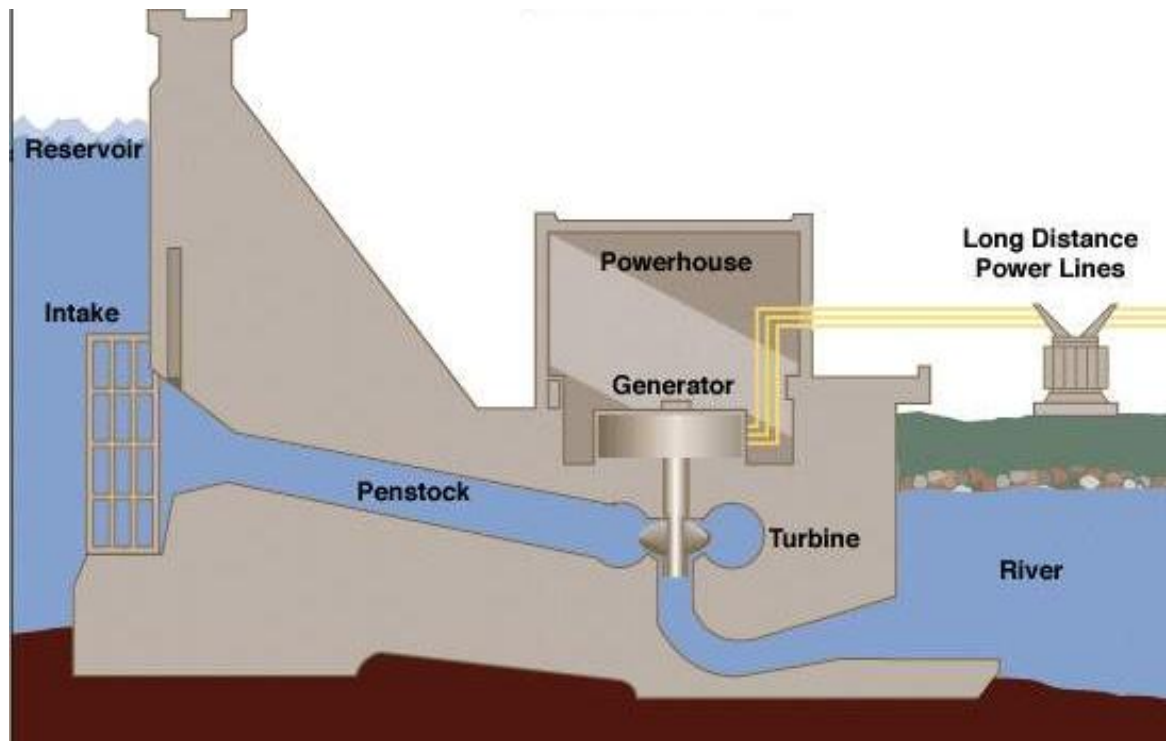
Final Class Presentation

June 2012

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- **Introduction to hydropower**
- **Operational Optimization**
- **Financial Optimization**

# Hydroelectricity utilizes the potential energy of water to produce electricity



**Power generated by a hydroelectric facility is a function of:**

- Head (dependent on the height of the reservoir)
- Volumetric flow rate (i.e., the amount of water flow)

**Energy generated by a hydroelectric facility is a function of:**

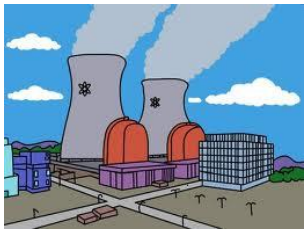
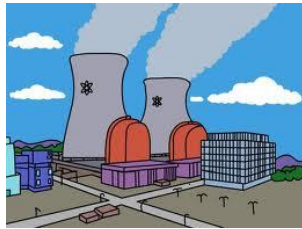
- Peak power (as described above)
- Efficiency of system
- Capacity factor (percent in operation)

Source: Tennessee Valley Authority

# Hydroelectric facilities are dependent entities, unlike other kinds of power plants

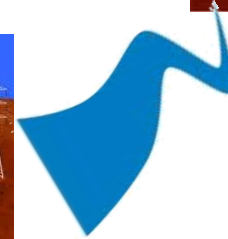
Most power plants operate independently of each other

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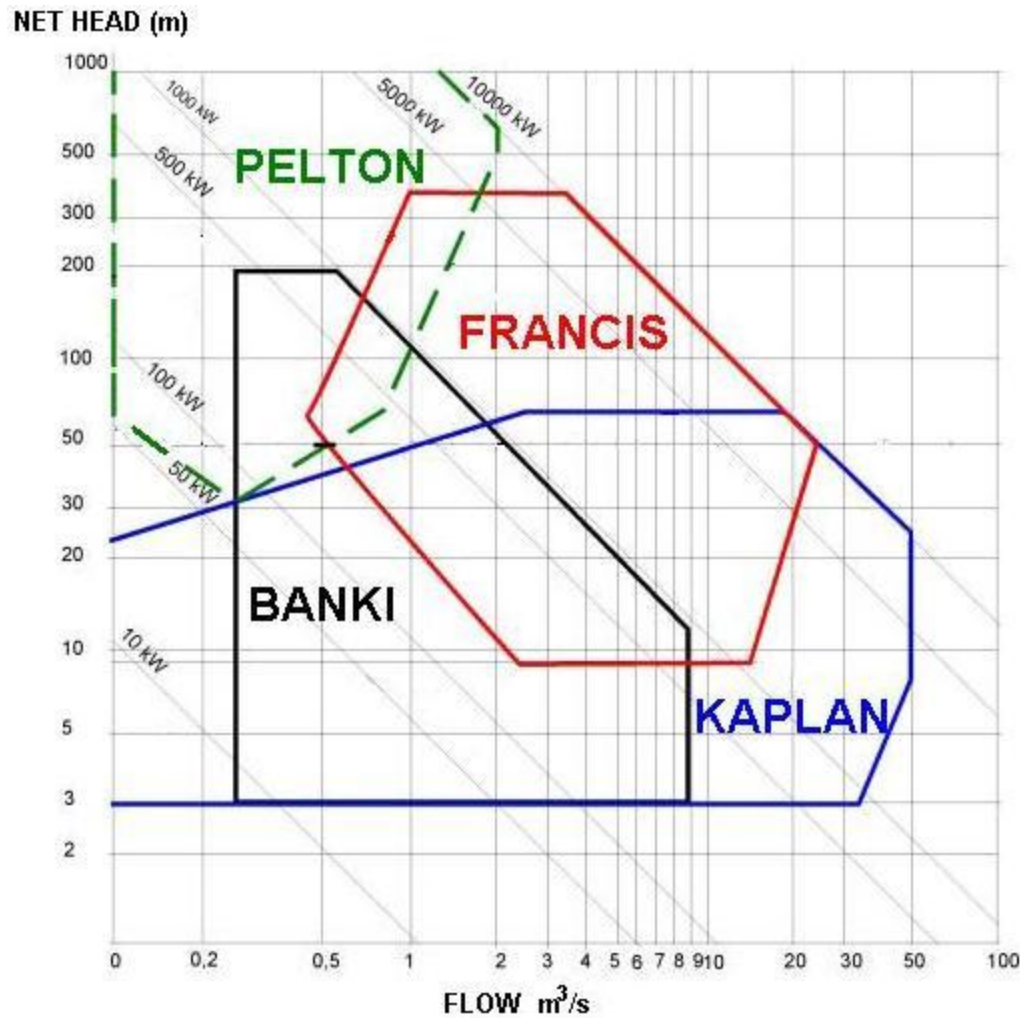
However, hydroelectric facilities are highly dependent on the same input!

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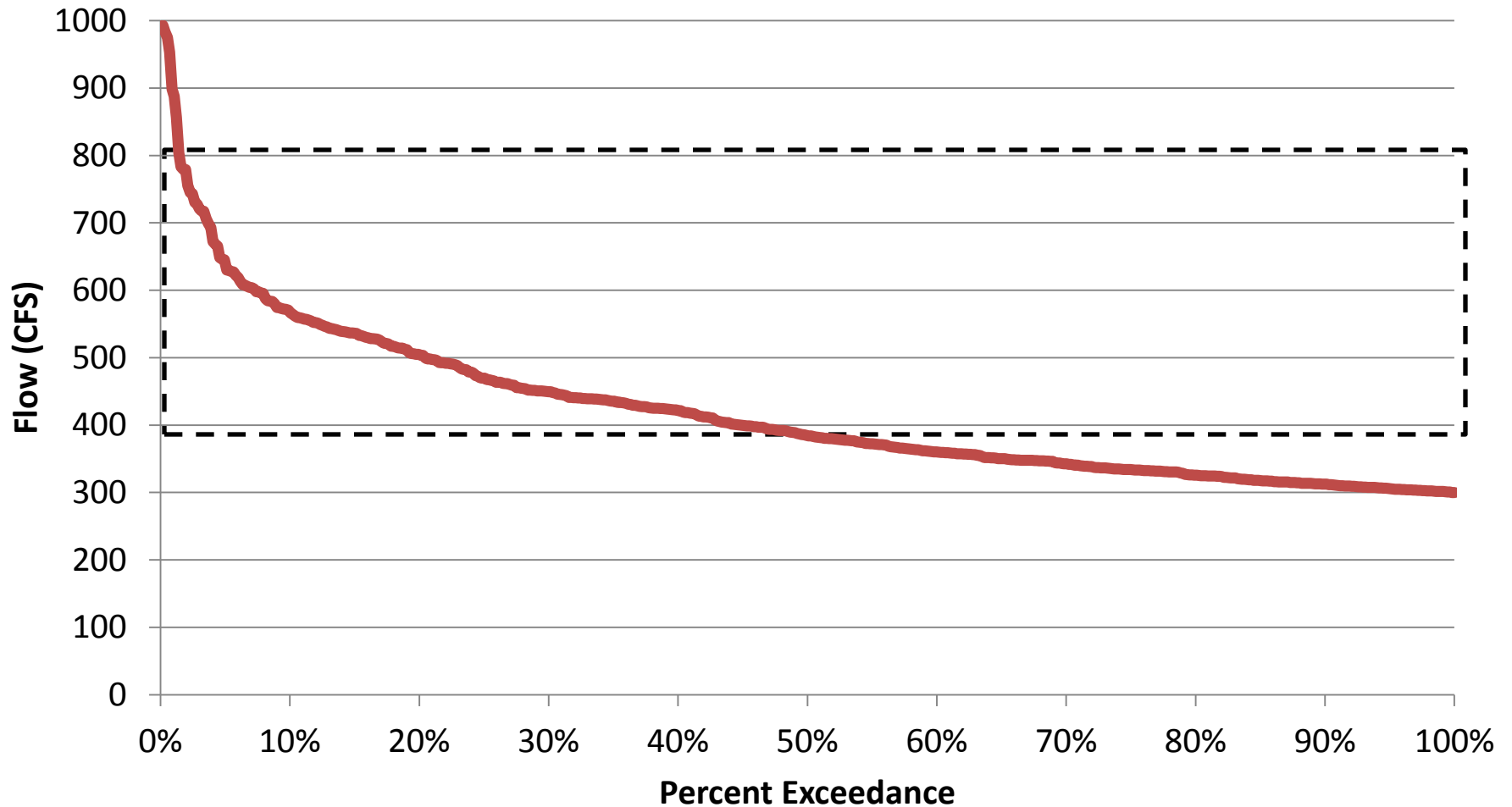
Source: Literature search

# Hydropower turbines work in a selected range of flows and head (and subsequent power)



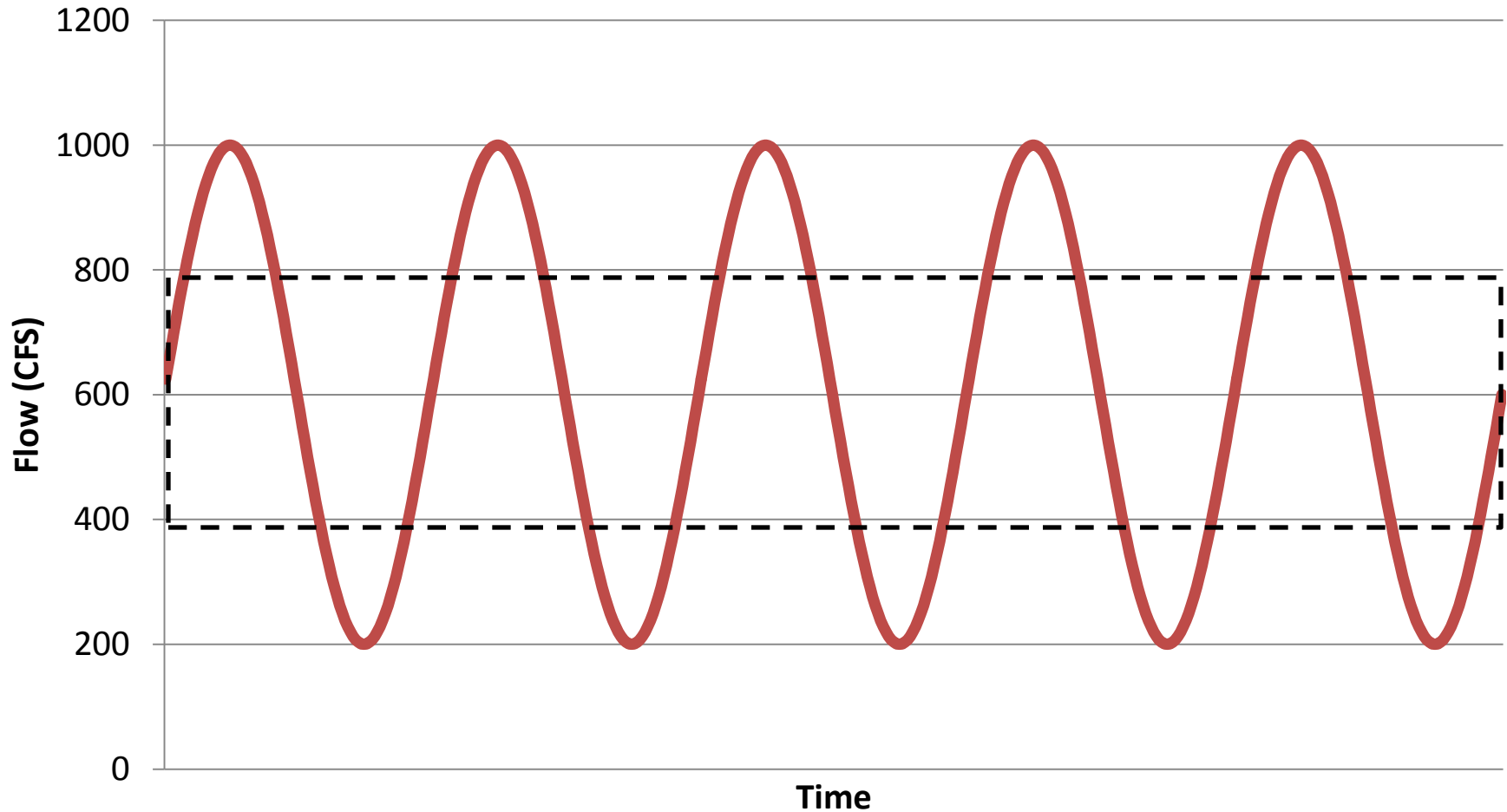
Source: INFORSE (International Network for Sustainable Energy)

# Flows that are outside the range of allowed flows are wasted



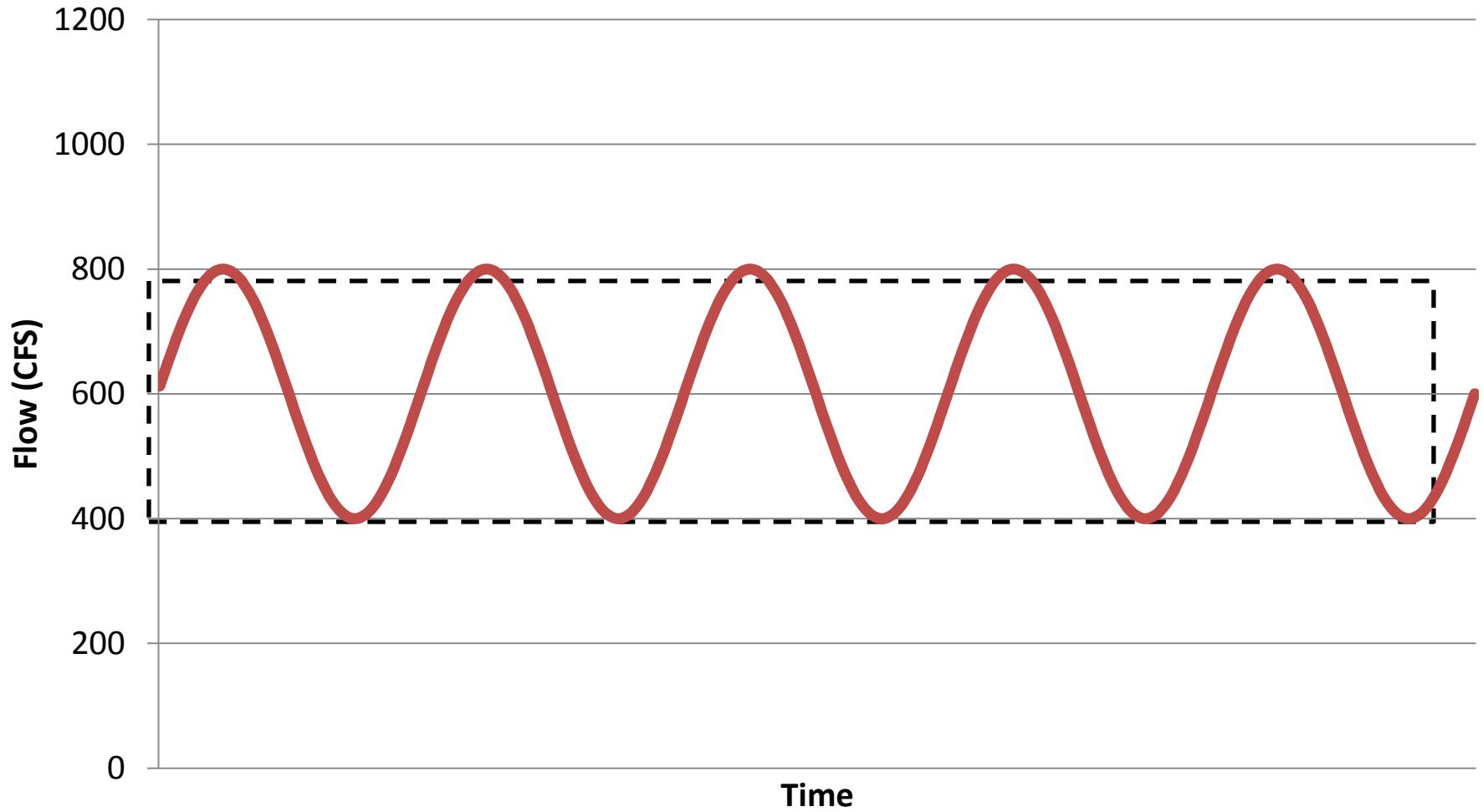
Source: Team analysis

# What if you could move from this...



Source: Team analysis

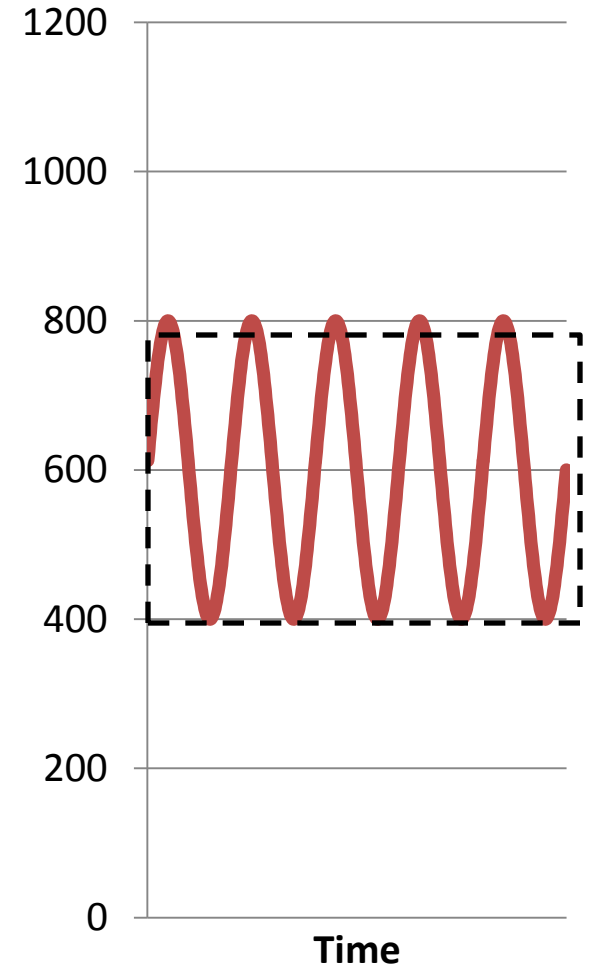
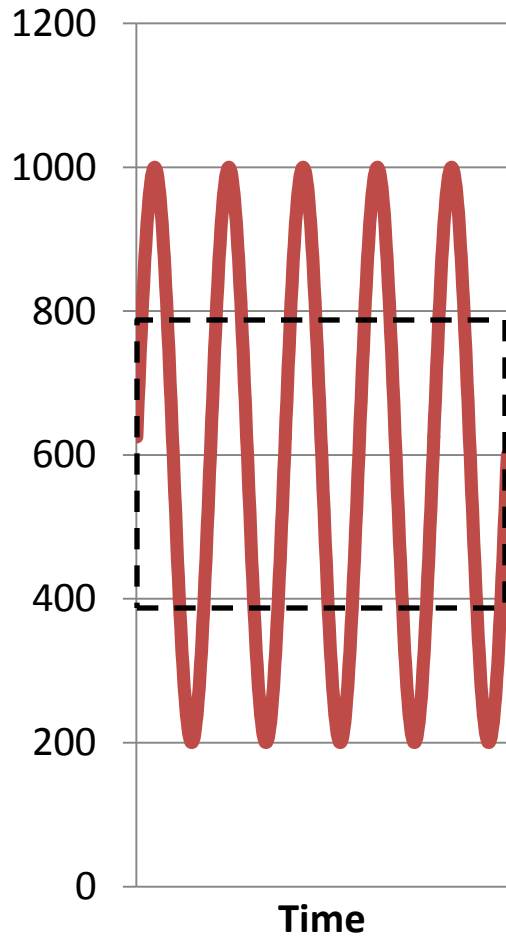
...to this...



Source: Team analysis



# ...using an upstream hydroelectric facility as a damper?



Source: Team analysis

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# Case study: Yuba-Bear and Drum-SpaULDing hydroelectric projects

## Yuba-Bear hydroelectric project

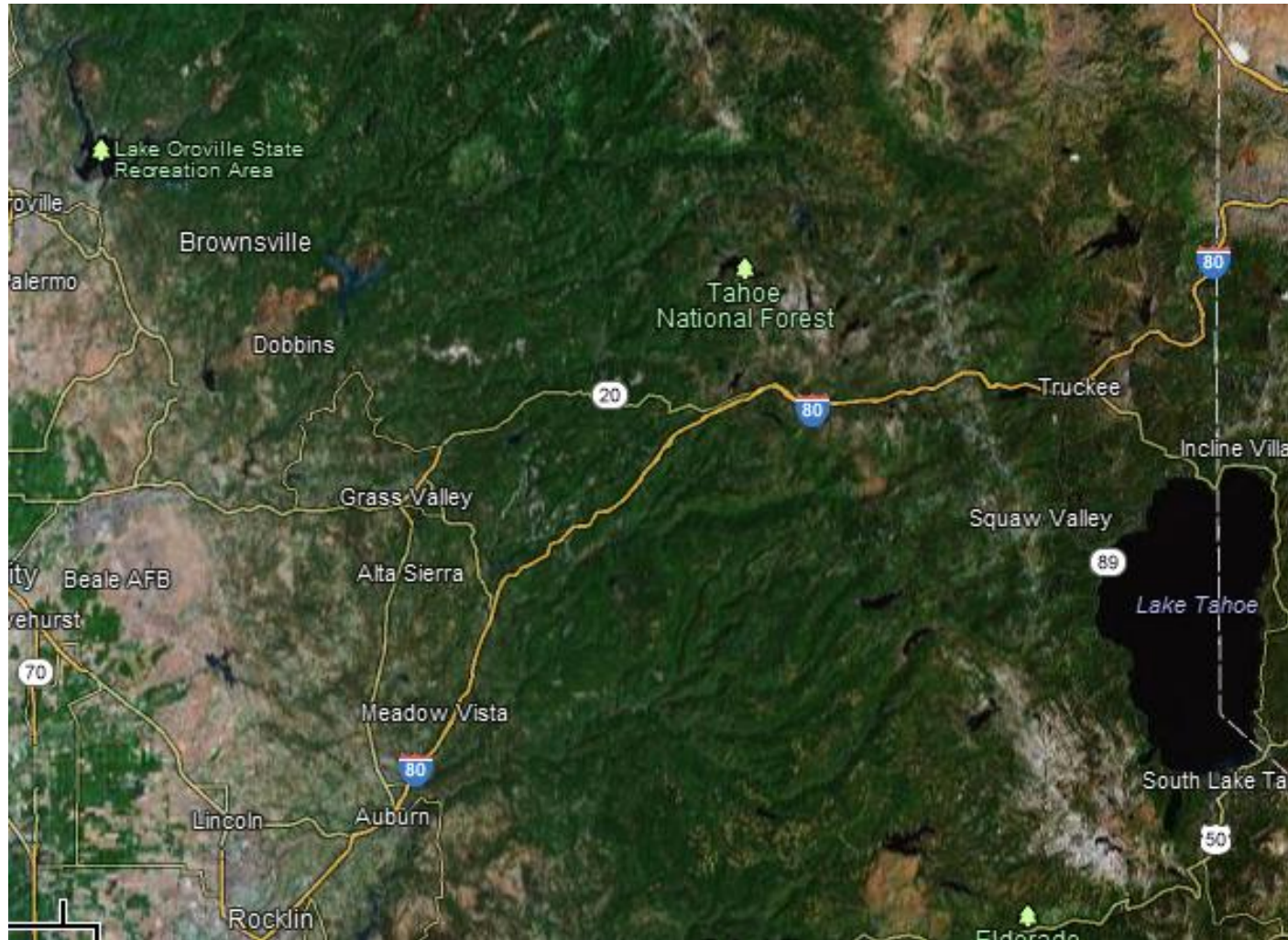
- Partnership between the Nevada Irrigation District and PG&E, which began in the mid-1950s
- 12 dams with a combined gross storage capacity of about 207,865 acre-feet of water
- Storage of water began in years ranging from 1859 – 1964
- Powerhouses with a capacity of nearly 75 MW

## Drum-SpaULDing hydroelectric project

- Developed by PG&E
- Composed of 12 dams and powerhouses with a total of 16 generating units
- Powerhouses with a capacity of nearly 190 MW
- Average annual generation comes to 786 GWh

Source: Literature search

# Yuba-Bear and Drum-Spaulding are located west of Lake Tahoe



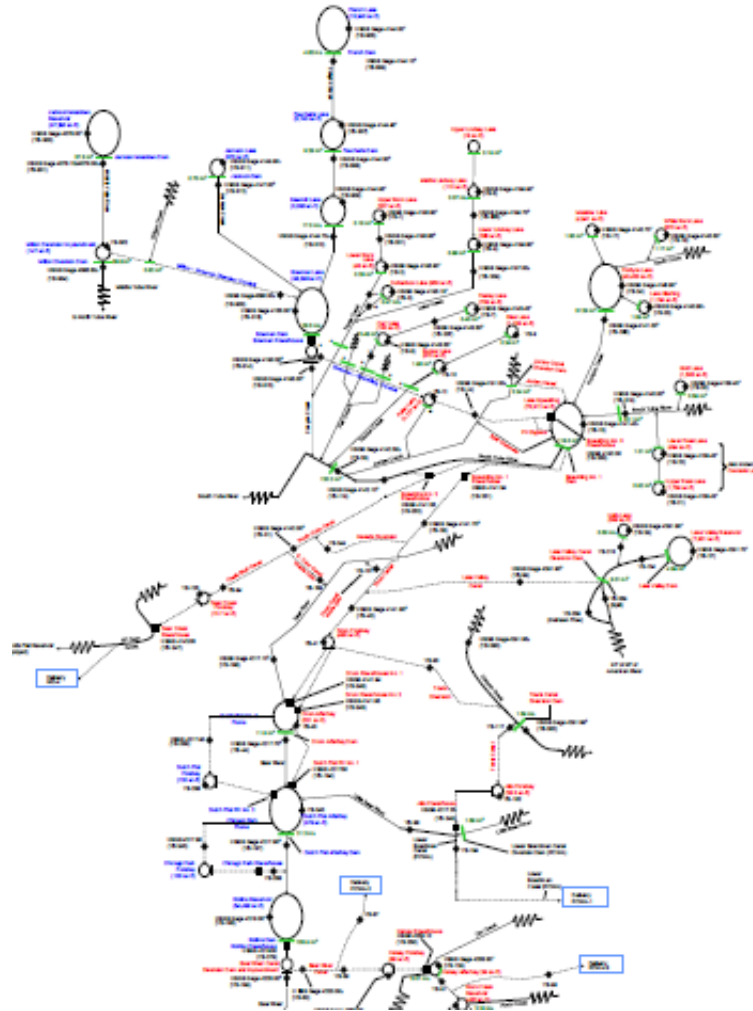
Source: Google Maps

# Schematic of Yuba-Bear and Drum-Spaulding hydroelectric projects

KEY:

NID's Yuba-Bear Project (FERC No. 2266)  
PG&E's Drum-Spaulding Project (FERC No. 2310)  
Non-FERC jurisdictional facilities

- Dam
- Unimpaired Hydrology Point
- Powerhouse
- Gage
- Reservoir/Lake/Header Box
- ← Incoming/Outgoing Flow



Source: Literature search







# Focus area: Fordyce Lake

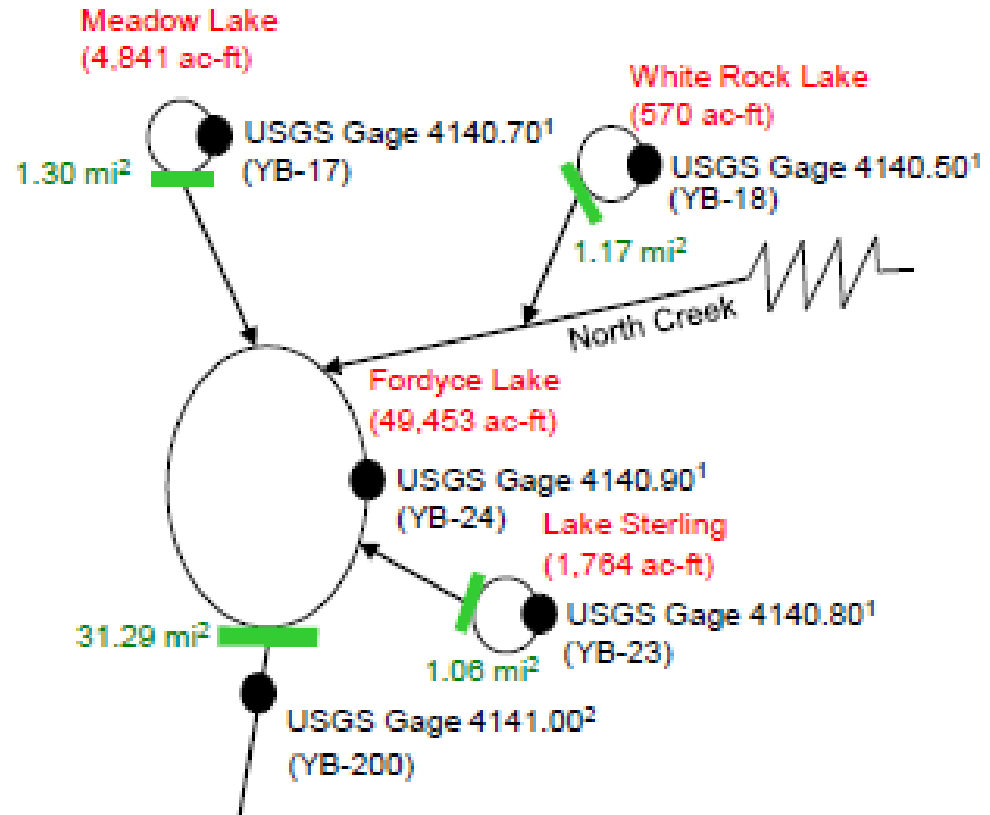
**KEY:**

NID's Yuba-Bear Project (FERC No. 2266)

PG&E's Drum-Spaulding Project (FERC No. 2310)

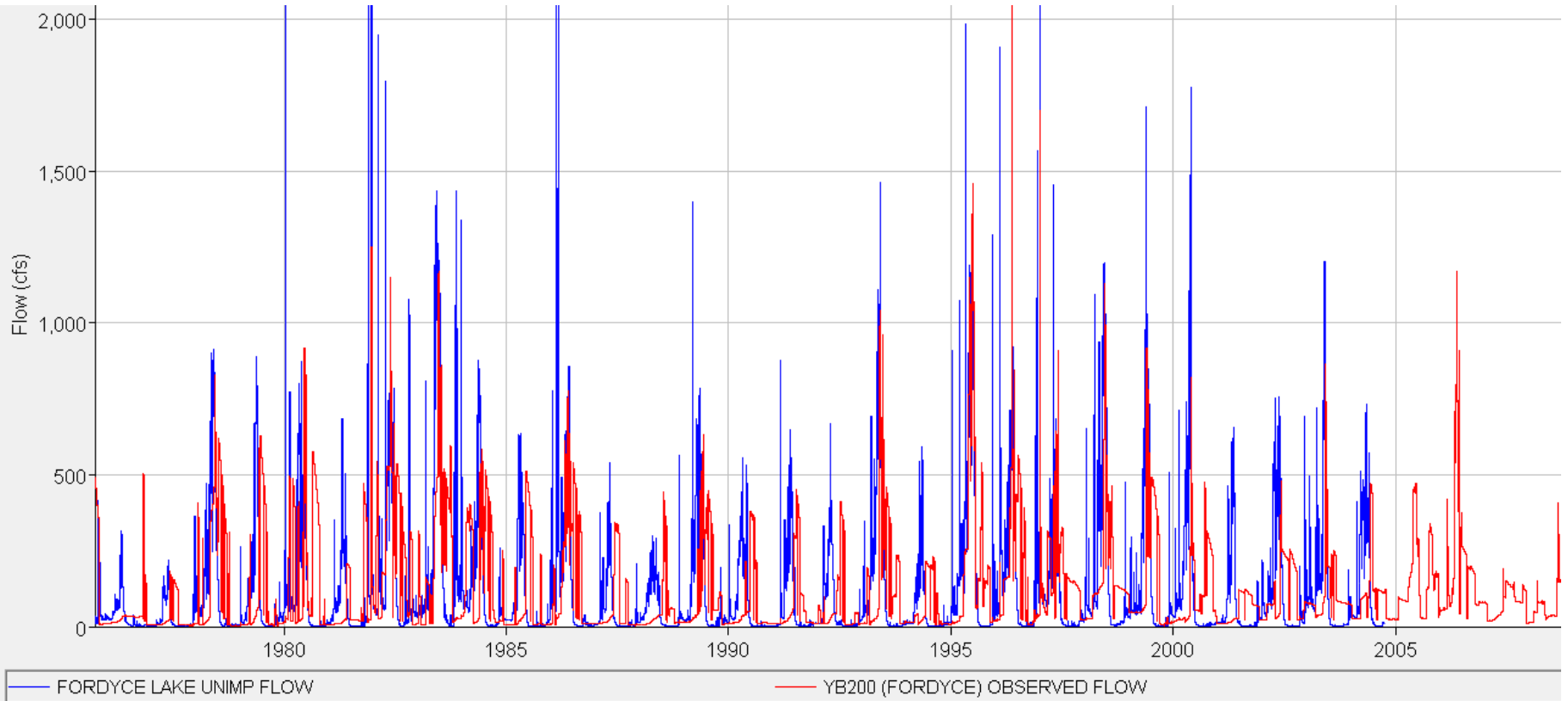
Non-FERC jurisdictional facilities

-  Dam
-  Unimpaired Hydrology Point
-  Powerhouse
-  Gage
-  Reservoir/Lake/Header Box
-  Incoming/Outgoing Flow



Source: Literature search

# Presence of upstream dam mitigates the extreme flow events, as shown in chronological data



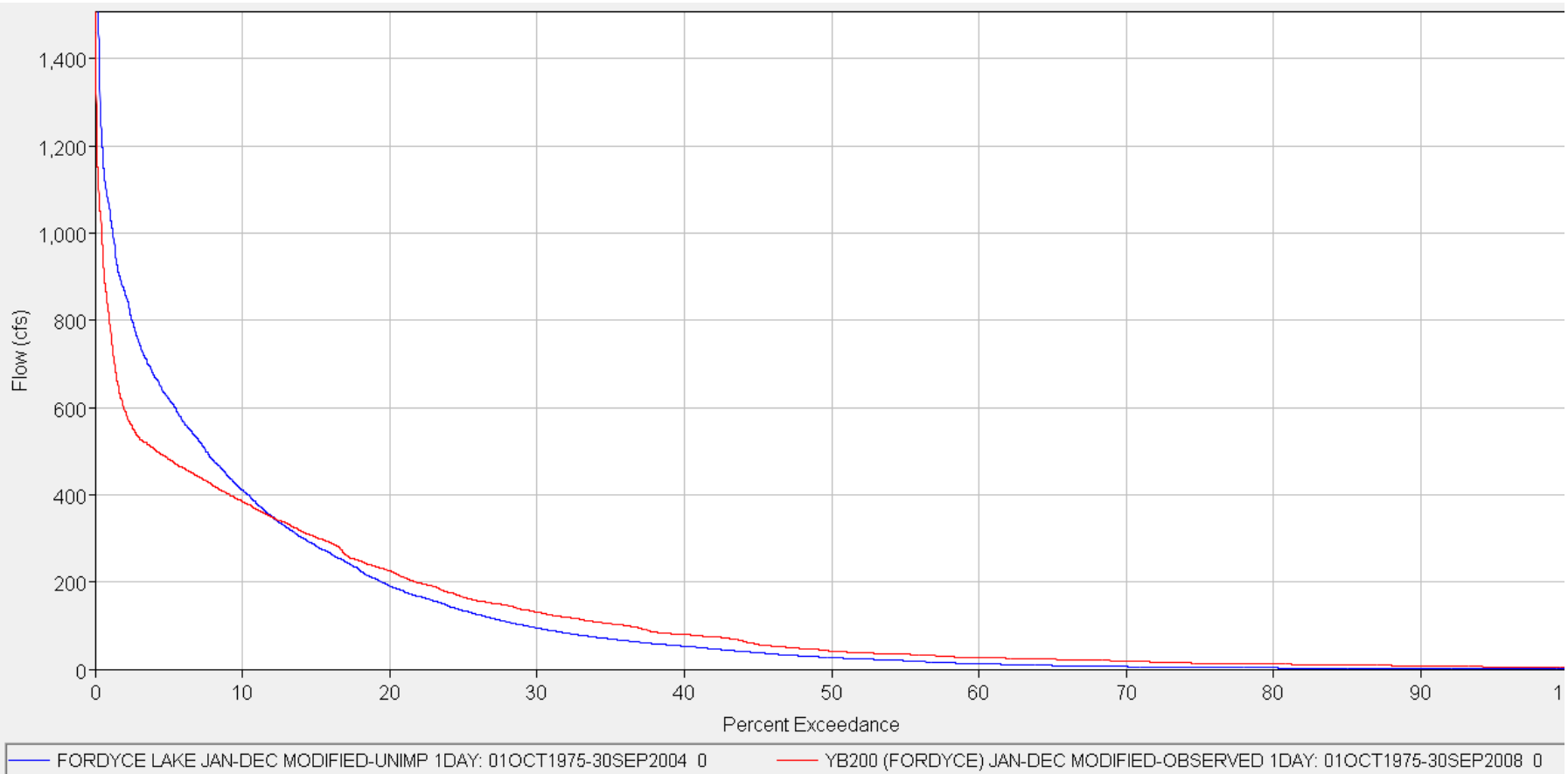
- Blue line shows flow data without upstream dam
- Red line shows flow data with upstream dam



**As shown, red line has less extreme flow events**

Source: U.S. Army Corps of Engineers' Hydrologic Engineering Center Data Storage System

# An upstream dam tends to “smooth out” the flow conditions of the hydroelectric facility



- Blue line shows flow data without upstream dam
- Red line shows flow data with upstream dam

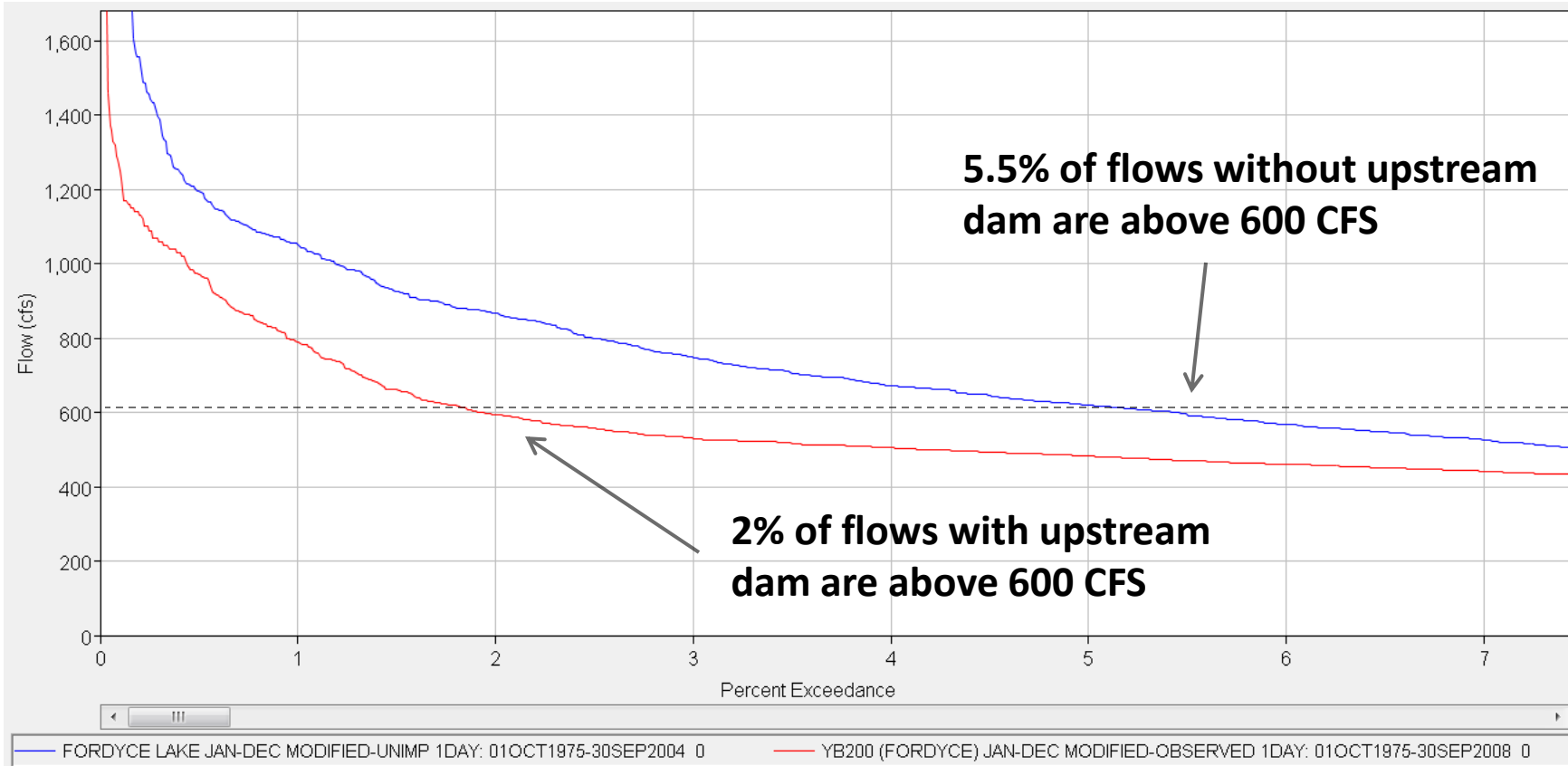


**As shown, red line has less range of flows**

Source: U.S. Army Corps of Engineers' Hydrologic Engineering Center Data Storage System

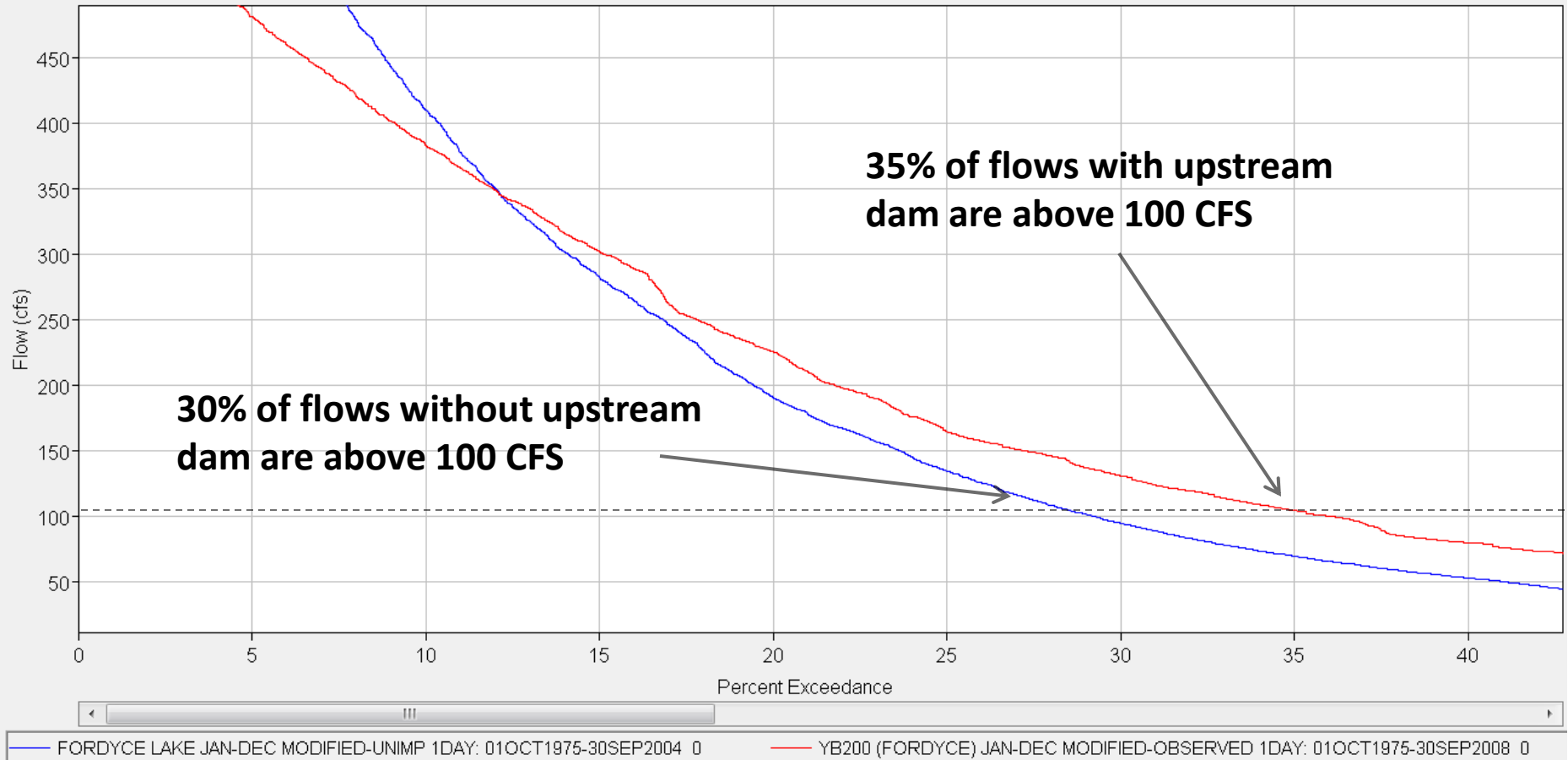


# An upstream dam causes less extreme flow events...



Source: U.S. Army Corps of Engineers' Hydrologic Engineering Center Data Storage System

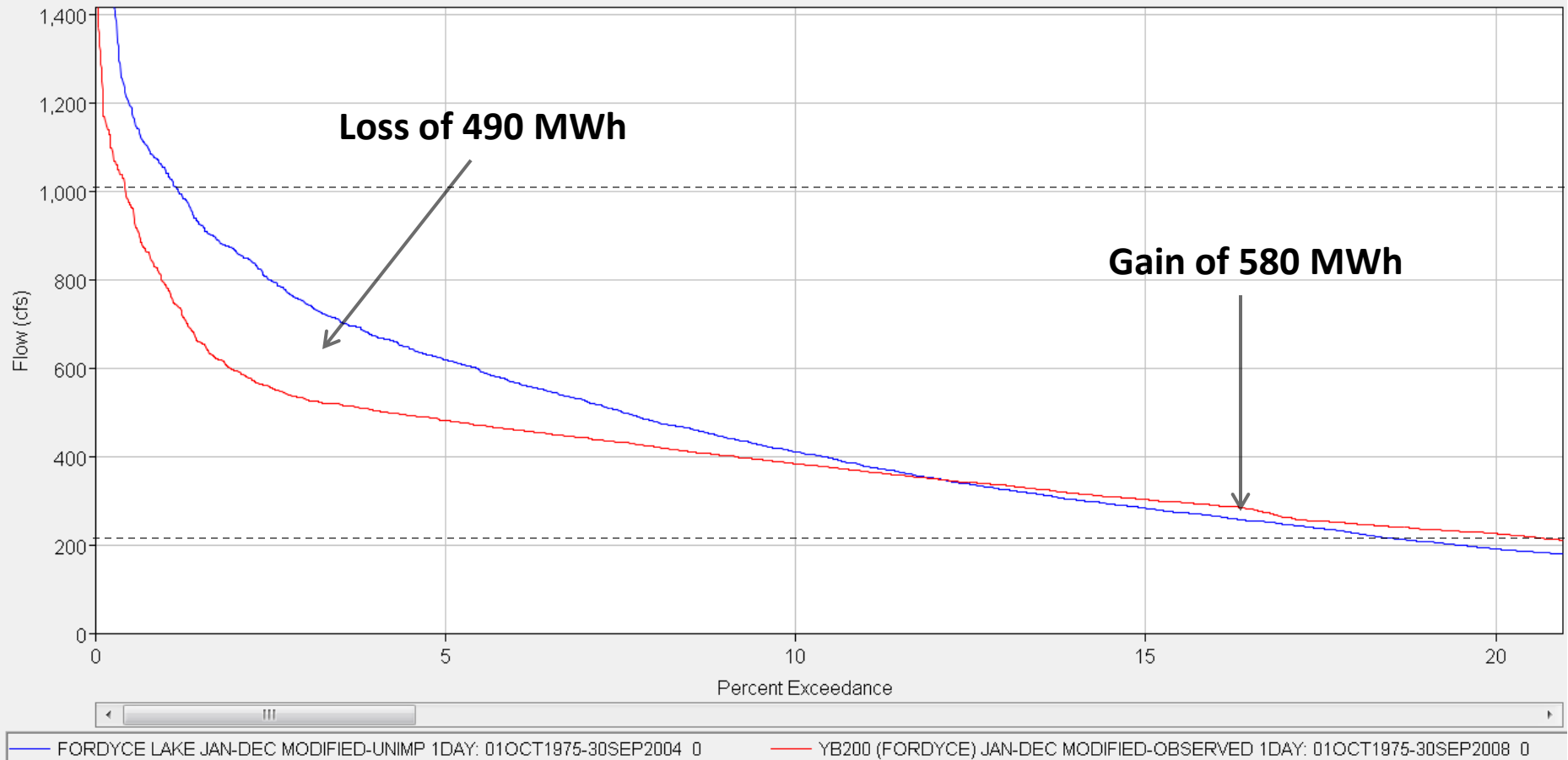
# ...and an upstream dam causes less low-flow events



Source: U.S. Army Corps of Engineers' Hydrologic Engineering Center Data Storage System

# Depending on power generation facility, headwater benefits can be positive or negative (1)

In this example, there is a net gain of ~90 MWh

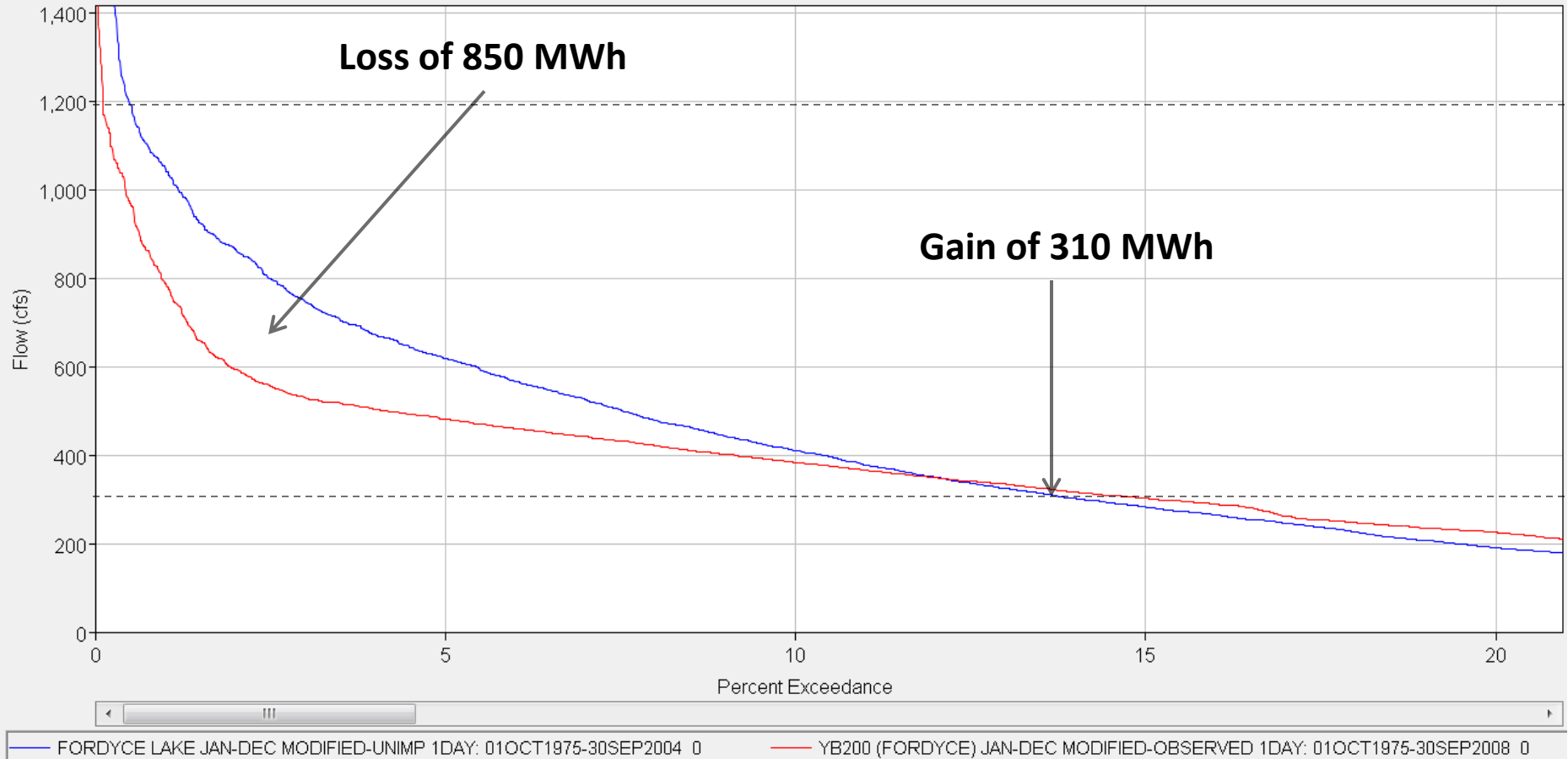


Note: Assumes dam with 148 ft head, 80% efficiency, 10 MW nameplate capacity, and flow range of 200 – 1000 CFS

Source: U.S. Army Corps of Engineers' Hydrologic Engineering Center Data Storage System

# Depending on power generation facility, headwater benefits can be positive or negative (2)

In this example, there is a net loss of ~540 MWh



Note: Assumes dam with 148 ft head, 80% efficiency, 12 MW nameplate capacity, and flow range of 300 – 1200 CFS

Source: U.S. Army Corps of Engineers' Hydrologic Engineering Center Data Storage System

# The impact of headwater benefits on revenues is highly dependent on turbine flow range

Percent increase in revenues

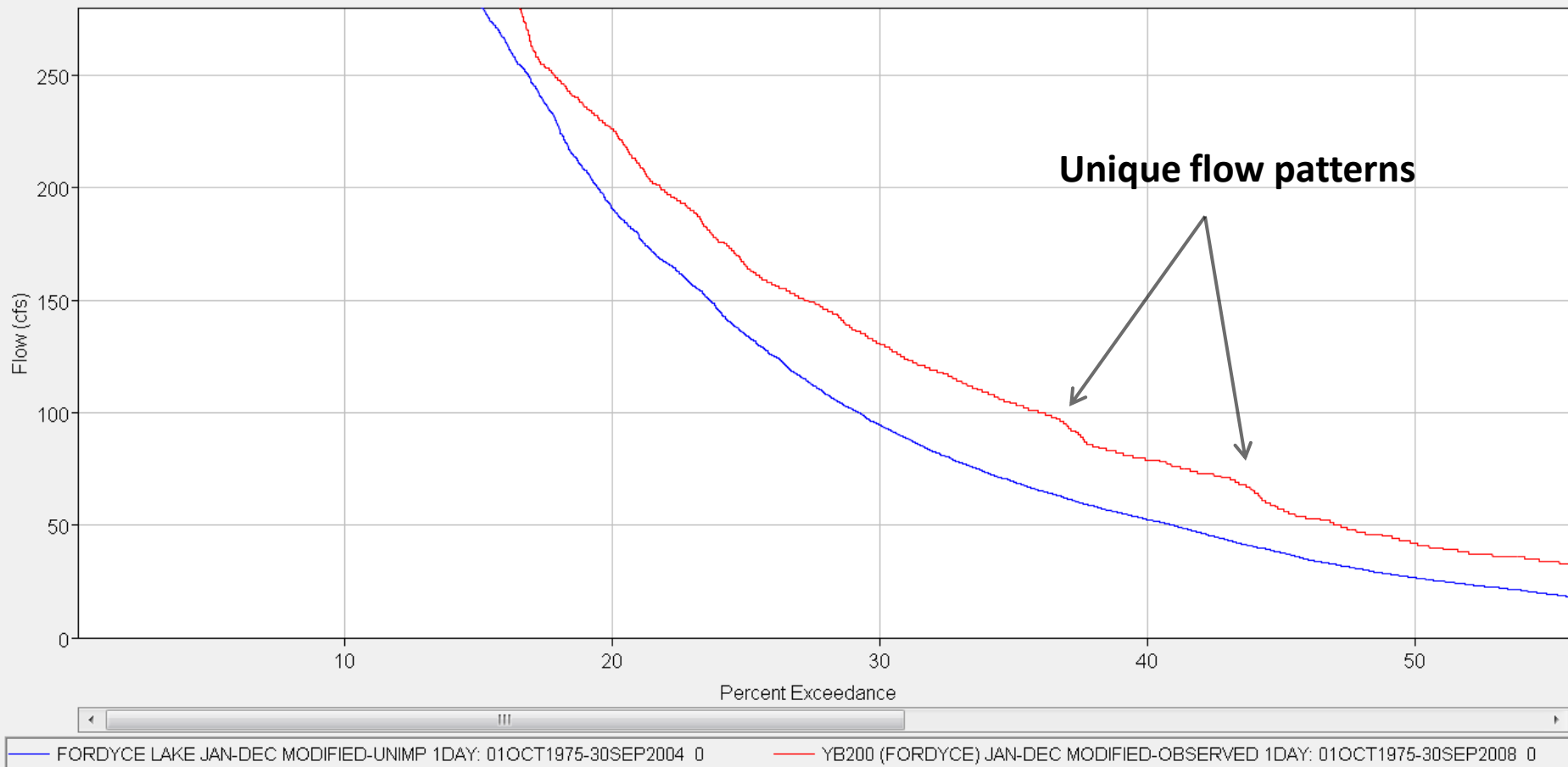
Maximum CFS

		200	400	600	800	1,000	1,200	1,400	1,600	1,800	2,000
Min CFS	50	27%	36%	37%	15%	6%	2%	1%	-1%	-1%	-2%
	100	45%	44%	43%	17%	7%	3%	1%	0%	-1%	-1%
	150	33%	41%	41%	13%	3%	-1%	-3%	-4%	-5%	-5%
	200		43%	42%	11%	1%	-4%	-5%	-7%	-7%	-8%
	250		40%	41%	7%	-3%	-8%	-9%	-11%	-11%	-12%
	300		65%	50%	9%	-3%	-8%	-10%	-12%	-12%	-13%
	350		76%	48%	2%	-10%	-14%	-16%	-18%	-18%	-19%
	400			42%	-7%	-19%	-23%	-24%	-26%	-27%	-27%
	450			34%	-20%	-30%	-33%	-34%	-36%	-36%	-37%
	500			7%	-40%	-46%	-47%	-48%	-49%	-50%	-50%

Note: Assumes dam with 148 ft head and 80% efficiency

Source: U.S. Army Corps of Engineers' Hydrologic Engineering Center Data Storage System

# Unique flow patterns can produce unexpected results



Source: U.S. Army Corps of Engineers' Hydrologic Engineering Center Data Storage System

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# Master Limited Partnerships (MLPs) are tax favored entities via special designation within the tax code

- **Master Limited Partnerships are partnerships that can be publicly traded as corporations (as described in Internal Revenue Code Section 7704)**
- **There are stringent requirements for what can and cannot be treated as a Master Limited Partnership (MLP)**
  - 90% of entity's gross income must be "qualified income"
  - "Qualified income" includes interest, dividends, real property, and "income and gains derived from the exploration, development, mining or production, processing, refining, transportation (including pipelines transporting gas, oil, or products thereof), or the marketing of any mineral or natural resource (including fertilizer, geothermal energy, and timber)"
- **MLPs are "pass-through entities" with favorable tax treatment that also allow for investors at scale (i.e., publicly traded)**

Source: Internal Revenue Code



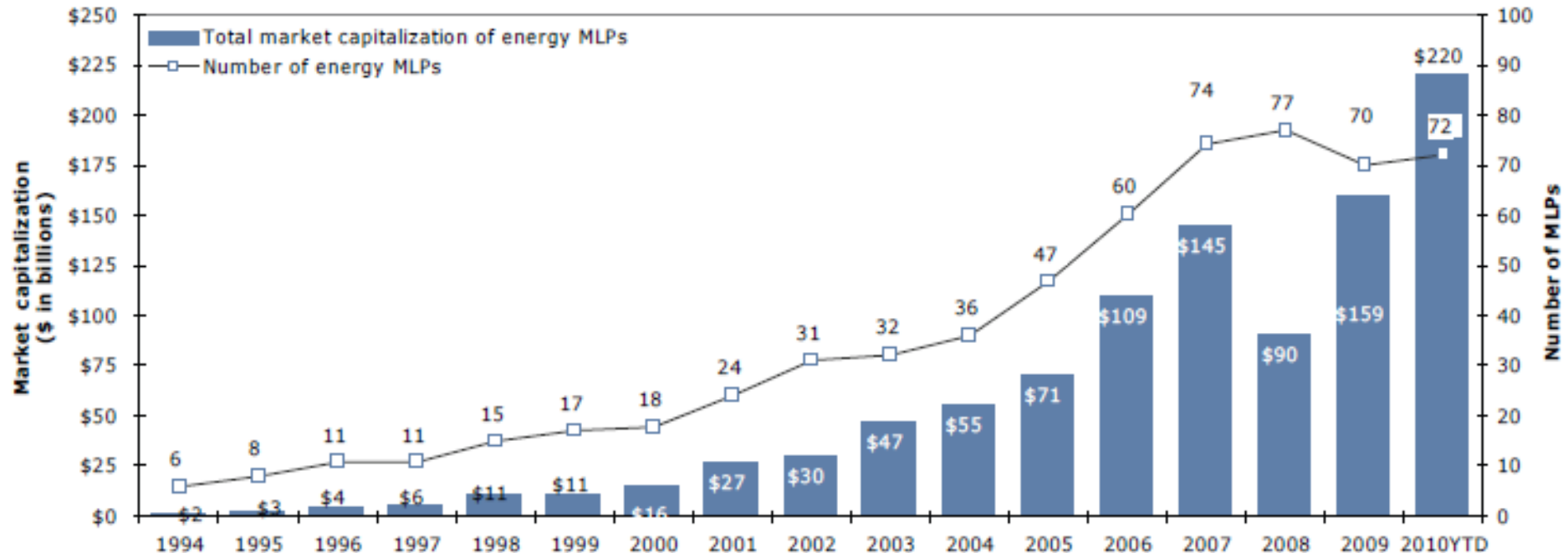
# MLPs have the tax advantages of an LLC and the liquidity advantages of a C corporation

	C corporation	LLC or LP	MLP
<b>Tax status</b>	<p> Income taxed at corporate level</p> <p> “Double taxation” for shareholders (also taxed at personal level)</p>	<p> No corporate-level taxes</p> <p> “Pass-through” entity (no double taxation)</p>	<p> No corporate-level taxes</p> <p> “Pass-through” entity (no double taxation)</p>
<b>Liquidity</b>	<p> Unlimited number of shareholders</p> <p> Can be publicly traded</p>	<p> Generally cannot pursue initial public offering (IPO) to be publicly traded</p>	<p> Unlimited number of shareholders</p> <p> Can be publicly traded</p>

Source: Team analysis

# MLPs have a large and growing market presence

MLPs comprised \$220 BN in market capitalization in 2010



- Two benchmark indices exist for MLPs: Alerian MLP Index (AMZ) and Cushing 30 MLP Index (MLPX-CME)
- Average yield of MLPs is around 7% - 8%

Source: Team analysis

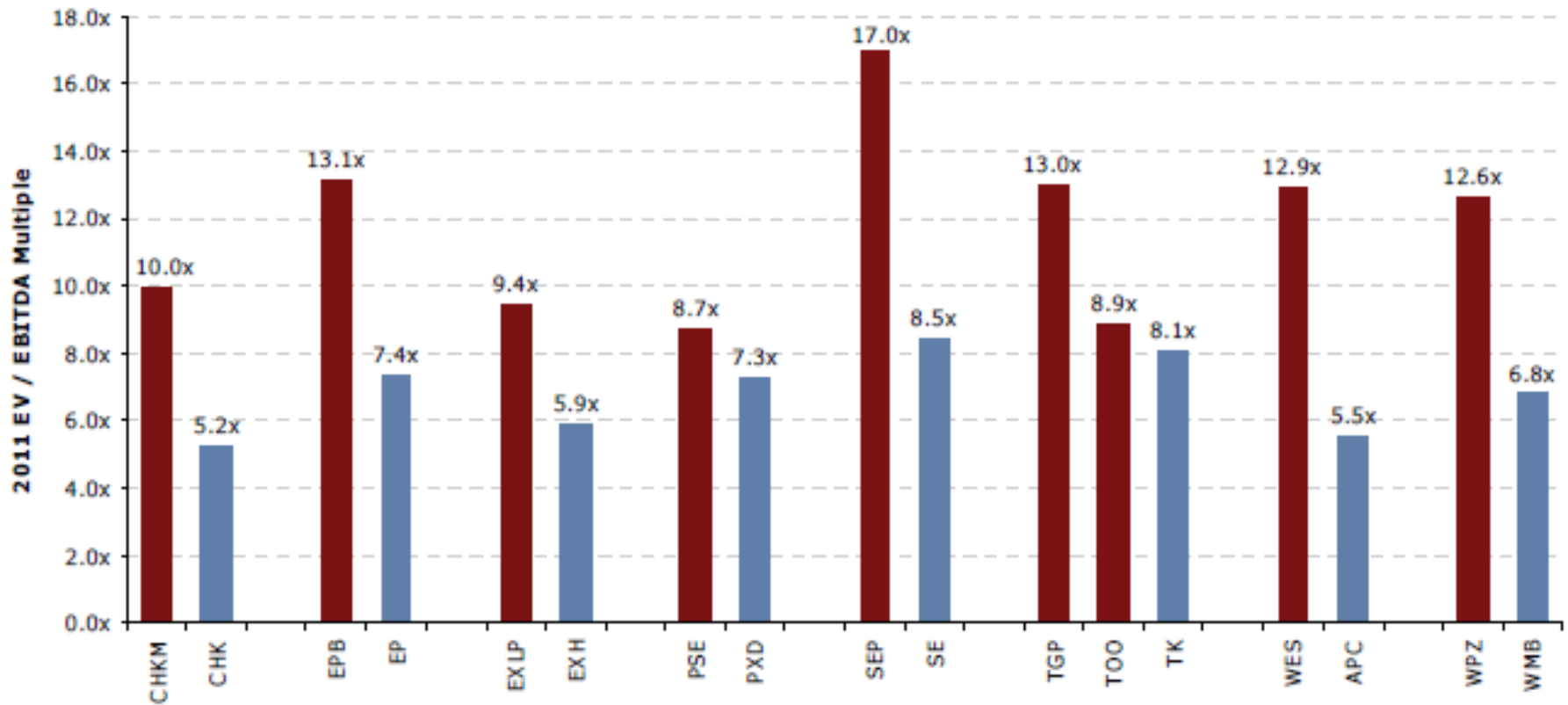
# MLPs are attractive entities for sponsors...

<b>Benefit for Sponsor</b>	<b>Description</b>
<b>Premium valuation</b>	<ul style="list-style-type: none"><li>• Assets within the MLP structure typically trade at higher valuations in the market than those same assets within a C-corp. structure</li></ul>
<b>Competitive advantage via tax benefits</b>	<ul style="list-style-type: none"><li>• Potential to pay more for an acquisition than a corporation and realize the same cash flow</li><li>• Potential to realize more cash flow from an acquisition given the same acquisition price.</li></ul>
<b>Capital access</b>	<ul style="list-style-type: none"><li>• High access to capital, making financing acquisitions and organic projects feasible</li></ul>
<b>Asset control</b>	<ul style="list-style-type: none"><li>• General Partner can retain control of the asset while maintaining just a 2% equity interest in the MLP</li></ul>

Source: Wells Fargo MLP Primer; team analysis

# ...especially since they usually trade at valuations significantly higher than equivalent C-Corp entities

As shown in the table below, MLPs with C-corp. sponsors traded at an estimated median 2011 enterprise value-to-adjusted EBITDA multiple of 12.6x, versus 7.0x for the associated C corp.



Source: Wells Fargo MLP Primer; FactSet and Wells Fargo Securities

# MLPs have also become very compelling for investors...

<b>Benefit for Investor</b>	<b>Description</b>
<b>Stable and predictable</b>	<ul style="list-style-type: none"><li>• MLPs have stable cash flows that can be predicted with a high degree of accuracy (e.g., compared with the advertising revenue of Google in any given quarter)</li></ul>
<b>Attractive yield</b>	<ul style="list-style-type: none"><li>• Investors have come to view MLPs as providing an attractive yield, compared with other investments (e.g., bonds)</li><li>• Expected yields of 5% - 10% (with growth of 3% - 5%)</li></ul>
<b>Tax benefits</b>	<ul style="list-style-type: none"><li>• MLPs offer a tax-efficient means of energy investing</li><li>• Tax shield for 80% - 90% of cash distributions, with tax-deferrals for remaining until asset sale</li></ul>
<b>Low correlation</b>	<ul style="list-style-type: none"><li>• Provide significant portfolio diversification due to low correlation with most asset classes</li></ul>

Source: Wells Fargo MLP Primer; team analysis

# ...as they fulfill investor need for yield and have been highly sought-after

*“Investors right now are focused on yield...it’s part of a larger thematic story, with the retirement of baby-boomers and historically low interest rates.”*

*“Everybody is looking for different ways to access yield, and MLPs, with an average yield over 6%, are an attractive way to do that, because the underlying cash-flow streams of these companies tend to be more stable than many other businesses.”*

– March 2011

**Alerian**

## ***Frenzy in Energy Partnerships: Investors Stick Billions of Dollars Into a Stock-Market Niche Known as MLPs***

*“Lured by hefty yields, investors are pouring billions of dollars into a small corner of the stock market—energy-focused master limited partnerships—which has seen a huge rally of 15% this year”*

*“Their major appeal is payouts to investors these days averaging around 7% a year at a time when bond yields are at all-time lows. MLPs are expected to increase those distributions by another five percentage points or so a year”*

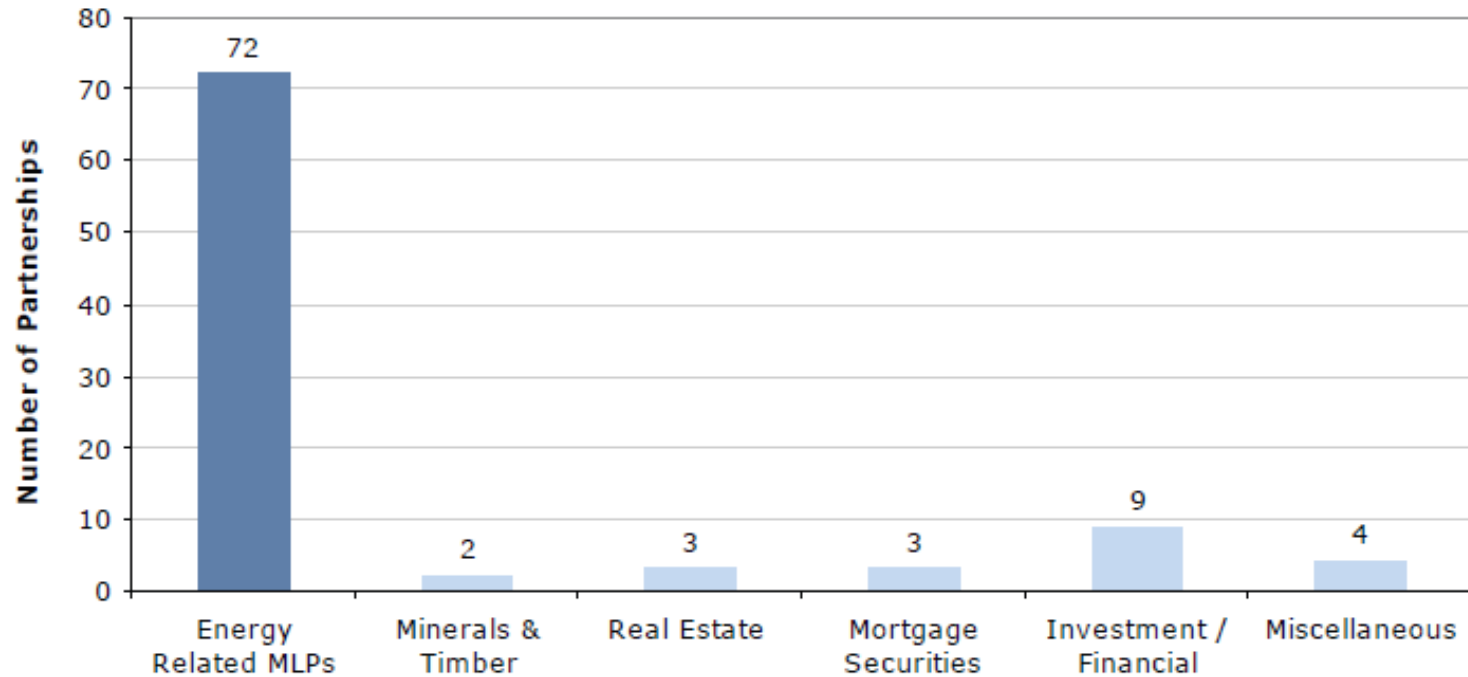
– August 2010

**WALL STREET JOURNAL**

Source: Literature search

# A majority of MLPs are focused on energy, mostly in the oil and gas sectors

Almost 80% of publicly traded MLPs are related to energy



- 72 of 93 publicly-traded MLPs in 2010 were energy-focused
- Of the \$15 billion of capital raised by MLPs in 2010, \$13 billion was raised by energy-focused MLPs (mostly oil and gas)

Source: Wells Fargo MLP Primer; National Association of Publicly Traded Partnerships; Mintz Levin

# Congress has excluded inexhaustible energy sources, including hydroelectricity, as qualified income

- **Congress has amended the law around MLP structures to exclude energy produced from inexhaustible sources, although there are exceptions**
  - In 1988, qualifying income was clarified to not include income from “fishing, farming (including the cultivation of fruits or nuts), or from hydroelectric, solar, wind, or nuclear power production”
  - Other examples of inexhaustible resources that are not included are soil, sod, turf, water, air and minerals from sea water
  - Exception was made for geothermal power in 1987
  - Under a 2008 law, Congress added industrial carbon dioxide, transportation biofuels, alcohol and certain other alternative fuels
- **There is a potential for lobbying efforts to include renewable energy to be included as qualifying income**
  - “Renewables for Publicly Traded Partnerships Group” lobbying entity was formed in July 2011
  - AWEA has indicated that it would favor and pursue MLP status for wind

Source: Internal Revenue Code; literature search



# Innovative tax-favored structures applied to hydroelectricity are worth exploring

- **There may be an opportunity to leverage the “real property” component of qualified income for hydroelectric power**
  - In June 2007, a private letter ruling (PLR) was released by the Treasury (PLR 200725015) that confirmed the “real property” status of a broad range of energy assets
  - Real property status could be leveraged via a real estate investment trust (REIT) or master limited partnership (MLP)
  - Various components of a hydroelectric system that are separate from the turbines in the power houses (e.g., reservoirs, dams, canals, watersheds, tunnels, pipes, flumes, aqueducts and associated land) could feasibly be applied to “real property”
- **Further study is required to assess whether hydroelectricity assets could be applied to tax-favored corporate structures**

Source: Internal Revenue Code; literature search