Biomass Energy Overview

BIOMASS

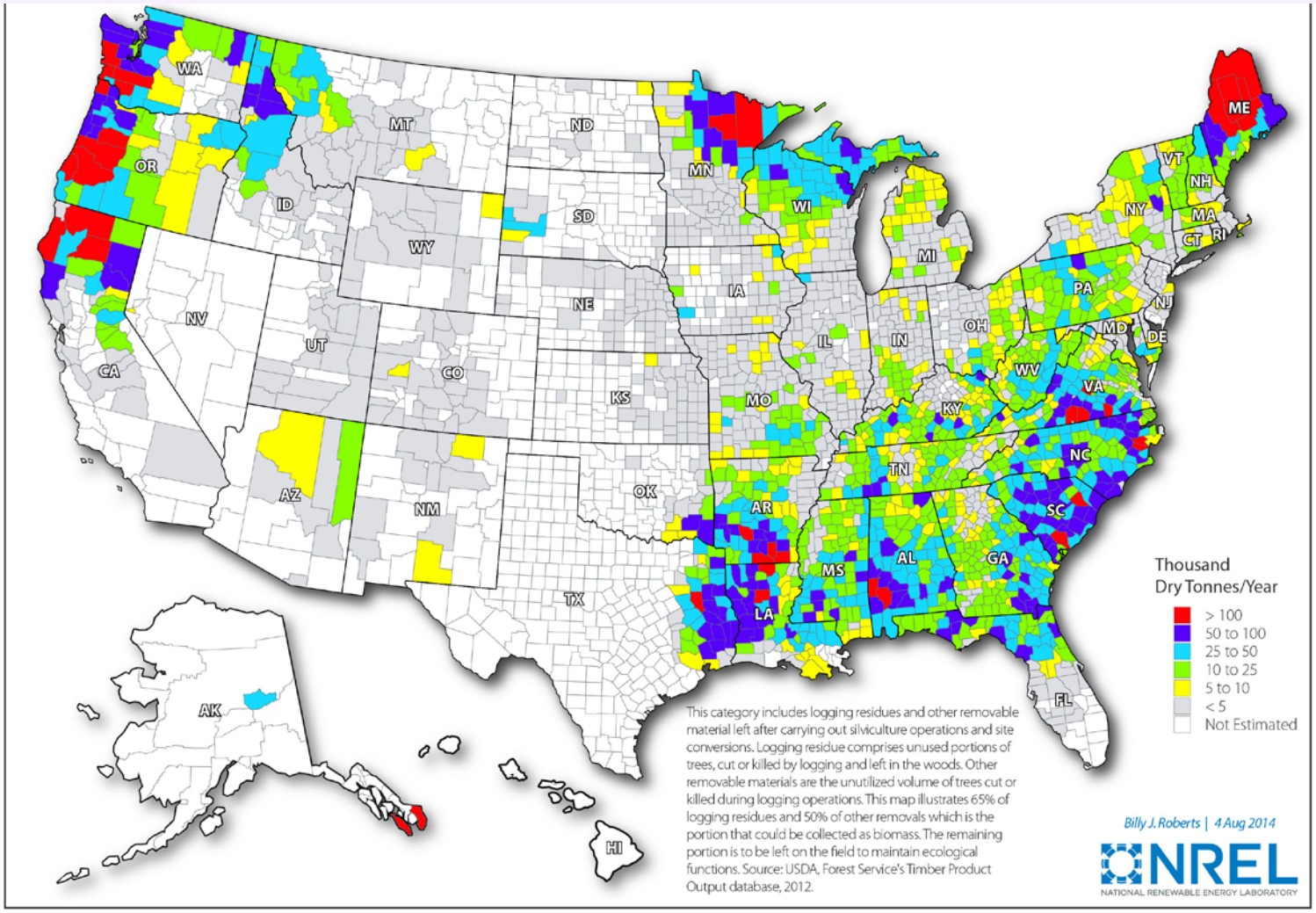
Biomass Resource

Benefits

Caveats

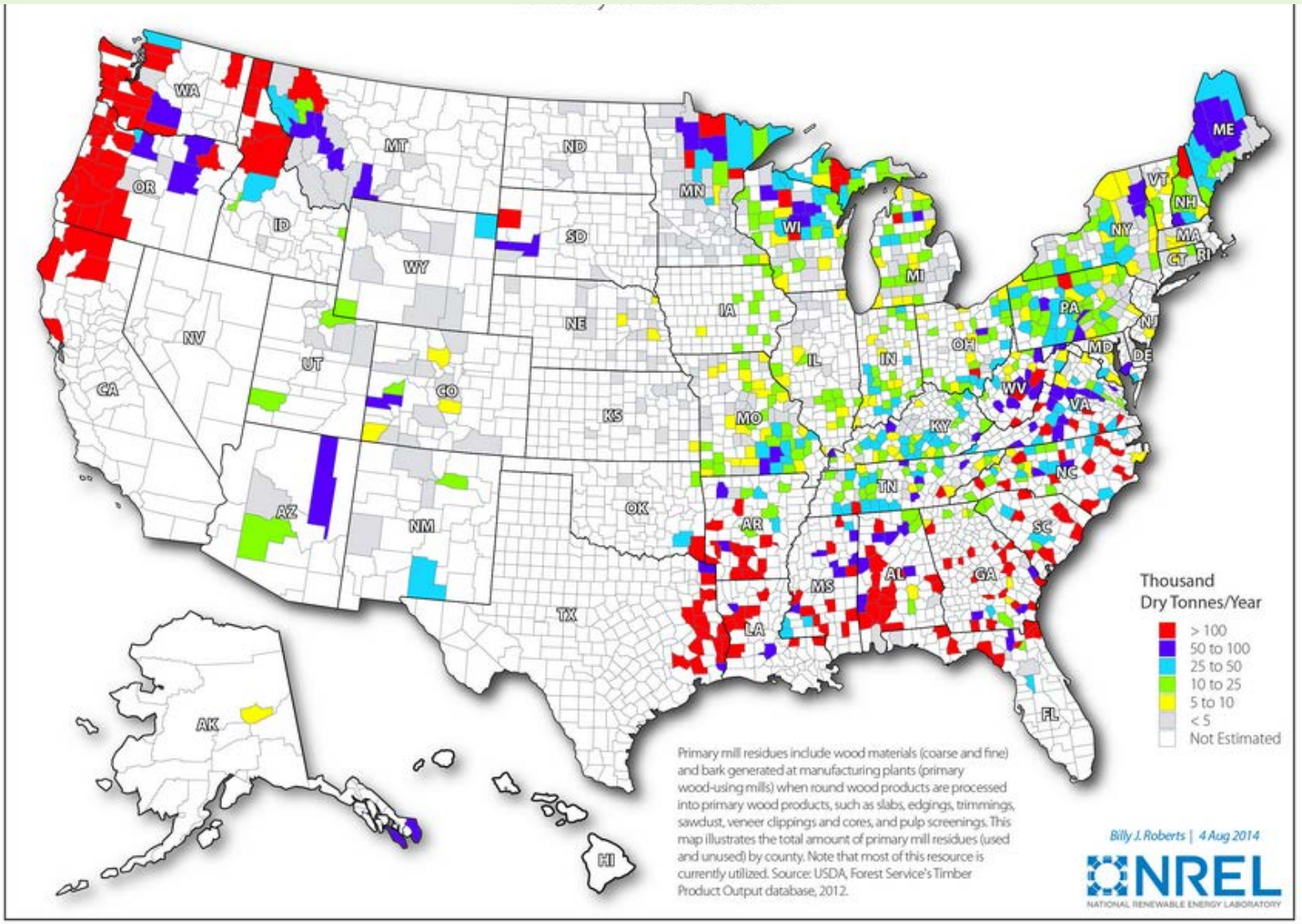
Biomass Resource – Forest Residues

Woody biomass represented 19% of the renewable energy generated in 2017 (slide 4) – a large portion of that is biomass waste being burned to dry timber for paper, pulp and furniture industries.



Biomass Resource – Primary Mill Residues

Energy content varies depending upon species, moisture and density: 8-12,000 BTU/ dry pound



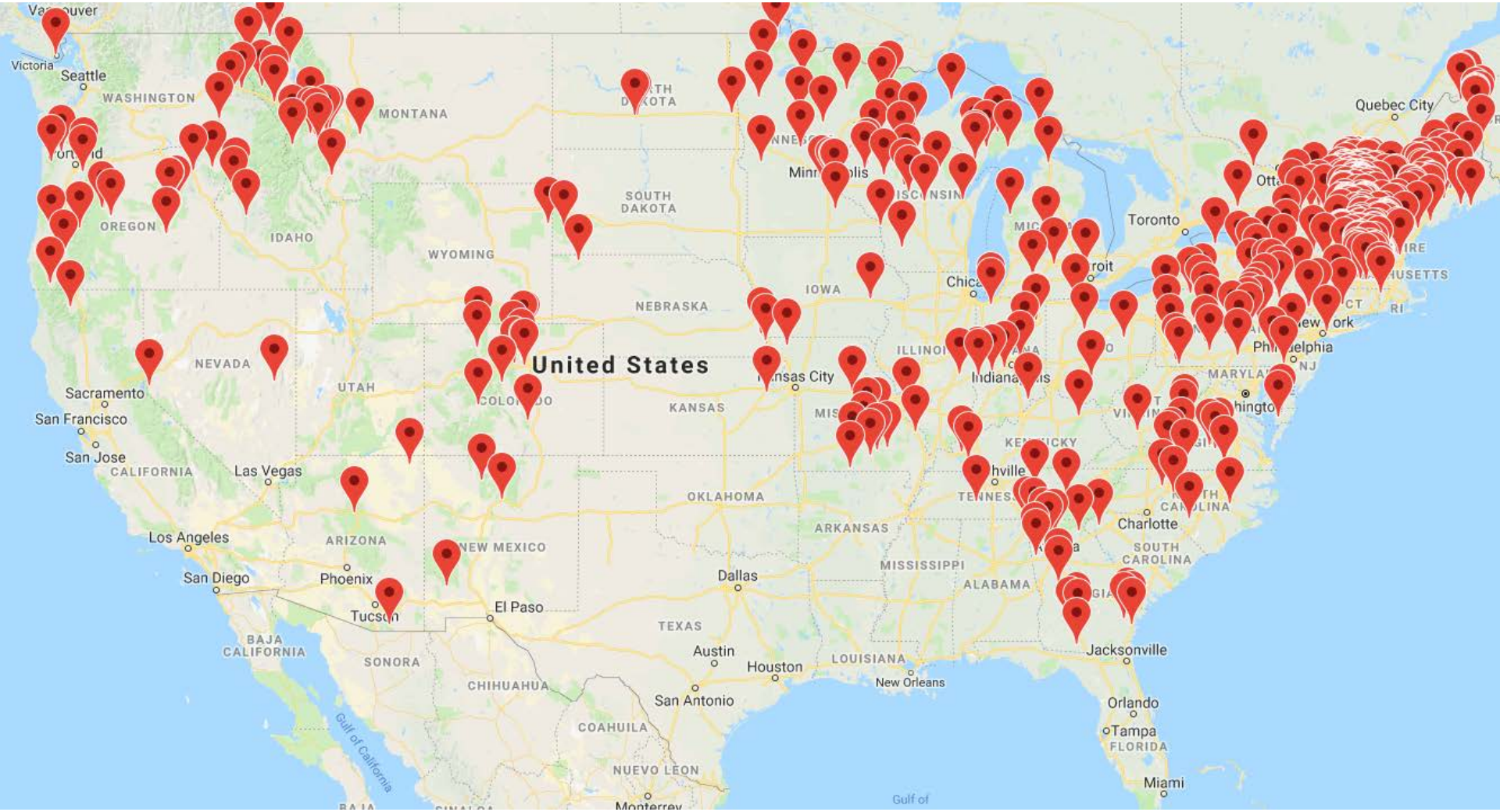
Biomass for Heating

Benefits:

- Uses local renewable energy / fuel source (typically ~50 miles is considered a maximum distance to economically viable woody biomass)
- Larger-scale systems burn more cleanly that "residential woodstove" – virtually no visible emissions or odors
- Wood chips for fuel can often come from sawmill, timber harvesting, or land development residues – these are essentially low-grade waste products turned into cost-saving fuel - e.g., wood pellets ---- >>

A wood heating system for 200,000 ft^2 building (school) has emissions ≈ 5 residential wood-burning stoves (~10,000 ft^2) That is a 20-to-1 reduction in emissions - larger system with higher temperatures results in cleaner burning

Biomass-burning Facilities in the US



Source: https://www.biomasscenter.org/database/map-search

Biomass for Heating

Benefits:

- Money spent on biomass keeps energy dollars re-circulating in the local economy and supports jobs in the local forest products industry
- Burning wood recycles carbon in the natural carbon cycle vs. burning fossil fuels which transfers dormant, underground carbon (crude oil, gas and coal) into the atmosphere

Townsend, Montana School District

School Wood Pellet Heating System

Heating Capacity (output): 199 kW (0.68 MMBtu/hr)

Annual Wood Pellet Use: 200-300 tons

Year Installed: 2007

Thermal Output: Hot water

Replaced: Fuel Oil system

Funding: $46k internal; Fuels for Schools grant - $198k; Local conservation district grant - $14k; USDA low-interest loan - $140k.

Total Cost: $432k

Payback

Lessons Learned: Fuel quality is important – whole tree pellets are not as consistent as sawmill waste pellets. Worth paying extra for sawmill pellets

Biomass for Heating

Plusses:

- Biomass feedstock for heating does not have to be as “clean” and “consistent” as biomass for making electricity, CHP or biofuels.
- Automatic loading systems greatly reduces labor time needed to operation & maintain these systems compared to earlier “manual load” systems – typically 1/2- 1 hr per day

Negatives:

- Generally requires some “yard space” for storing fuel
- Fuel stock needs to be rotated - don’t want same feedstock sitting in back of yard for years
- Even automated ‘loading systems’ – usually require some degree of manual oversight and/or maintenance – 1/2 -1 hr per day

Caveats:

- Economics depends on the cost of the fuel being replaced
- Switching to biomass – usually best if replacing electric heat (which can be expensive – particularly in the northeast) or fuel oil
- Usually more challenging if replacing gas

Biomass for Heating

Typical Costs:

- Biomass heating plants have installed costs that typically average between $500 to $1500 per kW-thermal of installed heating rate capacity.
- As these involve mature technologies, costs are not expected to drop significantly in the short term.

Typical Costs:

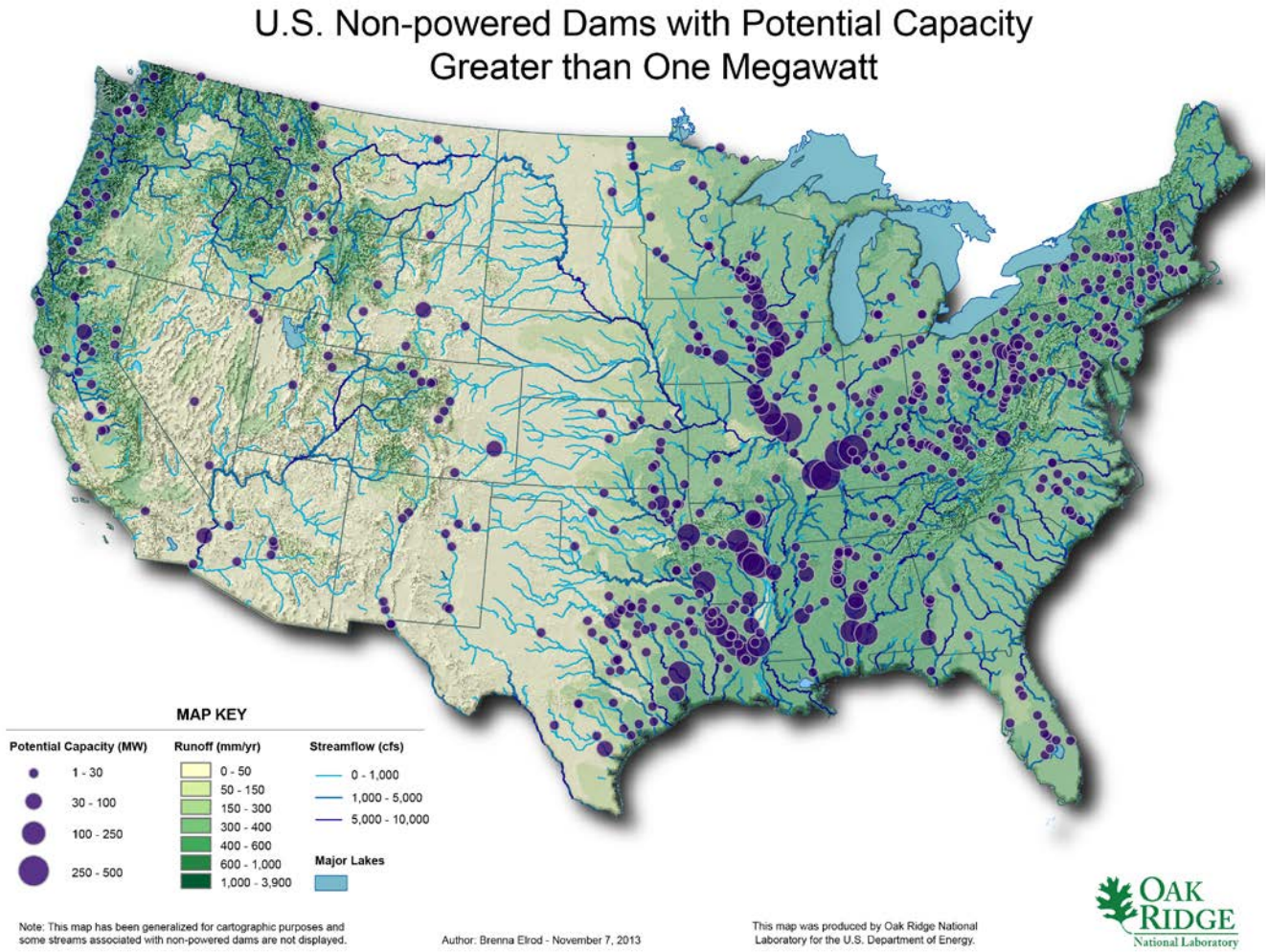
- Levelized cost of energy for heating with biomass is typically $10 to $20 dollars per million Btu
- Highly dependent on the
  a) Feedstock cost and quality
  b) O&M costs

A series of augers and belts deliver the wood chips in storage to the combustion chamber

Source: https://www.wbdg.org/resources/biomass-heat

Micro-hydro Energy Overview

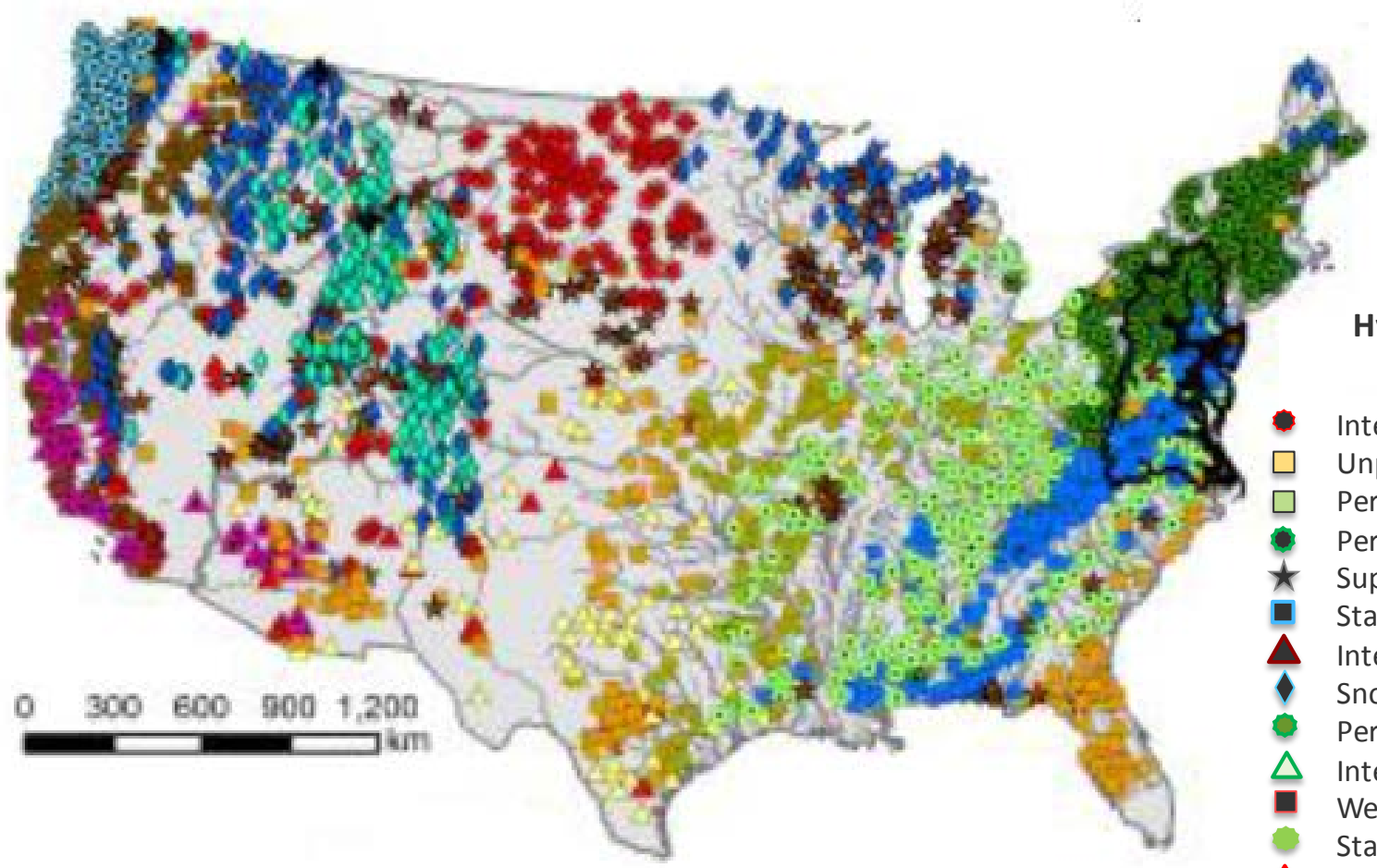
Existing Dams with Hydropower Potential



In the United States, there are about 80,000 dams of which only 2,400 produce power.
The other dams are for recreation, stock/farm ponds, flood control, water supply, and irrigation.

Source: https://nhaap.ornl.gov/sites/default/files/NPD_Map_20131205.jpg

National Maps/Databases of Rivers, Streams and Flow Data



Hydro Resources are Catalogued by Characteristics

MICRO HYDRO

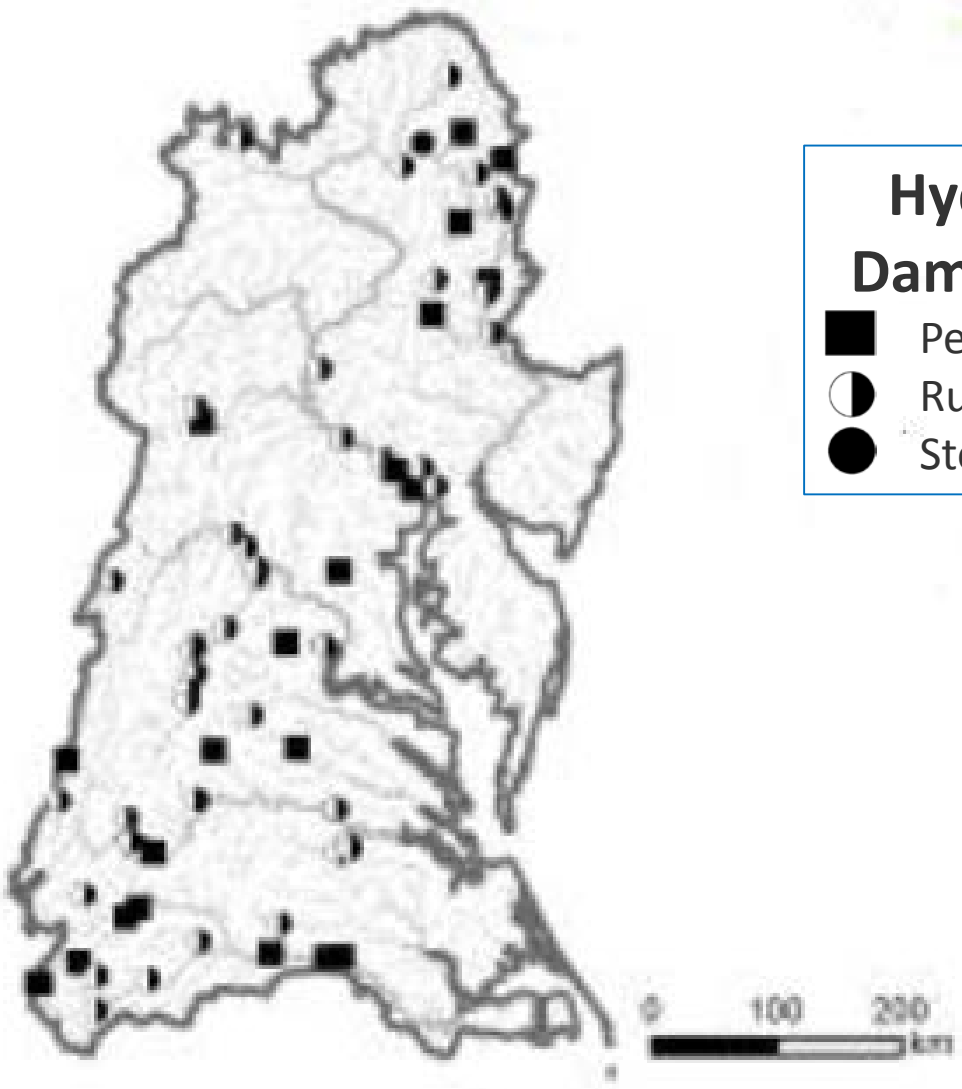
Hydrologic Classes

- Intermittent Flashy 1
- Unpredictable Perennial
- Perennial Runoff 1
- Perennial Runoff 2
- Super Stable GW
- Stable High Baseflow
- Intermittent Flashy SW
- Snowmelt 2
- Perennial Flashy
- Intermittent Flashy 2
- Western Coastal Runoff
- Stable High Runoff
- Harsh Intermittent
- Snowmelt 1
- Glacial High Runoff

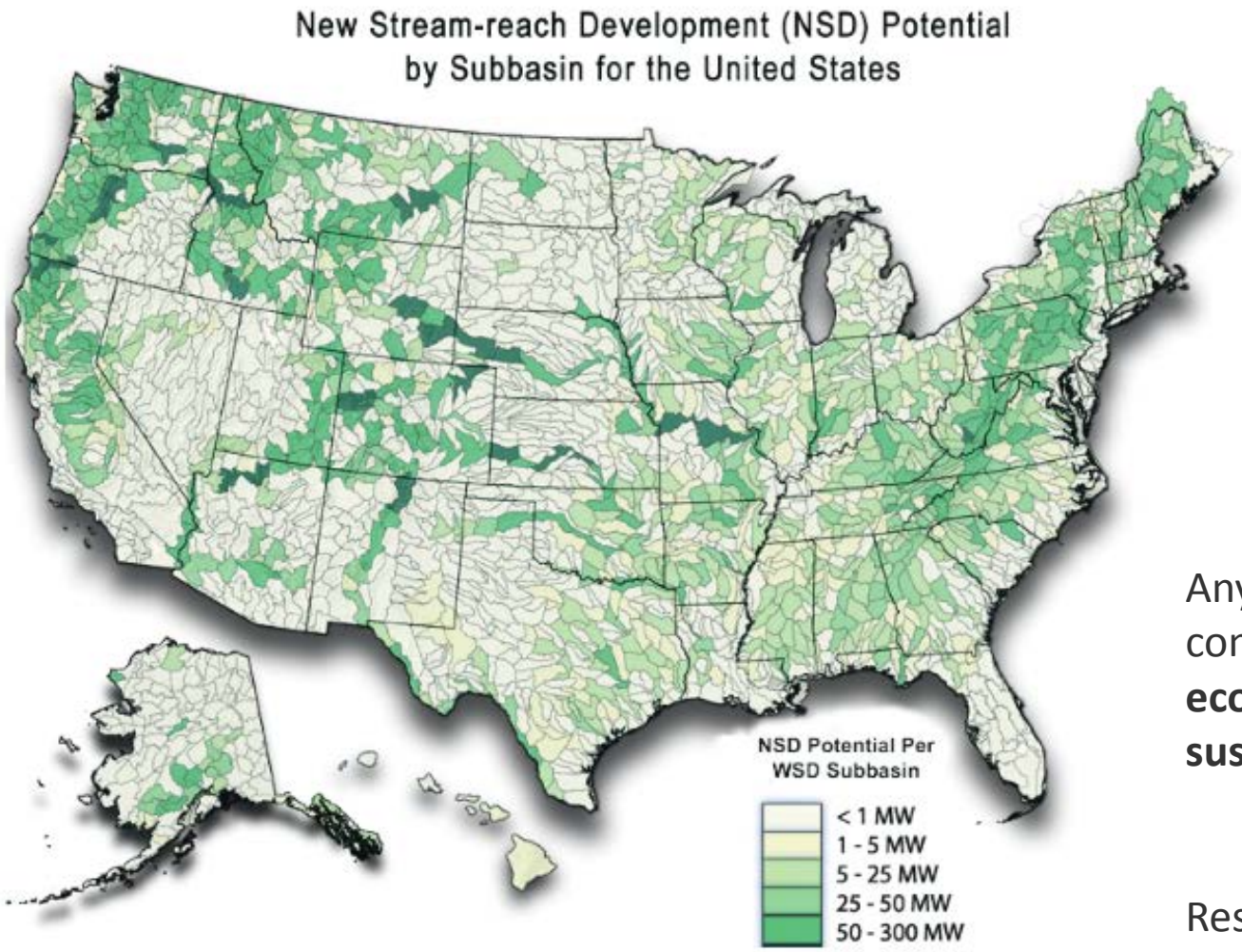
Temperature Classes

- Cold
- Transitional Cold
- Transitional Warm
- Warm

Maps of Current Use of Water



New Stream-reach Potential



Most rigorous assessment of hydropower potential to date.

Did NOT make recommendations on feasibility of sites.

Any development consideration **must include ecological and social sustainability.**

Resource capacity was estimated at **84.7 GW** with generation of **460 TWh/yr**

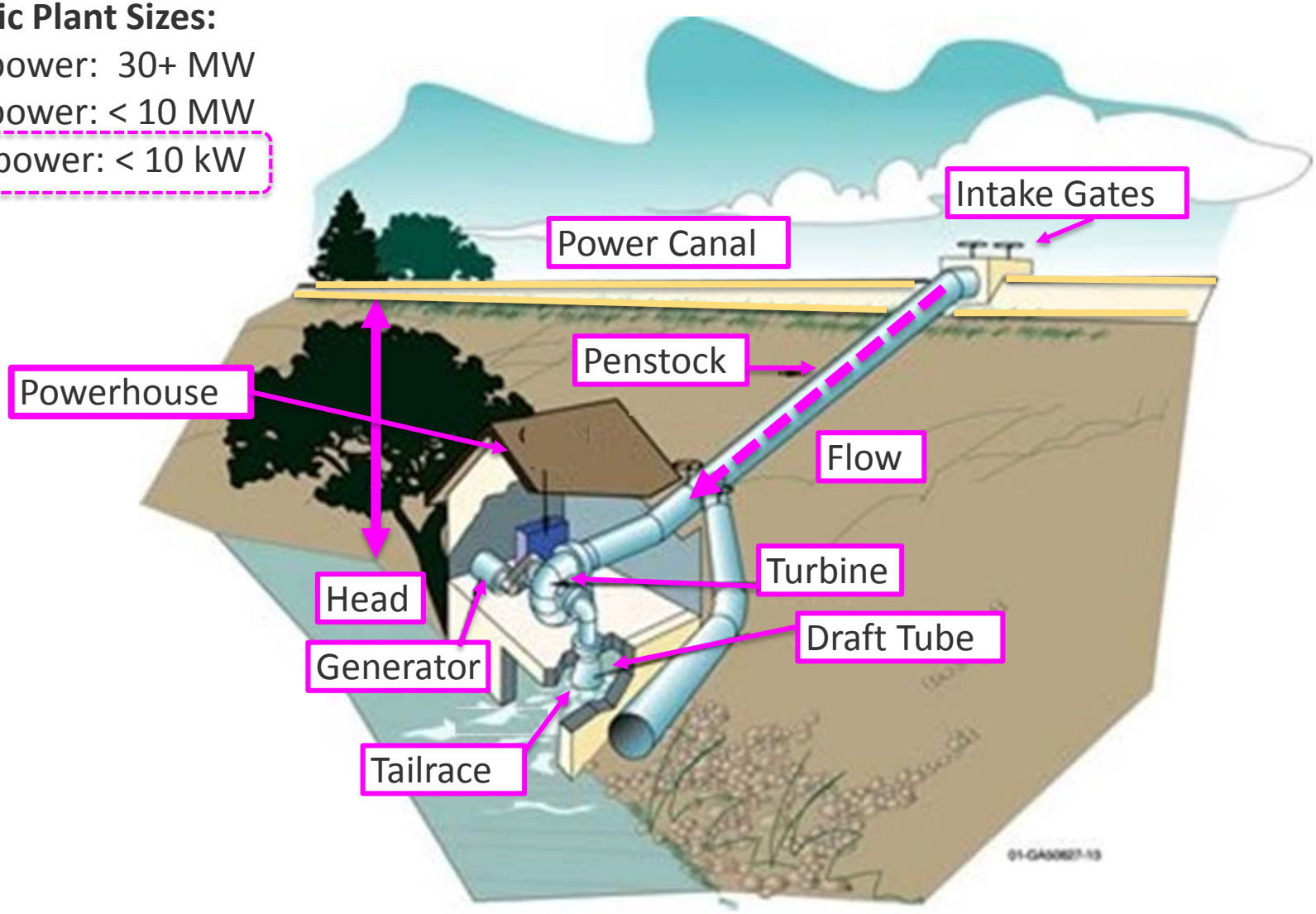
Micro Hydropower - Resource

Hydro-electric Plant Sizes:

Large Hydropower: 30+ MW

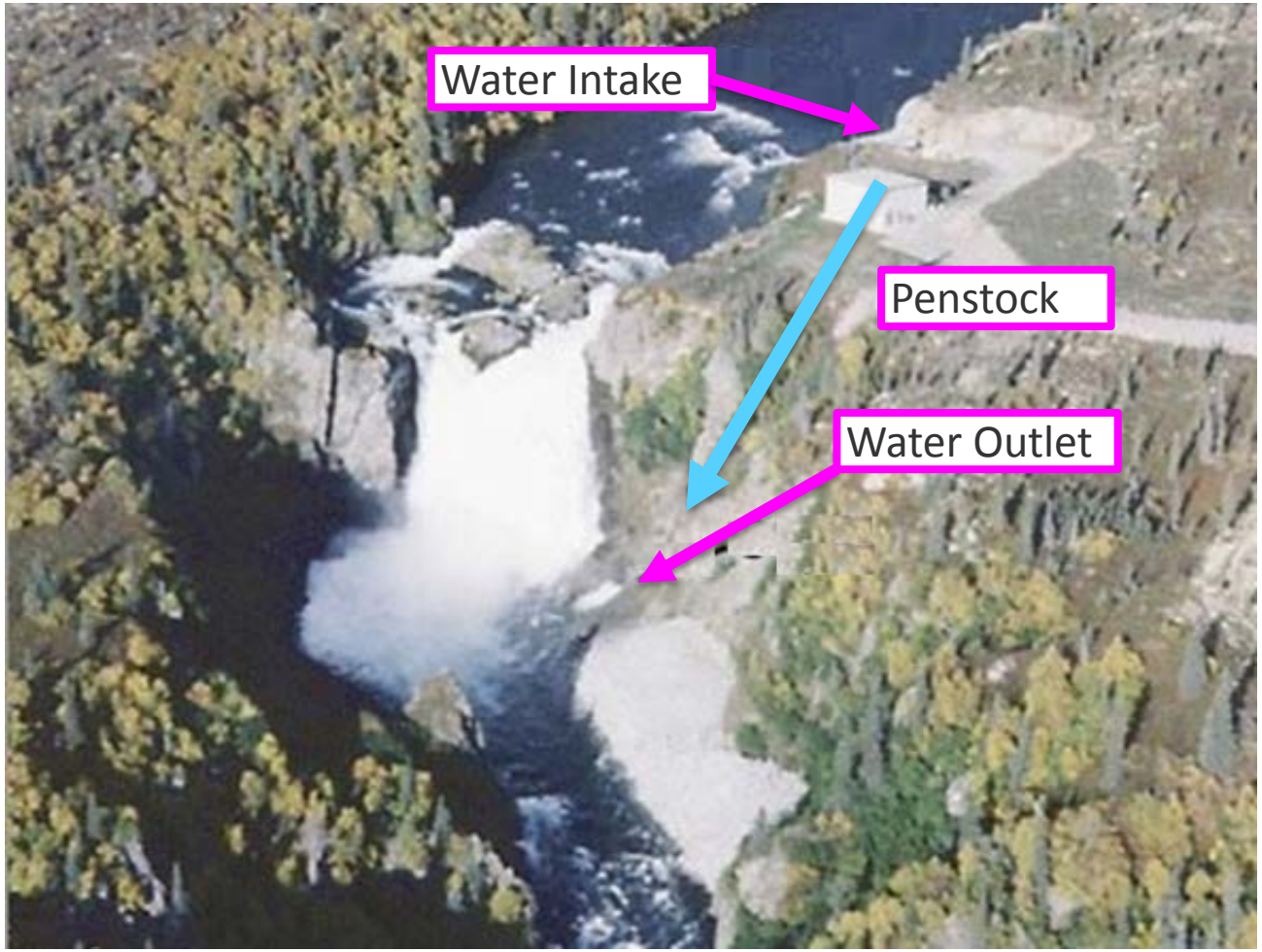
Small Hydropower: < 10 MW

Micro Hydropower: < 10 kW



Source: https://www.energy.gov/eere/water/types-hydropower-plants

Run of River Hydropower Approach

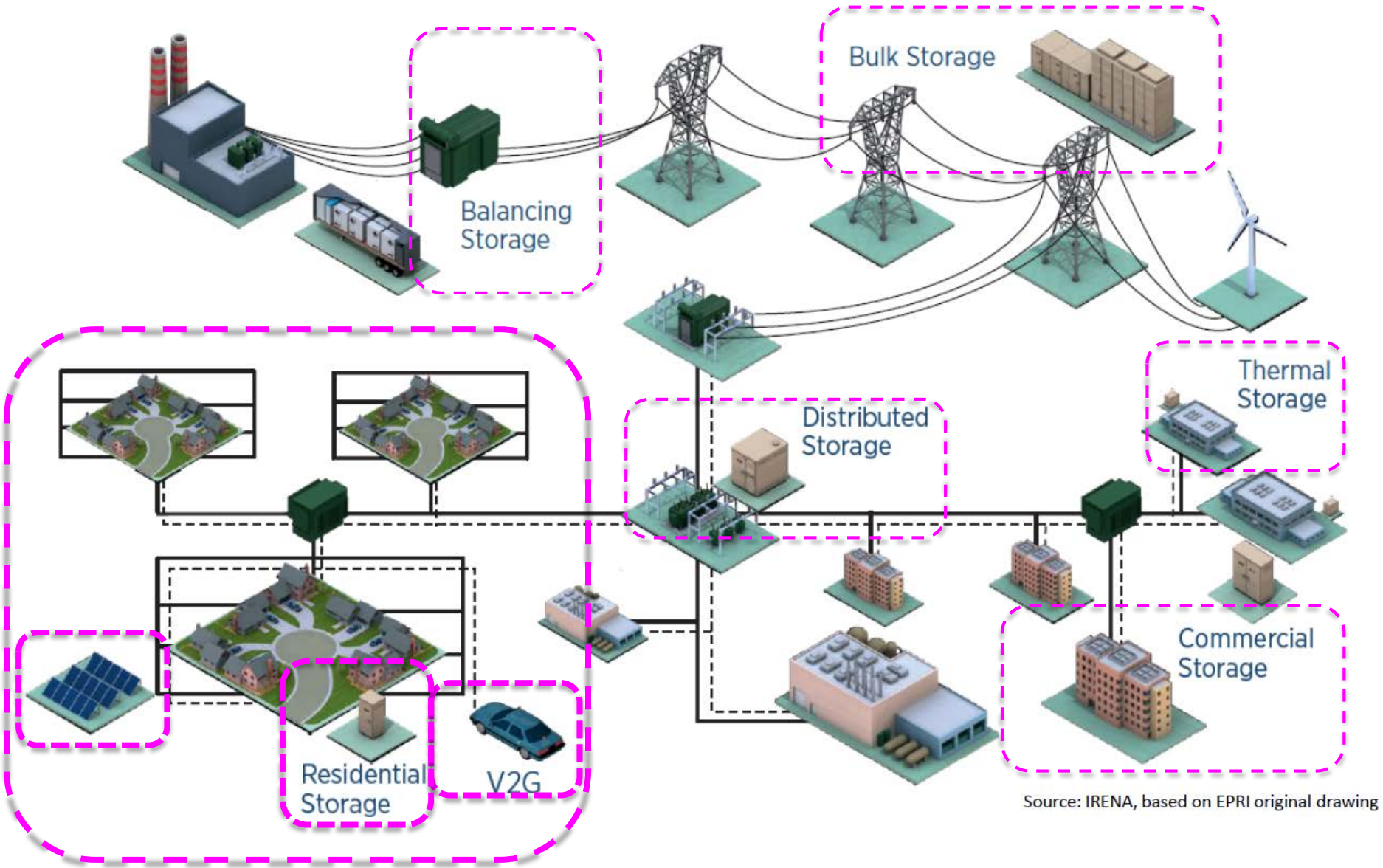


Run-of-river hydro tries to minimize the impact to the natural flowing stream while still obtaining some of its immense and near-continuous power.

It channels some of the river to the water intake and into the penstock, generates power then releases it back into the river.

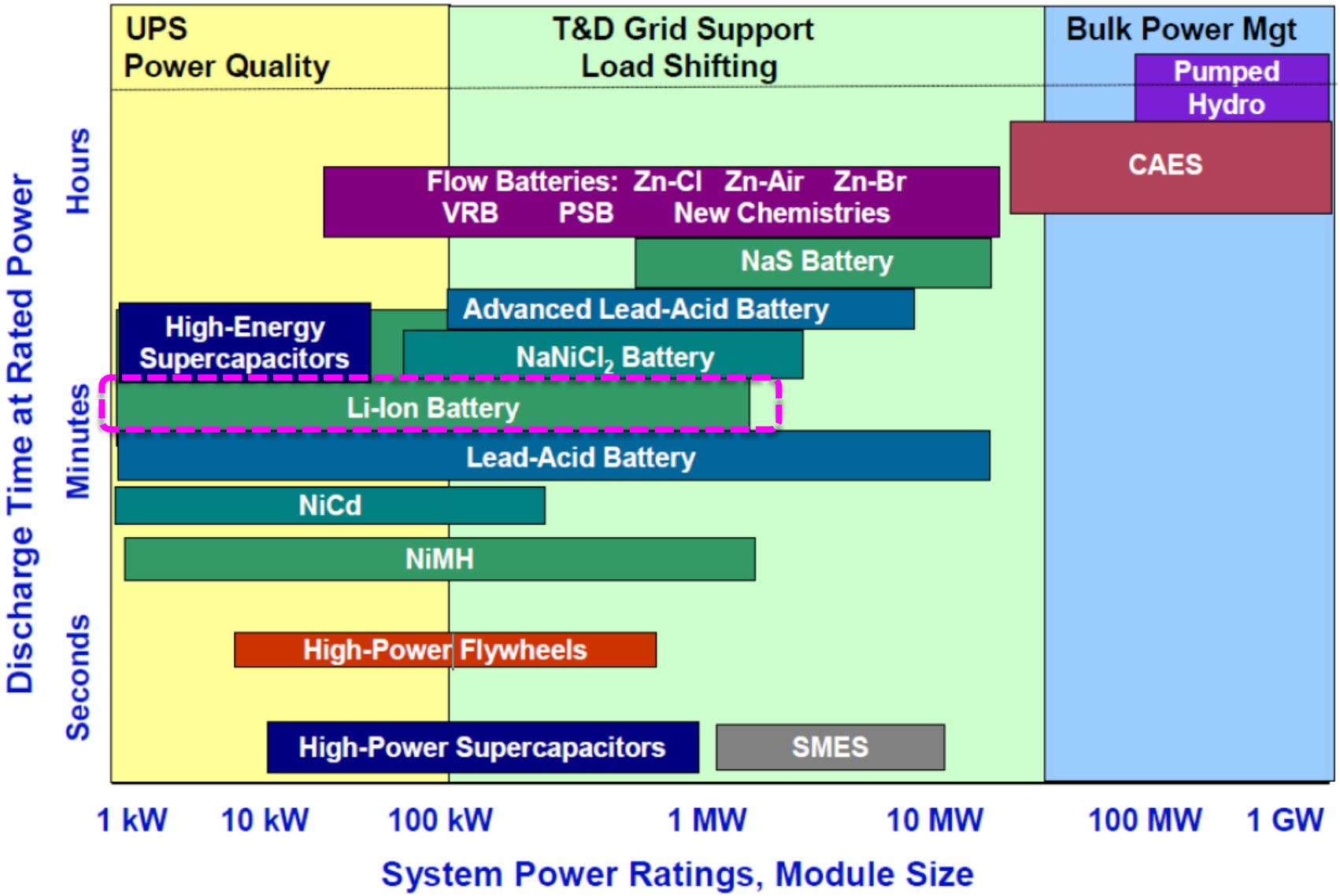
Battery Storage Overview

Battery Storage by Application

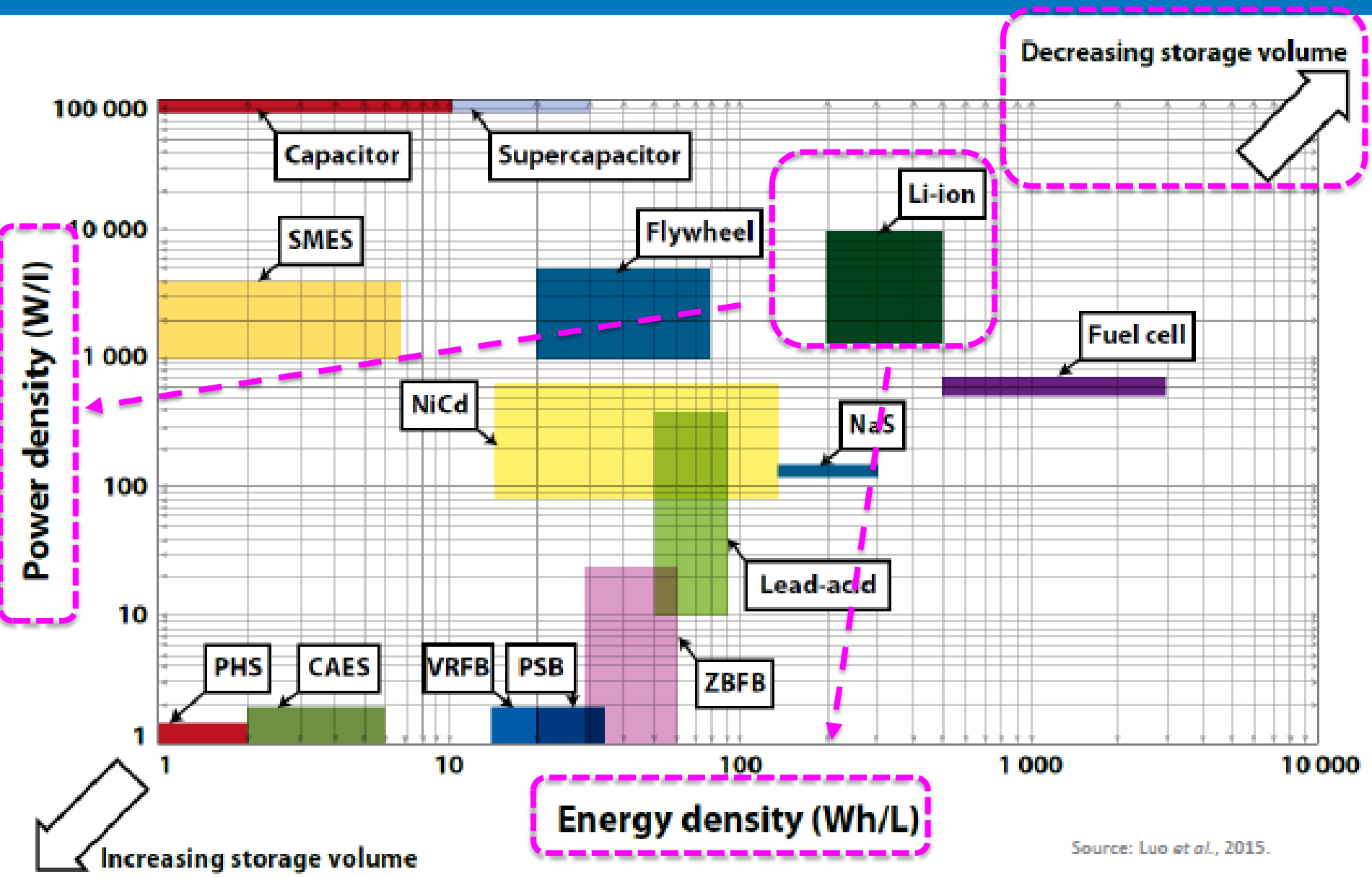


Source: IRENA, based on EPRI original drawing

Battery Storage Technologies

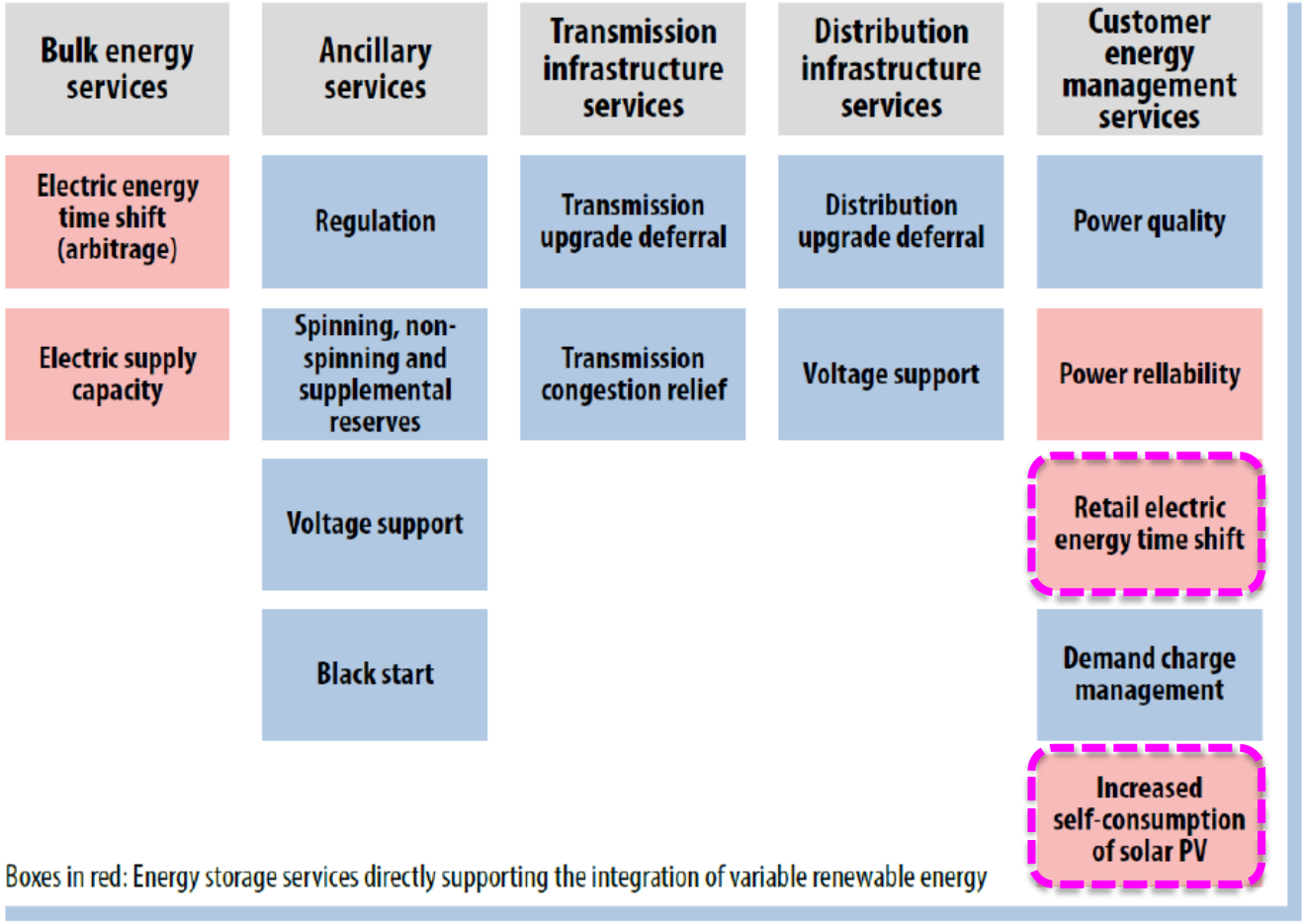


Battery Storage Technologies



Source: Luo *et al.*, 2015.

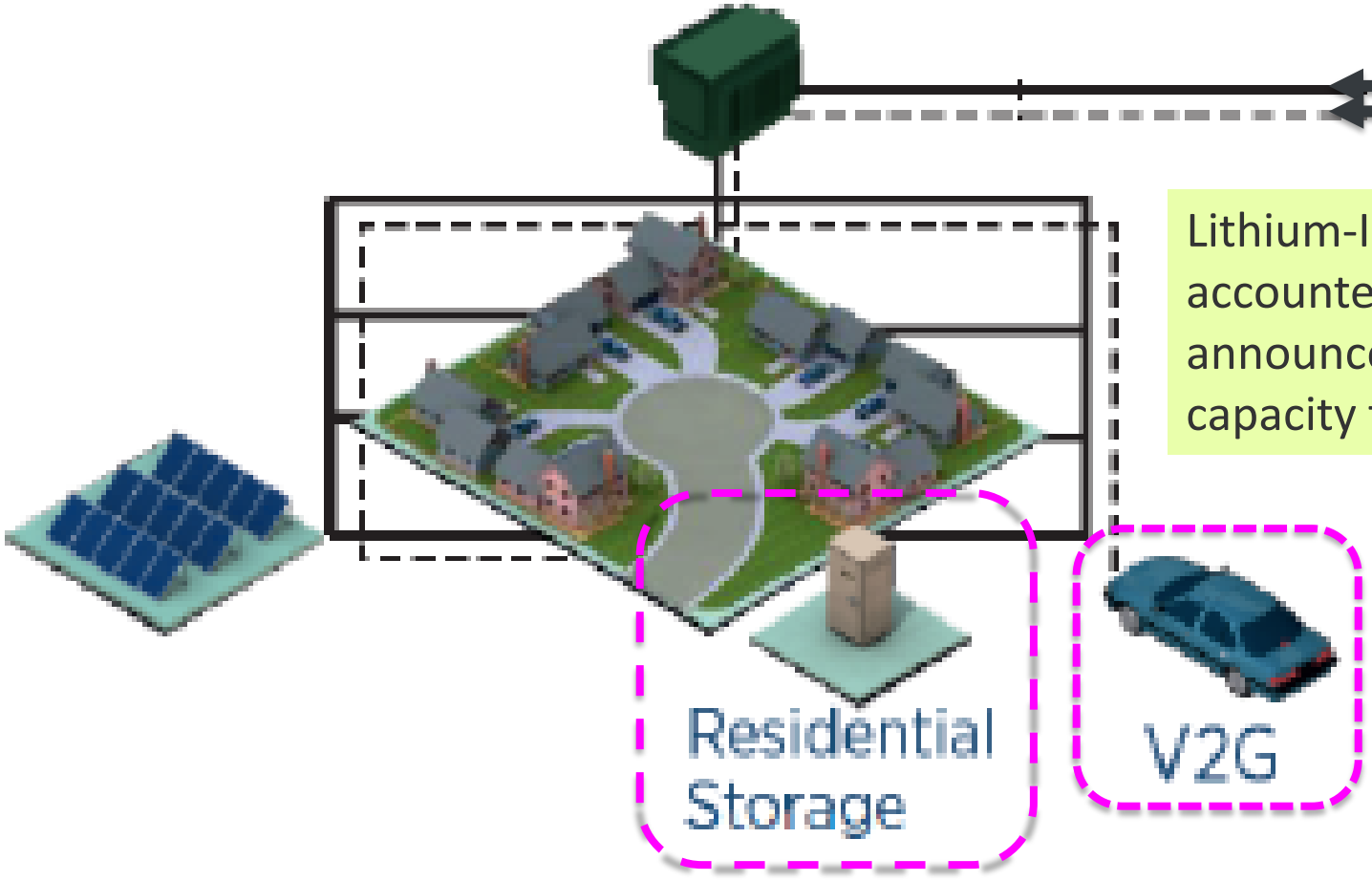
Services Provided by Electricity Storage



Battery energy systems can serve a lot of different needs for different customers

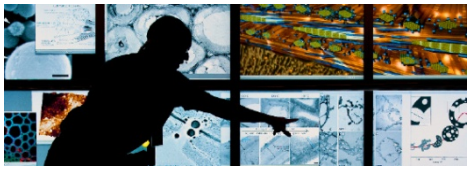
Over the next decade these are the areas most likely to benefit Tribes as residential and small commercial users.

Battery Storage by Application



Lithium-Ion (Li-ion) accounted for 83% of newly announced energy storage capacity through Q3 2016.

A significant part of the increase is targeting the emerging electric vehicle (EV)market. Being able to operate 4-8 hours continuously for EV is similar to other bulk energy storage needs – commercial business, micro-grid, etc. R&D for one will benefit the other.



robi.robichaud@nrel.gov