Northwest Power and Conservation Council

May 26, 2011

MEMORANDUM

TO: Council Members

FROM: Lauren Casey, Montana State Staff

SUBJECT: Panel on Small and Innovative Technologies

At the Whitefish meeting, a panel of experts will address the Council on small and innovative energy technologies being tested or deployed locally.

John Murdock, Vice President of Algae Aqua-Culture Technologies (AACT), will describe how AACT uses waste heat and carbon dioxide from the lumber manufacturing process to cultivate algae and convert it into methane. A byproduct of the process is high grade organic fertilizer. AACT currently operates a demonstration scale greenhouse in Columbia Falls, MT, and is nearing the end of construction on its first commercial scale project. The AACT process holds promise for on-site energy production at wood product processing, wastewater treatment, and other facilities common in the northwest.

Kevin Witt, Chief Technology Officer at Zinc Air, Inc. (ZAI), will explain how Zinc Air is in the process of developing and commercializing a grid storage solution in the form of a large Zinc Redox flow battery. ZAI is trying to bring down the cost of energy storage by utilizing chemical efficiencies, with a goal of providing storage large enough to support projects of 1 to 25 MW. Energy storage of this scale could significantly improve the ability of utilities to integrate wind energy, among other intermittent resources.

Cheryl Talley, Director of Energy and Member Services at Flathead Electric Cooperative (FEC), will provide an introduction and update on a couple of small generation projects developed and underway by FEC. The first is a landfill gas to energy facility that has been operating at the Flathead County landfill since 2009. The second is a project to replace a dilapidated hydroelectric facility owned by the City of Whitefish. FEC has proposed financing to the City and would be repaid through electricity generated by the project.

851 S.W. Sixth Avenue, Suite 1100
Portland, Oregon 97204-1348
www.nwcouncil.org

Steve Crow
Executive Director

503-222-5161
800-452-5161
Fax: 503-820-2370

Utility-Scale Energy Storage Solutions

Kevin Witt, Sr. VP / CTO

Zinc Air, Inc.

+1 .406.755.9462
www.zincairinc.com

ZAI's Value Proposition

Cost-effective, Reliable, Safe, Utility-Scale Energy Storage
will significantly increase the customer's ROI for existing assets

Why do we believe we can do this?

Leveraging 9 Years and many $M of prior R&D
Demonstrated results (lab scale)
Intrinsic cost advantage
Kalispell & Electrochemistry

<u>Advantages</u>

Materials: Low Cost, Readily available in high-volume, US-based
Process: Ambient Temperatures, Atmospheric Pressure
Safety: Non-toxic, Non-reactive, Non-Flammable, Non-fattening

Zinc Air, Inc at a Glance

Headquartered in Columbia Falls, MT

- Formed 2009 in Kalispell
- ~7000 ft^2 north of FCA on Highway 2 West
- 20 employees
- 3 imports (CA, MN), 14 locals, 3 commuters (WA, OR, FL)

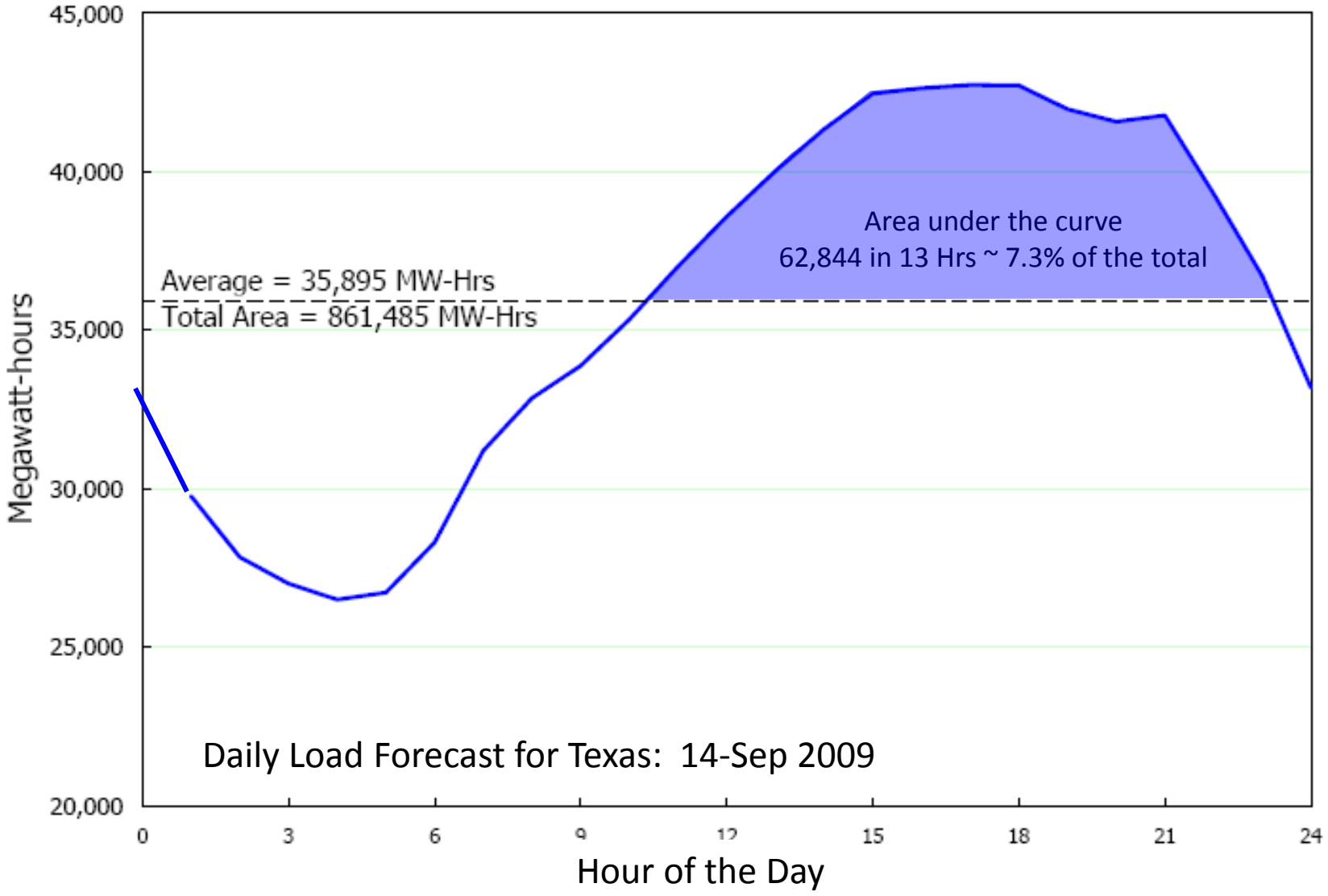
Privately financed

- Debt-free
- Anticipating 1st revenue in 2011
- Currently ¾ of the way through a $2M fund raising program

Commercializing zinc-based energy technologies

- Redox Battery for Utility scale storage(Now)
- Fuel Cell for electric vehicles (Soon)
- Outsourcing sub-assemblies: locally & regionally
- Core competencies in: Design, Test, Support

Energy Demand is Time Varying



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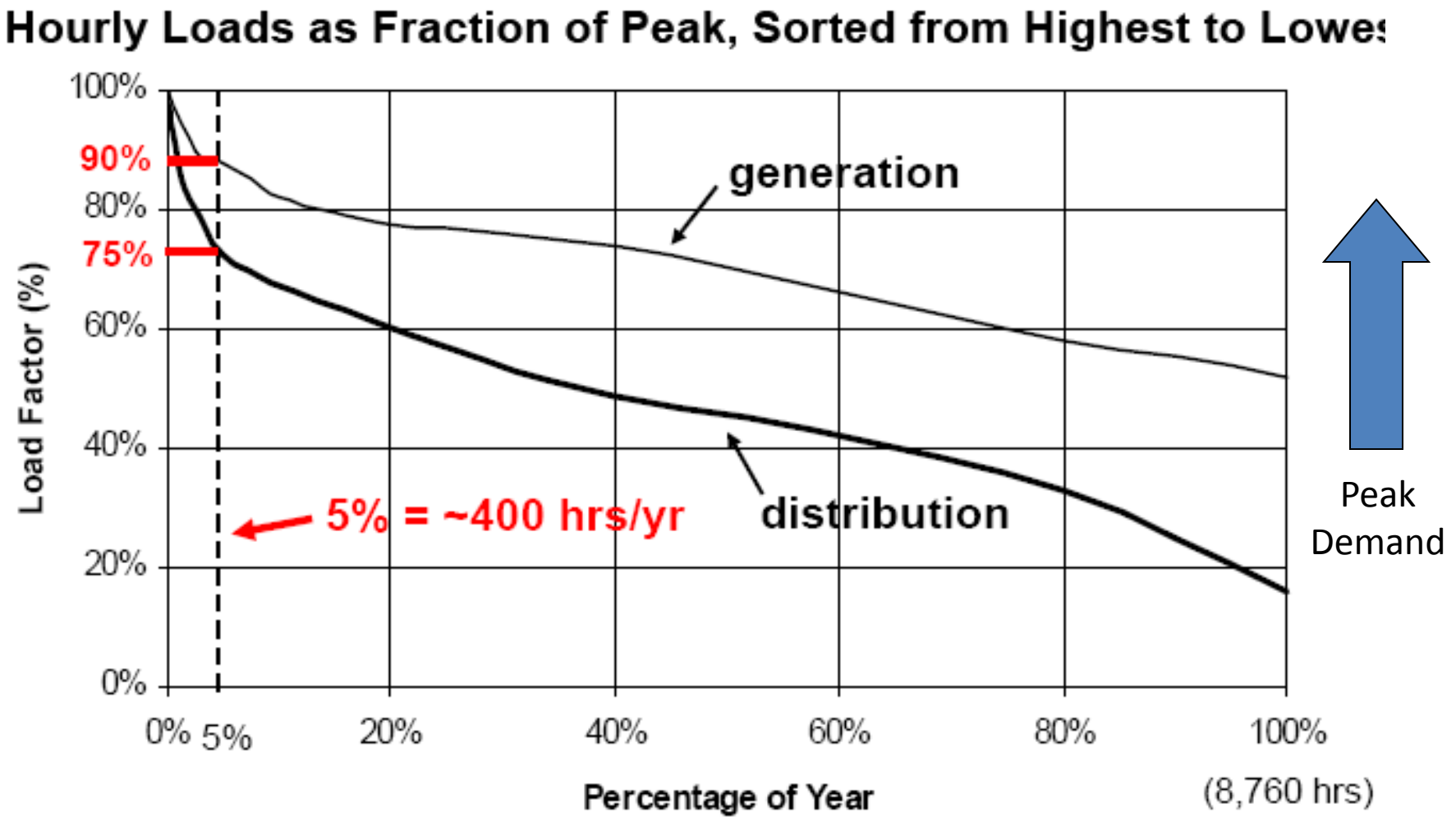
Only ***5% of the year*** is generation at 90% or more of capacity and distribution at 75% or greater



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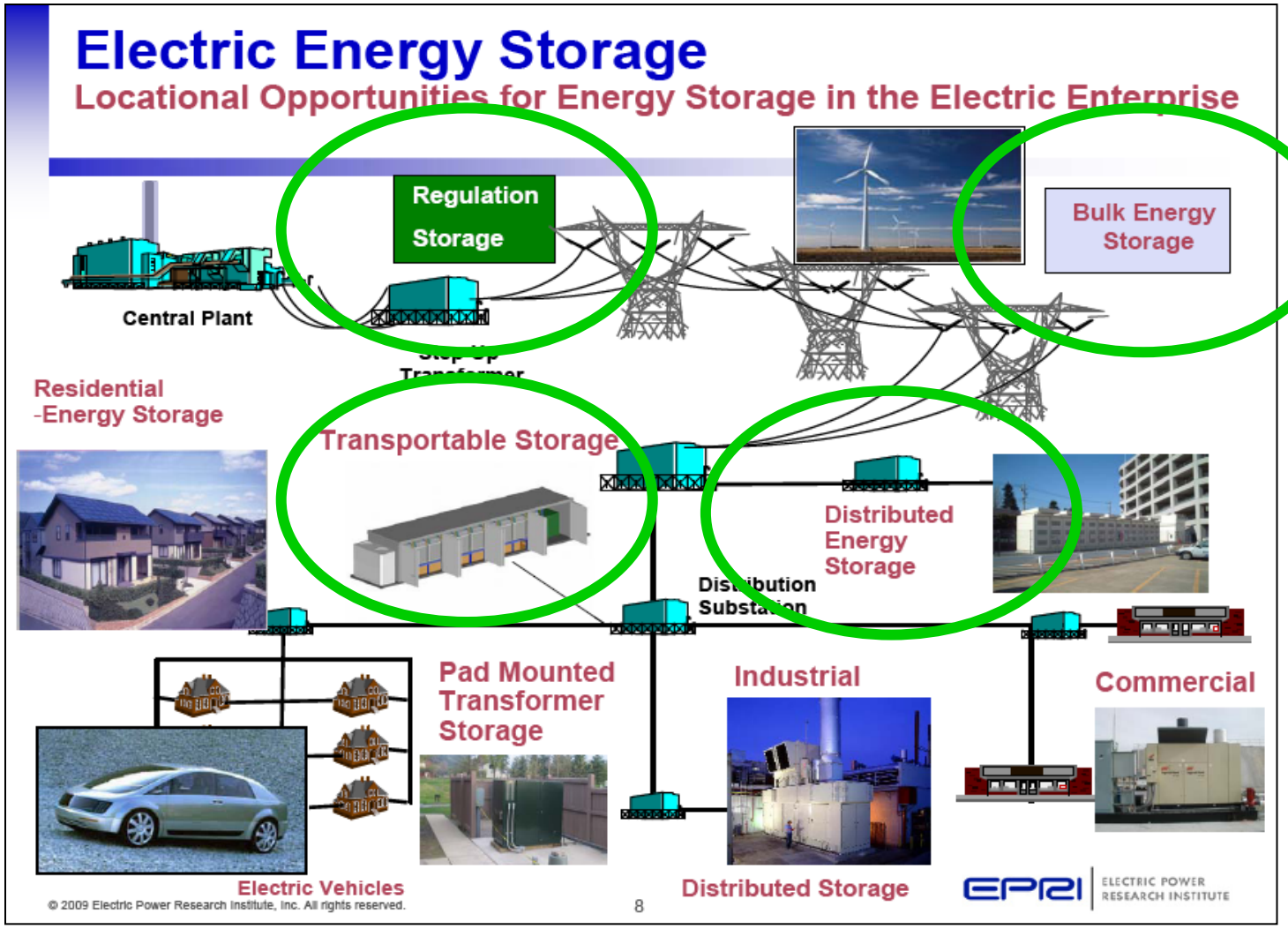
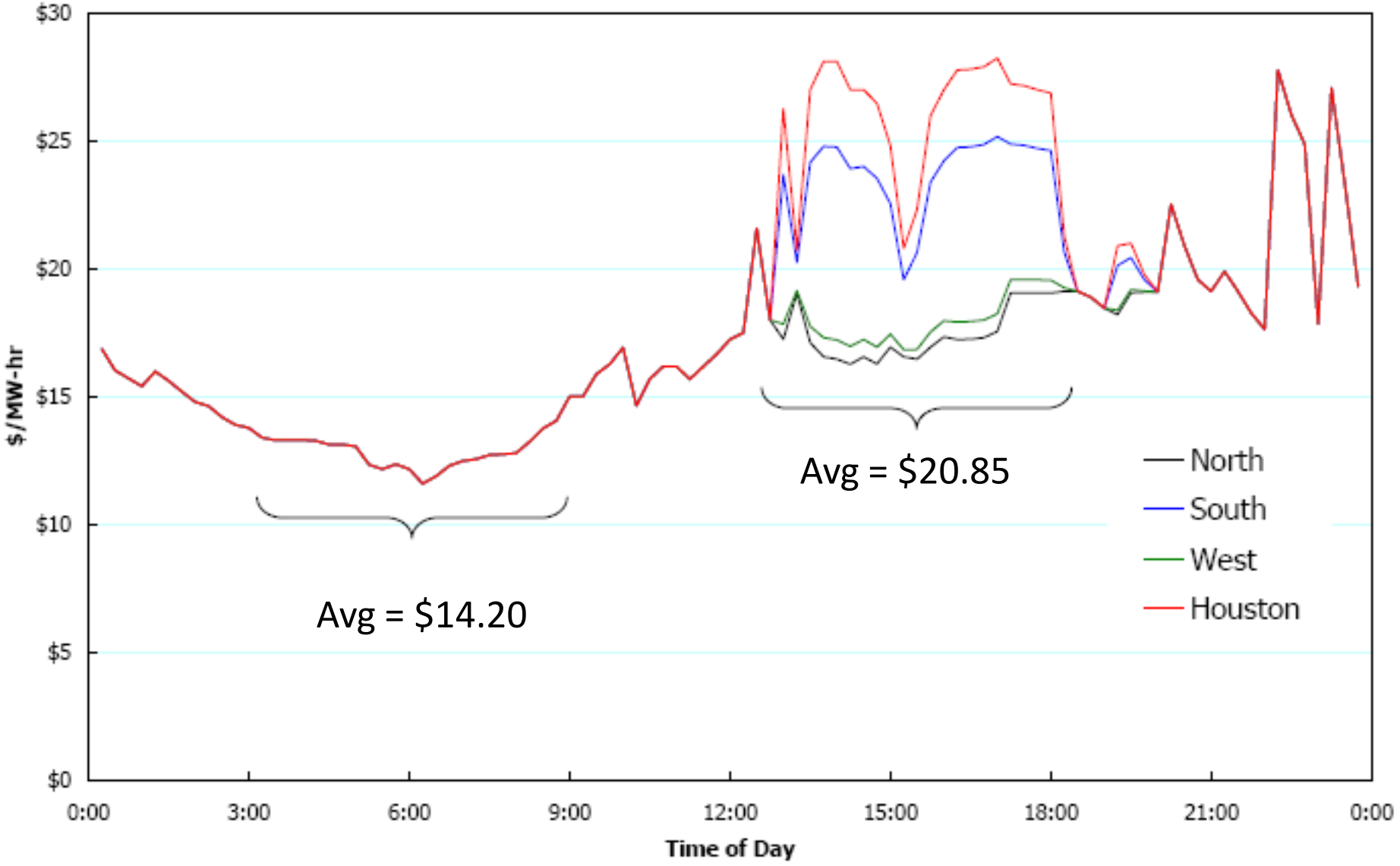
The grid needs inventory



- Dan Rastler, EPRI

Example: Texas Retail Electricity Prices: 13-Sep 2009



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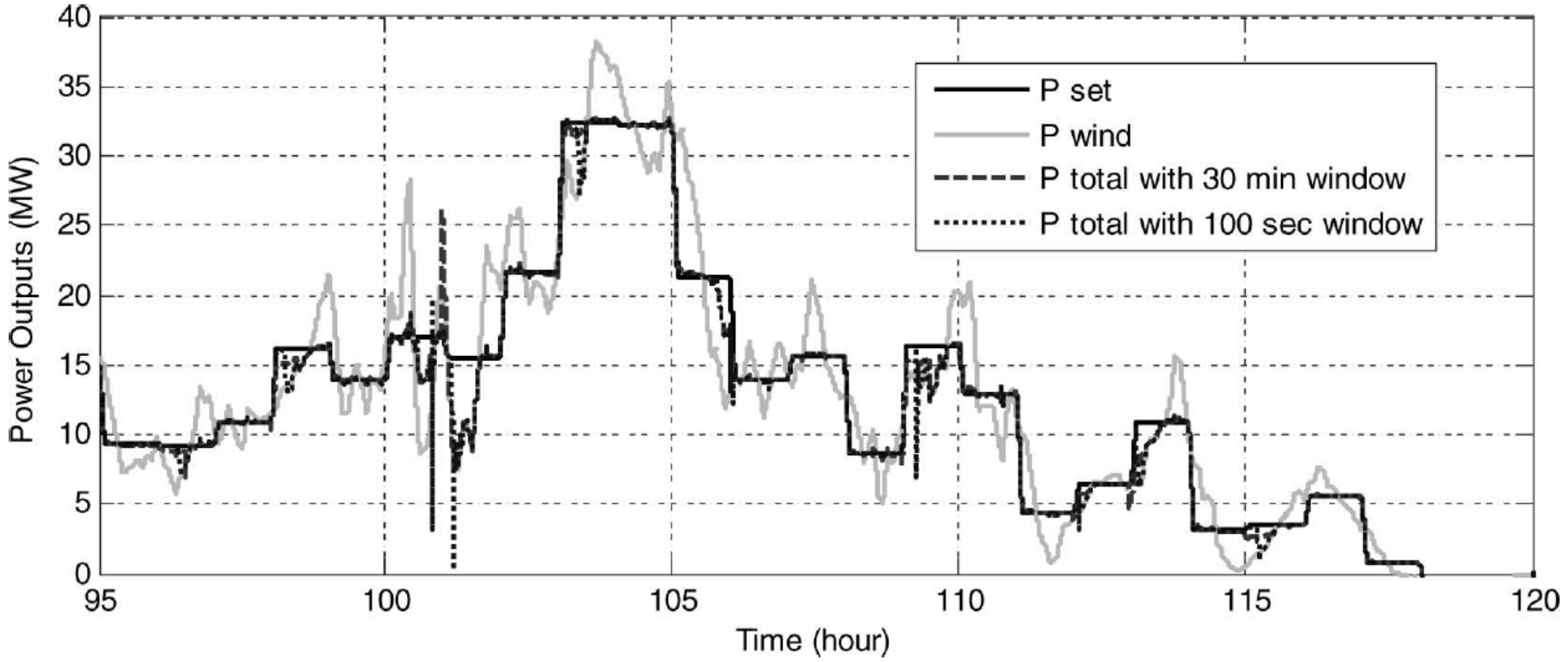
Firming Wind Power and Dispatching: Economic Opportunity



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Total US Electric Power Generation: June 2009

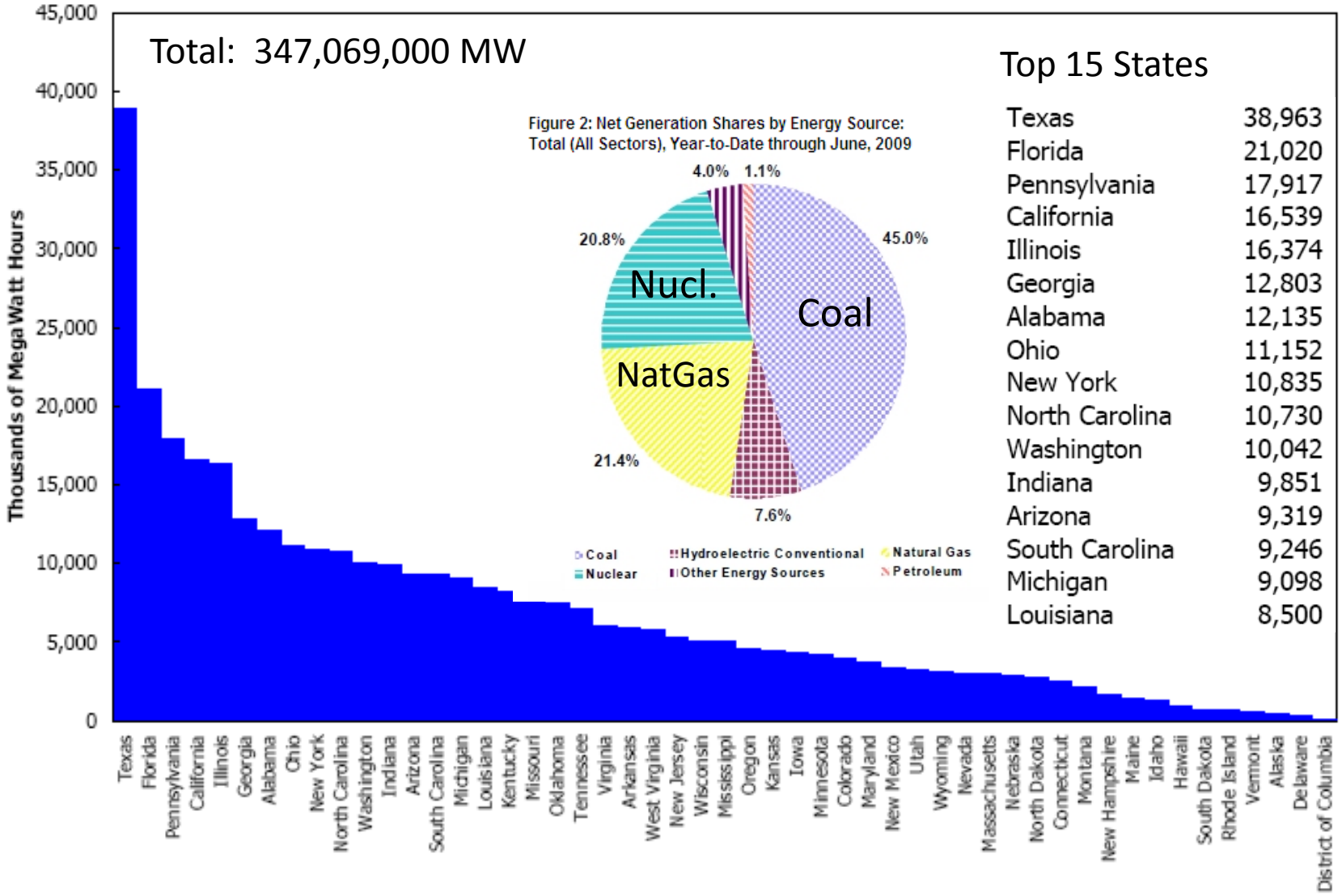


Figure 2: Net Generation Shares by Energy Source: Total (All Sectors), Year-to-Date through June, 2009

Top 15 States

Texas	38,963
Florida	21,020
Pennsylvania	17,917
California	16,539
Illinois	16,374
Georgia	12,803
Alabama	12,135
Ohio	11,152
New York	10,835
North Carolina	10,730
Washington	10,042
Indiana	9,851
Arizona	9,319
South Carolina	9,246
Michigan	9,098
Louisiana	8,500

Source: http://www.eia.doe.gov/cneaf/electricity/epm/table1_6_a.html

TAM estimate: 1.7 *Trillion* USD

(excluding consumption increases)

US Total: 347,069,000 MW-Hrs

7.3% (TX)= 25,336,000 MW-Hrs

2% (est. for rest of US) = 6,941,380 MW-Hrs

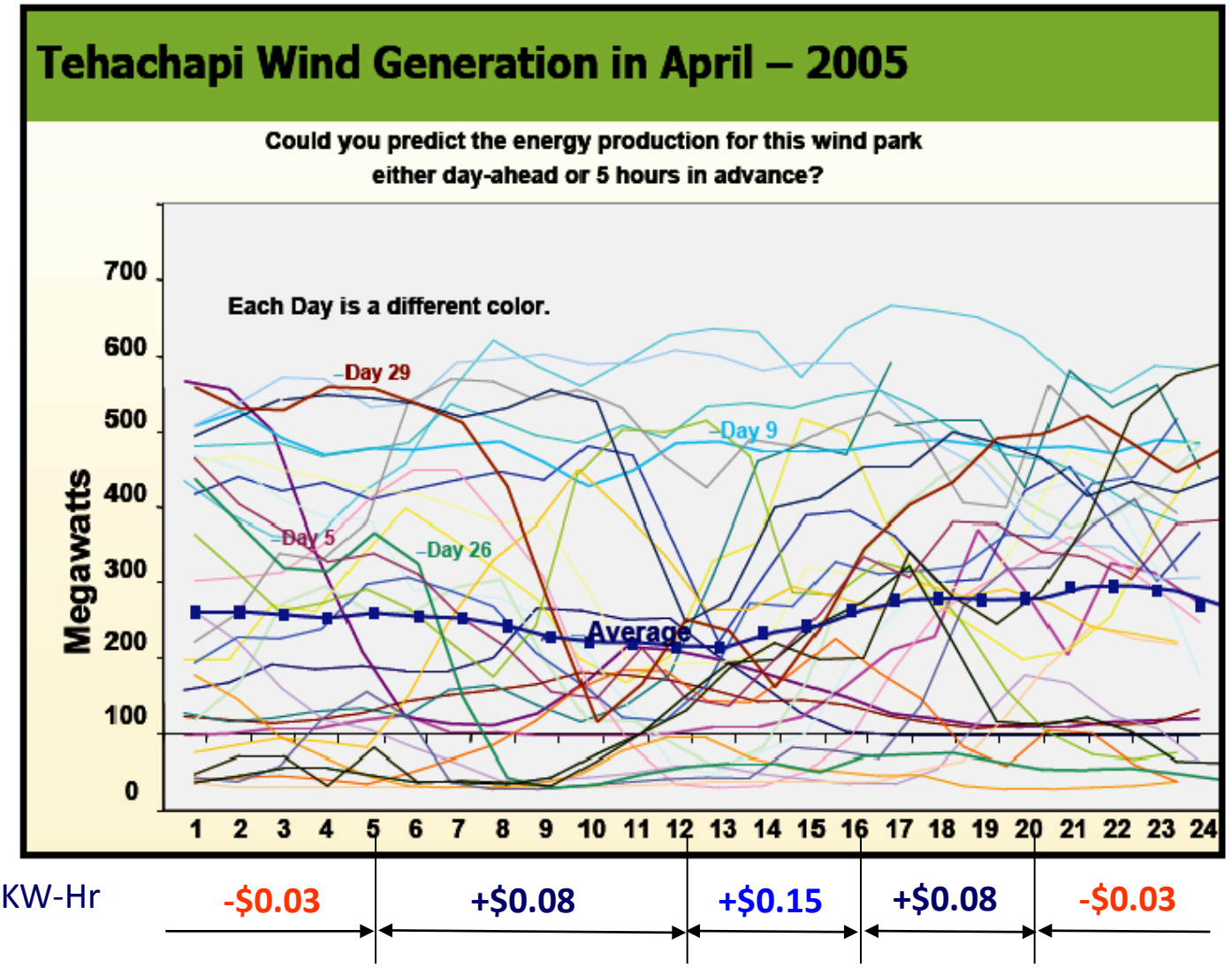
Opportunity: 1,156,896 8 MW-Hr batteries

At $250/KW-Hr, TAM = $ 1,735,345,000,000

Wind power

Average MW generated are 36% of capacity.

Of that, 37% occurs during the 9 night hours



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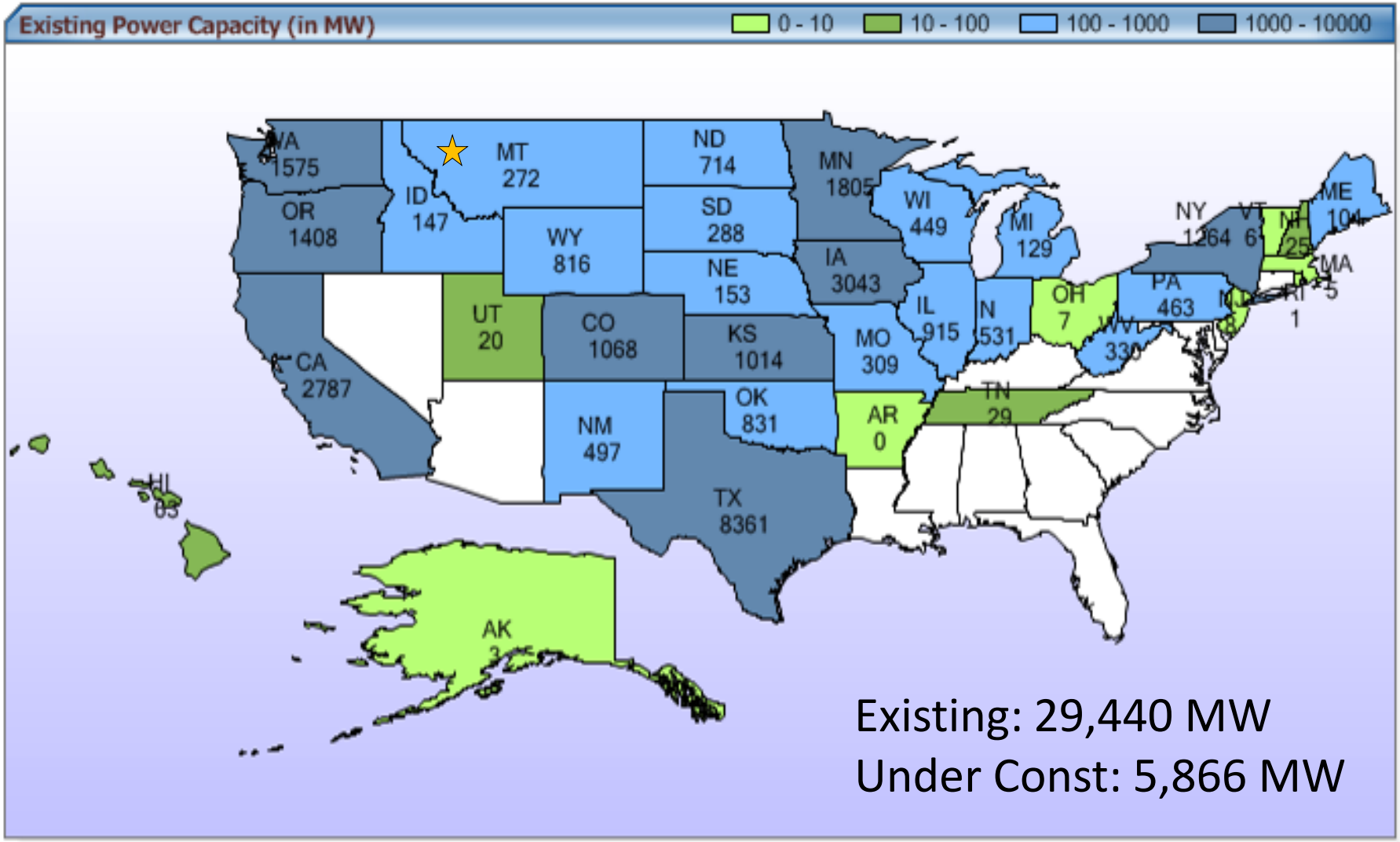
U.S. Wind Energy Projects (as of 06/27/2009)



Source:
AWEA AMERICAN WIND ENERGY ASSOCIATION
http://www.awea.org/projects/

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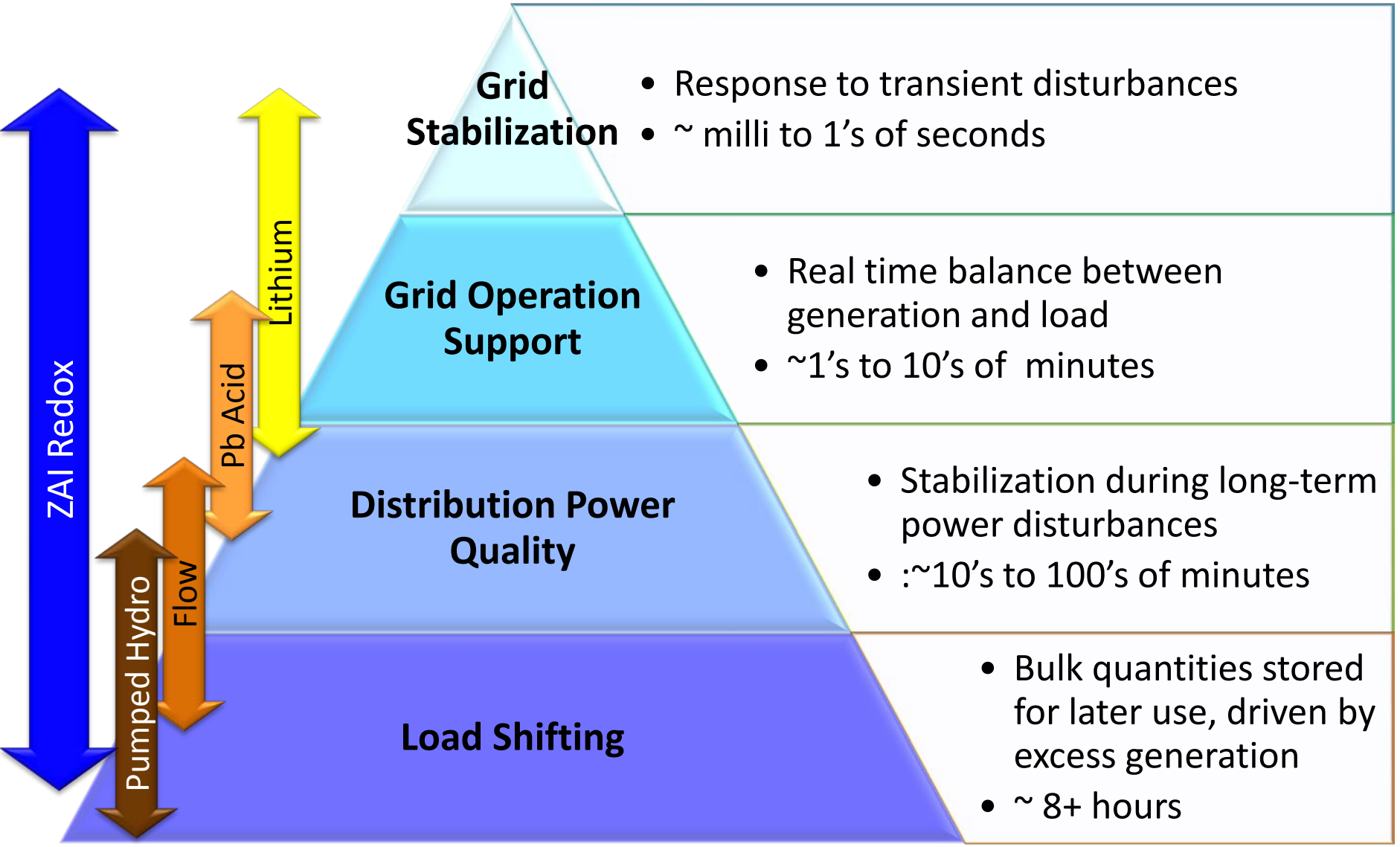
Wind Power: Peak Shifting / Firming

TAM estimate: 23 Billion USD

(excluding consumption increases)

29,440 MW of wind power installed in the US (capacity)
254,352 estimated MW-Hrs of actual generation (36%x24hrs)
Of that , 37% occurs at night. 94,114 MW-hrs
Market opportunity is for 11, 764 8-Hr Batteries
At $250/KW-Hr, TAM = $23,528,500,000

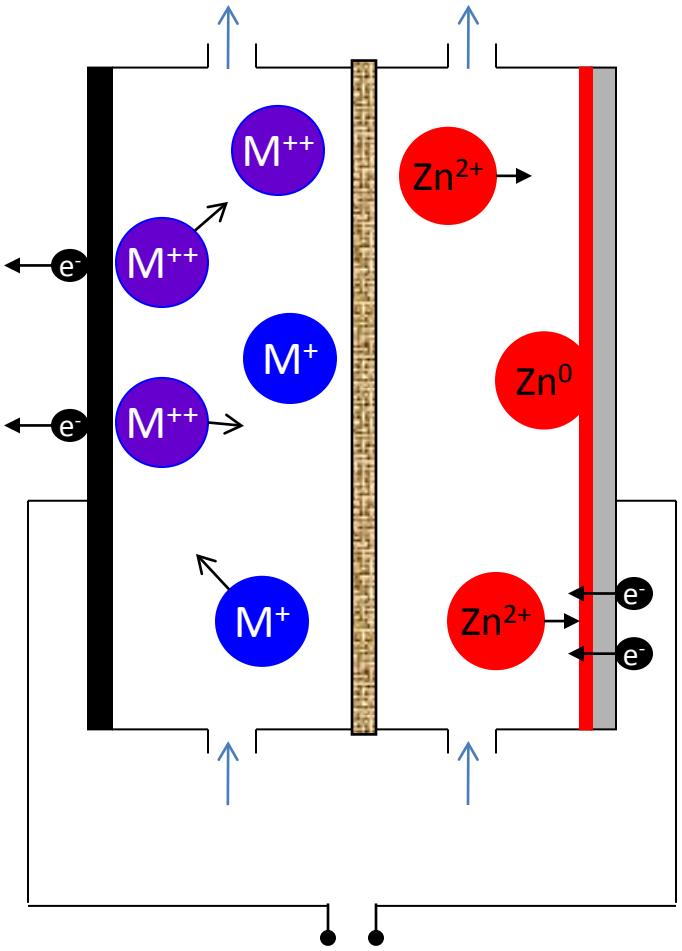
Zinc Redox Covers a Wide Range of Applications



How a Zinc Redox Cell Works

Reduction:

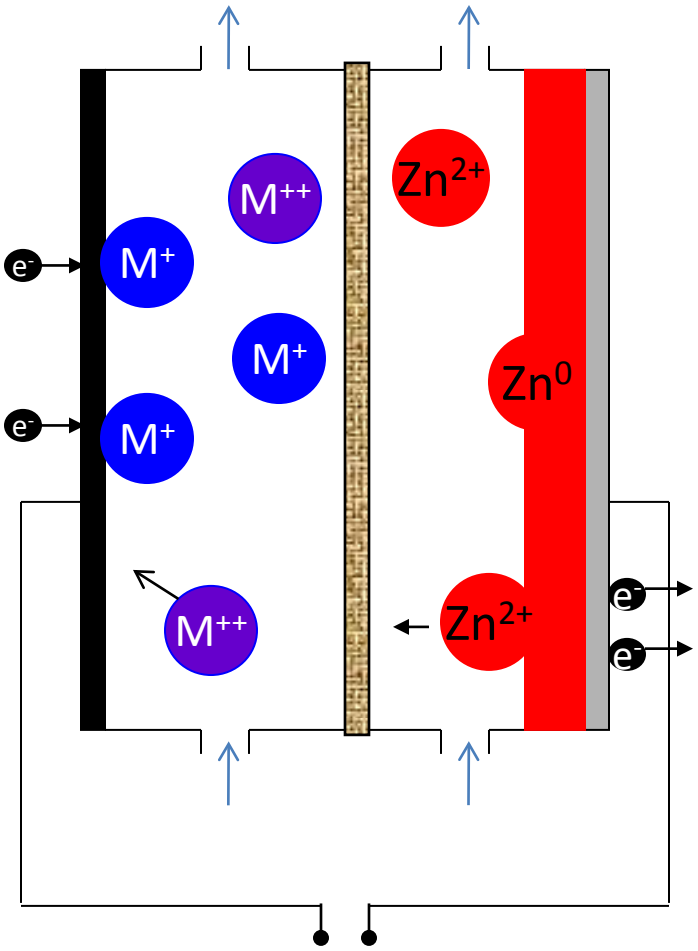
$Zn^{2+} + 2e^- \rightarrow Zn^0$



Input energy from the Grid

Oxidation:

$Zn^0 \rightarrow Zn^{2+} + 2e^-$



Output energy to the Grid

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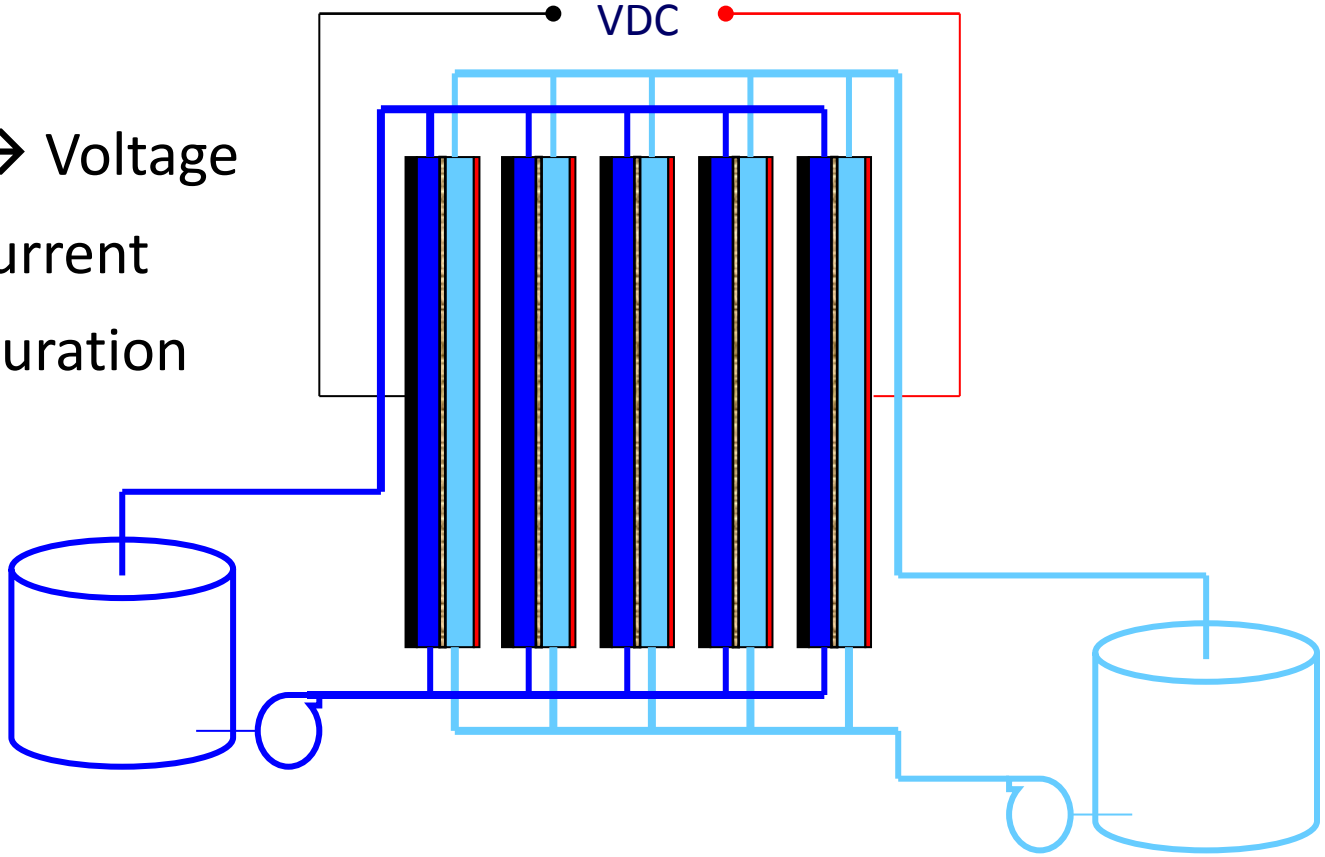
Number of cells → Voltage

Area of cells → Current

Size of Tanks → Duration

A Battery “Stack”



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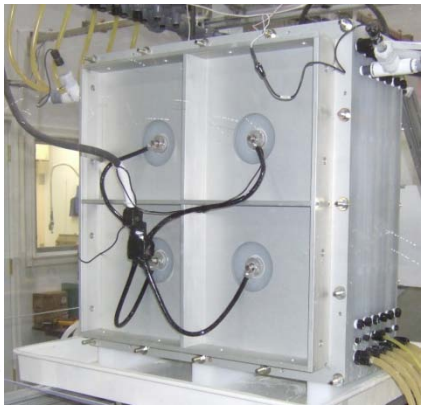
Energy Storage Competitive Landscape

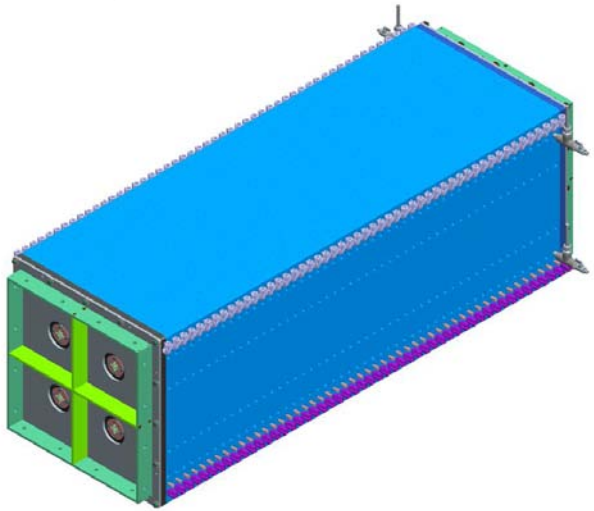
Vendor	battery type	Power (MW)	Energy (MWh)	CAPEX (M$)	CAPEX/ kWh sold*	site
VRB Power	V Flow	2.0	12.0	8.30	$0.15	Donegal Ireland
NGK Insultors	NaS Flow	1.0	7.2	2.50	$0.20	AEP, WV
Lishen	Li Ion	1.0	0.3	0.10	$0.22	
Zinc Air Inc	**Zn Redox**	**1.0**	**8.0**	**2.00**	**$0.07**	
Premium Power	ZnBr Flow	0.5	2.8	1.00	$0.10	Duke Power
Example	Lead Acid	0.3	0.8	0.15	$0.21	
ZBB Energy	ZnBr Flow	0.3	0.5	0.36	$0.51	

*CAPEX divided by energy, cycle life, and efficiency

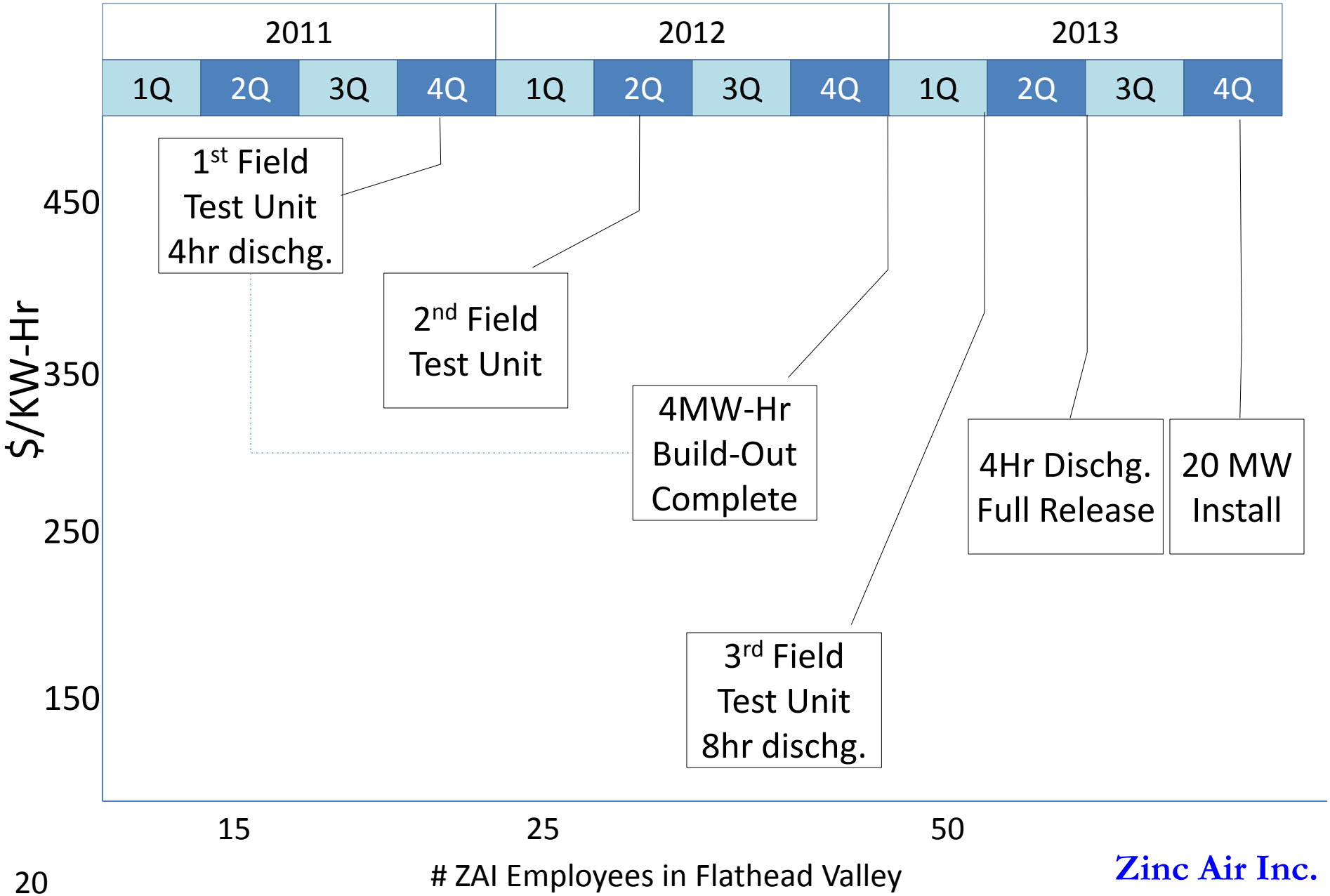
ZAI Today

- Moved into Columbia Falls facility in Dec. ’10
- 1st Target staffing level achieved in May 2011
  - 2 Sr. Scientists/Electrochemists
  - 1 Analytical Chemist
  - 2 Mechanical Engineers
  - 1 Numerical Modeler/Simulationist
  - 1 Facility Manager
  - 5 Technicians (2 FT/ 3 PT Student from FVCC)
  - 1 Receptologist
  - 7 Overhead (e.g. CEO, CTO, COO, etc.)
- First PO expected in June ‘11 (US Customer)
- 1st product shipment in the 4th calendar quarter of ‘11





Roadmap



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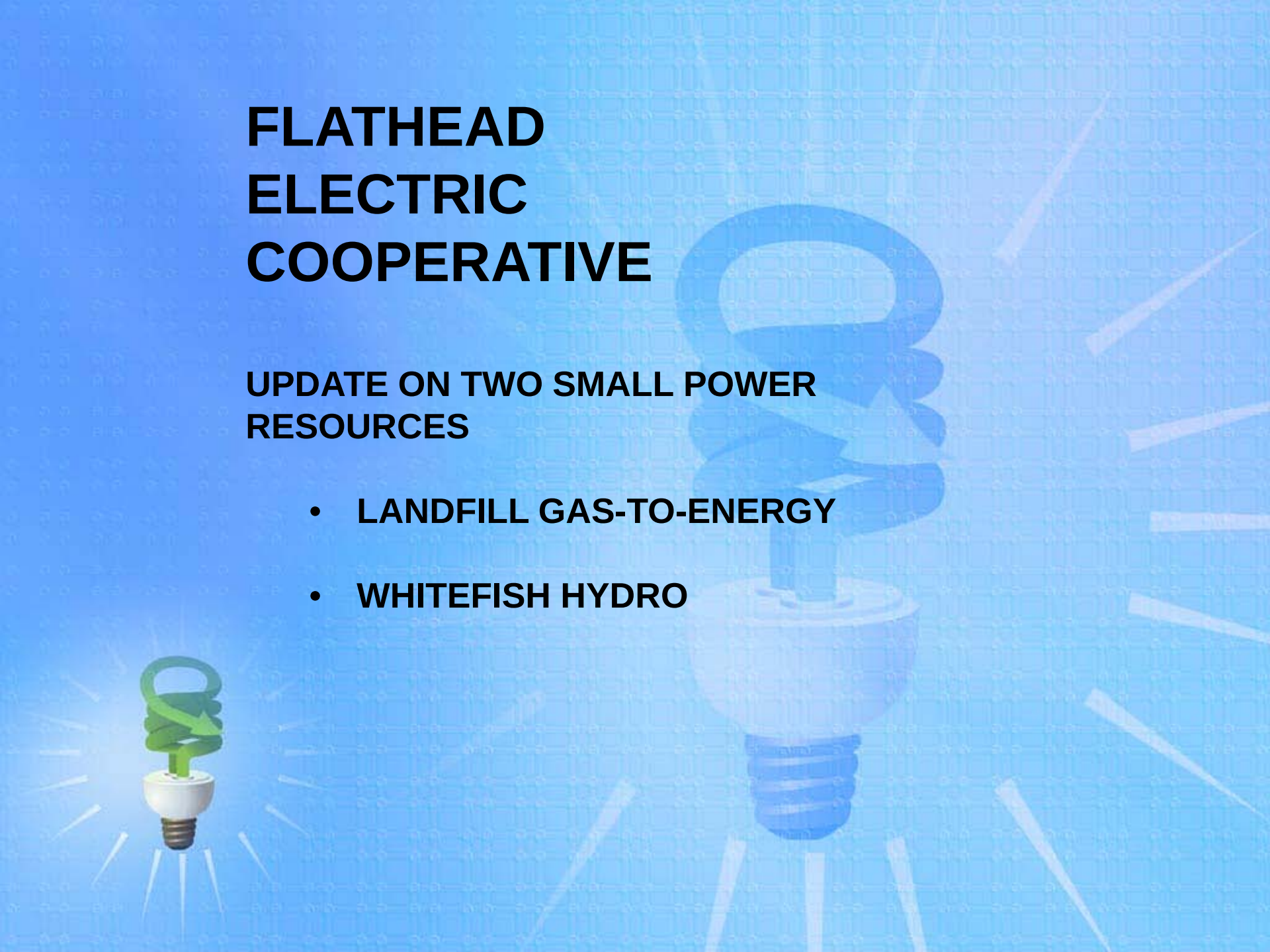
FLATHEAD ELECTRIC COOPERATIVE

UPDATE ON TWO SMALL POWER RESOURCES

- LANDFILL GAS-TO-ENERGY
- WHITEFISH HYDRO



LANDFILL GAS-TO-ENERGY FACILITY

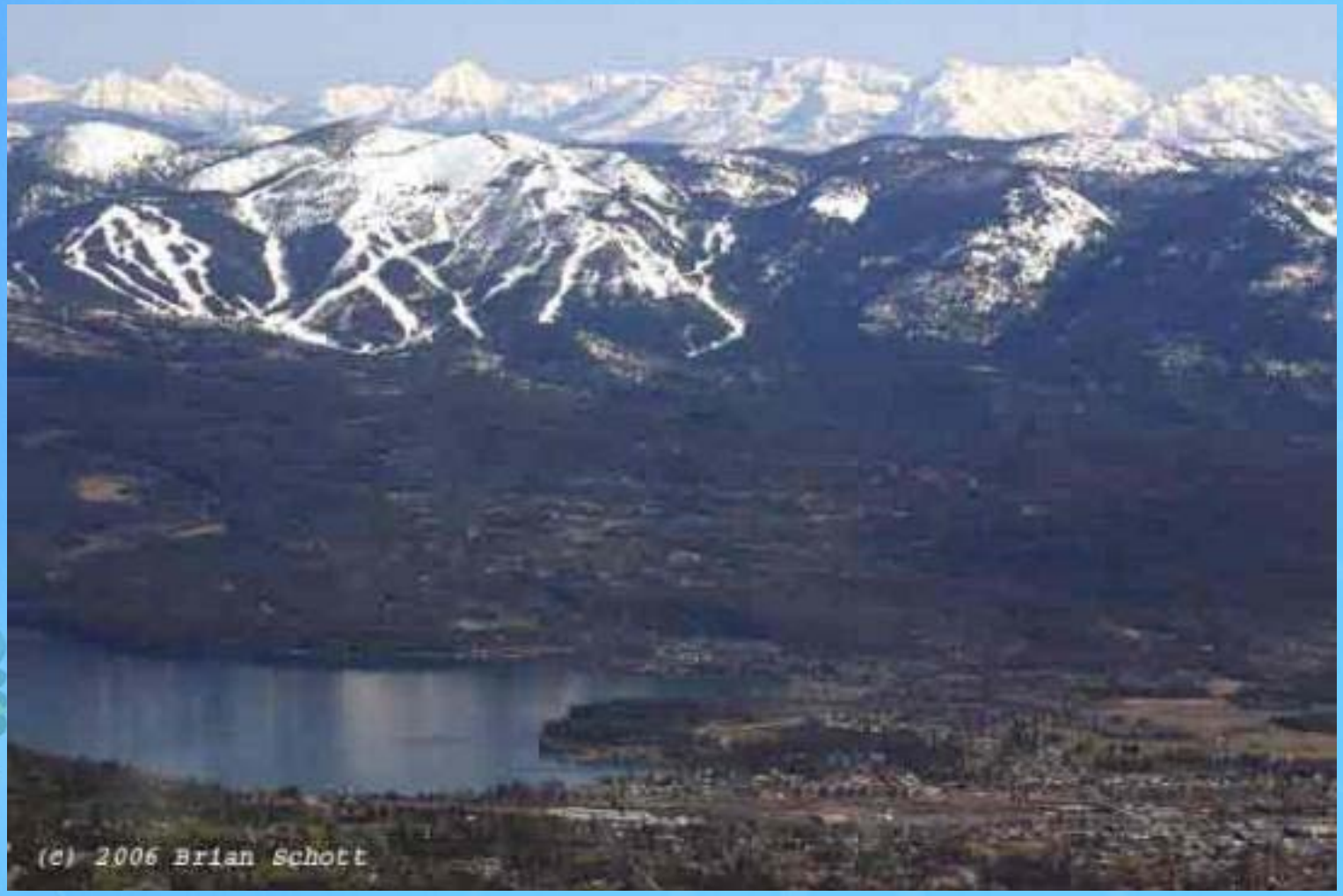
LANDFILL GAS-TO-ENERGY FACILITY

- Landfill gas is about 50% methane
- Have been generating about 900 kw
- Generated over 11 million kwh since startup
- Costs have been $0.05 / kwh for 2011
- First major maintenance in March went well
- Cooperative arrangement with County good

LANDFILL GAS-TO-ENERGY FACILITY

- Starting this month, expanding the well field
  - SCS Engineers begin a well field expansion for about $400,000.
  - Add 6 vertical wells and 2 horizontal well
  - Laterals across the top to enable gas to be drawn in 2 directions
  - Lay a horizontal pipe in the new active face for future use as a horizontal well.
  - The addition is proposed to add about 35% more gas, which should boost the output to about 1.2 MW.
  - The drilling will begin next month and the project will be completed in August

WHITEFISH HYDROELECTRIC PROJECT



WHITEFISH HYDROELECTRIC PROJECT

- City of Whitefish operated small hydroelectric plant from 1982-1989, until lightening strike
- 2 intakes capture water from Haskill Creek, which drains from the Whitefish Range
- Convey 640 ft down mountainside in 15” line to water treatment plant, serves as penstock

In addition,

- The City will replace the damaged turbine and outdated controls – 235 kw nameplate
- Run-of-stream will have continuous, but seasonal, output about: 900,000 kwh annually

WHITEFISH HYDROELECTRIC PROJECT

- City of Whitefish received a $200,000 Energy Efficiency and Conservation Block Grant from MDEQ towards the $600,000 project
- Finalizing the 20-yr Power Purchase Agreement
  - City of Whitefish will own and operate
  - FEC will pay $400,000 to pre-purchase the energy output
    - FEC will take electricity until the $400,000 is paid back, 6-8 years
    - Then, the City will net-meter the output against their water and waste use
    - FEC will get green tags for life of plant
- City in process of amending water use permit

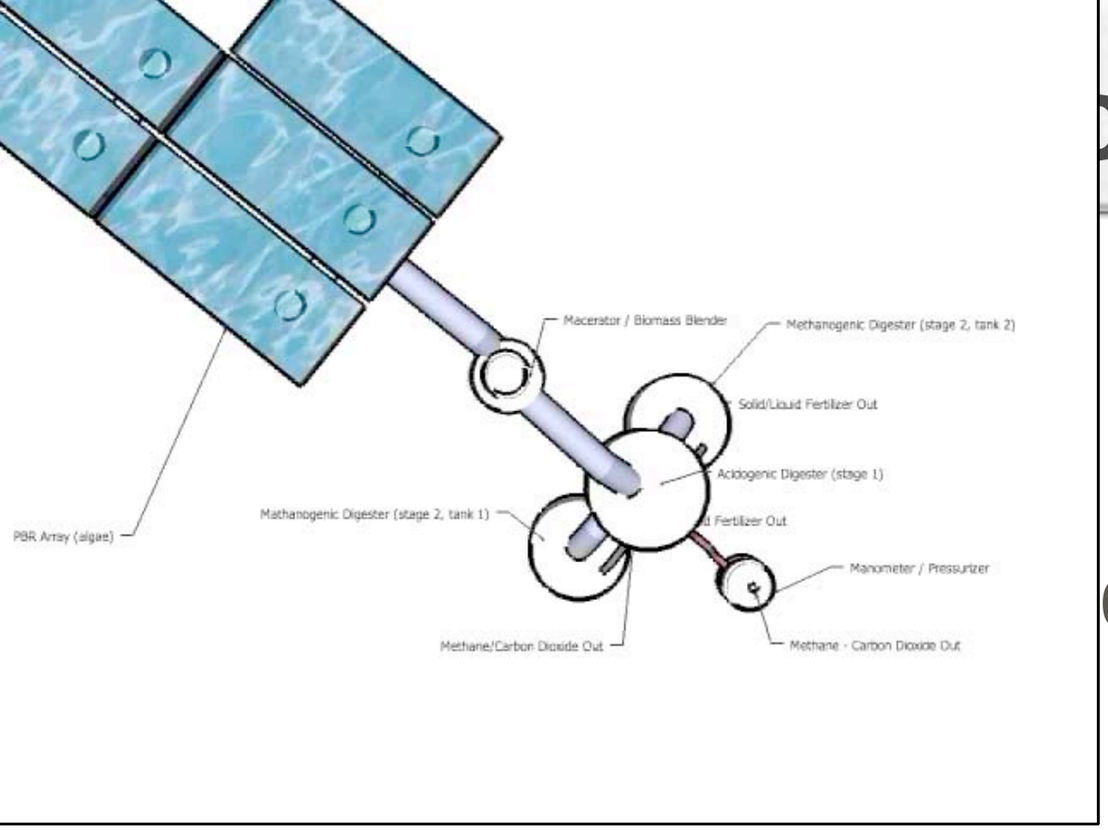
Algae Aqua-Culture Technologies

AACT

“Integrated Smart Technologies for a Sustainable Future”

Whitefish, MT

ocess Overview



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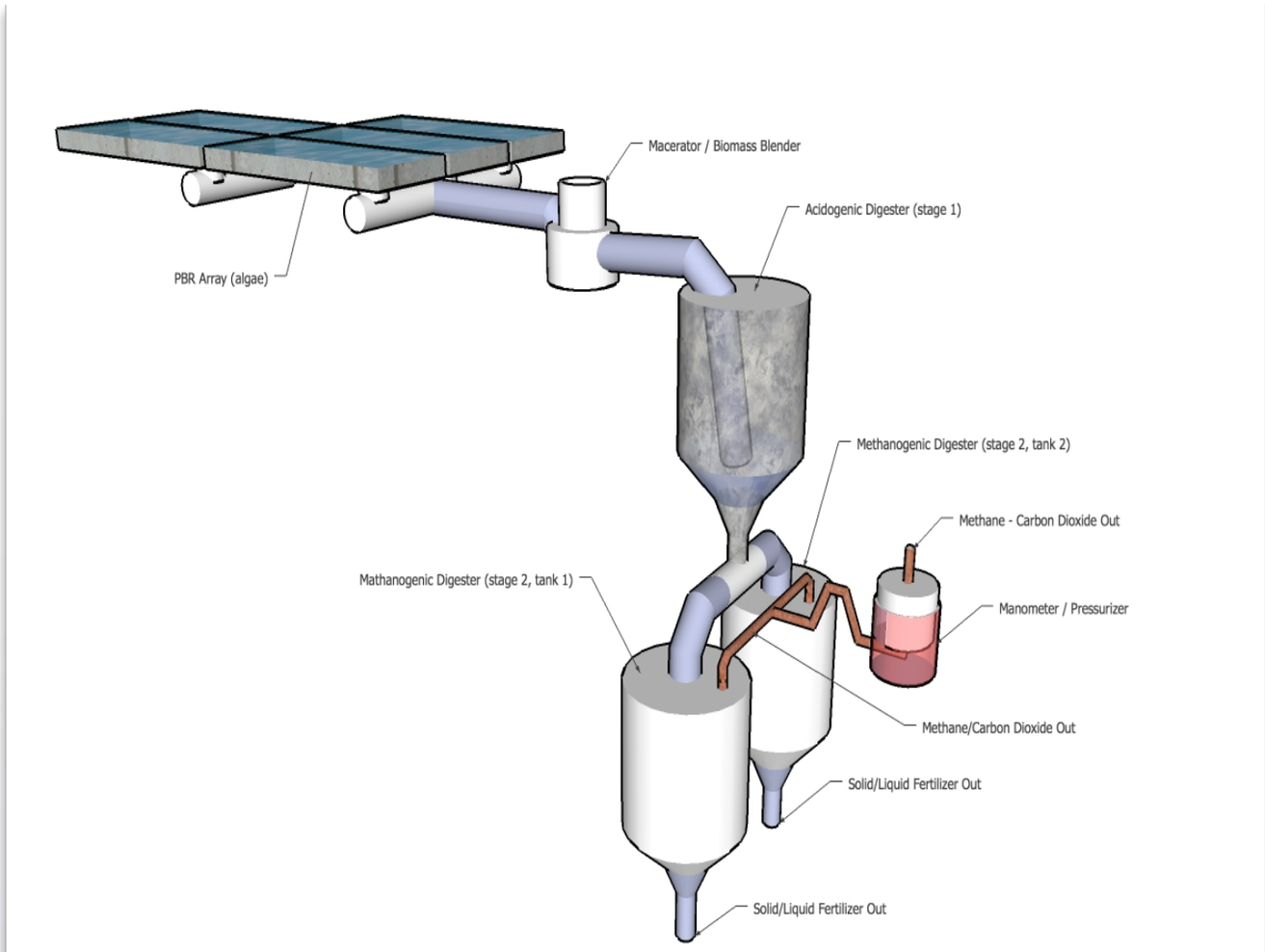
- Algae digestion, combustible gas & fertilizer production

- Biomass gasification



Inputs: Water, Heat, Sunlight & Biomass

Anaerobic Digester Gas Production

- Two stages anaerobic digestion process
- Parallel processes accelerate digestion and maximizes CH_4 & H_2 gas production
- Electrical generation capacity of *at least* 30 KWH per system

Heat, Gas, Biomass & Controls

Biomass to Fuel

- Reduces woody biomass into biofuels and biochar

- Virtually any type of cellulosic biomass are feedstocks:
  - Invasive weeds
  - Grasses
  - Agricultural waste

Cellulosic Biomass Conversion

Prototype Gasifier Outputs

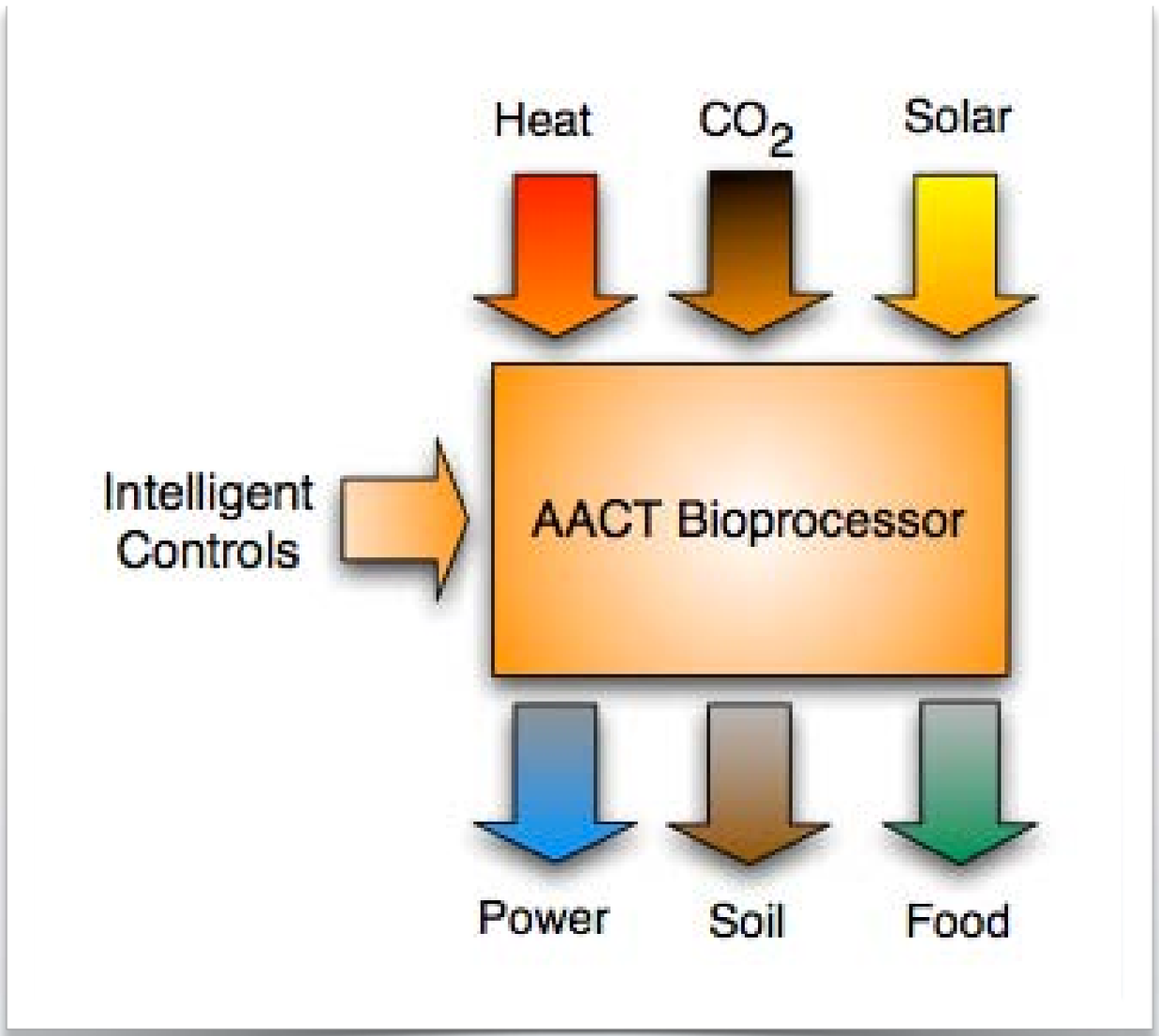
Fuel Gases, Bio-Oil & Organic Carbon

Revenue Streams

1. Soil Amendment
i. Liquid Fertilizer
ii. Solid Fertilizer
iii. BioChar

- Energy
- Electricity
- Methane
- Bio-oil

- Agricultural
- Culinary
- Medicinal
- Reforestation, Restoration



System Outputs

Regenerating Soils, Clean Energy & Food

Algae Aqua-Culture Technology, Inc
PO Box 1171 Whitefish, MT 59937
www.algaeaqua.com

Michael Smith – President
michaels@dancehammer.com

John Murdock – VP
john.murdock01@gmail.com

Investors & Licensees Welcome

Green & Sustainable