

# Large Scale Hydrokinetics in the Mississippi River

## Free Flow Power Corporation

*A new generation of energy*

LSU Alternative Energy Conference  
April 23<sup>rd</sup>, 2008

Renewable  
Energy  
Generation

Technology  
Development





# The Company

- Founded to produce clean, renewable energy from moving water without dams
- More reliable than wind
- Not visible above the water
- Focus on
  - **Simple proven technology** with **clear opportunities for improving efficiency** and
  - **Economies of scale** from mass production facilitated by
    - large scale developments
    - using replicable, efficient processes

# Two Divisions



## Manufacturing

- Build and sell turbines to:
  - FFP projects
  - existing hydro
  - 100,000 potential sites in North America
  - larger, faster growing global market (China, India and South America)

## Project Development

- Develop free flow projects
  - largest developer in North America (initially 2,000 MW; 200,000 turbines)
  - Outside the US with international partners
- Generate revenues from:
  - Project Management Fees
  - return on FFP equity contribution
- Projects financed with non-recourse debt and equity



# The Opportunity

- *FFP is only business with the sites, technology and know-how to be first to market*
- River-based hydrokinetic has potential to be **most reliable renewable** with least ecological or social complications
- **Robust financial projections** based on current price of electricity
  - potential for Renewable Portfolio Standards and tax treatment equivalent to solar and wind accelerate returns dramatically
- Federal regulatory agencies **eager to expedite processing**

# Conventional Hydro Limited



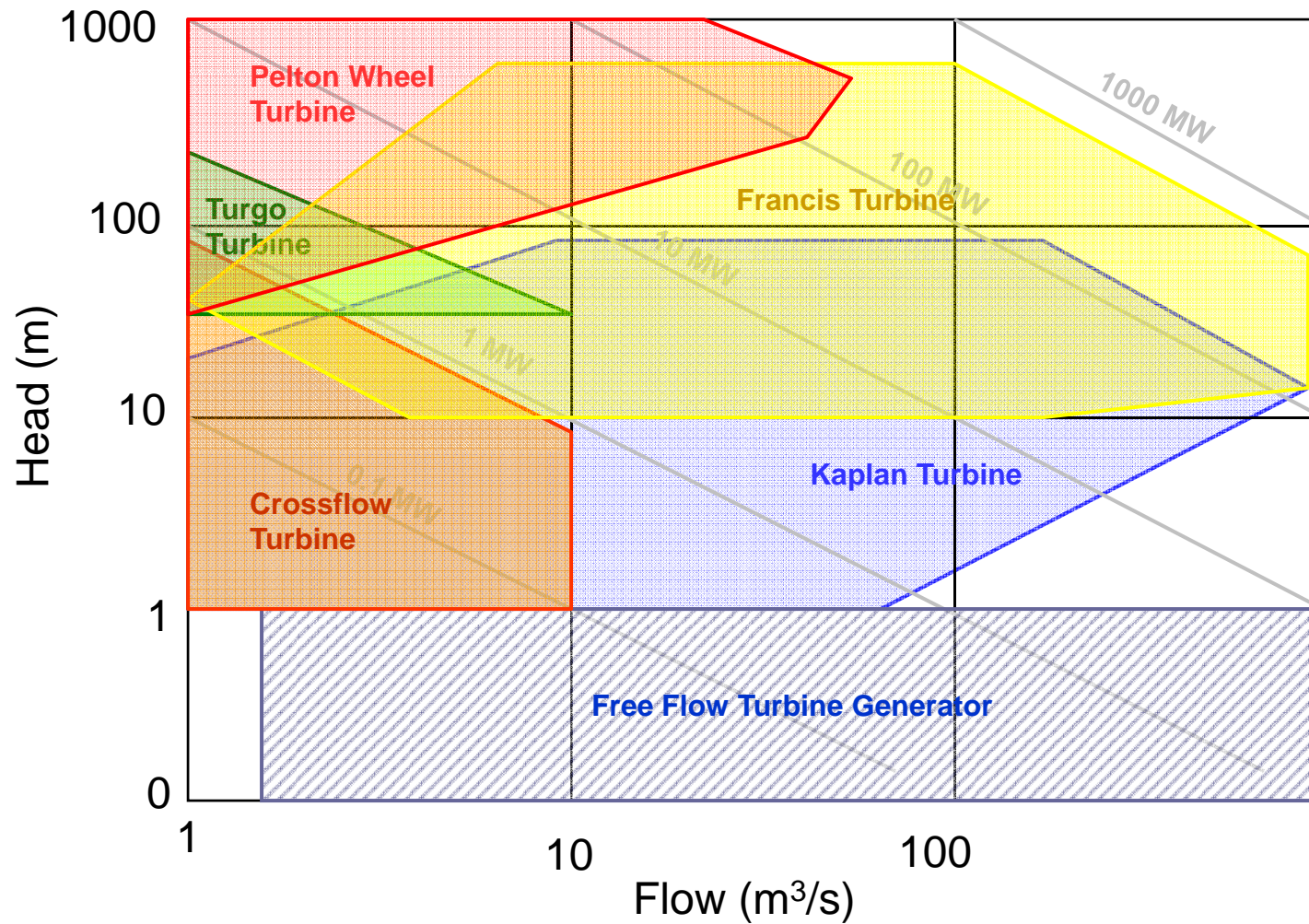
- Lack of sites
- Environmental concerns
  - blockage of fish passage,
  - potential injury from downstream passage through high pressure turbines
  - down stream habitat and water quality (e.g., reduced levels of dissolved oxygen, adverse impact on sedimentation and flow),
  - greenhouse gas emissions from decaying organic matter trapped in dammed reservoirs,
  - flooding, and
  - dam failures

# FERC Recognizes Potential to Exceed All Other Renewables



“Estimates suggest that new hydrokinetic technologies, if fully developed, could double the amount of hydropower production in the United States, **bringing it from just under 10 percent to close to 20 percent of the national electric energy supply.** Given the potential benefits of this new, clean power source, **the Commission has taken steps to lower the regulatory barriers to its development.** (*FERC Policy Statement Docket No. PL08-1-000*)” [emphasis added]

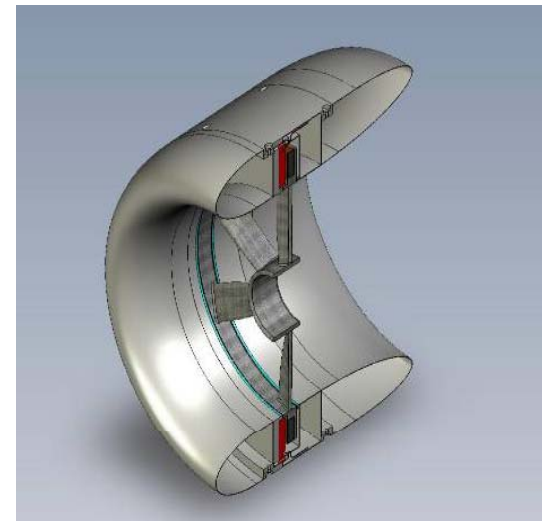
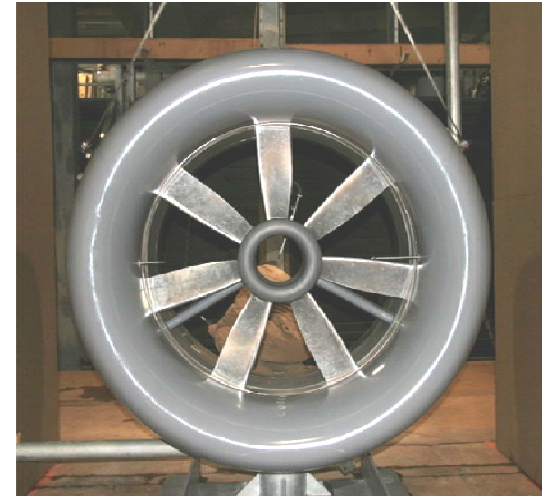
# Hydro Turbines in Context



# Free Flow Turbine Generator



- 2 meter diameter turbine
  - 10 kW in flow of 2 meters per second
  - 40 kW in flow of 3 meters per second
- 1 meter diameter turbine
  - 10 kW in flow of 3 meters per second
- Both units operate in flow speeds between 2 and 5 meters per second





# Free Flow Turbine Generator

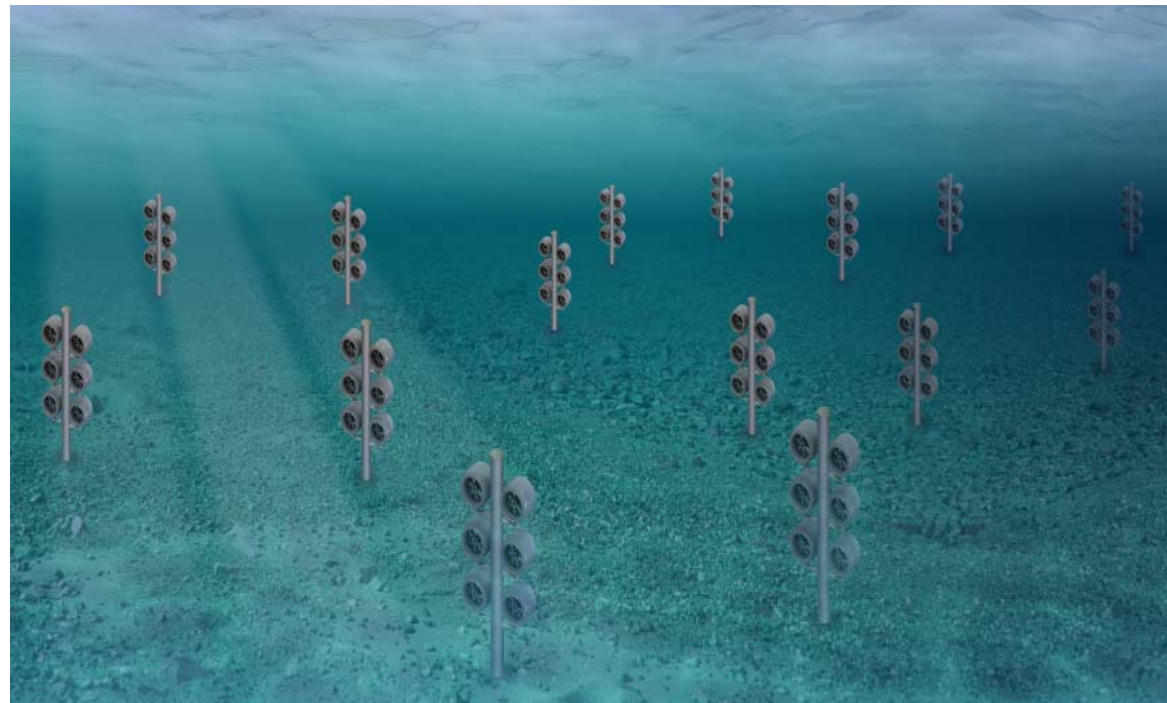


- Integrated turbine generator
- Does not require pressure or “head”
- Rim-driven, direct drive generator with
  - permanent rare earth magnets
  - configured in Halbach arrays
- Electronically controlled 3-phase DC output
- Hydrodynamic bearings avoid lubricants
- Designed for
  - mass production
  - flexible deployment options

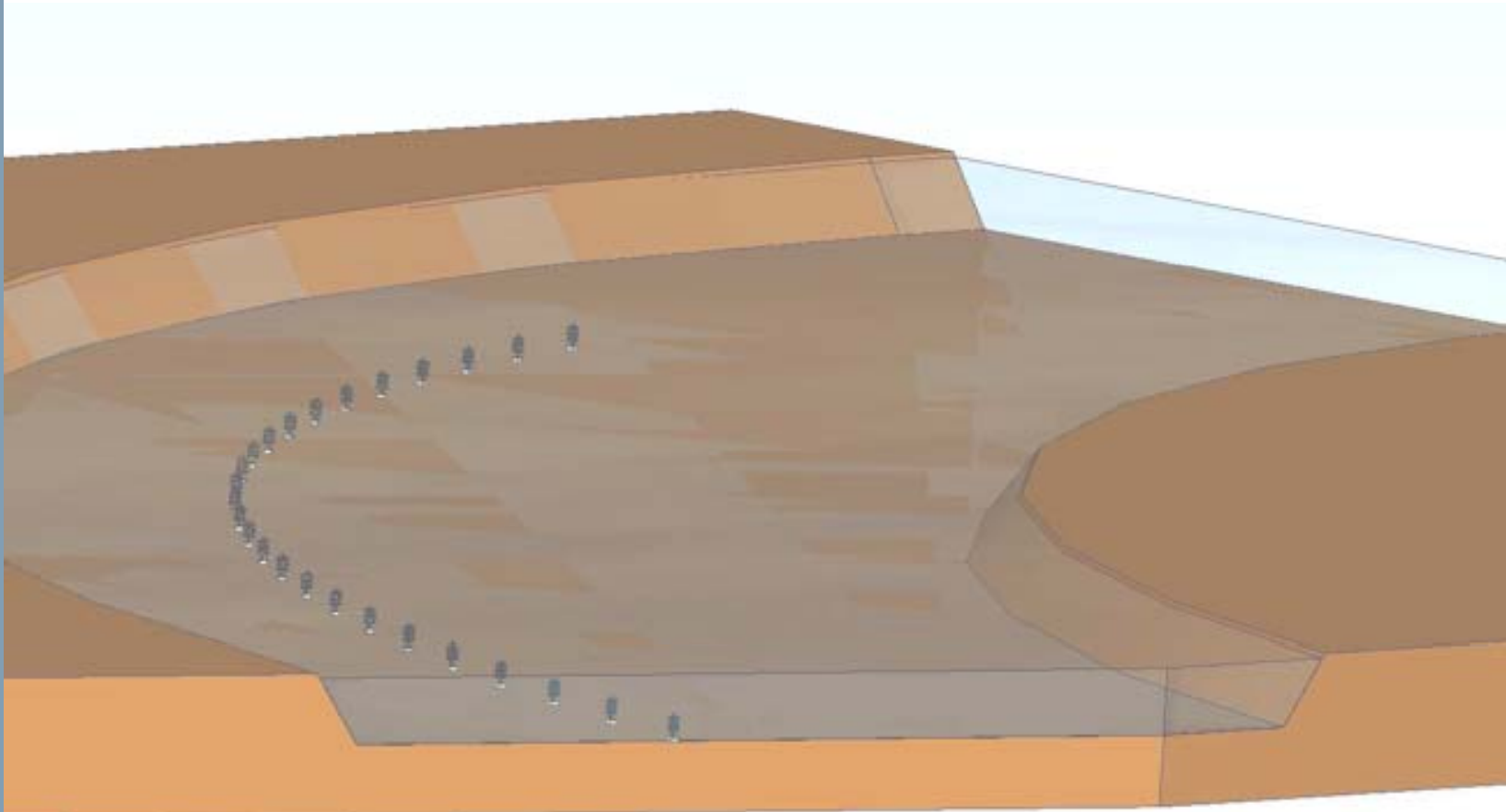


# Turbine Generator Arrays

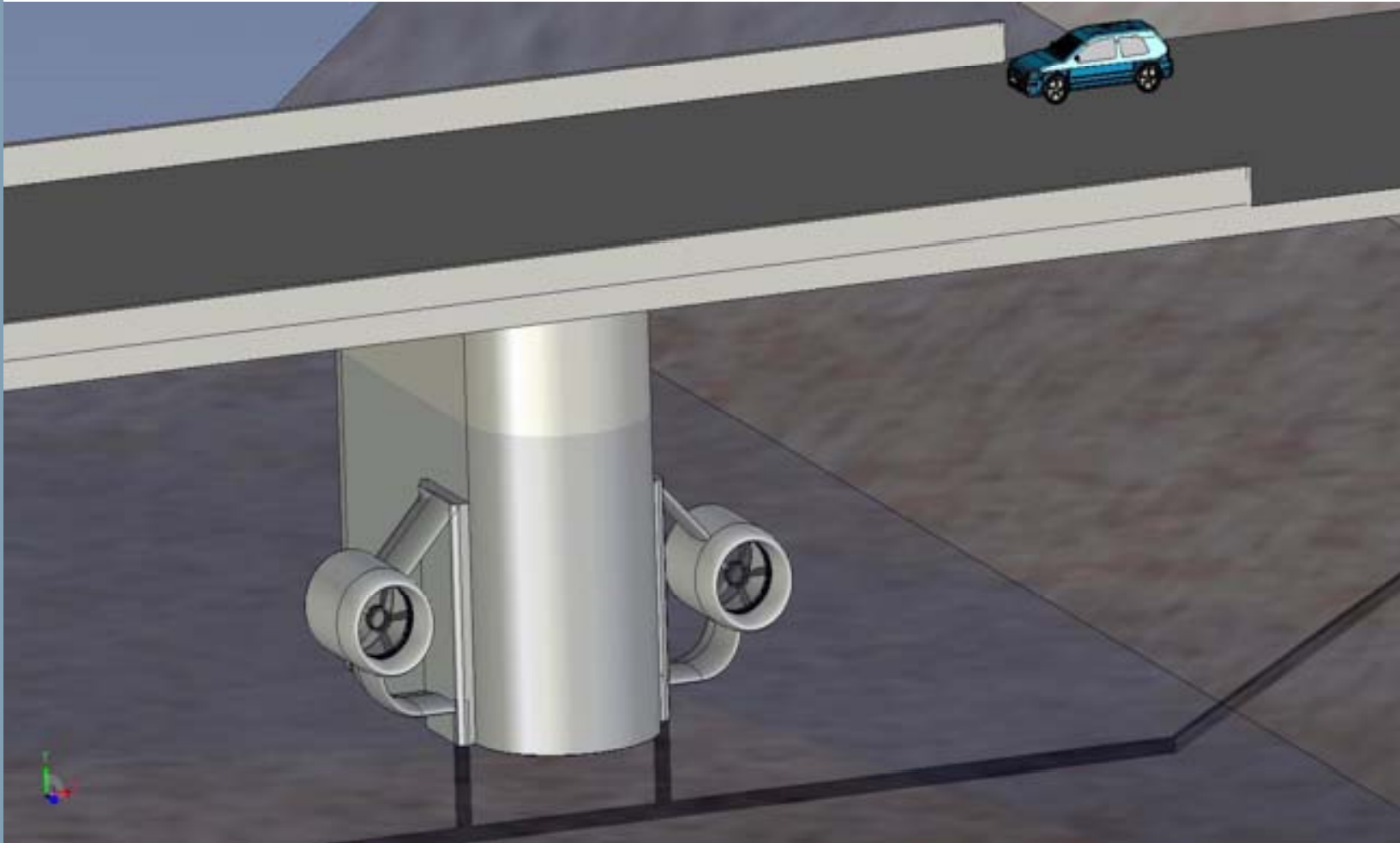
- Typical installation includes six turbines
- Mounted on piling below shipping traffic
- Staggered to minimize flow interference



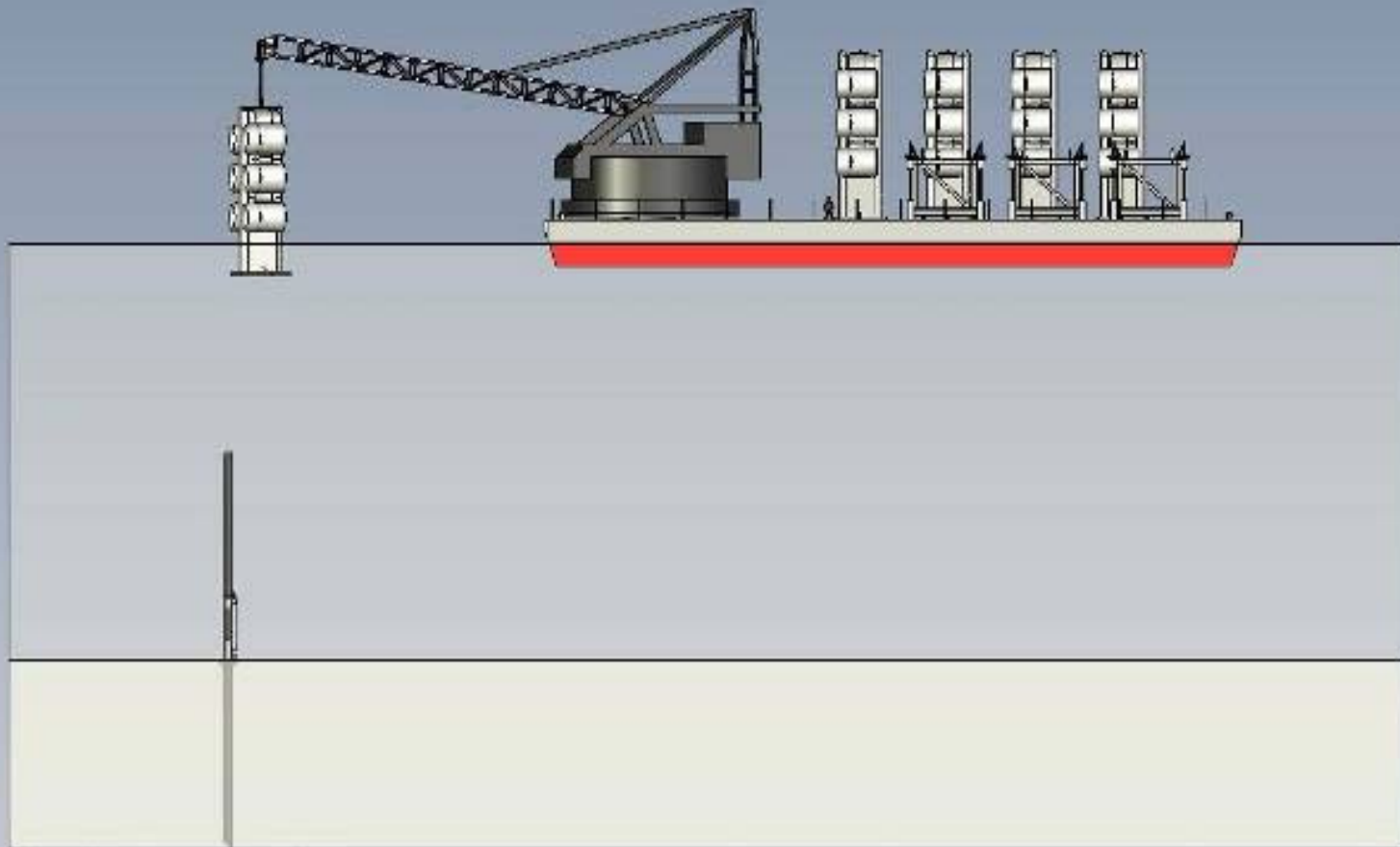
# Deployment Along the River



# Deployment on Bridge Piling



# Deployment and O&M Use Standard Marine Construction Techniques



# US Development Business



- Source of demand that can permit mass production of turbines
- Leading developer of **river** sites, which we prefer to tides or currents in the near term
  - One directional flow with lower fluctuation
  - Fresh water
  - Relatively easy shore access with proximity to infrastructure and consumers
  - Environmental issues well defined



# US Regulation Presents Challenge and Opportunity

- FERC preliminary permit
  - Exclusive priority in filing for License
  - 3 year term with FERC right to extend
- FERC License:
  - Exclusive right to develop with eminent domain
  - Term up to 50 years
  - May be revoked only for reasons contained in Federal Power Act or with consent of licensee



# FERC Policy Actions on Hydrokinetic Development

- 2005: “Verdant Order”
- 2/07: New hydrokinetic rules
- 7/07: Pilot hydrokinetic license
- 11/07: Conditional hydrokinetic licenses
- 12/07: First conditional pilot hydrokinetic project license





# Approach to US Projects

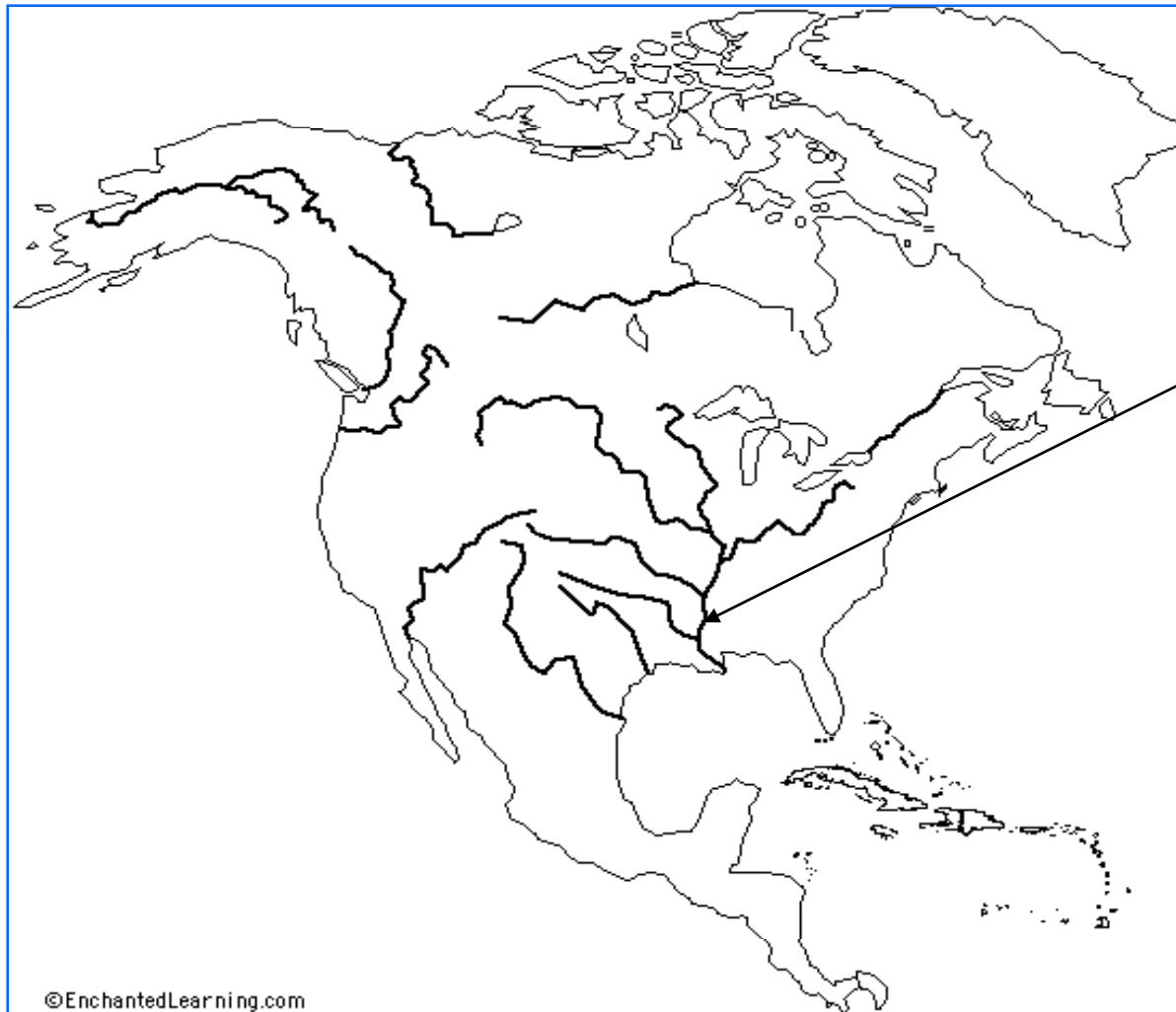
- Obtain FERC Permits to preserve priority
- Develop efficient licensing process
- Use Verdant Rule and Pilot Project Licenses for limited deployment and required studies
- Negotiate power sales with utilities and users
- Use project-supported debt and equity
- Deploy turbines
  - On a large scale (on pilings)
  - In controlled phases (we assume over 5 years)



# Permitting Strategy

- Screened 80,000 sites
- Sites selected for
  - Scale (1,000+ turbines)
  - No interference with navigation or other uses (projects less than 1% of site)
  - Proximity to large users or grid
  - Flow Speed (2 meters/second)
  - Licensing efficiency (few jurisdictions)

# Initial Focus on Mississippi River



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## Lower Mississippi

- Largest available source of river energy in North America
- Importance as navigational resource
  - Prevented prior hydro development
  - preserved availability for hydrokinetics

# Initial FERC Permits

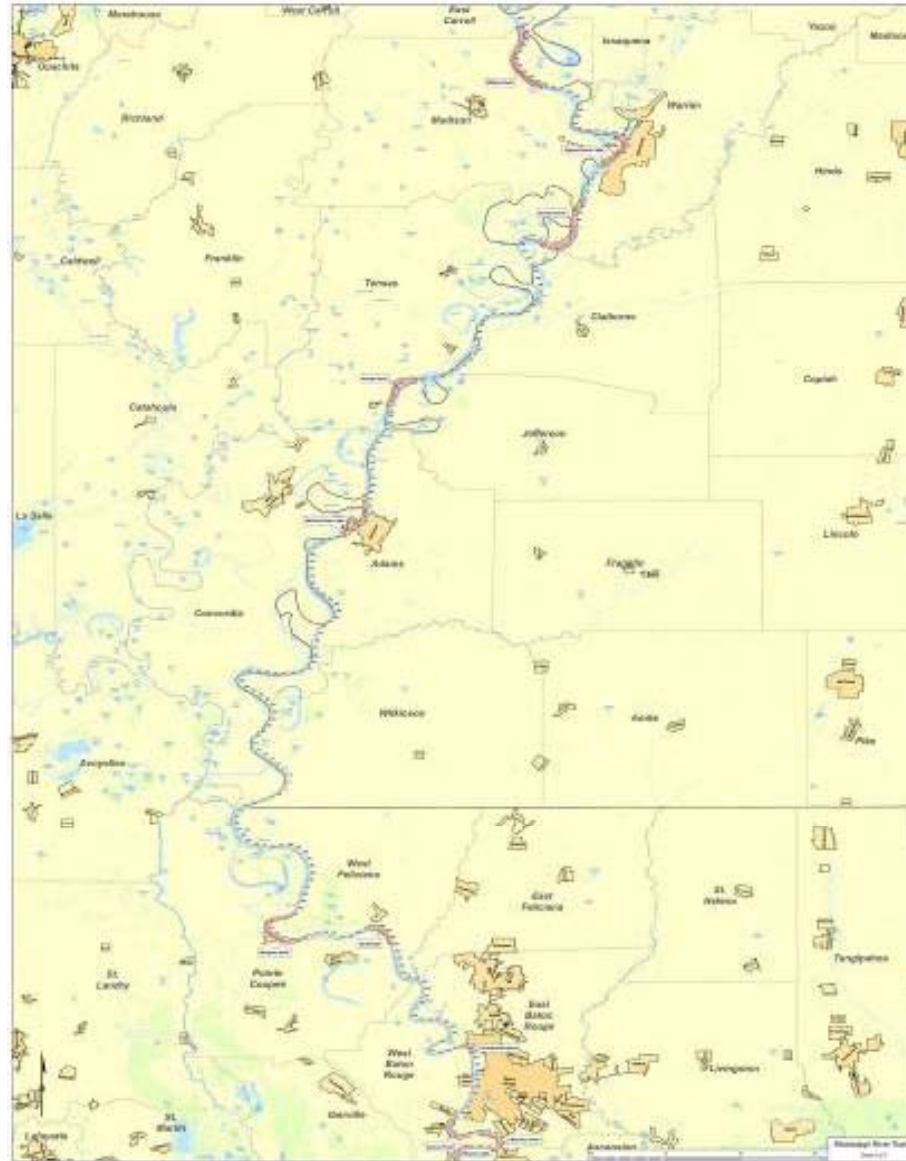


States	Permits Applied for/Pending	Permits Granted	Thousands of Turbines	Average Generation in MW
LA	30	28	61	607
LA / MS	6	5	21	210
AR / MS	5	5	23	226
AR / TN	4	4	18	181
TN / MO	2	2	6	63
MO / KY	4	4	14	138
MO / IL	8	7	17	171
MO	26	0	115	1152
MO/KS	1	0	4	38
KY/IL	5	0	16	159
KY/IN	17	0	40	401
<b>Total:</b>	<b>108</b>	<b>55</b>	<b>335</b>	<b>3,346</b>

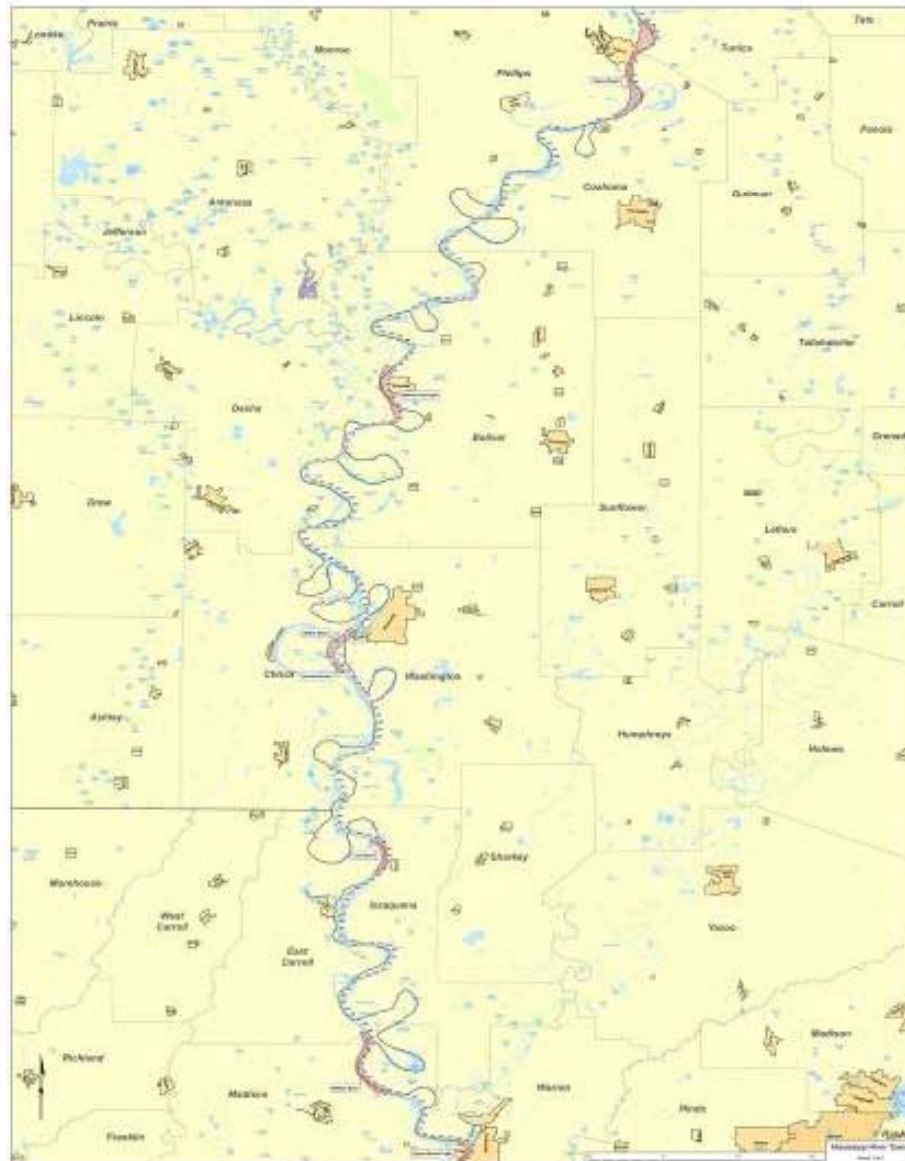
# Delta to Baton Rouge



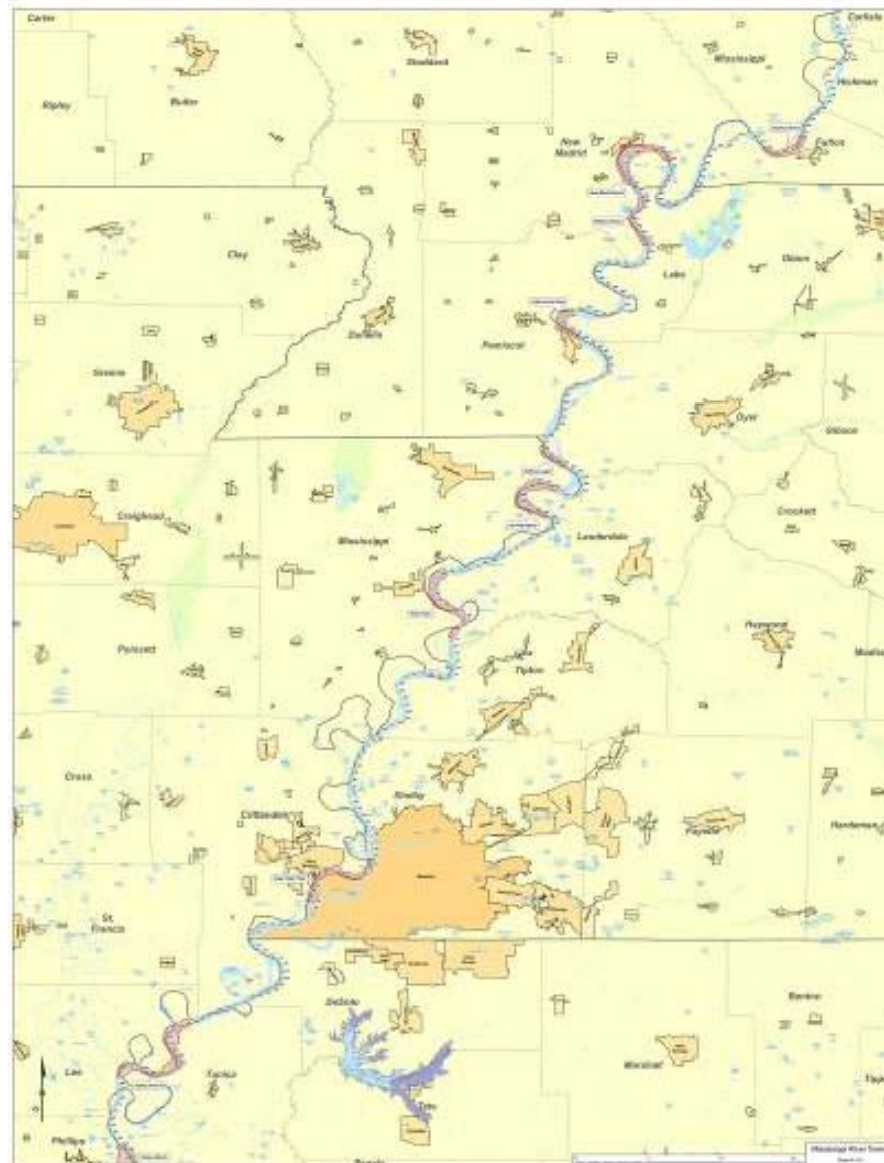
# Baton Rouge to Vicksburg



# Vicksburg to Helena

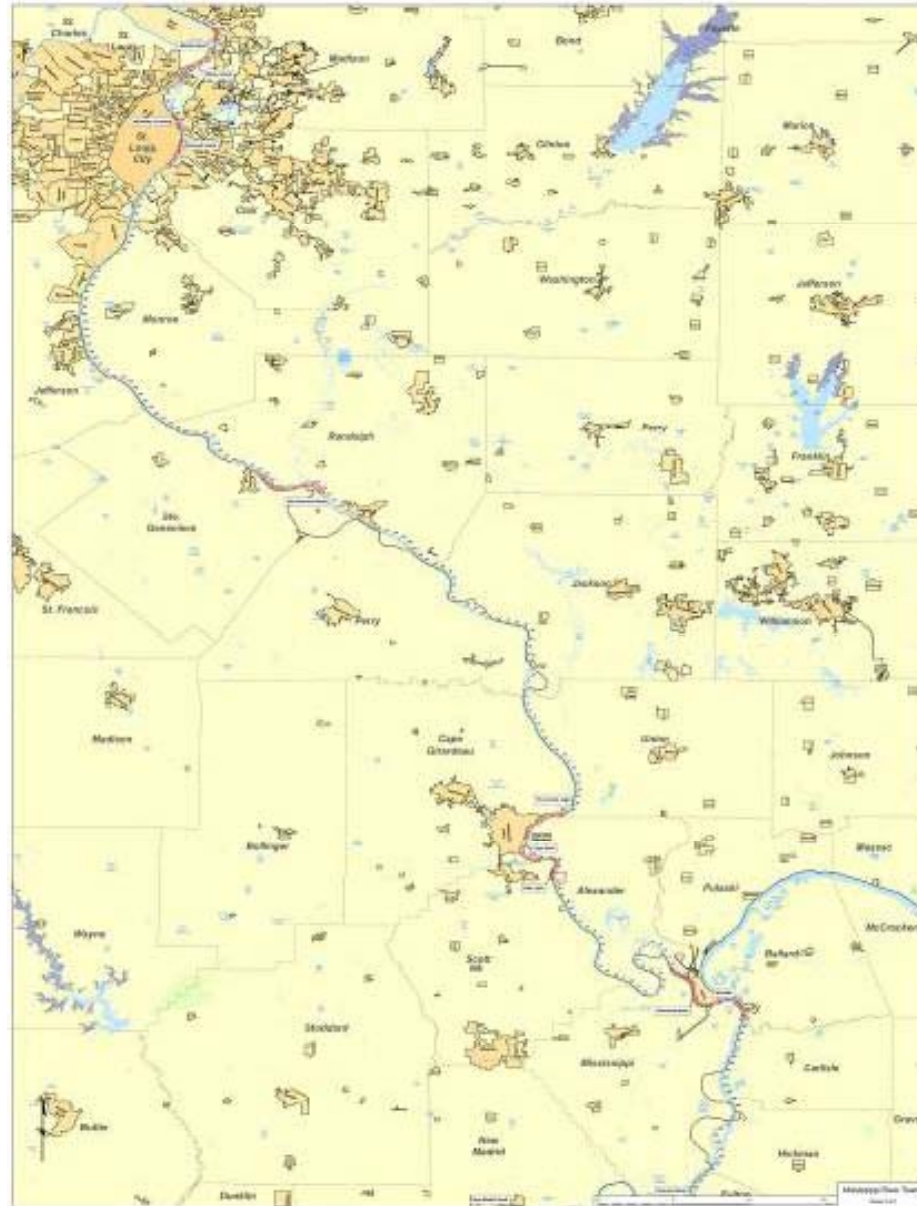


# Helena to Kentucky





# Kentucky to St. Louis





# FERC Licensing Process

- Considers concerns of many constituents
  - Governments and agencies (e.g. Army Corps, state EPAs, US Fish and Wildlife)
  - Non-governmental organizations (e.g. Nature Conservancy, Sierra Club)
  - Private interests (e.g. fishing industry)
- Licensing process being refined for hydrokinetics
- Financial projections assume process will take 5 years to ground-breaking



# Negotiating New License Process to Cut Cost and Time

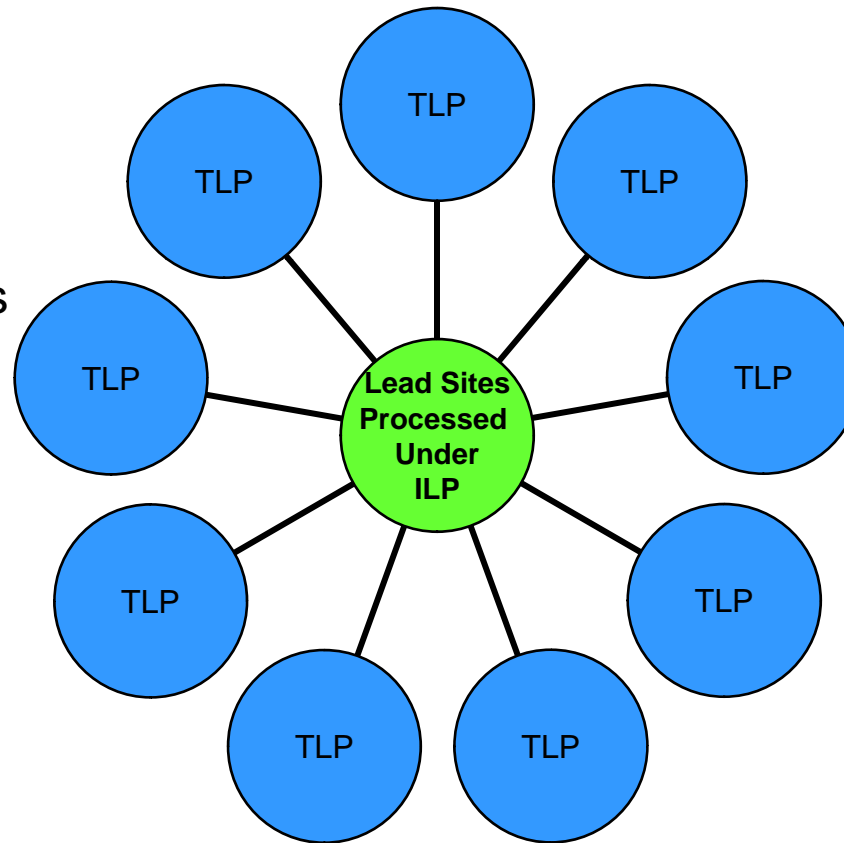
- “Lead Sites” use more rigid Integrated Licensing Process (“ILP”) to define issues, studies
- Other sites use Traditional Licensing Process (“TLP”)—faster once issues defined



# ILP/TLP Process

## ILP for Lead Site

- Orderly process
- All issues identified early in concrete context
- Template for processing of other sites



## TLP for Other Sites

- More streamlined process for multiple sites
- Less duplication of effort
- Flexibility to include or exclude specific sites



# ILP/TLP Approach

- Streamlines process and reduces cost
  - ILP forces negotiation of all issues up front
  - TLP allows rapid FERC approval, once issues have been defined
- Avoids unnecessary duplication of effort in processing sites with similar issues
- Allows studies for a single site to be used for other sites

# Renewable Energy Incentives



- Renewable Portfolio Standards drive market for Renewable Energy Certificates (RECs)
  - 20 states require between 4% and 24% of generation from renewable energy
  - National renewable portfolio standards being considered
  - RECs in Northeast trade at 4-6 cents/kWh
- Revision of PTC to cover all hydrokinetics would have major impact (passed by House and Senate)



# Why Now

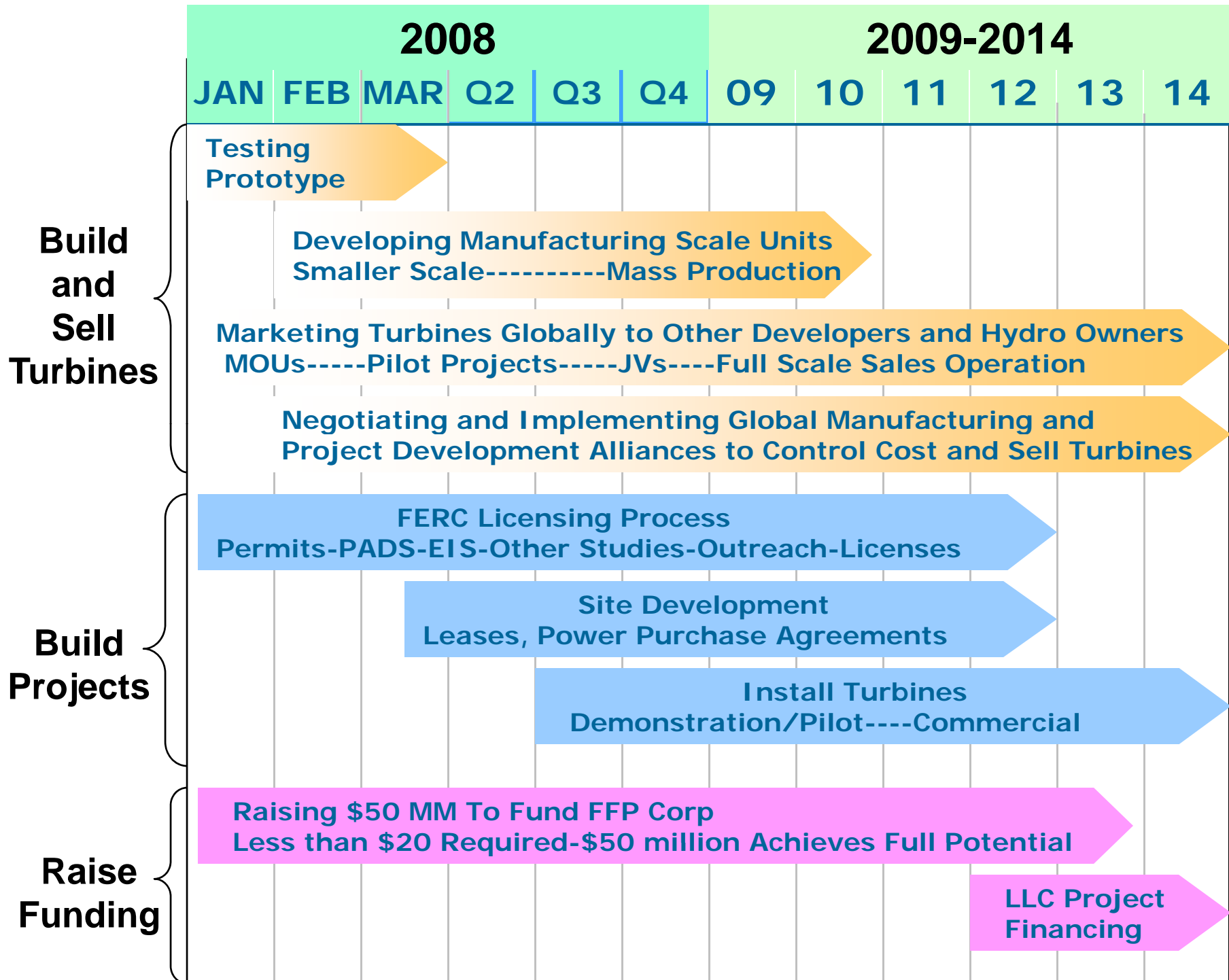
- Public policies favoring clean renewable energy
- Limitations on conventional hydro
- Navigational role of big river systems
  - prevented further damming
  - preserved availability for hydrokinetic generation
- Improvements in manufacturing techniques for light-weight, high-strength plastics and composites
- Greater availability of rare earth magnets
- Separation of electric generation from distribution
- Advances in project financing and securitization pioneered by wind developers

# Summary of Progress

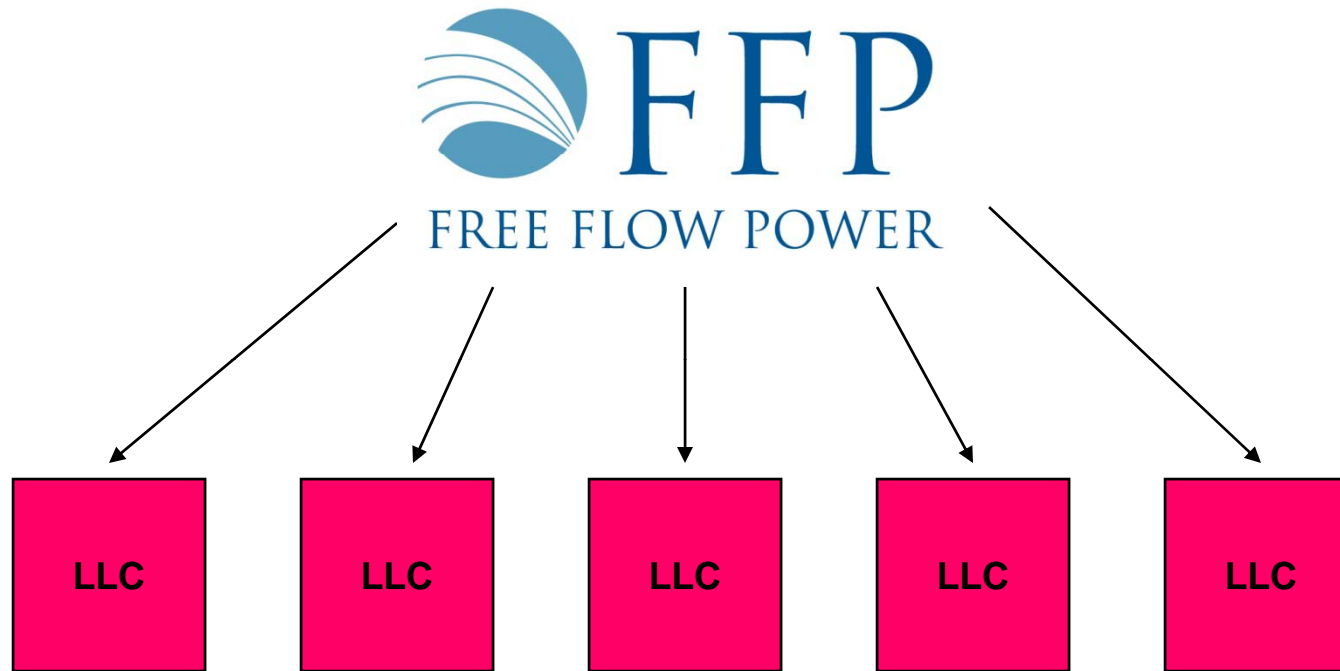


- Fully functional prototype turbine generator for free flow application
- 55 FERC permits granted on the Mississippi River confirming priority in applying for FERC licenses to deploy over 1,500 MW
- Negotiated new approach to licensing with FERC and resource agencies to cut time and cost
- Pilot projects in New York and Massachusetts:
  - Memorandum of Understanding with Holyoke Gas & Electric
  - negotiating partnership arrangements with a large industrial company and a large hydro owner
- Additional permits in process for Missouri and Ohio Rivers



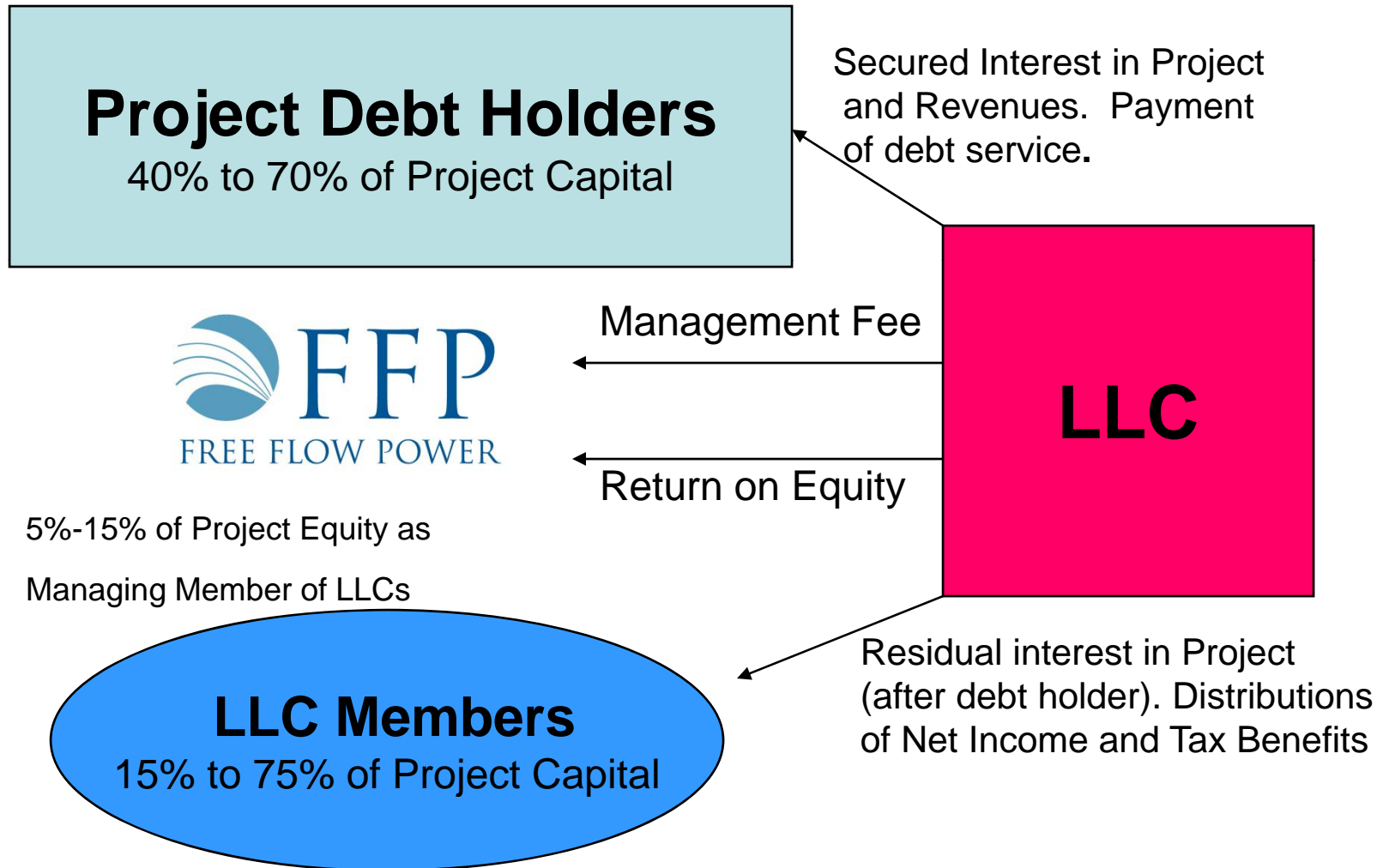


# Project Finance Model

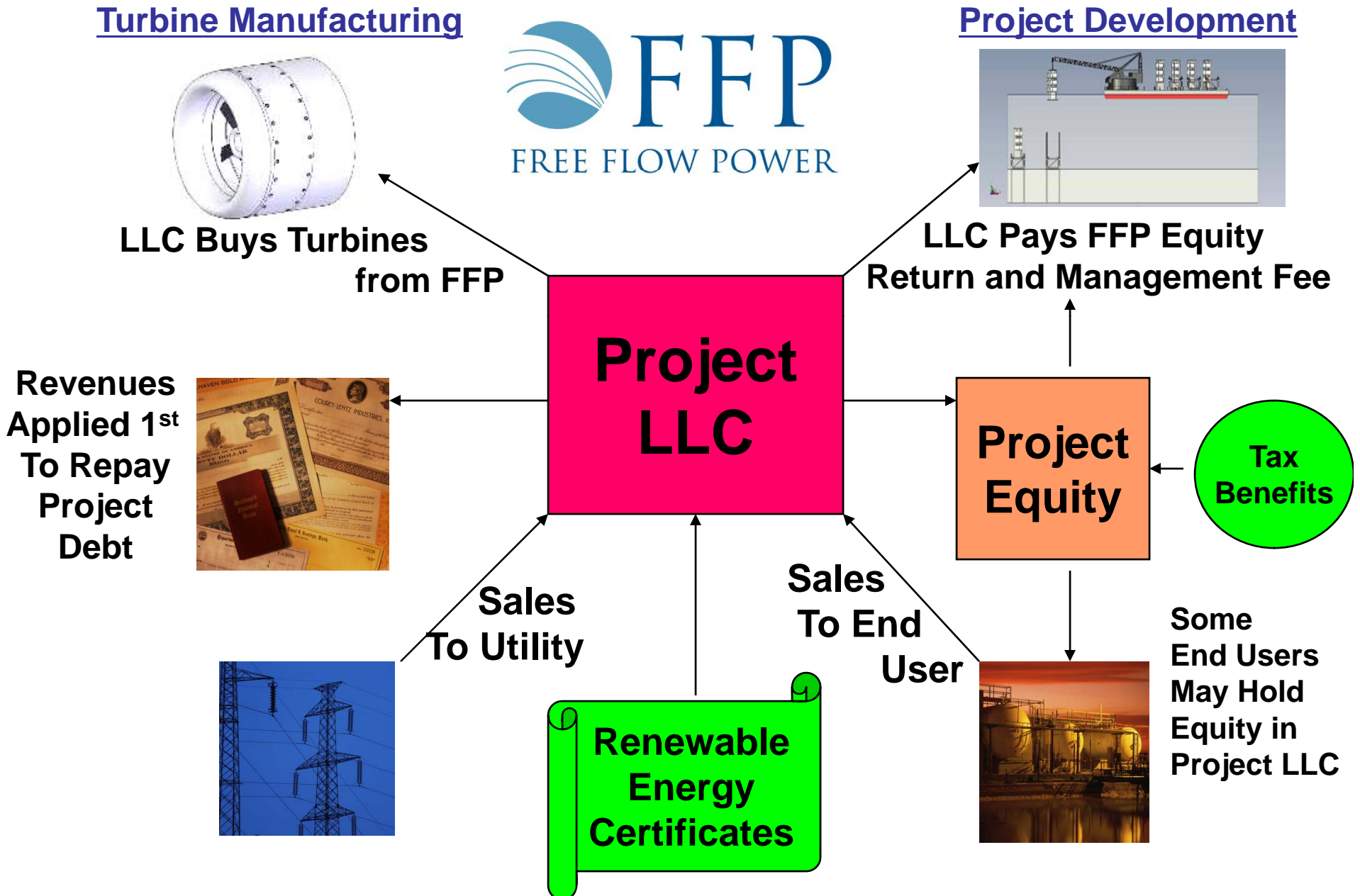


- FFP Invests Equity in each LLC as managing member
- FFP Earns Management Fees and Return on Equity
- FFP sells turbines to each LLC

# Project Finance Model



# Project Financing and Revenue Model





# Summary

- Minimal environmental impact
  - Underwater: Invisible and no noise
  - Plastic parts: No corrosion
  - Hydrodynamic bearings: No lubricants to leak
  - Sites are a very small part of the river area/volume
- Cost effective
  - Mass-produced small turbine
  - O&M figured in, standard techniques
  - Competitive with fossil fuels
- Path to Scale
  - Pilot projects
  - Medium volume manufacturing
  - Manufacturing Alliances
  - Project debt/equity finance model

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