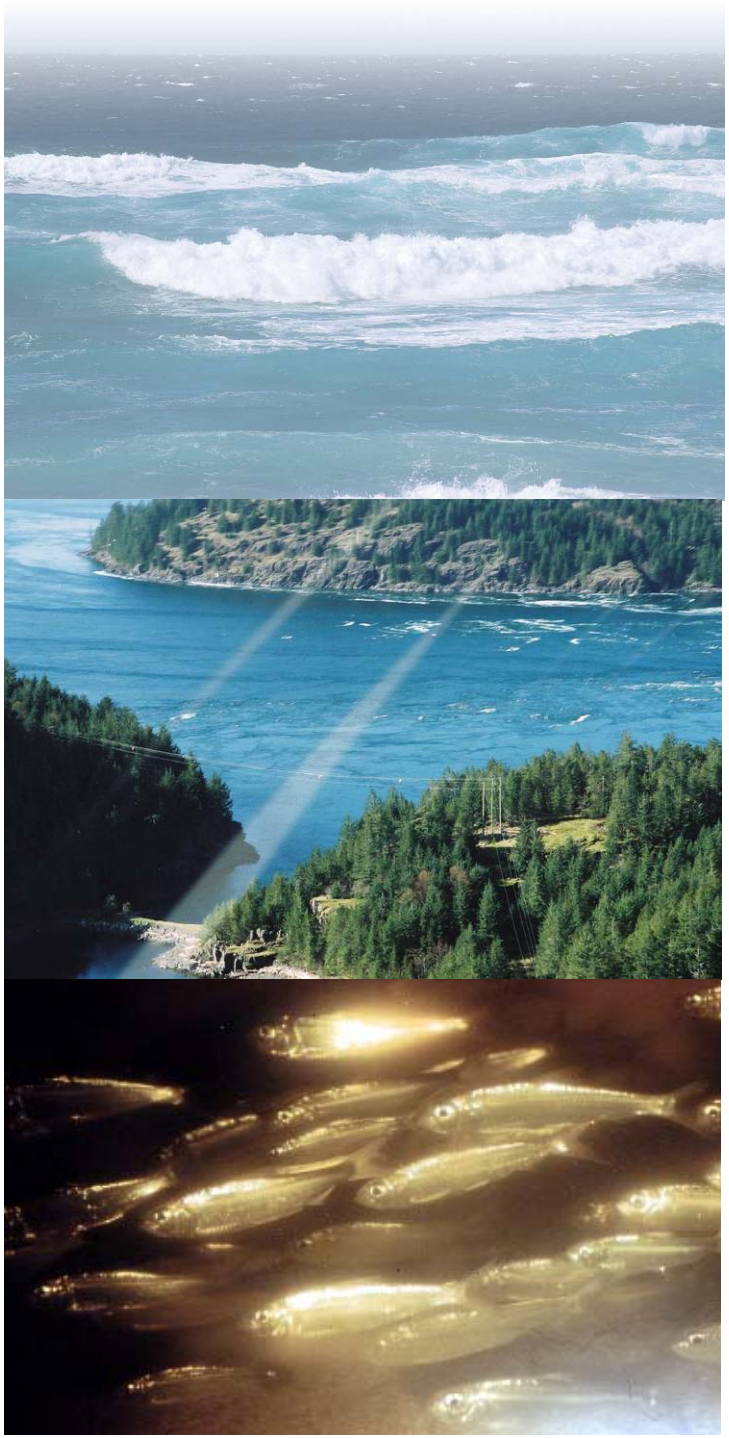

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Fish and the Energy Industry:

How energy companies go about projects that may have impacts on fish

Douglas A. Dixon, Ph.D.

Program Manager, Fish Protection Research Programs

ASMFC Energy Development Workshop

October 24, 2006

Overview of Presentation

- EPRI Organization & Mission
- EPRI Fish Protection Programs
  - Scope & products
- EPRI Ocean Energy Program
  - Scope
  - Technologies
  - Environmental impact assessment
- Industry concerns

EPRI Overview

- Non-profit research institution
- Research addresses generation, transmission, distribution, and environmental issues associated with electricity generation
- ~95% of funding comes from the electric power industry
  - ~ 100 research areas
- Fund research & development to universities, national labs, federal-state-local government, and private consultants
- Environmental research in air, global climate, surface water, EMF, and land & groundwater

EPRI Fish-Related Research Programs

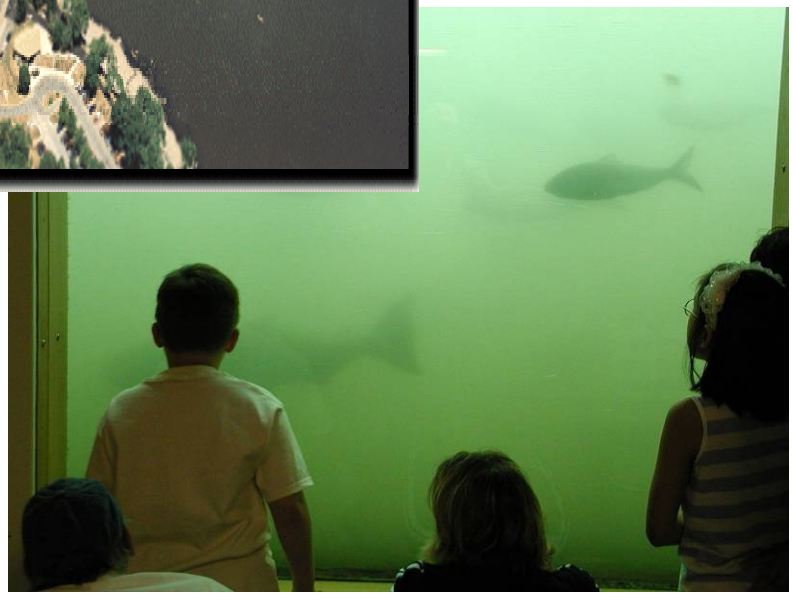
- Water-related research programs for effluent guidelines, TMDLs, water sustainability, and mercury, metals and organics
- **Clean Water Act Section 316 Fish Protection Program**
- **Hydropower Environmental Issues Program**
- **Ocean/Tidal/Instream Energy Research Program**

Clean Water Act §316(a&B) Program Scope

Empirical research, tool development and information summary and synthesis for impingement and entrainment and thermal discharge, e.g.;

- Evaluation of screen performance
- Evaluation of strobe lights & acoustics systems for repelling fish at water intakes
- Methods for impingement & entrainment sampling

EPRI Hydropower Program Scope



Empirical research, tool development and information summary and synthesis for minimizing impacts on fish & wildlife, e.g.;

- Assessment of sturgeon guidance by an angled louver array
- Synthesis of American eel life history, hydro impacts & mitigation methods
- Quantitative & qualitative Instream flow methods

EPRI Example Products

EPRI Member Reports:

- EPRI-web-based upstream & downstream fish passage manual
- Design Considerations and Specifications for Fish Barrier Net Deployment at Cooling Water Intake Structures

Public/Professional Literature Products:

- Biology, Management, and Protection of Catadromous Eels (D. Dixon, editor, AFS 2003)
- Data, Models, and Decisions in US Marine Fisheries Management: Lessons for Ecologists. Rose & Cowan. 2003. *Annu. Rev. Ecol. Evol. Syst.* 2003. 34:127–51
- **EPRI Ocean/Tidal Energy Assessment Studies (www.epri.com/oceanenergy/)**

EPRI Ocean Energy Program (Public-Private Collaborative)

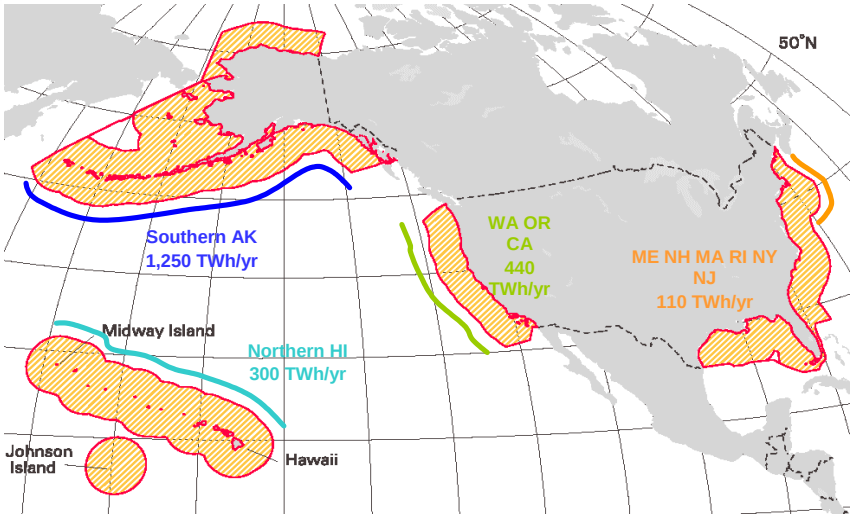
Wave Energy Conversion Program (with ME, MA, CA, OR, WA, HI and DOE-NREL)

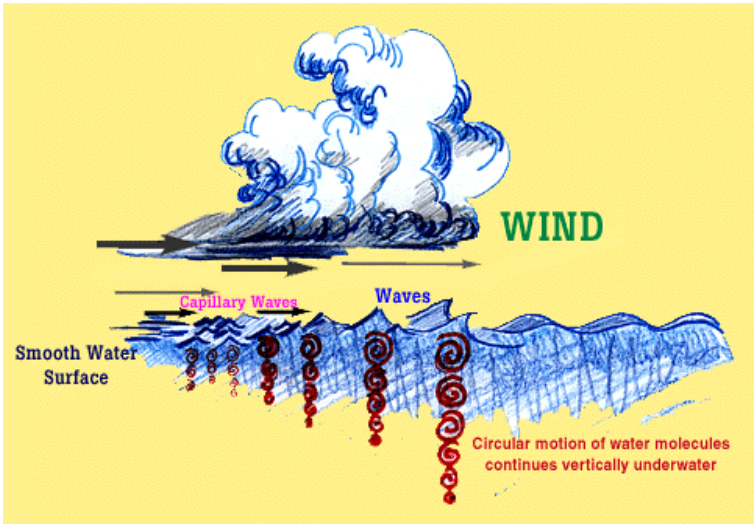
- Assess & demonstrate feasibility (efficient, reliable, environmental-friendly, cost-effective)
- Create push toward commercialization

Tidal Energy Conversion Program

- Same objectives

Significant Wave & Tidal Energy Resource in the U.S.





- **EPRI Ocean Energy Assessments available at www.epri.com/oceanenergy/**
- Renewable
- Carbon-free
- Domestic

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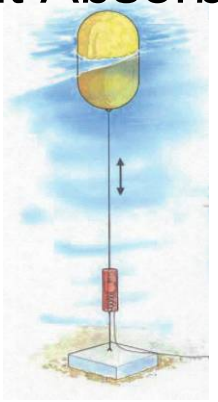
Electricity Supply – Big Picture

Harnessing 25% of offshore wave energy resource at 50% efficiency would be comparable to all US conventional hydro generation in 2006

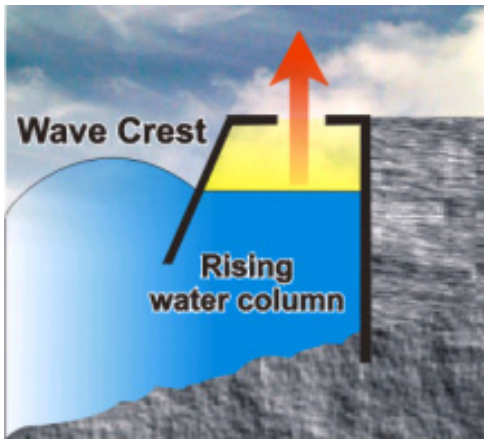
Fuel Type	%
Coal	50%
Nuclear	20%
Natural Gas	18%
Hydroelectric	7%
Fuel Oil	2%
Biomass	2%
Geothermal	1%
Wind	<1/2%
Solar PV	<1/20%

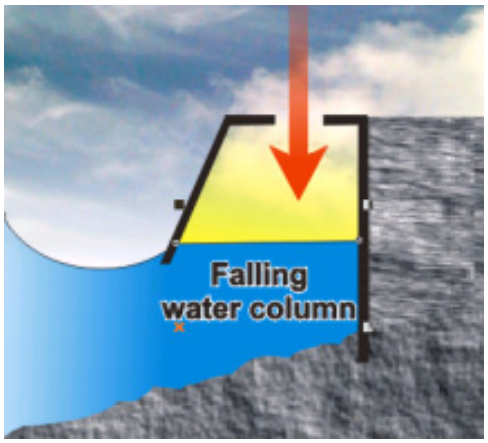
4 Primary Types of Wave Energy Conversion

Point Absorber

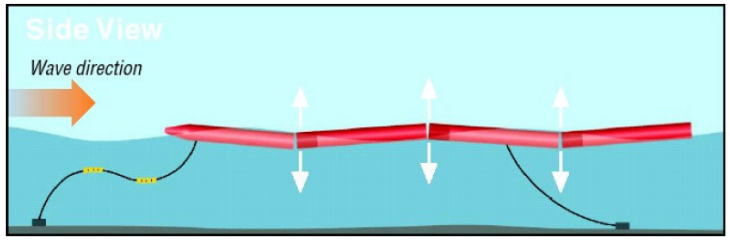


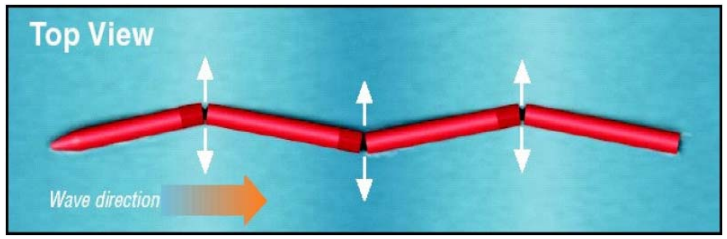
Terminator- Oscillating Water Column





Attenuator

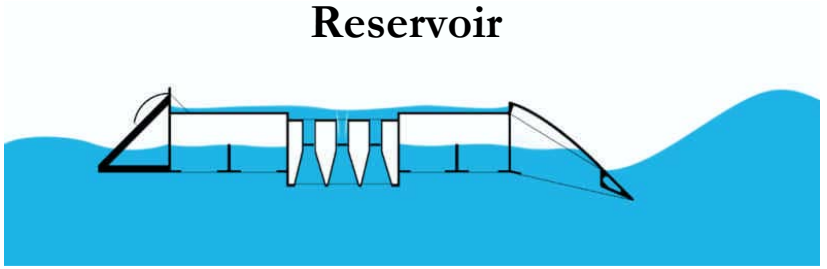




Overtopping

Waves overtopping the ramp

Reservoir



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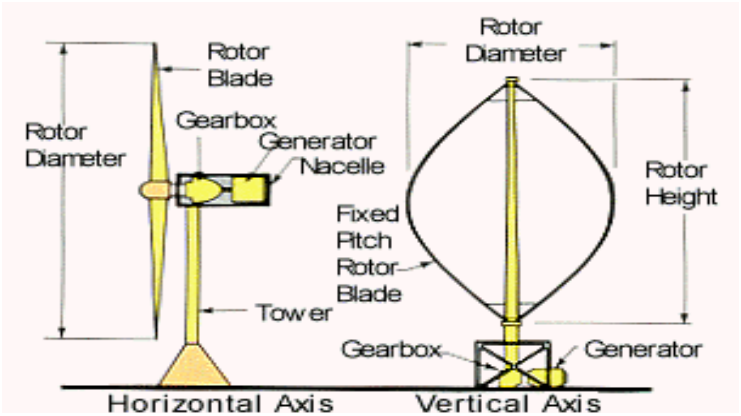
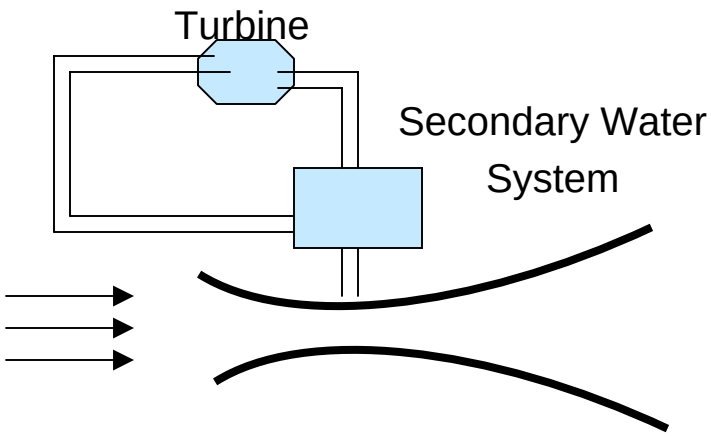
Four Primary Types of In Stream Tidal Flow Energy Conversion Devices (TISECs)

Horizontal Axis Turbines

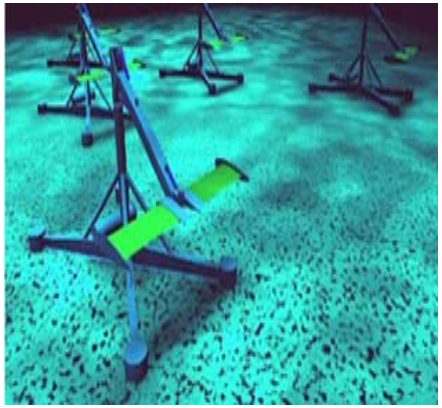
Vertical Axis Turbine



Venturi



Oscillatory



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Environmental Issues Considered

- Withdrawal of wave energy
- Interactions with marine life and seabirds
- Atmospheric and oceanic emissions
- Interactions with coastal sedimentary processes
- Visual appearance and noise
- Potential conflicts with other uses of sea space
- Installation and decommissioning

Environmental Issues Considered (cont'd)

- Physical effects - associated with direct harm
- Behavioral effects - associated with changing behavior
- Impacts avoided (i.e., placing impacts in context of impacts associated with other forms of energy production)
- Life-cycle impacts (from manufacture of components, installation, operation and servicing, and decommissioning)

Impact Assessment Process

Desktop analyses:

- Few direct empirical studies
- Synthesize & extrapolate information from multiple sources (e.g., hydropower, oil & gas industry, dredging, fish-shellfish-marine mammal-seabird life history information)

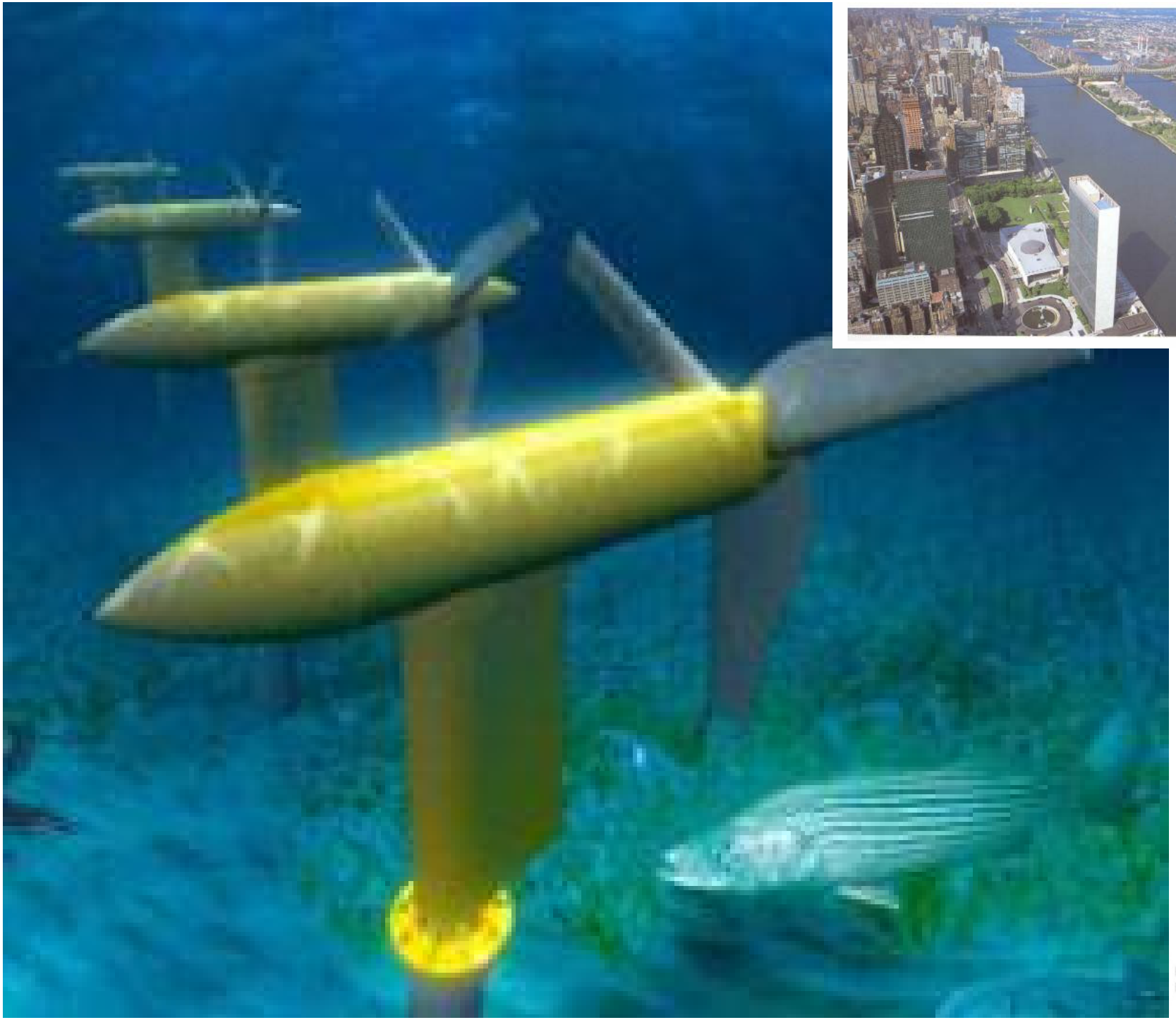
Adaptively managed empirical studies would greatly increase the data base of information

Generic Impact Assessment Results

- Impacts relatively benign and can be managed – comparable to cable installation, buoy mooring, off-shore structures
- Direct operational emissions relatively minor/non-existent
- Minor physical harm from operational structures
- Some impacts can be viewed positively – habitat creation
- Visual/aesthetic – depend on location & device type
- Interaction with coastal sedimentary processes – possibly significant only for shoreline proximal units
- Conflict with other uses – can be managed with dialog
- **Carbon-free, domestic, renewable**

Verdant RITE Project Timeline

- 2000 – initial project engineering
- 2001 – initial proposal to NYSDEC, Army Corps, FERC
- 2002 – barge mounted pilot study
- 2002-2006 – agency consultation & permits acquisition
- 2006 – pilot project (6 turbines)
- Next 18 months – environmental & engineering evaluation



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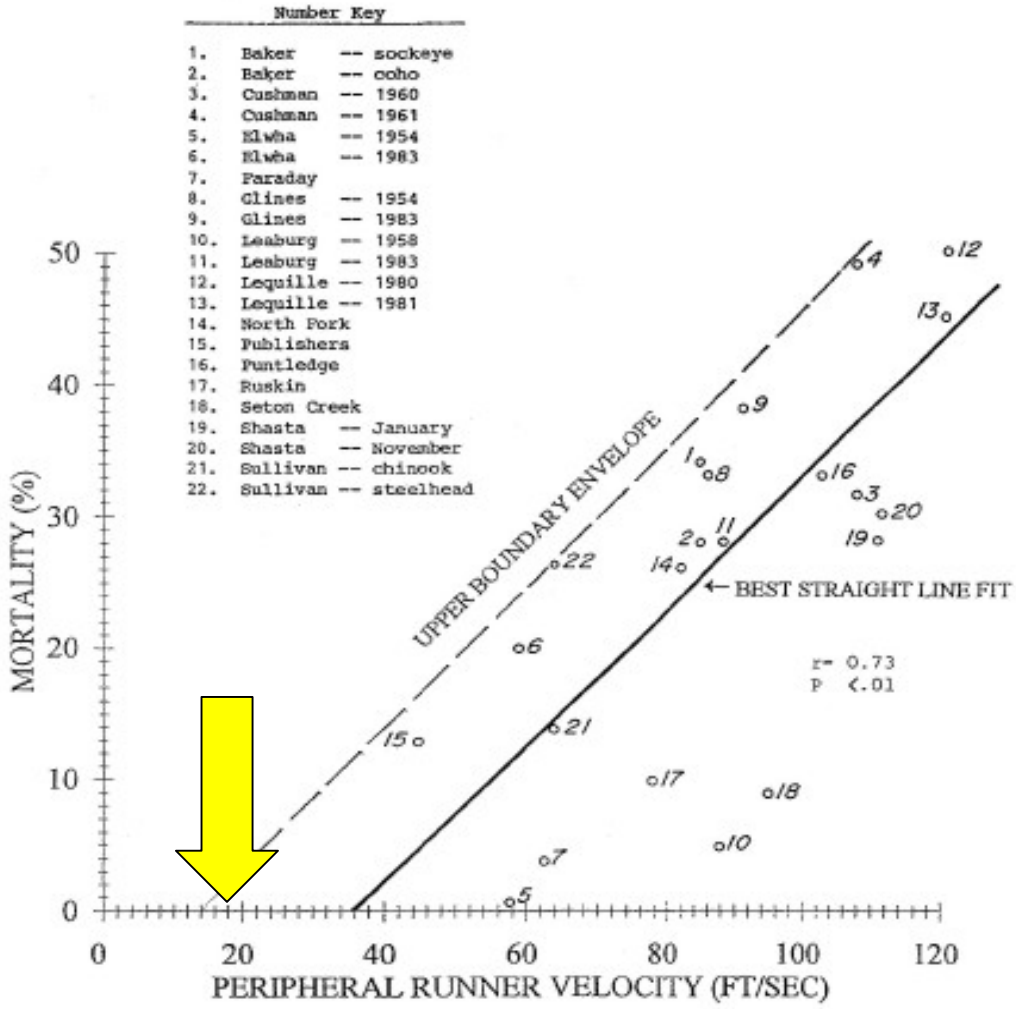


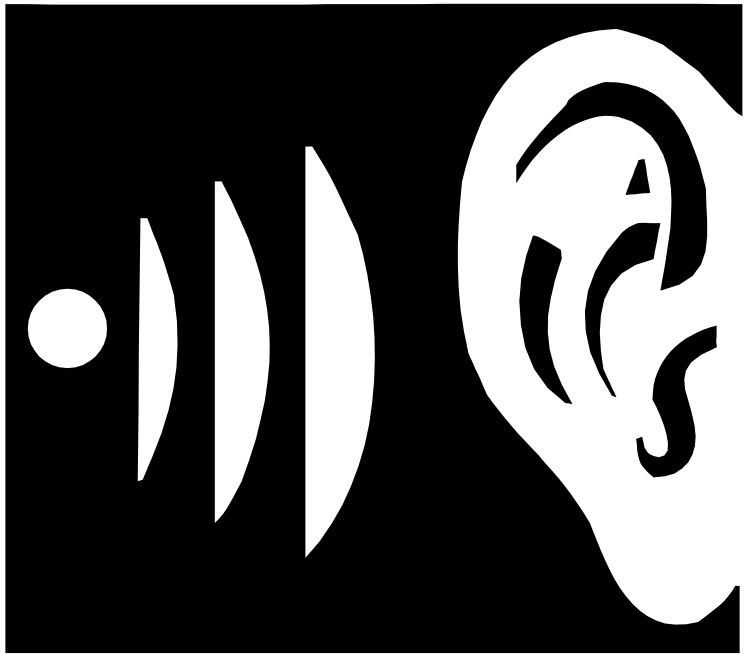
Figure 2-8
Relationship of Peripheral Runner Velocity to Mortality for Francis Turbines, Source: Adapted from COE 1991

Blade Tip Speeds:

- **Outboard: 40-196 fps**
- **Inboard: 52-262 fps**
- **Tug boat: 125 fps**
- **Merchant ship: 25-53 fps**
- **Aircraft carrier: ~110 fps**
- **Hydropower turbine: 20-100 fps**
- **Verdant turbine: 15-25 fps**

What Do I Hear from Industry?

- Minimal government R&D support
- Time consuming regulatory process
- Multiple permitting/regulatory authorities
- **Extreme & unbalanced expectations for environmental protection & certainty**
- Lack of flexibility



EPRI Perspective

- Wave and In Stream Tidal Energy and Other Ocean Energy Sources are potentially important energy sources and should be evaluated for adding to our energy supply portfolios
  - Indigenous– keep the wealth at home and increase energy security
- A balanced and diversified portfolio of energy supply options is the foundation of a reliable and robust electrical system
- Clean, no greenhouse gases and no aesthetic issues
- Economics appear to be close to other options

A small investment today might stimulate a worldwide industry which may employ thousands of people and generate billions of dollars of economic output while using an abundant and clean natural resource. It is worth taking a serious look at whether this technology should be added to our portfolio of energy supply options

Need EPRI Information?

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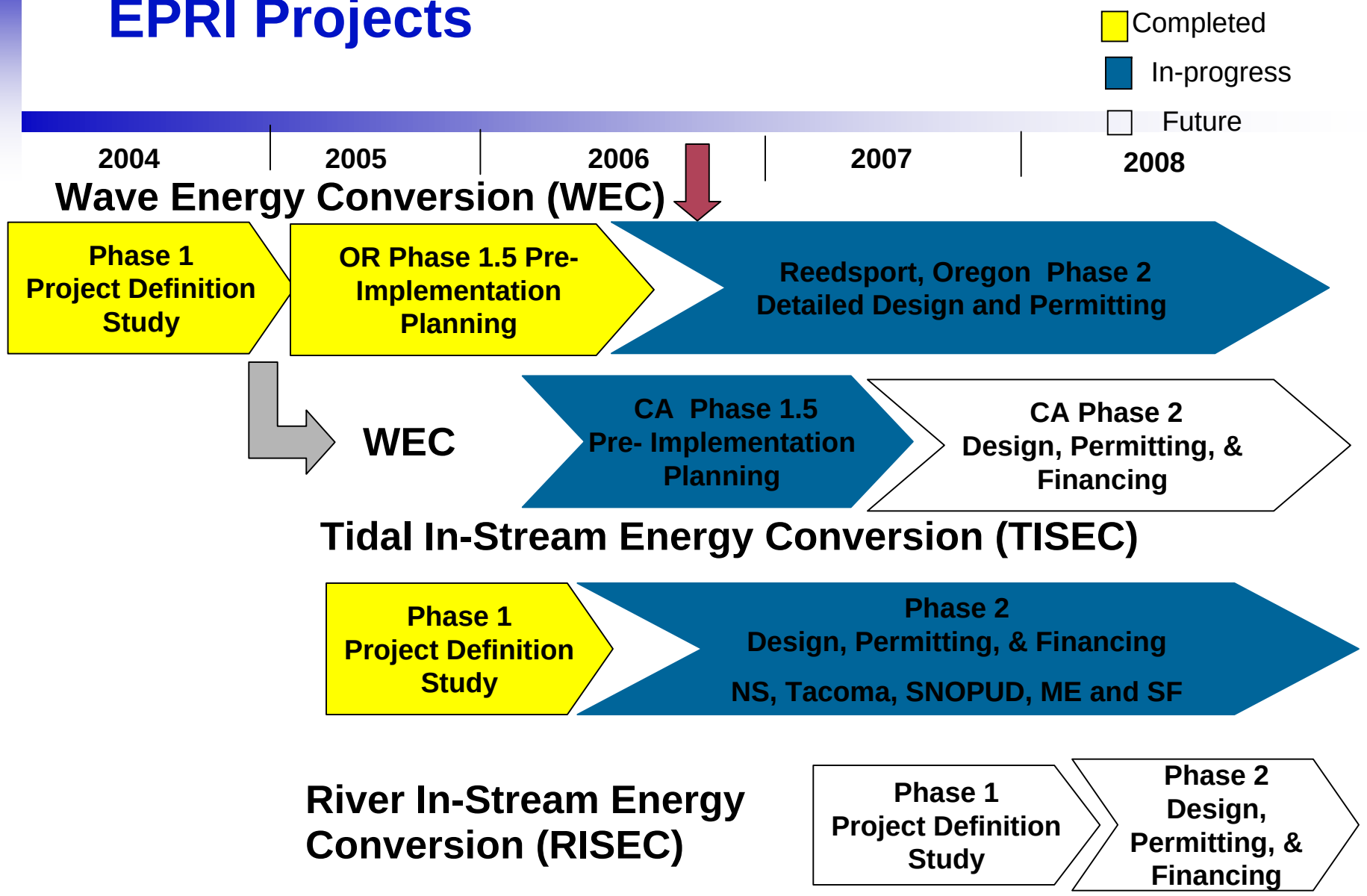
EPRI Projects



Examples of Wave Energy Devices (WECs)

Point Absorber (Ocean Power Technologies PowerBuoy™)

Terminator (Energetech Oscillating Water Column)

Attenuator (OPD Pelamis)

Overtopping (Wave Dragon)

Examples of Tidal Stream Technology

Horizontal Axis – Verdant Power

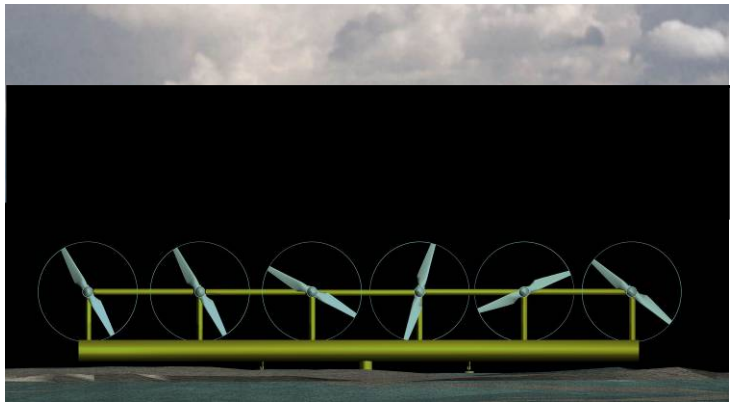
Vertical Axis
- Gorlov

Venturi

Oscillatory - Engineering Business Stingray

EPRI Ongoing Collaboration: Golden Gate, San Francisco, CA

Golden Gate Bridge



View from Baker Beach