Annex XXIV

Integration of Wind and Hydropower Systems

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Progress Report to ExCo 56, Lucerne, Switzerland

Progress Report

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- Review: Objectives and Means
- Conceptual View
- Progress since ExCo 55
- Members & Contributions
- Collaboration with Hydro IA
- Schedule
- Budget
- Actions

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Review – Annex Objectives

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- Establishment of an *international forum for exchange of knowledge, ideas, and experiences* related to the integration of wind and hydropower technologies.
- *Share information* concerning grid integration, transmission, hydrological and hydropower impacts, markets and economics, and simplified modeling.
- *Identify technically and economically feasible system configurations* for integrating wind and hydropower.
- *Database of case studies* conducted through cooperative research of the Annex

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Review – Means to Achieve Objectives

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- Share research methods and results from projects on-going in member countries, as related to the proposed annex research areas:
  - Grid Integration Case Studies
  - Hydrologic Impact Case Studies
  - Market and Economic Case Studies
  - Simplified Modeling of Wind-Hydro Integration Potential

- Collaborate and critique analysis methods and interpretation of results.

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Wind Plant Variability & The System Operator

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- What the system operator wants:

  Firm, dispatchable energy resources

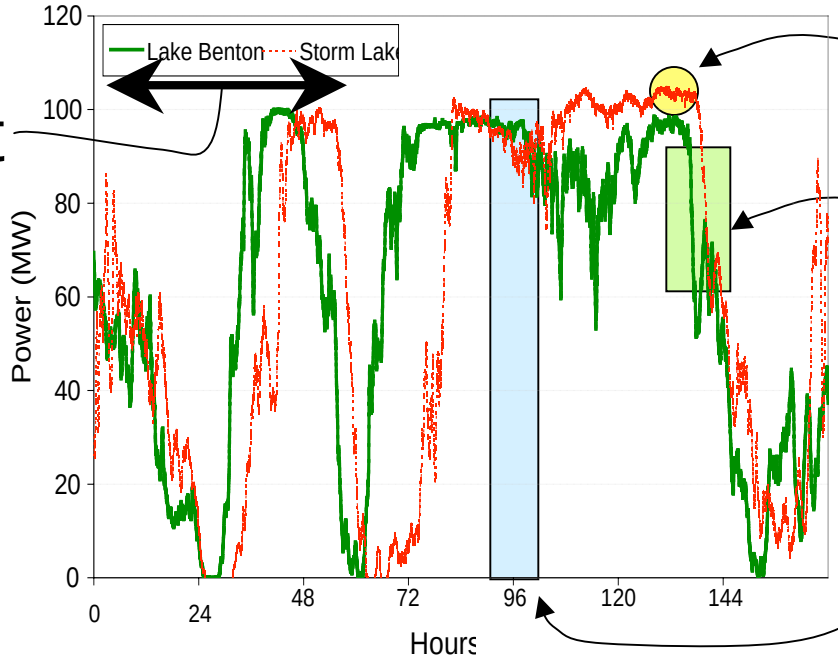
- What wind provides:

  Natural variability, short-term predictability

Unit Commitment

Are these variations significant?

Depends on the system & load



Regulation

Load Following

Storage

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Hydro Plant Output & The System Operator

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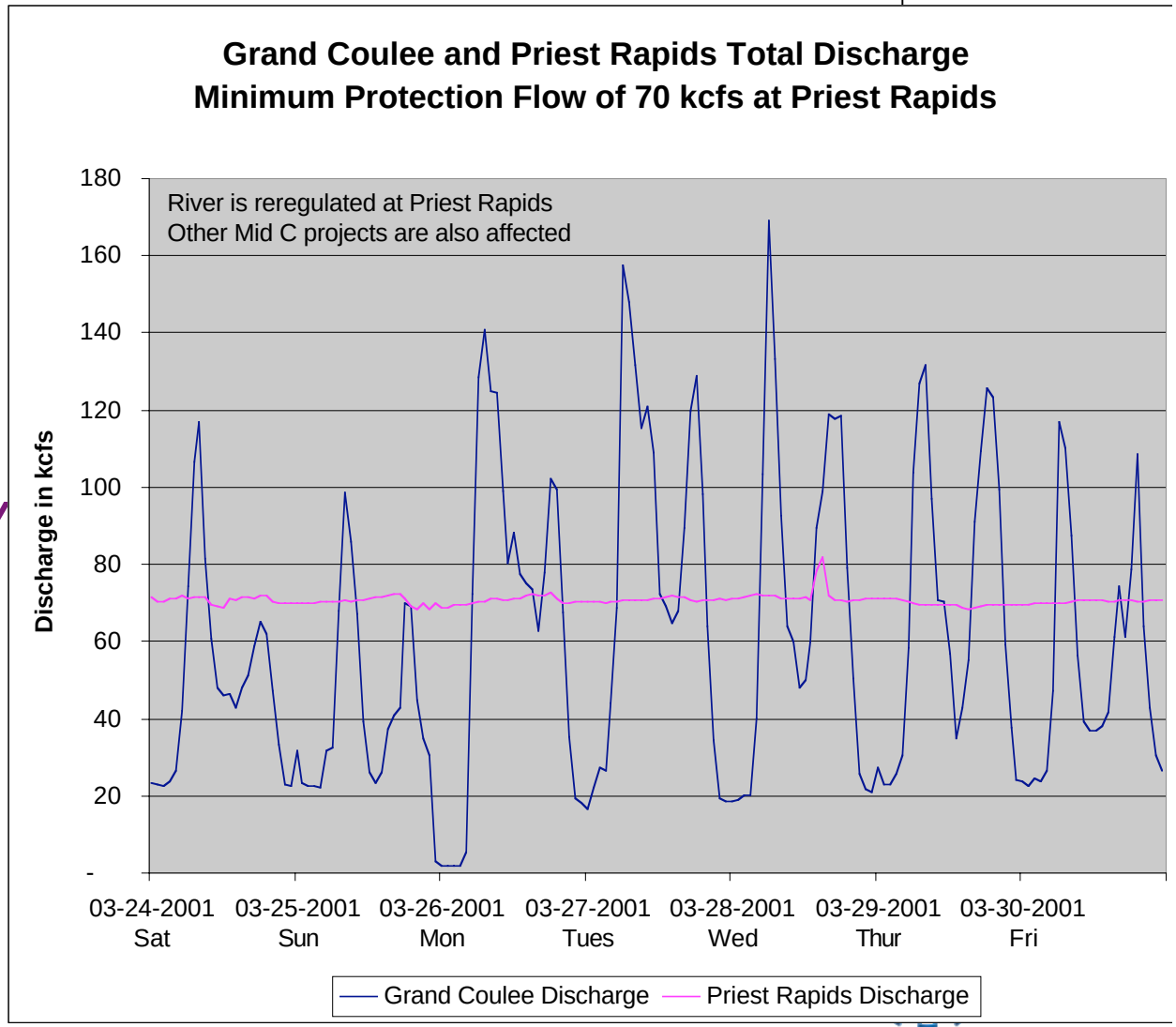
- What hydro provides:

  Dispatchable, Low cost, Mid- to Long-term variability, Seasonal and daily flow constraints

- Project specific characteristics



Source: Grant County PUD

Conceptual View

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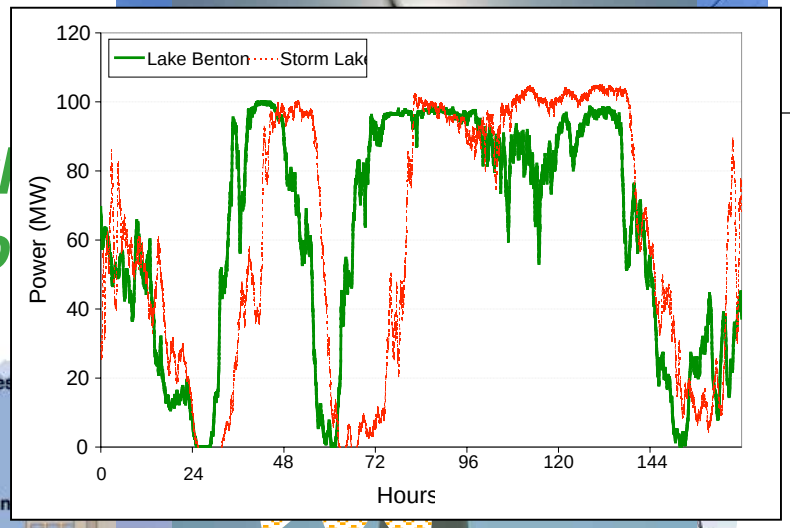

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Econo

Laws ,Regulations, Hydrology

Hydro Facility

Hydrologic Operations & Priorities

Hydropower Operation

Need for Ancillary Services

Opportunity to store resources

Wind Plant ***scheduled*** **by nature**

Ancillary services

Power to grid

Power to grid

Transmission Control Area

Loads, Generation, Reliability

Organizations /Stakeholders

Agreements and

Progress since ExCo 55, May 2005

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- Planned *R&D Meeting #1*; Friday, Sept. 30.
- Commitment letters received from all seven member countries.
- Web site initiated; currently building site
- Country contributions received from members; Article 6 of Annex proposal is complete
- Several participant case studies initiated
- Initiation of the "*Matrix*" – consistent formulation for project study and comparison

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Annex Members

Country	Contracting Party	Participant
Australia	Australia Wind Energy Assoc.	Hydro Tasmania
Canada	Natural Resources Canada	Natural Resources Canada Manitoba Hydro
Finland	TEKES National Technology Agency in Finland	VTT Processes
Norway	Norwegian Water Resources and Energy Directorate	Sintef Energy Research
Sweden	Swedish Energy Agency	KTH Swedish Institute of Technology
Switzerland	Swiss Federal Office of Energy	EW Ursern
United States	U.S. Department of Energy	National Renewable Energy Laboratory Arizona Power Authority Bonneville Power Administration Grant County Public Utility District GE Global Research Sacramento Municipal Utility District

IEA IA Ocean Energy Systems Interested in Joining

Country Contributions

Country	Effort (man-months/year)	Grid Integration Case Studies	Hydrologic Case Studies	Economic and Market Case Studies	Simplified Modeling	Comments
Australia	6	x	x	x	x	Three to five studies
Canada	4.5	x	x	x		Two studies plus RETScreen
Finland	4-6	x		x	x	Three studies
Norway	6	x	x	x	x	Two studies
Sweden	2-4	x		x		Four studies
Switzerland	3-4	x		x		Two to four studies
USA	6-12	x	x	x	x	Three or more studies

Collaboration with Hydro IA

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- IEA Hydropower IA "twin" Annex X
  - "Integration of Hydropower and Wind Systems"
  - Status: Proposed
- Similar objectives, but different emphasis on outcomes:
  - Wind IA Annex – increase penetration of wind energy
  - Hydro IA Annex – increase value of and opportunities for hydropower
- Current – Meet jointly, share projects & discussions, and formulate consistent outcomes

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Schedule

Activity	2004	2005	2006	2007	2008
Approved in-Principle	May UK				
R&D Report at ExCo	October Finland	Sept. Switz.	Sept. Aust.	TBD	
Kickoff Meeting		Feb. USA			
Execute work plan		Sept. Switz.	Sept. Aust.	R&D; meet	R&D; meet ?
Final Report to ExCo					May –report

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Related Publications

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- Söder, Lennart, "Modelling approach impact on estimation of integration cost of wind power," 7th IAEE European Energy Conference European Energy Markets in Transition, The Norwegian School of Economics and Business Administration NHH, Bergen, Norway, August 28–30th, 2005.

- Acker, Thomas L., "Synthesizing Wind and Hydropower: Opportunities and Challenges," Proceedings of the Waterpower XIV Conference, Austin, TX, USA, July 18-22, 2005.

- Acker, Thomas L., "Characterization of Wind and Hydropower in the USA," Proceedings of the Windpower 2005 Conference, Denver, CO, USA, May 16-18, 2005.

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Budget

- Invoices issued to each member country

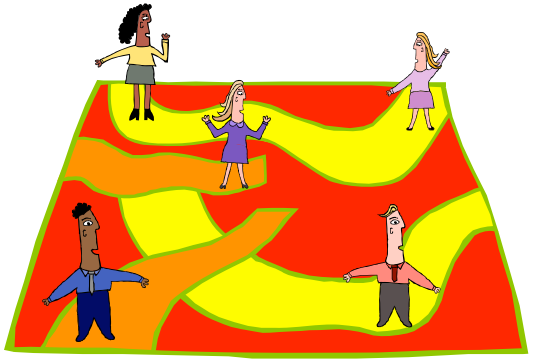
  7 countries: US $5,476 / year / country (Euro ~ 4190)

Estimated Expenses of the Operating Agent – Years 2, 3, & 4

Item	Per Year (US$)	Total (US$)
Coordination & management including meetings; 1.33 person-months/year	33,000	99,000
Travel, hotel, sustenance (2 meeting per year: one ExCo, one research participants)	4,000	12,000
Preparing proceedings, publication		4,000
Expected Year 1 Cost of Annex		38,333
Expected Total Cost of Annex		115,000

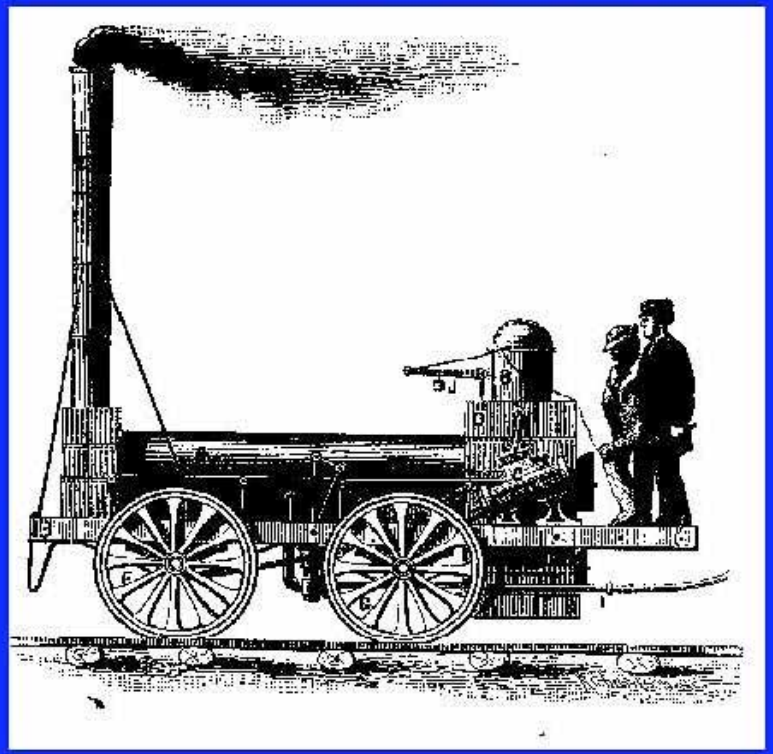
Actions

- Annex R&D Meeting #1
- Annex web site
- Refine “Matrix”
- “Long version” of country projects
  - Specifics of project
  - In context of the matrix
- Continue progress on case studies
- Plan follow-on meetings
  - Australia, September 2006



1830: "Rail travel at high speeds is not possible because passengers, unable to breathe, would die of asphyxia."

– Dionysius Lardner, Professor of Natural Philosophy and Astronomy at University College, London, and author of "The Steam Engine Explained and Illustrated"



1977: "There is no reason anyone would want a computer in their home."

– Ken Olson, president, chairman and founder of Digital Equipment Corp.

Questions & Comments

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Power System Operation Impacts

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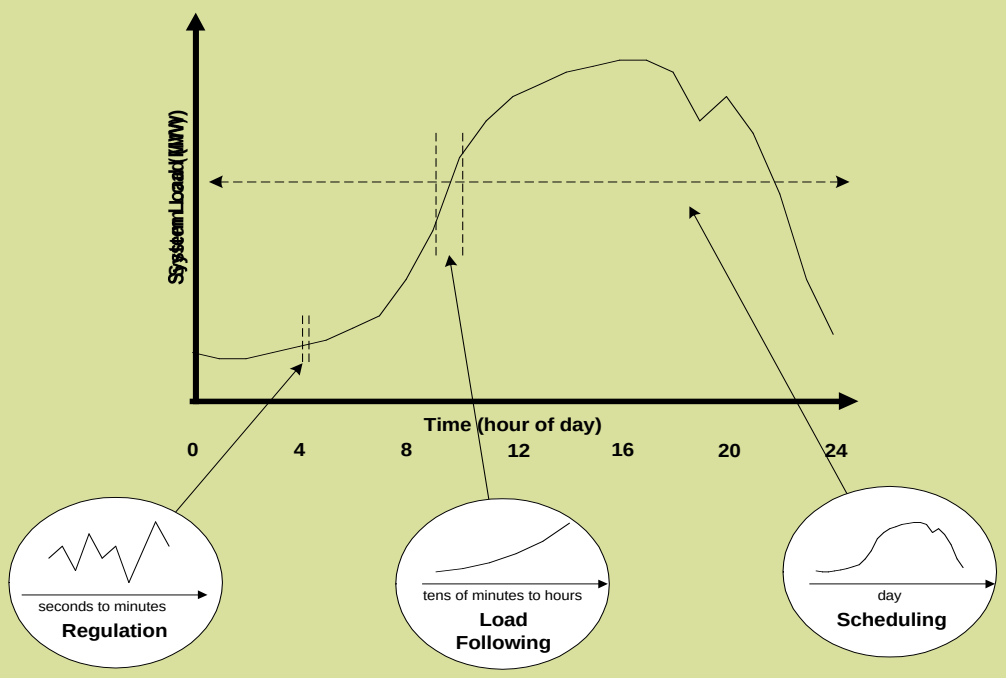
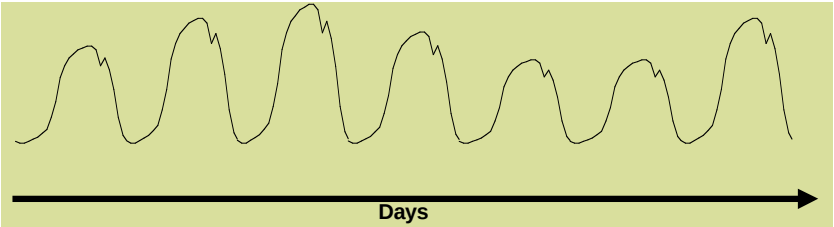
Time Scales of Interest:



- Regulation -- seconds to a few minutes -- similar to variations in customer demand
- Load-following -- tens of minutes to a few hours -- usage follows predictable patterns



Unit Commitment

- Scheduling and commitment of generating units -- one to several days

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