IEA Hydrogen Task 18: Evaluation of Integrated Demonstration Systems

Susan Schoenung
Longitude 122 West, Inc.
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This presentation does not contain any proprietary or confidential information

Project ID #SAP1

Overview of IEA Integrated Systems Project (Task 18)

Timeline

- Project start date:
  January 1, 2004
- Project end date:
  December 31, 2006
- Percent complete: ~44%

Barriers Addressed from MYPP

- To safety, codes and standards
  - Conflicts between domestic and international C&S
- To systems analysis
  - Lack of consistent data, assumptions and guidelines; lack of consensus on modeling tools
- To tech validation
  - Inadequate integrated infrastructure system experience; lack of validated data

Budget

- Total project funding
  - DOE share: $450K
  - Contractor co-share: contributed labor (~$50K)
  - International partners: 18 FTE
- Funding received in FY04: $98K
- Funding for FY05: $107K

Partners / Collaborators

- International Energy Agency, Hydrogen Implementing Agreement
  Task 18 members:
  - Eleven countries
  - European commission
- Sandia National Laboratory (Lutz)
- Los Alamos National Laboratory (Padró)

Participants of IEA Hydrogen Task 18

Canada
Natural Resources Canada

Japan
AIST Laboratory

Italy
ENEA

Iceland
Icelandic New Energy

France
CEA

European Commission
Joint Research Center

Norway
IFE

Spain
INTA

Sweden
Sydkraft

United Kingdom
EA Technology

United States
Department of Energy

Denmark
Gas Technology Center

Potential members: Netherlands, Korea, Australia, Singapore

Objectives of IEA Hydrogen Task 18

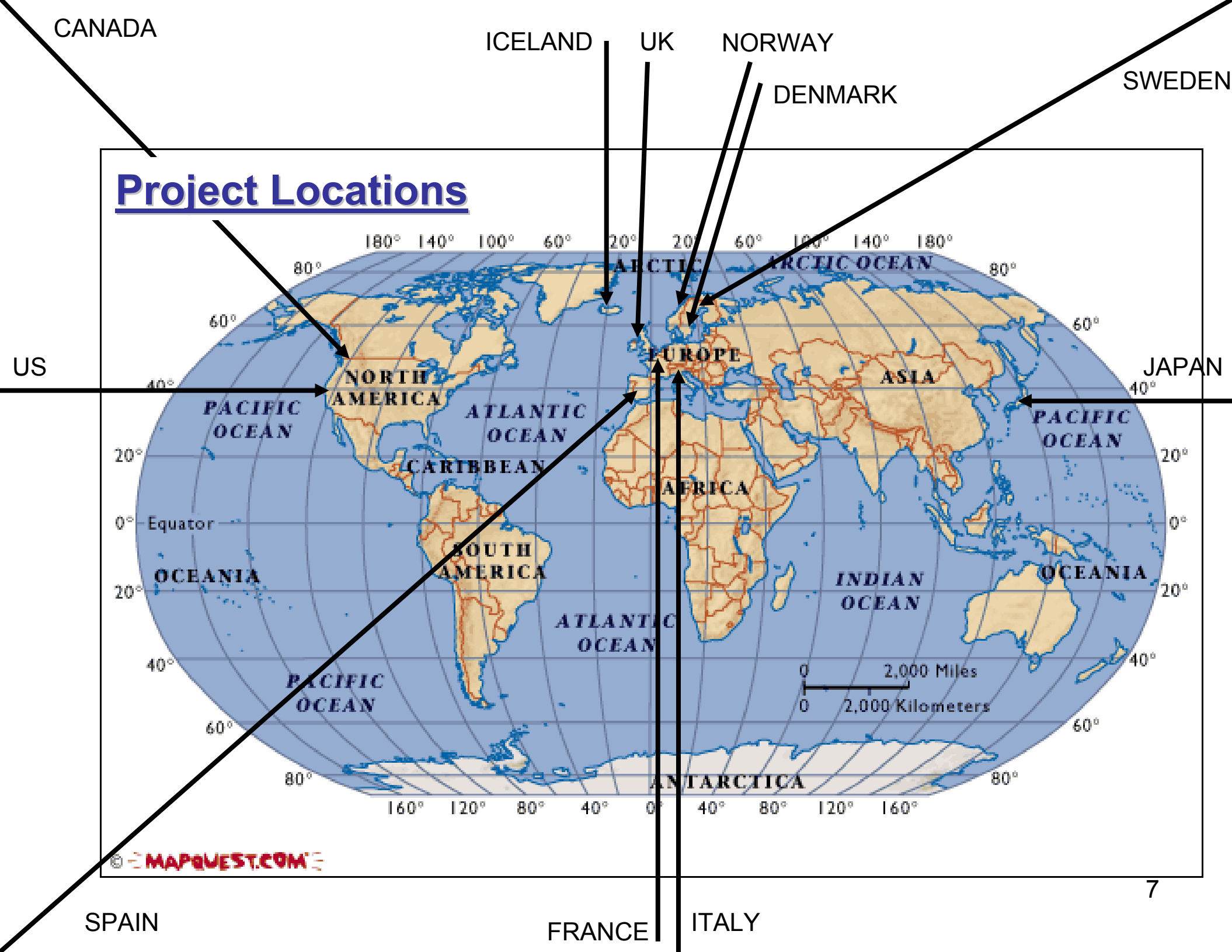
1) To use modeling and analysis tools to evaluate hydrogen demonstration projects. Focus is on lessons learned and providing design guidance for future projects.
2) To develop information datasets and compiled summaries of <u>integrated</u> hydrogen system demonstrations and development plans. Focus is on determining patterns and the evolution of trends from lessons learned.
3) To participate in Hydrogen Resources Study: “Where will the hydrogen come from?”

Approach => Collaboration

- Members of IEA Hydrogen Implementing Agreement Task 18 work collaboratively within two subtasks:
  - Subtask A: Information Base Development
  - Subtask B: Demonstration Project Evaluation
- **U.S. DOE Sponsors the Operating Agent; Subtask Leaders are sponsored by Canada and Norway, respectively**
- Subtask A: Members Responsibilities:
  - Deliver to searchable web portal national studies and requested data
- Subtask B: Members Responsibilities:
  - Work as a group to establish a list of desired data for each project
  - Bring to the group data from that country's project
  - Clarify with the data provider any limitations on data release or use
  - Make use of appropriate modeling & analysis tool for selected projects
  - Provide assessments & evaluations of the project based on the analysis results
- Members/experts meet twice per year to review progress; ongoing collaboration is carried out electronically
- Members deliver progress reports annually

Technical Accomplishments/ Progress/Results

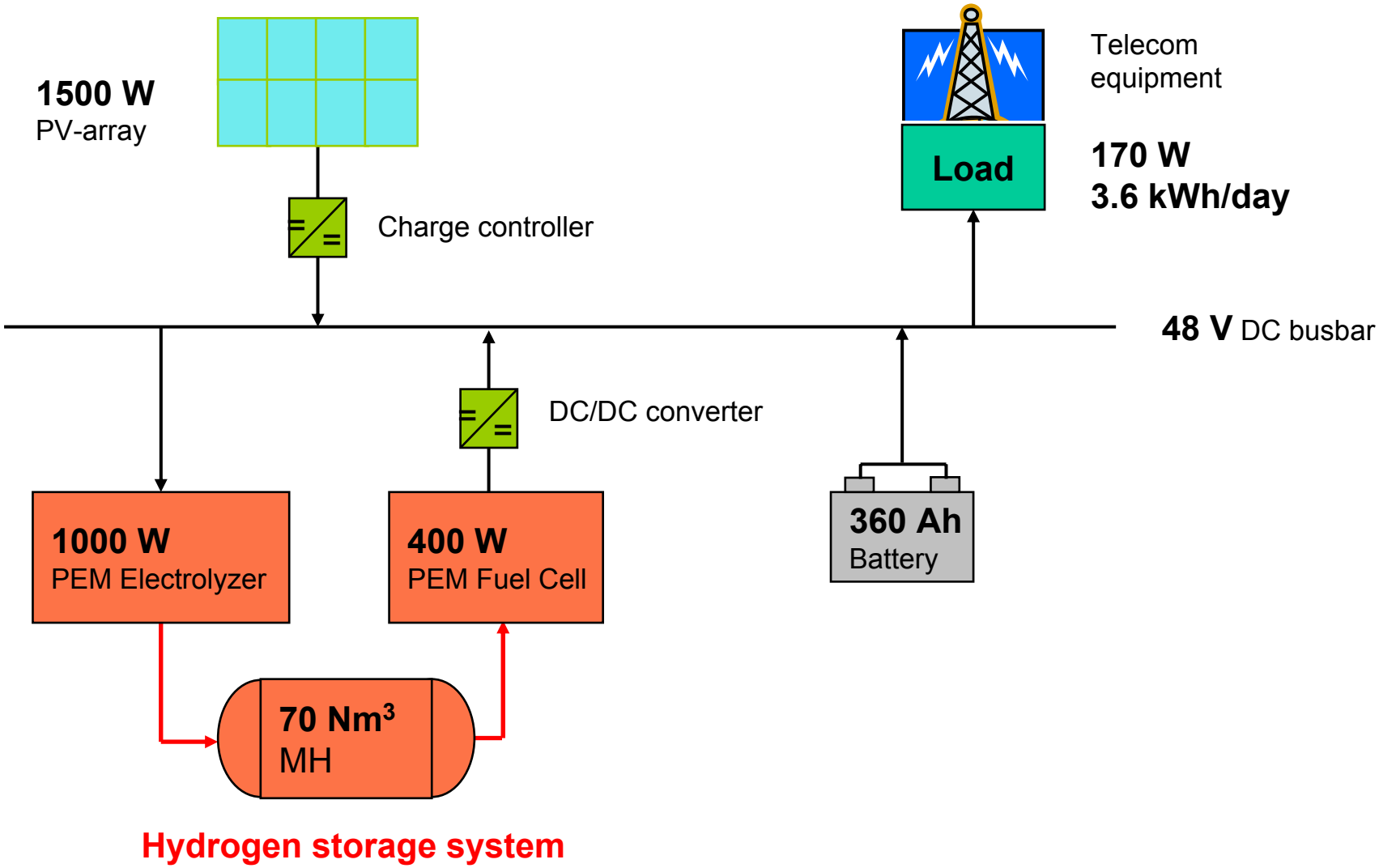
- Subtask B: Analysis of 8 demo projects completed or underway:
  - Spain - UK
  - Sweden - Japan (2)
  - Iceland - US
  - Canada
- **All assessments include documentation of safety, codes and standards**
- Subtask A: Database contains 83 documents, analysis in progress
- Case studies: 3 completed within the last year
  - California Fuel Cell Partnership (US)
  - Compressed Hydrogen Infrastructure Project (Canada)
  - Fuel Cell Innovative Research System for Telecommunication (Spain)
- Hydrogen resources study in progress:
  - "Where will the hydrogen come from?" (in Collaboration with Padró/LANL)


CANADA
ICELAND
UK
NORWAY
DENMARK
SWEDEN
Project Locations
US
JAPAN
SPAIN
FRANCE
ITALY
NORTH AMERICA
PACIFIC OCEAN
ATLANTIC OCEAN
CARIBBEAN
EUROPE
ASIA
AFRICA
SOUTH AMERICA
OCEANIA
INDIAN OCEAN
ANTARCTICA
Equator
0 2,000 Miles
0 2,000 Kilometers
MAPQUEST.COM

Subtask B: Systems Being Assessed

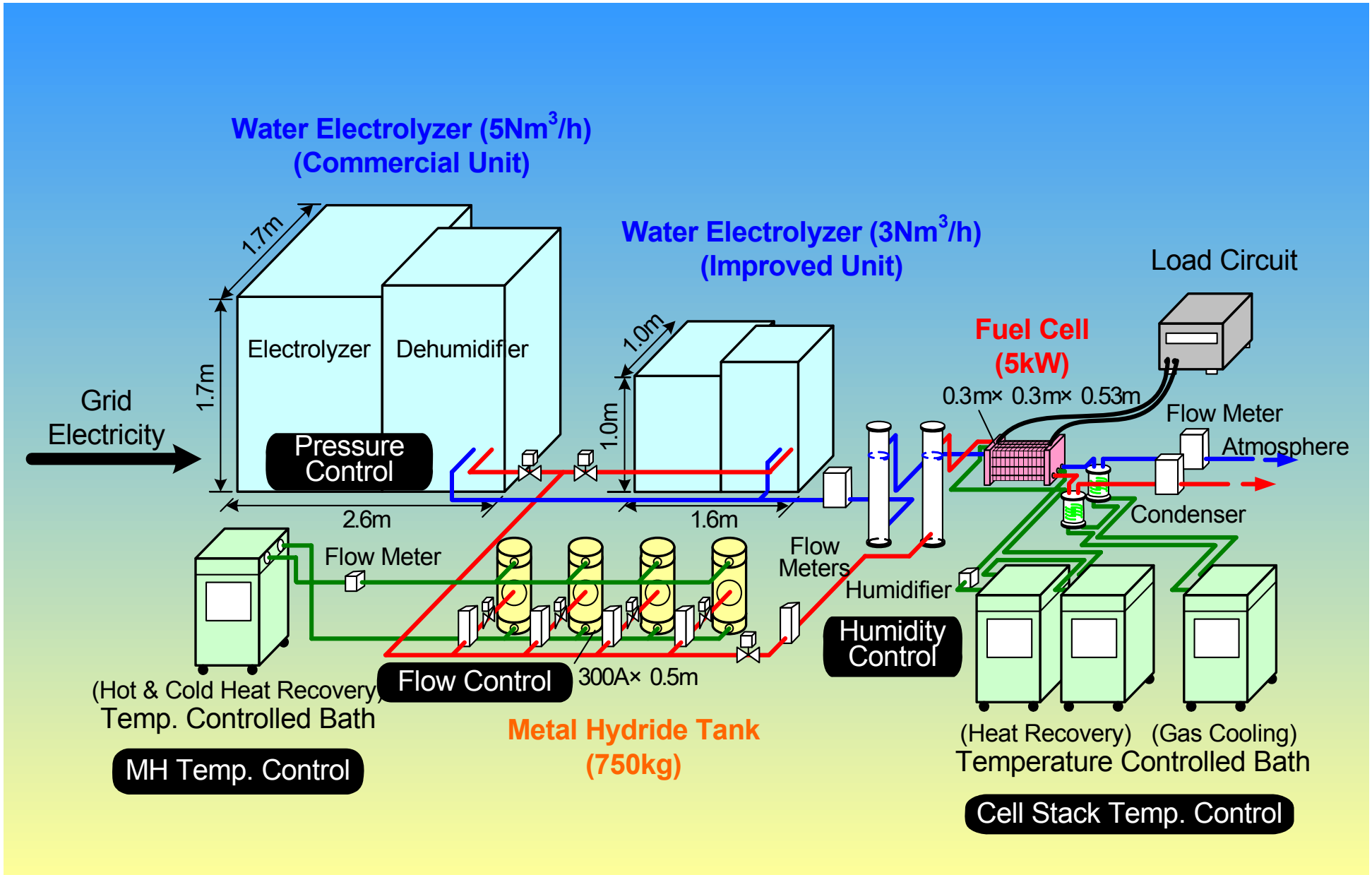
#	**Description**	Renewables - based	Fossil (NG) - based
1	Grid-connected power systems	√	√
2	Refueling stations	√	√
3	Combinations of 1 & 2		√
4	Stand-alone power systems (SAPS) & Special applications	√	

PV/ H_2 Telecom System, Madrid, Spain



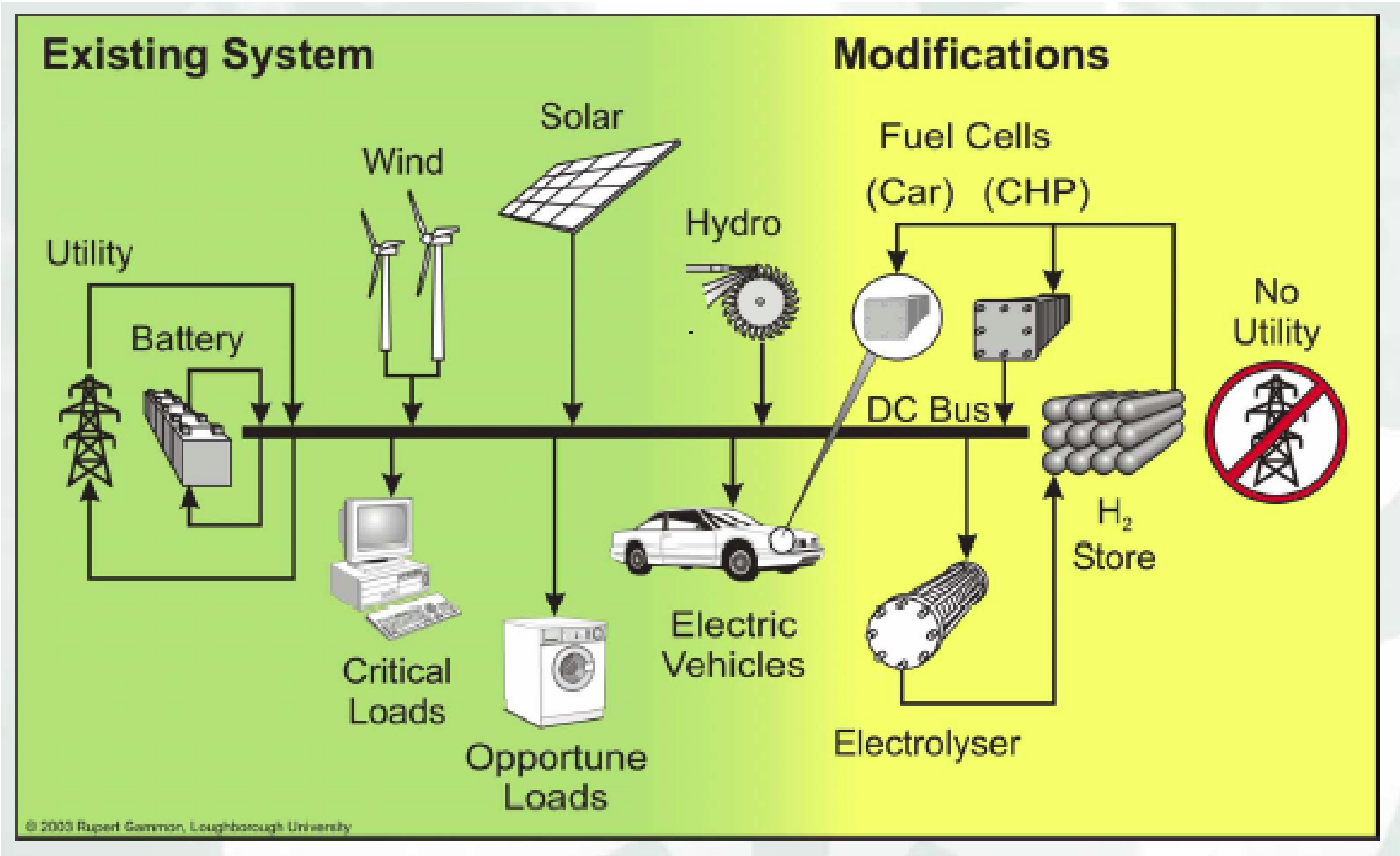
Evaluation status: Model complete, sensitivity studies in progress

Integrated H_2 System, Atsugi, Japan



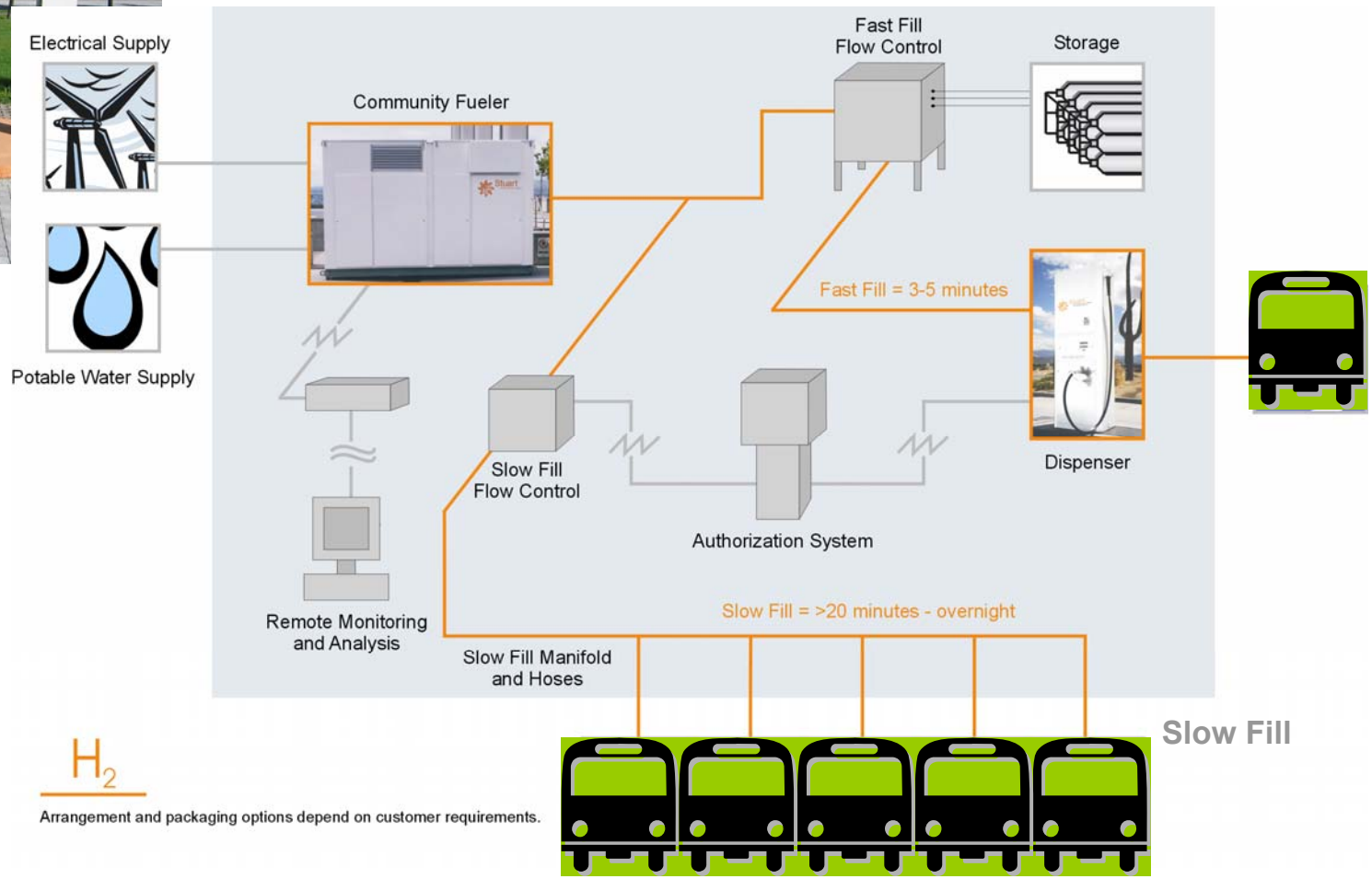
Evaluation status: Data collection in progress, analysis to come

Hydrogen and Renewables Integration (HARI) Project - UK



Evaluation status: Data acquisition in place, modeling tools in development

H_2 Refueling Station, Malmö, Sweden



Evaluation status: Data analysis complete, sensitivity studies in progress

H_2 Energy Station, Las Vegas

Evaluation status: Safety analysis complete, additional data unavailable

H_2 Fueling Station, Reykjavik

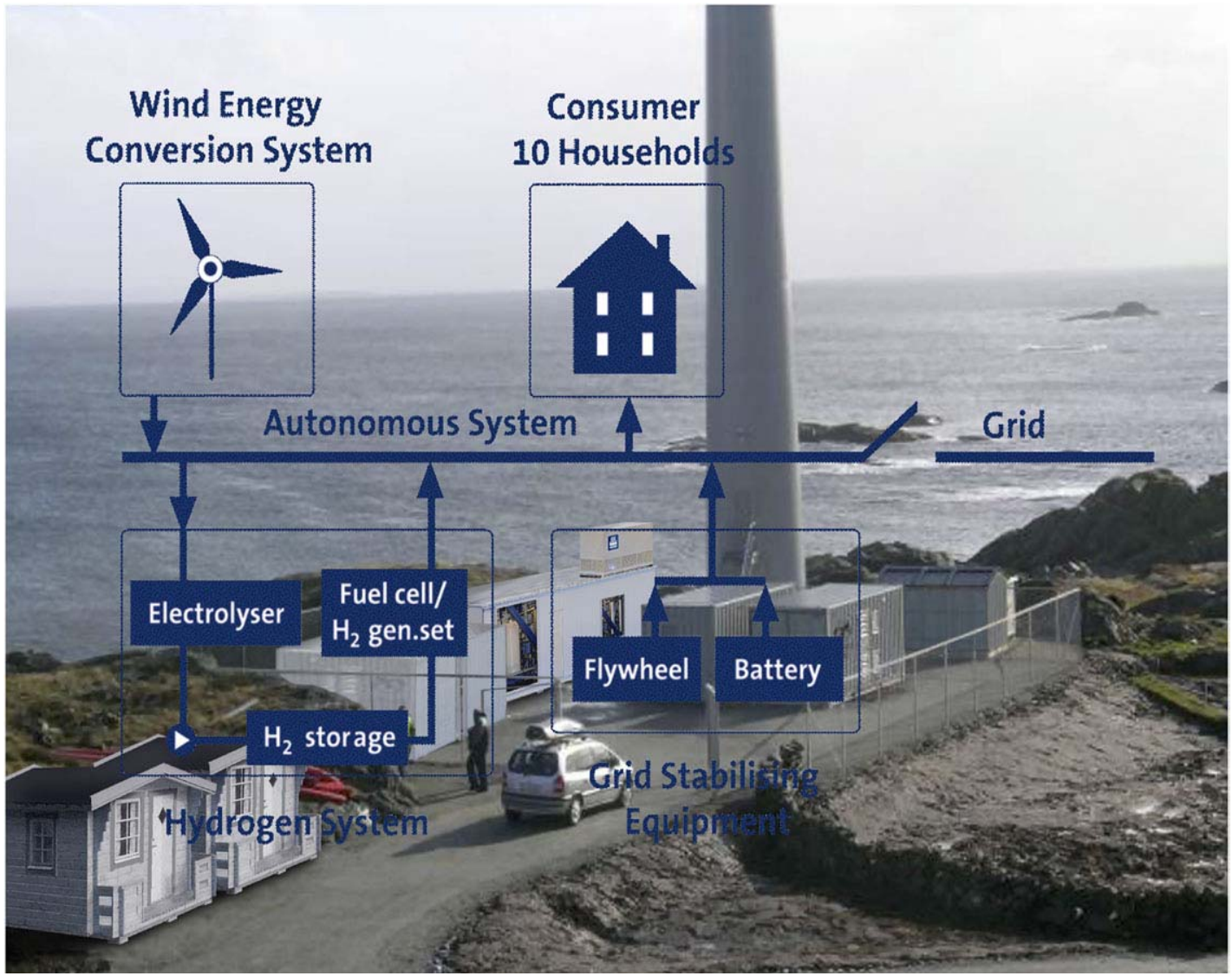
<u>Evaluation status: Data collection complete, performance analysis scheduled</u>

Pacific Spirit Station, Vancouver

- Located at the National Research Council's Institute for Fuel Cell Innovation on the campus of the University of British Columbia
- Integral part of Hydrogen Highway
- Participants include;
  - General Hydrogen
  - BOC
  - Fuel Cells Canada
  - Natural Resources Canada
  - National Research Council
- Operational now - Spring 2005

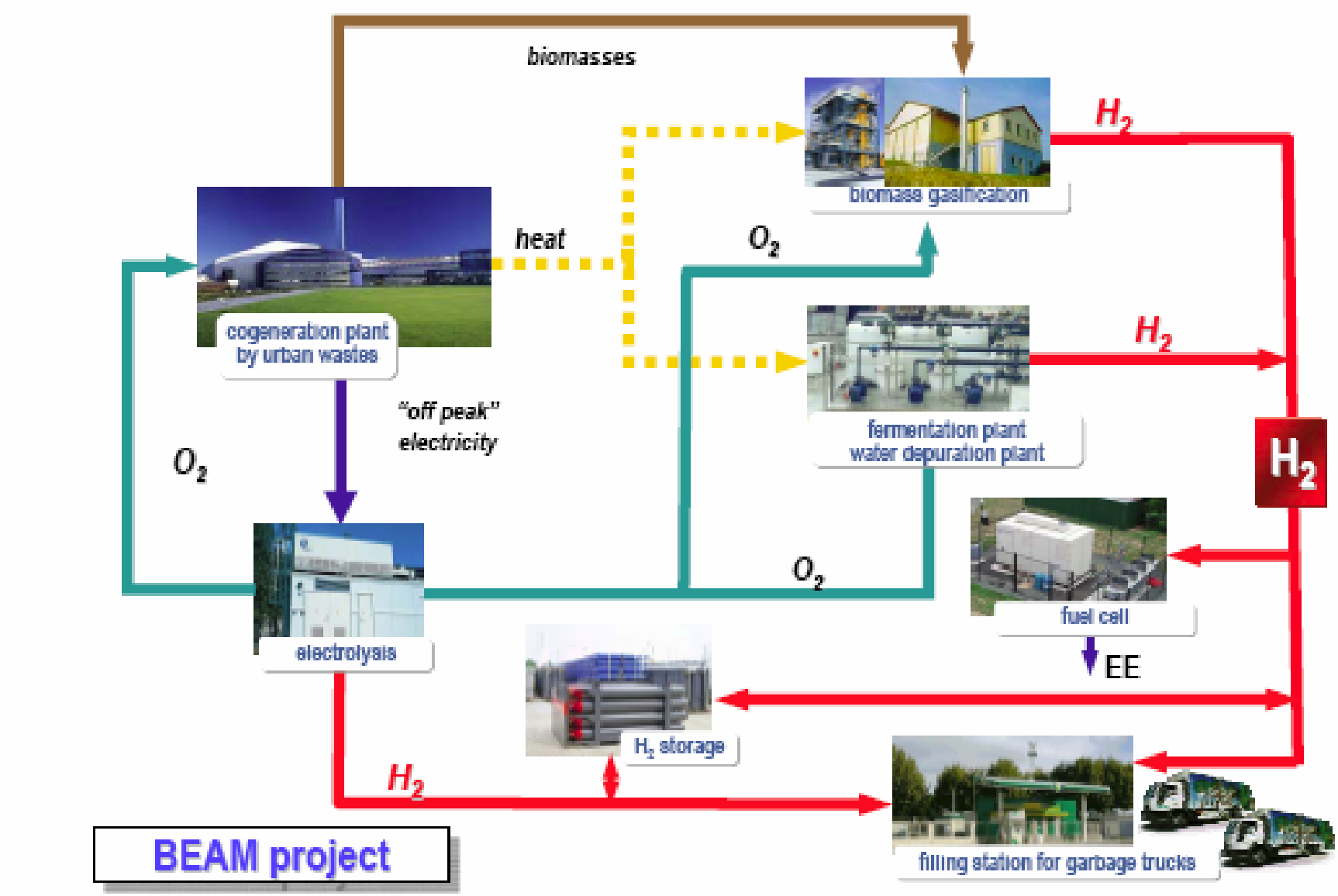
Evaluation status: Data gathering in progress, modeling planned

Renewable H2 Project, Utsira, Norway



Evaluation status: Planning for Phase 2

Italian BEAM Project - Power and Fuel from Urban Waste



Evaluation status: Planning for Phase 2

Two Basic Types of System Studies / Documentation

I. H_2-refueling stations

1. Future scenario/sensitivity study (Malmö)
2. Overall system performance study (Reykjavik)
3. Overall system performance study (Vancouver)
4. Comparative study of refueling station experience (Reykjavik, Vancouver, Malmö, & others: Japan, Singapore, Las Vegas?)

II. Integrated RE/ H_2-energy systems

1. Detailed technical system performance study (Japan)
2. General technical system performance study (Spain)
3. Techno-economic system design study (UK)
4. Future (Italy, Norway, New Zealand?)

Models for Evaluation and Design Guidance

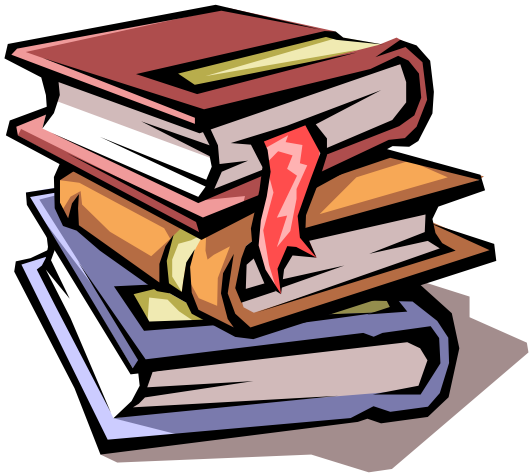
1. Time series simulations (η is calculated)
   - Dynamic performance
   - Detailed system design & controls √
2. Steady-state approximations (η is provided)
   - General system design
   - H_2-energy pathway studies
3. Economic calculations
   - Cost of energy √
   - Based on capital, O&M, and estimated lifetimes
4. Environmental damage calculations (LCA)
   - Material & energy usage, emissions over system lifetime
5. Combinations of the above

Time Series Modeling
Basic Data Requirements

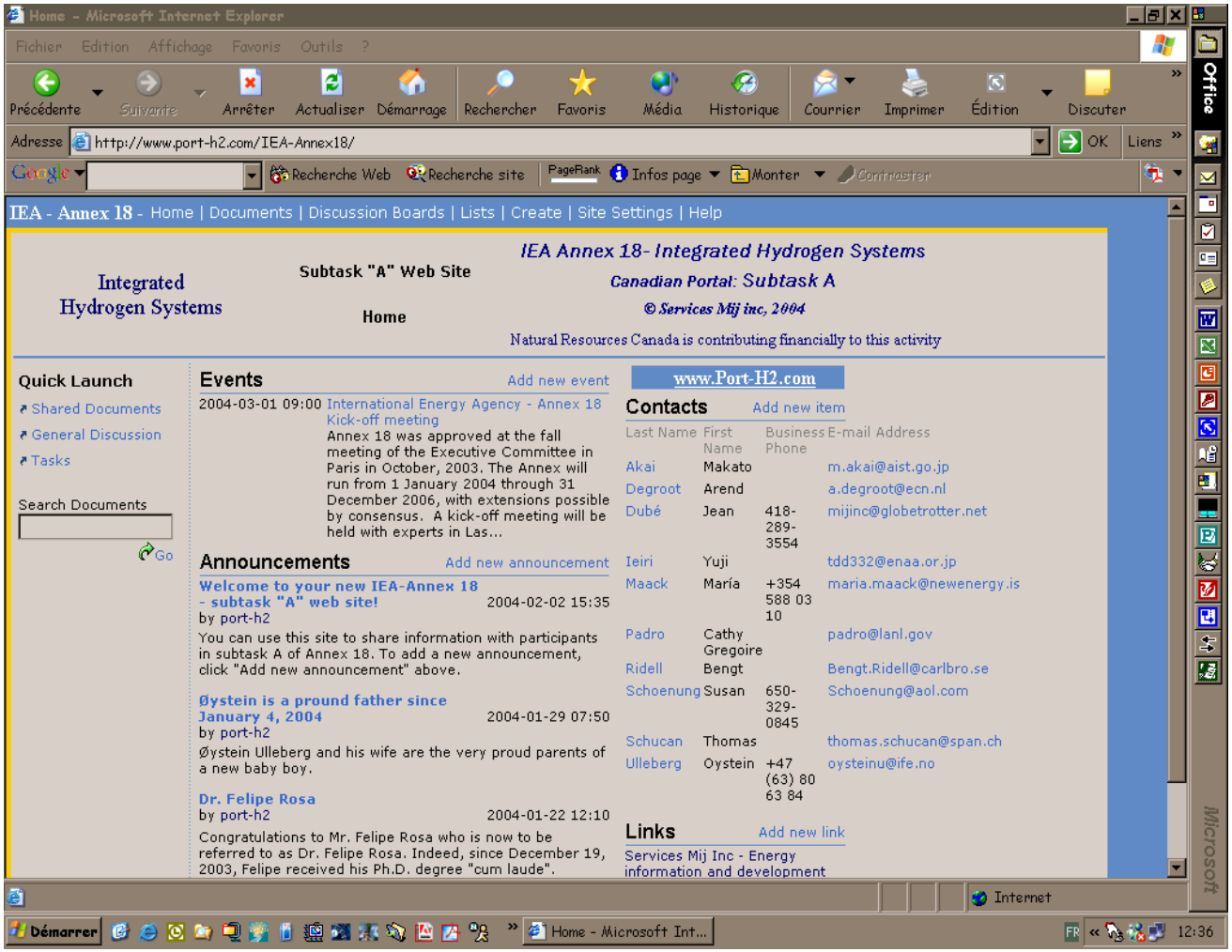
- Inputs (forcing functions)
  - RE-source (e.g. solar radiation, wind speeds)
  - Electrical and/or thermal energy load profiles
  - Other forcing functions (e.g., H_2-refueling station duty cycle)
  - Minimum resolution on data: **hourly values**
- Parameters – System Specifications
  - Rated powers, H_2-flow rates, etc.
  - Max. or min. temperature, pressure, etc.
  - Cells in series per stack, stacks in series per unit, etc.
  - Minimum requirement: **clearly defined system**
- Parameters – Component characteristics
  - *IU*-curves
  - *PCT*-curves
  - η-curves
  - Minimum requirement: Tables with **numerical values**
- Other vital items
  - Information on control strategy (including start-up regimes, idling and/or on/off-switching of components)
  - Minimum requirement: Schematic of **overall control strategy**

Subtask A: Information Base Development

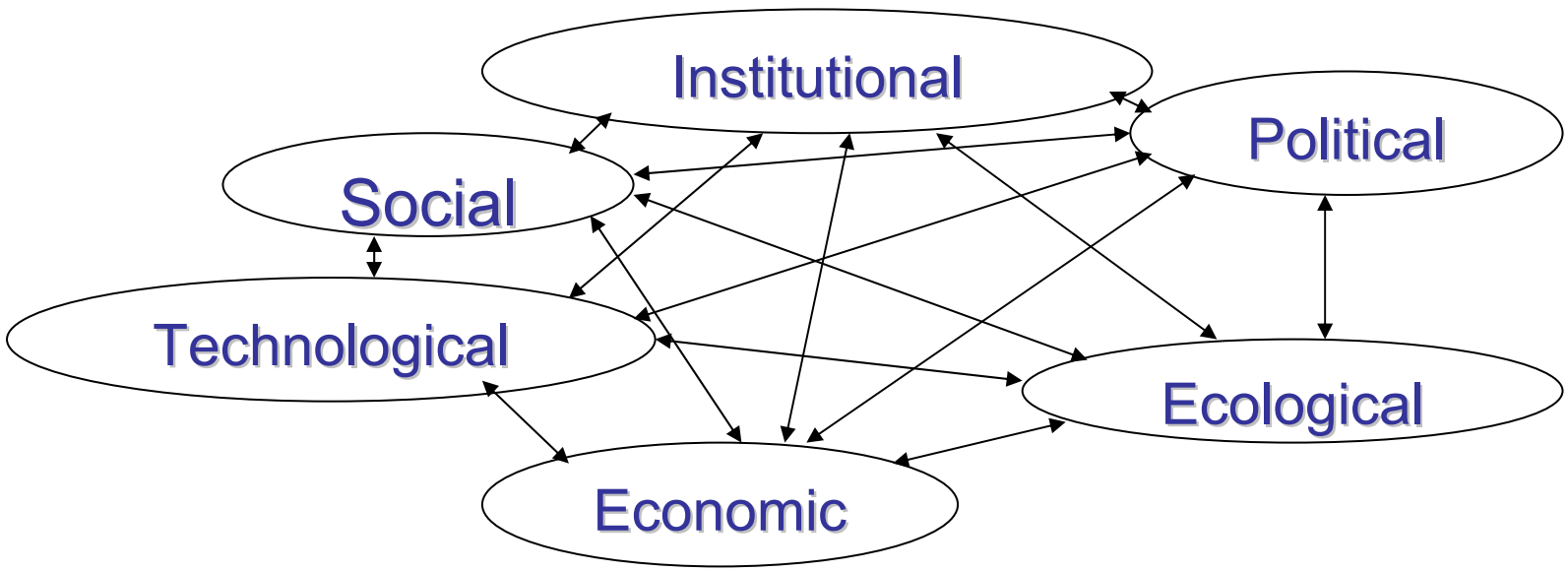
- National plans
- Demonstration progress
- Hydrogen resources
- Vendors
- Utilization rates
- Geographic information
- Refueling projections
- Costs
- Infrastructure
- Codes and Standards
- Economic analysis



Annex 18 website: Searchable portal



Information Base Development - Progress



- Initiated the definition of a structure for the proposed Information Base: Technology, Market and Supply chain.
- Participants took a step back from the usual technological viewpoint and considered the possibility to document “hydrogen” in consideration of the hydrogen energy Macroenvironment and determined that Subtask “A” would perform a Monitoring (What is going on ?) function.
- 83 documents from 11 countries being analysed for priorities and trends; additional documentation anticipated.

Task 18 Milestone Schedule

	2004			2005			2006		
Expert Meetings	KO		F04	S05		F05	S06		F06
Subtask A									
Data plan and format			X						
Initial summaries				X					
Updated summaries						X			X
Draft and final report							X		X
Hydrogen Resource study - input					X	X			
Subtask B									
Case Studies			X X	X X	X	X	X		X
Project selection	X								
Tools operational			X						
Data gathering		ongoing			ongoing				
First demo evaluation				X					
Second demo evaluation						X			
Third demo evaluation							X		
Final summary report									X

Future Work: Plans for 2005-2006

Technical progress plans

- Draft input to Hydrogen Resources study due by end of May; final by September
- Telecom system analysis, Malmö sensitivity studies and Iceland refueling station performance analysis all due by end of 2005
- Data gathering on Japan project, Vancouver refueling station and HARI project ongoing through 2005 for analysis in 2006
- Comparative assessment of refueling station experience - draft due spring of 2006
- ECTOS Case Study to be completed in 2005, HARI in 2006

Management plans

- Task Experts meet twice per year; fall 2005 meeting is scheduled for Iceland in September; spring 2006 meeting is planned for Vancouver in March
- Operating agent meets twice a year with Executive Committee; fall 2005 meeting planned for Singapore in September
- Semi-annual reports due in September and April, annual in December

Supplemental Slides

Publications and Presentations

- 2004 NHA Conference Poster
  - Schoenung, Susan. “Hydrogen Integrated Systems Modeling and Analysis for the International Energy Agency”
- 2004 Windsor Workshop Presentation
  - Dubé, Jean, and Susan Schoenung. “International Energy Agency Hydrogen Implementing Agreement; Task 18 - Integrated Systems Evaluation”
- 2004 Australian Hydrogen and Fuel Cells Conference paper and presentation
  - Ulleberg Ø. and R. Glöckner. “Development of Renewable Energy/Hydrogen Systems: From Concepts to Actual Demonstrations.” Hydrogen and Fuel Cells Futures Conference,Perth, 12-15 September 2004.
- H2004 Workshop Presentation
  - Ulleberg, Øystein. “IEA H2 Annex 18: Integrated System Evaluations.” Murdoch University, 16-17 September, 2004.
- Las Vegas Energy Station safety study
  - Skolnick, Ed. “Site Visit Report:The Las Vegas Hydrogen Energy Station”
- Case studies (Available on IEA Hydrogen Implementing Agreement website: http://www.ieahia.org/case_studies.html)
  - Gromis, Adam, and Thomas Schucan. “California Fuel Cell Partnership.”
  - Wong, Joe, and Thomas Schucan. “Compressed Hydrogen Infrastructure Program.”
  - Argumosa, Maria de Pilar, and Thomas Schucan. “Fuel Cell Innovative Research System for Telecommunications.”
- Public Website: www.port-h2.com/IEA-Annex-18/

Hydrogen Safety

The most significant hydrogen hazard associated with this project is:

- The modeling and analysis work associated with this project do not pose any hydrogen safety hazards.

Our approach to deal with this hazard is:

- Each demonstration project applies local safety regulations and codes and standards, which are being documented for each project. Dealing with the hazard is out of scope.