Biomass

Hydro
Wind
Solar

Nuclear

Oil

Coal

Natural
Gas

With Carbon Sequestration

Electrolytic Hydrogen Production

Matt Kauffman

Technology Barriers

- Cost
- System efficiency
- Electricity cost and emissions
- Renewable integrated systems
- Codes and standards
- Delivery (electrons vs. hydrogen)

Targets and Status

Water Electrolysis

Characteristics	Units	2003 status	2005	2010
250 kg/day refueling station 5000 psi				
Electricity cost	$/kg H_2	1.95	1.80	1.60
Total cost	$/kg H_2	4.65	3.80	2.50
Efficiency	%	60	64	73
5 kg/day refueling unit 5000 psi				
Electricity cost	$/kg H_2	4.10	3.30	2.80
Total cost	$/kg H_2	7.40	5.30	3.75
Efficiency	%	50	58	70

Current Projects
Electrolytic Hydrogen Production

• Low Cost, High Efficiency Reversible Solid Oxide System	Technology Management Inc.
• High-Efficiency Steam Electrolyzer	LLNL
• High-Temperature Solid Oxide Electrolyzer System	INEEL

2004 New Starts

Electrolytic Hydrogen Production

- High-Pressure Electrolyzer Without Downstream Compressor
- Integrated H_2 Generation System Using Wind Energy
- Electrolysis System Based on Titan HM200 Industrial Gas Generator

- Giner Electrochemical Systems
- Proton Energy Systems, Inc.
- Teledyne Energy Systems, Inc.

R&D Direction

Develop electrolysis technology for large scale production

- Analysis effort exploring large scale renewable production and delivery
- Rural hydrogen fueling stations
- Increase utilization of stranded renewable electricity sources

Develop distributed refueling technologies

- Electrochemical compression
- Plug and play, safe, modular systems
- Siting, Codes and Standards

R&D Technologies

- **Alkaline is nearer term technology for larger systems**
  - System cost reduction
  - Improve system efficiency/durability
  - Renewable integration (power conversion, storage)
- **Solid oxide electrolysis is in early development**
  - Materials and manufacturing R&D
  - Evaluate technology for power park systems
- **PEM technology geared to smaller home refueling**
  - Cost reduction and efficiency improvements needed
  - Integral compression