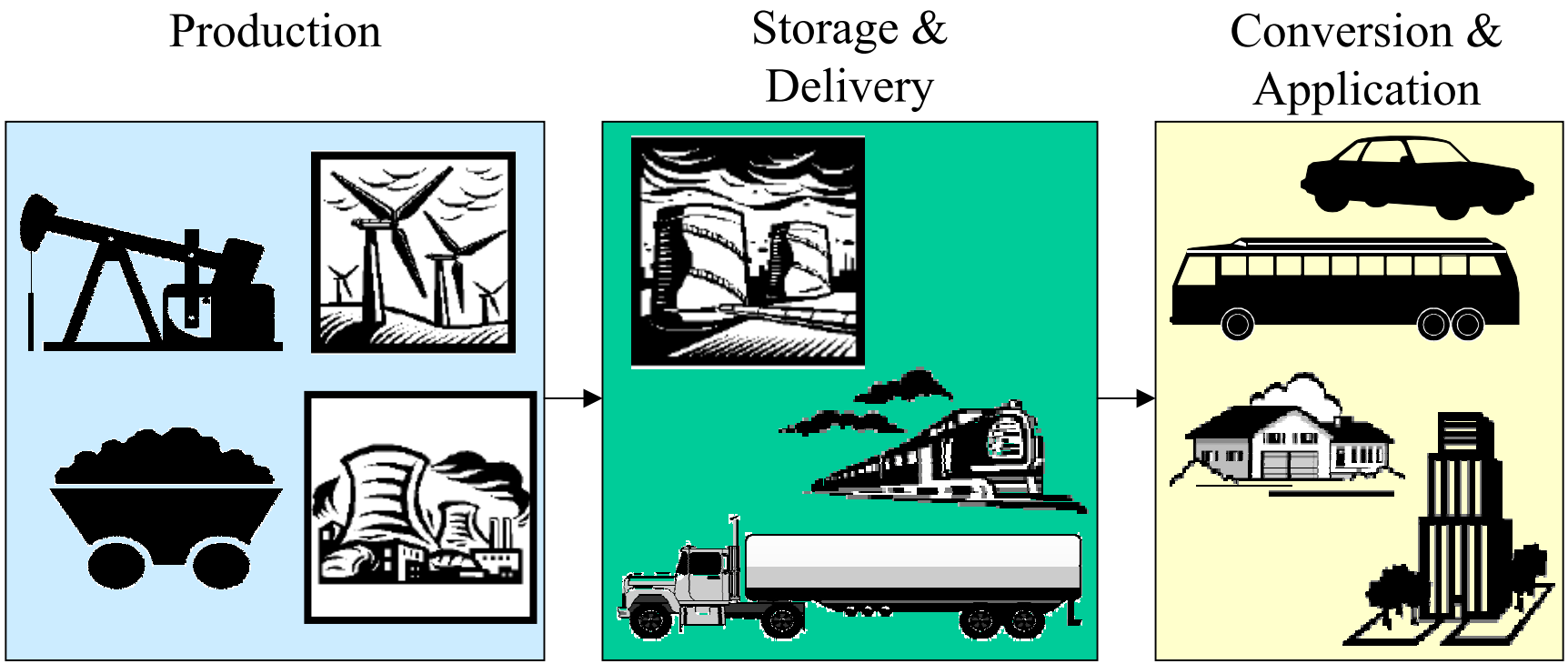
Hydrogen Fueling Systems and Infrastructure



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Objectives

Hydrogen Production and Delivery

- Reduce the cost of distributed production of hydrogen from natural gas and/or liquid fuels to $1.50/kg (delivered, untaxed) at the pump by 2010.

- By 2015, reduce the cost of H_2 fuel delivery from the point of production to the point of use in vehicles or stationary power units to <$1.00/kg in total.

Targets and Status

Distributed H_2: Natural Gas, Liquid

Characteristics	Units	2003 Status	2005	2010
Reforming				
Natural gas cost	$/kg H_2	0.66	0.62	0.58
Other costs	$/kg H_2	3.08	1.36	0.24
Primary energy efficiency	% (LHV)	70	72	75
Total				
Total cost	$/kg H_2	5.06	3.00	1.50
Primary energy efficiency	% (LHV)	62	68	75

Barriers

Distributed Hydrogen Production

- Fuel Processor Capital Cost
- Operation and Maintenance
- Feedstock Flexibility
- GHG Emissions
- Control and Safety

Development Focus

Distributed Production Costs, Reliability, and Safety

- More robust and tolerant catalyst system
- Combining unit operations: reforming, shift, separations, heat integration
- Designing for: manufacturability, operability, low maintenance, safety, compactness

Feedstock

- GHG emissions: renewable based feedstock
- Flexibility

Targets and Status

Hydrogen Delivery

Characteristics	Units	2003 status	2005	2010
Gaseous Hydrogen Compression				
Cost	$/kg H_2	0.18	0.17	0.14
Energy efficiency	%	90	92	95
Hydrogen Liquefaction				
Cost	$/kg H_2	1.11	1.01	0.53
Energy efficiency	%	65	70	87
Hydrogen Gas Pipelines				
Trunk lines	$/mile	1.4M	1.2M	600k
Distribution lines	$/mile	600k	500k	350k
Hydrogen Carrier Technology				
Hydrogen content	% by wt	3	6.5	10
Energy efficiency	%	80	82	85

Barriers

Hydrogen Delivery

- Lack of hydrogen/carrier and infrastructure options analysis
- High costs of hydrogen compression
- High costs of hydrogen liquefaction
- High capital cost of pipelines
- Solid and liquid hydrogen carrier transport
- Transport storage costs

Projects

Hydrogen Infrastructure Development

• Turnkey Commercial Hydrogen Fueling Station	Air Products & Chemicals, Inc.
• Autothermal Cyclic Reforming-Based Fueling System	GE Energy
• Natural Gas to Hydrogen Fuel Station	Gas Technologies Institute
• Production & Delivery Analysis	NREL
• H_2 Reformer, Fuel Cell Power Plant, & Vehicle Refueling System	Air Products & Chemicals, Inc.

Projects (Continued)
Hydrogen Infrastructure Development

• Fuels Choice	TIAX
• Renewable Energy Transportation System	Sunline
• Hydrogen Storage & Compression	LAX, Praxair

Posters

Hydrogen Infrastructure Development

• Distributed Hydrogen Fueling Systems Analysis	Directed Technologies, Inc.
• Power Park Analysis	Air Products & Chemicals, Inc.
• Power Parks	State of HI
• Power Parks	Pinnacle West
• Power Parks	DTE
• Power Park System Simulation	SNL
• Filling Up With Hydrogen 2000	Stuart Energy
• Integrating a Hydrogen Energy Station into a Federal Building	TIAX