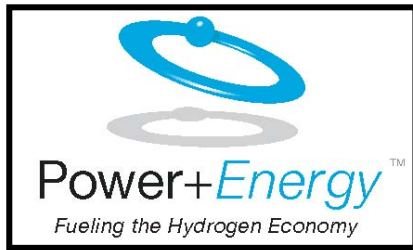


High Efficiency, On-Demand Recovery of Hydrogen from Renewable Fuels

Presented at the
Renewable Energy Forum
Delaware Valley College, August 4, 2006
Sponsored by Congressman Michael Fitzpatrick

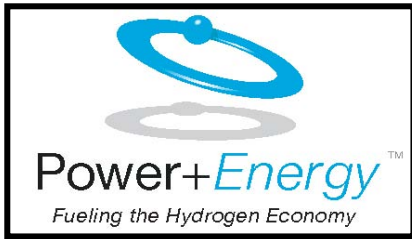
Peter Bossard, PhD
Power + Energy, Inc.



Power+Energy, Inc.

Leader in H₂ separation systems

- Founded in 1993, based near Philadelphia, PA.
- Leading global supplier of Pd alloy membrane hydrogen purifier systems & H₂ separators
- Broad ranging capability from bench-top to high volume bulk hydrogen purifiers.
- Multiple customers use P+E membranes for Methanol reformer applications > 10K hours.
- Diesel, Ethanol & Ammonia reformates



P&E Fuel Processor Technology



Reduces Fuel Consumption via High Efficiency Conversion to Hydrogen

Benefits:

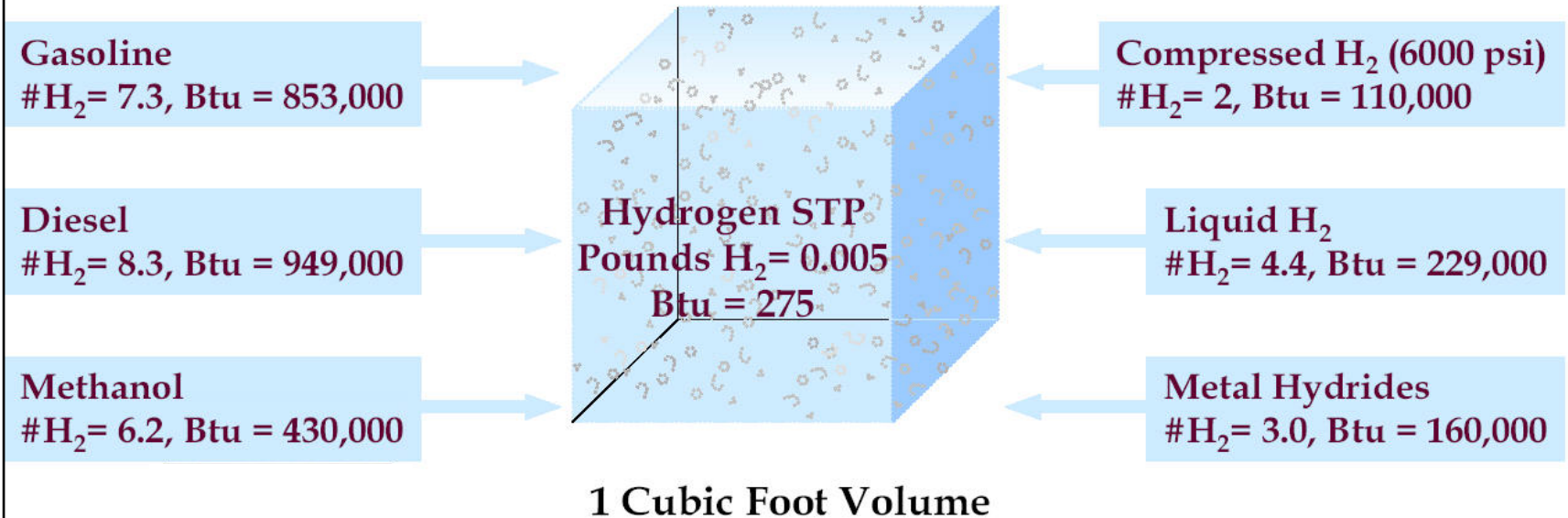
- Will Convert Liquid Fuel to a Stream of pure Hydrogen with 95% Efficiency – With An Energy Loss of 5%.
- Combined with a PEM Fuel Cell - Electrical Power can be generated at 45+% efficiency from each gallon of Liquid Fuel.

Principal Industries impacted:

- Fossil Fuel Suppliers and Bio-Fuel Suppliers
- Transportation: Cars, Trucks and Boats
- Distributed Power: Both Electrical and Natural Gas
- Emergency Backup and Remote Power Generation

Why: Reduces Energy Consumption by 50%

Hydrogen Storage



Hydrogen is very difficult to store efficiently

Liquid fuels contain much more H₂ per unit volume

Liquid fuels are more easily stored and transported

Slide Adapted from



Descriptor - include initials, /org#/date

Power+Energy at the Nexus of the Hydrogen Economy

Pure Hydrogen + PEM Fuel Cell Improves Fuel Efficiency 100%



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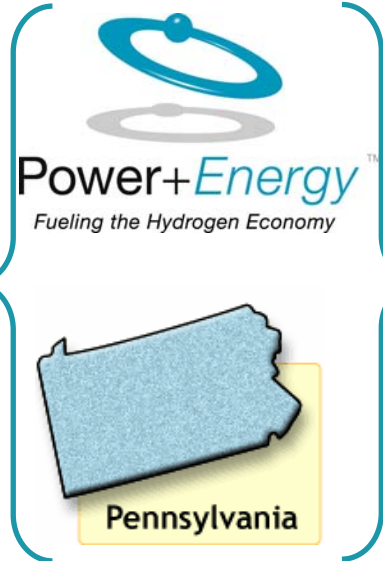
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P&E Technology

Pure Hydrogen:

- 1) Low Cost
- 2) Readily Available



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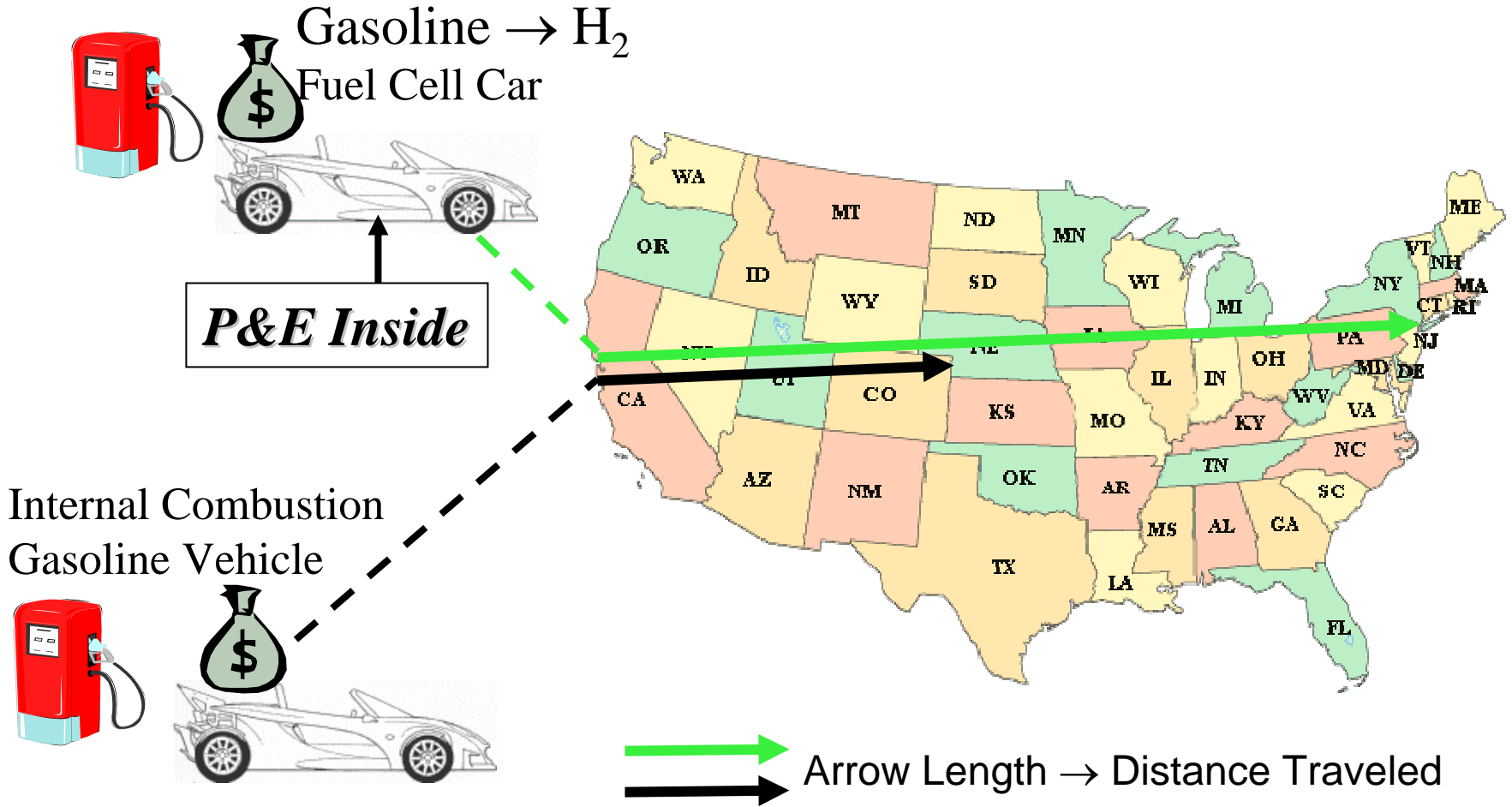
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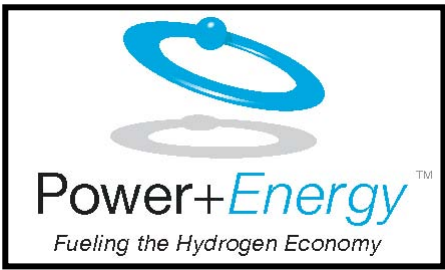
High Efficiency, On-Demand H2 Recovery from Renewable Fuels



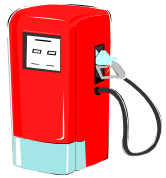
Power & Energy Liquid Fuel → Pure H₂ Using “P&E’s Technology”



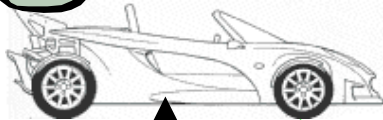
High Efficiency, On-Demand H₂
Recovery from Renewable Fuels



Power & Energy Liquid Fuel → Pure H₂ Using “P&E’s Technology”

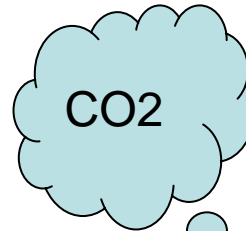
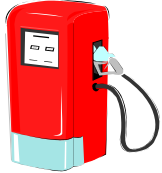


Gasoline → H₂
Fuel Cell Car

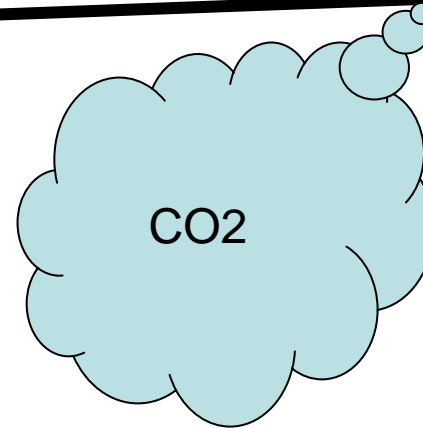
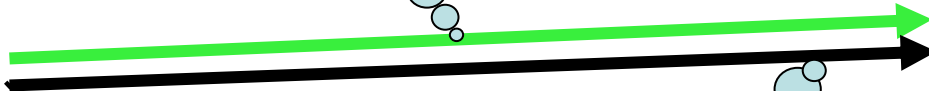


P&E Inside

Internal Combustion
Using Gasoline



50% Less CO₂ Emissions
Less Compared to
Internal Combustion Engines



High Efficiency, On-Demand H₂
Recovery from Renewable Fuels



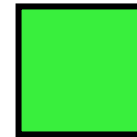
Power & Energy Liquid Fuel → Pure H₂ Using “P&E’s Technology”

Fuel Cell Car
Ethanol to H₂ on-demand



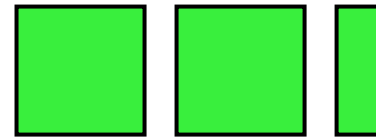
P&E Inside

Resources Required for Ethanol Production
Using P&E Technology + Fuel Cell



Resources Required For Ethanol Production
Using an Internal Combustion Engine

Internal Combustion Engine
Fueled with Ethanol

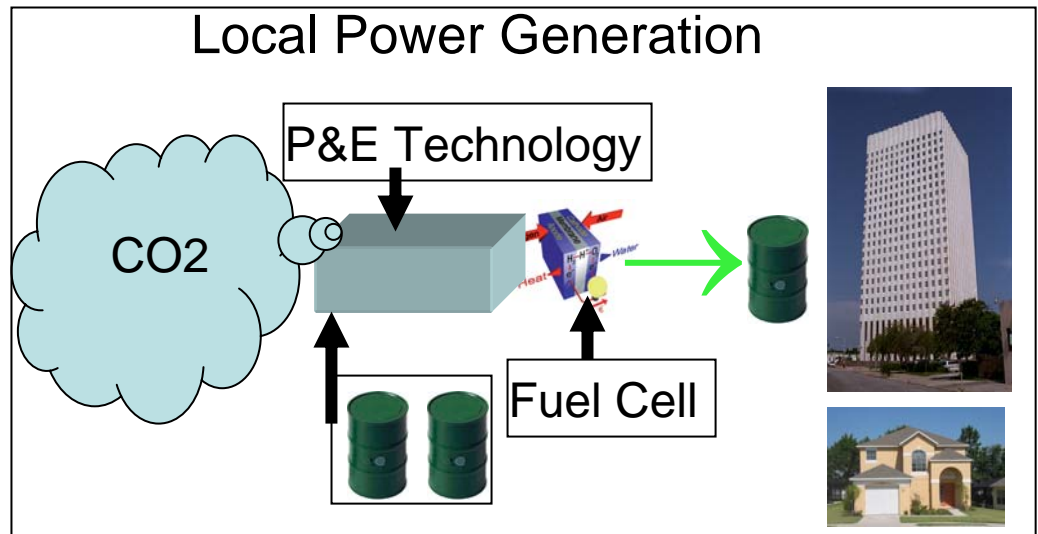
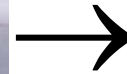
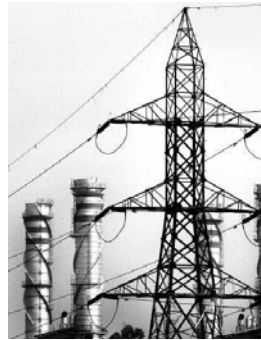
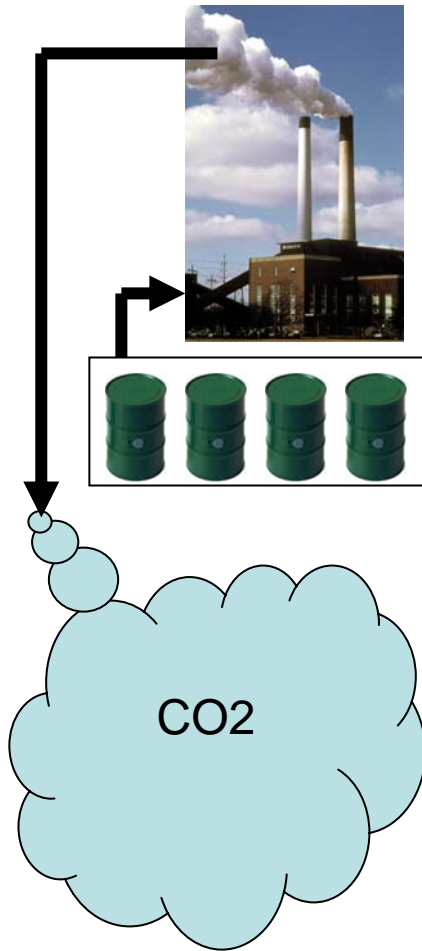


High Efficiency, On-Demand H₂
Recovery from Renewable Fuels

Power Distribution Over The Grid

Major Energy Losses in Transmission & Reliability Issues

 = Energy

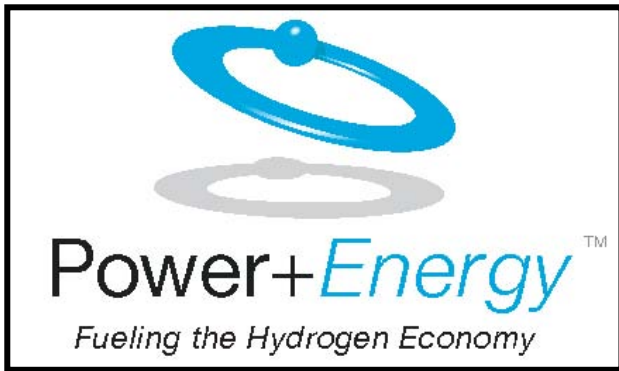


High Efficiency, On-Demand H2
Recovery from Renewable Fuels

CONCLUSIONS

P&E's Fuel Processing Technology Enables:

- Renewable & traditional fuels to be efficiently converted to high quality hydrogen at the point of use.
- P&E's Fuel Processor Technology + fuel cell: 50% reduction in net energy consumption and pollution.
- Adoption of P&E Fuel processing Technology by energy-intensive companies will cut manufacturing costs.
- Use of renewable fuel will result in a competitive market for energy in transportation and stationary applications.
- Last Quarter 2006 for 5 kW Fuel Processor for Ethanol
- **Energy costs will be reduced with improved efficiency and increased use of renewable energy resources.**



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