

Toward a Hydrogen Economy in the Caribbean: Beyond 2020

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Outline

- Hydrogen Economy – Global Trends
- Fossil Resource Depletion
- Hydrogen Energy
- Renewable Energy Resources
- Developing a Hydrogen Economy in TT

Hydrogen Economy

Definition

A future state where worldwide energy demands will be met by hydrogen

- H₂ will replace fossils as worldwide energy vector
- H₂ will come from renewable sources
- H₂ economy unique for each country

Hydrogen Economy

- Hydrogen used to power vehicles
- Gasoline pumps replaced by hydrogen infrastructure



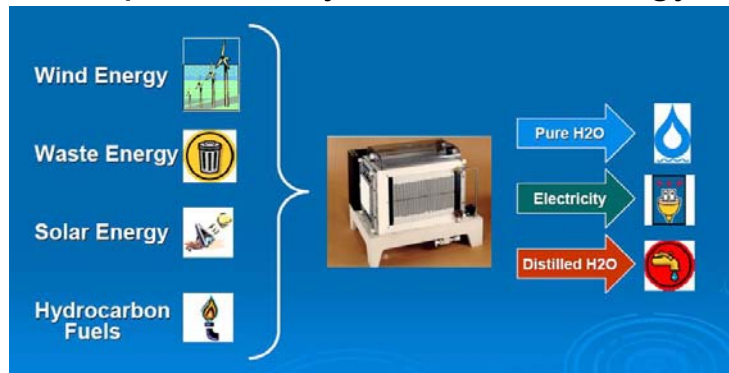
Hydrogen Economy

- Fuel cells used for distributed power generation
- Fuel cells used to power laptops, cell phones, mp3 players

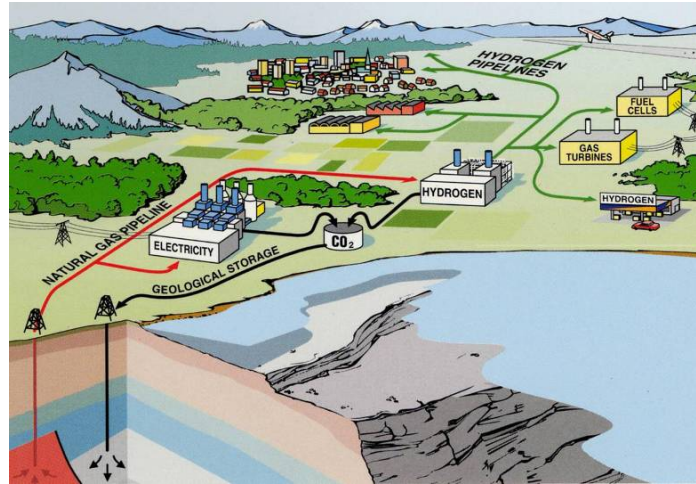


Hydrogen Economy

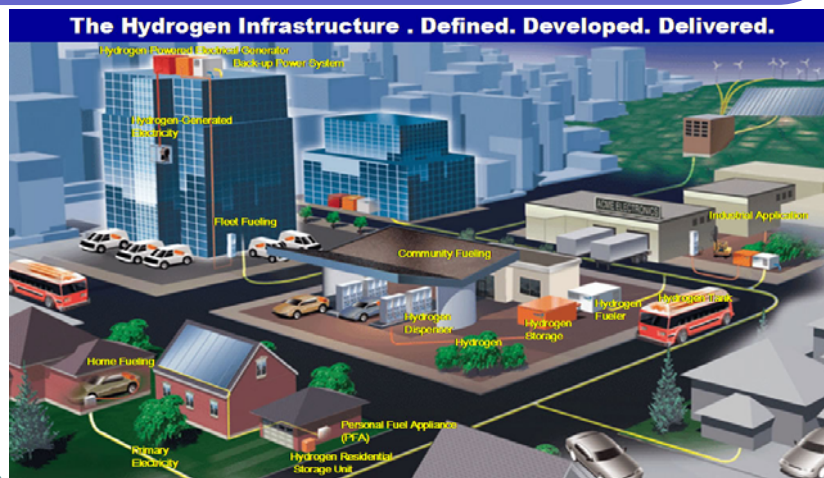
- Hydrogen produced from electrolysis of water powered by renewable energy



Hydrogen Economy



Hydrogen Economy



Hydrogen Economy

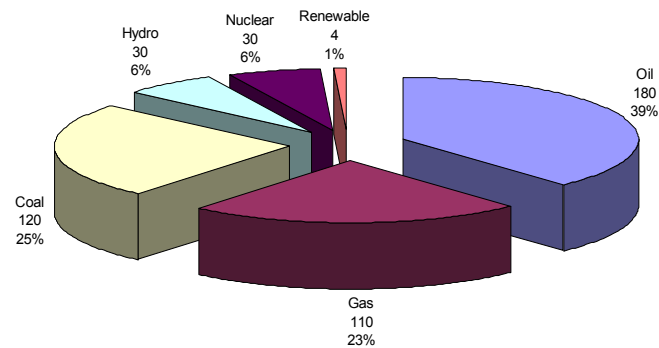
- Many countries have detailed plans to accomplish hydrogen economy by 2050
- US long term goal
 - Use natural gas to phase out oil
 - Develop renewable hydrogen technologies
 - Use hydrogen to phase out natural gas

Hydrogen Economy

- Reasons for global trend toward a hydrogen economy
 - Environmental concerns
 - Political concerns
 - Fossil depletion concerns

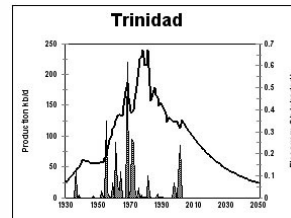
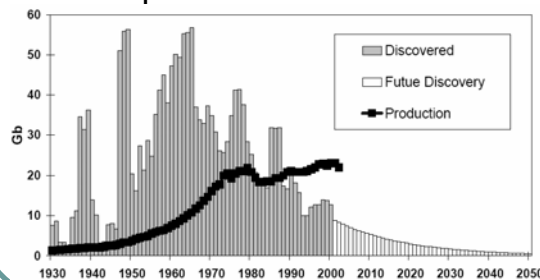
Fossil Resource Depletion

- Heavy global dependence on fossils



Fossil Resource Depletion

- Hubbert's Peak – peak of oil production, followed by terminal decline in production
 - Hubbert's global peak ~ 2010 – 2020
 - TT peak ~ 1985



Fossil Resource Depletion

- TT's oil and natural gas closer to depletion than rest of the world

	Global Oil (Gb)	TT Oil (Mb)	Global Natural Gas (billion m ³)	TT Natural Gas (billion m ³)
2007 Proved Reserves	1,030	606	178,045	703
2007 Production	24	44	2,848	40
Depletion Timeframe (years)	43.1	13.8	62.5	17.6

Fossil Resource Depletion

- TT needs to secure its energy supply and its economy
- Solution:
 - Renewable Energy
 - Renewable Hydrogen*

* hydrogen produced from renewable sources

Hydrogen Energy

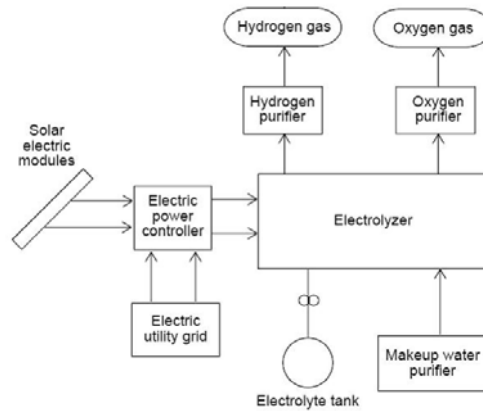
- Key Issues
 - Production
 - Storage and Transport
 - Energy Conversion
 - Safety

Hydrogen Energy

- Storage
 - High pressure gas
 - Cryogenic liquid
 - Solid hydride
- Transport
 - Pipelines
 - Tankers
- Conversion
 - Fuel Cells

Hydrogen Energy

- Hydrogen presently produced from reformation of natural gas
- In future, hydrogen will come from renewable sources



Renewable Resources in TT

- Solar
- Wind
- Wave
- Biomass

Solar Energy

- Irradiation ~ 230 W/m² (Caribbean)
- Photovoltaic (PV) panels can supply all domestic energy needs in the Caribbean
- 12% efficiency → 20 kWh /month /m² of installed PV
- Other countries are encouraging their citizens to invest in this technology to reduce fossil dependence
 - US goal: 1 million roofs by 2010

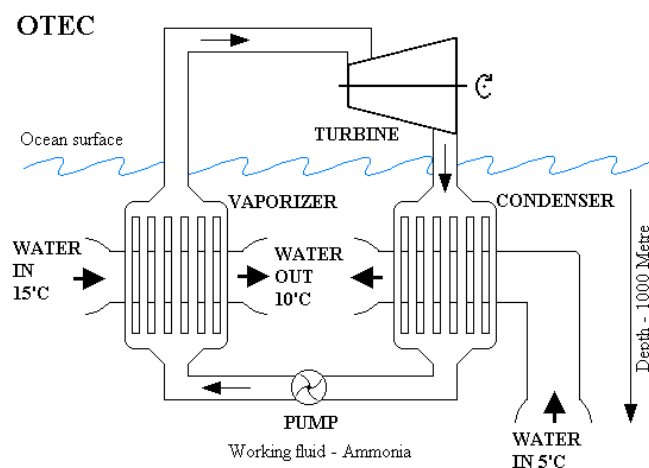
Wind Energy

- Average Caribbean wind speed ~ 20 mph
- Wind generated electricity ~ 5 cents / kWh
- Wind generated hydrogen ~ \$1.85 / gallon gasoline based on room temperature electrolysis
- Wind turbines can be used for large scale electricity production

Wave Energy

- Ocean Thermal Energy Conversion (OTEC) uses temperature difference in ocean as driving force for energy conversion
- OTEC can be used for large scale hydrogen production
- 500 – 1000 OTEC plants can supply ALL of the world's hydrogen needs

Wave Energy - OTEC



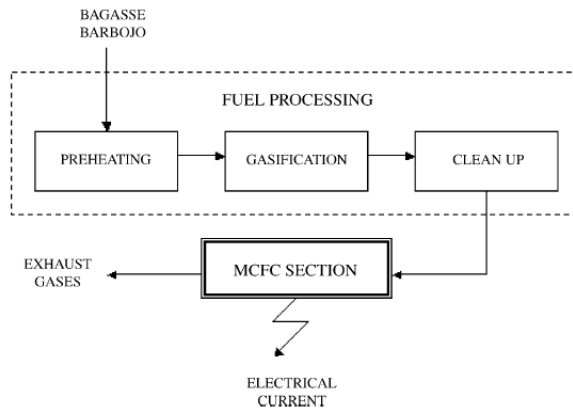
Biomass

- General term for organic material that has stored sunlight in form of chemical energy
- e.g. starchy and woody plants, organic waste
- TT has sugar cane resource

Biomass – Sugar Cane

- Sugar cane has very high intensity of biomass energy
 - 1 ton sugar cane → 1.7 GJ energy
 - Sugar cane-to-ethanol is 5-6 times more efficient than corn-to-ethanol
- Brazil produces 13 M tons of ethanol per year to fuel 3 M cars
- TT can use sugar cane to produce methanol, ethanol or hydrogen

Biomass / Fuel Cell hybrid



Development of H₂ Economy in TT

- Role of government
- Role of academia
- Role of industry
- Role of the public

Role of Government

- Create policy amenable to hydrogen economy
- Stimulate research
- Offer incentives for industry participation
- Promote education in hydrogen and fuel cell technologies
- Bear cost subsidies of renewable energy technologies
- Regional & international partnerships

Role of Academia

- Conduct meaningful research
- Train engineers and scientists
- Advise government on necessary research initiatives

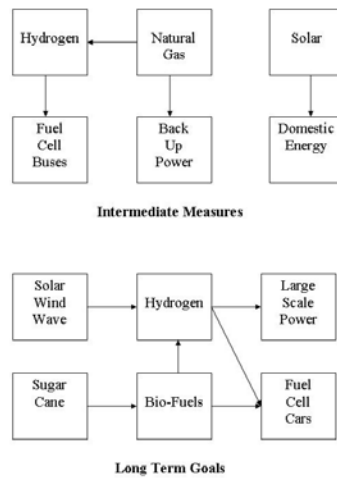
Role of Industry

- Fund meaningful research
- Offer facilities for experimentation and development of renewable technologies

Role of Public

- Invest in renewable technologies, e.g. solar PV
- Embrace inevitable changes

Proposed Local Initiatives



Conclusion

TT needs to develop a renewable hydrogen economy

