Making Way for Scotland’s Hydrogen Economy

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Ian Williamson
Hydrogen and Bio Energy Systems Director
Air Products
Infrastructure Discussion

- Today’s state of affairs
- The next few years
- Longer term
Air Products and Industry is Focused on Energy

- Clean energy
- Non-conventional oil and gas
- Industrial gases for refining
- Power generation
Air Products
50+ years of hydrogen experience

- Over 5000MT per day H₂ production
- Bulk, liquid, and pipeline distribution
- World’s largest H₂ producer
- H₂ energy projects since 1993
  - > 110 hydrogen stns
  - > 100,000 fuelings/yr
- Stations in 18 countries
- Active in UK hydrogen arena
  - via UKFCHA, CENEX & SHFCA
- Active in Europe
  - via the JTI and the EHA

Today’s state of affairs
Applications that transition to hydrogen, and deliver value today

- Fuel Cell Vehicles
- Mass transit/central fleets
- Material handling networks
- Back-up/stationary power
- Renewable Energy Parks
Battery and Fuel Cell Technologies are both required within the portfolio
Retail-like fueling experience
Hydrogen stations
Auto Companies Continue Development

- MoU signed by most major car companies saying that they will roll out mass produced fuel cell vehicles by 2015
- This will be in limited geographies
  - Germany
  - California
  - Japan
- Public Infrastructure support being delivered
Renewable hydrogen is a must

- Status quo is not an option
- Industry is committed to collaborative programs focused on renewable hydrogen
Infrastructure Transition

- Provide technologies which have utility today while positioning for the future
- Focus on a regional model with abundant H2 and population.
- Focus on mass transit in other urban areas.

Future Hydrogen Infrastructure will include:
- Pipeline delivered hydrogen similar to NG
- Multiple feed sources of hydrogen from:
  - Biomass
  - Geothermal
  - Wind
  - Solar
  - Nuclear
  - Coal
  - Methane reforming
- Delivered or distributed product in the outlying areas
Hydrogen Energy Station Vision

Feedstock Source:
- Natural Gas
- Digester Gas
- Landfill Gas
- Agricultural Wastes
- Pyrolysis Products
- Bio-Syngas / Syngas
- Vegetable Oils / Oils
- Other Methane Sources

Biogas

Natural Gas

CNG

H₂/CNG

Renewable hydrogen – for onsite requirements or regional distribution

H₂ Energy and Fueling Station

Heat

Power

Neighborhoods

Farms

Businesses

Brewery

Laundry

Biogas

Hydrogen

Power

Heat

Natural Gas
Renewable-Supplied Hydrogen Station – Fountain Valley, California

**Fountain Valley Station**

- 100 kg/day capacity
- 350 and 700 bar fueling capability
- Host site: Orange County Sanitation District
- Co-located with existing CNG dispenser
- Renewable hydrogen production using Hydrogen Energy Station
- Funding support by California Air Resources Board, DOE, Air Products and South Coast Air Quality Management District
Municipal Waste Gasification

- Producing hydrogen from waste will help meet EU Landfill Directives and produce clean energy.
- Multiple technology options exist.
- Gasification is a green method of waste destruction which delivers a green syngas – a CO:H2 gas mix.
- This technology is future proofed in that significant volumes of both hydrogen and power can be jointly generated via this route.
- Press release announcement last month.
- Multi hundreds of millions investment.
- First world scale plant is at the pre planning application stage for Teesside.
Initial Facility Lay Out
Plant Details

- 950MT/D waste processed
- 50MW of power produced
- 40 - 50 long term jobs created
- 700+ construction jobs at peak (3 yrs)
- Trial location for fuel cell power train
- Possible upgrading of power train to fuel cells
- Possible further expansion to second train
- Possible sale of hydrogen and/or syngas to chemical companies locally
Hebridean Hydrogen Park
H2seed

Electricity from biogas

Production: 5Nm³/h
Storage (buffer): ~22Nm³ at 30 bar
Storage (high pressure): ~65Nm³ at 420 bar

H2 production - water electrolysis

Application

Storage

Fuelling station
Wind to Hydrogen

- GAS NATURAL: Sotavento wind farm (60 Nm³/h H₂ production)
AP have supplied an S100 hydrogen fuelling system + green hydrogen store for Hydrogen Mini Grid

Funded by Yorkshire Forward as part of the Objective 1 investment programme
PV to hydrogen

- Hércules project (Spain)
- Located at the site of a solar collector facility
- Transport application
- Converting a diesel car into a hybrid
- 8 companies participating, including Air Products

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London leading the way in hydrogen

- Onstream late 2010
- Fuelling of up to 10 buses for 5 years
- LHY supply via a novel supply concept trailer
Latest Delivery Vehicle Concepts

Air Products London Delivery Vehicle
Central Grocers, Inc.

- Opened March 2009
- 946,000 sft. Warehouse greenfield site
- 140+ MHE fleet, largest under one roof. Expanding to 240 MHE units.
- 3 indoor dispensers, 2 more in a year
Hydrogen Competes with Gasoline Today

**Pipeline Station -- CA**

- ~100 cars/ wk capacity
- Pipeline hydrogen supply
- New station, retail design
- To be on-stream early 2010
- Hydrogen dispensed into a car at $3.50-4.00/kg (delivered to the station at $2.50/kg, latest technology fuel station adds $1.00-1.50/kg)
Next Phase JTI Projects

• CHIC
  • London represented again with further bus deployments
  • Development of a new high pressure gas trailer as a mobile fuelling station
  • Delivery for all 350 bar applications direct to the vehicle
  • Full European approval

• 2010 Application in preparation
  • Strong political support
  • Project in development
  • Taxi and other vehicle deployments
  • Further public space fuelling station
Riding in a hydrogen-powered bus never looked so cool.

The most abundant fuel in the world.

Yes, hydrogen is everywhere. It’s in the air we breathe, the water we drink, and now in the cars we drive. And guess what? When you burn it, its main byproduct is water. Much better than that polluting exhaust that causes all those smoggy days.

How do you get involved?

Make sure you ride the hydrogen bus while at Lehigh Valley Hospital’s Crayola Great Campus. There’s also a hydrogen-powered bus operating on the Air Products campus in Allentown, PA. And visit the Da Vinci Science Center to learn more about hydrogen. Discover how and why hydrogen should be developed as a fuel of the future through the center’s innovative hydrogen exhibits and programs coming soon.

This brochure can’t explain it all.

You may still be curious about hydrogen and all its benefits and use as an alternative fuel. Don’t worry—visit the website. We’ve got it all explained on our website. Just visit HydrogenFutureToday.com where there is also a fun quiz for kids.

Hydrogen Fueling Station
Air Products and Chemicals, Inc.
7200 Hamilton Boulevard
Allentown, PA 18195-1501
800-364-0547

Da Vinci Science Center
3145 Hamilton Boulevard Bypass
Allentown, PA 18103
610-466-1002
Open Monday through Saturday 9:30 am to 5:00 pm.
Sunday 12:00 noon to 5:00 p.m.
The Bottom Line

- The use of Hydrogen as a fuel continues to make strides globally in many markets
- Commercial benefits exist today in some geographies which will drive FC cost reduction
- Car company commitment to role out mass produced vehicles by 2015
- Methods of large scale green hydrogen production are just around the corner
- EU is beginning to understand how to affect the market
- Rapid introduction required otherwise events will overtake
- The UK needs to secure its place in the hydrogen world
- Hydrogen remains and is the *only* fuel that over the long run, has the ability to meet objectives regarding energy independence, greenhouse gas emissions *and* sustainability
Thank you

tell me more

www.airproducts.com/H2energy