Scotland's Hydrogen Future

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Ian Williamson
Hydrogen and Bio Energy Systems Director
Air Products

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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

Today's state of affairs

Air Products
50+ years of hydrogen experience

- Over 5000MT per day H_2 production
- Bulk, liquid, and pipeline distribution
- World's largest H2 producer
- H_2 energy projects since 1993
  - > 110 hydrogen stns
  - > 100,000 fuelings/yr
- Stations in 18 countries
- Active in UK hydrogen arena
  - via UKHA, CENEX & SHFCA
- Active in Europe
  - via the JTI and the EHA

Today's state of affairs

Real advances are being made

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

Today's state of affairs

Retail-like fueling experience

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Hydrogen stations

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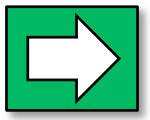
Auto Companies Continue Development

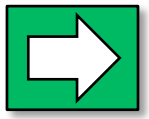
- MoU signed by most major car companies saying that they will roll out mass produced fuel cell vehicles by 2015
- This will be in limited geographies
  - Germany
  - California
  - Japan
- Public Infrastructure support being delivered

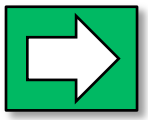
Renewable hydrogen is a must

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

Longer term







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*

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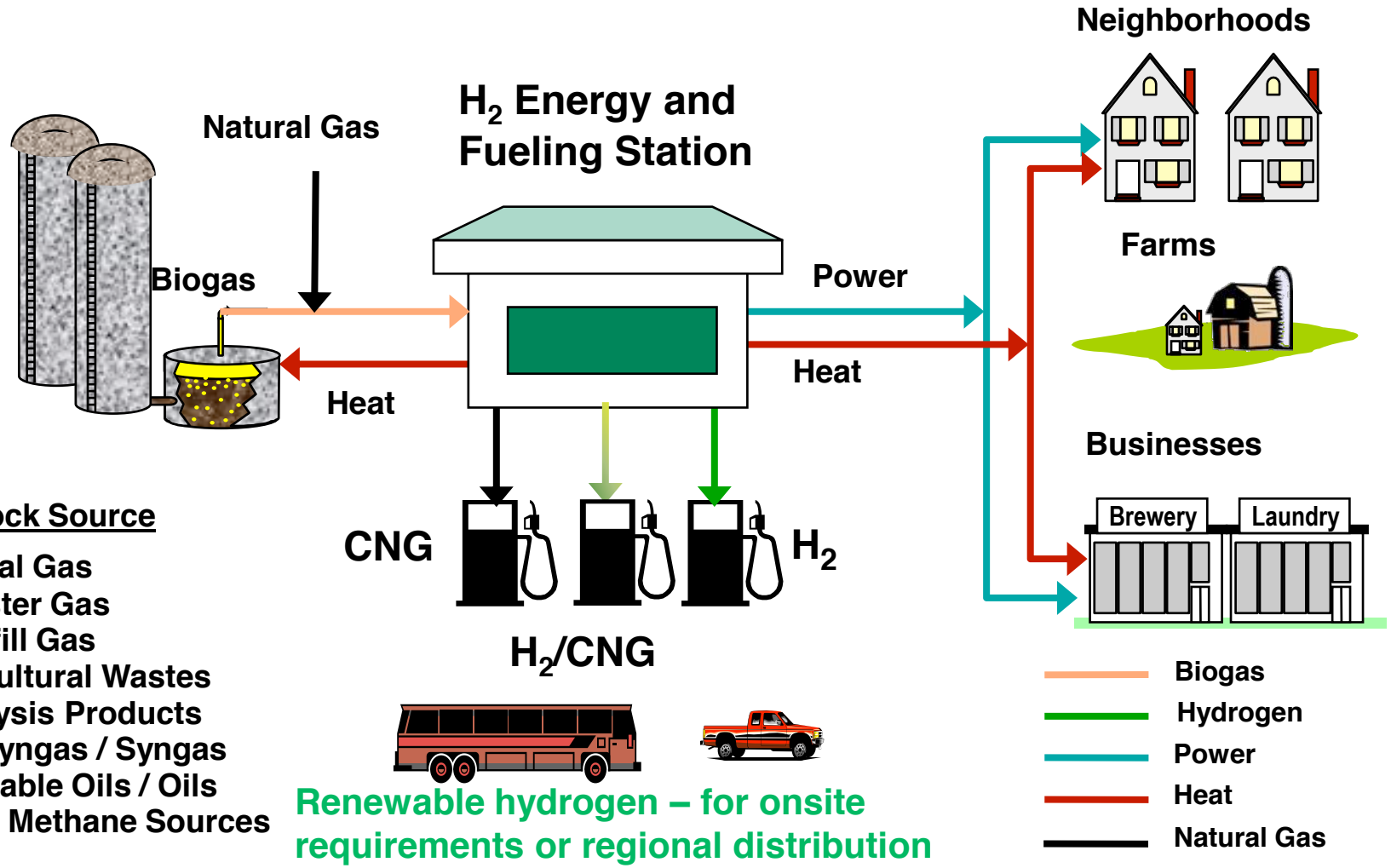
Hydrogen Energy Station Vision



Feedstock Source

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

Renewable hydrogen – for onsite requirements or regional distribution

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Municipal Waste Gasification

- Multiple technology options
- Green method of waste destruction which delivers a green syngas – a CO:H2 gas mix
- The key is cleaning of this syngas
- Gas cleaning is a strategic competence of Air Products
- Significant volumes of hydrogen and power can be generated via this route
- Timescale to commercial plant onstream 36 months

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Initial Facility Lay Out

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Plant Details

- 750MT/D waste processed
- 40+MW of power produced
- 70 - 80 long term jobs created
- 700+ construction jobs at peak
- 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

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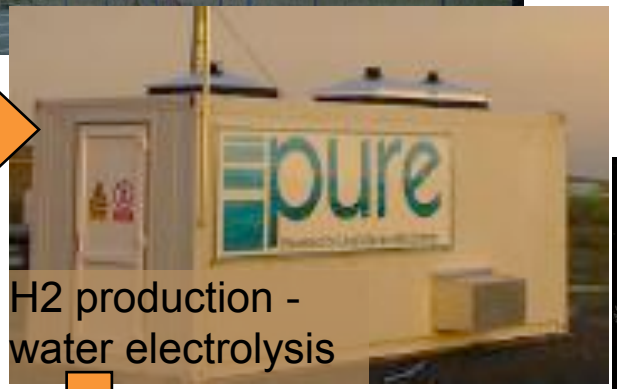
Hebridean Hydrogen Park H2seed



Storage

Fuelling station

Production: 5Nm^3/h

Storage (buffer): ~22Nm^3 at 30 bar

Storage (high pressure): ~65Nm^3 at 420 bar

Application

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Wind to Hydrogen

- GAS NATURAL: Sotavento wind farm (60 Nm^3/h H_2 production)

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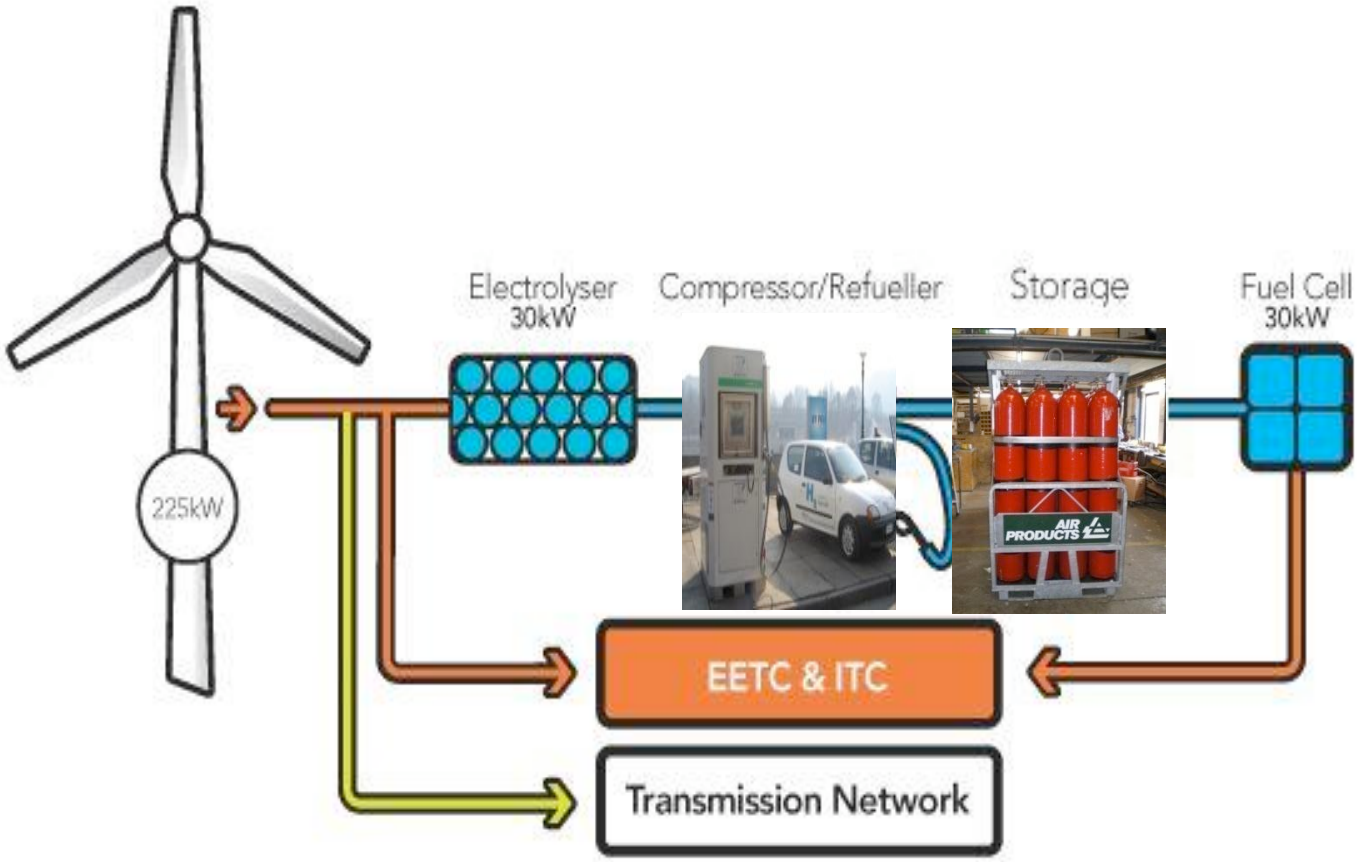
Hydrogen Mini Grid Rotherham

- **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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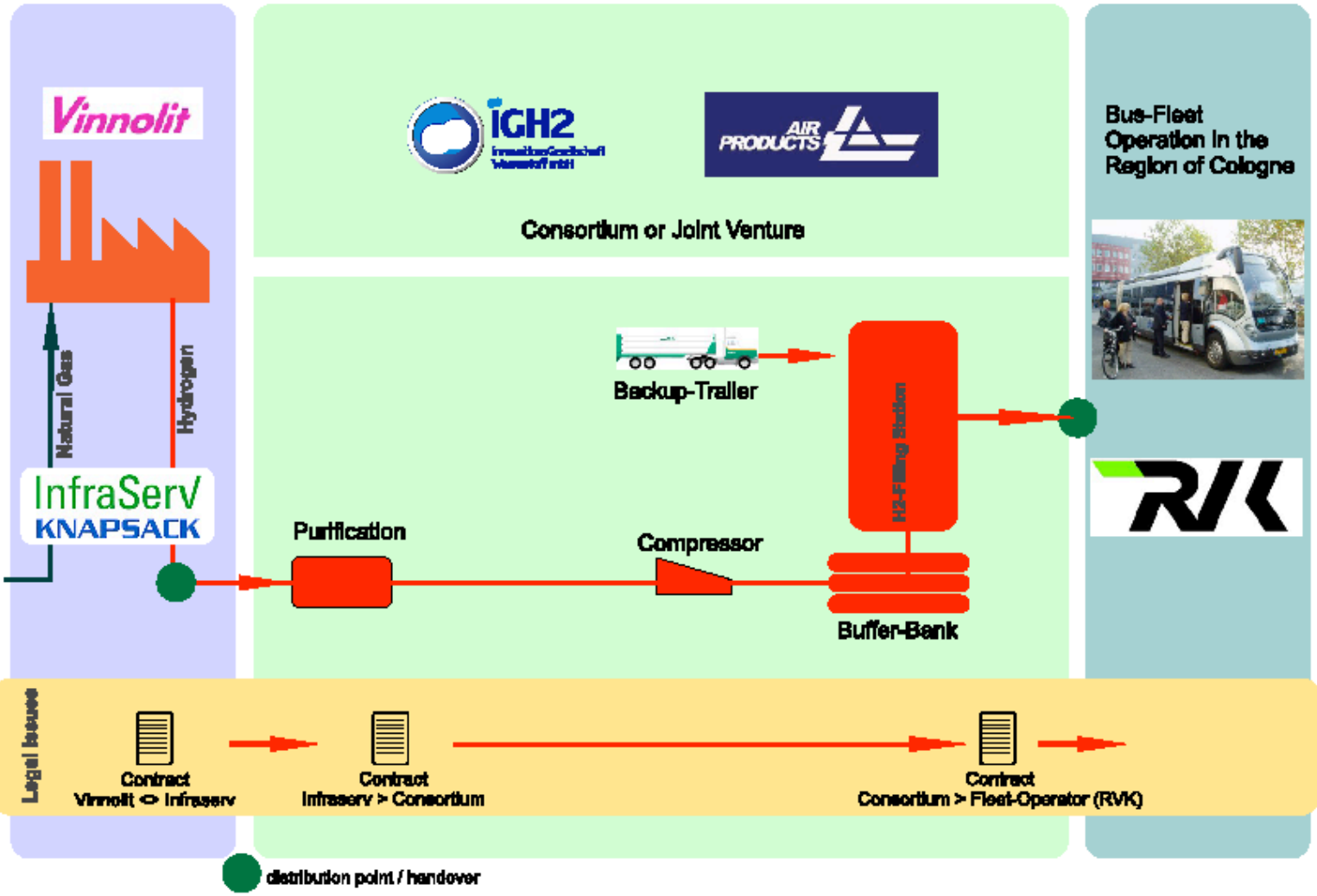
TfL, London Bus Supply

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

Hürth Bus Project Organisation



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

The Bottom Line

- The use of Hydrogen as a fuel continues to make strides globally in many markets
- Industry looks for political leadership
- Commercial benefits exist today in some geographies which will drive FC cost reduction
- Car company commitment to role out mass produced vehicles by 2015
- Hydrogen is the ***only*** fuel that over the long run, has the ability to meet objectives regarding energy independence, greenhouse gas emissions ***and*** sustainability
- Methods of large scale green hydrogen production are just around the corner

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Thank you

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