FABIG

FIRE AND BLAST INFORMATION GROUP

WEBINAR 001 PROCEEDINGS

UPDATE ON HYDROGEN RESEARCH AT SPADEADAM

23rd April 2020

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Hydrogen @ Spadeadam Research and Testing

Dan Allason, DNV GL

Historic Projects

AIR PRODUCTS

NATURALHY

OSAKA GAS GROUP

Current Projects

H21 NIC – Phase 1

Hy4Heat

FFI Forsvarets forskningsinstitutt
Norwegian Defence Research Establishment

Future Projects

H21 Phase 2/H21 Field Trials

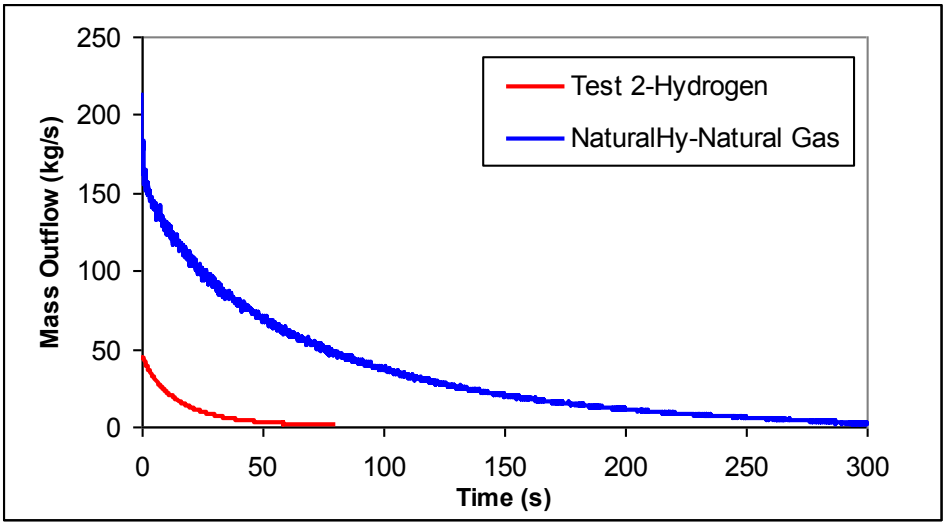
nationalgrid HyNTS

LH2@SCALE

Air Products / NaturalHy Transmission Fires

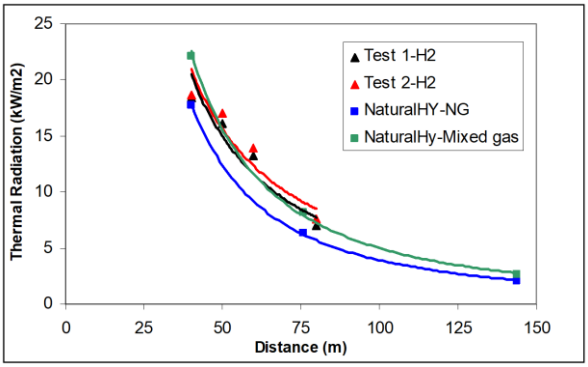
- Transmission releases up to 150mm double ended @ 70bar
- Outflow, thermal and overpressure measurements

AP / NaturalHy Transmission Fires: Key Finding

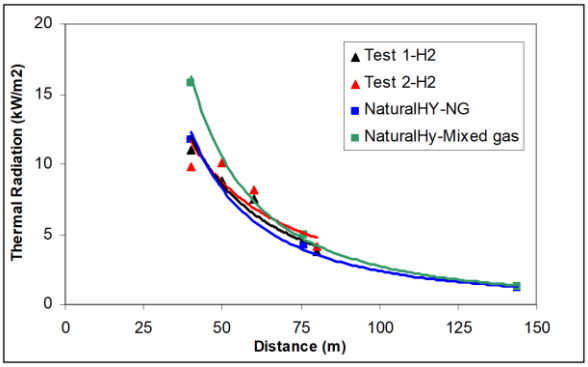


Air Products Hydrogen Transmission Fires: Key Findings

2800 MW



1500 MW



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Osaka Gas Filling Station Project

- Release pressure of 100bar, nozzle sizes up to 1.6mm (flow up to 20 g/s)
- Partially ventilated enclosure, monitored accumulation / venting

- Full scale filling station and plant room
- Culmination of more idealised explosion experiments

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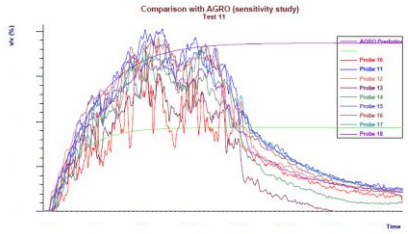
Osaka Gas Filling Station Project: Headlines



- Accumulation largely predictable by existing phenomenological models
- No real surprises when compared to other buoyant gases (e.g. NG)

- Explosions range from benign to extreme for relatively minor changes in ventilation, outflow rate, confinement and congestion

8% H_2

26% H_2

Introduction to the Current projects: H21 and Hy4Heat

Hy4Heat

Government Programme - £25m (Hy4Heat) Downstream of the meter

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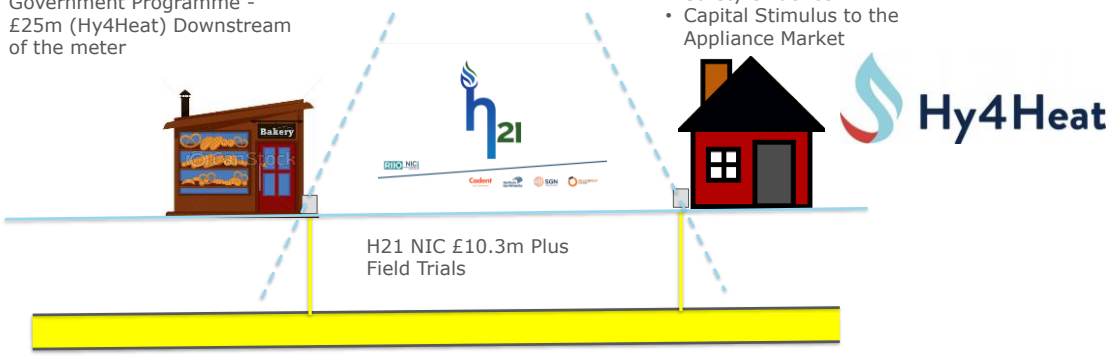
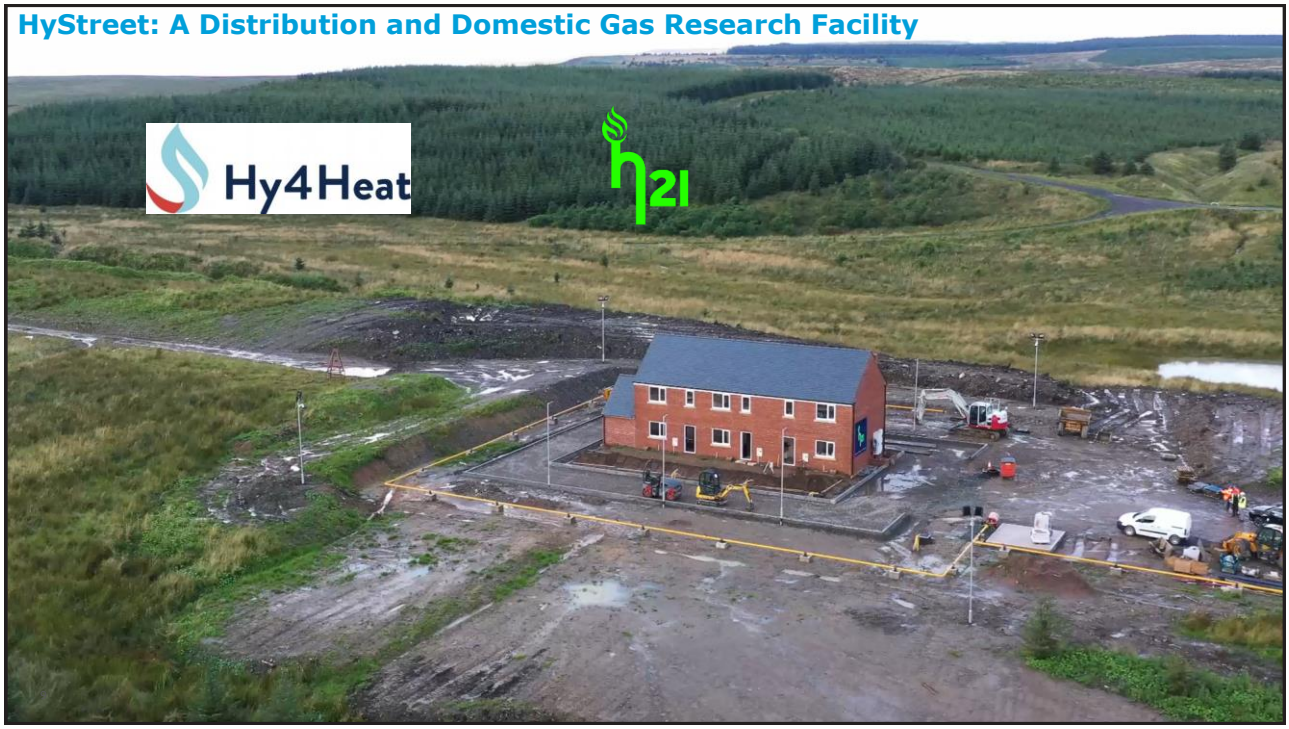
- Safety evidence
- Capital Stimulus to the Appliance Market



Hy4Heat

HyStreet: A Distribution and Domestic Gas Research Facility



Network

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HyStreet

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Location

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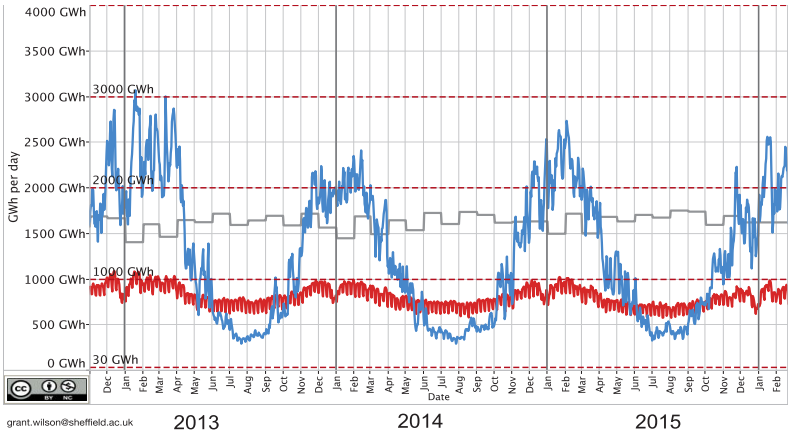
H21: Motivation

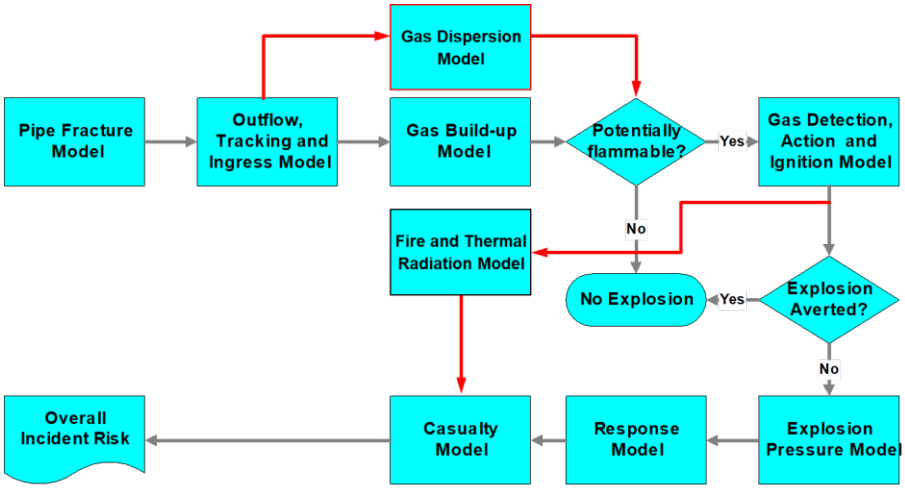


- UK Government now committed to net-zero by 2050
- Energy needs must be met
- Gas infrastructure most suited
- Must be shown to be of manageable risk (i.e. equal or lower to natural gas)

H21: Phase 1B Methodology

- Risks of Natural Gas Distribution known and managed
- Current predictive methodologies can be measured against statistics => risks can be quantified, mitigated and accepted
- How does a change to Hydrogen impact this?

H21: Phase 1B Methodology



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H21 WBS1: Small Releases

Test ID	Diameter (mm)	Orientation	Mflow (SLPM measured)	Gas	SP01	SP02	SP03	SP04	SP05	SP06	SP07	SP08	SP09	SP10	SP11	SP12	SP13	SP14	SP15	SP16	SP17	SP18	SP19	SP20	SP21	SP22	SP23	SP24	SP25
SRA02	20	Side		methane																									
SRA01	20	Side		hydrogen																									
SRA03	20	Side		methane																									
SRA04	20	Side		hydrogen																									
SRA06	20	Side		methane																									
SRA07	20	Side		methane																									
SRA05	20	Side	↓	hydrogen																									

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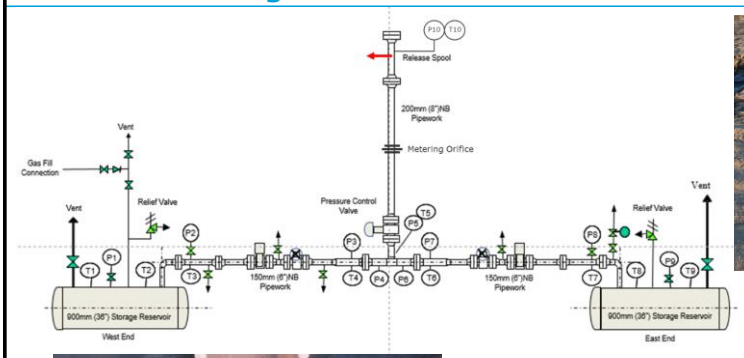
H21 WBS2: Large Releases



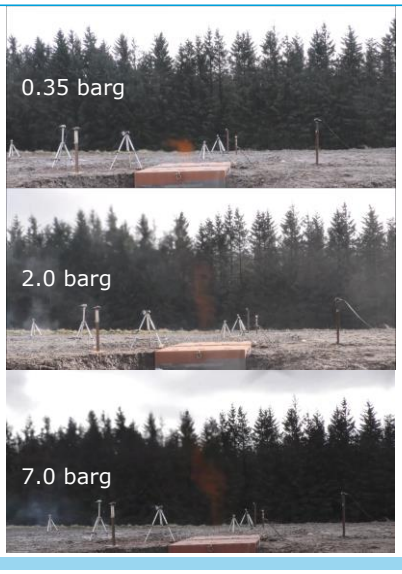
- Buried or pre-formed 'trench'
- Up to 200mm double ended
- Ignited or unignited
- Instrumented for dispersion or thermal radiation / overpressure

H21 WBS2: Presented at ICHS 2019

All open excavation experiments, upwards from 20mm hole:

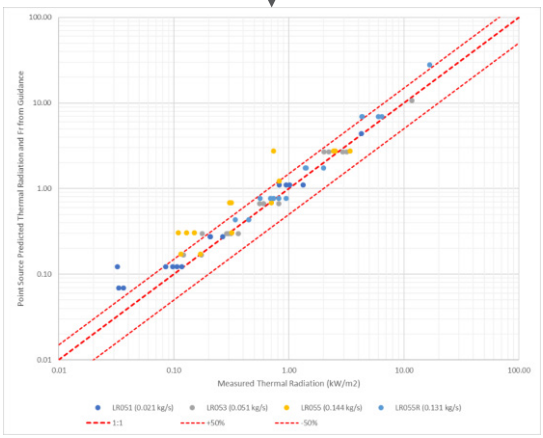
Test ID	Diameter (mm)	Orientation	Outlet Pressure (barg)	Outlet Pressure (stdev)	Mflow (kg/s)	Mass Flow (stdev)	Power (kW)
LR051	20	Up	0.355	0.003	0.019	0.0002	2482
LR053	20	Up	1.973	0.014	0.048	0.0005	6055
LR055	20	Up	7.447	0.080	0.146	0.0031	17245
LR055R	20	Up	6.684	0.100	0.135	0.0019	15679

H21 WBS2: Presented at ICHS 2019



$$I = \frac{QF_r}{4\pi r^2}$$

Very simple point source check



H21 WBS3: Ignition Testing

- Items relevant to incident response prioritised
- Established fact that H2 << NG MIE
- Here aim is to investigate real devices and 'Ignition Potential'

H21 WBS4: Explosion Severity

- Limited explosion studies
- Concerned with finding show-stopping events in likely scenarios
- None found in cases considered

H21 WBS5: Operational Safety

- Flow loop commissioned for demonstrations of network operations:
  - Purging / venting
  - Flow stopping
  - Excavation

Hy4Heat WP7: Lots 2 and 3

Hy4Heat

- Concerned with domestic leakage downstream of ECV
- Room Level Leakage and Property Level Leakage

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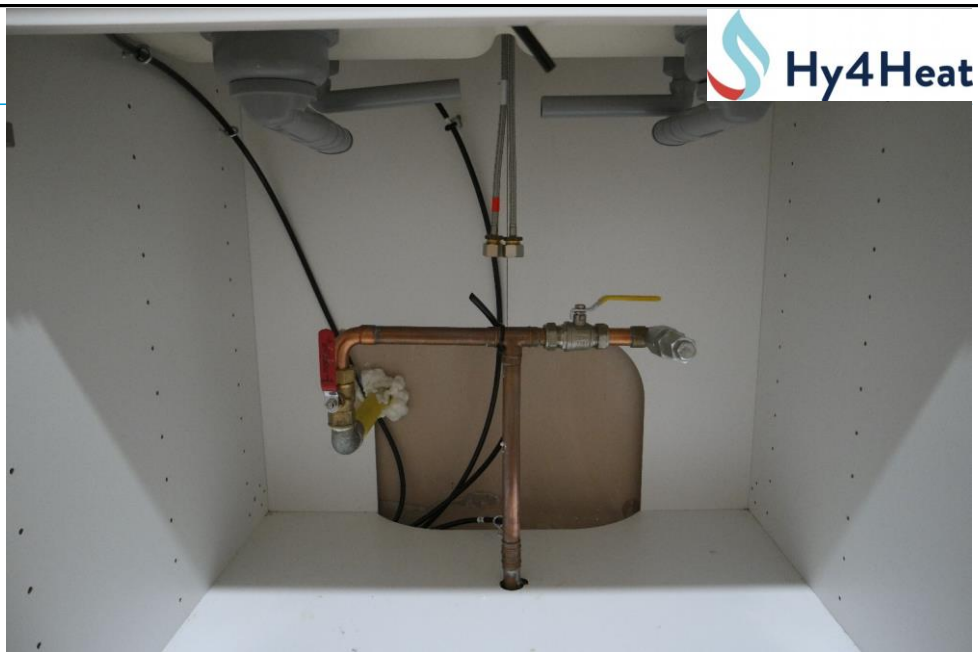
Release Points



Hy4Heat

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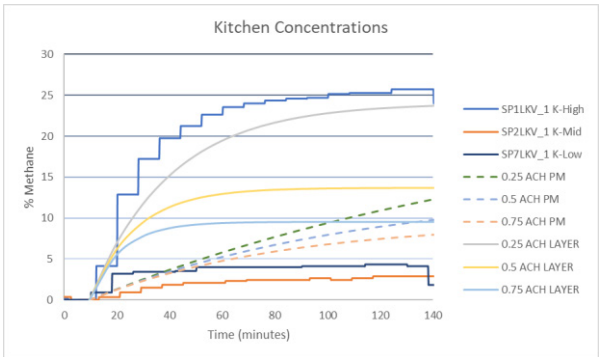
Control and Metering

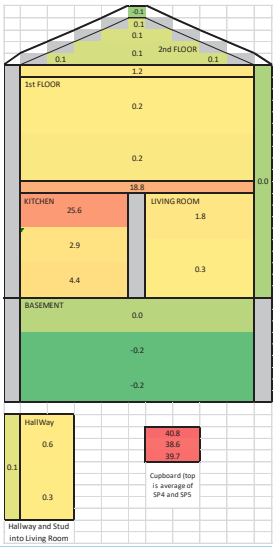
Hy4Heat

Simple Model: Versus Methane

$$C = \left(\frac{100Q_g}{Q_a + Q_g}\right)\left\{1 - \exp\left[-\left(Q_a + Q_g\right)t / V\right]\right\}$$

Room Length	5	m
Room Width	3	m
Room Height	2.4	m
Leak Height	2.0	m



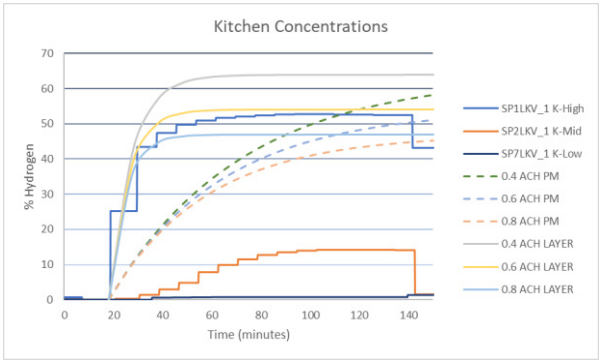


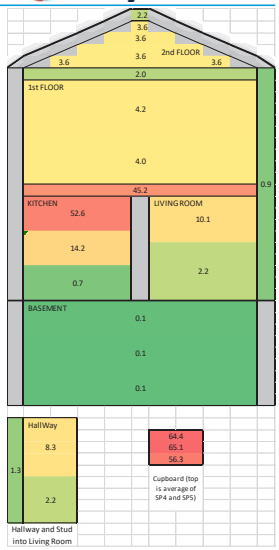
Simple Model: Versus Hydrogen

Hy4Heat

$$C = \left(\frac{100Q_g}{Q_a + Q_g}\right)\left\{1 - \exp\left[-\left(Q_a + Q_g\right)t/V\right]\right\}$$

Room Length	5	**m**
Room Width	3	**m**
Room Height	2.4	**m**
Leak Height	2.0	**m**





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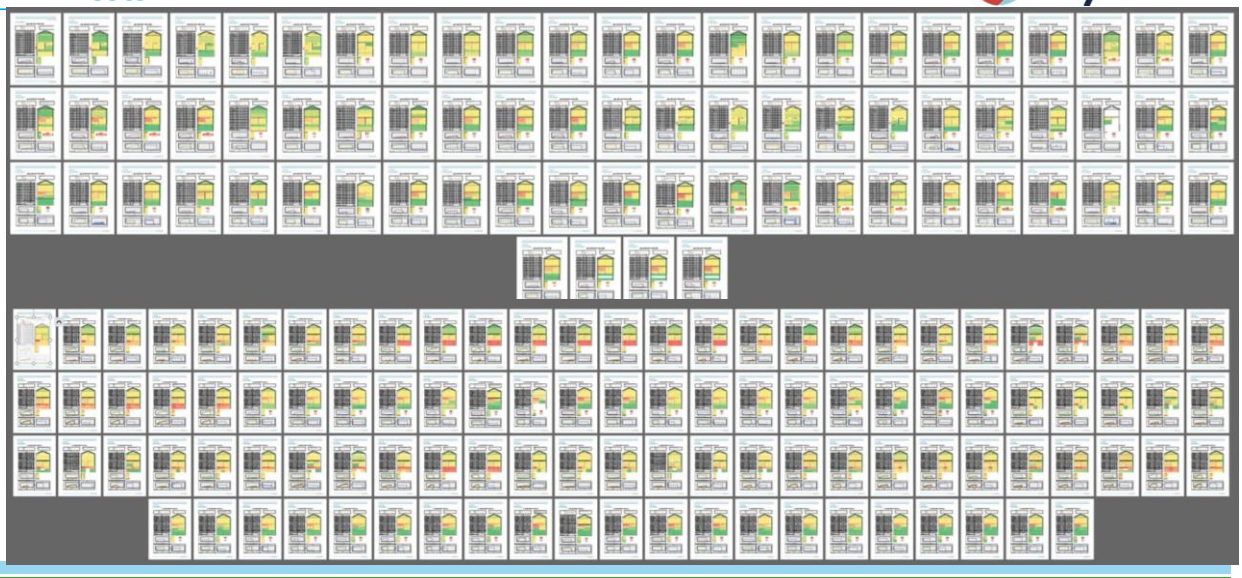
All Tests

Hy4Heat



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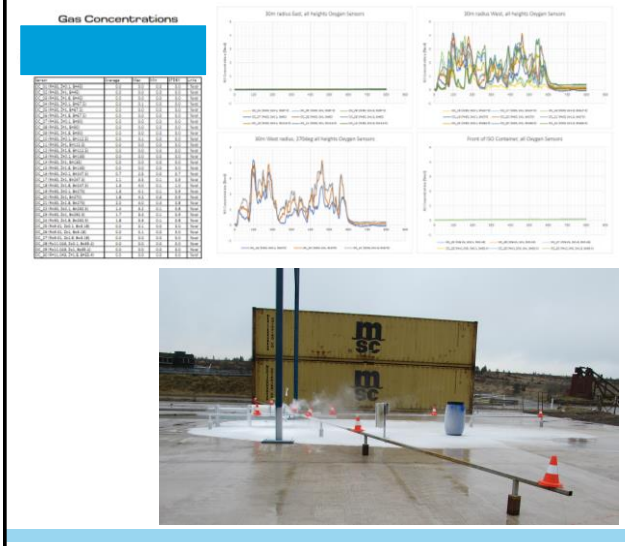
Relevant Experience: LH_2 (FFI)

FFI Forsvarets forskningsinstitutt
Norwegian Defence Research Establishment



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The Future

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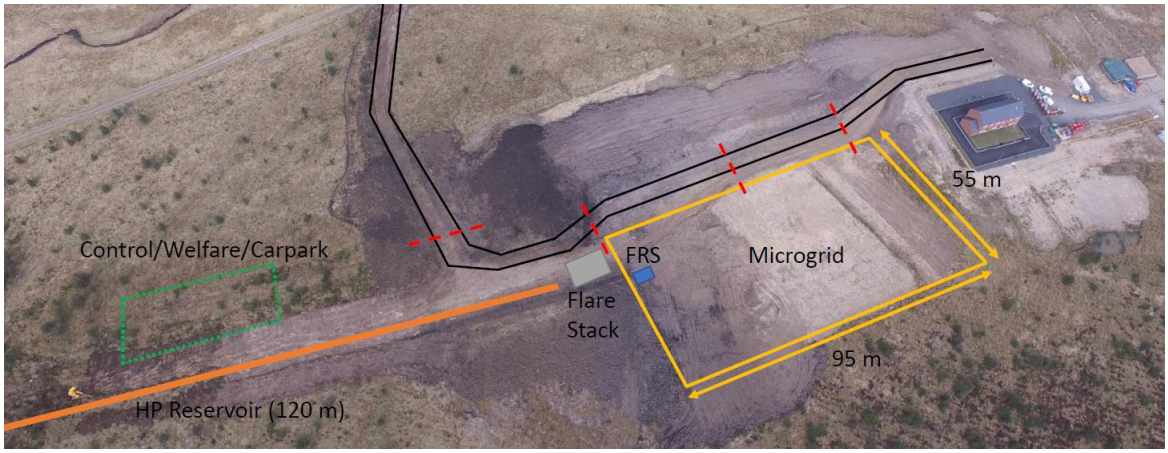
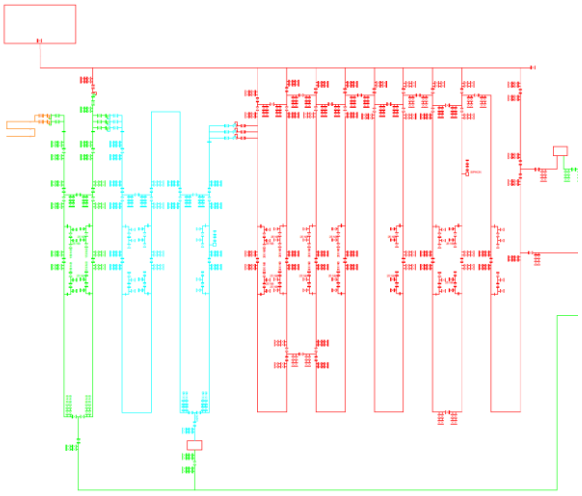
The Future

H21 Phase 2: Microgrid

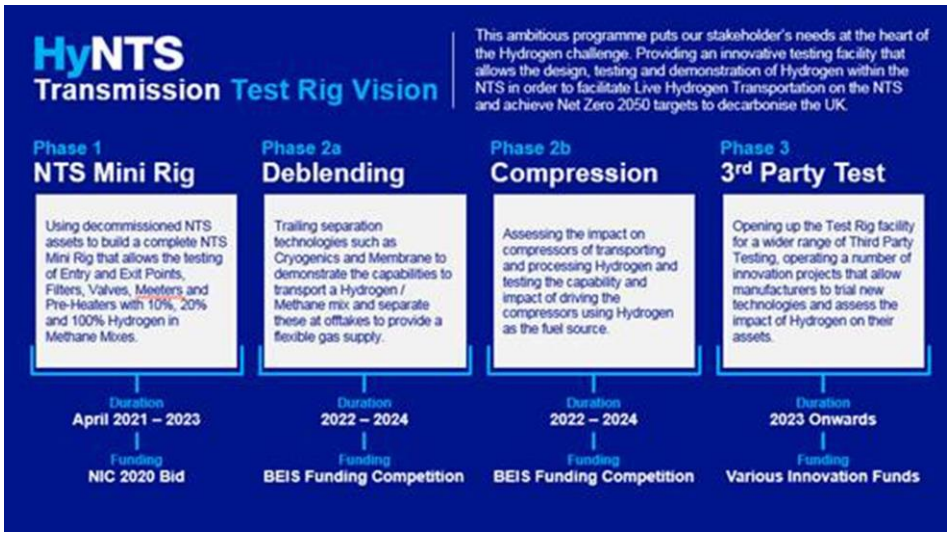


H21 Phase 2: Microgrid

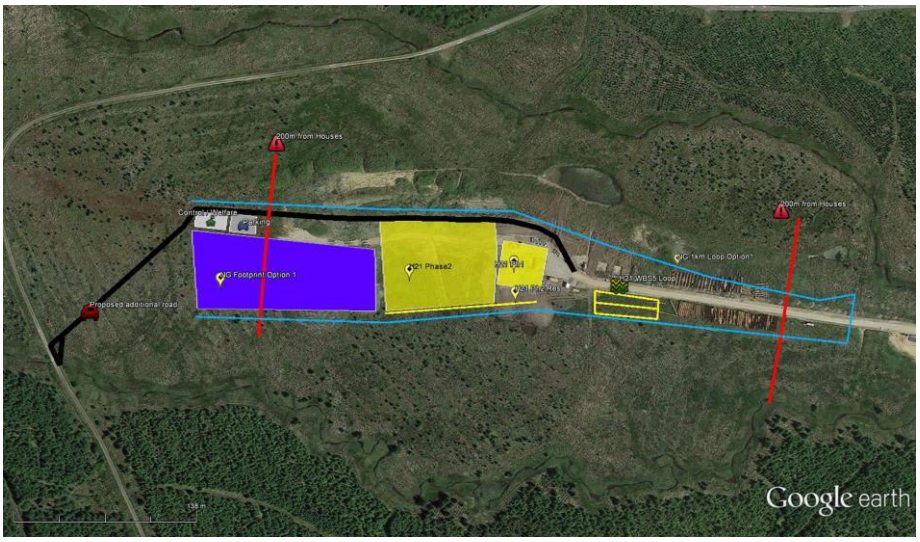
- HP, IP, MP, LP
- Various diameters
- Flow Assurance
- Operational Assurance
- Prove conversion



HyNTS Future Grid (ISP only)



Potential Future Position



LH2@SCALE

- Looking for partners to join a Joint Industry Project
- Experimentation, modelling, validation and potential tool creation
- Investigate liquid hydrogen phenomena at more representative scales than have been considered before:
  - Outflow, pressure drop, two-phase behaviour
  - Pooling, dispersion, accumulation, ventilation
  - Fire, explosion, BLEVE
  - Effects on materials
  - Other H2 based fuels?
- Currently canvassing for scope and partners

Thanks for your attention!

Questions?

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