WORKING GROUP #4
HYDROGEN NETWORK COMPONENTS

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COMPARATIVE PHYSICS OF METHANE VS HYDROGEN

Physical Property	Methane (CH_4)	Hydrogen (H_2)
HHV volumetric	40 MJ/m^3	12.7 MJ/m^3
LEL	5% by volume in air	4% by volume in air
UEL	17% by volume in air	75% by volume in air

Change in BTU/HHV

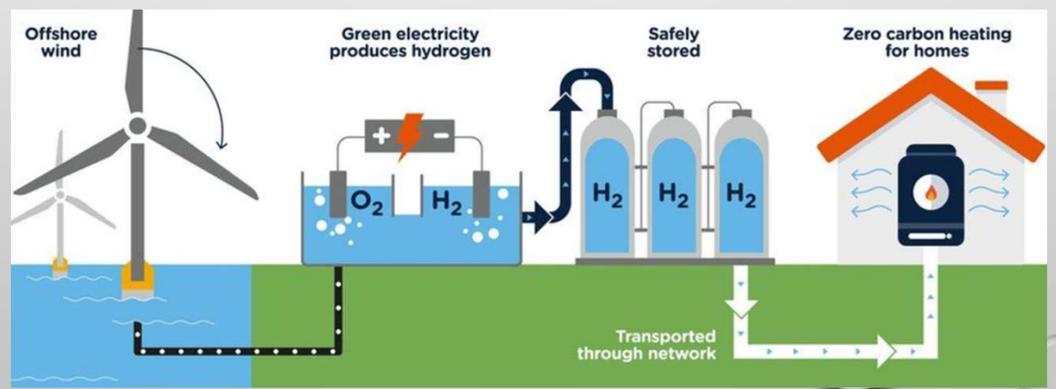
Mixing/Monitoring for H2 blends

Use of pipeline as storage vessel

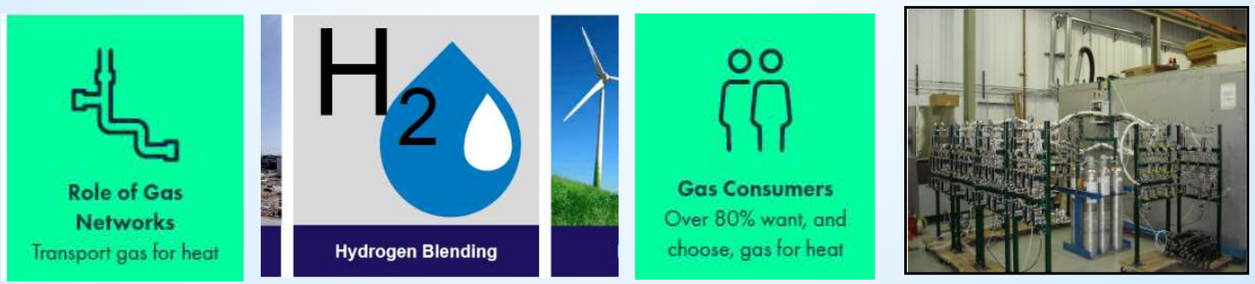
Ability to store hydrogen and transport over long distances

GAPS

- Full inventory and knowledge gathering on impact of hydrogen on gas operations
- Scaling of laboratory work to testing live conditions in the field
- Assessment and improvement of economics that lead to practical application of green hydrogen – production & distribution
- Pilot tests & implementation - Blended hydrogen at 20% blends and higher



SAFETY IN GAS OPERATIONS



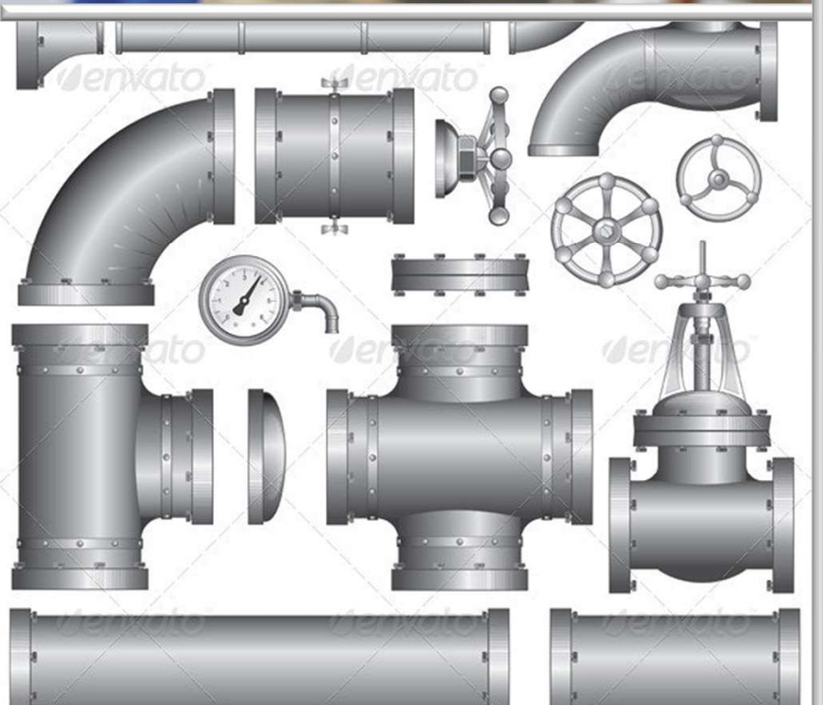
NYSEARCH PROJECTS

HYDROGEN BLENDING

HYDROGEN - NATURAL GAS LIVING LAB

PROJECT OVERVIEW

- 2-year demonstration project to simulate hydrogen blending in a high pressure and medium pressure system
- Blend 25 to 35% hydrogen into the test-system
- SoCalGas small-scale hydrogen blending demo in 2021 - Facilitate customer service training, assess end-use equipment for blends up to 20 vol%
- Leverage the knowledge and experience gained to develop a larger scale demonstration to evaluate blending at higher hydrogen content



HYDROGEN - NATURAL GAS LIVING LAB

PROJECT WORKSCOPE

- Investigation on pipeline and pipeline equipment material and performance impacts
  - Polyethylene pipe, steel pipe, gaskets, elastomers, fittings, regulators, valves
  - Periodic removal of pipe and components to examine material changes
  - Compressor (emissions from a compressor's rod packing system)
  - Pressure regulating station
- Test new leak survey/detection/quantification technologies as they become available
- Assess the need and extent for new safety training

HYDROGEN - NATURAL GAS LIVING LAB POTENTIAL FUTURE PHASE

- Installation Of Blending And Injection Skid
- Appliance Testing
- Odorant Compatibility (TBM And THT)
- Expand Footprint To Accommodate Additional Testing Infrastructure
- 24/7 Testing

Odorant Monitoring System

IMPACT OF HYDROGEN/NATURAL GAS BLENDS ON LDC INFRASTRUCTURE INTEGRITY

OBJECTIVE

Determine if blending hydrogen into a fuel gas will change the physical properties of elastomers used as materials of construction in a natural gas delivery system

EXPECTED OUTCOMES

Knowledge and quantification of changes to physical properties of elastomers in LDC networks

- Anticipated results from Phase II: confirmation and quantification of creep, stress, shrinkage, swelling for a wide range of elastomer materials and for some blends of H2/NG including 'rich' gas with heavy hydrocarbons
- If warranted by funders, test additional H2/NG blends using same or expanded materials testing protocols (e.g., wider range of temperatures and pressures)

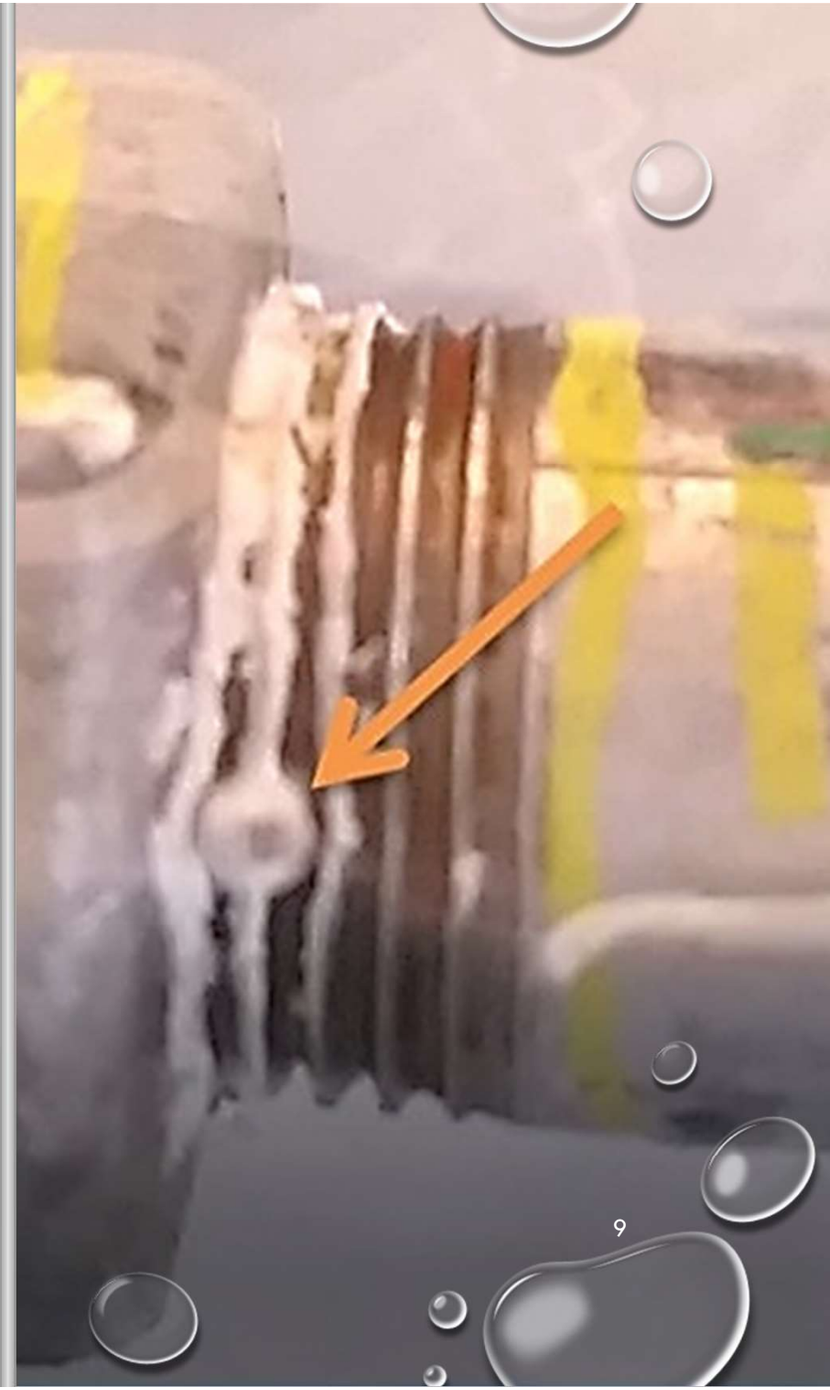
IMPACT OF BLENDED H2 ON THREADED CONNECTIONS

Challenge: Does blended hydrogen increase the risk of leaks at threaded connections and is the flow rate of the leak greater?

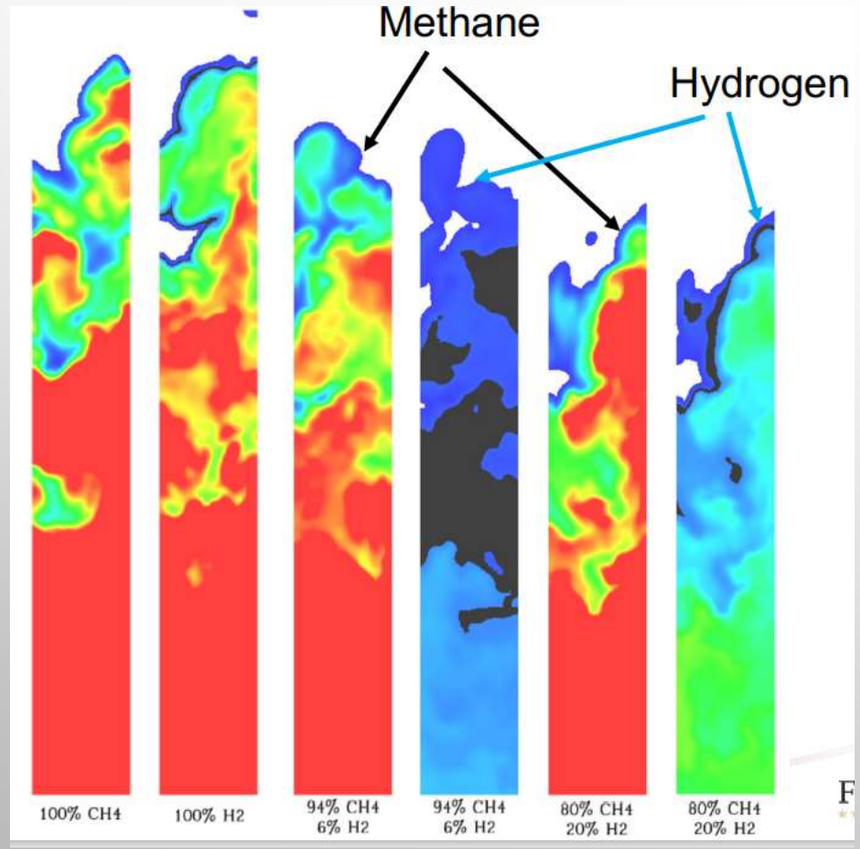
Objective: Evaluate the impact of blended hydrogen at threaded connections by determining failure rate and flow rate through experimentation and statistical analysis.

Project basis: NYSEARCH's threaded connections evaluation program (started in 2018 and completing end of 2021)

Expected outcomes: Insight into leak behavior at threaded connections with blended hydrogen



IMPACT OF HYDROGEN ON NATURAL GAS DISPERSION IN A RESIDENTIAL STRUCTURE



CFD Simulation

Is the NFPA 715 Standard for methane detector placement and detection valid for gas blended with hydrogen?

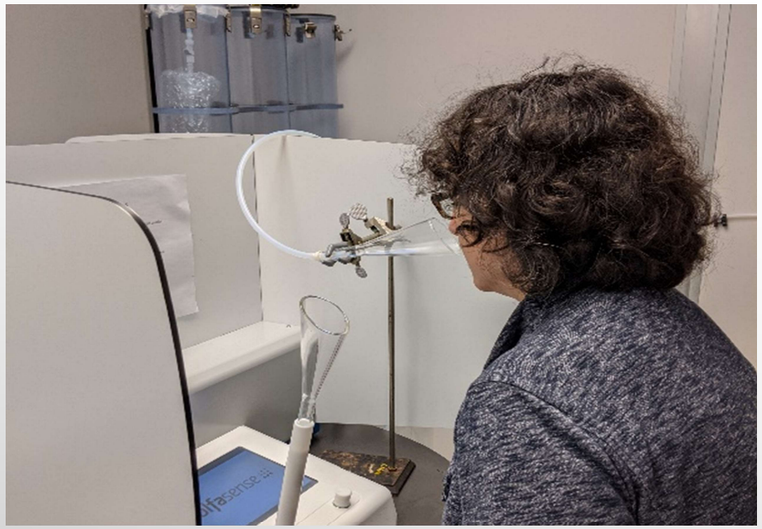
OBJECTIVE

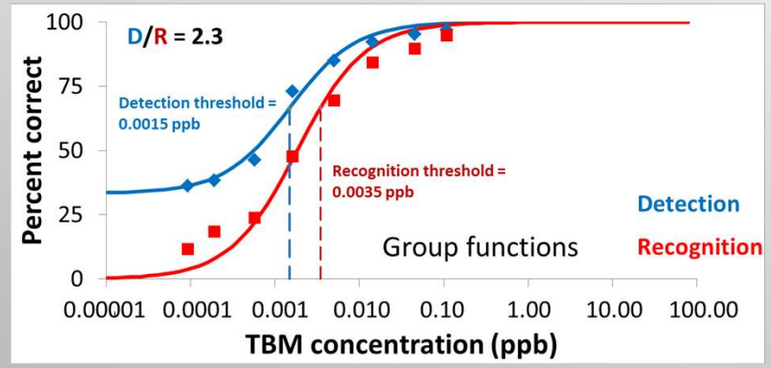
Study physics of hydrogen and map dispersion of natural gas blended with up to 20% hydrogen

PROJECT BASIS

Dispersion testing & modeling of natural gas in a residential structure with & without natural ventilation & HVAC (started in 2018; completed Ph II in 2020)

ODOR DETECTION STUDY – EFFECT OF HYDROGEN BLENDS ON ODORIZING NG





OBJECTIVE

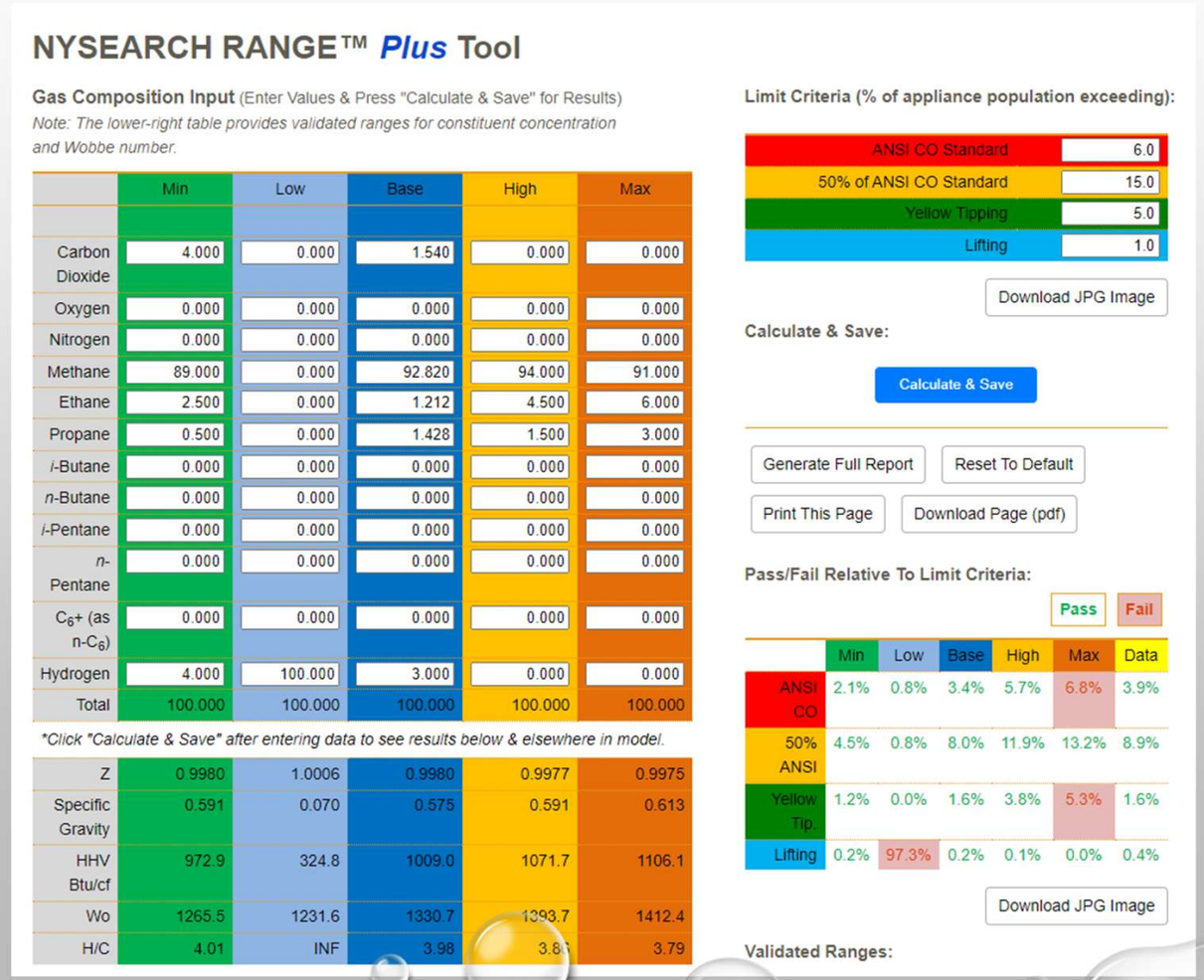
To determine the detectability and recognizability of some primary NG odorant/odorant blends in the presence of hydrogen (example blends: TBM/THT, Scentinel-N, Scentinel F-25)

Expected outcomes

- Comparable data for different blends of H2 starting at 10% using TBM/THT (and other mercaptans) to traditional odor detection and recognition threshold information from base project
- If warranted, test additional blends or 100% H2 using same odor detection and recognition threshold protocols

NYSEARCH RANGE PLUS™ MODEL INTERCHANGEABILITY WITH HYDROGEN BLENDING

- Spreadsheet-based, interchangeability assessment model
- Projects performance of in-service residential appliance populations when new gas supplies are introduced
- Added capability - upto 20% blended hydrogen
- High flame speed of hydrogen – flashback
- Hydrogen-natural gas blends can reduce or eliminate flame lifting



NYSEARCH RANGE™ *Plus* Tool

Gas Composition Input (Enter Values & Press "Calculate & Save" for Results)

Note: The lower-right table provides validated ranges for constituent concentration and Wobbe number.

	Min	Low	Base	High	Max
Carbon Dioxide	4.000	0.000	1.540	0.000	0.000
Oxygen	0.000	0.000	0.000	0.000	0.000
Nitrogen	0.000	0.000	0.000	0.000	0.000
Methane	89.000	0.000	92.820	94.000	91.000
Ethane	2.500	0.000	1.212	4.500	6.000
Propane	0.500	0.000	1.428	1.500	3.000
i-Butane	0.000	0.000	0.000	0.000	0.000
n-Butane	0.000	0.000	0.000	0.000	0.000
i-Pentane	0.000	0.000	0.000	0.000	0.000
n-Pentane	0.000	0.000	0.000	0.000	0.000
C_6+ (as n-C_6)	0.000	0.000	0.000	0.000	0.000
Hydrogen	4.000	100.000	3.000	0.000	0.000
Total	100.000	100.000	100.000	100.000	100.000

**Click "Calculate & Save" after entering data to see results below & elsewhere in model.*

Z	0.9980	1.0006	0.9980	0.9977	0.9975
Specific Gravity	0.591	0.070	0.575	0.591	0.613
HHV Btu/cf	972.9	324.8	1009.0	1071.7	1106.1
Wo	1265.5	1231.6	1330.7	1393.7	1412.4
H/C	4.01	INF	3.98	3.8	3.79

Limit Criteria (% of appliance population exceeding):

ANSI CO Standard	6.0
50% of ANSI CO Standard	15.0
Yellow Tipping	5.0
Lifting	1.0

Download JPG Image

Calculate & Save:

Calculate & Save

Generate Full Report | Reset To Default

Print This Page | Download Page (pdf)

Pass/Fail Relative To Limit Criteria:

Pass | Fail

	Min	Low	Base	High	Max	Data
ANSI CO	2.1%	0.8%	3.4%	5.7%	6.8%	3.9%
50% ANSI	4.5%	0.8%	8.0%	11.9%	13.2%	8.9%
Yellow Tip.	1.2%	0.0%	1.6%	3.8%	5.3%	1.6%
Lifting	0.2%	97.3%	0.2%	0.1%	0.0%	0.4%

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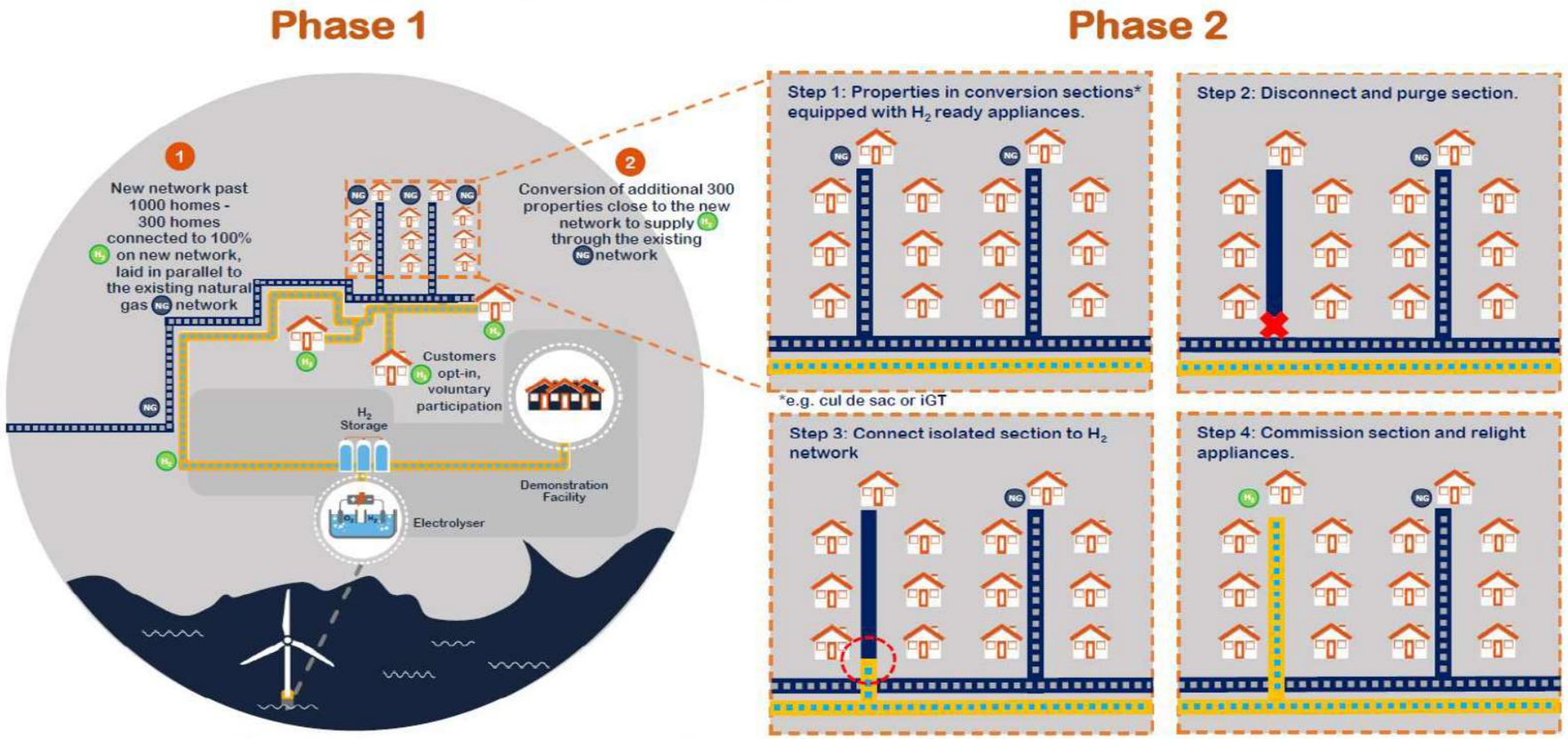
Validated Ranges:

GREEN HYDROGEN PROJECT FOR 300 CUSTOMERS (PE PIPE) IN UK

H100 Fife – Hydrogen Neighbourhood



This step by step approach for converting targeted areas of the network for Phase 2 allows for a phased process, where customers can have their natural gas supply switched to hydrogen and be back on gas in less than 24 hours. This keeps disruption to the customer at a minimum. Customers will have the choice to revert back to their natural gas supply.

FUTURE OF HYDROGEN IS HERE

- **Pilots and at scale demonstrations** – to support the development of policy, business cases, technology, consumer confidence and build supply chain capacity.
- **Public understanding** – a shift in the public perception of 'energy' as just electricity, the need to decarbonize the entire energy system and promote the role hydrogen could play.
- **Coordinated research** – a centrally coordinated group from across academia and industry to determine knowledge gaps and agree a portfolio of evidence gathering research.
- **Learn from overseas** – there are opportunities to learn and build on best practice from across the world, from advanced blending to repurposing transmission pipelines