Aqua-Ammonia; The Future of Space Heating

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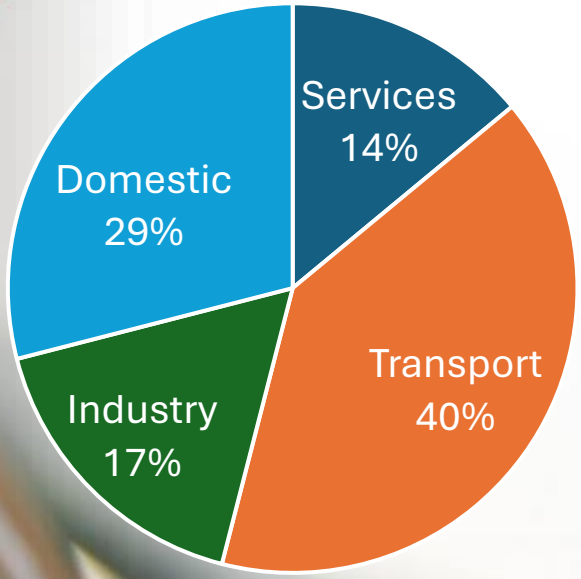
Net-zero carbon emission

Space heating sector is responsible for about **30% of the UK's CO2 emissions**

that

Is **heavily dependent on natural gas**.



- By **2030**, the UK aims to reduce greenhouse gas emissions by 68% compared to 1990 levels.
- By **2050**, the UK aims to achieve net-zero carbon emissions
- From **2025**, new homes in the UK will **not be permitted** to install gas boilers

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Available alternatives to natural gas

Heat Pumps

Strain the electricity grid; Require costly infrastructure upgrade

Electric heating

Strain the electricity grid; Require costly infrastructure upgrade

Hydrogen

significant storage and safety concerns; Unsuitable for residential applications

Biogas

Corrosive; Inconsistent energy content; Storage challenges; Odour issues; Upfront costs

Ammonia

Corrosive; Toxic; odour issue;

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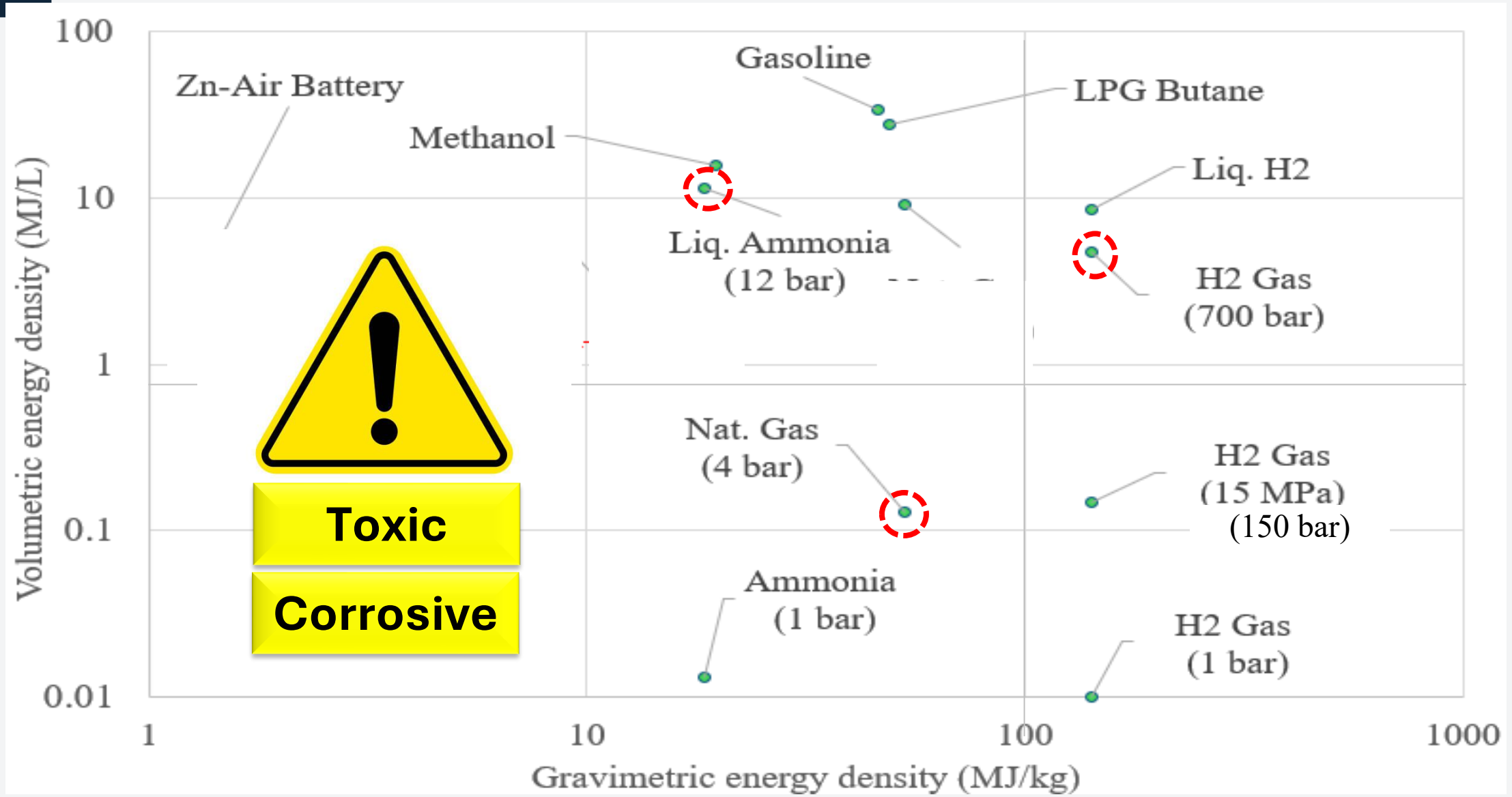
Ammonia


100
10
1
0.1
0.01
Volumetric energy density (MJ/L)
1
10
100
1000
Gravimetric energy density (MJ/kg)
Zn-Air Battery
Gasoline
LPG Butane
Methanol
Liq. Ammonia
(12 bar)
Liq. H2
H2 Gas
(700 bar)
Nat. Gas
(4 bar)
H2 Gas
(15 MPa)
(150 bar)
Ammonia
(1 bar)
H2 Gas
(1 bar)
Toxic
Corrosive

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Aqua-Ammonia

- Formed by dissolving gaseous ammonia in water
- Shares the benefits of pure ammonia—carbon-free, high-energy density, and renewable production—while minimizing its drawbacks;
- Less Toxic;
- Less corrosive;
- Liquid at ambient conditions;
- Higher volumetric Energy density than NG, Pure ammonia, hydrogen
- Transportable with current NG pipeline, With 8 times more energy than NG
- Easy to Store;
- Cost-effective to transport;
- Ample Hydrogen carrier

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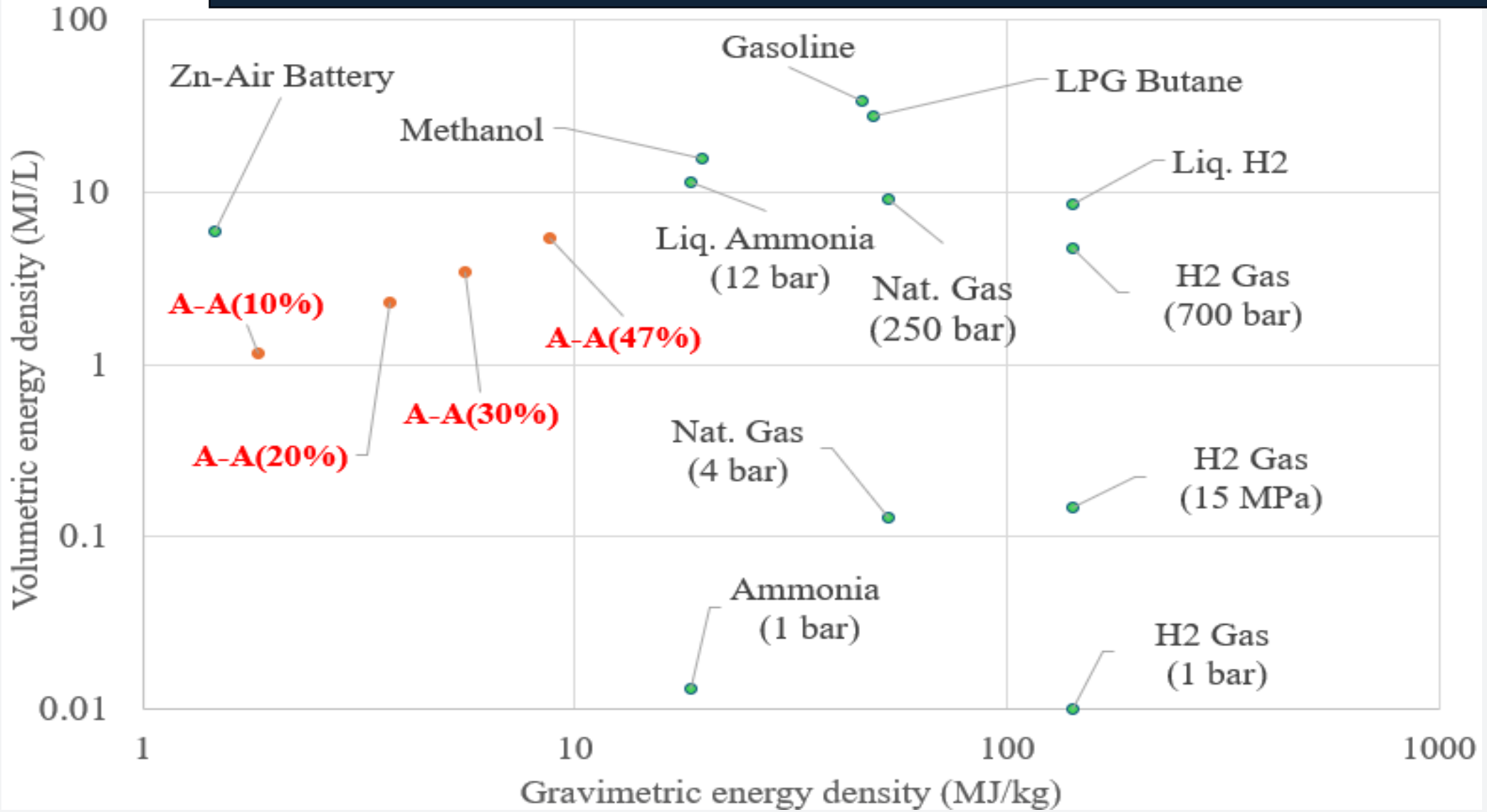
Aqua-Ammonia



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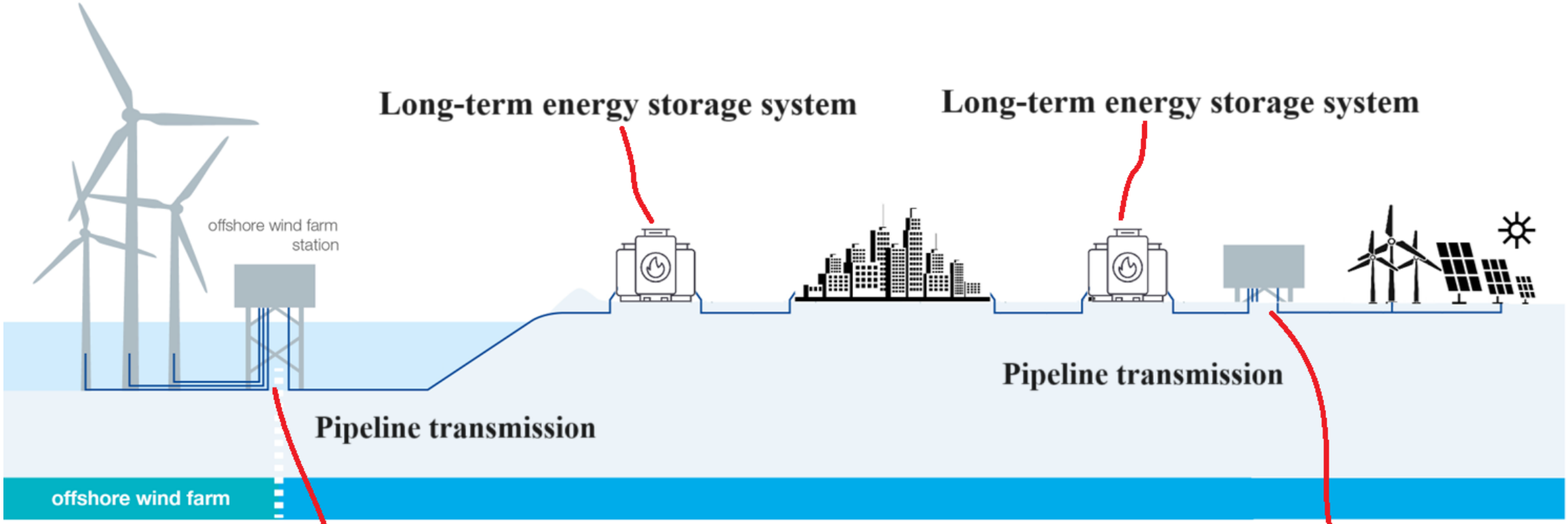
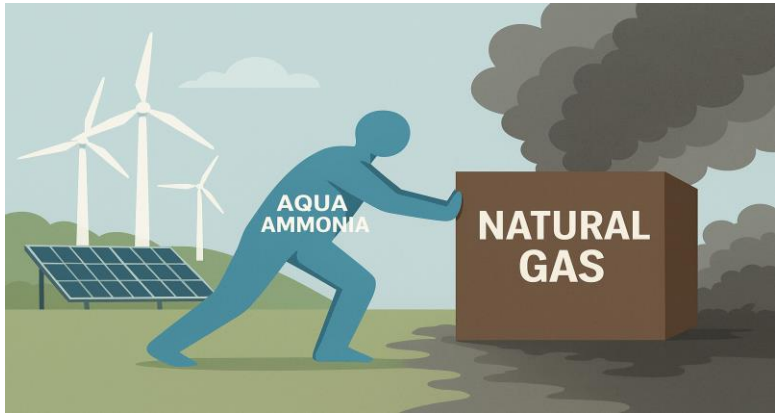
Carbon-Free Energy Delivery Through Low-Pressure Pipework





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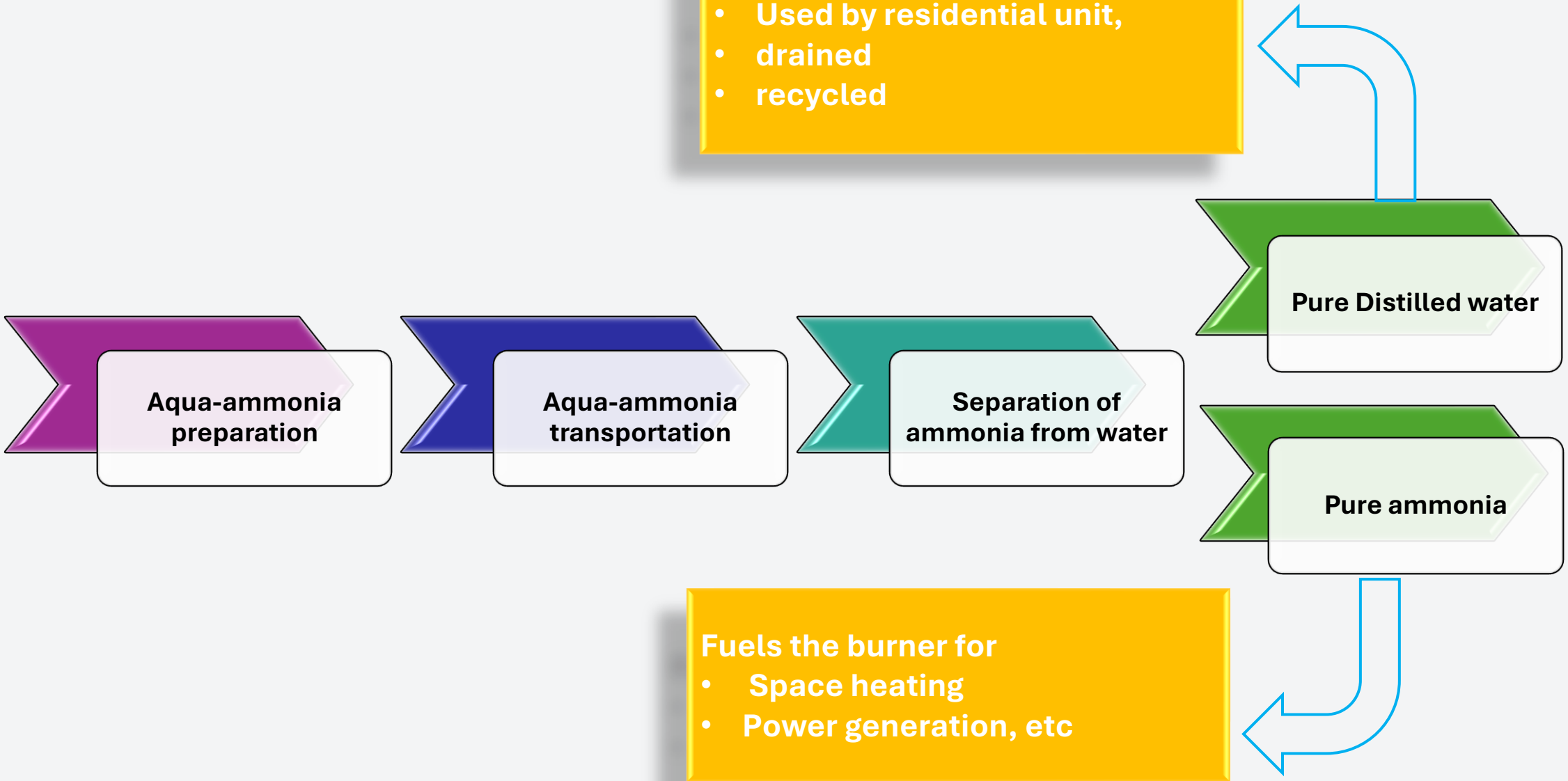
Core Concept Overview

- Used by residential unit,
- drained
- recycled



Fuels the burner for
- Space heating
- Power generation, etc

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Is it feasible?!

The overall feasibility hinges on the efficient and cost-effective separation of ammonia and water

The prototype achieved ammonia separation from the mixture leaving ammonia concentrations below 17ppm - well below safe discharge thresholds.

internally-awarded IAA project (EP/X525765/1)

Patent No.:GB2502988.5

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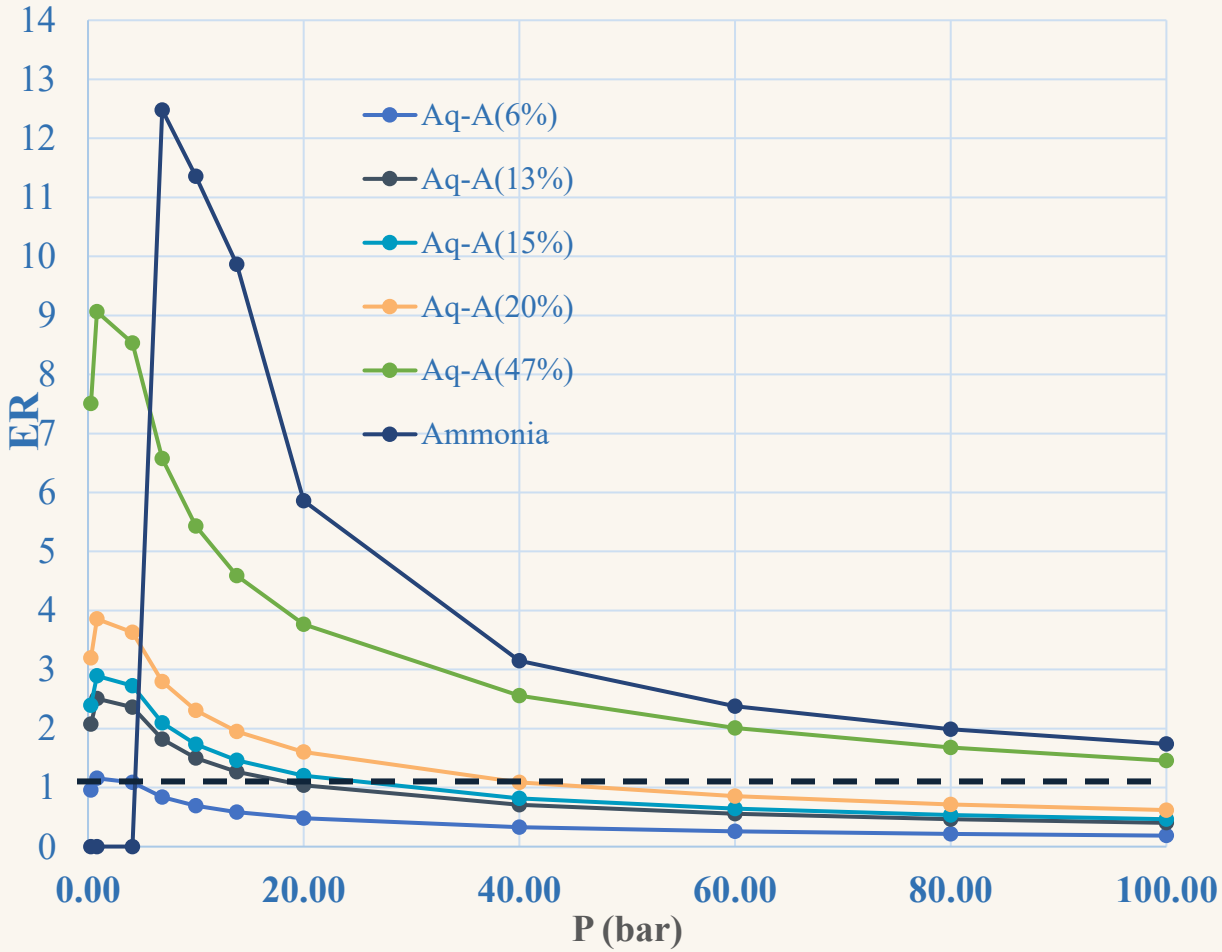
Is it compatible with gas infrastructure?!

- Material Perspective
- Operating condition (pressure, Temperature)
- Capacity

Stage	Pressure Range (bar)	Pressure Range (mbar)
High-Pressure Transmission	30 - 85	30,000 - 85,000
City Gate Station Output	4 - 10	4,000 - 10,000
Medium-Pressure Networks	1 - 4	1,000 - 4,000
Service Lines (Homes)	0.020 - 0.1	20 - 100



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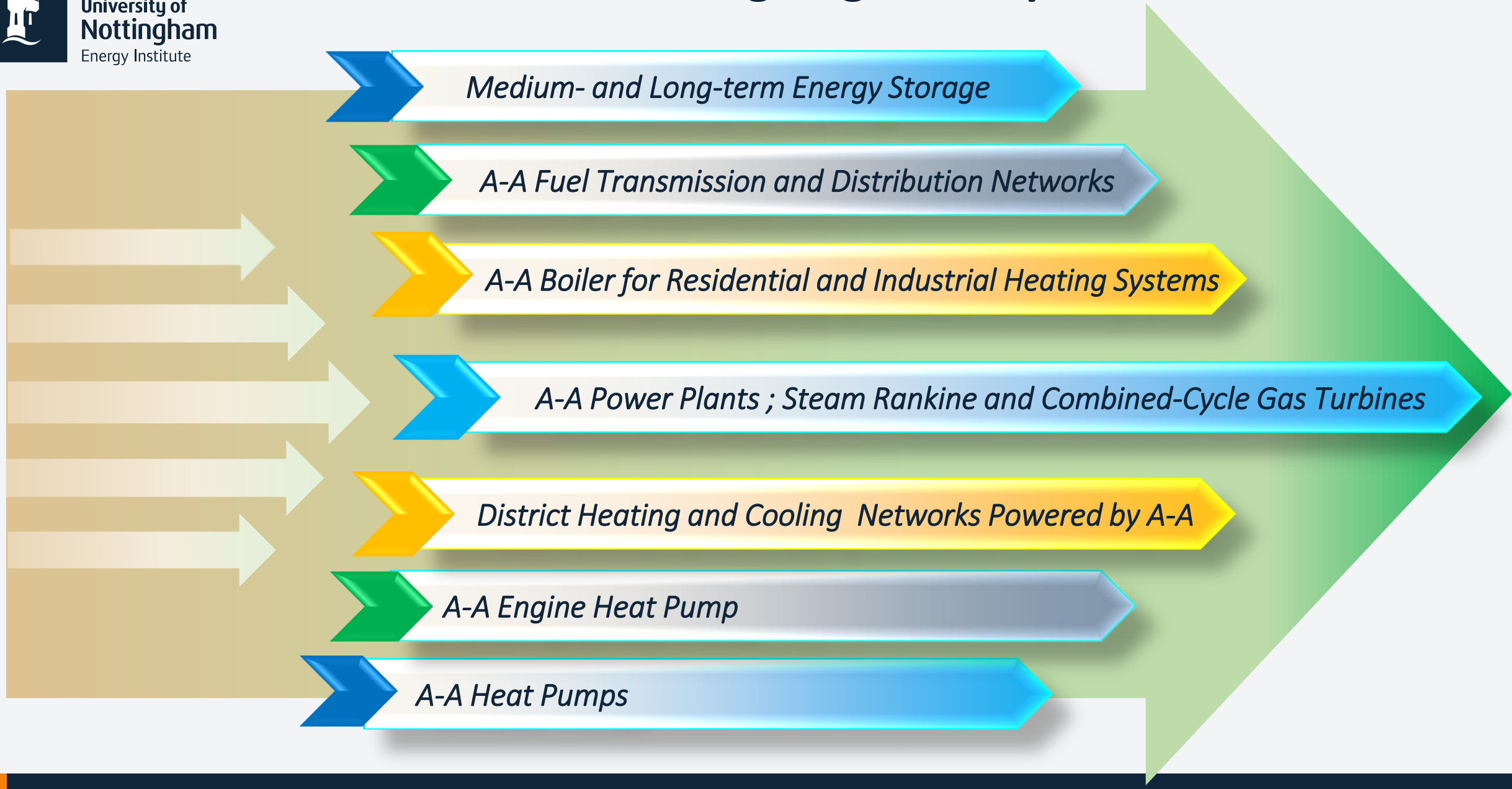
Future outlook and ongoing developments with A-A



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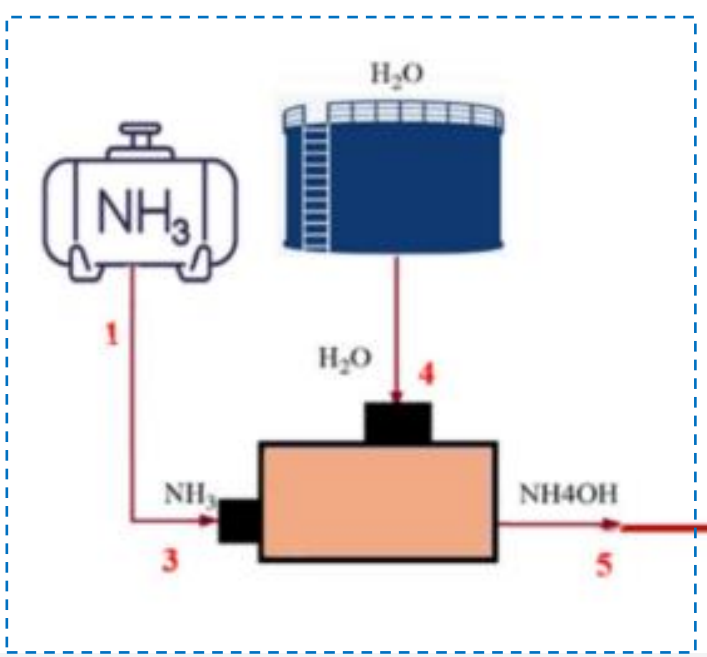
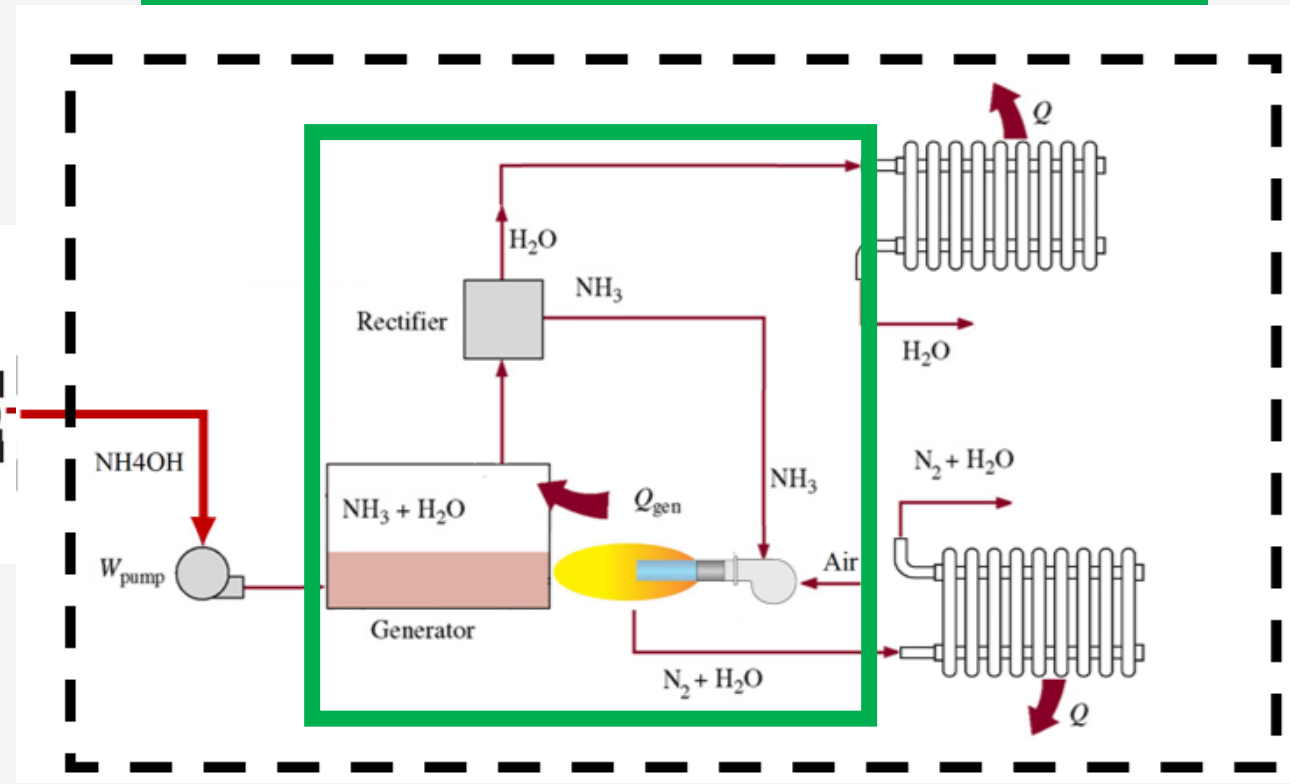
Aqua-Ammonia boiler for residential heating



Efficiency: 97.5%

"Aqua-Ammonia Boiler"



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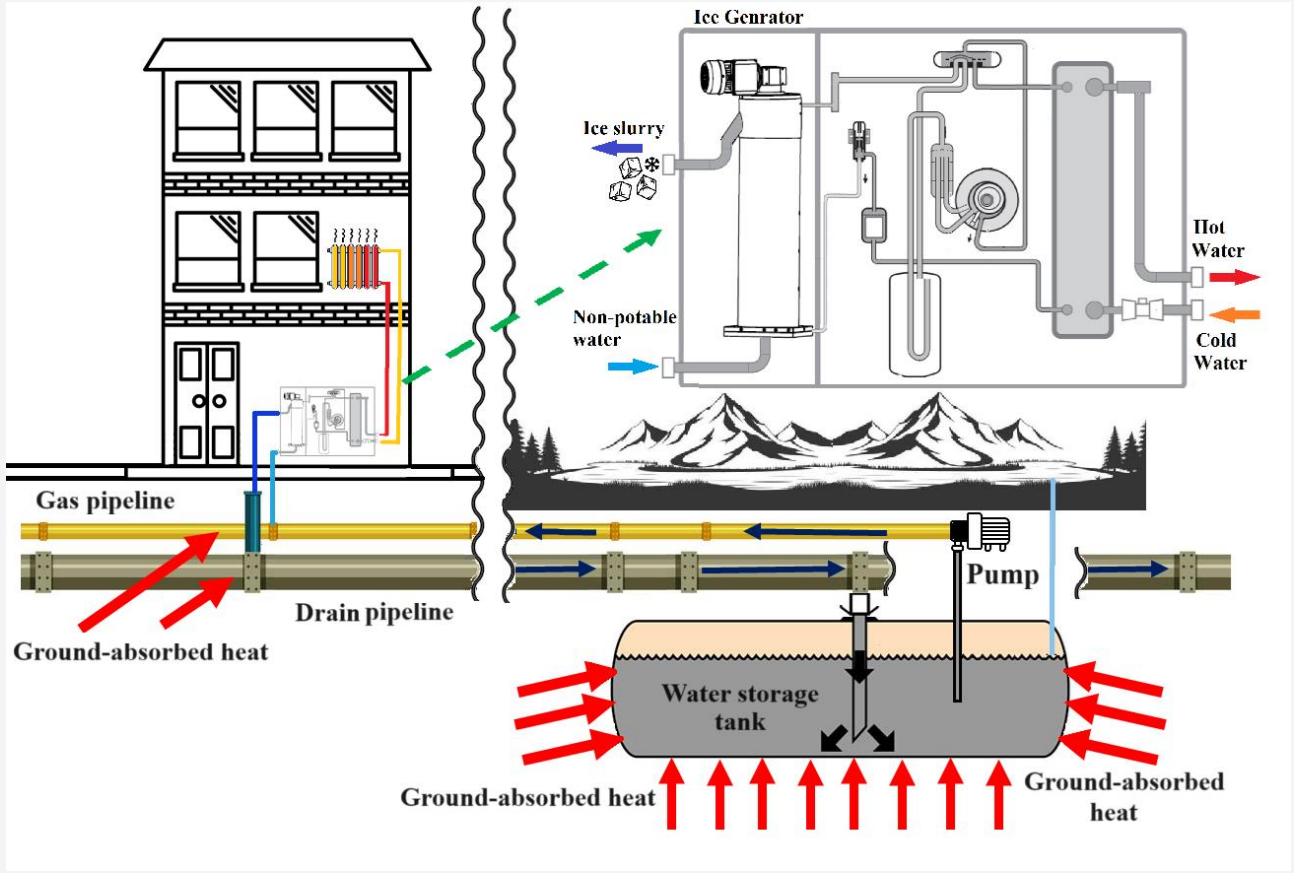
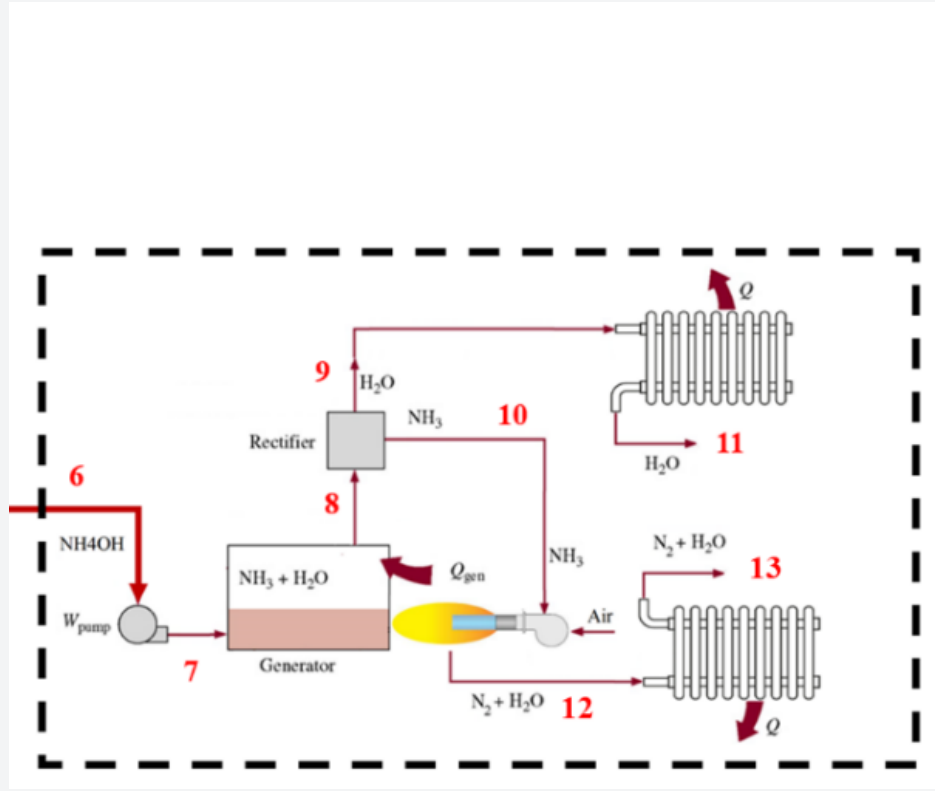
Aqua-Ammonia Heat Pump





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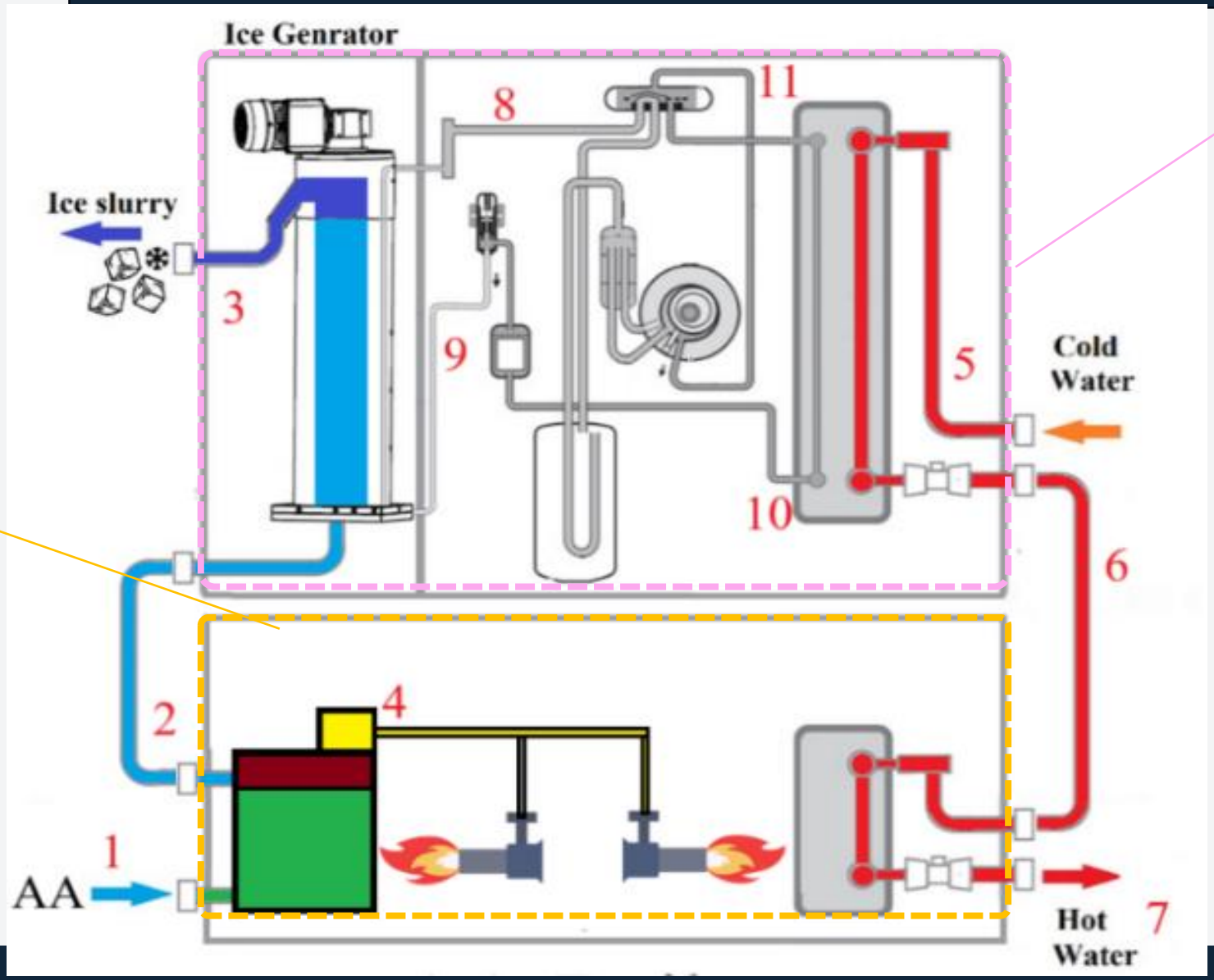
Aqua-Ammonia Heat Pump



Ice-Source Heat Pump

A-A Boiler

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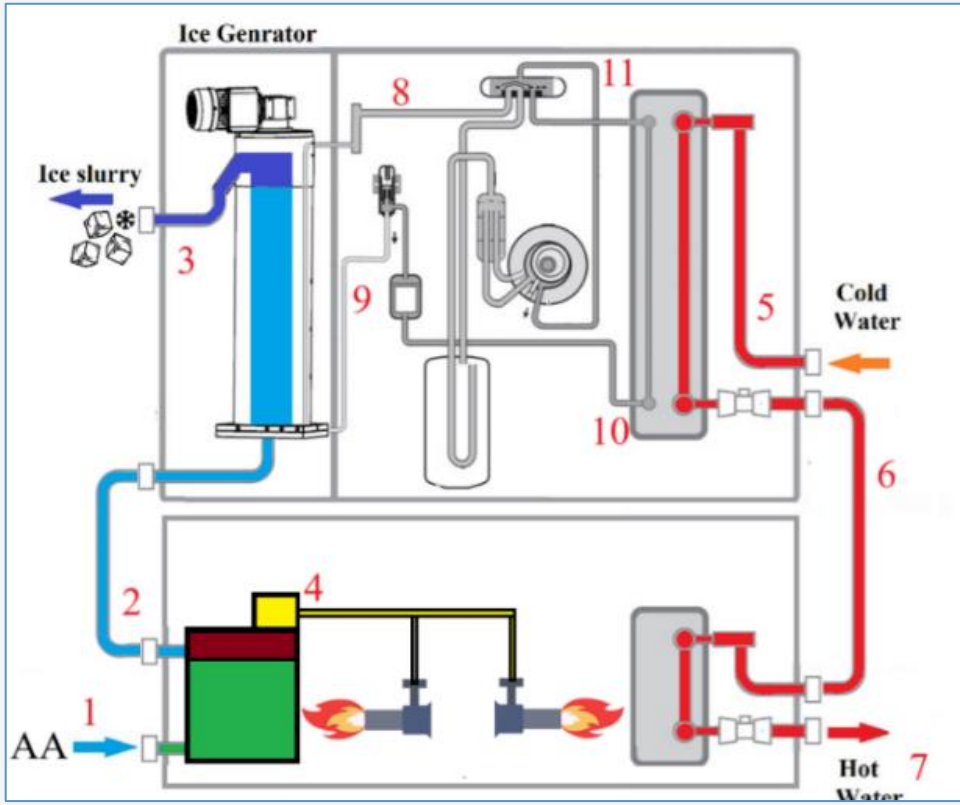
Advantages of the Proposed A-A Heat Pump

- Ability to be installed **indoors**.
- **Low noise** levels (due to the elimination of a fan)
- **Simple control system** (due to operation at a constant temperature in the evaporator and condenser sections)
- **Steady performance** independent of ambient temperature
- Ability to produce **high-temperature water** ***without performance loss***
- Potential **reuse of existing gas pipes** to transfer A-A as the heat pump's heat source
- Suitable for high-density areas and apartment buildings



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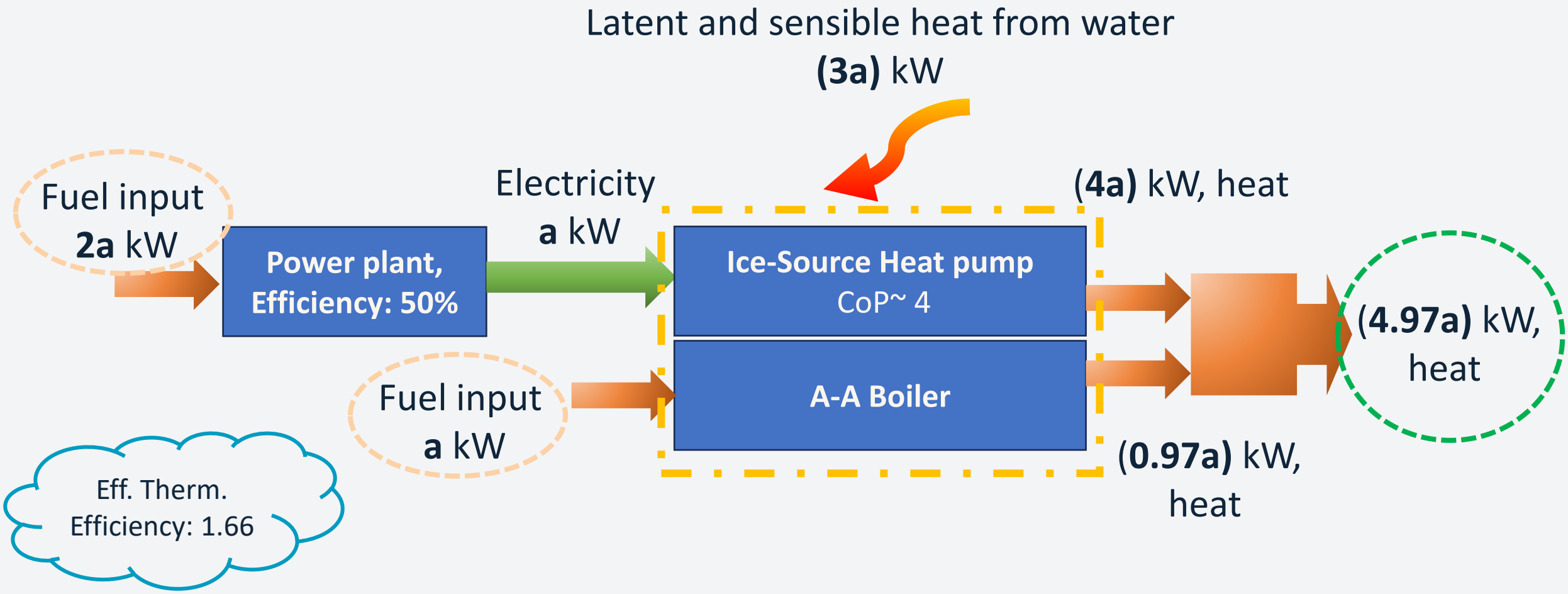
Effective Thermal Efficiency for Aqua-Ammonia Heat Pump



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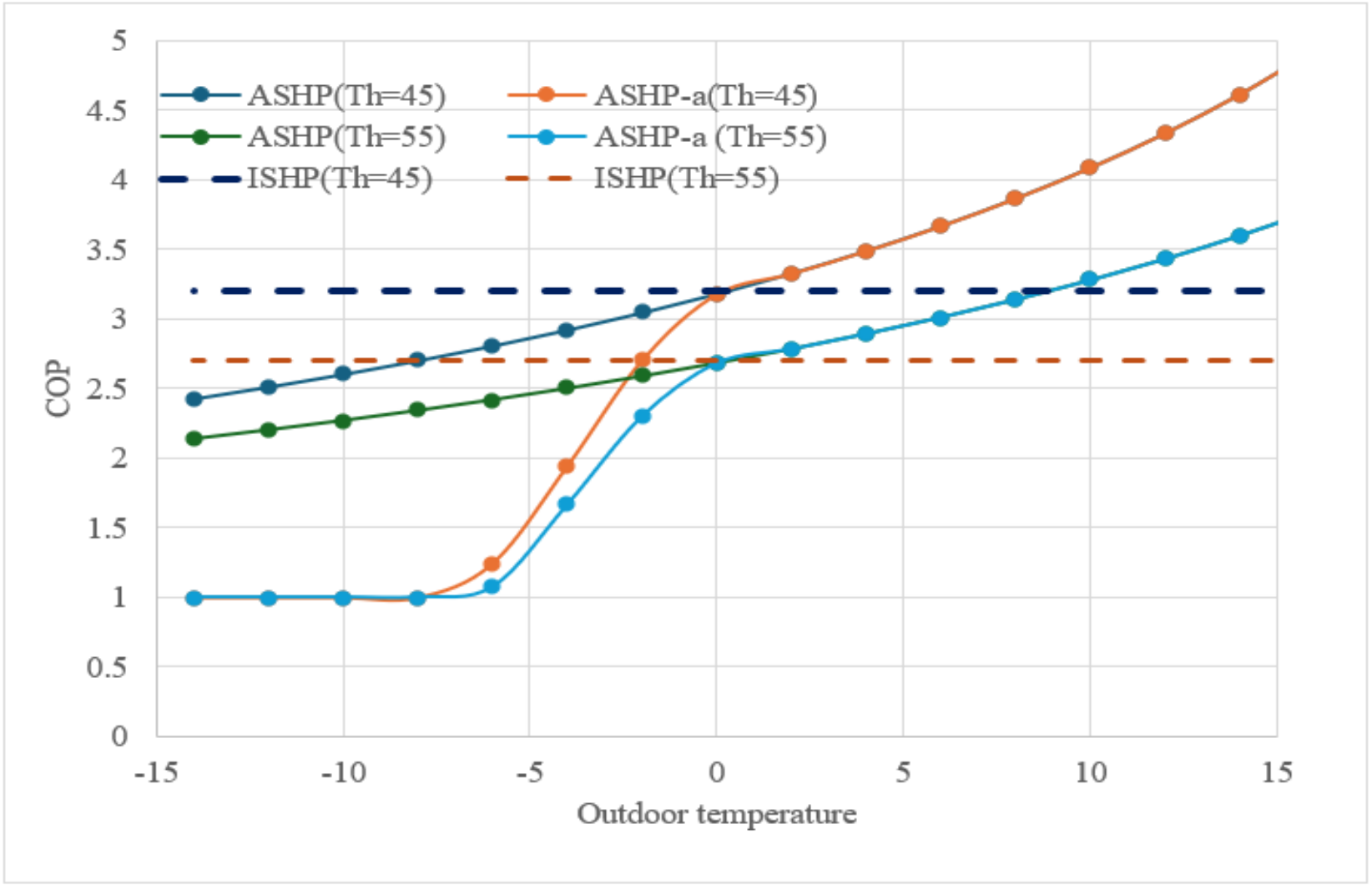
Performance vs Ambient Temperature



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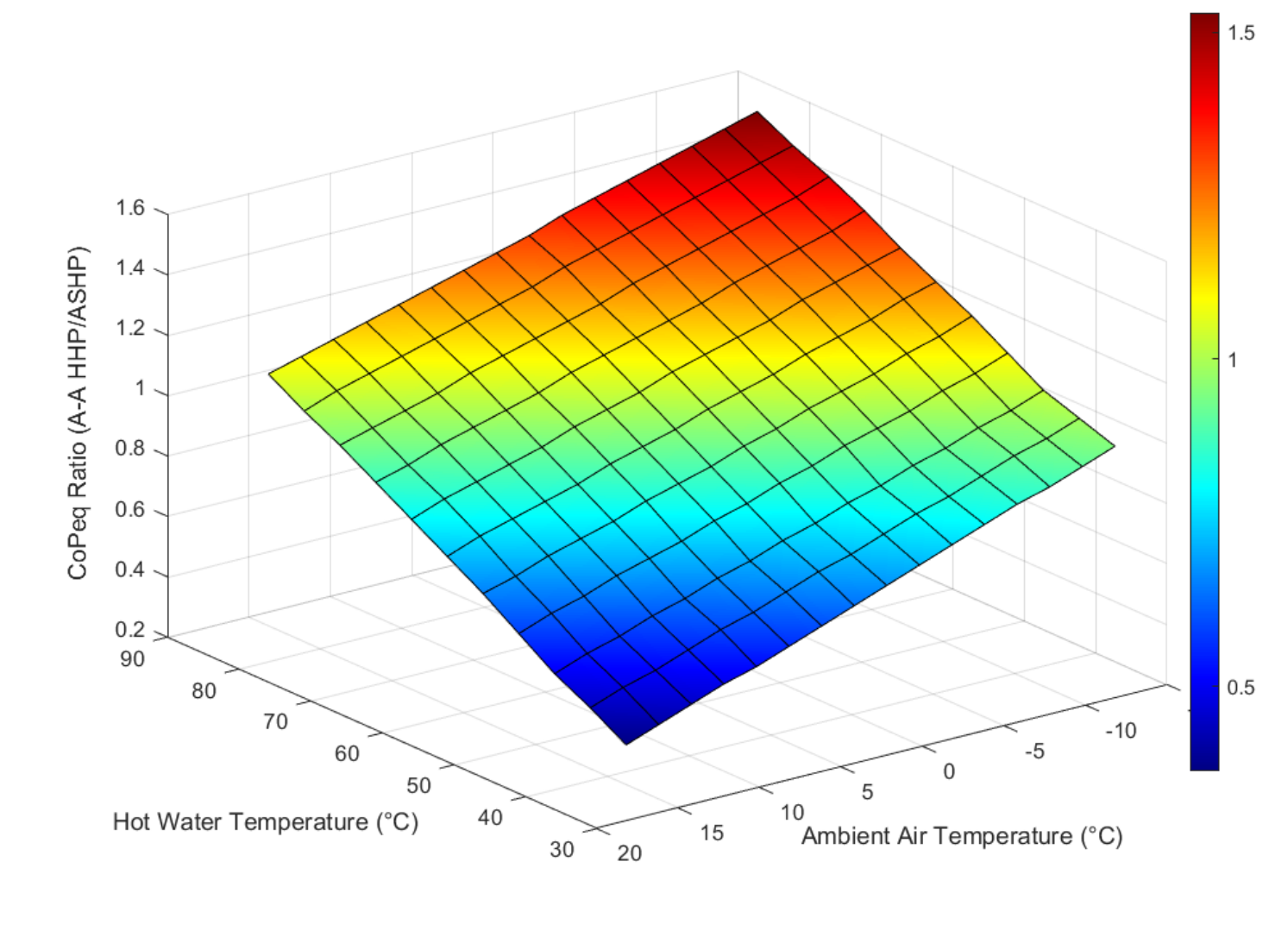
Aqua-Ammonia Heat Pump vs Air-source Heat Pump



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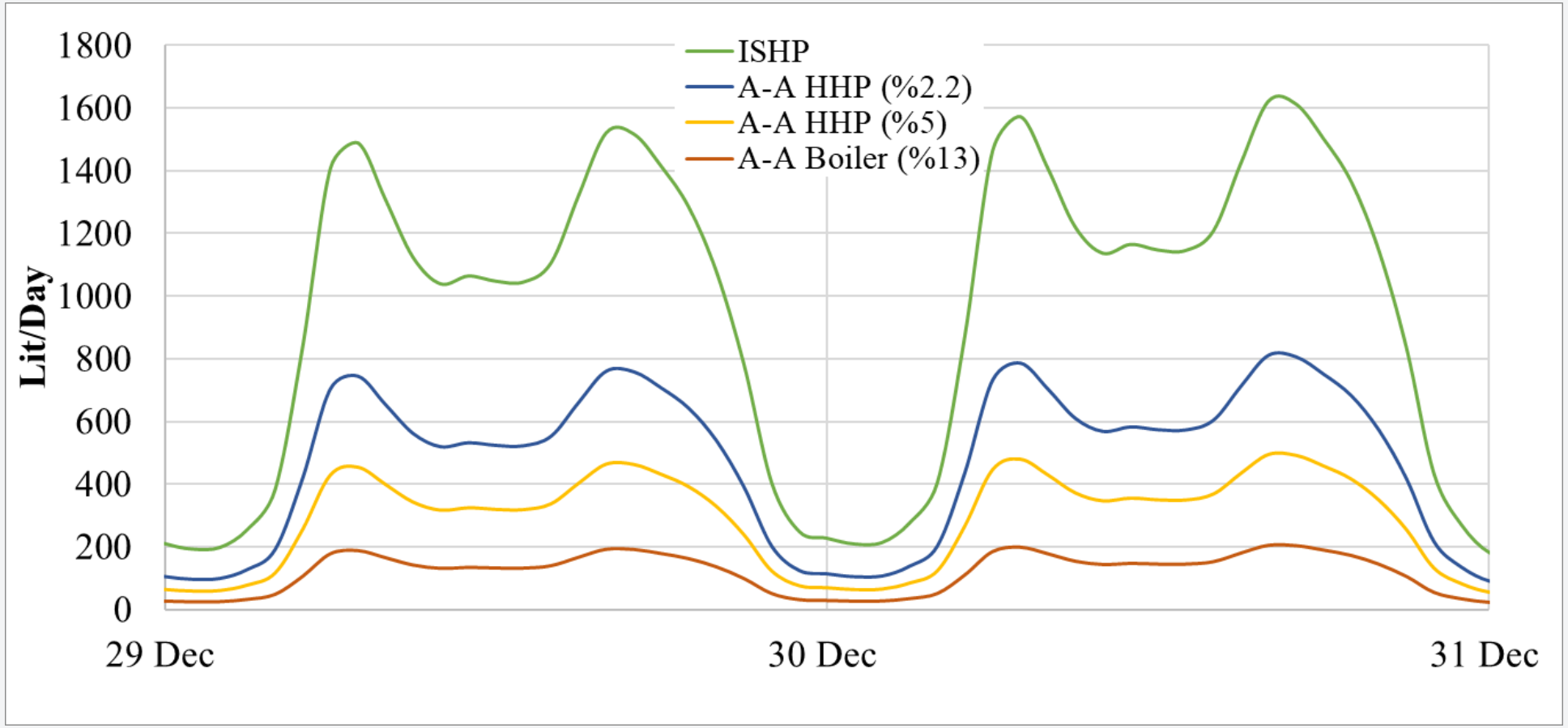
Water Consumption



Average water consumption per household per day in the UK: ~350 Lit/Day

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Conclusion

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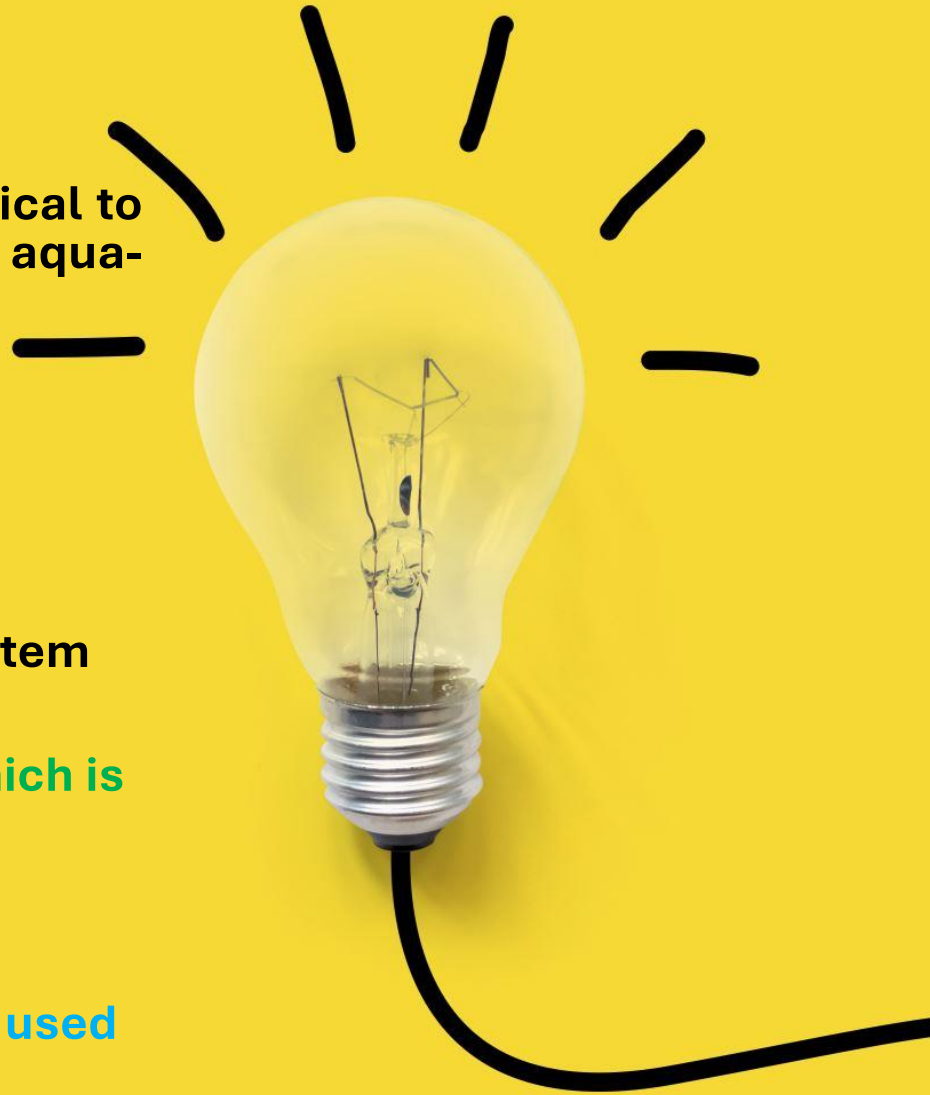
- **The involving subsystem technology is already established; Practical to meet the 2050 target** with the **least possible adjustment because aqua-Ammonia is compatible with current NG infrastructure.**
- It be simply adopted for both **domestic and industrial heating.**
- **The A-A Heat pump delivers constant CoP independent of ambient temperature.**
- **Hot water temperature doesn't affect the CoP.**
- **No need for a complicated variable speed compressor, control system or even a fan; simpler design!**
- **A-A is an alternative fuel that can replace NG in any application which is currently dependent on NG.**



From **a social perspective**, while **hydrogen is known for its explosion hazards**, ammonia has different history. Pure ammonia **was commonly used in residential refrigerators until the 1950s. In cleaners, ammonia concentrations typically range from 5%-25%.**

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Join Us in Advancing the Technology

Our Progress

- System Integration
- Demonstrator for ISHP
- Demonstrator for Separation Unit
- Patents, Papers
- Theoretical Validation
- **Concept & Feasibility**

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Aqua-Ammonia — Simple solutions for big challenges

THANK YOU

"The simplest solution is often the best one."
Occam’s Razor