

RESULTS QUESTIONNAIRE HYDROGEN BACKBONE

October 2021

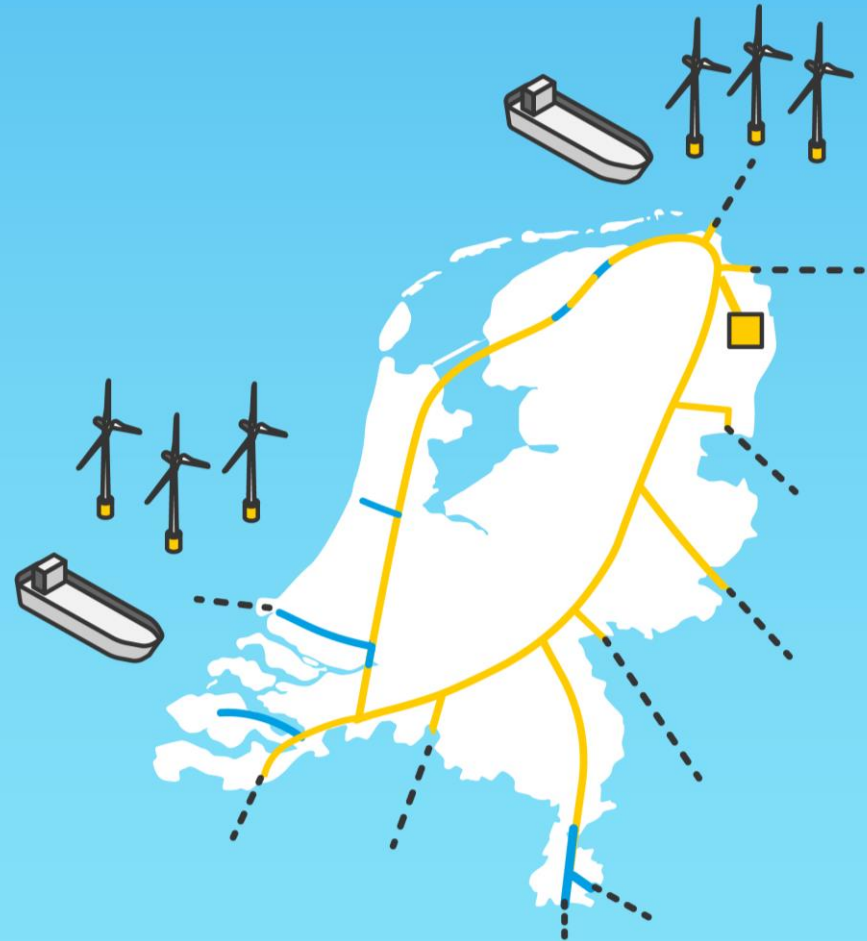
Introduction to this document

- HyNetwork Services (HNS) aims to develop a **hydrogen backbone** that connects five industrial clusters to each other, internationally and to **hydrogen conversion** and **storage facilities**.
- On 1 October 2020, HNS sent out a questionnaire to consult **(future) hydrogen backbone users** on their **vision on hydrogen** and **potential hydrogen projects**.
- The questionnaire received **58 responses**, from which HNS wants to share the **key insights** with the market to further stimulate **hydrogen knowledge development**.
- This document presents the key insights in an **anonymised way**; it does **not** represent **HNS' own opinion** on the questionnaire topics.
- For **questions and ideas** please reach out to info@hynetworkservices.nl

Summary

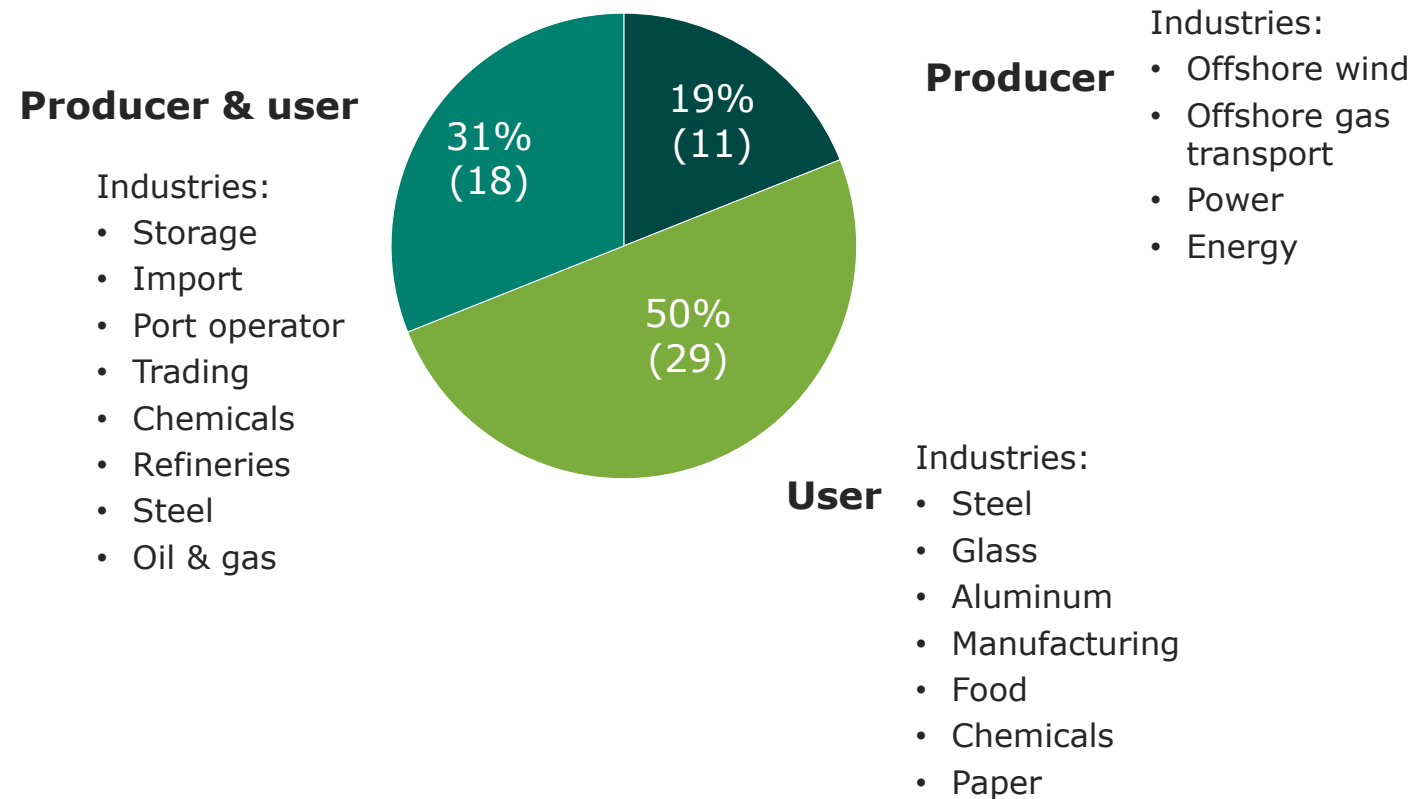
- The questionnaire received **58 responses** from (future) hydrogen **producers, users** and **producers & users** across **all industries and regions** in the Netherlands.
- Respondents want hydrogen to **reduce carbon footprint** and envision it to **fulfill a substantial share** of their future energy usage.
- Users see **barriers and risks** mainly around **(burner) technology availability** and **sufficient hydrogen supply**, while producers also identify **access to renewable energy** as barrier.
- **Producers** are furthest in their **project status**, while many **users** have their projects still in the **idea phase**; nearly all respondents intend to **use the hydrogen backbone** for transport.
- This is reflected in expected volumes, where **producers** have a **clear and sizeable expectation** to produce and transport roughly **100 TWh** hydrogen in **2030**, while **users** plan to use roughly **20 TWh**; in **2035** this increases to **225k** and **80 TWh**, respectively.
- **30 bar** is the preferred pressure, for quality **producers** see the **highest specification** as best suited for their process, **users** the **lowest**.
- For connection equipment, compression and purification services, **users** look at **HNS** while **producers** prefer **themselves** or a **third party** to be responsible.

National Overall insights



The questionnaire has 58 respondents, of which the majority are (future) hydrogen users

With regard to hydrogen, would you describe your company (now or in future) as a:
n=58



Companies want hydrogen to reduce their carbon footprint and envision it to fulfill a substantial share of their energy usage

For what purpose do you intend to produce/use hydrogen? **n=50**

Fulfillment of EU, German and own corporate **climate targets**
User

To provide the NL / EU market with a new **clean energy carrier** / feedstock.
Producer

Lower Carbon Footprint, lower dependency on natural gas
User

Lower **carbon footprint**, lower dependency on natural gas and new market.
Producer & user

To create **new possibilities** for existing and new **customers**
Producer & user

Mainly lower **carbon footprint**
User

We intend to produce hydrogen to enable **industrial decarbonisation** of refineries, chemicals production and metals production, and to enable **emissions free** dispatchable power production and heavy mobility
Producer

How much of your energy usage do you want to fill with it? **n=42**

Extreme amount of hydrogen
User

10% currently
45% by 2027
100% by 2040
User

Roughly **60%**, Unknown year
User

2030 - about **30%**;
2050 - **100%**
User

100%, starting **2025**
User

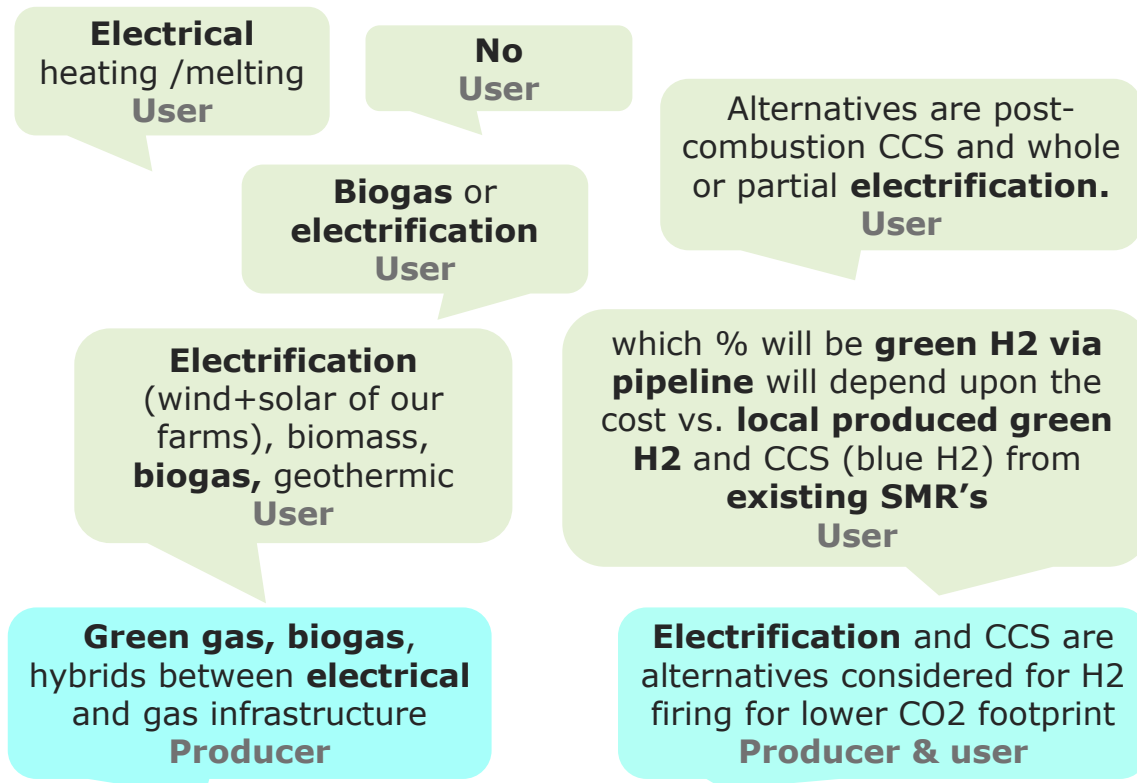
Depends on the future outlook. Can be up to **100%**. Best guess is **25-50%**.
User

100% of our thermal energy by 2030
User

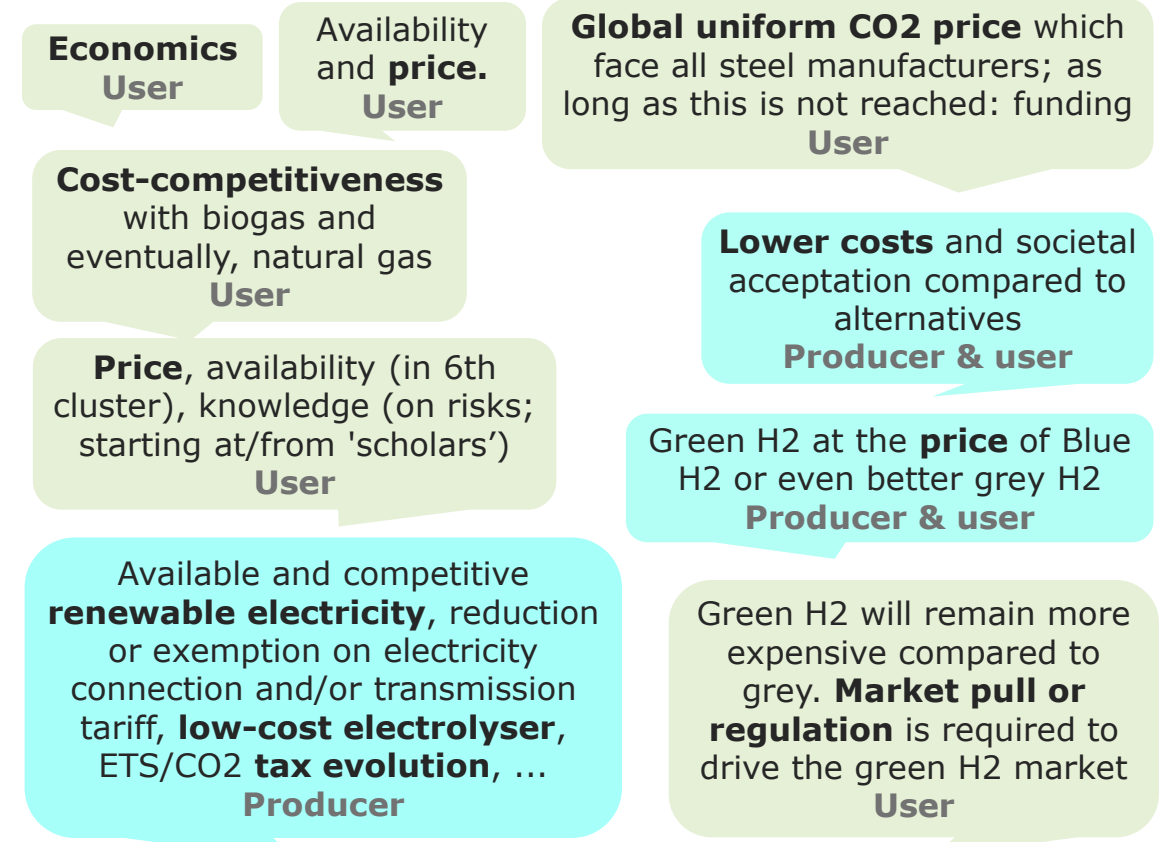
Current total energy can be partly electrified, roughly **35%** of current energy use will be left. Ca in 2040
User

Companies do consider alternatives to hydrogen, primarily electrification and biogas, and consider hydrogen a competitive option if prices decrease

What alternatives [to hydrogen] are you considering? **n=31**



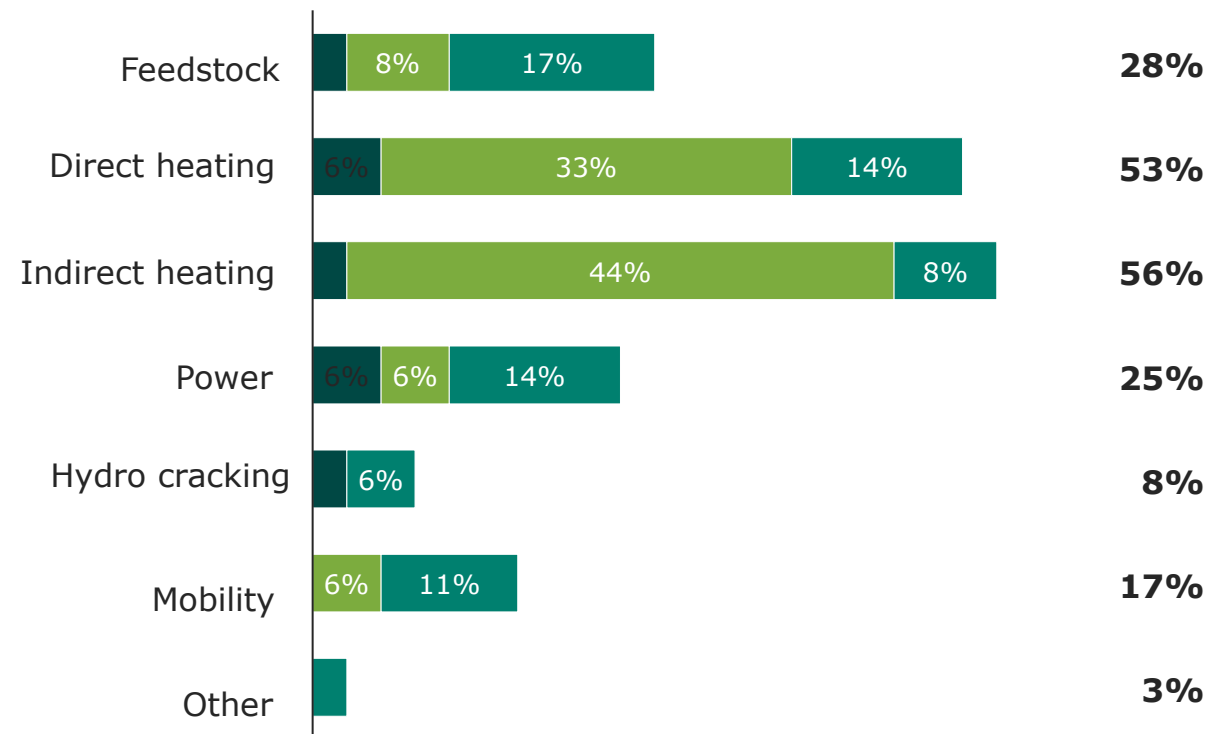
What would make hydrogen a competitive option? **n=34**



Heating, direct and indirect, is the most-mentioned use for hydrogen; electrolysis with electricity from offshore wind is the most-mentioned production method

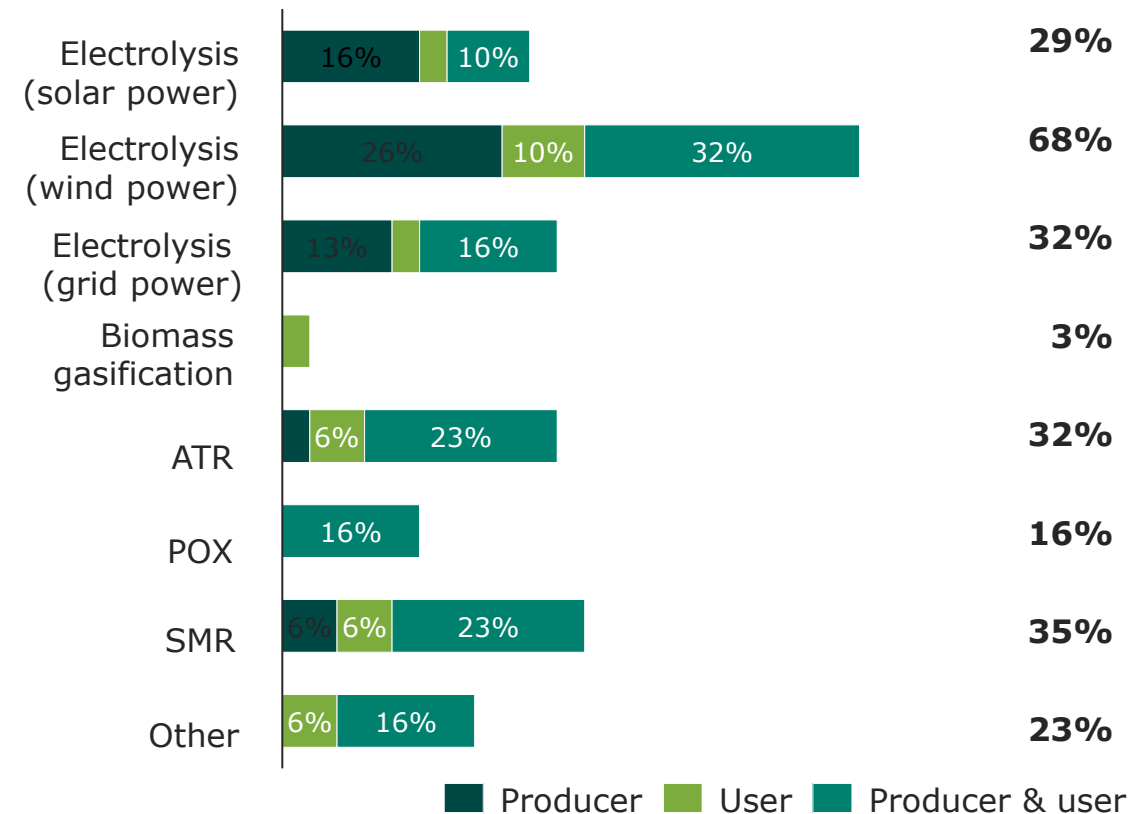
Can you describe hydrogen's role in your process(es)?

n=36, multiple answers possible



Can you describe how you plan to produce hydrogen?

n=31, multiple answers possible



Users see barriers and risks mainly around (burner) technology availability and sufficient supply, while producers also identify access to renewable energy as barrier

What developments are required before you can start?
n=35

The **hydrogen burners** we need to use are not available and the NOx-amount must be allocated
User

A dedicated **hydrogen backbone**
Producer & user

Subsidy schemes need to match gap in financing of CAPEX and OPEX
User

We would need a **burner** from one of our equipment manufacturers capable of burning hydrogen safely and at high enough output.
User

Burner Techniques, including control algorithms. Backbone, **supply assurance**
User

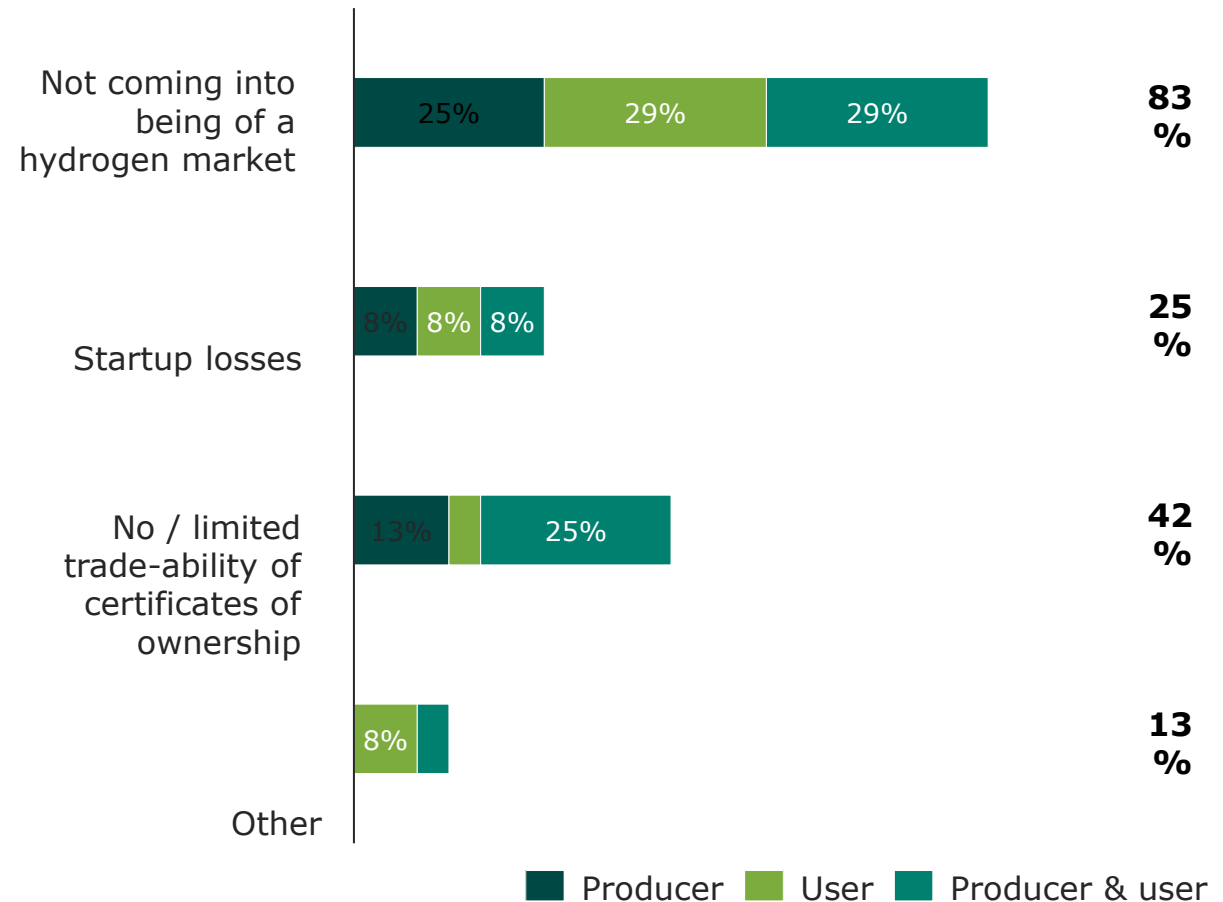
Burner technology
User

Creating **enough green H2**, enough sustainable sources, enough converting capacity, competitive prices
User

Access to **renewable energy** (offshore wind projects), scale-up of industrial electrolyser equipment, favorable regulatory framework.
Producer

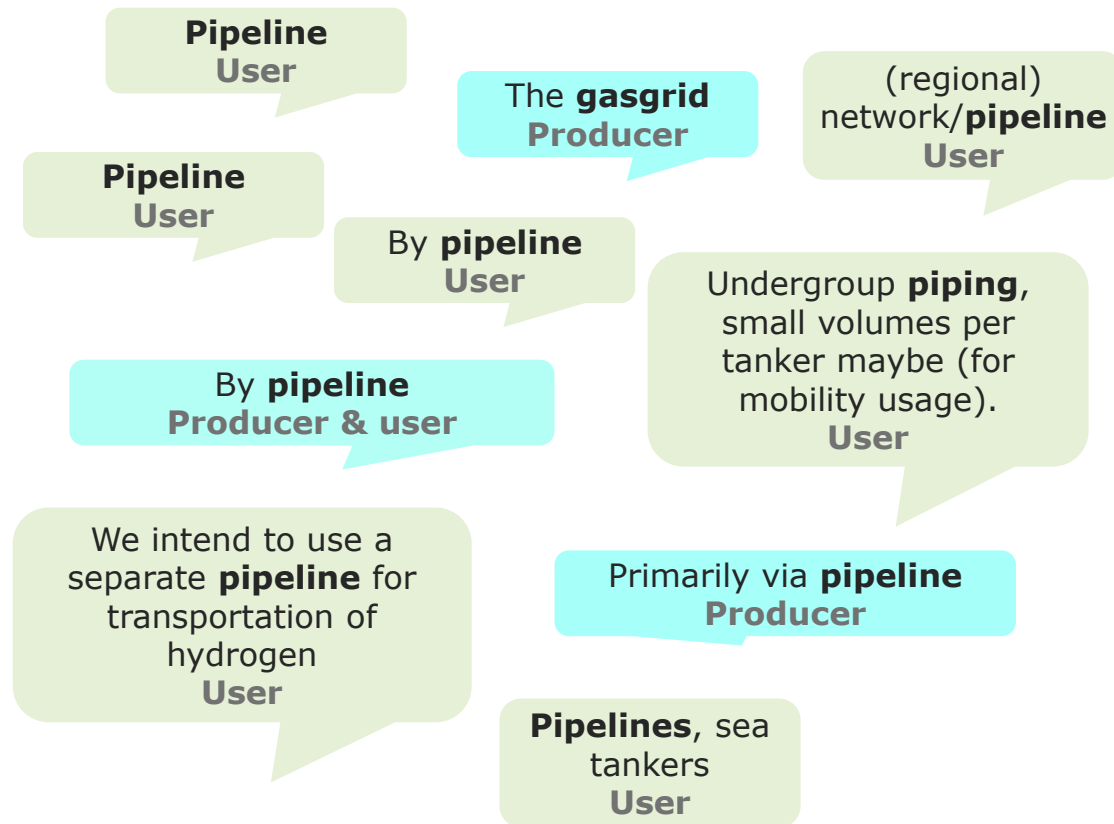
What risks do you see for realizing of your project(s)?

n=24, multiple answers possible

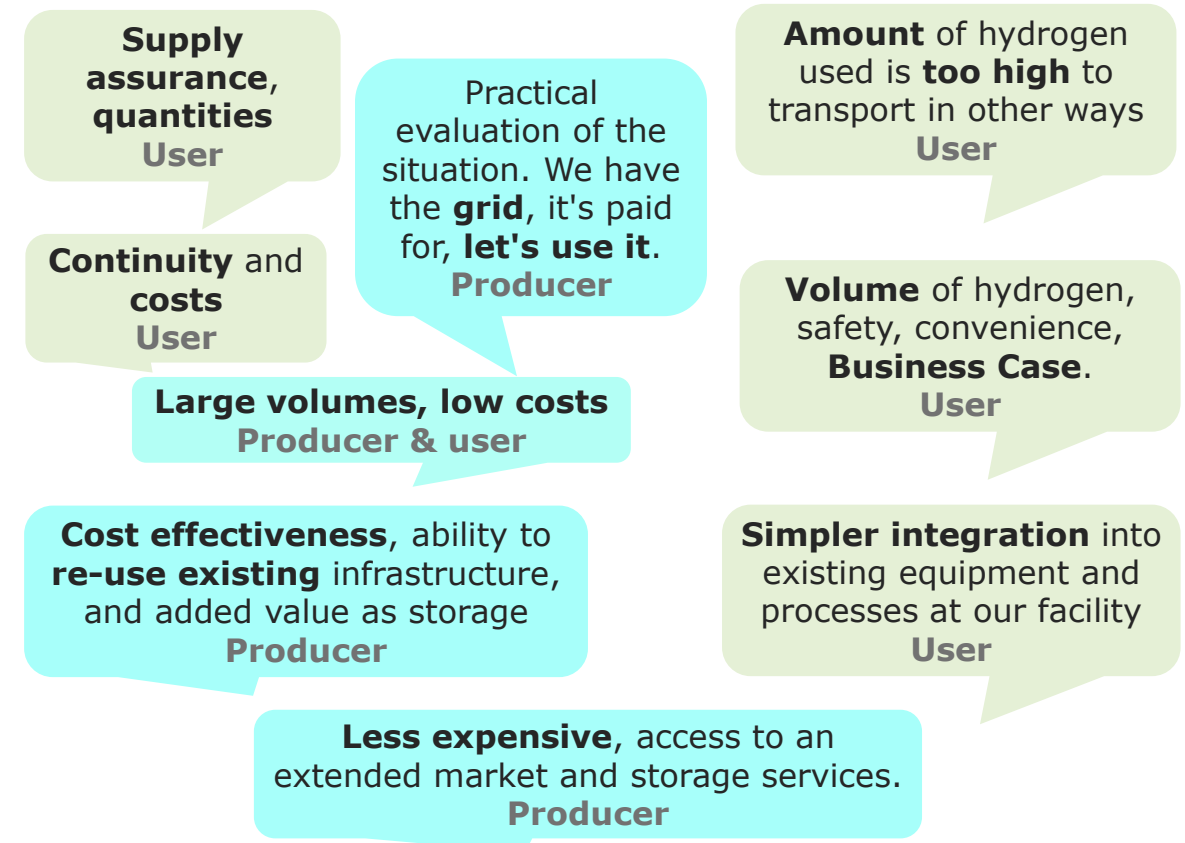


Transport by pipeline is widely favored, because of the ability to handle large continuous volumes, cost-efficiency and integration with existing operations

How do you intend to transport hydrogen?
n=38

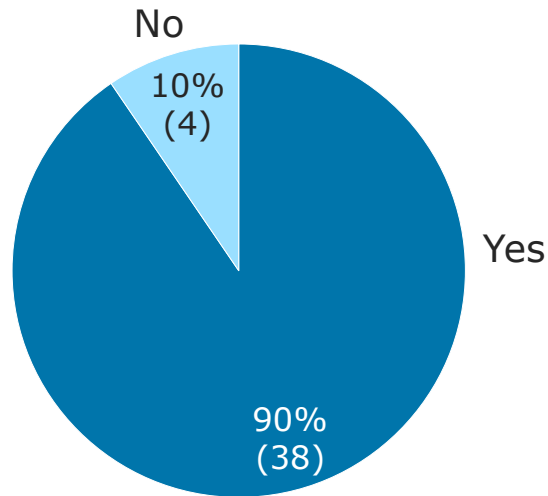


Why would you choose transport by pipeline?
n=36

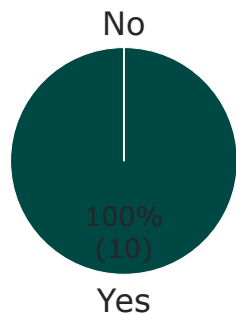


Producers are furthest in taking their projects towards a front-end engineering design, while most users are considering hydrogen only as an idea

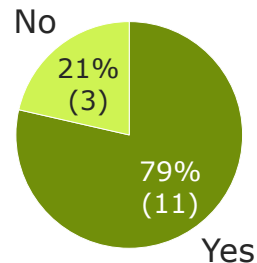
Do you envisage hydrogen projects in your company?
n=41



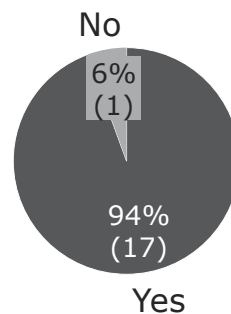
Producer



User



Producer & user



What is the status of your project(s)?
n=35, multiple answers possible

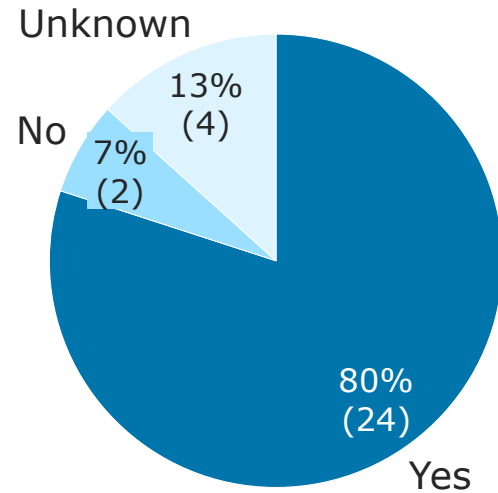


■ Producer ■ User ■ Producer & user

After projects become operational, most respondents intend to use the hydrogen backbone

Do you intend to use the national hydrogen backbone after RFO, alongside one of the regional pipelines?

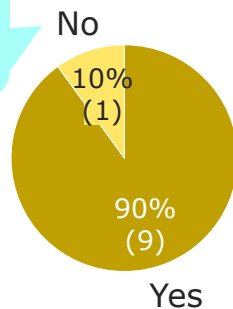
n=30



Not during the Pilot but after 2028-2030.

Producer

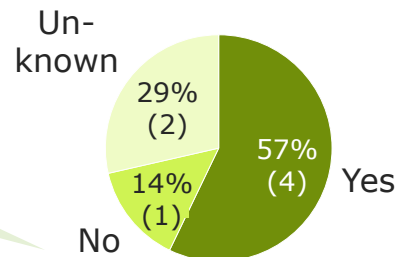
Producer



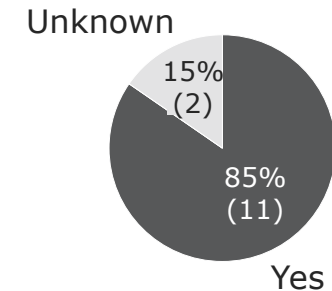
No, not for this project [on-site production], backbone required to buy additional green H2 from third parties

User

User



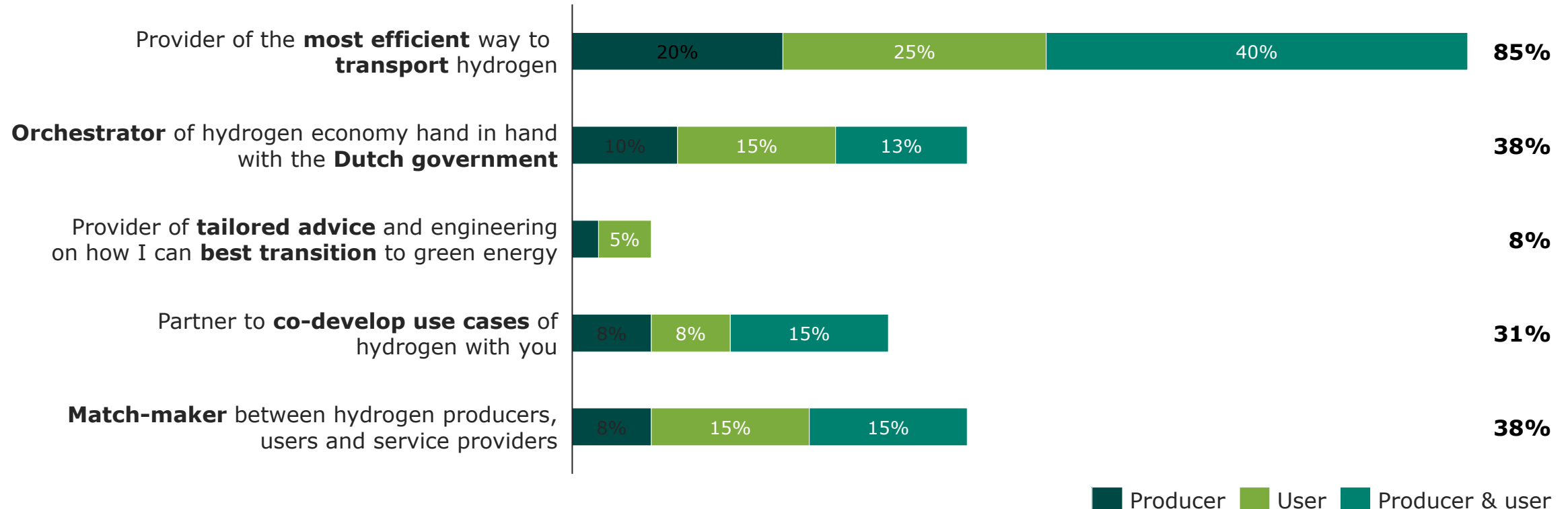
Producer & user



Most companies ask Gasunie for efficient transport; an orchestrator role hand in hand with government and/or a match maker role are preferred second-best

Which of the following role(s) by Gasunie would best match your current hydrogen needs:
n=40, multiple answers possible

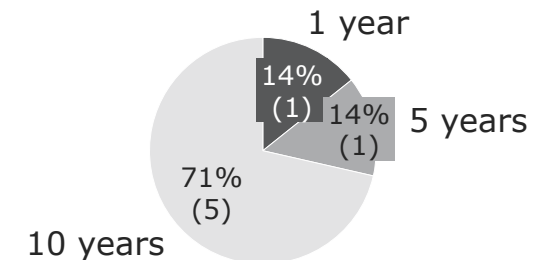
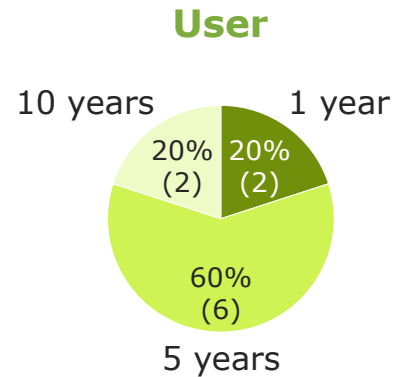
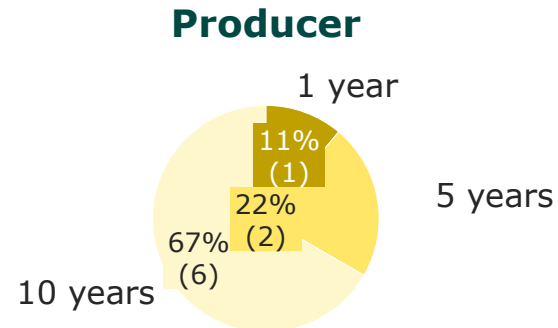
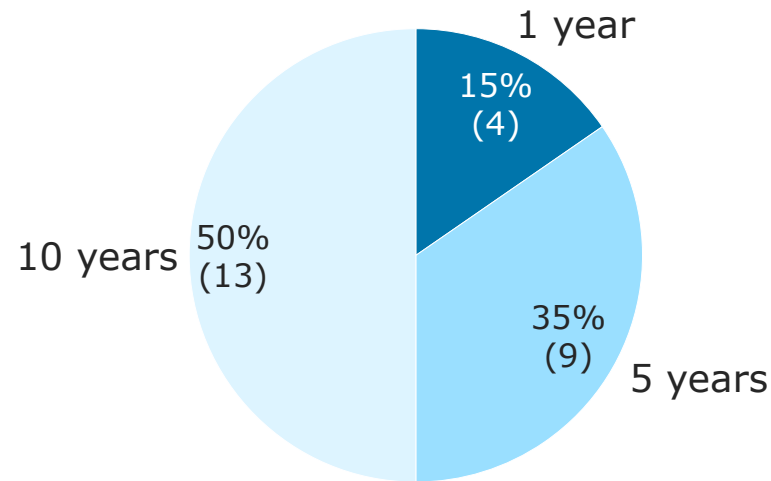
Gasunie as...



Most producers prefer 10 years contract term, users 5 years

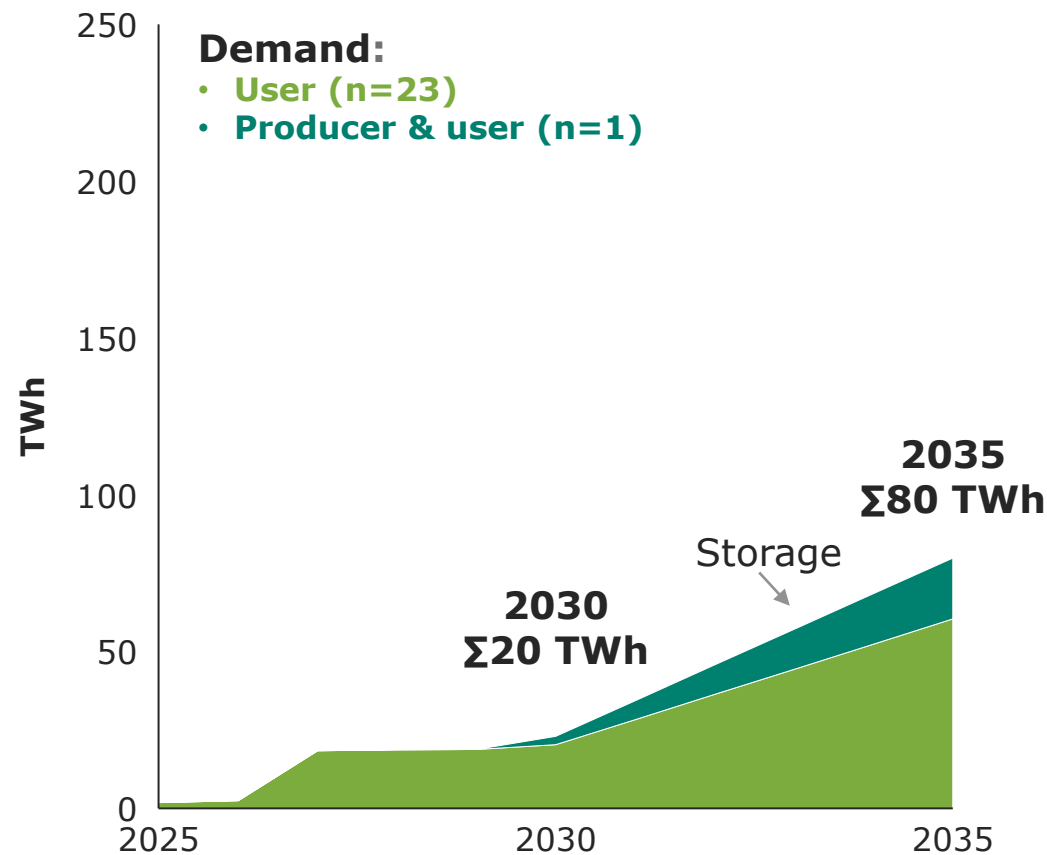
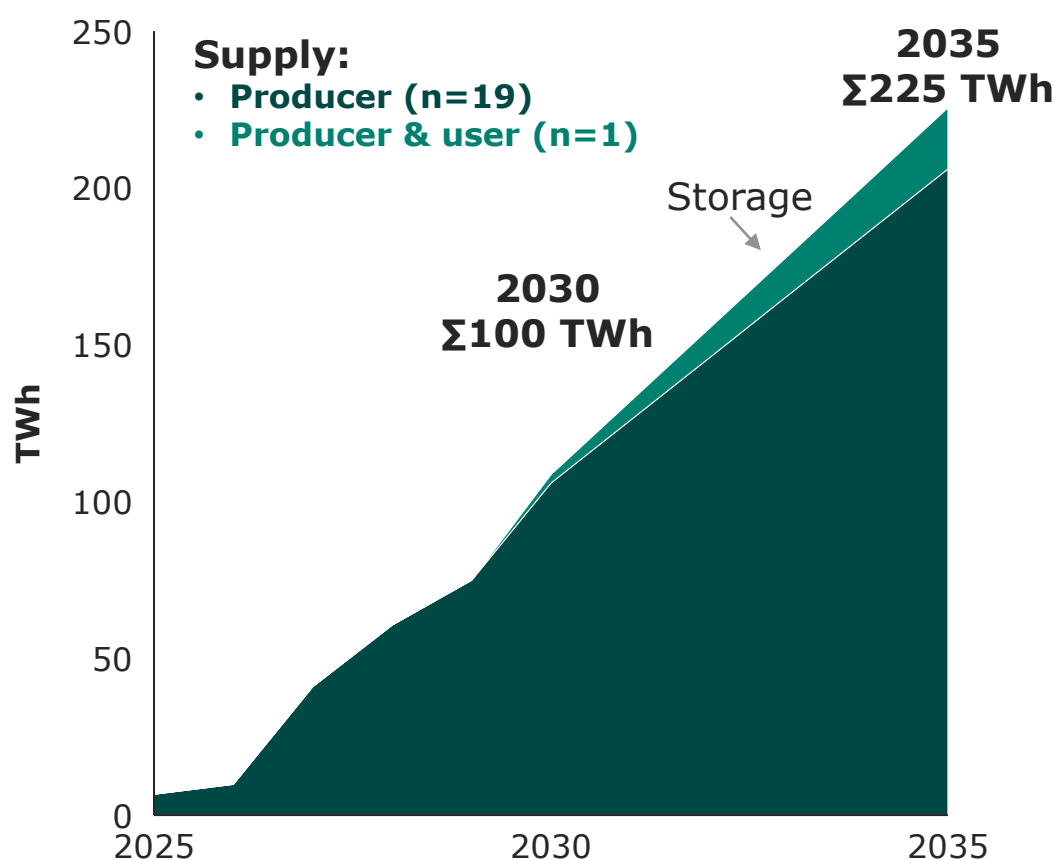
What would be your preferred contract term?

n=26



In 2030, producers expect to produce and transport roughly 100 TWh hydrogen, users expect to use roughly 20 TWh; in 2035 this increases to 225 and 80 TWh

Can you give a (non-binding) indication of the volume you expect to transport in the period 2026-2035?
n=43

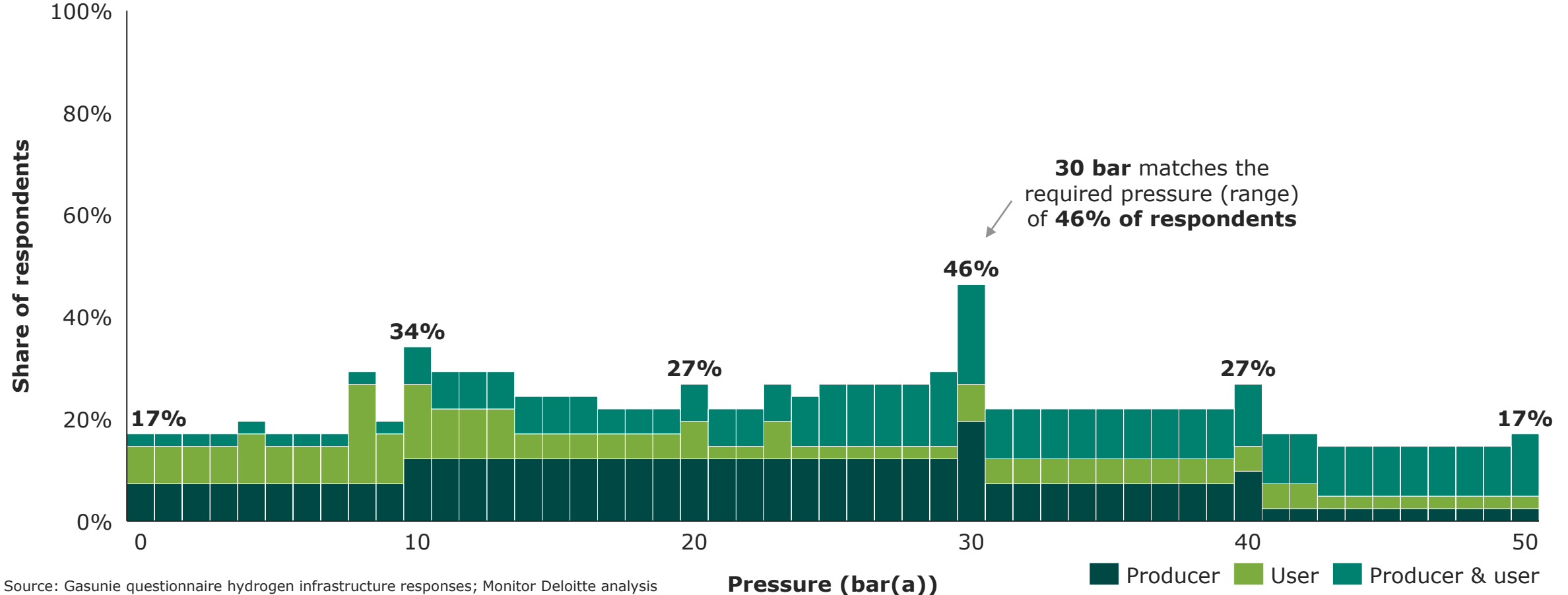


Note: Respondents in 'producer & user' segment have been manually assigned to 'producer' or 'user' for this questions based on their hydrogen plans, to avoid double counting of volumes; Producer includes import. Source: Gasunie questionnaire hydrogen infrastructure responses; Monitor Deloitte analysis

Companies mostly give a range for required pressure, with 30 bar being the pressure that falls into the required pressure range of the largest share of respondents

What are the required delivery/feed-in pressures?

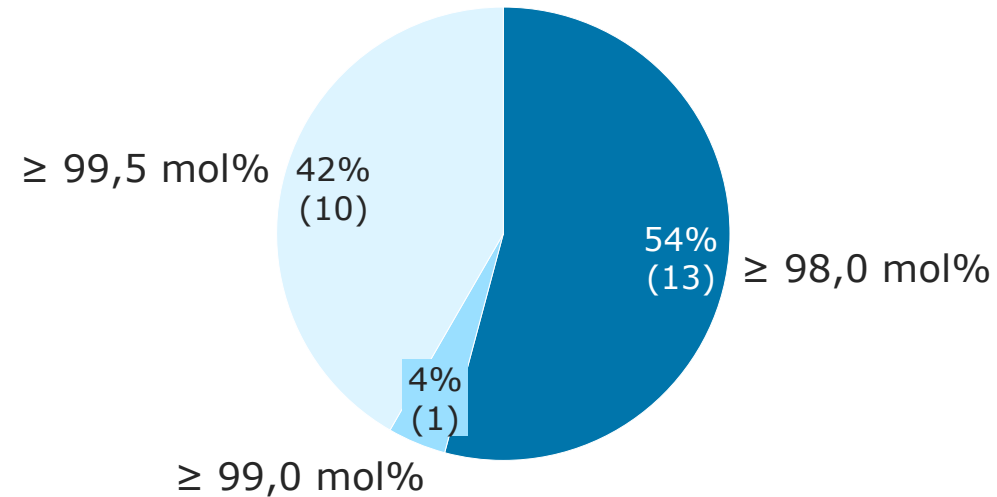
n=39



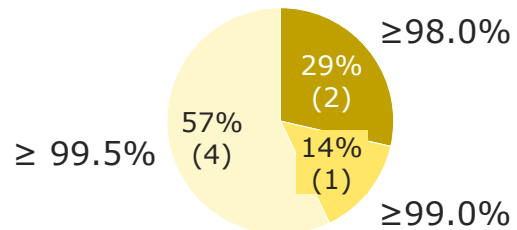
Producers see the highest quality specification as best suited for their process, users the lowest

Which of the quality specifications is suited for your process?

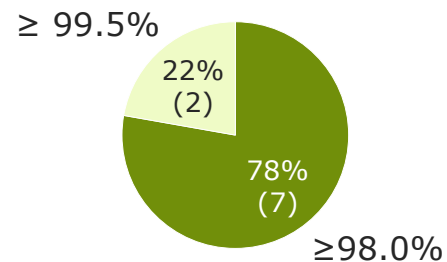
n=24



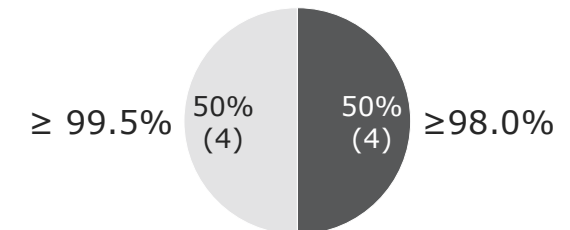
Producer



User



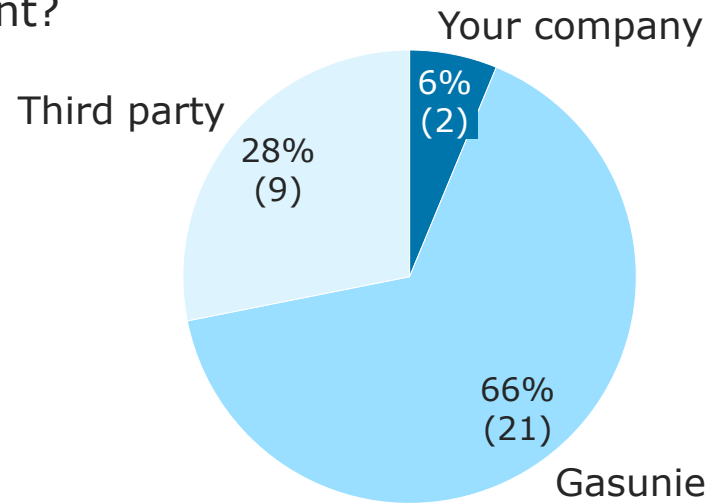
Producer & user



For connection equipment, users look at Gasunie while producers at third parties; for metering, both users and producers point to third parties to be responsible

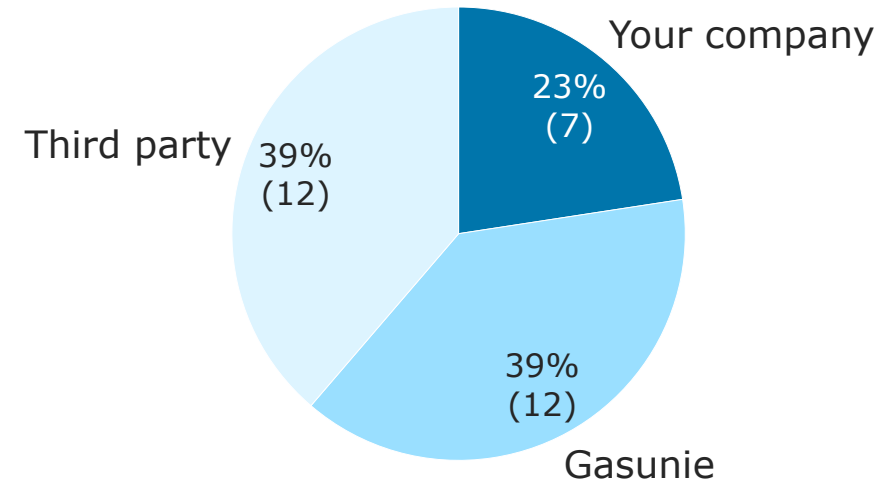
Connection and metering and regulating equipment?

n=32

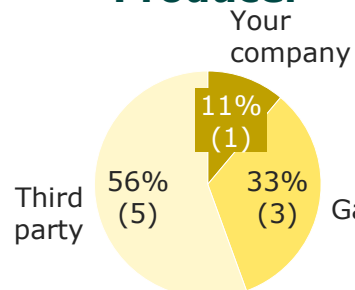


Who should be responsible for metering?

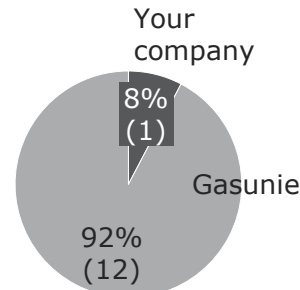
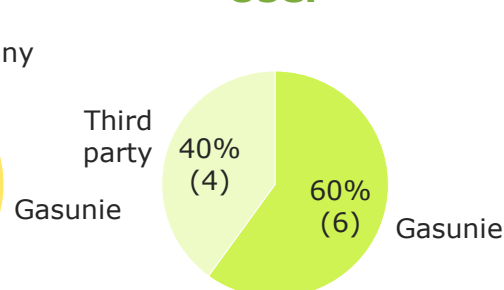
n=31



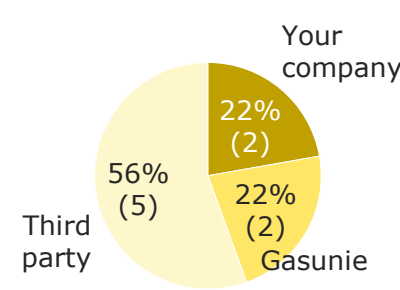
Producer



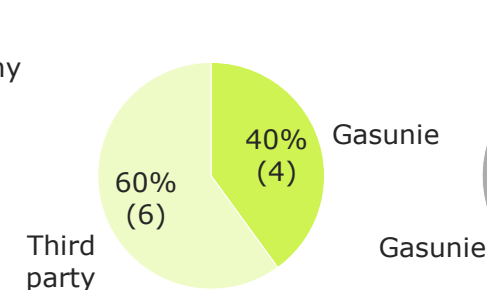
User



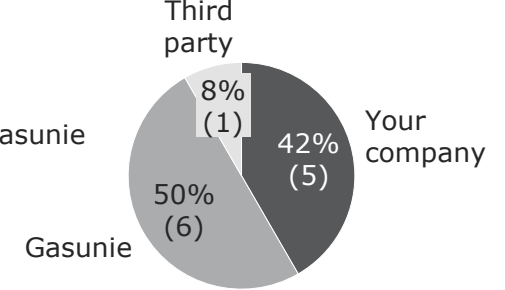
Producer



User



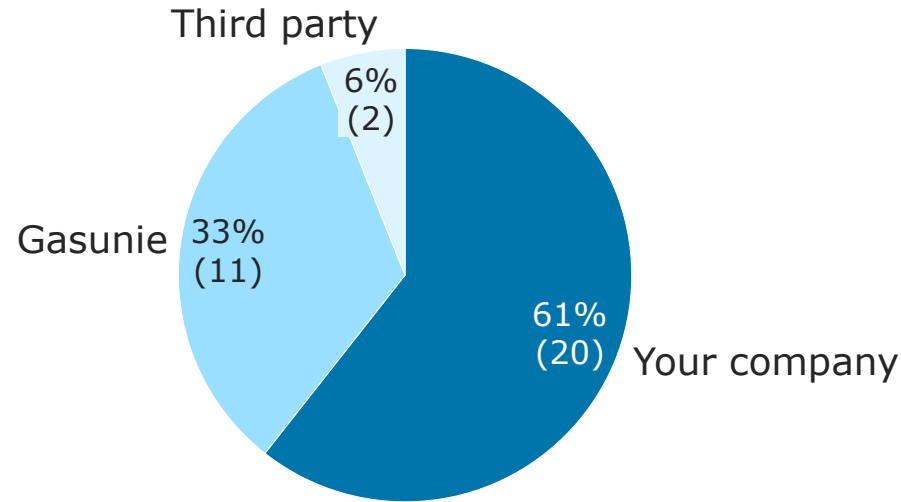
Producer & user



For compression as well as purification, producers seem to want to be responsible themselves, while users look at Gasunie

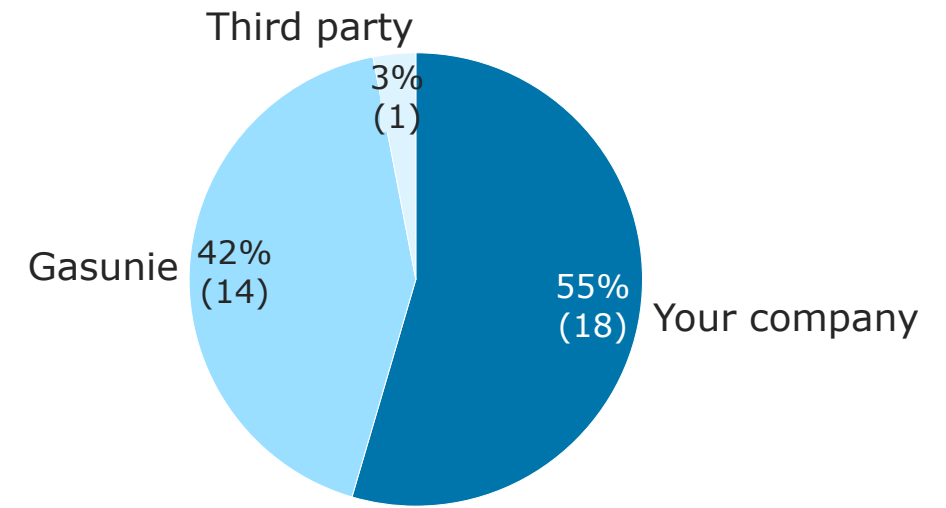
Who should be responsible for compression?

n=33

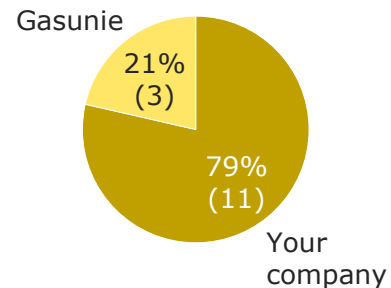


Who should be responsible for purification?

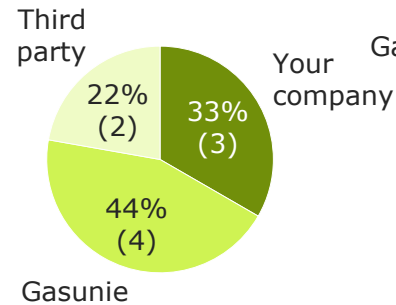
n=33



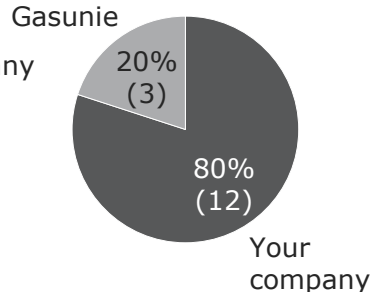
Producer



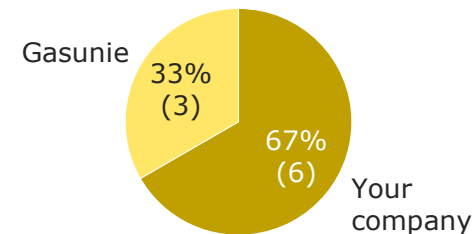
User



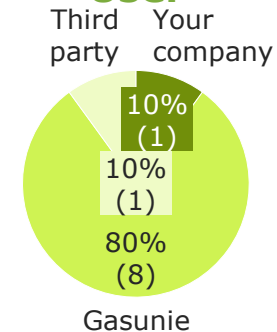
Producer & user



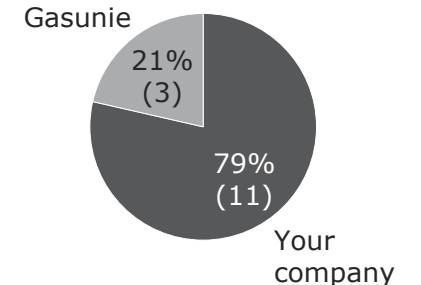
Producer



User

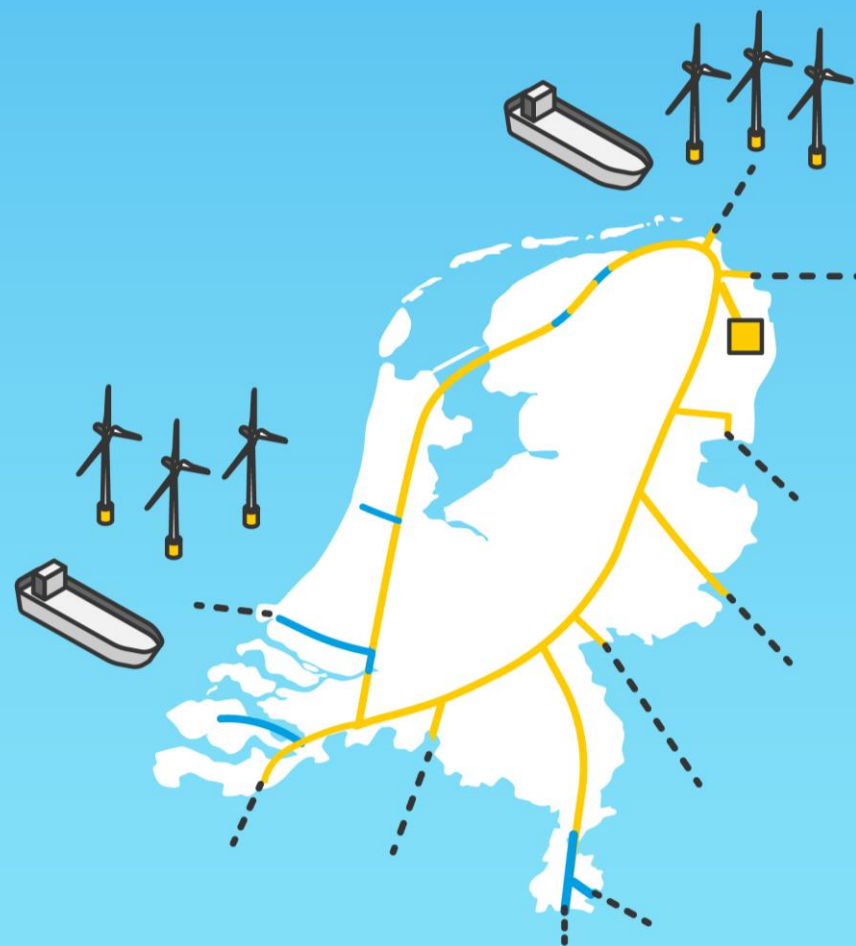


Producer & user



Regional insights

The following results demonstrate the ambitions of market parties. They are not backed by commitment of market parties in the form of Expressions of Interest.

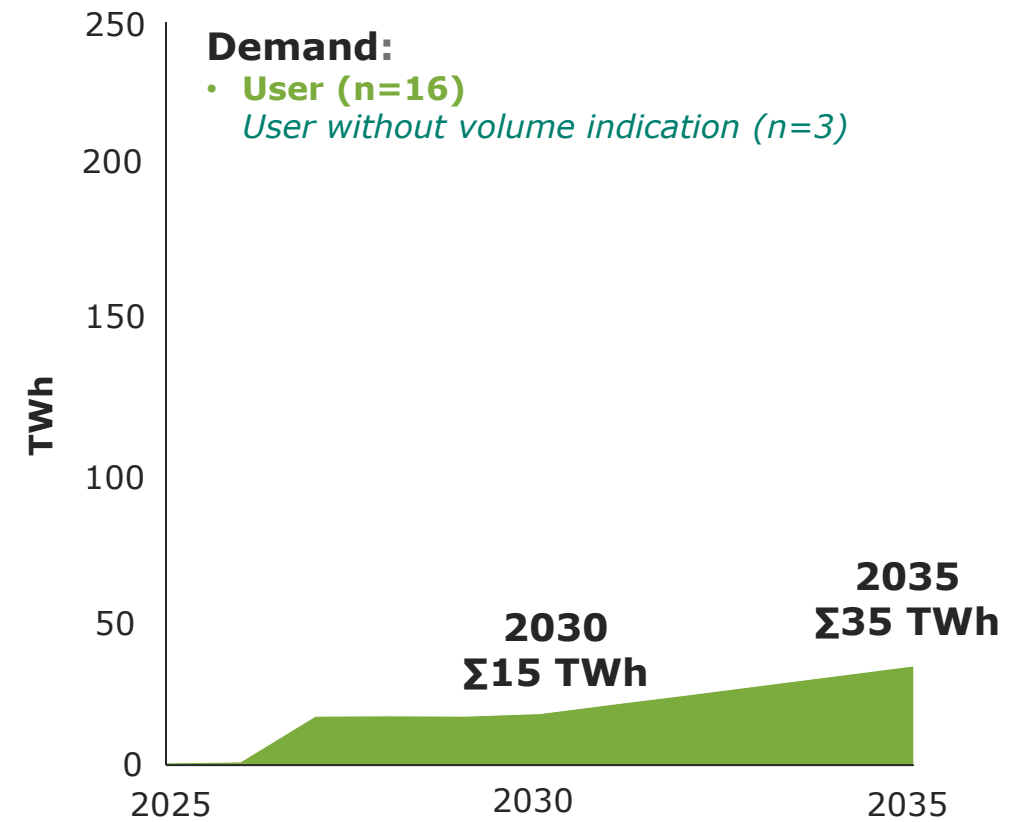
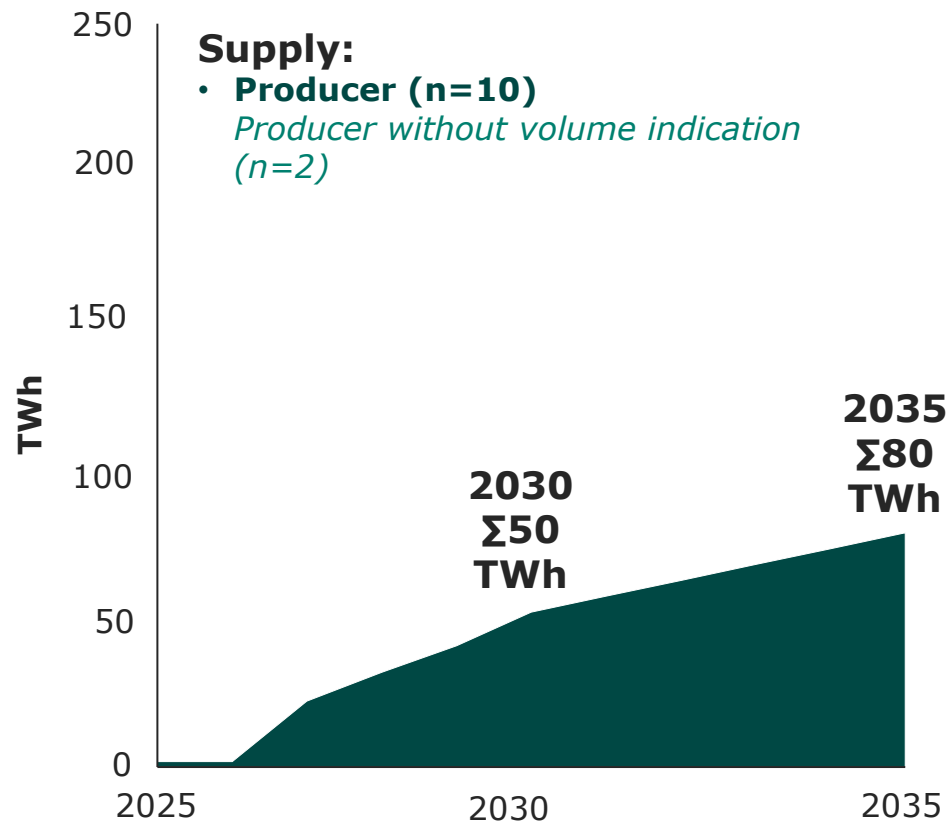


Noord

Because region Noord has highest number of respondents, it also has the highest expected volumes; with 50 TWh of supply and 15 TWh of demand in 2030

Can you give a (non-binding) indication of the volume you expect to transport in the period 2026-2035?

Noord n=25



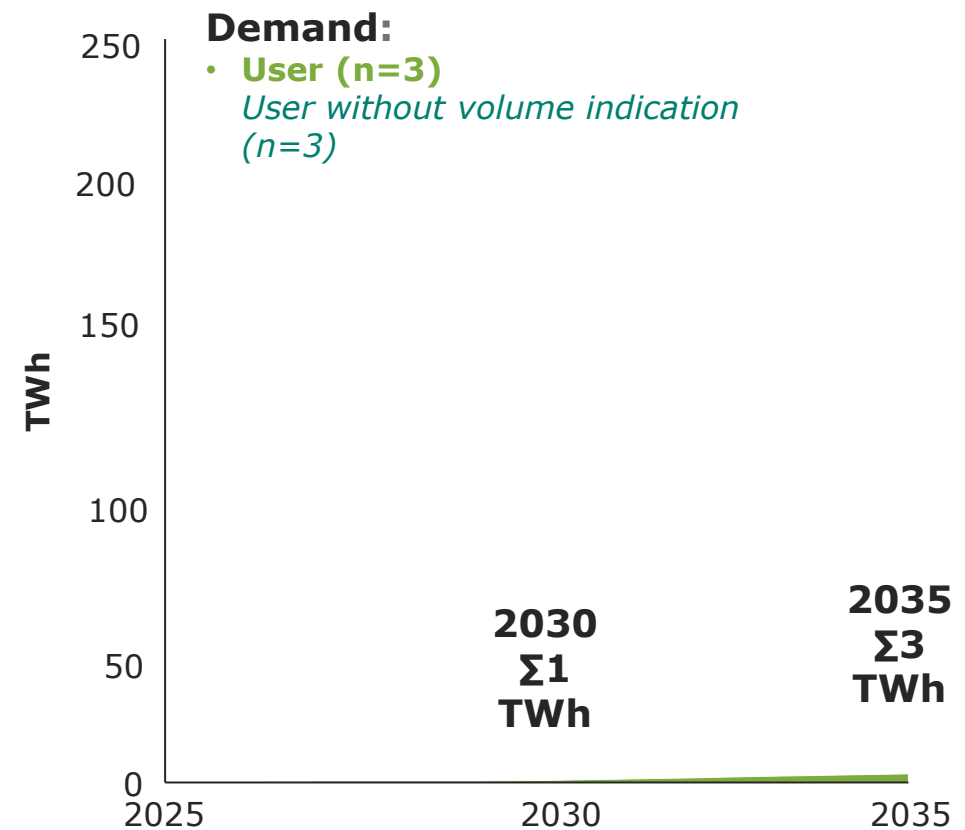
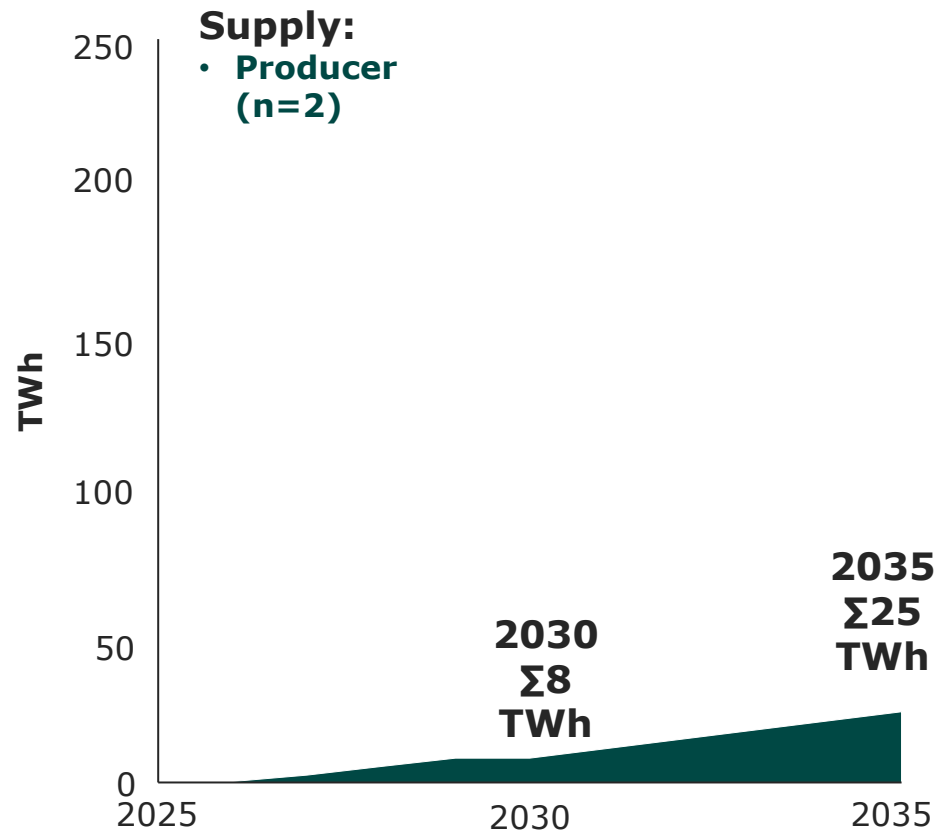
Note: Respondents in 'producer & user' segment have been manually assigned to 'producer' and/or 'user' for this questions based on their hydrogen plans, therefore sum of n producers and users may not add up to total n ; Producer includes import; **Five respondents indicate multiple regions for where their hydrogen project may materialize and their volumes are included in each of these regions** Source: Gasunie questionnaire hydrogen infrastructure responses; Monitor Deloitte analysis

Amsterdam

Two producers together plan 8 TWh of hydrogen supply in 2030, and the four users plan to use 1 TWh in 2030

Can you give a (non-binding) indication of the volume you expect to transport in the period 2026-2035?

Amsterdam n=4



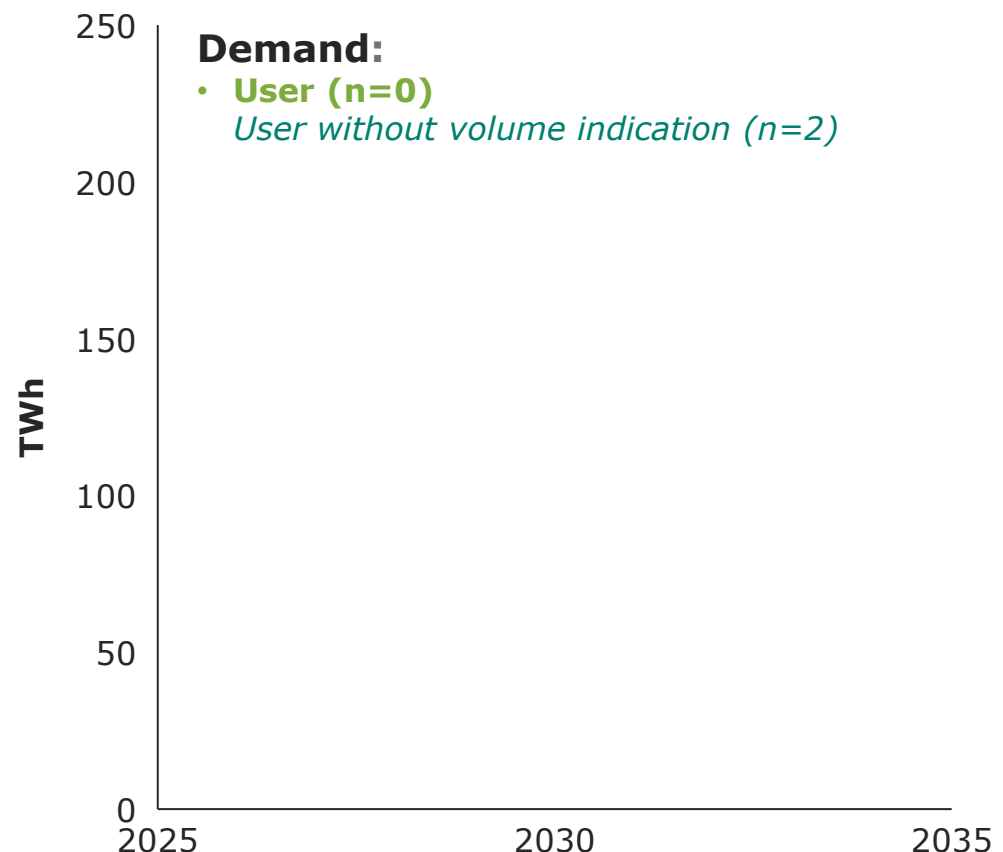
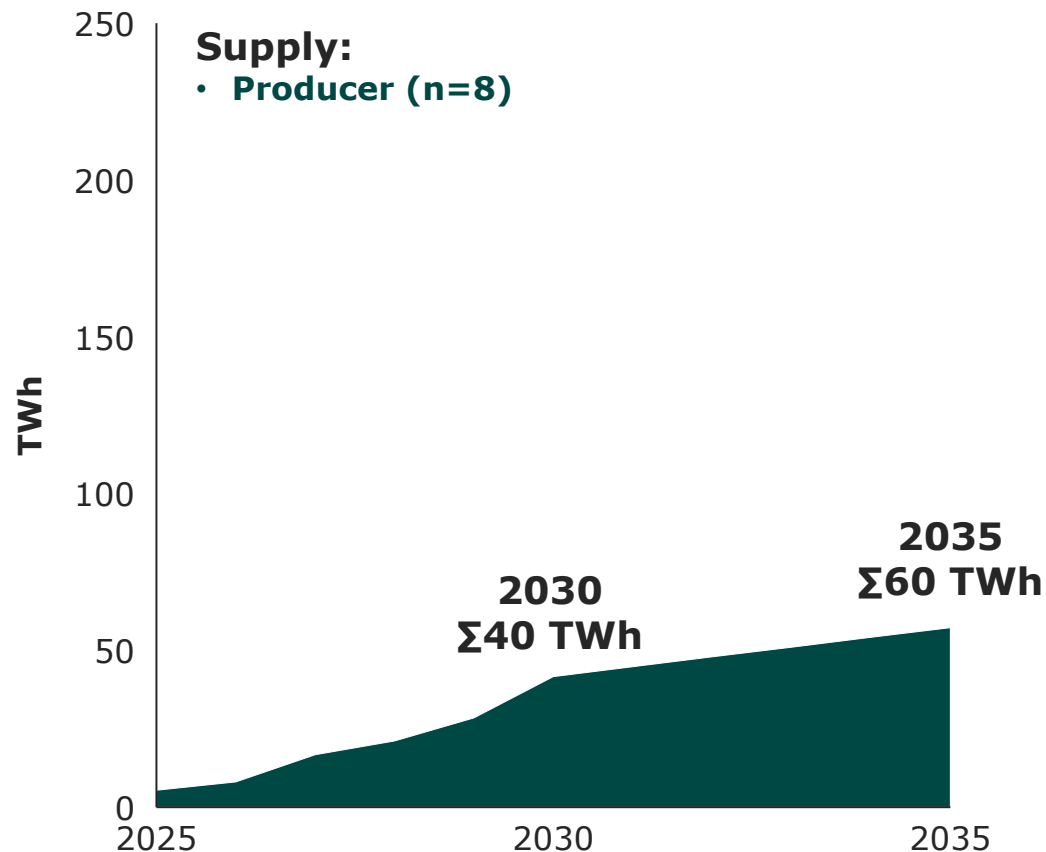
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Rotterdam

Seven producers expect to supply in total 40 TWh of hydrogen in 2030; of the respondents in the user segment none have yet indicated an expected volume

Can you give a (non-binding) indication of the volume you expect to transport in the period 2026-2035?

Rotterdam n=8



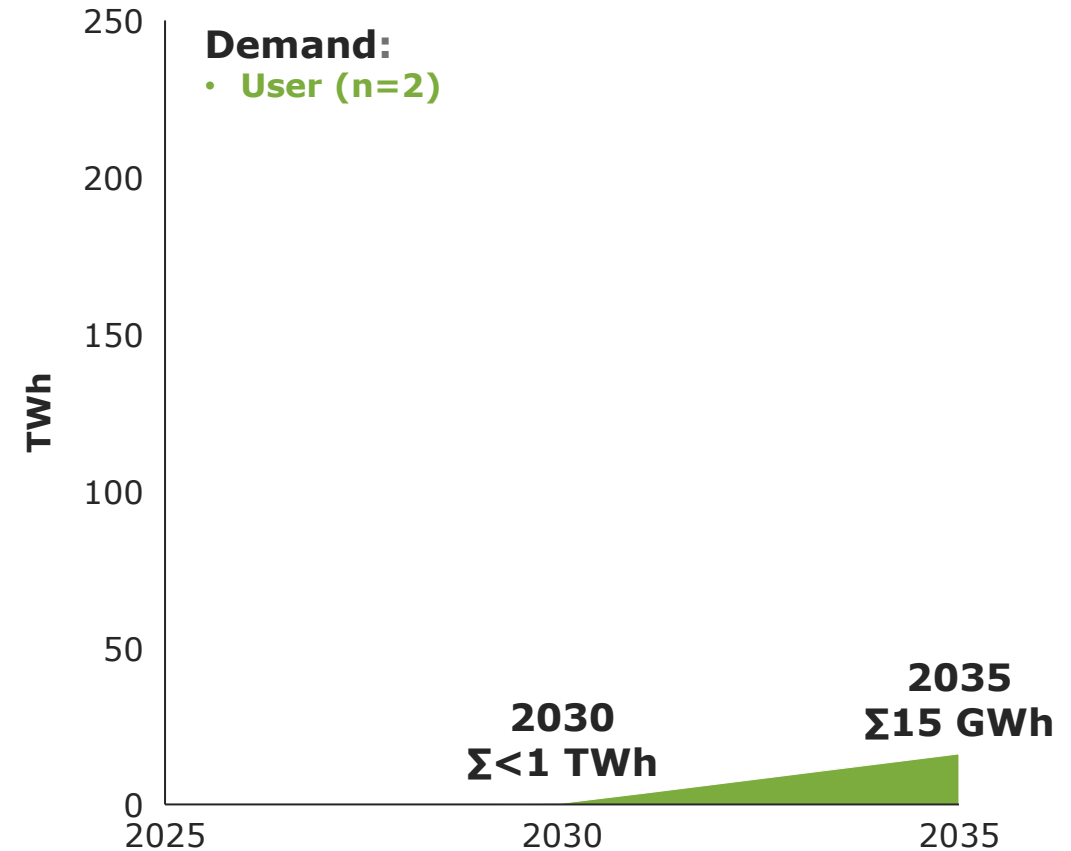
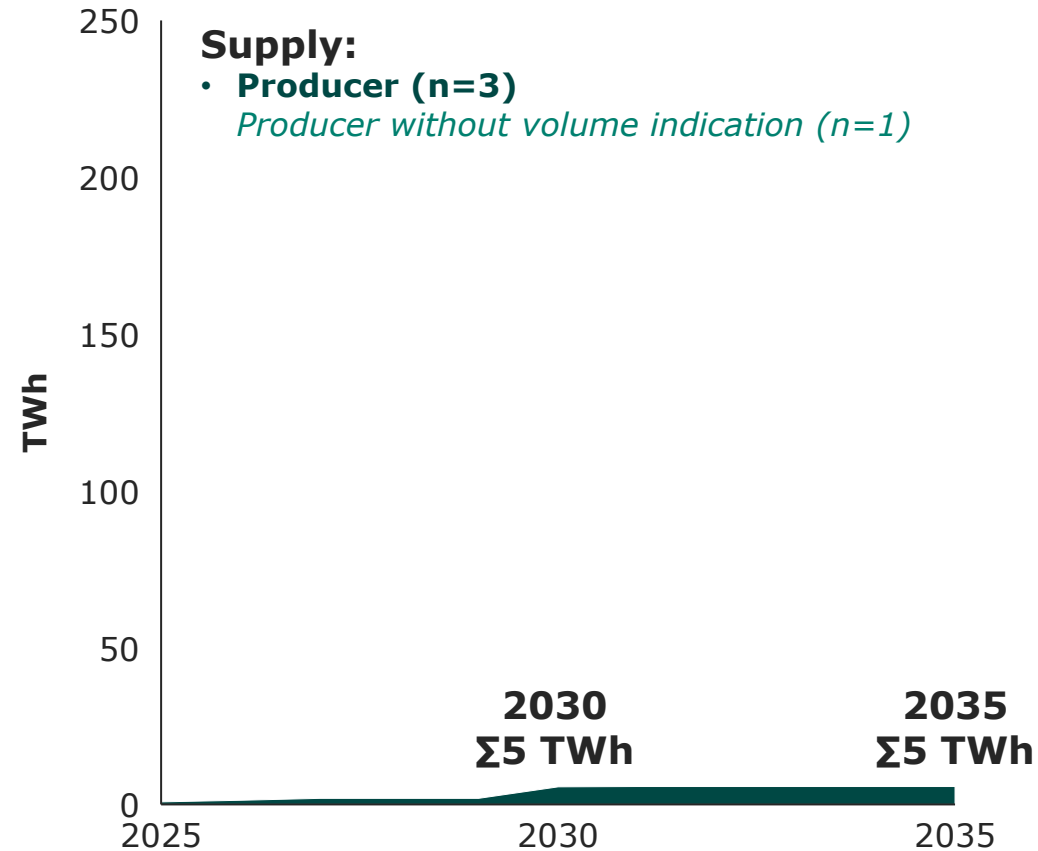
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Zeeland

Three producers expect to supply 5 TWh of hydrogen in 2030 and 2035, and two users expect <1 TWh of demand in 2030, growing to 15 TWh in 2035

Can you give a (non-binding) indication of the volume you expect to transport in the period 2026-2035?

Zeeland n=5



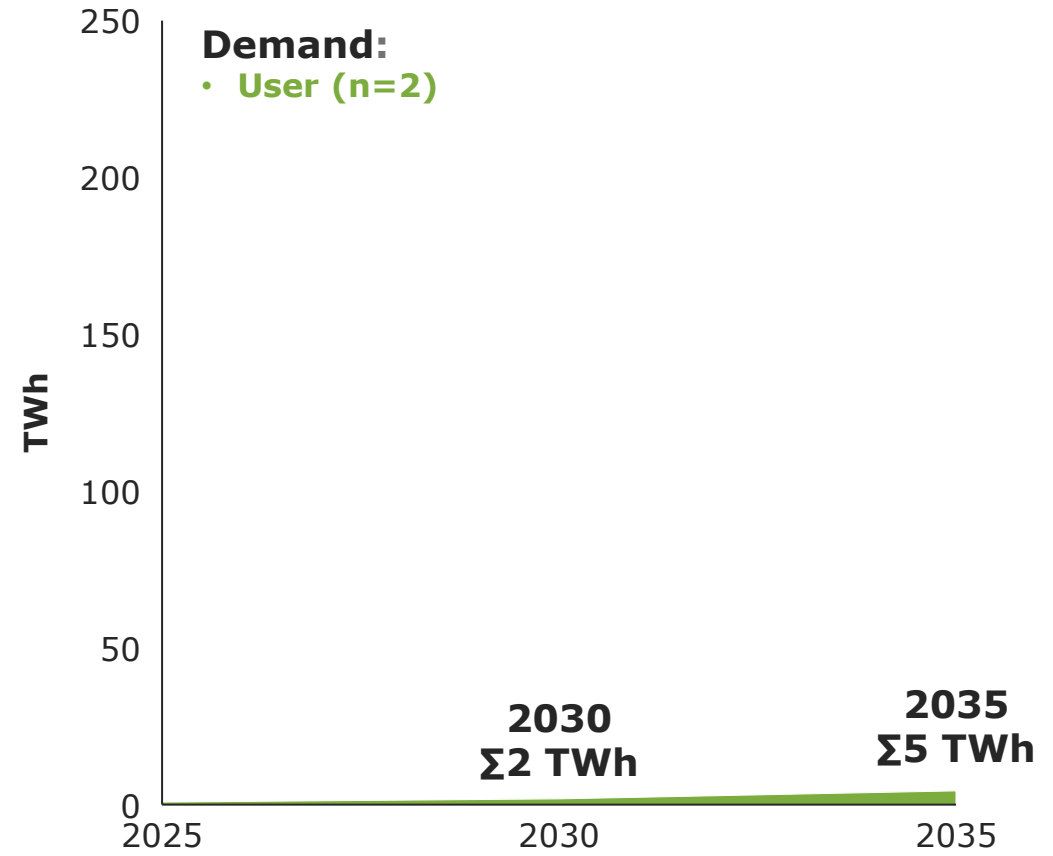
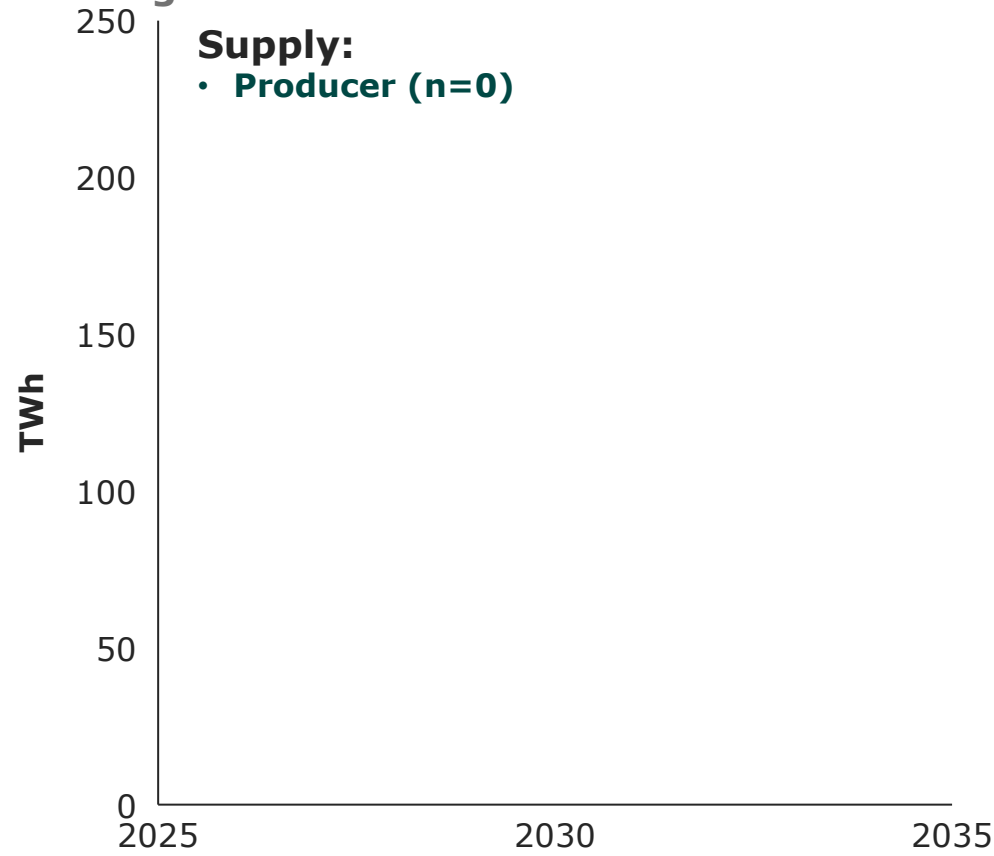
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Limburg

The two users expect 2 TWh of demand in 2030 and 5 TWh in 2035

Can you give a (non-binding) indication of the volume you expect to transport in the period 2026-2035?

Limburg n=2



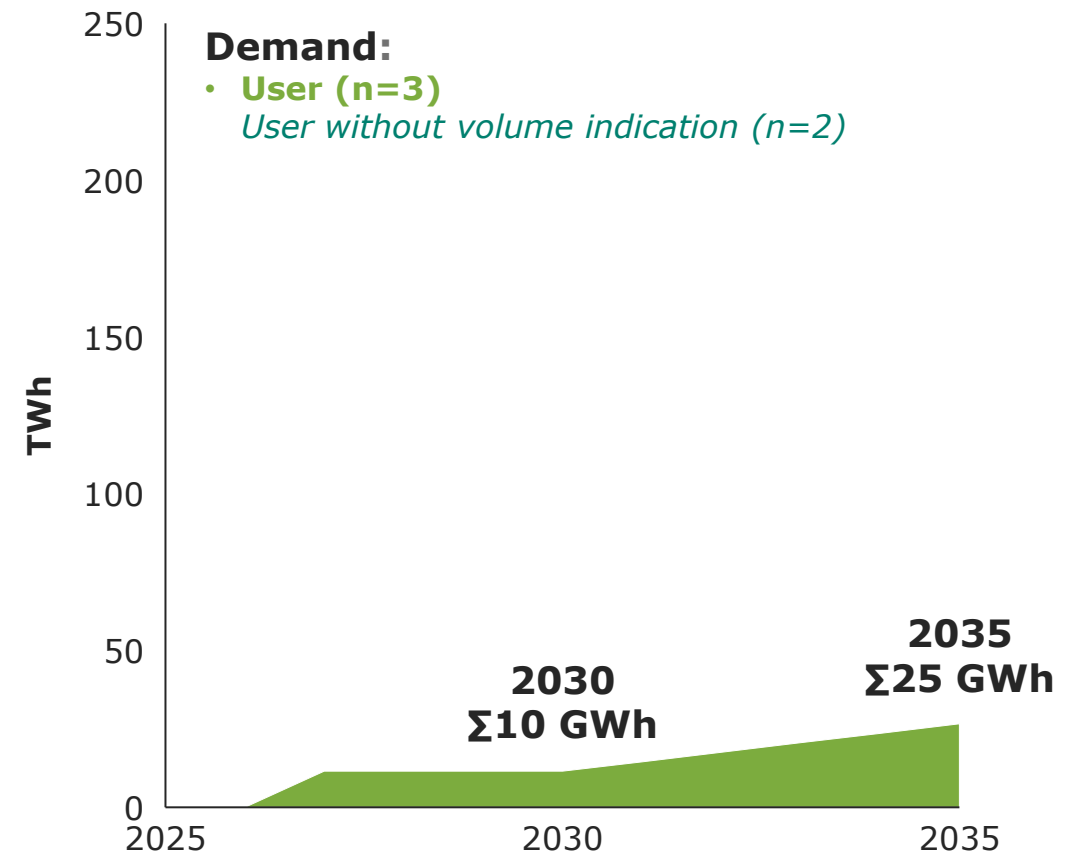
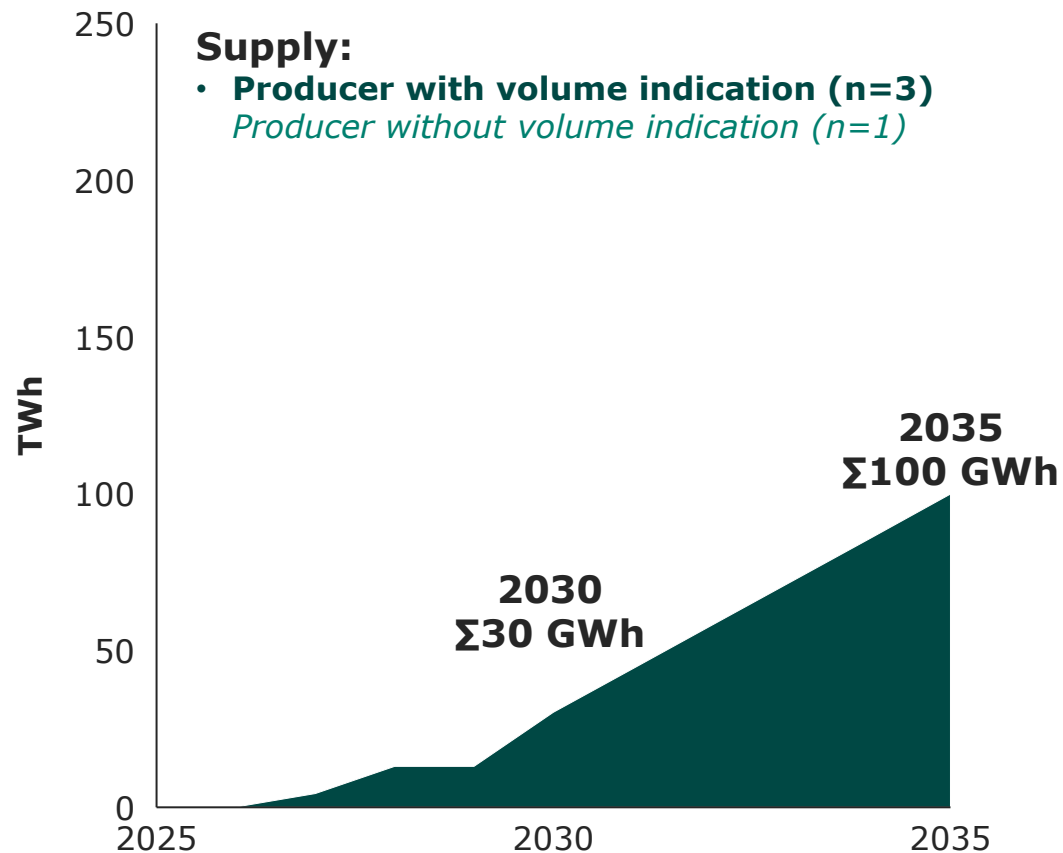
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Cluster 6

Three producers expect 30 TWh supply in 2030, and two users 10 TWh expect of demand

Can you give a (non-binding) indication of the volume you expect to transport in the period 2026-2035?

Cluster 6 n=6



Note: Respondents in 'producer & user' segment have been manually assigned to 'producer' and/or 'user' for this questions based on their hydrogen plans, therefore sum of n producers and users may not add up to total n ; Producer includes import; **Five respondents indicate multiple regions for where their hydrogen project may materialize and their volumes are included in each of these regions.** Source: Gasunie questionnaire hydrogen infrastructure responses; Monitor Deloitte analysis

Conclusions

The results of the questionnaire and a number of background discussions with potential users show the following specifications to be the wish of market parties:

Specifications	
Pressure	50 bar entry, 30 bar exit
Optional (start)	30 bar entry, 10 bar exit
Quality	> 98,0 mol%