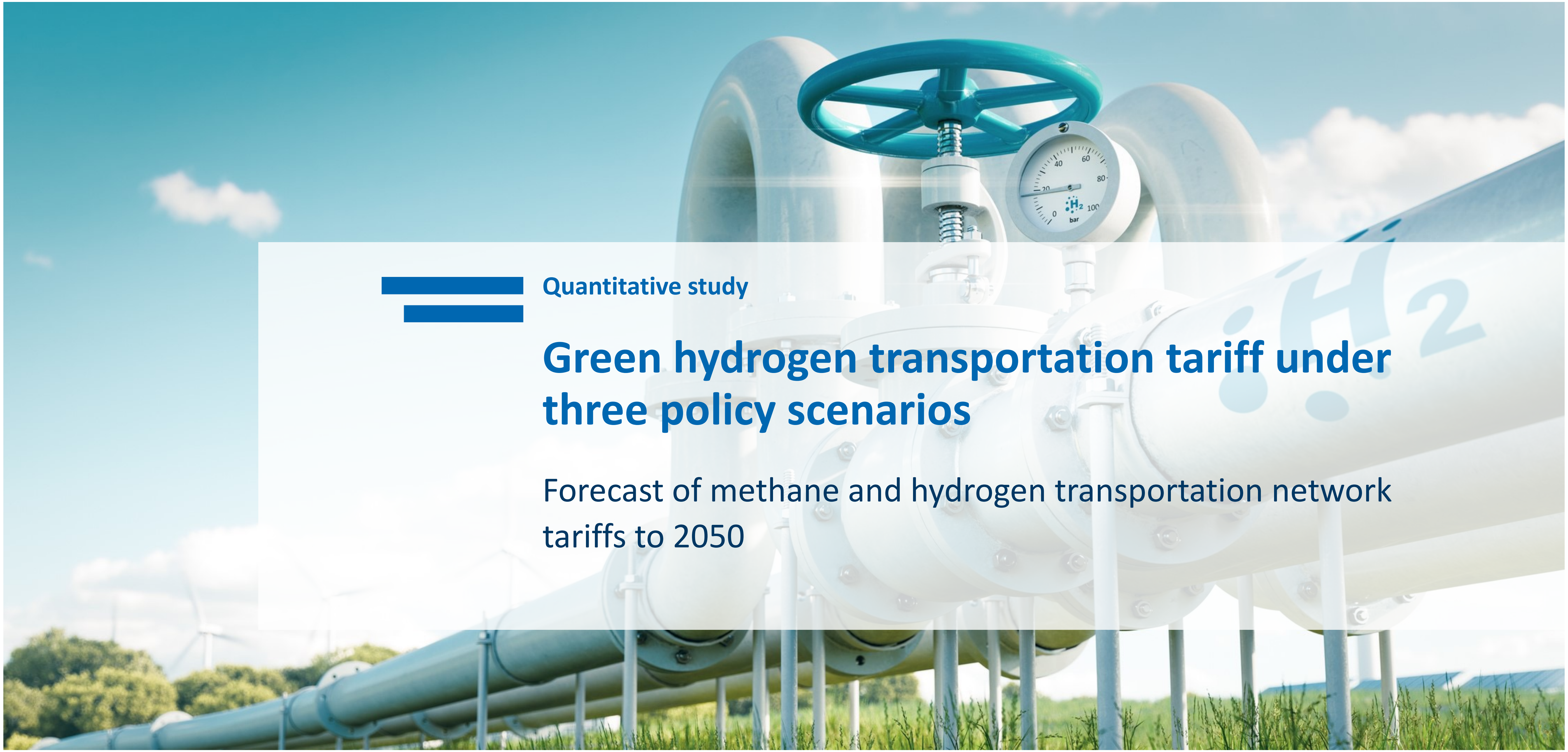

Quantitative study

Green hydrogen transportation tariff under three policy scenarios

Forecast of methane and hydrogen transportation network tariffs to 2050

FTI CONSULTING

March 2023

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0. Executive Summary

FTI CONSULTING™

FTI Consulting conducted a high-level analysis of hydrogen transportation tariff scenarios, using the European Hydrogen Backbone studies as a basis

FTI Consulting scope of work

OBJECTIVES OF THE STUDY

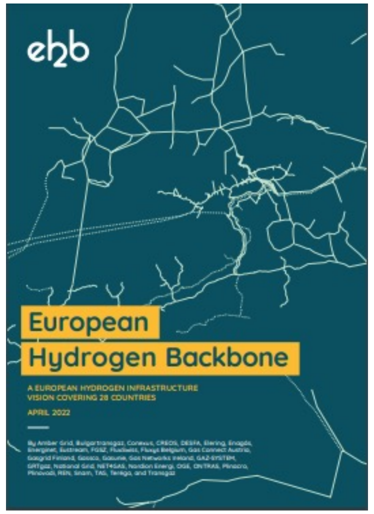
Provide a fact-based high-level analysis of different hydrogen transportation tariff options to support the discussion of a way forward for a hydrogen network in Europe, through

- Analysis different options of cross-subsidy between hydrogen users and either methane network users or taxpayers
- A high-level review of stakeholders’ positions should also be provided to support a view of acceptability

FTI CONSULTING’S SCOPE OF WORK

- The timeframe for the study is between 2024 and 2050, with the results captured for the years 2030, 2040 and 2050.
- Our focus is on the seven countries include Spain, Italy, Germany, Belgium, the Netherlands, France and Poland (collectively EU7), which represents nearly 70% of natural gas demand in the EU + UK between 2030 and 2050.
- We used the European Hydrogen Backbone studies (EHB) as a basis for the hydrogen network development, understanding the connections between the countries as well as the supply and demand information

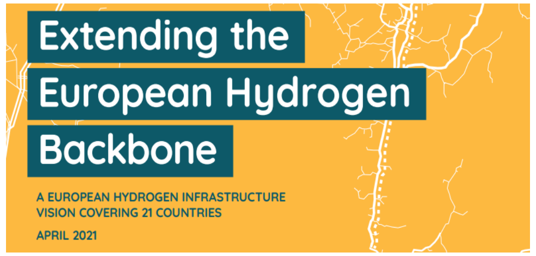
MAIN SOURCES



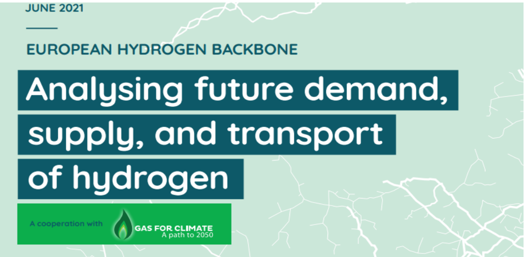
European Hydrogen Backbone (EHB) study report, April 2022

European Hydrogen Backbone (EHB): Five hydrogen supply corridors for Europe in 2030, May 2022

European Hydrogen Backbone (EHB): Extending the European Hydrogen Backbone, April 2021



European Hydrogen Backbone (EHB): Analysing future demand, supply and transport of hydrogen, June 2021



Source: European Hydrogen Backbone, FTI Consulting analysis, Regulation of the European Parliament and of the Council on the internal markets for renewable and natural gases and for hydrogen, 2021.

We relied on a distance minimizing dispatch model to calculate hydrogen flows, a natural gas flows model and a financial model to quantify tariffs

Summary of the dispatch model, natural gas flows and the financial model

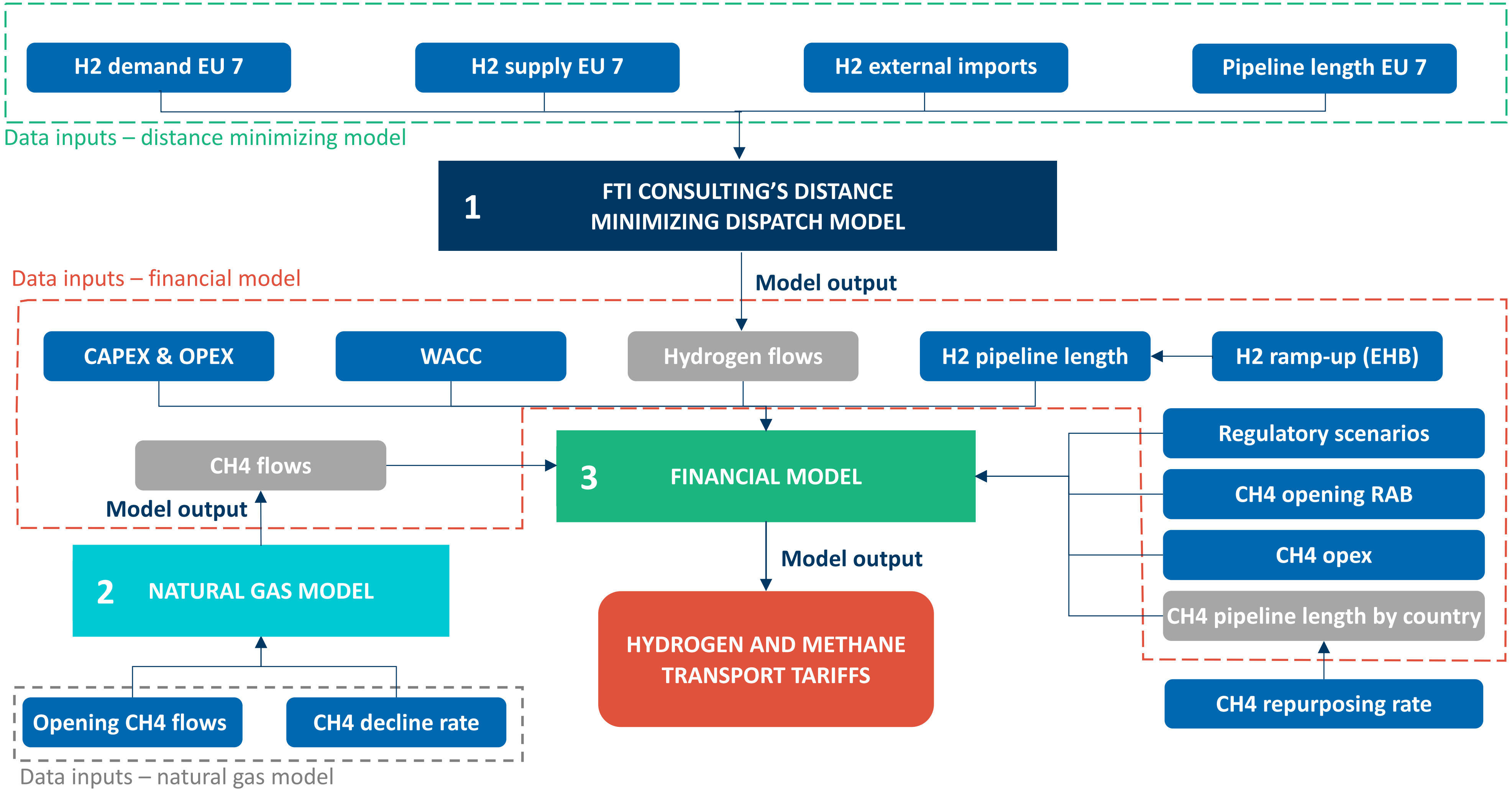
Input Output RAB: Regulated Asset Base

There are three models supporting our quantitative analysis:

1 **Distance minimizing dispatch model**, whereby we source hydrogen supply from geographically closest sources until the demand is served. The output of this model are hydrogen flows across EU7.

2 **Natural gas model** uses current gas flows from ENTSOG by country. We then apply annual decline rate sourced from ENTSOG scenario. The output are natural gas flows across EU7.

3 **Financial model** takes the output of models 1 and 2, as well as hydrogen Opex, WACC and natural gas opening RAB, Opex and WACC, applies this to the length of the hydrogen and natural gas pipes and calculates hydrogen and methane tariffs. Note that our calculation is made in nominal terms.



Germany has the largest H2 flows, followed by Belgium; transit flows represent 4% of total flows in 2030, and 13% in 2050

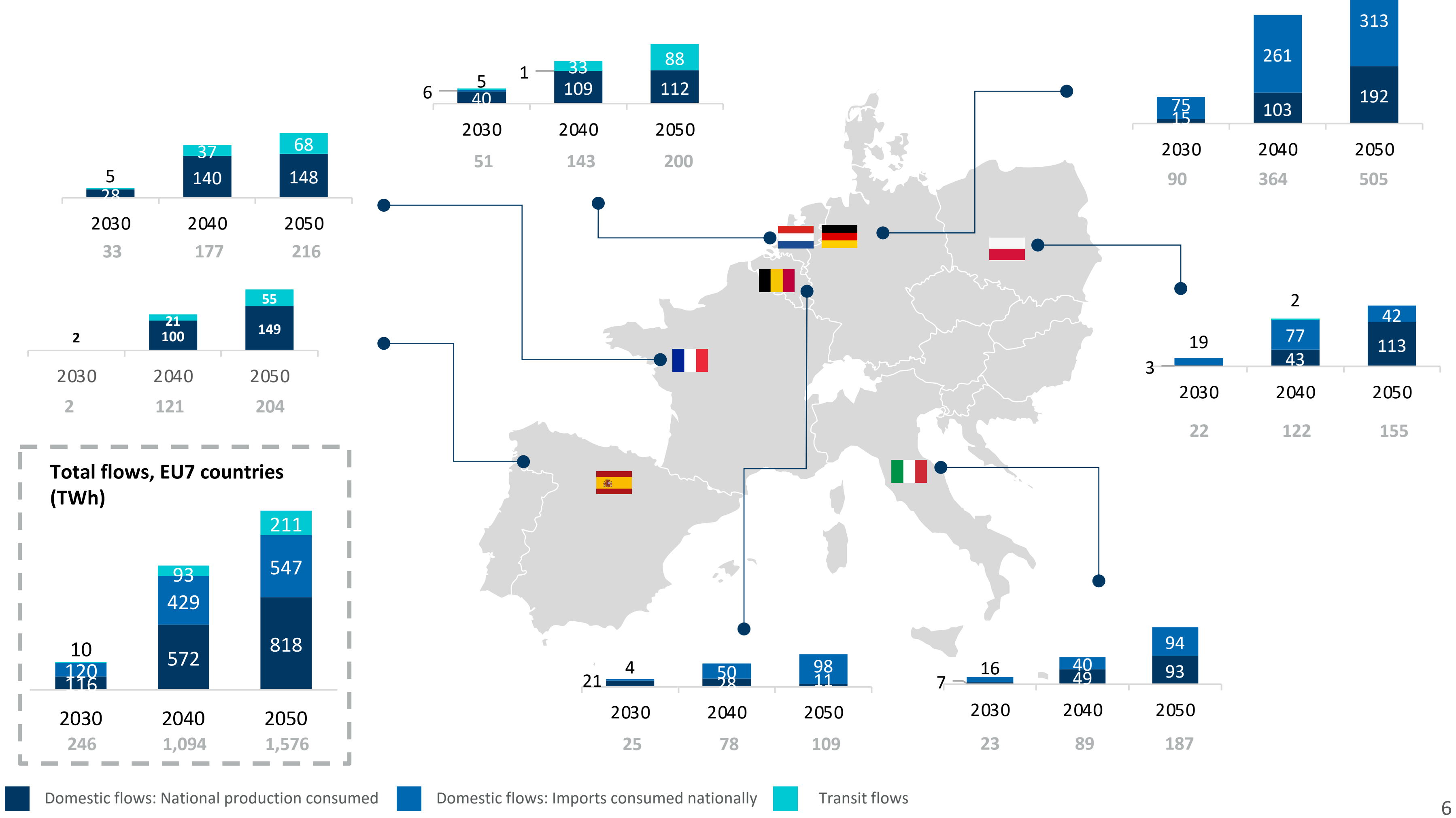
Total flows and percentage of H2 domestic and transit flows for EU7 countries, 2030-2050 (TWh and %)

- For countries in our scope, total H2 flows increase significantly between the years of 2030 and 2050.
- Germany is the country with the highest H2 flows in 2030, 2040 and 2050.
- Transit flows represent 8% of total H2 flows in 2030, 18% in 2040 and 28% in 2050.

Share of transit flows in total H2 flows (%)

Share (%)	2030	2040	2050
Spain	0%	17%	27%
France	15%	21%	31%
Germany	0%	0%	0%
Belgium	0%	0%	0%
Netherlands	10%	23%	44%
Italy	0%	0%	0%
Poland	0%	2%	0%
Total	**4%**	**9%**	**13%**

Total hydrogen flows split between the transit and national consumption, 2030-2050 (TWh)



Total EU7 CH4 flows decline by 49% between 2030 at 2050 ; NL has the highest decline rate (-72%), with only 62 TWh of CH4 flows left in 2050

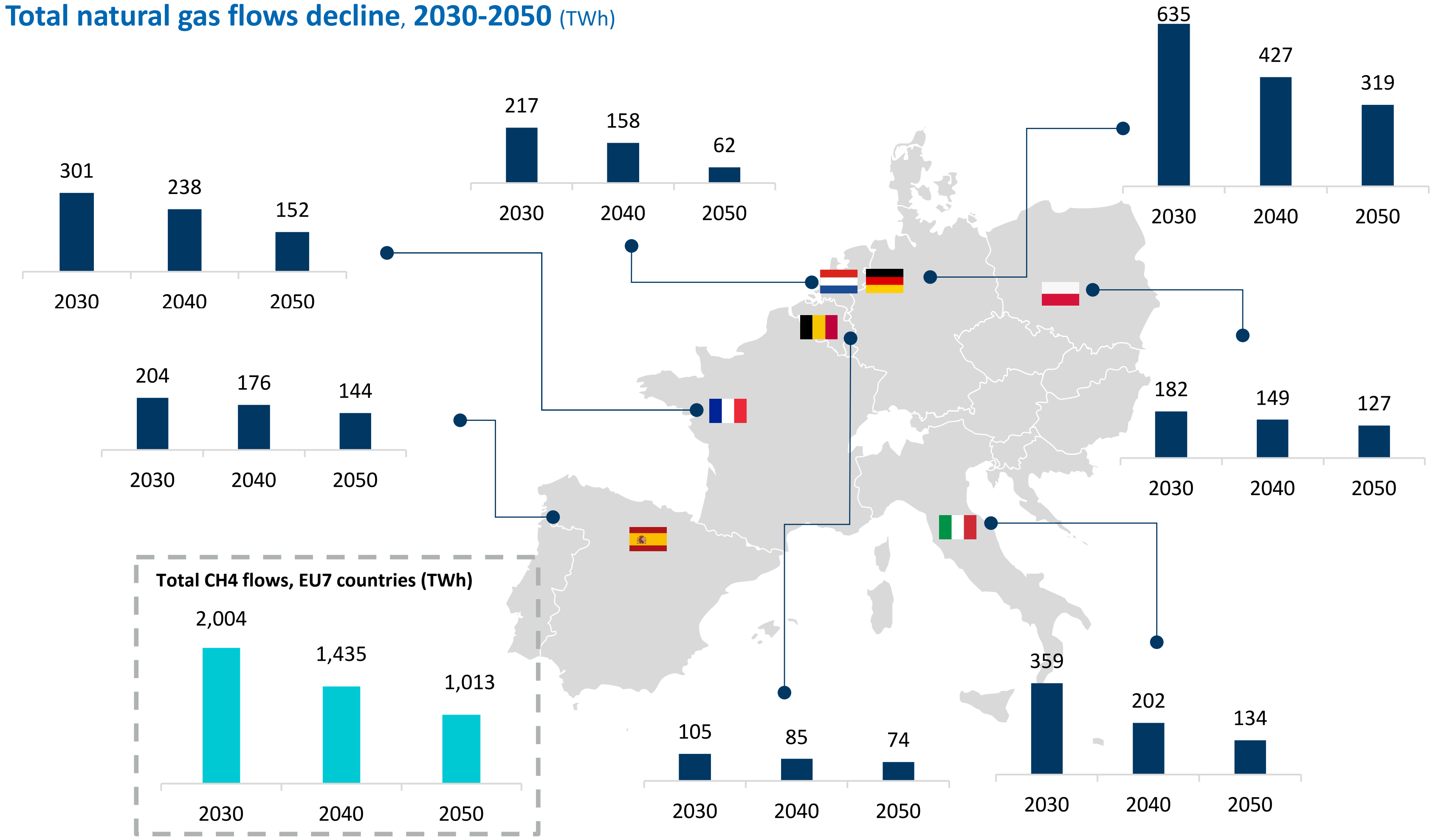
Natural gas flows decline in EU7 – Global Ambition

- Total EU7 natural gas flows decrease from 2004 TWh in 2040 to 1,013 TWh in 2050 (-49%).
- The Netherlands have the highest decline rate (-72%) while Spain and Belgium have the lowest (-30%).
- Germany has the highest CH4 flows throughout all years starting at at 635 TWh in 2030 and decreasing to 319 TWh in 2050.

CH4 flows decline, 2030-2050 (%)

Decline rate (%)	2030-50
Spain	-30%
France	-49%
Germany	-50%
Belgium	-30%
Netherlands	-72%
Italy	-62%
Poland	-31%
Total	**-49%**

Total natural gas flows decline, 2030-2050 (TWh)



Based on H2 & CH4 required network revenues and forecasted flows, we calculate transport tariffs following four support scenarios

Scenarios used for tariffs calculations

Scenario 0 – 0 "Do nothing"

- Separate tariffs for H2 and CH4
- No subsidy

$$\text{H2 tariff} = \frac{\text{H2 revenues}}{\text{H2 flows}} \qquad \text{CH4 tariff} = \frac{\text{CH4 revenues}}{\text{CH4 flows}}$$

Scenario 1 1

- To calculate a unified tariff, we will take the total of revenues for hydrogen and natural gas (based on the financial regulated asset model) and divide it by the sum of flows:

$$\text{Unified tariff} = \frac{\text{H2 revenues + CH4 revenues}}{\text{H2 flows + CH4 flows}}$$

- We will compare this unified tariff over 2024-2050 with the alternative of separate tariffs for methane and hydrogen users

Scenario 2 2

- To calculate a hydrogen tariff needed to split across the asset life to cover the costs of the initially underutilised pipeline, we use 2050 tariff for all the years from 2030 to 2050 and calculate the subsidy by subtracting the product of flows and tariff from the 2030 or 2040 year revenue as follows :

$$\text{Total tariff} = \frac{\text{2050 H2 revenues}}{\text{2050 H2 flows}}$$

$$\text{Subsidy}_{2030*} = \text{2030 H2 revenues} - \text{2030 H2 flows} \times \text{Total tariff}$$

Subsidy_{2040} uses the same formula as above, but replaces 2030 revenues and flows with 2040

Scenario 3 3

- To calculate hydrogen tariff with a discount stipulated by the European Commission's draft package1), we assume that hydrogen users pay only 25% capacity portion of the allowed revenue :

$$\text{Total tariff} = \frac{\text{Capital charges + OPEX}}{\text{H2 flows}} \qquad \text{User tariff} = \frac{\text{25\% x Capital charges+ OPEX}}{\text{H2 flows}} \qquad \text{Subsidy} = \frac{\text{75\% x Capital charges}}{\text{H2 flows}}$$

Source: 1) Regulation of the European Parliament and of the Council on the internal markets for renewable and natural gases and for hydrogen (recast), 2021

Under Scenario 1, hydrogen and methane only tariffs cross in 2037: natural gas users subsidize hydrogen until then and the reverse afterwards

Results for methane only and hydrogen only tariffs for the EU71 under Scenario 1 – Global Ambition

Description of Scenario 1 tariffs

- Allowed revenues of methane and hydrogen are combined, sharing all cost across the flows of methane and hydrogen users.

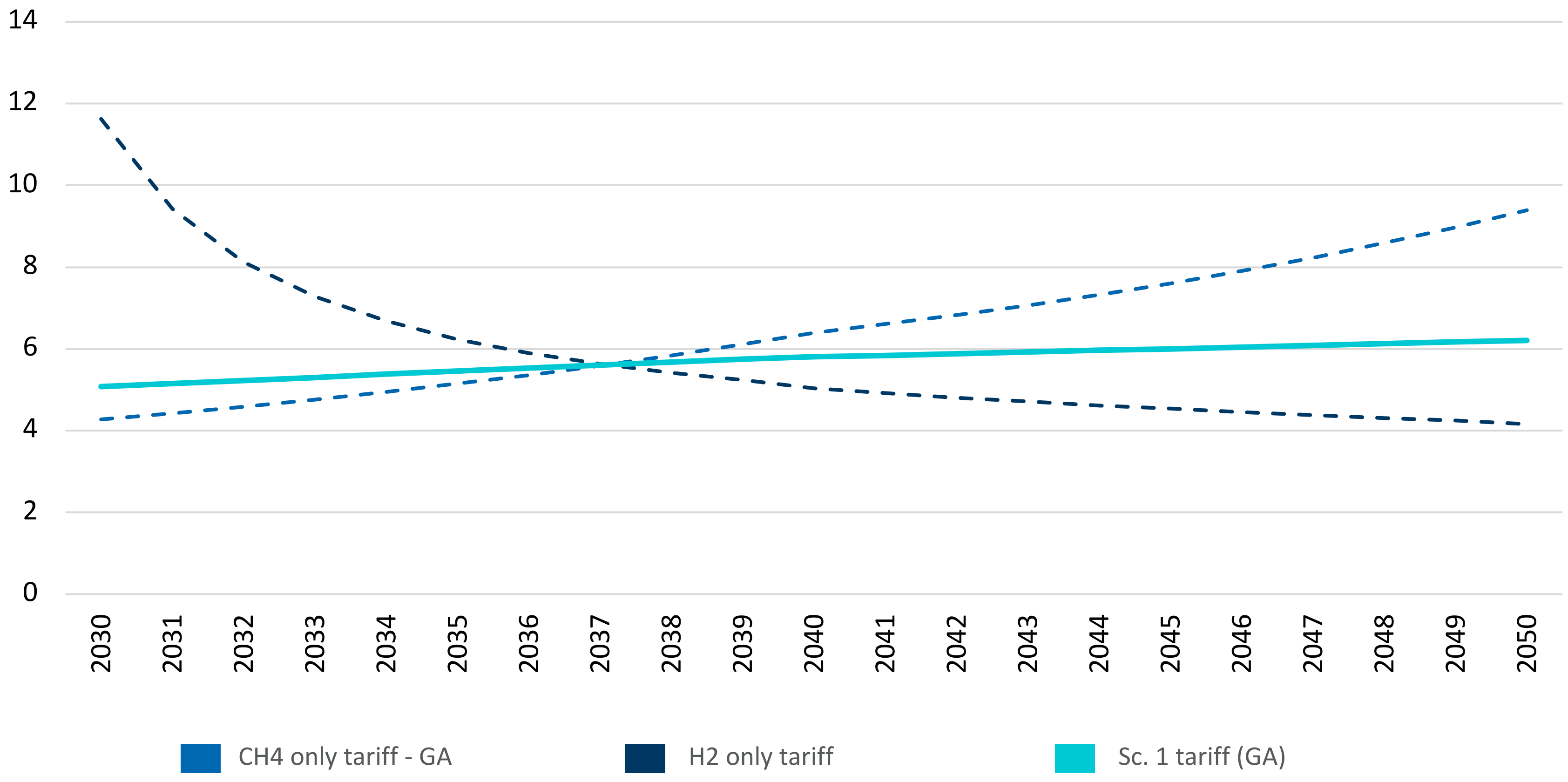
Subsidising profile

- Subsidising hydrogen transportation will help kick-start the hydrogen economy and develop the network necessary to meet decarbonisation targets within the EU block.
- For the Scenario 1 (unified hydrogen and methane tariff), taken separately hydrogen and methane only tariffs break-even in 2037.
- This means that natural gas users subsidise hydrogen users up until 2037. After this point the trend reverses and hydrogen users start subsidising natural gas users.

Assumptions

- This comparison is made under the ENTSOG Global Ambition variant (under a Variant – Distributed Energy, break-even point is reached earlier in 2035. This is discussed in the Sensitivities section of the report.)
- This is the tariff for EU7 as a group, individual EU7 countries have different profiles. This is discussed in the Country level results section.

EU7 CH4 and H2 only and Scenario 1 combined tariff (€/MWh)



Notes:1 – EU7-wide tariff is equal to allowed revenue divided by the flows, as opposed to an average tariff for all seven countries. In this way, we calculate the tariff level if it was charged across EU7.
ENTSOG’s TYNDP 2020 Global Ambition Scenario used for methane flows

Hydrogen tariffs under the Scenario 2 assumptions is lower than methane tariff, due to public subsidies that decline over time, reaching zero in 2050

Results of Scenario 2 vs hydrogen and methane only tariffs and subsidies for the EU7[1] – Global Ambition

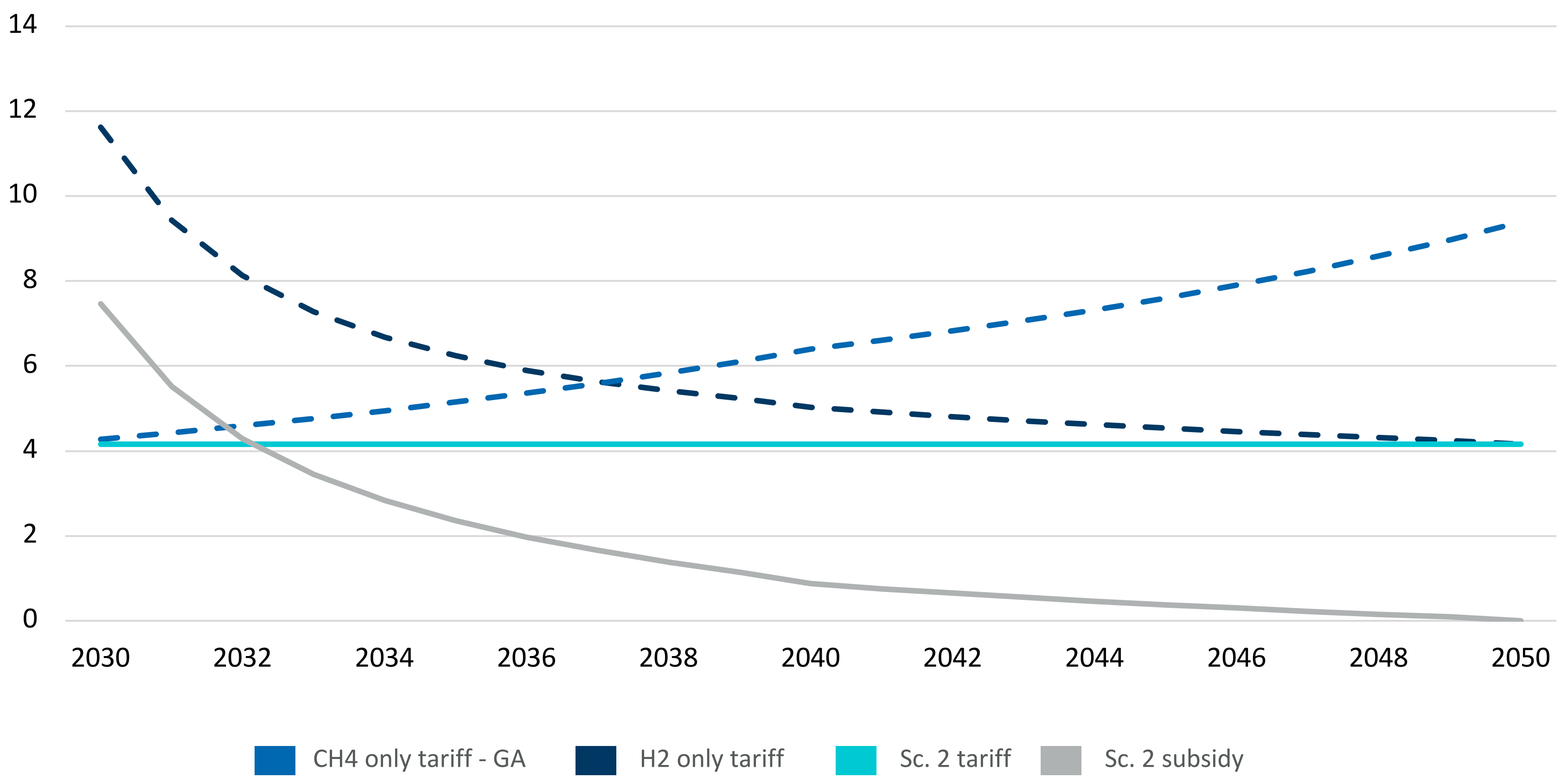
Description of Scenario 2 tariffs

- Under Scenario 2, we assume that 2050 hydrogen tariff is applied to 2030 and 2040 to avoid penalising early hydrogen users.
- Hydrogen tariff under the Scenario 2 is stable throughout the years, at 4.2 EUR/MWh. Methane only tariff always exceed the Scenario 2 hydrogen tariff.

Subsidising profile

- In order to reach the low tariffs under Scenario 2, and in the absence of a combined tariff arrangement, hydrogen users will be subsidized by taxpayers. This makes hydrogen transportation more attractive for the users as costs are borne out of the energy transport system.
- The EU7-wide subsidy starts at 7.5 EUR/MWh in 2030, rapidly dropping to 0.9 EUR/MWh in 2040 before reaching zero in 2050.
- Total subsidy required to support H2 users under Scenario 2 starts at EUR 1,836 M EUR in 2030, declines to 953 M EUR in 2040 due to increasing H2 flows, and drops down to zero in 2050.

EU7 CH4 and H2 only and Scenario 2 tariff and subsidy (€/MWh)



Notes:1 – EU7-wide tariff is equal to allowed revenue divided by the flows, as opposed to an average tariff for all seven countries. In this way, we calculate the tariff level if it was charged across EU7.
ENTSOG's TYNDP 2020 Global Ambition Scenario used for methane flows

Hydrogen tariffs under the Scenario 3 assumptions are lower than methane only tariffs; public subsidies are always needed for support

Results of Scenario 3 vs hydrogen and methane only tariffs and subsidies for the EU7[1]

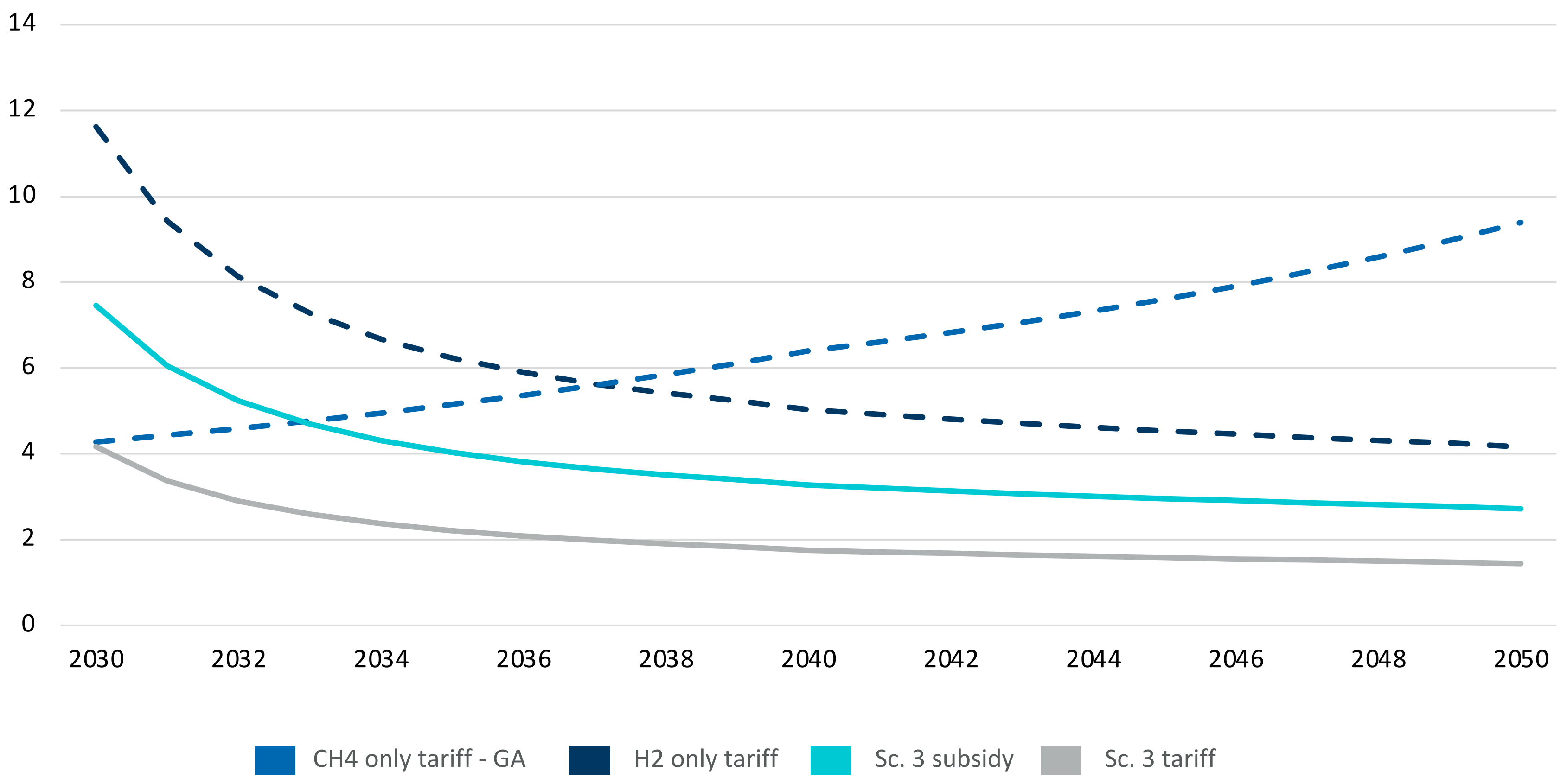
Description of Scenario 3 tariffs

- Under Scenario 3 assumptions, where 75% discount is given to the capital portion of the allowed revenue, tariff starts at 4.2 EUR/MWh in 2030, declines to 1.8 EUR/MWH in 2040 and then to 1.4 EUR/MWH in 2050.
- Under the Scenario 3, the hydrogen only tariff is always lower than the methane only tariff.

Subsidising profile

- In order to reach the low tariffs under Scenario 2, and in the absence of a combined tariff arrangement, hydrogen users will have to be subsidized by taxpayers. This makes hydrogen transportation more attractive for the users as costs are borne out of the energy transport system.
- The EU7-wide subsidy to support tariff under the Scenario 3 starts at 7.5 EUR/MWh in 2030, declines to 3.3 EUR/MWh in 2040 and 2.72 EUR/MWh, still higher than the hydrogen tariff.
- The total subsidy required in 2030 is EUR 1,834m, in 2040 it is EUR 3,580m as allowed revenue increases, before reaching EUR 4,281m in 2050.

EU7 CH4 and H2 only and Scenario 3 tariff and subsidy (€/MWh)



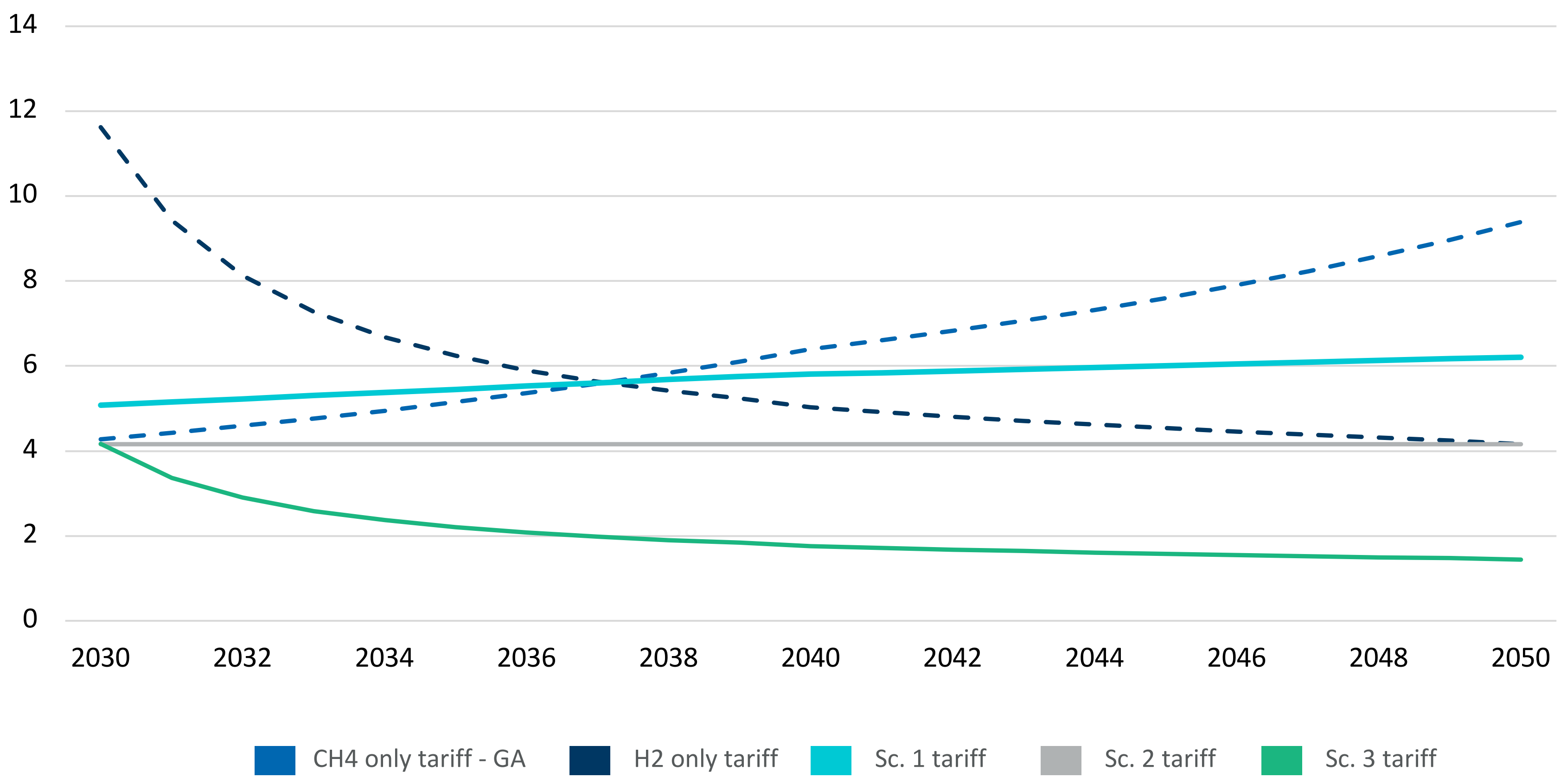
Notes:1 – EU7-wide tariff is equal to allowed revenue divided by the flows, as opposed to an average tariff for all seven countries. In this way, we calculate the tariff level if it was charged across EU7.
ENTSOG's TYNDP 2020 Global Ambition Scenario used for methane flows

Scenario 1 (combined tariff) always exceeds hydrogen tariffs under Scenario 2 and 3 from 2030 to 2050; Scenario 3 has the lowest tariffs

Comparison of Tariffs under Scenarios 1, 2 and 3 for the EU7[1]

- Overall, a combined hydrogen tariff is higher than Scenario 2 or 3 tariffs from 2030 and 2050.
- Not having a combined tariff would result in higher costs under the H2 only tariff until circa 2035 and after around 2035 under the CH4 only tariff (aka "doing nothing" – Scenario 0).
- The combined tariff under the Scenario 1 for EU7 countries starts at 5.1 EUR/MWh in 2030 and increases to 6.2 EUR/MWh in 2050.
- EU7-wide tariff for Scenario 2 for all EU7 countries is stable at 4.2 EUR/MWh, as hydrogen users pay 2050 tariff throughout all years.
- EU7-wide tariff under Scenario 3 starts at the same level as tariff 2 (4.16 EUR/MWh) then rapidly decreases to reach 2.0 EUR/MWh in 2035.

Tariffs for Scenario 0, 1, 2 and 3, 2030 to 2050 (€/MWh)



Notes:1 – EU7-wide tariff is equal to allowed revenue divided by the flows, as opposed to an average tariff for all seven countries. In this way, we calculate the tariff level if it was charged across EU7.
ENTSOG's TYNDP 2020 Global Ambition Scenario used for methane flows

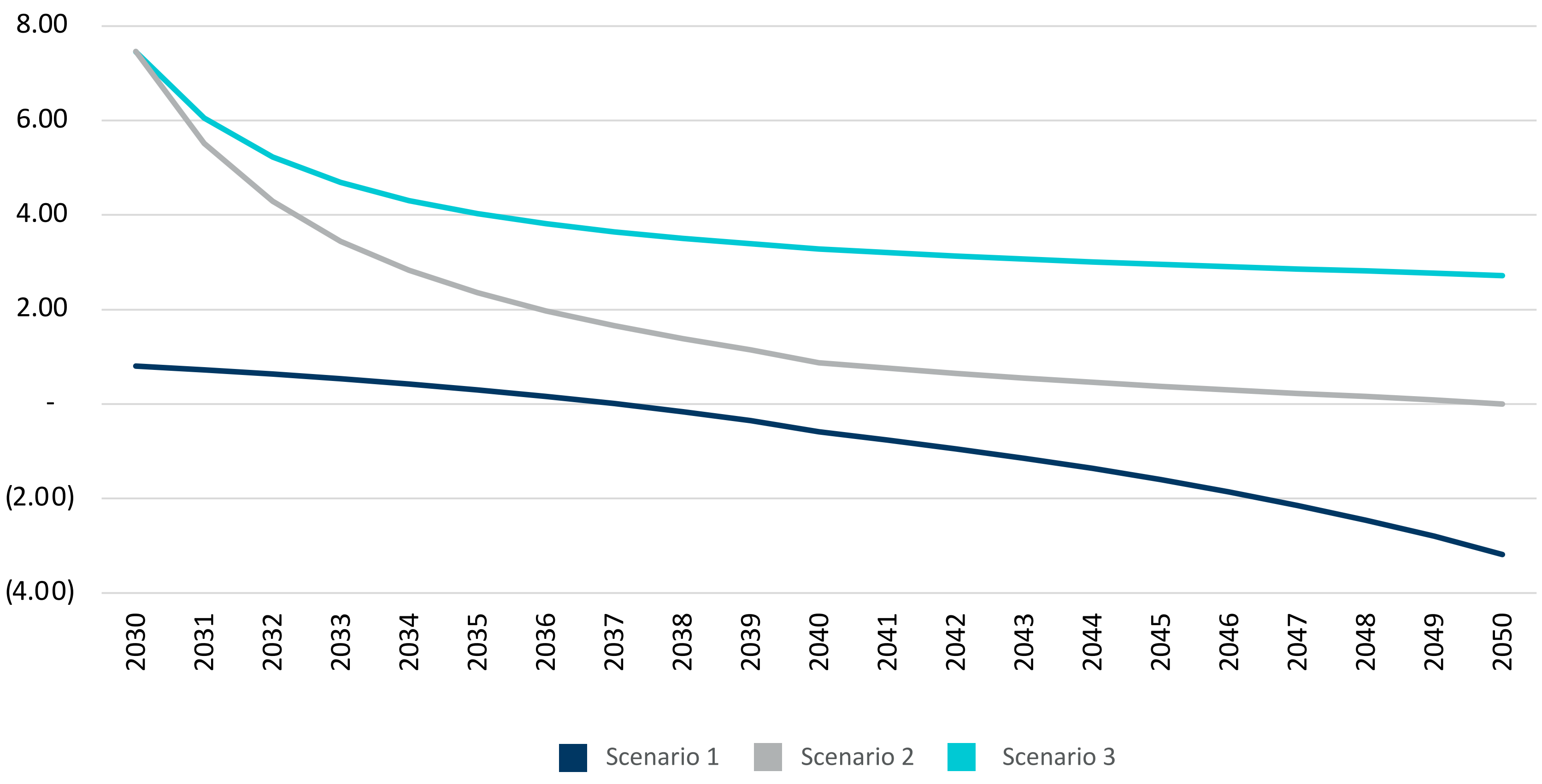
The combined tariff requires the least amount of subsidies, dropping to 0 EUR/MWh before 2037, whilst Scenario 3 requires most subsidies

Subsidies required to support hydrogen users under the Scenarios 1, 2 and 3

Subsidies under different scenarios

- The least subsidy required is under Scenario 1. It starts at 0.83 EUR/MWh in 2030, declines to 0.08 EUR/MWh in 2035, after which point, hydrogen users start subsidising natural gas ones. In 2050, natural gas users are underpaying 5.6 EUR/MWh.
- Under the Scenario 2 (2050 hydrogen tariff is applied throughout the years), the subsidy amount starts at 7.5 EUR/MWh it declines to 0.9 EUR/MWh in 2040, before declining to 0 EUR/MWh in 2050.
- Under the Scenario 3 (75% capital portion discount), the subsidy amount also starts at 7.5 EUR/MWh, 3.3 EUR/MWh in 2040 and 2.7 EUR/MWh. This is the Scenario with the highest subsidy amount needed, which does not reach 0 even in 2050.

Subsidies under Scenario 1 ,2 and 3, 2030 to 2050 (€/MWh)



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ENTSOG's TYNDP 2020 Global Ambition Scenario used for methane flows

1. FTI Consulting's scope of work and methodology overview

We conducted a high-level analysis of three hydrogen transportation tariff scenarios, using the European Hydrogen Backbone studies as a basis

FTI Consulting's scope of work

REQUIREMENTS

We have completed a fact-based analysis of different hydrogen transportation tariff options to support the discussion of a way forward for a hydrogen network in Europe. Tariffs have been explored under three policy scenarios:

- **Scenario 1** – single tariff for both hydrogen and natural gas transport
- **Scenario 2** – hydrogen only tariff, assuming that 2050 tariff applies to 2030 and 2040
- **Scenario 3** – discount on the capacity portion of allowed revenue for hydrogen tariff, as suggested by current draft renewable and natural gases and hydrogen regulation
- All of the scenarios are assumed **a)** to start in the year 2030, and **b)** to consider a more pessimistic case where hydrogen flows are delayed by 4 years to 2034 while hydrogen infrastructure remains unchanged.

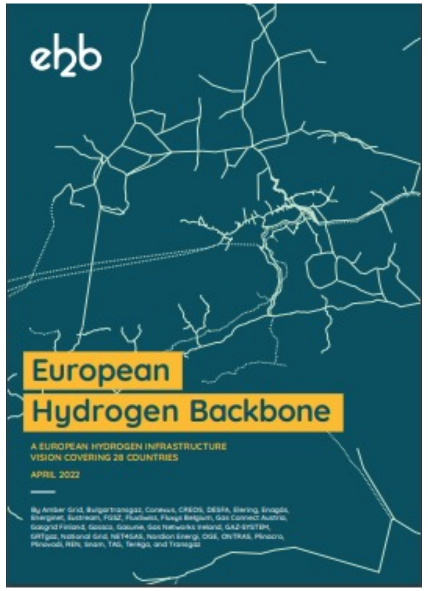
We were also interested in understanding:

- **The impact** of the tariffs on natural gas, hydrogen users and the taxpayers.
- **The acceptability** of the proposed tariffs to manufacturers and other industry players and practical implications.

FTI CONSULTING'S SCOPE OF WORK

- FTI Consulting is conducting a high-level study to address the requirements above.
- The timeframe for the study is between 2024 and 2050, with the results captured for the years 2030, 2040 and 2050.

- Our focus is on the seven countries, namely, Spain, Italy, Germany, Belgium, the Netherlands, France and Poland (collectively EU7), which represents nearly 70% of natural gas demand in the EU + UK between 2030 and 2050.
- We used the European Hydrogen Backbone studies (EHB) as a basis for the hydrogen network development, understanding the connections between the countries as well as the supply and demand information.



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Source: European Hydrogen Backbone, FTI Consulting analysis, Regulation of the European Parliament and of the Council on the internal markets for renewable and natural gases and for hydrogen, 2021

We relied on a distance minimizing dispatch model to calculate hydrogen flows, a natural gas flows model and a financial model to quantify tariffs

Summary of the dispatch model, natural gas flows and the financial model

Input | Output | RAB: Regulated Asset Base

There are three models supporting our quantitative analysis:

1 **Distance minimizing dispatch model**, whereby we source hydrogen supply from geographically closest sources until the demand is served. The output of this model are hydrogen flows across EU7.

2 **Natural gas model** uses current gas flows from ENTSOG by country. We then apply annual decline rate sourced from ENTSOG scenario. The output are natural gas flows across EU7.

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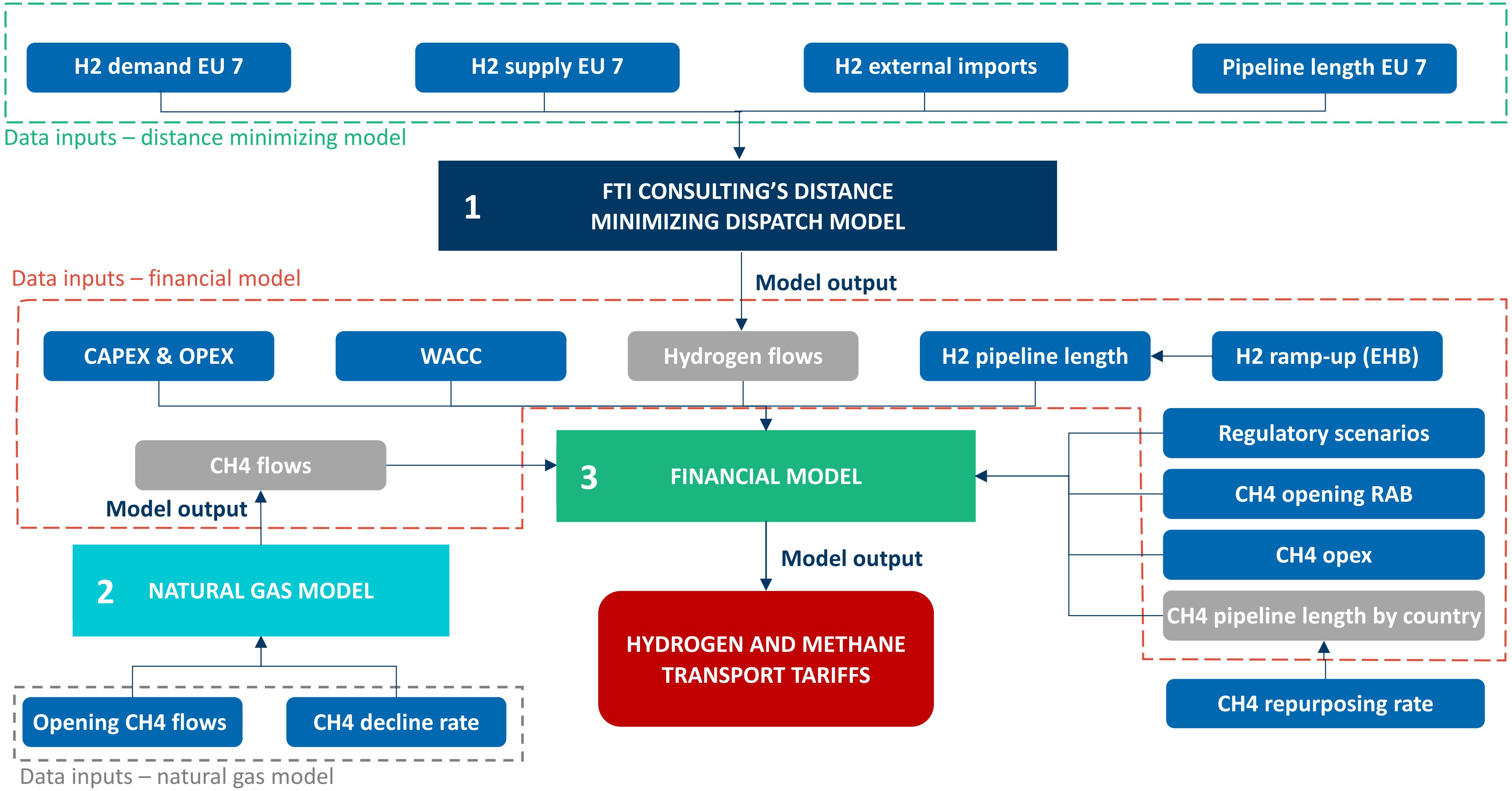


Our modelling includes variants on hydrogen flow volumes, delay in hydrogen flows and natural gas pipeline decommissioning

Summary of the dispatch model, natural gas flows and the financial model

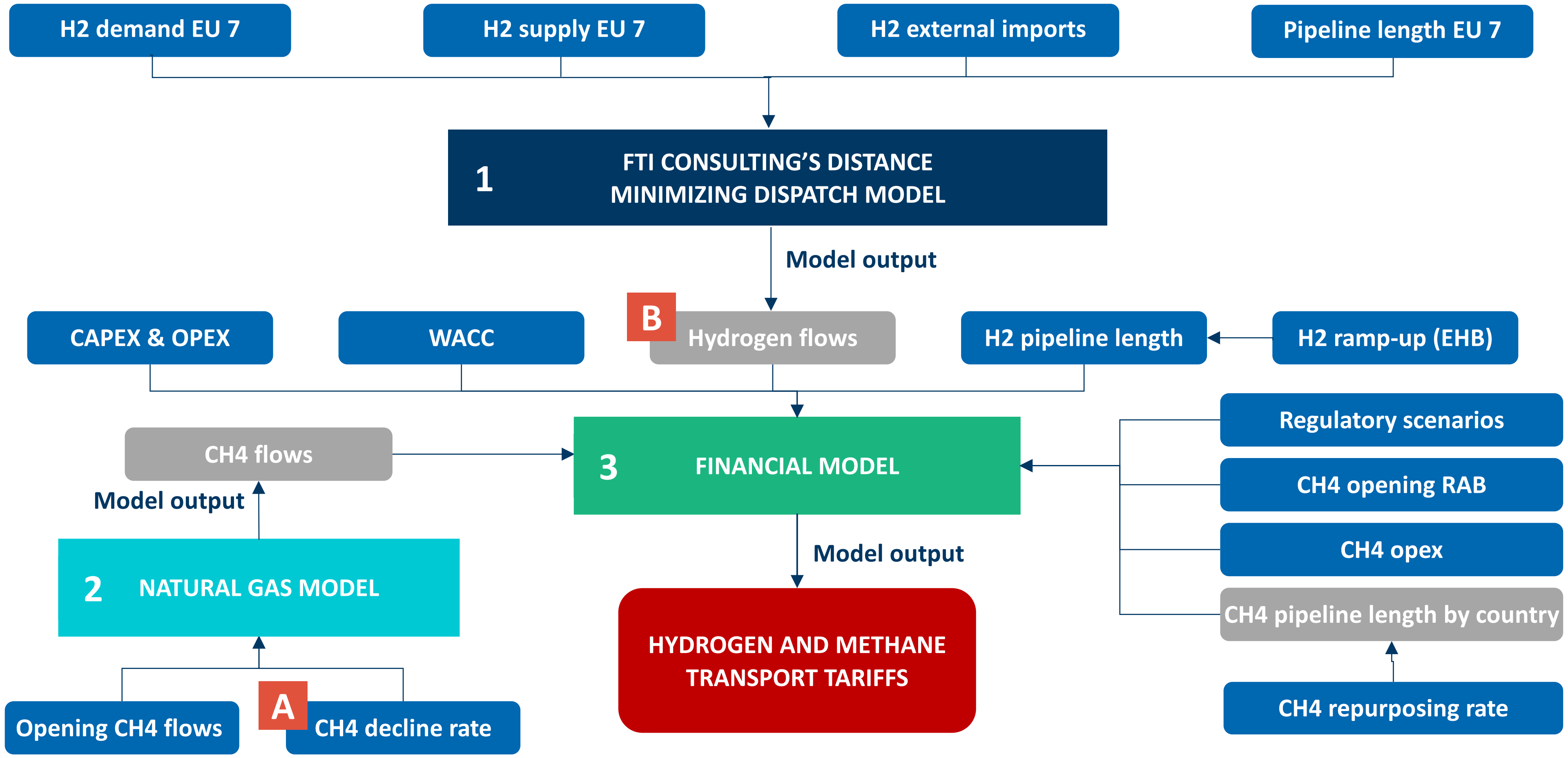
Input | Output | RAB: Regulated Asset Base

A We modelled two natural gas rate of decline variants:

- **Variant 1 – Central case** assumes that the decline is in line with the ENTSOG Global ambition scenario, which is more in line with a centralized hydrogen market.
- **Variant 2** assumes that the decline is in line with the ENTSOG Distributed energy scenario.

B We have two **temporal hydrogen** flow variants, whereby:

- **Variant 1 – Central case** assumes that hydrogen starts flowing through the network as envisaged by the EHB studies.
- **Variant 2** assumes there is a 4-year delay to hydrogen flows compared to the EHB studies



FTI Consulting's provided only a high-level analysis, with simplifying assumptions - In case different assumptions are used, this might impact the results

Main modelling limitations

Hydrogen	■ We do not take into account alternative transportation of hydrogen, outside the transport network. Alternative means of hydrogen transportation such as through ships or trucks might reduce the flows that are going through the pipelines and thus increase the tariffs. ■ The H2 import flows are selected based on a minimization of transport distance, as a proxy to H2 transport costs. In practice, flows will be optimized based on both the H2 transport costs and the H2 production costs. ■ We have used the same Weighted Average Cost of Capital (WACC) for remunerating both hydrogen and natural gas Regulated Asset base (RAB). Different WACC might be used for hydrogen and methane networks to reflect different risks. ■ In the absence of precision communicated by EHB studies, we made assumptions to define the national network length, through (1) defining the EU7 hydrogen network, based on the share of the EU7 hydrogen demand out of total EU27 demand, and then (2) splitting the EU7 hydrogen network by country based on the country's share of hydrogen flows. In reality, the network length may be apportioned differently, considering geographic specificities.
Natural gas	■ We assumed a linear depreciation of RAB over 26 years, which represent the current requirements in Belgium and Denmark which aim to depreciate their existing methane networks by 2050 and 2052. This pattern will in practice differ from country to country, and from asset class to asset class, with an impact on the capital charges level in the required (allowed) revenues of the methane network. ■ We assumed no decommissioning costs for natural gas networks due to lack of clarity around the value of
Hydrogen / Natural gas interface	■ We apply the EU27 ratio of the hydrogen network being made of 60% of refurbished methane pipelines to be applied in every EU7 country ■ We assume no asset transfer value from methane to hydrogen network. In reality, this will be determined by individual TSOs and national regulators and can create a cross-subsidy between methane and hydrogen users, depending on whether DCF value, accounting value, RAB value or replacement value is used.

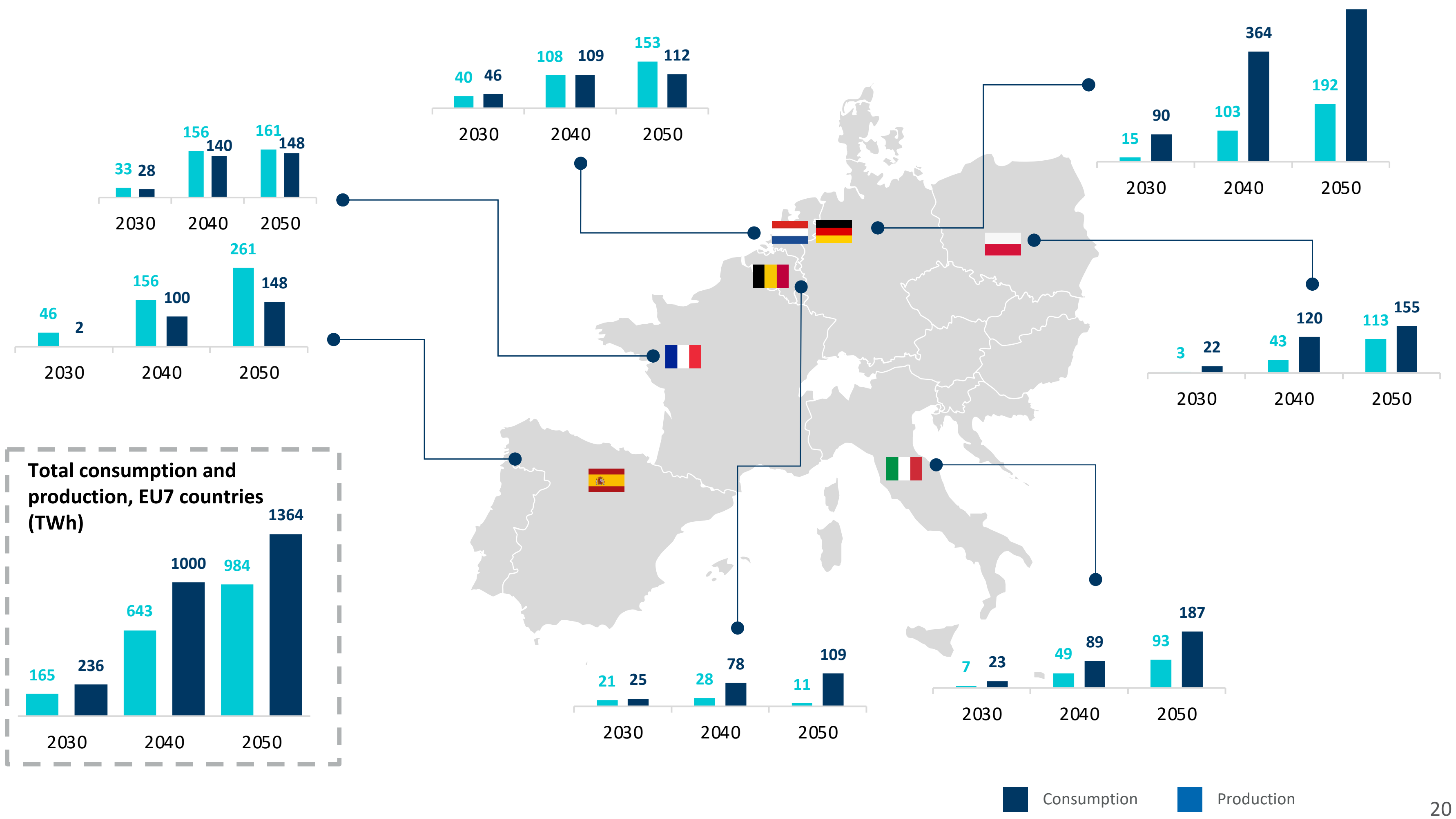
2. Distance minimising dispatch model

The hydrogen demand in EU7 is primarily driven by Germany, whilst Spain, France and the Netherlands have the highest supply

2030-2050 EU7 country H2 consumption and supply (in TWh)

- We used the latest EHB studies as the basis for hydrogen consumption and supply.
- Total consumption across countries in our scope rises from 236 TWh in 2030 to 1,364 TWh in 2050 (an almost 5-fold increase). This is primarily driven by Germany, which accounts for around 40% of the demand between 2030 and 2050.
- Total production across the EU7 countries increases from 165TWh in 2030 to 984TWh in 2050. This an increase of almost 500% (similar rate of increase to the demand), however, this is not enough to meet the demand as the starting base is lower.
- The production is primarily dominated by the following countries:
  - — Spain, that accounts for nearly 30% of the total EU7 production (from 2030 to 2050)
  - — France, contributing to circa 16% throughout the years
  - — The Netherlands, contributing 25% in 2030, but then reducing the contribution as a percentage of total to 15%.

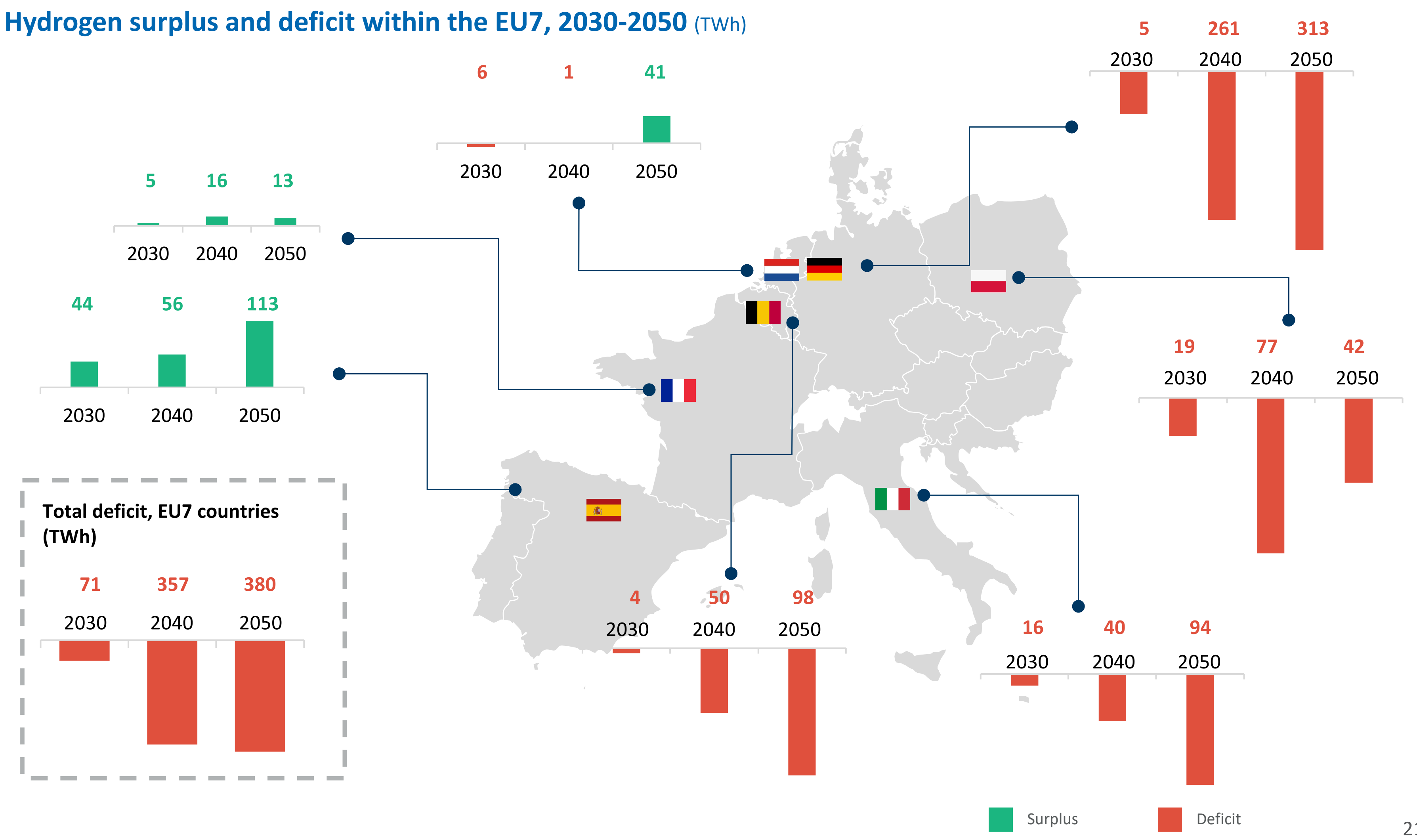
Hydrogen consumption and national production, 2030-2050 (TWh)



The surplus and deficit across countries is split unevenly, with Germany having the largest deficit and Spain and France having a consistent surplus

Hydrogen balance (equals demand minus supply) by country, 2030-2050, TWh

- Total difference between demand and supply across the EU7 is a deficit of 71 TWh in 2030, 357 TWh in 2040, and 380 TWh in 2050 (+435% compared to 2030).
- France and Spain are the only countries in our scope with a H2 surplus across all years, while the Netherlands reach a H2 surplus in 2050.
- Germany has the biggest hydrogen deficit across all years, growing from 75 TWh in 2030 to 313 TWh in 2050 (+317%).
- Therefore, there is a need to obtain supplies from outside of the EU7.
- Polish deficit reduces from 77 TWh in 2040 to 42 TWh in 2050 due to greater increase for production than consumption.



To balance supply and demand, we optimise the flows of hydrogen based on the shortest distance between supply and demand

Distance minimising dispatch model summary

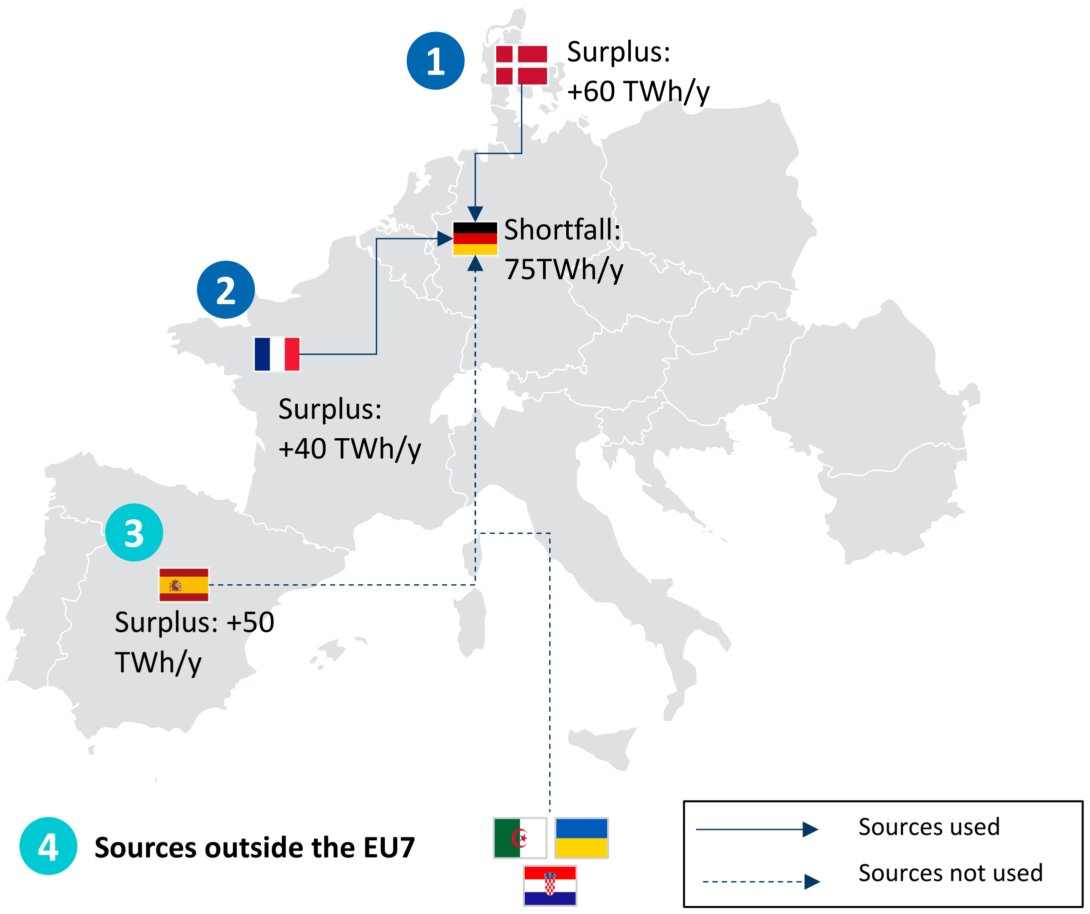
Our Approach

- We have estimated hydrogen flows based on moving extra hydrogen from European countries with a surplus to EU7 deficit countries, minimising distance
- In line with EHB studies, neighbouring sources accessible via pipeline in Morocco, Algeria and Tunisia are also considered
- The countries with the highest deficit are prioritised for the supply, to reflect stronger "pull"

For the illustrative example on the right:

- Germany has a **deficit of -75 TWh/y of hydrogen** in 2030
  1. **Denmark** is the closest country to Germany with a surplus and **supplies 60 TWh/y** (i.e., all of the Denmark's surplus) to Germany
  2. Next, **France** is the 2nd closest country to Germany with a surplus and **supplies 15TWh/y** (i.e., 37.5% of its total 40TWh/y surplus) to Germany, which satisfies the German deficit
  3. Spain, while being a potential source of supply, is further than France, and therefore does not supply Germany
  4. If the sources within the EU7 are exhausted, **we take hydrogen from the countries further afield** (i.e., outside the EU7) based on the shortest distance

An illustrative example of demand fulfillment (TWh, 2030)



Germany has the largest flows, followed by Belgium; transit flows represent 4% of total flows in 2030, and 13% in 2050

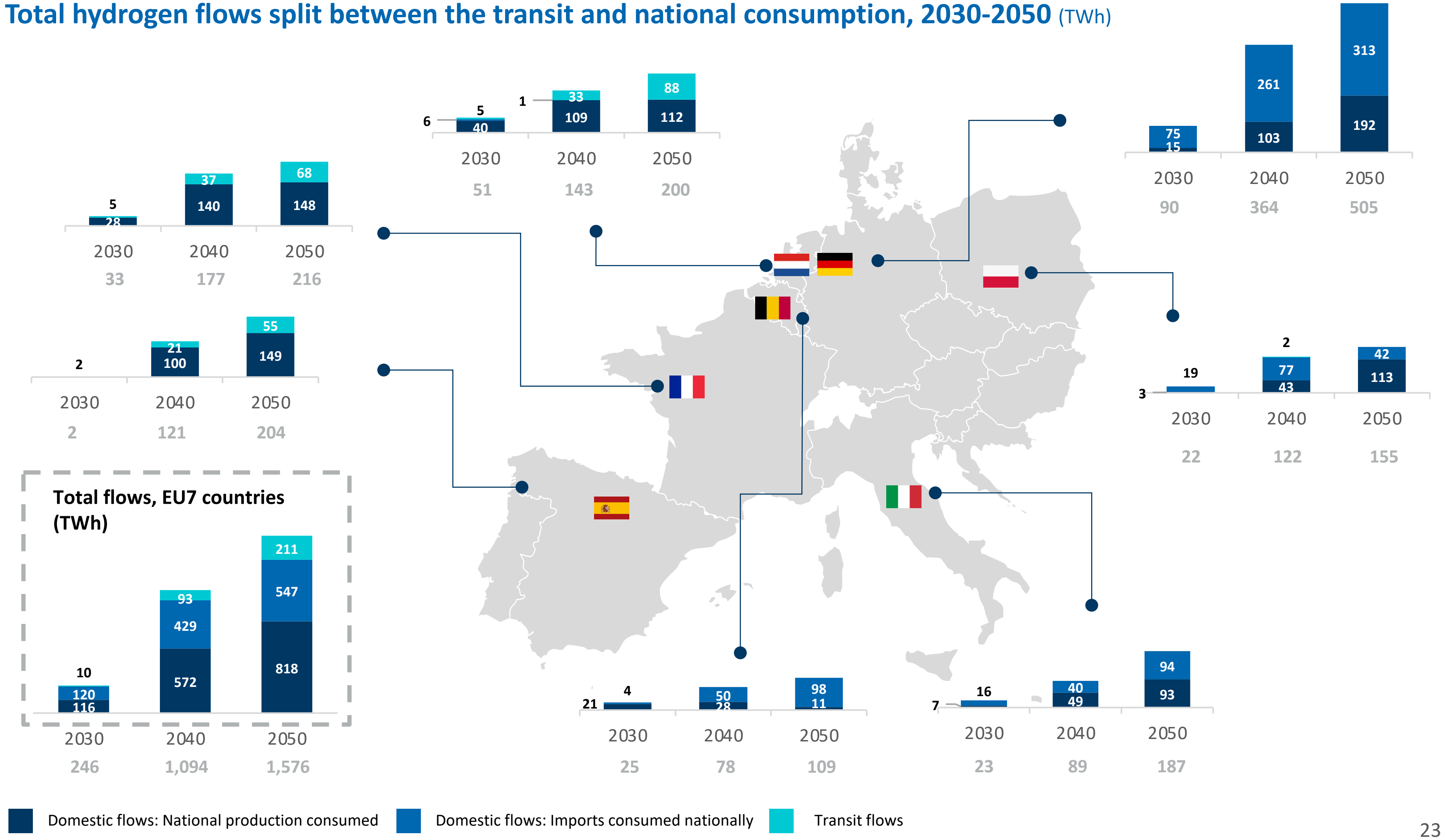
Total H2 flows and percentage of domestic and transit flows for EU7 countries, 2030-2050 (TWh and %)

- For countries in our scope, total flows increase significantly between the years of 2030 and 2050.
- Germany is the country with the highest flows in 2030, 2040 and 2050.
- Transit flows represent 8% of total flows in 2030, 18% in 2040 and 28% in 2050.

Share of transit flows in total flows (%)

Share (%)	2030	2040	2050
Spain	0%	17%	27%
France	15%	21%	31%
Germany	0%	0%	0%
Belgium	0%	0%	0%
Netherlands	10%	23%	44%
Italy	0%	0%	0%
Poland	0%	2%	0%
Total	**4%**	**9%**	**13%**

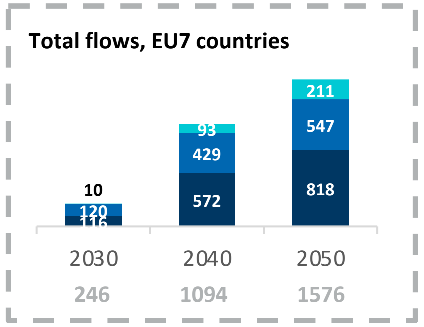
Total hydrogen flows split between the transit and national consumption, 2030-2050 (TWh)

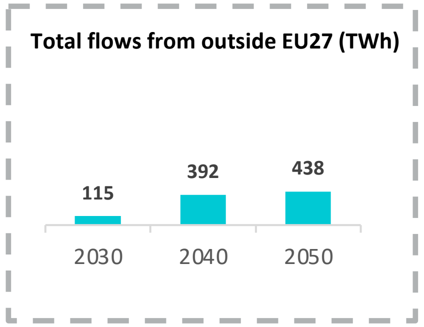


In order to satisfy the EU7 demand, hydrogen is sourced from outside the EU7, accounting for up to 46% of total flows of the EU7

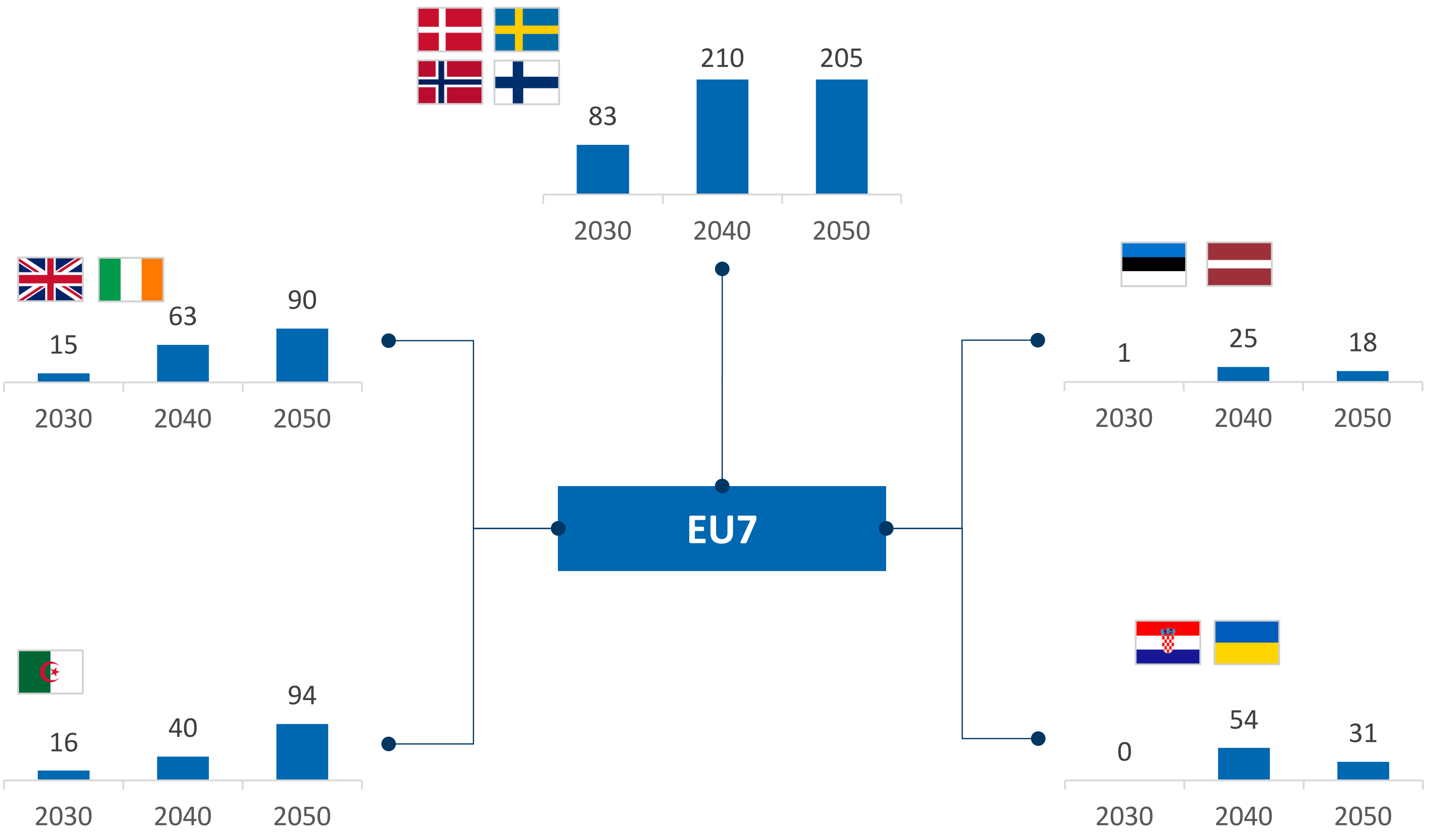
Hydrogen flow volumes from outside sources

- Total flows towards EU7 from outside sources grow from 115 TWh in 2030 to 438 TWh in 2050, ranging from 30% to 46% of total flows in the EU7.
- Eleven countries export hydrogen to the seven countries in our scope.
- Norway is the biggest exporter of hydrogen towards EU7, representing 28% of total flows from outside countries across all three years.
- Algeria, the second biggest exporter, only exports its hydrogen to Italy and represents 14% of total flows across all three years.
- The United Kingdom exports its hydrogen to three EU7 countries, but only represents 10% of total flows.





Hydrogen flow volumes from outside EU7 sources, 2030-2050 (TWh)



Source: Source: European Hydrogen Backbone study, 2022, FTI Consulting Analysis

3. Natural gas flows model

FTI CONSULTING

We use natural gas flows as forecasted by ENTSOG in its Ten-Year Network Development Plan, under 2 scenarios: Distributed Energy & Global Ambition

Starting point of natural gas flows modelling

Source: ENTSOG modelling

- The European Network of Transport System Operator for Gas (ENTSOG) develops ten-year network development plan (TYNDP) every two years.
- The gas TSOs thus forecasts to 2050 the demand, supply and transport needs of natural gas, and derive infrastructure needs.
- These plans are made to respect the EU's commitment to the Paris Agreement, and the EU Climate Law ambition, which include a minimum of 55 % GHG emission reductions by 2030 and net zero by 2050
- Within the TYNDP, ENTSOG has defined two pathways to these policy objectives: the Global Ambition Scenario and Distributed Energy Scenarios

Distributed Energy assumptions

- Aims for the EU energy autonomy through maximisation of renewables.
- Reduced energy demand is expected through circularity and better energy consumption behaviours.
- Under this scenario, the natural gas consumption is expected to decline on average 10% between the years of 2019 and 2030, 4% in the decade leading to 2040 and 5% leading up to 2050.

Global Ambition assumptions

- High renewables development, supplemented with low carbon energy and imports.
- Energy demand declines but priority is given to decarbonisation of energy supply.
- Under this scenario, the natural gas consumption is expected to decline on average 9% between the years of 2019 and 2030, 3% between 2030 and 2040 and 4% between the years 2040 to 2050.

ENTSOG Distributed Energy and Global Ambition scenario assumptions

	DISTRIBUTED ENERGY Higher European autonomy with renewable and decentralised focus	GLOBAL AMBITION Global economy with centralized low carbon and RES options
Green Transition	Atleast a 55% reduction in 2030, climate neutral in 2050	Atleast a 55% reduction in 2030, climate neutral in 2050
Driving force of the energy transition	Transition initiated at a local/ national level (prosumers)	Transition initiated at a European/ international level
	Aims for EU energy autonomy through maximisation of RES and smart sector integration (P2G/L)	High EU RES development supplemented with low carbon energy and imports
Energy intensity	Reduced energy demand through circularity and better energy consumption behaviour	Energy demand also declines, but priority is given to decarbonisation of energy supply
	Digitalisation driven by prosumer and variable RES management	Digitalisation and automation reinforce competitiveness of EU business
Technologies	Focus of decentralised technologies (PV, batteries, etc.) and smart Charging	Focus on large scale technologies (offshore wind, large storage)
	Focus on electric heat pumps and district heating	Focus on hybrid heating technology
	Higher share of EV, with e-liquids and biofuels supplementing for heavy transport	Wide range of technologies across mobility sectors (electricity, hydrogen and biofuels)
	Minimal CCS and nuclear	Integration of nuclear and CCS

Note: Our modelling starts in 2024.; Source: ENTSOG TYNDP 2020

Global Ambition, more in line with a European H2 network, is our central case, compared to Distributed Energy which relies on local/national systems

Assessment of ENTSOG scenarios for the purpose of this study

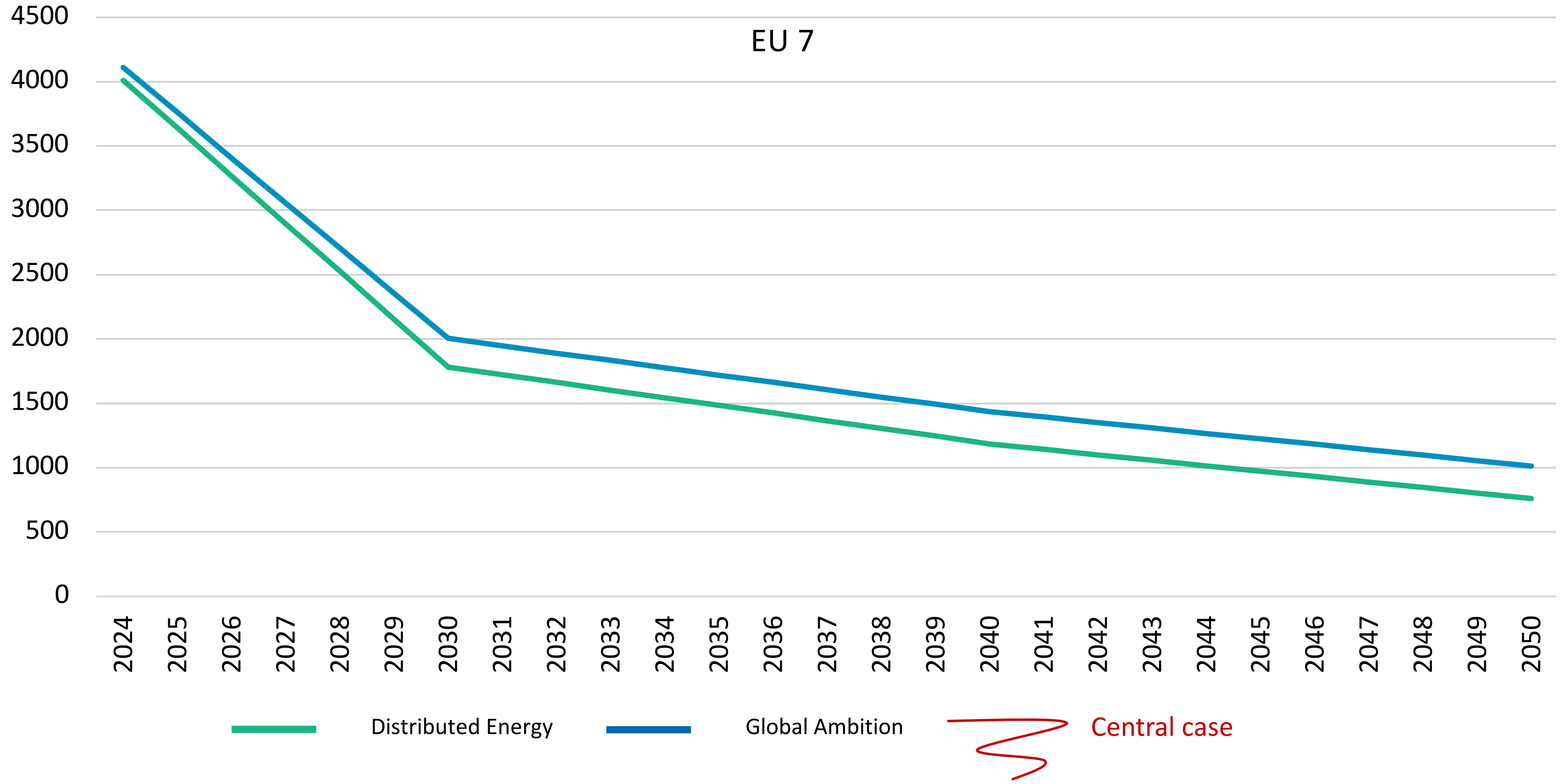
Approach

- We modelled two natural gas rate of decline variants:
  - **Variant 1 – Central case** assumes that the decline is in line with the ENTSOG Global Ambition (GA) scenario.
  - **Variant 2 - Sensitivity** assumes that the decline is in line with the ENTSOG Distributed Energy (DE) scenario.
- The decline highlighted on the previous slide applies to the 2030, 2040, 2050 points. In between these points, we assume a linear decline rate. This explains the change in the direction of the graph at the decade points.

Results

- Distributed Energy variant natural gas flows decline more than the Global ambition variant across the EU7.
- We consider Global Ambition as a central case, as it is more in line with a centralized hydrogen market.
- The reduction rate between the individual EU7 countries vary and is detailed in the next slide as well as in the Section 6.

Natural gas demand across the EU7 under the ENTSOG Distributed Energy and Global Ambition scenarios, 2024-2050 (TWh)



Note: Our modelling starts in 2024.

Total EU7 CH4 flows decline by 49% between 2030 at 2050 ; NL has the highest decline rate (-72%), with only 62 TWh of CH4 flows left in 2050

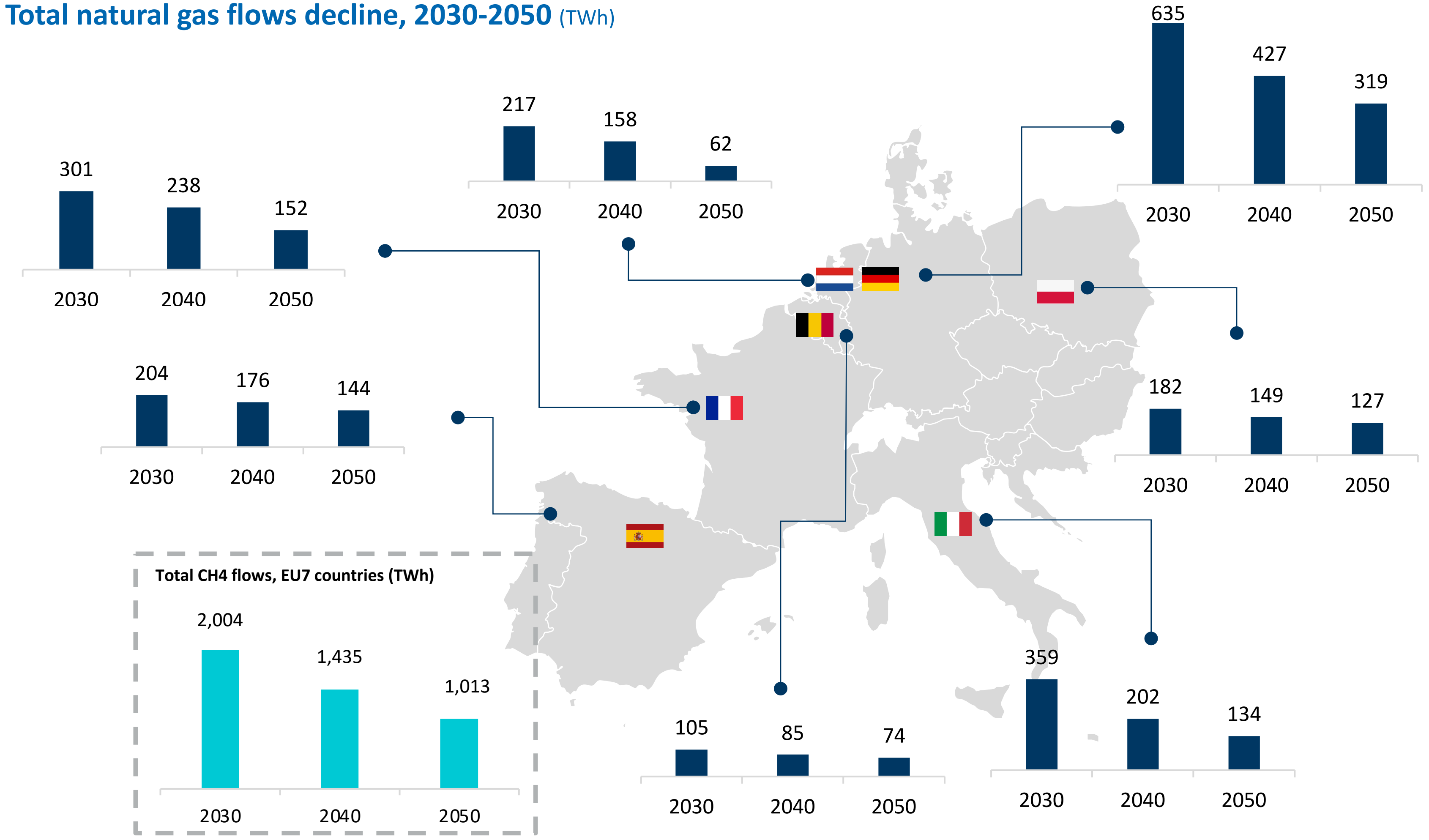
Natural gas flows decline in EU7 – Global Ambition

- Total EU7 natural gas flows decrease from 2004 TWh in 2040 to 1,013 TWh in 2050 (-49%).
- The Netherlands have the highest decline rate (-72%) while Spain and Belgium have the lowest (-30%).
- Germany has the highest CH4 flows throughout all years starting at at 635 TWh in 2030 and decreasing to 319 TWh in 2050.

CH4 flows decline, 2030-2050 (%)

Decline rate (%)	2030-50
Spain	-30%
France	-49%
Germany	-50%
Belgium	-30%
Netherlands	-72%
Italy	-62%
Poland	-31%
Total	**-49%**

Total natural gas flows decline, 2030-2050 (TWh)



4. Financial model

Financial model

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RESULTS BY COUNTRY

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Our financial model calculates the allowed revenues for hydrogen and natural gas transport using the standard regulated asset-based approach

Our approach to calculating hydrogen and natural gas allowed revenue

To assess average hydrogen and methane tariffs we have calculated the allowed revenues for hydrogen and natural gas transport networks:

- These are calculated using a **regulated asset model**, which is the approach currently used for natural gas assets across the European Union
- Regulated asset is an approach whereby depreciation expense is counted as part of allowed revenue and therefore could be recouped by the asset owner

To calculate the amount of allowed revenue in any given year in the seven focus countries, we will use the formula below:

Capital charges

ALLOWED REVENUE = REGULATED ASSET BASE × WACC + DEPRECIATION + OPERATING EXPENDITURE

Regulated Asset Base (RAB) = capitalised value of an asset (i.e. pipeline infrastructure) reduced by the amount of depreciation each year

- **For natural gas**, we start with the opening RAB of each gas TSO, keeping it constant in real terms (i.e. adding inflation), but making deductions necessary for the transfer of pipes to the hydrogen network.
- **For hydrogen**, CAPEX estimates from EHB studies are applied to pipeline length and compressors to obtain RAB. We also apply inflation to CAPEX.

- **WACC** = Weighted Average Cost of Capital for current gas TSOs is to be used for hydrogen and natural gas allowed revenue

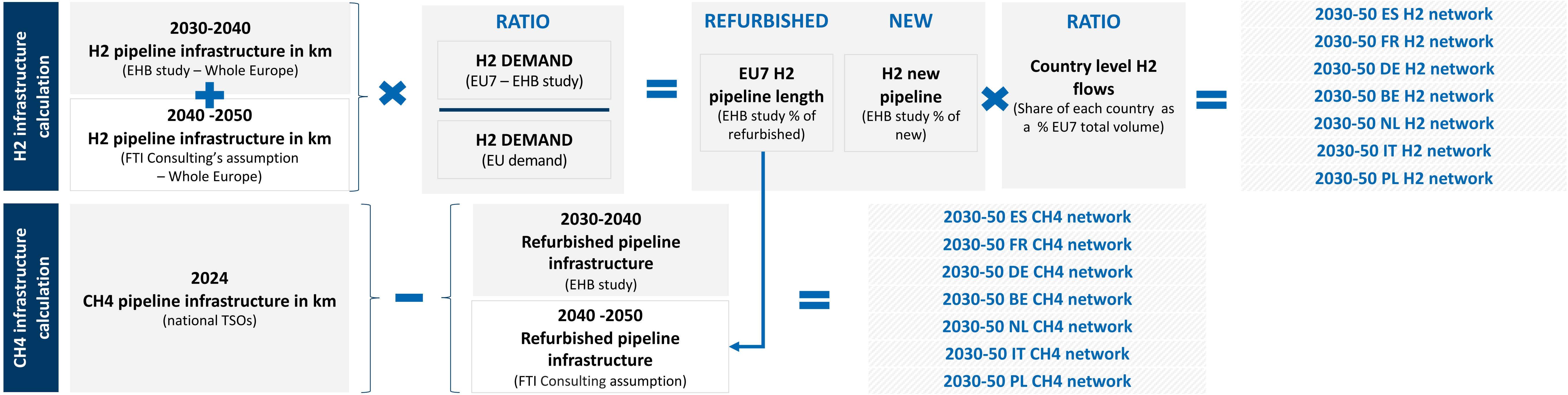
- **Depreciation** = We assume that depreciation on the natural gas network is offset by the additions to it, keeping the network at the constant level except for transfers to hydrogen network. Hydrogen network is depreciated over a straight-line, using useful economic life for the pipes and the compressor as determined by EHB studies.

Operating Expenditure (OPEX) = current OPEX for gas from national TSOs and regulators and OPEX for H2 from the Hydrogen Backbone Report

- **Natural gas:** Opex is applied based on a ratio of the opening opex and capex. We apply inflation to opex.
- **Hydrogen:** Opex is sourced from the EHB and applied to the length of pipes and a compressor. We apply inflation to opex.

We calculate the length of hydrogen and natural gas pipes using data on both networks in Europe and the amount of transported flows

Methodology for the calculation of the length of H2 pipes



We calculate the length of the H2 and CH4 pipes per country the following ways :

- For H2 infrastructure, we source H2 infrastructure from 2030 to 2040 from EHB at the European level and assume half of the 2030-2040 growth to occur between 2040 and 2050. We multiply this total European infrastructure by the share of EU7 H2 demand in all of Europe H2 demand, to obtain EU7 H2 infrastructure. We split the EU7 H2 infrastructure according the ratio between refurbished and new pipelines for whole Europe from EHB (60%/40%). To get the hydrogen network length in individual countries, we calculate the ratio of individual country flows as a proportion of total EU7 flows (from our H2 flows model) and apply this ratio to the EU7 H2 pipeline calculated before.
- For CH4 infrastructure, we start from the 2024 CH4 infrastructure length sourced from EU7 TSOs, and then subtract each country's CH4 infrastructure refurbished into H2 until 2050 to obtain 2030-50 CH4 infrastructure for each country.

Based on H2 & CH4 required network revenues and forecasted flows, we calculate transport tariffs following four support scenarios

Scenarios used for tariffs calculations

Scenario 0 – 0 "Do nothing"

- Separate tariffs for H2 and CH4
- No subsidy

$$\text{H2 tariff} = \frac{\text{H2 revenues}}{\text{H2 flows}} \qquad \text{CH4 tariff} = \frac{\text{CH4 revenues}}{\text{CH4 flows}}$$

Scenario 1 1

- To calculate a unified tariff, we will take the total of revenues for hydrogen and natural gas (based on the financial regulated asset model) and divide it by the sum of flows:

$$\text{Unified tariff} = \frac{\text{H2 revenues + CH4 revenues}}{\text{H2 flows + CH4 flows}}$$

- We will compare this unified tariff over 2024-2050 with the alternative of separate tariffs for methane and hydrogen users

Scenario 2 2

- To calculate a hydrogen tariff needed to split across the asset life to cover the costs of the initially underutilised pipeline, we use 2050 tariff for all the years from 2030 to 2050 and calculate the subsidy by subtracting the product of flows and tariff from the 2030 or 2040 year revenue as follows :

$$\text{Total tariff} = \frac{\text{2050 H2 revenues}}{\text{2050 H2 flows}}$$

$$\text{Subsidy}_{2030*} = \text{2030 H2 revenues} - \text{2030 H2 flows} \times \text{Total tariff}$$

Subsidy_{2040} uses the same formula as above, but replaces 2030 revenues and flows with 2040

Scenario 3 3

- To calculate hydrogen tariff with a discount stipulated by the European Commission's draft package1), we assume that hydrogen users pay only 25% capacity portion of the allowed revenue :

$$\text{Total tariff} = \frac{\text{Capital charges + OPEX}}{\text{H2 flows}} \qquad \text{User tariff} = \frac{\text{25\% x Capital charges+ OPEX}}{\text{H2 flows}} \qquad \text{Subsidy} = \frac{\text{75\% x Capital charges}}{\text{H2 flows}}$$

Source: 1) Regulation of the European Parliament and of the Council on the internal markets for renewable and natural gases and for hydrogen (recast), 2021

Under Scenario 0, hydrogen-only and methane-only tariffs cross in 2037, with slower decrease of hydrogen-only tariffs after 2034

Results for methane-only and hydrogen-only tariffs for the EU7[1] under Global Ambition Scenario

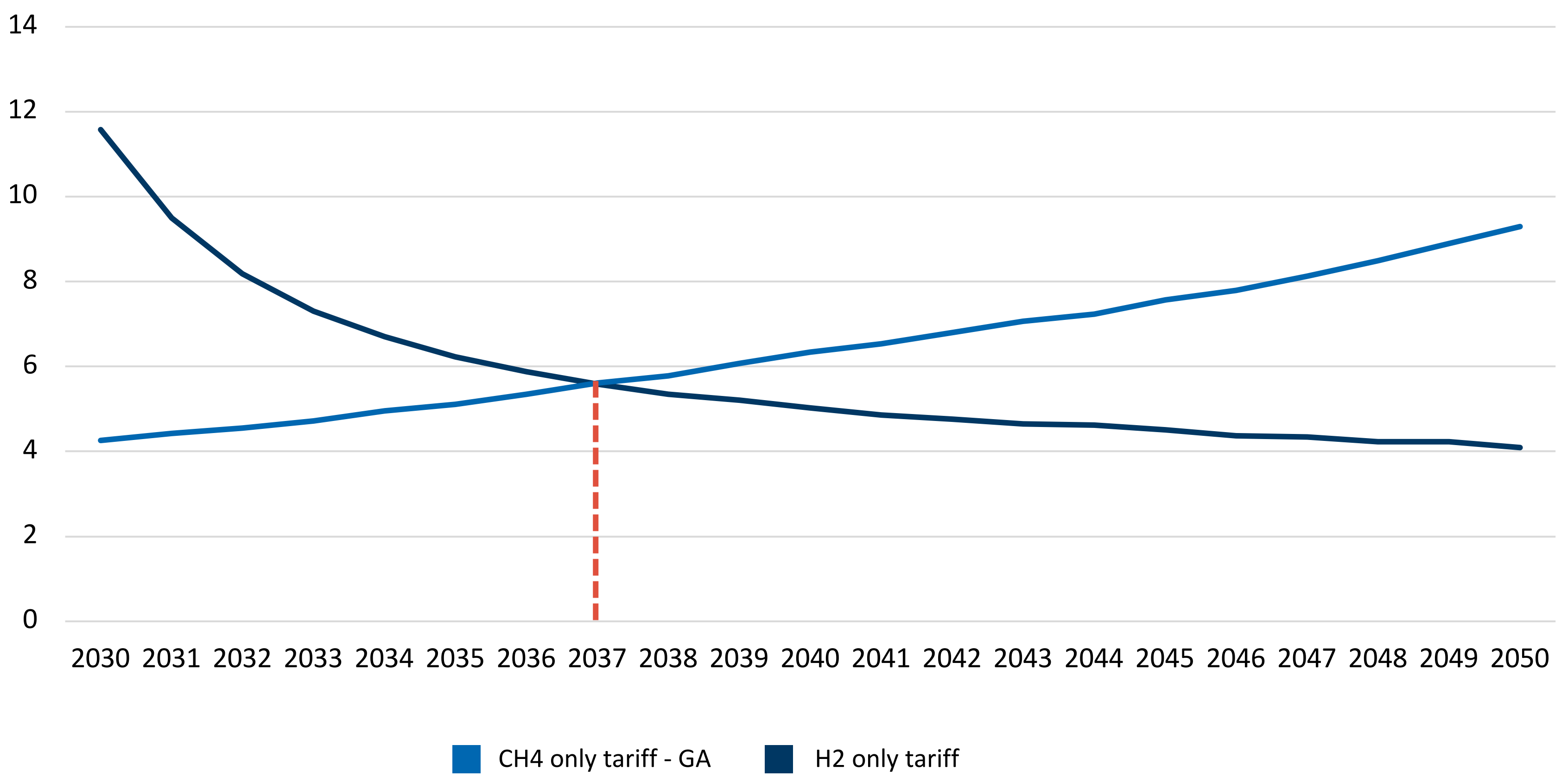
Description of Scenario 0 tariffs

- For the Scenario 0, with hydrogen and methane separately considered, with no subsidy, hydrogen and methane cross in 2037.
- Methane tariff increase significantly over the period 2030-2050 (+120%) due to declining flows.
- H2 tariff decreases by 64% over the period 2030-2050, starting at 11.6 EUR/MWh and reaching 4.2 EUR/MWh.

Assumptions

- This comparison is made under the ENTSOG Global Ambition variant (under a second Variant – Distributed Energy, methane/hydrogen crossing point is reached earlier due to lower methane flows / higher methane tariffs. This is discussed in the Sensitivities section of the report.)
- This is the tariff for EU7 as a group, individual EU7 countries have different profiles. This is discussed in the Country level results section.

EU7 methane and hydrogen only tariffs (€/MWh)



Notes:1 – EU7-wide tariff is equal to allowed revenue divided by the flows, as opposed to an average tariff for all seven countries. In this way, we calculate the tariff level if it was charged across EU7.

Under Scenario 1, hydrogen and methane only tariffs cross in 2037: natural gas users subsidize hydrogen until then and the reverse afterwards

Results for methane only and hydrogen only tariffs for the EU7[1] under Scenario 1 – Global Ambition

Description of Scenario 1 tariffs

- Allowed revenues of methane and hydrogen are combined, sharing all cost across the flows of methane and hydrogen users.

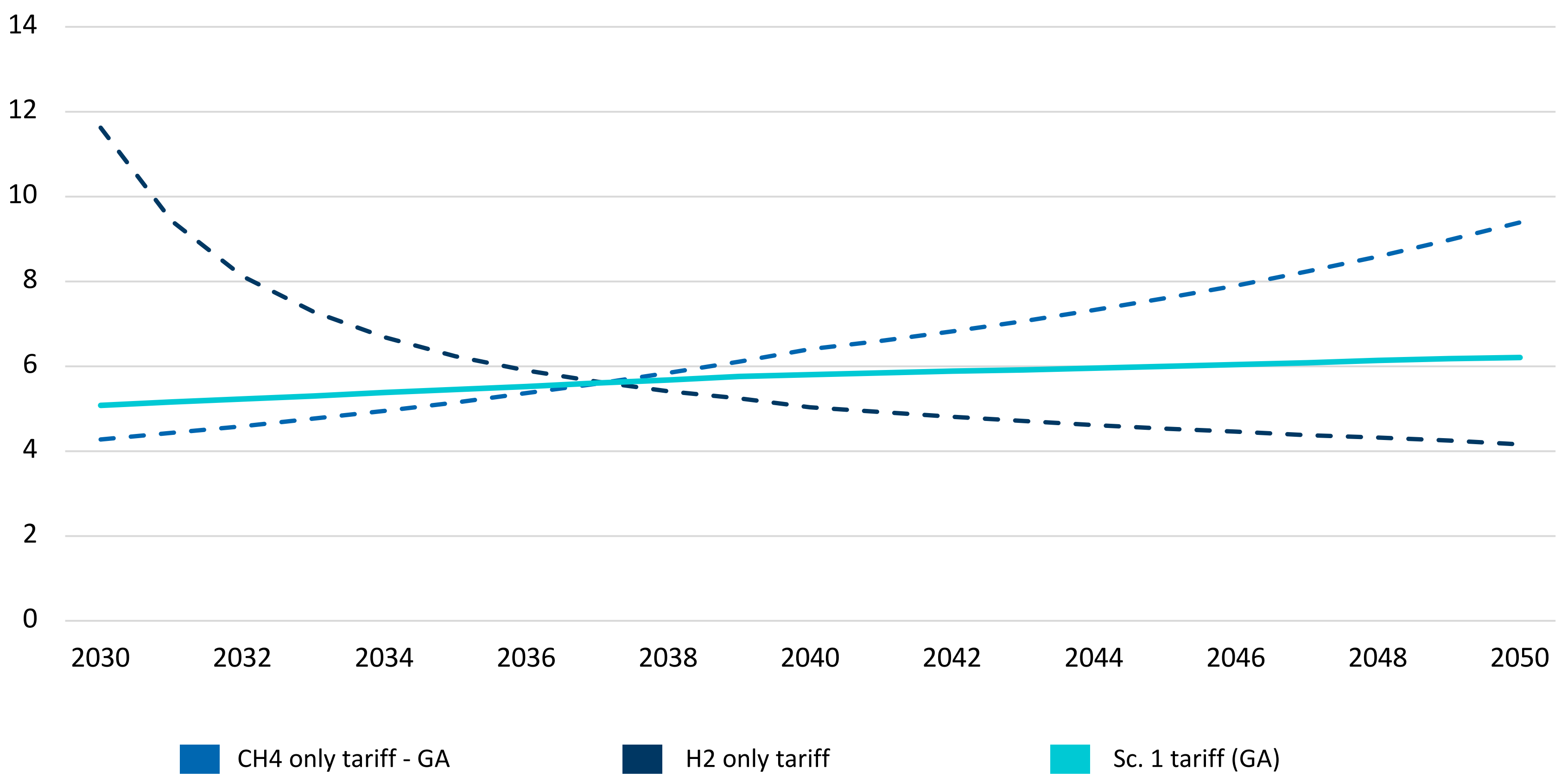
Subsidising profile

- Subsidising hydrogen transportation will help kick-start the hydrogen economy and develop the network necessary to meet decarbonisation targets within the EU block.
- For the Scenario 1 (unified hydrogen and methane tariff), taken separately hydrogen and methane only tariffs break-even in 2037.
- This means that natural gas users subsidise hydrogen users up until 2037. After this point the trend reverses and hydrogen users start subsidising natural gas users.

Assumptions

- This comparison is made under the ENTSOG Global Ambition variant (under a Variant – Distributed Energy, break-even point is reached earlier in 2035. This is discussed in the Sensitivities section of the report.)
- This is the tariff for EU7 as a group, individual EU7 countries have different profiles. This is discussed in the Country level results section.

EU7 CH4 and H2 only and Scenario 1 combined tariff (€/MWh)



Notes:1 – EU7-wide tariff is equal to allowed revenue divided by the flows, as opposed to an average tariff for all seven countries. In this way, we calculate the tariff level if it was charged across EU7.

Hydrogen tariffs under the Scenario 2 assumptions is lower than methane tariff, due to public subsidies that decline over time, reaching zero in 2050

Results of Scenario 2 vs hydrogen and methane only tariffs and subsidies for the EU7[1] – Global Ambition

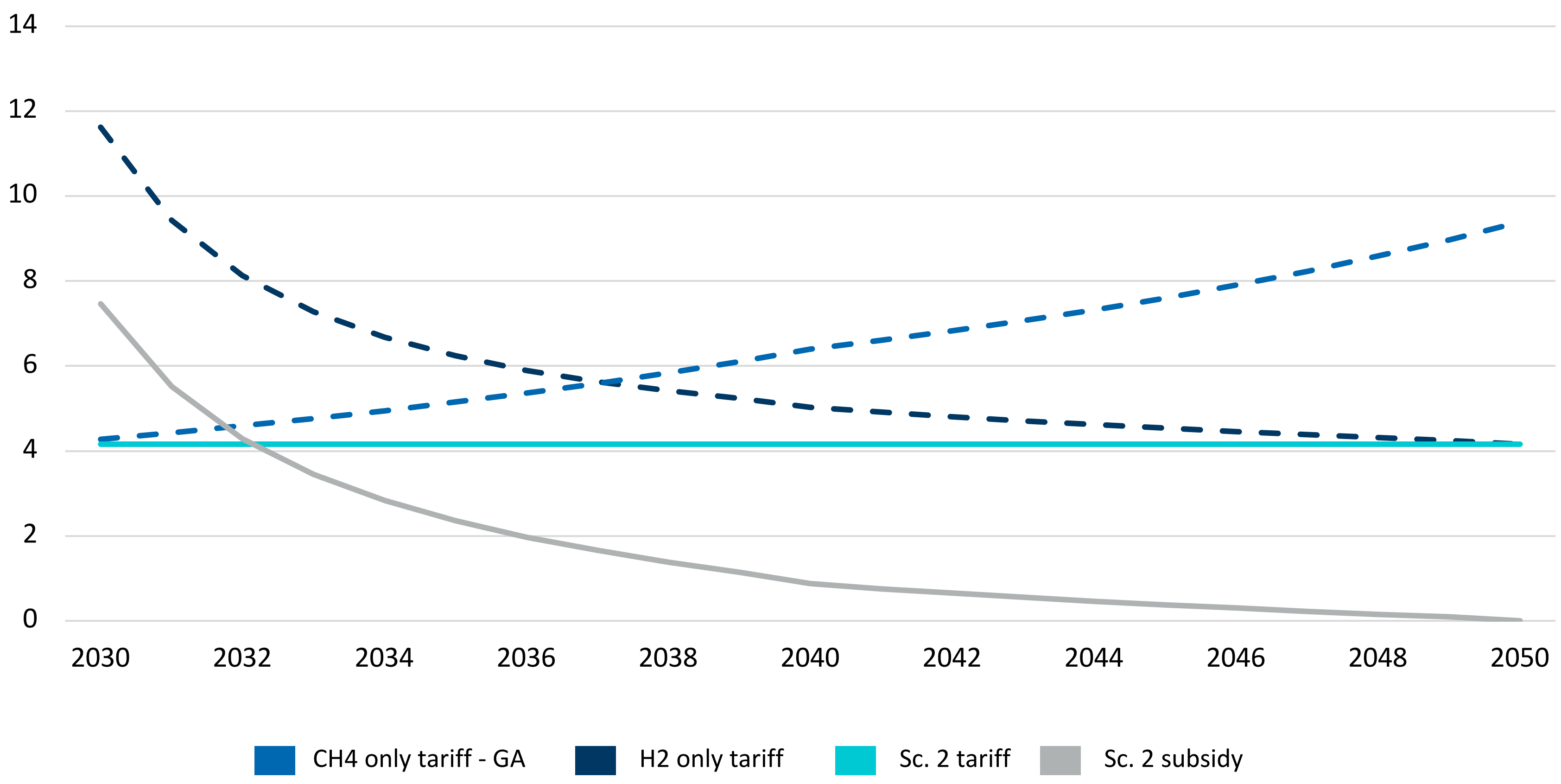
Description of Scenario 2 tariffs

- Under Scenario 2, we assume that 2050 hydrogen tariff is applied to 2030 and 2040 to avoid penalising early hydrogen users.
- Hydrogen tariff under the Scenario 2 is stable throughout the years, at 4.2 EUR/MWh. Methane only tariff always exceed the Scenario 2 hydrogen tariff.

Subsidising profile

- In order to reach the low tariffs under Scenario 2, and in the absence of a combined tariff arrangement, hydrogen users will be subsidized by taxpayers. This makes hydrogen transportation more attractive for the users as costs are borne out of the energy transport system.
- The EU7-wide subsidy starts at 7.5 EUR/MWh in 2030, rapidly dropping to 0.9 EUR/MWh in 2040 before reaching zero in 2050.
- Total subsidy required to support H2 users under Scenario 2 starts at EUR 1,836 M EUR in 2030, declines to 953 M EUR in 2040 due to increasing H2 flows, and drops down to zero in 2050.

EU7 CH4 and H2 only and Scenario 2 tariff and subsidy (€/MWh)



Notes:1 – EU7-wide tariff is equal to allowed revenue divided by the flows, as opposed to an average tariff for all seven countries. In this way, we calculate the tariff level if it was charged across EU7.

Hydrogen tariffs under the Scenario 3 assumptions are lower than methane only tariffs; public subsidies are always needed for support

Results of Scenario 3 vs hydrogen and methane only tariffs and subsidies for the EU7[1] – Global Ambition

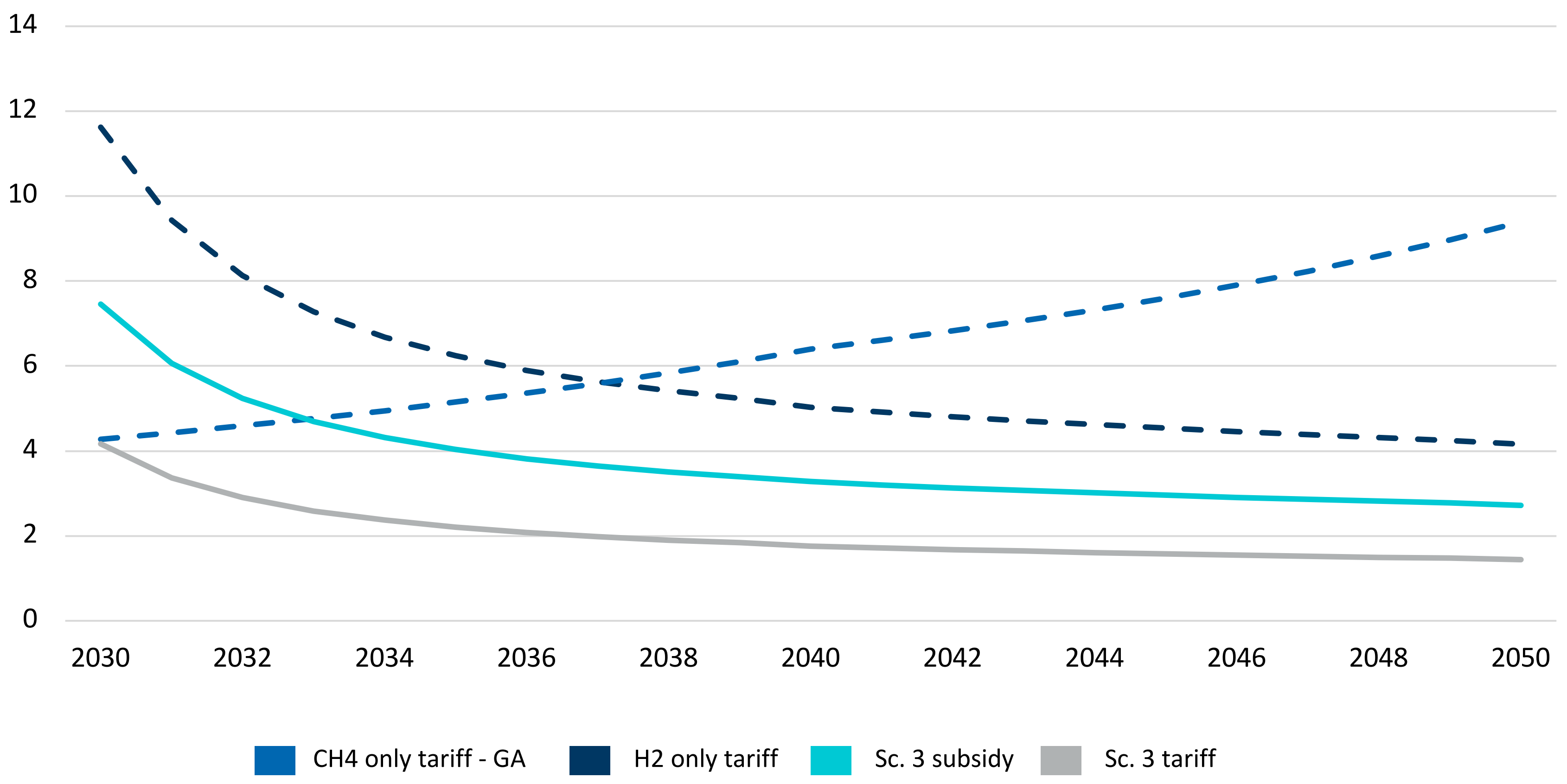
Description of Scenario 3 tariffs

- Under Scenario 3 assumptions, where 75% discount is given to the capital portion of the allowed revenue, tariff starts at 4.2 EUR/MWh in 2030, declines to 1.8 EUR/MWH in 2040 and then to 1.4 EUR/MWH in 2050.
- Under the Scenario 3, the hydrogen only tariff is always lower than the methane only tariff.

Subsidising profile

- In order to reach the low tariffs under Scenario 2, and in the absence of a combined tariff arrangement, hydrogen users will have to be subsidized by taxpayers. This makes hydrogen transportation more attractive for the users as costs are borne out of the energy transport system.
- The EU7-wide subsidy to support tariff under the Scenario 3 starts at 7.5 EUR/MWh in 2030, declines to 3.3 EUR/MWh in 2040 and 2.72 EUR/MWh, still higher than the hydrogen tariff.
- The total subsidy required in 2030 is EUR 1,834m, in 2040 it is EUR 3,580m as allowed revenue increases, before reaching EUR 4,281m in 2050.

EU7 CH4 and H2 only and Scenario 3 tariff and subsidy (€/MWh)



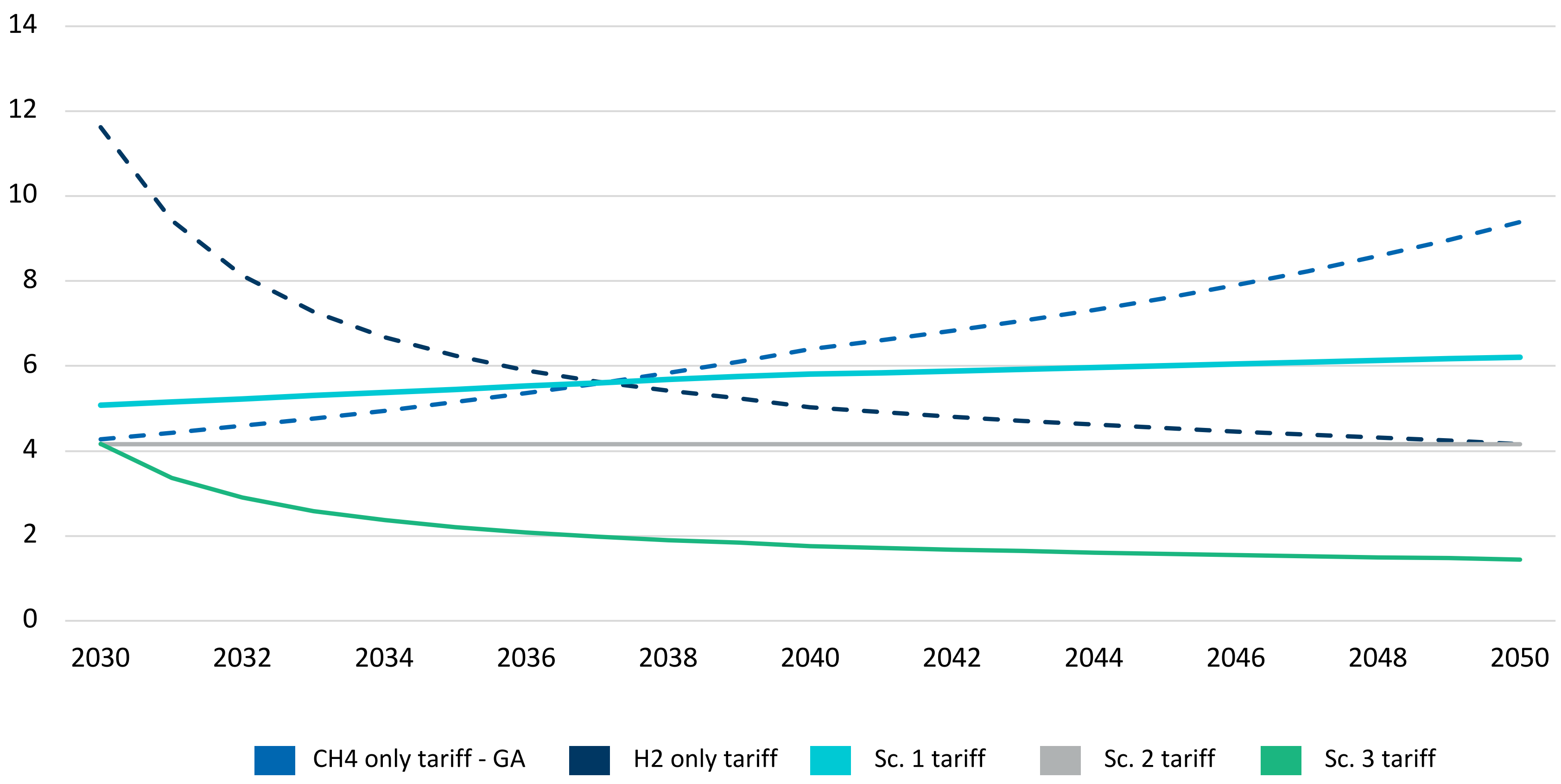
Notes:1 – EU7-wide tariff is equal to allowed revenue divided by the flows, as opposed to an average tariff for all seven countries. In this way, we calculate the tariff level if it was charged across EU7.

Scenario 1 (combined tariff) always exceeds hydrogen tariffs under Scenario 2 and 3 from 2030 to 2050; Scenario 3 has the lowest tariffs

Comparison of Tariffs under Scenarios 1, 2 and 3 for the EU7[1]

- Overall, a combined EU7-wide1 hydrogen tariff is higher than Scenario 2 or 3 tariffs from 2030 and 2050.
- Not having a combined tariff would result in higher costs under the H2 only tariff until circa 2035 and after around 2035 under the CH4 only tariff (aka “doing nothing” – Scenario 0).
- The combined tariff under the Scenario 1 for EU7 countries starts at 5.1 EUR/MWh in 2030 and increases to 6.2 EUR/MWh in 2050.
- EU7-wide tariff for Scenario 2 for all EU7 countries is stable at 4.2 EUR/MWh, as hydrogen users pay 2050 tariff throughout all years.
- EU7-wide tariff under Scenario 3 starts at the same level as tariff 2 (4.2 EUR/MWh) then rapidly decreases to reach 2.0 EUR/MWh in 2035.
- Scenario 2 and 3 coincidentally start on the same level.

Tariffs for Scenario 0, 1, 2 and 3, 2030 to 2050 (EUR/MWh)



Notes:1 – EU7-wide tariff is equal to allowed revenue divided by the flows, as opposed to an average tariff for all seven countries. In this way, we calculate the tariff level if it was charged across EU7.

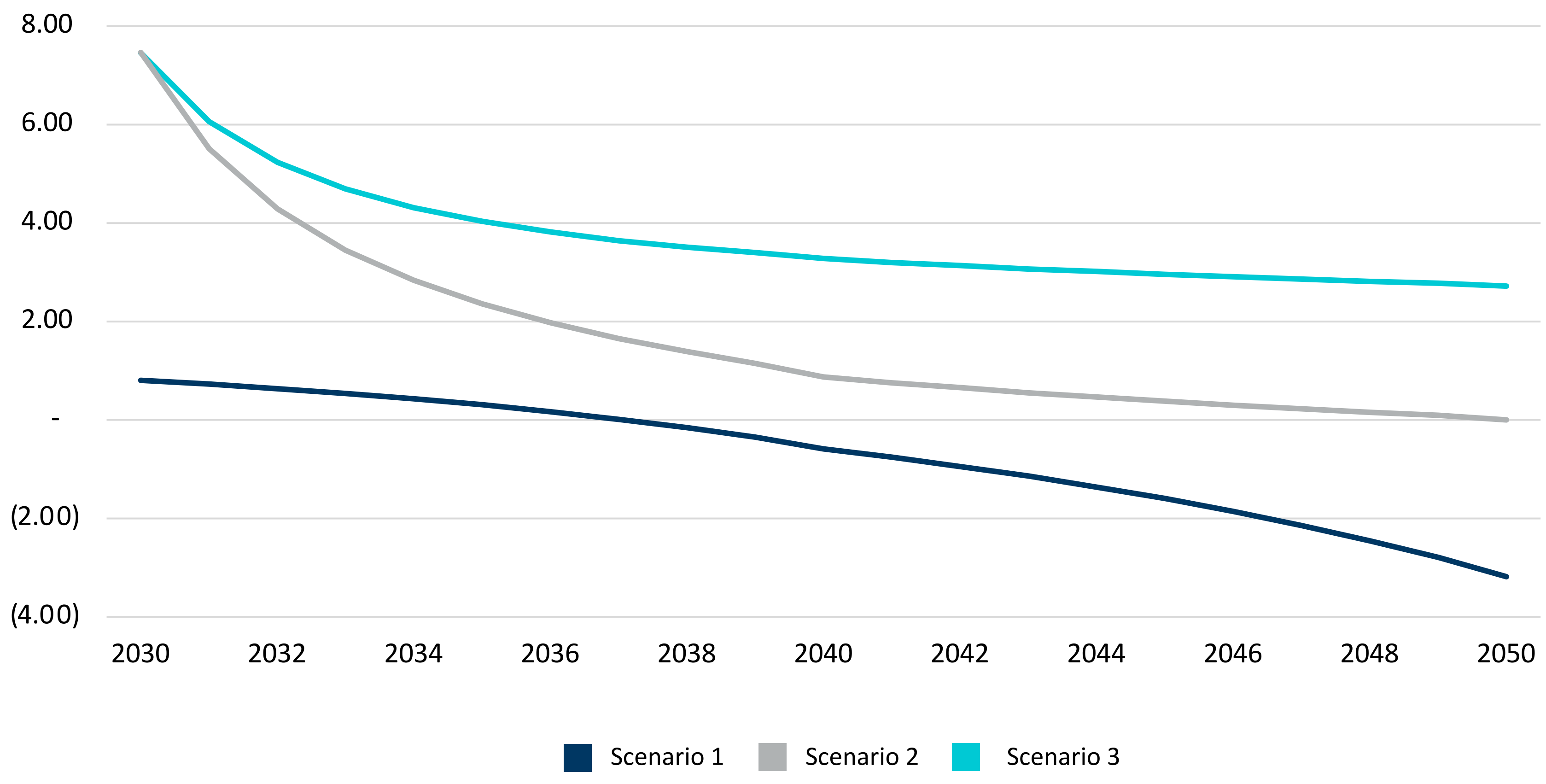
The combined tariff requires the least amount of subsidies, dropping to 0 EUR/MWh before 2037, whilst Scenario 3 requires most subsidies

Subsidies required to support hydrogen users under the Scenarios 1, 2 and 3

Subsidies under different scenarios

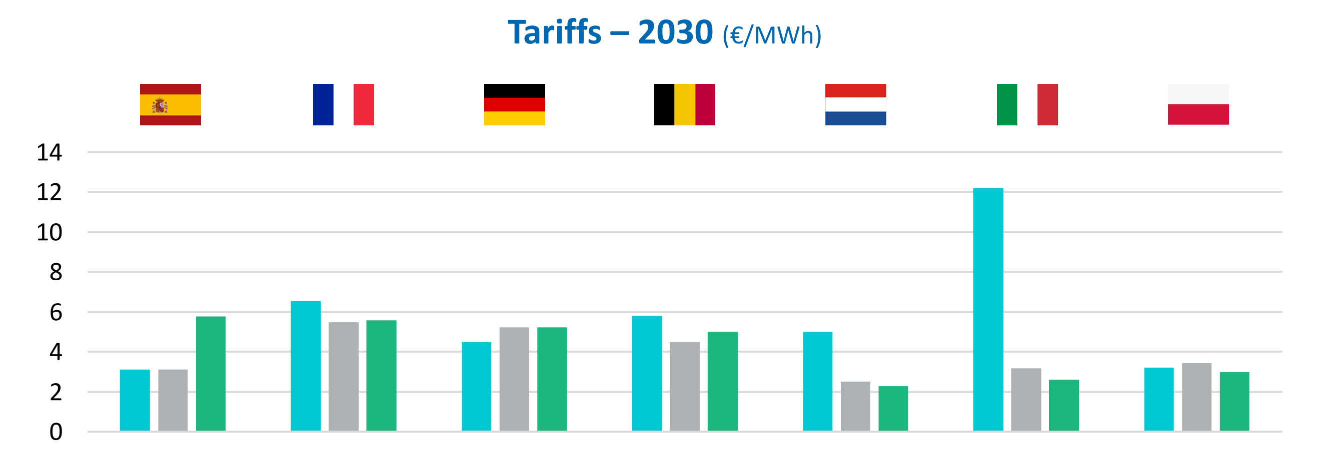
- The least subsidy required is under Scenario 1. It starts at 0.83 EUR/MWh in 2030, declines to 0.08 EUR/MWh in 2035, after which point, hydrogen users start subsidising natural gas ones. In 2050, natural gas users are underpaying 5.6 EUR/MWh.
- Under the Scenario 2 (2050 hydrogen tariff is applied throughout the years), the subsidy amount starts at 7.5 EUR/MWh it declines to 0.9 EUR/MWh in 2040, before declining to 0 EUR/MWh in 2050.
- Under the Scenario 3 (75% capital portion discount), the subsidy amount also starts at 7.5 EUR/MWh, 3.3 EUR/MWh in 2040 and 2.7 EUR/MWh. This is the Scenario with the highest subsidy amount needed, which does not reach 0 even in 2050.

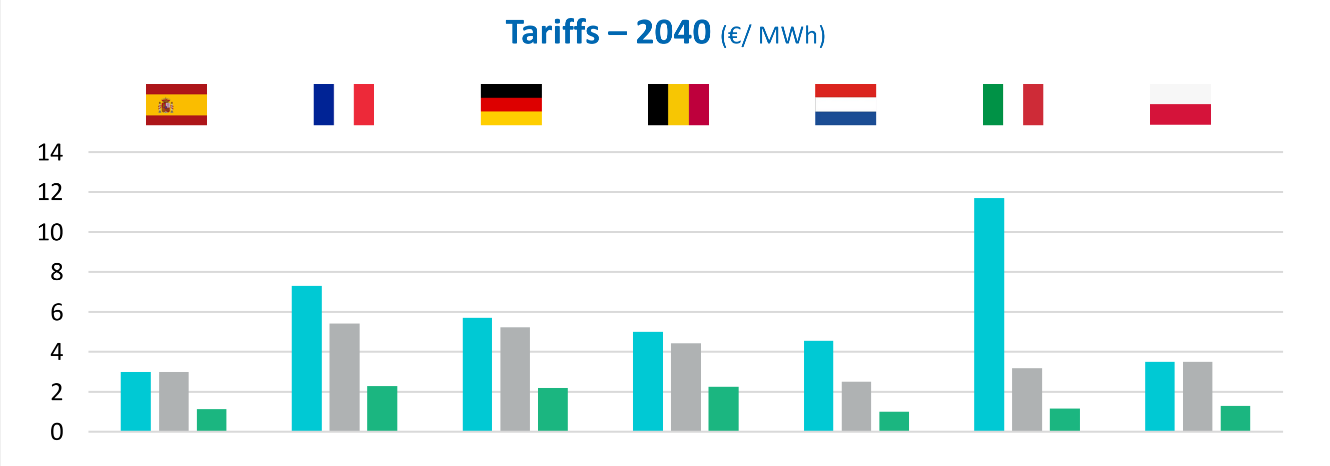
Subsidies under Scenario 1 ,2 and 3, 2030 to 2050 (EUR/MWh)

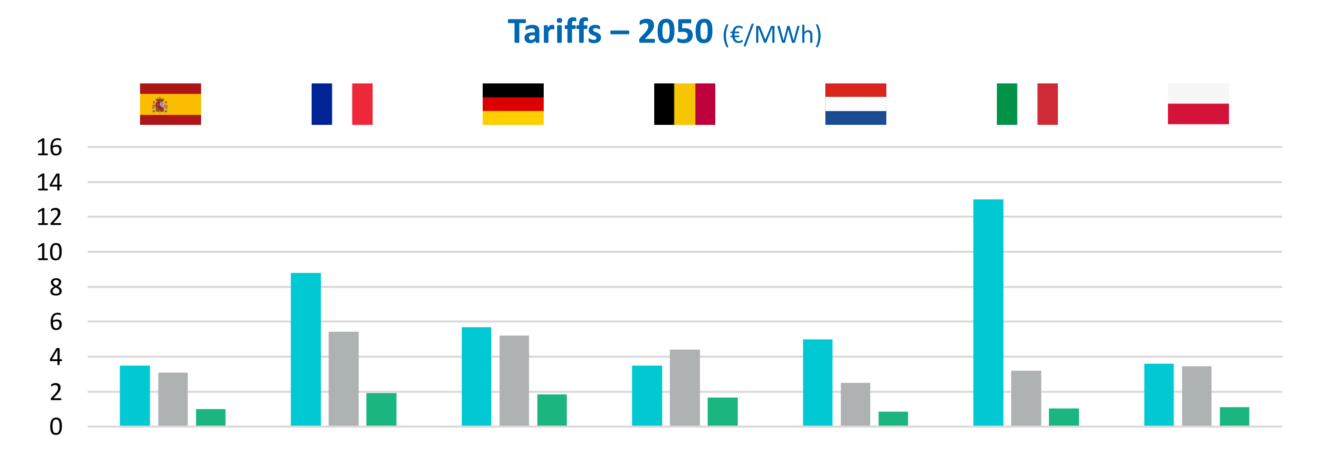


The combined H2 tariff under Scenario 1 is the highest tariff whilst H2 tariff with discount (Scenario 3) is the lowest from 2040

Hydrogen tariffs for Scenario 1 (GA), 2 and 3





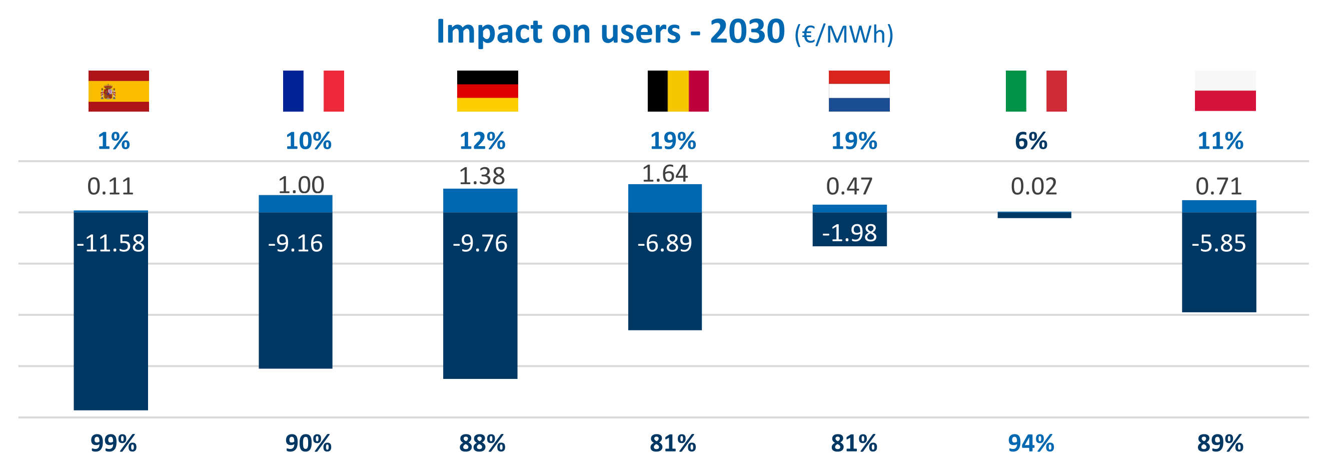


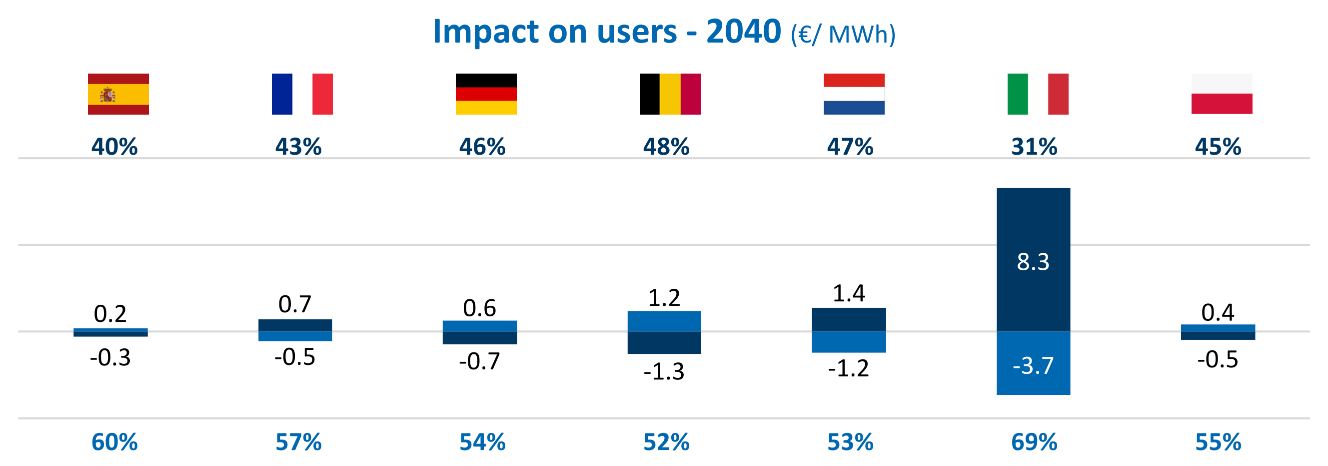
- In 2030, Scenario 1 tariff is the highest tariff, except for Spain and France.
- From 2040, Scenario 3 is the lowest tariff out of the three scenarios for all countries.
- Italian tariff under the Scenario 1 is high because of the low hydrogen flows and a relatively large natural gas network in proportion to the hydrogen one. A ratio of six compared to other countries where ratio varies from 1-4.

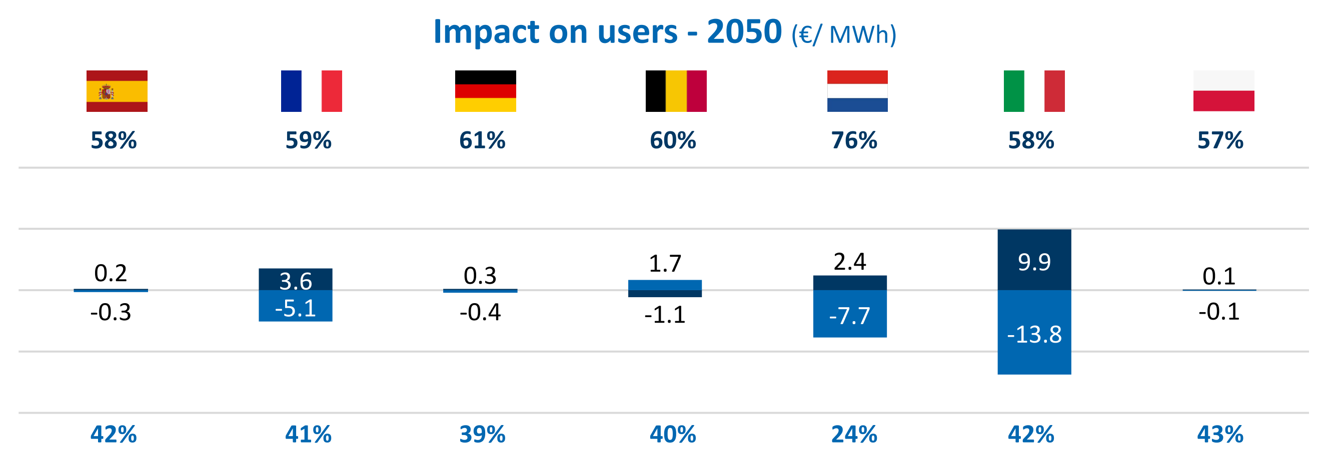
Sc. 1 tariff   Sc. 2 tariff   Sc. 3 tariff

In 2030, methane users are subsidising hydrogen users, whilst by 2040, the trend switches in all countries and hydrogen users overpay

Impact of Scenario 1 (GA) on hydrogen and natural gas users, compared with standalone tariffs (Scenario 0)







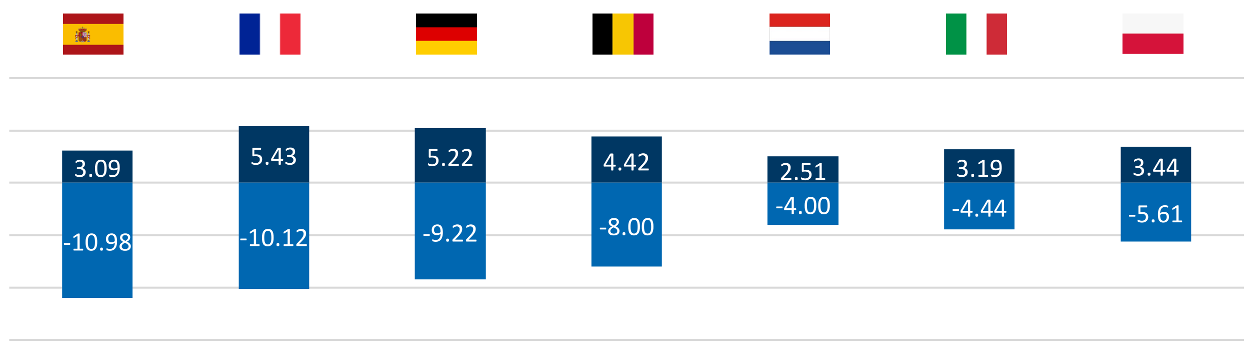
- In 2030, for all countries in our scope, under the combined tariff, methane users are overpaying due to low hydrogen flows; whilst hydrogen users are underpaying compared to the standalone methane and hydrogen tariffs.
- The country with the largest overpay is Spain, driven by a very low volume of flows in that year (2TWh).
- By 2040, in all countries, hydrogen users are now overpaying whilst natural gas users are underpaying. Same holds true in 2050, where the largest hydrogen users overpaying is recorded for the Netherlands and Italy.

H2 users CH4 users **10%** Impact share of CH4 users' tariff **90%** Impact share of H2 users' tariff

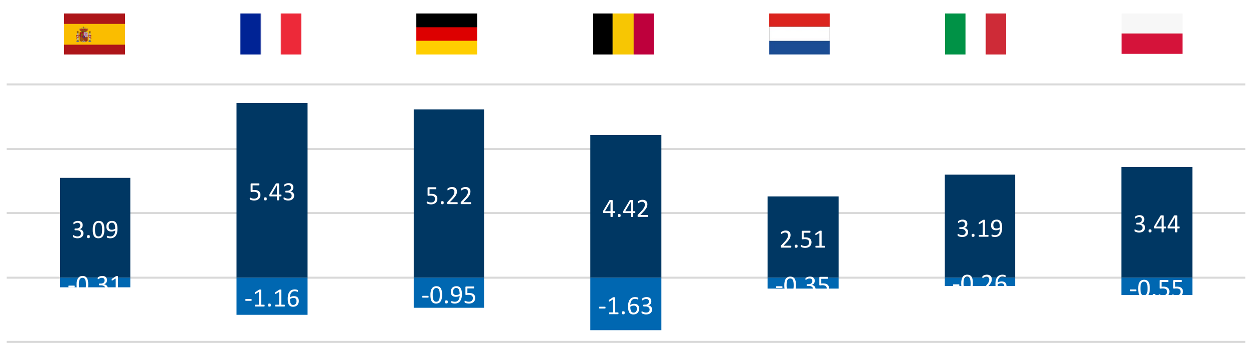
In 2030, subsidy is up to 2 times larger than the H2 tariff, with Spain, France and Germany needing most ; in 2050 no more subsidy is required

Impact of Scenario 2 on hydrogen users and taxpayers

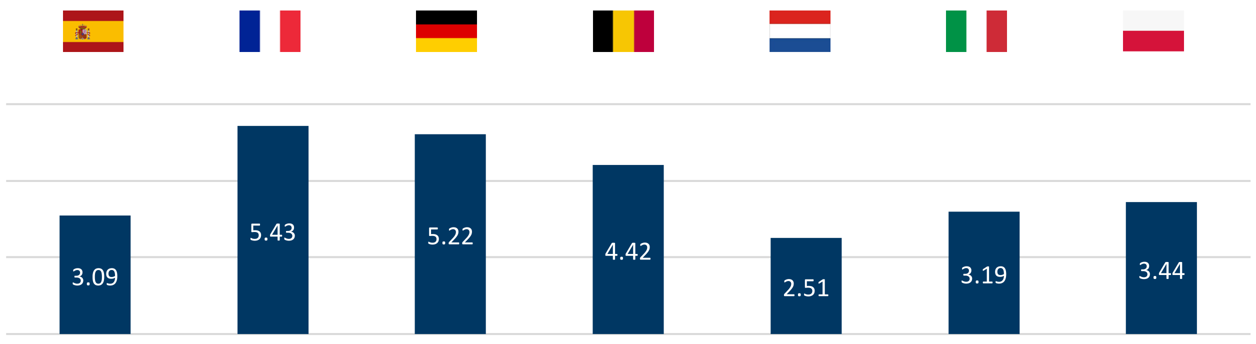
Impact on users - 2030 (€/MWh)



Impact on users - 2040 (€/ MWh)



Impact on users - 2050 (€/ MWh)



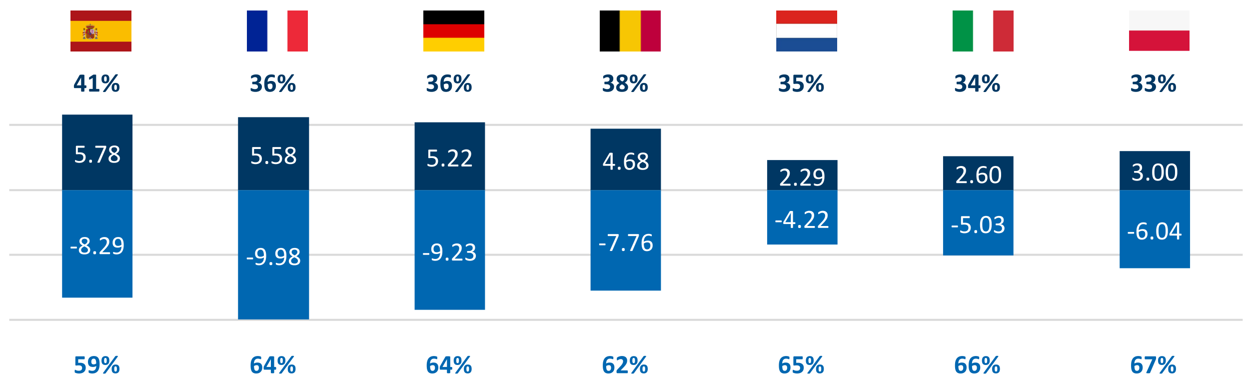
- Scenario 2 assumes a constant 2050 tariff is applied to 2030 and 2040.
- Under this Scenario, in 2030, subsidies to support hydrogen transportation are the largest in Germany at 830 EUR/MWh and the smallest in Spain at 22 EUR/MWh.
- Subsidies required are the highest across all three Scenarios.
- In 2040 the subsidy required shrinks in all countries except for Spain (due to more flows than in the 2030).
- By 2050, there are no subsidies required.

■ Tariff paid by H2 users ■ Subsidy paid by taxpayers **88%** Share paid by taxpayers **12%** Share paid by H2 users

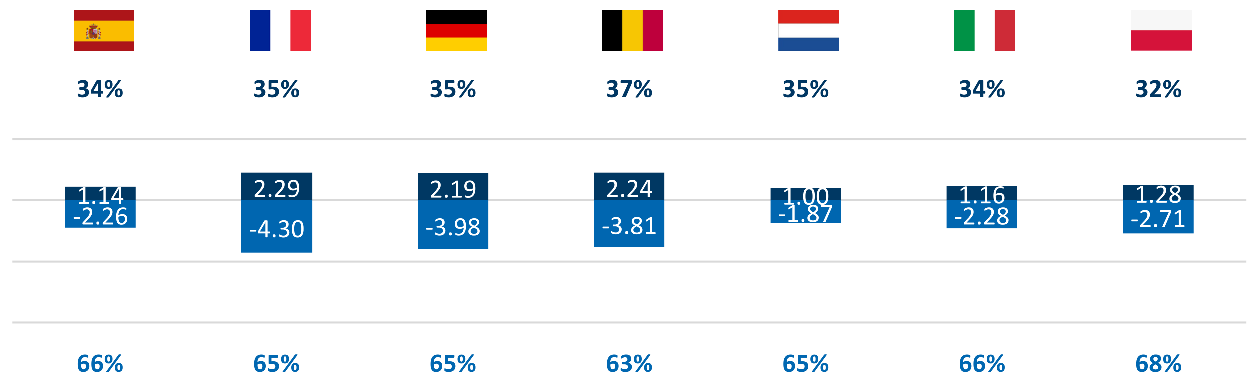
In Sc.3, subsidy up to 2 times larger than the hydrogen tariff will be needed to subsidise H2 users in EU7, with France and Germany needing most

Impact of Scenario 3 on hydrogen users and taxpayers

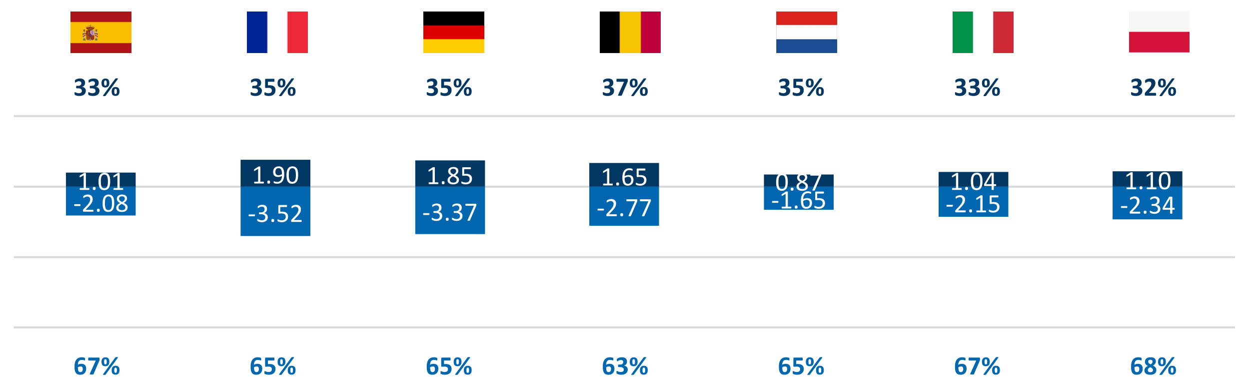
Impact on users - 2030 (€/MWh)



Impact on users - 2040 (€/ MWh)



Impact on users - 2050 (€/ MWh)

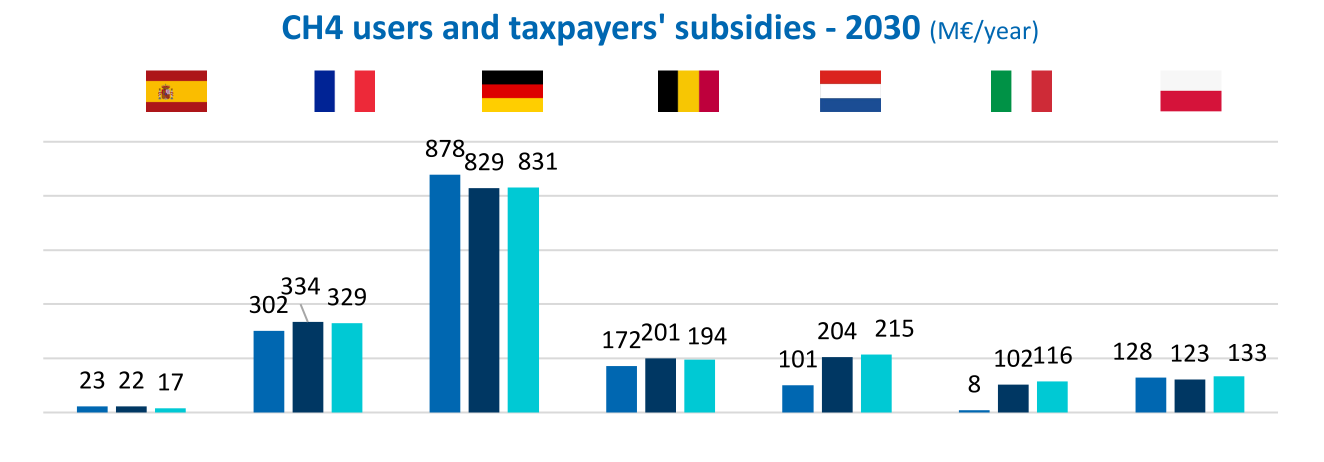


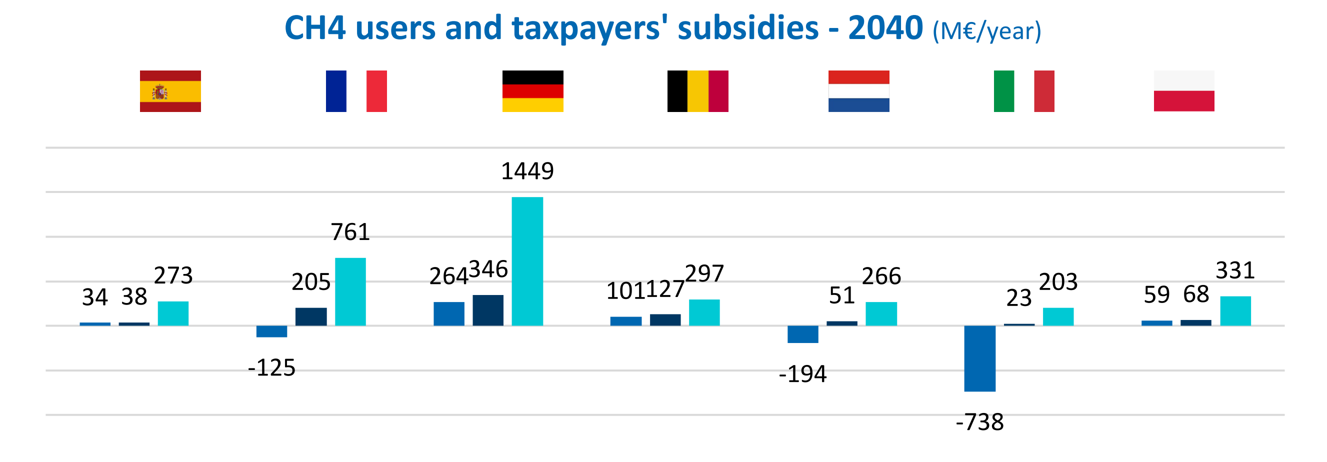
- In all countries, throughout the years, providing a 75% discount to the capital portion of the allowed revenue, means that a substantial state subsidy will be needed to support hydrogen users.
- The subsidy needed ranges from 1.4 times the amount of subsidy amount compared to the tariff paid by hydrogen users to 2.1 times.
- The highest subsidy, in absolute unit terms will be needed in France and Germany in 2030, at 10.0 EUR/MWh and 9.2 EUR/MWh respectively. This is due to a higher allowed revenue compared to actual flows France and Germany.

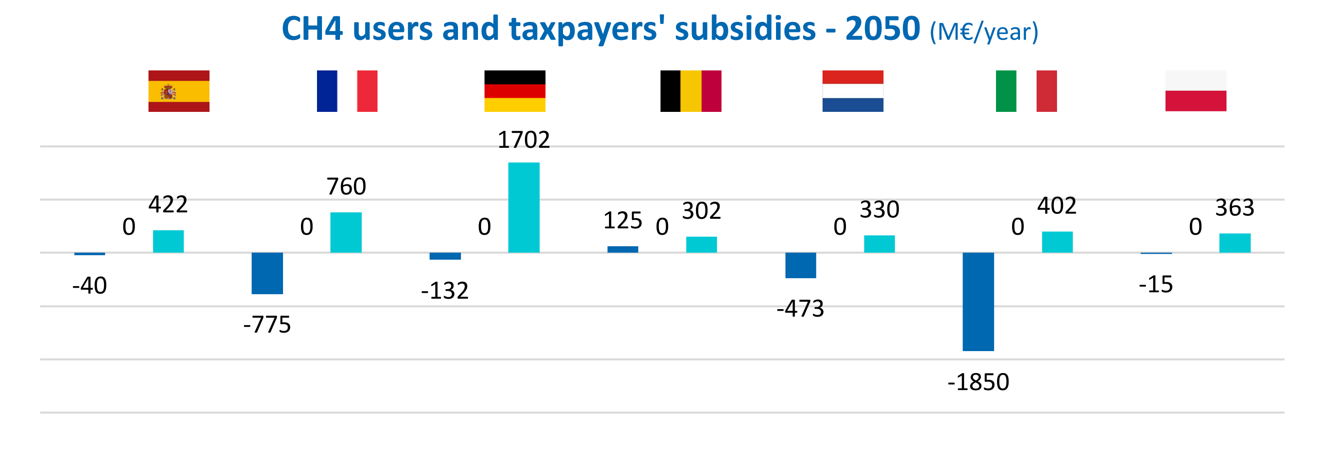
Tariff paid by H2 users | Subsidy paid by taxpayers | **59%** Share paid by taxpayers | **41%** Share paid by H2 users

Scenario 3 requires the greatest amount of subsidy in 2040; Germany supports by far the biggest subsidies under Scenario 2

Absolute subsidies paid by taxpayers and CH4 users, Scenario 1 (GA), 2 and 3







- In 2040, Scenario 3 requires the greatest amount of subsidy, paid for by taxpayers.
- In 2050, there is no more subsidy under Scenario 2.
- Scenario 1 and 2 require much smaller amounts from taxpayers or CH4 users, with CH4 users being in turn subsidized from 2040 under Scenario 1.

Subsidy by CH4 users – scenario 1
Subsidy by taxpayers – scenario 2
Subsidy by taxpayers – scenario 3

5. Sensitivities

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Sensitivities

Chapter contents

I

ENTSOG DISTRIBUTED ENERGY INSTEAD OF ENTSOG GLOBAL AMBITION METHANE SCENARIOS

II

FOUR-YEAR DELAY IN H2 DEMAND DEVELOPMENT

Total EU7 CH4 flows decline by 83% between 2030 at 2050 ; NL has the highest decline rate (-95%), with only 21 TWh of CH4 flows left in 2050

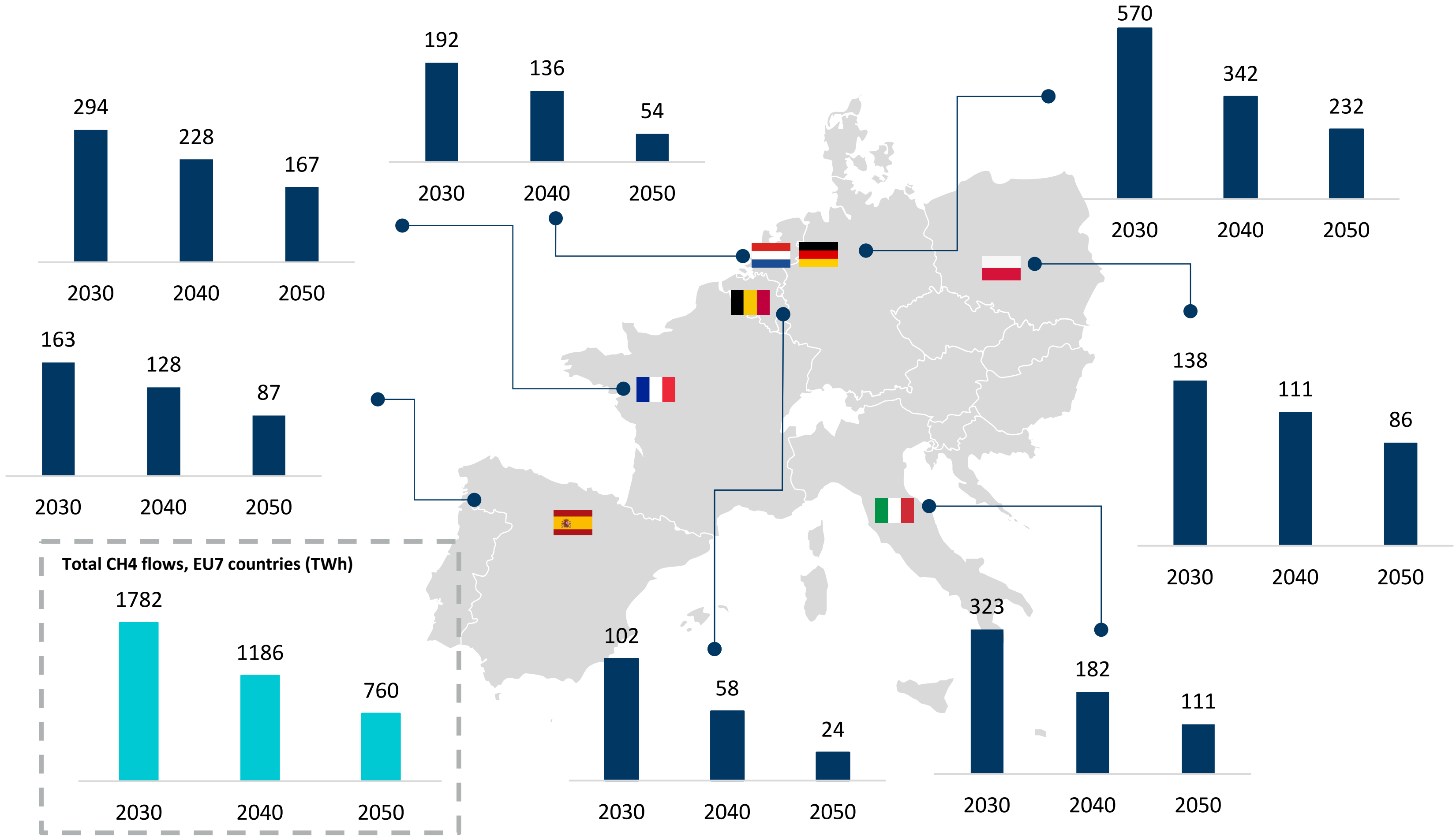
Natural gas flows decline in EU7 – Distributed Energy variant

- Total EU7 natural gas flows decrease from 1,782 TWh in 2030 to 760 TWh in 2050 (-57%).
- Belgium has the highest decline rate (-77%) while Poland has the lowest (-38%).
- Germany has the highest CH4 flows throughout all years starting at at 570 TWh in 2030 and decreasing to 232 TWh in 2050.

CH4 flows decline, 2030-2050 (%)

Decline rate (%)	2030-50
Spain	-47%
France	-43%
Germany	-59%
Belgium	-77%
Netherlands	-72%
Italy	-66%
Poland	-38%
Total	**-57%**

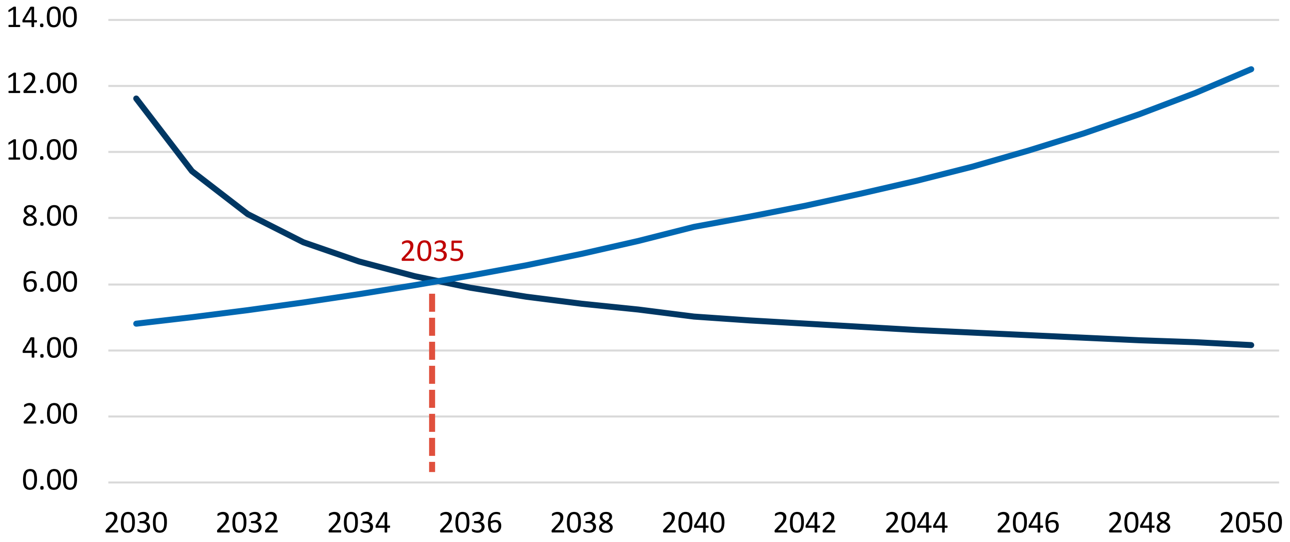
Total natural gas flows decline, 2030-2050 (TWh)



Under Global ambition, for Scenario 1, hydrogen tariffs break-even with methane tariffs 2 years earlier than under the Distributed Energy

Results of CH4 only and H2 only tariffs for the EU7 under Distributed Energy and Global Ambition scenarios

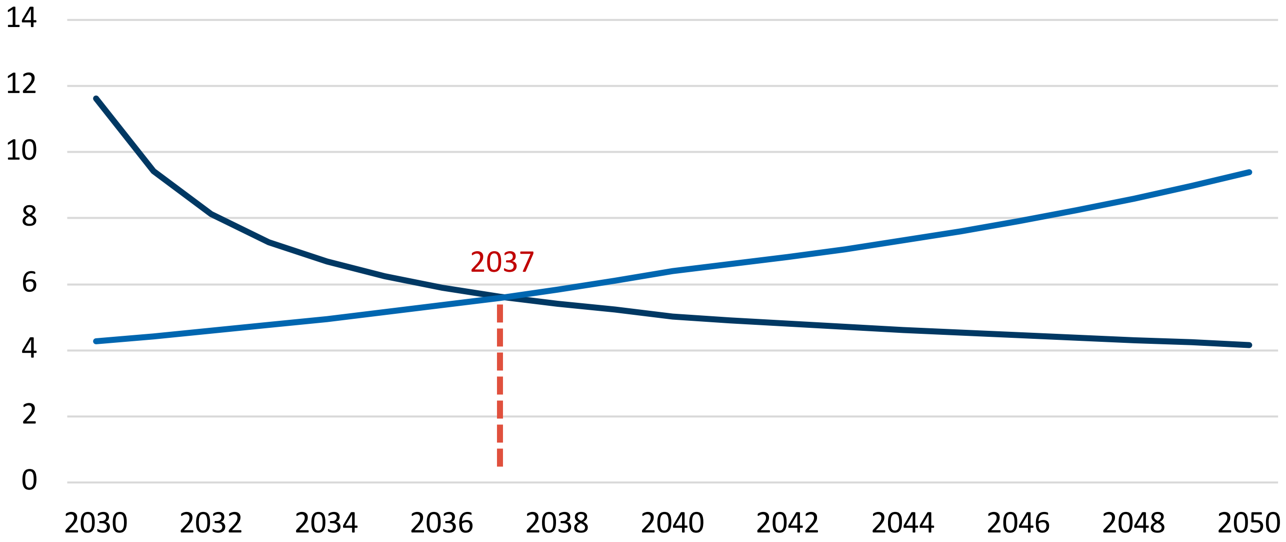
EU7 Tariffs – Distributed Energy (€/MWh)



- ENTSOG presents two scenarios for CH4 consumption until 2050 : Distributed Energy and Global Ambition.
- Under the Distributed Energy Scenario, H2 only tariffs break-even with CH4 only tariffs in 2035.

CH4 tariff   H2 tariff

EU7 Tariffs – Global Ambition (€/ MWh)



- Under the Global Ambition Scenario H2 only tariffs break-even with CH4 only tariffs in 2037.
- In the Global Ambition Scenario methane flows are higher, and thus the methane-only tariffs do not grow as much after 2040 (+47%) as compared to Distributed Energy (+62%).

Under Scenario 0, hydrogen and methane only tariffs cross in 2035, with slower decrease of H2 only tariffs after 2034

Results for methane only and hydrogen only tariffs for the EU7[1] under Distributed Energy Scenario

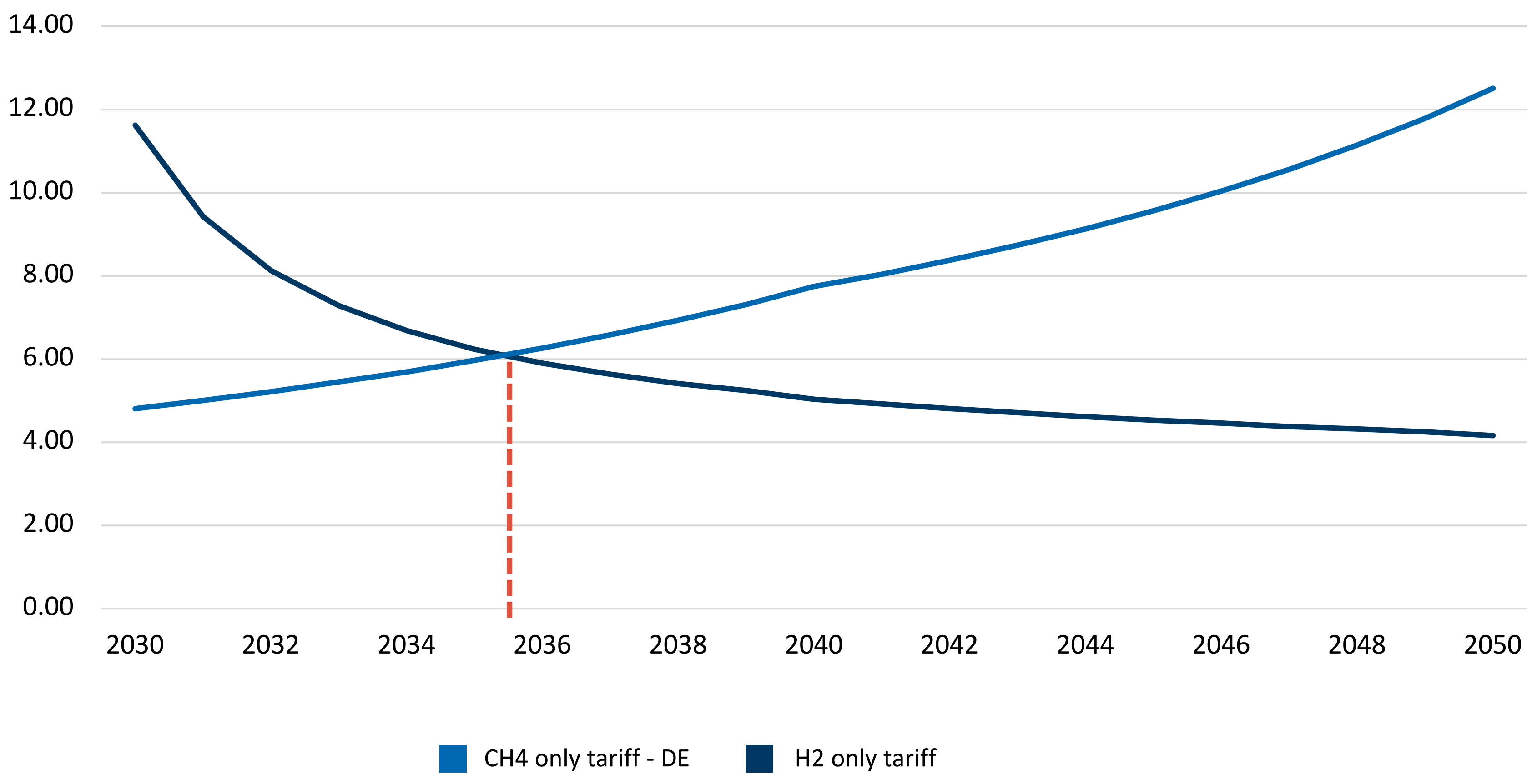
Break-even

- For the Scenario 0, with hydrogen and methane separately considered, with no subsidy, hydrogen and methane cross in 2035.
- Methane tariff increase significantly over the period 2030-2050 (+160%) due to declining flows.
- H2 tariff decreases by 67% over the period 2030-2050, starting at 11.6 EUR/MWh and reaching 4.2 EUR/MWh.

Assumptions

- This comparison is made under the ENTSOG Distributed Energy variant (under a second Variant – Distributed Energy, methane/hydrogen crossing point is reached in later. This is discussed in the Sensitivities section of the report.)
- This is the tariff for EU7 as a group, individual EU7 countries have different profiles. This is discussed in the Country level results section.

EU7 methane and hydrogen only tariffs (€/MWh)



Notes:1 – EU7-wide tariff is equal to allowed revenue divided by the flows, as opposed to an average tariff for all seven countries. In this way, we calculate the tariff level if it was charged across EU7.

Under Scenario 1, hydrogen and methane only tariffs cross in 2035: natural gas users subsidize hydrogen until then and the reverse afterwards

Results for methane only and hydrogen only tariffs for the EU7[1] under Scenario 1 – Distributed Energy

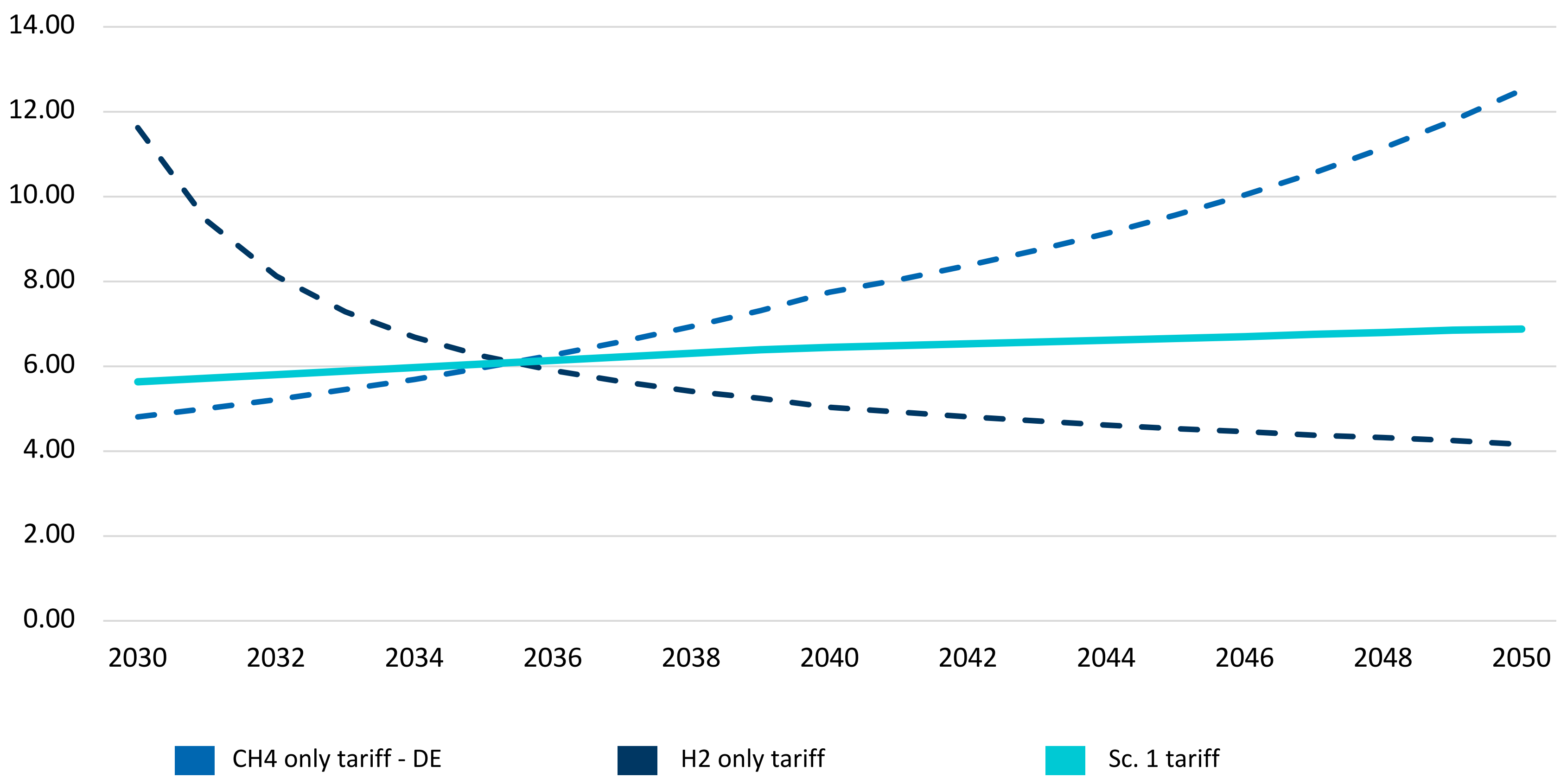
Description of Scenario 1 tariffs

- Combined methane and natural gas tariff allows for the sharing of costs between natural gas and hydrogen users.

Subsidising profile

- Subsidising hydrogen transportation will help kick-start the hydrogen economy and develop the network necessary to meet decarbonisation targets within the EU block.
- For the Scenario 1 (unified hydrogen and methane tariff), taken separately hydrogen and methane only tariffs break-even in 2035.
- This means that natural gas users subsidise hydrogen users up until 2036. After this point the trend reverses and hydrogen users start subsidising natural gas users.

EU7 CH4 and H2 only and Scenario 1 combined tariff (€/MWh)



Notes:1 – EU7-wide tariff is equal to allowed revenue divided by the flows, as opposed to an average tariff for all seven countries. In this way, we calculate the tariff level if it was charged across EU7.

Hydrogen tariffs under the Scenario 2 assumptions is lower than methane tariff, due to public subsidies that decline over time, reaching zero in 2050

Results of Scenario 2 vs hydrogen and methane only tariffs and subsidies for the EU7[1] - Distributed Energy

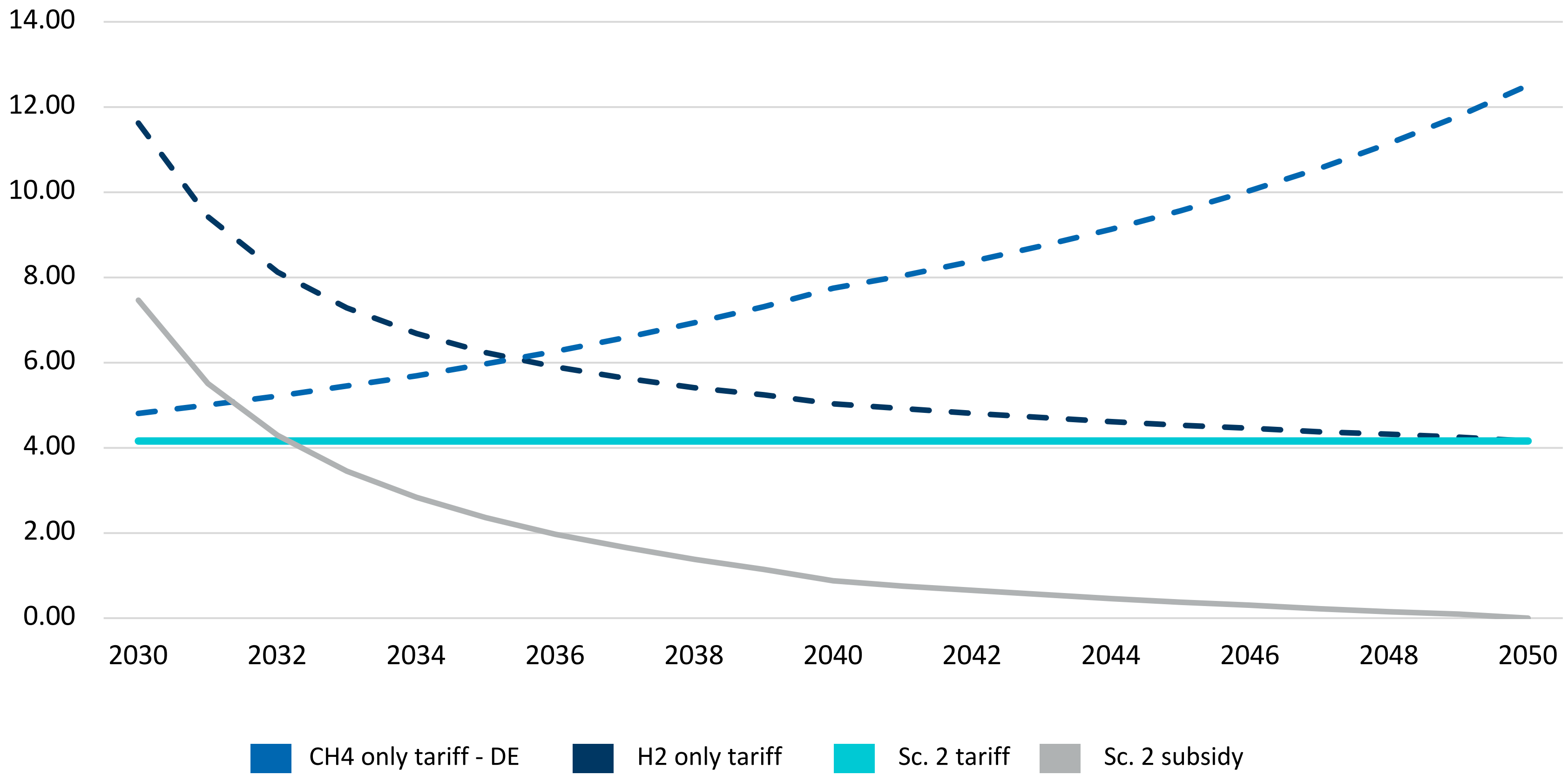
Description of Scenario 2 tariffs

- Under Scenario 2, we assume that 2050 hydrogen tariff is applied to 2030 and 2040 to avoid penalising early hydrogen users.
- Hydrogen tariff under the Scenario 2 is stable throughout the years, at 4.2 EUR/MWh. Methane only tariff always exceed the Scenario 2 hydrogen tariff.

Subsidising profile

- In order to reach the low tariffs under Scenario 2, and in the absence of a combined tariff arrangement, hydrogen users will be subsidized by taxpayers. This makes hydrogen transportation more attractive for the users as costs are borne out of the energy transport system.
- The EU7-wide subsidy starts at 7.5 EUR/MWh in 2030, rapidly dropping to 0.9 EUR/MWh in 2040 before reaching zero in 2050.
- Total subsidy required to support H2 users under Scenario 2 starts at EUR 1,834 M EUR in 2030, increases to 3,580 M EUR in 2040 due to increasing H2 flows, and drops down to zero in 2050.

EU7 CH4 and H2 only and Scenario 2 tariff and subsidy (€/MWh)



Notes:1 – EU7-wide tariff is equal to allowed revenue divided by the flows, as opposed to an average tariff for all seven countries. In this way, we calculate the tariff level if it was charged across EU7.

Hydrogen tariffs under the Scenario 3 assumptions are lower than methane only tariffs; public subsidies are always needed for support

Results of Scenario 3 vs hydrogen and methane only tariffs and subsidies for the EU7[1] – Distributed Energy

Hydrogen tariff (Scenario 3)

- Under Scenario 3 assumptions, where 75% discount is given to the capital portion of the allowed revenue, tariff starts at 4.2 EUR/MWh in 2030, declines to 1.6 EUR/MWH in 2040 and then to 1.35 EUR/MWH in 2050.

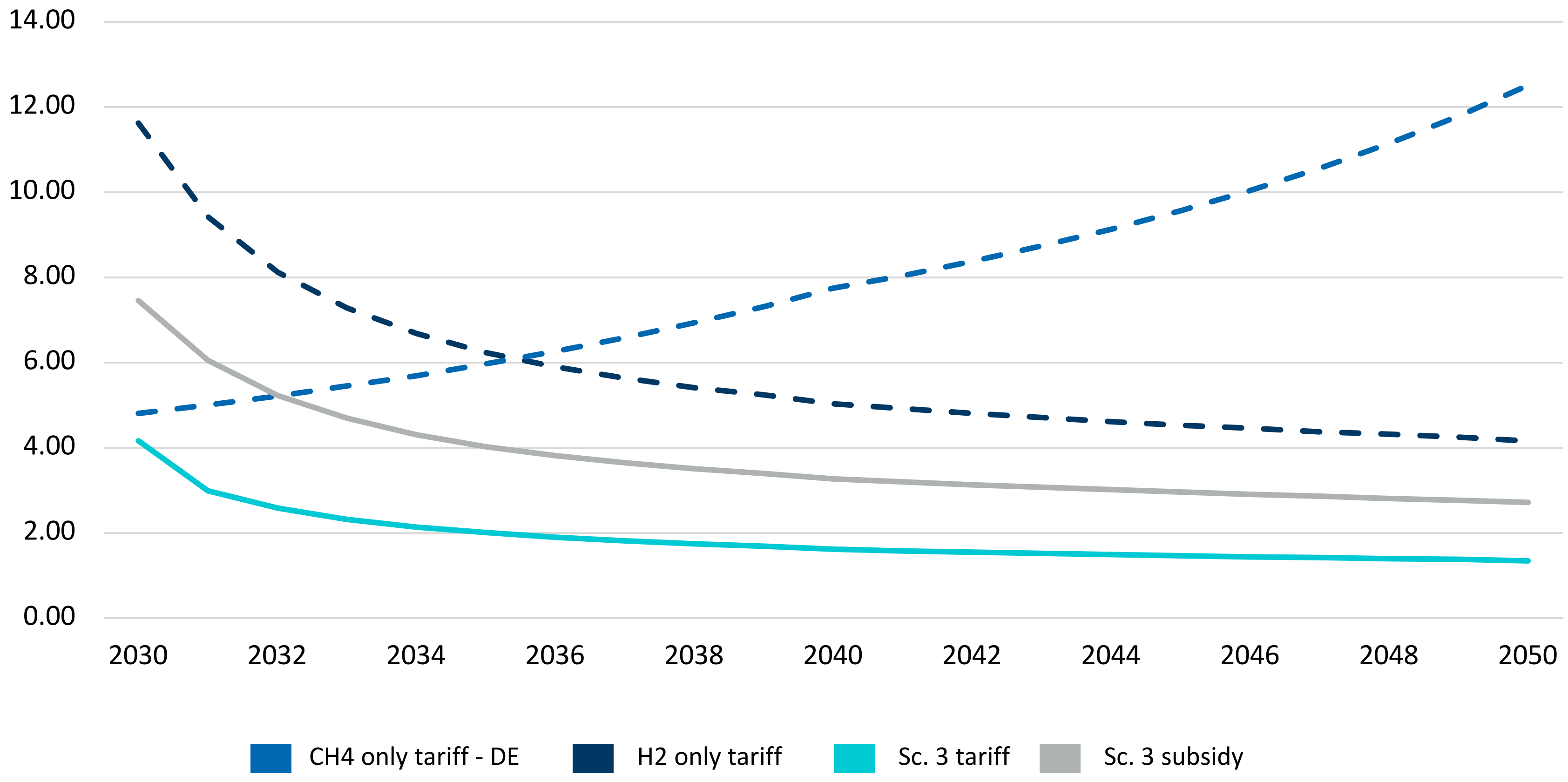
Break-even

- Under the Scenario 3, the hydrogen only tariff is always lower than the methane only tariff.

Subsidising profile

- In order to reach the low tariffs under Scenario 2, and in the absence of a combined tariff arrangement, hydrogen users will have to be subsidized by taxpayers. This makes hydrogen transportation more attractive for the users as costs are borne out of the energy transport system.
- The EU7-wide subsidy to support tariff under the Scenario 3 starts at 7.5 EUR/MWh in 2030, declines to 3.3 EUR/MWh in 2040 and 2.7 EUR/MWh in 2050, still higher than the hydrogen tariff.
- The total subsidy required in 2030 is EUR 1,834m, in 2040 it is EUR 3,580m as allowed revenue increases, before reaching EUR 4,281m in 2050.

EU7 CH4 and H2 only and Scenario 3 tariff and subsidy (€/MWh)



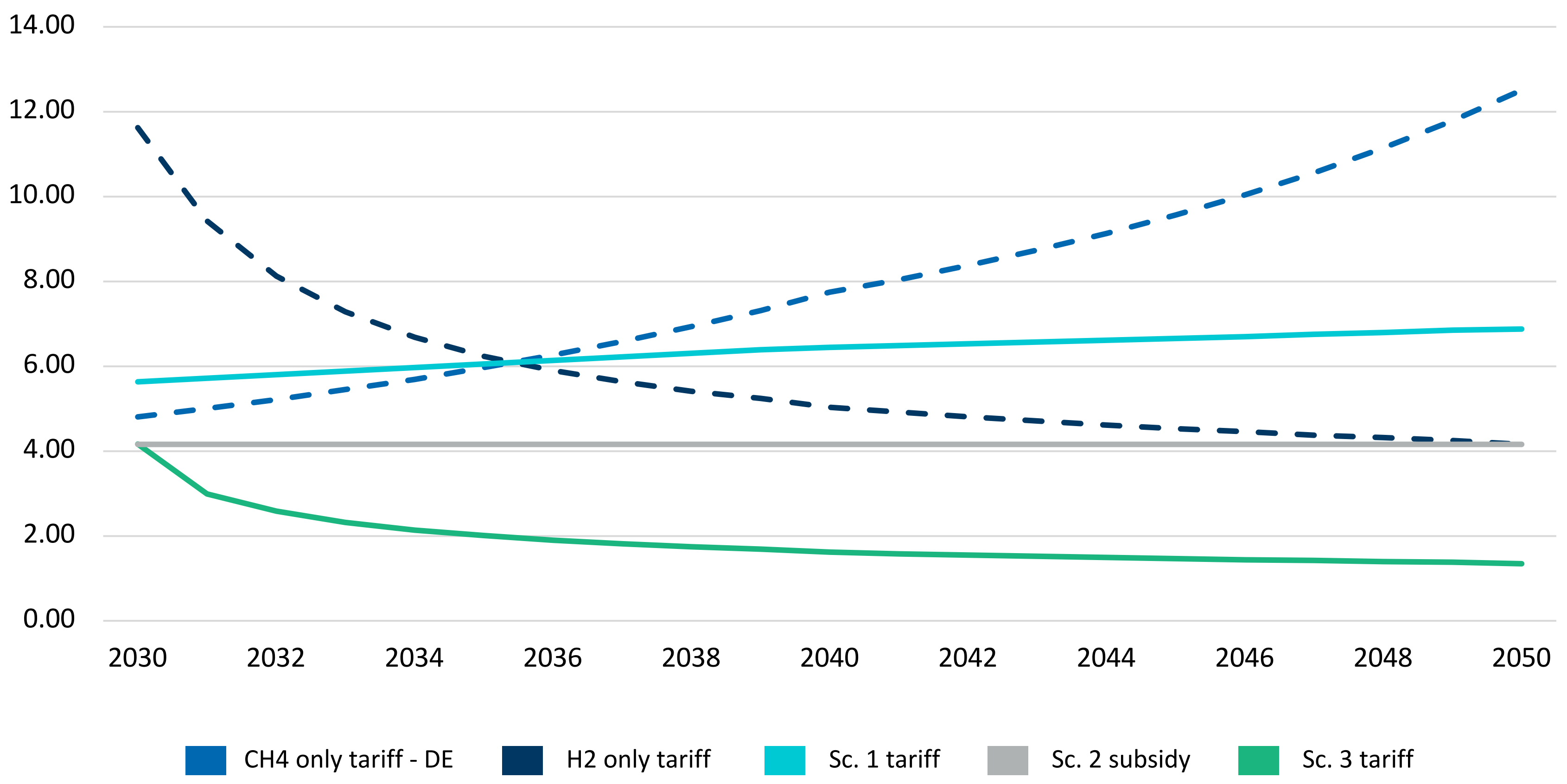
Notes:1 – EU7-wide tariff is equal to allowed revenue divided by the flows, as opposed to an average tariff for all seven countries. In this way, we calculate the tariff level if it was charged across EU7.

Scenario 1 (combined tariff) always exceeds hydrogen tariffs under Scenario 2 and 3 from 2030 to 2050; Scenario 3 has the lowest tariffs

Comparison of Tariffs under Scenarios 1, 2 and 3 for the EU7[1]

- Overall, a combined EU7-wide1 hydrogen tariff is higher than Scenario 2 or 3 tariffs from 2030 and 2050.
- Not having a combined tariff would result in higher costs under the H2 only tariff until circa 2035 and after around 2035 under the CH4 only tariff (aka "doing nothing" – Scenario 0).
- The combined tariff under the Scenario 1 for EU7 countries starts at 5.6 EUR/MWh in 2030 and increases to 6.9 EUR/MWh in 2050.
- EU7-wide tariff for Scenario 2 for all EU7 countries is stable at 4.2 EUR/MWh, as hydrogen users pay 2050 tariff throughout all years.
- EU7-wide tariff under Scenario 3 starts at the same level as tariff 2 (4.2 EUR/MWh) then rapidly decreases to reach 2.0 EUR/MWh in 2035.

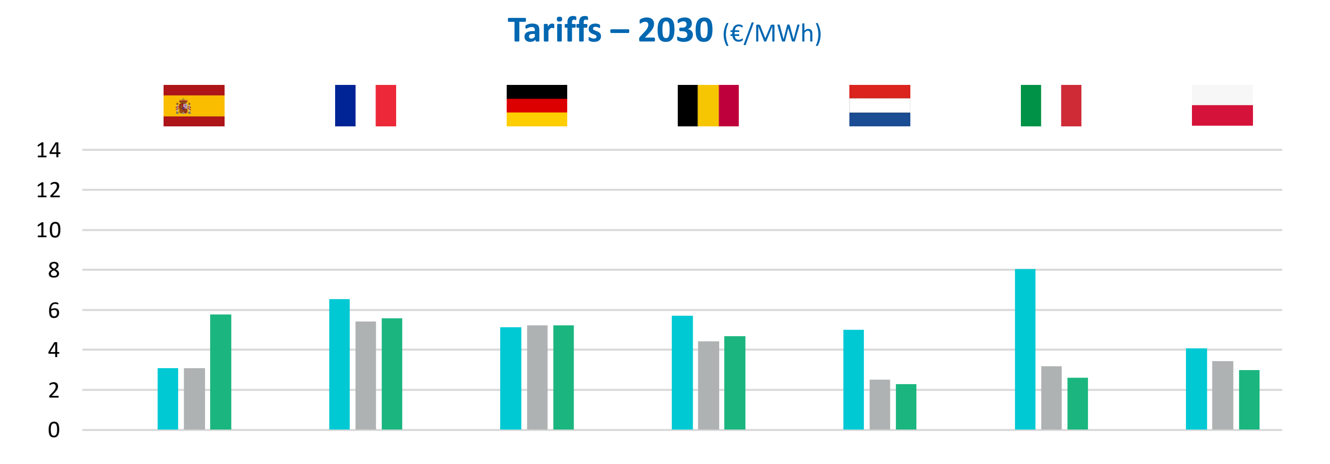
Tariffs for Scenario 0, 1,2 and 3, 2030 to 2050 (EUR/MWh)

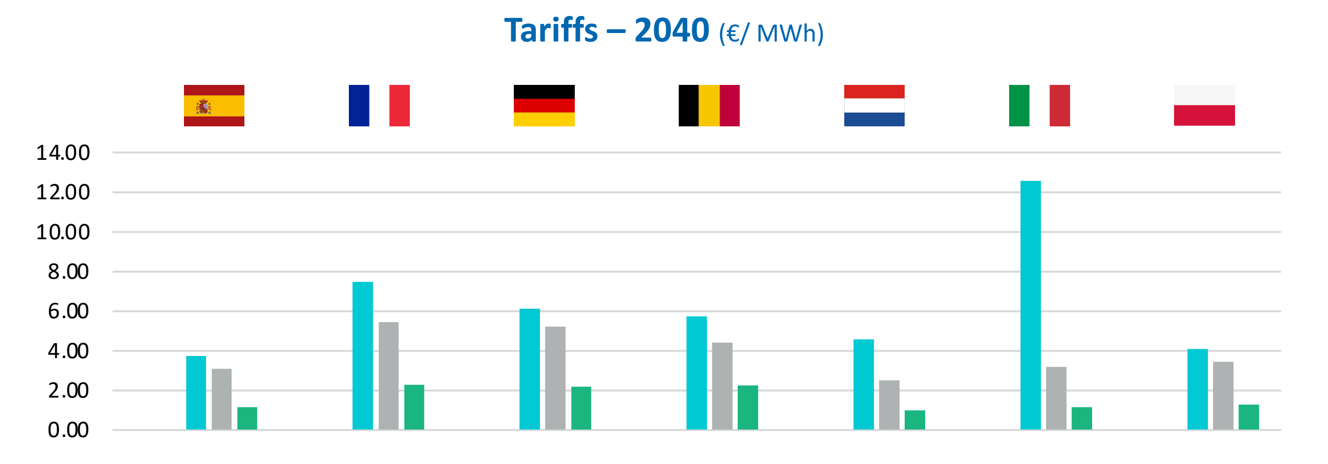


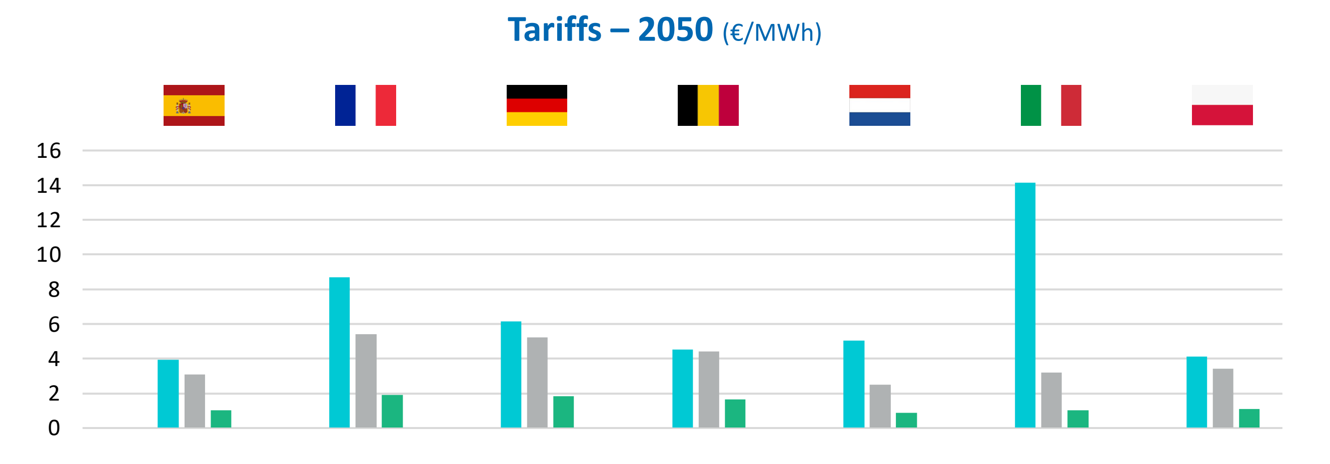
Notes:1 – EU7-wide tariff is equal to allowed revenue divided by the flows, as opposed to an average tariff for all seven countries. In this way, we calculate the tariff level if it was charged across EU7.

The combined H2 tariff under Scenario 1 is the highest tariff whilst H2 tariff with discount (Scenario 3) is the lowest from 2040

Hydrogen tariffs for Scenario 1 (DE), 2 and 3





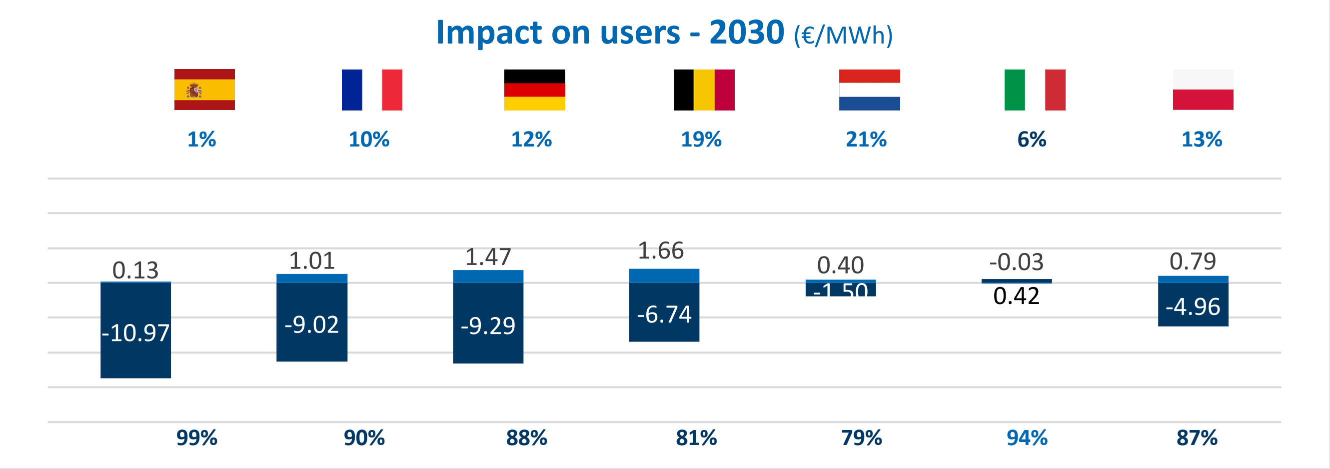


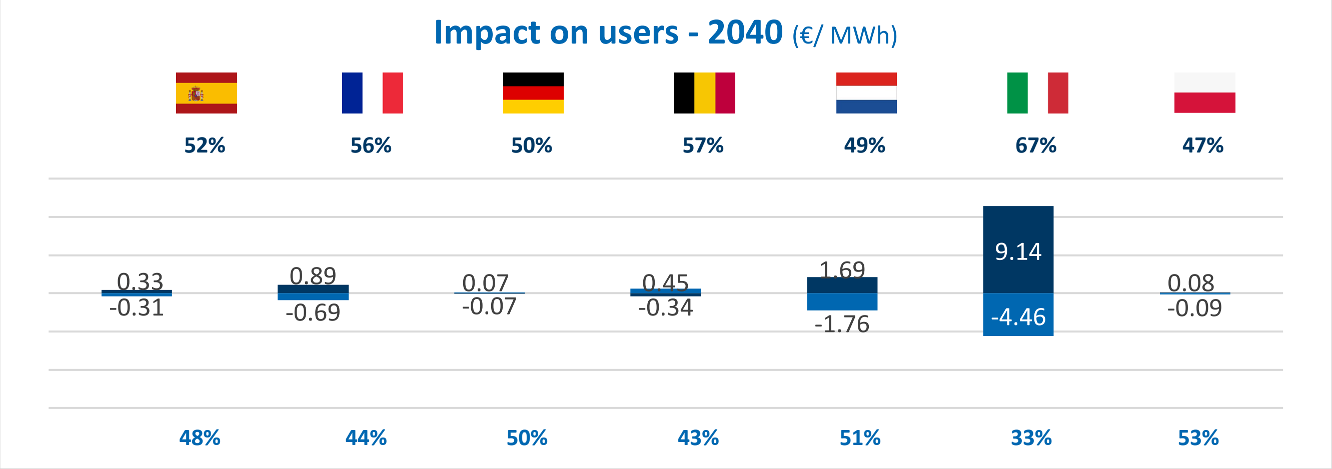
- In 2030, Scenario 1 tariff is the highest tariff, except for Spain and France.
- From 2040, Scenario 3 is the lowest tariff out of the three scenarios for all countries.
- Italian tariff under the Scenario 1 is large when comparing to others because it has the smallest amount (of all countries) of hydrogen and methane flows compared to their respective allowed revenue. Small denominator and large nominator results in the large tariff.

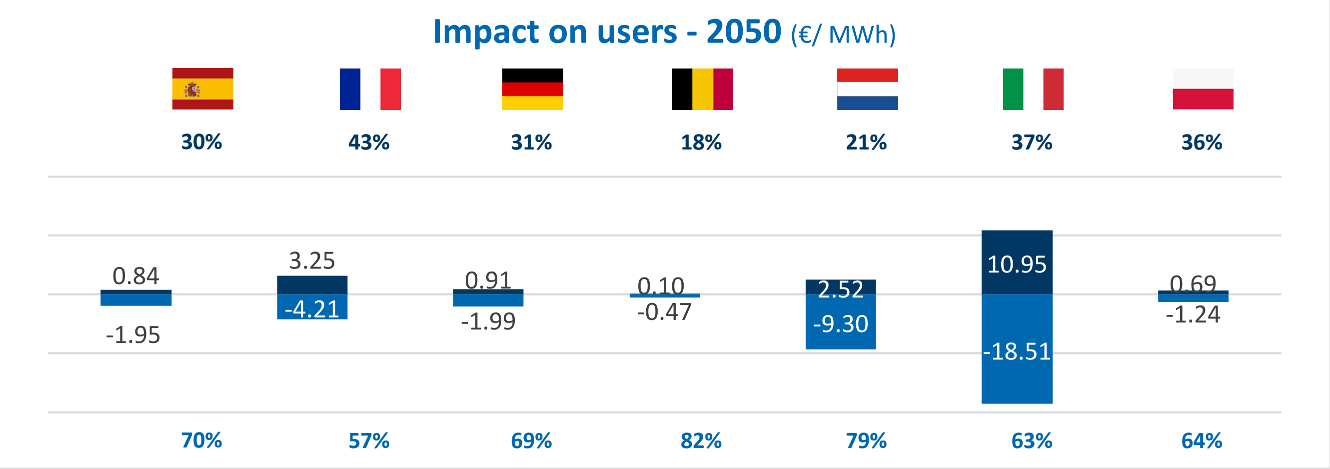
Sc. 1 tariff   Sc. 2 tariff   Sc. 3 tariff

In 2030, methane users are subsidising hydrogen users, whilst by 2040, the trend switches in all countries and hydrogen users overpay

Impact of Scenario 1 (DE) on hydrogen and natural gas users, compared with standalone tariffs (Scenario 0)





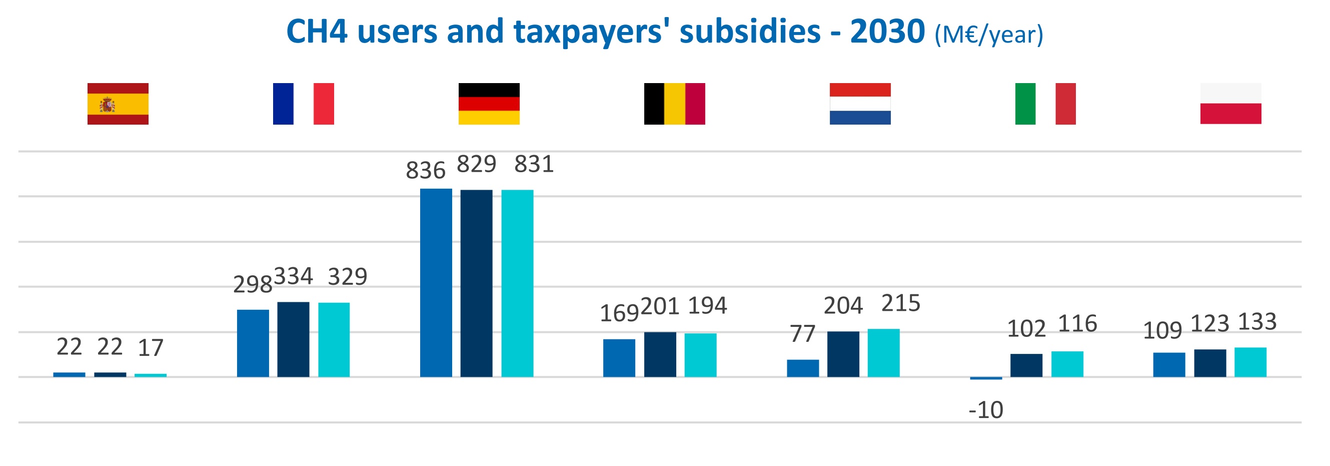


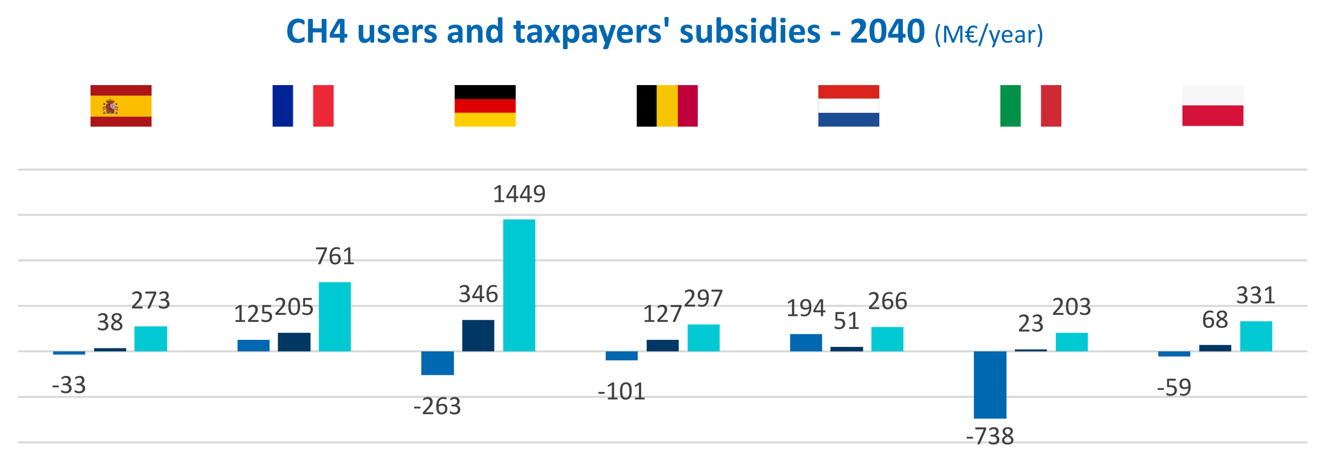
- In 2030, for all countries in our scope, under the combined tariff, methane users are overpaying due to low hydrogen flows; whilst hydrogen users are underpaying compared to the standalone methane and hydrogen tariffs.
- The country with the largest overpay is Spain, driven by a very low volume of flows in that year (2TWh).
- By 2040, in all countries, hydrogen users are now overpaying whilst natural gas users are underpaying. Same holds true in 2050, where the largest hydrogen users overpaying is recorded for the Netherlands and Italy.

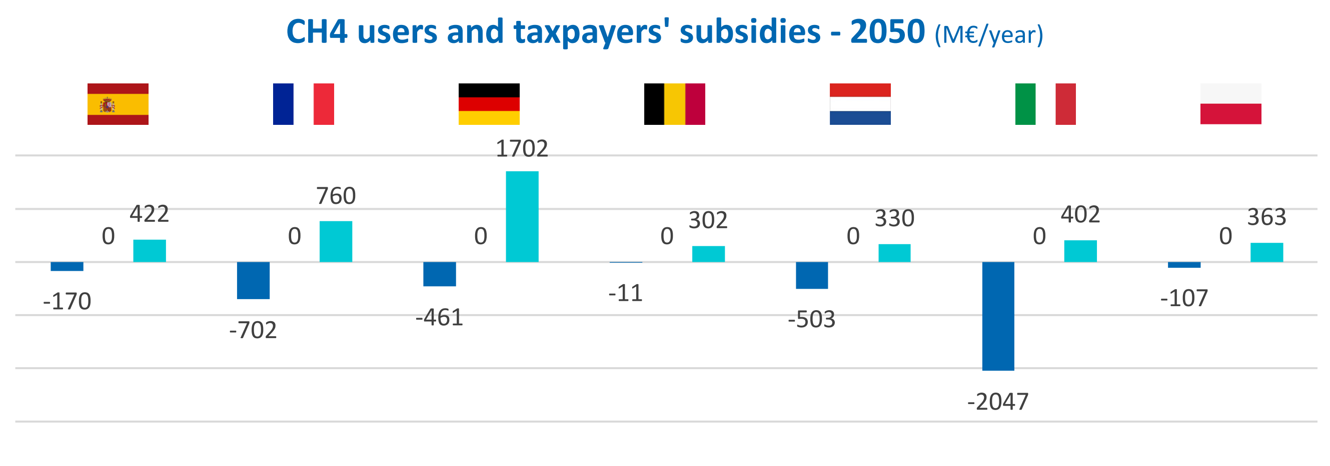
H2 users CH4 users **10%** Impact share of CH4 users' tariff **90%** Impact share of H2 users' tariff

Scenario 3 requires the greatest amount of subsidy in 2040 ; Germany supports by far the biggest subsidies under Scenario 2

Absolute subsidies paid by taxpayers and CH4 users, Scenario 1 (DE), 2 and 3







- In 2040, Scenario 3 requires the greatest amount of subsidy, paid for by taxpayers
- In 2050, there is no more subsidy under Scenario 2
- Scenario 1 and 2 require much smaller amounts form taxpayers or CH4 users, with CH4 users being in turn subsidized from 2040 under Scenario 1

Subsidy by CH4 users – scenario 1

Subsidy by taxpayers – scenario 2

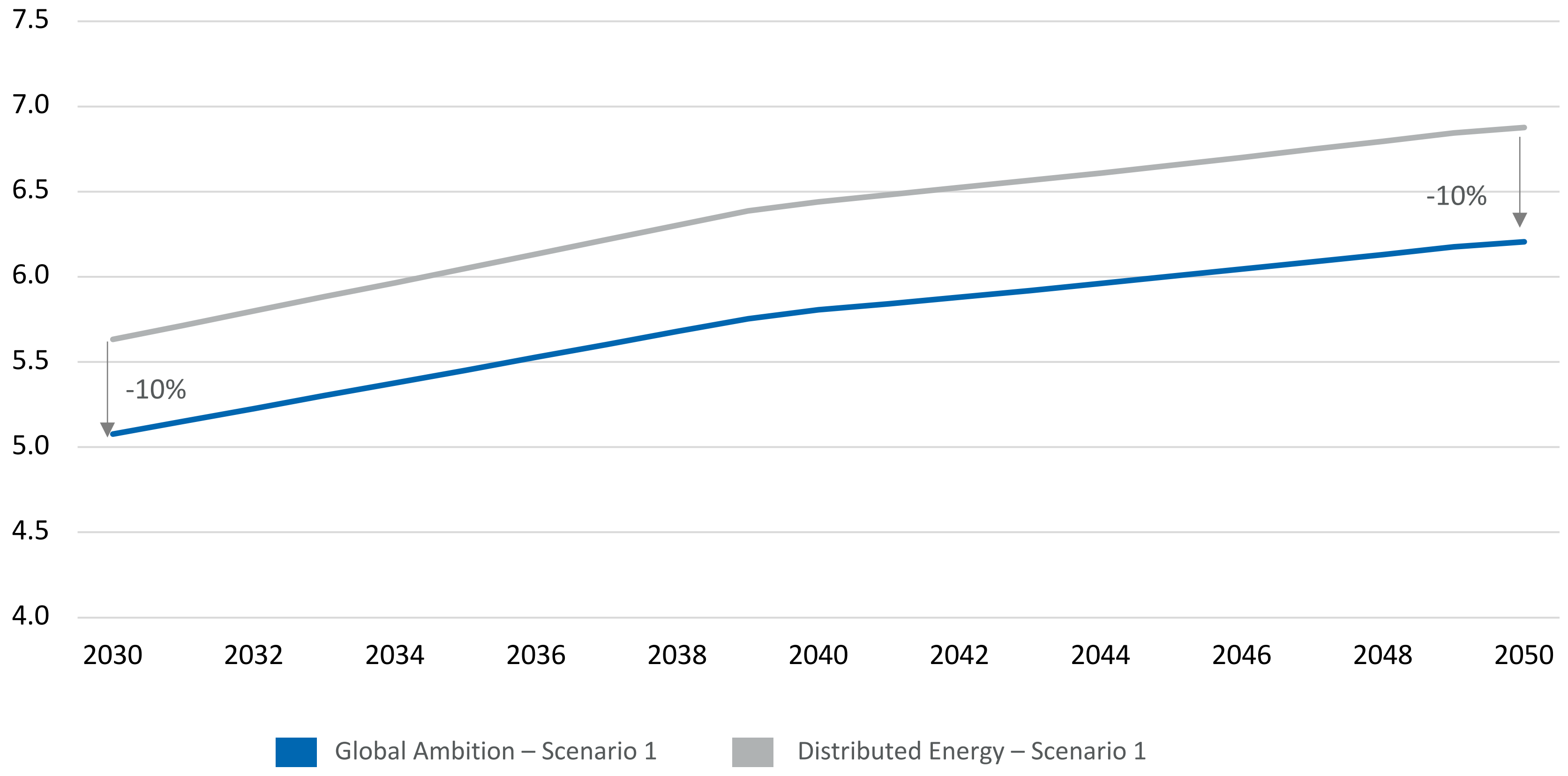
Subsidy by taxpayers – scenario 3

In Scenario 1, the Global Ambition scenario results in a lower tariff compared to the distributed energy due to higher methane flows

Scenario 1 combined tariff, Global Ambition and Distributed Energy Scenarios, 2030 to 2050

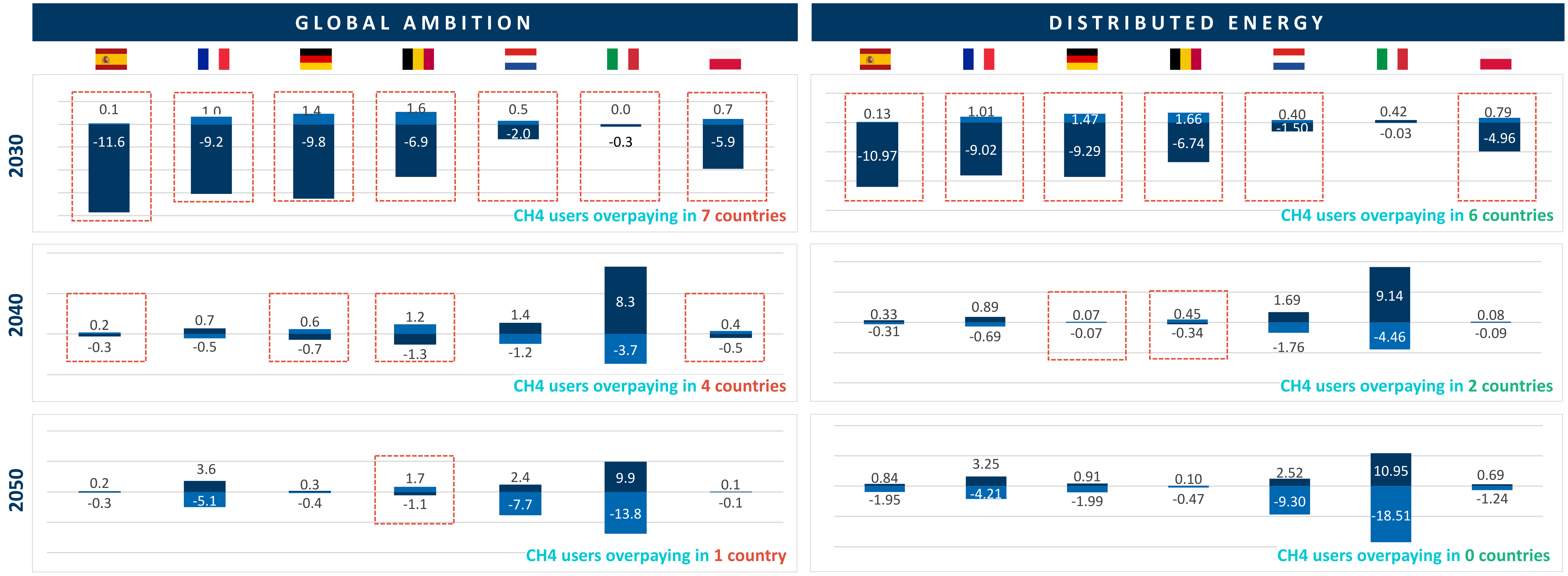
- Scenario 1 tariff under the Global Ambition Scenario is 10% lower than the Distributed Energy Scenario.
- Higher tariff in the Distributed Energy Scenario is due to a greater decrease of methane flows in this Scenario.
- Under both tariffs, other assumptions (hydrogen flows, hydrogen revenues and methane revenues) remain the same.

Tariffs under the Global Ambition and Distributed Energy Scenarios, 2030 to 2050 (EUR/MWh)



With the Global Ambition Scenario, CH4 users overpay the combined tariff for a longer time than with the Distributed Energy Scenario

Comparison on Global Ambition and Distributed Energy Scenarios impact on CH4 and H2 users [EUR/MWh]



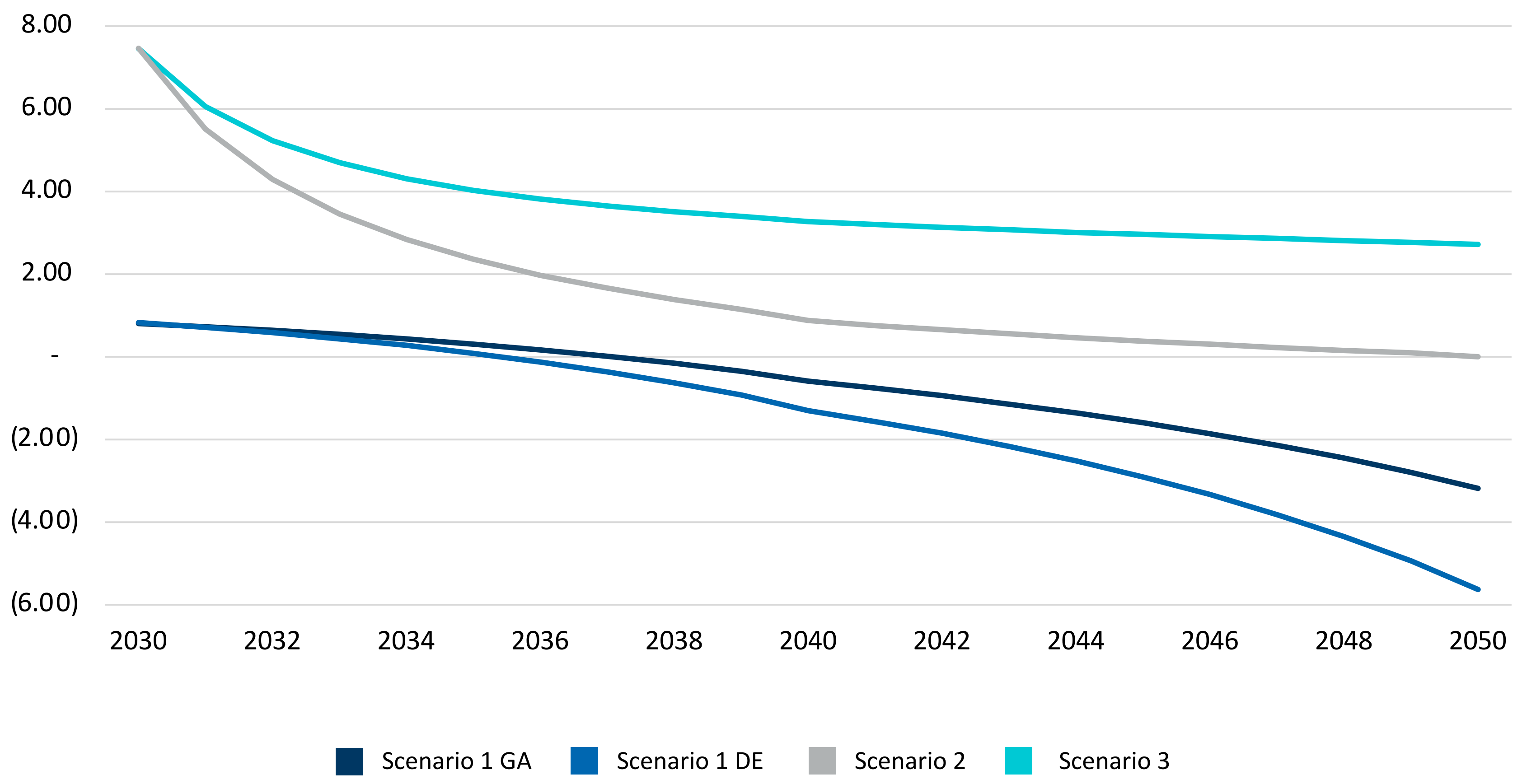
Due to lower CH4 demand, Distributed Energy leads to more benefits for the methane user under a combined H2-CH4 tariff

Subsidies required to support hydrogen users under the Scenarios 1, 2 and 3

Subsidies under different scenarios

- The least subsidy required is under Scenario 1 (Distributed Energy variant). It starts at 0.83 EUR/MWh in 2030, declines to 0.1 EUR/MWh in 2035, after which point, hydrogen users start subsidising natural gas ones. In 2050, natural gas users are underpaying 5.63 EUR/MWh.
- The Scenario 1 Global Ambition variant requires the second lowest subsidies. In 2030 it is at 0.8 EUR/MWh, declining to 0.01 EUR/MWh in 2037. Hydrogen users start paying natural gas users after this point, and natural gas users are underpaying by 0.59 EUR/MWh in 2040 and 3.2 EUR/MWh in 2050, when compared to the combined tariff.
- Under the Scenario 2 (2050 hydrogen tariff is applied throughout the years), the subsidy amount starts at 7.5 EUR/MWh it declines to 0.9 EUR/MWh in 2040, before declining to 0 EUR/MWh in 2050.
- Under the Scenario 3 (75% capital portion discount), the subsidy amount also starts at 7.5 EUR/MWh, 3.3 EUR/MWh in 2040 and 2.7 EUR/MWh. This is the Scenario with the highest subsidy amount needed, which does not reach 0 even in 2050.

Subsidies under Scenario 1 (GA and DE),2 and 3, 2030 to 2050 (EUR/MWh)



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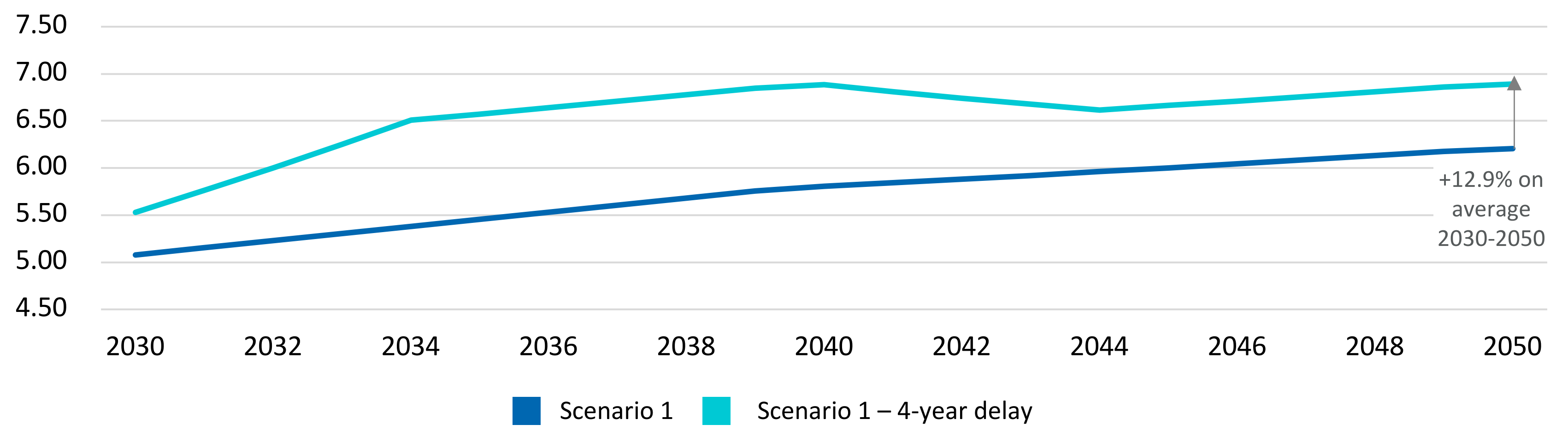
With a four-year delay, the tariff for Scenario 1 is 13% higher on average than under no delay

Results of Scenario 1 under the no flows delay and a four-year delay in flows (Global Ambition)

- With a four-year delay, the Global Ambition tariff increases significantly compared to the tariff with no delay. This is because the hydrogen network is in place from 2030 (i.e., the revenue is the same with or without the four-year delay), but the flows are significantly reduced at the beginning. They then reset every 10 years, 4 years later than in the base case scenario.
- The delayed tariff is 12.9% higher on average than the tariff in the central case, with a peak 17% difference in 2034 before declining to 10% difference in 2050.
- The decline in 2044 delayed tariff happens the allowed revenue is similar between 2040 and 2044, but the flows increase significantly from 754TWh/yr to 1093 TWh/yr.

Tariffs for Scenario 1 – comparison with a four-year delay, 2030 to 2050 (EUR/MWh)



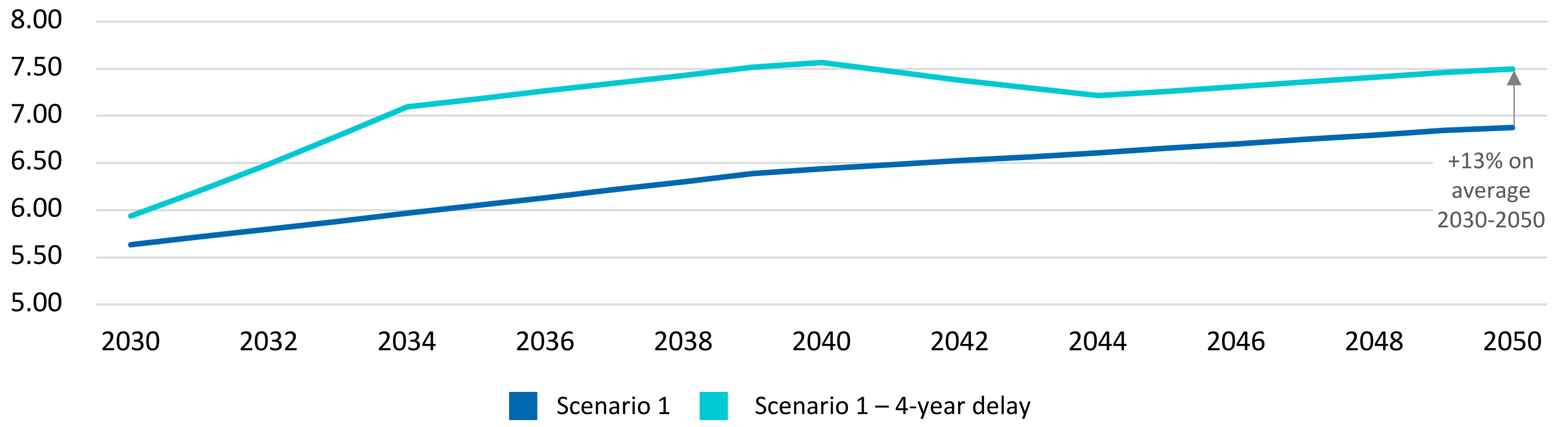
	2030	2034	2040	2044	2050
H2 flow growth (no delay) (TWh/y)	85	85	48	48	48
H2 flow growth (4-year delay) (TWh/y)	24	85	85	48	48
H2 flow volumes (no delay) (TWh/y)	246	585	1093	1286	1575
H2 flow volumes (4-year delay) (TWh/y)	142	246	754	1093	1382
H2 Revenue (no delay and with delay) EURm	2859	3907	5498	5939	6550

With a four-year delay, the tariff for Scenario 1 is 13% higher on average than under no delay

Results of Scenario 1 under the no flows delay and a four-year delay in flows (Distributed Energy)

- With a four-year delay, the tariff increases significantly compared to the tariff with no delay. This is because the hydrogen network is in place from 2030, but the flows are significantly reduced at the beginning. They then reset every 10 years, 4 years later than in the base case scenario.
- The delayed tariff is 13% higher on average than the tariff in the central case, with a peak 19% difference in 2034 and 2035
- The decline in 2044 delayed tariff is explained by the resetting of growth rate that year whilst the allowed revenue amount is the same.

Tariffs for Scenario 1 – comparison with a four-year delay, 2030 to 2050 (EUR/MWh)



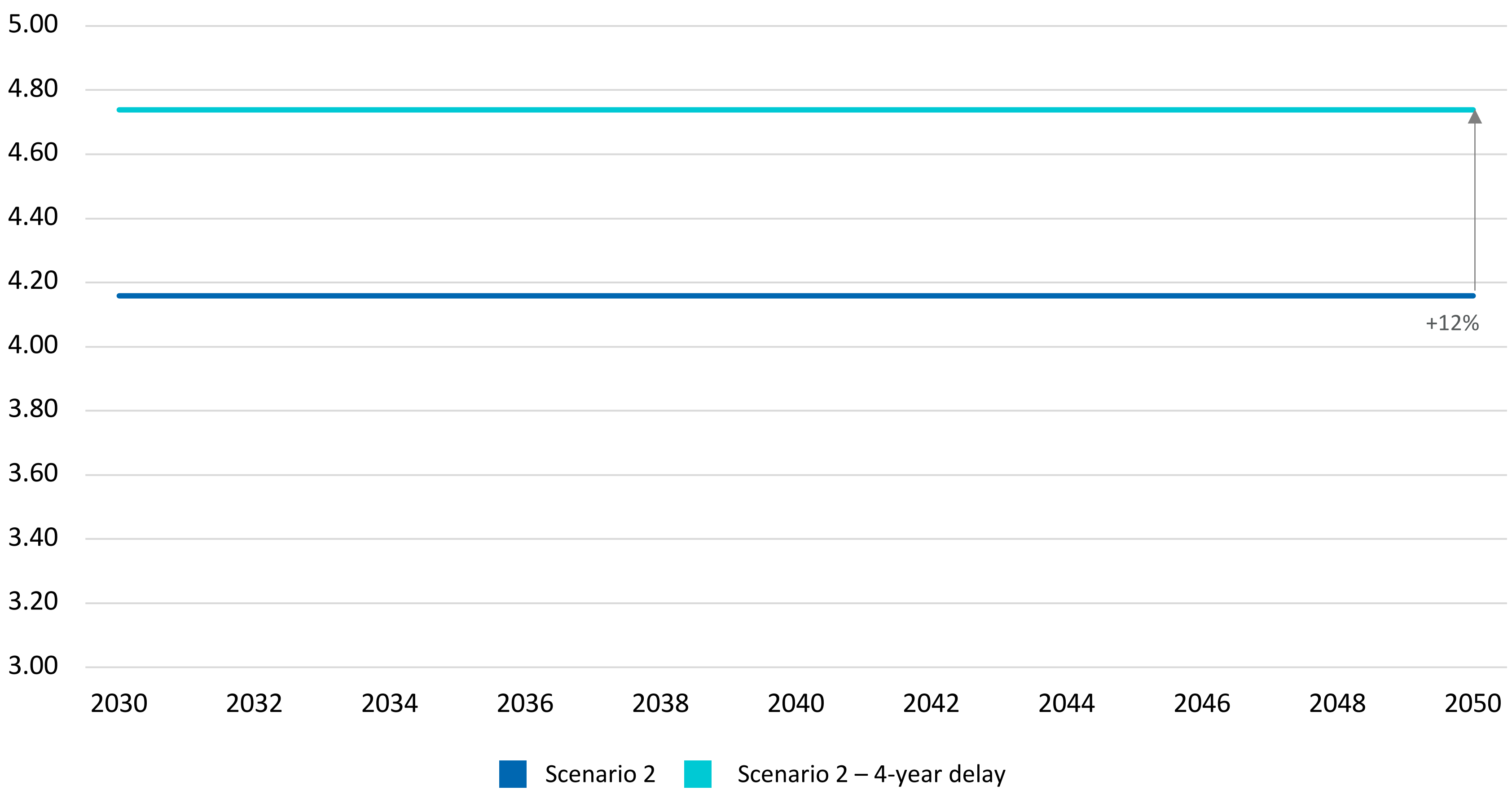
	2030	2034	2040	2044	2050
H2 flow growth (no delay) (TWh/y)	85	85	48	48	48
H2 flow growth (4-year delay) (TWh/y)	24	85	85	48	48
H2 flow volumes (no delay) (TWh/y)	246	585	1093	1286	1575
H2 flow volumes (4-year delay) (TWh/y)	142	246	754	1093	1382
H2 Revenue (no delay and with delay) EURm	2859	3907	5498	5939	6550

With a four-year delay, the tariff for the Scenario 2 is 12% higher than with no delay, due to less flows and the same amount of allowed revenue

Results of Scenario 2 under no flows delay and a four-year delay in flows

- With a four-year delay, the reduction of hydrogen flows causes the tariffs to increase significantly compared to the tariff with no delay.
- While normal Scenario 2 tariff is constant at 4.2 EUR/MWh, a delayed Scenario 2 tariff is 12% higher at 4.7 EUR/MWh.
- This is explained by the smaller amount of flow volumes compared to the same amount of allowed revenue as with the central case without a delay.

Tariffs for Scenario 2 – comparison with 4 year-delay, 2030 to 2050 (EUR/MWh)

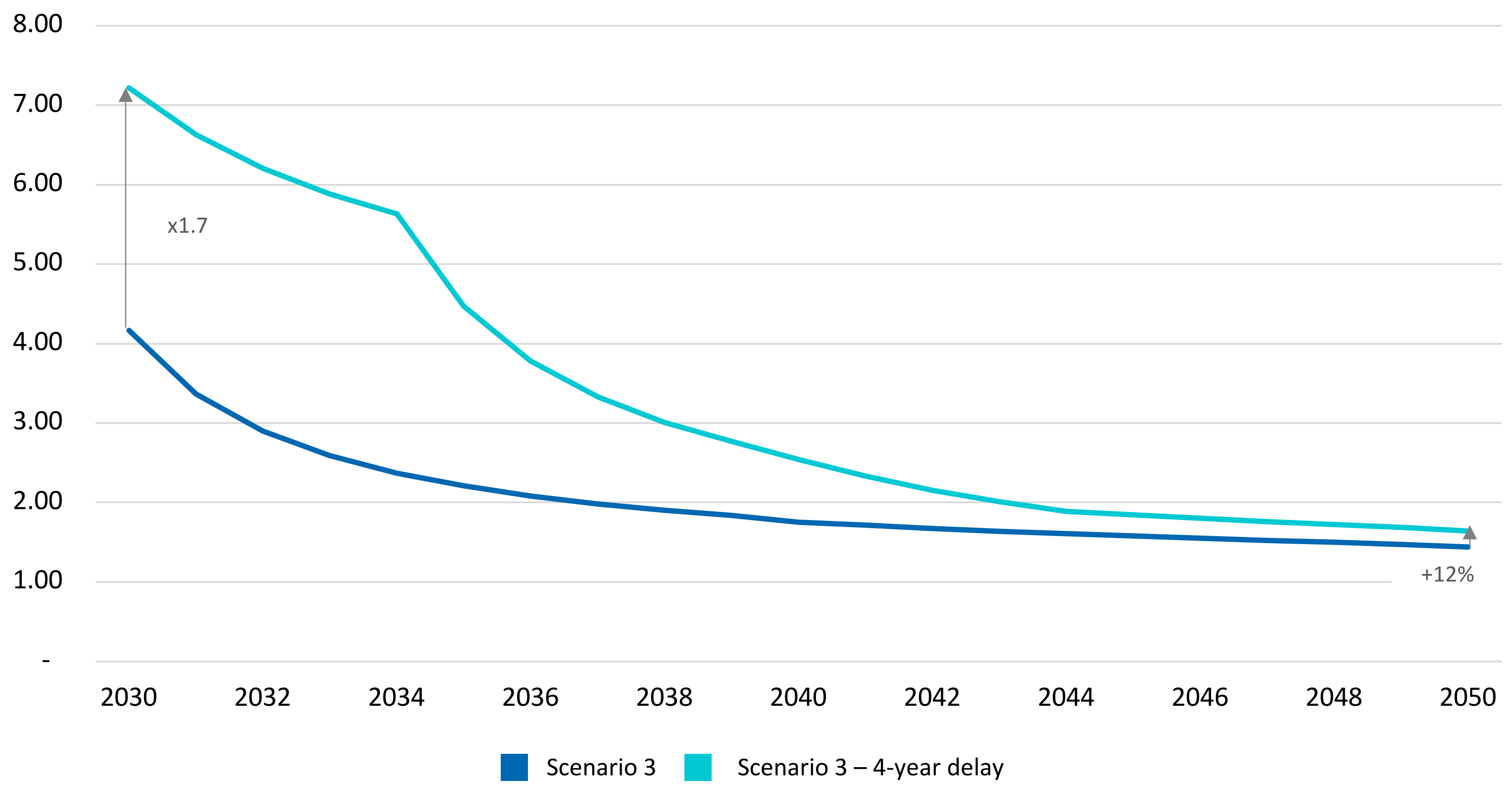


With a four-year delay, Scenario 3 tariff in 2030 is 1.7 times higher than with no-delay; from 2044, difference between the two is 12%

Results of Scenario 3 under no flows delay and a four-year delay in flows

- With a four-year delay, the reduction of hydrogen flows causes the tariffs to increase significantly compared to the tariff with no delay.
- Scenario 3 with a delay starts at a maximum of 7.2 EUR/MWh in 2030, equal to 1.7 times the no delay tariff.
- From 2030 to 2034 a significant drop in the four-year delay tariff is noticeable (-22%), due to hydrogen flows picking the speed of growth.
- There is a second peak in 2034, explained by the flow growth rate resetting in that year.
- The four-year delay tariff then gradually decreases at a slower rate, as flows increase, to reach 1.6 EUR/MWh in 2050, only 12% above the normal tariff.

Tariffs for Scenario 3 – comparison with 4 year-delay, 2030 to 2050 (EUR/MWh)



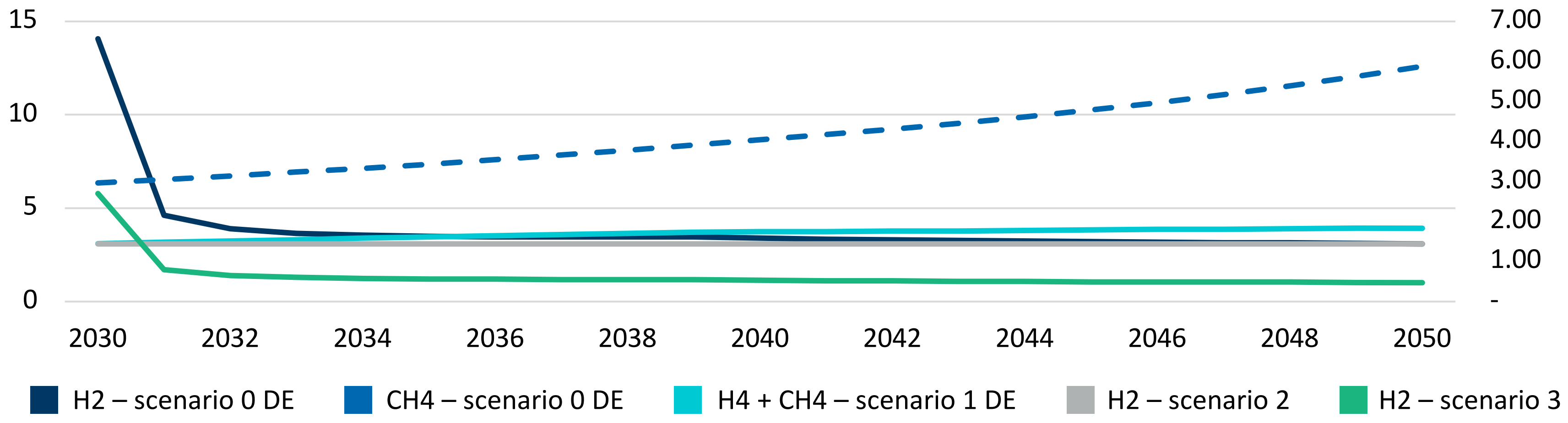
6. Country-level results

Spanish hydrogen-only tariff breaks even with methane-only tariff in 2031; H2 network is still two times smaller than CH4 network in 2050

Hydrogen and natural gas tariffs in Spain, 2030 - 2050

- Hydrogen only tariff under Scenario 0 break-even with the methane only tariff in 2031; hydrogen tariff under Scenario 2 and 3 remain inferior to methane only tariffs throughout all years.
- Scenario 3 tariff is the lowest of the Scenario 1-3 from 2031. The steep decline in tariffs 1 and 3 to 2032 is due to the increase in flows from a low base of 2TWh.
- Spain's hydrogen tariff starts high (14.07 EUR/MWh) as flows are small in relation to the allowed revenue, then rapidly decrease to reach 4.6 EUR/MWh in 2030.
- Assumptions for the calculation of Spanish tariffs are the following :
  - 5% WACC as determined by national energy regulator for gas TSOs;
  - Allowed revenue for hydrogen growing from 28 M€ in 2030 to 631 M€ in 2050 (+2154%) ;
  - Allowed revenue for methane ramps up from 485 M€ in 2030 to 515 M€ in 2040, then decreases back to 511 M€ in 2050 ;
  - Hydrogen network length is multiplied by 36 from 2030 to 2050 km ;
  - Methane network length decreases from 13,285 km in 2030 9,001 km in 2050 ;
  - In 2050, hydrogen network is still 1.9 times smaller than the methane Network.

Tariffs for Scenario 0, 1, 2 and 3 for methane and hydrogen 2030 to 2050 (EUR/MWh)



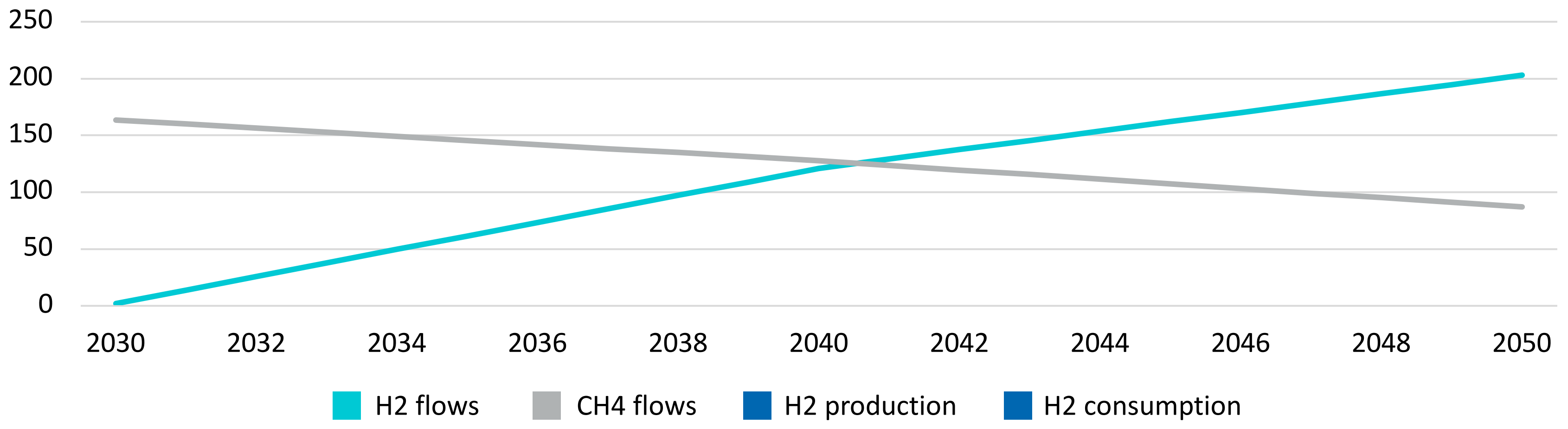
Item	Assumption		
	2030	2040	2050
Allowed revenue (H2)	28 M€	414 M€	631 M€
Allowed revenue (CH4 Distributed Energy)	485 M€	515 M€	511 M€
Network length (H2)	126 km	3,247 km	4,671 km
Network length (CH4 Distributed Energy)	13,285 km	11,337 km	9,001 Km
WACC (H2 and CH4)	5.00%		

Methane flows decrease by 47% between 2030 and 2050, crossing with hydrogen flows in 2040; Spain has a surplus of H2 throughout all years

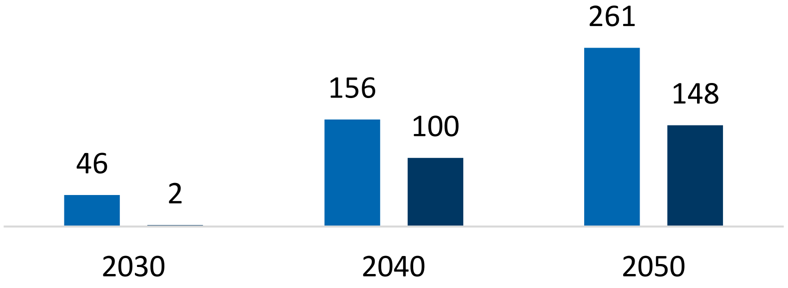
Hydrogen and natural gas flows in Spain, 2030 - 2050

- Under the ENTSOG Distributed Energy Scenario, methane flows decrease at a steady rate between 2030 and 2050 (-47% in total).
- Hydrogen flows increase from 2 TWh in 2030 to 203 TWh in 2050, and crosses with methane flows in 2040.
- Total hydrogen production develops strongly over 2030-2050 (+467%), although growing at a slower rate than hydrogen consumption (+7300%), leading to a surplus totaling 113 TWh in 2050 (x55 compared to 2030).
- Exports to other EU7 countries grows from 0 TWh in 2030, to 21 TWh in 2040 and 55 TWh in 2050.
- No transit flows go through Spain in 2030, but this changes in 2040 with 21TWh and 55TWh in 2050.

H2 and CH4 flows for the Distributed Energy Scenario, 2030 to 2050 (TWh/year)



H2 consumption and production (TWh/year)



H2 total flows (TWh/year)

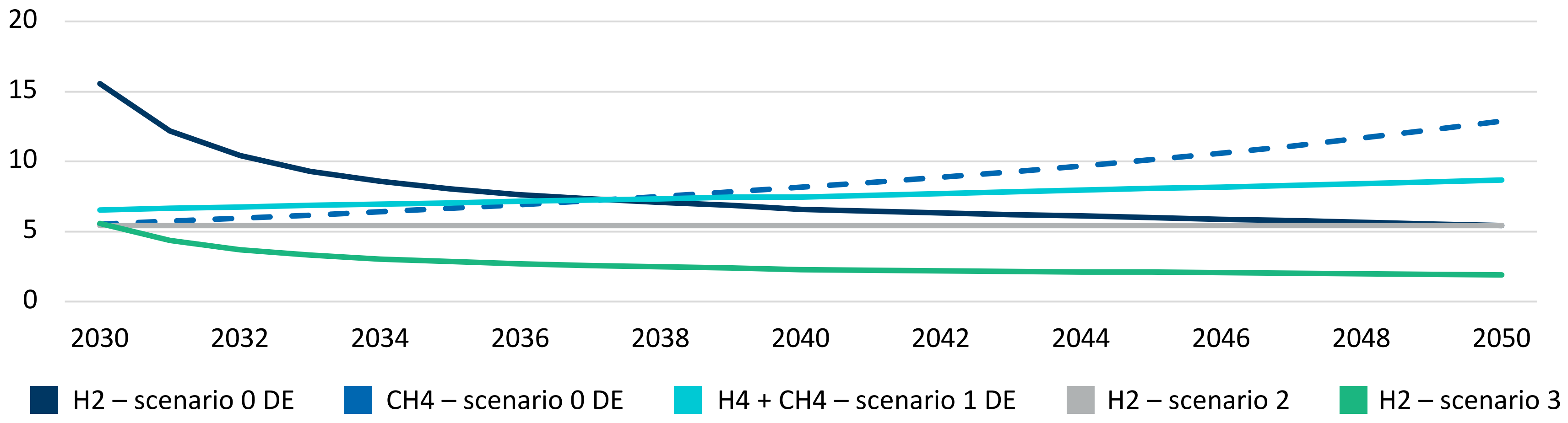
Item	Value		
	2030	2040	2050
National production consumed	2	100	148
Imported consumption flows	0	0	0
Transit flows	0	21	55
Total	2	121	203

French hydrogen-only tariff breaks even with methane-only tariff in 2038; hydrogen network is still 6 times smaller than the methane network in 2050

Hydrogen and natural gas tariffs in France, 2030 - 2050

- Hydrogen only tariff under Scenario 0 break-even with the methane only tariff in 2038.
- Scenario 3 tariff is the lowest of the Scenario 1-3 from 2031.
- France's hydrogen only tariff decreases at a rapid rate from 2030 to 2040 (-58%) ; reduction of tariff between 2040 and 2050 is less strong (-17%).
- Assumptions for the calculation of French tariffs are the following :
  - 6% WACC, as determined by national energy regulator for gas TSOs ;
  - Allowed revenue for H2 growing from 517 M€ in 2030 to 1,180 M€ in 2050 (+128%) ;
  - Allowed revenue for CH4 ramps up from 1,624 M€ in 2030 to 2,149€ in 2050 ;
  - H2 network length increases by 139% from 2,092 km in 2030 to 5,003 km in 2050 ;
  - CH4 network length decreases from 36,390 km in 2030 to 31,055 km in 2050.
- In 2050, H2 network is still 6 times smaller than the CH4 Network.

Tariffs for Scenario 0, 1, 2 and 3 for CH4 and H2 2030 to 2050 (EUR/MWh)



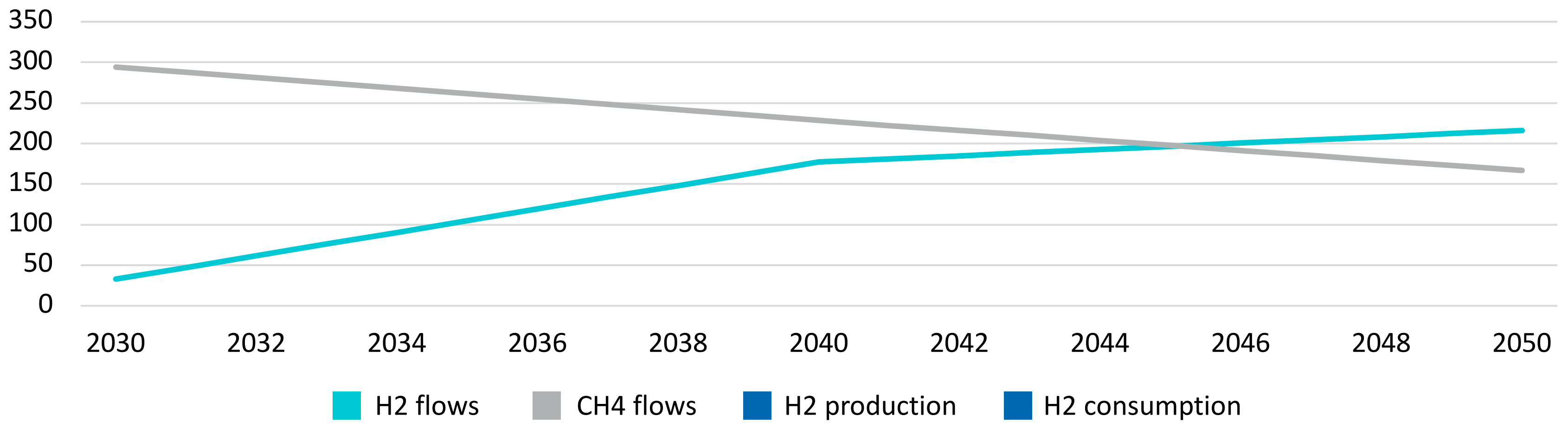
Item	Assumption		
	2030	2040	2050
Allowed revenue (H2)	517 M€	1,174 M€	1,180 M€
Allowed revenue (CH4 Distributed Energy)	1,624 M€	1,864 M€	2,149 M€
Network length (H2)	2,078 km	4,749 km	4,971 km
Network length (CH4 Distributed Energy)	36,390 km	33,540 km	31,055 km
WACC (H2 and CH4)	6.00%		

Methane flows decrease by 43% between 2030 and 2050, crossing with hydrogen flows in 2045; France has a surplus of H2 throughout all years

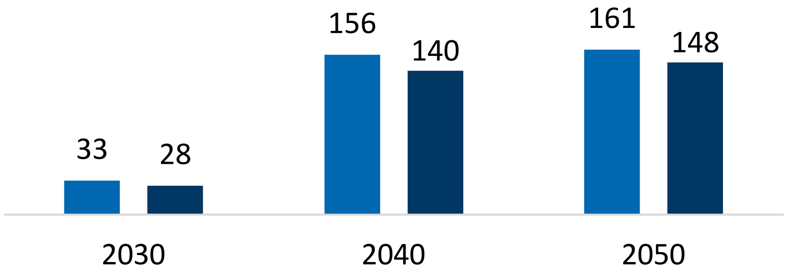
Hydrogen and natural gas flows in France, 2030 - 2050

- Under the Distributed Energy Scenario, methane flows decrease at a steady rate between 2030 and 2050 (-43% in total).
- Hydrogen flows ramp-up from 33 TWh in 2030 to 216 TWh in 2050, and crosses with methane flows in 2038.
- Total H2 production (+388%) rises higher, but with a slower rate, than H2 consumption (+429%), leading to a surplus, totaling 13 TWh in 2050 (x1,6 compared to 2030).
- Exports to other EU7 countries grows from 5 TWh in 2030, to 37 TWh in 2040 and 68 TWh in 2050 (x12,6 compared to 2030).
- 5 TWh of transit flows go through pipelines in France in 2030, 37 TWh in 2040 and 68TWh in 2050 – an increase of 13 times from the beginning.

H2 and CH4 flows for the Distributed Energy Scenario, 2030 to 2050 (TWh/year)



H2 consumption and production (TWh/year)



H2 total flows (TWh/year)

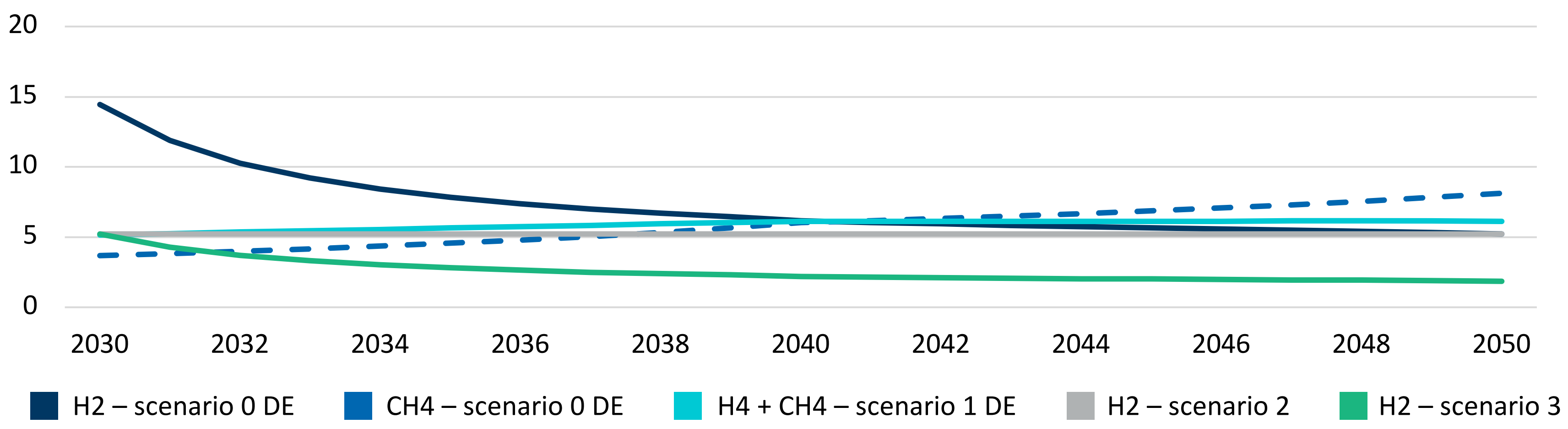
Item	Value		
	2030	2040	2050
National production consumed	28	140	148
Imported consumption flows	0	0	0
Transit flows	5	37	68
Total	33	177	216

German H2-only tariff breaks even with CH4-only tariff in 2041 ; H2 network doubles from 2030 to 2050, but is still 1.3 times smaller than CH4 network

Hydrogen and natural gas tariffs in Germany, 2030 - 2050

- H2 only tariffs under Scenario 0 break-even with the CH4 only tariff in 2041.
- Scenario 3 tariff is the lowest of the Scenario 1-3 from 2031.
- Germany's H2 only tariff decreases at a rapid rate from 2030 to 2040 (-57%) ; reduction of tariff between 2040 and 2050 is less strong (-15%)
- Assumptions for the calculation of German tariffs are the following:
  - 5% WACC, as determined by national energy regulator for gas TSOs ;
  - Allowed revenue for H2 growing from 1,300 M€ in 2030 to 2,637 M€ in 2050 (+103%) ;
  - Allowed revenue for CH4 decreases from 2,098 M€ in 2030 to 1,883 M€ in 2050 ;
  - H2 network length increases by 105% from 2030 (5,668 km) to 2050 (11,621) km ;
  - CH4 network length decreases from 27,394 km in 2030 to 15,723 km in 2050.
- In 2050, H2 network is only 1.3 times smaller than the CH4 Network.

Tariffs for Scenario 0, 1, 2 and 3 for CH4 and H2 2030 to 2050 (EUR/MWh)



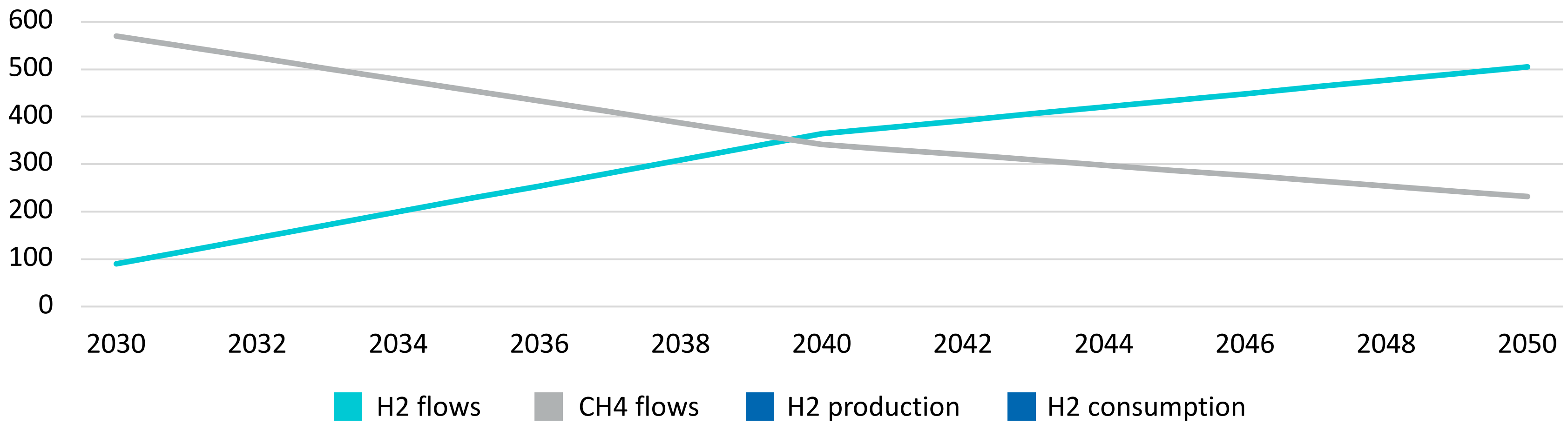
Item	Assumption		
	2030	2040	2050
Allowed revenue (H2)	1,300 M€	2,247 M€	2,637 M€
Allowed revenue (CH4 Distributed Energy)	2,098 M€	2,060 M€	1,883 M€
Network length (H2)	5,668 km	9,767 km	11,621 km
Network length (CH4 Distributed Energy)	27,394 km	21,534 km	15,723 km
WACC (H2 and CH4)	5.00%		

CH4 flows decrease by 59% between 2030 and 2050, crossing with H2 flows in 2039; Germany has the biggest deficit out of all EU7 countries

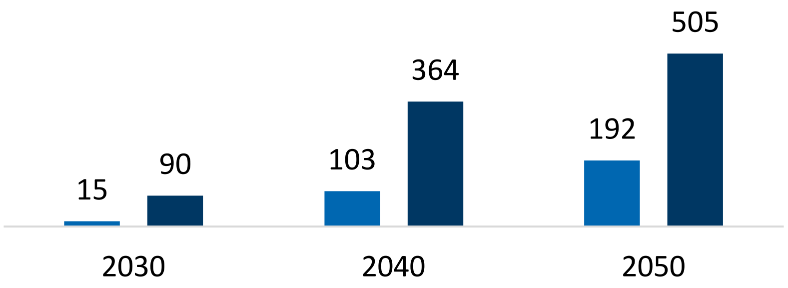
Hydrogen and natural gas flows in Germany, 2030 - 2050

- Under the Distributed Energy Scenario, CH4 flows decrease at a steady rate between 2030 and 2050 (-59% in total).
- H2 flows ramp-up from 90 TWh in 2030 to 505 TWh in 2050 (+461%), and break-even with CH4 flows in 2038.
- Total H2 consumption (+461%) rises higher, but with a slower rate, than H2 consumption (+1180%), leading to a deficit, totaling 313 TWh in 2050 (+317% compared to 2030).
- No flows transit through pipelines in Germany.

H2 and CH4 flows for the Distributed Energy Scenario, 2030 to 2050 (TWh/year)



H2 consumption and production (TWh/year)



H2 total flows (TWh/year)

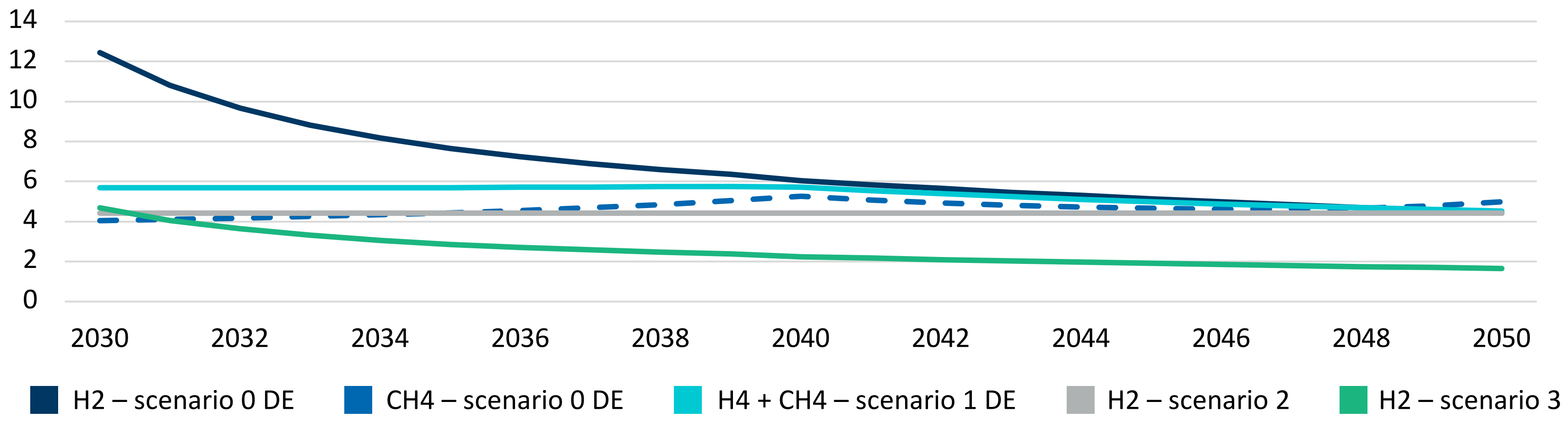
Item	Value		
	2030	2040	2050
National production consumed	15	103	192
Imported consumption flows	75	261	313
Transit flows	0	0	0
Total	90	364	505

Belgium's hydrogen only tariff breaks even with the natural only tariff in 2049; the H2 network surpasses the CH4 network in 2049

Hydrogen and natural gas tariffs in Belgium, 2030 - 2050

- H2 only tariffs under Scenario 0 break-even with the CH4 only tariff in 2049.
- Scenario 3 tariff is lower Scenario 1 and 2 tariffs from 2031.
- Belgium's H2 only tariff decreases at a rapid rate from 2030 to 2040 (-51%) ; reduction of tariff between 2040 and 2050 is less strong (-27%)
- Assumptions for the calculation of Belgium's tariffs are the following :
  - 4% WACC, as determined by national energy regulator for gas TSO (Fluxys Belgium) ;
  - Allowed revenue for H2 growing from 311 M€ in 2030 to 482 M€ in 2050 (+55%) ;
  - Allowed revenue for CH4 decreases from 411 M€ in 2030 to 118 M€ in 2050 ;
  - H2 network length increases by 59% from 2030 (1,575 km) to 2050 (2,508) km ;
  - CH4 network length decreases from 3,055 km in 2030 to 545 km in 2050 (-55%).
- In 2050, H2 network is 1.4 times bigger than the CH4 network. Length of H2 network surpasses length of CH4 network in 2037.

Tariffs for Scenario 0, 1, 2 and 3 for CH4 and H2 2030 to 2050 (EUR/MWh)



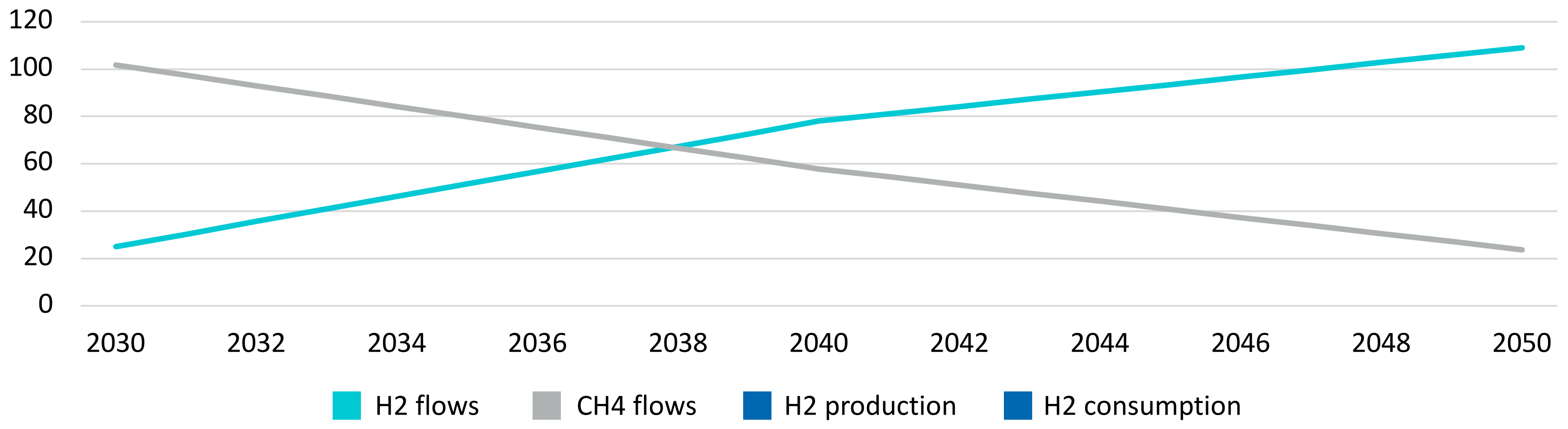
Item	Assumption		
	2030	2040	2050
Allowed revenue (H2)	311 M€	472 M€	482 M€
Allowed revenue (CH4 Distributed Energy)	411 M€	305 M€	118M€
Network length (H2)	1,575 km	2,388 km	2,508 km
Network length (CH4 Distributed Energy)	3,055 km	1,800 km	545 km
WACC (H2 and CH4)	4.00%		

CH4 flows decrease by 76% between 2030 and 2050, crossing with H2 flows in 2038; Belgium's H2 deficit grows as production declines in 2050

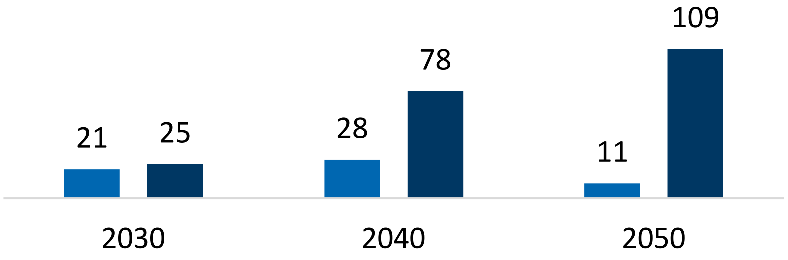
Hydrogen and natural gas flows in Belgium, 2030 - 2050

- Under the Distributed Energy Scenario, CH4 flows decrease at a steady rate between 2030 and 2050 (-76% in total).
- H2 flows ramp-up from 25 TWh in 2030 to 109 TWh in 2050 (+336%), and break-even with CH4 flows in 2037.
- While consumption of H2 grows steadily between 2030 and 2050 (+336%), production decreases from 2030 to 2050 (-48%), with a peak level in 2040.
- No flows transit through pipelines in Belgium.

H2 and CH4 flows for the Distributed Energy Scenario, 2030 to 2050 (TWh/year)



H2 consumption and production (TWh/year)



H2 total flows (TWh/year)

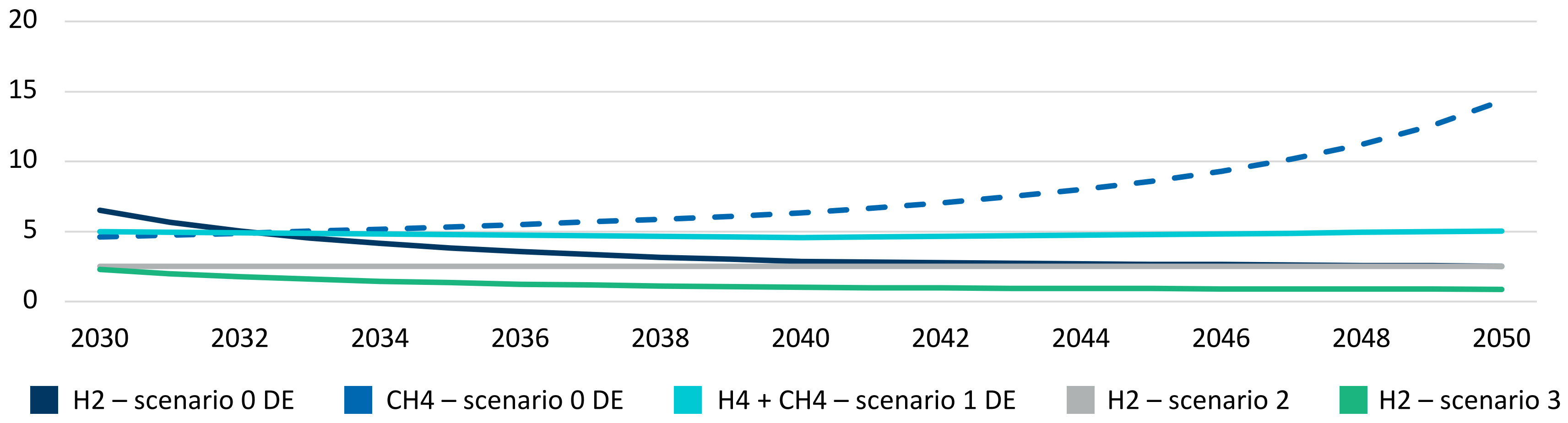
Item	Value		
	2030	2040	2050
National production consumed	21	28	11
Imported consumption flows	4	50	98
Transit flows	0	0	0
Total	25	78	109

The Netherlands' H2 tariff breaks-even with the CH4 only tariff in 2033; H2 network increases by 43% in 20 years but is still smaller than CH4 network

Hydrogen and natural gas tariffs in the Netherlands, 2030 - 2050

- H2 only tariffs under Scenario 0 break-even with the CH4 only tariff in 2033.
- Scenario 3 tariff is lower Scenario 1 and 2 tariffs from 2030.
- The Netherlands' H2 only tariff decreases at a rapid rate from 2030 to 2040 (-56%) ; reduction of tariff between 2040 and 2050 is less strong (-12%)
- Assumptions for the calculation of The Netherlands' tariffs are the following :
  - 4% WACC, as determined by national energy regulator for gas TSO (Gasunie Transport Services) ;
  - Allowed revenue for H2 growing from 332 M€ in 2030 to 503 M€ in 2050 (+48%) ;
  - Allowed revenue for CH4 decreases from 884 M€ in 2030 to 775 M€ in 2050 ;
  - H2 network length increases by 43% from 2030 (3,212 km) to 2050 (4,602) km ;
  - CH4 network length decreases from 10,435 km in 2030 to 5,847 km in 2050.
- In 2050, H2 network is 1.3 times smaller than the CH4 Network.

Tariffs for Scenario 0, 1, 2 and 3 for CH4 and H2 2030 to 2050 (EUR/MWh)



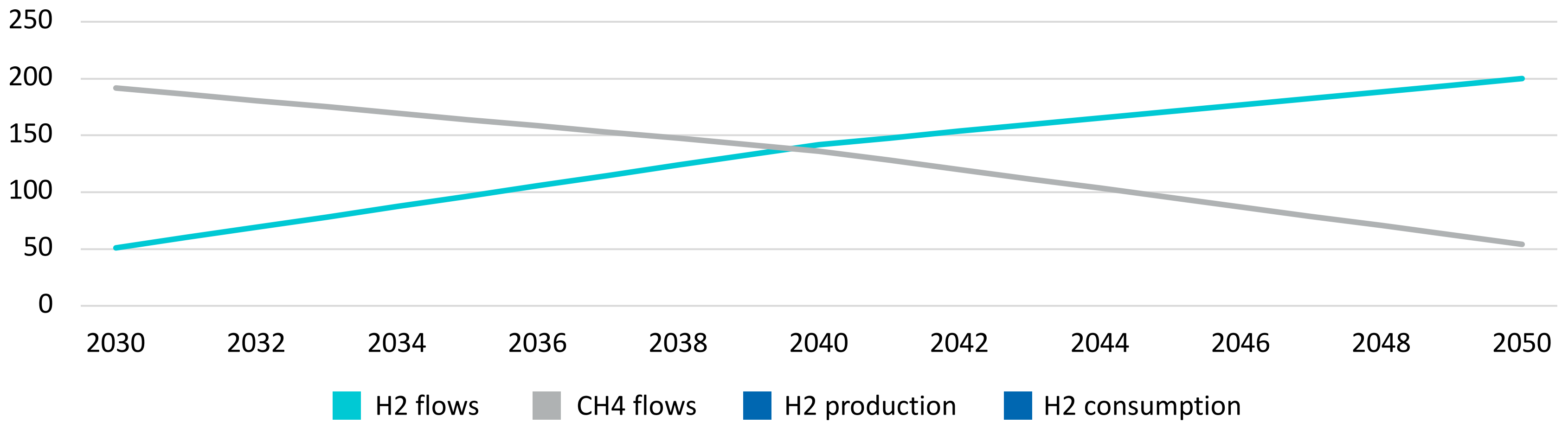
Item	Assumption		
	2030	2040	2050
Allowed revenue (H2)	332 M€	408 M€	503 M€
Allowed revenue (CH4 Distributed Energy)	884 M€	863 M€	775 M€
Network length (H2)	3,212 km	3,810 km	4,602 km
Network length (CH4 Distributed Energy)	10,435 km	8,148 km	5,847 km
WACC (H2 and CH4)	4.00%		

CH4 flows decrease by 71% in 20 years, crossing with H2 flows in 2040 ; consumptions grows at a slower rate than production, creating a surplus

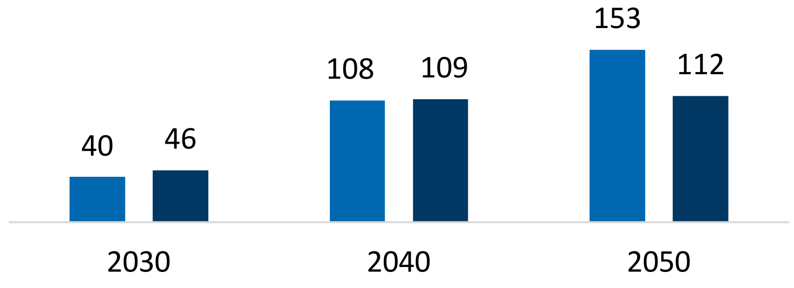
Hydrogen and natural gas flows in the Netherlands, 2030 - 2050

- Under the Distributed Energy Scenario, CH4 flows decrease at a steady rate between 2030 and 2050 (-71% in total).
- H2 flows ramp-up from 51 TWh in 2030 to 200 TWh in 2050 (+292%), and break-even with CH4 flows in 2036.
- Consumption of H2 (+148%) grows at a slower rate than production (+283%), leading to a surplus of 41 TWh in 2050.
- The Netherlands import 6 TWh in 2030 and 1 TWh in 2040 ; the country then exports all its surplus (41 TWh) in 2050.
- 5 TWh of H2 transit through the Netherlands in 2030, 33 TWh in 2040 and 47 TWh in 2050 (+840%).

H2 and CH4 flows for the Distributed Energy Scenario, 2030 to 2050 (TWh/year)



H2 consumption and production (TWh/year)



H2 total flows (TWh/year)

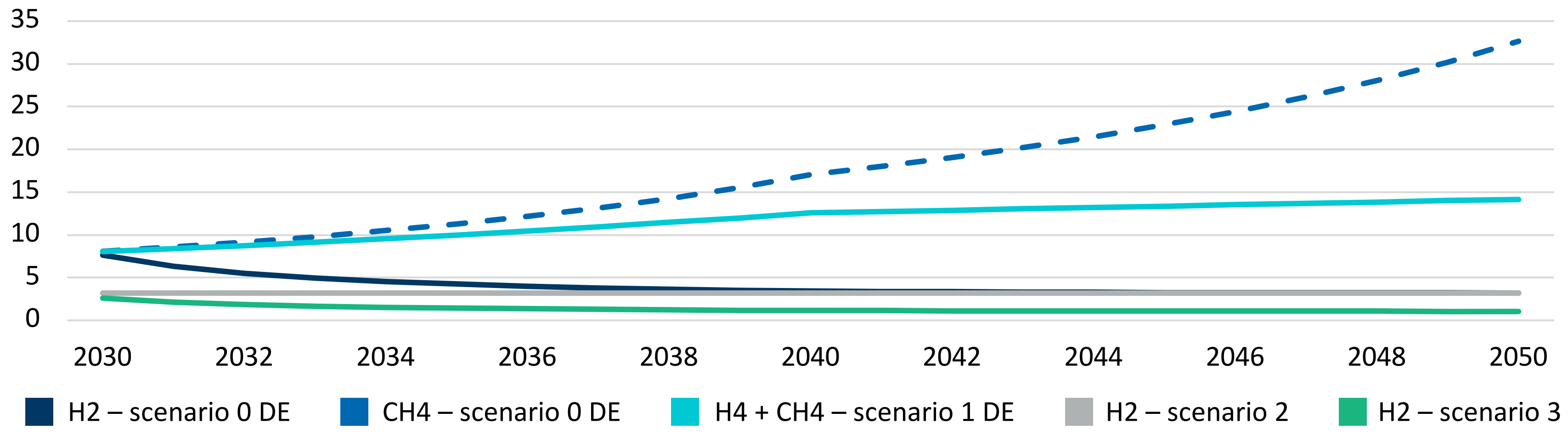
Item	Value		
	2030	2040	2050
National production consumed	40	109	112
Imported consumption flows	6	1	0
Transit flows	5	33	88
Total	51	143	200

Italian H2 only tariff breaks even with NG only tariff in 2030 ; H2 network is multiplied by 3 in 20 years, but is still 7 times smaller than CH4 network

Hydrogen and natural gas tariffs in Italy, 2030 - 2050

- H2 only tariffs under Scenario 0 break-even with the CH4 only tariff in 2030.
- Scenario 3 tariff is lower Scenario 1 and 2 tariffs from 2030.
- Italy's H2 only tariff decreases at a rapid rate from 2030 to 2040 (-55%) ; reduction of tariff between 2040 and 2050 is less strong (-7%)
- Assumptions for the calculation of Italy's tariffs are the following :
  - 6% WACC, as determined by national energy regulator for gas TSO (Snam) ;
  - Allowed revenue for H2 growing from 175 M€ in 2030 to 596 M€ in 2050 (+239%) ;
  - Allowed revenue for CH4 increases from 2,609 M€ in 2030 to 3,609 M€ in 2050 ;
  - H2 network length increases by 197% from 2030 (1,449 km) to 2050 (4,303) km ;
  - CH4 network length decreases from 33,522 km in 2030 to 29,937 km in 2050 (-12%).
- In 2050, H2 network is still 7 times smaller than the CH4 Network.

Tariffs for Scenario 0, 1, 2 and 3 for CH4 and H2 2030 to 2050 (EUR/MWh)



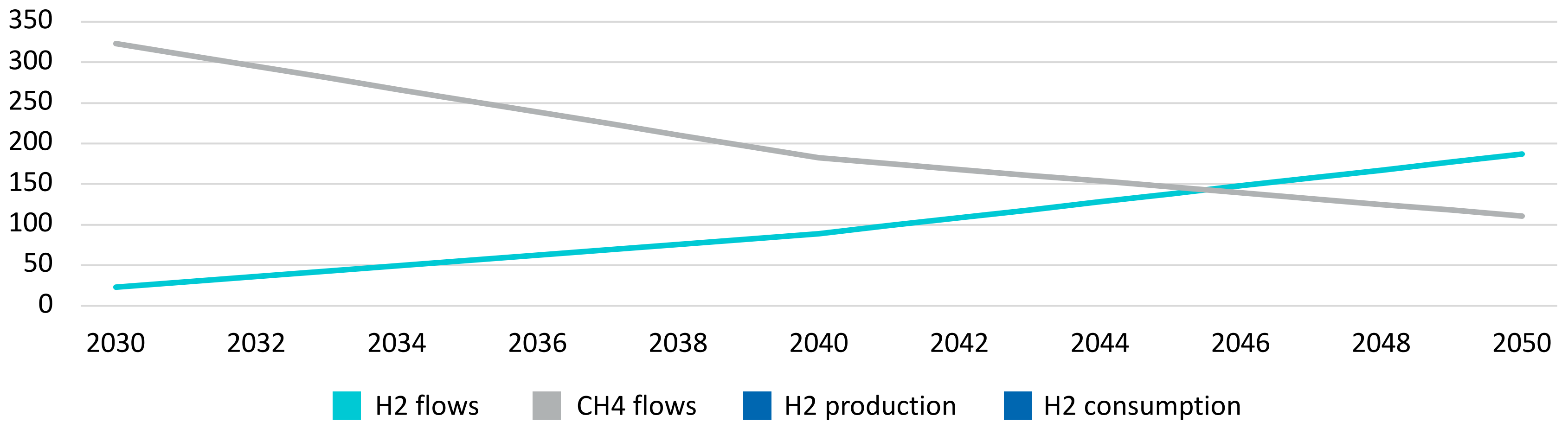
Item	Assumption		
	2030	2040	2050
Allowed revenue (H2)	175 M€	307 M€	596 M€
Allowed revenue (CH4 Distributed Energy)	2,609 M€	3,108 M€	3,609 M€
Network length (H2)	1,449 km	2,388 km	4,303 km
Network length (CH4 Distributed Energy)	33,522 km	32,089 km	29,937 km
WACC (H2 and CH4)	6.00%		

CH4 flows decrease by 65% between 2030 and 2050, crossing with H2 flows in 2042; Italy has a deficit of H2 throughout all years

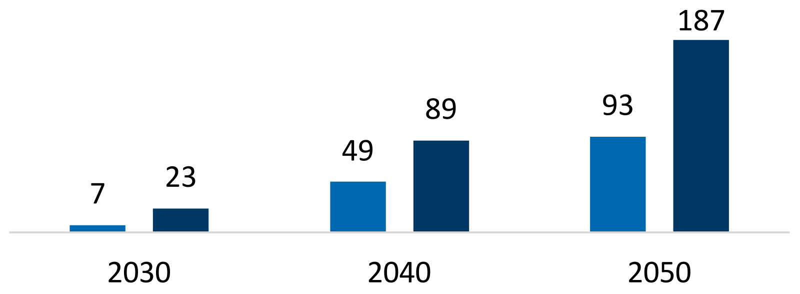
Hydrogen and natural gas flows in Italy, 2030 - 2050

- Under the Distributed Energy Scenario, CH4 flows decrease at a steady rate between 2030 and 2050 (-65% in total).
- H2 flows ramp-up from 23 TWh in 2030 to 187 TWh in 2050 (+713%), and break-even with CH4 flows in 2043.
- While consumption and production of H2 grow steadily between 2030 and 2050 (+713% for consumption +840% for production), the deficit increases due to a lower starting point for production (7 TWh vs. 32 TWh), reaching 94 TWh in 2050.
- No flows transit directly through pipelines in Italy. North African countries are not called to export to the EU7 besides Italy, as large surpluses are available in closer sources.

H2 and CH4 flows for the Distributed Energy Scenario, 2030 to 2050 (TWh/year)



H2 consumption and production (TWh/year)



H2 total flows (TWh/year)

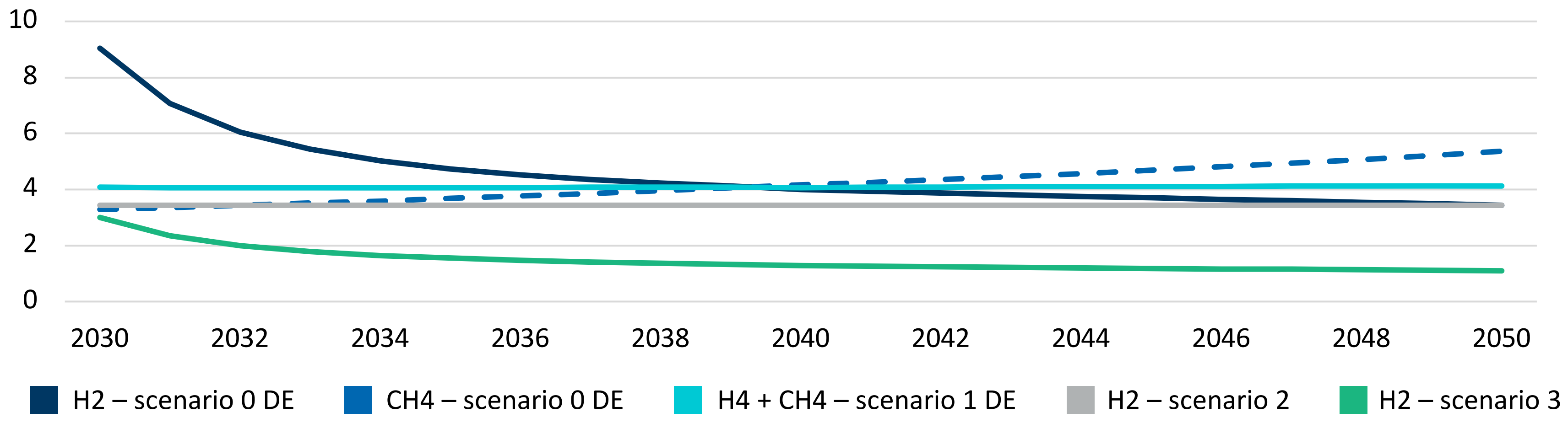
Item	Value		
	2030	2040	2050
National production consumed	7	49	93
Imported consumption flows	16	40	94
Transit flows	0	0	0
Total	23	89	187

Polish H2 only tariff breaks even with NG only tariff in 2039 ; H2 network doubles from 2030 to 2050, but is still 1.7 times smaller than CH4 network

Hydrogen and natural gas tariffs in Poland, 2030 - 2050

- H2 only tariffs under Scenario 0 break-even with the CH4 only tariff in 2039.
- Scenario 3 tariff is lower Scenario 1 and 2 tariffs from 2030.
- Poland's H2 only tariff decreases at a rapid rate from 2030 to 2040 (-56%) ; reduction of tariff between 2040 and 2050 is less strong (-14%)
- Assumptions for the calculation of Poland's tariffs are the following:
  - 7% WACC, as determined by national energy regulator for gas TSO (Gaz System) ;
  - Allowed revenue for H2 growing from 199 M€ in 2030 to 533 M€ in 2050 (+168%) ;
  - Allowed revenue for CH4 slowly increases from 454 M€ in 2030 to 462 M€ in 2050 (+2%) ;
  - H2 network length increases from 1,449 km in 2030 to 4,303 km in 2050 ;
  - CH4 network length decreases from 10,780 km in 2030 to 7,302 km in 2050.
- In 2050, H2 network is 1.7 times bigger than the CH4 Network.

Tariffs for Scenario 0, 1, 2 and 3 for CH4 and H2 2030 to 2050 (EUR/MWh)



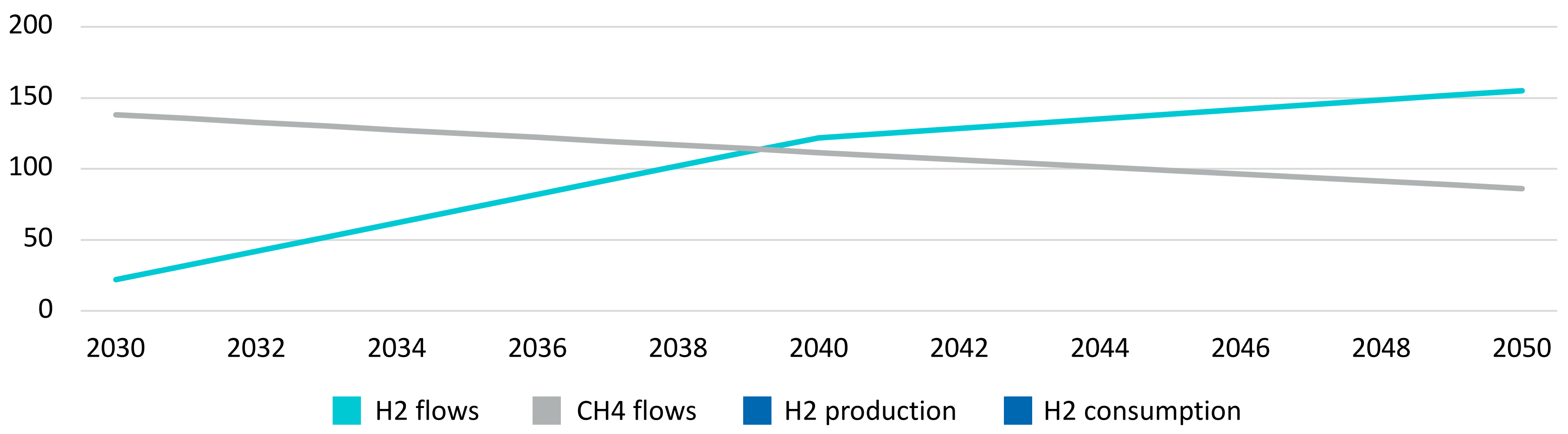
Item	Assumption		
	2030	2040	2050
Allowed revenue (H2)	199M€	487 M€	533 M€
Allowed revenue (CH4 Distributed Energy)	454 M€	463 M€	462 M€
Network length (H2)	1,449 km	2,388 km	4,303 km
Network length (CH4 Distributed Energy)	10,780 km	8,816 km	7,032 km
WACC (H2 and CH4)	7.00%		

CH4 flows decrease by 37% between 2030 and 2050, crossing with H2 flows in 2039; growth in H2 production helps reduce long-lasting H2 deficit

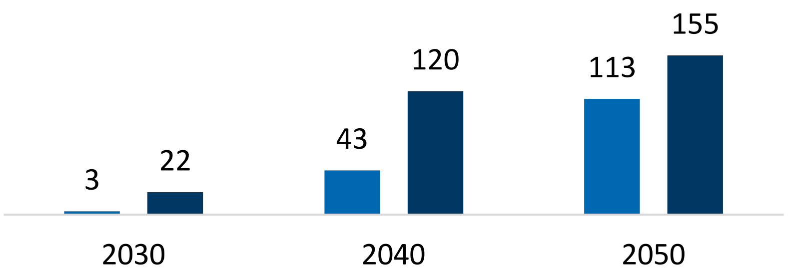
Hydrogen and natural gas flows in Poland, 2030 - 2050

- Under the Distributed Energy Scenario, CH4 flows decrease at a steady rate between 2030 and 2050 (-37% in total).
- H2 flows ramp-up from 22 TWh in 2030 to 155 TWh in 2050 (+605%), and break-even with CH4 flows in 2039.
- Consumption (+605%) and production (+3367%) of H2 grow steadily between 2030 and 2050, and the gaps between the two closes between 2040 and 2050.
- National deficit grows from 2030 to 2040 (+305%), then reduces to 42 TWh in 2050 (-45%) as production is multiplied by nearly 3x.
- 2 TWh of flows transit through Polish pipelines in 2040. This is due to Germany importing H2 from Latvia in 2040 only ; in 2030 and 2050, closer sources provide the needed H2.

H2 and CH4 flows for the Distributed Energy Scenario, 2030 to 2050 (TWh/year)



H2 consumption and production (TWh/year)



H2 total flows (TWh/year)

Item	Value		
	2030	2040	2050
National production consumed	3	43	113
Imported consumption flows	19	77	42
Transit flows	0	2	0
Total	22	122	155

7. Cross border implications

The share of transit flows in total hydrogen flows differ strongly between countries, with three countries not affected by transit flows

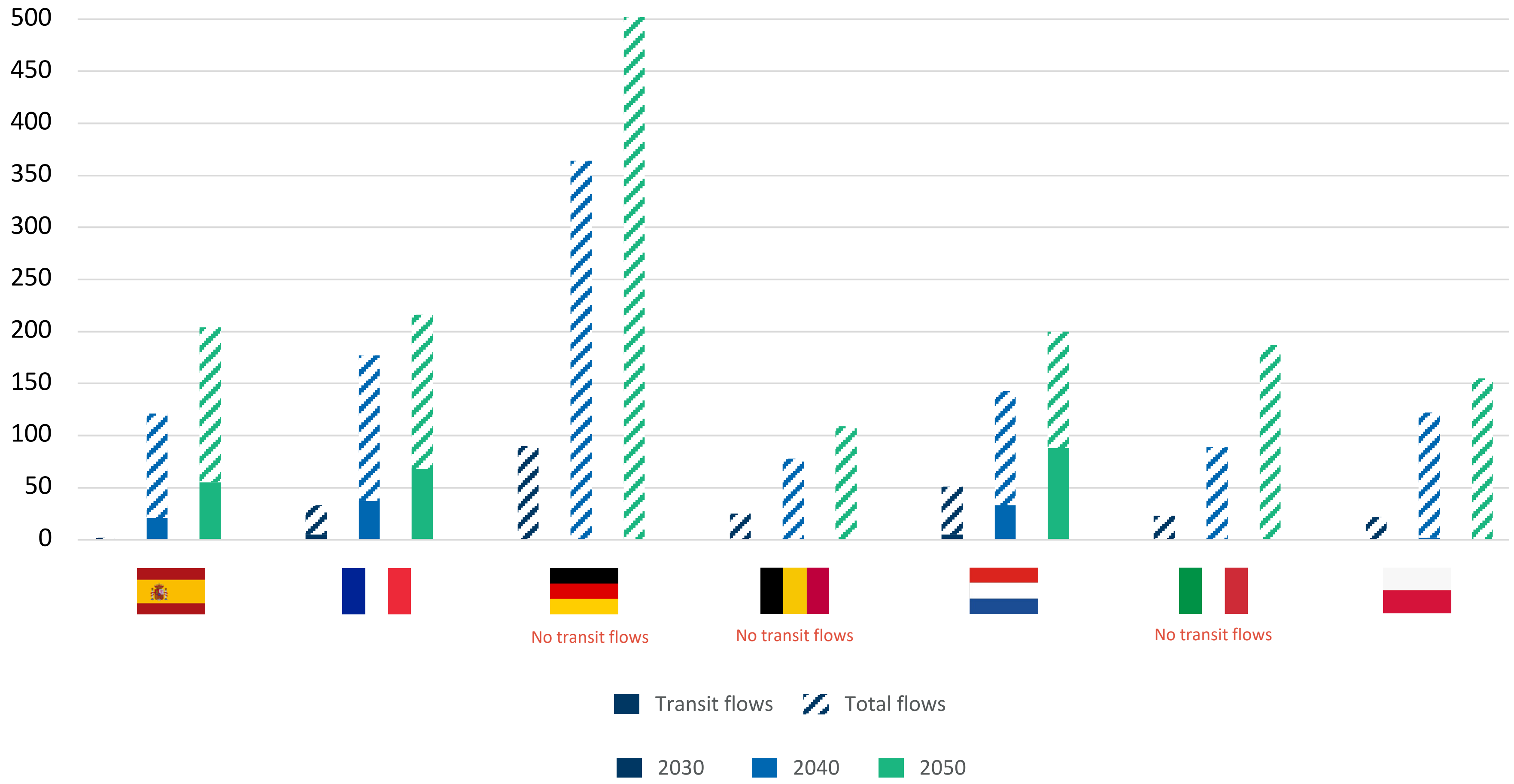
Share of H2 transit flows in total H2 flows for EU7 countries

- Out of the seven countries in our scope, only four countries have transit flows (Spain, France, Poland and the Netherlands).
- In 2050, the Netherlands is the country with the highest transit flows, both in absolute values and share. It is also the country with the highest combined flows for 2030, 2040 and 2050.

Share of transit flows in total H2 flows (%)

Share (%)	2030	2040	2050
Spain	0%	17%	27%
France	15%	21%	31%
Germany	0%	0%	0%
Belgium	0%	0%	0%
Netherlands	10%	23%	44%
Italy	0%	0%	0%
Poland	0%	2%	0%
Total	**4%**	**9%**	**13%**

H2 transit flows as a share of total flows for EU7 countries, 2030 to 2050 (TWh/year)

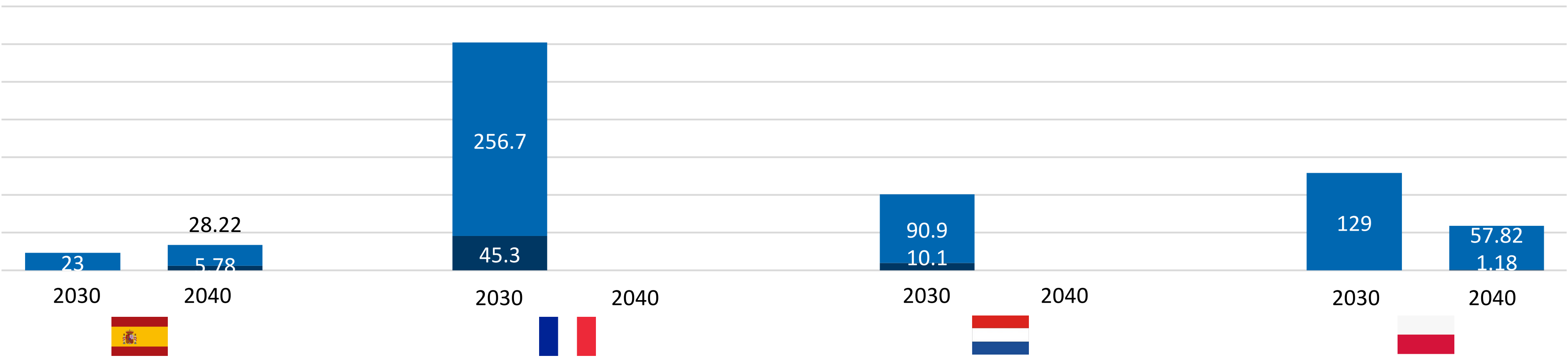


In Scenario 1 (Global Ambition), CH4 users subsidize transit flows to Germany, in France and the Netherlands in 2030 by 0.05-0.15 €/MWh

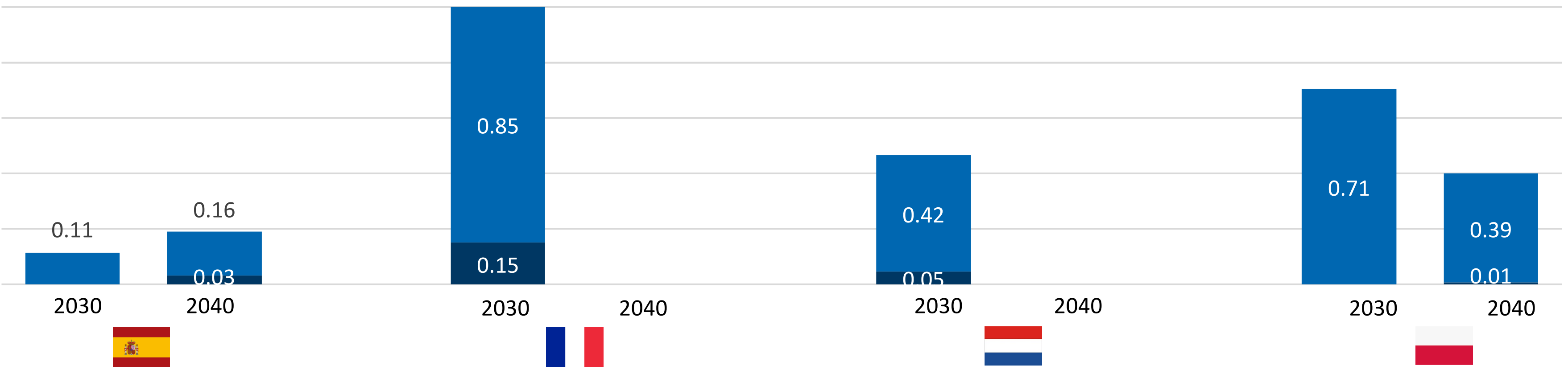
Share of CH4 subsidy under Scenario 1 (Global Ambition) paid for transit flows

- The share of the subsidy paid for transit flows is calculated by multiplying the amount of subsidy paid by CH4 users with the share of transit of flows in total flows for each country.
- In 2030, out of the 6 countries in which CH4 users pay a subsidy to H2 users (all countries except Italy), only two countries are affected by transit flows: France and the Netherlands.
- In all EU7, the amount paid for by CH4 users because of transit flows is equal to 76.7 M EUR in 2030.
- After 2040, in countries for which there are transit flows, CH4 users pay a subsidy to H2 users only in Spain and Poland.
- In 2050, CH4 users do not pay a subsidy on transit flows in any country.

Share of subsidy by CH4 users paid for transit flows, 2030 (M EUR /year)



Share of subsidy by CH4 users paid for transit flows, 2030 (EUR /MWh)



Subsidy paid by CH4 users on transit flows

Subsidy paid by CH4 users on other flows

In Scenario 1 (Distributed Energy), CH4 users subsidize transit flows to Germany in the Netherlands in 2030 by 0.30 €/MWh

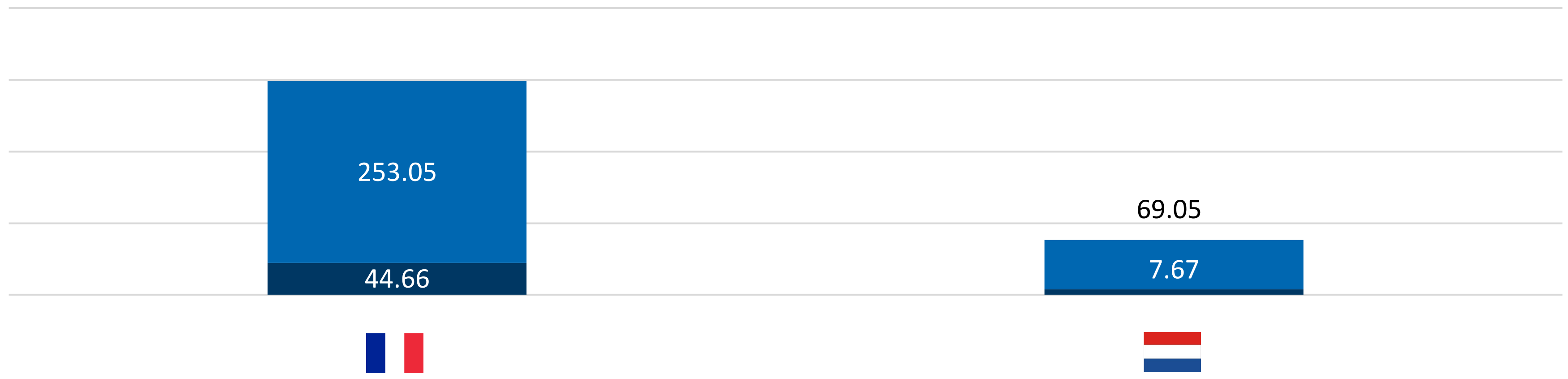
Share of CH4 subsidy under Scenario 1 (Distributed Energy) paid for transit flows

- The share of the subsidy paid for transit flows is calculated by multiplying the amount of subsidy paid by CH4 users with the share of transit of flows in total flows for each country.
- In 2030, out of the 6 countries in which CH4 users pay a subsidy to H2 users (all countries except Italy), only two countries have transit flows: France and the Netherlands.
- In France, CH4 users pay 298 M EUR of subsidy to H2 users in 2030, out of which pro-rata 15% (44.7 M EUR) is paid to cover transit flows.
- In the Netherlands, CH4 users pay 77 M EUR of subsidy to H2 users in 2030, out of which pro-rata 10% (7.7 M EUR) is paid to cover transit flows.
- After 2040, in countries for which there are transit flows (Spain, France, the Netherlands and Poland), CH4 users do not pay a subsidy to H2 users, but rather receive a subsidy. Therefore, in 2040 and 2050, CH4 users do not pay a subsidy on transit flows.

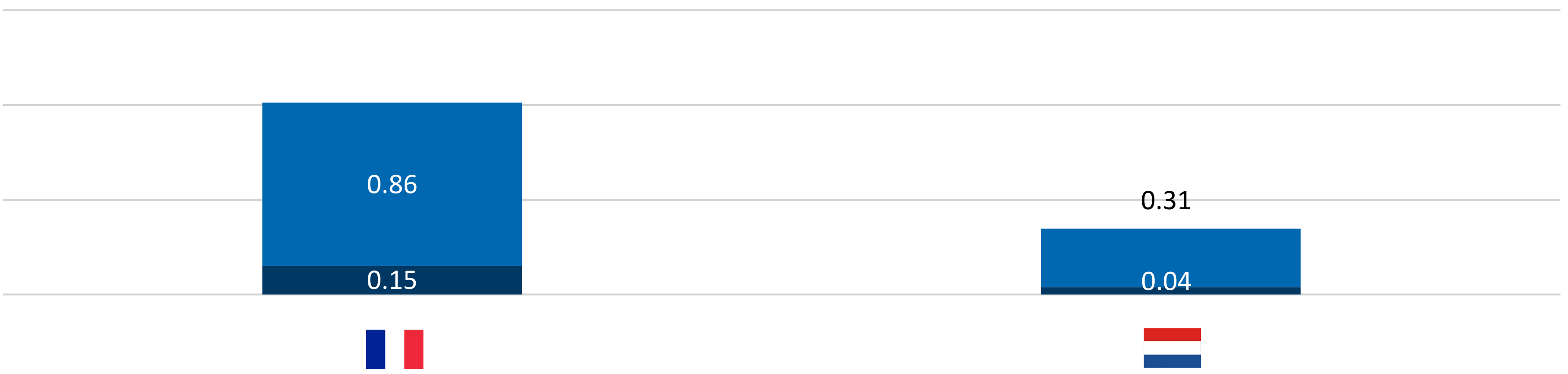
Subsidy paid by CH4 users on transit flows

Subsidy paid by CH4 users on other flows

Share of subsidy by CH4 users paid for transit flows, 2030-40 (M EUR /year)



Share of subsidy by CH4 users paid for transit flows, 2030-40 (EUR /MWh)

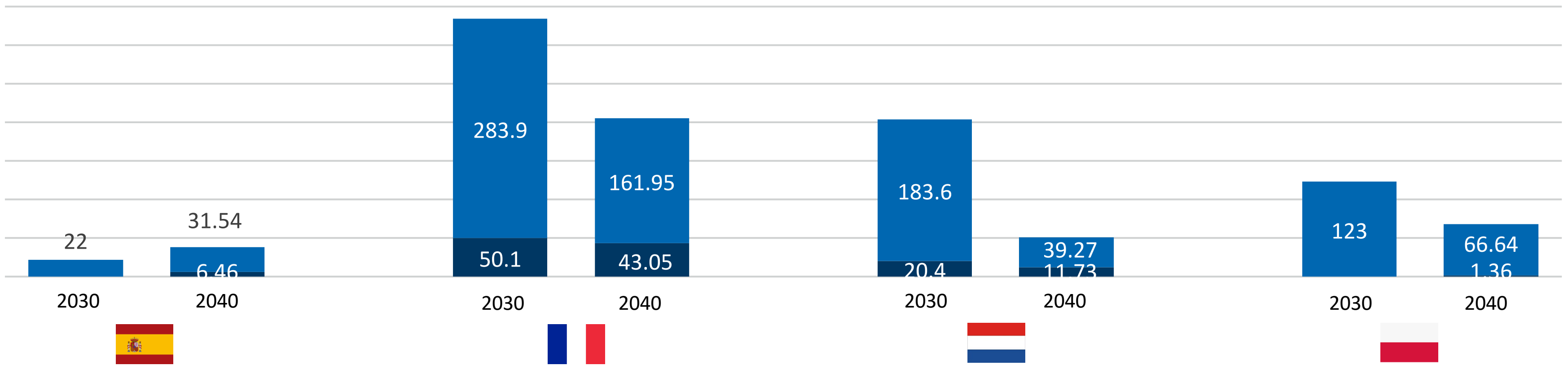


In 2030 and 2040 under Scenario 2, taxpayers support a subsidy on transit flows in 4 countries ; in 2050, no subsidy is paid

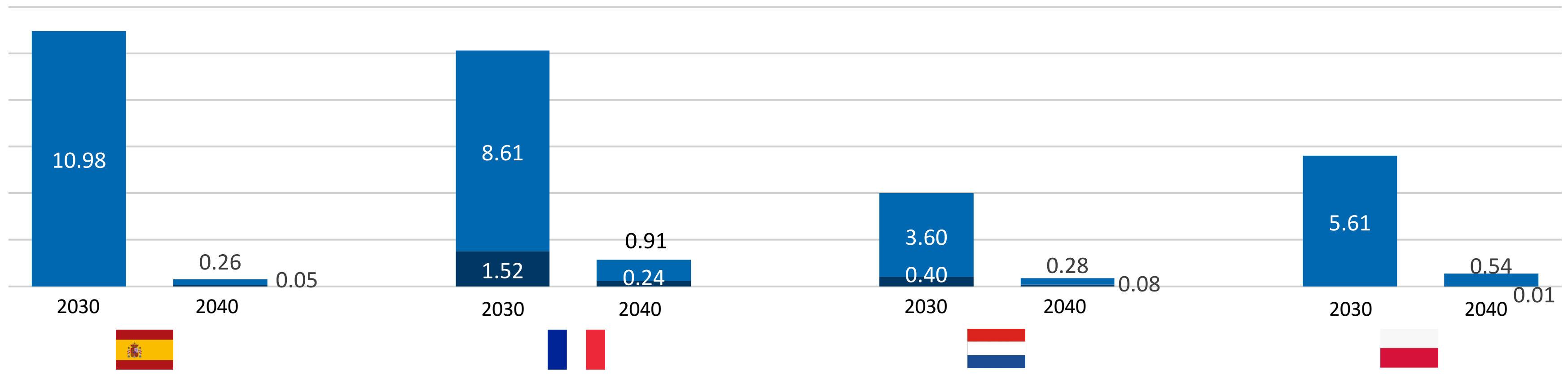
Share of subsidy under Scenario 2 paid for transit flows – Same for Global Ambition and Distributed Energy

- The share of the subsidy paid for transit flows is calculated by multiplying the amount of subsidy paid by taxpayers with the share of transit of flows in total flows for each country.
- Only four countries pay subsidies for transit flows, namely Spain, France, the Netherlands and Poland in 2030 and 2040.
- France pays the largest amount of transit subsidies, amounting up to 50 M EUR in 2030.
- There are no subsidies for transit flows in 2050 because by this point no subsidy is needed under Scenario 2.

Share of subsidy by CH4 users paid for transit flows, 2030 (M EUR /year)



Share of subsidy by CH4 users paid for transit flows, 2030 (EUR /MWh)



Subsidy paid by taxpayers on transit flows

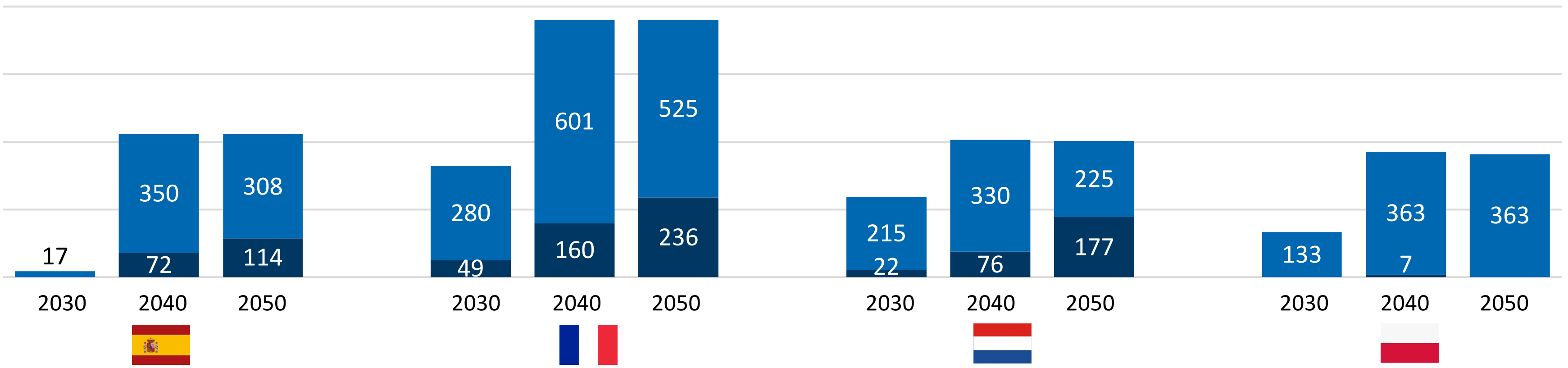
Subsidy paid by taxpayers on other flows

Under Scenario 3, taxpayers pay subsidies on transit flows in four countries – ES, FR, NL and PL – from 2030 to 2050

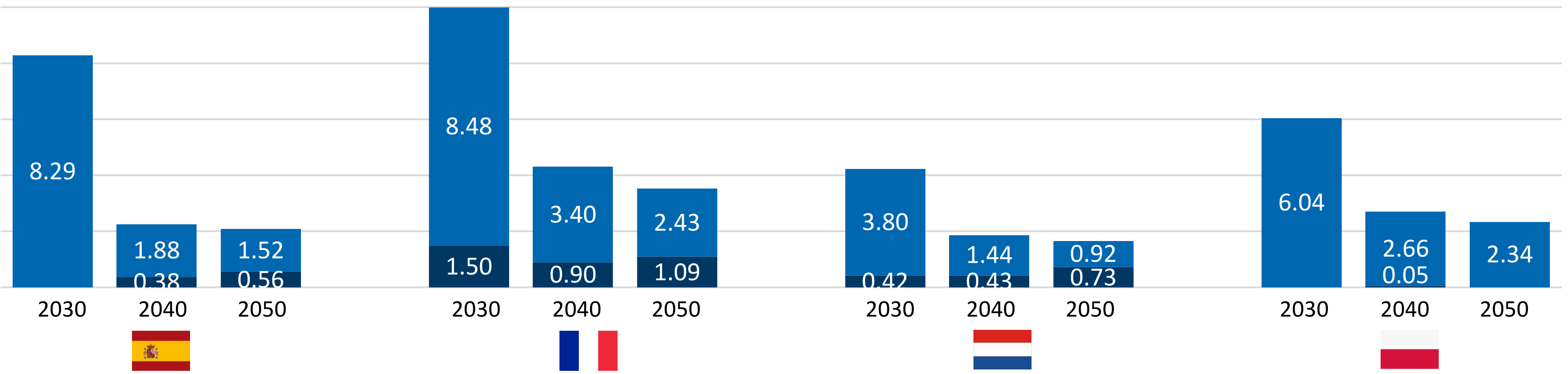
Share of subsidy under Scenario 3 paid for transit flows – Same for Global Ambition and Distributed Energy

- The share of the subsidy paid for transit flows is calculated by multiplying the amount of subsidy paid by taxpayers with the share of transit of flows in total flows for each country.
- Only four countries pay subsidies for transit flows, namely Spain, France, the Netherlands and Poland in 2030, 2040 and 2040.
- France pays the largest amount of transit subsidies, amounting up to 236 M EUR in 2040.

Share of subsidy paid for transit flows, 2030 to 2040 (M EUR /year)



Share of subsidy paid for transit flows, 2030 to 2040 (EUR /MWh)



Subsidy paid by taxpayers on transit flows

Subsidy paid by taxpayers on other flows

Appendix: Assumptions

Appendix

Our natural gas flows assumptions are based on national TSOs and ENTSOG information, assuming linear annual growth

Natural gas transportation network flows assumptions

Starting point flows	▪ We source natural gas flows from the national Transmission System Operators at seven countries in our scope (Italy, Spain, France, Germany, the Netherlands, Belgium and Poland). The TSO data is for 2019. We assume that these flows is our starting point in each of the countries. Our starting point for the modelling is in 2024 to allow for some building-up of the network as well as flows before 2030.
Development of flows	▪ For the years 2030, 2040 and 2050, we source our data from ENTSOG 10-year network development plan. We used two Scenarios estimating the future natural gas flows in 2030, 40 and 50: — ENTSOG Distributed Energy scenario and — ENTSOG Global Ambition Scenario (this Scenario is our base case, because it assumes centralized energy transition initiated at European/ international level. ▪ The growth rate of natural gas flows between these periods is linear. The same amount is added each year to the previous years closing balance. The growth rate resets every 10 years.

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Our hydrogen flows assumptions are largely based EHB demand and supply information and distances between the capital cities

Hydrogen transportation network flows assumptions

Hydrogen supply/ demand	▪ We source the supply, demand and the balance (surplus or deficit) from the European Hydrogen Backbone report for the years 2030, 2040 and 2050. The report contains supply, demand information for the EU27 + UK and Norway and outside countries (Ukraine, Algeria, Marocco, etc).
Distances between the countries	▪ We list the capitals of all the countries within the scope of the EHB and find their coordinates, using Excel Longitude and Latitude functions. To calculate the distance between the capital cities we use the Excel ACOS, SIN, COS and Radians functions. This calculates the shortest distance between two points (i.e. bird's fly).
Surplus/ deficit order	▪ We order the countries in scope with deficit from the largest to the smallest deficit in 2030, 2040 and 2050. The order between the years might vary. We start filling their deficit in that order, from the largest deficit country.
Supply routes to fill deficit	▪ We map out all routes of supply to fill the country's deficit based on the shortest distance available and the planned hydrogen network connections to in between the countries based on the EHB reports. Note that we revise the available connections in 2030 and 2040 based on the development of network outlined in the EHB, therefore the routes will differ between the years 2030, 2040 and 2050.
Filling deficit	▪ Where there is domestic production, we assume that this is used within the country first. ▪ We then fill the remaining deficit from the closest countries, as measured by the distances, considering EU27, Uk, Norway, Ukraine and North Africa – as done in the EHB Corridors study ▪ The flows are recorded as outgoing in the exporting country, incoming in the demand country, domestic production flows are also counted as flows within the country. If there is supply that remains after filling the country's needs, these flows are recorded as transit flows within the country where it passes by.
Total flows	▪ To get the total country's flows in 2030, 2040 and 2050 we sum all the flows, making a distinction between domestic supply flows, transit flows and imported flows.
Annual flows	▪ We assume a linear growth of flows between the years with information from EHB (2030, 2040 and 2050), adding the annual growth to the previous year's closing balance. ▪ We assume that 2024 flows (starting point of the model) are slightly above zero.
4-year delay	▪ We assume the amount of flows will be smaller at the start by moving the 2030 flows calculated in our dispatch model to 2034, and then computing a linear growth back to 2024, i.e., we use a linear growth between 2024-2034 instead of 2024-2030, with the same start and finish values.

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Our natural gas finance model assumptions are based on the TSO RAB, opex and WACC that is applied to the length of pipes calculated based on EHB

Natural gas transportation network finance model assumptions

Opening RAB	■ Opening RAB was taken from the national regulator reports for seven countries in scope (Italy, Spain, Poland, Germany, Belgium, the Netherlands, France) for the years 2019-2021 depending on a country and a TSO: — Data for German RAB was limited to only 3 TSOs (out of 16). We therefore extrapolated the length weighted average price per km for three TSOs to cover the entire network in Germany — In 2024, we assume the same opening RAB as we found via our research.
Pipeline length in Europe	■ Our starting point of natural gas pipeline length in 2024 is the EU27 pipeline length of 200,000km sourced from ACER. We know from EHB that this pipeline will be reduced to make transfers to the hydrogen network. ■ To find the reduction amount to the CH4 network we take the length of H2 pipeline in 2030, 2040 and 2050 and multiply this by the 60% (the expected refurbished rate in the EHB network). This is the amount that will be deducted from CH4 network in 2030, 2040 and 2050. ■ We know the starting length of the EU7 pipelines as it is the sum of individual country pipeline length sourced from national TSOs. This is reduced by 60% in 2030, 2040 and 50% in 2050 as the transfers are made to the H2 network. ■ Between these points, the reduction in pipeline length is assumed to be linear.
Depreciation	■ We assume a 26 years depreciation for the natural gas assets in line with some examples recorded in Denmark and Germany. We assume that depreciation on the natural gas network is offset by the additions to it, keeping the network at the constant RAB level except for transfers to hydrogen network.
Inflation	■ We assume that RAB is increased every year by 2.2% - the amount of long-term inflation forecasted the European Central Bank
WACC	■ Weighted average cost of capital has been sourced from the national regulator reports for seven countries in scope
Opex	■ Because opex is dependent on the size of the network, our estimate is based on the opex/ capex proportion recorded in the seven countries today (data ranges between 2019 and 2021 depending on the country).
Opening RAB	■ Opening RAB was taken from the national regulator reports for seven countries in scope (Italy, Spain, Poland, Germany, Belgium, the Netherlands, France) for the years 2019-2021 depending on a country and a TSO: ■ Data for German RAB was limited to only 3 TSOs (out of 16). We therefore extrapolated the length weighted average price per km for three TSOs to cover the entire network in Germany ■ In 2024, we assume the same opening RAB as we found via our research.

Our hydrogen finance model assumptions are based on the EHB studies and the same WACC as for the natural gas

Hydrogen transportation network finance model assumptions

Pipeline length	■ The length of the pipeline in each country was calculated by: — Sourcing European-wide pipeline network length for 2030 and 2040 from EHB. In between 2040 and 2050, and in the absence of EHB assumptions, we assume half of the 2030-2040 growth to occur between 2040 and 2050. This is a reasonable assumption given that the EHB states that ” The backbone as proposed for 2040 represents a foundational network, “a mature hydrogen highway”, upon which further developments can be built.” — We find the ratio between hydrogen demand within the EU7 and the entire Europe from the EHB and apply this ratio to the Europe H2 network length (obtained from the EHB). This gives us a total length of hydrogen pipelines in the EU7. — To calculate the length of pipelines in each country, we take the ratio of country flows in the total EU7 flows computed in our distance-minimising dispatch model. The result is the length of H2 network length in each country. — Each year the pipeline growth rate is assumed to be linear, with a change in the growth rate in 2030 and 2040.
Capex	■ For new and refurbished pipelines we took the medium size of pipeline and medium cost scenario from the EHB report. For the compressor we assumed the max pressure. ■ We used the 60%/40% ratio between refurbished and new pipelines as set by the EHB.
Depreciation	■ Depreciation of 40 years is applied to hydrogen pipelines and 25 years for the compressor.
Inflation	■ We assume that RAB is increased every year by 2.2% - the amount of long-term inflation forecasted the European Central Bank
Additions	■ Each year the pipeline grows by the same amount with the resetting of the annual amount happening in 2030 and 2040.
WACC	■ Weighted average cost of capital has been sourced from the national regulator reports for seven countries in scope. The same amount as applied to the CH4 network.
Opex	■ For new and refurbished pipelines we assume the medium size of pipeline and medium cost scenario from the EHB report. For the compressor we assumed maximum pressure.

The decommissioning costs and retirement schedule of NG networks remain uncertain, and have thus not been included in this high-level analysis

Development of regulatory framework for the natural gas decommissioning

- The publication on **"The future regulatory decisions on natural gas networks: repurposing, decommissioning and reinvestments"** commissioned by the European Agency for the Cooperation of Energy Regulators (ACER) recognises that the European and national climate policy and energy sector decarbonisation targets are expected to result in a **significant decline of natural gas demand.**
- The report concludes that "**natural gas transmission network assets may not be further utilised** any longer and be **decommissioned** at some point in the future", however the precise detail as to how this will be done is missing.
- Options are outlined that either the TSOs or the National regulators have to:

Determine individual assets to be decommissioned and

*Decide on the treatment of physical **decommissioning** and **dismantling costs***

- We have also inspected the annual report of the Dutch Transmission System Operator to check the treatment of decommissioning assets. We noted that there is a provision made for decommissioning costs of "specific" assets within the foreseeable future, however, the detail around which asset the decommissioning provision was made is missing.

In the absence of quantitative decommissioning costs assessment as the regulatory framework is still under the development and lack of clarity within the individual TSO accounts, we conclude that there is not enough information to make an accurate estimate of decommissioning costs. We therefore did not include this in our modelling.

Sources: Acer Europe 2022, Gasunie 2019.

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