



PICTURE: FRANKHH/ SHUTTERSTOCK

# PROJECT DEVELOPMENT ASSISTANCE FOR REGIONS

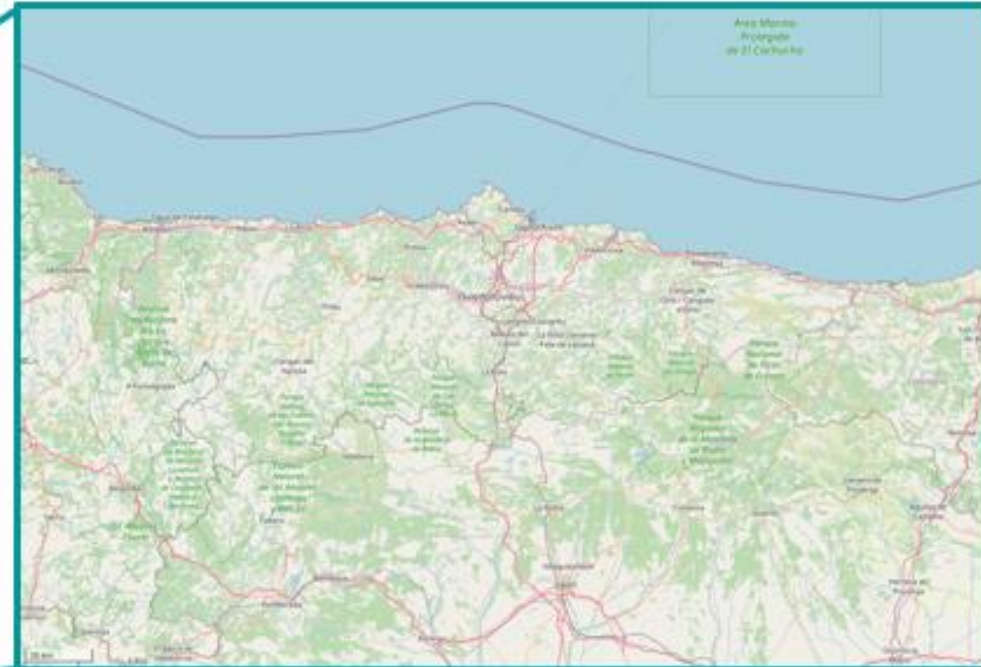
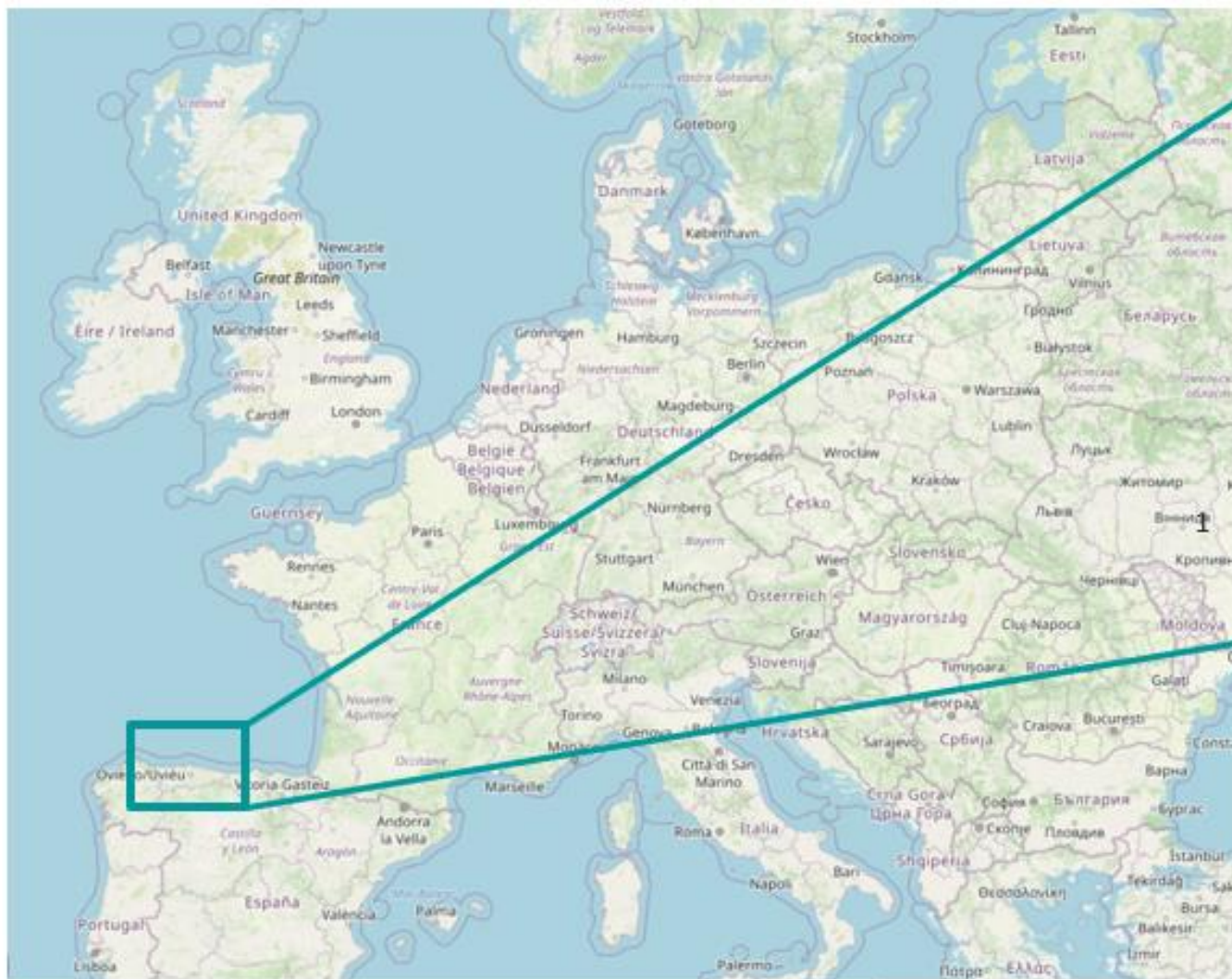
Summary on activities

Final version, 07.06.2021

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## PDA REGION

# ASTURIAS (SPAIN)



HRS



Public transport



H2 production, injection and export infrastructure

openstreetmap.org

# ASTURIAS



HRS



Buses



H2 production, injection and export infrastructure

## SCOPE OF THE PROJECT – SUPPLY CHAIN, SCALE, LOCATION

- **The Asturias region, in the north of Spain, was dependent on the coal industry for a long time, with several coal mines and power plants.** It is now entering an energy transition phase, in which green hydrogen will play a significant role in the coming years for the industry and transport sectors.
- The Asturias hydrogen project is a combination of several initiatives from different stakeholders willing to develop the hydrogen value chain. The Region of Asturias and the local energy agency FAEN have been working, with the support of the Project Development Assistance programme, to assist these initiatives and to promote synergies and collaboration between them, notably to access public funding.
- **The first initiative is based in the coal mining valleys in the centre and south of Asturias** (“Cuencas Mineras asturianas”). **45 MW of electrolyser capacity**, with potential future increase in the long term, will be installed by 2026 in several phases, with the intention to supply hydrogen to public transport vehicles including buses, for injection in the gas distribution grid, and for industrial uses.
- **The second initiative is the installation of two green hydrogen production facilities in two sites in the centre of Asturias.** One will supply a hydrogen refuelling station for heavy vehicles, and the other will be used to test the injection of hydrogen in a combined cycle turbine, to prepare for the future increase of hydrogen concentration in the gas grid.
- **The third initiative is the installation in two phases of 200 MW of onshore electrolyser capacity and 5 MW of offshore electrolyser capacity**, connected to a new 100 MW onshore wind farm and a 250 MW offshore wind farm off the coast of Asturias. Hydrogen will be used for local industries (steel manufacturing, shipyards), injection in the gas grid, transport, and export to other European countries.
- The Region of Asturias and FAEN continue to build a **framework to include other new hydrogen projects in Asturias and involve stakeholders under the ReCoDe H2 initiative**, that will facilitate collaboration and synergies to develop a large-scale green hydrogen ecosystem, which will contribute to the energy transition in the region and the development of new local industrial and manufacturing activities in the hydrogen sector.

# ASTURIAS



H2 production, injection and export infrastructure

## PROJECT SPECIFICATIONS



### Key stakeholders

- The Region of Asturias: Gobierno del Principado de Asturias
- The regional energy agency: Fundación Asturiana de la Energía (FAEN)
- First initiative: HUNOSA, Duro Felguera, Nortegas, Alsa
- Second initiative: EDP
- Third initiative: Enagas, Naturgy



### Budget

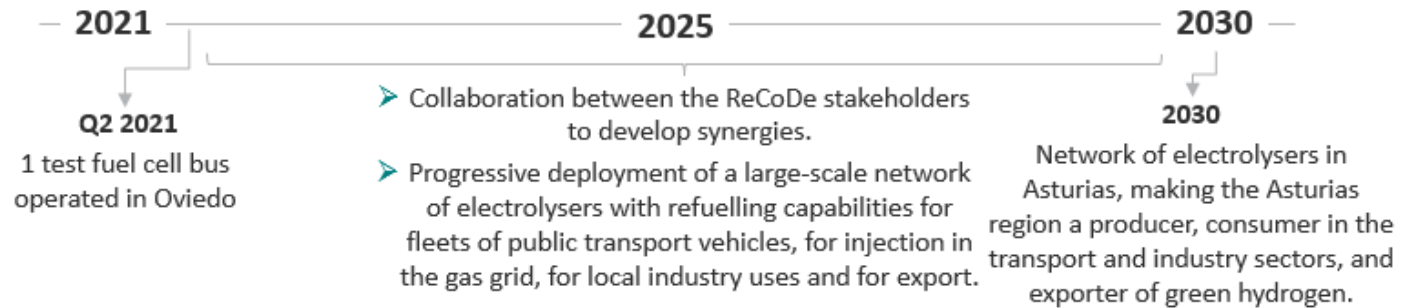
- The future investments for the Asturias hydrogen ecosystem cover the full supply chain: hydrogen production and distribution equipment, renewable electricity production and fuel cell vehicles
- The initiative of Enagas and Naturgy could create more than 1,500 jobs for the construction and operation phases

### Funding strategy

- The funding strategy will be based on a combination of public and private funding
- The delivery of the project will depend on obtaining public national and European funding. Some sources identified are the Recovery and Resilience facility, the Transition fund, CEF, IPCEI
- The stakeholders will monitor the future opening national and European funding calls



### Timeline for deployment



### Summary of work undertaken in the PDA process

The PDA process has helped the partners to build the framework of a complete hydrogen ecosystem in Asturias ready to apply for funding which is necessary to proceed to the implementation phase. Consultancy support to the project stakeholders has:

- 1) **Provided support in choosing best technical solutions** for some components of the value chain
- 2) **Initiated regular meetings with the different stakeholders involved in all the initiatives**
- 3) **Initiated discussions with key equipment suppliers**
- 4) **Supported the partners in the specification of clear budget, project plans, technical characteristics of the full ecosystem** based on the project partner needs, to prepare for applications to funding calls. Advised on the current and potential future available calls

The main output of the PDA process that the Region of Asturias and FAEN will receive is a detailed report presenting the specifications of the ecosystem, which will serve as a basis for future funding applications and to continue attracting stakeholders to develop the green hydrogen industry in Asturias.

# ASTURIAS



## H2 production, injection and export infrastructure

### PRECONDITIONS – NEXT STEPS

#### Preconditions for implementation

The public and private partners involved in the project are committed to proceed to the implementation of the project with the installation of the production and distribution facilities and the deployment of fleets of fuel cell vehicles for public transport.

However, the ability to proceed to the implementation phase is reliant on several topics identified during PDA:

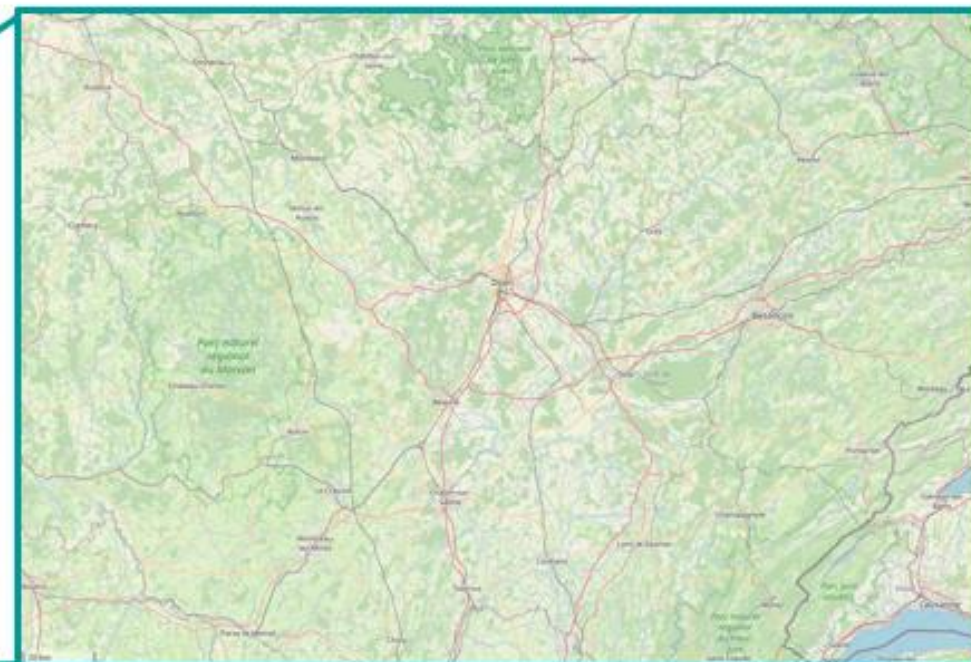
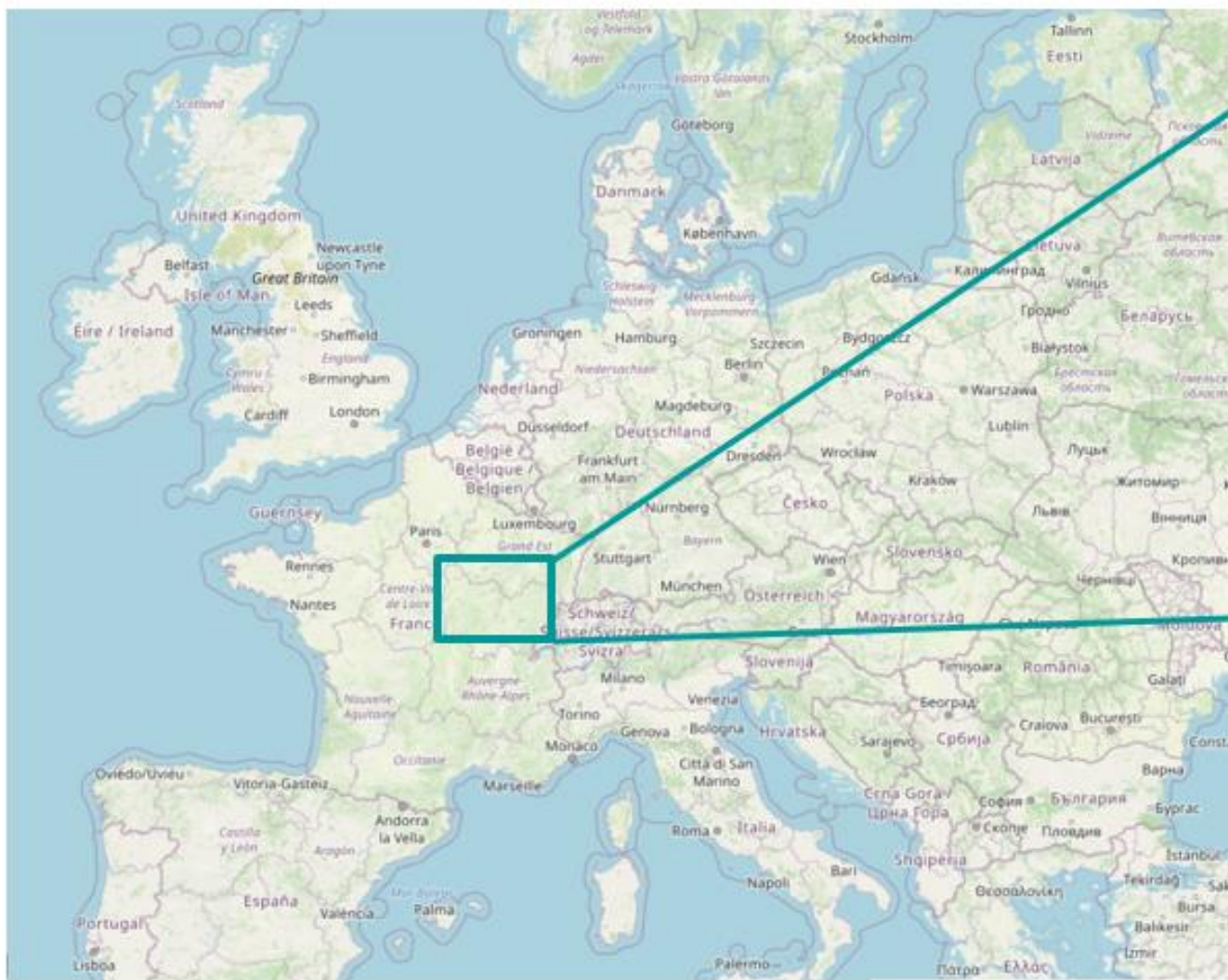
- The **acquisition of funding** to support the full gap funding for deployment hydrogen or fuel cell vehicles (in comparison to diesel vehicles)
- The **acquisition of funding** to support the purchase of hydrogen production and distribution infrastructure and then reach acceptable hydrogen prices for the consumers

The work undertaken during the PDA programme has enabled the Region of Asturias, FAEN and the private stakeholders to identify several European funding bodies relevant to this ecosystem that could help starting the implementation phase of the project.

#### Next steps

In order to reach the next phase of implementation the project will aim to:

- **Investigate EU and national funding streams** for green hydrogen production, distribution, and use. Funding are necessary especially for the purchase of the fuel cell vehicles
- **Continue building the ReCoDe initiative** to find synergies between stakeholders and projects and facilitate the acquisition of funding, depending on the eligibility criteria, and to work jointly on the decarbonisation of the region of Asturias
- **Continue integrating green hydrogen in the overall transition Asturias is facing**



PDA REGION

BOURGOGNE- FRANCHE COMTÉ

(FRANCE)



Buses



Trucks



HRS

# BOURGOGNE-FRANCHE-COMTÉ



## SCOPE OF THE PROJECT – SUPPLY CHAIN, SCALE, LOCATION

- The ambition of the BFC Region is to become a positive energy territory by 2050, namely, to produce more energy than it consumes. Hydrogen is an important part of this ambition, and to accelerate the development of the sector, the BFC Region has adopted a hydrogen roadmap in November 2019. With this roadmap, the **Region committed to invest €90 mn in the hydrogen regional value chain in the next decade.**
- A number of high-profile projects are emerging in the BFC Region, most notably several hydrogen ecosystems gathering different mobility applications, and industry or stationary applications depending on the project. These hydrogen ecosystem projects have mostly been initiated at a local level, stemming from the willingness of municipalities to transition public fleet to zero emission and hydrogen vehicles.
- Among these ecosystems developing in the BFC region, 7 are well-advanced and have received, have applied for or are applying to receive regional and/or national funding for their projects. However, these projects are progressing individually, without a regional frame or a common objective. **The ambition of the BFC Region is to coordinate these projects and deployments at a regional level,** with the objective to group these projects in a single regional project and present this project to European funding opportunities.
- The regional project is constituted of the deployments planned in 7 different cities: **Auxerre, Belfort, Dijon, Dole, Mâcon, Nevers et Saint-Florentin.**
- Overall, this combined regional ecosystem has the potential to gather the deployment of 101 to 105 heavy vehicles, between 2022 and 2026. These heavy vehicles are 65 fuel cell buses and 36 to 40 fuel cell refuse trucks. These deployments are distributed between 6 cities (Auxerre, Belfort, Dijon, Mâcon, Nevers, Saint-Florentin).
- Overall, purchasing the vehicles represent a budget of approximately **€60 mn between 2022 and 2026.**



# BOURGOGNE-FRANCHE-COMTÉ

## PROJECT SPECIFICATIONS



### Key stakeholders

- Région Bourgogne-Franche-Comté
- Agence Economique Régional (Regional Economic Agency)
- Communauté d'Agglomération de l'Auxerrois
- Grand Belfort
- Dijon Métropole
- Grand Dole, Mâcon Beaujolais Agglomération
- SIEEEN (Nièvre), Yonne Energie

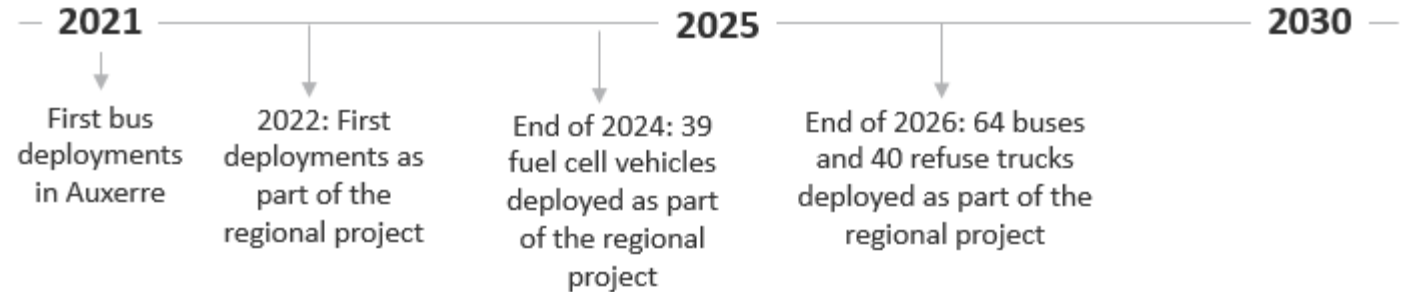
### Budget

- For the deployment of 64 buses and 40 refuse trucks: **~€60 mn**
- For the deployment of 2 electrolysers and 3 refuelling stations: **~€20 mn**
- Total CAPEX: **~€80 mn**

### Funding strategy

- First step, taken individually by the project leaders: **apply to national (ADEME) and regional funding**
- Second step, taken collectively as a part of the regional project: **apply to European funding**
- Final step, taken collectively as a part of the regional project: **obtain financial support for the purchase of hydrogen**

### Timeline for deployment



### Summary of work undertaken in the PDA process

The PDA process has helped the partners to build the key elements of a regional project gathering the most advanced ecosystem projects in the region. Consultancy support to the project stakeholders has:

- 1) **Provided stakeholders with information about successful European deployments** to develop their understanding of the sector
- 2) **Gathered information from the projects in the region developing separately** in order to develop a common regional project gathering these advanced projects
- 3) **Supported the partners in the development of clear budget, project plans, technical specifications of the full ecosystem** based on partner needs, to prepare for applications to funding calls. Advised on the current and potential future available calls
- 4) **Provided support in the determination** of the funding strategy for the project, in particular for European funding opportunities

# BOURGOGNE-FRANCHE-COMTÉ



## PRECONDITIONS – NEXT STEPS

### Preconditions for implementation

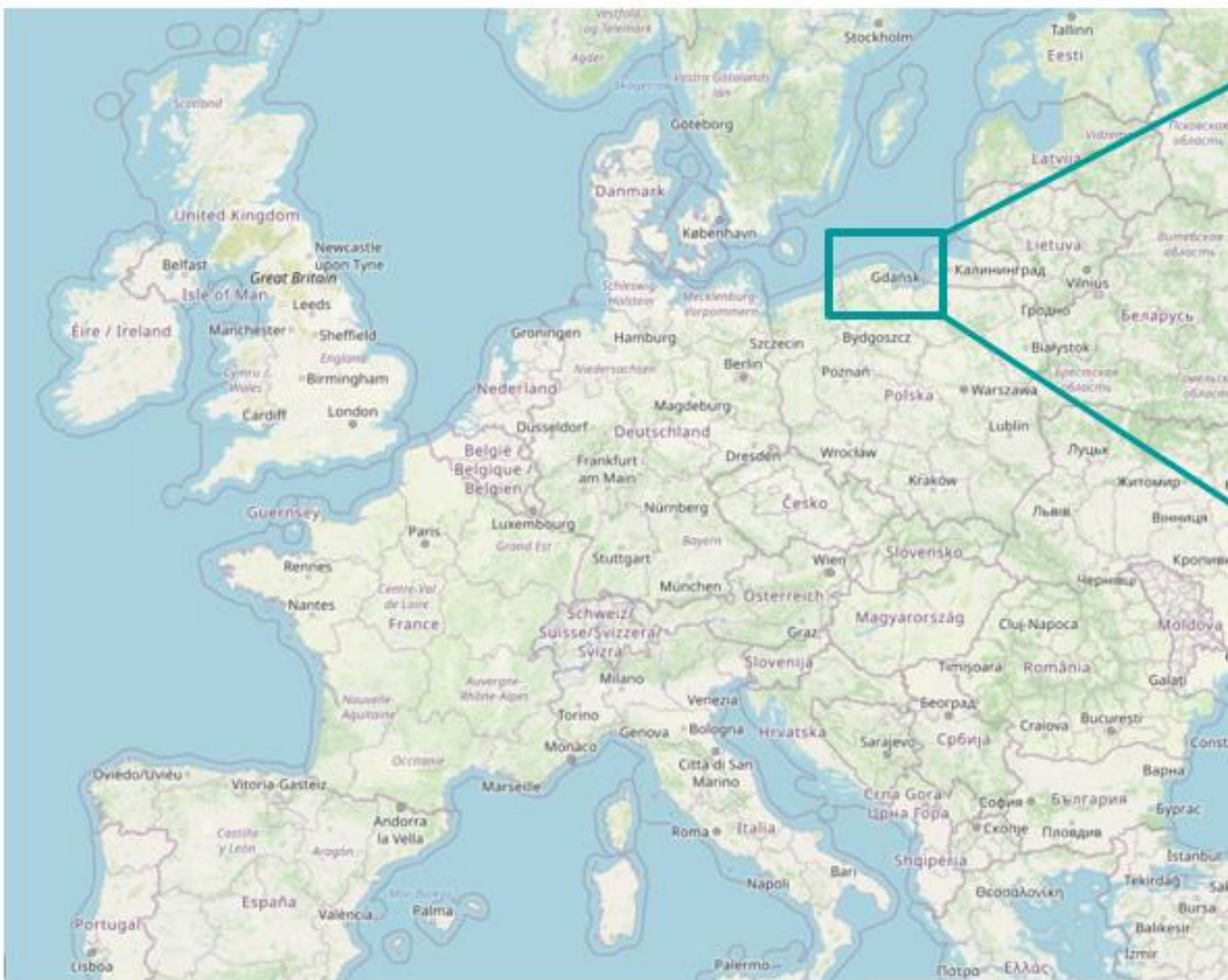
The public and private partners involved in the project are committed to proceed to the implementation of the project. However, the ability to proceed to the implementation phase is reliant on several topics identified during PDA:

- The **acquisition of funding** to support the cost gap for the deployment of fuel cell vehicles (in comparison to diesel vehicles) and of the associated infrastructure
- The **acquisition of funding** to support the purchase of hydrogen production and distribution infrastructure and then reach acceptable hydrogen prices for the consumers

### Next steps

In order to reach the next phase of implementation the project will aim to:

- **Investigate national funding streams**, especially for the purchase of the fuel cell vehicles and for the associated infrastructure
- **Investigate European funding streams**, with the objective to complement subsidies from national sources
- **Investigate complementary funding streams**, for instance with subsidies on the purchase of hydrogen
- **Strengthen individual projects constituting the regional project.** Some aspects of some projects constituting the regional project are not fully defined yet and need to be finalised in the coming months. This includes looking at synergies between each project and the opportunities for cost-sharing in similar deployments



PDA REGION

**GDYNIA (POLAND)**



Buses



HRS

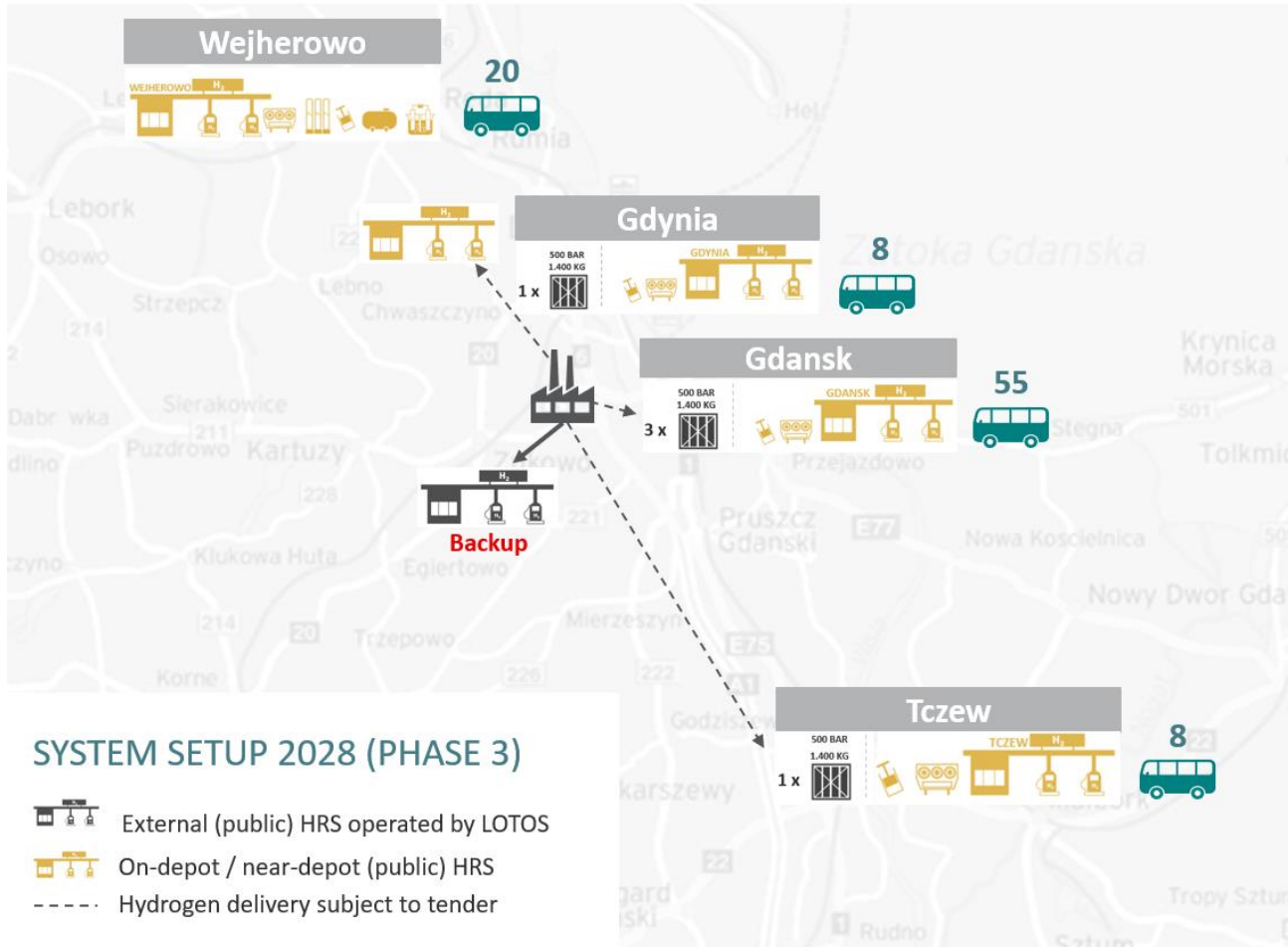


H2 infrastructure

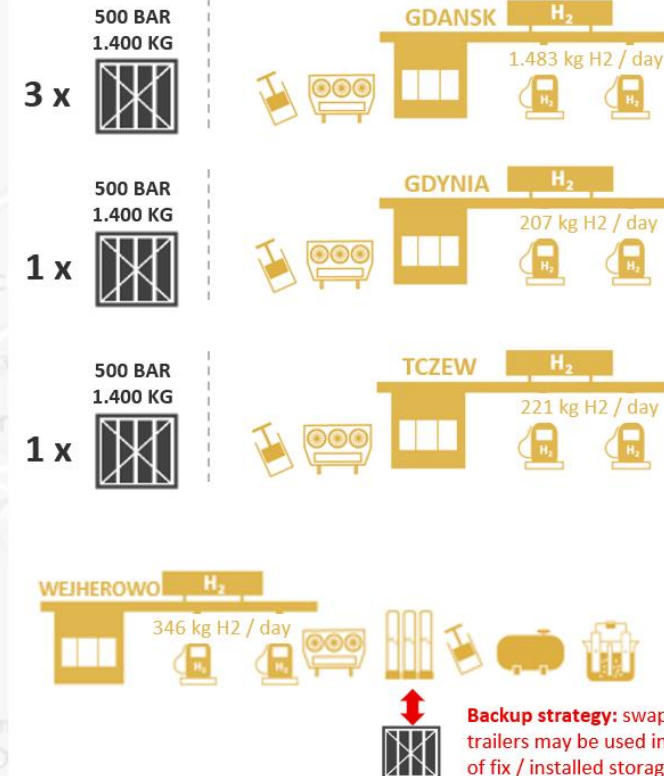
# GDYNIA

Buses HRS H2 infrastructure

## SCOPE OF THE PROJECT – SUPPLY CHAIN, SCALE, LOCATION

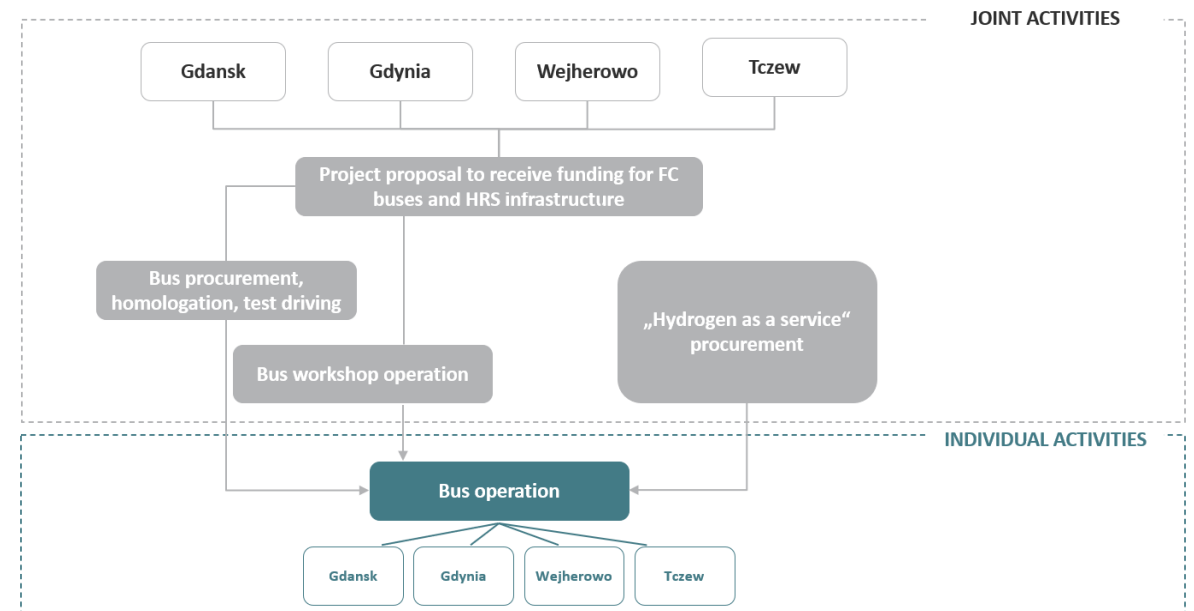
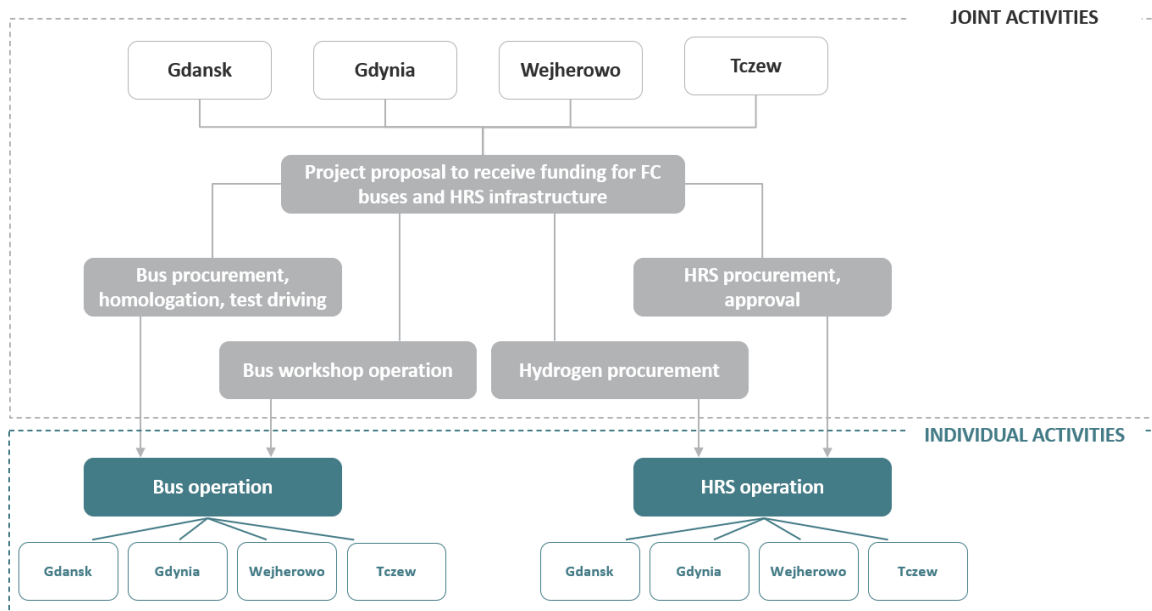


**Backup strategy:**  
swap trailers  
(flexible use of  
each of the HRS)



# GDYNIA Buses HRS H2 infrastructure

## SCOPE OF THE PROJECT – JOINT APPROACH IN THE CONTEXT OF ALTERNATIVE HRS OPERATOR MODELS<sup>1</sup>



(1) To be decided based on availability and conditions of the "hydrogen as a service" option

# GDYNIA



## PROJECT SPECIFICATIONS



### Key stakeholders

- GAI T - Gdańskie Autobusy i Tramwaje Sp. z o.o
- MZK - Miejski Zakład Komunikacji Wejherowo Sp. z o.o.
- Municipal office in Tczew
- Strategy department Gdynia city hall
- Grupa LOTOS SA



### Budget

#### Gdansk (55 buses, 1 HRS)

€38,4 mn unfunded, €6,4 mn funded

#### Gdynia (8 buses, 1 HRS)

€6,9 mn unfunded, €1,7 mn funded

#### Tczew (8 buses, 1 HRS)

€6,5 mn unfunded, €1,8 mn funded

#### Wejherowo (20 buses, 1 HRS, 1 electrolysis)

€14,1 mn unfunded, €3,7 mn funded

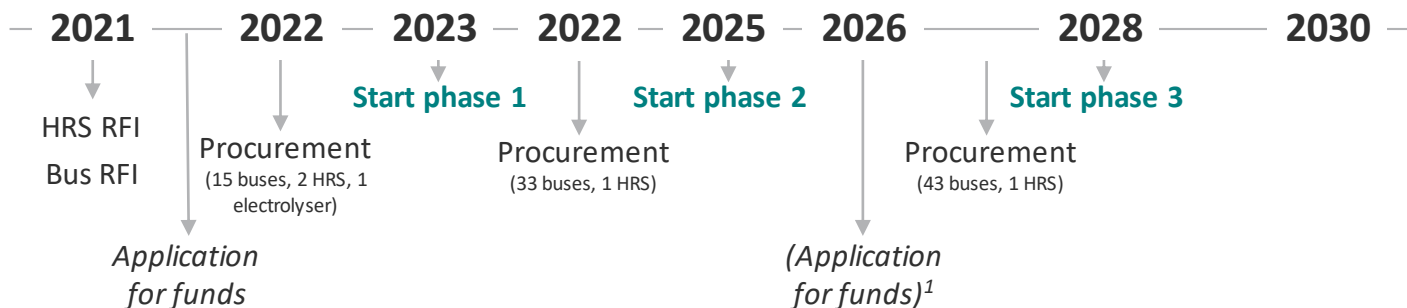
(1) May become necessary if funding programme requires earlier start of operation

### Funding strategy

2<sup>nd</sup> call in the Polish “Green Public Transport” programme of the National Fund for Environmental Protection and Water Management (90% bus CAPEX, 50% HRS CAPEX), expected for the end of 2021



### Timeline for deployment



### Summary of work undertaken in the PDA process

- 1) Analysis of daily hydrogen demand based on bus lines considered for hydrogen
- 2) Discussion on alternative operatorship models for bus workshop and HRS
- 3) SWOT analysis and optimization of initial project approach to include backup strategies & reduce cost
- 4) Individual TCO calculation for each of the 4 cities and all three phases
- 5) Risk analysis and mitigation plan (project, legal, financial, acceptance and operational risks)
- 6) Identification of a funding and financing plan
- 7) Suggestions for a project governance structure, work packages and timeline
- 8) Networking with HRS suppliers
- 9) Launch of a request for information (RFI) process on buses, including 12 suppliers

GDYNIA



Buses



HRS



H2 infrastructure

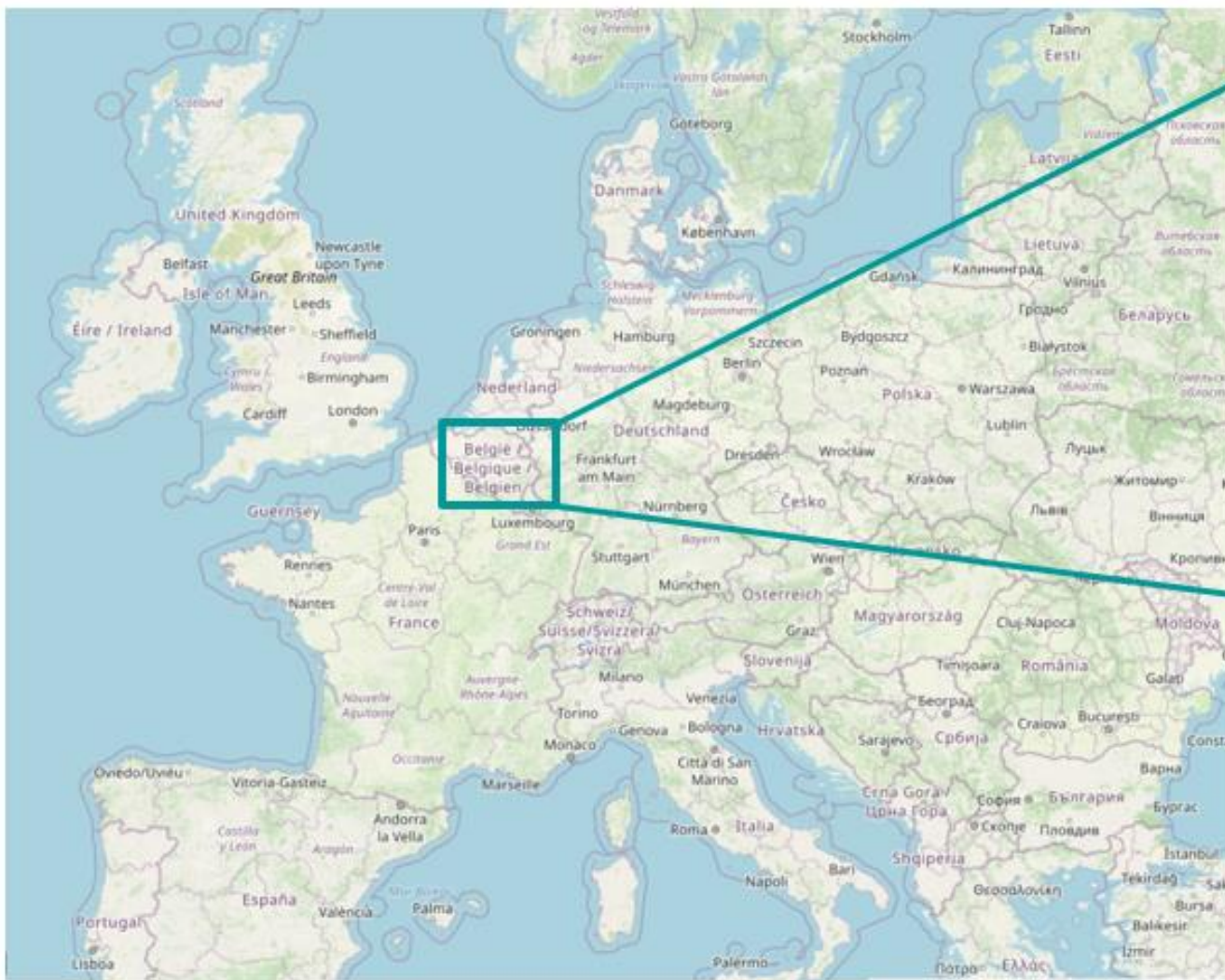
## PRECONDITIONS – NEXT STEPS

## Preconditions for implementation

- **Market availability of the FCH technologies** (buses, HRS, electrolysis, hydrogen)
- **Successful application in the “Green Public Transport” programme** (90% funding of bus CAPEX and 50% funding of HRS CAPEX)

## Next steps

- **Finalize RFI on buses process** (remind open requests)
- **Decide on HRS operatorship model** and launch RFI on HRS
- **Decide on a bus workshop operatorship model** and identify site (retrofitting or new build)
- **Continue discussions with HRS suppliers**, identify other „hydrogen as a service“ suppliers
- **Draft application** for the next call in the „Green Public Transport“ programme (expected for fall / winter 2021)



PDA REGION

# LIMBURG (BELGIUM)

 Trucks  H2 infrastructure  HRS

openstreetmap.org



# POM LIMBURG



Trucks



H2 infrastructure



HRS

## SCOPE OF THE PROJECT – SUPPLY CHAIN, SCALE, LOCATION

Despite its history in coal mining, the region of Limburg has committedly embarked upon a trajectory towards climate neutrality in 2050. Investments are made in renewable power generation and strategic portfolio of investment projects are made to improve the socio-economic climate of the region. The PDA intends to contribute to these developments as it addresses the introduction of hydrogen in the heavy duty transportation sector. The city of Genk hosts several key logistic services companies and is strategically located on the logistic corridor between Belgium, the Netherlands and Germany. Implementing a hydrogen ecosystem around the logistic hub of Genk has been the primary focus of the PDA scope.

An inventory has been made of the potential hydrogen demand of the participating members of the newly founded Hydrogen Society Limburg (location Genk) and constitutes about 600 kg per day. The demand is mainly coming from trucks, shunters, refuse trucks and light commercial vehicles. The location of the refuelling station for hydrogen refuelling is foreseen at the heart of the logistics centre in Genk.

A scale-up scenario in three stages is foreseen upon the successful introduction of a first fleet of vehicles. The vehicles within scope of the project are in a relative early state of development and require practical implementation before scaling-up fleets. As part of the implementation, stakeholders foresee the need to first test vehicles in an operational setting to confirm suitability with operational practices before scaling up.

# POM LIMBURG

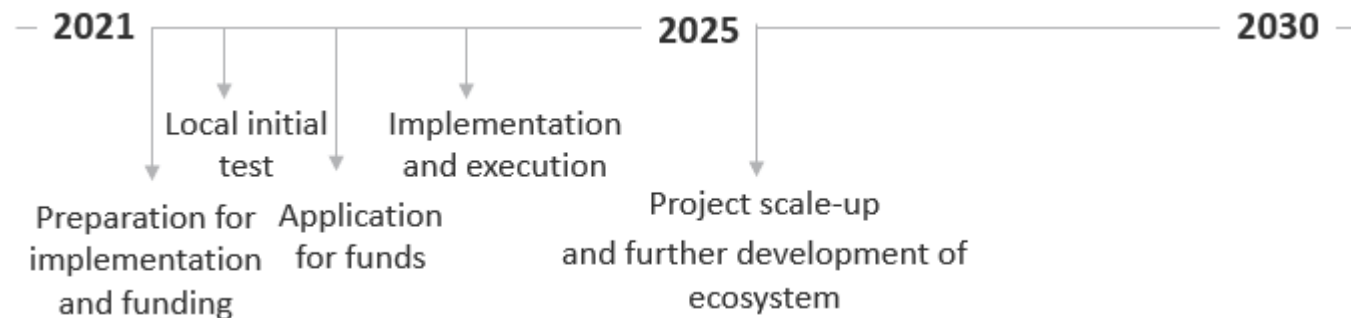
## PROJECT SPECIFICATIONS



### Key stakeholders

- POM Limburg (PDA Awardee)
- Bruno Service Station
- Lidl, IKEA, H.Essers, Limburg.net, City Genk, E-Trucks Europe

### Timeline for deployment



### Budget

- €6 mn (HRS + Mobility)

### Funding strategy

- National (Ecologiepremie plus, STRategische EcologieSteun)
- European (Innovation Fund, Interreg)

### Summary of work undertaken in the PDA process

- 1) Development of Hydrogen Society Limburg (location: Genk)
- 2) Knowledge and expertise development within the region regarding development of hydrogen ecosystem
- 3) Regular meetings with key stakeholders and technology suppliers
- 4) Lead and assisting in obtaining quotations and technical specifications for hydrogen applications
- 5) Tailored individual business case development for stakeholders
- 6) Development of implementation strategy
- 7) Overall business case development for the project

# POM LIMBURG



Trucks



H2 infrastructure



HRS

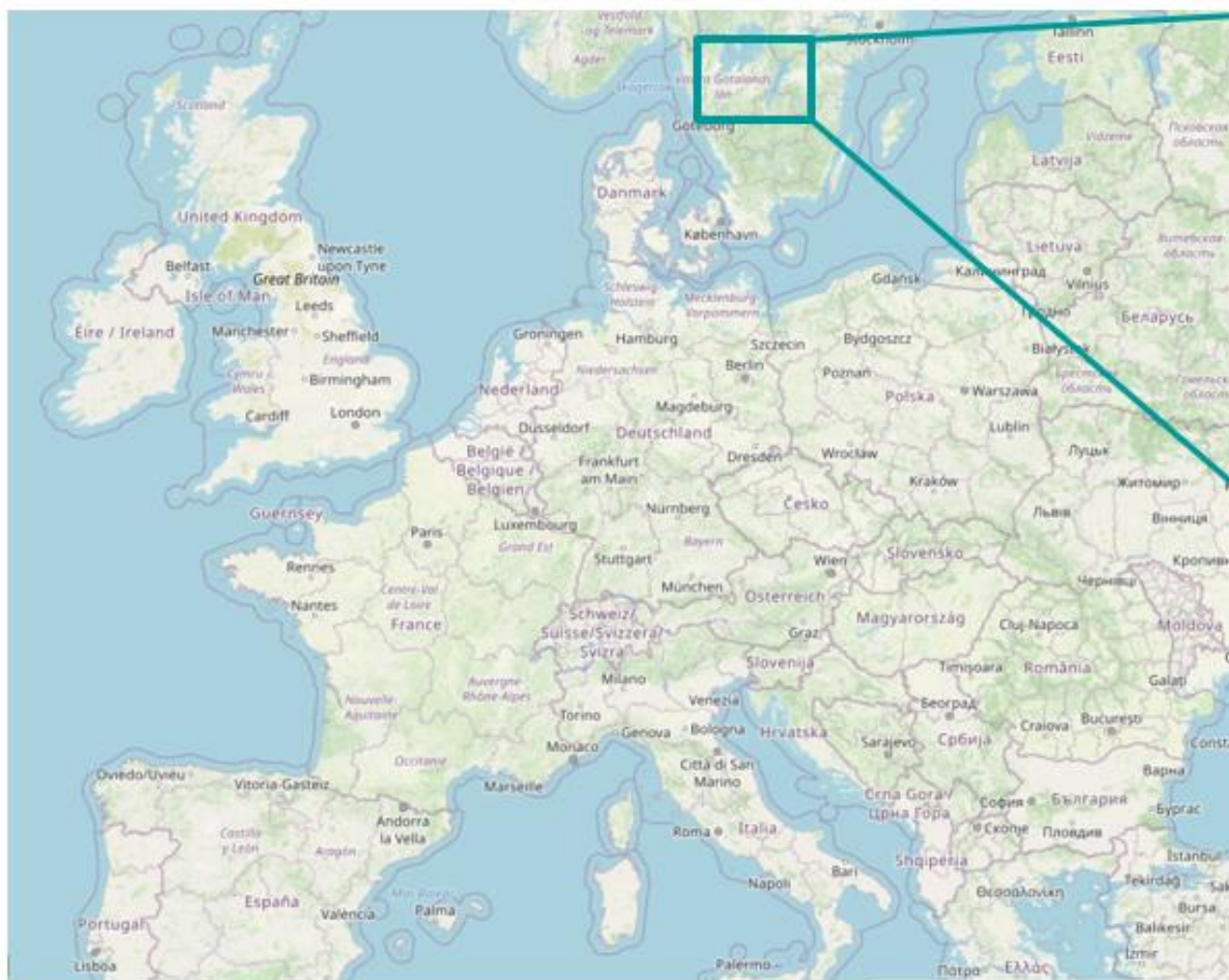
## PRECONDITIONS – NEXT STEPS

### Preconditions for implementation

- Availability and application to funding
- Final commitment of stakeholders
- Agreement on a governance structure for next steps through Hydrogen Society Limburg

### Next steps

- (Managerial) commitment to proceed with taking next steps in the implementation process
- Assignment of an interlocutor to organise the process of application for funds
- Preparation and applications for funding
- Preparation of necessary permits



PDA REGION

# MARIESTAD (SWEDEN)



Trains



H2 infrastructure



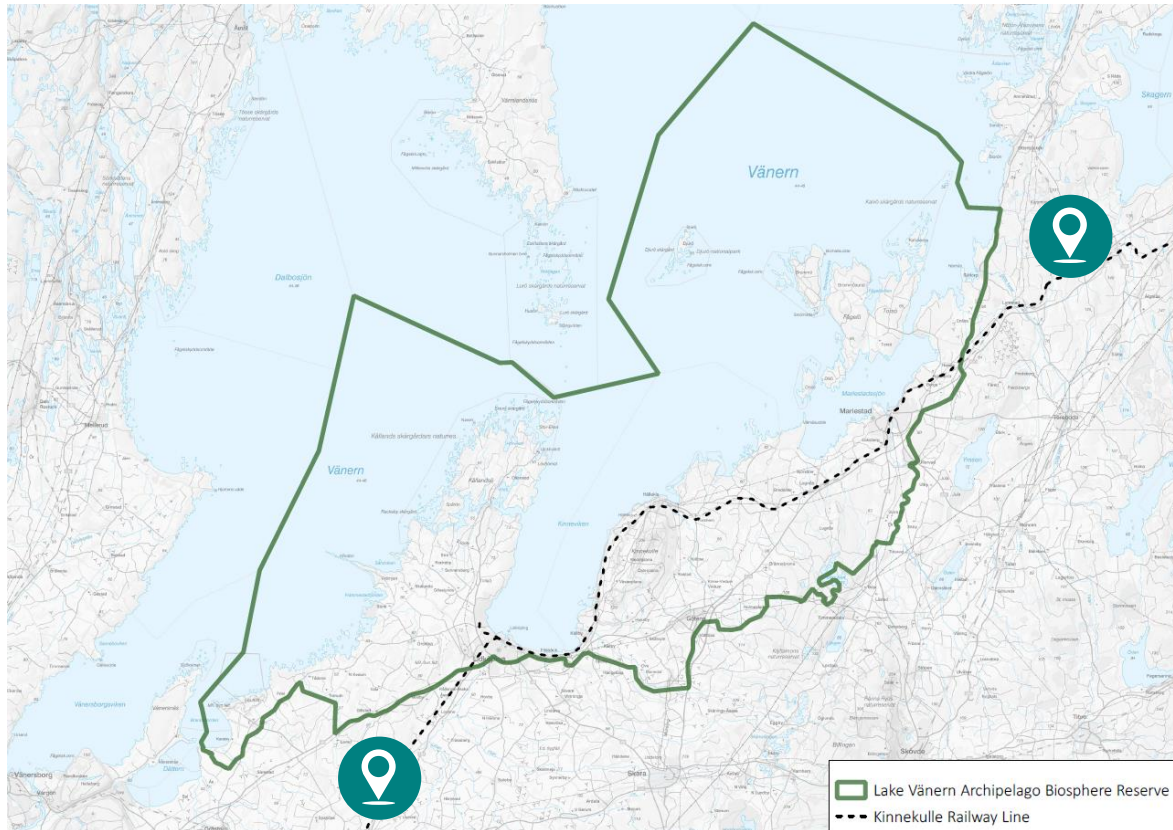
Multi-purpose HRS

openstreetmap.org

# MARIESTAD Trains H2 infrastructure Multi-purpose HRS

## SCOPE OF THE PROJECT – SUPPLY CHAIN, SCALE, LOCATION

**Decarbonise the Kinnekullebanan  
(121 km single track commuter trainline)**



### PRE-TEST PHASE (AUGUST 2021)



1 FC train (Alstom iLint)



1 mobile HRS

### PILOT PHASE (2022 - 2026)



2 FC trains



2 combi HRS  
(Gullspång and Lidköping)



10 FC buses



2 MW on-site electrolysis

### TRANSITION PHASE (> 2026)



10 FC trains



5+ combi HRS  
(all 5 municipalities)



50 FC buses



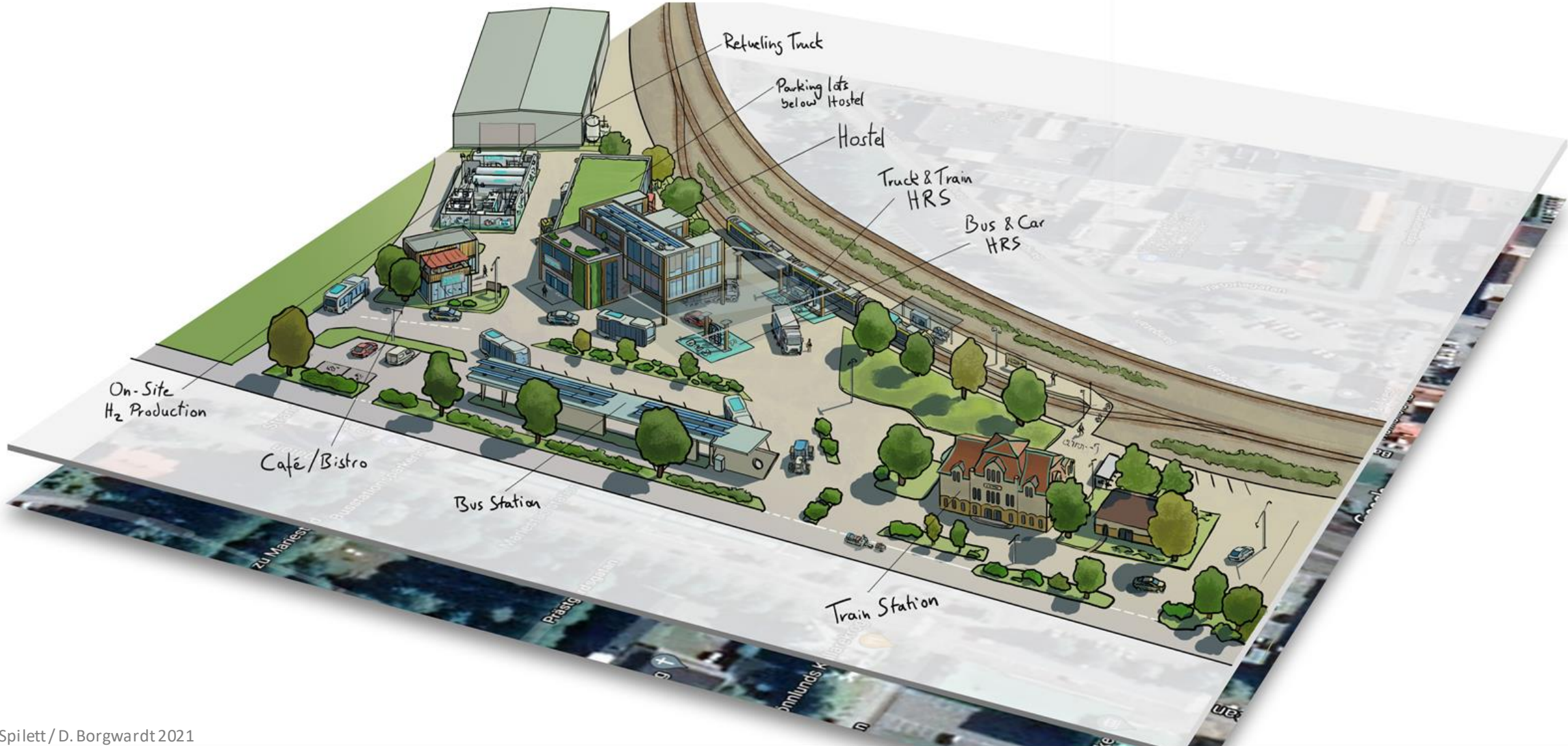
6 MW on-site electrolysis



200 municipal cars

# MULTI-VEHICLE HRS

## EXAMPLE FOR REALISATION IN MARIESTAD



# MARIESTAD

Trains H2 infrastructure Multi-purpose HRS

## PROJECT SPECIFICATIONS

### Key stakeholders

- Gullspång, Götene, Lidköping, Vara and Mariestad municipalities
- Skaraborg regional organisation
- Västra Götalands region
- Wasttrafik
- Alstom
- PowerCell
- Lindkoping University

### Budget

#### Pilot project (2 trains, 2 HRS, 2 electrolysers, 10 buses)

€22,3 mn CAPEX (of which 50% grant support)

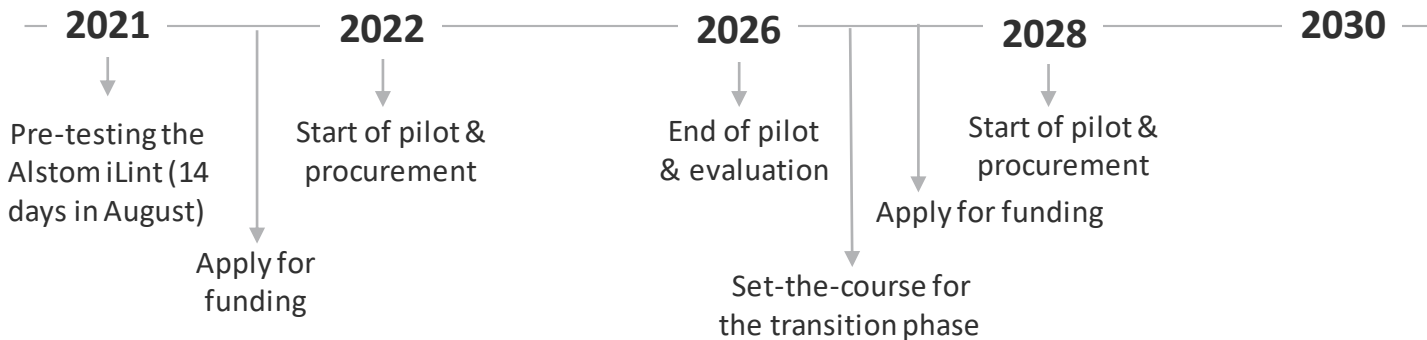
#### Transition phase (10 trains, 50 buses, 5 HRS, 200 cars)

€74,9 mn CAPEX (of which 50% grant support)

### Funding strategy

2<sup>nd</sup> call in the EU Innovation Fund on large-scale projects expected for the end of 2021 / beginning 2022.  
Co-Funding from external investor

### Timeline for deployment



### Summary of work undertaken in the PDA process

- 1) Development of a long term ramp-up strategy for a hydrogen mobility in the 5 municipalities
- 2) Definition of a pilot project to demonstrate technical, economic, legal and societal feasibility
- 3) Forming a project delivery group to include all perspectives into the pilot project development
- 4) Weekly meetings with the regional core team
- 5) Bilateral talks and meetings with political leaders and municipalities to motivate engagement
- 6) TCO analysis of the project pilot phase
- 7) Drafting of material to be used for decision support (presentations, illustration, cost calculation)
- 8) Education on technical feasibility, state of the art and market availability
- 9) Summary of all ideas and information in the project delivery report

# MARIESTAD



Trains



H2 infrastructure



Multi-purpose HRS

## PRECONDITIONS – NEXT STEPS

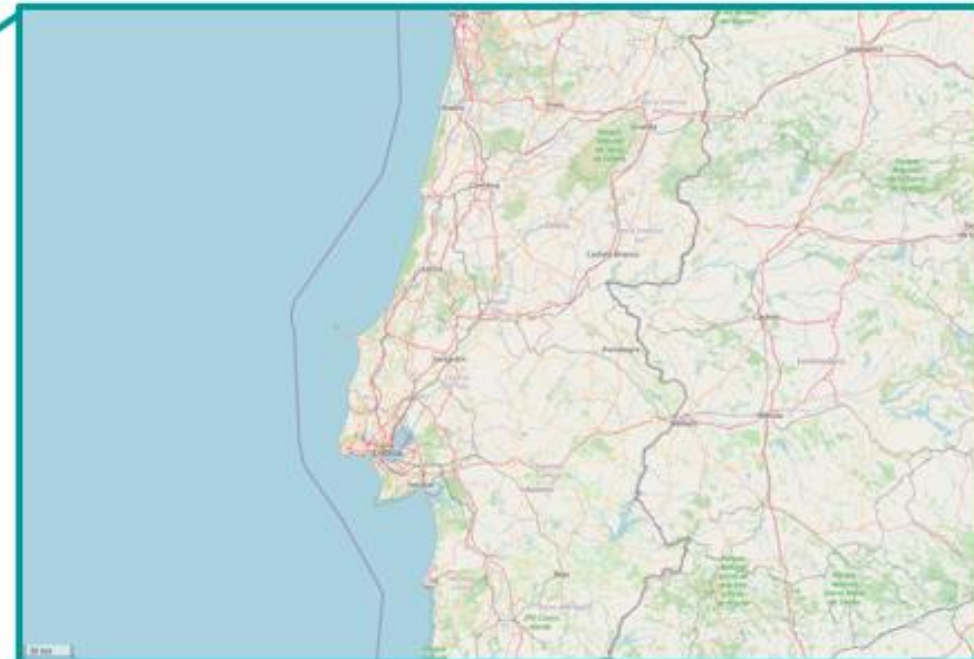
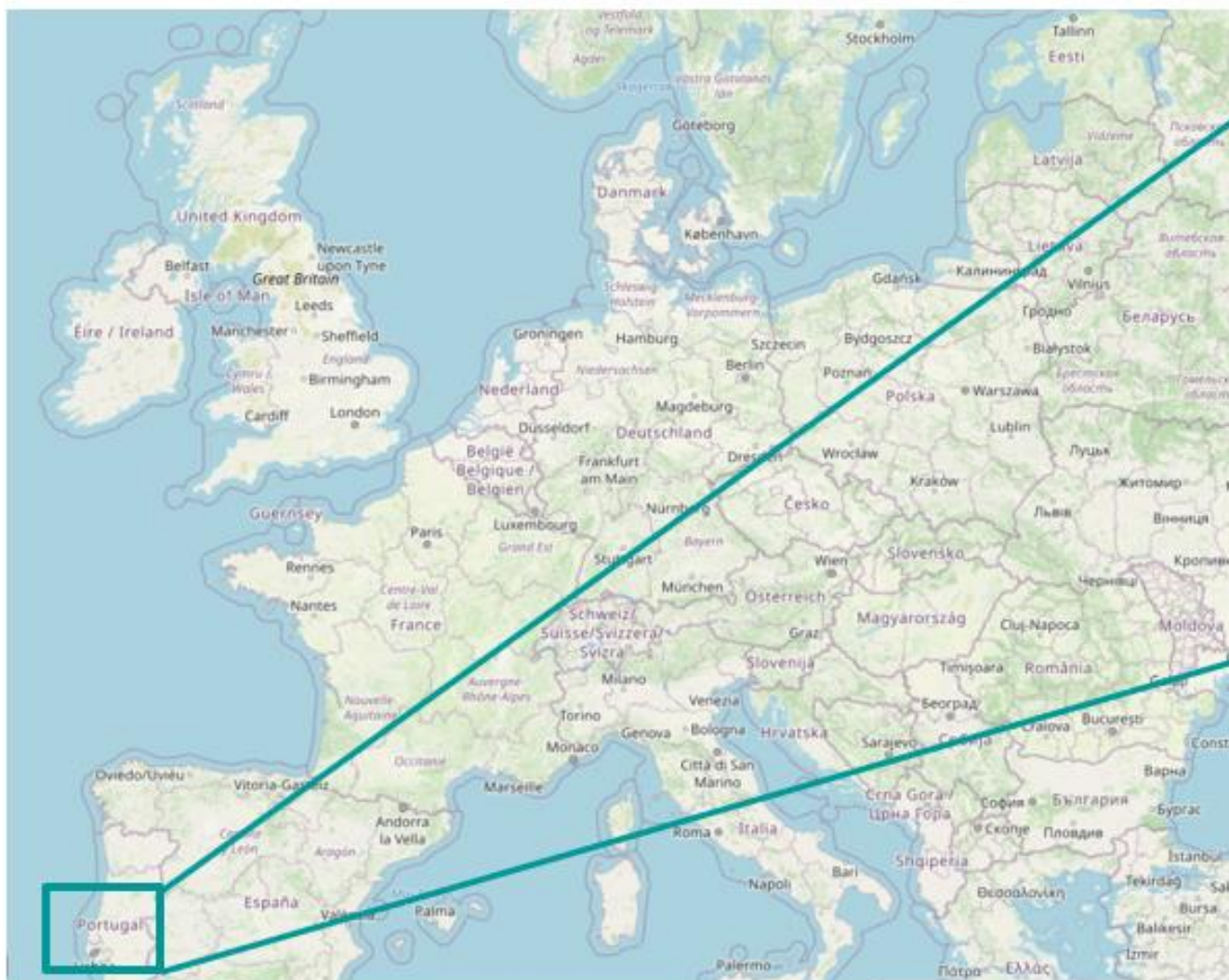
### Preconditions for implementation

- Political support from the municipalities and the region
- Successful application for funding (> 50 % of CAPEX)
- Availability of a second train supplier / project partner to retrofit trains willing to demonstrate FC trains in Sweden in the pilot phase (2022 – 2026)

### Next steps

- Organising the pre-testing phase (operation of the Alstom iLint train during 2 weeks in August 2021, accompanying evaluation of train performance, cost and acceptance)
- Settling for an ownership and operatorship model for the pilot phase (being transferable to the transition phase)
- Draft application for the next call in the EU Innovation Fund
- Launch RFI processes on HRS, electrolysers and buses





PDA REGION

# MEDIO-TÉJO (PORTUGAL)



openstreetmap.org

# MÉDIO-TÉJO



## SCOPE OF THE PROJECT – SUPPLY CHAIN, SCALE, LOCATION

- **The Médio Tejo region, in the centre of Portugal, is facing an important energy transition in the coming years, to decrease related greenhouse gas emissions.** On the transportation sector, the inhabitants heavily depend on the use of private cars and public transport to reach essential services such as education and healthcare.
- **As part of its mobility and energy strategies, the intermunicipal community of Médio Tejo (CIMT) and the regional energy agency MédioTejo21 see green hydrogen as one of the key solutions for the transition.** This is in line with the Portuguese hydrogen strategy released in 2020, aiming the increase use of hydrogen in key sectors such as road transport, gas network and industries. Moreover, the Recovery and Resilience Facility (RRF) plan for Portugal, submitted in April 2021, also considers hydrogen as a key sector to invest in the next years.
- **The Médio Tejo hydrogen project aims to build a full low carbon hydrogen supply chain in the region.** The objective is to install hydrogen production facilities, hydrogen refuelling stations, infrastructure for injection into the gas grid, to decarbonise sectors such as transportation and industry.
- **In terms of production, hydrogen will be produced via electrolysis using renewable electricity.**
- **In terms of hydrogen distribution,** the objective is to deploy several hydrogen refuelling stations, tailored to types and numbers of fuel cell vehicles deployed. It will create a region-wide network to facilitate refuelling of fleets.
- **The main transport use will be a fleet of 12 fuel cell coaches to operate on a new circular route** linking 6 small and medium-size cities in Médio Tejo. The objective is also to progressively integrate 17 coaches on the existing lines, so the inhabitants can benefit from low carbon public transport to travel between and within the municipalities. Other vehicles for public services, including vans and refuse trucks for waste collection, will be deployed. The project has several potential configurations and scales currently being finalised.
- **Hydrogen will also be used for injection into the gas grid.** This constitutes an opportunity to decarbonise heavy consumers of natural gas for heating purposes in the industrial, commercial and residential sectors.

# MEDIO-TÉJO



## PROJECT SPECIFICATIONS



### Key stakeholders

- Intermunicipal community of Médio Tejo (CIMT, Comunidade Intermunicipal do Médio Tejo)
- The regional energy agency MédioTejo21
- Several companies will be involved in this project, on the fuel value chain, from the production of hydrogen and renewable electricity to the operation of vehicles



### Budget

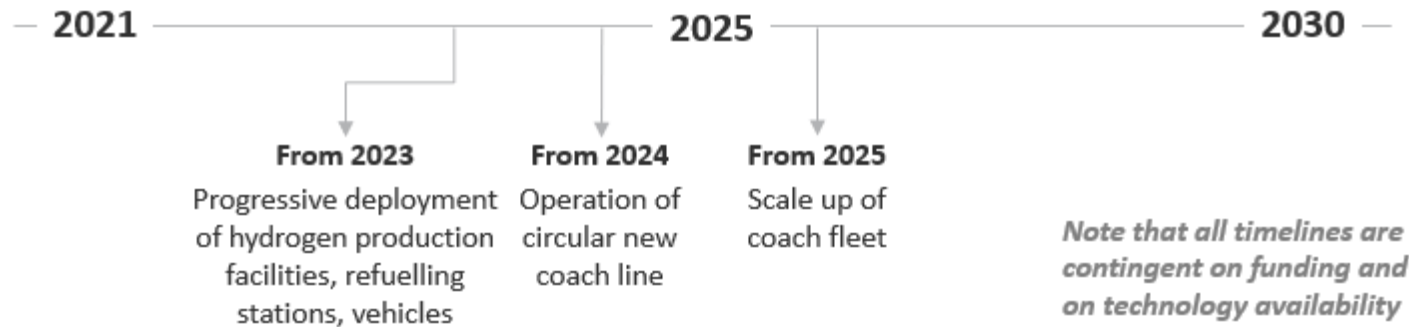
- The estimated budget for the fuel cell vehicles to be operated, including the fleet of coaches is €43 mn
- The future investments for the Médio Tejo hydrogen ecosystem will also cover hydrogen production, distribution equipment and infrastructure for injection in the gas grid

### Funding strategy

- The funding strategy will be based on a combination of public and private funding
- The delivery of the project will depend on obtaining public national and European funding. Some sources identified are the Recovery and Resilience facility, the Transition fund, CEF



### Timeline for deployment



### Summary of work undertaken in the PDA process

The PDA process has helped the partners to build the framework of a hydrogen ecosystem ready to be presented to local policy makers and to apply for funding which are necessary to proceed to the implementation phase. Consultancy support to the project stakeholders has:

- 1) **Provided stakeholders with information on fuel cell technologies** and successful European deployments to develop their understanding of the sector
- 2) **Led numerous stakeholder interviews** to include them in the process of the regional project development, inc. with potential H2 producers, vehicle suppliers, industrials
- 3) **Analysed in detail** data of local transport fleets, industries, gas networks to propose new opportunities for hydrogen demand in the region
- 4) **Proposed several configurations of deployment of infrastructure and vehicles**
- 5) **Supported the partners in the development of clear budget, project plans, technical specifications** to prepare for applications to funding calls

# MEDIO-TÉJO



Coaches



HRS



H2 infrastructure

## PRECONDITIONS – NEXT STEPS

### Preconditions for implementation

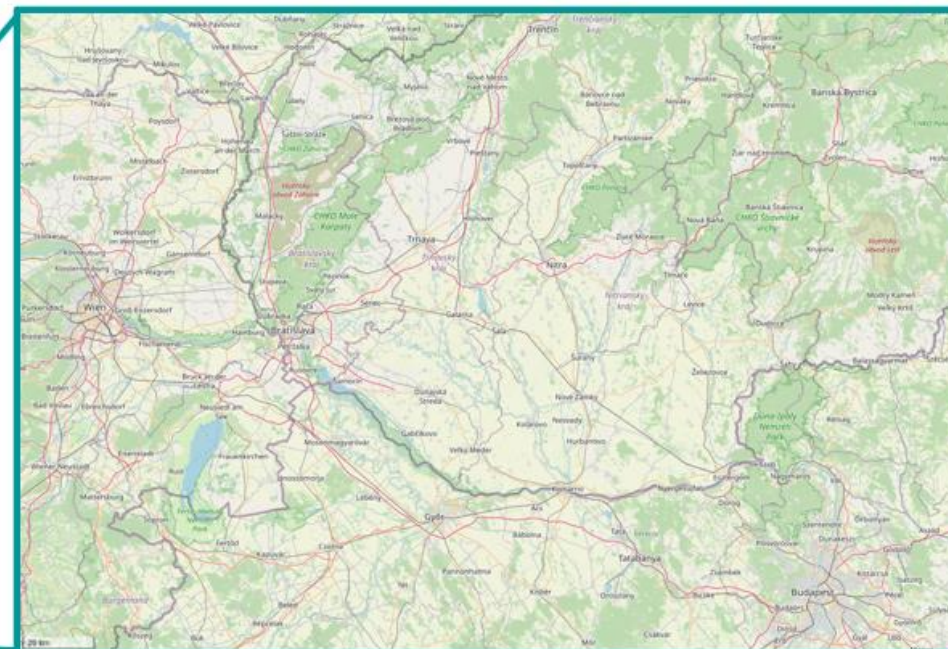
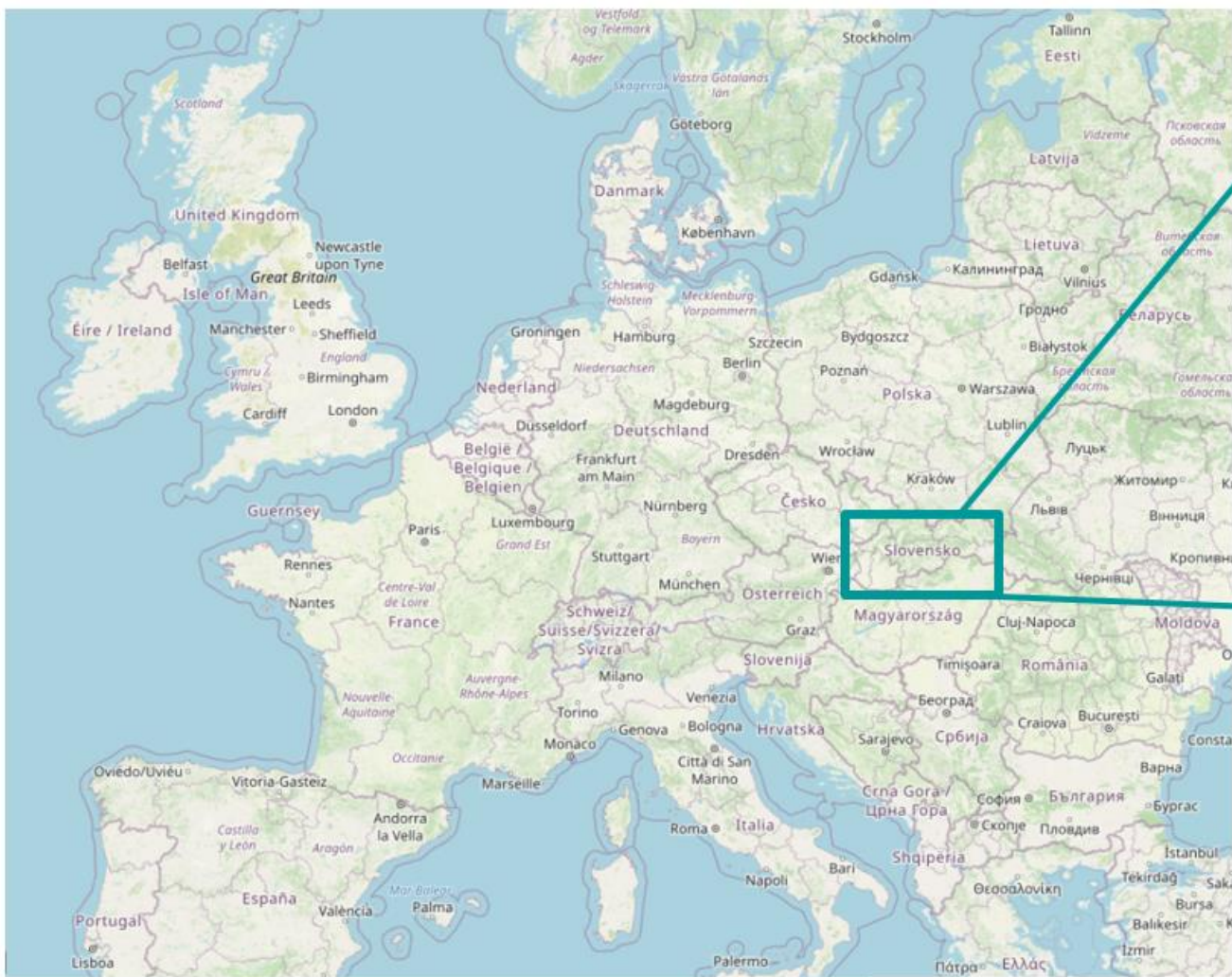
The public and private partners involved in the project are committed to proceed to the implementation of the project. However, the ability to proceed to the implementation phase is reliant on several topics identified during PDA:

- **Policy changes on a national scale** to clarify the regulation around hydrogen injection into the gas grid. This is planned by the Portuguese hydrogen strategy released in 2020
- **The availability of fuel cell coaches** in the envisaged timeline, as they would constitute the majority of the demand from transport
- **The acquisition of funding** to support the current cost gap for fuel cell vehicles relative to diesel vehicles

### Next steps

In order to reach the next phase of implementation the project will aim to:

- **Investigate EU and national funding streams** for green hydrogen production, distribution and use. The availability of funding from the Portugal Recovery and Resilience plan will be particularly monitored
- **Monitor any policy changes** about green hydrogen in Portugal, including regulation around the injection of hydrogen in the gas grid and licensing of hydrogen production project (existing “renewable gas” application for hydrogen production)



PDA REGION

# MOCENOK (SLOVAKIA)



Electrolysis green ammonia



HRS



Trains

openstreetmap.org

# MOČENOK



Electrolysis green ammonia



HRS



Trains

## SCOPE OF THE PROJECT – SUPPLY CHAIN, SCALE, LOCATION

- The H2Muctynic project aims to build the **first green hydrogen supply chain in Slovakia**, installing renewable energy sources, a hydrogen production hub, distribution facilities and refuelling infrastructure to **introduce low- or zero- carbon hydrogen into industrial and transport applications**.
- The project will **install up to 50MW of purpose-built renewable energy sources** to support the operation of a **20MW electrolyser on the Duslo ammonia facility in Močenok**. Due to the variability of electricity from renewable energy sources, the electrolyser will require a connection to the national grid network for ‘back-up’ energy supply. This connection can also be utilized to help **balance electricity demands** on a local and national scale, by absorbing additional energy on the electricity network and/or providing up/down response to help stabilise frequency and voltage variations.
- The low- or zero-carbon hydrogen produced by the electrolyser will primarily be used in the ammonia production process as a green replacement for existing fossil-fuel produced hydrogen. This will help Duslo reduce their emissions from the hydrogen production process, which today is expected to be responsible for 840,000 tonnes of carbon dioxide emissions per year. A **proportion of the hydrogen will also be dedicated to transport use cases** to demonstrate the technical and commercial feasibility of hydrogen refuelling stations and fuel cell electric vehicles. As the first planned fuel cell deployment in the country, the project will begin with a **pilot demonstration of two fuel cell multiple unit trains** which will be designed and built by local manufacturer ŽOS Vrutky, and deployed on regional routes by national railway carrier, Železničná spoločnosť Slovensko (ZSSK).
- After a successful demonstration, the project then aims to enter a **second phase from 2027 to scale up hydrogen demand from transport applications**. This includes plans to expand the fleet of fuel cell multiple units to replace all 12 vehicles operating on the regional route between Nové Zámky and Prievidza.
- It is **expected that the work conducted in the project will lead to further knock-on developments** as both public and private knowledge (and buy-in) of hydrogen increases. Partners are already looking at a ‘Phase 3’, with **Duslo outlining IPCEI plans for a 100MW electrolyser** and **ZSSK assessing their national network to determine the role fuel cells can play in their fleet composition** going forward (up to 53 trains have been deemed feasible).

# MOČENOK



Electrolysis green ammonia



HRS



Trains

## PROJECT SPECIFICATIONS



### Key stakeholders

- Močenok Municipality
- Slovak National Hydrogen Association (NVAŠ)
- Duslo a.s.
- Železničná spoločnosť Slovensko (ZSSK)
- Slovenská elektrizačná prenosová sústava, a. s. (SEPS)



### Timeline for deployment



### Budget

In total, the CAPEX and OPEX of the project are expected to amount to ~**€228.6 mn**, of which:

- **€188.9 mn** is for hydrogen production.
- **€39.7 mn** is for the hydrogen refuelling infrastructure and the deployment of two fuel cell multiple unit trains

### Funding strategy

- A total funding request of between €104.6 mn and €116.5 mn will be required for the project
- Key national funding targets have been identified, including:
  - Achieving Important Project of Common European Interest (IPCEI) status to allow state aid
  - Green Deal Funding (e.g. Just Transition)
  - Modernisation Fund
  - Dedicated EU funds will also be explored such as CEF funding

### Summary of work undertaken in the PDA process

Project Development Assistance has helped develop the H2Muctynic to an extent where partners are able to apply for funding and begin the transition to the implementation phase. Consultancy support to the project stakeholders has:

- 1) Provided stakeholders with materials and information** to further their understanding of the sector and develop their individual project plans (e.g. preparation of policy white paper to support hydrogen in national frameworks, composed requests for information to be sent to suppliers, etc.)
- 2) Initiated regular meetings between key project stakeholders** and defined a governance structure to drive project progress going forward
- 3) Supported outreach to other possible stakeholders** and initiated discussions with key equipment suppliers
- 4) Developed a clear project plan** outlining the key objectives, technical specifications and activities required to achieve implementation
- 5) Supported stakeholders in developing their business case** for deployment and devised a project budget to help guide funding applications

# MOČENOK



Electrolysis green ammonia



HRS



Trains



## PRECONDITIONS – NEXT STEPS

### Preconditions for implementation

Stakeholders within the H2Muctynic project are committed to developing the project further, with the aim to enter an implementation phase within one year. However, the ability to proceed to the implementation phase is heavily reliant on:

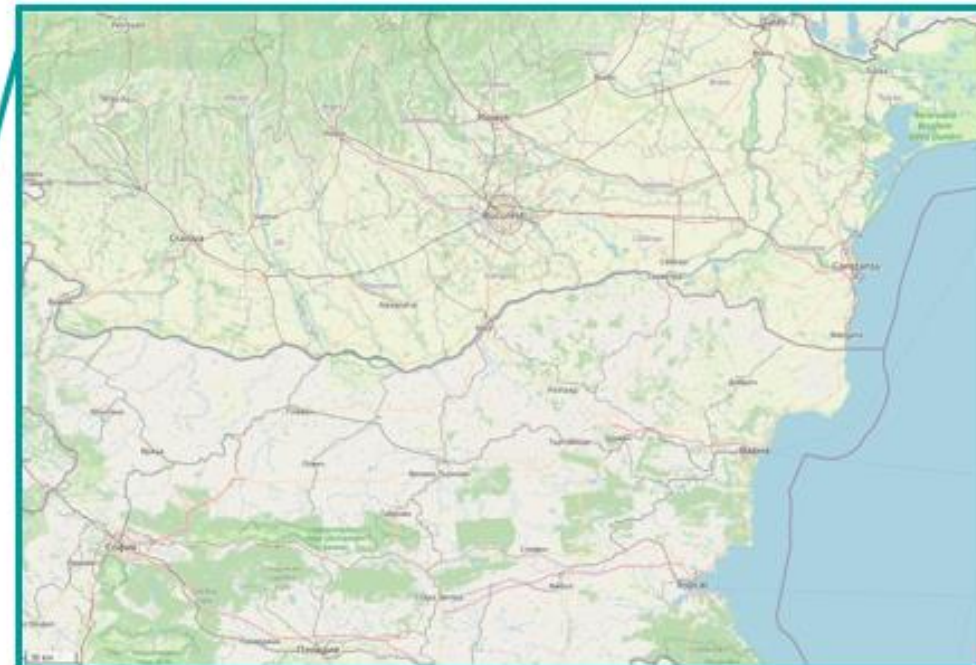
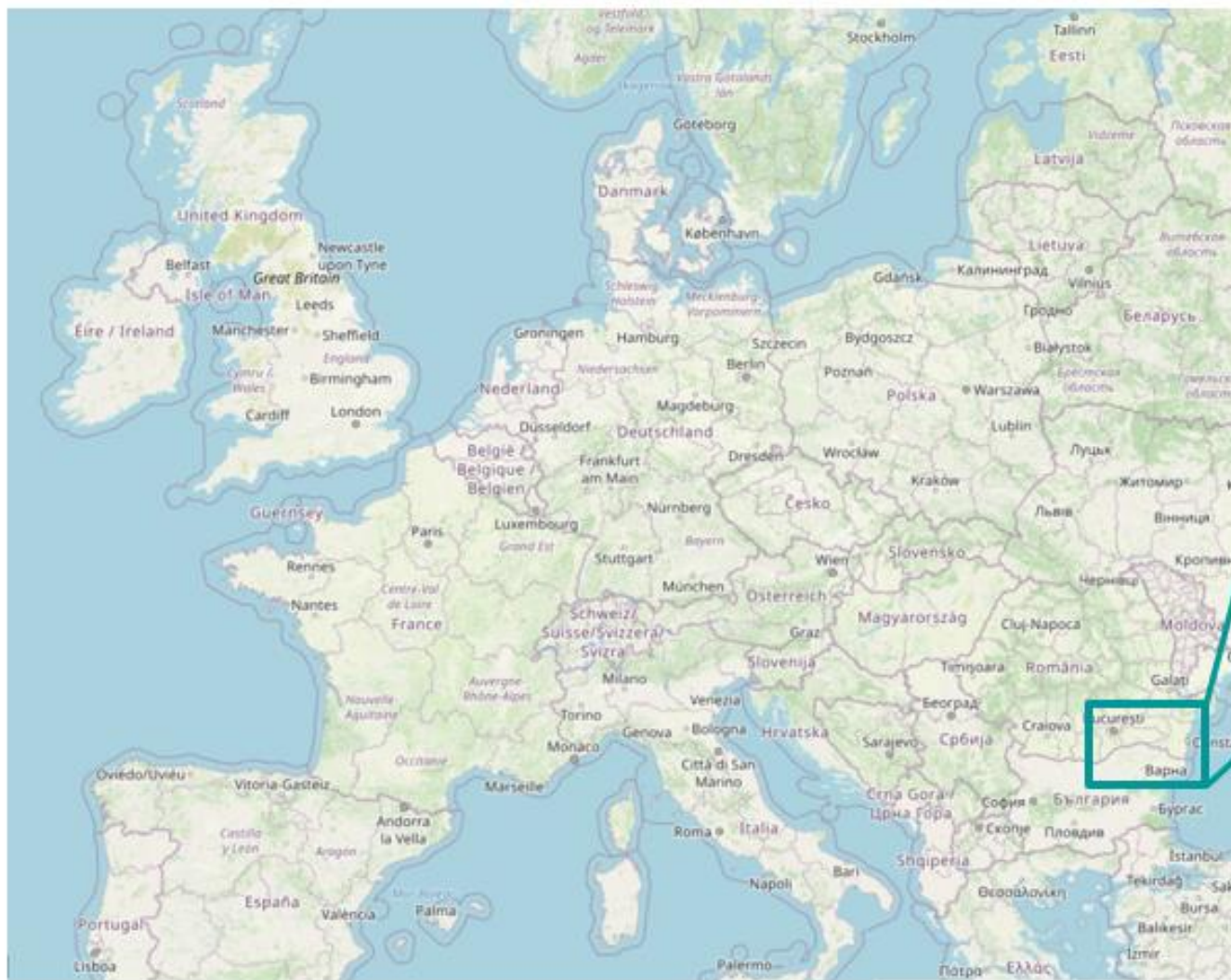
- Slovakia **recognising hydrogen as key to enabling a transition** to a green economy and hence incentivising its uptake
- **Policy changes on a national scale** to reduce the legislative barriers in the way of creating a green hydrogen supply chain (e.g. reduce barriers to access low-cost electricity for the electrolyser)
- The **acquisition of funding** to support the full funding gap encountered when producing zero- or low-carbon hydrogen (in comparison to steam-methane reforming processes) and operating fuel cell vehicles (in comparison to diesel vehicles)
- **All stakeholders to move in parallel** to ensure that commissioning timelines are aligned and the business case for operations is optimised

### Next steps

In order to reach the next phase of implementation the project should aim to:

- Leverage the national hydrogen strategy and **advocate for political and financial support from policy makers**
- **Submit a proposal to policy makers** which outlines the key areas for legislative changes required on the energy market
- **Provide policy makers with suggestions on policy support** dedicated to green hydrogen production to provide a foundation for new legislation
- **Investigate and apply to EU funding streams and advocate for dedicated funding** for green hydrogen production, and use, in Slovakia





PDA REGION

RUSE (BULGARIA)



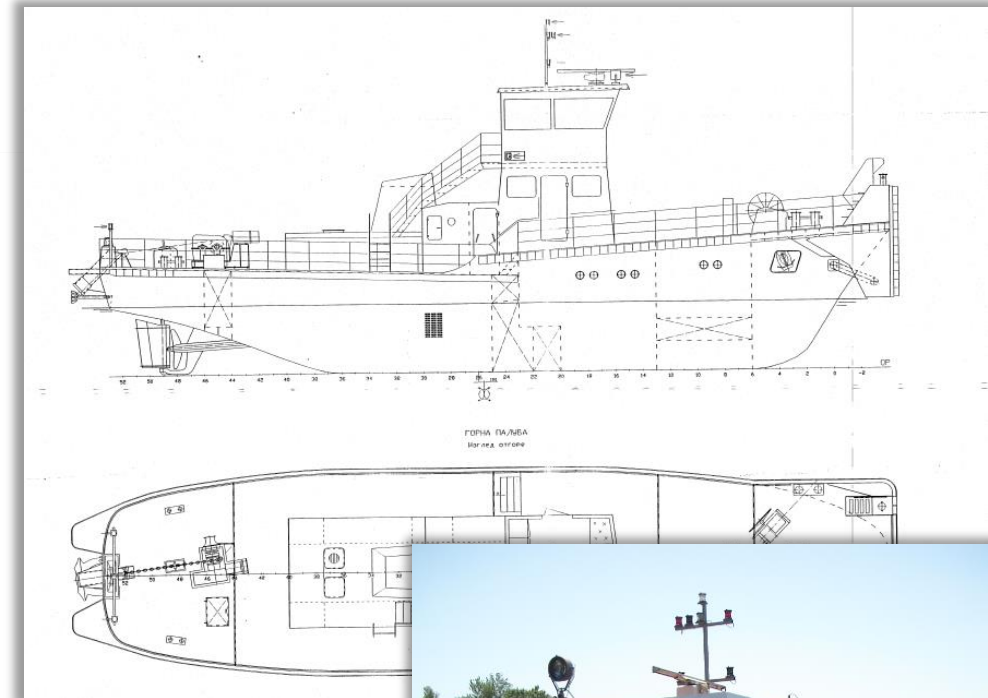
# RUSE Freight ships

## SCOPE OF THE PROJECT – SUPPLY CHAIN, SCALE, LOCATION

In future, it is expected that the plentiful solar resources in Bulgaria will allow the country to export large quantities of low-cost low-carbon hydrogen to North Europe. The Green Hydrogen @ Blue Danube strategy envisages that the production and transport of hydrogen will become a major economic activity for Bulgaria, and the Danube River transport axis will play a key role in this strategy. Zero emission vessels will carry large quantities of low-carbon hydrogen, produced from solar electricity at large-scale, centralised electrolysis sites, to countries such as Germany via the Danube River.

The implementation of this strategy will require significant upscaling in green hydrogen production capacity, development of zero emission freight vessel technology, and deployment of large-scale refuelling infrastructure at ports along the Danube. Ruse will take the first step in the development of this new economic activity for Bulgaria by demonstrating the viability of hydrogen production, refuelling, and maritime technology, developing skills and knowledge around hydrogen, and setting out a legislative framework for future deployments. Further deployment of hydrogen technology at critical Danube port locations is expected to follow the initial demonstration in Ruse.

The Ruse hydrogen project will retrofit an existing tugboat with a zero-emission hybrid battery and fuel cell drivetrain and operate the vessel on the Danube River. The vessel will be refuelled at Port Ruse East using a novel mobile refuelling solution and low carbon hydrogen produced from an electrolyser located at the Ruse municipal bus depot. The electrolyser will be supplied with power from a new photovoltaic park, also located at the bus depot. In addition to use in the tugboat, hydrogen will also be used to fuel a fleet of twenty standard fuel cell buses, operated on public transport routes in the city as part of the Ruse Municipal fleet.



Tugboat 'Voyager', that will be retrofitted with a hybrid fuel cell and battery system



Source of pictures: Bulgarian River Shipping J.S.Co.

# RUSE Freight ships

## PROJECT SPECIFICATIONS



### Key stakeholders

- **Association of Danube River Municipalities:** project management
- **Bulgarian River Shipping J.S.Co:** will provide the ship and retrofit the ship with the battery/hydrogen drivetrain
- **Ruse Municipal Transport J.S.Co:** operation and maintenance of fuel cell buses and electrolyser



### Budget

### Funding strategy

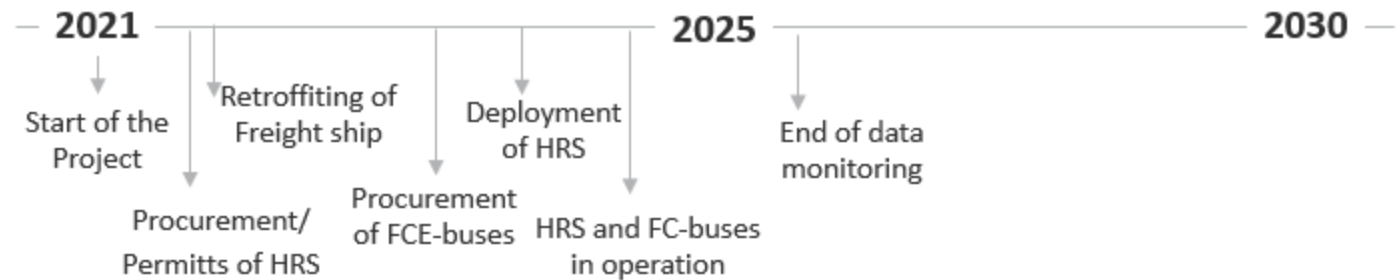
- €11 mn (FC buses)
- €8 mn CAPEX & OPEX Electrolyser
- €4 mn (Retrofitting of Freight ship (CAPEX))
- €384,000 (Project management)
- **Total: €23.4 mn**

Funding for the project is expected to be sourced from a combination of Bulgarian national funding programmes:

- State aid through the Green Hydrogen @ Blue Danube IPCEI
- The Recovery and Resilience Facility
- The Modernization Fund



### Timeline for deployment



### Summary of work undertaken in the PDA process

- 1) Engaging with Bulgarian River Shipping as a key stakeholder in the project
- 2) Selection of a suitable vessel for retrofitting activities
- 3) Analysis of freight ship performance requirements to set up a initial freight ship specification and characteristics
- 4) Development of technical specifications for hydrogen production and refuelling infrastructure
- 5) Analysis of bus routes to set up a technical specification for the 20 fuel cell buses
- 6) Project financial analysis and development of funding strategy, through analysis of available funding sources
- 7) Development of an Implementation strategy and work package structure, to act as a working document during the project implementation

# RUSE Freight ships

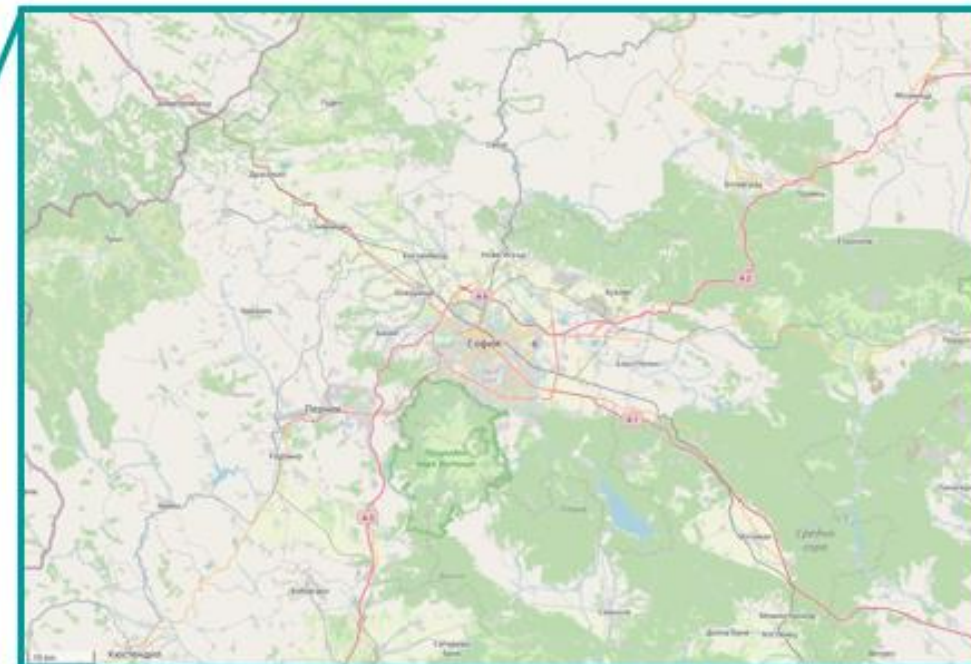
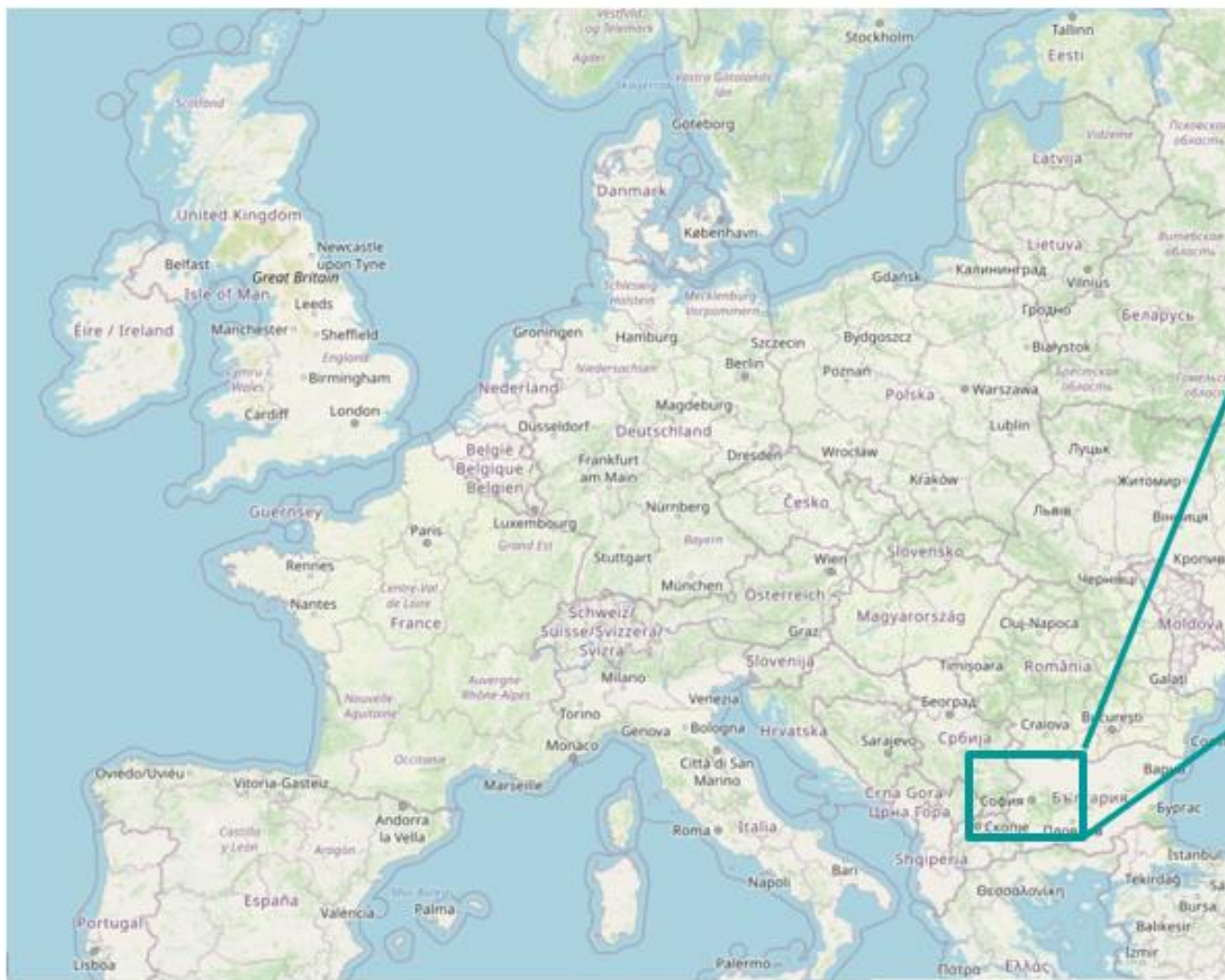
## PRECONDITIONS – NEXT STEPS

### Preconditions for implementation

- Stakeholders within the Ruse project are committed to proceeding to the implementation phase of the project within the next year, following the acquisition of funding to support the project. Project Development Assistance has supported the Ruse project to develop mitigation strategies in the case that national funding is not available. Funding may be sought from:
  - The Connecting Europe Facility (CEF) for production and refuelling infrastructure
  - The Innovation Fund for tugboat retrofitting activities.
  - Other European calls that are yet to be published: Horizon Europe, Green Deal, etc.
- The Ruse team will monitor the relevant portals for further European funding opportunities
- Further, successful implementation of the project is reliant on:
  - Detailed design and certification of the planned tugboat retrofit system
  - Availability of fuel cell buses in Bulgaria on the required timelines

### Next steps

- In order to proceed to the implementation phase of the project, the Ruse team will complete the following steps over the year following PDA support:
  - Prepare and submit a funding proposal for the first phase of the Green Hydrogen @ Blue Danube IPCEI to the Bulgarian government
  - Submit an application for funding under the Recovery and Resilience facility to the Bulgaria government
  - Maintain close communication with maritime registration and certification authorities on vessel retrofitting activities
  - Work closely with fellow PDA region Sofia to develop Bulgarian expertise on vehicle and vessel retrofitting with fuel cell technology, and exploit this in ,follower‘ regions Stara Zagora and Burgas
  - Develop a network of Danube river hydrogen regions for communication and dissemination



PDA REGION

**SOFIA (BULGARIA)**



Buses



HRS

# SOFIA



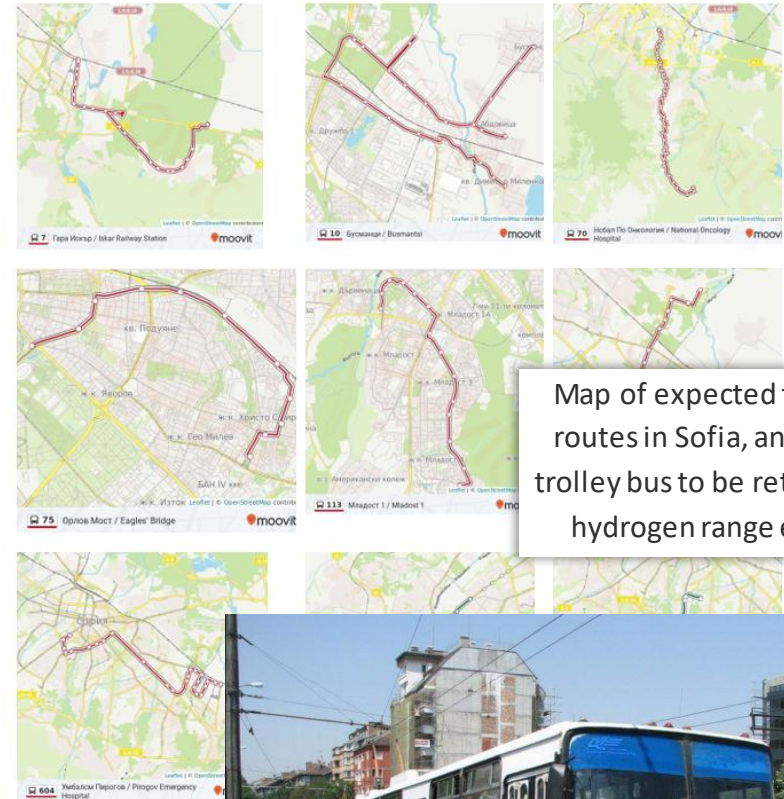
## SCOPE OF THE PROJECT – SUPPLY CHAIN, SCALE, LOCATION

Bulgaria is currently heavily reliant on coal production to both produce electricity and generate jobs. The country views clean hydrogen as a new economic activity that will exploit existing expertise to create new jobs across two key sectors:

- Creating a new market for low cost, low-carbon hydrogen produced from abundant solar resources at large-scale centralised production hubs for use in Bulgaria and for export to the rest of Europe
- Developing capabilities to retrofit existing vehicles with fuel cell drivetrains for use across the country, thereby keeping the economic benefits of the new sector within the country since Bulgaria is not home to any vehicle manufacturers

While hydrogen has not yet been deployed in Bulgaria as a clean energy vector, interest in the sector has been steadily growing for a number of years. The Sofia hydrogen project will be a flagship deployment of hydrogen transport in Bulgaria, demonstrating the efficacy of hydrogen fuel cell technology in public transport applications. A combination of new and retrofitted hydrogen fuel cell vehicles will be demonstrated on public transport routes across Sofia. This will include 24 standard fuel cell buses and 6 inter-city buses, as well as 30 trolleybuses that will be retrofitted with hydrogen range extenders to allow them to travel on expanded routes across the city.

Low-carbon hydrogen will be provided by an integrated electrolyser and refuelling station located at the bus depot. Electricity to supply the electrolyser will be sourced from a photovoltaic park, located on municipal land in Sofia. The electricity will be transmitted through the DC trolleybus grid, thereby increasing the efficiency of hydrogen production and reducing electrolyser system capital costs by mitigating the need for a rectifier (which would be required if using AC grid electricity).



Map of expected fuel cell bus routes in Sofia, and the Ikarus trolley bus to be retrofitted with hydrogen range extenders.



Source of pictures: Sofia Municipality / Stolichen Elektrotransport, moovitapp.com

# SOFIA




## PROJECT SPECIFICATIONS



### Key stakeholders

- Sofia Municipality
- Zagora Holding
- Stolichen Elektrotransport
- BGH2A
- Bulgarian Academy of Sciences
- Stara Zagora Municipality



### Budget

- €17 mn (FC buses)
- €13 mn CAPEX & OPEX Electrolyser
- €16 mn (Retrofitting of Trolleybuses)
- €432,000 (Project management)
- **Total: €46 mn**

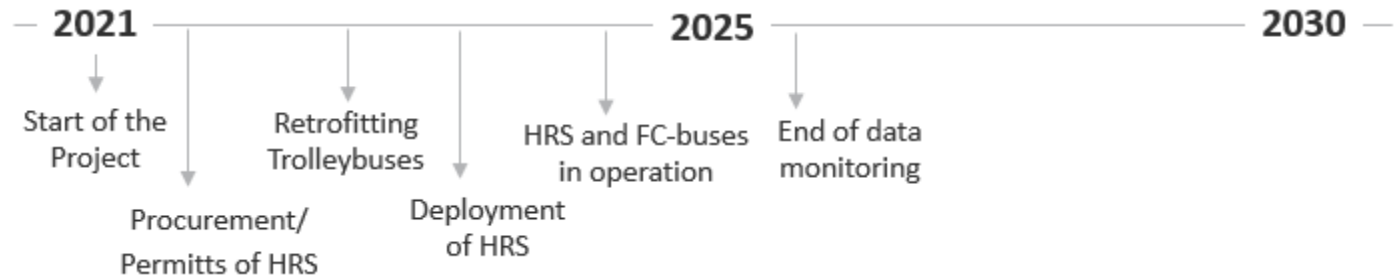
### Funding strategy

Funding for the project is expected to be sourced from a combination of Bulgarian national and EU funding programmes:

- The Recovery and Resilience Facility
- The Modernization Fund,
- State aid through designation of the project as an Important Project of Common European Interest
- Other EU programmes (FCH JU, CEF)



### Timeline for deployment



### Summary of work undertaken in the PDA process

- 1) Support for siting and sizing of photovoltaics and electrolyser, and development of the strategy for clean energy distribution using the DC trolleybus grid
- 2) Development of technical specifications for hydrogen production and refuelling infrastructure
- 3) Analysis of bus routes to set up a initial FCE-bus specification and characteristics of trolleybus retrofitting concept
- 4) Engagement with bus OEMs to provide details of the planned market offering in the coming years
- 5) Financial analysis of project costs and funding gap
- 6) Development of funding strategy based on analysis of available national and European funding sources
- 7) Set up an implementation strategy and work package structure, to be used as a basis for the implementation of the project
- 8) Support of engagement with Stara Zagora on vehicle retrofitting programmes



## PRECONDITIONS – NEXT STEPS

### Preconditions for implementation

Stakeholders within the Sofia project are committed to proceeding to the implementation phase of the project within the next year.

Implementation of the project is, however, contingent on a number of conditions:

- Acquisition of funding from the Bulgarian government through operational programmes and national funding sources
- Certification of trolleybus technology for use on public transport routes
- Availability of fuel cell buses and coaches in Bulgaria on the required timelines
- Continued cooperation with Stara Zagora on the vehicle retrofitting programme

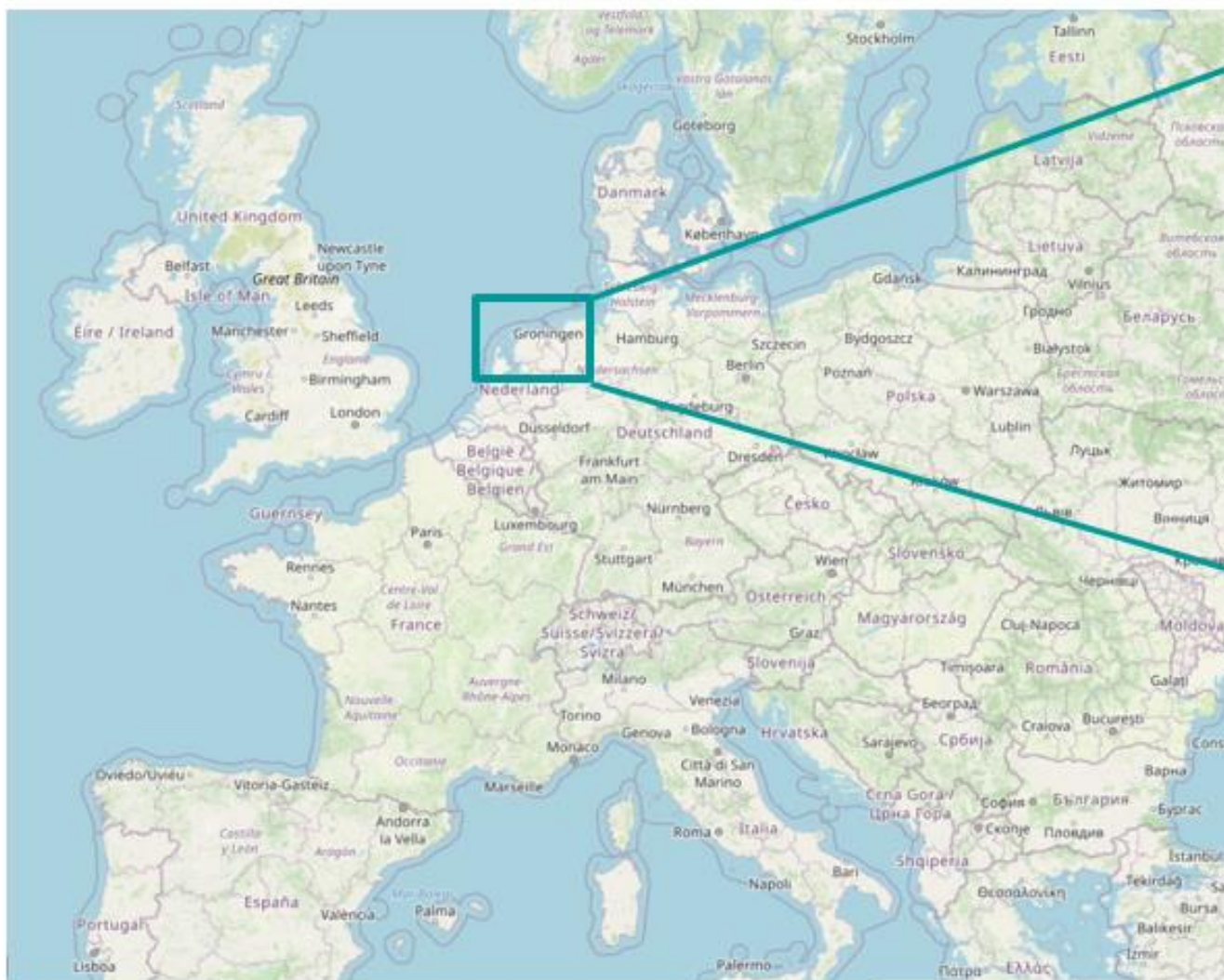
Project Development Assistance has supported the project to develop mitigation strategies should any of these risks occur

### Next steps

In order to proceed to the implementation phase of the project, the Sofia team will complete the following steps over the year following PDA support:

- Prepare and submit a funding proposal to the Bulgarian government for operational programme funding
- Working alongside the Bulgarian government to develop plans for implementation of policy support for the use of low carbon hydrogen in transport, to enable future projects
- Work closely with fellow PDA region Ruse to develop Bulgarian expertise on vehicle and vessel retrofitting with fuel cell technology
- Continue work with Stara Zagora to develop training programmes on vehicle retrofitting with fuel cell drivetrains





PDA REGION

TEXEL ISLAND (THE NETHERLANDS)



Smart sector-coupling on islands

# TEXEL



Smart sector-coupling on islands

## SCOPE OF THE PROJECT – SUPPLY CHAIN, SCALE, LOCATION

The Texel island is embarking upon a transition towards sustainability and self-sufficiency in which hydrogen is foreseen to play an important role in decarbonising sectors like mobility, residential and maritime as well as (renewable) energy storage and grid congestion management. A hydrogen blueprint for islands was worked out during the PDA which centred around the indigenous production of green hydrogen and oxygen from the existing 2MWp renewable energy PV field at the wastewater treatment plant of the island. The electrolyser will be integrated in the existing smart grid and energy management system of the complete waste and pump water system of the island. Hydrogen therefore will be the next, big step, towards an energy self-sufficient island, since the water system is already energy neutral on the renewable energy.

A 1 MW electrolyser will produce green oxygen that may initially be utilised at the wastewater treatment plant itself, for oxygen aeration and ozone production in the future. Ozone can be used to further improve the water quality by removing micro-pollutants, which results in cleaner water on the Texel island, included in the Nature 2000 nature areas' farmlands and Unesco World Heritage Wadden Sea. The green hydrogen produced can be utilised for decarbonisation purposes. In the scope of the PDA are zero-emission refuse trucks, street sweepers, public transport, taxi services, personal vehicles, light commercial vehicles, residential and recreational buildings and a living lab for auxiliary power provision on a research vessel.

A scale-up scenario is foreseen in which an increase in hydrogen demand in the future can be accommodated as much as possible. A blueprint concept in which green oxygen and hydrogen are produced and consumed on the island to facilitate the transition towards cleaner energy and water would, at least in concept, be replicable to other islands and/or regions.

# TEXEL ISLAND



Smart sector-coupling on islands

## PROJECT SPECIFICATIONS



### Key stakeholders

- Municipality of Texel (PDA Awardee + municipal fleet)
- Regional water authority (HHNK)
- Public transport / contracted taxi services (TBO)
- Residential (Woontij)
- Living Lab for resesach vessel (NIOZ)
- Light commercial vehicles HHNK (HHNK, Tatenhove, SBB)



### Budget

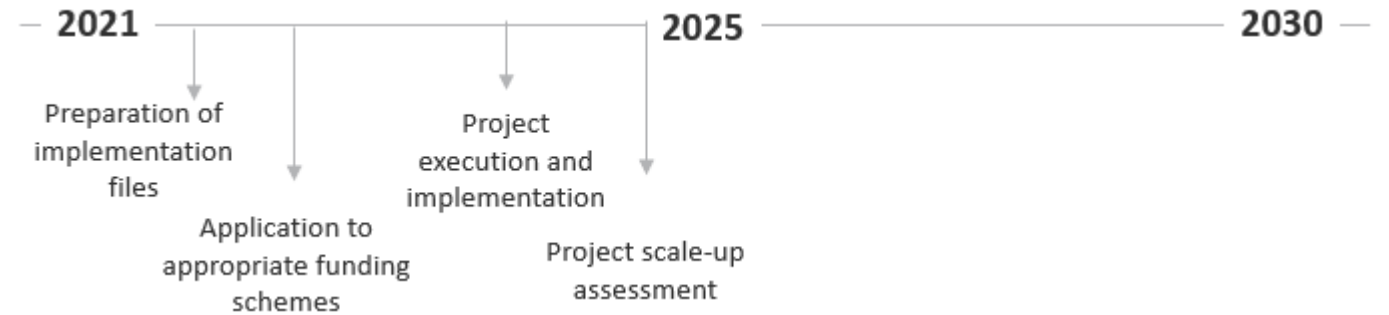
- Total project portfolio: € 9-12 mn

### Funding strategy

- Regional (Waddenfonds, IKW-Eilanden op Eigen Kracht, Programma Waddeneilanden, Provincie Noord-Holland)
- National (DKTI, SDE++, DEI+)
- Europe (Innovation Fund, Interreg, Life, Recovery and Resillaince Facility, NESOI Island Facility)



### Timeline for deployment



### Summary of work undertaken in the PDA process

- 1) Knowledge and capacity building for stakeholders involved in the PDA
- 2) Stakeholder visits, interaction and communication
- 3) Tailored individual business case development for stakeholders in Dutch
- 4) Acquisition of market and supplier information and pricing of products
- 5) Assistance in the development of a matured tool for the techno-economic assessment of green hydrogen and oxygen production at wastewater treatment plant
- 6) Overall business case development for the project
- 7) Interaction with funding organisations through funding pitches and meetings
- 8) Development of implementation strategy

# TEXEL ISLAND



Smart sector-coupling on islands

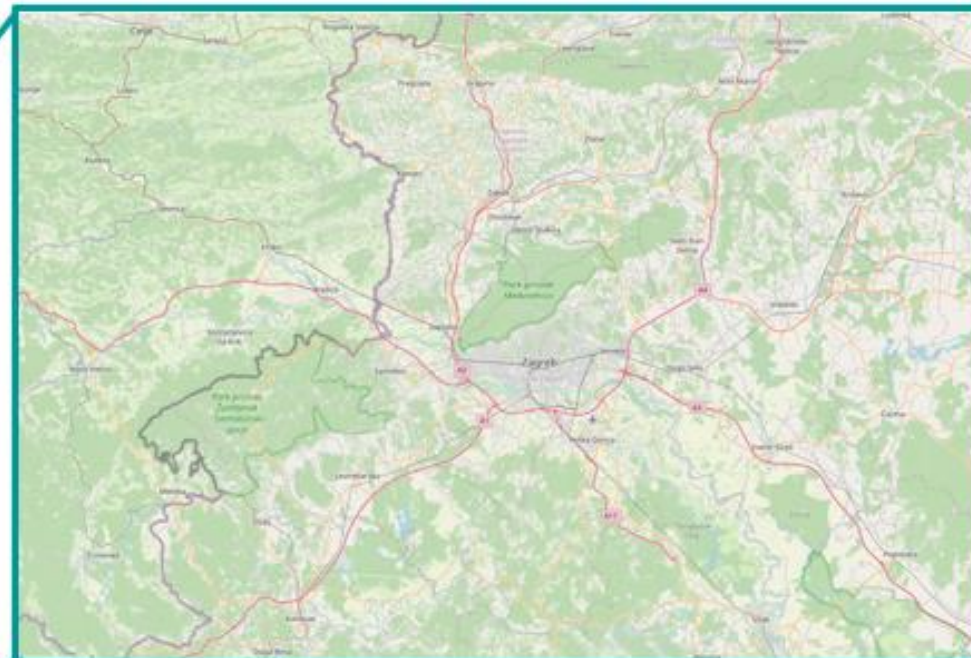
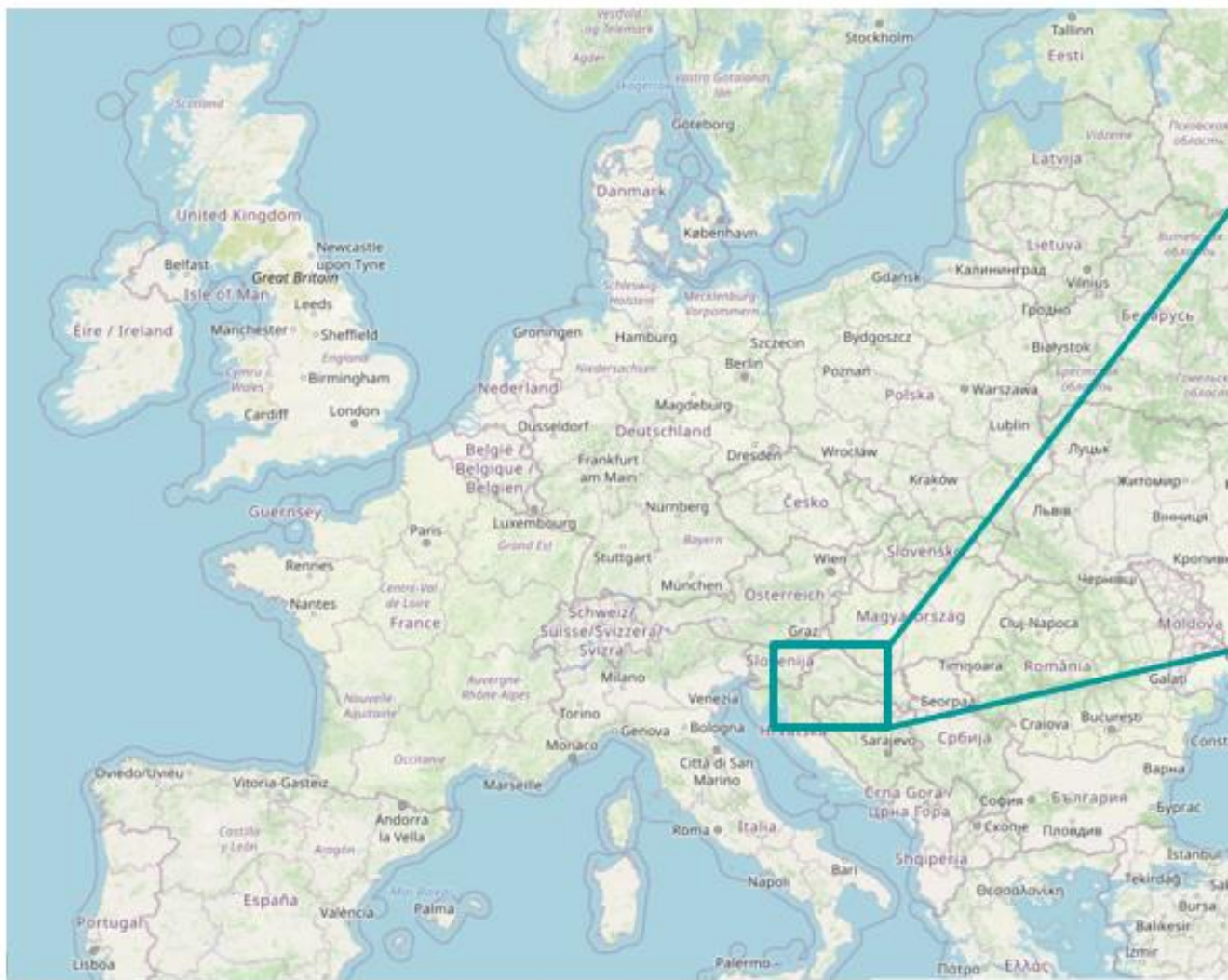
## PRECONDITIONS – NEXT STEPS

### Proconditios for implementation

- Access to funding is key as business cases are challenging. Funding sources need to enable the development of small, local hydrogen ecosystems. Several funding programmes, both on national and European level, are currently under development which makes the applicability and timing of call topics uncertain, but would on the other hand still allow for dedicated lobbying efforts for the blueprint concept
- The development of an ecosystem requires commitment from a diverse set of stakeholders towards implementation of hydrogen on the island. Such a commitment is partially dependent on the finance ability and alignment of the individual and the overall business case. The application of an appropriate governance and funding structure to manage the overall project and the individual partners is key for taking the next steps

### Next steps

- Obtain (managerial) commitment from all relevant stakeholders that want to proceed with taking the next steps towards the development of a hydrogen ecosystem blueprint on Texel
- Application of a governance structure, funding and assignment of a project manager to organise and manage the different elements of the development of the hydrogen ecosystem blueprint
- Lobbying, pitching and application for funds on regional, national and European level
- Due to the complexity of getting funding, the required expertise for that and the small size of the stakeholders, external funding for this is probably needed to start that process
- Preparation of the necessary steps prior to the implementation of the hydrogen ecosystem blueprint, for example permits



PDA REGION

# ZAGREB (CROATIA)



Buses



HRS



H2 infrastructure

openstreetmap.org

# ZAGREB



Buses



HRS



H2 infrastructure

## SCOPE OF THE PROJECT – SUPPLY CHAIN, SCALE, LOCATION

The Zagreb hydrogen project will **kick-start the use of low carbon hydrogen as a clean energy vector** to decarbonise various difficult-to-address sectors of the economy in Croatia, starting with the demonstration of the benefits and use case for hydrogen in public transport applications.

The Zagreb project will use **600kg/day of hydrogen for public transport** in the City of Zagreb, with deployment expected in 2025. This demand will be provided by a fleet of fuel cell buses owned and operated by Zagreb Electric Tram (ZET) on public transport routes across the city with full support of the City of Zagreb.

Plans for **low-carbon hydrogen production from electrolysis** at one of the Croatian nation oil company (INA) refineries at Rijeka or Sisak have been developed to guarantee a source of low-carbon hydrogen will be available for the project. During the PDA support period, the City of Zagreb, in accordance with the national legislation regarding RED II implementation for transport, has mandated that only low-carbon hydrogen is permitted to be used in transport. This hydrogen will fuel the buses at a hydrogen refuelling station located in Zagreb, at the Podsused depot.

Investment in this flagship project for Croatia is expected to kick-start the use of hydrogen to **achieve Croatian climate goals, reduce local air pollution** in the City of Zagreb, and develop the necessary skills and expertise to **allow other Croatian cities and regions to decarbonise their own public transport fleets** through the use of hydrogen fuel cell vehicles. Subsequent hydrogen deployment projects in Croatia will benefit from the experience of the Zagreb project, increasing the speed and scale at which they can be deployed and reducing both project cost and investment risk. Developing a hydrogen supply chain at scale in Croatia will also lead to significant economic benefits by allowing skilled workers from the oil and gas industry to transfer their skills to a new sector compatible with a decarbonised economy.



# ZAGREB



Buses



HRS



H2 infrastructure

## PROJECT SPECIFICATIONS



### Key stakeholders

- **The City of Zagreb:** procurement of buses and hydrogen, project management, dissemination
- **Zagreb Electric Tram:** operation of the fuel cell buses
- **INA:** Croatian national oil company responsible for hydrogen production, distribution and refuelling



### Budget

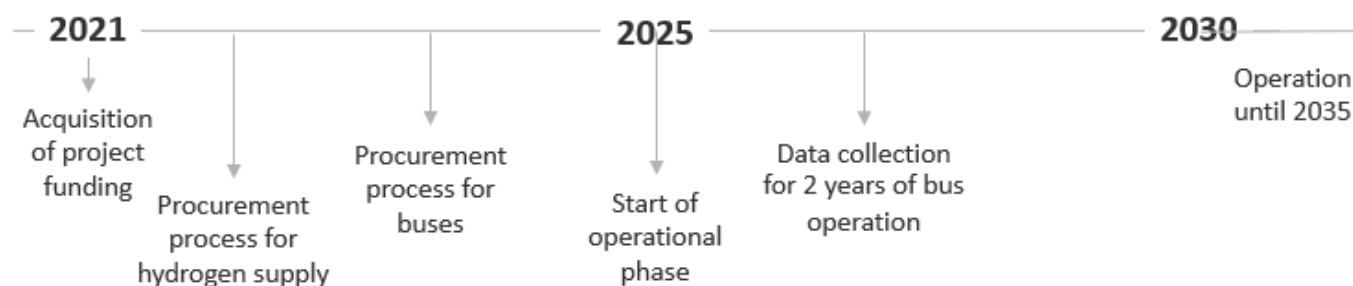
- CAPEX: €16 mn - €23 mn for buses and bus depot upgrades
- OPEX: €17 mn - €30 mn operating expenses (fuel and maintenance) over the first 10 years of deployment.

### Funding strategy

- City of Zagreb public transport operational programme is expected to fund the cost of the project, with significant EU and national-level co-funding



### Timeline for deployment



### Summary of work undertaken in the PDA process

- 1) Information on the availability and use case for fuel cell buses has enabled ZET to determine routes to be taken by the fuel cell buses
- 2) Engagement with relevant departments at the City of Zagreb has removed regulatory barriers to deployment, e.g. permitting
- 3) Procurement and contracting strategies for the hydrogen for the project are now in place
- 4) Techno-economic modelling and best practice advice on hydrogen production have been provided to support the development of plans for low-carbon hydrogen production at one of INA's refineries
- 5) INA and ZET have published requests for information (RFIs) on hydrogen infrastructure and fuel cell buses respectively and send these to technology suppliers
- 6) Financial modelling for the project has been used to demonstrate the funding required to support the project and sensitivity to key variables

# ZAGREB



Buses



HRS



H2 infrastructure

## PRECONDITIONS – NEXT STEPS

### Preconditions for implementation

- Stakeholders within the Zagreb project are committed to proceeding to the implementation phase of the project within the next year
- Implementation of the project according to the plans developed during the support period is heavily contingent on:
  - The acquisition of funding to cover the full funding gap for deployment of hydrogen fuel cell vehicles, compared with the diesel alternatives
  - Continued political support for the project following the recent elections in Zagreb
  - INA proceeding with plans to install low carbon hydrogen production at one of its refinery sites in Croatia
  - Bus OEMs bringing an articulated fuel cell bus to market on the 2024 timescale
- Wherever possible, Project Development Assistance has supported the Zagreb project to develop mitigation strategies should any of the risks to the project occur

### Next steps

In order to reach the next phase of implementation the project will:

- Continue to communicate the importance and positive impacts of the project to decision makers at a local and national level
- Lobby for dedicated funding for the project from the Croatian government
- Engage with other regions in Croatia to support the development of further hydrogen projects across the country
- Release a tender for 600kg/day of low carbon hydrogen supply and refuelling at the Podsused bus depot



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**FUEL CELLS AND HYDROGEN**  
JOINT UNDERTAKING