

# EMPOWER

Eco-operated, Modular, highly efficient, and flexible multi-POWERtrain for long-haul heavy-duty vehicles

Presenter:

Popovac Mirza (AIT)





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## General information

- Topic:  
Modular multi-powertrain zero-emission systems for HDV (BEV and FCEV) for efficient and economic operation (2ZERO)
- Topic identifier:  
HORIZON-CL5-2022-D5-01-08
- Type of action:  
Innovation Action (IA)
- Coordinator:  
AIT Austrian Institute of Technology GmbH
- Grant agreement number:  
101096028 - EMPOWER
- Maximum grant amount:  
18,052,313.00 EUR

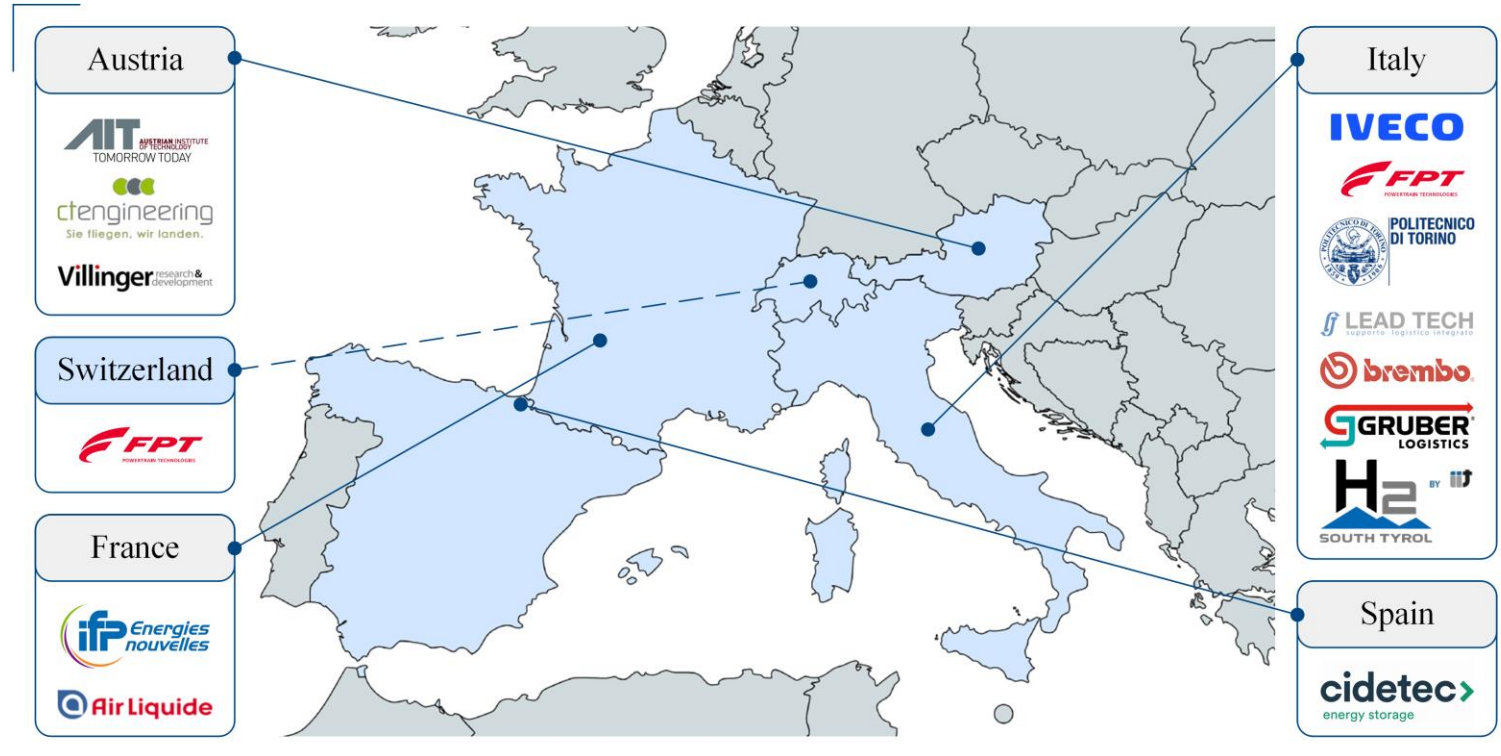


## Eco-operated, Modular, highly efficient, and flexible multi-POWERtrain for long-haul heavy-duty vehicles Consortium

<b>Participant No</b>	<b>Short name</b>	<b>Participant organisation name</b>	<b>Country</b>
1 Coordinator	AIT	AIT Austrian Institute of Technology GmbH	AT
2	IVECO	IVECO SPA	IT
3	FPT	FPT Industrial SPA	IT
4	IFPEN	IFP Énergies nouvelles	FR
5	POLITO	Politecnico di Torino	IT
6	LT	Lead Tech SRL	IT
7	VIL	Villinger GmbH	AT
8	CID	Fundación CIDETEC	ES
9	CTE	CT Engineering GmbH	AT
10	GLO	GRUBER Logistics S.p.A.	IT
11	BRE	BREMBO SPA	IT
12	IIT	Istituto per Innovazioni Tecnologiche Bolzano S.c.a.r.l.	IT
13	ALFI	Air Liquide France Industrie	FR
14	FMF	FPT Motorenforschung AG	CH



## Eco-operated, Modular, highly efficient, and flexible multi-POWERtrain for long-haul heavy-duty vehicles Consortium composition





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## Objectives and ambition

- The objective of EMPOWER is to deliver **two modular and flexible Zero-Emission Heavy-Duty Vehicles (ZE HDVs)** of **Vehicle Energy Consumption Calculation Tool (VECTO) group 9**
- **Fuel Cell Electric Vehicle (FCEV)** suitable for **long-haul operation** conditions with a maximum unrefuelled driving range of **750 km**
- **Battery Electric Vehicle (BEV)** designed for **regional delivery mission** profiles with a maximum uncharged driving range of **400 km**
- Gross Vehicle Weight (GVW) of at least **40 tons**, both at **Technology Readiness Level (TRL) 8**
- Develop, implement and demonstrate **FCEV** and **BEV**, guaranteeing a **maximum load capacity of not less than 90 %** compared to conventional trucks of this class and making them **ready to enter the market in 2029** with equal total cost of operation with 2020 engine-based solutions assuming a production volume of more than 10,000 pieces/year.



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## AREAs

- To reach the objectives and ambition, EMPOWER will draw from a rich portfolio of technology bricks in the following **AREAs**:
  - **AREA I** Component Design and Modularity
  - **AREA II** Integration and Infrastructure
  - **AREA III** Demonstration



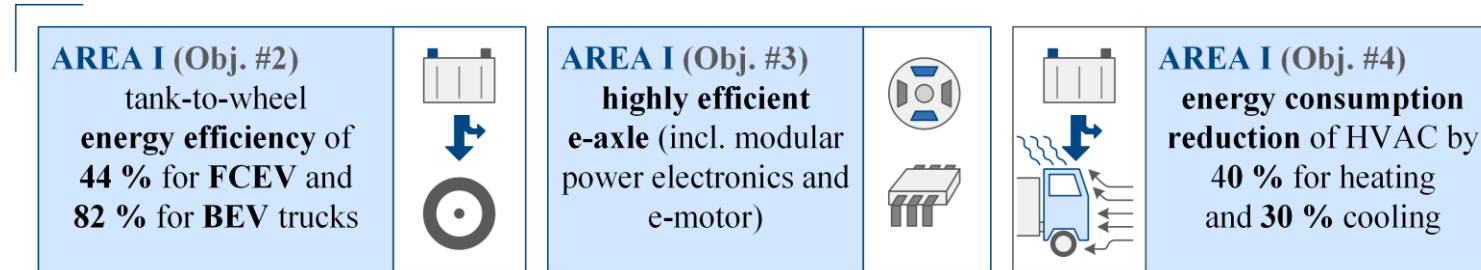
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### Main objectives of EMPOWER organised in AREAs

<p><b>AREA I (Obj. #2)</b> tank-to-wheel <b>energy efficiency</b> of <b>44 %</b> for FCEV and <b>82 %</b> for BEV trucks</p>		<p><b>AREA I (Obj. #3)</b> <b>highly efficient</b> <b>e-axle</b> (incl. modular power electronics and e-motor)</p>			<p><b>AREA I (Obj. #4)</b> <b>energy consumption</b> <b>reduction</b> of HVAC by <b>40 %</b> for heating and <b>30 %</b> cooling</p>
<p><b>AREA I-II (Obj. #5)</b> delivery <b>load capacity</b> not less than <b>90 %</b> compared to available trucks</p>		<p><b>IVECO</b> vehicle platform (VECTO vehicle group 9) <b>(Obj. #1)</b>      <b>FCEV</b>                          <b>BEV</b></p>		<p>EOL</p>	<p><b>AREA I-II (Obj. #6)</b> <b>FC</b> availability of <b>90 %</b> and <b>30,000 h</b> operational life</p>
<p><b>AREA III (Obj. #7)</b> <b>750 km</b> (FCEV), <b>400 km</b> (BEV) unrefueled/unrecharged <b>driving range</b></p>		<p><b>AREA III (Obj. #8)</b> <b>500 km</b> (FCEV), <b>300 km</b> (BEV) average daily operation</p>		<p>TCO</p>	<p><b>AREA III (Obj. #9)</b> <b>reducing total cost of</b> <b>operation</b> assuming production volume ≥ 10,000 p.a.</p>

## Eco-operated, Modular, highly efficient, and flexible multi-POWERtrain for long-haul heavy-duty vehicles

### Technology Bricks



- 1) modular vehicle system architecture
- 2) modular low voltage E/E architecture
- 3) FC system with high reliability and extended operational lifetime with a modular energy storage
- 4) highly efficient e-axle
- 5) optimised thermal- and energy management
- 6) optimised HVAC system featuring CO<sub>2</sub> as refrigerant and infrared heating panels
- 7) electrified distributed braking system
- 8) digital twin models of the demonstrator vehicles










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## Technology Bricks

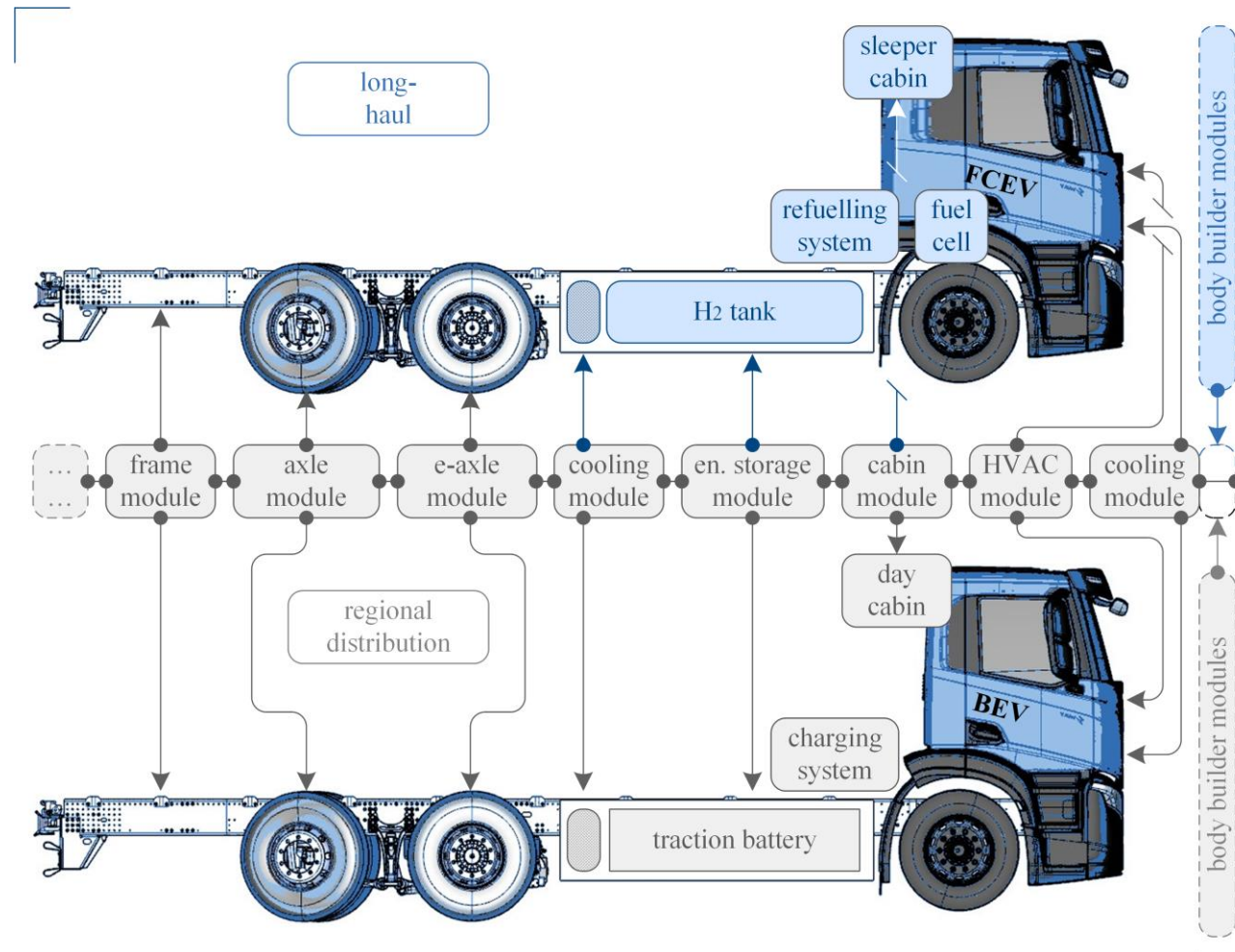
- 9) innovative Human Vehicle Interface for optimised control of the vehicle systems, featuring Vehicle-to-Grid communication and eco-routing
- 10) fleet management system for the integration of ZE HDV into the fleet

<p><b>AREA I-II (Obj. #5)</b> delivery <b>load capacity</b> not less than <b>90 %</b> compared to available trucks</p>	  	<p><b>IVECO</b> vehicle platform (VECTO vehicle group 9) <b>(Obj. #1)</b>      <b>FCEV</b>                                  <b>BEV</b></p> 	    EOL	<p><b>AREA I-II (Obj. #6)</b> <b>FC</b> availability of <b>90 %</b> and <b>30,000 h</b> operational life</p>
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- 11) overall LCA and TCO assessment
- 12) operation of a green hydrogen infrastructure for ZE HDV needed for the long-haul European cross-border demonstration





## Eco-operated, Modular, highly efficient, and flexible multi-POWERtrain for long-haul heavy-duty vehicles Modular structure of the FCEV and BEV demonstrators



## Eco-operated, Modular, highly efficient, and flexible multi-POWERtrain for long-haul heavy-duty vehicles Demonstration

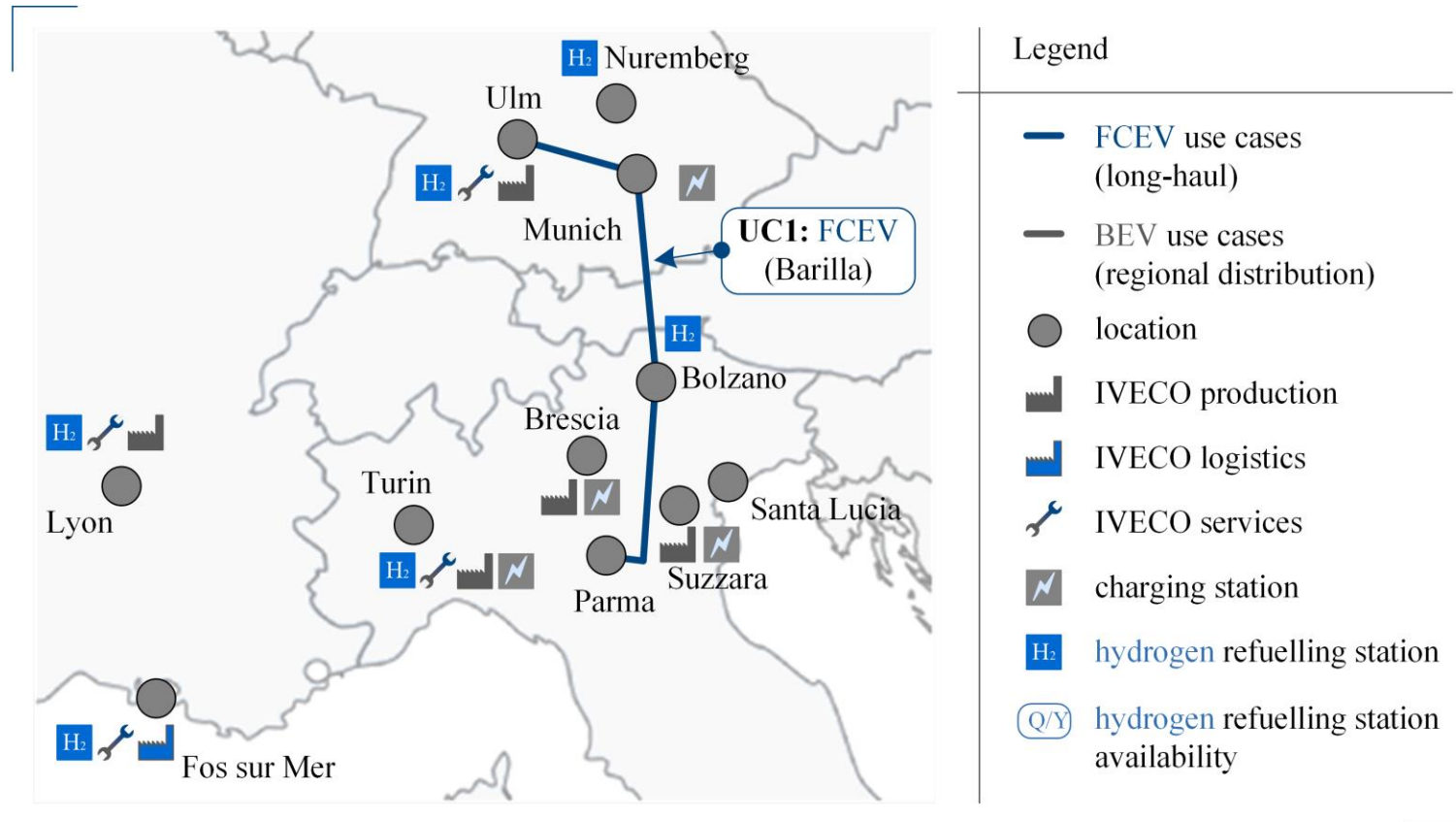
- **Stage 1** demonstrates the maximum unrefuelled/unrecharged driving ranges of
  - 750 km for the FCEV
  - 400 km for the BEV
 both on the Balocco Proving Ground (IT)
  
- **Stage 2** is the concluding six-month demonstration in different real-world use cases (UCs)

<p><b>AREA III (Obj. #7)</b> 750 km (FCEV), 400 km (BEV) unrefueled/unrecharged <b>driving range</b></p>		<p><b>AREA III (Obj. #8)</b> 500 km (FCEV), 300 km (BEV) average daily operation</p>		<p>€  TCO</p>	<p><b>AREA III (Obj. #9)</b> <b>reducing total cost of operation</b> assuming production volume ≥ 10,000 p.a.</p>
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## Eco-operated, Modular, highly efficient, and flexible multi-POWERtrain for long-haul heavy-duty vehicles Relevant routes and locations for the EMPOWER demonstration phase

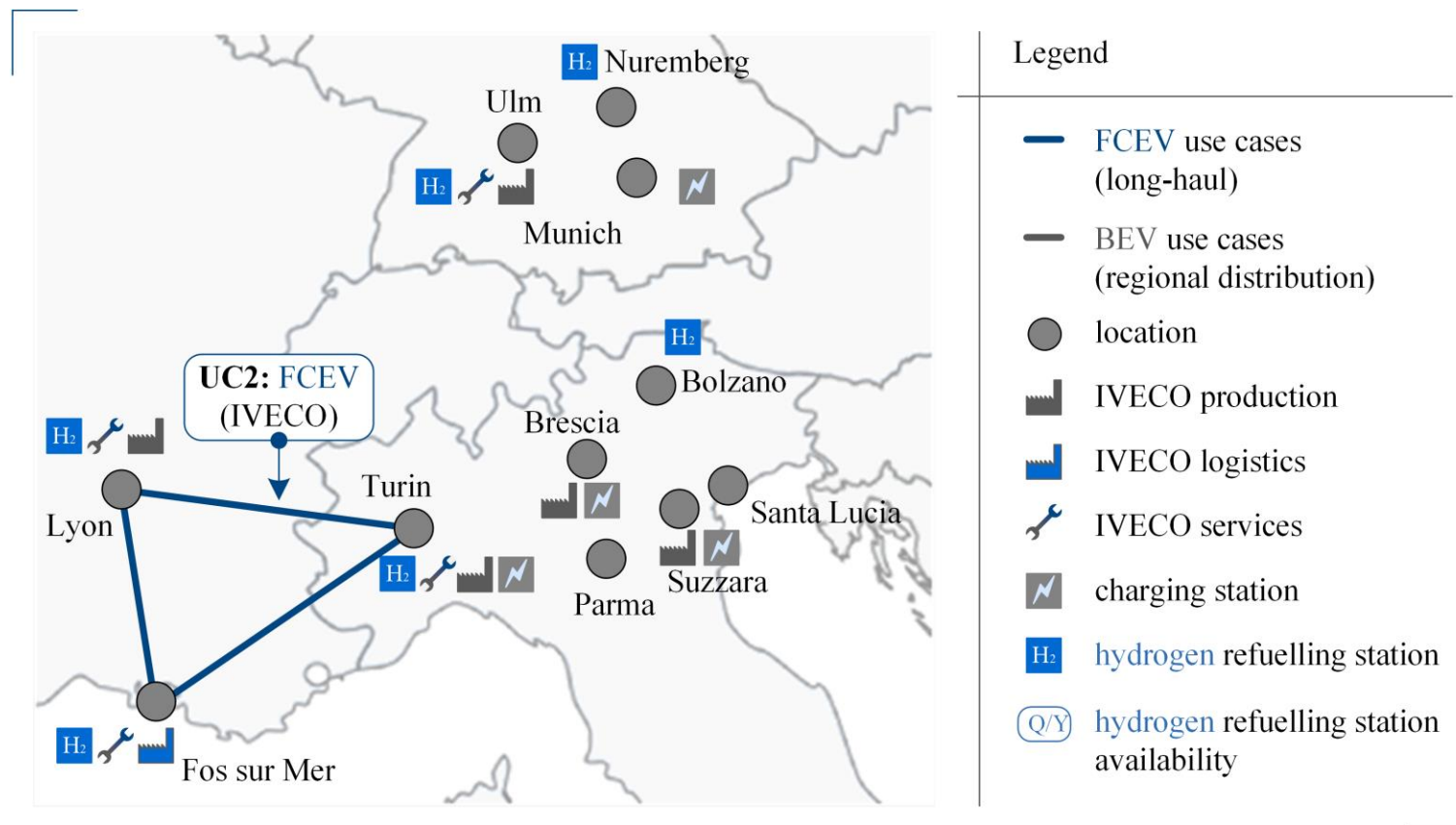
### Use case No. 1



# Eco-operated, Modular, highly efficient, and flexible multi-POWERtrain for long-haul heavy-duty vehicles

## Relevant routes and locations for the EMPOWER demonstration phase

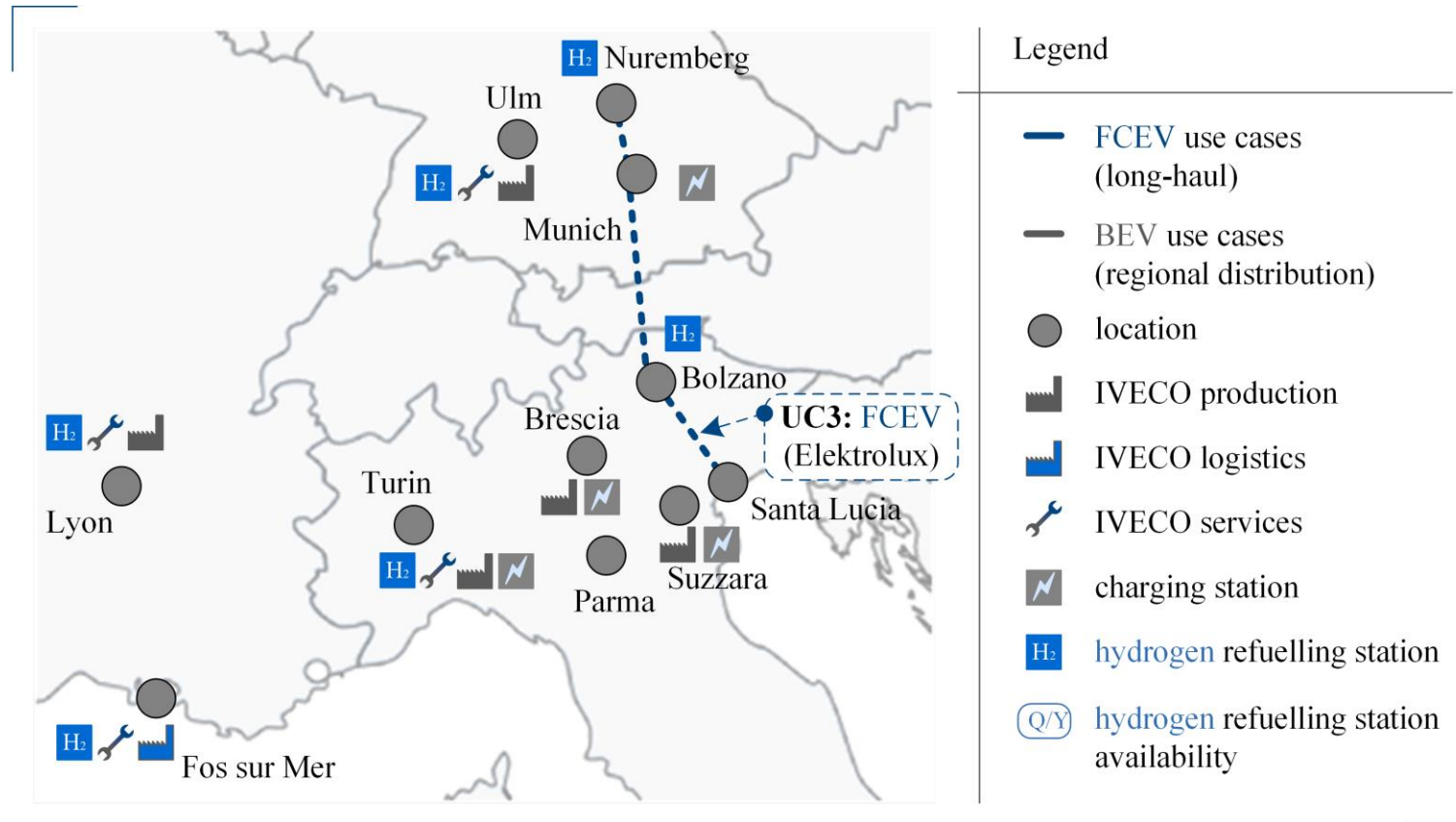
Use case No. 2



# Eco-operated, Modular, highly efficient, and flexible multi-POWERtrain for long-haul heavy-duty vehicles

## Relevant routes and locations for the EMPOWER demonstration phase

Use case **No. 3**  
(optional)

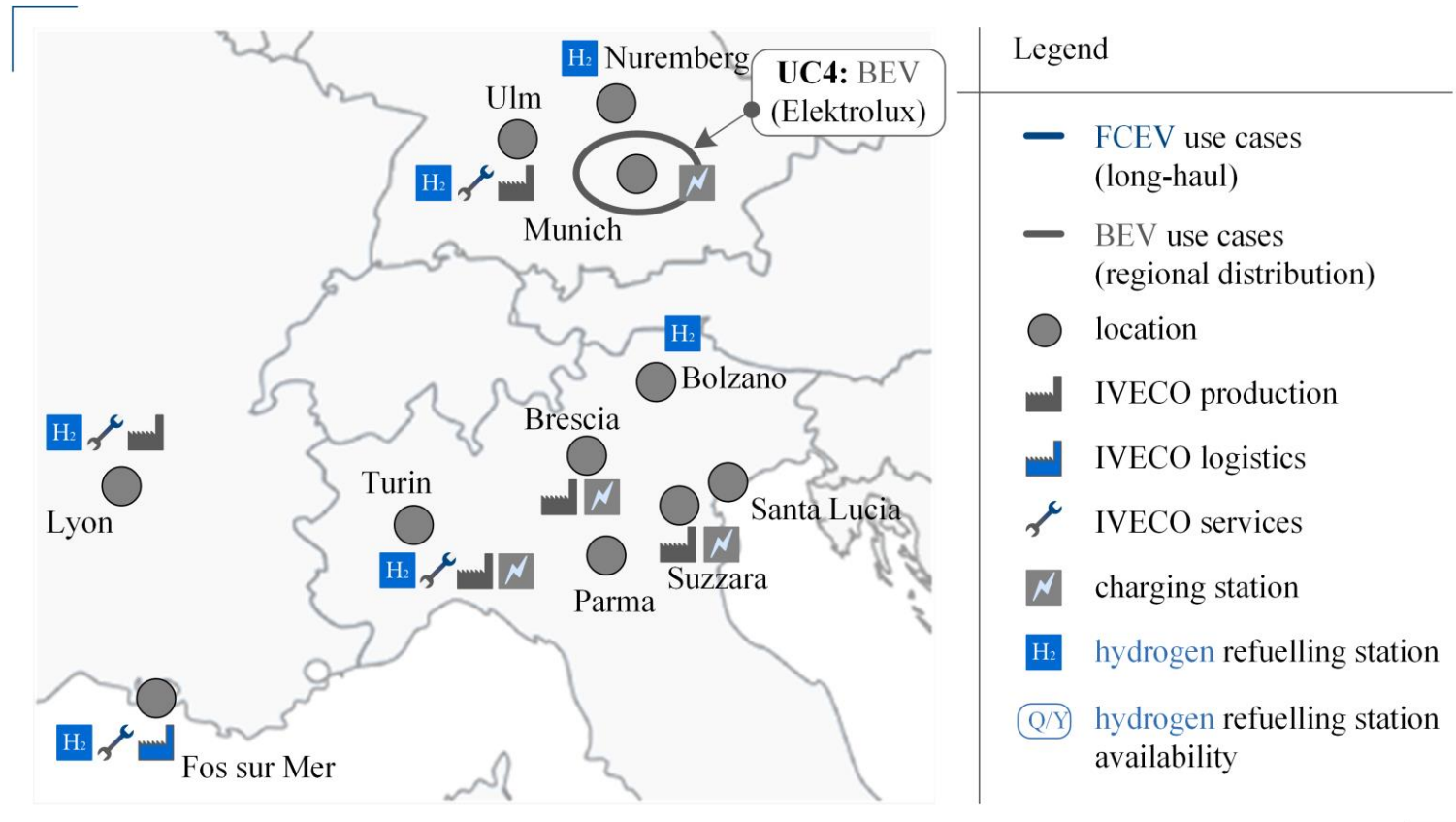




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## Relevant routes and locations for the EMPOWER demonstration phase

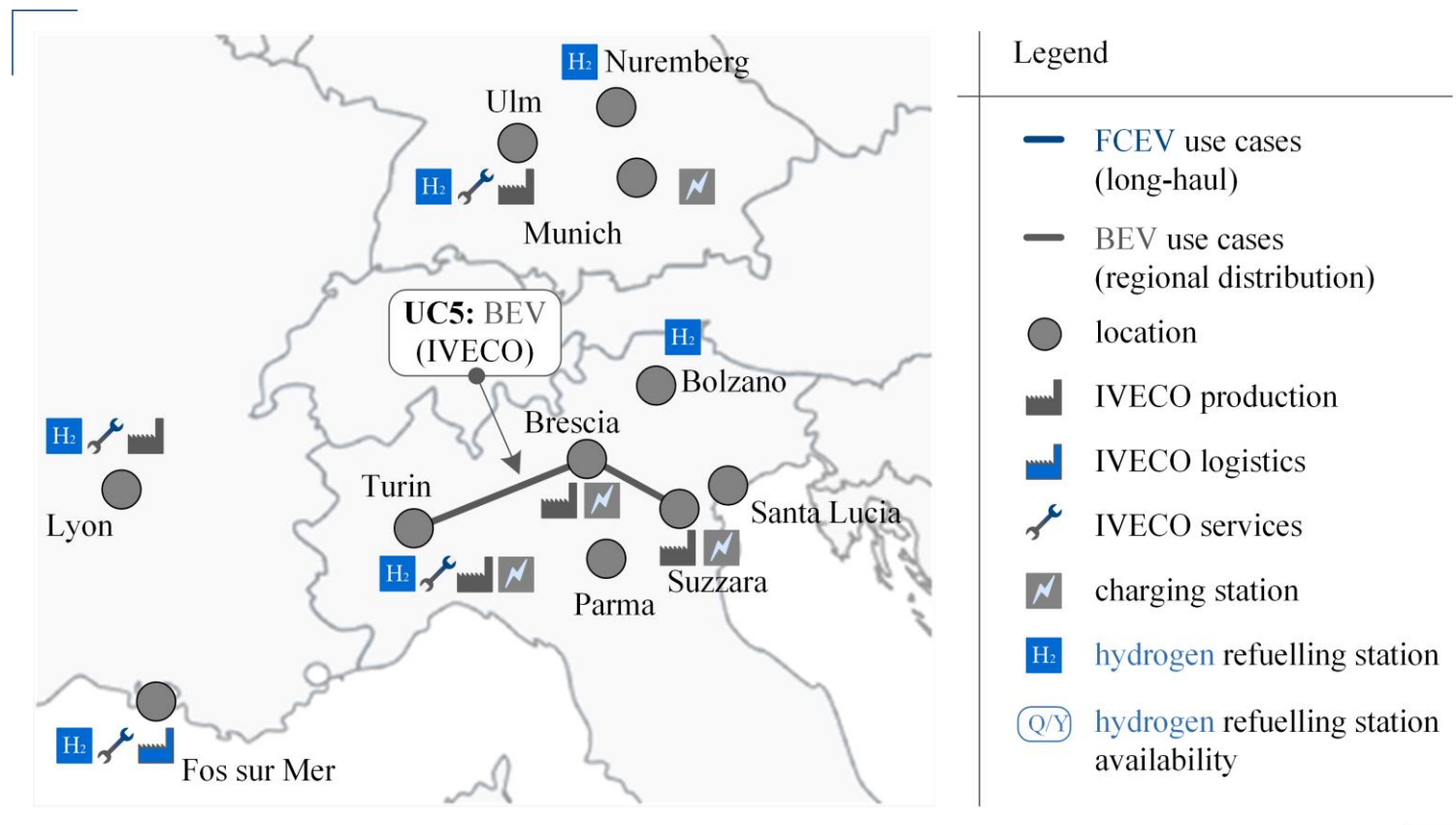
Use case No. 4



# Eco-operated, Modular, highly efficient, and flexible multi-POWERtrain for long-haul heavy-duty vehicles

## Relevant routes and locations for the EMPOWER demonstration phase

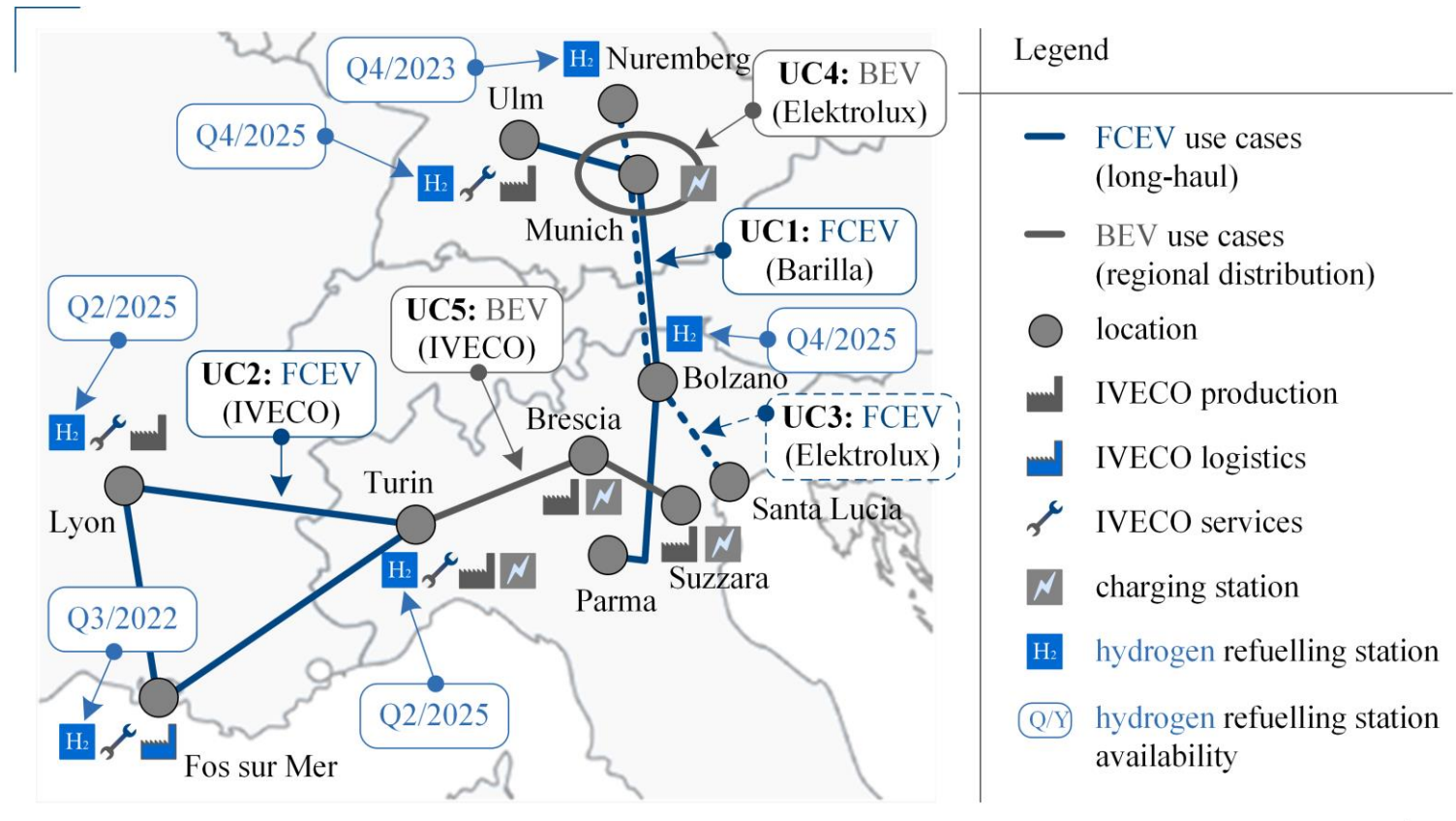
### Use case No. 5





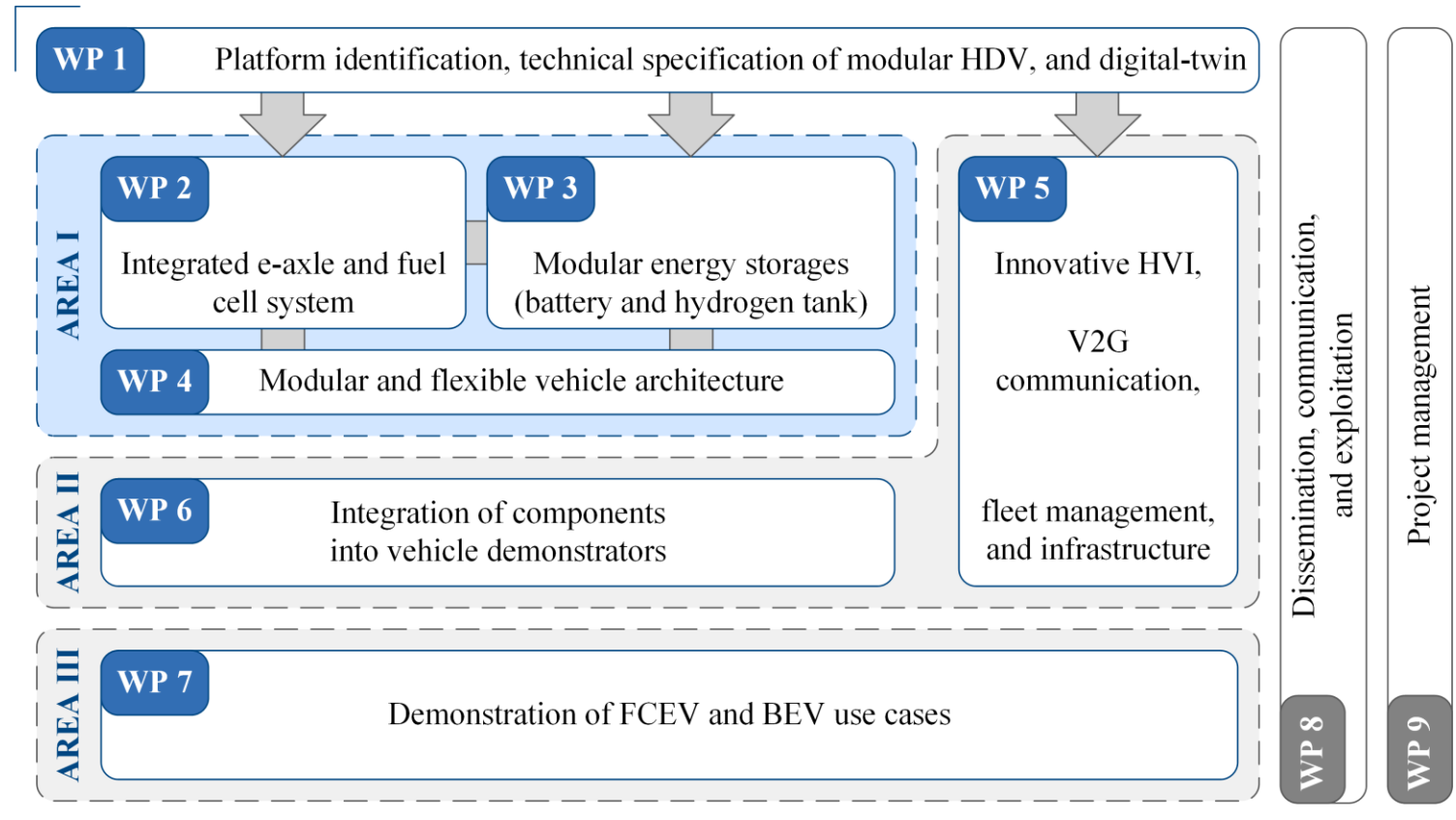
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## Relevant routes and locations for the EMPOWER demonstration phase





## Eco-operated, Modular, highly efficient, and flexible multi-POWERtrain for long-haul heavy-duty vehicles Pert diagram and Workpackages



Thank you!  
I'm looking forward to a good cooperation!

Presenter:

Popovac Mirza (AIT)

