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Zero Emission flexible vehicle platform with modular powertrains serving the long-haul Freight Eco System

ZEFES - Deliverable report

D4.2 – Infrastructure model/dataset (V2I Concept)

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Publishable summary

The ZEFES project is geared towards novel powertrain solutions for heavy trucks, i.e., electric, hydrogen and their application in the field. To enable and to support this application in the field, different supporting software services are to be implemented and tested. There is a broad variety of datasets and services of both vehicle data and infrastructure data to be respected. The orchestration and the application of these data and services take place in different scenarios enabled by the ZEFES platform.

This deliverable focuses on the set of infrastructure data for the ZEFES platform. It introduces the methodology of ZEFES WP4 of collecting the different partner contributions regarding data and services. Each contribution will be introduced and put into systematic context to ZEFES.

The deliverable also introduces the aspect of novel energy nodes as part of see infrastructure data set. These can be considered as main innovation driver for the infrastructure data set.

Furthermore, this deliverable provides a concept for the development towards a digital twin for the infrastructure, i.e. the process steps to work from a real world environment towards a digital representation of different information building blocks. Each building block consists of a separate data or service layer. The different services and datasets are then individually introduced.

In a following step the high-level requirements towards technical requirements legal requirements business requirements and specific data sets requirements for the services of the different partners are collected and listed. Lastly the interplay of data and services objects with the ZEFES platform is addressed.

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Abbreviations & Definitions

Abbreviation	Explanation
API	Application Programming Interfaces
BEV	Battery electric vehicle
CCS	Combined Charging System
CGH2	Compressed hydrogen
CPO	Charge Point Operator
CRG	Curved Regular Grid
CSS	Combined Charging System
CSV	Comma-separated values
DC	Direct Current
DT	Digital twin
FCD	Floating Car Data
GTFS	General Transit Feed Specification
H2	Hydrogen
HD	High density
HoLa	Hochleistungsladen im Lkw-Fernverkehr (high performance charging for long-haul trucking)
HRS	Hydrogen Refuelling Stations
JSON	JavaScript Object Notation
JSON-LD	JavaScript Object Notation for Linked Data
LH2	liquid hydrogen
MCS	Megawatt Charging System
NACS	North American Charging Standard
NeTEx	Network and Timetable Exchange. NeTEx is a CEN/ Technical Standard
OCPP	Open Charge Point Protocol
REST	Representational State Transfer
t	Ton
TAB	Tabulator
TEN-T	Trans-European Transport Network
URI	Universal Resource Identifier
V	Volt
VSS	Vehicle storage system
ZEFES	Zero Emissions flexible vehicle platforms with modular powertrains serving the long-haul Freight Eco System

1 Introduction

The ZEFES project is geared towards testing of novel powertrain solutions for heavy trucks, i.e., electric, hydrogen and the application in the field. To enable and to support this application in the field different software and data processes need to be established and tested.

Central to the ZEFES project is the establishment of a digital twin understood as data and tool representation that will support and optimise the operation of heavy duty BEV and FCEV vehicles and related logistics processes. The specific goal for digital twin development within ZEFES is to design and provide an optimization framework to further improve and facilitate heavy duty ZEV and FCEV powertrain development considering the interaction with the charging/refuelling and energy infrastructure and long-haul logistics requirements.

The infrastructure data addressed in this deliverable will therefore play an enabling role to the digital twin as well as to digital services facilitated in the ZEFES platform.

Bringing all aspects together at a larger project scale, the ZEFES platform (a digital twin platform), will enable vehicle buying decisions, mission planning, vehicle application within the logistics duty, the twinning of the model and the real-world data provides a seamless information stream and support predictive maintenance tools specifically for ZEV.

2 Methodology & Timeline

Task 4.4 methodological approach is to collect and to prepare the contribution to the digital data platform. The tasks as such addresses the following goals:

- Conduction of a comprehensive review of existing services and data sets relevant to infrastructure.
- Alignment with ZEFES platform towards design concept & patterns.
- Identification of requirements for ZEFES platform (task 4.3) to expose data and services.
- Definition of a staging approach to expose infrastructure relevant data at different project stages via API and Docker through the ZEFES platform.
- Definition of test use cases inspired by WP1 use cases and selecting 1 dedicated use case to act as technical reference test candidate.

A hybrid approach was selected combining team web-meetings, bilateral web-meetings, and physical workshops. The work was clustered into 3 sequential steps:

Step 1)

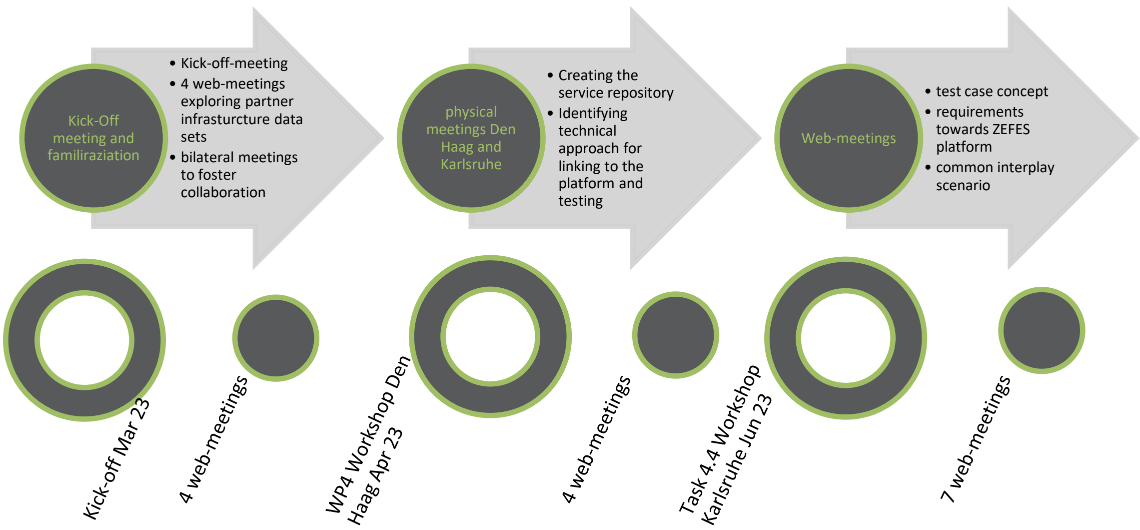
- the kick-off and the on-boarding of the task partners
- the exploration of the potential data(sets) which are available at individual partner level and the creation of a common understanding of the data(sets)

Step 2)

- a data and service repository has been created, providing a comprehensive list of data & services linked to the infrastructure digital which are to be exposed to the project.
- the identification and the alignment of a concept to expose and to link the identified data(sets) to the ZEFES platform .

Step 3)

- data and services are reviewed at a technical concept level, linking conceptually the test data to the ZEFES platform and integrating these into basic combined workflows.



3 Towards the infrastructure data set and beyond

Data exchange and sharing is a vital enabler to ZEFES platform and the linked tools and software services. This chapter describes the approach and the steps towards the data collection for infrastructure data.

3.1 Workflow methodology to identify and segment the transport infrastructure data sets

This section describes the technical process of identifying the data subsets encompassing the ZEFES infrastructure data set. The infrastructure data set contributes to the ZEFES platform and ultimately to linked digital maps, digital services, and simulation. Hence it enables a digital playground to assess the impact of different network situations and to identify how the transport system is likely to perform in the future.

Technically, a digital representation is created by capturing data about the physical object to be digitally depicted and feeding it into the digital model. This is done with the help of sensors and digitalization strategies. In this way, a digital twin can monitor the behaviour of the original in real-time and calculate the reaction in alternative scenarios, or even make predictions about how the object would behave in the future. The application possibilities of digital twins are diverse, depending on the context of use. The applied data sets and their interplay in ZEFES therefore determines the potential digital twin variability and performance.

Step 1: Identify the spatial area to model.
In the first step, the spatial area that shall be focussed on is defined. The area definition is thereby driven by management decision on the test area. Driving factors for the decision making are use case area coverage and use case needs.

Figure 1: Spatial area definition, source PTV

Step 2: Reduce the spatial area to only the focus area.

In the second step, the defined spatial area is to be shaped in a way, that all geographically unnecessary data and / or not needed detail data for the envisaged use cases is cut off.

Figure 2: Spatial area reduction, source PTV

Step 3: Identify the relevant data layers.

The model is built from various data sources, which all should relate to the base model including base timeframe, base settings, etc. For the focussed area, a data analysis is performed, resulting in a comprehensive list of data elements which are relevant to the infrastructure data set. These are to be digitized and collected.

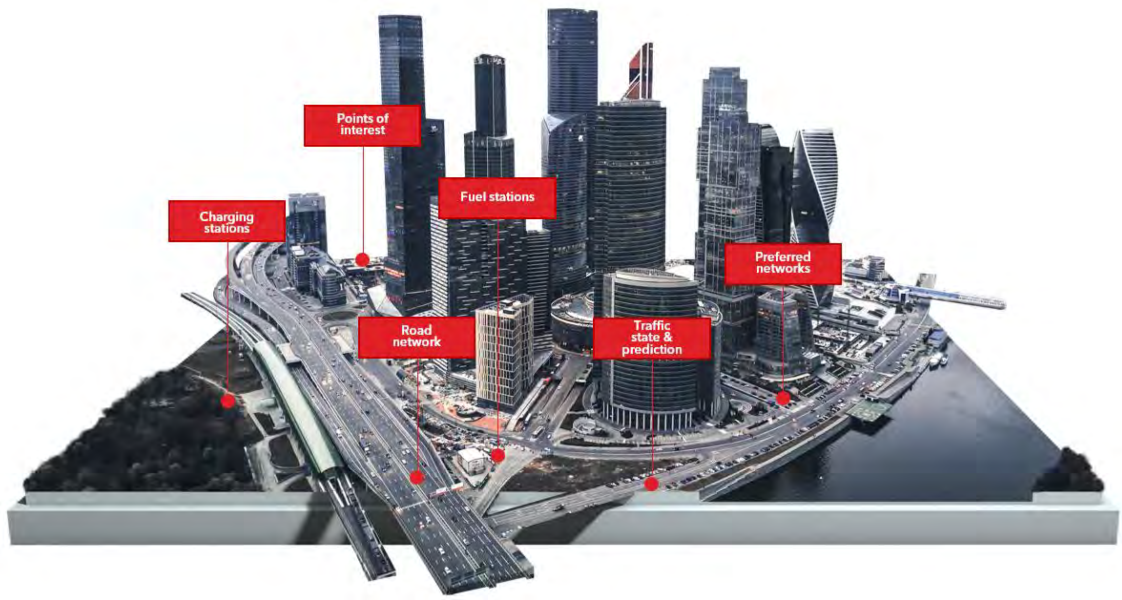


Figure 3: Layer identification, source PTV

Step 4: Valorisation of data.

This step covers the final process step under the assumption that digitized data are available and further processed by external services which result in novel data sets. The external services thereby consume and process data, e.g., data fusion and data valorisation. The processing result is additional novel data layers for the infrastructure data set.

As the modelled system evolves over time, the model also needs to be maintained and updated to remain representative of the geographical model region. Over time, data sets of the focussed area may change as well. Small changes can be covered by learning over time adaptation methods, whereas significant changes in the modelled data will lead to bigger updates to the overall model. This case requires most likely a recalibration. The frequency of such updates depends on the scope of transport and mobility changes in the region and the timeline.

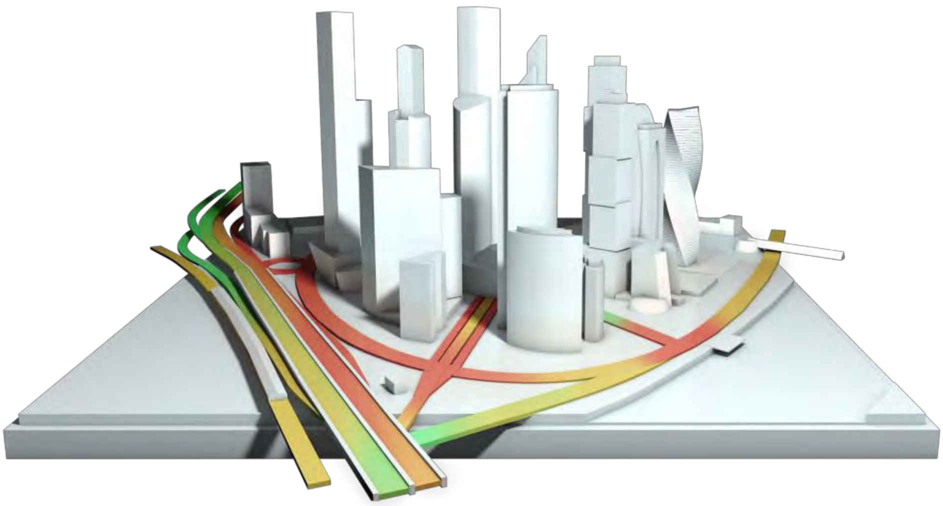


Figure 4: From data to model creation, source PTV

3.2 Requirements for infrastructure data interplay and further application in a digital twin

In an increasingly digital and automated world, high-accuracy and high-fidelity geospatial data is critical for understanding the physical environment and in building innovative technologies and map solutions. This especially applies to the mobility and logistics sectors, where reliable data is the fundament to enable actions, such as analysing, planning, and managing transportation networks.

Data and information exchange relies on numerous formal and informal data and metadata standards on a semantic level. Key is to agree among data exchanging parties on common data representations and rules. However, an effective standard is not simply a set of rules, but one that is widely accepted and implemented by the industry, which allows data held by one organization to be understood and used by others in a time- and cost-efficient and scalable manner.

The digital twin data representation in ZEFES is therefore built based on information gathered from many different sources (infrastructure, vehicle etc.), including sensors, cameras, information systems, etc.

Applications constantly process and analyze this data – current values but also history generated over time etc. to automate certain tasks or bring support to smart decisions by end users.
A ZEFES digital twin is *an entity which digitally represents a real-world physical asset*. Each digital twin

- Should be universally identified with a Universal Resource Identifier (URI),
- Should belong to a well-known data object (e.g., a vehicle type, a charging location, an EV battery etc.). This type should be universally identified by a URI.
- Should exhibit attributes, that are in turn classified as:
  - Properties holding data (e.g., the current rate of charging, the temperature of the dispenser etc.),
  - Relationships, each holding a URI identifying another digital twin entity the given entity is linked to (e.g., a vehicle where a concrete battery is linked to).

Attributes may vary ranging from attributes that are quite static (powertrain type of a truck) to attributes that change very dynamically (the rate of charging, the temperature of the battery).
Note that the attributes of a digital twin are not only limited to observable data *but also inferred* data. For example, digital twin of a vehicle may not only have the attribute "current speed" but also an attribute "forecasted speed in 30 seconds". The prediction might rely on historical information (again represented as an attribute) about the traffic.
ZEFES digital twins *should standardize two elements to support effective data integration*:

1. the API to get access to the digital twin data (e.g., RESTful API)
2. the data model describing the attributes and semantics associated with the different types of digital twins (e.g., JSON or JSON-LD specifications)

4 Energy nodes as part of the infrastructure data for ZEFES

ZEFES includes hydrogen and electricity as energies for alternative fuel vehicles. Both energy sources will be introduced toward charging / fuelling in this chapter. Dedicated services and data sets linked to these energies will be introduced in chapter 5.

4.1 E-Charging infrastructure and charging strategies

Emission-free logistics as well as public transportation, such as electric buses, reduces local air and noise pollution. The battery-electric truck market is still in its early stages, with approximately 20,000 units sold in 2021, with most of these units being medium- rather than heavy-duty vehicles. However, electrifying fleets can come with challenges, especially in choosing the right infrastructure to support the fleet's operational needs. Charger types and node installations are thereby linked to the operational use cases of the fleets. One can consider three main use cases towards charging:

Depot charging

Every vehicle in a fleet will have to return to a depot for varying amounts of time, and this is the perfect time to charge the vehicle. As most use cases, e.g., busses, garbage collection, grocery delivery, provide longer times out of operations in depot, this is a suitable time for charging with a lower charging power. Only few applications, e.g., long-distance logistics, have use cases where vehicles are near-constantly moving, with only short loading and unloading times in the logistics centres. In depot charging, there is potential for energy management solutions to optimize charging process according to various charging strategies. Optimization goals include, depending on use case, best use of charging infrastructure and available power to ensure readiness of vehicles for new missions with corresponding reduction of required infrastructure, reduction of energy costs by moving charging processes into times of lower energy prices or increased self-consumption, or increase of battery life. Such optimization may include other flexible energy consumers or assets at the site.

Opportunity charging (mostly for buses)

Some routes may be impossible to complete even with a fully charged vehicle. In particular for buses in public transport operating on defined routes, one solution that has been developed is to use a very powerful charger at places of opportunity along their route – such as bus stops with longer waiting times due to large numbers of changeover passengers or end-of-line stops. As such opportunities are usually short, maybe only 3-6 minutes, automated means of connecting the power are required, and automated pantograph solutions have been developed and implemented.

Thus, opportunity charging is an ideal solution for ensuring zero-emission transport during the day without impacting normal route operations in the use case of urban and suburban buses.

This solution, or variants thereof, may also be suitable for vehicles in closed industrial applications, e.g., mining trucks, vehicles moving goods or containers in port or factory environments, or similar.

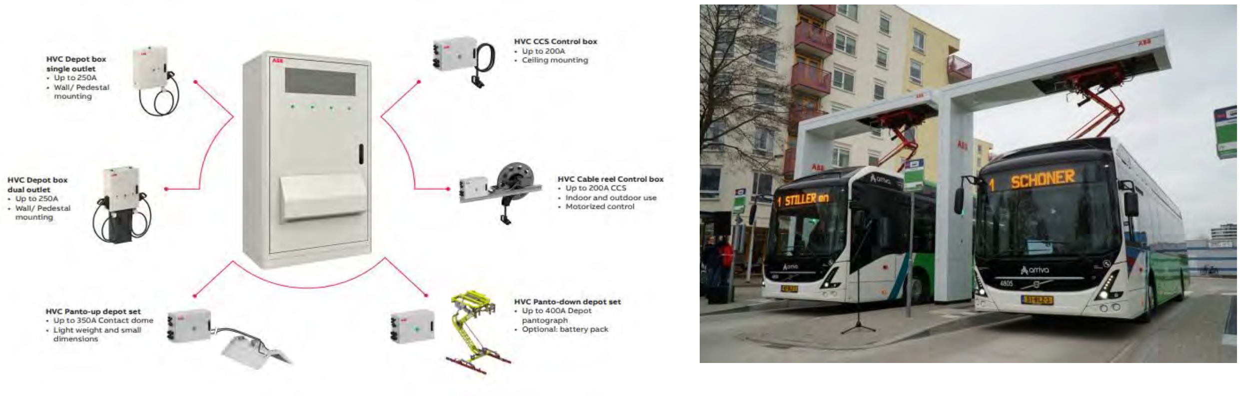


Figure 5: E-charger hardware with pantograph option, source ABB

To run successful charging operations in dynamic environments, connectivity is essential. State of the art digital solutions range provides services that accelerates electrification and supports the growth of electric mobility, while conserving resources and promoting zero carbon progress.

Public charging (for long-range heavy duty trucks)

For heavy duty trucks, pantograph solutions are presently tested in several field tests across Europe. Opportunity charging during loading and unloading of freight can be envisioned to support depot charging, if suitable charging infrastructure can be provided at the loading ramps. As loading times are often longer than 15 minutes, utilization of CCS2 (Combined Charging System) plugs seems suitable for these use cases.

However, for longer distances of truck transport, e.g., well over 400 km, it is no longer economical to provide the truck with a battery that can cover the whole distance, and recharging on-route has to be added to the solution. Here, the charging opportunity is the mandatory 45 minutes driver's break, as outlined in D1.2 and D1.4, which will usually be taken at public highway rest stations, rest stations close to highways (e.g.German: Autohof), or similar public sites. These sites are already offering charging facilities to car drivers and parking facilities for trucks, so upgrading the truck parking facilities with chargers seems suitable. As calculated in D1.2 and D1.4, a charging power of 800 kW is appropriate. Current CCS2 chargers with up to 360 kW charging power, and current series produced heavy duty trucks by major OEMs with 250 to 350 kW charging power, can be utilized in this way as well, but may require longer drivers' breaks.

Representative of this state-of-the-art is e.g., ABB's Terra HP Generation 3 charger, capable of providing 350 kW at 500 A continuous (at -35 to +35 °C. Lower maximum current at +35 to +55 °C). This charger is equally suitable for charging cars, busses and trucks.

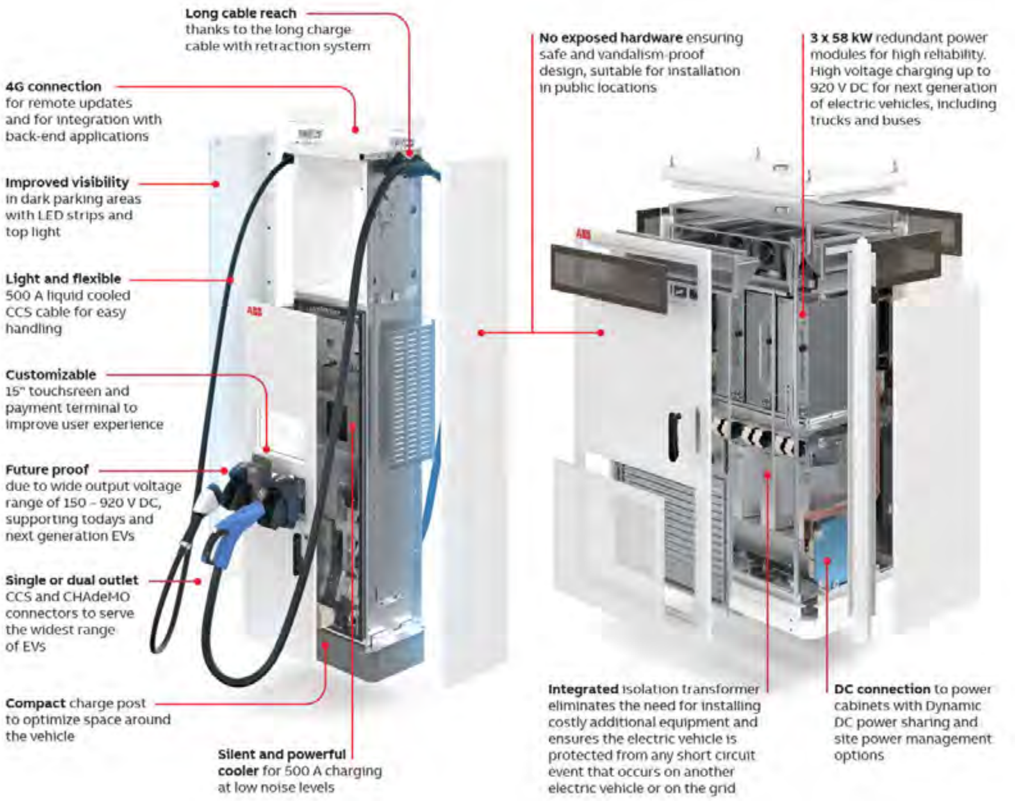


Figure 6: Terra HP Generation 3 charger, source ABB

However, the upcoming MCS standard specifies plugs and communication standards to approach this. In the framework of ZEFES and the German project HoLa, such chargers are being developed, and will be field tested. With these chargers and corresponding trucks, the European mandatory drivers' break will be sufficient to charge trucks to the required power for true long-distance trucking use cases.

Planned Megawatt Charging

ABB infrastructure- relevant to MCS- is currently described as a charging system with 1 or 2 outlets per charge post of which 1 is always MCS and the other is optional, and can be CCS1, CCS2, or NACS. The cabinet can deliver a max power of 800 kW, voltage up to 920VDC, and current of 1000A, for up to 2 power cabinets per charge post. The charge post supports current up to 1500A.
Future MCS developments will improve the charging system current support up to 3000A and voltage up to 1250 VDC. The communication standard is ISO-15118-20 for MCS, ISO-15118-2 or -20 for CCS.

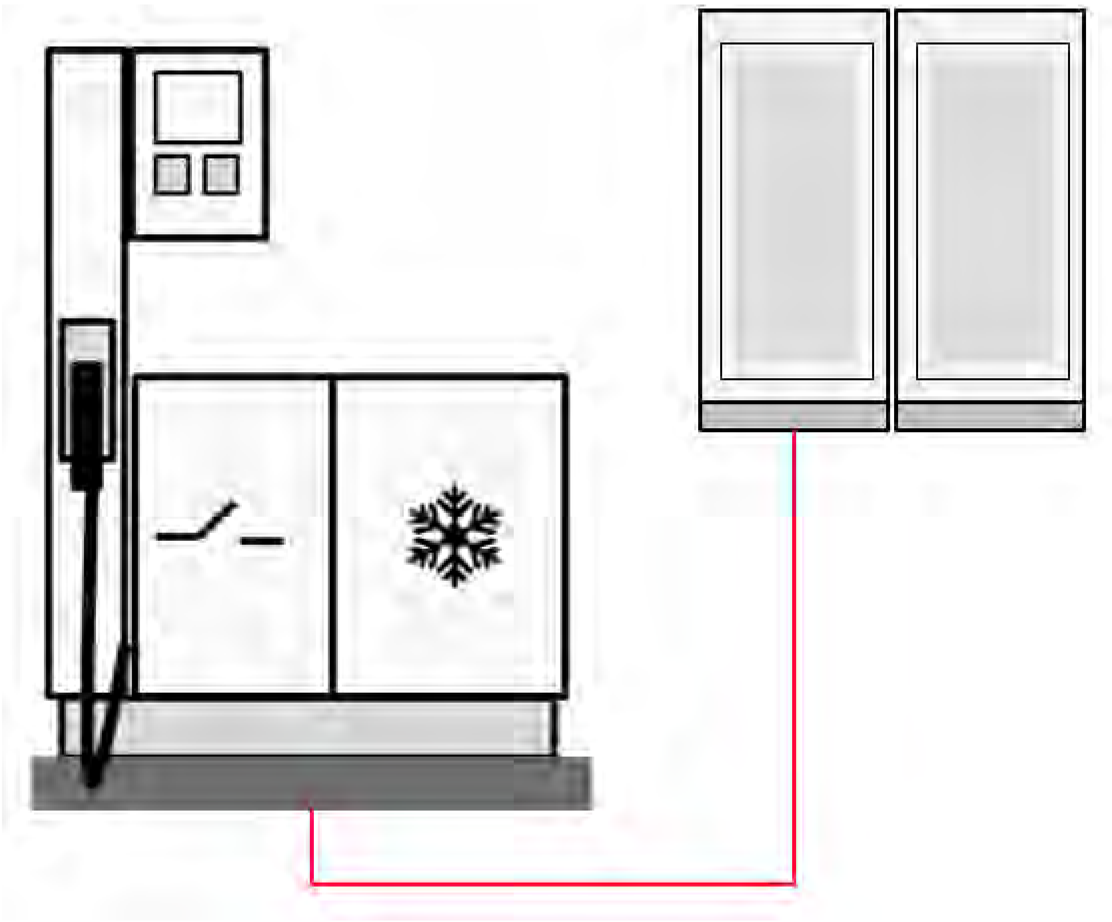


Figure 7: Schematic of Megawatt Charging System, source ABB

Charging environment and supporting software solutions

In the field, a wide range of chargers exist supporting a range of output voltages, from 150 – 850 V DC. Some, including Terra HP Generation 3, even offer up to 920 V DC, supporting the vehicles of today and the next generation.

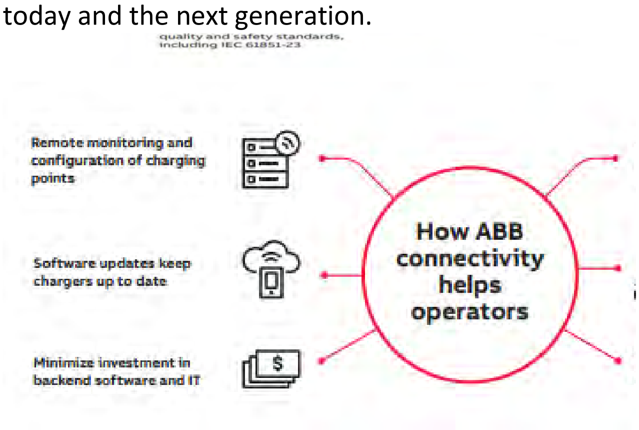
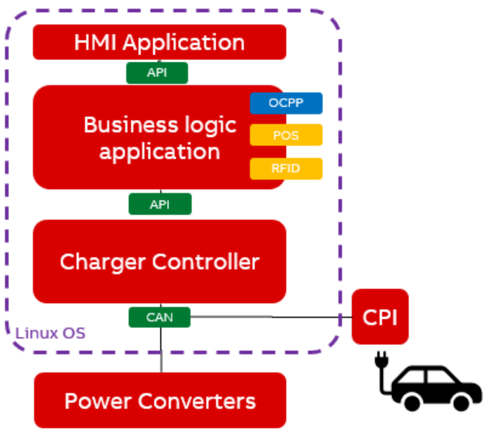


Figure 8: E-charging ecosystem, source ABB



To run successful charging operations in dynamic environments, connectivity is essential. This includes an HMI with touch screen and a payment terminal, communication with the vehicle, and 4G and Ethernet connections using OCPP for authorization, integration with load management, and other business-related functions. Via an API, new applications can connect to the charger, forming a charging ecosystem.

4.2 H2 fuels and infrastructures

The hydrogen refuelling station network is growing all over the world while still remaining in a niche market position. As of 2021, around 550 filling stations were available worldwide. Hydrogen fuelling stations can be divided into off-site stations, where hydrogen is delivered by truck or pipeline, and on-site stations that produce and compress hydrogen for the vehicles.[5][6]In Europe there are around 200 HRS, of which nearly 100 are located in Germany, along national highways and trans-European corridors.

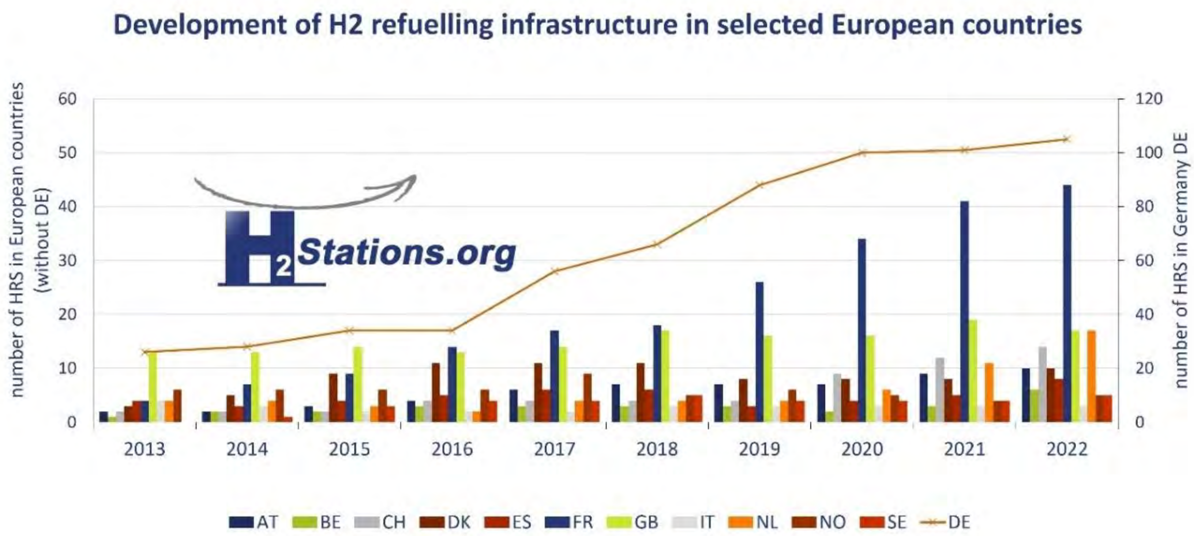


Figure 9: H2 station distribution, source H2 .

The advancement of HRS technology from the research and development stage to high performance commercial application and availability is proving successful. However, small stations (max. throughput of 200 kg H2/day) and medium stations (max. throughput of 500 kg H2/day) are built for the first initial ramp up of public HRS it still in a niches position.
Europe's future hydrogen refuelling infrastructure will be built according to expected demand. It should allow for international coverage along all important transport corridors for trans-European logistics. Additionally, HRS should be built close to key logistic and distribution centres for consumer convenience. Multiple stakeholders on the international, European and German level have committed themselves to building comprehensive hydrogen refuelling infrastructure.

Within the next years, the market and availability of commercial FCEV will grow with the ongoing push to reduce emissions in the transport sector, especially where daily mileages are high. To keep up with these developments, HRS infrastructure needs to be established for these vehicle types.

The heavy-duty transport market will push the rise of more HRS towards 2030 and beyond. One hydrogen refuelling site should be available every 200 kilometres along the TEN-T core network by 2030 with a daily capacity of at least six tons of H2 with a minimum of two dispensers per station. The forecasted demand to supply this segment is presented below.

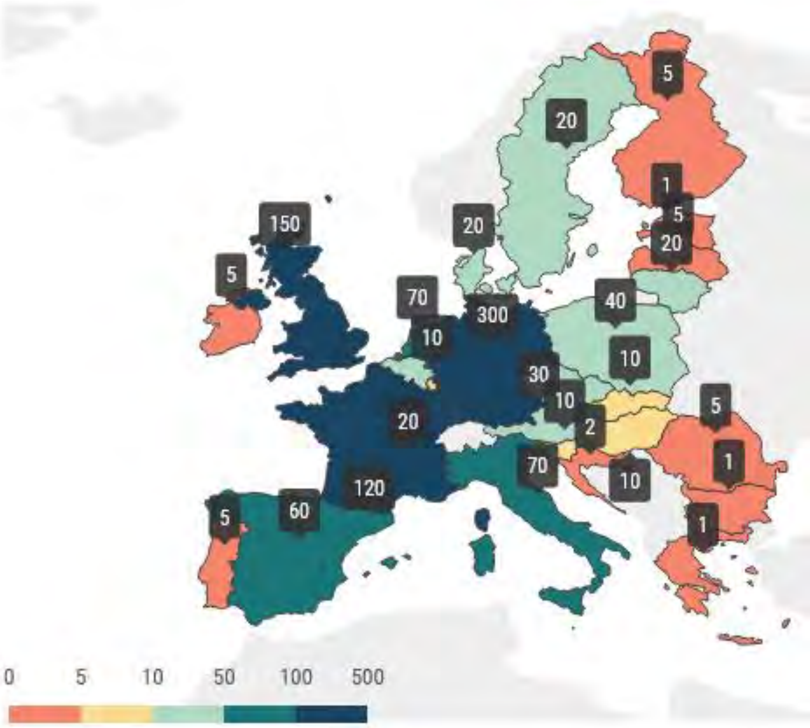


Figure 10: H2 station demand for Hydrogen refuelling in Europe by 2025, source ACEA[j]

The process of refuelling at a hydrogen station is not very different from that of a conventional petrol station, although there are some details that make the experience a little different. This is because hydrogen is supplied at high pressure and, as it is an extremely volatile gas, the connection between the vehicle's receptacle or connection point and the pump must be Gastight and secured.
The hydrogen is pumped into the vehicle's fuel tank, which powers the fuel cell that generates the electricity needed to drive the vehicle. The only waste product produced is water vapour, which is expelled through the exhaust pipe.
Depending on the refuelling technology, the hydrogen can be delivered to the HRS in either gaseous or liquid form. For commercial use, supply by trailer (CGH2 or LH2 trailer) or pipeline (CGH2) are being considered. Furthermore, it is also possible to generate the hydrogen on-site with electrolysis.

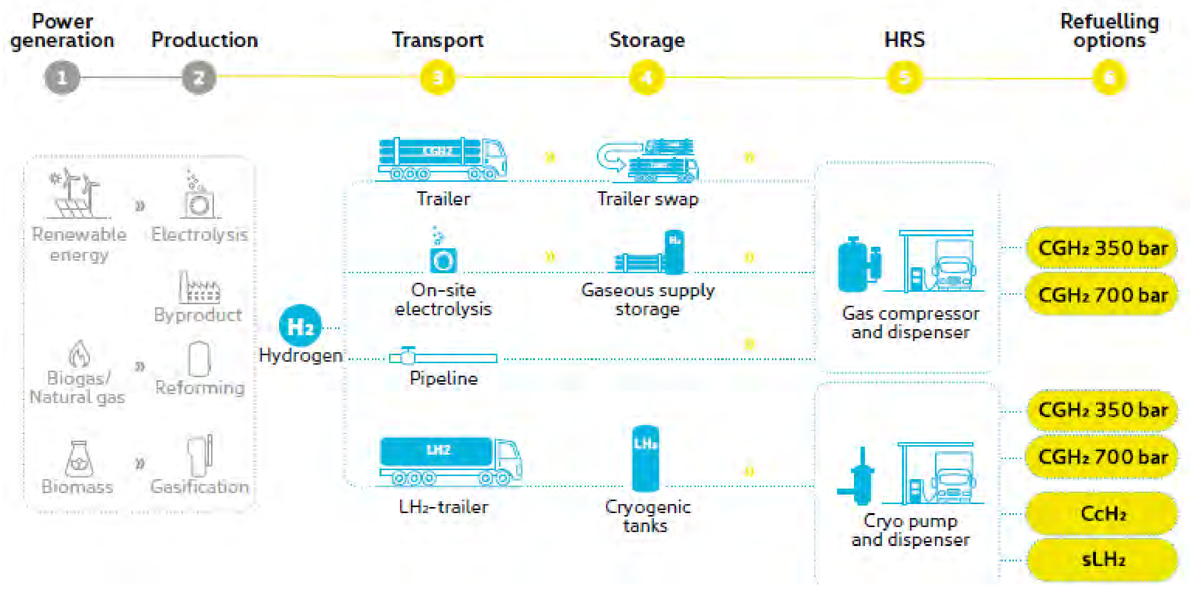


Figure 11: H2 process chain schematic view, source H2 Mobility.

Depending on the state of the hydrogen in the vehicle storage system (VSS) CGH2 or LH2, different refuelling technologies apply. Generally, the aim is to have a HDV refuelling time of 10 to 15 minutes. Today, CGH2 can be refuelled at 350 or 700 bar either by compressing and pre-cooling the refuelled CGH2 or by "cryo pumping" liquid hydrogen, which then needs to be heated before entering the VSS. While gaseous refuelling standards for PV, LDV and busses have been established, there are no high-performance refuelling protocols for heavy duty tank sizes (up to 100 kg) yet.

HYDROGEN REFUELLING INFRASTRUCTURE

Size	S	M	L	2XL
Max. hydrogen throughput per day	200 kg	500 kg	1,000 kg	4,000 kg
Vehicle	PV, LCV	(PV, LCV, busses), MDV	(PV, LCV, busses), MDV, HDV	(PV, LCV, busses), MDV, HDV
Average hydrogen throughput per day	150 kg	350 kg	700 kg	2,500 kg
Annual demand	1 - 10 t	100 t+	500 t+	900 t+
Refuelling nozzle	1	2	2 - 3	2 - 4
Size components area	80 - 250 m²	200 - 350 m²	250 - 800 m²	depending on HRS technology

Figure 12: Hydrogen refueling infrastructure, Source: H2 Mobility

From a technical standpoint, the possibility to upgrade the stations from size S to size M or even to L and 2XL exists. To serve specific customer needs each HRS configuration can be adjusted in terms of hydrogen demand, peak performance, and efficiency. When looking at future large-scale truck refuelling, a 2XL configuration with 2.5 t/day average hydrogen throughput will most likely be needed. Assuming an average hydrogen demand of 60 kg per fill, more than 40 HDV can then be refueled per day per station. If no special peak utilization is required, two refuelling nozzles will most likely be sufficient. With this set-up, up to eight HDV can be refueled every hour at the targeted refuelling time of 10 to 15 minutes.

5 Collection and review of infrastructure data and services

This chapter explains the collection process of the infrastructure data sets. Furthermore, it lists the different infrastructure data artefacts.

5.1 Collection process

The ZEFES task 4.4 conducted a sequence of virtual meetings, starting with an explanation of the approach, followed by a set of meetings dedicated to relevant data and service items at individual partner level. This approach was helpful to create a common understanding of the task as such and especially about the individual data sets and services relevant to the infrastructure digital twin.

To foster collaboration, a series of bilateral meetings took place as well. During this phase, knowledge regarding current state of play was created, i.e., the partners achieved a common understanding of what data and which service they have available and could bring in for the infrastructure digital data twin. The team jointly discussed application scenarios for each contribution and concluded at a physical workshop with the creation of a comprehensive repository of data and services.

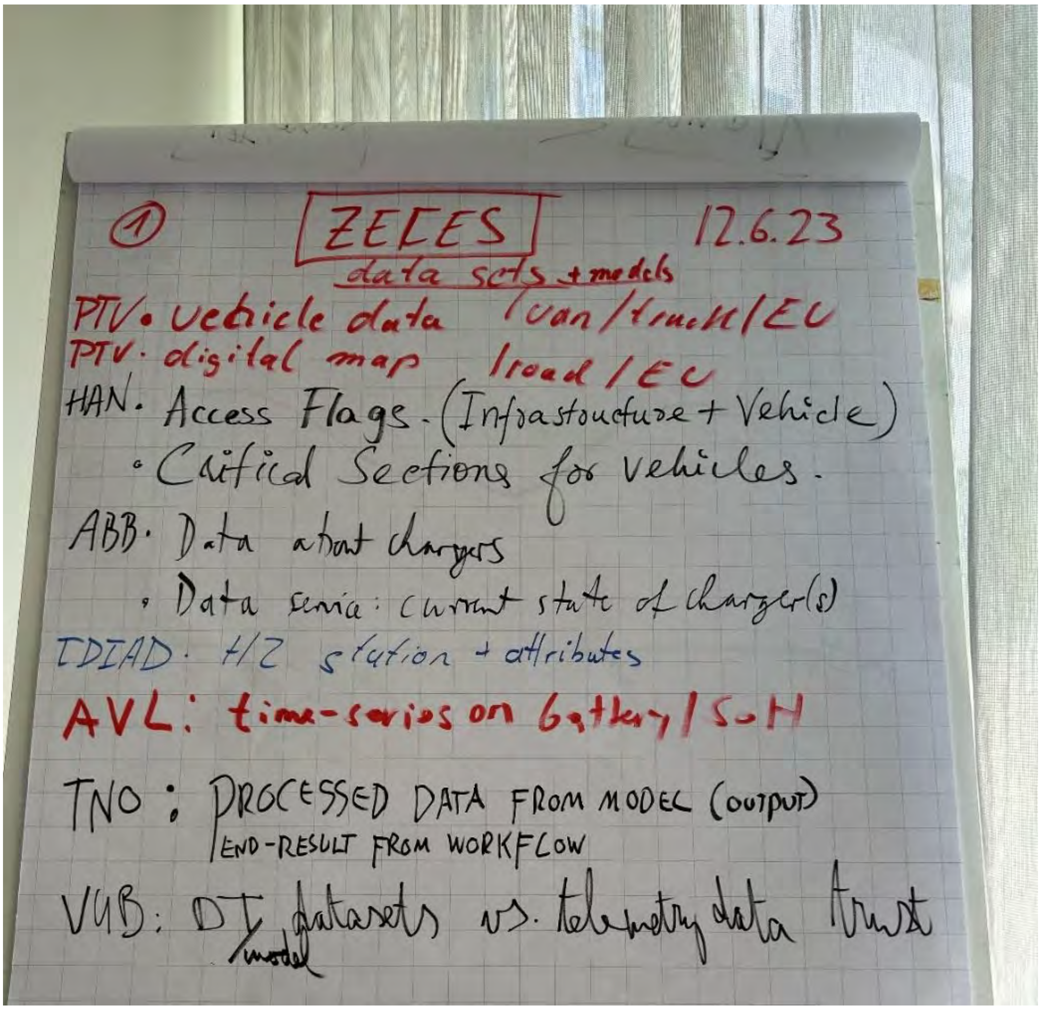


Figure 13: White board picture on artefacts from physical meeting at PTV, June 2023

5.2 Transferring the collected data to the infrastructure data set:

The following sub-chapters will introduce the different data and services that will be used to create the infrastructure digital twin in its initial setup.
Each of the layers can be linked to other layers of the digital map as well as to the digital map as such. This layered approach provides a high flexibility of injecting data layers to the digital twin while enabling easy addition and maintenance of data layers.

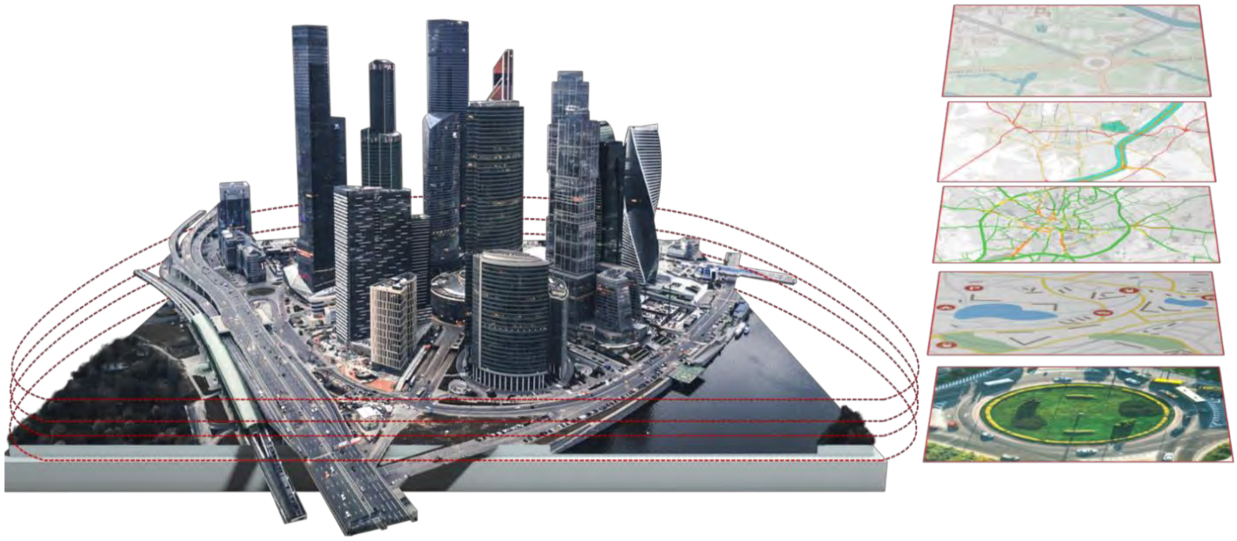


Figure 14: Infrastructure data layers, source PTV

5.2.1 Map data

Owner	PTV
Short description	Digital Maps, traffic and market data for optimized route planning
Detailed description	Digital rendering – often referred to as digital mapping – is the process of visualising geographic data on digital maps. While early digital maps contained the same cartographic information as scanned versions of paper maps, the expansion of GPS has added many functionalities to digital maps, like the possibility to include points of interest and other location-based datasets. Digital rendering is a prerequisite for all geographical and logistical functions and crucial for tasks such as vehicle routing and optimisation.
API or database	API
Access rights	Needs permission
Example data / screen shot 1	Layer view of map data

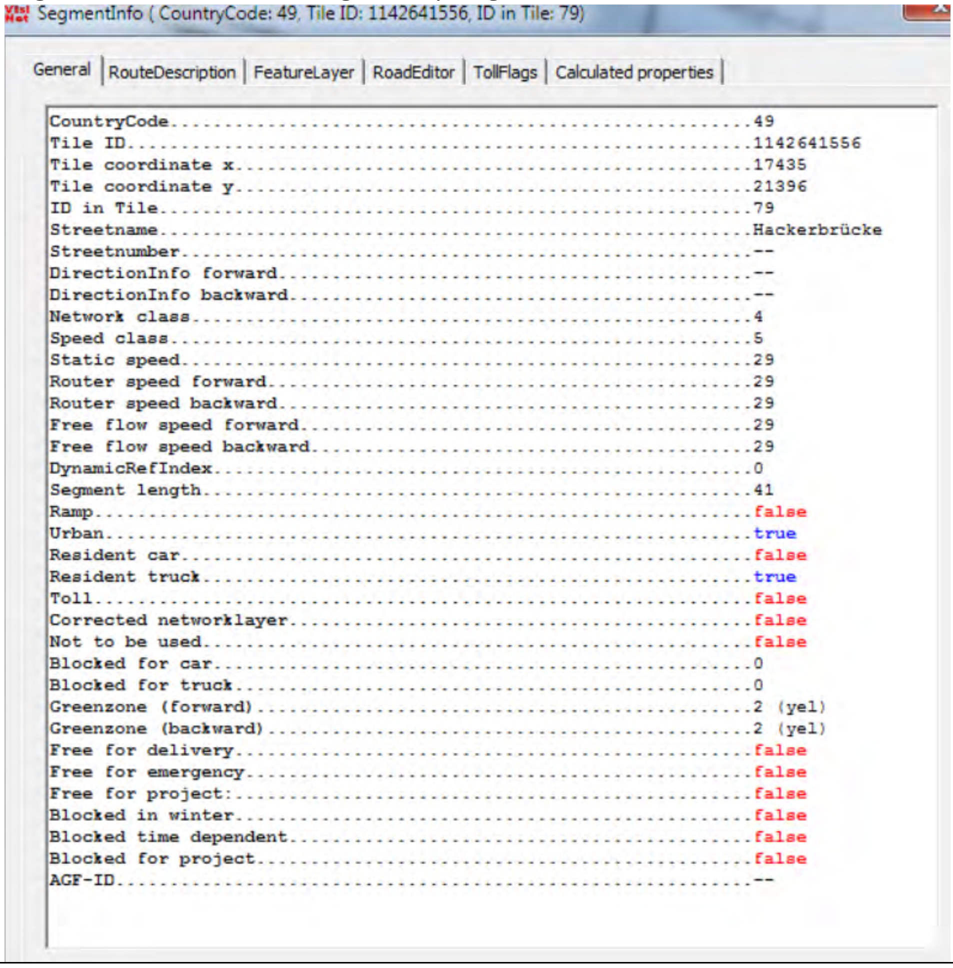
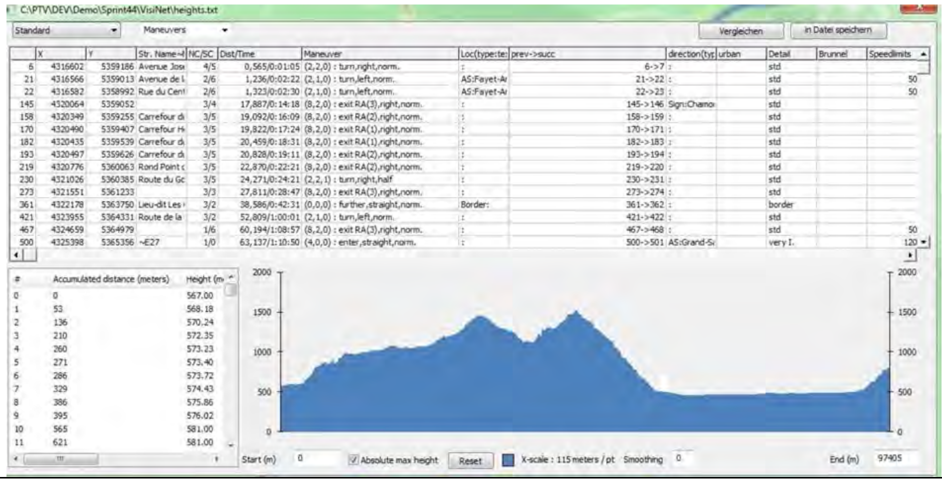
	
Example data / screen shot 2	Segment information of a digital map edge.  SegmentInfo (CountryCode: 49, Tile ID: 1142641556, ID in Tile: 79) General | RouteDescription | FeatureLayer | RoadEditor | TollFlags | Calculated properties CountryCode........49 Tile ID........1142641556 Tile coordinate x........17435 Tile coordinate y........21396 ID in Tile........79 Streetname........Hackerbrücke Streetnumber........-- DirectionInfo forward........-- DirectionInfo backward........-- Network class........4 Speed class........5 Static speed........29 Router speed forward........29 Router speed backward........29 Free flow speed forward........29 Free flow speed backward........29 DynamicRefIndex........0 Segment length........41 Ramp........false Urban........true Resident car........false Resident truck........true Toll........false Corrected networklayer........false Not to be used........false Blocked for car........0 Blocked for truck........0 Greenzone (forward)........2 (yel) Greenzone (backward)........2 (yel) Free for delivery........false Free for emergency........false Free for project:........false Blocked in winter........false Blocked time dependent........false Blocked for project........false AGF-ID........--
Link to documentation	https://www.ptvgroup.com/en-us/solutions/products/ptv-xserver/areas-of-application/digital-maps-data/

Table 1: Data artefact - map data

5.3 Routing

Owner	PTV
Short description	Plan and optimise truck-specific routes
Detailed description	Various online platforms offer free and easy-to-use route calculation. Professional truck and vehicle routing, however, provides much more than

	that. Many specific requirements and challenges need to be taken into account when optimising routes for commercial vehicles: Truck attributes like size, weight and speed profiles, access restrictions in inner-city areas, toll costs, legal provisions like driving times and rest periods as well as time restrictions such as opening hours of ramps and depots are just a few examples. Additionally, the route with the shortest travel time may not be the fastest or most fuel-efficient route. All these factors turn route optimisation for trucks into a real challenge. In transport logistics, however, efficiency is key in ensuring profitability and sustainable business success. Therefore, it is crucial to ensure that commercial vehicles always take the optimal route available.
API or database	API
Access rights	Needs permission
Example data / screen shot 1	Routing response with manoeuvre instructions and topology 
Example data / screen shot 2	Truck route with inclusion of truck attributes Segment information of a digital map edge.

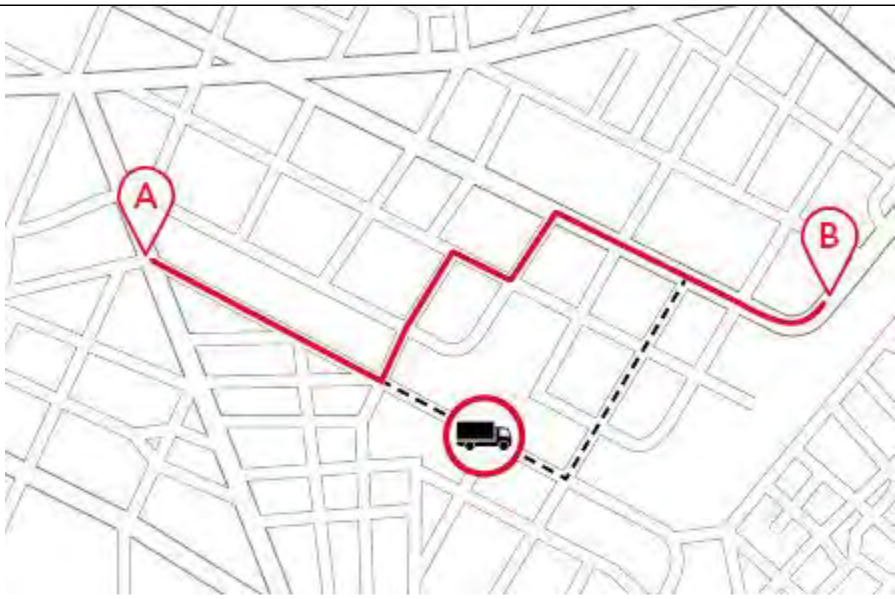
	
Link to documentation	https://www.ptvgroup.com/en/solutions/products/ptv-xserver/developer-zone/route-planning-api/#c12321

Table 2: Service artefact - routing

5.4 Point of interest data

Owner	PTV
Short description	Points of interest
Detailed description	Points of interest and other point data are an integral part of numerous applications both for your marketing or location planning as well as for your customers. Integrated into many route planners and navigation systems, they mark, for example, special buildings or facilities such as museums, monuments, or world heritage sites along a selected route. When it comes to location or territory planning, they provide information about the development of a particular location and its connection to private or public facilities. For this reason, POIs add value to any environment analysis. But other point data also delivers key advantages for competitive analyses, location and sales planning, or routing tasks, such as city files, house coordinates, or specialised data like route-specific and location-specific fuel prices.
API or database	Database: CSV, TAB, Access
Access rights	Needs permission

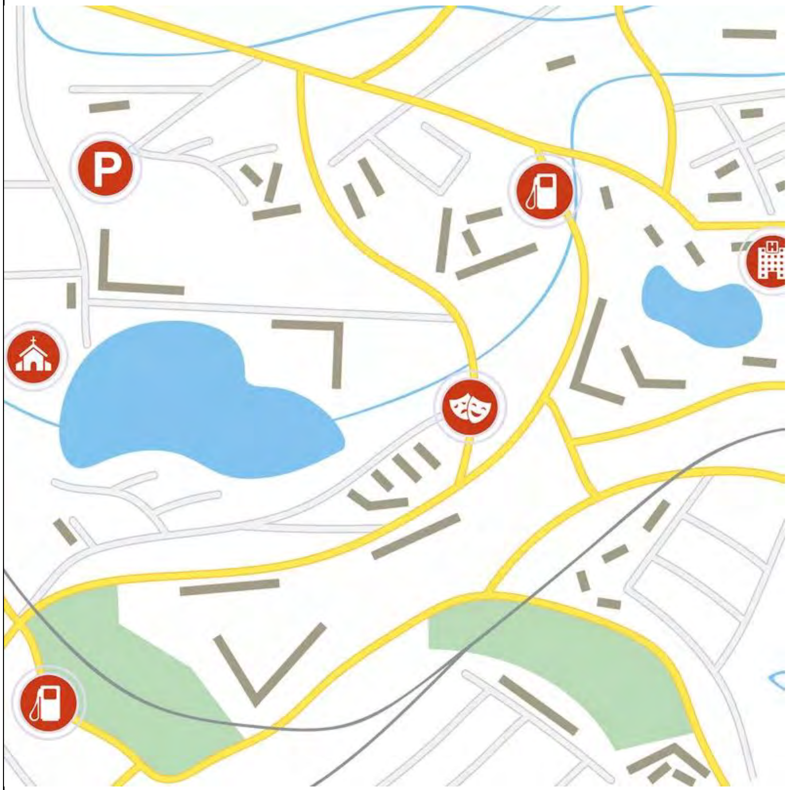
Example data / screen shot 1	Point of interest 
Link to documentation	https://www.ptvlogistics.com/en/data/ptv-data/points-interest#testdata

Table 3: Data artefact - POI

5.5 Traffic data package

Owner	PTV
Short description	Traffic data package
Detailed description	Traffic information is real-time data which doesn't include forecasts. In contrast to traffic patterns, it contains data on current traffic incidents. It further includes information on long-term construction work and events (e.g. parade on Saturday, from 10:00 a.m. - 3:00 p.m.). It is thus appropriate for current route planning, but not for any planning in advance. This traffic information that is saved to a Traffic server is transmitted in short configurable intervals by an add-on module (servlet), the so-called TrafficInfoLoader. • Dynamic traffic information for Europe based on TomTom HD traffic. • Traffic Patterns (historical traffic information based on FCD) • Additional data content is provided via FeatureLayer technology: Traffic patterns and traffic information.
API or database	Database: API
Access rights	Needs permission

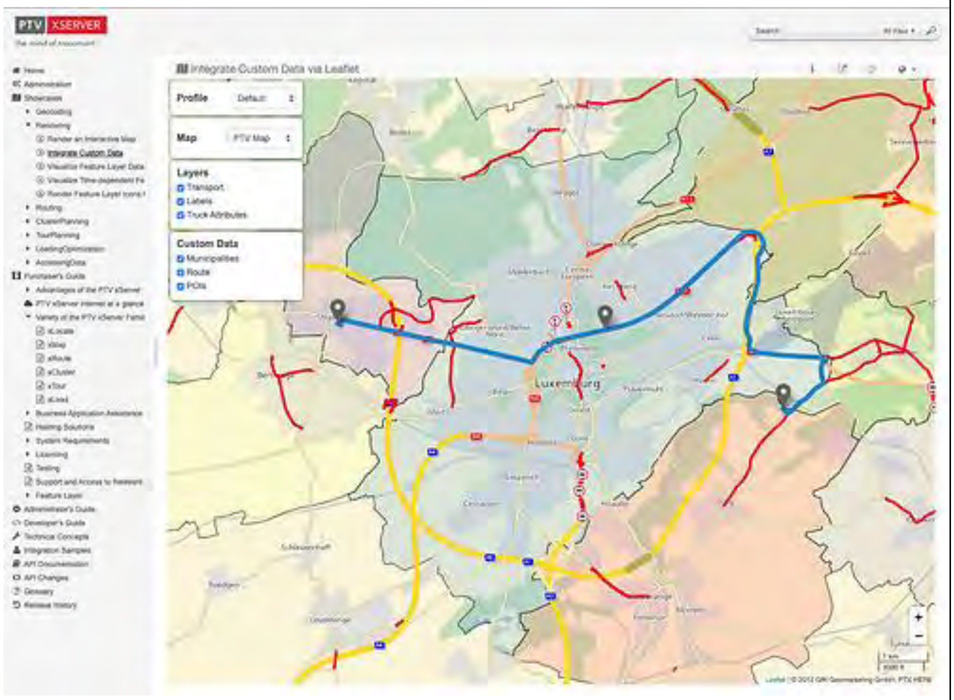
Example data / screen shot 1	
Link to documentation	https://xtour-eu-n-test.cloud.ptvgroup.com/manual/Content/Use%20cases/xRoute/UC_How-to-install-traffic-info-loader.htm

Table 4: Service artefact – Traffic information

5.6 Charging infrastructure hardware

Owner	ABB
Short description	Information about charging infrastructure specifications
Detailed description	Information about capabilities of chargers, e.g. number and type of plugs (1 or 2 per charge post of which 1 is always MCS and the other is optional and can be CCS1, CCS2, NACS), max power (800 kW per power cabinet, up to 2 per post) current (up to 1000A per power cabinet, 1500A per charge post; later on MCS goes up to 3000A), voltage (up to 920 VDC for now, 1250 VDC in the future), communication standard (ISO15118-20 for MCS, ISO-15118-2 or 20 for CCS), accessibility for types of vehicles. Some of this information, e.g. location and maximum size of vehicles, has to be provided by the charge point operator. Note that ABB cannot provide a complete map of all installed charging infrastructure, but only the data of the specific chargers provided by ABB to be used in ZEFES.
API or database	Database
Access rights	Charger specs are publicly available. Details and customization are available on request only.

Example data / screen shot 1	Datasheet of the Terra HP Generation 3 (excerpt)

Technical specifications	
Charge post	
Charging performance	500 A continuous up to 35°C with noise level of ≤60 dB(A) at 1 m
Charge cable	5.3 m / 17 ft with retraction system
DC output current	500 A CCS (liquid cooled) 200 A CHAdeMO
DC output voltage	150 – 920 V DC
Maximum noise level	68 dB(A) at 1 m
Touch screen	15" high brightness
RFID	ISO/IEC 14443A/B, ISO/IEC 15393, FeliCa™1, NFC, Mifare, Calypso
Network connections	4G, Ethernet
Dimensions (H x W x D)	2458 x 590 x 425 mm / 96.8 x 23.2 x 16.7 in
Weight	250 kg / 551 lbs
Connector types	CCS1 / CCS2 / CHAdeMO
Power cabinet	
Output power	175 kW up to 40°C
Output power derating	5% per 5 additional degrees
Output current	1 cabinet: 375 A 2 cabinets: 500 A
AC connection	L1, L2, L3, GND (no neutral)
CE version	400 V AC ± 10%, 50 Hz (option: 60 Hz) 277 A, 192 kVA nominal Recommended breaker: 315 A
UL version	480Y/277 V AC +/-10%, 60 Hz 231 A, 192 kVA nominal Recommended breaker: 300 A
CSA version	600 V AC ± 10%, 60 Hz 185 A, 192 kVA noninal Recommended breaker: 250 A
Short circuit rating	CE: 25 kAIC UL/CSA: 65 kAIC
Overvoltage	CAT III
Efficiency	≥ 94% at full load
Power factor	≥ 0.97
THDi	≤ 8%
EMC emission (conducted)	Standard: Class A (industrial) Optional: Class B (residential) with external filter
Noise level	≤67 dB(A) at 1 m
Dimensions (H x W x D)	2030 x 1170 x 770 mm / 79.9 x 46.1 x 30.3 in
Weight	1340 kg / 2954 lbs
System	
Compliance	CE, cTUVus for UL and Canada
Environment	IP54, NEMA 3R outdoor use IK10 (screen: IK08)
Operating temperature	-35 °C to +55 °C (derating applies)
Storage	+5 to +40 °C with RH 5 to 85%
Altitude	2000 m / 6560 ft

Link to documentation	https://new.abb.com/ev-charging/high-power-charging

Table 5: Data and service artefact – charging infrastructure hardware

5.7 Charging infrastructure status information

Owner	ABB
Short description	Information about charging infrastructure status
Detailed description	Chargers used in ZEFES will be capable of providing information about their status through an API. This includes information on availability, current electrical output, connected vehicle, state of charging process, as well as billing info on the current charging process.
API or database	Usually Database (OCPP), e.g. for CPO (API in special cases e.g. for payment terminal)
Access rights	Depending on data. General on the charger specs and availability can be public, but information on connected vehicles is sensitive.
Example data / screen shot 1	Available on request
Link to documentation	Available on request

Table 6: Data and service artefact – charging infrastructure status information

5.8 HD road data (HAN)

Owner	HAN
Short description	3D models of critical road sections
Detailed description	The infrastructure data of relevance are the locations of roundabouts, sharp turns and highway entry/exits in any mission route. In order to obtain these critical sections in a route, input from 3rd party APIs like Google and PTV are needed. Data in the form of GPS coordinates are used to locate and annotate the data with roundabouts, sharp turns and highway entry/exits (Google's data set contains these annotations but lacks logistics specific routing that PTV's data provides). These identified sections are then constructed in the Curved Regular Grid (CRG) format based on the actual trajectories of the sections as described in ZEFES deliverable 4.1. The resulting infrastructure data set is a set of CRG files (one for each identified critical section) that is available for MATLAB's Simscape tool to use to analyse vehicle performance in each section. Road boundaries needed for swept path analysis are not directly available from map APIs, hence satellite images of the critical sections (especially roundabouts and sharp turns) are processed to obtain clear definitions of the road lanes and boundaries. The resulting road boundary data in the form of polygons (cartesian coordinates in the frame of each road section) are then used during swept path analysis.
API or database	Database
Access rights	Available upon request

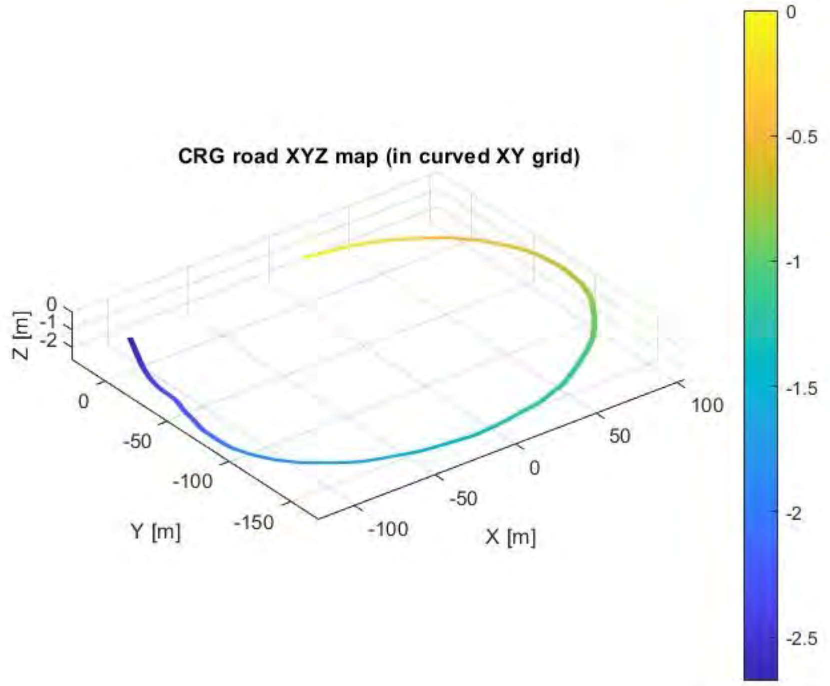
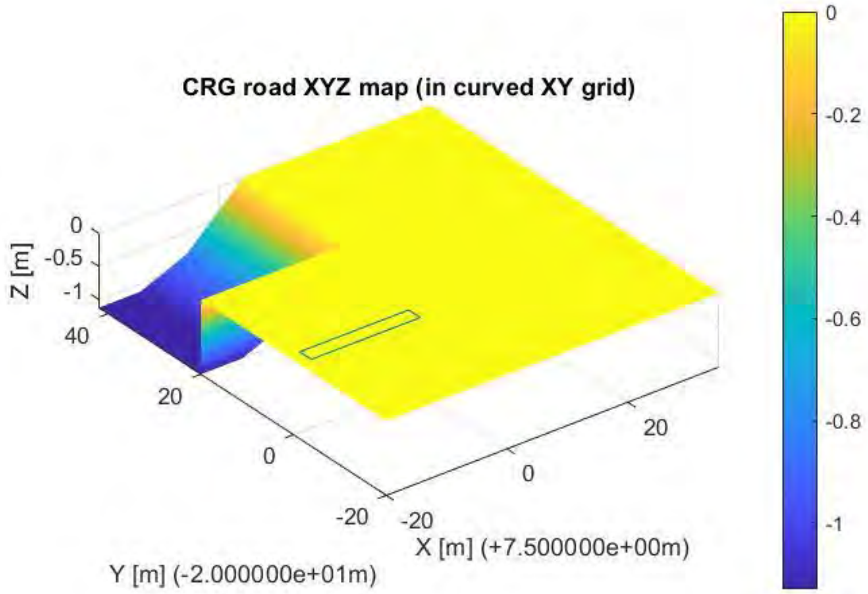
Example data / screen shot 1	Highway exit XYZ map with elevation 
Example data / screen shot 2	Distribution centre with sloped docking area 
Link to documentation	[HAN Automotive Research · GitHub]() (access only upon request)

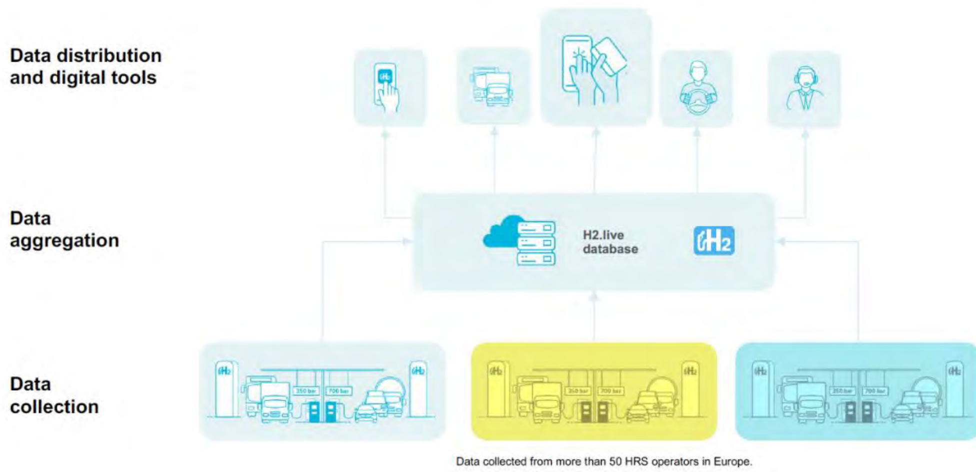
Table 7: Data artefact – HD road data

5.9 H2 station locations (POI data)

Owner	Idiada via H2 Mobility
Short description	Locations for H2 fuelling stations
Detailed description	Detailed POI description of European H2 stations including description of location coordinates, operator, technical equipment, etc. Flat csv file
API or database	CSV
Access rights	Public
Example data / screen shot 1	
Link to documentation	https://h2.live/en/

Table 8: Data artefact – H2 station data

5.10 H2 station value added services

Owner	Idiada via H2 Mobility
Short description	Value added services for HRS.
Detailed description	Information-apps and API-integrations with B2B customers. H2 Refuelling & Payment and digital offers. **Real-time** H2 information via a direct connection to the interfaces. of the plant manufacturers
API or database	API
Access rights	Needs permission
Example data / screen shot 1	The App H2Live data provides the status of stations in service. Detailed data like for example "direct" H2 throughput isn't available. 

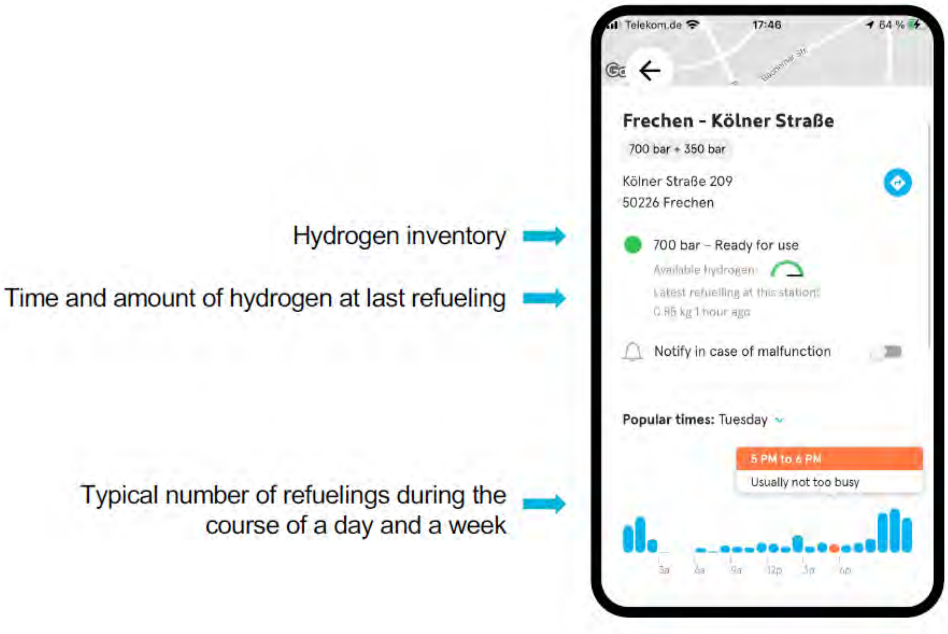
Example data / screen shot 2	
Link to documentation	https://h2.live/en/

Table 9: Data artefact – H2 station VAS and APIs

5.11 Weather API

Owner	OpenMeteo
Short description	Environmental information
Detailed description	In order to realistically take weather conditions into account when planning routes, PTV uses the OpenMeteo.com weather service as an open-source weather API. The service is operated by OpenMeteo, Switzerland. The use of the API is based on our legitimate interest, which is to be able to offer users a meaningful and realistic route planner for electric vehicles, which is not possible without taking weather data into account. Open-Meteo leverages a powerful combination of global (11 km) and mesoscale (1 km) weather models from esteemed national weather services, providing comprehensive forecasts.
API or database	API
Access rights	commercial and non-commercial licenses

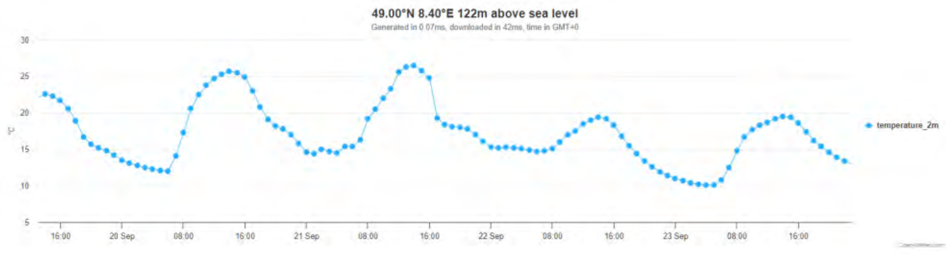
Example data / screen shot 1	
Example data / screen shot 2	
Link to documentation	https://open-meteo.com/

Table 10: Service artefact – weather data

6 Requirements of infrastructure data & service stakeholders to share via ZEFES

This chapter provides the high-level requirements of the data & service owners to share data to the project.

6.1 Technical requirements

Partner	Requirements
PTV (for all data sets)	• Only trusted, safe and secure connectivity to be used • GDPR compliant process
ABB	• Need to know about expected data quality (including refresh rates) in order to setup service level agreements
ABB	• Only trusted, safe and secure connectivity to be used • GDPR compliant process
ABB	• Chargers must be accessible to cover the Maintenance Repair Overhaul cycle
HAN	• Only trusted, safe and secure connectivity to be used • GDPR compliant process • Sufficient resolution quality of input satellite images to reconstruct low speed critical sections • Sufficient density of input GPS waypoints of the mission to identify critical sections
IDIADA	• Only trusted, safe and secure connectivity to be used • GDPR compliant process

Table 11: high-level technical requirements for data and service exploitation using ZEFES platform.

6.2 Legal requirements

Partner	Requirements
PTV	• Data processing agreements must be agreed on. • GDPR compliance must be respected. • No sharing to entities outside of the ZEFES consortium • No service level guarantee for test instances • If partner uses PTV services, they shall inform PTV
ABB	• Data processing agreements must be agreed on. • GDPR compliance must be respected. • No sharing to entities outside of the ZEFES consortium • No service level guarantee for test instances • If partner uses ABB services, they shall inform ABB
ABB	• Data policy beyond GDPR (works council)
ABB	• Rules and regulations to connect ABB chargers to the grid must be respected. • Rules and regulations to operate ABB chargers must be respected
HAN	• Data processing agreements must be agreed on. • GDPR compliance must be respected. • No sharing to entities outside of the ZEFES consortium • No service level guarantee for test instances • If partner uses HAN services, they shall inform HAN

Idiada	• Data processing agreements must be agreed on. • GDPR compliance must be respected. • Public service

Table 12: high-level legal requirements for data and service exploitation using ZEFES platform.

6.3 Business requirements

Partner	Requirements
PTV	• For sample data no requirements • For commercially used data, standard business terms and conditions are to be respected
ABB	• For sample data no requirements • For commercially used data, standard business terms and conditions are to be respected
ABB	• Respect the conditions to service the charger. Service technicians must have received appropriate training certification
HAN	• For sample data no requirements • For commercially used data, standard business terms and conditions are to be respected

Table 13: high-level business requirements for data and service exploitation using ZEFES platform.

7 Data integration and interplay with the platform

The gathered data and information should be provided to the Digital Twin Platform (Task 4.3) for keeping or requesting it in secure manner to fulfil the goals of the tools which should be elaborated within ZEFES project. This chapter is dedicated to the providing infrastructure data to the platform and the ways to request it in secure, authorized manner.

7.1 Infrastructure data injection to platform

There are different ways data could be injected to the platform. The specific way depends on the choice to provide the dataset to the platform or to allow to request data by demand.
Every data owner has its own authorized account on the Digital Twin platform. Only by using such an account ZEFES participant can access the platform for any action on tools, models and data.

Dataset uploading to platform

If the dataset is provided to keep at the platform, it could be uploaded to the platform by the data owner. Every authorized data owner receives the possibility to upload needed dataset to the platform through web form with existing button for uploading. For the upload, a special temporary secure session is open to guarantee that data is being uploaded in secure manner. The dataset under upload is being kept in the isolated data folder of the data owner. By default, the uploaded dataset is visible only to the data owner. After uploading, the data owner can choose the users account from the platform with which data owner wants to share data. Only those accounts chosen by data owner are able to access data afterwards.

Request for data through owner API

Data owner can provide the API to access the requested dataset in the case of need. In this case the dataset is being kept on the data owner premises. There should be an API, always available to listen to the upcoming requests for data. From the platform side a special Docker image will be constructed, which is responsible to request dataset, establish communication under that request, download required part of dataset and provide it directly to the processing without keeping it on platform side. When an instance of such Docker container starts, it takes the data request parameters from the user, establishes the communication with the premises of data owner, sends request for data, awaits for the response with the dataset, and forms the received dataset for the immediate use in the processing.
In this case data owner still needs an account on the Digital Twin platform. The dataset should be registered in Metadata registry. For each dataset data owner provides the list of ZEFES accounts which are allowed to access this dataset. Before starting the communication, Docker instance checks whether the given account is able to access the requested dataset. If the account is not in the list, data request does not proceed, and user receives the message that the request cannot be fulfilled because they have no right to access the dataset. Users can communicate with data owners to request to include the account of the user to the accounts list for data access.

7.2 Exposing collaborative data via platform

Every ZEFES participant has their own user account. The rights to use specific dataset is associated with such user account.
Every dataset is exposed only to the user accounts chosen by data owner to access that specific dataset. The list of such accounts is being managed by data owner. Only authorized user accounts which are in the list of data owner are able to access data from that owner.
Every data owner should register their datasets in Metadata registry by providing the description of the dataset and the contact point information for managing that dataset. The users of ZEFES platform in case of need can communicate with the data owner to include him/her into the list of the accounts which are able to access that specific dataset. After being included in the list of the authorized user accounts by data owner, such dataset becomes available for that specific user account. Data could be used as an input to the ZEFEStools.

7.3 Valorising collaborative data via platform

In the ZEFES project, 5 tools are being made for the stakeholders of the project. Every tool in the end is represented as a workflow to run to reach the required results. Such workflow could be run only by an authorized account of a Digital Twin platform user. The access to the allowed workflows is provided by the rights associated with the user account. If the user account requires to start specific workflow, the right to access the datasets associated with this workflow and specifically to access the input dataset is checked before running the workflow. If the account does not have the right to access datasets, needed to run that specific workflow, the workflow will not be started, and user receives the message that they do not have rights to access that dataset. Users can check Metadata registry on who is the owner of the dataset and request the right to access the specific dataset from data owner. After the data owner puts the user account into the list of the accounts which are allowed to use that specific dataset, the user can run workflow with the necessary infrastructure data.

8 Results & Discussion

This Chapter summarizes the main results of the task 4.4 of M1-M9. The results will be taken up as basis for application and integration course of T4.5.

8.1 Results

Main objective of Task 4.4 is putting together a platform for major data objectives including external data sets, e.g., road, filling stations, traffic, etc. that can interact with surrogate vehicle models of BEV and FCEV. To achieve these results, the inputs from WP3 to WP7 as well as requirements from WP1 have been taken into account. The main result is a comprehensive set of information and services establish a complete digital model that represents the infrastructure, traffic and environment conditions.

Sub-results are:

Result 1:
The related activity T4.4 analysed needs and requirements for data and service sets. Furthermore, an approach has developed to collect data in a systematic way.

Result 2:
Artefacts for data sets and services have been collected and documented. These include 9 artefacts:

- Map data
- Routing
- Point of interest data
- Traffic data
- Charging infrastructure hardware
- Charging infrastructure status information
- High density road data
- Hydrogen fuelling station data
- Weather data

Result 3:
Processes and conditions for application and interplay of data sets and services along the value stream in the ZEFES platform and further valorisation scenarios have been stated.

8.2 Contribution to project (linked) Objectives.

Overall, this deliverable contributes to project objective 3 "provide digital and fleet management tools specifically for HD ZEVs, fleet integration with remote operational optimisation of vehicle performance " and objective 4 "demonstrate missions on cross-border, TEN-T corridors, fulfilling the requirements for range and payload, and comparing the deployability of BEVs and FCEVs for different mission profiles."

Objective 3 foresees ZEFES to design an open platform to represent European logistics missions, enabling an assessment of the impact on environment and society of using HD ZEV. The platform will include different modules, such as "life-cycle assessment", "assignment and routing", "vehicle performance", "vehicle condition", "logistics performance" etc.
Part of this objective is to develop and validate truck Digital Twins (DTs) and fleet management tools.

A DT here is a virtual representation of an object or system, possibly spanning its lifecycle, that is updated using real-world, possibly real-time data. Such a DT uses simulation, machine learning and reasoning to help decision-making[7].

The DT in ZEFES has different layers: component, vehicle, infrastructure and fleet operation. A platform will be created to make DTs of individual ZEV HDV operations with common data representations. The DTs of ZEFES will be applicable in the following domains: design and build, testing and validation, logistics operations, and charging infrastructure and management.

This deliverable as part of task 4.4 **contributes to the digital twin and digital platform services for infrastructure related data, model, and services.**

Objective 4 aims to demonstrate missions on cross-border, TEN-T corridors, fulfilling the requirements for range and payload, and comparing the deployability of BEVs and FCEVs for different mission profiles.

To perform the tests in real world environment, different digital services regarding the given infrastructure need to be facilitated in DTs of ZEFES.

This deliverable **contributes to the digital twin and digital platform services for infrastructure related data, model, and services for testing in course of objective 4 and related test scenarios.**

8.3 Contribution to major project exploitable result

The ZEFES project has 5 main objectives:

1. Execute real-world demonstrations, multimodal and cross border, of long-haul BEVs and FCEVs across Europe to take zero-emission long-haul goods transport in Europe to the next level.
2. Create a pathway for long-haul BEVs and FCEVs to become more affordable and reliable, more energy efficient, with a longer range per single charge and reduced charging times able to meet the user’s needs.
3. Develop technologies which can deliver promised benefits (easy handling, similar driving hours & charging/hydrogen refuelling stations, high speeds, and ability to operate in complex transport supply chains).
4. Demonstrate an interoperable Megawatt Charging System (MCS) and the location deployment strategy for hydrogen refuelling stations (HRS). Make the mapping of flexible and abundant charging/refuelling points and novel charging concepts.
5. Create novel tools for fleet management to seamlessly integrate the rising number of long-haul BEVs and FCEVs vehicles in the logistics supply chains, in the form of a Digital Twin.

The deliverable provides a major contribution to the ZEFES offering and testing of software, process is and solutions for zero emission vehicles. Thereby, infrastructure data is key to enable core scenarios of ZEFES. With infrastructure data for services and applications, it supports objective 1, 2, 3, and 5.

9 Conclusion and Recommendation

This document introduced the building blocks regarding infrastructure data and services. Infrastructure data and services are vital to ZEFES. However, infrastructure data is to be viewed at from an integrated scenario, where different other elements, such as vehicle or logistics planning, and operations data are to be linked and respected.

The ZEFES platform therefore facilitates as ZEFES software services backbone the exchange and the sharing of data. Connected via the ZEFES platform the exposed infrastructure data contributes to enable:

- Electro and hydrogen truck use cases for planning and operation,
- Data valorization to improve data and service quality and ultimately, to create,
- Potentially novel use cases.

Overall the infrastructure data is expected to be rather dynamic especially in regards to e-charging and H2 – fuelling infrastructures. Both are rather novel technologies and the market availability to will increase over time. Therefore, new functionalities and novel services must be expected to appear in the market, which can have some positive effects to the ZEFES platform and the ZEFES project overall. A future monitoring of existing and newly appearing infrastructure data and services is therefore a strong recommendation.

A second recommendation is to only connect data and services via the ZEFES platform since the implications towards technical implementation are more beneficial due to connecting only once. On the other side, the legal aspect of exchanging via the one platform only is also legally beneficial since data policy and data quality procedures can potentially be aggregated resulting in a reduced effort to onboard and connect new or change existing data sets and services

10 Risks and interconnections

10.1 Risks/problems encountered

Risk No.	What is the risk	Probability of risk occurrence[1]	Effect of risk[1]	Solutions to overcome the risk
WP4.1	Delay in provisioning of data and services	2	2	• Conduct regular status meetings in order to track progress and strengthen the interaction with WP partners/ stakeholders. • Develop appropriate mitigation strategies at operational level in case these are needed.
WP4.2	Data quality of artefacts not as intended	3	2	• Contributing partners of data and services artefacts to check quality, to indicate quality and to perform quality improvements if needed
WP4.3	Legal issues preventing data processing and data valorisation	2	1	• Conduct regular status meetings in order to track progress and strengthen the interaction with WP partners/ stakeholders. • Develop appropriate mitigation strategies at operational level in case these are needed. • Communicate openly and as early as possible the use case and the condition of the data & services to raise awareness at contributor level.
WP4.4	Contributing partner leaving the consortium	2	1	• In case of a partner leaving the project, effected tasks have to be covered by replacement. Escalation to project board level.

1) Probability risk will occur: 1 = high, 2 = medium, 3 = Low

11 Linked deliverables

The objective of the task 4.4 which is linked to this deliverable it set the foundation for integrating and putting together a platform for major data objectives including external data sets (road, rail, filling stations, traffic, and environmental data etc.) that can interact with surrogate vehicle models of BEV and FCEV. Considering the requirements from WP1 as well as the specifications from WP2, 3, 5,6 and WP7 a common data representation will be provided including static and dynamic data.

The graphic below shows the project work package and the interdependencies of the workstreams.

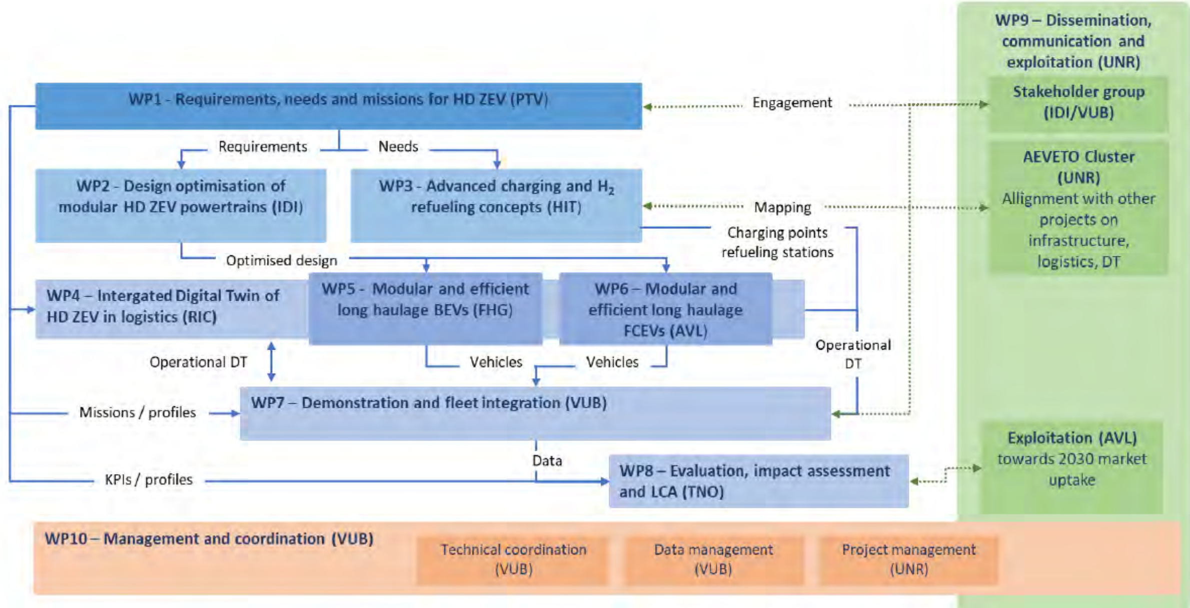


Figure 15: ZEFES work package structure

At a technical detail level, this deliverable is strongly connected with WP1 deliverables

- D1.2 - **Defined Use Cases**, Target metrics and needs - KPIs per use case on energy savings and mission efficiency (T1.2)
- D1.3 - **ZEFES ecosystem specification** - use case KPI needs, stakeholder business needs, consolidation towards consistent system, TCO (T1.3, 1.4, 1.5)
- D1.4 - **Supply chain mapping** - mapping of ZEFES use cases at a supply chain level (T1.3)

Towards WP4, this deliverable is strongly connected to all WP4 deliverables:

- D4.1 - **Digital twin and platform specification & architecture** - selection of tools, scaling of models, model fidelity, run time and usage assessment (T4.1 and T4.2).
- D4.3 - **Interfaces standard and tool** – tool based on current commercial products and the interfaces handle confidential data from various partners. (T4.3)
- D4.4 - **Decision making platforms** - buying decision, route planning, vehicle assignment, dynamic correlation, predictive maintenance and AI applications (T4.5)
- D4.5 - **Process and outcomes of model validation** - LCA and EIA interfaces and outcomes from WP4. A validated digital twin platform with the functionality of decision-making platforms (T4.6, T4.7)

12 Deviations from Annex 1

Minor delay in comparison to the original plan regarding the delivery date of the deliverable.

13 References

https://cordis.europa.eu/project/id/874997

14 Acknowledgement

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Project partners:

#	Partner short name	Partner Full Name
1	VUB	VRIJE UNIVERSITEIT BRUSSEL
2	FRD	FORD OTOMOTIV SANAYI ANONIM SIRKETI
4	KAE	KASSBOHRER FAHRZEUGWERKE GMBH
5	REN	RENAULT TRUCKS SAS
6	SCA	SCANIA CV AB
7	VET	VAN ECK TRAILERS BV
8	VOL	VOLVO TECHNOLOGY AB
9	ABB	ABB E-MOBILITY BV
9.1	ABP	ABB E-MOBILITY SPOLKA Z OGRANICZONAODPOWIEDZIALNOSCIA
10	AVL	AVL LIST GMBH
11	CM	SOCIEDAD ESPANOLA DE CARBUROS METALICOS SA
11.1	APG	AIR PRODUCTS GMBH
12	HEPL	HITACHI ENERGY POLAND SPOLKA Z OGRANICZONA ODPOWIEDZIALNOSCIA
13	MIC	MANUFACTURE FRANCAISE DES PNEUMATIQUES MICHELIN
14	POW	PLASTIC OMNIUM NEW ENERGIES WELS GMBH
15	RIC-CZ	RICARDO PRAGUE S.R.O.
15.1	RIC-DE	RICARDO GMBH
16	UNR	UNIRESEARCH BV
17	ZF	ZF CV SYSTEMS HANNOVER GMBH
18	ALI	ALLIANCE FOR LOGISTICS INNOVATION THROUGH COLLABORATION IN EUROPE
19	DPD	DPD (NEDERLAND) B.V.
20	COL	ETABLISSEMENTEN FRANZ COLRUYT NV
21	GRU	GRUBER LOGISTICS S.P.A.
22	GBW	GEBRUEDER WEISS GESELLSCHAFT M.B.H.
23	PG	PROCTER & GAMBLE SERVICES COMPANY NV
23.1	PGP	PROCTER AND GAMBLE POLSKA SPOLKA Z OGRANICZONA ODPOWIEDZIALNOSCIA
23.2	PGA	PROCTER & GAMBLE AMIENS
24	PRI	PRIMAFRIO CORPORACION, S.A.
25	PTV	PTV PLANUNG TRANSPORT VERKEHR GmbH
26	Fraunhofer	FRAUNHOFER GESELLSCHAFT ZUR FORDERUNG DER ANGEWANDTEN FORSCHUNG EV

27	HAN	STICHTING HOGESCHOOL VAN ARNHEM ENNIJMEGEN HAN
28	IDI	IDIADA AUTOMOTIVE TECHNOLOGY SA
29	TNO	NEDERLANDSE ORGANISATIE VOOR TOEGEPAST NATUURWETENSCHAPPELIJK ONDERZOEK TNO
30	UIC	UNION INTERNATIONALE DES CHEMINS DE FER
31	CFL	CFL MULTIMODAL S.A.
32	GSS	Grupo Logistico Sese
33	HIT	Hitachi ABB Power Grids Ltd.
34	IRU	UNION INTERNATIONALE DES TRANSPORTS ROUTIERS (IRU)
35	RIC-UK	RICARDO CONSULTING ENGINEERS LIMITED

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15 Appendix A – Review of tools generated during previous EU funded projects

15.1.1 Road network information

- Road network information
  - Attributes obtained from HERE databases are:
    - LinkID
    - Speed limit
    - Traffic flow average speed
    - Free flow speed
    - Link length
    - Functional class (road type)
    - List of longitude/latitude/elevation
    - Termination of the link (traffic light, stop road signs, etc.)
    - Road roughness
- Weather information
  - Forecast weather description
  - Temperature
  - Atmospheric pressure
  - Solar irradiance.
- Traffic information
- Traffic events
- Charging point locations