EU OVERVIEW OF CLEAN FUEL INFRASTRUCTURES AND GREEN INTERMODAL TRANSPORT

D.T3.1.1

Version Final
04 2020

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Elaborated by

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1. Introduction

Nowadays, freight transport represents a challenge in the Central Europe area as its volume is constantly growing and intermodal nodes have difficulties to channel it onto sustainable transport modes. In fact, the rapid growth of freight transport resulted in a loss of market share for sustainable transport models such as rail- and inland waterway transport, while road transport in Europe has tripled. The climate crisis that we are facing is an absolute priority that we cannot ignore and policies aiming at protecting the environment by reducing pollution, for instance, cannot be postponed. The transport sector has a major responsibility when we come to air pollution, and the reduction of road transport is therefore necessary.

Transport nodes in Europe represent a crucial component of intermodal freight transport, as they are the nucleus, start and ending point for most of the freight transport. Different transport scales, modes and spatial restrictions must be considered when organizing freight transport in nodes reaching an environmentally friendly transformation. However, nodes face several challenges that obstruct their crucial role as sustainable transport enablers and these challenges can be political, technical and on a spatial planning level. Capacity restraints as well as planning restrictions are partly responsible, but also communication gaps between different actors and stakeholders and a common lack of harmonization, especially regarding the incorporation into the TEN-T networks, make the transition towards a well-organized and sustainable freight transport particularly difficult. In fact, different technological choices in different parts of Europe have led to a fragmentation of the internal market, whose penetration is hampered by the lack of infrastructure and common technical specifications and requires additional specific policy measures. Widely known solutions on a technical level are therefore needed in order to make transhipment and last mile transport greener.

The InterGreen-Nodes project aims at facilitating the alignment between regional interest and EC recommendations on freight transport and regional development, building capacities and ensuring the transfer of knowledge on solutions and opportunities across authorities and freight stakeholders. The recent publication of the Green Deal[1] is the proof that European Commission is taking care also of the transport sector. The project wants to improve coordination between planning authorities and freight transport stakeholders with the target of increasing the share of multimodal and sustainable transport and to support the development of the Central Europe region. This will be done through the harmonization of methods and practices such as spatial planning and intermodal terminal processes.

Within the work package 3 of the project, different innovations and solutions will be tested and disseminated first to the other project partners, and then to terminals and ports outside the project partnership. Before these solutions will be developed and tested, this report intends to give an overview of past and ongoing experiences in the use of clean fuels in intermodal transport, especially in terminal operations and last mile transport. This catalogue of past and ongoing experiences highlights the lessons learnt as well as the solutions adopted in this framework.

Chapter 2 focuses on the alternative fuels for a sustainable mobility in Europe; it shows the currently existing alternative fuels along the TEN-T corridors and summarizes the new obligations for Member States of the EU on clean fuel for transport.

Chapter 3 offers a review of good practices and European projects on clean fuel infrastructures and intermodal transport. Some of the good practices collected are local initiatives, some others have been financed through European funding.

Chapter 4 explores the concept of green terminal operations through the example of a European project.

Chapter 5 examines the last mile transport and gives a review of green solutions on last mile transport.

1 https://ec.europa.eu/info/strategy/priorities-2019-2024/european-green-deal_en

Lastly, chapter 6 makes some final considerations based on the lessons learnt from previous experiences and gives some recommendations for the development of the demonstrators foreseen by the InterGreen-Nodes project.

2. Alternative fuels for a sustainable mobility in Europe

According to the European Commission, transport today relies on oil for 94% of its energy needs. Europe imports around 87% of its crude oil products from abroad, estimated at around €187 billions in 2015, with additional costs for the environment (1). The effect of the oil dependency on the European economy is too large to neglect, and Europe must act to end it. It is estimated that a strategy for the transport sector to gradually replace oil with alternative fuels and build up the necessary infrastructure could bring savings of €4.2 billion per year in 2020, increasing to €9.3 billion per year in 2030, and another €1 billion per year from dampening of price hikes. Support to the market development of alternative fuels and investment in their infrastructure in Europe will boost growth and a wide range of jobs in the EU; research convened by the European Climate Foundation finds that 'greening' cars could generate about 700,000 additional jobs by 2025 (2).

Thanks to research and technological development, we do already have successful demonstrations of alternative fuel solutions for all transport modes, but additional policy action is necessary in order for the market to take up. Moreover, the existing provision of alternative fuels along the TEN-T corridor network differs by Corridor and especially by Member State, as different set of policies and incentives for the ownership and usage of alternative fuels vehicles as well as the build-up of the infrastructures may be provided by each State. Some Member States have adopted ambitious targets on the deployment of alternative fuels and taken initiatives on infrastructure, whereas in other Member States, discussions on initiatives have only started recently. Nonetheless, there is a common trend throughout the European Union to use the potential of alternative fuels in transport.

As stated in the proposal for a Directive on the deployment of alternative fuels recharging and refueling infrastructure (COM/2013/18), the main alternative fuel options are electricity, hydrogen, biofuels, natural gas (in the forms of Compressed Natural Gas (CNG), Liquefied Natural Gas (LNG), or Gas-To-Liquid (GTL)), and Liquefied Petroleum Gas (LPG).

As previously mentioned, the existing provision of alternative fuels along the TEN-T corridor network varies by Corridor and by Member State. The number of existing LNG stations in the EU is still relatively small, but they are growing rapidly. The majority of these stations are publicly accessible and can provide fuel for any LNG vehicles and in some cases, they also provide CNG (3).

2.1. Clean fuel for transport: new obligations for Member States

The Alternative Fuels Directive (2014/94/EU), through which the European Commission is seeking to promote the deployment of alternative fuels infrastructure to enable an increase in the uptake of alternative fuels vehicles and thus reduce Europe’s dependence on oil:

- requires Member States to develop national policy frameworks for the market development of alternative fuel and their infrastructure
- foresees the use of common technical specifications for recharging and refuelling stations
- paves the way for setting up appropriate consumer information on alternative fuels, including a clear and sound price comparison methodology.

The national policy frameworks that Member States are required to develop may consist of several plans, strategies or other planning documentation developed separately or in an integrated manner, and they must take into account the needs of the different transport modes existing on the territory concerned.

Up to now, clean fuels have been held back by three main barriers:

1. the high cost of vehicles;

2. a low level of consumer acceptance;
3. the lack of recharging and refuelling stations.

With this directive, Member States will have to provide a minimum infrastructure for alternative fuels such as electricity, hydrogen and natural gas, as well as common EU-wide standards for equipment needed and user information.

In particular, the regulatory framework of the directive is set for the following fuels:

- Electricity: Member States are required to set targets for recharging points accessible to the public to be built by 2020, in order to ensure that electric vehicles can circulate at least in urban and suburban areas. Ideal target is a minimum of one recharging point per ten electric vehicles. It is also mandatory to use a common plug across the EU.
- Liquefied Natural Gas (LNG): natural gas used in trucks and ships can substitute diesel. As for road transport, Member States must ensure a sufficient number of publicly accessible refuelling points, with common standards, on the TEN-T core network. Ideally, they should be built every 400 km by end 2025. A minimum coverage is required also for ensuring accessibility on LNG in maritime and inland ports.
- Compressed Natural Gas (CNG): a sufficient number of publicly accessible refuelling points with common standards must be ensured both in urban and suburban areas as well as on the TEN-T core network, ideally every 150 km by end 2025.
- Hydrogen: a sufficient number of publicly accessible refuelling points with common standards must be built by end 2025.ù

Moreover, the directive requires also clear information for consumers about the fuels that can be used for a vehicle and for comparing alternative fuel prices with conventional fuel prices. Information about the geographical location of publicly accessible recharging and refuelling points must also be ensured.

3. Good practices on clean fuel infrastructures and intermodal transport: a review

The InterGreen-Nodes project foresees the realization of six demonstrators, and in particular:

1. A cargobike-rail intermodal transport pilot for last mile distribution
2. A full electric intermodal terminal pilot
3. An electric ship for inland waterway transport
4. BREEAM and LEED-ratings for logistics buildings
5. Solar energy use for terminal operations
6. LNG use for freight transport instead of traditional fuel

This chapter is a review of the already existing good practices on clean fuel infrastructures and intermodal transport. Some of these have been financed by European programmes, whereas some others are local initiatives.

3.1. Local initiatives on clean fuels

Some local initiatives already existing on the use of clean fuels and intermodal transport have been collected within the project partnership.

The following scheme briefly introduces some already existing good practices.

Where is the good practice taking place?	*What is it about?*
Westhafen (Behala), Berlin, Germany	1. **Demonstrator of a fully electrified, intermodal supply chain in long-distance transport**. While electric traction is the standard solution for rail transport in Germany, integrating an e-truck into a long-distance transport chain (which requires higher payloads) is a novelty. In addition, an emission-free last mile transport-leg was demonstrated by utilising an existing solar power plant. To accomplish this goal, a fully electrified 40 t semi-trailer truck was developed, based on an existing demonstrator of a terminal tractor. 2. In 2014 BEHALA replaced the old diesel-driven road-rail-vehicle for the shunting of railway wagons by a **full electric remote controlled vehicle**. This makes the electric diesel-driven road-rail-vehicle more economical than the previous conventional solution. 3. Most of the cars used in the port are **electric or hybrid powered**. 4. **CNG lorries** transport containers which arrive in and leave Berlin by means of combined transportation to the ramps of the forwarder's customers. 5. R&D project "ELEKTRA" is the world's first **hybrid hydrogen-electrically powered push boat**. In cooperation with Technische Universität Berlin and BEHALA as well as a number

	of other partners, the construction of the vessel is currently under way.
Gothenburg, Sweden	Introduction and tests of a **last mile transport system** for vendors in the inner city districts of Gothenburg. The scheme calls for closing these districts for heavy freight vehicles and instead utilize a small Urban Freight Terminal to consolidate deliveries on light electric vehicle.
Kecskemét, Hungary	The city of Kecskemét developed a Sustainable Urban Mobility Plan in 2016 and one of its measures is to provide a sustainable way for last mile delivery by elaborating several tools, such as central warehouse for collecting goods, concentrated loading spots, and procurement of electric or hybrid freight vehicles for the last mile delivery. The realization of these measures did not yet happen, as it has to be supported by setting up the related legislative, administrative and technical framework.

Table 1 Local initiative on clean fuels

3.2. Good practices on clean fuels from EU projects

Many of the already existing good practices on clean fuels have been developed within European projects, through European funding. Together with InterGreen-Nodes partners, a number of good practices realized/planned within European projects have been collected, and for each of them, a form was completed in order to collect all the relevant information in relation to the goals of the InterGreen-Nodes project.

Name of the good practice	Sustainable Urban Logistics Plan of Budapest in the framework of SULPITER project
Website (if available)	https://www.interreg-central.eu/Content.Node/SULPiTER.html
Source of funding	Central Europe
Status	Ended in 2019
Aim of the project/of the good practice	Establishment of charging infrastructure for trucks using alternative fuel sources
Locations	Budapest (Hungary)
Background	Sustainable Urban Logistics Plan of Budapest was prepared in 2018 in the framework of SULPITER project. It recognizes the importance of clean fuel infrastructures and green intermodal transport. The spreading of modern, energy-efficient and green transport equipment can only be truly successful if the conditions of use for these vehicles are ensured, and that the capital city is well equipped with charging stations of appropriate quality. There are very few vehicles among large trucks used in freight transport that use only alternative fuel sources, however, hybrid vehicles are less rare. For larger vehicles, the various types of natural gas (CNG, LNG) and LPG (auto-gas) as fuels are highly popular, as are drives assisted by electric engines. Smaller trucks, that are responsible for the final (last-mile) phase of the logistics process, however, frequently have purely alternative fuel drive-trains. The use of CNG, LPG and LNG gases is also popular for small trucks, as is the purely electric drive-train. There is a great need for the development and expansion of the network of electric charging stations in Budapest, in the interest of encouraging the use of electric freight transport vehicles. The establishment of rapid charge stations plays a priority role in the expansion and development of charging

	stations, as a freight transport vehicle only has the chance for extended charging during the night, as it is in constant movement for deliveries during the day. The expansion of the network of gas-filling stations (CNG, LPG, LNG) is also required, but these are for the most part relevant on the outskirts of the city and near consolidation centres.
Results	There are currently 179 electric charging stations in Budapest while the network is being constantly developed. An online, frequently updated map based database (https://e-mobi.hu/hu/map) is available where the location of the deployed charging stations can be checked. Because of traffic regulations not all off the charging stations can be used by any kind of goods vehicles.

Table 2 SULPITER project description

Name of the good practice	Venice LNG multimodal facility
Website (if available)	http://www.venicelng.it/index_eng.html
Source of funding	The Venice LNG multimodal facility is co-financed by the European Union's Connecting Europe Facility (CEF)
Status	2019-2022
Aim of the project/of the good practice	The project aims at accelerating the deployment of the alternative fuels network in the North-East of Italy. The new LNG port storage facility in Venice aims to supply the road, maritime and inland waterways transport modes.
Locations	Venice (Italy)
Background	In the long run, the project will contribute to the reduction of both air pollutant and greenhouse gas emissions in maritime and road transport in the area of the port of Venice. The Venice LNG facility will be completely dedicated to LNG distribution as an alternative fuel for trucks and ships. The terminal will be supplied by LNG medium size vessels, while the distribution will be done by trucks, barges and trains.
Results	LNG carriers will replace the ships that today transport oil products. A maximum of 50 carriers per year is expected, i.e. an average of one ship per week. Trucks that today transport oil products will be replaced by LNG-fuelled trucks, and they will transport LNG. As a result, the whole handling process will be environmentally friendly.

Table 3 Venice LNG project description

Name of the good practice	TEN-T Project "POSEIDON MED II"
Website (if available)	https://www.poseidonmedii.eu/
Source of funding	Co-financed by the European Union's Connecting Europe Facility (CEF)
Status	2015-2020
Aim of the project/of the good practice	Poseidon Med II aims to contribute to reducing negative impacts of heavy fuel oil powering and to facilitate the implementation of the requirements of a number of EU Directives regarding alternative fuels for a sustainable future in the shipping industry.
Locations	Greece, Italy, Cyprus
Background	The project foresees actions and initiatives towards the adoption of LNG as marine fuel in the East Mediterranean Sea (Greece, Italy and Cyprus). In the Port of Venice, Rimorchiatori Riuniti Panfido builds the first highly innovative prototype of a bunkering vessel for the transport and bunkering of LNG to ships, in order to complete the LNG supply chain in Venice and the North-Adriatic area. The co-financing concerns the design and construction of this ship prototype called SBBT (Semi Ballastable Barge Transporter). This bunker barge will supply mainly the entire area of the North Adriatic, but it will be the first vessel of this type to be employed in the whole Mediterranean.
Results	The specific objectives of the project are to: • facilitate the adoption of the regulatory framework for the LNG bunkering • design the extension of Revithoussa LNG terminal • design and construct an LNG fuelled specific feeder vessel • implement technical designs and plan approvals for the retrofit/new building of LNG fuelled vessels and for additional ports' infrastructure for bunkering operations • examine potential synergies with other uses of LNG • develop a sustainable LNG trading and pricing pattern • develop financial instruments to support the port and vessel installations • develop synergies with other sectors (mainly Energy) that will create economies of scale in the use of LNG. The project is still ongoing.

Table 4 Poseidon Med II project description

Name of the good practice	GIFT – Green Intermodal Freight Transport
Website (if available)	http://www.southeast-europe.net/en/projects/approved_projects/?id=170
Source of funding	South East Europe (SEE)
Status	Ended in 2014
Aim of the project/of the good practice	The main aim of the project is to map, analyse, and evaluate the status of the transport sector in the GIFT transport network and propose new policies and strategies in infrastructure, processes, assets, ICT, legislation, norms and harmonization/ standardization issues, in order to promote innovative green intermodal freight transport corridors.
Locations	Greece, Italy, Romania, Slovenia, Hungary, Bulgaria, Serbia, Croatia, Albania, Slovakia
Background	GIFT project will drill down in three Pan-European Transport Corridors, namely IV, V and VII that cover almost the entire SEE region. These corridors have been selected, since: They connect ports to landlocked countries via road and rail infrastructure A very significant flow of freight from/to Europe uses these corridors. They involve important areas such as the Adriatic, the Danube, the Black Sea regions and the Balkans They have the potential to become green, since the instruments (both economical and operational) that can enhance a better integration of different modes of transport, exist. Moreover, it was decided to use the PEC Corridors (instead of the TEN-T corridors) as the latter do not cross non-EU countries such as Serbia, BiH, Albania, etc, which however belong to the SEE region.
Results	Desktop analyses & ground pilot testing in selected corridors Green proposals for selected corridors Mapping of current status of freight transport in selected corridors Mapping of EU and SEE national green transport-related policies (all deliverables can be downloaded from the website)

Table 5 GIFT project description

Name of the good practice	LNG Blue Corridors Project
Website (if available)	http://lngbc.eu/
Source of funding	LNG Blue Corridors Project is supported by the European Commission under the Seventh Framework Programme (FP7)
Status	Ended in 2018
Aim of the project/of the good practice	The Blue Corridors project's aim is to establish LNG as a real alternative for medium- and long-distance transport—first as a complementary fuel and later as an adequate substitute for diesel.
Locations	France, Germany, Italy, Portugal, Spain, Belgium, Sweden
Background	LNG has huge potential for contributing to achieving Europe's policy objectives, such as the Commission's targets for greenhouse gas reduction, air quality targets, while at the same time reducing dependency on crude oil and guaranteeing supply security. Natural gas heavy-duty vehicles already comply with Euro V emission standards and have enormous potential to reach future Euro VI emission standards without complex exhaust gas after-treatment technologies, which have increased procurement and maintenance costs. To meet the objectives, a series of LNG refuelling points have been defined along the four corridors covering the Atlantic area (green line), the Mediterranean region (red line) and connecting Europe's South with the North (blue line) and its West and East (yellow line) accordingly. In order to implement a sustainable transport network for Europe, the project has set the goal to build approximately 14 new LNG stations, both permanent and mobile, on critical locations along the Blue Corridors whilst building up a fleet of approximately 100 Heavy-Duty Vehicles powered by LNG.
Results	The Project fleet of 140LNG trucks has run in total more than 31.5 million kilometers, consuming in total about 14,200 tons LNG, thanks to a total of about 111,000 refueling operations done in the 12 stations of the Project. The average amount of LNG delivered is about 130 Kg per filling. The large majority of the filling operations went on smoothly and safely. Minor operational draw-back where experienced sometimes, just in the case of early phases of start-up, generally due to the still budding local market. The sector has harmonized connectors profile with EN ISO 12617, Safety was never at stake whatsoever. Of the total fleet in the Project, 78% is IVECO LNG trucks, and 22% is VOLVO LNG trucks. Euro VI trucks are 76%, the rest is Euro V. The corridor road network is still expanding progressively. New routes become available for the LNG trucks, thanks to the development of the infrastructure. More and more industrial and productive areas in the European territory are covered by the truck itineraries, in particular in Belgium, France, Germany (north), Italy (north and central), Netherlands, Portugal, Spain, Sweden (south) and UK (south). New models of high power LNG trucks are entering the market built by Iveco, Scania and Volvo. When the Project started, there were on the European market some LNG HD vehicles, which power of about 300 HP was not deemed

	as optimum for the needs of the long-haul goods transport on trucks having a total weight of some tens of tons along the main European routes. During the Project the OEMs understood this need, risen from a constantly growing customer park. So, they designed and put on market new LNG truck models offering more power, torque and running range. These new models are now perfectly suitable to this mission, and paralleling diesel trucks as for performance, but with lower emissions.

Table 6 LNG Blue Corridors project description

Name of the good practice	SMARTER TOGETHER
Website (if available)	https://www.smarter-together.eu/
Source of funding	Horizon2020
Status	2016-2021
Aim of the project/of the good practice	To improve citizen's quality of life in nowadays transforming cities.
Locations	Germany, France, Austria, Spain, Bulgaria, Italy, Ukraine, Japan
Background	Sustainable development builds on people in integrated, inclusive societies that develop in partnership and foster dialogue among all parties - being 'smarter together'. It equally builds on modern technologies and constant innovation as key ingredients at the service of people, societal development and economic transformation. Sharing these fundamental values and philosophy, SMARTER TOGETHER is a joint project that aims to improve citizen's quality of life in nowadays transforming cities. The project will focus on finding the right balance between ICT technologies, citizen engagement and institutional governance to deliver smart and inclusive solutions. Therefore, six neighborhoods in different European countries will experiment with innovative smart city components, including co-creation processes and high-quality refurbishment measures to explore new ways of adding value in urban societies **Munich, Lyon and Vienna** – the three lighthouse cities will implement the main demonstration activities in specific districts, monitor the results and upscale solutions at city level **Santiago de Compostela, Sofia and Venice** – the three follower cities will replicate the key findings from lighthouse cities in targeted areas, implementing them in different urban and institutional environments **Kiev and Yokohama** – the observer cities will increase the outreach of the project whilst bringing in the perspective of cities from East Europe and Asia. SMARTER TOGETHER will deepen the knowledge and know-how in the fields of data management, eco-refurbishment and e-mobility through large-scale demonstration activities, user-centric innovation and sustainable smart city business models. Research and business stakeholders will benefit from the in-depth transfer of the results, which will prepare the ground for a large-scale replication of successful solutions in other cities, contributing to positive societal dynamics in European countries and beyond.
Results	Together, Lyon, Munich and Vienna aim to adopt a pioneering role for many critical issues relating to the future of cities – by implementing urban labs as testing grounds to think about how technological innovation should be managed for the benefit of the citizen and with the citizens.

Table 7 SMARTER TOGETHER project description

Name of the good practice	SmartEnCity
Website (if available)	https://smartencity.eu/
Source of funding	Horizon2020
Status	2016-2021
Aim of the project/of the good practice	SmartEnCity's main objective is to develop a highly adaptable and replicable systemic approach towards urban transition into sustainable, smart and resource-efficient cities in Europe. This will be achieved through the integrated planning and implementation of measures aimed at improving energy efficiency in main consuming sectors in cities, while increasing their supply of renewable energy and demonstrating the benefits.
Locations	Bulgaria, Denmark, Estonia, Germany, Italy and Spain.
Background	Cities play a key role in fighting climate change. Energy demand and CO_2 emissions are particularly high in urban areas. At the same time, urban density allows more alternatives for energy-efficient housing, eco-friendly transport and service provision. SmartEnCity's vision is to create Smart Zero Carbon Cities that are more sustainable and inclusive, improve citizens' quality of life, create jobs and wealth, and offer equal growth opportunities. SmartEnCity aims to develop a systemic approach for transforming European cities into sustainable, smart and resource-efficient urban environments in Europe. Activities include retrofitting in buildings, integrating infrastructures, developing sustainable mobility and the intelligent use of Information and Communication Technologies.
Results	SmartEnCity expected results are: • Retrofitting of about 2,500 dwellings and over 165,000 m^2 • Benefits for 29,300 inhabitants • Energy savings of about 30,000,000 kWh/y • CO_2 reduction of 19,000 Tn/y • Increased use of renewable energy sources for heating • Smart lighting concepts • Innovative strategies for sustainable mobility (electric vehicles, bike and car sharing, biogas buses etc.)

Table 8 SmartEnCity project description

Name of the good practice	GUTS – Green Urban Transport Systems
Website (if available)	http://www.gutscentral.eu/
Source of funding	Central Europe
Status	2007-2013
Aim of the project/of the good practice	Creating a strong institutional, financial and technological guidance for the development of sustainable public transport systems for small and medium-sized cities. The focus is laid on finding innovative solutions for converting urban public transport (PT) into clean and sustainable systems by increasing the share of renewable energies.
Locations	Hungary, Italy, Slovenia, Poland, Czech Republic
Background	The GUTS partnership understands that developing cleaner public transport systems can play a direct role in creating an attractive environment in urban areas, while also contributing to the health and quality of life of inhabitants. The project therefore investigates green public transport solutions, especially for municipal bus fleets. GUTS sees the need for cities to develop a shared view regarding the nature of transport policy objectives. The project analyses and compares state-of-the-art technologies based on partner cities' pilot feasibility studies to find the most adaptable solutions for their public transport, taking into account local development needs and the need to minimize the local carbon footprint The project's focus is on hydrogen and biofuels, both proven means for powering energy-efficient buses, but GUTS also studies solutions using solar energy and compressed natural gas. When promoting public transport that uses alternative fuels, the project looks at everything from technical parameters to financing models for each suggested solution.
Results	The results of the project's initiatives are gathered into a transnational strategy on clean public transport systems. The goal of this output is to give policy makers knowledge that they can use when forming their own urban planning strategies. Partner cities develop specific action plans that are ready to be put to use immediately.

Table 9 GUTS project description

3.3. Good practices on intermodal transport

This report aims at giving an overview of good practices on clean fuels infrastructures and intermodal transport, and because the previous paragraph mainly dealt with clean fuels, the following list browses some stories focused on intermodal transport particularly. The following tables briefly summarize some former EU projects on the promotion of intermodal and multimodal transport solutions, collected through the collaboration of the InterGreen-Nodes project partners.

Name of the good practice	Transnational Network for the Promotion of the Water-Ground Multimodal Transport - WATERMODE
Website (if available)	http://www.southeast-europe.net/en/projects/approved_projects/?id=82
Source of funding	South East Europe
Status	Ended in 2011
Aim of the project/of the good practice	The project objective is to promote the coordination between actors dealing with logistics for a better management of the transport policies and an efficient implementation of the multimodal logistics cooperation, especially exploiting the ground/water connections.
Locations	Austria, Bulgaria, Greece, Hungary, Italy, Romania, Slovenia, Albania, Montenegro, Serbia
Background	Italian regions and Central European countries have developed relevant economic ties with the South East European area, due to the current organization of the manufacturing production and the relevance of these growing markets. Trade relations are mainly organized through road transport, with low or any coordination between economic actors, involving a negative impact on the territorial competitiveness and environment of the territories crossed: air pollution, noise and reduced mobility. The project WATERMODE has been set up to promote a better coordination between policy actors and stakeholders to increase the competitiveness of the alternatives to road transport, especially valorizing the potentials of the water/ground multimodal logistics cooperation. To do that, project activities have been defined to provide instruments for improving the policy coordination and highlight potentials of water/ground multimodal transport.
Results	Feasibility studies, guidelines and reports are uploaded on the project website.

Table 10 WATERMODE project description

Name of the good practice	Adriatic - Danube - Black Sea multimodal platform - ADB multiplatform
Website (if available)	http://www.southeast-europe.net/en/projects/approved_projects/?id=162
Source of funding	South East Europe
Status	Ended in 2014
Aim of the project/of the good practice	The idea of the project is to develop and promote environmentally friendly, multimodal transport solutions from the ports in the SEE program area (Black Sea, Aegean, and Adriatic) to inland countries and regions along a selected pilot transnational network.
Locations	Austria, Bulgaria, Greece, Hungary, Italy, Romania, Slovakia, Slovenia, Albania, Croatia, Montenegro, Serbia, Ukraine
Background	Improving accessibility to SEE involves better freight mobility, upgrading transport standards, developing unified models of sustainable mobility management and integrated logistics chains and attracting innovative investments: the project combines these key factors of territorial development looking at the SEE integration into the EU common market economy. The integration strictly involves the relations between old and new M.S. and better cooperation among the different SEE Countries and Regions. The scenario for action considers the existing infrastructure network and transport policies in the perspective of the EU TEN-T ongoing implementation process, whose limited funding capacity implies to combine physical and professional training investments through interregional transport networking and pre-feasibility studies. Furthermore, the usage of intermodal transport in SEE is still limited. Therefore, main envisaged activities are the assessment of existing transport standards and terminal supply, gap analysis, the development of "Corridor quality networks" and "Multimodal Development Centres", harmonization of existing ICT tools for tracing rail transport and interface with customs, the establishment of "ADB Green Transport Agreements" and common training modules.
Results	The lessons learnt on the external costs of transport are uploaded on the project website.

Table 11 ADB multiplatform project description

Name of the good practice	SOUTH EASTERN EUROPE MARINE AND RIVER INTEGRATED SYSTEM FOR MONITORING THE TRANSPORTATION OF DANGEROUS GOODS - SEE MARINER
Website (if available)	HYPERLINK "http://www.southeast-europe.net/en/projects/approved_projects/?id=162" http://www.seemariner.eu/
Source of funding	South East Europe
Status	Ended in 2013
Aim of the project/of the good practice	The SEE MARINER project originates from the need to provide greater environmental protection through a coherent monitoring and response mechanism within a multi-sectoral setting as marine/river pollution has transboundary implications in addition to social, legal and economic dimensions in the SEE area.
Locations	Austria, Bulgaria, Greece, Hungary, Italy, Romania, Slovenia, Albania, Montenegro
Background	The SEE MARINER consortium has realized that economic development and a strong growth of transport and increased traffic in the SEE area cause high environmental burdens and increased threats of pollution and thus exertion of tremendous pressures on the relevant stakeholders to manage the environmental challenges. Although the existing Pan-European Transport network provides basic accessibility to the area, risk management structures on a transnational level are missing and coordination in the protection against the prevention of marine/ river incidents and accidents is insufficient. Hence, a shift in policy and also strategy is required to improve cooperation including the adoption of new technologies and monitoring management systems to enhance risk prevention and minimize pollution risk. The need to ensure clean seas and inland waterway requires coordinated and collaborative efforts among key stakeholders at local, national and international levels. Key determinants that ensure the effectiveness of such efforts are the availability and management of up to date and reliable monitoring information of the dangerous goods (DG)being transported in the SEE marine areas and rivers. The common concern of the project partners is to improve prevention of environmental risks e.g. spills caused by accidents or oil pollution arising from discharges, but also additional pollution problems in operational activities such as deballasting, tank cleaning or dumping of bilge water and sludge, by using innovative technological tools to create, network and maintain a mechanism for monitoring the DGs in the SEE marine areas and rivers. The partnership is ready to take transnational initiative to improve prevention of environmental risks and build the foundation for an improved network of information dissemination, integration, analysis and access by multiple users in the SEE area to finally achieve sustainable development of coastal and marine resources in the SEE program area
Results	All outputs divided by WP can be found on the project website.

Table 12 SEE MARINER project description

More on intermodality, the Central Europe Programme has published some project stories on sustainable public transport and logistics, some of which are indeed specifically addressed to intermodal transport (4). These projects are described in the following tables.

Name of the good practice	ChemLog - Chemical Logistics Cooperation in Central and Eastern Europe
Website (if available)	Project Stories from the CENTRAL EUROPE Programme Sustainable Public Transport and Logistics (publication)
Source of funding	Central Europe
Status	Ended in 2012
Aim of the project/of the good practice	Aim of the project was to strengthen the competitiveness of the chemical industry by improving conditions for chemical supply chain management in central and Eastern Europe.
Locations	Austria, Czech Republic, Germany, Hungary, Italy, Poland and Slovakia.
Background	The project partners implemented several feasibility studies analyzing the potential to improve intermodal transport of chemical goods in central and Eastern Europe by increasing the proportion of non-road transport. The Ministry of Regional Development and Transport in Saxony-Anhalt analyzed the potential for a shift in transport modes along the Trans-European Transport (TEN-T) Corridor II, from Berlin to Warsaw and Moscow. The study identified the potential to shift 4.3 million tons of cargo to intermodal transport by 2025. Based on the conclusions of the study, regional stakeholders from Germany started a discussion to develop a terminal network that creates hubs for bundling shipments to central and Eastern Europe. The analysis of Corridor II served to intensify discussion between the Polish Ministry of Transport, the Polish Chamber of the Chemical Industry and important logistics service providers – all of whom are seeking better intermodal connections to Poland and Russia. Partners from the Czech Republic, Hungary, the Province of Novara in Italy and Slovakia analyzed the improvement of intermodal transport alongside TEN-T Corridor V. They identified a lack of bi-modal cleaning stations, which can address the needs of both truck and train containers for chemical transport along this route. Together these partners began a discussion about the creation of a European Cleaning Station Network, and promoted plans for building new cleaning stations in Zahony (Hungary), Novara (Italy) and Cierna (Slovakia)
Results	The CENTRAL EUROPE project ChemLog has been working from 2009 to 2012 to improve chemical logistics in Central and Eastern Europe. Partners from public administrations, chemical industry associations and research institutions have cooperated to identify major problems and bottlenecks and develop recommendations for improvement of infrastructure and logistic related measures in order to strengthen the competitiveness of the chemical industry in Europe. The project has started in the 1st year with an SWOT-analysis for chemical logistics in Central and Eastern Europe. On this basis a

	number of bottlenecks have been identified and general recommendations for the improvement of framework conditions have been developed. The second year of project implementation was focused on the implementation of eight feasibility studies for the concrete improvement of transport of chemical goods alongside important transnational transport corridors looking at intermodal transport, waterway transport and pipelines. On the basis of the results from the feasibility studies the project partners have developed the ChemLog Strategy and Action Plan. The SAP includes regional specified strategic objectives and a description of concrete measures for the improvement of chemical logistics. Furthermore information about the involved stakeholders, time planning and financial resources are provided. The project has organized four Policy Advisory Group Meetings in Brussels and in Moscow to discuss project recommendations with policy makers from the European Commission and other relevant policy makers. The partners have also founded European Network on Chemical Logistics in Central and Eastern Europe under the umbrella of the European Chemical Regions Network. This network should ensure the continuation of transnational cooperation and the representation of interest at European level. The project has established a deeper cooperation with regional stakeholders from chemical companies, logistic service providers and research organizations in the framework of the Regional Stakeholder Meetings to integrate regional expertise and interest into the project. Altogether 63 Meetings have been organized with 1511 Participants.

Table 13 ChemLog project description

Name of the good practice	FLAVIA - Freight and Logistics Advancement in Central Europe - Validation of processes, Improvements, Application of co-operation
Website (if available)	Project Stories from the CENTRAL EUROPE Programme Sustainable Public Transport and Logistics (publication)
Source of funding	Central Europe
Status	Ended in 2013
Aim of the project/of the good practice	Aim of the project was to strengthen the competitiveness of the chemical industry by improving conditions for chemical supply chain management in central and Eastern Europe.
Locations	Germany, Poland, Austria, Romania, Hungary, Czech Republic, Slovakia.
Background	The current trade and goods traffic relations in Central Europe (CE) are strongly oriented towards Western Europe. However, through the accession of the South-Eastern European countries to the EU new sales and supply structures arise which have to be strengthened in the fields of trade as well as in goods traffic and logistics. The main direction of impact of the FLAVIA project is to substantial contribute to the European cohesion, especially along the TEN-T corridors IV and VII and the FLAVIA corridor itself. This will be achieved by the reduction of organizational and network barriers in the intermodal logistic channels of the involved regions which will increase the accessibility of regions from the logistical point of view. Furthermore, strategic enlargements of the sales and supply structures are necessary to reach new potential trade partners around the Black Sea and the TRACECA area (Transport Corridor Europe Caucasus Asia). The countries in these areas are on the one hand interesting business markets for European industrial products and on the other hand there are valuable natural and energy resources. To link efficiently these new markets and the Southern Silk Road to the European heartland is the topic of the FLAVIA project. Thereby the focus of the project is an intermodal cargo flow related and process-oriented approach. Through the logistical approach and the logistical instruments being used (e.g. benchmarking, accessibility analyses, running time und bottleneck analyses, pre-feasibility studies to prepare necessary investments) new and innovative measures for a better interconnectivity of the regions will be developed and implemented. Also the exchange of knowledge and the promotion of best practice will be an essential part of the FLAVIA project to foster the use of environmentally friendly transport rail and inland waterway. More than 10 pre-feasibility studies to support inter- / multimodal goods transport in the FLAVIA corridor will be carried out. The related investments will improve the accessibility of the involved regions drastically in terms of intermodal transport, unburden the congested roads and contribute to the ecological aims of the regions. But the Southern endpoint of the FLAVIA corridor does not mark also the final destination of the logistics channels. Therefore an extension of the corridor towards the Black Sea bordering and TRACECA countries is foreseen. Main goal of the extension process is the establishment of cooperation structures in the fields of trade and transport.

Results	The FLAVIA project improves the intermodal transport along the corridor Central/Southeast Europe. FLAVIA uses a logistics-oriented approach. This means, after analyzing the corridor and the existing bottlenecks concrete action plans are elaborated to remove them. Finally, new intermodal concepts (rail, inland waterway, terminal development) are developed with the help of pre-feasibility studies. The FLAVIA road show continued with further events in Pardubice, in Bucharest and two events close to Berlin. The road show is a chain of events with various stops along the corridor. In each FLAVIA country the partners have prepared project appearances on notable national conferences, fairs and symposiums. After promoting the concept of a pro-rail alliance during the project the establishment of three pro-rail alliances was accomplished. According to the already existing model in Germany, new alliances were set up in Poland, Austria and Romania. In all three countries memorundam of understandings were signed by profit and non-profit organizations. The alliances will communicate the needs of the railway sector towards the policy decision makers and the public. A similar approach could be finished successfully as well. During the project lifetime, the idea of a terminal alliance was discussed. In Budapest an initial group with terminal representatives from Germany, Hungary and Romania was formed. The terminal alliance shall be used as a platform in order to implement common actions and interests like staff educating, marketing or business development. Furthermore, all pre-feasibility studies have been finalized. Since the beginning of the project the topics terminal development, railway services, green logistics and inland waterway transport were dealt with. Furthermore, the partnership released overall 8 best practice brochures '"From truck to train". An IT routing tool has been further developed. It enables the user to route intermodal transports along Europe. Together with the intermodal wiki both tools shall help to raise the awareness for intermodal transports. The wiki provides a knowledge base for intermodal transport topics.

Table 14 FLAVIA project description

Name of the good practice	SoNorA - SOuth-NORth Axis
Website (if available)	https://www.sonoraproject.eu/
Source of funding	Central Europe
Status	Ended in 2012
Aim of the project/of the good practice	The project aims at developing accessibility in South North direction, between the Adriatic and Baltic seas, in terms of: 1. Making the SoNorA network real, through support for the completion of transport infrastructure; 2. Activating and improving multimodal freight logistics services; 3. Developing transnational action plans for future realizations; 4. Supporting new regional development opportunities, due to transport network improvements.
Locations	Austria, Czech Republic, Germany, Italy, Poland, Slovenia
Background	SoNorA studied possible directions for central Europe's transport network while taking regional development into consideration, thus seeking synergies and investigating ways in which transport growth can assist in overall regional development. A main objective of the project was to make the South-North Axis (SoNorA) a true intermodal transport network, served by various types of transportation – rail, waterway, road, etc. -, which can encourage more economically efficient and environmentally friendly transport solutions. The SoNorA project sought to ensure exploitation of all access points of the network using the most environmentally sustainable transportation possible. The project encouraged the creation of logistics services, by detailing the preliminary infrastructure investments needed for the development of new services. As part of this work, the project provided a software tool that presents intermodal routing information for logistic services.
Results	Some of the targets positively achieved: a) needs of individual areas which have trans-national relevance for the integrity of the entire corridor have been evaluated both by means of analytical capabilities of model activities and with specific focuses on regional/local level; b) conditions for improved accessibility for landlocked countries to European seaports have been dealt as a specific case of the previous point but also in the may business cases analysis performed; c) The elaborations of proposal for facilitating intermodality has been carried out with generally good results both with reference to infrastructure needs and development of concrete proposal for new services for road, rail and to less extent waterways; d) Strategic cooperation between and within trans-European transport corridors have been dealt in the successful development of a network proposal for the TEN-T revision, in spite of the difficulty of the issue;

	e) A specific deal has been paid to connections between high priority transport corridors and national and regional networks in the results achieved; f) support the deployment of sustainable transport modes have been dealt with particular attention paid to the emerging issue of green corridors idea.

Table 15 SoNorA project description

Name of the good practice	EMPIRIC - Enhancing Multimodal Platforms, Inland Waterways and Railways services Integration in Central Europe
Website (if available)	Project Stories from the CENTRAL EUROPE Programme Sustainable Public Transport and Logistics (publication)
Source of funding	Central Europe
Status	Ended in 2014
Aim of the project/of the good practice	The EMPIRIC has been developed to support the start up and improvement of multimodal connections from/to North Adriatic Ports with Central Europe hinterland.
Locations	Italy, Austria, Germany, Hungary, Slovenia, Poland, Czech Republic
Background	The EMPIRIC project was conceived by the partnership as an initiative to integrate and capitalize the previous projects and local initiatives for the promotion of multimodal transport and the interconnectivity of the transport modes – mainly held at policy level and with limited transfer of knowledge to the operators and economic stakeholders - with the goal to provide an adequate preparation to the incoming investments in infrastructures and services to strengthen the attractiveness of the multimodal transport. In particular, the partners focused on the interconnection between the Adriatic ports, nowadays associated in the Northern Adriatic Port Articulation, and their economic hinterland, through the activation/support to the existing railways services, as well as ensuring the transfer of the experience and knowledge related to the inland navigation developed along the Danube river to the Po river inland waterways system, in order to accompany the investments for its RIS infrastructure and support the growth of the inland waterways transport sector. Consequently, the partnership was set up according to 3 criteria: previous involvement in projects of relevance for the program area related to intermodal transport, capacity to provide expertise and/or local support for the preparation of the incoming investments in infrastructures and services, capacity to rise the interest of policy, economic and scientific stakeholders.
Results	The new TEN-T network aims at delivering safer, smoother and less congested travel with shorter journey times across the road, rail, air and shipping transport industries. It introduces a new double-layer structure distinguishing between a core network to be put into place as a priority and a comprehensive network to be completed later on. Empiric project has developed feasibility studies, business plans and surveys through a pragmatic approach linking all of them with the ongoing revision of TEN-T core network and Comprehensive Network. Thanks to the transnational cooperation established through empiric project, partners have been able to individuate specific services and infrastructures to be upgraded or created in order to contribute to the objectives outlined by the new EU policy. Also, the private stakeholders involved in the project gave their contribute to improve incentives policies, safety legislation and practices and ICT tools.

	EMPIRIC helped the partners and the important stakeholders involved to think about the European relevance of their local development plans towards the goal of the establishment of the core network towards 2030 and the comprehensive network towards 2050.

Table 16 EMPIRIC project description

Another good practice that is worth mentioning about decarbonisation of urban freight is the **TDA Whitepaper Zero Emission Urban Freight.**

The Transport Decarbonisation Alliance elaborated a white paper in 2019 on how to reach zero emission urban freight by uniting Countries, Cities/Regions and Companies. Although solutions are specific for each situation, and they must be tailored to each urban area, there are some common denominators. A five-step process methodology is detailed to facilitate joint action and risk alleviation when taking measures to reduce and eliminate urban freight emissions. This is based on the TDA Manifesto for transport decarbonisation. The whitepaper shows the major challenges and existing solutions to overcome them, such as the structure of the urban logistics sector, the ownership issues, and the lack of efficient implemented solutions. Each challenge is fully documented with identified solutions (aligned with the proposed methodology) and practical examples of real situations with implemented solutions. As well as proving their feasibility, this provides a wide array of knowledge and ideas for Countries, Cities/Regions and Companies. As for its results, at the end of the document, a solution-mapping grid summarizes a best practice approach to transforming urban freight. It provides a qualitative assessment of the proposed solutions in terms of anticipated level of investment, involvement and impact, and implementation timeframe.

4. Green terminal operations

In the previous chapters, we reviewed some good practices on the use of clean fuels and intermodal transport, but when we talk about "greening" the nodes we should also include all those operations that are undertaken in the nodes themselves. The efforts of decarbonisation are indeed to be addressed to all the activities of the nodes, and these are not only related to transport. Whereas ports can become greener by focusing on the maritime and the land transport side, terminals will have to focus on their own operations and on the equipment.

In fact, as the air quality standards and regulations become stricter, ports and terminals will have not only to reduce their energy consumption, but also their carbon footprint, which is dependent on equipment and operations as much as on the energy mix and the management of energy consumption. In a way, climate change and energy transition may be seen as an opportunity: infrastructures must be made climate-proof, the oil and coal traffic should decline and new business opportunities will emerge. The European Union contributes to this transition with the EU Port policy (regulation 2017/352), which addresses these challenges through the Port Services Regulation (2019), modern state aid control, support to multimodal and alternative fuel infrastructure and actions to accompany the digitalization of transport (5).

Sea and inland navigation terminals as well as freight villages are crucial nodal points within intermodal transport chains. Sustainable freight transport requires integrating the energy consumption and the emissions caused by the terminal operations into overall chain. While some terminals, mainly the bigger ones, have already started to invest into eco-efficient technologies and handling equipment, this is still an outstanding issue for others. It is not easy to compare terminals to each other, as operational conditions can be very distinct; sometimes processes are at the same site, but in other cases they might be regionally distributed causing additional transport operations. In general, the development of terminals must include (6):

- Models to calculate, benchmark and control energy demand and supply
- Eco-efficient and economic handling equipment, technologies and operation
- ICT for strategic planning, tactical controlling and benchmarking
- Management of energy demand and supply.

As already stated, CO2 footprint in ports, terminals and freight villages can be reduced only through a cleaner energy mix and a reduction of the consumption of energy. In order to achieve this goal, practicable, understandable and transparent methods and standards must be developed. These will then provide a basis for policy-making aiming at the reduction of port and terminal carbon footprint and strengthened competitiveness of the sector.

The research project Green EFFORTS is an example of "greening" terminal operations; in fact, it aimed at contributing to greener terminals and ports and at improving the energy management. Like before, the following table summarized its targets and outcomes.

Name of the good practice	Green EFFORTS - Green and Effective Operations at Terminals and in Ports
Website (if available)	https://greenefforts.eu/
Source of funding	The Green EFFORTS is a collaborative research project, co-funded by the European Commissions under the Seventh Framework Program
Status	Ended in 2014

Aim of the project/of the good practice	The Green EFFORTS project primarily aimed at the reduction of energy consumption and a cleaner energy mix at terminals (container, RoRo and inland waterway) to be controlled in a standardized transparent and easy-to-follow way but also considers the role of a port authority may play to achieve these goals. In short, it defined the following objectives: 1. Transfer the knowledge and project achievements to the stakeholders in the maritime sector through dissemination activities 2. Investigate the current energy mix in ports and terminals while identifying the activities which account for real energy saving 3. Investigate the range of regenerative energy sources which could be adapted to the port and terminal environment
Locations	Germany, France, Netherlands
Background	Among the crucial research, the main questions were: • Which operational processes and consumers must be charged to the terminals' and the ports' account and which belong to others accounts? • Which measures really account to significant energy savings and which are just decoration? • Does it pay off to produce energy on site by e.g. solar panels or by using wind energy? • Is onshore power supply to ships berthed really the best solution when considering the whole energy production and distribution process chain? • How to ensure that technical and operational solutions are really accepted and applied by on site staff and how to implant the "innovators' gene" to all staff to initiate and maintain a continuous improvement process? Therefore the research project Green EFFORTS contributed to greener terminals and ports and to an improved energy management by • standardized calculation methods and process simulation • detailed view on consumption, supply, production and management of energy • implementation strategy supported by training and incentive programs. The consortium of eight partners, including Erasmus University Rotterdam were involved collaboratively in the project examined how a broad range of measures in strategic energy management can be employed to make port operations more energy-efficient and environmental-friendly.
Results	The project aimed at developing:

	1. A *Port and Terminal Knowledge Landscape (PTKL)*. The PTKL is a terminal process map which identifies the relevant domains and processes with regard to reduction and optimization of energy consumption and carbon footprint applicable to container, Ro-Ro and inland waterway terminals. The PTKL will serve as an important tool for further dissemination, training, exploitation and decision making for ports and terminal actors and other potential contributors 2. *Carbon footprint calculation methods for port and terminal domains*. The carbon footprint calculation model is applicable to the container, RoRo and inland waterway terminals and allow them to practice benchmarking on a comparable basis. 3. A *Simulation model for terminal energy consumption and supply*. This model is developed based on the captured processes in container, RoRo and inland waterway terminals shown in the PTKL map. 4. A *Virtual Green EFFORTS Terminal*. The model terminal is developed as a reference point in order to allow comparison with other terminal energy performances 5. A *Qualification and incentive concept*. The qualification and incentive concept includes an incentive system to reward the best practices and outstanding results, a training and learning concept and e-learning materials. The substantial number of public deliverables about energy consumption, supply and management as well as many other topics, including a video and the final report, can be found on the project website.

Table 17 Green EFFORTS project description

5. The last mile transport

In the last years, the concept of Urban Node[2] is frequently adopted as constitutive element of the Trans-European Transport Network (TEN-T) which foster the integration of the network into urban circumstances like spatial structure, economy and regional development. Although it is commonly used for passenger transport, it is also important for freight which is constantly increasing its volumes. As the volume of freight increases, freight vehicles increase too, thus causing an important impact on the city living condition and on the environment as a whole. The movement of freight vehicles causes additional congestion, air pollution, and therefore it must be controlled without affecting the economy.

If we consider the supply chain, the final user/the customer represents the final step, and in the production's journey from warehouse shelf to customer doorstep, the last mile of delivery is the last of the whole process. The last mile transport is indeed quite a crucial step, for it impacts the most on the customer's satisfaction, representing at the same time the most expensive and time-consuming part of the shipping process. It is indeed estimated that last mile delivery costs are around 53% of the total cost of shipping, and because customers are less and less willing to pay a delivery fee, retailers and logistics partners are forced to shoulder the costs. Therefore, the last mile delivery became the place where new technologies and process improvements are tested (7).

One of the main challenges of the last mile is to handle low-density deliveries cost-effectively. Additionally, the environmental components of the last mile equation must be taken well in mind, for the logistics sector has a big negative impact on the environment and has to take active measures to reduce its carbon footprint. With the last mile being both inefficient and top-of-mind for customers, it is fundamental that efforts are made to reduce the environmental impact of this part of the delivery journey particularly.

There is no question that day-to-day delivery is negatively impacting on infrastructures and adding congestions in the cities, and if e-commerce continues to grow pushing delivery times to decrease, this will likely worsen. Competition on price and delivery times does not go together with the protection of the environment but can only cause its hurting in the long run; this is why last mile transport is crucial and this is why sustainable solutions shall be adopted in this step.

5.1. Strategies and existing solutions for reducing the impacts of last mile freight

If we consider the urban context, urban freight represents a diversified set of stakeholders, goals, and physical places. Between the strategies that can be put in place for reducing last mile freight impacts, there are the following.

- **Size of vehicles and delivery time regulations**: some policies regulate when, where and which freight vehicles are allowed. Vehicles can be regulated by Municipalities according to their dimension, loading factor and emission factor or fuel type. By so doing, specific vehicles can be allowed to specific areas at specific times to avoid congestion during peak hours (8).
- **Sharing economy**: with the aim of reducing the number of trips, companies can start sharing vehicle capacity between them, thus reducing also the number of empty vehicle-km. However, this solution requires precise analysis and careful coordination between partners (9).
- **Urban distribution centers**: using more distribution centers in an urban area would significantly impact on last mile delivery as the number of trips and the cost of last mile delivery would be

2 According to regulation 1315/2013 of the EU, article 3 (p), "urban node means an urban area where the transport infrastructure of the trans-European transport network, such as ports including passenger terminals, airports, railway stations, logistic platforms and freight terminals located in and around an urban area, is connected with other parts of that infrastructure and with the infrastructure for regional and local traffic."

reduced. In addition, electric vehicles or cargo-bikes may be used as they easily adapt to short driving ranges (10).

- **Customer last mile visibility and engagement**: real-time tracking via map on mobile devices can help anticipating the time of arrival or helping the driver in getting the right way in case it shall be on the wrong route.

Beside strategies, innovative ideas are also needed for offering a delivery service as little impacting as possible. Some already existing green solutions are:

- **Electric tricycle**: tricycles with an electric motor are able to deliver small parcels and pallets up to 200 kg and can help solving the problem of congestion in cities densely populated without even polluting.
- **Self-driving vehicles**: self-driving makes driving more efficient in terms of better traffic flows, less fuel consumption, reduced maintenance costs and number of accidents, improved fuel efficiency and reduced carbon emissions (11).
- **Electric vehicles**: many companies are already operating in last mile delivery market by BEV, which has an obvious positive impact on the environment in less of no emissions.
- **Drones**: the adoption of drones in last mile delivery is rapidly growing among consumers and companies. These small quadcopters rapidly deliver packages to costumers' doors, eliminating waiting times and the cost of human labor.
- **Cubicycles**: for the delivery of small packages and mails, cubicycle may be a solution, an innovative cargo-bike for urban distribution. This solution would help improving the quality of air, reducing pollution in big cities and solving congestion problems.

The above-mentioned strategies and solutions can be adopted in all territories even though their implementation depends on the particular features and conditions of the actors involved, which may be different from a country to another.

6. Conclusions and lessons learnt

This report reviews a wide variety of good practices on the topics of clean fuels and intermodal transport, demonstrating that countries are aware of the importance of switching to sustainability and thus realizing actions and developing policies that go in this direction. Transport is within the main responsible sectors of pollution, and if we think of freight, nodes are their nucleus and a crucial component of intermodal transport, so it becomes necessary acting on nodes for making them greener.

Our review is mainly focused on four topics:

1. Clean fuels
2. Intermodal transport
3. Green terminal operations
4. Last mile transport

Altogether, these four topics have a significant impact on a more sustainable freight transport and on more sustainable – green - nodes. Good practices and local as well as transnational initiatives must be supported by policy makers, and good practices themselves shall provide inputs for policy making. The good practices included in this review may divided in demonstrators/practices and policies, although some provide both actions and inputs to policy making. The following table provides a summary.

	Practices/demonstrator	Policy
Clean fuels	• Good practices from Behala (Westhafen, Berlin) • SUMP of Kecskemét (Hungary) • SULPITER project • Venice LNG multimodal facility • Poseidon II project • GIFT project • LNG blue corridor project • Smarter together project • SmartEnCity project	• Directive on the deployment of alternative fuels recharging and refueling infrastructure (COM/2013/18) • Alternative Fuels Directive (2014/94/EU) • GUTS project
Intermodal transport	• ADB multiplatform • ChemLog project • FLAVIA project • Sonora project • EMPIRIC project	• Watermode • ADB multiplatform • ChemLog project • FLAVIA project • Sonora project • TDA white paper
Green terminals	• Green EFFORTS project	• EU Port policy (regulation 2017/352)
Last mile	• Test of a last mile transport system in Gothenburg (Sweden) • SUMP of Kecskemét (Hungary)	

Table 18 Good practices and policies

The separation of good practices by topics or by "type" of action (demonstrator or policy) is not always easy nor doable, for many practices are hybrid and may belong to more than one category. For instance, the SUMP of Kecskemét appears both in clean fuels and last mile as it provides clean fuel solutions for last mile transport. Even the "type" of action is not always easy to categorize: many projects/practices provide both concrete actions and inputs for policies, for instance through the elaboration of transnational strategies, recommendations for the improvement of frameworks, proposals, action plans or guidelines.

The six demonstrators that will be developed within InterGreen-Nodes refer to the same topics, and in particular:

	Demonstrator
Clean fuels	1. Electric ship for inland waterway transport 2. LNG use for freight transport instead of traditional fuel
Intermodal transport	3. Full electric intermodal terminal pilot
Green terminals	4. BREEAM and LEED-ratings for logistics buildings 5. Solar energy use for terminal operations
Last mile	6. Cargobike-rail intermodal transport pilot for last mile consumer goods

Table 19 InterGreen-Nodes demostrators

Objective of the demonstrators will be to improve coordination between planning authorities and freight transport stakeholders with the target of increasing the share of multimodal and sustainable transport and to support the development of the Central Europe region.

Bottom line is that the use of clean fuels and the promotion of intermodal transport must be supported by a policy framework that, by giving requirements to Member states, fills the existing gaps of communication between different stakeholders and improves harmonization between regions and countries. Starting from this, good practices shall be implemented and their development shall provide inputs to policy makers so that the way towards sustainable freight transport and green nodes will be faster and easier.

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