ASSESSMENT OF THE ALTERNATIVE ROAD FUELS INFRASTRUCTURE AND THE DEVELOPMENT PATHWAY TO INTEROPERABILITY
International best practices for promoting the development of alternative fuels infrastructure

Why and how to support?

1. Alternative fuels relate to the three major challenges in the transport sector

| GHG emissions | Reliance on fossil fuels | Congestion mitigation |

2. Some branches of the alternative transportation sector are already fully competitive

| Industrial applications of electric vehicles | CNG public transport | LPG in personal transport |

3. Other sectors are hindered by obstacles that are either real or perceived

| Actual cost differences - ICEs vs AFVs | Cost perceptions | Technological conservatism |
| Technological performance | Unfamiliarity, lack of knowledge | Perceived risk of investments |

4. In order for policy to overcome the above stated challenges, the following goals should be pursued

| Facilitate socio-technical transitions | Overcome cost barriers | Increase competitiveness of AFVs and infr. |
International best practices for promoting the development of alternative fuels infrastructure

Preferred alternative fuels in various non-EU states

<table>
<thead>
<tr>
<th>Country</th>
<th>Goals</th>
<th>Preferred technology</th>
<th>Policies</th>
<th>Incentives</th>
<th>Comparative advantage</th>
</tr>
</thead>
<tbody>
<tr>
<td>Brazil</td>
<td>Mitigate emission levels, utilization of inland production factors</td>
<td>Biofuels, primarily bioethanol</td>
<td>Stations obligated to sell ethanol</td>
<td>Setting blending mandate (18 -25 %), Fuel price control, tax reduction, credits</td>
<td>High supply of domestic raw materials</td>
</tr>
<tr>
<td>Japan</td>
<td>Reduce oil dependency, improve efficiency</td>
<td>EVs and Fuel Cell</td>
<td>R&amp;D programmes on batteries and HFVs</td>
<td>Incentives for FCVs and infrastructure development</td>
<td>Need for compact solutions</td>
</tr>
<tr>
<td>USA</td>
<td>Lower emission levels</td>
<td>All, except LPG</td>
<td>Loans for EV development, pilot projects for next generation EVs</td>
<td>PHEV tax credit, rebates for ZEVs</td>
<td>Technological comparative advantage</td>
</tr>
<tr>
<td>Iran</td>
<td>Avoid effects of sanctions, decrease dependency on oil</td>
<td>Natural gas</td>
<td>Ban imports on natural gas vehicle technologies</td>
<td>Price of natural gas significantly below that of gasoline</td>
<td>Availability of domestic resource</td>
</tr>
</tbody>
</table>

International best practices for promoting the development of alternative fuels infrastructure

The suggested policy hierarchy to support AFVs

- **Level 1: Reduction of fixed costs (subsidies)**
  - Based on international studies, consumers first of all require the associated with the purchase of AFVs reduction of fixed costs.
  - Subsidies and tax breaks are the available options, predominantly for national governments.

- **Level 2: Removing infrastructure bottlenecks**
  - The second most important action to be taken is the removal of infrastructure bottlenecks.
  - International cooperation is required at this level, tax breaks and direct support/development are all viable.

- **Level 3: Support to help usage**
  - Finally, consumers require that the usage of AFVs is made easier or economically more attractive.
  - Tax credits on fuels, special access rights in cities, favourable parking fees and bus lane usage are viable alternatives.

The hierarchy of alternative transport support measures stipulates that first of all the reduction of fixed costs is required, followed by the removal of infrastructure bottlenecks. Finally, the usage of AFVs should be made easier or economically more attractive.
Cross-analysis of different alternative fuel technologies: application potential among the various vehicle categories

<table>
<thead>
<tr>
<th>Vehicle category</th>
<th>1st gen liquid biofuels</th>
<th>PHEV</th>
<th>BEV</th>
<th>CNG</th>
<th>LNG</th>
<th>Hydrogen</th>
<th>Sum</th>
</tr>
</thead>
<tbody>
<tr>
<td>M1</td>
<td>5</td>
<td>5</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>5</td>
<td>25</td>
</tr>
<tr>
<td>M2</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>3</td>
<td>19</td>
</tr>
<tr>
<td>M3</td>
<td>5</td>
<td>1</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>17</td>
</tr>
<tr>
<td>N1</td>
<td>5</td>
<td>4</td>
<td>4</td>
<td>5</td>
<td>1</td>
<td>4</td>
<td>24</td>
</tr>
<tr>
<td>N2</td>
<td>5</td>
<td>1</td>
<td>2</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>19</td>
</tr>
<tr>
<td>N3</td>
<td>5</td>
<td>1</td>
<td>1</td>
<td>3</td>
<td>5</td>
<td>3</td>
<td>18</td>
</tr>
<tr>
<td>Sum</td>
<td>30</td>
<td>13</td>
<td>18</td>
<td>26</td>
<td>17</td>
<td>21</td>
<td></td>
</tr>
</tbody>
</table>

- **1st generation liquid biofuels** are entirely compatible with the current technological status quo
- Therefore, their application potential is unlimited across all vehicle categories

- **Hybrid vehicles** are best utilised in cases with frequent stops, therefore M1 category city traffic and cars
- The application of **BEVs** are restricted as per the low energy density of batteries

- **CNG** is best utilised in the smaller vehicle categories, in larger categories the range potential can be limited
- **LNG** is best utilised almost exclusively in the M3 and N3 vehicle categories

- **Hydrogen** can be applied in virtually any vehicle category
- The application potential decreases with vehicle size because of the lower energy density of high pressure \( H_2 \)

First generation liquid biofuels may provide an alternative in virtually all vehicle categories, followed by CNG and hydrogen. The application potential of electric vehicles decreases with size as batteries have the lowest energy densities among virtually all alternative fuel and storage systems.
International best practices for promoting the development of alternative fuels infrastructure
Cross-analysis of different alternative fuel technologies

<table>
<thead>
<tr>
<th><strong>E-mobility</strong></th>
<th><strong>Natural gas</strong></th>
<th><strong>Biofuels</strong></th>
<th><strong>Hydrogen</strong></th>
</tr>
</thead>
<tbody>
<tr>
<td>E-mobility offers <strong>great potential</strong> in terms of <strong>emission reduction</strong> in the transport sector.</td>
<td>Natural gas is promoted to be used in the road and shipping sectors as an alternative fuel.</td>
<td><strong>Biofuels are 100% compatible</strong> with the current transport technological status quo.</td>
<td>Hydrogen is a <strong>long-term option</strong>, considering its WTT carbon intensity and available infrastructure.</td>
</tr>
<tr>
<td>It is a great <strong>opportunity for European industry</strong>, considering the car manufacturing capacities.</td>
<td>However, the <strong>benefit for emission reduction remains low</strong>, especially if compared to diesel.</td>
<td><strong>Biofuel feedstocks</strong>, such as corn and wheat are <strong>grown in the Danube region</strong> in large quantities.</td>
<td>There is not a satisfactory amount of <strong>business cases</strong> for hydrogen vehicles now.</td>
</tr>
<tr>
<td>Shows strong coherence with European mobility requirements and existing infrastructure.</td>
<td>In the <strong>short-term</strong> it is the only cost-effective solution for transport, as exemplified by its already economic application.</td>
<td>However, <strong>EU-wide support</strong> for 1st generation liquid biofuels is <strong>questionable after 2020</strong>.</td>
<td><strong>Strong financial commitment is required</strong> from industry and government for further development.</td>
</tr>
</tbody>
</table>

For the Danube Region as a whole, the report argues that electric mobility and natural gas are the only feasible alternative fuels probably up to 2050, as first generation liquid biofuels do not provide a long-term solution, while hydrogen may only be considered as a long term option.
The basis for the development of the alternative fuel infrastructure: snapshots of the national transportation sectors

The Danube Region is the most heterogeneous macroregion within Europe. This is clearly indicated in the characteristics of the national transport sectors as well.

Clean connectivity within the Danube Region means connecting countries with highly diverging habits around freight and passenger transportation.

For example: passenger cars account for 80% of the passenger-kilometres travelled in Austria, in Moldova this figure is 42%.

Clean connectivity in the Danube Region is faced with a number of obstacles. One of them is that as the Danube Region is the most economically diverse macroregions in Europe, a common and harmonised green transport policy will connect countries with highly diverging freight and passenger transportation characteristics.

Modal split of passenger transportation in the Danube Region (2015)

*For Montenegro, railway includes public transportation

Source: [Ser]
The basis for the development of the alternative fuel infrastructure: snapshots of the national transportation sectors

There are similar differences in freight transport among the Danube Region states than in passenger transportation.

**Germany stands out** with the amount of freight transported on its national territory, however, **cross-border transport is the greatest** in BG, RO, HU, SK, CZ.

It is therefore **these countries** that form **the core of the SE-NW trading path** that crosses the Danube Region, thus it is **these countries where LNG stations are most needed**.

The Danube Region serves as an important SE-NW trading corridor in road freight transport. However, among the countries the cross-border trade is the greatest in Bulgaria, Romania, Hungary, Slovakia and the Czech Republic, requiring these countries to support sustainable freight transport practices as a priority.
The basis for the development of the alternative fuel infrastructure: snapshots of the national transportation sectors

It has been established that **passenger cars** are the most often used mode of passenger transportation in the Danube Region countries.

However, the **composition** of the passenger car stock of each country is diverging significantly and can differ markedly even among EU countries of the region.

For instance, in 2015 **AT had three times as much cars** in its national portfolio that were **younger than 2 years** compared to HU. Only **5.1%** of the cars in AT are older than **20 years**, compared to HU where **10.8%** are.

The heterogeneity of the national transport sectors within the Region are also exhibited by the varying age structure of the passenger vehicle fleets. Among EU countries there is significant divergence as well, suggesting that the roll-out of alternative fuel vehicles will be highly different in countries with modern and rather aging fleets.
Factors that influence the prospects for interoperability: Emission intensity of alternative fuels compared to gasoline and diesel in the Danube Region

If countries rely excessively on fossil electricity generation sources, then the well-to-wheel emission intensity of electricity will be greater than any other fuel in consideration. CNG provides significant emission reduction to gasoline in all cases, however, savings are limited unless the country is a major gas producer.
Factors that influence the prospects for interoperability: Absolute emission levels

To find out which fuel provides for the lowest overall emission levels given the passenger vehicle fleet of each country, we hypothesized that all M1 category vehicles are powered by one kind of fuel in the Danube Region, with the below results.

Despite that e-mobility does not provide for the lowest emission levels in all countries, at the region level it is the lowest emission option of all fuels.

CNG provides for only the third lowest emission levels at the regional level, diesel slightly outperforms CNG in its climate performance.

Gasoline has the highest emission levels both in terms of relative and absolute emissions and therefore it is a fuel that is worth to be substituted.

Diesel provides for the second lowest absolute emission levels, however, the associated PM and NOX emissions do not justify the wider usage of the fuel.

Similarly to most of the cases in the relative emission levels, e-mobility provides for the lowest emission levels when looked at in absolute terms. Diesel and CNG perform almost the same in the matter, while gasoline has the highest emission levels of all fuels in consideration.
Factors that influence the prospects for interoperability:
Economic competitiveness of the technologies

Given the average fuel costs in each country and the available subsidies for the purchases of vehicles, we estimated how much it would cost to purchase a Volkswagen Golf in its four variants and then operate it for 5 years.

In all instances, e-mobility provides for the highest cost of 100 km, despite the fact that this is the only technology that is supported via direct purchase incentives.

CNG rivals the costs of a gasoline car in a number of countries, such as Germany and Serbia. In the Czech Republic, CNG is more price competitive than diesel even in 5 years.

Gasoline provides for the lowest cost per 100 km given the current conditions, however, mostly because the purchase price of gasoline vehicles are well below those of diesel.

Diesel provides for the second lowest costs per 100 km, however, over a longer time period and higher annual mileage diesel tends to be more cost advantageous.

Given the current fuel costs and available subsidies for the purchase of vehicles, conventional fuels still provide for lower costs per 100 km, therefore the policy support measures for natural gas based and especially electric transport is justified.
Factors that influence the prospects for interoperability: current number of vehicles per publicly available charging infrastructure

The 2014/94/EU directive on the deployment of alternative fuels infrastructure stipulates that there should be 1 electric charger per 10 electric vehicles, taking into consideration the type of cars, type of charging infrastructure, etc.

It is clear that in most countries in the Danube Region, there is significantly less vehicles per publicly available charging spot, indicating the increased need for level 1 support measures.

It is suggested to have 10 electric cars per every publicly available charging point. In the Danube region countries, there are significantly less vehicles per charging point, which highlights the difficulties in incentivising consumers to opt for electric vehicles, calling for the need of more level 1 support policies.

![Number of BEVs per publicly available charging point in the Danube Region countries](image)
Factors that influence the prospects for interoperability: number of CNG vehicles per filling station

The 2014/94/EU directive does not stipulate the number of CNG vehicles per filling station, however, international bets practices suggest that if there are less than 500 vehicles per filling station, the stations will unlikely to be able to stay in business in the long term.

Given the current CNG vehicle fleet in the Danube Region countries, it is evident that the filling infrastructure is likely suffering from major underutilisation in most of the countries, with the exception of Bulgaria and Hungary.

As the CNG filling infrastructure is likely suffering from major underutilisation in virtually all Danube Region countries with the exception of Hungary and Bulgaria, it is suggested to introduce level 1 support measures in the field of CNG as well to boost the size of the natural gas vehicle stock.
Factors that influence the prospects for interoperability: availability of alternative fuel vehicles in the Danube Region on the primary market

Arguably one of the primary obstacles to further development in the number of alternative fuel vehicles in the Danube Region is that the AFV variants of the most popular vehicles at best have limited availability for purchase in these countries.

Just taking the Volkswagen Golf as an example, which is one of the very few M1 category cars that has four engine variants, the CNG version is not available for purchase in 5 EU countries, while the electric version is not sold in any of the non-EU states of the Danube Region.

One of the obstacles that needs to be overcome is that consumers in Danube Region countries that have lower purchasing power do not have access to alternative fuelled vehicles on the primary market. More level 1 policies could be signals for car manufacturers and importers that it is worthwhile to offer the AFVs for sale.
To reach interoperability it is necessary that national governments place similar emphasis on the different alternative fuel technologies. Currently e-mobility enjoys the greatest support, often at all 3 levels of the hierarchy, however, non-EU countries currently do not provide any incentives for alternative fuels.

Factors that influence the prospects for interoperability: Diverging support policies for alternative fuels in the Danube Region

Very few countries support any of the technologies at all levels of the proposed hierarchy.

Of the EU countries, HR and SK supports e-mobility at two levels of the hierarchy, while Slovakia also provides the widest available support for natural gas infrastructure and vehicles.

CNG is most often supported via a single level of the support hierarchy, most often through excise duty breaks.

Unfortunately the research did not reveal any support measures for any of the alternative fuel technologies in non-EU member state countries.

Availability of support measures for alternative fuels as per the proposed hierarchy of support measures

<table>
<thead>
<tr>
<th></th>
<th>E-mobility</th>
<th>Natural gas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Austria</td>
<td>3/3</td>
<td>1/3</td>
</tr>
<tr>
<td>Bosnia and Herzegovina</td>
<td>0/3</td>
<td>0/3</td>
</tr>
<tr>
<td>Bulgaria</td>
<td>1/3</td>
<td>0/3</td>
</tr>
<tr>
<td>Croatia</td>
<td>2/3</td>
<td>0/3</td>
</tr>
<tr>
<td>Czech Republic</td>
<td>1/3</td>
<td>1/3</td>
</tr>
<tr>
<td>Germany</td>
<td>3/3</td>
<td>1/3</td>
</tr>
<tr>
<td>Hungary</td>
<td>3/3</td>
<td>1/3</td>
</tr>
<tr>
<td>Montenegro</td>
<td>0/3</td>
<td>0/3</td>
</tr>
<tr>
<td>Romania</td>
<td>1/3</td>
<td>0/3</td>
</tr>
<tr>
<td>Serbia</td>
<td>0/3</td>
<td>0/3</td>
</tr>
<tr>
<td>Slovakia</td>
<td>2/3</td>
<td>2/3</td>
</tr>
<tr>
<td>Slovenia</td>
<td>3/3</td>
<td>0/3</td>
</tr>
<tr>
<td>Moldova</td>
<td>0/3</td>
<td>0/3</td>
</tr>
<tr>
<td>Ukraine</td>
<td>0/3</td>
<td>0/3</td>
</tr>
</tbody>
</table>
### Proposed measures for interoperability: Choice of alternative fuel technologies in the Danube Region

#### Environmentally friendly public transport

<table>
<thead>
<tr>
<th>Environmental considerations</th>
<th>Suggested choice of alternative fuels for the region</th>
</tr>
</thead>
<tbody>
<tr>
<td>• At the regional level <strong>electric mobility</strong> provides lower GHG emissions than CNG</td>
<td>• For <strong>M1 category</strong>, <strong>e-mobility</strong> should be promoted given the climate benefits and the orientation of the market</td>
</tr>
<tr>
<td>• CNG has the advantage of lower PM and NOx emissions, which is especially important in urban environments</td>
<td>• Although <strong>CNG</strong> is already a popular fuel in the region, in the long term it should be the clean fuel for public transportation</td>
</tr>
</tbody>
</table>

#### Economic considerations

<table>
<thead>
<tr>
<th>Economic considerations</th>
<th>Business environment considerations</th>
</tr>
</thead>
<tbody>
<tr>
<td>• E-mobility though is significantly more expensive given current prices and support measures than CNG or conventional fuels</td>
<td>• In the region, most countries support e-mobility with a wide variety of measures</td>
</tr>
<tr>
<td>• In some countries CNG’s competitiveness approaches that of diesel</td>
<td>• Non-EU countries do not provide support</td>
</tr>
<tr>
<td></td>
<td>• CNG models are often more difficult to buy than electric ones</td>
</tr>
</tbody>
</table>

#### Business environment considerations

- In the region, most countries support e-mobility with a wide variety of measures.
- Non-EU countries do not provide support.
- CNG models are often more difficult to buy than electric ones.

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It is suggested that in the passenger vehicle category, electric mobility is promoted, with CNG serving as the clean fuel choice of public transportation in the long term and LNG providing for the needs of the freight transport.
Proposed measures for interoperability:
clean transport infrastructure development along the most important transport corridors

1. Developing AFVs is meaningless without the related filling infrastructure.
2. It is through the TEN-T network that the EU wishes to enhance transport connections between countries.
3. EU member states are required to provide alternative fuels infrastructure along core TEN-T networks.
4. The TEN-T network is indicatively extended into third countries as well, recognising that tourism, mobility of employees and trade connect the states.

Proposals

In the Western Balkans, have indicative TEN-T networks be equipped with electric and in a few cases with LNG infrastructure.

The capitals of Moldova and Ukraine should be accessible with electric vehicles from EU MS.

To create interoperability within the Danube Region, it is suggested that the indicative TEN-T routes that penetrate Western Balkan countries are equipped with electric charging infrastructure, and if needed LNG, while the capitals of Ukraine and Moldova should be accessible from EU countries with electric vehicles.
Proposed measures for interoperability: formalise support to extend the LNG Blue Corridors into the Danube Region

1. The Danube Region serves as an important SE-NW transport corridor, connecting SE-European EU countries and Turkey to Western Europe.

2. There are already considerable developments through CEF funded LNG projects in Hungary, Slovenia, Croatia and Slovakia, with refuelling stations totalling 12.

3. With only 8 additional LNG filling stations in Danube Region countries, the report argues that the most important SE-NW transit route is interoperable with LNG trucks.

4. It is suggested that these LNG filling stations are organised into a network that could serve as the extension of the already functioning LNG Blue Corridors.

As the Danube Region countries serve as an important SE-NW transit route, it is essential that these countries offer LNG filling opportunities for the transiting freight. Interoperability of LNG vehicles can be achieved with only 8 additional filling stations that could serve as the extension of the already existing LNG Blue Corridors.
Considering the current truck loading capable terminals, it is almost exactly the Danube Region countries which lie the furthest away from these terminals, increasing the cost of the commodity to be used in the transport sector. It is therefore vital that the to-be-built Krk terminal will have SSLNG capabilities from the start of operations.

Proposed measures for interoperability:

- Equip the to-be-built Krk LNG terminal with small-scale LNG capabilities.

CEF funded projects will install 3-3 LNG stations in Slovenia and Croatia, 5 stations in Hungary, providing for an initial demand for SSLNG at the Krk terminal.

With the current infrastructure, it is the Danube Region that is the most inaccessible (or expensive) to transport LNG to be used in long-haul goods transport.

With the Krk terminal, a large part of the Danube Region enjoys favorable transportation costs of the commodity.
With an additional 36-47 fast charging points and 8 LNG stations, the Danube Region could be interoperable with such vehicles. The combined costs of the developments account to EUR 10,350,000. These infrastructure developments should take place by 2025, so that the Region will not lag behind the EU-wide roll-out.
As natural gas and electricity further advance as transport fuels, energy, climate and transport considerations will become increasingly inseparable from each other. As a result, it is suggested that Energy Community countries set themselves targets and development plans in the alternative fuels sector, on common grounds.

With the emergence of natural gas and electricity as fuels, transport, energy and climate policy will become increasingly inseparable.

Therefore, the energy security issues pertaining to electricity and natural gas that form a large part of energy policy will appear in transport policy, too.

It is thus advisable that countries of the Energy Community declare their intentions by 2020 about the development of their alternative fuels markets.

Thereby establishing non-binding targets that set the development paths for 2025, 2030 and 2035 for the alternative fuel sectors in the respective country.

Source: Energy Community
Thank you for your attention!