

JIVE/JIVE2/MEHRLIN

D4.13 - Key learnings and impacts from the 1st JIVE 2 CEE Bus Roadshow



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Content

EXECUTIVE SUMMARY	4
INTRODUCTION	5
PURPOSE OF THE DELIVERABLE	6
KEY LEARNINGS AND RESULTS	7
1. Course of the 1 st JIVE 2 CEE Bus Roadshow.....	7
2. Results from the test drives of the FCBs.....	12
3. Key learnings from national workshops and identified barriers to the deployment of FCBs in the area.....	17
4. Impacts of the roadshow	20
5. Lessons learned from the first roadshow.....	33
6. Impact on dissemination activities of the JIVE 2 project.....	33

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EXECUTIVE SUMMARY

As the uptake of FCBs has been significantly higher in Western Europe, JIVE 2 proposed a side activity in the form of a bus roadshow across carefully selected cities throughout Central and Eastern Europe (CEE). The aim of the proposal is to provide an opportunity to showcase the technology and allow cities to experience and test it, with the possibility to place orders at the end of the tour.

The roadshow included a total of 13 events, including national workshops, student events, professional events and media events that were attended by over 900 participants. The different events reached out to a wide range of stakeholders, including government representatives, operators and local authorities, students, and members of the academic world, thus ensuring that the roadshow had the largest possible impact. In addition to this, an extensive media coverage including physical and digital newspapers, TV, radio and social media allowed to reach over 2.5 million people. This has allowed to disseminate knowledge and increase public awareness about hydrogen in transports. It has also helped to reduce preconceived ideas around the safety and environmental performance of hydrogen buses.

Furthermore, another of the main aims of the roadshow, namely for all participants (cities/operators) to announce public commitments to deploy FCBs by 2025-2030 and developing the regional capacity to deploy FCBs has also been reached in most cities. Most of the cities that trial the technology (over 90%) have announced a formal interest in deploying FCBs after the roadshow. In total, it is expected that over 150 hydrogen buses will be deployed in the region over the next years, and some cities have developed or are in the process of developing plans related to FCB deployment.

The good performance of the bus during the roadshow leading to high satisfaction of operators/authorities that trialed it, had a direct impact on strengthening their FCB plan. This is due to the good performance of the bus on its route. Indeed, the bus drove across 5 countries traveling a total distance of 1 641 km and consuming approximately 125 kg of H₂, resulting in an average consumption of 7,6 kg/100km. The bus has been tested in different landscapes, including both relatively flat routes as well as mountainous contexts, with important elevation gains. Furthermore, it has also been tested in extreme conditions with temperatures below 0°C. The bus has performed well consistently. In most countries drivers and passengers were satisfied by the experience and have appreciated the efficiency and comfortable ride provided by the bus.

A short summary of the impact of the roadshow in each country can be found below.

SLOVENIA

The municipal authorities have seen that the hydrogen bus is an excellent asset and are keen to explore the possibility of deploying it in their city. The municipality of Kanal has already put in place a strategy for the use of hydrogen public transport. The support for the initiators of the development of the Northern Adriatic Hydrogen Valley has accelerated significantly following the roadshow.

CROATIA

The city of Zagreb and its PTO (Zagreb Electric Tram Ltd. – “ZET”) are fully preparing for zero-emission bus fleet renewal activities. The JIVE2 CEE roadshow provided an excellent real-life

insight into FCH technology. The 1st JIVE 2 CEE bus roadshow was very-well received by the city of Zagreb & ZET since it was the first time that an actual FCH technology was tested in the city under various conditions.

SLOVAKIA

The roadshow stimulated demand in Trnava where the buses are expected to be deployed late 2026 or early 2027. The choice of specific bus models or bus companies will be decided depending on the availability of EU funding. Demand for FCBs is also strong in other cities such as Kosice, Prievidza and Bratislava. A total of at least 125 buses are expected to be deployed in the upcoming years.

HUNGARY

The roadshow has stimulated demand in Hungary in the city of Paks, where the bus was tested. Further, the Hungarian Mobility Development Agency (HUMDA) plans to deploy a bus for testing, following the model/example of the roadshow, during a longer period, in several cities.

CZECH REPUBLIC

Despite the occurrence of a technical issue during the roadshow, the city of Most, where the bus could be tested, but also other cities (e.g., Ostrava) are showing a great interest in developing the technology, considering FCBs advantages over diesel buses that are currently in use.

INTRODUCTION

The 1st JIVE 2 CEE (Central and Eastern Europe) bus roadshow has taken place from mid-November 2022 to end of January 2023 in Slovenia, Croatia, Czech Republic, Slovakia and Hungary. This **deliverable** is a summary of the collation of the reports of national coordinators **describing the course of the roadshow and associated events, results of the test trails and workshop discussions** and the **impact/learnings of the roadshow**.

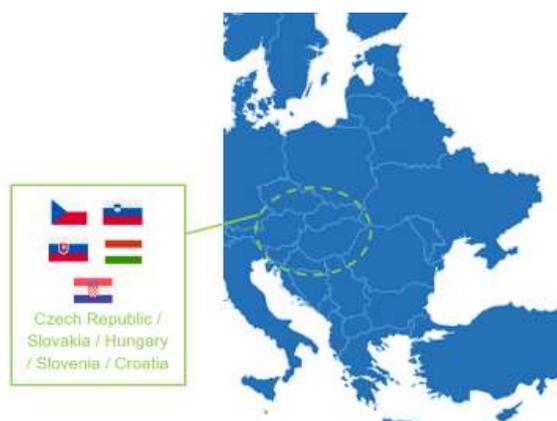


Figure 1: Countries covered by the first roadshow

The 1st JIVE 2 CEE bus roadshow was coordinated overall by Hydrogen Europe and H2LV and nationally by national coordinators –ECUBES in Slovenia, the Croatian Hydrogen Association in Croatia, Czech Hydrogen Technology Platform in Czech Republic, Slovak National Hydrogen

Association – Cluster in Slovakia, the Hungarian Hydrogen & Fuel Cell Association in Hungary – with the support of Element Energy and UITP.

The FCB (Fuel Cell Bus) has been provided by Caetano (H2 City.Gold) and the mobile refuelling station by Messer. During the roadshow the bus was accompanied by a fuel cell vehicle - a Toyota Mirai. Each city stop lasted approximately one week, including transportation and installation/deinstallation of the station. A national workshop was held in each country whilst the roadshow was occurring. The national workshop program always included discussions on available European funding mechanisms for FCBs and associated infrastructures, presentation of the JIVE and JIVE 2 projects early results and presentation of the results of the test trials.



Figure 2: The Caetano bus and two Toyota Mirais during the Croatia stop



Figure 3: HRS in Ljubljana



PURPOSE OF THE DELIVERABLE

This deliverable (D4.13) “Key learnings and impacts from the 1st JIVE 2 CEE Bus Roadshow” has been developed by Element Energy thanks to the inputs of the **reports from the national coordinators** (Aleksander Gerbec (ECUBES, Slovenia), Vesna Kucan Polak (Croatian Hydrogen Association, Croatia), Jan Sochor (Czech Hydrogen Technology Platform, Czech Republic),

Stanislava Malová (Slovak National Hydrogen Association - Cluster, Slovakia), Zoltan Mayer (Hungarian Hydrogen & Fuel Cell Association, Hungary)) describing the course of the roadshow and associated events, results of the test trails and discussions and the lessons learnt/impacts of the roadshow in their area, and inputs from Hydrogen Europe, H2LV and the infrastructure providers – Caetano, Messer and Toyota.

The aim of the deliverable is:

- **Analyse the data collected** during the roadshow with the **aim of proving the relevance of the technology in the area.**
- Summarize the **key learnings, opportunities, and barriers to the deployment of FCBs and associated infrastructures** in Slovenia, Croatia, Czech Republic, Slovakia and Hungary - from the discussions, workshops and events held during the roadshow linked to the deployment of FCBs and associated infrastructures.
- **Analyse the impact the JIVE 2 CEE Bus Roadshow had on the FCB demand** on the area but also on the **wider audience.**
- **Gather the lessons learnt from the organization of this 1st JIVE 2 CEE Bus Roadshow**



Figure 4: Course of the roadshow

KEY LEARNINGS AND RESULTS

1. Course of the 1st JIVE 2 CEE Bus Roadshow

The roadshow started in Slovenia on the 17th of November. Until the 22nd of November it travelled across the following cities – Tolmin, Kanal, Gorizia, Velenje and Celje. The Slovenian national workshop was held in Tolmin on the 17th of November.



Figure 5: Itinerary of the roadshow in Slovenia

The 2nd stop of the roadshow was in Croatia. The hydrogen bus was tested in Zagreb between the 28th of November and the 1st of December. The Croatian national workshop of the 1st JIVE 2 CEE (Central Eastern Europe) bus roadshow, allowing to share the results of the bus tests, was held in the Technical museum Nikola Tesla in Zagreb on the 1st of December.

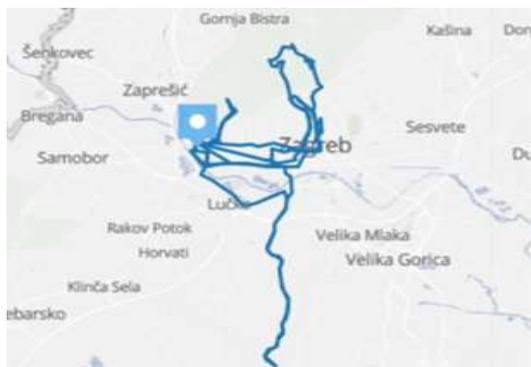


Figure 5: Itinerary in Croatia

After Croatia, the bus continued its itinerary in the Czech Republic. Unfortunately, due to technical reasons, the hydrogen bus only operated for one and a half day in the city of Most. The national workshop was held in Prague on the 10th of December.

The 4th stop of the roadshow was in Slovakia. The bus operated in the city of Trnava between the 9th and the 12th of January (on normal bus lines from the 10th). The national workshop took place on the 12th of January in the city of Trnava.

The final stop took place in Hungary, between the 16th and the 18th of January, in the city of Paks. The bus also serviced a small agglomeration village a few kilometres from Paks during the trial. The Official Workshop was organized in Paks, on the second day of the roadshow.

The course of event, and the number of participants to each national workshop are summarised in the table below.

	SLOVENIA	CROATIA	CZECH REPUBLIC	SLOVAKIA	HUNGARY
Roadshow event (date, town)	<u>17th November-22nd November 2022</u> , Tolmin – Kanal – Gorizia – Velenje – Celje	<u>28th November-1st December 2022</u> , Zagreb	<u>7th – 8th December 2022</u> , Most	<u>9th – 12th January 2023</u> , Trnava	<u>16-17-18 January 2023</u> , Paks
Number of participants in the stakeholder event	Tolmin (17 th Nov) > 60 Kanal (17 th Nov) > 90 Šoštanj (21 st Nov) > 100	Zagreb (1 st Dec.) > 80 Total > 80	Most -6 th Dec) 87 Praha (10 th December) 55	Trnava (9 th Jan) 28 Trnava (12 th Jan) 50	Paks (17 th Jan) 100 Paks (18 th Jan) 134

	Celje (22 nd Nov) > 150		Total 142	Total 78	Total 234
	Total > 400				

The 1st JIVE 2 CEE Bus Roadshow attracted **over 900 participants**, who participated to various events such as national workshops, student events, professional events and media events. The different events reached out to a wide range of stakeholders, including government representatives, operators and local authorities' students and members of the academic world, thus ensuring that the roadshow had the largest possible impact.

Below a selection of pictures showing the diversity of the roadshow activities:

SLOVENIA



Figure 7: H2STUDENT workshop in Tolmin



Figure 8: Bus in Slovenia



Figure 9: Group Picture (Roadshow partners) - Slovenia



Figure 10: Toyota Mirai, H2 City Gold and refuelling station

CROATIA



Figure 11: Group Picture (Roadshow partners) - Croatia



Figure 12: National workshop in Croatia



Figure 13: Driver, Croatia



Figure 14: Networking, Croatian National Workshop (Zagreb)

CZECH REPUBLIC



Figure 15: National workshop (Prague), Czech Republic



Figure 16: Bus in Most - Czech Republic



Figure 17: Press Conference, Most City Hall



Figure 18: Press Conference, Most City Hall

SLOVAKIA



Figure 19: Bus, Slovakia



Figure 20: Bus and station, Slovakia



Figure 21: National workshop, Slovakia



Figure 22: Bus, Slovakia

HUNGARY



Figure 23: Toyota Mirai and H2 City Gold in Hungary



Figure 24: Group Picture (Roadshow partners) - Hungary



Figure 25: Driver, Hungary



Figure 26: Opening speech by the Major of Paks, Hungary

2. Results from the test drives of the FCBs

The bus drove across 5 countries traveling a total distance of **1 641 km** and consuming approximately **125 kg of H₂**, resulting in an average consumption of **7,6 kg/100km**.

A table outlining the bus's performance in different countries can be found on the next page.

The JIVE 2 CEE bus roadshow showed to participating cities that fuel-cell buses and their associated refuelling infrastructures are ready for deployment in their area. Bus operators, drivers, passengers, and politicians were able to test the technology for themselves during the roadshow. In most cases, the cities were able to trial tests with passengers on bus lines. For example, during the trials in Paks, Hungary, the number of passengers who tested the bus amounted to about 2000 passengers/3 days. At the national workshops, the bus was tested by "VIP" passengers: local mayor, secretary of state, company CEO, etc. Nevertheless in some cases this was not possible due to legal reasons. This was the case in Croatia where test drives cannot contain passengers if it doesn't have a national plate – there the operator here, ZET, was not able to test the bus with passengers, in "real life" conditions.

- **Drivers' experiences**

The drivers were overall very satisfied with their driving experience of the FCB. In Slovenia, drivers emphasized their satisfaction with their user experience due to the lightness of the bus, especially at roundabouts. In Hungary, the drivers emphasized the very good acceleration possibilities, which even exceed those offered by existing battery electric buses. As the bus was also serving a small settlement a few kilometres from Paks during the test, drivers pointed out that on the suburban road sections the FCB had better driving characteristics than the existing battery electric version. In Slovakia, the drivers emphasized that the bus was easy to operate and comfortable.

It has been mentioned by several country coordinators that the presence of Caetano's driving instructor throughout the test drives proved to be very useful, as he was able to immediately correct minor errors of the test drivers and make precise adjustments while driving.

- **Passengers' experience**

Overall, all passengers appreciated the quiet, comfortable, and smooth ride on the bus. For instance, in Hungary passengers enjoyed the very low noise and vibration level of the bus.

- **Bus performance**

The bus has been tested in different landscapes, including both relatively flat routes as well as mountainous contexts, with significant elevation gains. The bus has performed well consistently. Furthermore, in Croatia, the asphalt on certain sections of the routes was not in good condition, but this has not hindered the hydrogen bus's performance. This is due to the efficient suspensions of the FC bus, which allow to provide a smooth ride for passengers, as it efficiently absorbs shocks due to large bumps.

Overall, all operators who tested the technology were very satisfied with it. The PTO in Most (Czech Republic) mentioned that the sufficient range and performance of the vehicle was superior to that of equivalent diesel buses currently in service, even when loaded with passengers. The PTO in Trnava (Slovakia), Arriva Trnava was very satisfied with the performance of the bus. Mr. Peter Nemeč, the CEO of Arriva Trnava, said: "The efficiency of hydrogen cells is constantly increasing. Thanks to that, hydrogen buses become a reliable alternative to vehicles using diesel. This was also confirmed by the intensive 3-day testing of the CAETANO hydrogen bus on one of the city lines in Trnava."

In Croatia, on all tested lines, the FCB performed well. Considering this information, FC buses could replace the current diesel buses operating on these lines without the need to adjust or change the timetable schedule and the daily maintenance regime (upon arrival at the garage – cleaning and washing, refueling, bus inspection). Additionally, the power of the motor is sufficient for the demanding mountain line on which it was tested. After returning to the start of the line at the base of the hill, there was a recuperation of power in battery (data of the energy regenerated available in Annex 1).

The autonomy provided by the FCB is also one of the main advantages identified by the operators who had the opportunity to test the bus. Thus, the city of Trnava could benefit not only from urban transport but also from suburban transport (knowing that the bus has a range of at least 400 km). In Hungary, thanks to the actual test undertaken it has been estimated that the range of the bus could be approximately 500km in the flat city of Paks. After testing, it became clear that with a single refueling the bus could run for a whole day, even in winter conditions, almost two days of operation would be possible if the bus was used on a shorter route. Also, the observed consumption of the bus in Hungary was very close to the official statement of the OEM. This caused positive reactions from the local Public Transport Operator, as well as from the professional organizers considering that the relevant literature on fuel cell bus trials in the EU and in the US disclose higher consumption data. The flat topology of Paks helped reaching low levels of consumption.

"The efficiency of hydrogen cells is constantly increasing. Thanks to that hydrogen buses become a reliable alternative to vehicles using diesel. This was also confirmed by the intensive 3-day testing of the CAETANO hydrogen bus on one of the city lines in Trnava."

Mr. Peter Nemeč, the CEO of Arriva Trnava

In Czech Republic, the bus was only able to be tested in a shorter period of time than expected (only for 1,5 days). Although the consumption was higher than expected (10kg/100km) the hydrogen bus proved to be a resilient option for public transportation, even in the freezing climate, where the bus's autonomy proved to be around 350 kilometers. During the trial test in Czech Republic, it is to be noted the importance of the driver behavior. It is advisable that drivers

are properly trained before operating hydrogen buses. One of the two drivers had a fuel consumption of 10kg/100km due to his experience with battery buses, which meant that he made full use of the bus's recovery. The second driver, however, had no direct experience with non-diesel buses, making its consumption higher (about 2kg more/100 km) due to insufficient use of the recovery function. This was also noted in Croatia where it has been identified that a more aggressive driving style is associated with higher fuel consumption.

- **Station performance**

There were no problems with the hydrogen refueling of the bus, nor with any of the refueling equipment encountered during the roadshow. A professional representative from Messer Hungary performed the hydrogen refueling, but the driver was always on site and could observe and learn about the refueling process.

Hydrogen refueling was done by Messer with a technology allowing the transfer of the gas from the trailer (with working pressure of around 200 bars) to the tanks of the fuel cell bus. This resulted in approx. 20 kilograms of hydrogen being refueled to the bus giving it a range of approx. 200 kilometers.

Table outlining the bus's performance across the 5 countries.

During the FCBs trial	SLOVENIA	CROATIA	CZECH REPUBLIC	SLOVAKIA	HUNGARY	TOTAL
Bus KPI						
Total Distance Travelled	245 km	262 km	161 km	410 km	724 km	1641 km
Average Hydrogen Consumption data	7,34 kg/100km	8,654 kg/100km*	>10 kg/100km**	9,59 kg/100km*** (i.e 1.76 kWh/km)	6,36 kg/100km****	7,6kg/100km
Average outside temperature	NA	NA	3 °C	5°C	7,5°C	NA
Average speed	NA	NA	25 km/h	25,4 km/h	32 km/h	NA
Station KPI						
Number of hydrogen refuelling events	2	1	4	8	6	21
Total Kg of H2 delivered	22 kg	22,7 kg	73 kg	66 kg	44 kg	227,7 kg

*Hydrogen bus was tested in Zagreb in some cases in extreme operating conditions (below 0°C, hilly terrain), showing excellent results especially in terms of efficiency

**Only able to test the bus in a very short period (1,5 days). Additionally, the city of Most ran the bus on line 17, which is known for its high altitude. The bus had to climb 80 meters for each circuit of the line, which usually runs on the same route every hour. The temperature recorded throughout the one-and-a-half-day trial was similar on the first and second day and ranged between +3 and +4 Celsius. According to the data received, the bus used at least 2-3 kg per 100 km for heating. In a climate like that of the Czech Republic, this proves to be one of the advantages of buses with internal combustion engines, which are able to use the excess heat from the engine and therefore do not have significant heating loss.

***The lack of time to gain experience on how to optimise driving characteristics has been identified as one of the impacts leading to one of the highest consumption levels of the roadshow. The bus was tested on line n°16 with frequent stops and the temperature was around plus 5°. Consumption would have been lower if the temperature was higher, the driving was smoother, and the speed was higher as in suburban and intercity transport. In addition, drivers need to pay more attention to their driving style

**** the geography of Paks is relatively flat, has no sharp rises, nor considerable altitude-differences (just approx. 25-30 m along the 11 km trial route). The fuel cell bus served line No. 1 in Paks, which is rather flat. The outside temperature was mostly in the range of 6-9 °C during the trial.

Pictures of test drives in the different countries



SLOVAKIA



SLOVENIA



**CZECH
REPUBLIC**



HUNGARY



CROATIA



3. Key learnings from national workshops and identified barriers to the deployment of FCBs in the area

During each stop a national workshop took place. The national workshop program included interventions from:

- The **Clean Hydrogen Partnership** and **Hydrogen Europe** to talk about the European funding mechanisms available for FCBs and associated infrastructures.
- A **representative from the JIVE and JIVE 2 projects** (**Element Energy** in Croatia, Czech Republic and Slovakia and **UITP** in Hungary) to present the learnings and early results of the projects – JIVE and JIVE 2 deploying 300 FCBs (Fuel Cell Buses) and 16 HRSS (Hydrogen Refuelling station).
- **Representative from the industry** – Messer and Caetano were present during the workshop to talk about their experience and performance of the technology.
- **High-level national, regional and local authorities** were present to talk about their future plans related to FCBs (Fuel Cell Buses) but also the wider ecosystem. Representatives from ministries were also present in some of the workshops – for example representatives of the Transport Ministry and of Sustainable Development Ministry were present.
- **Operators that tested the technology** to talk about their experience with the FCB thanks to the 1st JIVE 2 CEE bus roadshow
- **Local industries**



Figure 27: Ryo Ujimoto (CaetanoBus) and Aivars Starikovs (H2LV) – Slovenian National Workshop



Figure 28: Bart Biebuyck (Clean Hydrogen Joint Undertaking) – Slovakian National Workshop



Figure 31: Flavio Grazian (UITP) – Hungarian National Workshop



Figure 29: Eva Baker (Element Energy) – Croatian National Workshop



Figure 30: Presentation of the H2 CityGold Caetano Bus (CaetanoBus) – Czech Republic National Workshop



Figure 32: Slides showing results of trials in Zagreb



Figure 33: Slides showing results of trials in Trnava

Throughout the various workshops and events held during this roadshow, various discussions took place. Please find below some key learnings from the discussions:

- European support programmes and funding are available for hydrogen buses and stations - PDA (Project Development Assistance), CEF (Connecting Europe Facilities), EU Hydrogen Valleys.
- Great potential for Hydrogen Valleys has been identified.
- The roadshow has been pivotal to initiate local value chain discussions and demonstrate the benefits of hydrogen mobility. Main conclusion from the operators that tested the bus is that the technology is ready, adapted to their local routes and performed particularly well with low H₂/kg consumption.
- Local partners have confirmed their interest in deploying hydrogen buses and wider H₂ ecosystems in the near future.

It is important to highlight the very high interest in the technology from cities partners of the roadshow but also other cities/areas (non-partner of the roadshow) that attended the workshop and participated to the discussions. Some of the workshop participants came from far away to be able to attend - such as the representative from Košice in Slovakia who came from Košice (400 km away) to be able to participate in the Slovak national workshop.

During the different workshops the aim was also to discuss the ongoing barriers to the deployment of FCBs in the area. The main barriers identified are:

1) The price of hydrogen and of the buses.

The **cost of the technology itself** as well as the associated infrastructure. Indeed, currently the CAPEX of the technology is higher than the one of diesel buses.

In Croatia, the price of the hydrogen and of the buses have been identified as the main obstacles to the deployment of hydrogen buses in the area. According to the director of Arriva Slovakia - Mr. Nemeč, the introduction of hydrogen buses requires higher initial investments for the purchase of the vehicles, but also for the development of new infrastructure, including a filling station and infrastructure needed for the production of "green" hydrogen. The hydrogen price was also mentioned as during the workshop in Zagreb for instance – here volume and local production is expected to bring those prices down.

2) The lack of funding allowing to cover the high costs associated with hydrogen technology.

In Czech Republic, participants identified the lack of public funding for fuel cell buses as one of the main key barriers to their development in the country. This was also mentioned in Croatia, where the relevant ministries are expected to define the rules and support mechanisms for operators, especially during the start-up period. Operators requested support from ministries/policy makers. In Slovenia, stakeholders mentioned the lack of local government support schemes that would include support for hydrogen technologies.

3) Grid capacity - Electrification of public transport will result in additional challenges for power generation and infrastructure development which will need to be addressed for widescale uptake.

4) Building a full hydrogen ecosystem to be able to deploy FCBs. For example, Hungary mentioned that if the city only operates a few buses (2-4), to ensure the full utilisation of the hydrogen refuelling station and a better financial performance of the project, it is necessary to find several other hydrogen end-users for a given hydrogen refuelling station (taxi fleets, trucks, etc.). This can further raise the complexity of the project and requires harmonized investments from different (usually independent) stakeholder groups.

5) Lack of pilot projects. Participants from the Czech Republic mentioned that the lack of infrastructure and concrete pilot projects running for longer periods of time, proving the technology readiness, is an important issue hindering the deployment of fuel cell buses in the Czech Republic.

6) Regulatory barriers to the deployment of hydrogen buses. This issue was highlighted by Hungary, explaining that technical and legal safety requirements are not ready for the deployment of a hydrogen bus fleet yet. Hungary is expected to create a legal framework this year. The lack of clarity in the regulatory framework has also been identified as a major obstacle to the deployment of hydrogen projects in Croatia and leads to delays in the granting of permits and decisions by the competent authorities. Indeed, there are no clear regulations for the design of an integrated FCB system (i.e. FCBs and associated infrastructure - the HRS). The legislative framework in Croatia is currently inconsistent and outdated, with a complex and unclear authorisation process, different authorising authorities (3 different ministries), a lack of expertise on the part of national authorities and a general lack of knowledge about the technology. An adequate regulatory framework will be a key factor for the deployment of hydrogen.

7) Lack of awareness and some misconceptions regarding its safety and sustainability. This issue was mentioned by several countries.

The roadshow played a key role in overcoming some of the barriers mentioned above. Indeed, in all the national workshops, it was ensured that the topic of funding and procurement was central. The presentations focused on giving a concrete and comprehensive overview of the European funding tools available to deploy FCBs - the hydrogen valleys were identified as a key

element, as there is usually a desire to build a complete H2 ecosystem in the region where the bus stopped. Most of the questions asked at the workshops related to these different funding and support mechanisms. The roadshow also improved the general knowledge of the technology for key stakeholders, such as high-level policy makers. The results of the FCBS field tests as well as the results of the JIVE and JIVE 2 projects showed that the technology is ready. It was also pointed out that the roadshow helped to reduce preconceptions about the safety of the technology.

4. Impacts of the roadshow

The roadshow successfully generated much interest amongst the cities involved as well as across the region. Press coverage, citizens' and drivers' experience with the buses, as well as operators' impressions of the vehicles, was extremely positive. Several cities are now actively considering their next steps towards the emissions-free public transport that will be required if Europe is to achieve its decarbonisation objectives.

- Dissemination of the technology

The Central and Eastern Europe roadshow was promoted through the fuel cell bus website and social media platforms.

For promotional activities, the following platforms were used – LinkedIn, Twitter and Instagram. Some statistics regarding posts on the different social media platforms are provided below. More information can be found in part 5.

Platform	Number of posts	Impressions	Reactions	Engagement rate
LinkedIn	6	14451	394	71,91%
Twitter	4	NA	70	NA
Instagram	5	1525	114	37,5%
Total	15	15958	578	109.41%

The roadshow resulted in many positive responses to the test drives, a strong interest in the vehicle itself, and a lot of media attention, as evidenced by the numerous TV and online articles referring to the latter. A total of over 220 media articles, TV and radio programmes discussed the roadshow and the bus's performance, resulting in a reach of over 2,6 million people. The fact that diverse media supply were used allowed to reach and thereby spread awareness about hydrogen transport across a variety of audiences.

During the Slovenian stops, The University of Trieste conducted a study on the awareness of hydrogen technologies among the inhabitants of the Italian region of Friuli-Venezia Giulia in January 2023. According to the study, the level of awareness is highest in the small town of Gorizia. This result is the direct consequence of three days of hydrogen bus trials between Nova Gorica and Gorizia.



Figure 34: Interview of the President of the Croatian Hydrogen Association



Figure 35: Interview of Jan Sochor (Czech Republic Hydrogen Association)

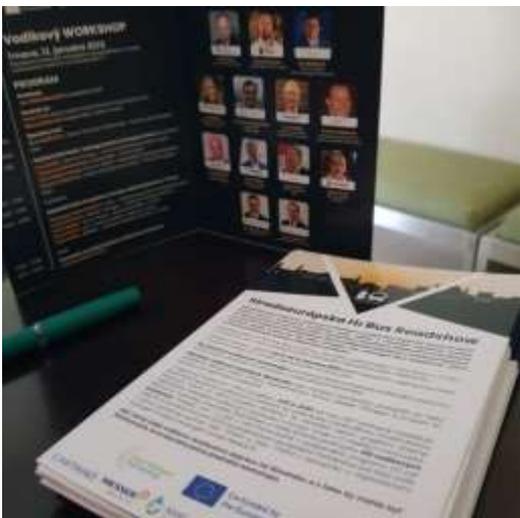


Figure 36: Leaflets on the 1st JIVE 2 CEE bus roadshow, workshop content and early results of the JIVE/JIVE 2 projects. Workshop in Trnava (Slovakia)



Figure 37: Press Event (Hungary)

- **Announcements during or following the roadshow**

Several countries have reported that important stakeholders such as representatives of Ministries and mayors have expressed their support and willingness to further develop the use of hydrogen in public transportation.

In Slovenia, the city of Ljubljana has announced that they will work to buy hydrogen Buses, because of successful trials in October and industry announcements during the roadshow.

In Croatia, at the event, important stakeholders including representatives from 4 different Ministries have expressed their willingness to further develop and work on the introduction of hydrogen buses in the city's public transport system.

At the opening of the event, the CEO of the Hydrocarbons Agency of Croatia has emphasised that the Agency will form a team to facilitate and accelerate the acquisition of EU funds for projects in the field of hydrogen.

In Slovakia, Mr. Peter Nemec, the CEO of Arriva Trnava, a large bus company, stated that: *“The efficiency of hydrogen cells is constantly increasing. Thanks to that hydrogen buses become a reliable alternative to vehicles using diesel. This was also confirmed by the intensive 3-day testing of the CAETANO hydrogen bus on one of the city lines in Trnava.”*

The mayor of the city of Trnava, the chairman of the Trnava self-governing region and the state secretary of the Ministry of Economy of the Slovak Republic expressed their support for hydrogen public transport.

- **Contributions of the roadshow to the development and deployment of FCB in cities**

In most cities where the bus was tested, local authorities are keen to further explore the possibility of deploying hydrogen buses in their city. In countries or cities that were already engaged in hydrogen activities, the JIVE2 CEE roadshow and the bus testing was an opportunity for relevant authorities to confirm that the deployment of hydrogen buses is an advantageous and interesting option. The roadshow also contributed to the creation or strengthening of collaboration between various stakeholders. A table describing the impacts in each country can be found at the end of the section.

Following the roadshow Messer, Toyota Tsusho and CaetanoBus proposed a joint offer to the cities that trailed their technology during the roadshow. This is one of the most important and concrete impact of the roadshow as it is a key next step to the deployment of FCBs in the area by providing a unique package **comprising all the equipment examined and tested during the roadshow, at scale and at feasible costs**. By implementing this proposal for ‘mobility as a service’ in two or more cities across the roadshow, the partners (Messer/Toyota/Caetano) are **confident that they can deliver full costs over the contract duration which are equivalent or below those for new diesel buses**.

The proposal will also deliver substantial emissions savings as well as additional social and economic benefits for the cities and regions who choose to go ahead.

‘One stop shop’:

Turnkey solution - “Starter Set” - including:

- 20+ H2City Gold fuel-cell electric buses per city fleet, with standard base configuration (Toyota/CaetanoBus);
- A scalable, full-function, hydrogen refuelling station with cryogenic cooling for maximum reliability (Messer);
- Reliable hydrogen supplies, based on on-site production and/or hydrogen trailers (Messer);
- A financing package incorporating EU financial support, to be established based on your commitment to proceed;
- A service package, ensuring that all vehicles (Caetano) and hydrogen infrastructure (Messer) are maintained and operational;
- An all-in pricing option based on a single, 10-year, largely fixed price per km driven (Toyota Tsusho / Messer).

Meetings in the towns and cities involved in the roadshow, with bus operators and national coordinators, are now being arranged and are expected to be completed by the end of March 2023.

Provided that sufficient letters of intent from interested bus operators can be obtained, a submission should be prepared by the partners for funding support by mid-April 2023. Should funding be granted by summer 2023, the deployment of the first hydrogen bus fleets in the countries covered by the roadshow could start from 2024.



11th February 2023

To:

Bus Fleet Operators and National Coordinators,
1st JIVE 2 CEE (Central Eastern Europe) H2 bus roadshow

Bearbeitung
T Evison

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Bad Soden,

Deployment of Hydrogen-powered, Fuel-Cell Electric Bus Fleets

Figure 38: Joint offer from Messer/Caetano/Toyota sent on the 11th February 2023 to the roadshow cities

SLOVENIA

City	Roadshow stop	Interest in the technology	Comment	Timeline for deployment	Number of buses	Comments
Kanal	YES	YES	High interest from Kanal - City authorities had a chance to see that Hydrogen Bus is an excellent asset, they are keen to explore towards implementing in their cities.	2025	1	Municipality Kanal has already set a strategy to use hydrogen public transport.
Ljubljana	YES	YES	In Ljubljana there was test already in October organized by Messer and Toyota.	2025	15	
Thanks to the roadshow the city of Celje has announced that they will prepare a plan for the implementation of hydrogen buses. Other Cities have not formally announced investments but have an interest in developing plans.						

The municipal authorities have seen that the hydrogen bus is an excellent asset and are keen to explore the possibility of deploying it in their city. The municipality of Kanal has already put in place a strategy for the use of hydrogen public transport. The support for the initiators of the development of the Northern Adriatic Hydrogen Valley has accelerated significantly following the roadshow.

CROATIA

City	Roadshow stop	Interest in the technology	Comment	Timeline for deployment	Number of buses	Comments
Zagreb	YES	YES	High interest from Zagreb (participation to 1st iteration of PDA, 2020-2021 + very satisfied by the FCB test during the roadshow) – but regulatory barrier to address	2025	20	<i>National Resilience and Recovery Plan have a budget for – up to 6 HRS's in bigger cities and TEN-T corridors and 70 BEV and FCBs by the end of 2024</i>

6 other cities interested in deploying FCBs - Split, Rijeka, Pula, Vinkovci, Šibenik, Dubrovnik.

The city of Zagreb and it's PTO (Zagreb Electric Tram Ltd. – "ZET") are fully preparing for zero-emission bus fleet renewal activities. The JIVE2 CEE roadshow provided an excellent real-life insight into FCH technology. The JIVE 2 CEE bus roadshow project was very-well received by the city of Zagreb & ZET since it was the first time that an actual FCH technology was tested in the city under various conditions.

CZECH REPUBLIC

City	Roadshow stop	Interest in the technology	Comment	Timeline for deployment	Number of buses	Comments
Most	YES	YES	High interest – very satisfied with the testing of the FCB – PTO of Most mention the overall sufficient range and vehicle performance considered to be better than equivalent diesel bus currently in operation even when loaded with passengers	Have not yet decided to implement FCB technology as many less 'rich' PTOs they are waiting with deployment of technologies (they do not even have CNG buses)	For now 0	Waiting for the right time. Still observing and they have not yet finished their strategy on decarbonisation for Most fleet.
Usti nad Labem	NO	YES	Are committed to building out HRS and using hydrogen produced in the city as by product (cheap from chlor-alkaline electrolysis). We did not give them a chance to test out, since they already signed a contract to buy 20 buses (Solaris Urbino).	Procurement expected upcoming years (2 years) depending on resolving financing issues with the HRS (due to union CEEAG rules – because they	20 buses	Due to availability of hydrogen in the city thanks to chemical power plant (chlor-alkali electrolysis) operated by the company called Spolchemie. + Is one of the region funded by Just Transition (strategical

				use hydrogen by product).		approach to hydrogen technologies).
Ostrava	NO (but was planned)	YES	Not able to test because of bus issue. High interest from Ostrava, they plan to build their own HRS and buy 10 buses in the first batch.	2023-2024	10	Planning to buy buses as stemming from long ranges their buses have to make each day – more than 300 km. Although they have not been given a chance to test out the bus, they still preserve their plans and reiterated internally their ambition to proceed with this technology.
Prague and Brno, will test out the FCEB from Škoda in 2023. Mníšek pod Brdy plans on buying 10 buses, they work closely with ČEZ, who will be building electrolyser powered by electricity from water.						

Despite the technical issue the roadshow has had a positive impact in Most, where the bus was tested, due to the positive experiences related to the important range and efficient performance of FCBs. Demand for FCBs is also important in other cities such as Ostrava (where the bus should have been tested) and Usti and Labem.

SLOVAKIA

City	Roadshow stop	Interest in the technology	Comment	Timeline for deployment	Number of buses	Comments
Trnava	YES	YES	Arriva Trnava is ready to initiate a hydrogen bus project and will use a refuelling station that is expected to be built in a year's time. The city does not want to focus only on urban transport but also on suburban transport (considering the bus has an autonomy of 350 km).	Late 2026 or early 2027	n/a	In 2024, the Empark company plans to operate a hydrogen filling station together with an electrolyzer for the production of hydrogen. The hydrogen filling station will be built in the Trnava area and should be used to the maximum extent for the benefit of its citizens.

Košice	NO	YES	Very interested in the technology – representatives come from this city 400km away from the workshop location	2025-2027	80	
Prievidza	NO	YES	High interest	Expected to organise a tender in April 2023	5 FCBs	
Bratislava	NO	YES	High interest. The city concluded a contract with Solaris.	2025 - 2027	20 buses (plus 20 optional)	

The roadshow stimulated demand in Trnava where the buses are expected to be deployed late 2026 or early 2027. The choice of specific bus models or bus companies will be decided depending on the availability of EU funding. Demand for FCBs is also strong in other cities such as Košice, Prievidza and Bratislava. A total of at least 125 buses are expected to be deployed in the upcoming years.

HUNGARY

City	Roadshow stop	Interest in the technology	Comment	Timeline for deployment	Number of buses	Comments
Paks	YES	YES	High interest – very satisfied with the testing of the FCB. Local Public Transport	Paks Transport Ltd. is currently carrying out preparatory work for the procurement and refuelling of hydrogen buses within the framework of an IKOP (Integrated Transportation Operative Program) project, in the frame of	Indicative only, and non-binding target: 2	The city has not yet finished its strategy on development needs for the local and regional bus-fleet. The actual purchases (timing, numbers etc.) also depend on the evolution of the central government funding system, as the FCEB cannot only be purchased from personal

			Ltd. is fully committed to zero emission public transport system.	which the necessary feasibility analysis and studies will be elaborated. After this PKK will initiate an “IKOP Plus” project which also incorporates the procurement of fuel cell buses and hydrogen refuelling station.		contribution or local government resources - central funding is inevitably required, especially if we add a hydrogen refuelling station to the project.
HUMDA (within nationwide hydrogen fuel cell bus demonstration programme of the “Hungarian Hydrogen Strategy 2030”	Local organizer partner	YES	High interest – very satisfied with the testing of the FCB – concrete next step is a more widespread testing of an FCEB for longer duration and in several cities	Exact timeline is under elaboration (not public yet)	1 bus	Its first step will be to hire a fuel cell bus and a mobile hydrogen refuelling station/equipment. Based on the feedbacks of this extensive demonstration program (incorporating several Hungarian, larger cities) HUMDA will extend its ongoing ‘Green Bus Program’ to hydrogen mobility as well. For the first step, HUMDA plans to purchase a few fuel cell buses to gain more deep experiences with operation of small FCEB fleets. This could be further extended to other hydrogen mobility solutions, where HUMDA can play an integrator role similarly to the ‘Green Bus Programme’. Besides, it is essential to instal hydrogen refuelling stations; HUMDA plans to establish 3 HRS until 2025 and tries to „pool” other fuel cell vehicles to utilize the HRS-es.

The roadshow has stimulated demand in Hungary in the city of Paks, where the bus was tested. Further, the Hungarian Mobility Development Agency (HUMDA) plans to deploy a bus for testing, following the model/example of the roadshow.

KPIs

- Quantitative

	SLOVENIA	CROATIA	CZECH REPUBLIC	SLOVAKIA	HUNGARY	TOTAL
Number of events organised.	5	1	2	2	3	13
Number of participants in the stakeholder events	400	80	142	50	228	900
Number of participants in the media events	200	80	55	28	9	372
Number of media articles, TV and radio programmes	23	40	25	38	95	221
Reach of the media articles, TV and radio programmes	205 000 (of which 5 000 in Italy)	289 000	50 000	1 386 800	2 141 986	4 022 786
Number of social media posts	10 (+)	22	7	22	18	79
Reach of the social media posts	7 000 (+)	72 000	38 000	17 316	75 559	209 875

As showed in the table below, there have been a high number of events organized during the roadshow with over 900 participants. A particularly interesting and unique feature of this roadshow is the wide variety of organized events – national/technical workshops, media events, students’ event, professional events – which allowed it to reach a large audience – from a technical one to the general public.

Number of events organised.	13
Number of participants in the stakeholder events	900
Number of participants in the media events	372
Number of media articles, TV and radio programmes	221

Table 1: Summary of quantitative KPIs

- Qualitative

<p>The number of hydrogen-powered vehicles in the partner country and Central and Eastern Europe is, in general, increasing</p>	<p>Yes, for 4 countries:</p> <ul style="list-style-type: none"> • In Slovenia on the 31st of January 2022, the list of winners of the Hydrogen Valley call for projects was published. The best hydrogen valley selected is the North Adriatic Hydrogen Valley, where ECUBES will provide a fleet of hydrogen trucks and cars and where funding of €25 million has been granted. More information can be found under this link. • The city of Zagreb and ZET participated in the FCH 2 JU's first iteration of the Project Development Assistance programme (2020. – 2021.) and gained significant insight into the overall FCH value chain. The city of Zagreb and it's PTO (Zagreb Electric Tram Ltd. – "ZET") are fully preparing for zero-emission bus fleet renewal activities. The overall plan for ZET is to initiate a sustainable and predictable bus fleet renewal process, whereby each year, a certain percentage of its current (mostly already-depreciated sub-EURO VI) bus fleet would be replaced by a zero-emission alternative including both FCH buses as well as battery-based buses (BEB). • In Slovakia, 1 Solaris bus was tested in Bratislava in December 2022, the contract for H2 buses will probably be signed in 2023. • In Hungary, the number of buses is increasing, and 4 buses will be in operation in the upcoming years
<p>Stakeholders convinced that hydrogen power is the future of public transportation and ready to take practical steps to introduce it</p>	<p>Yes, in all countries:</p> <ul style="list-style-type: none"> • In Slovenia the following cities are ready take practical steps - Tolmin, Nova Gorica, Celje, Šoštanj, Ljubljana. Slovenia is among the 3 countries that participated to the creation of the EU's first transnational hydrogen valley (along with Croatia and Italy). • In Croatia preparations for the zero-emission fleet renewal process (including hydrogen buses) are ongoing in City of Zagreb. • In the Czech Republic, all the participants that responded to the questionnaire considered that hydrogen is the future of public transportation. It is important to note that there is a tender open for 10 FC in Ostrava. • In Slovakia, the following cities have announced a formal interest - Košice, Trnava, Trenčín. Prievidza will organise a tender in April 2023 for 5 FC buses.

	<ul style="list-style-type: none"> In Hungary, the city of Paks plans to put 2 buses into circulation in the upcoming years, and 2 buses will be used by HUMDA for long term demos.
<p>General public is convinced that hydrogen power is safe, and it is the future of public transportation</p>	<p>Yes, in most countries, even though some resistance still persists:</p> <ul style="list-style-type: none"> In Slovenia, the H2STUDENT educational programme, developed in 2018 by ECUBES, has raised awareness among more than 4,500 young people that hydrogen transport is clean and safe. In Croatia, public communication around hydrogen transportation always stresses hydrogen safety. In the Czech Republic, no safety concerns have been expressed on social media or in news. In Slovakia, during the workshop session, safety issues related to hydrogen technology have been discussed and none of the participants have raised any concerns. In Hungary, all the passengers (around 2000) are convinced about the safety of the bus.
<p>Following the trial, the municipalities who tested the buses have announced a formal interest in the hydrogen-power technology</p>	<p>Yes, for all countries:</p> <ul style="list-style-type: none"> In Slovenia, the following cities announced a formal interest - Tolmin, Sostanj, Celje, Ljubljana. In Croatia, Zagreb announced a formal interest. In the Czech Republic, the cities of Ostrava and Ústí announced a formal interest. However, it is not necessarily due to the roadshow as the cities did not have the opportunity to test the buses. In Slovakia, the city of Trnava has announced a formal interest. In Hungary, the city of Paks, where the tests were conducted has announced a formal interest.
<p>Local politicians and public transport operators have made announcements regarding commitment for hydrogen-power technology procurement in the future</p>	<p>Yes, in all countries (details are provided in the section above).</p>

<p>National government or national politicians have made announcements regarding hydrogen power technology plans for the country</p>	<p>Yes, in 4 countries (details are provided in the section above).</p>
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5. Lessons learned from the first roadshow

The main area for improvement is related to the **time available to prepare the event** (approximately 3 months are requested).

Some countries that could not operate the bus in normal conditions mentioned that it is important that the FCBs are **tested on regular routes with regular users**. With this regard more time is also needed due to delays in obtaining certain permits required from authorities.

It has also been mentioned that it is important to have a national coordinator who deals with the other partners in each region to avoid any divergence of information between the partners. The coordinator should prepare a **contingency plan in case of problems** with the bus. In the future there could be instructions on how to proceed in case of a technological problem.

Finally, it has also been recommended that **drivers are more thoroughly trained before operating hydrogen buses**. In the Czech Republic, the drivers that tested the bus had very different consumption levels due to their diverging driving styles. One of the two drivers had a fuel consumption of 10 kg/100 km due to his experience with battery buses. The second driver, however, had no direct experience with non-diesel buses, making his consumption higher (about 2 kg more/100 km) due to an insufficient use of the recovery function. However, it is important to note that the on time training helped the drivers to understand what they were doing incorrectly and which parameters they should control.

6. Impact on dissemination activities of the JIVE 2 project

The Central and Eastern Europe roadshow was promoted through the fuel cell bus website and social media platforms. Dissemination partners liaised with the national coordinators to ensure that all communication activities were aligned and followed the dissemination guidelines of the projects.

For promotional activities, the following platforms were used – LinkedIn, Twitter and Instagram. Some statistics regarding posts on the different social media platforms are provided below. During the time period of the roadshow, most visitors were located in Belgium, Canada, France, Italy, Portugal and the UK. Additionally, most of them belonged to the renewable energy, truck transportation, business consulting and services industries.

All the press releases were published on the “fuel cell buses” website and shared on social media. Between November 2022 and January 2023, 7,787 users visited the page, resulting in 25,509 page views. Some statistics regarding the website’s use are provided in the figure below.



The top 10 visitors of the website are based in India (1595), Germany (958), the United Kingdom (842), the United States (787), France (249), Italy (238), the Netherlands (226), Spain (186), Canada (156) and China (131).

Several EU-funded projects ([ZEFER](#), [JIVE](#), [JIVE2](#), [H2ME2](#), [H2HAUL](#), [MEHRLIN](#), [REVIVE](#), [HECTOR](#), [3EMOTION](#)) organised a workshop to share best practices, experience and data collected throughout their lifecycle to validate the positive impact of hydrogen-powered vehicles on their deployed locations. 92 people registered for the event, 59 attended, and 33 did not, which means the participation rate was 64%. Furthermore, 47% of the participants were based in Central and Eastern Europe (CEE). The high participation rate from the CEE region could be linked to the first CEE Hydrogen Bus Roadshow, which took place between November 2022 and January 2023.

Hydrogen Europe launched a social media campaign on 9 March 2023. The campaign consists of a weekly post on Thursdays to take advantage of the "throwback Thursday" (#tbt) trend. In addition, each week is dedicated to one of the stops of the first roadshow.

With the launch of this social media campaign, the JIVE 2 project continues the momentum of this roadshow.

ANNEX

1. Additional Information on test drives in Croatia

Total operational data for period: 28/11/2022-30/11/2022:

Note: the data refers to the total vehicle operation during the set time and may include trips not included in the test performed



	Hydrogen used, kg	Distance driven, km	Average overall consumption kg/100 km	Average speed, km/h	Energy used, kWh	Energy regenerated, kWh
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November 28 th 2022	2.69	44.5	6.043	29.9	50.74	19.03
Nov 29 th - part 2	0,75	26.6	12.5133	31	43.43	18.69
Nov 29 th - part 3	0.29	4.9	5.8297	20	4.5	2.2
Nov 29 th - part 4	0.30	4.8	6.2721	22.1	7.3	3.24
Nov 30 th	2.96	35.5	8.3343	32	47.56	17.84

Project coordination:

elementenergy

an ERM Group company

Project dissemination:



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