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Report on the testing of a strategic decision-support tool

Version 1 – 03/2025

PP7 Regional Union of Chambers of Commerce of Veneto Region

PP3 City and Regional Utilities Lübben

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1. H2CE Project

H2CE addresses the challenge of integrating hydrogen solutions and renewable energies into the regional energy transition. Today, existing information and support focuses on the needs and perspectives of project owners and of the industry, treating public authorities as (passive) framework condition instead of understanding their expertise and authority as a further means to pro-actively support change.

H2CE aims at empowering public authorities and administration in Central Europe (CE) to integrate hydrogen proactively and sustainably into regional planning and development. This will lead to an acceleration of hydrogen infrastructure ramp-up and a more efficient use of available funds. The main results of the project will be mechanisms to empower regional decision makers to support a hydrogen-based energy transition, the initiation of a cross-regional & transnational network of H2-ready regions, and the implementation of a digital collaboration platform.

In this scope, the WP2 aims at Increasing the understanding of challenges, potentials and solutions for the cross-regional and cross-sectoral transition of regional energy systems among energy utilities, public authorities, planning departments and regional SMEs in all H2CE partner regions.

In the specific, the deliverable presents the results of the testing of a digital GIS platform developed within the H2CE project, which aims to integrate hydrogen into regional energy transition strategies. It outlines the methodology adopted, the GIS system prototype, and the evaluation results from pilot regions in Veneto and Styria (D2.1.1). Additionally, it analyzes the Energy Cells model in Lübben (D2.1.2), designed to optimize the use of local energy resources and reduce CO_2 emissions. The report also provides guidelines for the transferability of the GIS model and Energy Cells to other territorial contexts, with a particular focus on scalability opportunities and the technological and economic barriers associated with hydrogen production and distribution.

2. GIS-based tool developed in Veneto and Styria Region

2.1. Results of the testing

The tools provide a data-driven approach to hydrogen infrastructure planning, offering decision-makers a strategic platform to evaluate hydrogen production, demand, and distribution at different territorial scales.

1. Potential and Added Value of the GIS Tool

The GIS tool demonstrates significant potential in supporting hydrogen-related policies by enabling:

- Territorial mapping of hydrogen potential: Identifying optimal locations for hydrogen production, storage, and distribution based on spatial data.
- Integration with renewable energy sources: Supporting the alignment of hydrogen production with solar, wind, and hydroelectric energy resources.
- Scenario simulation and predictive modeling: Analyzing different hydrogen development pathways to support long-term planning and investment decisions.
- Optimization of the transport and distribution network: Identifying strategic locations for refueling stations, pipelines, and logistics hubs.
- Environmental and social impact assessment: Analyzing potential impacts of hydrogen infrastructure on ecosystems, air quality, and community acceptance.

The tool leverages Geographic Information Systems (GIS) to optimize infrastructure investments, ensuring an efficient and sustainable transition toward a hydrogen-based energy system.

2. Usability and Key Functionalities

The GIS tool is designed to be accessible and user-friendly, supporting a broad range of users, from technical experts to policymakers. Key usability features include:

- A web-based platform: Allows real-time access to spatial data, eliminating the need for complex installations.
- Interactive decision-making dashboard: Enables policymakers to configure different hydrogen adoption scenarios and visualize their impact.
- Advanced geospatial analytics: Supports real-time data querying, sector-specific analysis, and territorial comparisons.
- Multi-layer data integration: Combines industrial consumption, mobility patterns, population distribution, and existing energy networks into a unified planning interface.

- Customization and scalability: The system is designed to accommodate new datasets and evolving policy priorities, ensuring long-term adaptability.

Through these features, the tool provides a flexible decision-support system that can help authorities optimize investments and coordinate stakeholders in the hydrogen sector.

3. Scalability and replicability in other contexts

One of the most significant aspects of this project is its scalability, making it a valuable model for other regions planning to integrate hydrogen into their energy strategies.

Key factors enabling scalability:

- Common methodology: The GIS tool was developed using a shared approach between Veneto and Styria, allowing it to be adapted to different territorial contexts.
- Interoperability: The system is built with modular and interoperable architecture, enabling integration with other GIS platforms and national energy strategies.
- Transferable data framework: The methodology used to collect, structure, and visualize data can be applied to other regions, industries, or transport networks.
- Adaptability to policy frameworks: The tool can incorporate different regulations, incentives, and energy strategies across various jurisdictions.
- Cross-sector application: While focused on hydrogen, the GIS-based approach can be extended to other renewable energy sources, urban planning, and climate adaptation policies.

Potential Applications in Other Regions:

1. Expanding to other European regions with hydrogen ambitions.
2. Adapting the tool for industrial clusters requiring hydrogen integration.
3. Supporting cross-border energy corridors and hydrogen distribution networks.
4. Integrating with smart city initiatives for sustainable mobility planning.

2.2. Handbook and Transferability

This handbook provides a methodological framework for developing a GIS-based system to support the planning and management of hydrogen (H_2) infrastructure. The methodology is based on experiences from the H2CE project in the Veneto and Styria regions and is structured into a series of clear and replicable steps.

1. Defining the Context and Objectives

Objective: Identify regional needs and define the role of GIS in hydrogen planning

Operational Steps:

- Map the territorial context:
  - Analyze local, national, and European energy and climate policies.
  - Review existing decarbonization strategies.
- Define the strategic objectives of the GIS tool:
  - Support decisions on hydrogen production, storage, and distribution sites.
  - Identify key demand sectors (industry, transport, residential, etc.).
  - Create development scenarios based on territorial data.
- Engage stakeholders:
  - Public authorities and local administrations.
  - Industry and energy companies.
  - Universities and research centers.
  - Local communities and associations.

Expected Output:
Initial planning document with clear objectives and a project roadmap.

2. Data Collection and Organization

Objective: Create a structured database with the necessary information for GIS analysis.

Operational Steps:

- Identify primary and secondary data sources:
  - **Energy data**: industrial consumption, transport, residential demand, renewable energy distribution.
  - **Infrastructure data**: transport networks, pipelines, production and distribution facilities.
  - **Geospatial data**: territorial maps, administrative boundaries, environmental constraints.
  - **Economic and social data**: industrial growth, population distribution, demographic trends.
- Standardize and integrate data into GIS:

- Convert data into compatible formats (TOE, hydrogen ton equivalent).
- Ensure quality and consistency across different datasets.
- Create a centralized database accessible to project partners.

Expected Output:
GIS database organized with thematic layers for spatial analysis.

3. Development of the GIS Tool and Spatial Modeling

Objective: Create a GIS platform to analyze hydrogen development scenarios.

Operational Steps:

- **Define the structure of the GIS tool:**
  - Select GIS software (e.g., Atlas, QGIS, ArcGIS).
  - Configure interfaces and visualization dashboards.
- **Build the geospatial model:**
  - Map current and future hydrogen demand.
  - Analyze territorial compatibility for new hydrogen facilities.
  - Simulate scenarios for expanding the distribution network.
- **Integrate interactive functionalities:**
  - Query data by sector and geographic area.
  - Predictive analysis tools based on GIS models.
  - Dashboards to visualize CO_2 savings and environmental impacts.

Expected Output:
Beta version of the GIS tool with analysis and simulation functionalities.

4. Testing and Validation of the GIS Tool

Objective: Ensure that the tool provides accurate and useful data for decision-making.

Operational Steps:

- **Test with experts and public decision-makers:**
  - Engage key stakeholders to test functionalities.
  - Gather feedback on usability and reliability.
- **Verify data quality:**

- Compare results with real consumption data and forecasts.
- Optimize GIS models based on test results.

- **Improve and debug the system:**
  - Fix any discrepancies in the data.
  - Add functionalities requested by users.

Expected Output:
Final version of the GIS tool ready for implementation.

5. Implementation and Use for Territorial Planning

Objective: Integrate the GIS tool into regional development strategies.

Operational Steps:

- **Train end users:**
  - Organize workshops with public administrators and businesses to use the tool.
  - Create operational guidelines for data consultation.
- **Integrate into decision-making processes:**
  - Support planning of new hydrogen plants.
  - Analyze investment and funding opportunities.
  - Develop energy policies based on GIS data.
- **Monitor and continuously update the system:**
  - Periodically collect new data to update the system.
  - Assess the impact of decisions made using the GIS tool.

Expected Output:
Fully operational GIS tool used in regional planning processes.

3. Energy Cells Model in Lübben

3.1. Results of the testing

The energy system in Lübben has been analysed with the open plan tool. The idea was to analyse possible solutions for decarbonisation. The demand profile of the Region of Lübben is dominated by private households. The highest obstacle to take is the decarbonization of the heating sector in the region. The lack of industry using high temperature process makes the utilization of waste heat impossible. Therefore, other technologies must be used in order to meet the demand.

The region has high potential for renewable energy production with wind and solar. The electricity grid has limited capacity. Therefore, utilising the potential of renewable energies needs to happen with local consumption through sector coupling of the electricity and heating sector. The goal is to achieve climate neutrality by 2045 according to the German national law.

Electricity supply

The high potential for renewable energies in the region allows for complete self-sufficiency. There is also the possibility to sell energy via the electrical grid.

Sector coupling

About 62 % of the decentral heat demand is to be met with heat pumps, allowing to utilize the high potential for renewable energies. Biogas used in boilers makes up for the other 38 % to fulfil the the demand. For the central demand in the heating grid of Lübben a combination of a heat pump and a combined heat and power plant (chp). The electrical power of the chp can be used to power the heat pump. The use of a heat storage allows for more flexibility.

Comparing of central and decentral demand

The comparison of the centralized and decentralized demand shows significant differences in their value. The demand in the heating grid is about 2,5 % of the decentralized demand. Since the differences are so high, the optimization does not show optimal results for the central heat supply. The Sankey shows a branch called “heat_central_excess” that is bigger than the central heat demand. Excess energies are energies that the system produces but is not able to distribute and therefore qualifies as excess. Usually excess energy is meant to be as low as possible, but since the values of the decentralized demand are way higher, the excess energy is relatively small compared to the total demand. A more detailed analysis of the centralized heating demand needs to be made.

3.2. Handbook and Transferability

The energy system in Lübben shows various results that can be transferred to other regions in Central Europe.

Heat demand as a challenge for future energy systems

The energy transition in the heating sector poses an enormous challenge for regions. The energy demand in this sector usually exceeds the demand for electrical energy by far. In many regions, the current heat demand is covered by natural gas. In the future, it cannot be assumed that this demand cannot simply be replaced by biogas due to the lower availability. Current research shows, the heat pump is the cheapest way to supply heat. However, using heat pumps changes the required infrastructure because the performance of the heat pump is highly dependent on the temperature difference. For example, it is more efficient to emit room heat through underfloor heating instead of smaller radiators, which have to reach a significantly higher temperature to heat a room. In the majority of the housing stock, these infrastructure needs are not met. The same applies to heating networks. Currently, many heating networks operate with high temperatures, which reduce the efficiency of heat pumps in a central supply. In order to make the heat supply cheap and environmentally friendly in the future, an expansion of the infrastructure and renewable energies is indispensable.

Sector coupling and intelligent systems

The energy supply of the future works by coupling different sectors. Because many sectors are showing countercyclical demand patterns, synergies are to be expected here. Likewise, flexibility in processes must be increased to counter the fluctuation of renewable energies. This requires smart systems that can control processes according to the generation profile of renewable energies.

Role of hydrogen in the energy system

In regions such as Lübben without foreseeable hydrogen demand, hydrogen plays a subordinate role in the energy system. The region does not have any industrial processes for which the application of hydrogen is an option. The use in other sectors, such as the heating sector, is also not economically competitive.

However, due to the high potential for renewable energies, the production and export of hydrogen is an economically viable solution. The connection to the European Hydrogen Backbone thus opens economic opportunities for such regions.

Barriers to hydrogen production

The optimization shows that the use of hydrogen in the energy system is not economical based on the assumptions made. However, it also shows that the production of hydrogen is too possible and economical if the purchase price is sufficient. If a region cannot do without hydrogen due to economic processes, regional production is a good addition. The simulation also shows large surpluses of electrical energy for the year 2045. The decarbonization of energy systems requires the expansion of renewable energies. Because the expansion of electricity grids is a complex project, the use of energy surpluses for hydrogen production can prevent RE plants from having to be shut down to prevent grid overloads.

To use these energy surpluses electrolysers and other technical equipment for producing and storing hydrogen must get cheaper to create a viable business case.

4. Conclusions

The analysis and testing carried out within the H2CE project demonstrate how the GIS platform and the Energy Cells Model can serve as strategic tools for energy planning and the transition towards a hydrogen-based system. The GIS platform, tested in the pilot regions of Veneto and Styria, has proven to be an effective decision-support tool, providing a detailed view of hydrogen infrastructure by integrating territorial, environmental, and economic data. Its advanced modeling and simulation capabilities enable policymakers and planners to evaluate different hydrogen development scenarios, optimizing investments and implementation strategies.

The Energy Cells Model in Lübben, on the other hand, provides a concrete example of how local energy solutions can be optimized to support decarbonization, particularly in the heating sector. The integration of renewable energy production, local consumption, and storage systems highlights the potential of regional energy transition strategies. The Lübben experience also emphasizes the importance of adopting a sector coupling approach, integrating different energy sectors to improve overall system efficiency and reduce energy losses.

One of the most significant findings of the project is the scalability and transferability of these tools to other territorial contexts. The GIS platform, with its modular and interoperable approach, can be adapted to different regional configurations, allowing public authorities and administrations to design hydrogen development plans tailored to local needs. Similarly, the Energy Cells Model can be replicated in regions highly dependent on fossil fuels, providing concrete solutions for the gradual decarbonization of the energy sector.

The adoption of these tools by other regions could bring significant benefits:

- Optimization of infrastructure planning: ocal administrations could use the GIS platform to identify the most suitable areas for hydrogen production, distribution, and utilization, minimizing environmental impact and maximizing energy network efficiency.

- Better integration of renewable energy sources: the ability to simulate development scenarios allows for strategic planning of hydrogen use alongside other energy sources, promoting a more sustainable use of local resources.

- Support for public policies and investment decisions: by providing detailed analyses and reliable forecasts, these tools can facilitate access to funding for energy transition projects, guide policy decisions, and attract private investors.

- Reduction of emissions and improvement of air quality: the use of hydrogen in strategic sectors such as transportation and urban heating could significantly contribute to CO_2 emissions reduction, improving the quality of life for citizens.