PROGRESSIVE DEVELOPMENT OF CZECH HYDROGEN REFUELLING NETWORK WITH A VIEW TOWARDS 2050

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Introduction

In order to fulfill the requirements laid out in the Alternative fuel infrastructure regulation (AFIR) and also to ensure sufficient coverage of the Czech road network a number of hydrogen refuelling stations (HRS) will have to be built. In order to ensure methodical and meaningful development of the HRS network a methodology was created that shows how to determine the optimal locations for HRS in the years 2030, 2040 and 2050 based on a thorough network analysis. This poster will present the methodology for Progressive development of Czech hydrogen refuelling network with a view towards 2050 and the results of a network analysis based on the currently operating or planned HRS in the Czech Republic.

Methods

Scenarios

In order to determine the parameters of the HRS network, hydrogen demand in the examined years had to be determined first. The demand was modeled in two scenarios: **Reference** and **Concept**.

The **Reference** scenario is based on the best possible estimate of hydrogen vehicle development with regard to the possibilities of local hydrogen production and predicted hydrogen import capabilities. This scenario emphasizes the consumption of hydrogen fuel in heavy duty road transport.

The **Concept** scenario is based on the strategic documents issued by the Czech government such as the Czech Republic's Hydrogen Strategy [1] and National Action Plan for Clean Mobility [2]. Namely on the predictions for hydrogen vehicle numbers listed in these documents.

H2 consumption [t]	2030	2040	2050
Reference scenario	4 134	34 496	359 679
Concept scenario	8 412	100 480	632 154

Prognosis of hydrogen consumption in mobility

Hydrogen demand

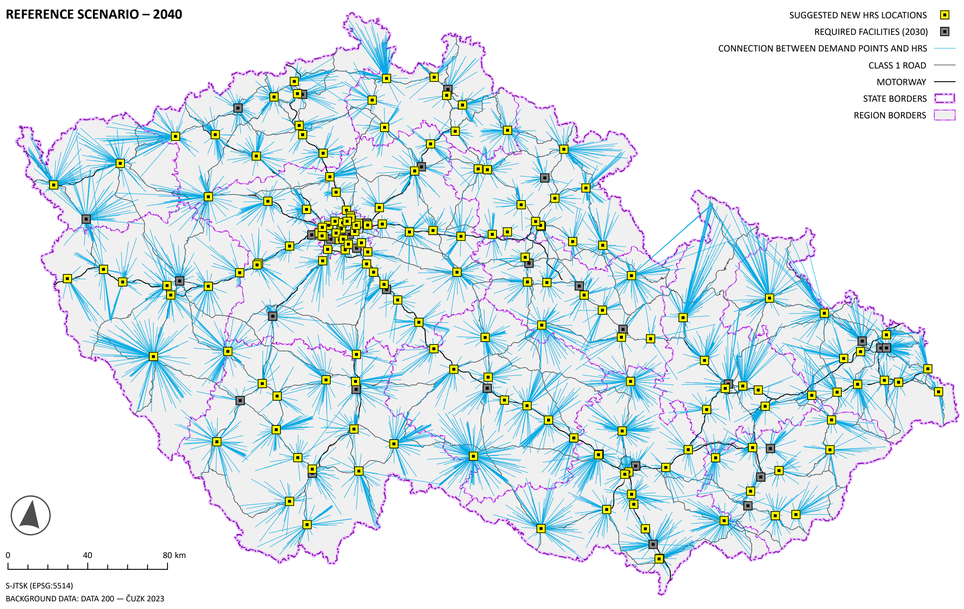
The consumptions determined for the above mentioned scenarios were then used to estimate the demand for hydrogen fuel on the Czech road network. It was presumed that the demand for hydrogen fuel would mirror the demand for conventional fuels used today. The contemporary demand for fuels was estimated based on the traffic census performed in 2022 for Prague and 2020 for the rest of the republic [3]. The projected demand in the examined years was determined based on the Prognosis of car traffic intensities [4]. Based on these inputs the hydrogen fuel demand for each section measured in the traffic census was determined. This demand served as the main input for selection of hydrogen refuelling station locations.

Additional inputs

- Besides the projected hydrogen demand additional inputs were used as criteria for HRS locations:
- Czech HRS in operation or with approved funding from Operational Programme Transport. [5]
- Current conventional fuel refuelling stations in operation (ČÚZK – Czech Office for Surveying, Mapping and Cadastre)
- Czech road network divided by road classification (ČÚZK)
- TEN-T road network
- Topographical database of the Czech Republic (ČÚZK)
- Urban node network as defined by [6]
- Alternative fuel infrastructure regulation (AFIR) [7]

Network analysis

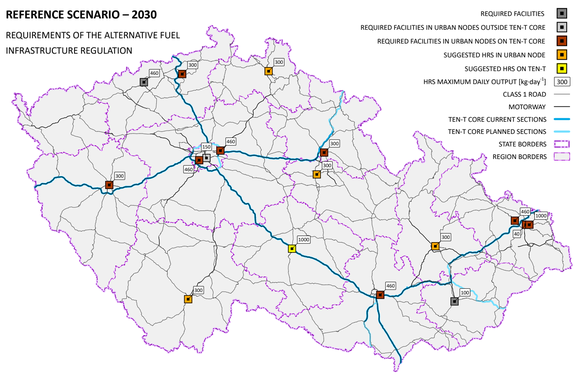
The network analysis was performed in geographic information system using the Maximize Capacitated Coverage algorithm. The algorithm's inputs are Candidate facilities – existing refuelling stations, Required facilities – HRS in operation or with approved funding (in later years the locations selected by the algorithm previously) and Demand Points – the demand for hydrogen in each section of the road network as described in **Hydrogen demand**. The algorithm matches the Demand points to the facilities in order to reach full coverage of the road network by HRS and to maximize the utilization of each refuelling station. The output of the algorithm are the locations of existing refuelling stations that are ideal for dispensing hydrogen in the examined years.

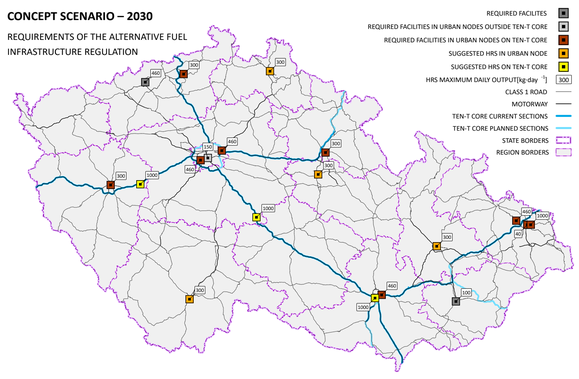


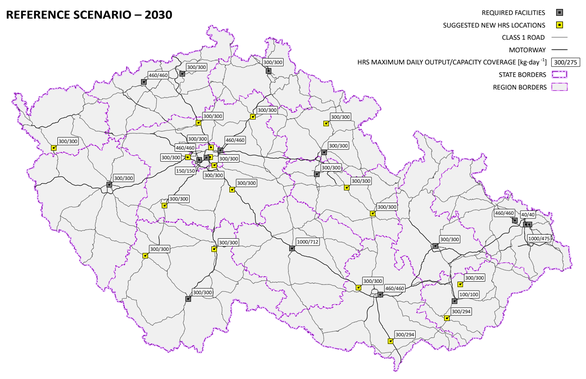
Results

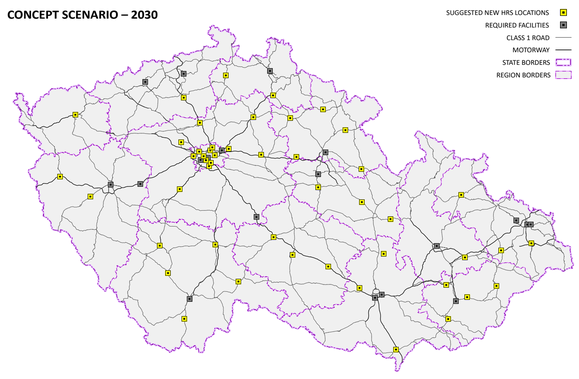
The methodology outlined in Methods was used to create maps showing the ideal locations of HRS in the Czech Republic. The set of maps show the following for both scenarios considered:

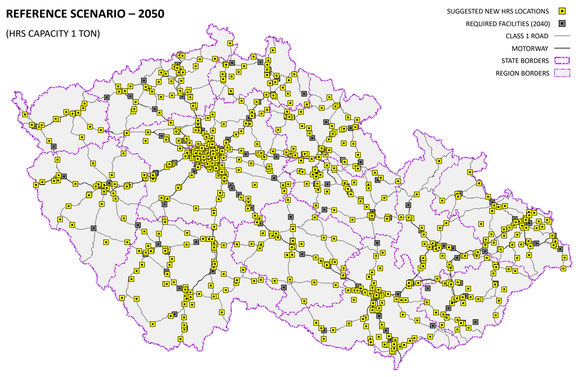
- Locations of HRS needed to satisfy the requirements of AFIR
- Locations of HRS needed to cover the demand of the Czech road network in 2030 – new HRS capacity 300 kg H2/day
- Locations of HRS needed to cover the demand of the Czech road network in 2040 – new HRS capacity 500 kg H2/day
- Locations of HRS needed to cover the demand of the Czech road network in 2050 – new HRS capacity 1 000 kg H2/day – Reference scenario only
- Locations of HRS needed to cover the demand of the Czech road network in 2050 – all HRS capacity 2 000 kg H2/day

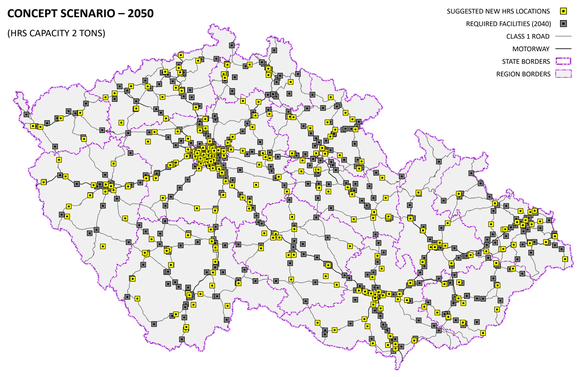


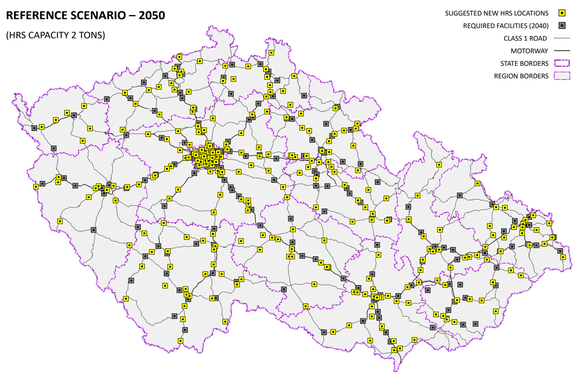


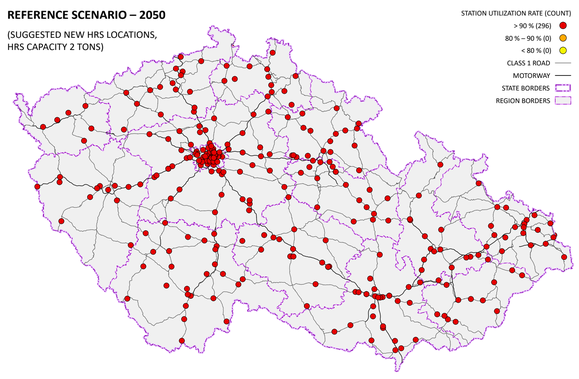












Maps of ideal locations of HRS in the Czech Republic:

a) 2030 – Reference scenario, AFIR coverage
b) 2030 – Concept scenario, AFIR coverage
c) 2030 – Reference scenario, Czechia coverage
d) 2030 – Concept scenario, Czechia coverage
e) 2040 – Reference scenario, Czechia coverage
f) 2040 – Concept scenario, Czechia coverage
g) 2050 – Reference scenario, Czechia coverage, 1 t HRS capacity
h) 2050 – Concept scenario, Czechia coverage, 1 t HRS capacity
i) 2050 – Reference scenario, Czechia coverage, 2 t HRS capacity
j) 2050 – Reference scenario, 2 t HRS capacity, utilization map

These maps serve as a way to showcase the methodology for Progressive development of Czech hydrogen refuelling network with a view towards 2050. The methodology provides a guide which can serve to update the results of the network analysis as the inputs change. The maps shown here are only a sample, showing the resulting HRS network at the time of the methodology's creation and are only a subset of the generated set of maps. The remaining maps generated are freely available online in Czech:
https://www.cistadoprava.cz/ck02000044-progresivni-rozvoj-vodikoveho-hospodarstvi-v-doprave-cr/

Acknowledgements

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