european network
of transmission system operators
for gas

TEN-YEAR NETWORK DEVELOPMENT PLAN

2020

ANNEX F – GAS QUALITY OUTLOOK

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1. Introduction

Article 18 of the network code on interoperability and data exchange rules (Commission Regulation (EU) 2015/703) requires ENTSOG to publish, alongside the TYNDP, a long-term gas quality monitoring outlook (Gas Quality Outlook - GQO) for transmission systems in order to identify the potential trends of gas quality parameters and respective potential variability within the next 10 years.

The GQO shall cover at least the gross calorific value (GCV) and the Wobbe Index (WI), produce different forecasts for different regions and be consistent and aligned with the TYNDP. The GQO covers existing and new supply sources, based on reference gas quality values from previous years when available. For each region, the forecast consists of a range within which the parameter is likely to evolve.

As part of the TYNDP, stakeholders are invited to provide their views on the evolution of gas quality parameters. The TYNDP 2020 is the third edition incorporating the GQO. One of the main improvements in this edition is the inclusion of an extended section about the influence of hydrogen on GCV and WI[1]. This report provides initial assessments only of the possible quantities of renewable, decarbonised and low-carbon gases. In this respect, the report does not prejudice the technical feasibility of injecting the projected quantities of such gases into the gas systems as this subject is still under investigation – and does therefore not constitute any legal responsibility on ENTSOG in this matter.

2. Methodology

The GQO is produced with a probabilistic approach based on a statistical characterisation of historical WI and GCV data supplied by TSOs for each different supply source. In the *Input data* subsection, a summary of the used values for all the sources included in the study can be found. It is worth noting that extreme values outside the forecast are possible.

The GQO is assessed with the NeMo gas balance simulations for predefined supply corridors/regions with different demand scenarios and price configurations. The result is a probability distribution of gas quality values for each assessed region and year.

For the GQO 2020, the TYNDP 2020 National Trends scenario is used as reference for 2030. The National Trends scenario relies on bottom-up data for the indigenous production for natural gas and biomethane. Additionally, P2G is added assuming that curtailed electricity will be used to

[1] Although not addressed in this report, in TYNDP 2020 ENTSOs have identified for the first time the need for hydrogen supply considering three major technologies: P2G, Steam Methane Reforming plus CCU/S, and Methane Pyrolysis.

produce hydrogen and synthetic methane. In addition, ENTSOG has run an additional data collection with its members to collect information from the final National Energy and Climate Plans (NECPs). Furthermore, the latest policy decisions have been considered[2]. For the sensitivity of hydrogen, the same scenario (National Trends) has been used, although the outlook goes up to 2040.

The underlying mathematical model is built on the following assumptions:

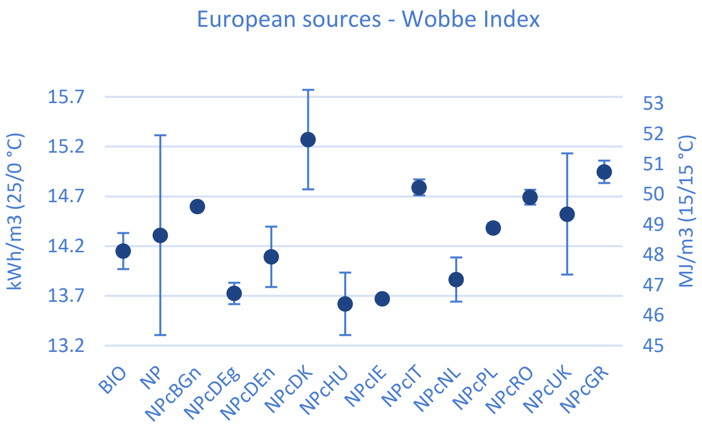
- The supply corridors and regions are defined like the regional groupings that develop the GRIPs:
  - South corridor: FR, ES, PT
  - South-North corridor: DE, BE, FR, IT, CH, LU
  - North-West corridor: SE, DK, DE, NL, BE, LU, FR, UK, IE
  - Baltic Energy Market Interconnection Plan (BEMIP) corridor: DK, SE, FI, PL, EE, LT, LV
  - Central Eastern Europe (CEE) corridor: DE, PL, CZ, SK, AT, HU, HR, RO, BG
  - South-Corridor: IT, AT, SI, SK, HU, HR, RO, BG, GR

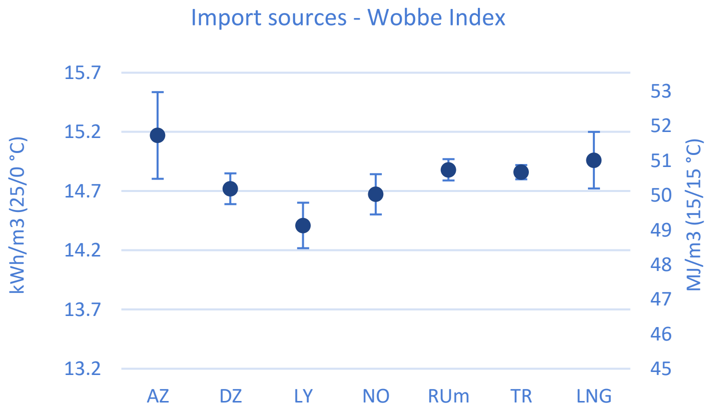
- WI and GCV have only been collected at entry points to the EU transmission network and indigenous production points.
- For each supply source, the probability distributions of GCV and WI are derived from the historical data and they are assumed to be representative for the future developments of that source.
- Gas quality parameters per identified supply source are assumed to follow a normal probability distribution.
- L-gas has not been considered for different reasons:
  - Unless it were analysed in a separate forecast, it would widely distort results.
  - The underlying network model does not make a distinction between L-gas and H-gas networks.
  - L-gas is expected to have a declining contribution in the coming years.
- Biomethane gas quality is assumed to lie within a common range for all production plants, irrespectively of the country where they are located.
- LNG is grouped as a single gas quality range, under the assumption that the same range of qualities can reach any terminal in Europe. The range used for the simulation is based on measured values from re-gasified LNG in different LNG terminals in the EU.
- Indigenous production data have been aggregated per country, except for biomethane.

[2] Such as for the German coal-phase out or the Dutch gas production.

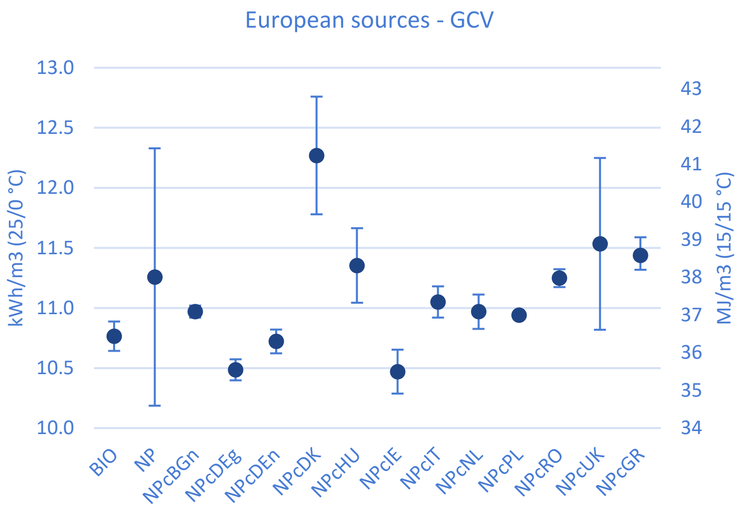
- In the cases where no WI data were available, the statistical parameters are inferred from the respective GCV data.
- For those countries not listed in the input data section, a generic probability distribution has been assumed for their national production (NP). The NP range is built considering the highest and the lowest values across all indigenous production data.
- Azeri average gas quality parameters are derived on forecasts provided by project promoters in the absence of measured values. The width of the range is assumed to be not larger than the widest range within the different supply origins.
- Regarding supply and demand data taken from the TYNDP 2020, the infrastructure development level is assumed to be low.
- Supply and gas quality figures are combined by means of Monte Carlo simulation.

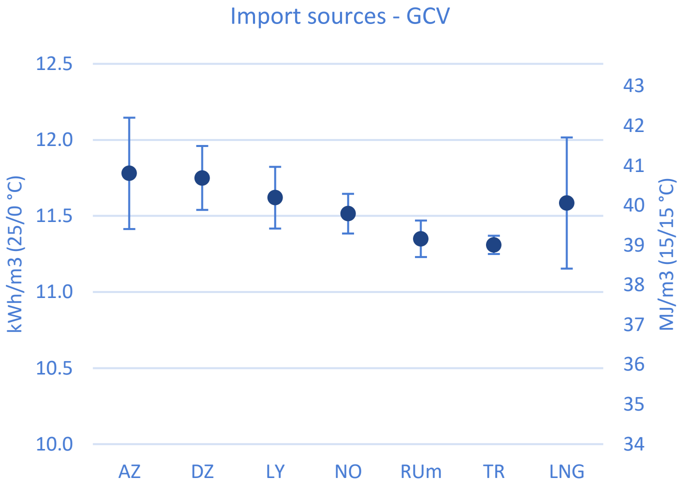
2.1. Input data[3]





[3] NP = National Production; BIO = Biomethane





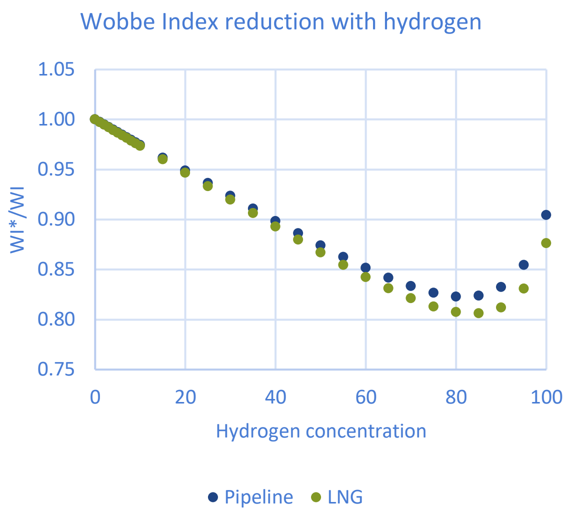
2.2. Hydrogen influence

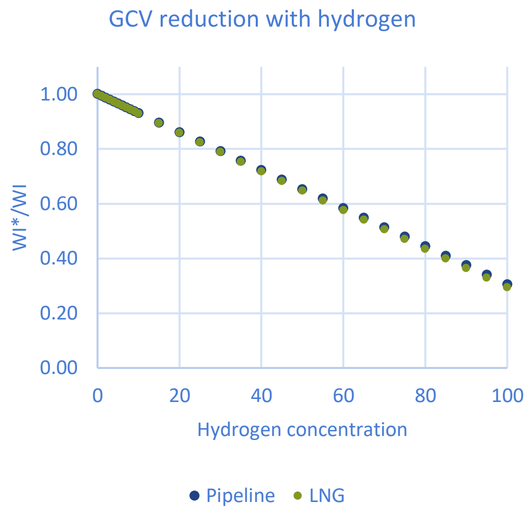
Hydrogen is already being injected into the gas grid in small amounts today and is projected to increase significantly in the long term[4]. The impact on Wobbe Index and Gross Calorific Value is well known and has been documented by different studies[5].

For both parameters, the influence of hydrogen is approximately linear for concentrations below 30% hydrogen in volume. The assumption is made for all the calculations in this outlook.

[4] ENTSOG roadmap 2050 for gas grids.

[5] See MARCOGAZ document: "Impact of hydrogen in natural gas on end-use applications. UTIL-GQ-17-29.pdf" [link].





The hydrogen showcase is provided in section 4. For this edition, the effect of different hydrogen volume fractions (i.e., 2%, 5%, 10%, 15%, 20%) on WI and GCV ranges has been analysed. The results shown are built on the National Trends scenario for 2030 and 2040 and considers that each supply source contains gas blended with hydrogen. Besides, it is built on average yearly data, thereby not illustrating the possible fluctuation in hydrogen injection in operation time scale.

3. Results

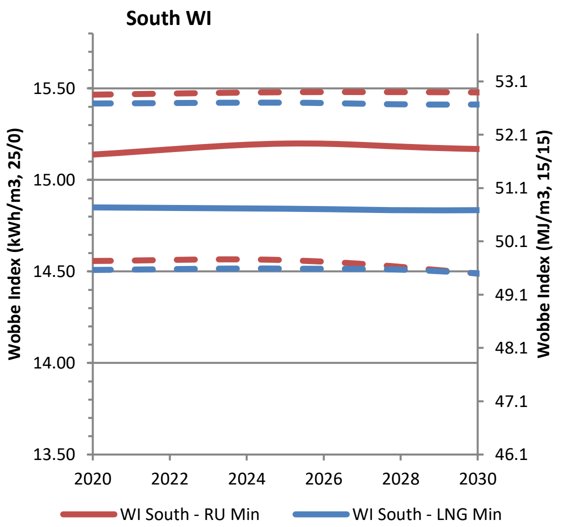
For each of the analysed regions, two different TYNDP price scenarios have been assessed: LNG min (expensive LNG) and RU min (expensive Russian gas)[6]. In order to identify trends in WI and GCV, the following figures present a plot of the median (50 percentile) of the resulting probability distribution. The variability of gas quality parameters is depicted in two different ways:

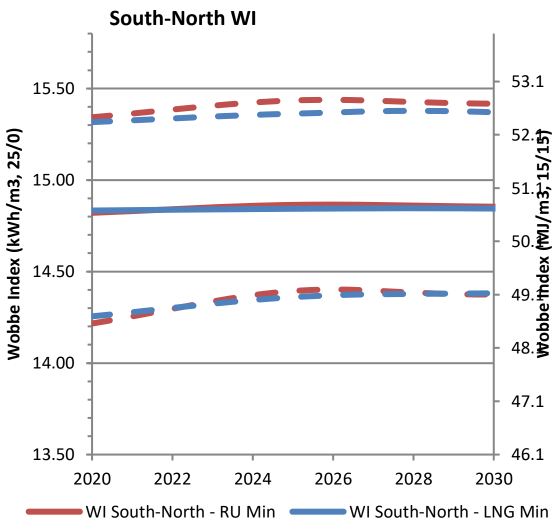
- 2.5 and 97.5 percentiles are plotted in dotted lines to inform of the extreme values most likely to be found.
- Except for sections 3.1 and 3.2, the trends are presented on top of a surface plot illustrating the probability distribution of different gas qualities across years. The darker the background, the higher the probability. This plot serves to highlight the fact that the probability distribution of the output does not follow a normal distribution even if all input sources are assumed to do it. In general, for one given region and scenario different local gas quality bandwidths may be found between the two extreme percentiles. The width and intensity (probability) of each band comes as a result of the

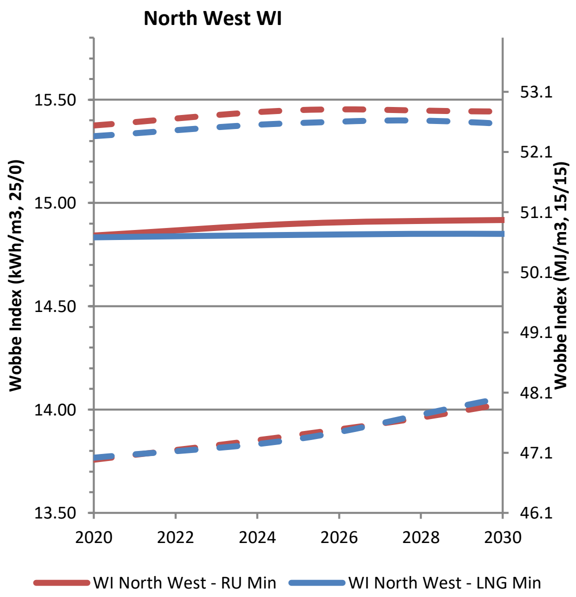
[6] See section 7.4.3 TYNDP 2020 for further information regarding price configurations [link]

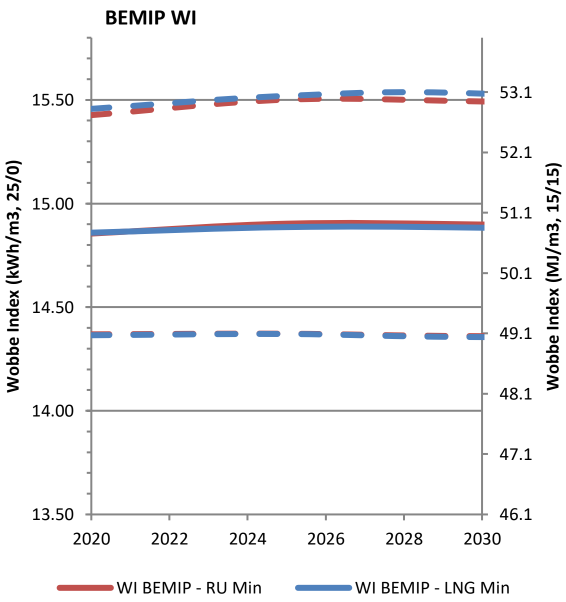
gas quality parameters of supply sources on one hand and their contribution to satisfy the forecasted gas demand on the other.

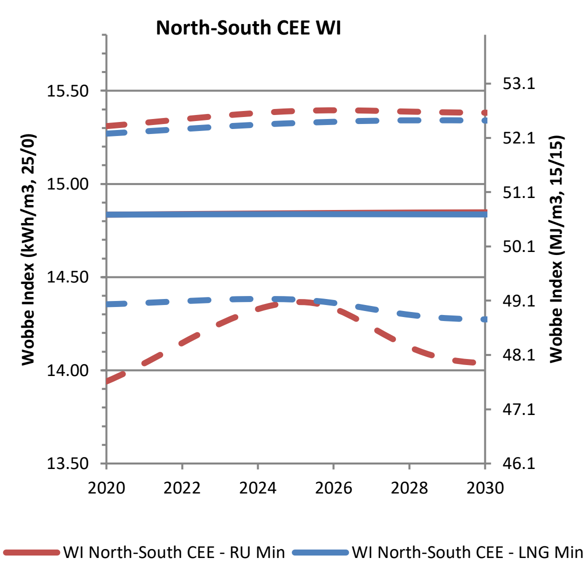
3.1. Wobbe Index (WI) overview

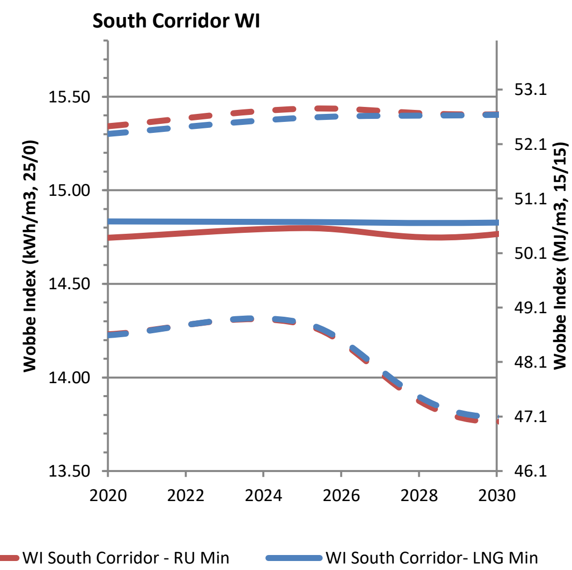






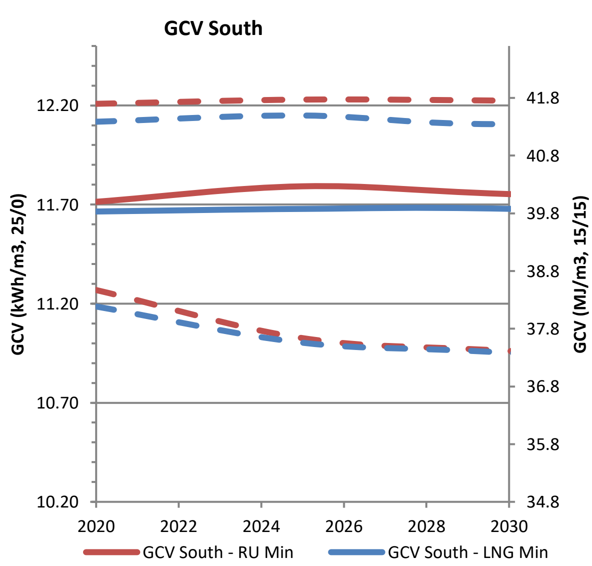


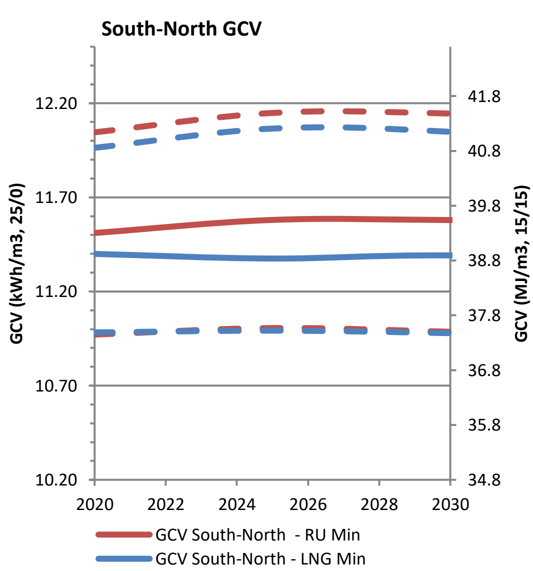


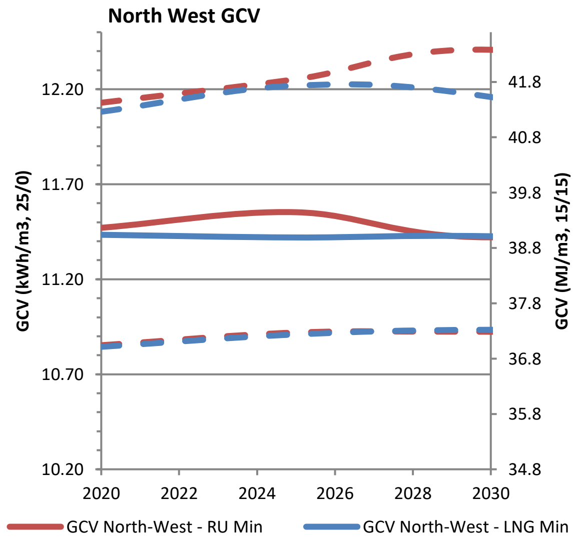


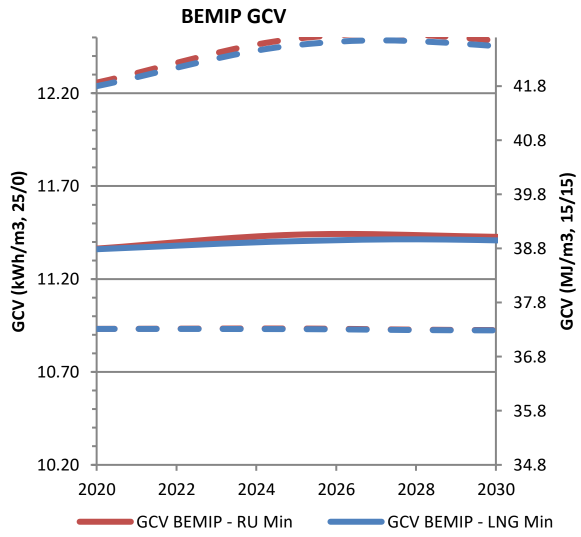
The WI ranges depicted depend more strongly on regions than on any other factor and seem to remain relatively stable for the next ten years. Trends seem to be in general not very sensitive to different price configurations (except for the CEE region). However, within one region, ranges may differ depending on the influence of different sources: LNG rising the higher limit and indigenous production decreasing the lower limit.

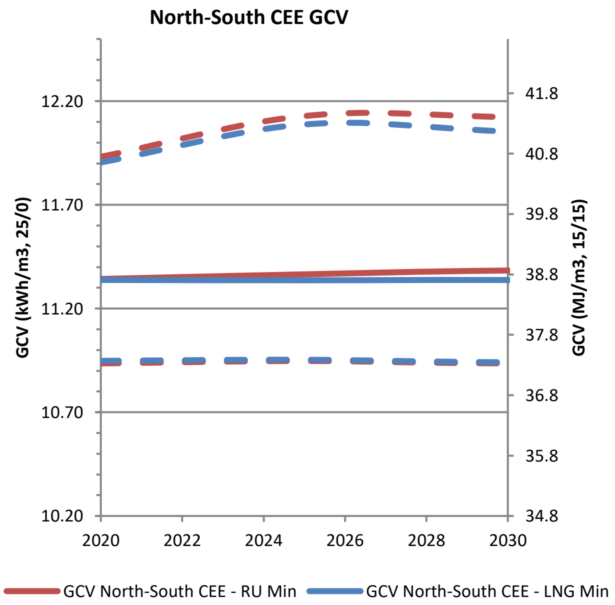
3.2. Gross Calorific Value (GCV) overview

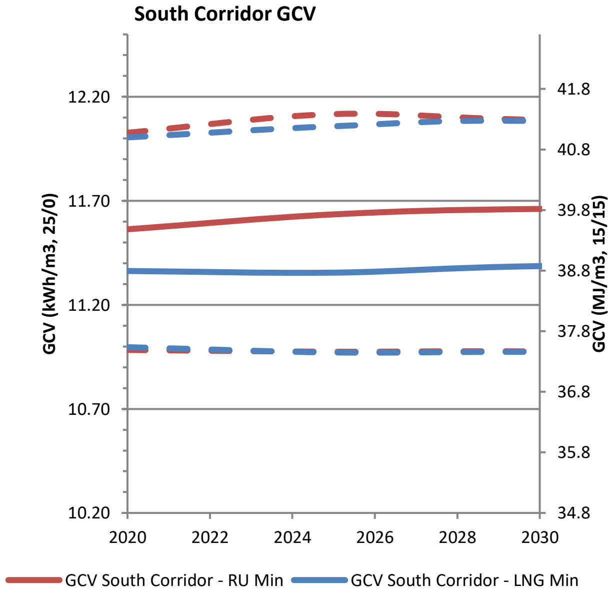






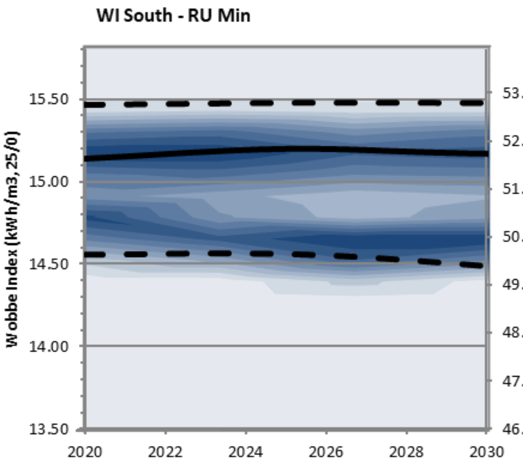


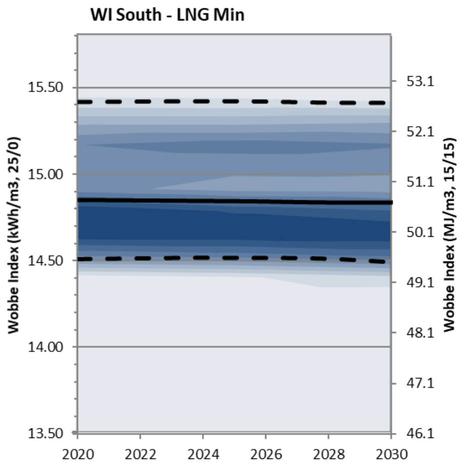




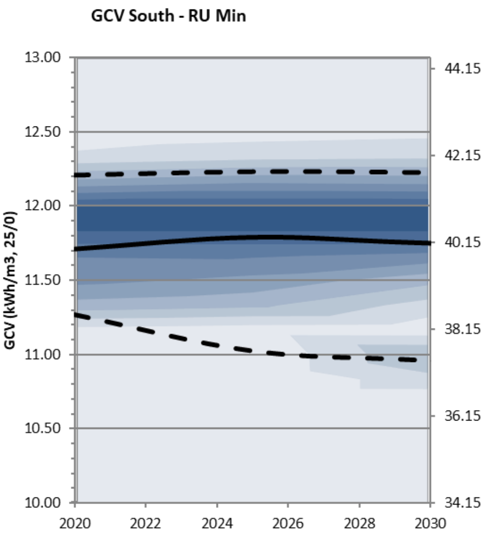
As for WI, overall GCV ranges are comparable across regions, but some of them (e.g. South Corridor) seem more sensitive to price configurations. Again, indigenous production explains the widening of the range towards lower values.

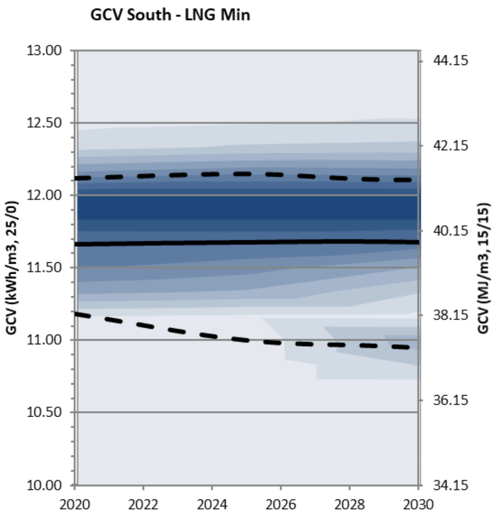
3.3. South region: ES, FR, PT



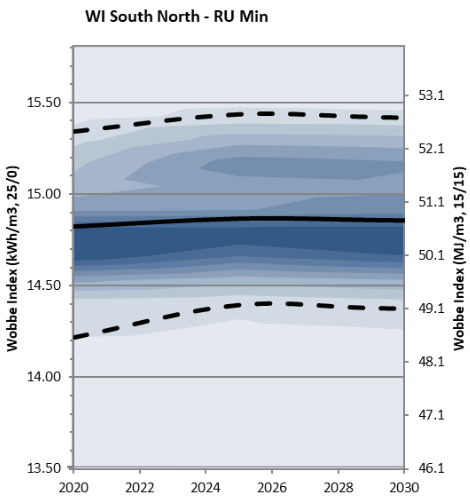


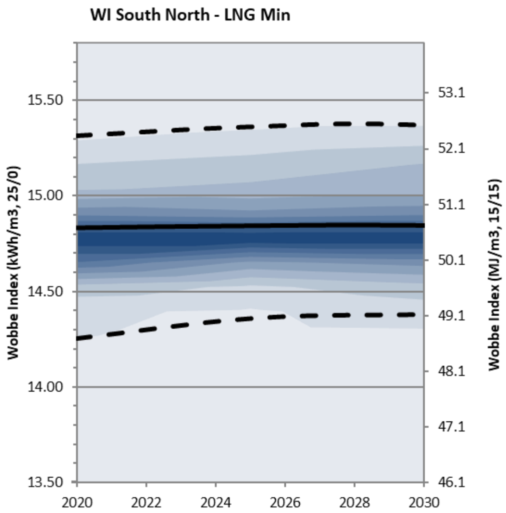
Gas quality ranges in this region present a rather stable outlook. Different price configurations appear to have little effects on the WI ranges' statistical distribution. Biomethane take-up at the end of the period is projected to widen GCV ranges.



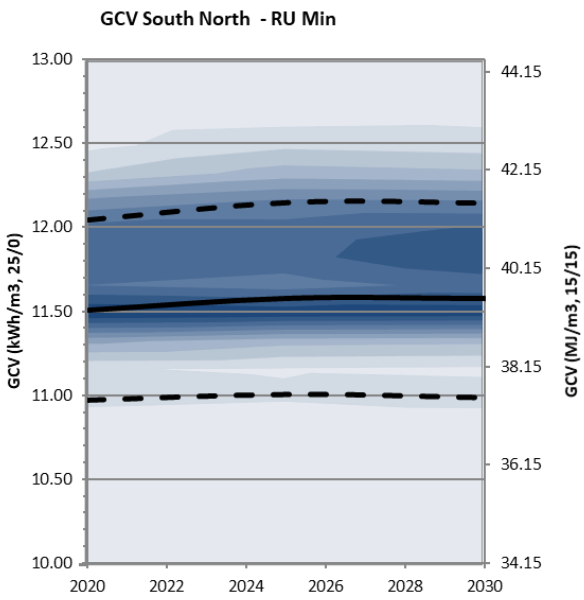


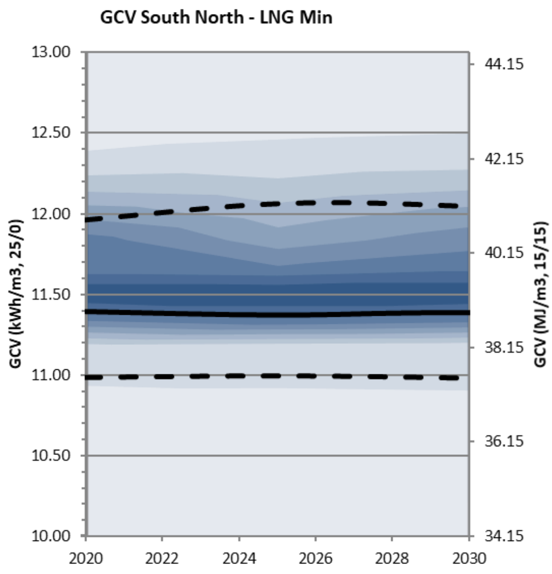
3.4. South-North region: BE, CH, DE, FR, LU, IT



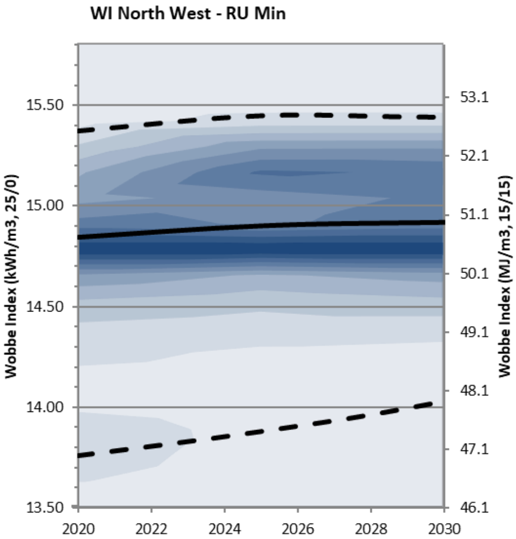


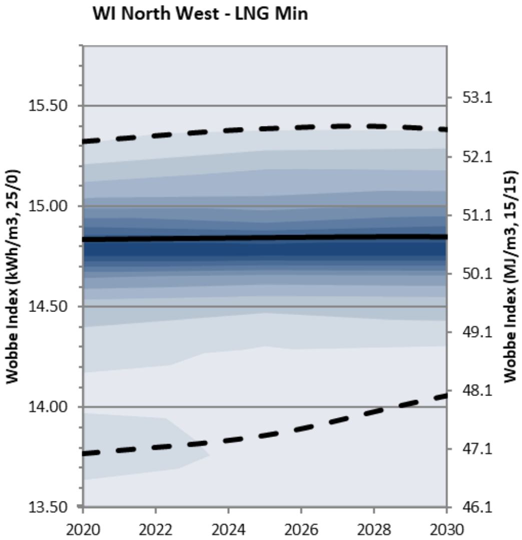
For South-North region, WI and GCV ranges show little sensitivity to scenarios and time.



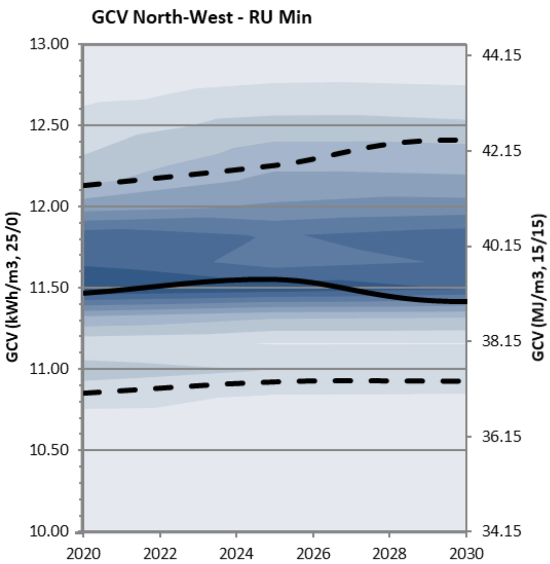


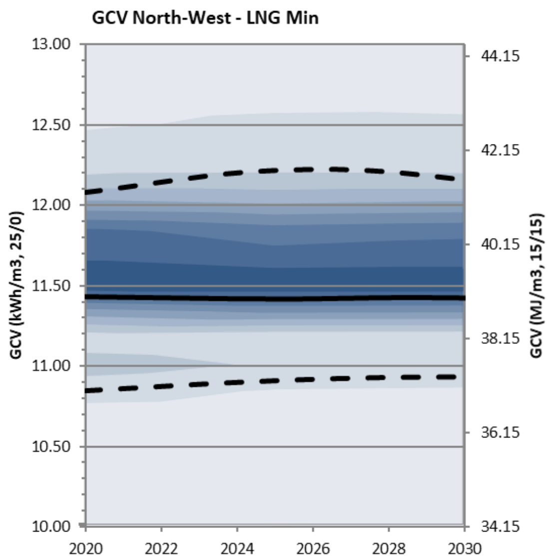
3.5. North-West region: SE, DK, DE, NL, BE, LU, FR, UK, IE



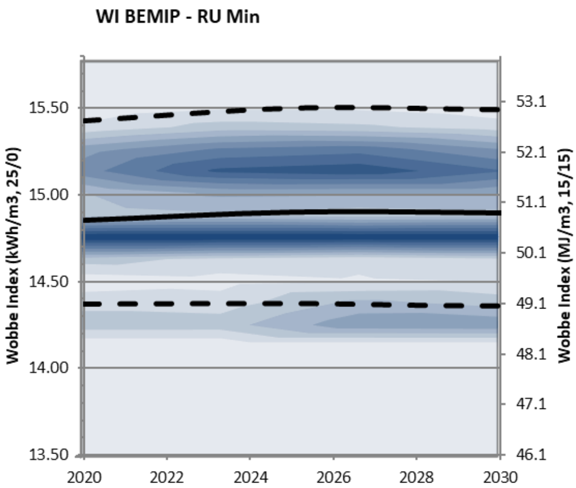


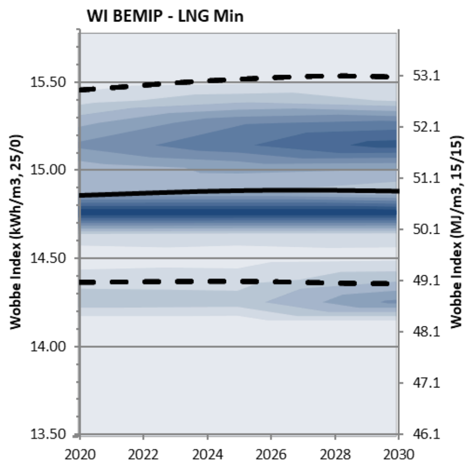
Modelling shows that WI ranges in the region tend to remain stable and determined by LNG and indigenous production. Probability distributions are projected to vary depending on the correlation of forces between supply corridors. GCV ranges for the RU min scenario tend to widen, mainly led by the increasing share of biomethane.



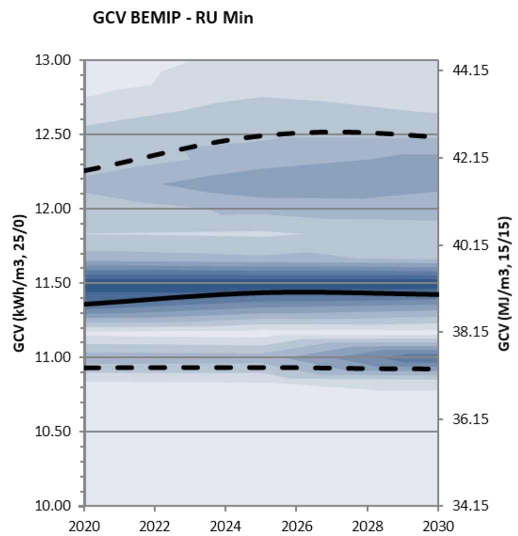


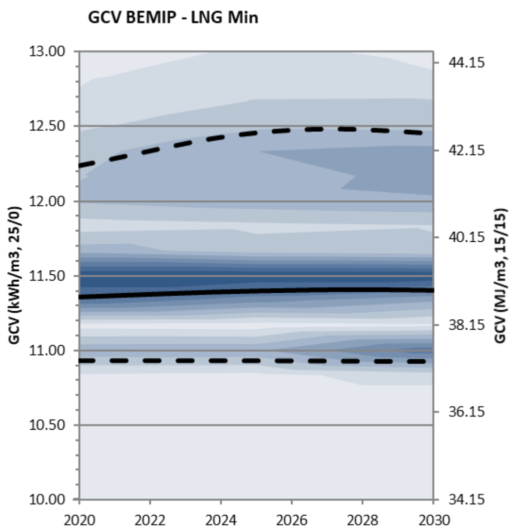
3.6. BEMIP region: DK, SE, FI, PL EE, LT, LV





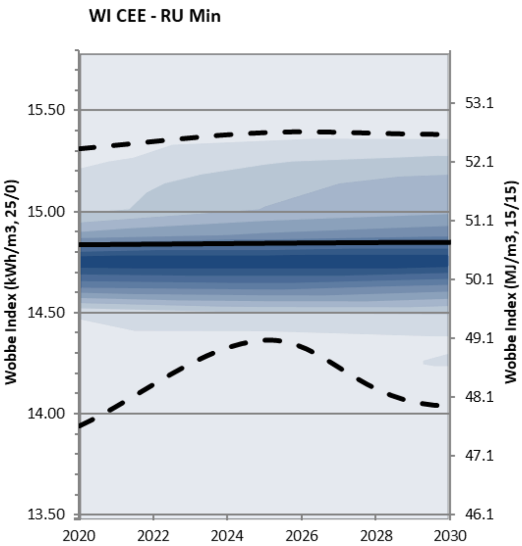
WI ranges in the BEMIP region tend to concentrate around main supply sources (LNG[7] and Russian gas). However, local production is projected to make the overall range still quite wide. As for GCV, there is a slight trend to widen the range depending on the biomethane share.

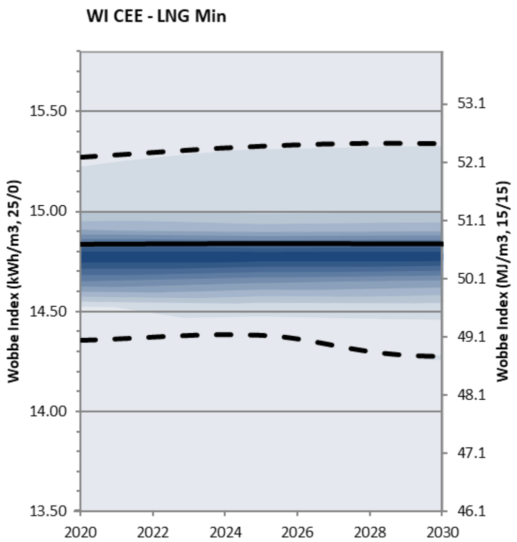




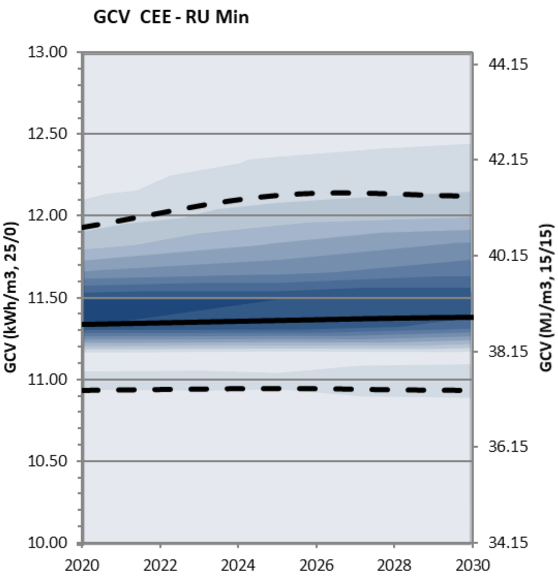
[7] It is worth mentioning that LNG flows have significantly increased for TYNDP 2020 compared to TYNDP 2018.

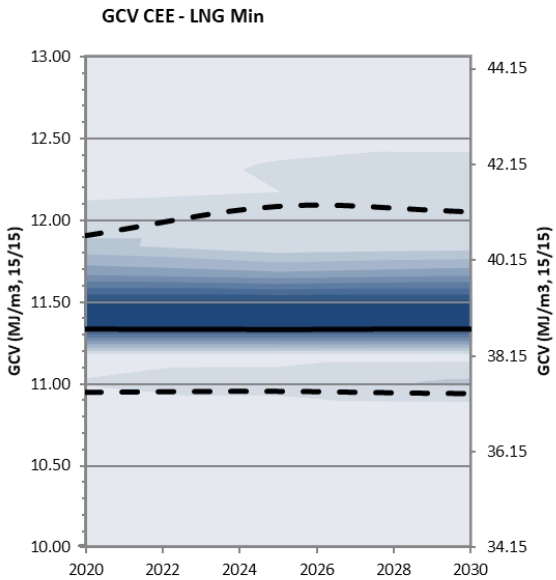
3.7. CEE: DE, PL, CZ, SK, AT, HU, HR, RO, BG



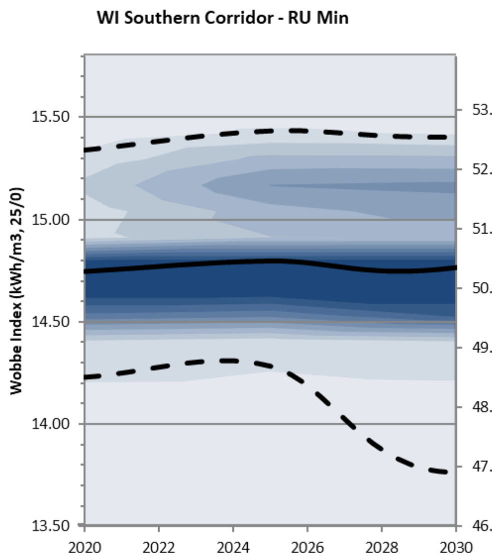


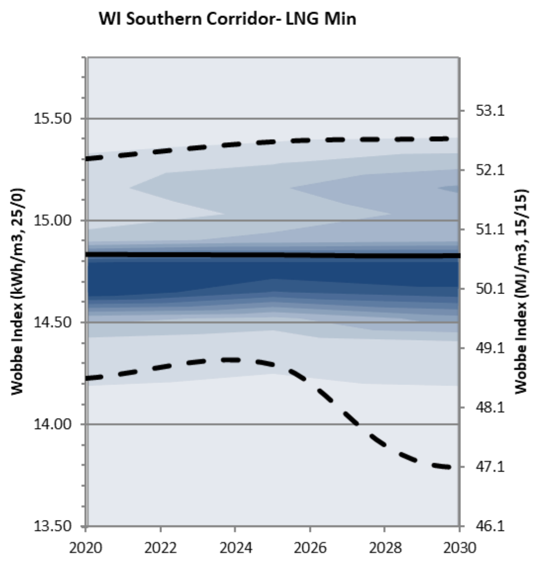
WI ranges in the CEE region are slightly more influenced by the price configuration. Depending on the distribution of supply sources, WI ranges between both scenarios may differ. Like for the BEMIP region, there is a slight trend to widen the GCV range, although it shows little sensitivity to scenarios and time.



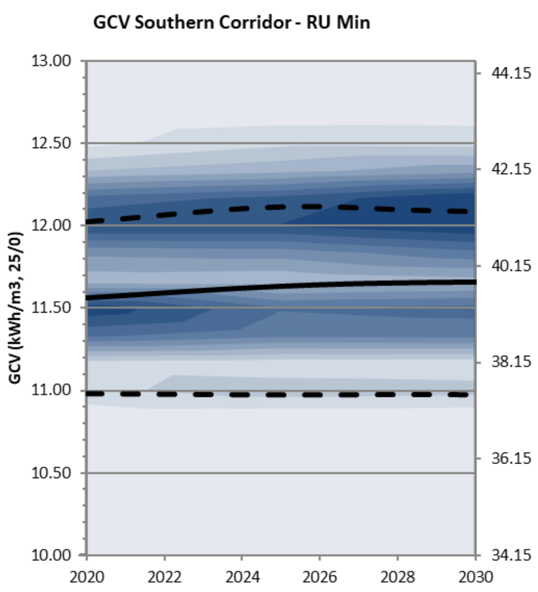


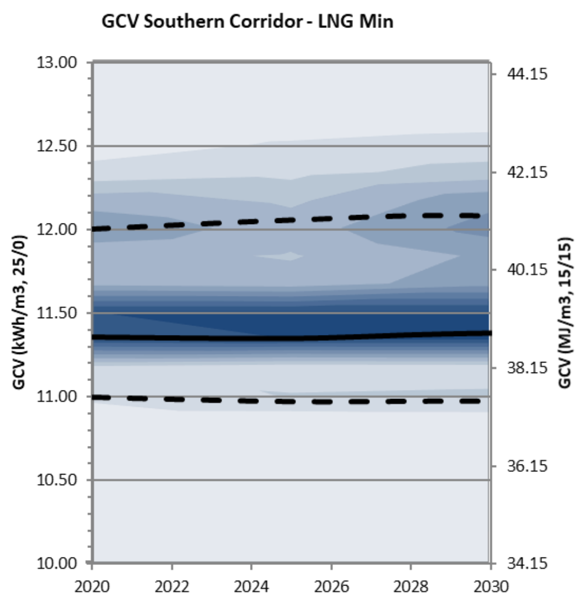
3.8. Southern Corridor: IT, AT, SI, SK, HU, HR, RO, BG, GR





The WI depends only slightly on price configurations. Over time, especially increasing contributions of LNG and NP widen the expected WI range The GCV range shows little sensitivity to scenarios and time.



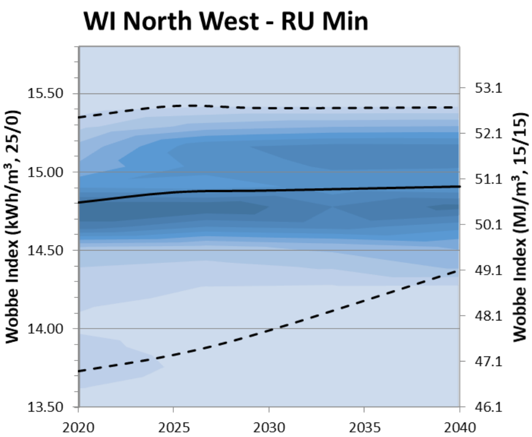


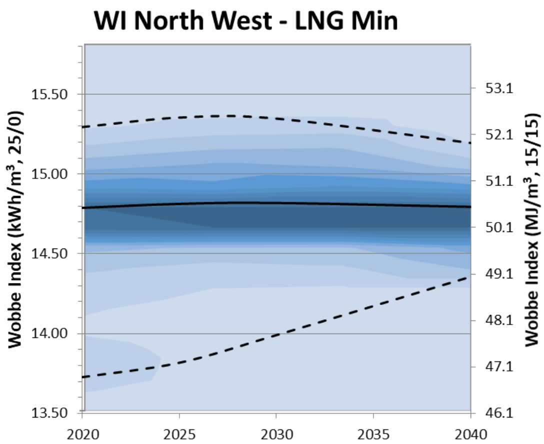
4. Hydrogen showcase: North-West region 2040

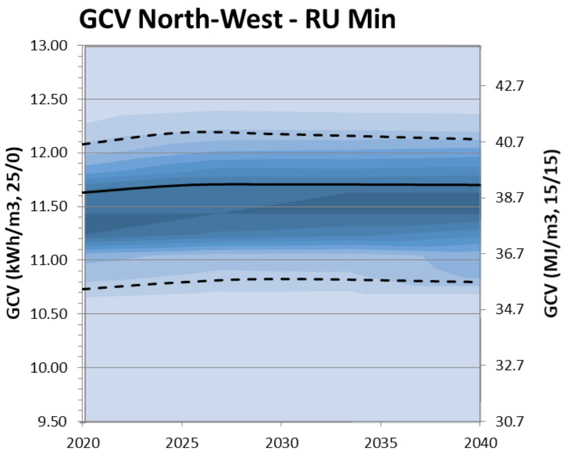
In this section the influence of different hydrogen volume fractions (i.e., 2%vol., 5%vol., 10%vol., 15%vol., 20%vol.) on WI and GCV ranges on the North-West region is presented. The method and assumptions are presented in section 2.2. The data used for this showcase is based on TYNDP data which contains ENTSOG's own assumptions and analysis based upon this information. However, the different hydrogen volumes used for the showcase have been carefully chosen to provide a greater overview of how different hydrogen concentrations could influence gas quality parameters in the next decades.

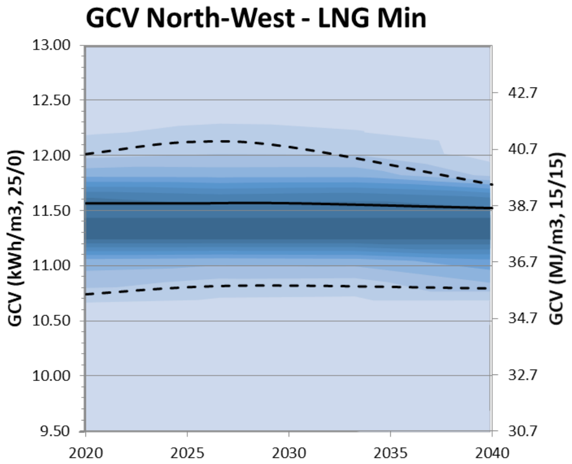
In general terms, both parameters seem to follow the trend of the non-blended case. For 2% vol., 5% vol., and 10% vol. of hydrogen, the outlook remains comparable with the ranges observed until 2030 in the previous sections, although impact on GCV is more noticeable. different price configurations appear to have little effects on the WI and GCV ranges' statistical distribution.

After 2030, hydrogen appears to drive WI values down, although the overall range remaining similar due to the declining role of local conventional sources. Simulations results show a noticeable decrease in WI and GCV ranges in 2040 for hydrogen concentrations above 15% vol. Yet, the effect on GCV is projected to be far more remarkable.

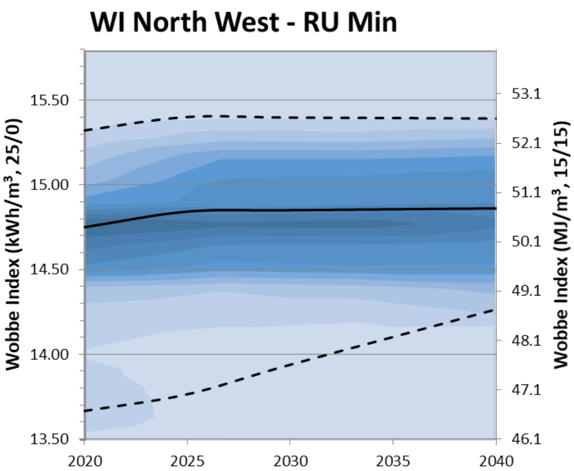


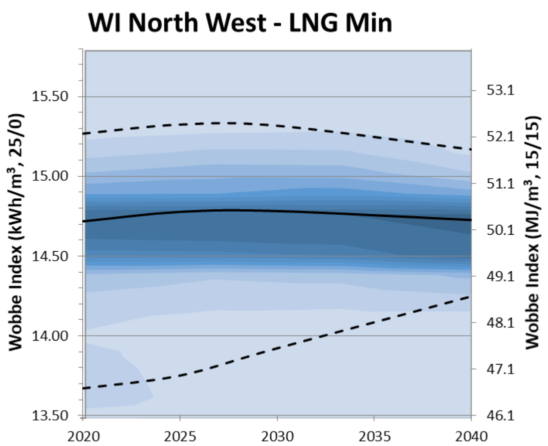


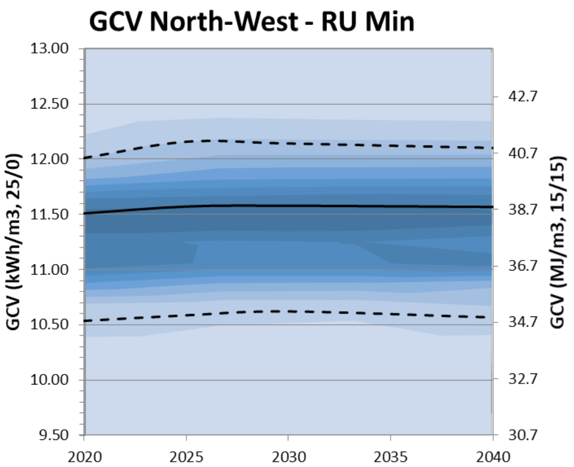


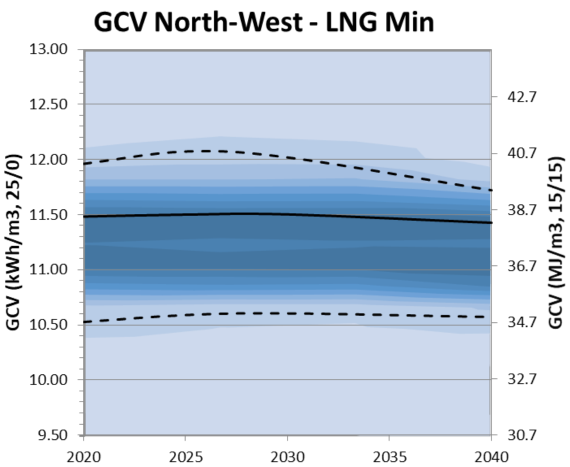


4.1. Influence of 5% vol. hydrogen on WI and GCV

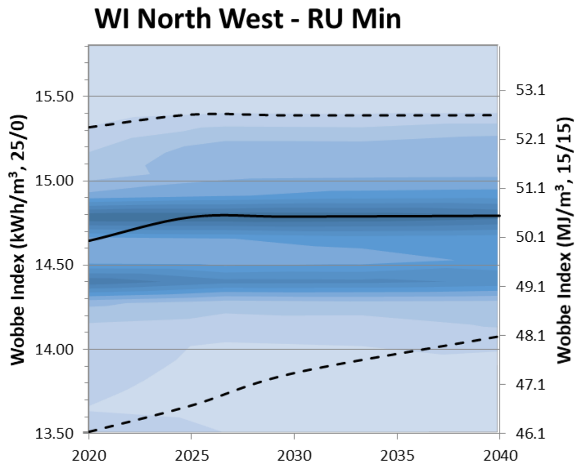


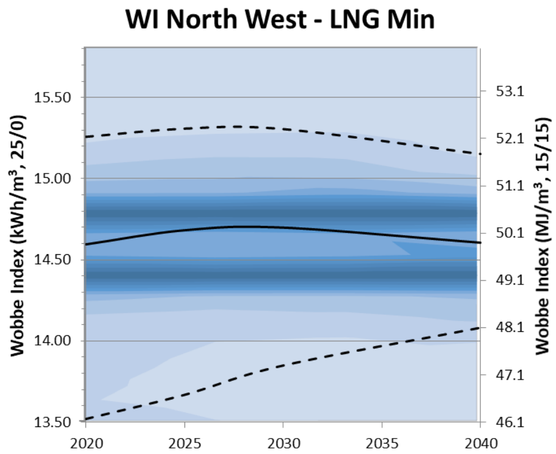


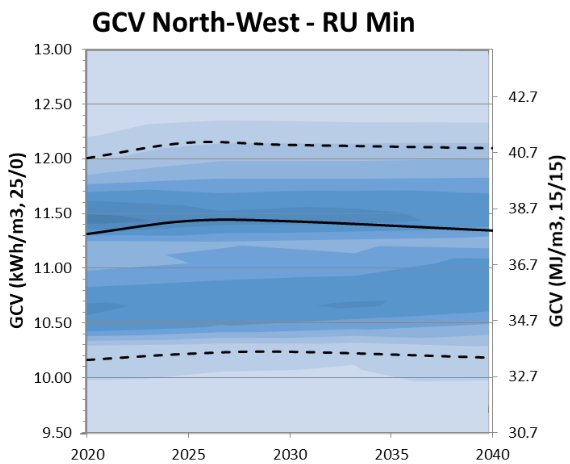


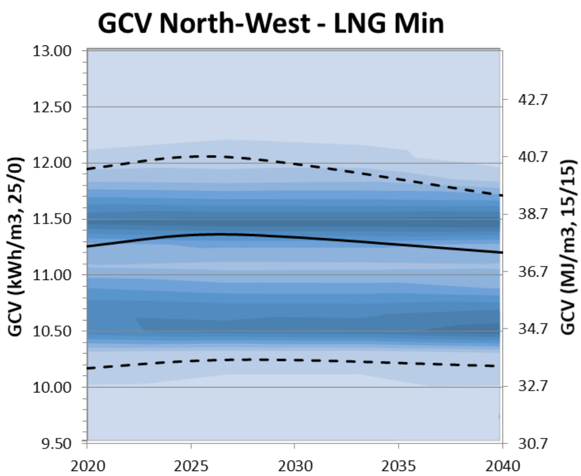


4.2. Influence of 10% vol. hydrogen on WI and GCV

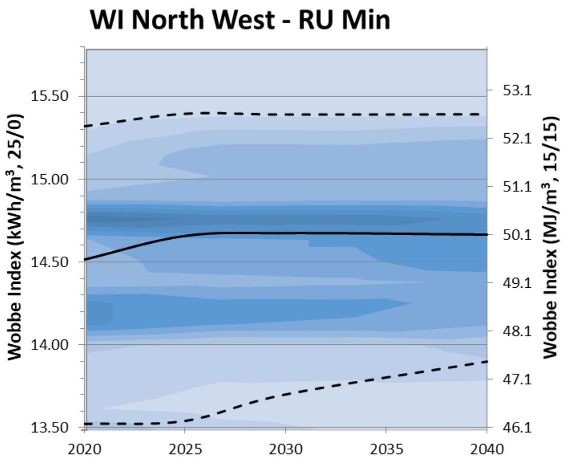


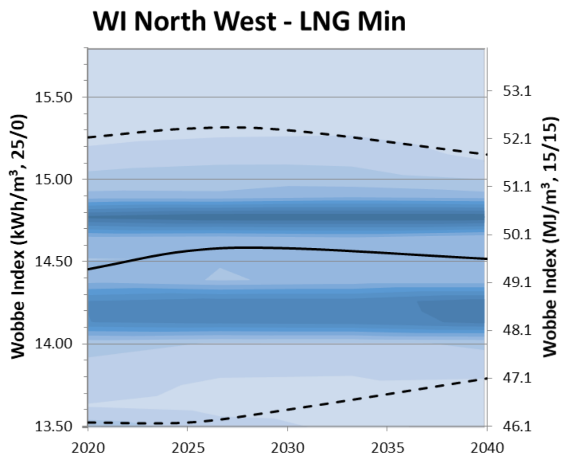


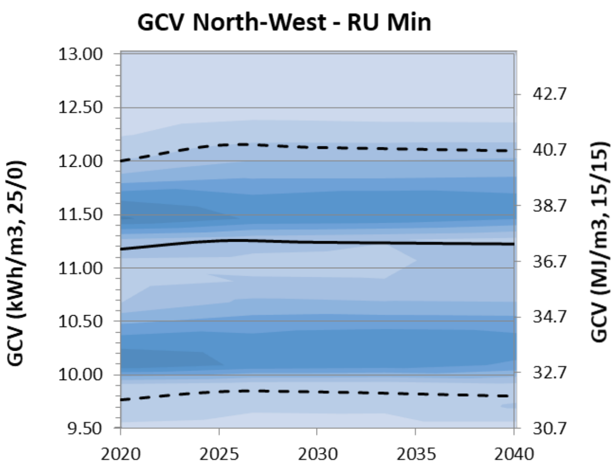


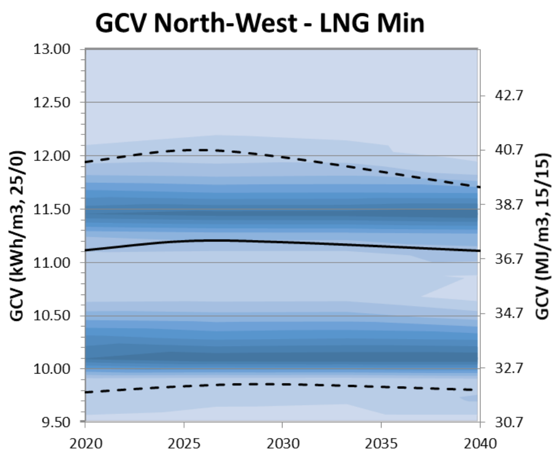


4.3. Influence of 15% vol. hydrogen on WI and GCV

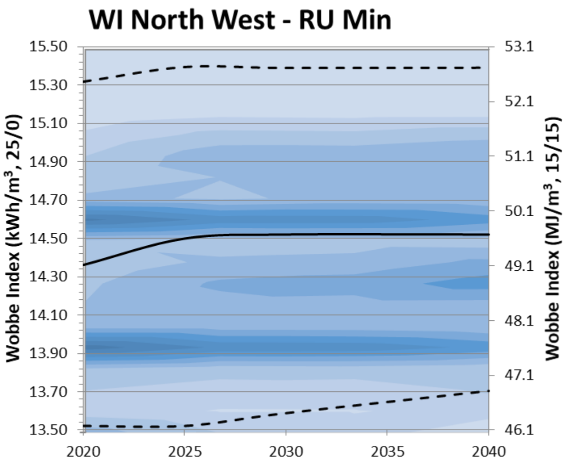


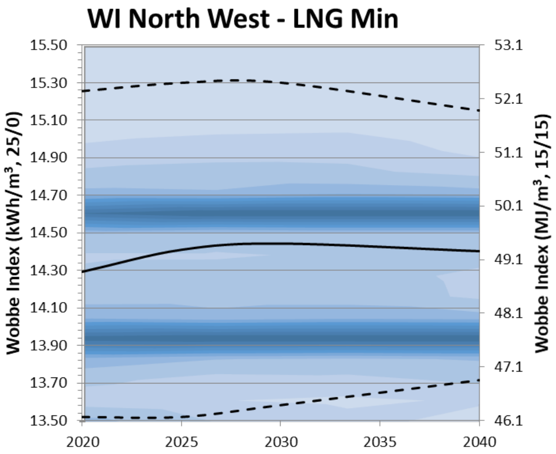


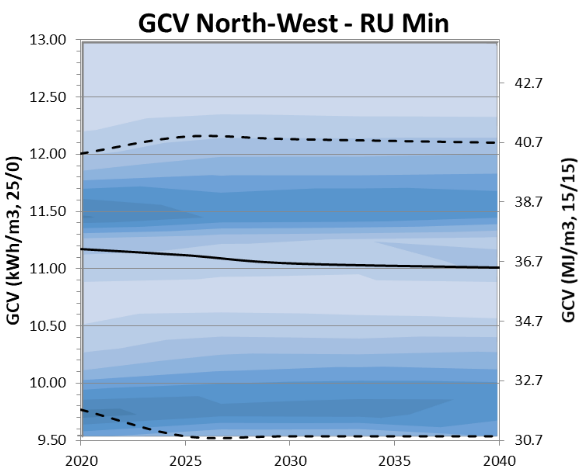


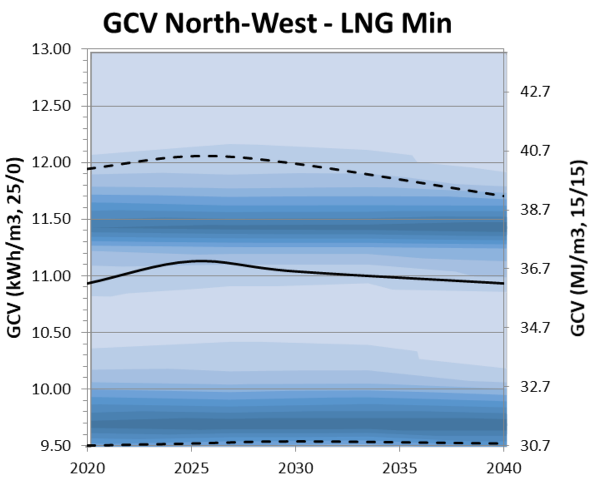


4.4. Influence of 20% vol. hydrogen on WI and GCV









List of abbreviations

- **ENTSOG** European Network of Transmission System Operators for Gas
- **EU** European Union
- **GCV** Gross Calorific Value
- **GRIP** Gas Regional Investment Plan
- **GQO** Gas Quality Outlook
- **H2** Hydrogen
- **H-gas** High calorific gas
- **INT NC** Interoperability and Data Exchange Network Code
- **L-gas** Low calorific gas
- **LNG** Liquefied Natural Gas
- **MWh** Megawatt hour
- **NECP** National Energy and Climate Plan
- **NeMo** Network Modelling
- **NP** National Production
- **PCI** Project of Common Interest
- **P2G** Power-to-Gas
- **REG-703** REGULATION (EU) 2015 / 703 of 30 April 2015 establishing a network code on interoperability and data exchange rules
- **TSO** Transmission System Operator
- **TYNDP** Ten-Year Network Development Plan
- **Vol.** Volume
- **WI** Wobbe Index

Country codes (ISO)

- AL Albania
- AT Austria
- AZ Azerbaijan
- BA Bosnia and Herzegovina
- BE Belgium
- BG Bulgaria
- BY Belarus
- CH Switzerland
- CY Cyprus
- CZ Czech Republic
- DE Germany
- DK Denmark
- DZ Algeria
- EE Estonia
- ES Spain
- FI Finland
- FR France
- GR Greece
- HR Croatia
- HU Hungary
- IE Ireland
- IT Italy
- LT Lithuania
- LU Luxembourg
- LV Latvia
- LY Libya
- MA Morocco
- ME Montenegro
- MK Macedonia
- MT Malta
- NL The Netherlands
- NO Norway
- PL Poland
- PT Portugal
- RO Romania
- RS Serbia
- RU Russia

- SE Sweden
- SI Slovenia
- SK Slovakia
- TM Turkmenistan
- TN Tunisia
- TR Turkey
- UA Ukraine
- UK United Kingdom

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