TEN-YEAR NETWORK DEVELOPMENT PLAN

2018

ANNEX – GAS QUALITY OUTLOOK

TABLE OF CONTENT

1 INTRODUCTION

Article 18 of the network code on interoperability and data exchange rules (Commission regulation EU 2015/703) requires ENTSOG to publish, alongside 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 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.

TYNDP 2018 is the second edition incorporating the Gas Quality Outlook. One of the main improvements is the inclusion of biomethane and hydrogen in the GQO. Additionally, a section is included about the influence of hydrogen on GCV and WI.

This report provides initial assessments only of the possible quantities of renewable and decarbonised gases. 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 2018, the TYNDP 2018 EUCO 2030 scenario is used as reference for 2030. No hydrogen is included in the EUCO 2030 scenario. For the sensitivity of hydrogen, the Sustainable transition and the Global Climate Action were used for 2030 and 2040 respectively.

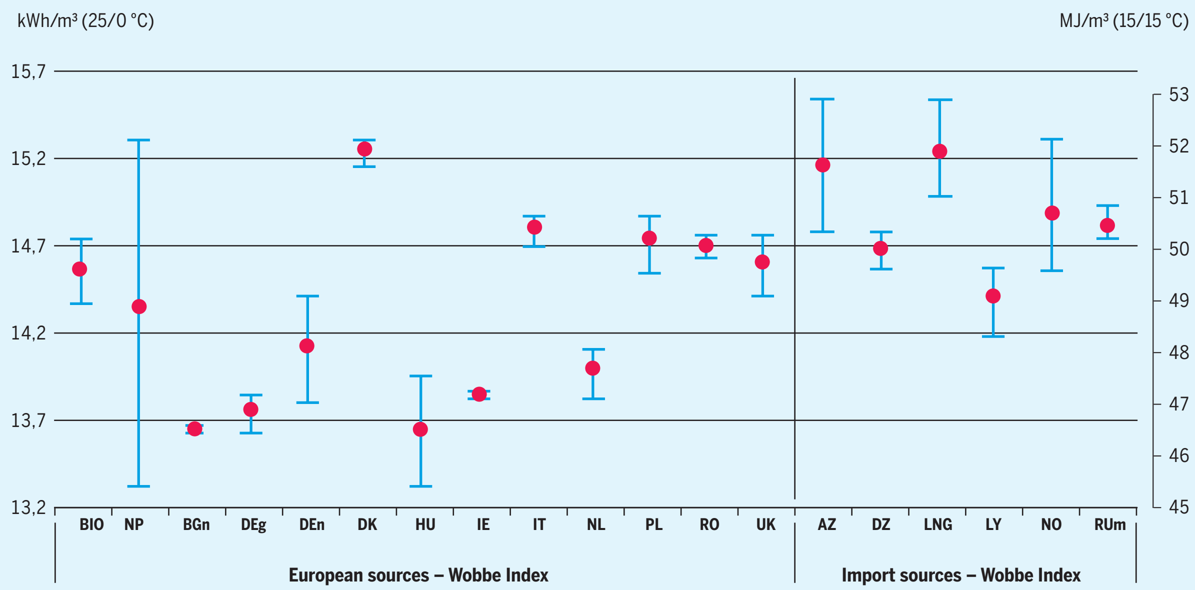
The supply corridors/regions are defined as the GRIPs. Considering the on-going discussions in the UK about a potential opening of the gas quality specifications, UK and IE are not split anymore from the North-West region. This means that re-gasified LNG ranges are assumed to be comparable with those found in the rest of Europe. This has the additional advantage of strengthening the forecast for the North-West region after combining more countries into a single region.

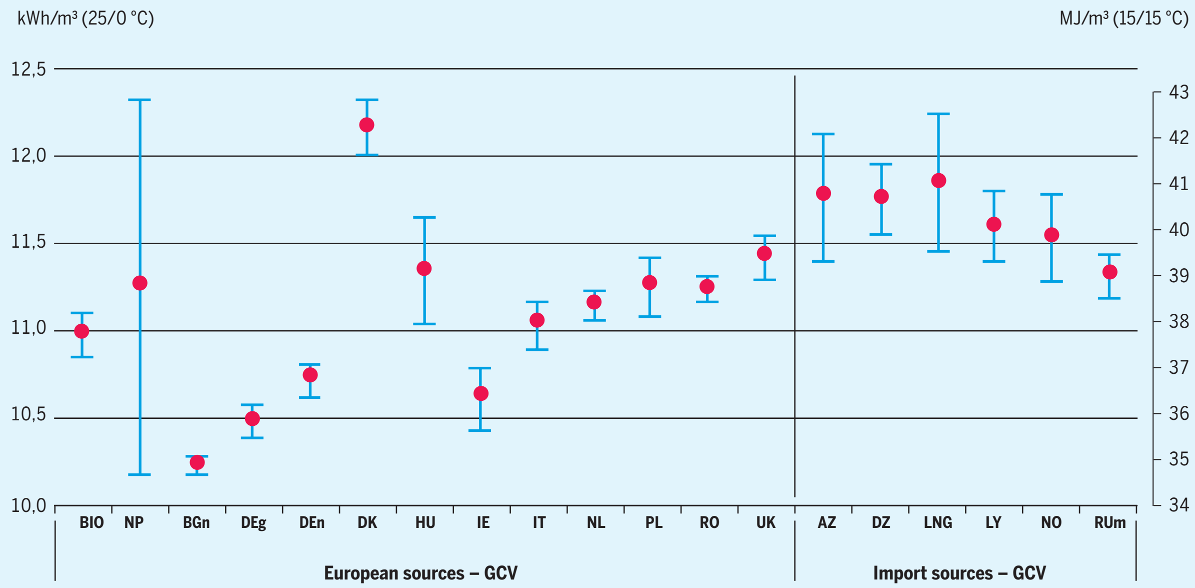
The underlying mathematical model is built on the following assumptions:

- 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 taken into account 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, with the exception of biometane.
- In the cases where no WI data were available, the statistical parameters are inferred from the respective GCV data (e. g. for RO).
- For those countries not listed in the input data section, a generic probability distribution (NP) has been assumed. 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 TYNDP 2018, 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

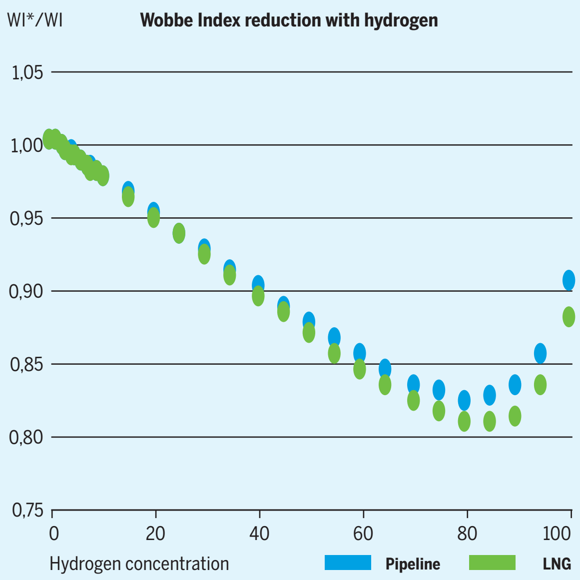


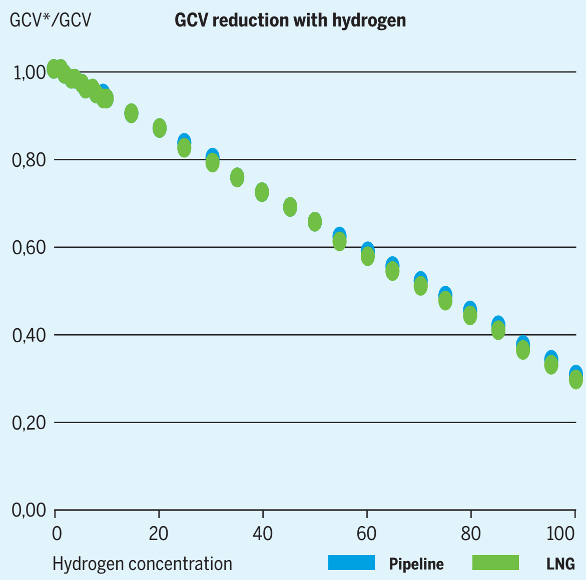


2.2 HYDROGEN INFLUENCE

Hydrogen is already being injected into the gas grid in small amounts today and are projected to increase significantly in the long term. The impact on Wobbe Index and Gross Calorific value is well known and documented by different studies[1].

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





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

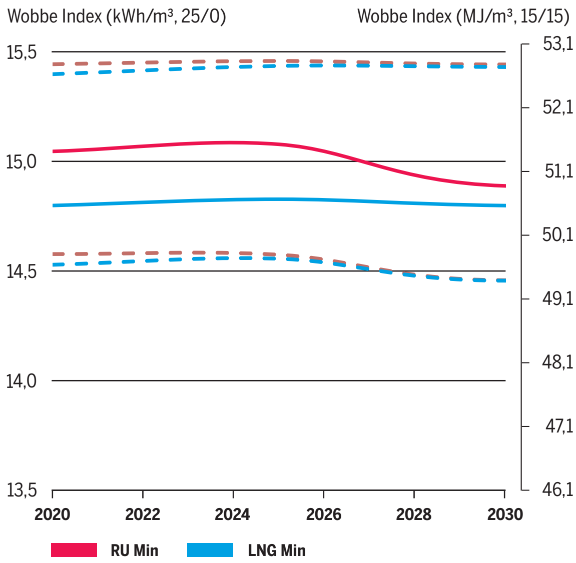
3.1 WOBBE INDEX OVERVIEW

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. However, within one region, ranges may actually differ depending on the influence of different sources:

1) Marcogaz presentation on Hydrogen

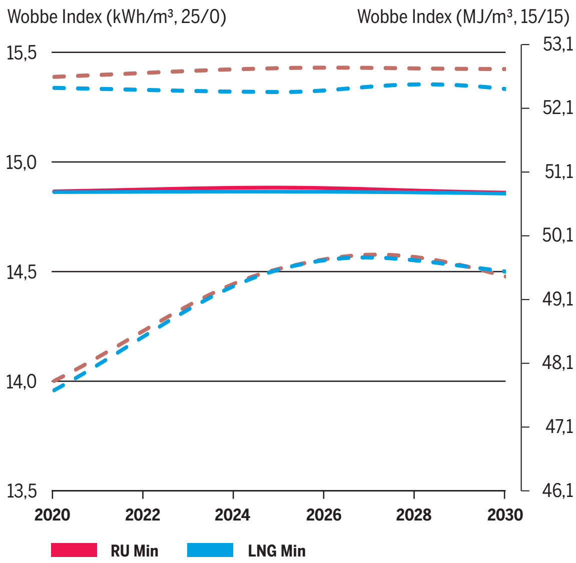
LNG rising the higher limit and indigenous production the lower. Except for the South region, which might stay within relatively narrower ranges, all regions are likely to experience a wide variety of WI values.

SOUTH WI

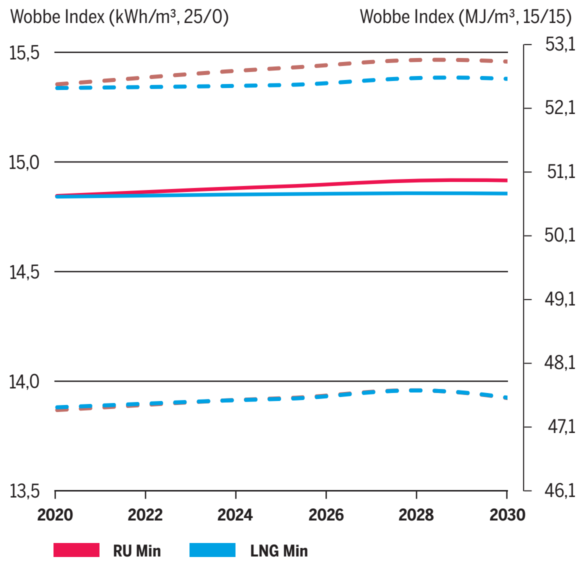


SOUTH-NORTH WI

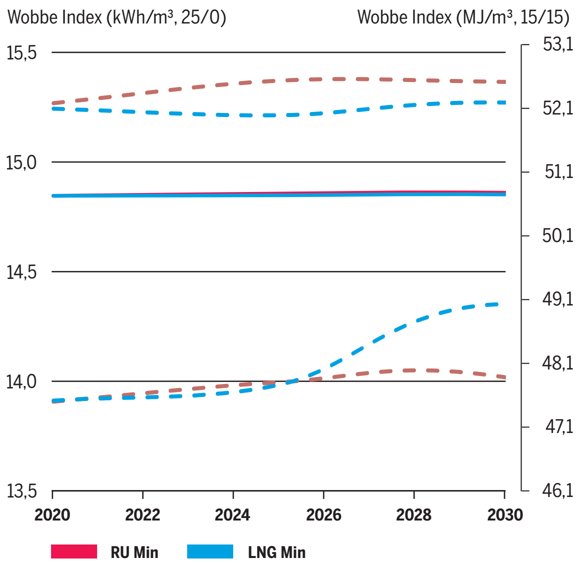
BEMIP WI



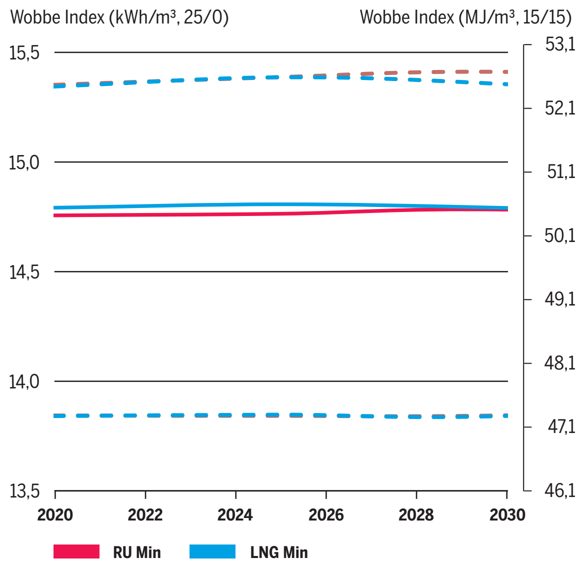
NORTH-WEST WI



NORTH-SOUTH CEE WI



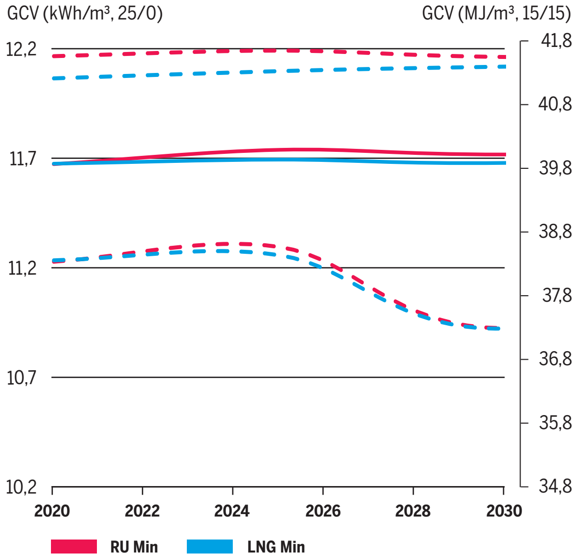
SOUTH CORRIDOR WI



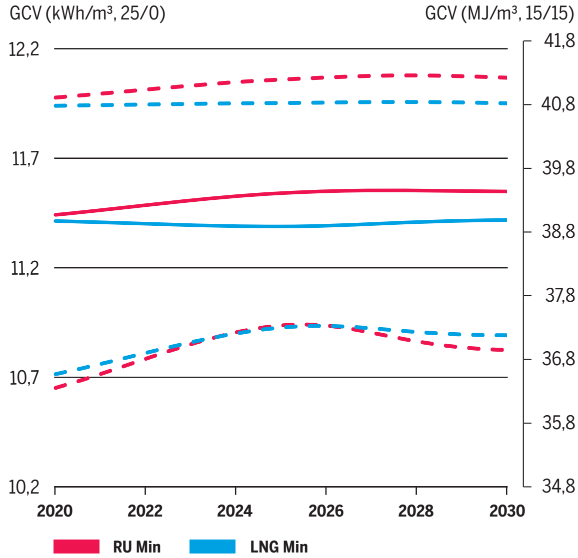
3.2 GCV OVERVIEW

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

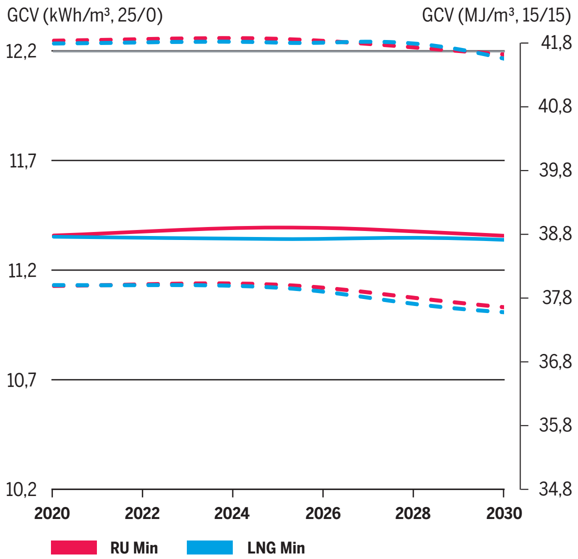
SOUTH GCV



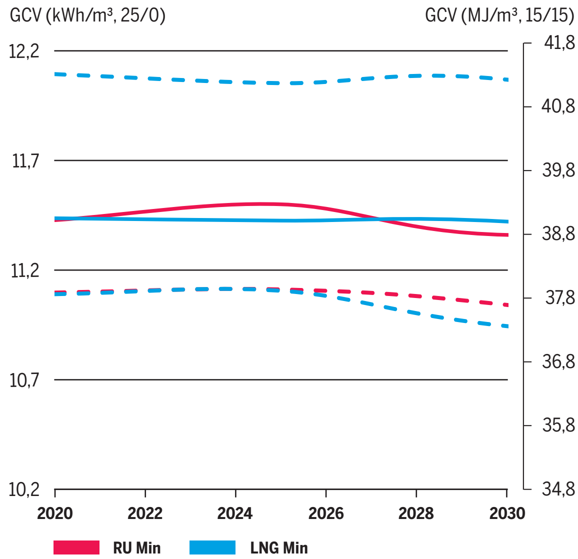
SOUTH-NORTH GCV



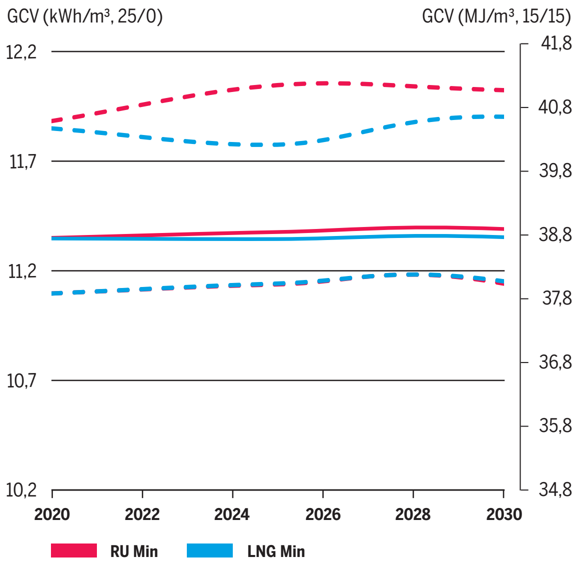
BEMIP GCV



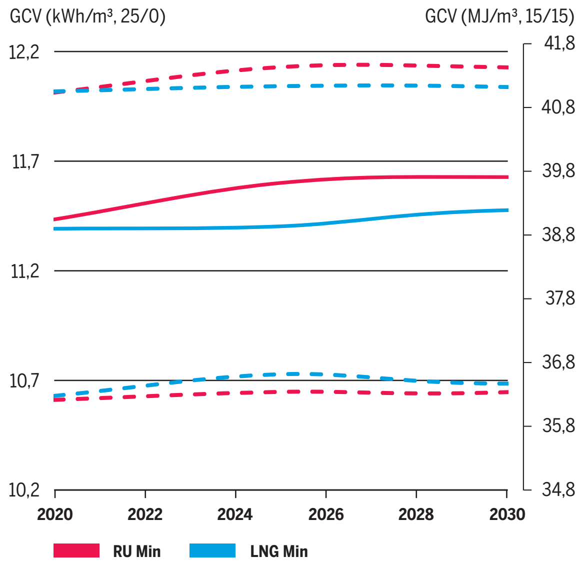
NORTH-WEST GCV



NORTH-SOUTH CEE GCV

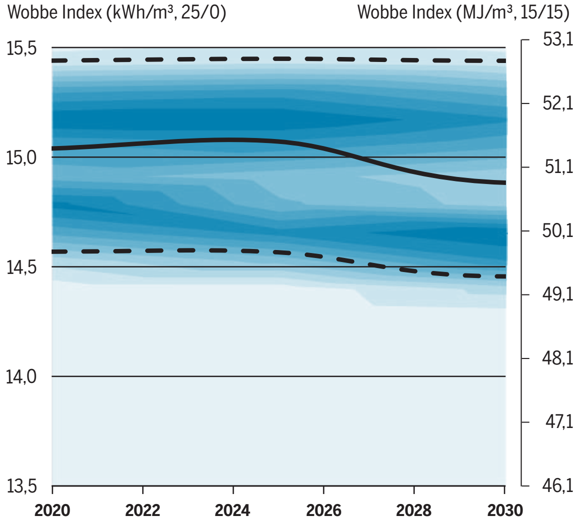


SOUTH CORRIDOR GCV

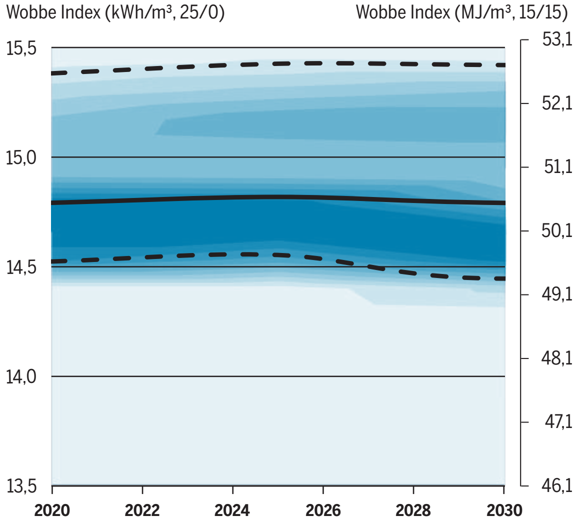


3.3 SOUTH REGION: ES, FR, PT

SOUTH WI – RU MIN

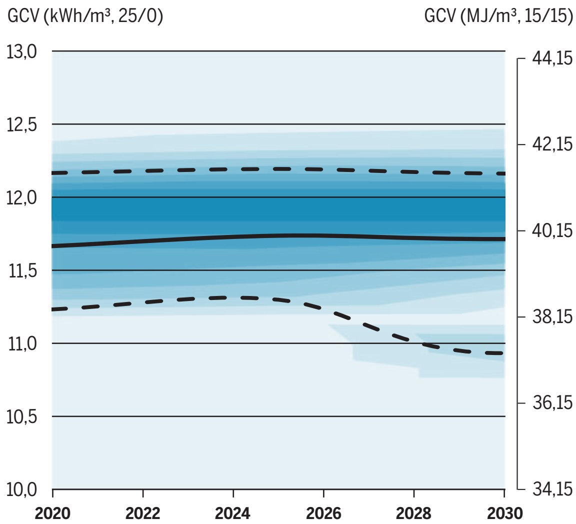


SOUTH WI – LNG MIN

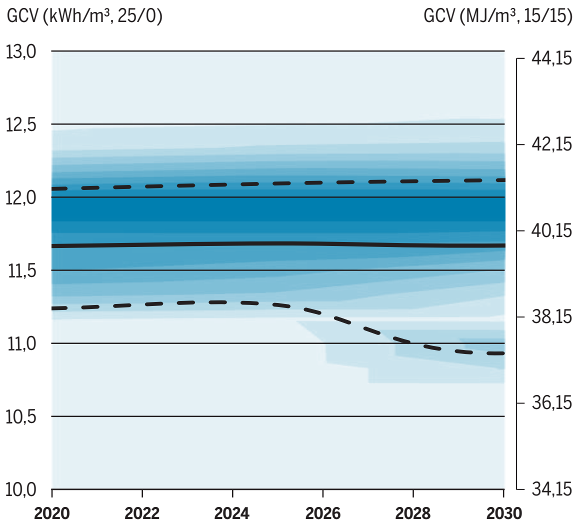


Gas quality ranges in this region present a rather stable outlook. Different price configurations appear to have significant effects on the WI ranges statistical distribution. Biomethane take-up at the end of the period is projected to widen GCV ranges.

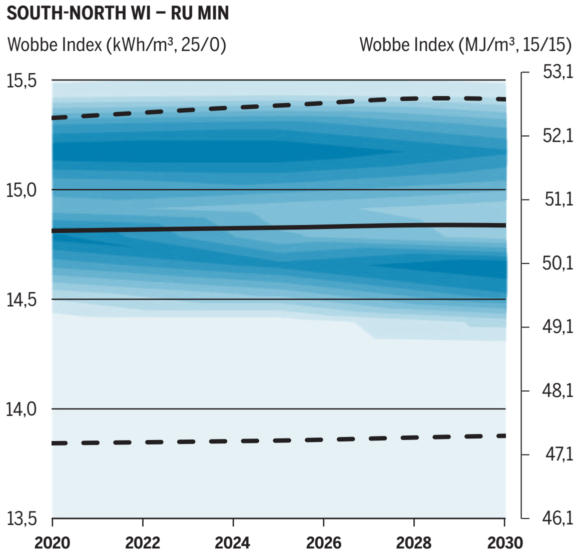
SOUTH GCV – RU MIN

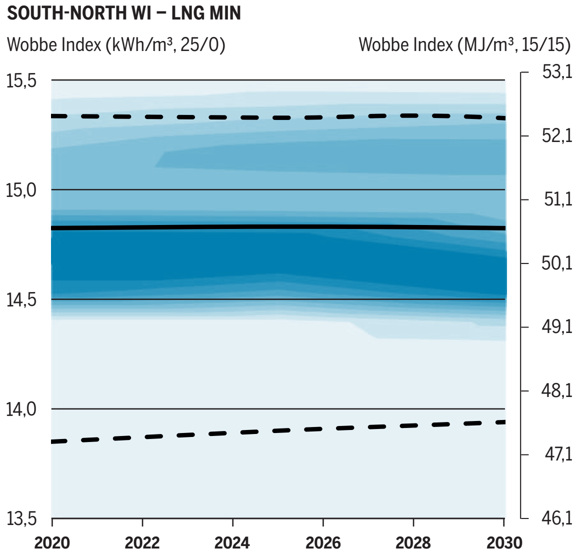


SOUTH GCV – LNG MIN

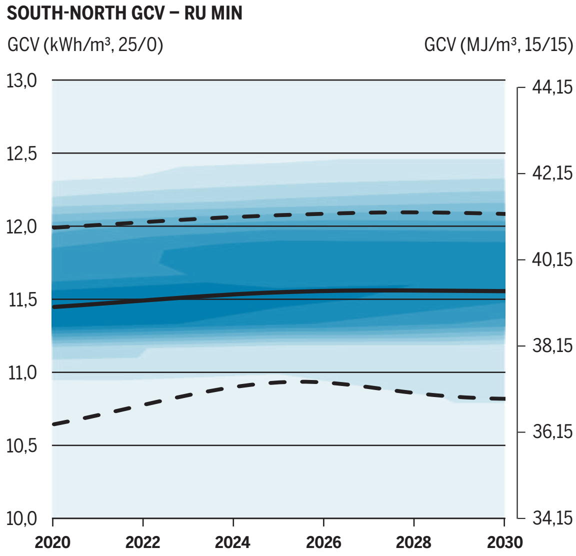


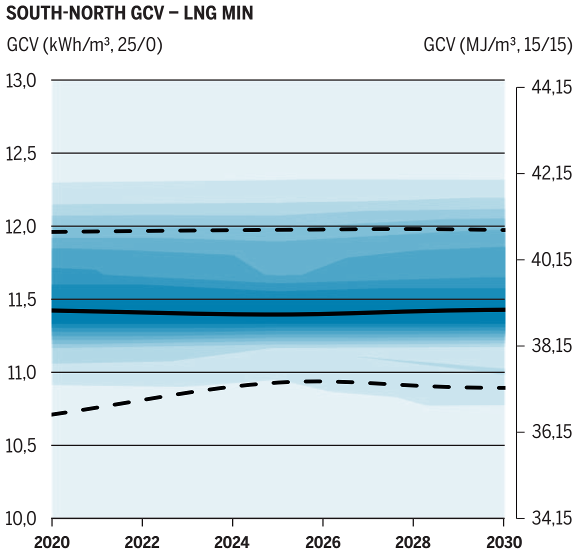
3.4 SOUTH-NORTH REGION: BE, CH, DE, FR, LU, IT





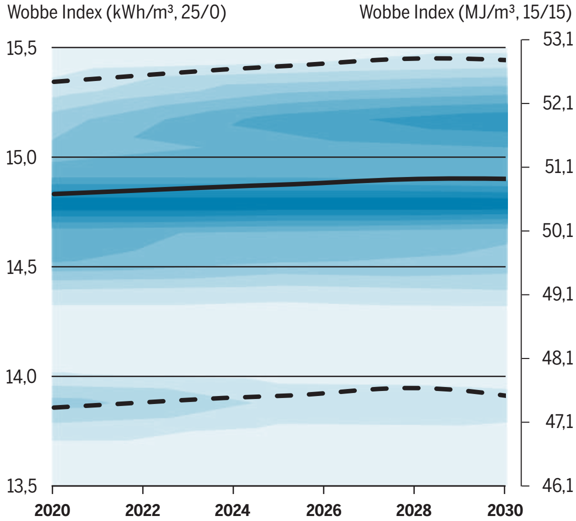
While overall ranges remain stable, WI statistical distribution seems to be more diverse in scenarios with less Russian gas and stronger presence of LNG and local sources. GCV ranges show less sensitivity to scenarios and time.



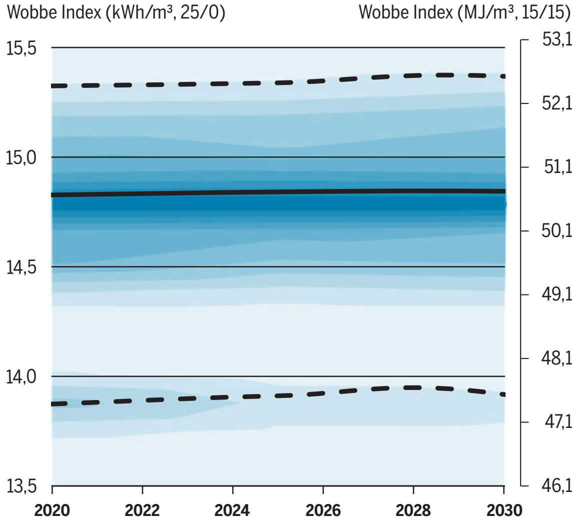


3.5 NORTH-WEST REGION: SE, DK, DE, NL, BE, LU, FR, UK, IE

NORTH-WEST WI – RU MIN

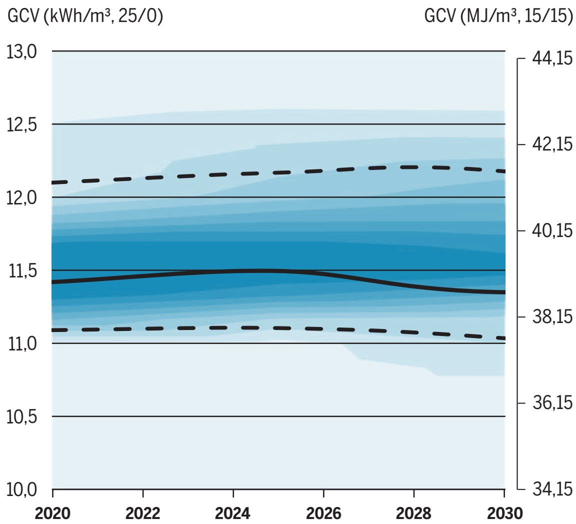


NORTH-WEST WI – LNG MIN

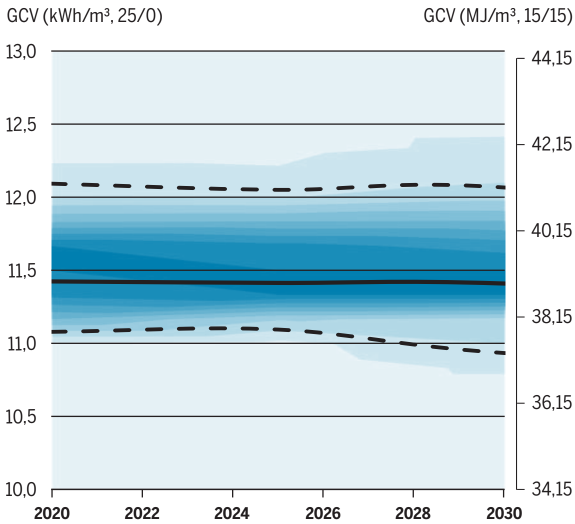


Modelling shows that WI ranges in the region tend to remain stable and determined by LNG and indigenous production. Probability distributions are projected to vary depending on the correlation of forces between supply corridors. GCV ranges tend to widen led by the increasing share of biomethane.

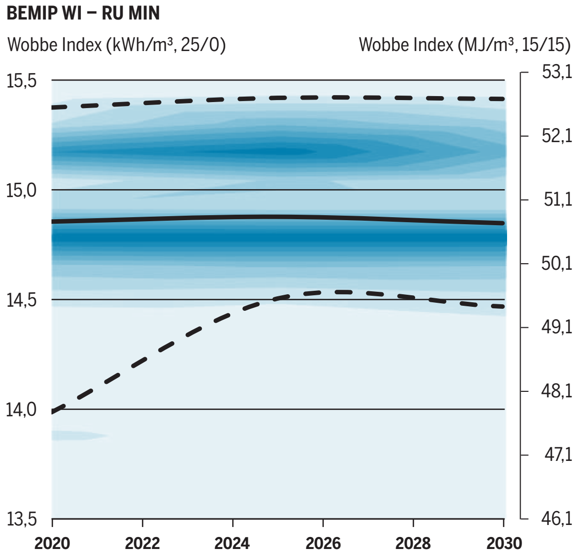
NORTH-WEST GCV – RU MIN

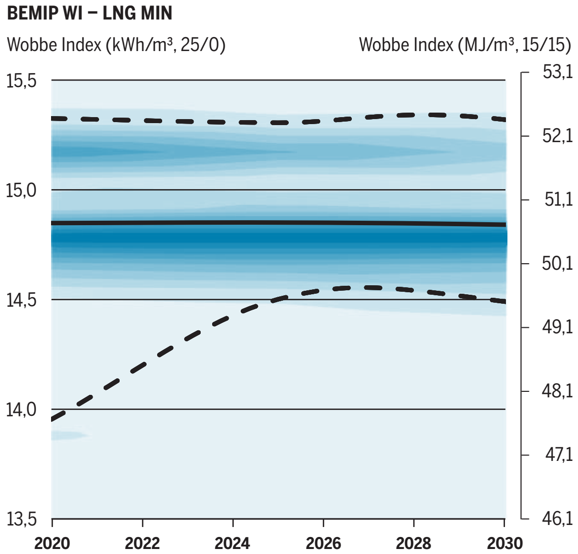


NORTH-WEST GCV – LNG MIN

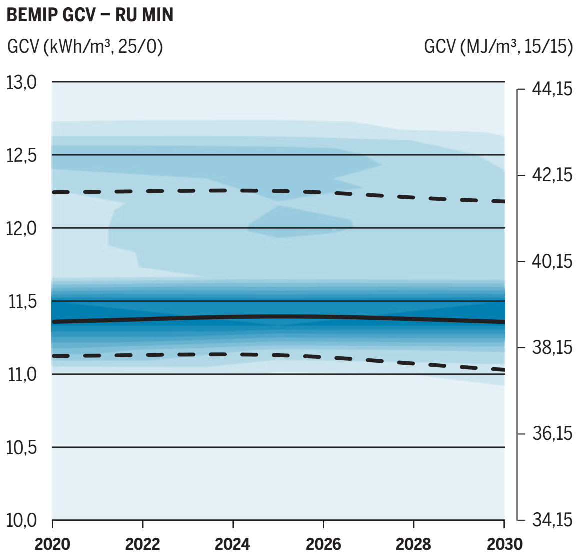


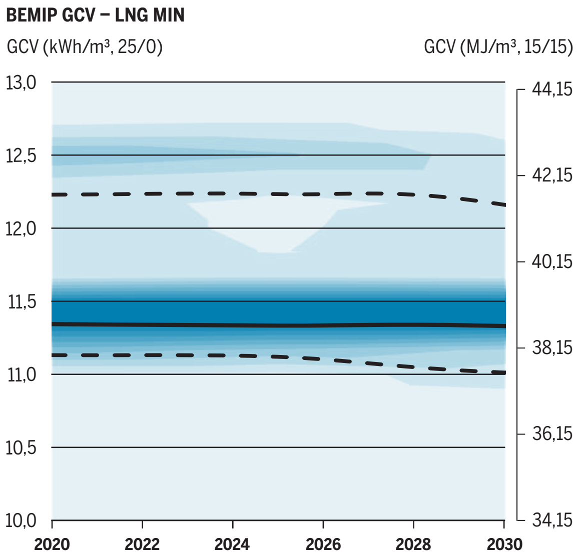
3.6 BEMIP REGION: DK, SE, FI, PL EE, LT, LV



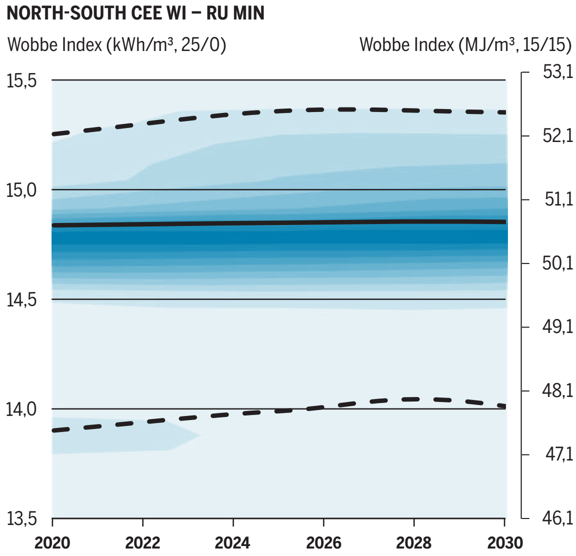


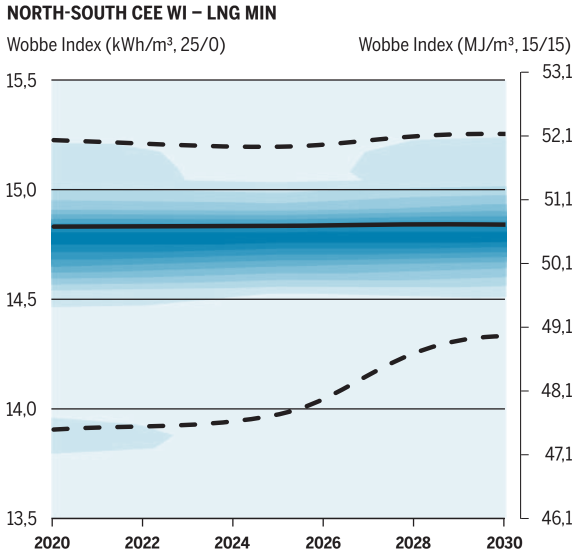
WI ranges in the BEMIP region tend to concentrate around main supply sources (LNG and Russian gas). However, local production is projected to make the overall range still quite wide. As for GCV, there is a slight trend to widen the range depending on the biomethane share.



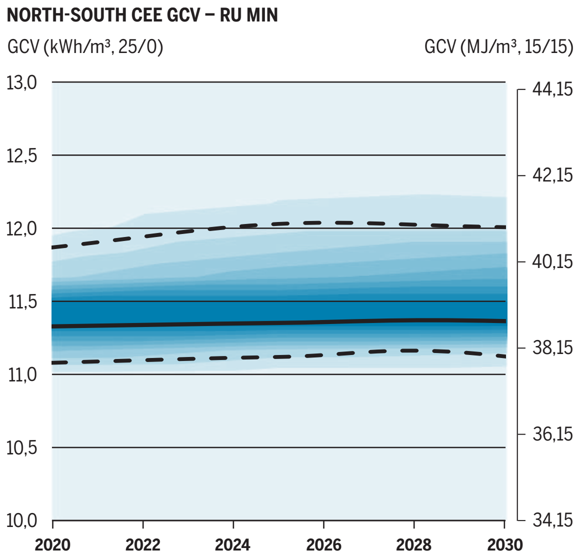


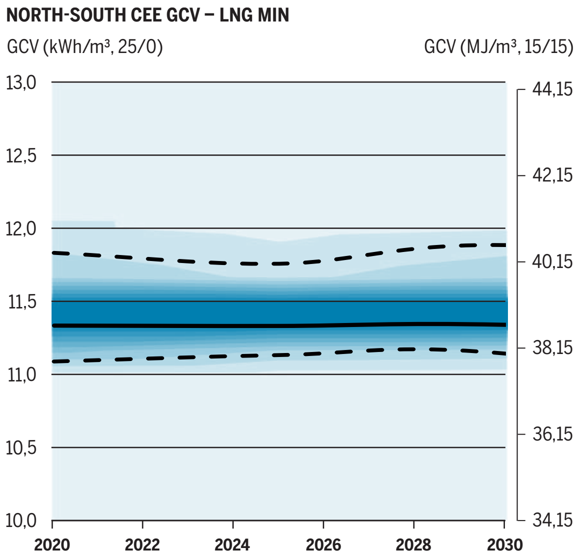
3.7 NORTH-SOUTH CEE: DE, PL, CZ, SK, AT, HU, HR, RO, BG



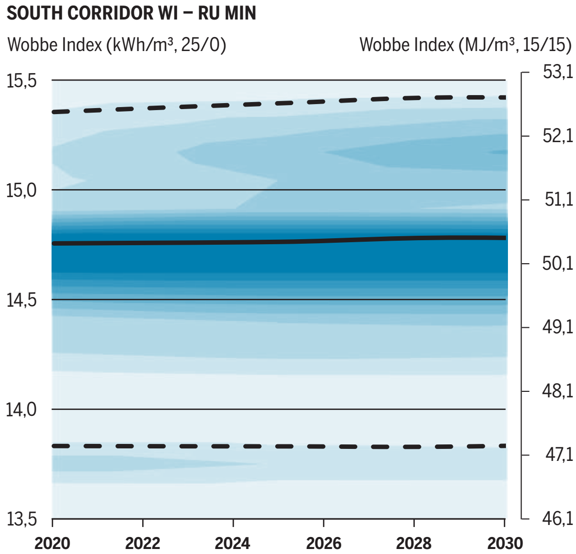


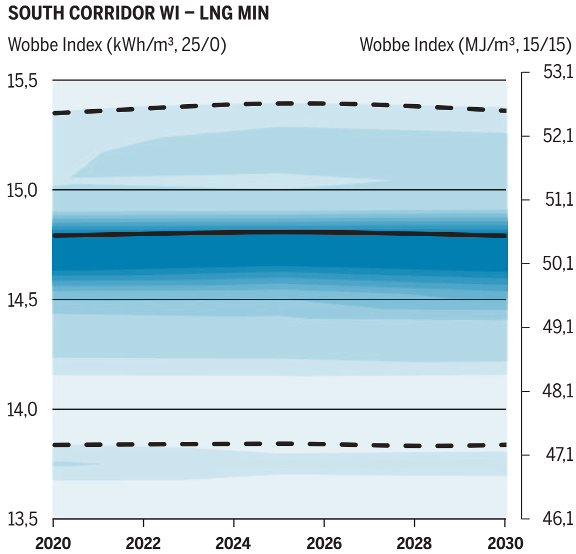
WI ranges may vary significantly in scenarios with lower LNG penetration due to the higher contribution of indigenous production, which may drive values down.



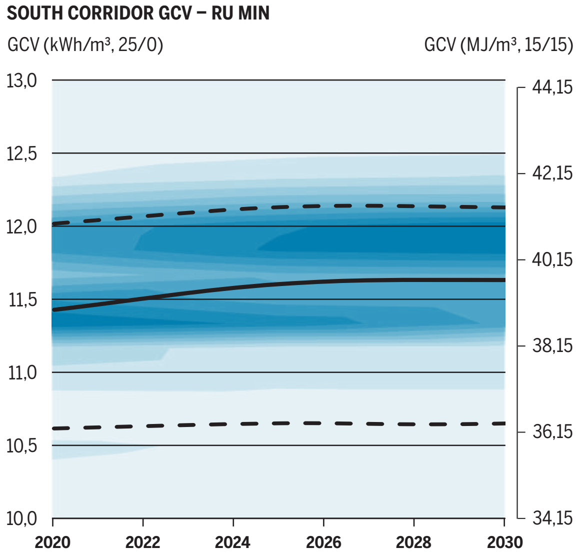


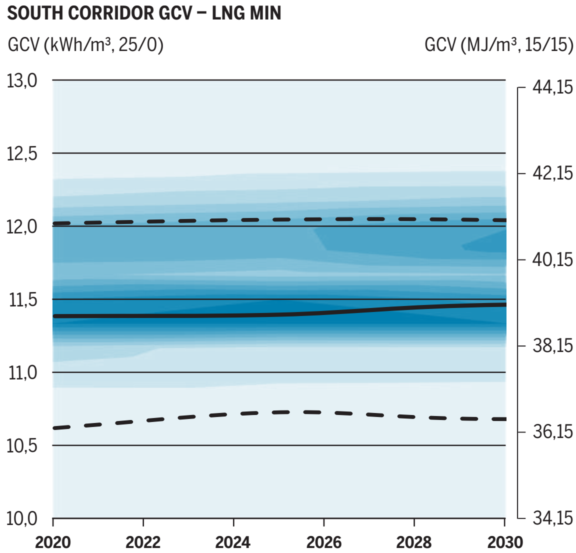
3.8 SOUTH-CORRIDOR: IT, AT, SI, SK, HU, HR, RO, BG, GR





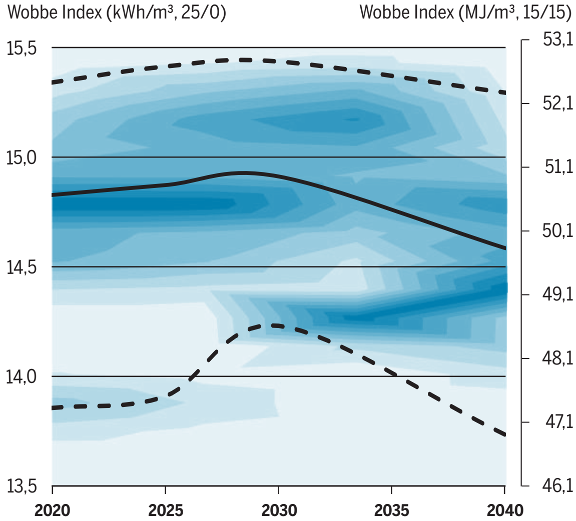
WI and GCV ranges are projected not to vary over time and the probability distribution depends only slightly on price configurations and time, with an increasing contribution of LNG over the years. The presence of significant indigenous production, especially in the short term, keeps ranges wide both for WI and GCV.



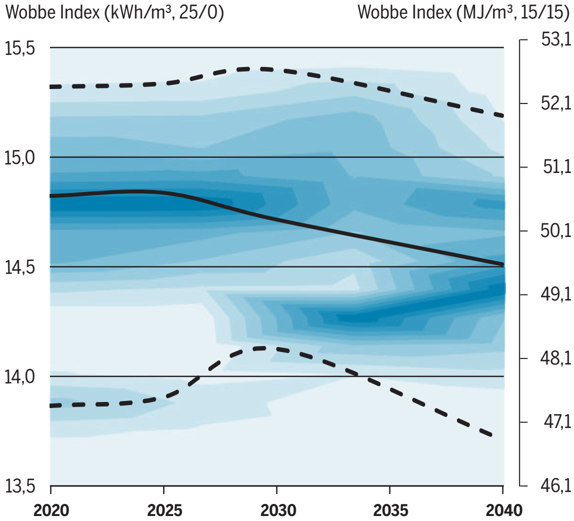


3.9 HYDROGEN: NORTH-WEST REGION 2040

NORTH-WEST HYDROGEN WI – RU MIN

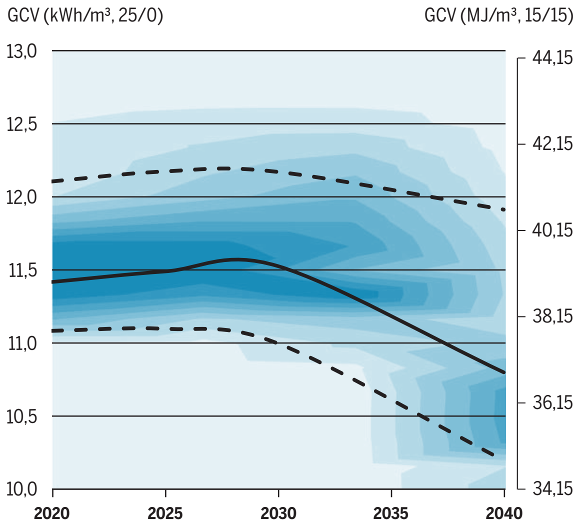


NORTH-WEST HYDROGEN WI – LNG MIN

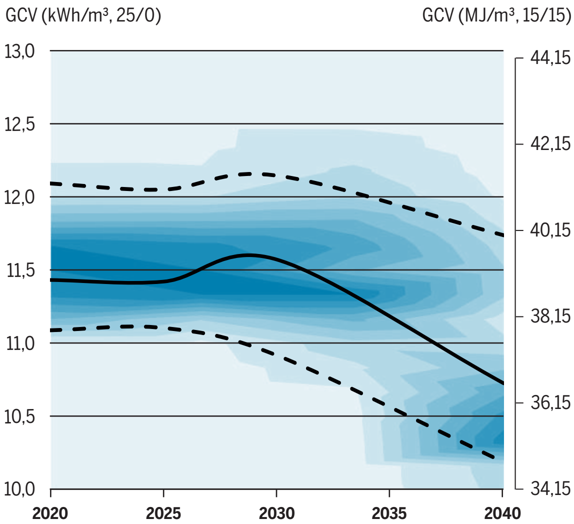


This sensitivity shows the influence of hydrogen for the scenario-region combination showing the highest hydrogen share in 2040. Until 2030, the outlook remains comparable with the ranges observed in the previous pages. Afterwards, hydrogen appears to drive WI values down, the overall range remaining similar due to the declining role of local conventional sources. The effect on GCV is projected to be far more noticeable. At the end of the period the share of hydrogen in this region is projected to be around 7 % volume.

NORTH-WEST HYDROGEN GCV – RU MIN



NORTH-WEST HYDROGEN GCV – LNG MIN



The hydrogen share in volume has been derived from the P2G share in the TYNDP 2018 Scenario 'Global Climate Action'. However, this P2G share might not, as expressed by some stakeholders, fully explore the P2G potential.

In addition, the potential of hydrogen production from methane reforming or pyrolysis has not yet been taken into account. As stated in the TYNDP 2018 Scenario report, the ENTSOs in next editions of Scenarios will seek to widen the range of consulted stakeholders and may look to provide assumptions on other sectors than power and gas.

Therefore, it should be emphasized that the indicated hydrogen share is based on a limited scope and that work is on-going to aim for more ambitious targets for exploiting the full potential for hydrogen in the European energy future.

LIST OF **ABBREVIATIONS**

ACER	Agency for the Cooperation of Energy Regulators
Bcm/Bcma	Billion cubic meters/Billion cubic meters per annum
CAM NC	Capacity Allocation Mechanism Network Code
CAPEX	Capital expenditure
CBA	Cost-Benefit Analysis
CIS	Commonwealth of Independent States
DIR-73	Directive 2009/73/EC of the European Parliament and of the Council of 13 July 2009 concerning common rules for the internal market in natural gas and repealing Directive 2003/55/EC.
EBP	European Border Price
EC	European Commission
EIA	Energy Information Administration
ENTSO-E	European Network of Transmission System Operators for Electricity
ENTSOG	European Network of Transmission System Operators for Gas
ETS	European Trading Scheme
EU	European Union
FEED	Front End Engineering Design
FID	Final Investment Decision
GCV	Gross Calorific Value
GIE	Gas Infrastructure Europe
GHG	Greenhouse Gases
GLE	Gas LNG Europe
GRIP	Gas Regional Investment Plan
GSE	Gas Storage Europe
GWh	Gigawatt hour
e-GWh	Gigawatt hour electrical
GQO	Gas Quality Outlook
HHI	Herfindahl-Hirschman-Index
H-gas	High calorific gas
HDV	Heavy duty vehicles
HGV	Heavy goods vehicles
IEA	International Energy Agency
IP	Interconnection Point
ktoe	A thousand tonnes of oil equivalent. Where gas demand figures have been calculated in TWh (based on GCV) from gas data expressed in ktoe, this was done on the basis of NCV and it was assumed that the NCV is 10 % less than GCV.
L-gas	Low calorific gas
LDV	Light Duty Vehicles
LNG	Liquefied Natural Gas

mcm	Million cubic meters
MMBTU	Million British Thermal Unit
MS	Member State
MTPA	Million Tonnes Per Annum
mtoe	A million tonnes of oil equivalents. Where gas demand figures have been calculated in TWh (based on GCV) from gas data expressed in mtoe, this was done on the basis of NCV and it was assumed that the NCV is 10 % less than GCV.
MWh	Megawatt hour
e-MWh	Megawatt hour electrical
NCV	Net Calorific Value
NERAP	National Energy Renewable Action Plans
OECD	Organisation for Economic Co-operation and Development
OPEC	Organization of the Petroleum Exporting Countries
OPEX	Operational expenditure
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
REG-347	Regulation (EU) No 347/2013 of the European Parliament and of the council of 17 April 2013 on guidelines for trans-European energy infrastructure and repealing Decision No 1364/2006/EC and amending Regulations (EC) No 713/2009, (EC) No 714/2009 and (EC) No 715/2009
REG-715	Regulation (EC) No 715/2009 of the European Parliament and of the Council of 13 July 2009 on conditions for access to the natural gas transmission networks.
REG-SoS	Regulation (EU) No 994/2010 of the European Parliament and of the Council of 20 October 2010 concerning measures to safeguard security of gas supply and repealing Council Directive 2004/67/EC.
RES	Renewable Energy Sources
SIF/SWF	Seasonal Injection Factor/Seasonal Withdrawal Factor
SoS	Security of Supply
Tcm	Tera cubic meter
TSO	Transmission System Operator
TWh	Terawatt hour
e-TWh	Terawatt hour electrical
TYNDP	Ten-Year Network Development Plan
UGS	Underground Gas Storage (facility)
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
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