

| Question  | Options for answer | Country: Spain  | Country: Germany  | Country: France                                    | Country: The Netherlands  | Country: Italy | Country: Belgium   | Country: Denmark  |
|---|--------------------|---|---|--|---|----------------|--|---|
| <b>Is it allowed to inject pure hydrogen into:</b>  |                    |   |   |  |   |                |  |   |
| - Distribution natural gas network?   | Yes/No             | NO  | YES   | NO   | YES   | NO             | NO   | YES   |
| - Transmission natural gas network?   | Yes/No             | NO  | YES   | NO   | YES [1]   | NO             | NO   | YES   |
| <b>If the answer is YES:</b><br>Name of regulation/standard/rule/specification (including publication date) for:                        |                    |   |   |  |   |                |  |   |
| - Distribution  |                    | -   | DVGW G262 ((technical rule on gas quality G260 refers to "renewable gas technical rule" G262) | -  | Regeling van de Minister van Economische Zaken van 11 juli 2014, nr. WJZ/13196684, tot vaststelling van regels voor de gaskwaliteit (Regeling gaskwaliteit  | -              | -  | [4] 8.1. Krav til brint, som tilsættes naturgasnettet   |
| - Transmission  |                    | -   |   | -  |   | -              | -  | -   |
| <b>If the answer is NO:</b><br>Is it forecast to review the current regulation to consider hydrogen injection into natural gas network? |                    |   |   |  |   |                |  |   |
|   | Yes/No/ Not known  | -   | -   | -  | YES<br>In explanatory notes of the current gas quality regulation this aspect is mentioned, however without mentioning any date.                            | Not known.     | NO   | -   |
| Comments/remarks to the injection of pure hydrogen into natural gas network:  |                    |   |   |  |   |                |  |   |
|   |                    | -   | -   | -  | A maximum value of 0.1 %mol for distribution and 0.02 %mol for transmission are specified in the current regulation.  | -              | The national TSO (Fluxys) takes part in a study project of P2G were injecting H2 in the natural gas grid could be one of the options investigated. | [5] The regulation referred below stipulates that <b>"the % Volume of H<sub>2</sub> that can be injected shall be acknowledged by the safety authorities"</b> . There is no value mentioned in the regulation |
| <b>Is it allowed to inject hydrogen/natural gas mixtures into:</b>  |                    |   |   |  |   |                |  |   |
| - Distribution natural gas network?   | Yes/No             | YES   | YES   | YES  | YES [2]   | YES            | No (limit 0.1 mol% H <sub>2</sub> )  | YES   |
| - Transmission natural gas network?   | Yes/No             | YES   | YES   | YES  | YES [3]   | YES            | No (limit 0.1 mol% H <sub>2</sub> )  | YES   |
| <b>If the answer is YES:</b><br>Name of regulation/standard/rule/specification (including date) for:                                    |                    |   |   |  |   |                |  |   |
| - Distribution  |                    | Norma de Gestión Técnica del Sistema. Protocolo de Detalle 1, NGTS PD-01 (Technical Management of the Gas System Regulations. Detail Protocol 1).<br>21st December 2012 | DVGW G262 ((technical rule on gas quality G260 refers to "renewable gas technical rule" G262) | French regulation (décret 2004-555 / 15 June 2004) | Regeling van de Minister van Economische Zaken van 11 juli 2014, nr. WJZ/13196684, tot vaststelling van regels voor de gaskwaliteit (Regeling gaskwaliteit) | -              | -  | [4] 8.1. Krav til brint, som tilsættes naturgasnettet   |
| - Transmission  |                    |   |   |  |   | -              | -  | -   |

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|--|---------------------|--|--|--|---|---|--|---|
| <b>If the answer is YES:</b><br>Maximum hydrogen concentration in the mixture for injection into the natural gas network:          | %mol / %vol / other |  |  |  |   |   |  |   |
| - Distribution   |                     |  |  |  | 0.1 %mol  |   | -  | The regulation referred below stipulates that <b>"the % Volume of H<sub>2</sub> that can be injected shall be acknowledged by the safety authorities"</b> . There is no value mentioned in the regulation   |
| - Transmission   |                     | 5 %mol   | See below  | 6 %mol in compliance with CV, Wobbe and density ranges   | 0.02 %mol   | 0.5 % mol   | -  |   |
| <b>If the answer is YES:</b><br>Is it compulsory/required to monitor hydrogen concentration mixture prior to injection point?      | Yes/No              | YES  | No, but for billing purposes it is required that hydrogen is either measured or less than 0.2% (technical PTB G14)   | No, it is the responsibility of the network operator to check the compliance of the gas with the legislation and its technical specifications, so each operator decides the parameter and the associated frequency of checking | Although not legally required, it will be part of the grid connection agreement between producer and TSO/DSO                  | -   | -  | -   |
| <b>If the answer is NO:</b><br>Is it forecast to review the current regulation to consider hydrogen/natural gas mixture injection? | Yes/No/ Not known   | Not known, although there could be an influence due to the current natural gas and biomethane quality harmonization process in progress. | Not known, but extensive research on hydrogen tolerance is in progress   | -  | In the explanatory notes of the current gas quality regulation this aspect is mentioned, however without mentioning any date. | -   | -  | This is a possibility that is under consideration within the gas industry and several investigations are presently on-going   |
| Comments/remarks to the hydrogen/natural gas mixture injection into natural gas network:   |                     | Hydrogen mixtures are considered as non-conventional gases in the regulation.  | There is not a clear limit value as such. An examination on a case-by-case basis is required. The technical rule G262 states that a concentration in a single digit percentage of hydrogen is uncritical in most cases if gas combustion parameters from DVGW 260 are met (Wobbe, CV). However, some restrictions are mentioned: a limit of 2 vol-% for tanks of CNG cars (DIN 51624), specified limits from gas turbines OEMs of 5 vol-% or even 1 vol%, porous underground storage. For the latter, no limit is specified but the injection of hydrogen into porous underground storage has to be minimized. | On-going French demonstration project (GRHYD) of H <sub>2</sub> injection in distribution grid and end-users.<br>On-going demonstration project of H <sub>2</sub> injection in transportation network and industrial users     | -   | For the time being, the only specification for the injection of a max quantity of 0.5 %mol of H <sub>2</sub> , is in a Technical report for the injection of biomethane in the grid (UNI TR 11537 of July 2014) | The project standard EN 16723-1 proposes a maximal H <sub>2</sub> -content of 2 mol%. If this standard is accepted, it will replace the Synergrid recommendation G5/42 | The regulation referred below stipulates that <b>"the % Volume of H<sub>2</sub> that can be injected shall be acknowledged by the safety authorities"</b> . There is no value mentioned in the regulation<br><br>H <sub>2</sub> requirement see [6] |

See NOTES on next page.

**NOTES:*****The Netherlands***

[1]: The TSO has legally the possibility to blend "off-spec" gases to bring them on specification (exit-specification in TSO network for hydrogen is limited to 0.02 %mol). The associated costs for this blending service needs to be paid for by the supplier. With the given value of 0.02 %mol, it is virtually impossible to accommodate pure hydrogen.

[2] Maximum allowable hydrogen concentration is limited to 0.1 %mol. With the given value of 0.1 %mol injection in the distribution grid is limited to hydrogen/natural gas mixtures containing maximum 0.1 %mol hydrogen.

[3]: The TSO has legally the possibility to blend "off-spec" gases to bring them on specification (exit-specification in TSO network for hydrogen is limited to 0.02 %mol). The associated costs for this blending service needs to be paid for by the supplier. With the given value of 0.02 %mol, it is virtually impossible to accommodate hydrogen/natural gas mixtures with a moderate to high hydrogen content.

***Denmark***

[4]: Gasreglementet afsnit C-12 Bestemmelser om gaskvaliteter. (14<sup>th</sup> December 2012): <http://www.sik.dk/Virksomhed/Gas-kloak-vand-og-afloeb-for-fagfolk/Love-og-regler-om-gas-og-vvs/Gasreglementet>

[5]: Requirements on H<sub>2</sub> for injection in the natural gas net: Same as below apart of: C<sub>n</sub>H<sub>m</sub> < 0,5 %vol (CH<sub>4</sub> equivalent); DP -50 °C at P<sub>atm</sub>.

[6]: There is presently the possibility to distribute hydrogen in the net for stationary fuel cells projects that requires the authorization of the safety authorities. For example there is such a project with H<sub>2</sub> distribution for a "fuel cell village" in DK. In this case there are specification for the Hydrogen distributed (see Gasreglementet afsnit C-12 Bestemmelser om gaskvaliteter. (14<sup>th</sup> December 2012): <http://www.sik.dk/Virksomhed/Gas-kloak-vand-og-afloeb-for-fagfolk/Love-og-regler-om-gas-og-vvs/Gasreglementet>.

The requirement on H<sub>2</sub> quality when used in H<sub>2</sub> net are: H<sub>2</sub> > 98 %vol; O<sub>2</sub> < 0,1 %vol; CO<sub>2</sub> < 0,1 %vol; C<sub>n</sub>H<sub>m</sub> < 50 ppm (CH<sub>4</sub> equivalent); DP -60 °C at P<sub>atm</sub>.