Hydrogen-readiness of engine power plants – A common definition

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Engine power plants support a reliable energy system by supplying flexible, dispatchable power and heat, complementing the variable generation from wind and sun. As the gas sector decarbonises, especially through the introduction of climate-neutral gases, engine power plants can provide climate-neutral energy.

Already today, most power plants are capable of handling a certain share of hydrogen blended into natural gas. Now, the power plant industry is optimising their technology for the use of hydrogen. Outlining the H2-readiness of future engine power plants will ensure that investments are future-proof and do not lead to carbon lock-in.

The purpose of this paper is to provide a common understanding of what "H2-readiness" means for new engine power plants. H2-readiness is defined by:

- **Percentage share (%) of hydrogen**[i]
- **Technical adaptions needed to reach the desired H2-readiness level in the future**

Level A **100% H2**[ii]	Level B **25% H2**[iii]	Level C **10% H2**[iii]
A1 no substantial modifications	**B1** no substantial modifications	**C1** no substantial modifications
A2 minor upgrading	**B2** minor upgrading	**C2** minor upgrading
A3 upgrading possible	**B3** upgrading possible	**C3** upgrading possible

- **No substantial modifications:** Limited modifications may be needed, with costs **up to 5%** of overall plant building costs.
- **Minor upgrading required:** Upgrade costs estimated to be **up to 10%** of overall plant building costs.
- **Upgrading technically and economically possible:** Technically suitable, upgrade costs estimated to be **up to 30%** of overall plant building costs.

Share (%) of Hydrogen

Hydrogen will remain a scarce resource over the next decade. It is likely that, in the near future, Europe will see a limited number of "hydrogen valleys" with a backbone grid connecting those valleys and large-scale generation facilities being built. The hydrogen valleys and pipelines will be progressively extended. In the remaining gas grid, especially the distribution grid, the blending of certain levels of hydrogen into natural gas pipelines will be a valuable option during the transition. The maximum blending share is expected to remain limited to around 25% – above that level there will most likely be a one-step switch to pure hydrogen. By 2050, the switch to hydrogen should be fully concluded.

Based on these assumptions, the European engine power plant industry defines three hydrogen-readiness levels according to the hydrogen content[i] of the gas used:

- **H2-Readiness Level A:** 100% hydrogen[ii]
- **H2-Readiness Level B:** up to 25% hydrogen blended into natural gas[iii]
- **H2-Readiness Level C:** up to 10% hydrogen blended into natural gas[iii]

Technical Adaptations

New engine power plants build today will typically start operating with natural gas for a number of years. However, a new power plant can already be designed and built to be H2-ready. This allows operators to easily upgrade the plant for the specific hydrogen content available in the gas grid. As plants are built according to specific requirements agreed between the plant operators and the technology providers,[iv] the effort to upgrade a power plant may be different for each plant.

The European power plant industry defines sub-categories for each H2-readiness level:

- **Category 1: No substantial modifications**
  No substantial modification of the power plant's hardware is necessary to reach the relevant H2-readiness level. However, the plant may require adaptations in operation, service & maintenance, operating procedures, software, etc. Modifications are estimated by the technology supplier to be **up to 5%** of the overall costs of building a new power plant. There may also be modifications necessary in the gas supply outside the plant.

- **Category 2: Minor upgrading necessary**
  The plant is technically suitable and retrofittable to operate with the hydrogen share of the category. Certain modifications of the hardware, software, etc. will be required before being able to operate. Many of the upgrading efforts can be done as part of regular inspection and maintenance activities. The technology suppliers estimate the costs for this upgrade to be **up to 10%** of the overall cost of building a new power plant.[v]

- **Category 3: Upgrading technically and economically possible**
  The plant is technically suitable and retrofittable to operate with the hydrogen share of the category. Certain modifications of the hardware, software, etc. will be required before being able to practically operate with the mentioned hydrogen level. The technology suppliers estimate the costs for this upgrade to be **up to 30%** of the overall cost of building the power plant.[v]

i The percentages given relate to the volume share of hydrogen blended into natural gas.
ii Non-technical wording. As there are often fractions of other gases in the pipeline system, the technically correct term would be "hydrogen content >95%".
iii Depending on the specific composition of the base gas.
iv The technical capability of a plant to handle hydrogen may already in some cases be higher than the contractually agreed capability.
v Costs relating to the inflation-adjusted costs of building the original plant. Subject to review when significant parameters change.

European Engine Power Plants Association EUGINE

EUGINE is the voice of Europe's engine power plant industry. Our members are the leading European manufacturers of engine power plants and their key components. Engine power plants are a flexible, efficient, reliable and sustainable technology, helping to ensure security of electricity supply and providing (renewable) electricity and heat.

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