

From: "Roberts Strods" <r.strods@digasgroup.com>
Sent: Mon, 13 Nov 2023 13:17:31 +0100
To: "Srv Post" <post@jernbanedirektoratet.no>
Subject: Hearing KVV Green, case 20230091

Dear KVV Green team,

As I see biogas is being ruled out due to the factors outlined in the table 9 (Screenshot 1).

Fuel-based solutions – biogas and bioalcohol	34. Biogas	No. There is a lack of interest in biogas on the railways in Europe. As there is little investment in biogas, Norway could potentially become the only user in Europe. The possibility therefore does not satisfy the requirement for the possibility of standardization.
	35. Bio alcohol	No. This type of internal combustion engine is not suitable for such heavy applications, and it cannot be expected that anyone will invest in developing the technology for railways.

Since they do not represent an accurate picture, our company wanted to comment upon them:

- **Statement:** There is a lack of interest in biogas on the railways in Europe. **DIGAS's comment:** DIGAS as the company has already done 5 retrofitted locomotives and this biogas option is included in AERRL study done by the largest European railway asset lessors (section 3.5., RNG - Renewable Natural Gas/Biomethane/Biogas)
- **Statement:** There is little investment in biogas. **DIGAS's comment:** not true since RepowerEU says that at least 20% of all natural gas consumption should in the future come from Biogas. The biogas plant uptake in France is seen below:



- **Statement:** The fact somehow influences standardization. **DIGAS's comment:** not true, since DIGAS has already come up with the methodology of certification of biogas railway vehicles and has implemented it throughout 5 different EU countries certifying new locomotive types in ERATV database. Right now DIGAS is doing a project with SNCF Voyager in France where the passenger DMU is being converted to biogas: <https://www.gaz-mobilite.fr/actus/nouvelle-aquitaine-train-biognc-sur-les-rails-3657.html>

As t Hydrogen, the same Table 9 contains the following:

Fuel-based solutions – hydrogen and the like	31. Hydrogen train with fuel cell	Yes. Available for passenger trains. However, there are challenges with sufficient amounts of energy for freight trains on e.g. Nordlandsbanen. Safety in tunnels must be clarified in more detail (framework condition 8).
	32. Hydrogen train with internal combustion engine	No. Internal combustion engines for hydrogen do consistently worse/much worse than fuel cells and other gas engines, with regard to e.g. energy efficiency and maintenance costs. This contributes to the fact that no work is being done on developing solutions for railways with combustion engines for hydrogen. It is nevertheless conceivable that some work machines in the future may use several fuels, including hydrogen.

- **Statement:** ICE for hydrogen do constantly worse/much worse than fuel cells and other gas engines. **DIGAS's comment:** Please see a screenshot attached from Ricardo:

Fuel cell and internal combustion engine comparisons			
PARAMETER	HYDROGEN FUELLED ENGINE (H ₂ ICE)	FUEL CELL (PEM TYPE)	WINNER
Efficiency	~44%+ expectation for DI H ₂ fuelled ICE	~60% peak electrical efficiency (at ~25% load) ~44% at full load	In theory – fuel cell in use – similar
Emissions in use	Engine– out NOx [low] Trace oil derived emissions	No tailpipe emissions	Fuel cell
Technology maturity	ICE well understood, modification to burning H ₂ in development	Existing FC system providers further optimisation to suit niche application needed.	Similar
Noise/vibration	Substantial NVH effort	Quiet	Fuel cell
Fuel purity requirement	Tolerant to fuel contaminants/ lower grade H ₂ standard not yet defined	ISO H ₂ purity standard (ISO 14687 Grade D)	H ₂ ICE
Air quality requirement	Robust to small particles	Sensitive to air contamination	H ₂ ICE
Durability	Diesel ICEs durable for >10,000 hours H ₂ ICEs expected to be similar	Durability & reliability improved to >10.000 hours	Similar
Auxiliary heat output	High grade heat similar to current ICE	Thermal management of low-grade heat for PEMFC required.	H ₂ ICE

- **Statement:** No work on developing solutions on railways with combustion engines for hydrogen. **DIGAS's comment:**
 - **DIGAS:** <https://www.irishrail.ie/en-ie/news/iarnrod-eireann-and-latvia-s-digas-to-trial-europe>
 - **Ricardo:** <https://www.ricardo.com/en/resources/introducing-hydrogen-in-railways>
 - **Wabtec:** <https://www.trains.com/trn/news-reviews/news-wire/wabtec-hydrogen-is-the-locomotive-fuel-of-the-future/>

Best Regards,
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DIGAS



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