Hydrogen Trains Groningen
Current Train Network
Zero emission solutions

- Catenary system;
- Partial catenary system with battery trains;
- Hydrogen (battery) trains.
Advantages Hydrogen Trains

• About 50% lower investment compared to catenary system and with battery trains still a lot of catenary as well;
• Flexible introduction;
• No catenary failures, blocking views and no maintenance costs for a catenary system as well;
• Less noise (3 up to 6dB compared to diesel trains);
• Easy to cross borders (no loc change is needed);
• Fits perfectly within our total hydrogen strategy.
Hydrogen economy
Hydrogen mobility
Disadvantages Hydrogen Trains

• It is still a big investment;
• The technique is still developing;
• Maximum speed of 140 km/h (for now);
• Tanking process needs to be fit within the total process;
Pilot first

Goals:

• Getting the dispensation;
• Testing the train performance on the track for two weeks during the nights;
• Testing the refuelling process (green hydrogen);
• Organise a public and press event.
Intercity train Groningen-Leeuwarden
Noise

Gemiddelde equivalente geluidniveau

$[\text{Aeq dB(A)}]$ vs $V \text{ in km/h}$

- GTW-DMU
- iLint
## Refuelling

<table>
<thead>
<tr>
<th>Date</th>
<th>Train section</th>
<th>Time START</th>
<th>Time READY</th>
<th>Pressure START [Bar]</th>
<th>Pressure READY [Bar]</th>
<th>Temp. START [℃]</th>
<th>Temp. READY [℃]</th>
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<td>1 Mar.</td>
<td>A</td>
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<td>9:25</td>
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<td>59</td>
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<td>11:41</td>
<td>44</td>
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<td>53</td>
<td>170</td>
<td>1</td>
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<td>B</td>
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<td>11:10</td>
<td>47</td>
<td>170</td>
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<td>170</td>
<td>4</td>
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Starting – and end pressure of the refueling process

Legend:
- Red: Train section A Starting pressure
- Orange: Train section A End pressure
- Yellow: Train section B Starting pressure
- Green: Train section B End pressure
Next steps

• Pilot very successful;
• Now scale up towards first four new trains needed in 2025 in the real operation and every new train after that;
• If they are successful the tender for a new concession in 2035 can include a demand for all trains to be zero emission with green hydrogen;
• Really interesting if other regions or countries with diesel tracks join us for a bigger market potential and to boost the development.
Questions?