

Hydrogen Trains Groningen



- Geëlektrificeerd 1500 V DC
- Elektrificatie in uitvoering, Geëlektrificeerd 1500 V DC
- Geëlektrificeerd 25 kV AC 50 Hz
- Geëlektrificeerd 15 kV AC 16,7 Hz (Duitsland)
- Geëlektrificeerd 3000 V DC (België)
- Niet geëlektrificeerd

Current Train Network



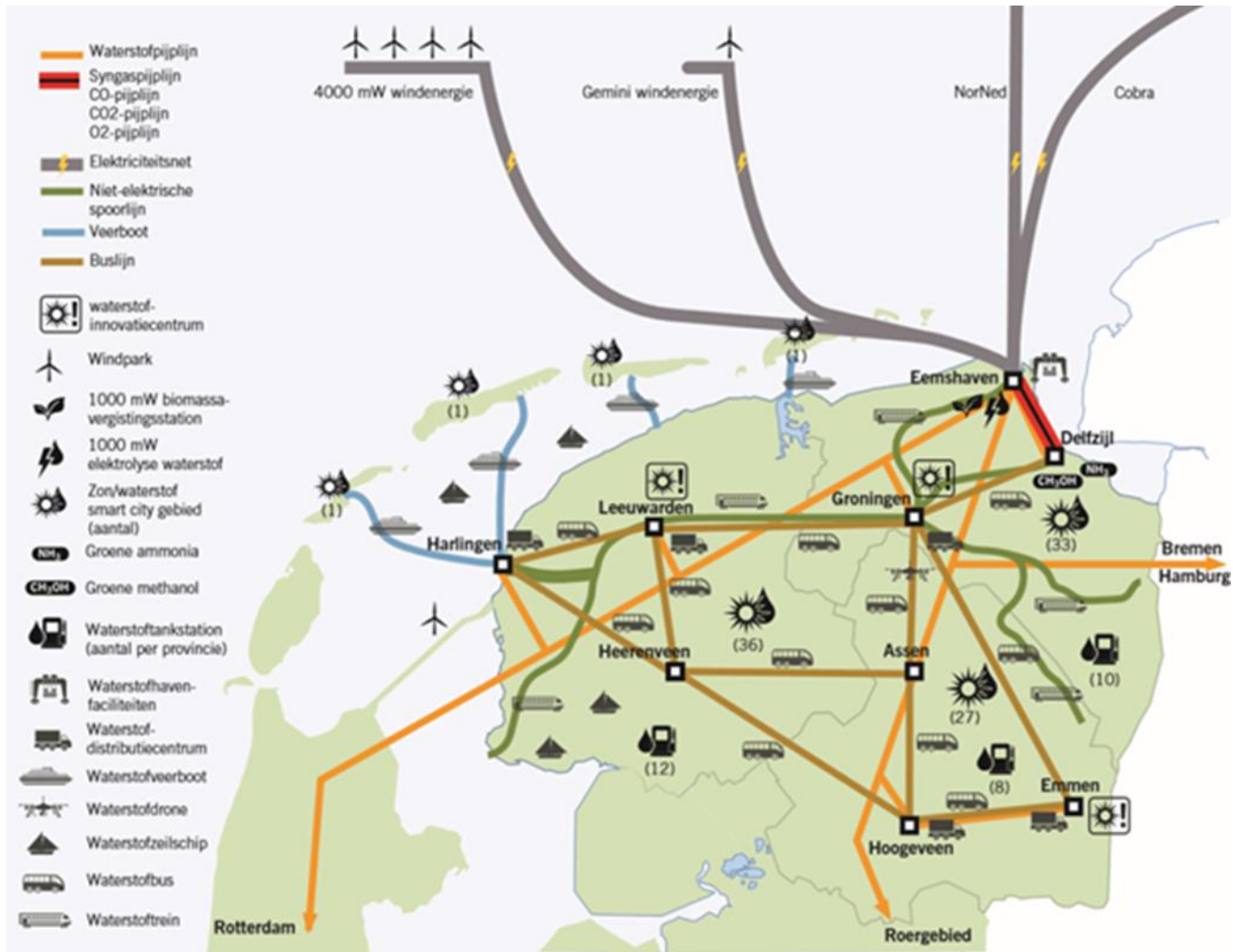
Zero emission solutions

- 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



Het waterstofplan in Noord-Nederland.

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;

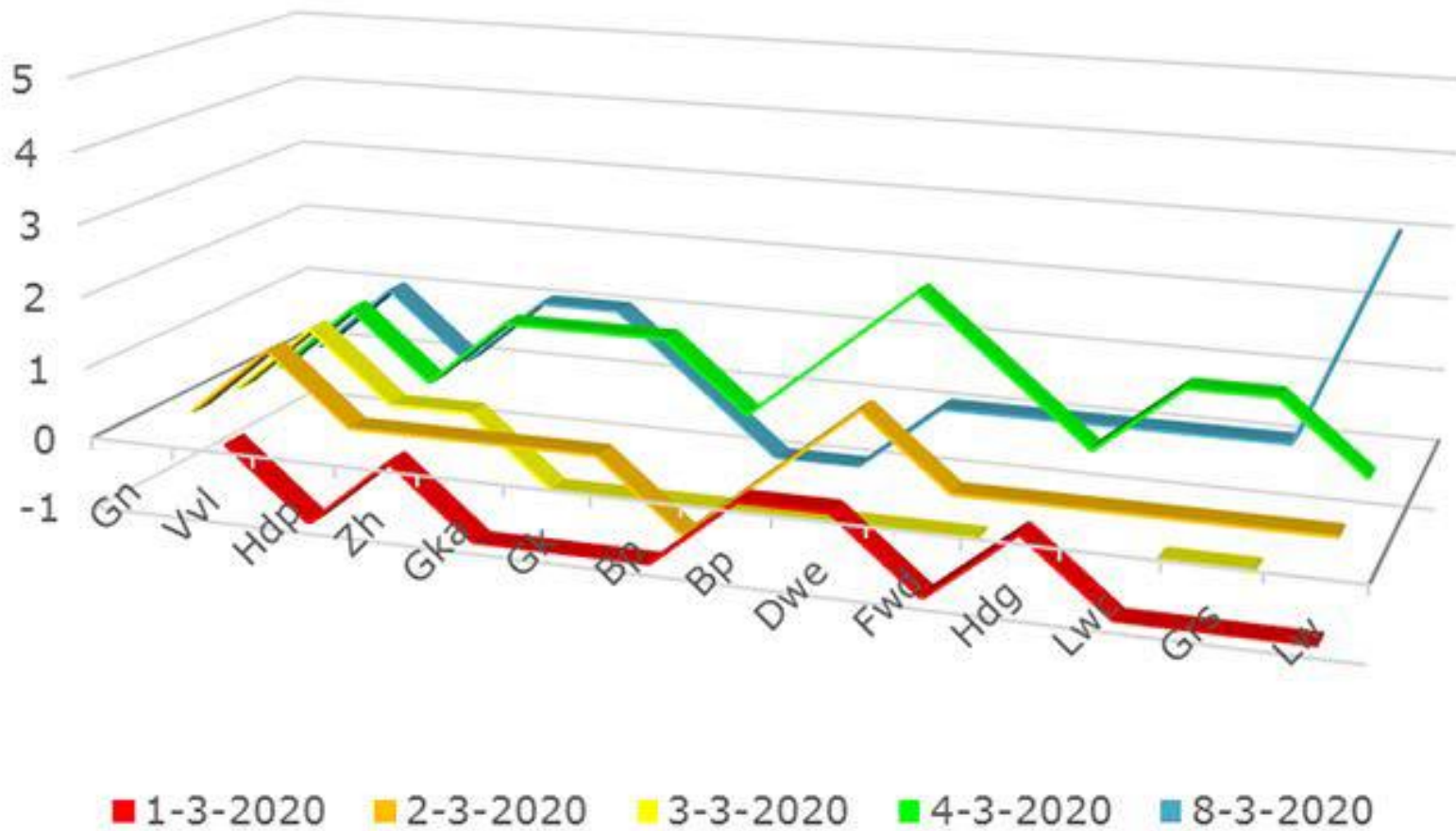
Pilot first

Goals:

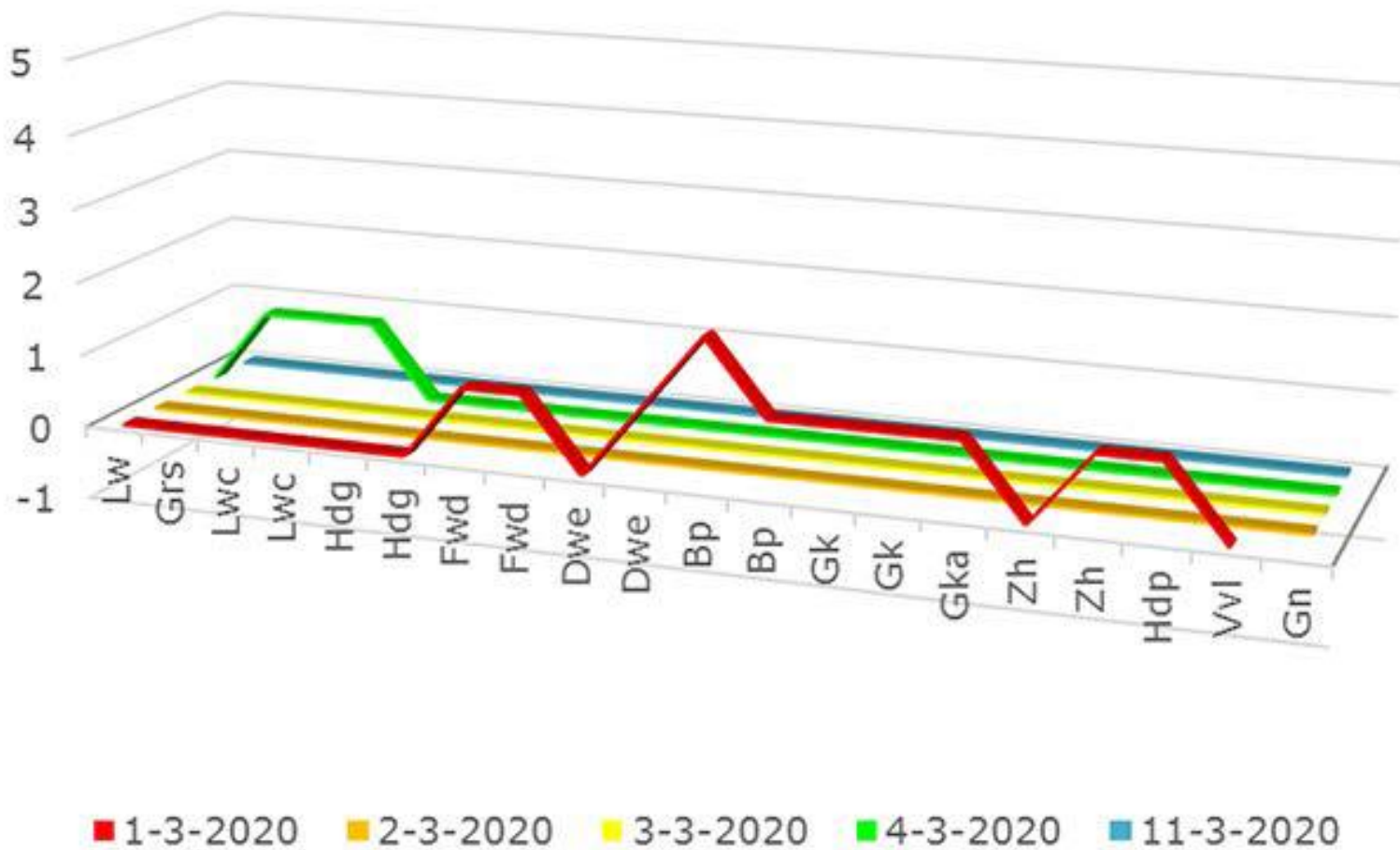
- Getting the dispensation;
- Testing the train performance on the track for two weeks during the nights;
- Testing the refuelling process (green hydrogen);
- Organise a public and press event.



Intercity train Groningen-Leeuwarden

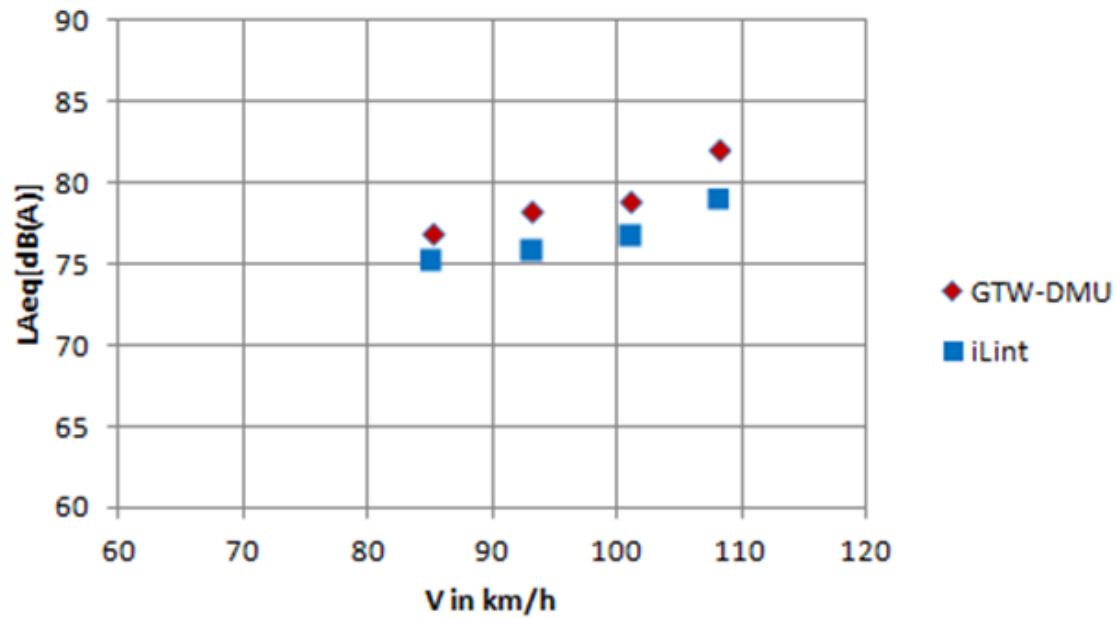


Local train Leeuwarden-Groningen



Noise

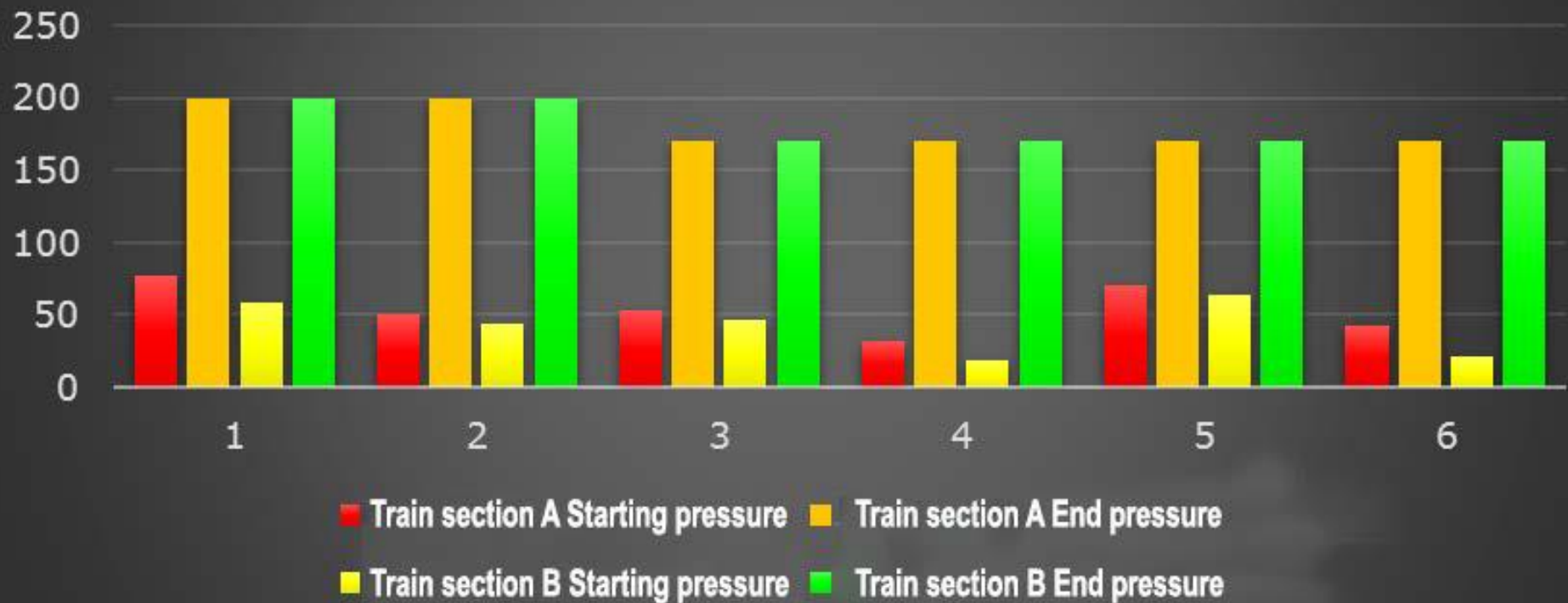
Gemiddelde equivalente geluidniveau



Refuelling

Date	Train section	Time START	Time READY	Pressure START [Bar]	Pressure READY [Bar]	Temp. START [°C]	Temp. READY [°C]
1 Mar.	A	9:10	9:25	77	200	4	-2
	B	9:30	9:53	59	200	4	6
2 Mar.	A	11:43	12:00	50	200	2	5
	B	11:25	11:41	44	200	2	5
3 Mar.	A	11:13	11:34	53	170	1	4
	B	10:53	11:10	47	170	0	1
4 Mar.	A	9:50	10:24	32	170	4	8
	B	10:25	11:02	19	170	4	16
6 Mar.	A	9:45	10:05	70	170	5	0
	B	10:00	10:40	64	170	6	0
9 Mar.	A	9:40	10:00	42	170	7	5
	B	10:04	10:40	22	170	8	5

Starting – and end pressure of the refueling process





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?

