From R&D to Market Deployment

Hydrogen Fuel Cell Trains in Germany

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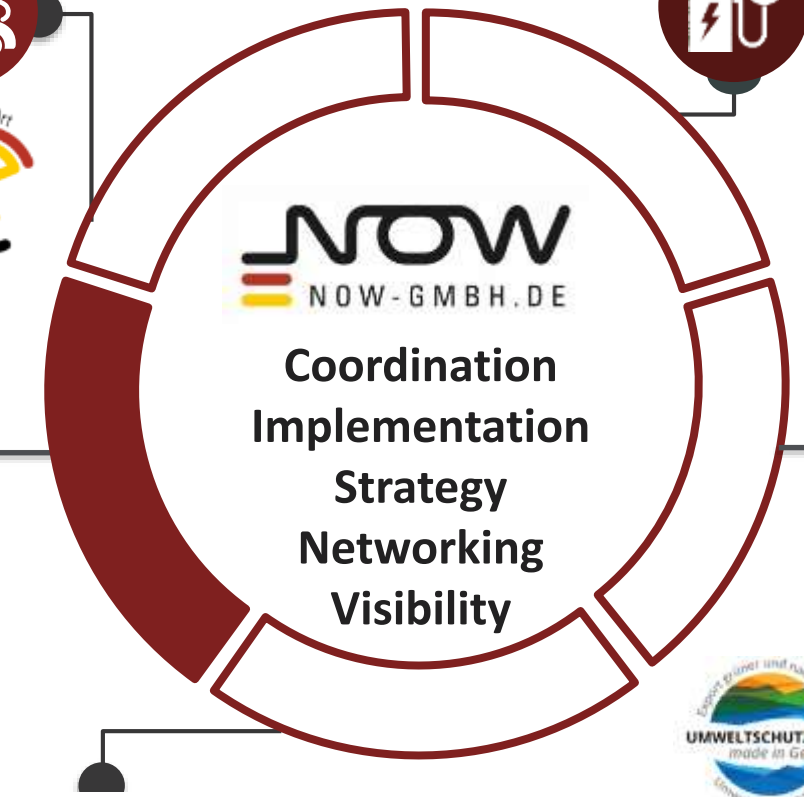
INTRODUCTION

THE NOW - PARTNER OF THE GERMAN GOVERNMENT
TASKS AND PROGRAMMES

Battery Electric Mobility
- Research and Development
- Communal mobility concepts
- Vehicle procurement

Federal Programme Charging Infrastructure
- Nationwide buildup
- Normal charging
- Fast charging



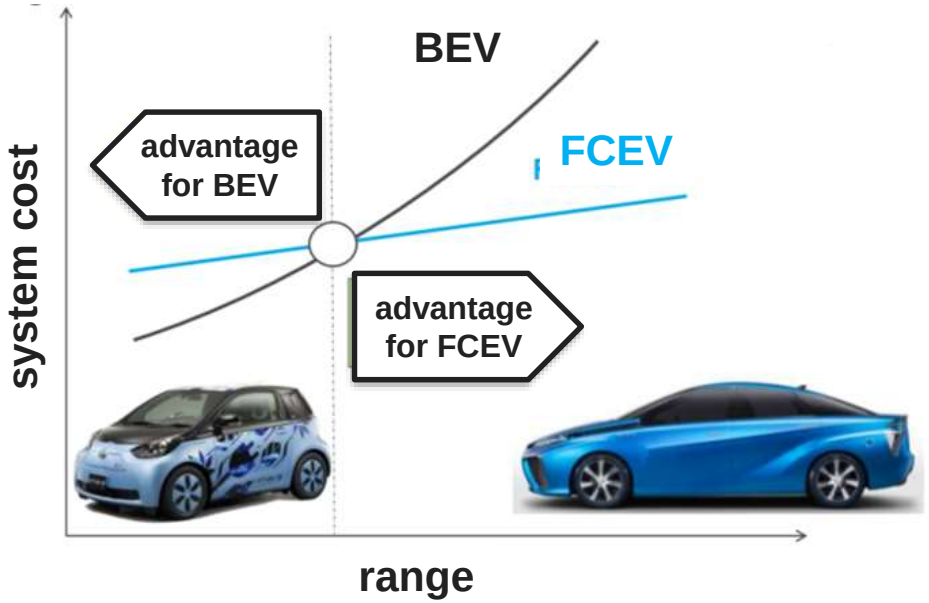
National Innovation Programme Hydrogen and Fuel Cell Technology (NIP)
- Research and Development
- Market activation

Mobility and Fuels Strategy
- Pilot projects on alternative fuels (efficient, emission-free)
- LNG as a marine fuel

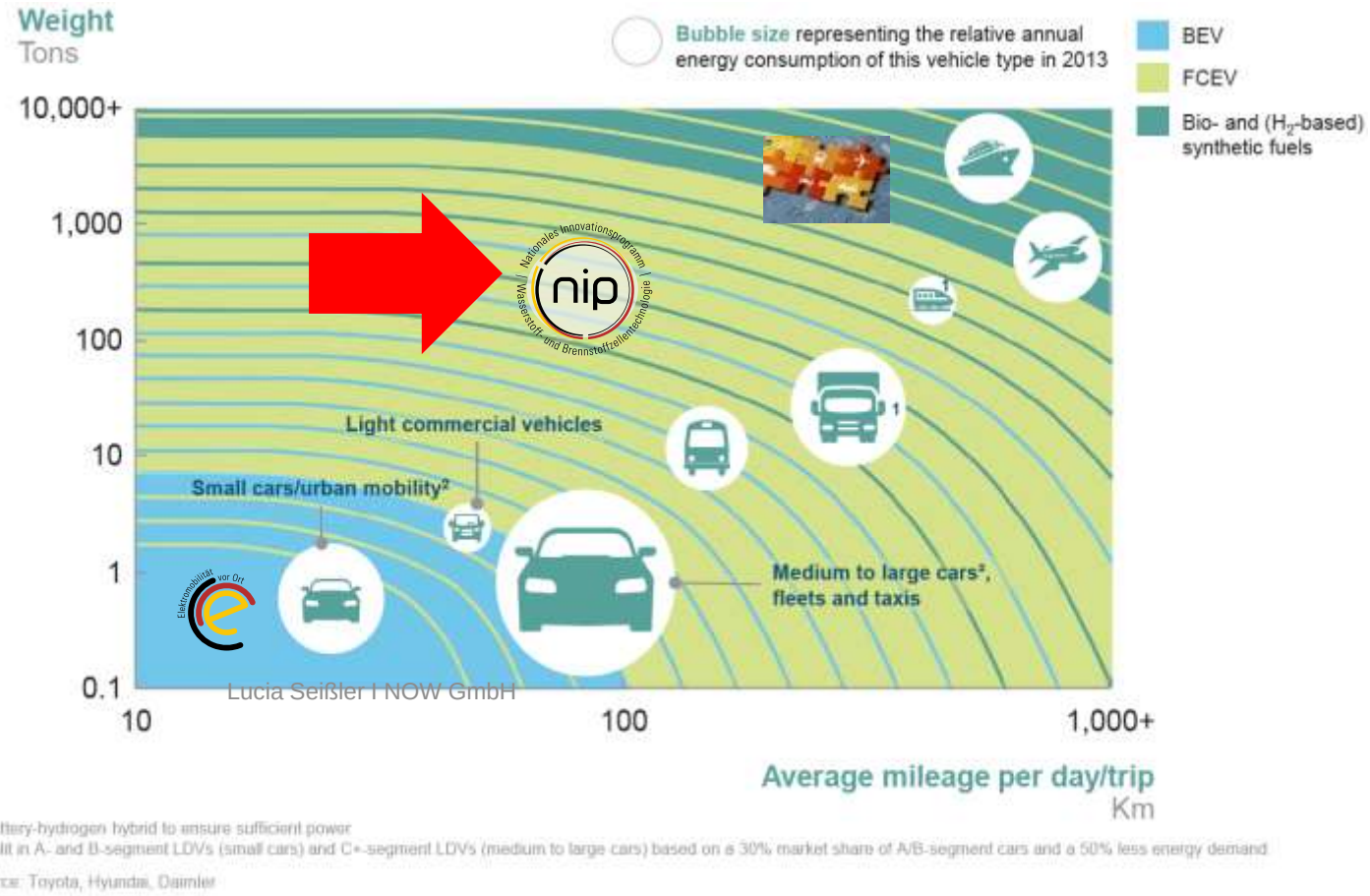
Export Initiative Environmental Technology
- German-Japanese cooperation PtG
- H2/FC technology in developing countries (cooperation with GIZ)

TRANSITION OF THE TRANSPORT SECTOR
TECHNOLOGIES FOR DIFFERENT APPLICATIONS

System Cost Comparison between BEV and FCEV



Source: Toyota

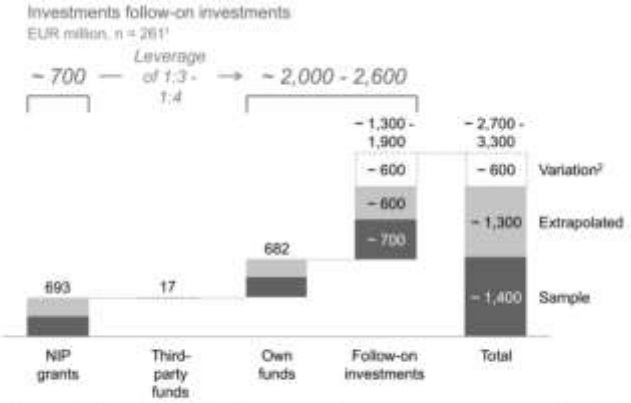


Source: Hydrogen Council

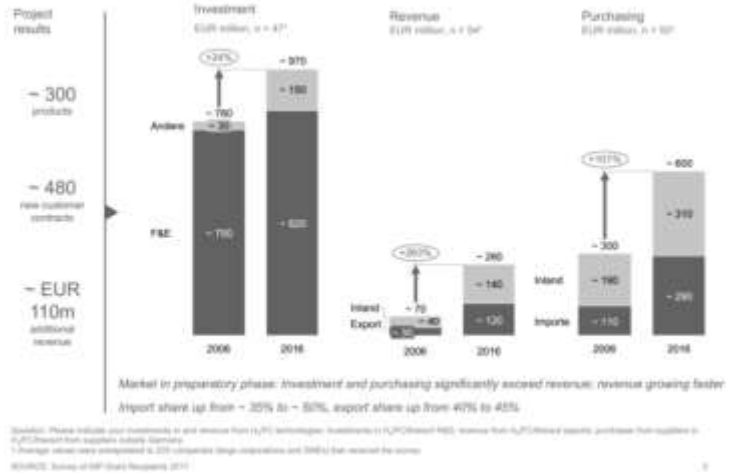
NATIONAL INNOVATION PROGRAM HYDROGEN AND FUEL CELL TECHNOLOGY (NIP)

NIP PHASE 1 (2007 – 2016)

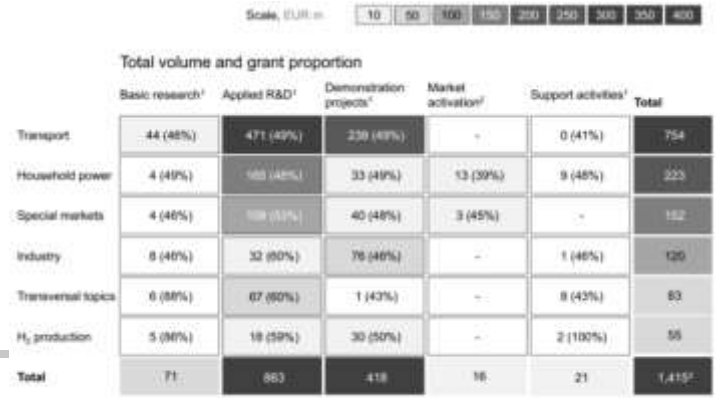
…TRIGGERED FOLLOW-ON-INVESTMENTS



…ACCELERATED MARKET DEVELOPMENT

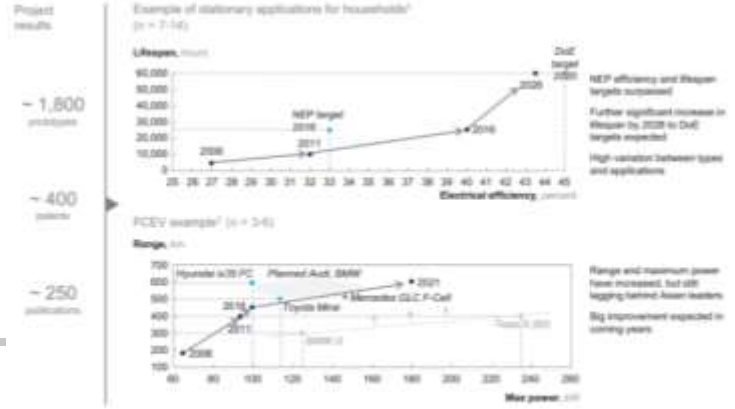


…710 MILLION EURO PUBLIC R&D FUNDING



	Basic research¹	Applied R&D¹	Demonstration projects¹	Market activation²	Support activities¹	Total
Transport	44 (46%)	471 (49%)	239 (49%)	-	0 (41%)	754
Household power	4 (49%)	165 (48%)	33 (49%)	13 (39%)	9 (48%)	223
Special markets	4 (46%)	109 (51%)	40 (48%)	3 (45%)	-	152
Industry	8 (46%)	32 (50%)	76 (46%)	-	1 (46%)	120
Transversal topics	6 (86%)	67 (60%)	1 (43%)	-	9 (43%)	83
H_2 production	5 (86%)	18 (59%)	30 (50%)	-	2 (100%)	55
Total	71	863	418	16	21	1,415³

…SAFEGUARDED GERMANY'S POSITION AS TECHNOLOGY LEADER



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NATIONAL INNOVATION PROGRAM HYDROGEN AND FUEL CELL TECHNOLOGY (NIP 2)

MEASURES OF THE MINISTRY OF TRANSPORT AND DIGITAL INFRASTRUCTURE (BMVI)

funding guideline open call

Federal Ministry of Transport and Digital Infrastructure

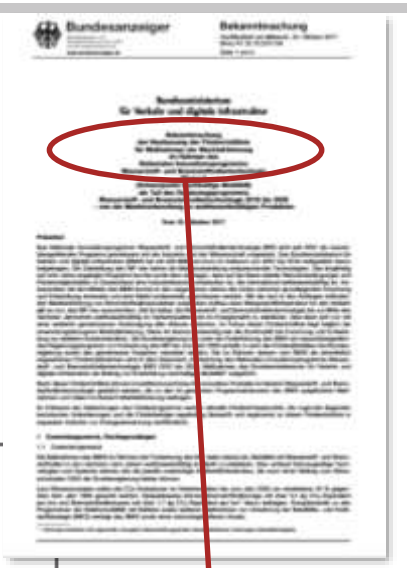
€ 250 million
2017 - 2019

MEASURES OF R&D AND INNOVATION

- Road transport
- Aviation
- Rail transport
- Shipping
- Logistics and special applications
- Electricity-based Fuels (H_2-production) → H_2

MEASURES OF MARKET ACTIVATION

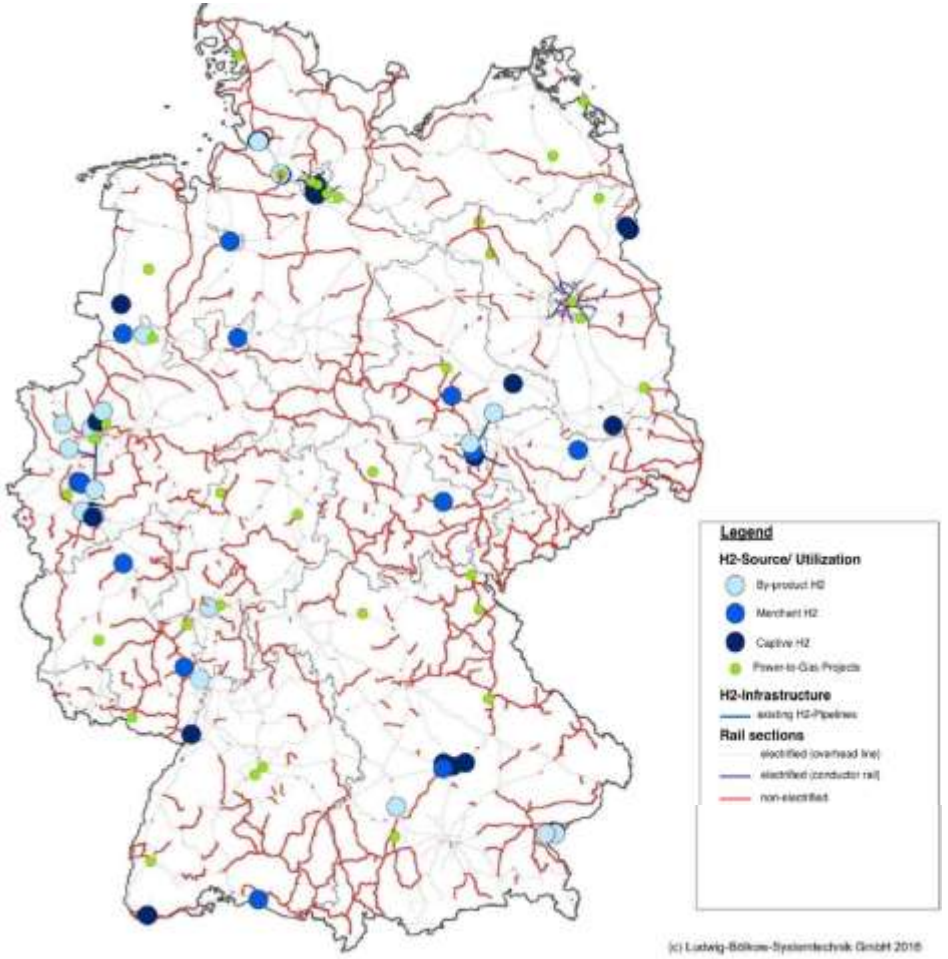
- Vehicles (road, rail, water) and aircraft with fuel cell drives/engines
- Electrolysis installations if operated with renewable power
- Special vehicles in logistics equipped with fuel cells and
- H_2 refuelling stations
- Fuel cell cogeneration installations for on-board power supply on ships, vehicles and aircrafts
- Fuel cell based independent power supply for critical or off-grid infrastructures



funding guideline implemented via individual calls

FROM R&D TO MARKET ENTRY

POTENTIAL FOR ZERO-EMISSION TRAINS IN GERMANY



- **> 40%** of the German rail grid is **not electrified**
- **> 20%** of the German rail traffic is currently **operated through diesel trains**
- Electrification of tracks is economically feasible on highly frequented sections only
- Battery trains can bridge short unelectrified distances (ca. 40km max)

- **Big potential for hydrogen fuel cell trains in**
  - low-frequency,
  - unelectrified sections,
  - possibly located near hydrogen supply

TIMELINE
FROM R&D…

Letter of intent for the use of hydrogen trains in the federal states of Lower Saxony, Hesse, Baden-Württemberg and North Rhyne-Westphalia

September 2014

Federal financial funding amounting to **7.9 million €** for the project **BetHy** by **Alstom** for the development of the hydrogen train **Coradia iLint**

November 2014

Publication of the study „**Hydrogen Infrastructure for Rail Transport**“ through the federal ministry for transport

2016

Federal funding of **1.14 million €** for the project **BetHy 2** for the development, validation & authorization of the Coradia iLint

October 2017

December 2017

Federal funding of the **Siemens** project **X-EMU** for the development & validation of a fuel cell drive for hybrid-EMU-trains with **11.7 million €**

TIMELINE
…TO MARKET LAUNCH

Deadline of the **first funding call for the acquisition of hydrogen trains** (including fuel stations and onsite electrolyzers)
→ **Proposals from 6 federal states for more than 160 trains in total**

March 2018

First press tour with the Coradia iLint from Wiesbaden to Frankfurt-Höchst

April 2018

Alstom receives the admission for passenger service within the German rail network for the Coradia iLint

July 2018

Lucia Seißler I NOW GmbH

Start of the trial operation of the Coradia iLint on the route Cuxhaven – Bremerhaven – Bremervörde – Buxtehude in Lower Saxony

September 2018

Regular operation from 2021 on:
14 Coradia iLint in Lower Saxony

+ additional locations …

R&D PROJECTS BETHY & BETHY 2
DEVELOPMENT OF THE CORADIA ILINT (ALSTOM & DLR)

Technical Data:

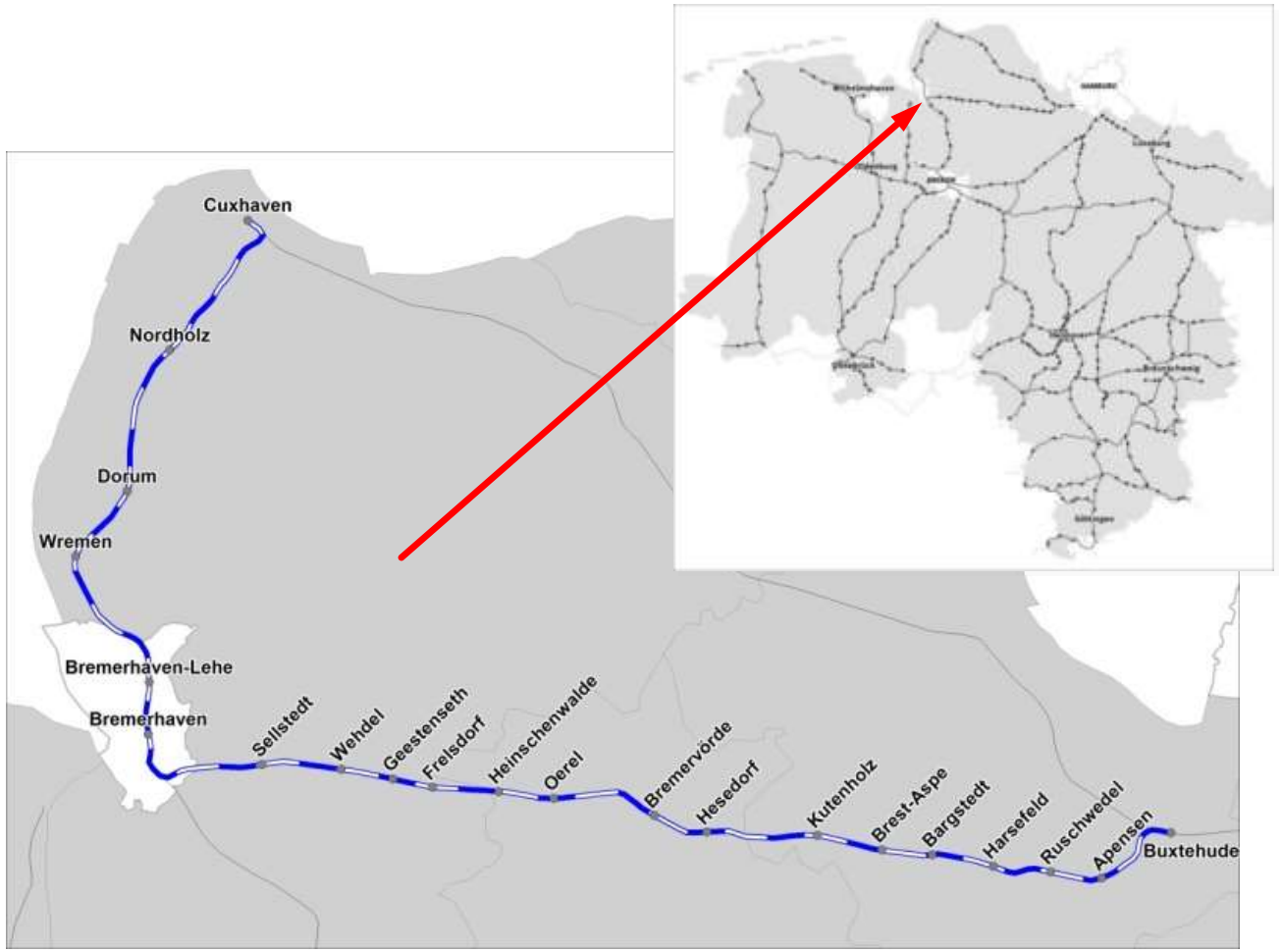
- Based on the diesel train Coradia Lint 54
- 2 fuel cell stacks
- 2 hydrogen tanks (each 130 kg)
- 2 x 272 kW power at the wheel
- Up to 1000 km range
- Maximum speed of 140 km/h
- Approximately 119 t total weight
- Approximately 55 m length

LOWER SAXONY – START OF OPERATION IN 12/2021
BUXTEHUDE – BREMERVÖRDE – BREMERHAVEN - CUXHAVEN

Track:
- Single-track branch line
- 123 km
- 21 stations
- Average distance between stations 9 km
- Current operator: EVB (*Eisenbahnen und Verkehrsbetriebe Elbe-Weser*)

Trains:
- 12+2 Coradia iLints
- 156 seats per train

Refueling station:
- One station and maintenance in Bremervörde
- Maximum of 12 refueling processes per day
- 15 minutes per train
- Two trains in parallel



R&D PROJECT X-EMU

DEVELOPMENT OF A FC-HYBRID-POWERTRAIN FOR TRAINS (SIEMENS, RWTH AACHEN)

Project Goals:

- Integration of a fuel cell stack in a modular traction system for trains
- Development of a **hardware-in-the-loop simulation** for the integration, development and evaluation of real components and models
- Integration in the Siemens E-Train platform „**Mireo**“

Funding:

- 20.3 M Euros project volume
- 11.7 M Euros of public funding (NIP 2)
- Runtime 01.10.2017 – 30.09.2019

→ **Modular battery and fuel cell** system, adoptable to different conditions and customer demands

FUTURE OUTLOOK

FURTHER EXPRESSIONS OF INTEREST

Next region to deploy hydrogen fuel cell trains:

- Hesse: RMV lines 11, 12, 15, 16 (Taunus grid), 23 trains will start operation 12/2022

Calls for tender open to zero-emission technologies:

- Baden-Württemberg: Grid “Ortenau”, 17 trains
- Schleswig-Holstein: three rail grids, approximately 50 trains
- North Rhine-Westphalia: approximately 50 trains

Press releases stating a specific interest in the utilization of fuel cell trains:

- Brandenburg: Section “ Heidekrautbahn”, 4-7 trains
- Central eastern Germany (Leipzig): feasibility study for the utilization of hydrogen fuel cell trains

COALITION AGREEMENT
POLITICAL INITIATIVE

„For rail transport we intend to establish a comprehensive funding program, which covers both the electrification of tracks and the acquisition of vehicles and the respective charging/refueling infrastructure. Furthermore, regional rail transport is intended to be supported through ***investment grants for fuel-cell-hybrid-railcars including facilities & depot modifications as well as the construction and operation of hydrogen refueling stations****.“*

– translated from the coalition agreement between CDU, CSU & SPD, 2018

New household item at the Federal Ministry of Transport and Digital Infrastructure BMVI to support alternative drives for trains

→ Additional 52.7 M € of budget is designated to the topic for the period until 2022

→ Funding guideline is being developed

HYLAND – HYDROGEN REGIONS IN GERMANY
A NEW FUNDING CONCEPT UNDER NIP 2

HyStarter

- **Six regions and/or municipalities** will be selected
- Winners get **consultation during 2 years** on content and organization
- **Development of a local actors network** to jointly create **initial H2FC concepts** on the basis of RE in transport but may include heat, electricity and storage
- **Expressions of interest can be stated**

HyExperts

- Selection through **competition**
- Winners get **prize money** in order **to create and calculate concrete project ideas** for H2FC concepts
- Regions new to the topic can apply with rough concepts
- Call for competition and the evaluation criteria to be announced in **spring 2019**

HyPerformer

- Selection through **competition**
- Winner(s) get **funding support to implement regional H2FC concepts**
- Competing regions demonstrate readiness and ability to implement their concepts
- Call for competition and the evaluation criteria to be be announced in **spring 2019**

Thank you very much for your attention!

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