

**DOCKETED**

<b>Docket Number:</b>	19-ERDD-01
<b>Project Title:</b>	Research Idea Exchange
<b>TN #:</b>	230459
<b>Document Title:</b>	Ricardo North America Comments - Ricardo Studies
<b>Description:</b>	N/A
<b>Filer:</b>	System
<b>Organization:</b>	Ricardo North America
<b>Submitter Role:</b>	Public
<b>Submission Date:</b>	10/31/2019 11:14:06 AM
<b>Docketed Date:</b>	10/31/2019

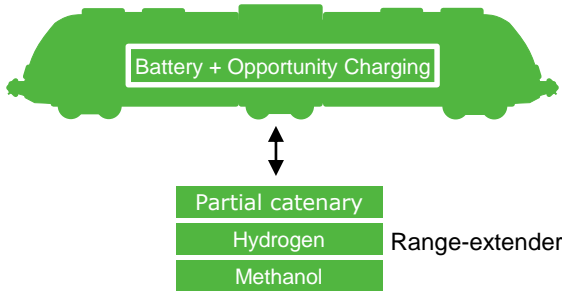
*Comment Received From: Ricardo North America*  
*Submitted On: 10/31/2019*  
*Docket Number: 19-ERDD-01*

## **Ricardo Studies**

A pre-study on this topic will give insight to the best solution for trains and other applications. See attached an example of Ricardo case study in Europe.

*Additional submitted attachment is included below.*

# Zero emission battery train



## Approach

Ricardo performed the following activities:

- Research on used technologies in existing zero emission transport, both by road and rail.
- Research on hydrogen, battery and charging technology.
- Make a first concept of the train (based on an existing train) as input for calculations.
- Calculation of the energy consumption in daily operation with in-house developed calculation software.
- Combining the gathered information into a solution for a zero emission train system.

## Situation and objective

- In the northern provinces of the Netherlands, railway transport is operated by diesel trains. The provinces consider alternatives to make the transport “zero-emission” (without CO<sub>2</sub> emissions).
- Earlier research showed that full electrification would be too expensive.
- Objective: Investigate whether a battery train or hydrogen train could be an alternative for diesel powered trains as well as the costs involved.
- The research would have to include a possible upgrade of existing trains.
- The “zero-emission” trains would start operation in 2025.

## Results and benefits

The results of the research were:

- Battery technology is developing fast resulting in an increase of capacity at lower costs, i.e. a battery train is possible.
- It is feasible to upgrade the existing diesel trains to zero emission battery trains.
- Train tables can be realised with battery charging stations at end stations as well as a few kilometres of overhead lines at locations to be determined.
- Costs are significantly lower than full electrification.
- Realisation is feasible within the required timeframe.