ENERGY EFFICIENCY IN RAILWAYS: ENERGY STORAGE AND ELECTRIC GENERATION IN DIESEL ELECTRIC LOCOMOTIVES

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OBJECTIVES:
- To increase the overall efficiency of diesel-electric haulage and reduce emissions (≈10%). To compete with electric traction.
- To develop and improve tools for evaluating energy efficiency.
- To show through simulation how batteries and SC can be used for this purpose.

TRAIN CHARACTERISTICS:
- Locomotive GM JT26TW: 120 t; 140km/h
  - Diesel engine: 2237kW
  - Max. tractive effort: 32kN
  - Dynamic braking: Resistor

Coaches (TALGO IV)

SIZING OF STORAGE. Options
- Simple: the energy is stored during braking periods (B) and used later (A).
  - Not expensive and easy.
  - Size = Máx (B1+B2-A1…)
  - In this case …. 85 MJ
- New diesel engine + storage: the use of old series S-319GM diesel1.3MW + higher energy reservoir (580MJ).
- Remember! P (average) is about 0.3MW

STATE OF THE ART: Worldwide
- Plathée (SNCF, France): Diesel + Fuel-cells + SC + Batteries + Flywheels.
- ALPS (FRA, EEUU): Diesel + Flywheels.
- Our case: Batteries vs. Supercapacitors

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Battery</th>
<th>Super Cap</th>
</tr>
</thead>
<tbody>
<tr>
<td>Energy (Wh/kg)</td>
<td>100-600</td>
<td>2-10</td>
</tr>
<tr>
<td>Number of cycles</td>
<td>&lt; 1000</td>
<td>500,000</td>
</tr>
<tr>
<td>Cost (€/kWh)</td>
<td>100-500</td>
<td>&lt; 10,000</td>
</tr>
</tbody>
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TRAIN SIMULATOR (by UPCT):
- Máx P: 1.9MW
- Average P: 0.3MW
- Braking losses (in R) up to 1.5MW
- En. Recovery! (regenerative)

RESULTS:
- Fuel costs (without storage): 300-400 k€/year
- SC costs: < 1.5 M€; Batteries 0.1-0.2 M€
- Fuel reduction: 30k€/year + CO$_2$ costs
- Installation costs + Maintenance + ..(+10%)

Further developments: the study of mobile DG generation by diesels in overhead lines.

More info: www.demandresponse.eu