RAILENERGY

Project General presentation

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UIC / Macroplan
Railenergy Facts & Figures

- Integrated Project co-funded by the EU under the 6th Framework Programme
- 27 partners across the EU
- Project start: 01 September 2006
- Duration: 4 years
- Budget: €14.7M (€8M EC grant)
Railway demands of the future

- energy-efficient
- cost-effective
- comfortable
- silent
- light
- fast
The main objective is to address the energy efficiency of the integrated railway system and to investigate and validate solutions ranging from the introduction of innovative traction technologies, components and layouts to the development of rolling stock, operation and infrastructure management strategies.

The overall objective of Railenergy is to cut the energy consumption in the railway system thus contributing to the reduction of life cycle costs of railway operation and of CO2 emission. The project target is to achieve a 6% reduction of the specific energy consumption of the rail system by 2020.
The target of 6% in energy saving in 2020 has been elaborated as follows:

- Savings Potential attributed to key technologies on the basis of existing research and experts’ knowledge
- Progressing them to system wide and fleet wide potential
- Deployment of 25% at 2020 has been estimated on the basis of investments, innovation cycles and initial condition of the railways (low to medium investment scenario)
Identification of the Target (2/2)

- **Domain**
  - Efficiency potentials on a subsystem level
  - Global contribution
  - System-wide impact

- **Operation**
  - Energy efficient driving 5-20%
  - Energy efficient timetable 5-10%
  - 2%

- **Trackside**
  - Recuperation DC networks 10-20%
  - Loss reduction (incl. contact lines) 2-5%
  - 4%

- **Components**
  - On-board energy storage 5-30%
  - Use of waste heat 5-20%
  - 5%

- **Traction**
  - Supercond. transf. 40-60%
  - Medium freq. transf. 35-55%
  - Perm. magnet mot/gen. 4-10%
  - 5%

- **Topologies**
  - Traction control 10-25%
  - Aux power supply 10-30%
  - Aux cooling system 5-15%
  - 2%

**Deployment in European railways:** 25%

**Overall target:** 6%
An Integrated Approach

- The 3 largest European networks are spending **€1.75 Billion** on energy (20% increase last year!)
- Inter-relationship of railway sub-systems is highly complex, especially with regard to assessing their consumption of energy
- Therefore, a **fully integrated approach** is the only way to achieve true energy savings
- Generate new validation standards for the energy performance of products and services and contribute to the European harmonisation process
Railenergy Project outputs (1/4)

- Relevant baseline figures and scenarios for selected reference systems
- A system-based concept for modelling energy consumption
- A common and standardised methodology to determine energy consumption by rail sub-systems and components in the development and procurement phases
- An integrated simulation tool for energy consumption and LCC
- An integrated railway energy efficiency management approach & decision support tool
Railenergy Project outputs (2/4)

- Strategic energy efficiency targets for rolling stock, infrastructure and traffic management
- An Energy Management Module which could provide the operator with a diagnostic of their complete installation (main energy flows, and their distribution, power peaks and mean, links with energy contract subscription, real time and statistics...)
- New validated energy efficiency-oriented railway technologies for trackside and on-board sub-systems and equipment, developed in compliance with the new integrated approach
- Refined best practices for Railway Operators and Infrastructure Managers
- Strategies for incentives, pricing, and policies
New innovative components could significantly reduce energy losses of traction systems.

One example: to substitute conventional transformers by superconducting or medium frequency components.
Integrated approach:

Railenergy will develop the Railenergy Global Model supported by the Decision Support Tool.
Features of Railenergy Model

- Open architecture for the whole sector
- Ability to break a global target into manageable units
- Assist in developm. of new energy-friendly hardw. and control syst.
- Help select the best combination of solutions for energy cost saving (during design, procurement and operation phases)
- Specific modules to assess the contribution of any new technical solution developed within Railenergy
- The ability to convert all test or simulation results into a common unit for measurement of Life Cycle Cost
- Support investment decisions
- “WHAT-IF” function to accommodate new technology options and different load profiles
2.1 Global System Modelling: “Plug & Play” principle

System Configuration Tree

- Traction
  - Sub-component A1, A2,..
  - Sub-component C1, C2,..

- Trackside
  - Sub-component B1, B2, ...

- Components
  - Sub-component B1, B2, ...
  - Sub-component D1, D2,..

- Topologies
  - Sub-component D1, D2,..

2.2 Standard Operational Profiles

2.3 EE Time Tabling

2.3 Eco-driving

2.4 Decision Support Tool “Configurator”:
  - GUI
  - Database
  - Scenario selection

2.4 Decision Support Tool “Evaluator”:
  - GUI
  - Database
  - Scenario calculation

Output data

EE strategies
CBA
Scenario evaluation

Operational aspects
Technical aspects

2.5 Operational & Technical Evaluation

2.6 Strategic & Business Evaluation

Global Model

Input data
- Fleet
- Network
- Technical options

Technical level

Operational level

Strategic level
‘Plug & Play’ Principle for new development

![Diagram showing the 'Plug & Play' Principle for new development.]

- Sub-system test and validation
- Development of new innovative systems
- Sub-system Modelling

Railenergy Global Model

SPx, SPy, SPz
**Coordination (UHIFE)**

1.1 Energy data & scenarios

1.2 Energy Efficiency Needs & Framwork influence

1.3 KPI definition

1.4 Requirements baseline and use cases

**IRG Needs (IZT)**

**IRG Efficiency Management (UIC)**

2.1 Railenergy Global Model

2.2 CE test cycles for energy determination

2.3 Energy efficient operation: Eco-driving and ee timetabling

2.4 Decision Support Tool: Configurator and Analyst/_evaluator

2.5 System validation and operational evaluation

2.6 Strategic and business evaluation

**IRG Trackside (RFI)**

3.1 trackside modelling

3.2 trackside components

3.3 New architectures

**IRG Components (Bombardier)**

4.1 Basic storage components

4.2 Re-use of waste heat

4.3 Eco-driving metering and DMI

**IRG Traction (Siemens)**

5.1 Analysing and modelling

5.2 Superconducting transformers

5.3 Medium frequency distribution

5.4 Hybrid DE propulsion

**IRG Topologies (AnsaldoBreda)**

6.1 Simulation for onboard integration

6.2 Efficient on-board traction

6.3 Architecture of on-board auxiliaries

6.4 Cooling circuits

**Training & dissemination (UIC)**

Training

Dissemination
## Validation and Prototypes

<table>
<thead>
<tr>
<th>Domain</th>
<th>Output</th>
<th>Level of Implementation</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Integrated Energy Efficiency Management</strong></td>
<td>Railenergy Global Model</td>
<td>Software Prototype</td>
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<tr>
<td></td>
<td>Decision Support Tool</td>
<td>Software Prototype</td>
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<td></td>
<td>Harmonised energy consumption determination for rolling stock</td>
<td>Contribution to Standards</td>
</tr>
<tr>
<td><strong>Operation</strong></td>
<td>Energy Efficient Time Tabling</td>
<td>Software Prototype</td>
</tr>
<tr>
<td></td>
<td>Real Time Drive Optimiser</td>
<td>Physical Prototype</td>
</tr>
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<td><strong>Components</strong></td>
<td>Eco-driving Metering and DMI</td>
<td>Physical Prototype mounted on board of the driver’s cab</td>
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<td><strong>Traction</strong></td>
<td>Cooling system for superconducting transformer</td>
<td>Physical Lab Prototype</td>
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<td></td>
<td>Medium Frequency Transformer</td>
<td>Physical Lab Prototype</td>
</tr>
<tr>
<td></td>
<td>Permanent Magnet Motor</td>
<td>Physical Lab Prototype</td>
</tr>
<tr>
<td><strong>Topologies</strong></td>
<td>Traction control system</td>
<td>Software Lab Prototype</td>
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<tr>
<td></td>
<td>Auxiliary Power Supply</td>
<td>Physical Lab Prototype</td>
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Examples of how the Railenergy solutions will be tested against real oper. conditions on existing lines.

Example 1: Passenger Traffic in International Routes

Scenario description
- High speed passenger train;
- Two countries;
- Both countries using AC traction;
- One country using 50 Hz;
- One country using 16 2/3 Hz

SP/WP Coverage
- WP4.3 – Eco-Driving Metering and DMIs
- WP5.2 – Superconducting Transformer
- WP5.3 – Medium Frequency Distribution
- SP6 – NRG-Topologies
Example 2: International Route with Mixed Traffic

Scenario description
- Mixed traffic (passengers and freight);
- International traffic (at least two countries);
- One country using DC traction;
- One country using AC traction;
- Domestic freight traffic scenario is a subset of the whole Demonstration Scenario.

SP/WP Coverage
- WP4.3 – Eco-Driving Metering and DMIs
- WP5.2 – Superconducting Transformer
- WP5.3 – Medium Frequency Distribution
- WP5.4 – Diesel-Electrical Multiple Units
- SP6 – NRG-Topologies
Example 3: Passenger Transport on Regional Services

Scenario description
- Passenger transport on regional lines
- Frequent stops

SP/WP Coverage
- WP3.2 – Trackside components for existing systems
- WP4.1 – Basic Storage Components
- WP4.2 – Re-use of Waste Heat
- WP5.4 – Diesel-Electrical Multiple Units
- SP6 – NRG-Topologies

Examples of how the Railenergy solutions will be tested against real oper. conditions on existing lines.
The exploitation of the Railenergy results among railway operators, infrastructure managers and manufacturers will be realised along the following main axes of management decisions:

• **Design and procurement**
  Investment decision support for the design, production (suppliers’ side), and procurement (customers’ perspective)

• **Optimisation of operation**
  Energy efficiency optimisation of the daily train operation

• **Harmonised communication**
  The creation and use of a harmonised language for energy efficiency within the railway sector will be of major value for enhancing the applicability of the solutions at hand.