Energy Efficiency, the best fuel to move our trains!
Do we need an energy meter?

Average European family:
3,500 kWh/year
Metered

Average European train:
1,500,000 kWh/year
Unmetered
Infrabel participated since November 2005 in UIC-project. Eress has given a presentation to our management. The first results in Norway had proven that tonnes-km can’t be used as accurate basis for invoicing.
How is energy measured on a train?

Sensors and transformers measure voltage and current and this for all traction systems.
Voltage Measurement Function (VMF)
Current Measurement Function (CMF)

An energy meter calculates every 1 or 5 minutes the consumed energy and also the energy returned during braking.
Energy Calculation Function (ECF)

A data logger adds GPS-positions and stores all data.
Data Handling System (DHS)
How accurate is energy meter?

Maximal permitted error is 1.5% (a.c.) or 2.0% (d.c.) and is based on:

$$\varepsilon_{EMF} = \sqrt{\left(\varepsilon_{VMF}\right)^2 + \left(\varepsilon_{CMF}\right)^2 + \left(\varepsilon_{ECF}\right)^2}$$

These are the maximal permitted errors for new devices to be tested in laboratories under the following conditions:

- voltage at input of Voltage Sensor between $U_{\text{min1}}$ and $U_{\text{max2}}$
- current through Current Sensor between 10 % $I_n$ and 120 % $I_n$ (with $I_n$ the Rated Primary Current of the EMF)
- ambient temperature of 23°C ($\pm$ 2°C)
- rail accuracy classes define permitted errors at lower currents and other temperatures

Basic requirements fixed by ERA in annex D of CR loc & pas TSI

Extra requirements are published in harmonized CENELEC-standard: EN 50463

New TSI mandatory for all rolling stock
How do you know meter is accurate?

<table>
<thead>
<tr>
<th></th>
<th>Design review</th>
<th>Type testing</th>
<th>Routine testing</th>
<th>Based on</th>
<th>Who?</th>
<th>Who?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Device testing</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>EN 50463-2</td>
<td>Manufacturer</td>
<td>Manufacturer</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>EN 50463-3</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Integration testing</td>
<td>yes</td>
<td>yes</td>
<td></td>
<td>EN 50463-5</td>
<td>Train builder</td>
<td>Manufacturer Integrator</td>
</tr>
<tr>
<td>Installation testing</td>
<td>yes</td>
<td>yes</td>
<td>yes</td>
<td>EN 50463-5</td>
<td>Train builder</td>
<td>Integrator and Railway Undertaking</td>
</tr>
</tbody>
</table>

NOTES
- Metrological marking of devices is permitted after device testing.
- Columns ‘Who?’ only give examples.
Is permission needed of NSA?

EN 50463 is an harmonized standard. Devices conform with EN 50463 comply with requirements of Directive (and TSI). An ‘EC’ verification is only needed for new rolling stock or retrofitting on recent already TSI compliant rolling stock.

This can be requested by train builder to National Safety Authority (NSA). NSA will assess the reports of assessments made in accordance with EN 50463-series. NSA might request assistance of Notified Body.

Adding devices in locomotive or on the roof can have impact on safety. So a request shall always be made to NSA to verify impact of adding these devices on the already given safety certification of the locomotive.
Is reverification needed?

Energy sensors and meters might loose accuracy during life time.

New loc&pas TSI (2014) has following text in clause 4.2.8.2.8: ‘The maintenance documentation described in clause 4.2.12.3 of this TSI shall include any periodic verification procedure, in order to ensure the required accuracy level of the on-board energy measurement system during its lifetime.’

Regulator of railway market in Member State where rolling stock is registered has to verify that the Railway Undertaking fulfils the requirements from this maintenance documentation.

So the need of reverification or recalibration shall be described by the manufacturer and included in the maintenance documentation of the rolling stock.
How is energy data handled on the ground?

**Energy meter on train**

**Data Collecting Service**
(= server on ground connected with internet)

**Leaflet 930**
This module verifies country where consumption took place.

**YourPower**
Invoice for traction energy to Railway Undertakings running on our network.

**Erex Exchange**
T28 runs in Germany. Eress transmits consumptions in Germany to DB Energie.

**Erex Settlement**
Consumption in Belgium is compared with train data and used to create energy invoice.

**GPRS**

UIC ENERGY EFFICIENCY DAYS 2014
Communication from train to ground

Mobile communication, e.g. GPRS or WiFi

Data Collecting Service (actually via commercial contracts)

Energy meter on train

EN 50463 has no fixed protocol for this communication. The same company delivers the data logger on the train and data collection on ground.

New Energy TSI contains requirements for Data Collecting Service. A communication between two subsystems (rolling stock and energy) shall be specified exactly. European Commission requests a unique communication protocol.

2014

2016

Adjusted EN 50463 shall have exact communication protocol. Adjusted TSI’s shall refer to this protocol.
What will become mandatory end 2018?

All new, renewed and upgraded traction units shall have an energy meter. Communication to ground shall be in accordance with new mandatory protocol (published end 2016).

All Member States shall ensure that an on-ground data collecting system able to collect these metering data is implemented.

All Member States shall ensure that an on-ground settlement system is implemented. This system shall be able to receive data, exchange data with other Member States, validate them and allocate them to the correct end user.
UIC ENERGY EFFICIENCY DAYS 2014

ANTWERPEN, 16 - 19 JUNE

ESSENTIAL DATA EXCHANGES WITH ENERGY MARKET

OVE NESVIK

Energy Efficiency, the best fuel to move our trains!
SHORT INTRODUCTION

• Worked with EDI in the energy sector since 1993
• Secretary and EDI consultant for
  – ebIX®
  – ebIX®, EFET and ENTSO-E Harmonisation Group
  – Nordic Ediel Group
  – Nordic Balancing System (NBS)
• Member of UN/CEFACT and IEC
Harmonised Electricity Market Role Model
RAILWAY ENERGY BILLING ROLE MODEL

(FROM UIC LEAFLET 930)
An Accounting Point (earlier called Local Metering Point) is a commercial entity for which there is balance responsibility where the energy volumes (consumption and generation) are computed for the related business processes and where a balance supplier change can take place.
A Metering Grid Area is a physical area where consumption, production and exchange can be metered. It is delimited by the placement of meters for period measurement for input to, and withdrawal from the area. It can be used to establish the sum of consumption and production with no period measurement and network losses.
MARKET BALANCE AREA

A geographic area consisting of one or more Metering Grid Areas with common market rules for which the settlement responsible party carries out a balance settlement and which has the same price for imbalance.

A Market Balance Area may also be defined due to bottlenecks.
RELATIONSHIPS [1]
IMBALANCE SETTLEMENT [1]
IMBALANCE SETTLEMENT [2]
IMBALANCE SETTLEMENT [3]
IMBALANCE SETTLEMENT [4]
IMBALANCE SETTLEMENT [5]
SOME USEFUL LINKS


www.ebix.org

www.eress.eu

www.nbs.coop (Nordic Balance Settlement)
THANK YOU FOR YOUR KIND ATTENTION!

<?xml version="1.0" encoding="UTF-8"?>
<ResponsibleForPresentation>
    <Name>Ove Nesvik</Name>
    <Email>ove.nesvik@edisys.no</Email>
    <Company>Edisys Consulting AS</Company>
    <Url>http://www.edisys.no</Url>
</ResponsibleForPresentation>
ROLES OF INFRASTRUCTURE MANAGER AT ENERGY MARKET

YULIANA MIRONOVA

CHIEF LEGAL ADVISOR OF THE « ENERGY DISTRIBUTION » DEPARTMENT
NATIONAL RAILWAY INFRASTRUCTURE MANAGER OF BULGARIA

Energy Efficiency, the best fuel to move our trains!
Legal ground of energy market actors and roles:

- First and Second Energy Packages: functional accounting and legal separation
- Third Package: separated network operation
IM as actor:

- IM is a common actor at the energy and railway markets
- IM is a vertically integrated company
- Three different models possible for IM
ROLES OF ELECTRICITY AND RAILWAY MARKETS

- ownership unbundling
- independent system operator (ISO)
- independent transmission operator (ITO)
THE OWNERSHIP UNBUNDLING

Grid operator
IM
VIC

Transport – Property of the grid

Generation

Supply
THE INDEPENDENT SYSTEM OPERATOR (ISO)
A. ITO
Limited liability company

B. Holding company IM

contracts

Generation

Supply

THE INDEPENDENT TRANSMISSION OPERATOR (ITO)
ANNEX 1 OF THE THIRD ENERGY PACKAGE

▲ details of price (tariff sheets)

▲ billing process
CHARGING OF SERVICES

(1)

The “Use of distribution network” service

COST

incurred directly as a result of operating the train service – elements:

○ full network costs
○ network losses
○ mark-ups for the active energy
○ taxes for other system operators
The “Supply of energy” service

COST
shown on the invoices separately - elements:

- energy costs
- costs for balancing
- costs of green certificates and cogeneration certificates
  - CO$_2$ emission rights
- suppliers taxes and profit
CONCLUSIONS:

1. Organizational and charging principles are more adequate today.

2. The regulations close together the railway principles to those of the electricity systems.
Thank you!

E-mail: u.mironova@rail-infra.bg
UIC ENERGY EFFICIENCY DAYS 2014

ANTWERPEN, 16 - 19 JUNE

RAILWAY TRACTION GRID

WALTER AERTSENS
ENERGY EXPERT - INFRABEL

Energy Efficiency, the best fuel to move our trains!
EUROPEAN LEGISLATION

- Railway directive 2012/34/EU:
  - IM may sell electricity to RU upon request in a non-discriminatory manner: additional service
- Electricity directive 2009/72/EU
  - Principles
    - Free choice of supplier
    - Ownership unbundling
      - Exceptions possible for DSOs: eg less than 100,000 customers
  - Roles
    - Transmission system operator (TSO)
    - Distribution system operator (DSO)
      - Closed distribution system operator (CDS - multi users site)
EUROPEAN LEGISLATION: CDS

• Definition (article 28):
  – A geographically confined industrial, commercial or shared service site if
    • There is an integrated system
    • Electricity is used primarily by the owner or their related undertakings

• Possible (European) exceptions:
  – Procurement of energy to cover the losses and reserve capacity
  – Tariffs and/or methodologies must not be approved in advance by the regulator

• Railway stations are mentioned as an example in the considerations (nr 30)
RAILWAY VS ELECTRICITY

- Network statement
  - Energy tariffs
- Users agreement
- EVN-number
- Energy meter

- Grid code
- Tariffs
- Connection agreement
- EAN-number
- Energy meter
- Balancing
BELGIAN LEGISLATION

• Separate definition in electricity law: railway traction grid
  – Electrical installations used by IM (catenary, substations,…)

• 2 possibilities
  – Traction units: railway legislation - network statement
  – Fixed installations: electricity legislation
    • To be considered as a closed distribution system
    • Connexion agreement

• Common principles
  – Free choice of supplier
  – Publicised tariffs
    • Separation between grid costs and energy
  – Infrabel demands explicit mandate for purchase of electricity
BELGIAN SOLUTION:
SOME MORE INFORMATION

• IM and incumbent RU are completely unbundled (2 separated companies)
• Incumbent RU operates railway stations
  – Railway stations are a CDS connected at the Traction Railway Grid
• Traction Railway Grid is an underlying grid:
  – 61 connections points with TSO and 1,400 with DSOs (including 20 feeding the catenary)
  – Problem: allocation of energy between balancing responsible parties
• Inside Infrabel: there is no separation between electricity grid and supply
  – DSO is not a separate legal entity (energy department contains 6 people)
  – Infrabel does not have own production facilities (but it is not forbidden)