

# Requirements and information for ordering and installing of Railway Energy Meters for trains



Example of an energy measurement unit installed in a locomotive

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## Introduction

The infrastructure managers in Norway (Bane NOR), Sweden (Trafikverket) and Denmark (Banedanmark) have formed a partnership named OREM (“The Operation of Railway Energy Measurement”). The purpose of OREM is to establish a reliable, flexible, efficient and accurate co-operation for measurement and data collection of train energy consumption, and the acquisition of maintenance services for energy meters, as well as acquisition of additional energy meters and spare parts.

The OREM partners have a frame agreement with Hasler Rail AG to supply energy meters, spare parts and services. The energy meters provided in this agreement with Hasler Rail AG fulfill the requirements in the EN50463:2012 standard and EN50463:2017 (energy measurement onboard train systems).

The costs of data collection, data validation, distribution, and related services are charged to the railway undertakings as administrative costs on the traction energy invoice from the infrastructure managers.

Energy data collected from the energy meters purchased under the OREM frame agreement with Hasler Rail AG and the former frame agreement with EnergyICT (now Honeywell) are sent to the Erex system for settlement and billing of traction energy.

The complete Energy Measurement System contains the following components:

- Energy Measurement Unit (Energy meter including GPS receiver and communication module)
- Voltage and current sensors
- Antenna for data transfer GSM/GPS
- Cabling
- Power supply to this system

## Ownership and terms and conditions

Below the ownerships and costs of energy meters are described for the Scandinavian countries.

**Norway:** Vehicle keeper will be the purchaser of the energy meters at the first time they are installed or for energy meters to new Vehicles.

Bane NOR will purchase and deliver energy meters to be installed on trains for repair cases/or replacement of old not working energy meters ordered from Bane NORs contracts.

Bane NOR is the owner of the energy meters.

**Sweden:** Trafikverket purchase, own and administer reparation for energy meters.

**Denmark:** The railway undertakings purchase, own and administer reparations for energy meters.

## Engineering of the Energy metering system

Some components need to be present on the train before installation of energy meter can start, voltage and current sensors, power supply and 4G/GPS antenna. This is the responsibility of the vehicle keeper. If the energy meter is to replace an old meter, these components may already be present. In this case, the antenna should be checked to see if it covers the required bands described in **table 1** under the section **Antennas**. Antennas and cables are purchased directly from suppliers by railway undertakings or the vehicle keepers.

Information about prices on energy meters or other items in the framework agreement can be supplied upon request to [emu@banenor.no](mailto:emu@banenor.no).

## Ordering

### Ordering energy meter

## Ordering energy meters

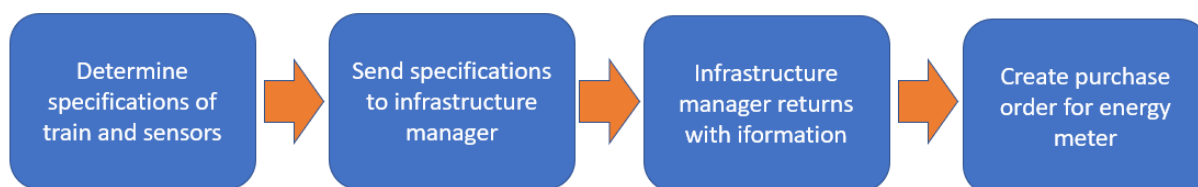


FIGURE 1: Steps for ordering energy meters.

In the framework agreement Bane NOR, Trafikverket and Banedanmark has with Hasler Rail AG, it is possible for railway undertakings or the vehicle keeper running on these infrastructure managers grids to order energy meters. It is also possible for parties acting on behalf of railway undertakings or vehicle keepers to order energy meters, such as train builders. The infrastructure manager is responsible of declaring the relations of a party to Hasler Rail AG when ordering energy meters.

Below the steps shown in the figure above is described in detail.

### Step 1:

Determine Energy Measurement System (energy meter) specifications.

The energy meter model to be used is to be defined by Hasler Rail AG. The model is defined based on specifications of the current transducer, voltage transformer for the specific train type.

The standard model in the frame agreement has 4G communication and a single channel for voltage and current measurement. If an energy meter with GSM-R communication is preferable, contact Trafikverket at [bjorn.allebrand@trafikverket.se](mailto:bjorn.allebrand@trafikverket.se).

Other variants or models of energy meters can be requested specifically, then with reservations of additional costs and delivery/development time.

### *Step 2:*

Sending the energy meter specifications to infrastructure manager.

The customer sends the specifications for the current transducer and voltage transformer to be used to the infrastructure manager. The form "Engineering details for EMS system.doc" is to be filled in and sent to [emu@banenor.no](mailto:emu@banenor.no).

The data sheets for the current transducer and voltage transformer are to be sent to Bane NOR: [emu@banenor.no](mailto:emu@banenor.no). Hasler Rail AG will make a judgement on the EMS accuracy of sensors and energy meter based on the standard EN50463. All TSI compliant vehicles need to fulfill the requirements in Loc and Pas TSI 2014 with amendments from 2018.

### *Step 3:*

Infrastructure manager returns with information.

The energy meter calculation result is to be presented to the infrastructure manager. If the accuracy requirement is fulfilled, the energy meter model can be decided by Hasler Rail AG. Exceptions from the requirements shall be approved by infrastructure manager.

After a final decision of energy meter model has been defined; the Purchase Order can be created by the customer.

At this time the INFRASTRUCTURE MANAGER will provide details about price and Reference number to framework agreement to be used for step 4.

### *Step 4:*

Creation of the purchase order.

This chapter gives information to the Customer on how to make a Purchase Order for energy meters to be ordered from the Framework agreement between Bane NOR, Trafikverket and Banedanmark and Hasler Rail AG.

The Customer creates the purchase order. The purchase order shall contain the following items.

- Traction unit type and railway undertaking who will be operating the trains.
- Unit price and quantity.
- Reference number to framework agreement.
- Part number of energy meter for specific traction unit type.
- Part number of mounting plate if mounting plate is wanted.
- Delivery address and contact person

The purchase order shall be sent to Hasler Rail on the email to the following contacts: [luca.foroni@haslerrail.com](mailto:luca.foroni@haslerrail.com). (Project manager), to: [Giordano.Bellomi@haslerrail.com](mailto:Giordano.Bellomi@haslerrail.com) (sales office) and a cc to [emu@banenor.no](mailto:emu@banenor.no)

After purchase order is received, the supplier will start manufacturing energy meters. When the energy meters are ready, they will be sent to the Customer to the agreed delivery address.

Delivery time from supplier is according to the contract 17 weeks after all details are confirmed.

From 2022, the delivery time became longer, delivery time is to be confirmed from the supplier.

### Solution for SIM cards

Infrastructure manager will order SIM cards to new energy meters. This SIM cards will be delivered to the company responsible for installation and commissioning of the energy meter. SIM cards will be inserted into the energy meters during installation of energy meter in the vehicle. The infrastructure manager is responsible for the data transfer costs for the SIM Cards delivered from Trafikverket and Bane NOR. In Denmark the railway undertakings are responsible for purchasing SIM Cards and the data transfer costs.

If SIM cards are damaged or lost, new ones can be provided by infrastructure manager for Sweden and Norway. The request should be sent to [emu@banenor.no](mailto:emu@banenor.no).

For energy meters ordered outside the frame agreement of Bane NOR and Trafikverket SIM cards will not be supplied by infrastructure manager.

### Antennas

The antenna used for the energy meter should be a combined GPS and 4G GSM antenna. For an antenna to be 4G compliant, it needs to cover the following frequency bands:

| Band            | 31  | 20  | 08  | 03   | 01   | 07   |
|-----------------|-----|-----|-----|------|------|------|
| Frequency (MHz) | 450 | 800 | 900 | 1800 | 2100 | 2600 |

TABLE 1: Frequency bands that shall be covered for an antenna connected to an energy meter.

### Technical specification

The energy meters are made for traction units operating on AC grids on 15 kV and 16,7 Hz frequency and/or 25 kV and 50 Hz frequency.

The full technical specifications for the energy meter can be supplied upon request. Send an email to [emu@banenor.no](mailto:emu@banenor.no) with your request.

### Compliance

Hasler Rail AG energy meters fulfill the requirements in the EN50463:2012 norm. From February 2022 the version of the meters that fulfilling the EN50463:2017 standard (energy measurement onboard train systems) is added to the Frame agreement with Hasler Rail.

Voltage transformers and current transducers must also be compliant with EN50463 requirements.

## Preparation and planning

The railway undertakings or vehicle keepers are responsible for planning and installation of all necessary equipment in the trains for the energy measurement system. Planning and engineering are the responsibility of the railway undertaking or vehicle keeper. The infrastructure manager is responsible for supplying the energy meter.

Experience shows that it will be a good solution to secure the energy meter from overvoltage's, with a fuse between the secondary side of voltage transformer and the measurement unit.

Power supply for the energy meter needs to be in correct size, and the new model provided requires more power supply than the older energy meter model from EnergyICT (used from 2007).

When ordering new energy meters, it's to be decided if a mounting plate for the new energy meter is needed or not. The mounting plate is made to have the same screw-holes as an old energy meter (Model from EnergyICT) for simpler installation.

The mounting plate could be supplied with a new energy meter. If ordered as a spare part on a later stage, costs will be charged directly to railway undertaking or vehicle keeper.

## Installation and commissioning

The energy meter supplier is responsible for the installation and commission procedure for the energy meter. The infrastructure manager will provide this procedure to railway undertakings or vehicle keepers before installation.

The procedure only covers the energy meter, for interfacing with train systems the railway undertaking, or vehicle keeper is responsible for providing additional documentation (e.g. current transducer, voltage transformer, antenna cabling etc.).

For more detailed information/specifications for the installation, see the Installation Manual, which can be viewed on request to [emu@banenor.no](mailto:emu@banenor.no).

To verify a successful installation, the person/company that has carried out the installation must run a system check in accordance with the energy meter installation and commissioning report (see attachment) and complete the report with test results and signature confirming that all tests have been carried out. All fields denoting the railway undertaking or vehicle keeper as the responsible party must be completed. The exception is the field for consumption, which can be left blank if it is not possible to verify this at the time of installation.

The completed and signed *installation and commissioning report* shall be sent to [emu@banenor.no](mailto:emu@banenor.no).

When a completed installation and commissioning report has been received, the energy meter will be registered, and the measured data values will be collected by a data collection system and sent to the Erex settlement system.

In addition, the vehicle keeper shall provide a conformity assessment report for vehicles under the Loc & Pas TSI (2014). The report shall show that the energy measurement requirements are met according to the requirements in EN50463-2017.

Commissioning procedures are different for energy meters compliant to EN50463-2012 compared with energy meters compliant to EN50463-2017.

For energy meters compliant to EN50463-2017 there is a more complex commissioning procedure to comply with the higher level of data security required by the EN50463-2017 norm. The infrastructure manager will provide the update of the commissioning procedure document written by Hasler Rail to the Vehicle keeper when it's finished from Hasler Rail. This document is expected to be finished in Q2 2022.

The energy meter supplier provides training session for installation and commissioning to the installation company. The infrastructure managers are normally responsible for covering the cost for this training session, the costs covered is the payment of the training session held by Hasler Rail. Time cost for the Vehicle keeper installation staff is not covered by the infrastructure managers.

## Warranty and Maintenance responsibility

Infrastructure manager keeps overview on the warranty period with the meter supplier.

Warranty period of energy meters are 36 months starting from the date the meter is delivered by supplier.

The railway undertaking is responsible for trouble shooting and replacement of broken energy meters if this is needed in the energy measurement system. If there is a need for replacement of energy meters already installed the infrastructure manager will provide replacement energy meters to the railway undertakings, this solution is for Sweden and Norway. In Denmark, the railway undertakings are in charge of organizing replacement meters with the supplier.

## Data control

When the meter is taken into use and sends data regularly, the OREM administration monitors that it works properly.

If an energy meter is suspected of having a fault, the following actions are taken:

- 1) The OREM system operator carries out an examination in their systems, to identify possible sources for the error.
- 2) The railway undertaking responsible for the vehicle with the affected energy meter will be contacted if troubleshooting is required on the affected traction unit. This will be done by the railway undertakings maintenance staff.
- 3) If a fault is identified on the energy meter, it is likely that it needs repair or to be replaced. It will then need to be sent to the energy meter-supplier. Specific actions are decided between infrastructure manager, railway undertaking and supplier.  
The railway undertaking is responsible for disconnecting, replacing, and shipping the energy meter. The infrastructure manager is responsible for supplying the replacement energy meter.



## Attachments and references

The referred attachments can be found at the webpage of Bane NOR:

<https://www.banenor.no/jernbaneforetak/tjenester-og-leveranser/tilleggstjenester/strom-til-togframforing/energimaling/>

- Installation and commissioning report
- Engineering details for energy meter 15 kV
- Engineering details for energy meter 25 kV

Reference documents:

“Cexalex\_32018RO868\_EN\_TXT “this is an amending Regulation (EU) No 1301/2014 and Regulation (EU) No 1302/2014 as regards provisions on energy measuring system and data collecting system implemented by REGULATION (EU) 2018/868 of 13 June 2018.

## Revision table

| <i>Description of changes</i>  | <i>Change by</i>   | <i>Date</i> |
|--|--|-------------|
| Document created   | Reidun Jørgensen<br>& Dag Storhaug                                   | 04.09.2019  |
| Clarified separate ownership conditions for Scandinavian countries. Inserted Step 3 to ordering EMUs.<br>Text cleanup.   | Reidun Jørgensen<br>& Dag Storhaug                                   | 17.09.2019  |
| Updates for Loc and Pas TSI (2014 with amendments from 2018) compliant Rolling stock requirements are described  | Reidun Jørgensen<br>& Dag Storhaug                                   | 14.01.2022  |
| List of attachment and Reference documents updated   | Reidun Jørgensen<br>& Dag Storhaug                                   | 14.01.2022  |
| Smaller editorial changes in general   | Reidun Jørgensen<br>& Dag Storhaug                                   | 14.01.2022  |
| “Warranty and Maintenance responsibility”<br>Smaller text updates  | Reidun Jørgensen<br>& Dag Storhaug                                   | 14.01.2022  |
| Changed terminology from ‘Energy Measurement Unit (EMU)’ to ‘energy meter’ for simpler language, and to avoid confusion with ‘Electrical Multiple Unit’.<br><br>Added some information to include changes in products and procedures as a result of the norm EN50463-2017. | Reidun<br>Jørgensen,<br>Dyre Martin<br>Gulbrandsen<br>& Dag Storhaug | 02.03.2022  |