![TRAFIKVERKET]

High Resolution data from energymeters in Sweden

Björn Ållebrand
Trafikverket

Eress Forum 2025

Different kind of high resolution data fron energymeters

1. High Frequency High Resolutions data (operational and statistical)
2. High Resolution data (Statistical)

3

History: Non billing functions on energymeters

- First installation of energymeters started in Sweden 2005

- It was requested by the TPOS-group (Train Positioning System) if it was possible to send in extra messages with GPS position.

- Once every ten second a GPS message were sent to a server at Trafikverket using UDP protocol.

On-board voltage measurement function

- First project description in 2011

- Included as an option in the procurement 2014

- Contract with Saira (Hasler Rail) 2015

- 2017-2020 Nordic project about functionality

- Intense work to convince IT to further develop their data receiving system to receive this vast amount of data

- Finally something really useful 2023!

On-board voltage measurement, UDP

- Special function in the REM102 used by Trafikverket in Sweden

- Transmits data using UPD protocol to a special server at Trafikverket. UDP protocol has no handshaking dialogues. Data lost is lost, 99% of data received

- `$ER,veh_nbr,id_code,v0,i0,cos0,v1,i1,cos1,pa0,pr0,pv0,pa1,pr1,pv1,time_t`

NAME
Server #1
- Broadcast
- Interface
- Destination
- Port
- Interval

TRAFIKVERKET

On-board voltage measurement

- Approx. 1200 electric vehicles in service in Sweden
    - 550 locos
    - 650 EMU

- Locos with Hasler Rail REM 102 energy meter
    - Data from 350 energy meters is currently collected and stored
    - 257 with GSM-R, 245 of them are sending data for analysis, the rest need a software update
    - 400 with GSM, 100 sends data for analysis, the rest is waiting for upgrade to 4G or SW upgrade.
    - In the next two years 200 more energy meters with GSM will be installed with automatic transfer of data.
    - 850 vehicles will send data in 2026

TRAFIKVERKET

Who is using the data at Trafikverket?

- Train positioning group

- Electric power supply group

- Also Train Operators want to use their data and some have received small parts of data.
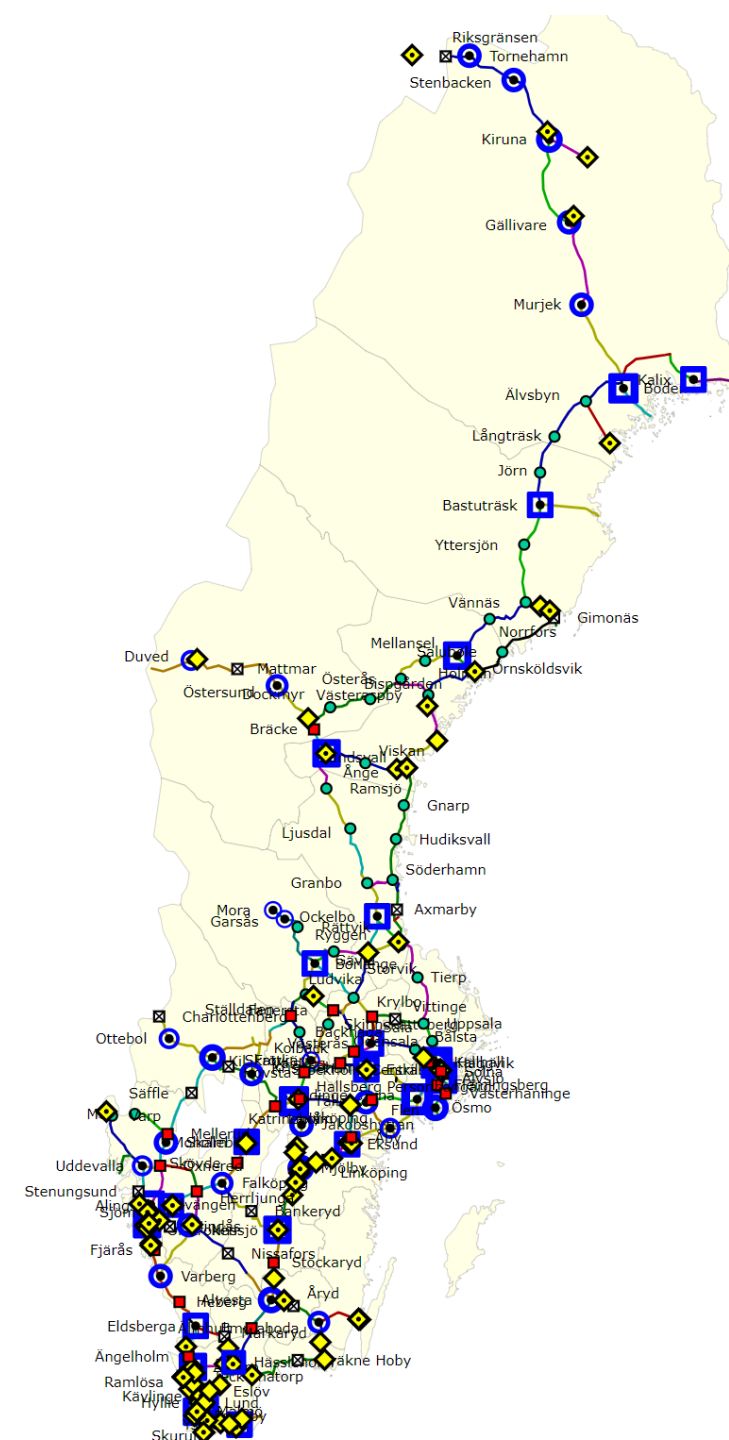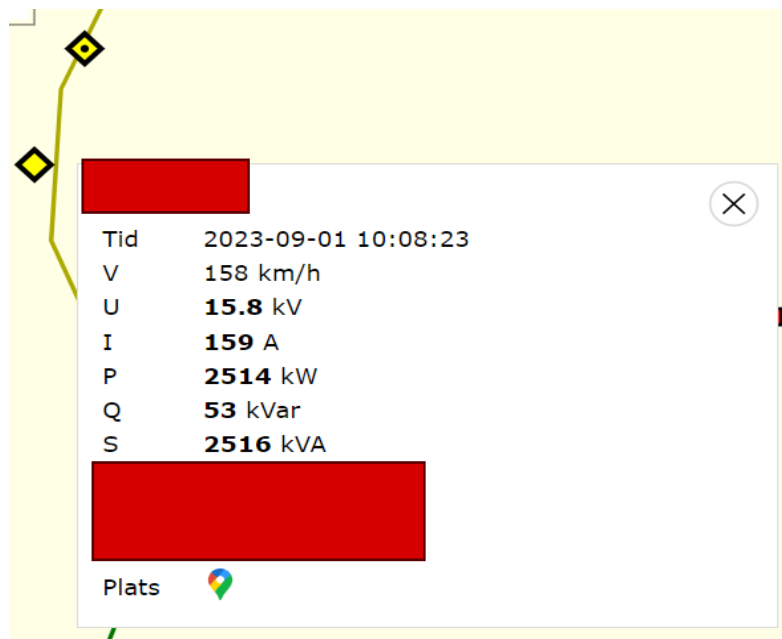
Limitations

- TPOS group needs data not older than 15 seconds to be useful. This is for train positioning.

- Electric Power Supply group. Need for data which is 2 seconds long or less. This is to get acceleration pattern of a train.

TRAFIKVERKET

Data

- Each energy meter sends with 2 seconds interval
  - Date
  - Time
  - Vehicle ID
  - Voltage
  - Current
  - Active power
  - Reactive power
  - Apparent power
  - CosPhi
  - Position
  - speed

- Typical 1 000 000 rows / vehicle / month

9

Operational use

- Power grid dispatcher,
  Real time or a snap shot in time.

|	
Tid	2023-09-01 10:08:23
V	158 km/h
U	**15.8** kV
I	**159** A
P	**2514** kW
Q	**53** kVar
S	**2516** kVA

Plats

Line Voltage

- Voltage (percentiles)

- Height profile

- Number of measurement values for each position (stations have more and higher measurement values because the trains are at standstill)

- Only implemented on 4 lines and not auto-updated so far
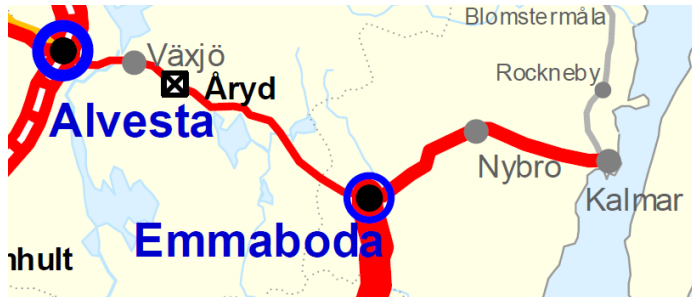
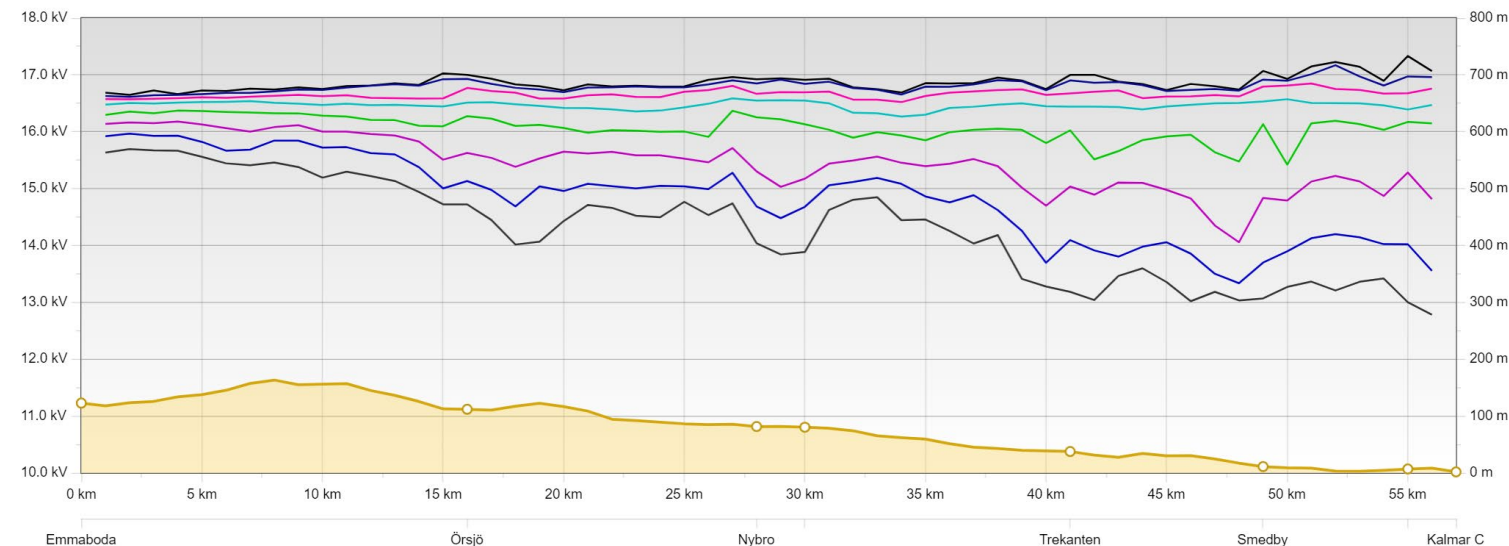Spänningshållning: Falköping (F) - Nässjö (N)

September - December 2022
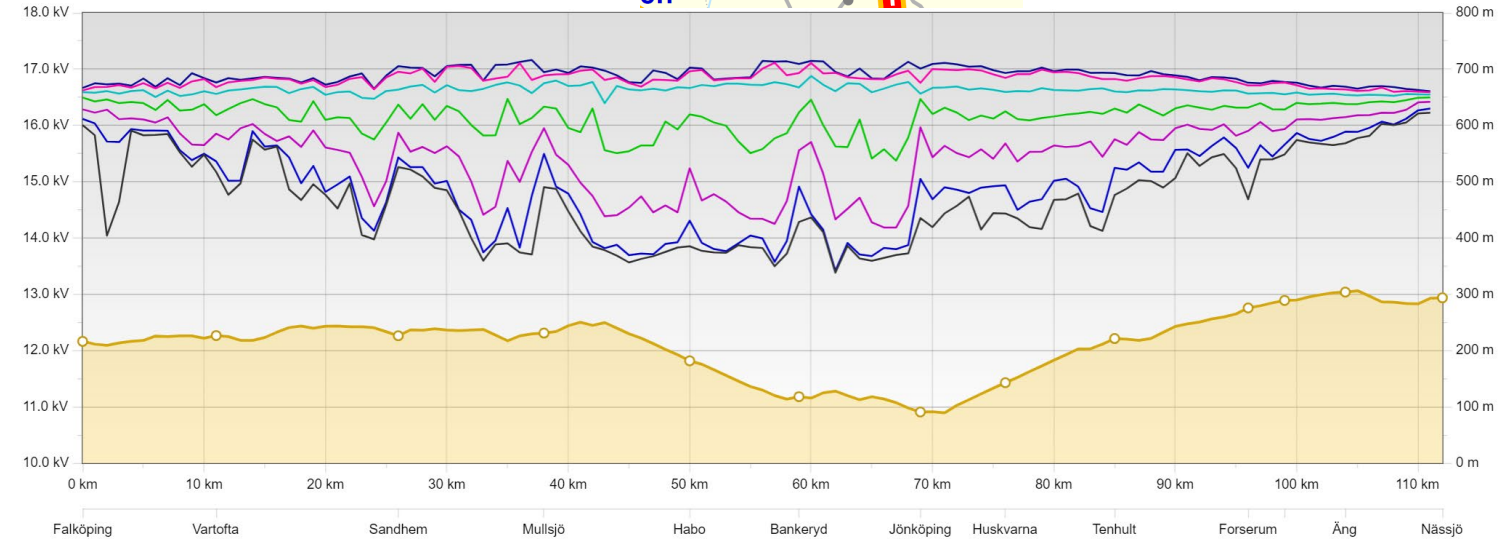
Spänningshållning: Emmaboda (EM) - Kalmar C (KAC)

September - December 2022
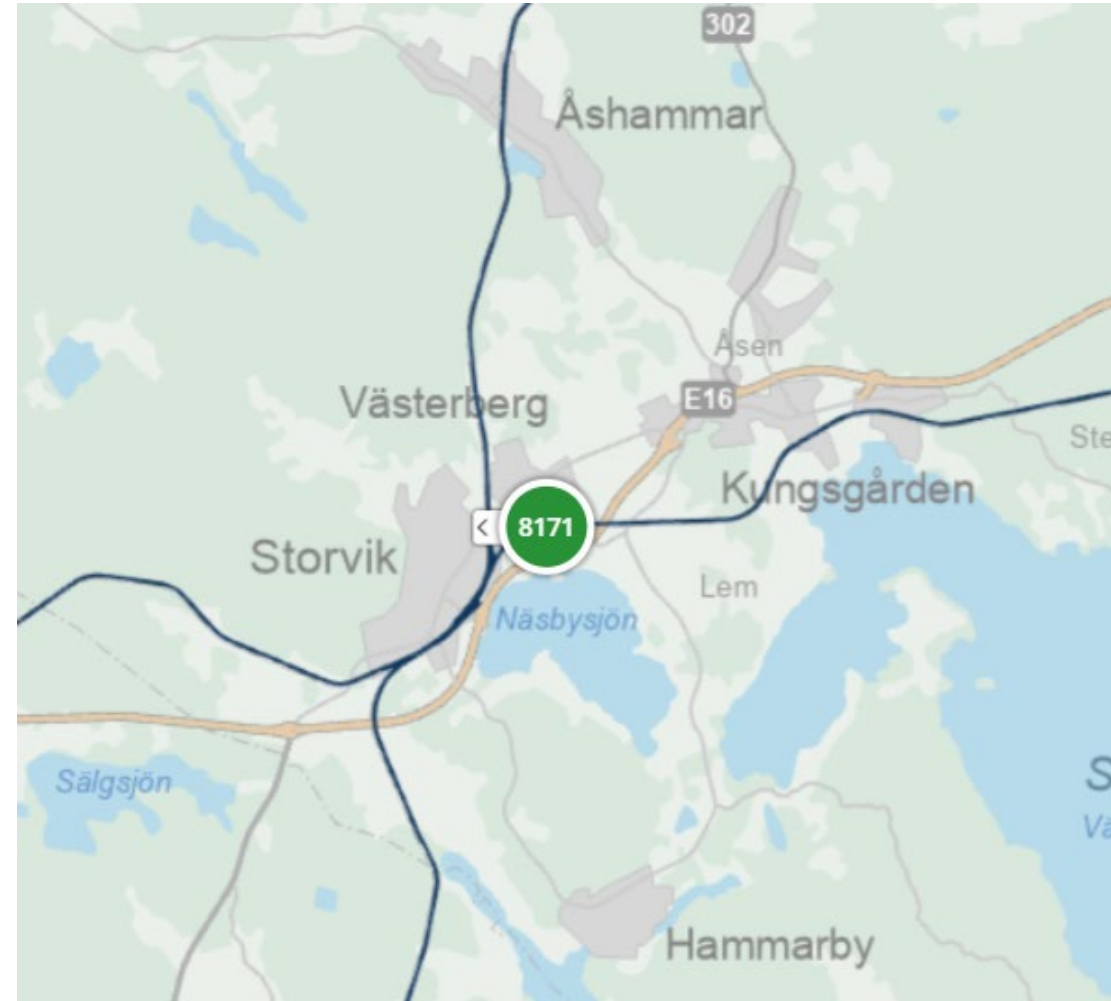
TRAFIKVERKET

Line Voltage user cases

- Do we need a converter station?

- Is the voltage level good enough?

Train Positioning group

- Arrival forecasts for trains

- Position to passengers (Public Train map)

- Information to emergency services

TRAFIKVERKET

Future

- Automatic fault detecting, both finding faults on trains and in the infrastructure.

- Scarecrows for game passages.

- Standardisation.

- Exchange of data between countries?

- Trainoperators

Thank you for listening!