

Advanced Metering Technology

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Agenda

- Cyber Security
- Measurement of traction electric energy consumption of stationary (active shutdown) vehicles
- Measurement start time after vehicle is turned on - advanced solution
- A brief review of the past and nowadays
- ETAS - Energy Tracking and Analysis System
- DCS
- BILLING
- Driver Advisory
- Current references

Cyber Security

- EMS POLL CEGM-3000 has been tested by NoBo VUZ (Výzkumný Ústav Železniční, a.s., <https://www.cdvuz.cz/homepage-en/>).
- The test was successful - EMS POLL CEGM-3000 withstood all tested cyber attacks.
- The outcome is an evaluation report and certificate issued by NoBo VUZ, based on the VUZ standard and following ISO 27001, IEC 62443 and TC 50701.

	VÝZKUMNÝ ÚSTAV ŽELEZNIČNÍ, a. s.	TECHNICKÁ ZPRÁVA Kybernetické testování	Úst: 1 Počet listů: 46
TECHNICKÁ ZPRÁVA			
Číslo technické zprávy:	TZ/Cyber/2025/0100		
Název zkoušky:	Zápis z penetračního testování vlakového elektroměru a měřicí skříně (CEGM 3000)		
Předmět zkoušky:	Kybernetické testování		
Objednatel:	Ing. Petr Dobrovolný Test and service manager Quality manager POLL, s.r.o. Výpadev 1676/4a, 153 00 Praha 5 E-mail: petr.dobrovolny@skodagroup.com Mob.: +420 732 368 325 www.poll.cz		
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Measurement of traction electric energy consumption of stationary (active shutdown) vehicles

- The CEGM-3000 is designed to reliably register energy consumption from as low as **0.1% of the rated current**.
- This **capability is verified by an accredited metrology laboratory** on each manufactured item, guaranteeing customers that energy consumption will be reliably measured even on parked vehicles.
- Example:
 - ▶ **Siemens Vectron with a power of 6400 kW**, which use measuring transformers with a primary rated current of **600 A** for consumption measurement.
 - ▶ However, when parked, their consumption is around 50 kW, which on a 25 kV traction system corresponds to a current of only 2 A. In this particular case, the electricity meter, which starts measuring consumption from 0.4% of the nominal current, will not measure while the vehicle is parked.
 - ▶ The CEGM-3000 is therefore designed to reliably register energy consumption from 0.1% of the nominal current. In addition, POLL has this capability verified by an accredited metrology laboratory on every manufactured unit, guaranteeing customers that energy consumption will be reliably measured even on parked vehicles.

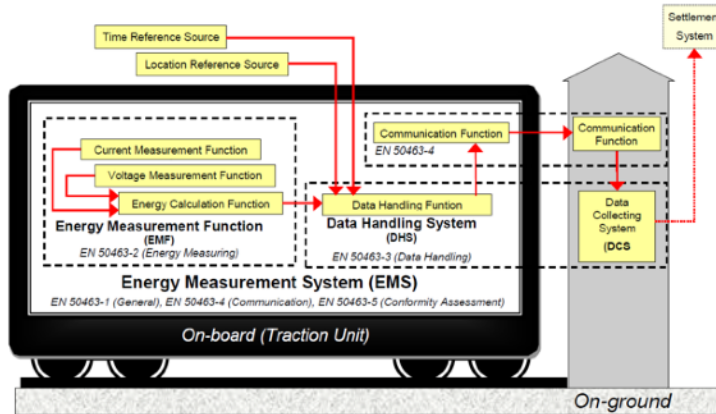
Measurement of traction electric energy consumption of stationary (active shutdown) vehicles



Measurement start time after vehicle is turned on - advanced solution

- The CEGM-3000 starts measuring consumption within 3 seconds of turning on the vehicle's on-board power supply.
- This time includes the start-up of the power supply parts of the electricity meter, the start of the electricity meter and the detection of the connected traction system.
- This functionality contributes to the robustness of the energy measurement system.
- Example:
 - In situations where the energy meter may be exposed to extreme external influences such as atmospheric and surge discharges.
 - Or other unforeseen events that would cause the measuring system to reset, the measurement will restart within 3 seconds.

A brief review of the past and nowadays



- CMF - Current Measurement Function
- VMF - Voltage Measurement Function
- EMF/ECF - Energy Measurement/Calculation Function
- DHS - Data Handling System
- Communication Function
- DCS - Data Collecting System
- BILLING System
- ETAS - Energy Tracking and Analysis System
- DAS - Driver Advisory System
- **Cyber Security**

Dual Energy Measurement System CEGM-3000

Key Features

- Fully Certified Dual/Single System.
- Compatible all certified measuring transformers/converters/transducers.
- Single/Dual Energy Measurement System - measurement of active and reactive energy, consumed and recuperated energy in all traction power systems (25kV/50Hz, 15kV/16 $\frac{2}{3}$ Hz, 3kVDC, 1,5kVDC, 750VDC, 600VDC).
- Saving and transfer of min./max. power, voltage and current values in set periods of time.
- Accuracy class 0.5R according to EN 50463/C acc. to EN 50470/0.5S acc. to IEC 62053-22 and IEC 62053-24.
- Broadband power supply 16.8V to 137.5V DC, power supply failure classS2.
- Isolated measuring inputs 2000V AC / 1 minute.
- Up to 72 days data logger.
- NTP or GPS time synchronisation.
- GPS localisation – logging and transfer of location reports.
- Data connection via GSM/GSM-R in ABL/XML/UTILTS data format.
- Remote monitoring/management/diagnosis via server (DCS) ...

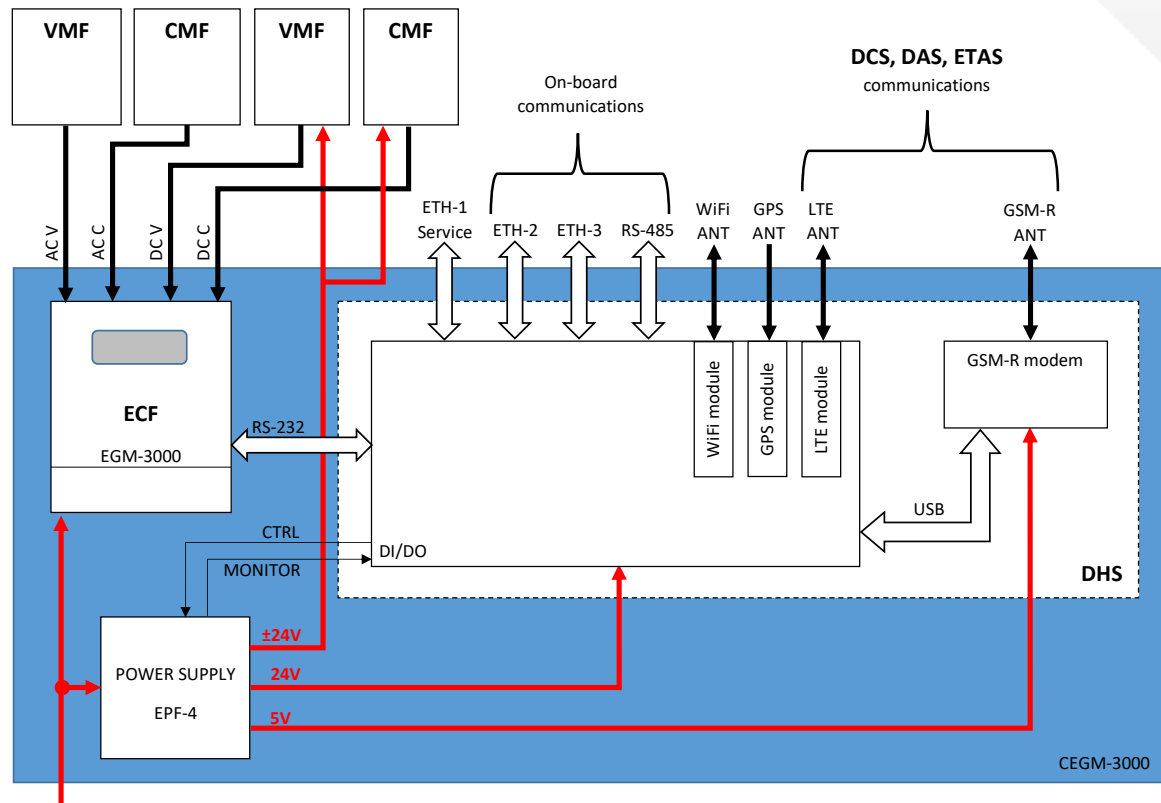
Dual Energy Measurement System CEGM-3000

Key Features

- Range of AC nominal voltages 40V to 250V
- Range of AC nominal currents 40mA to 5A
- Range of DC nominal currents on voltage input 20mA to 100mA
- Range of DC nominal currents 20mA to 2A
- Record period 1 minute to 60 minutes
- A record memory of at least 72 days
- Snapshot records after 1 second to 60 seconds
- Memory snapshot records 60 minutes
- Built-in GPS module
- Smart Sealing System – avoidance of misapplication
- IP54 covering and easy sealing of connected cables, even in setup without switch board
- Possibility of installation in a distribution box for easier and faster installation / replacement on a locomotive
- ERESS compatibility FTP/SFTP, HTTP data formats for full DCS.

Dual Energy Measurement System

System Architecture in Accordance with EN 50463:2017



16,8V – 137,5V

CEGM-3000



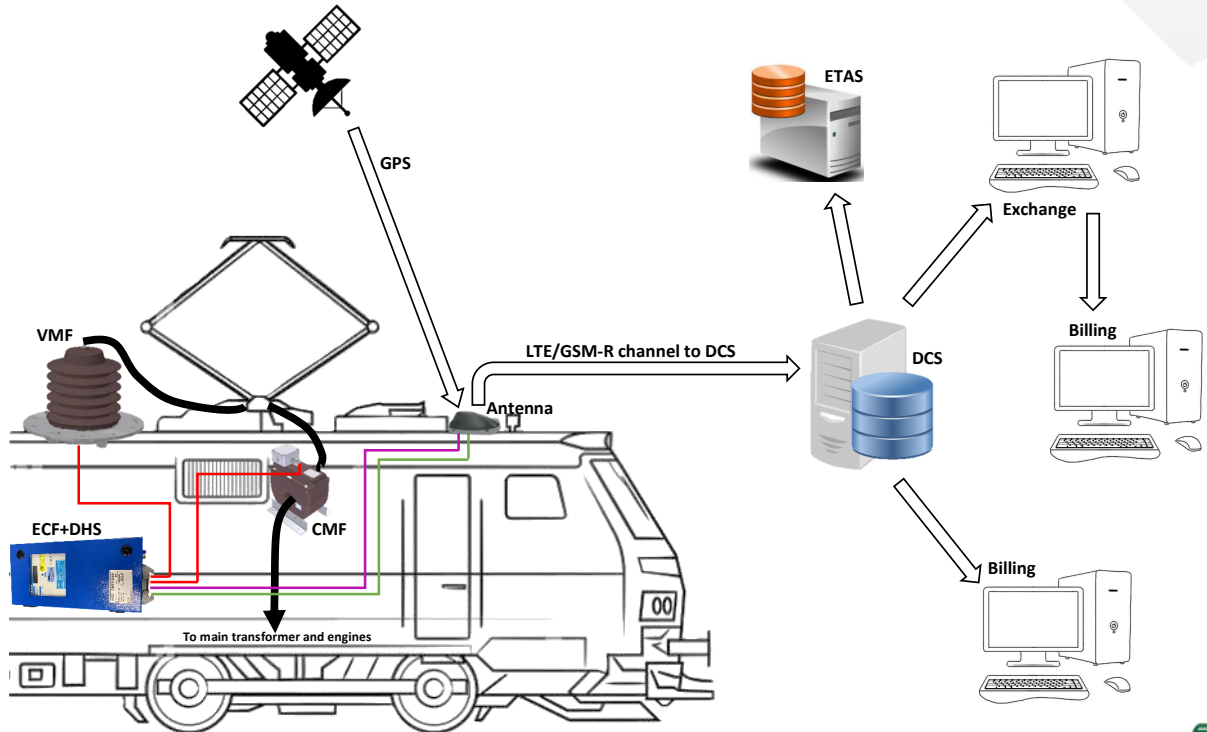
CEGM-3000 Communication Interface

Energy Measurement System Offers These Communication Interfaces:

- RS-485, RS-232 – Serial communication bus with possibility of external GPS module connection
- 2x 100Base-T Ethernet – internal train Ethernet network connection, 1x Ethernet for service access
- GPS – connector for external GPS antenna
- GSM – connector for external GSM/GSM-R/UMTS/LTE antenna
- WiFi – WiFi antenna connector
- WiFi Access point for wireless supervision / management
- Transmitted data formats ABL, XML, HTML, UTILTS
- CAN (on demand)

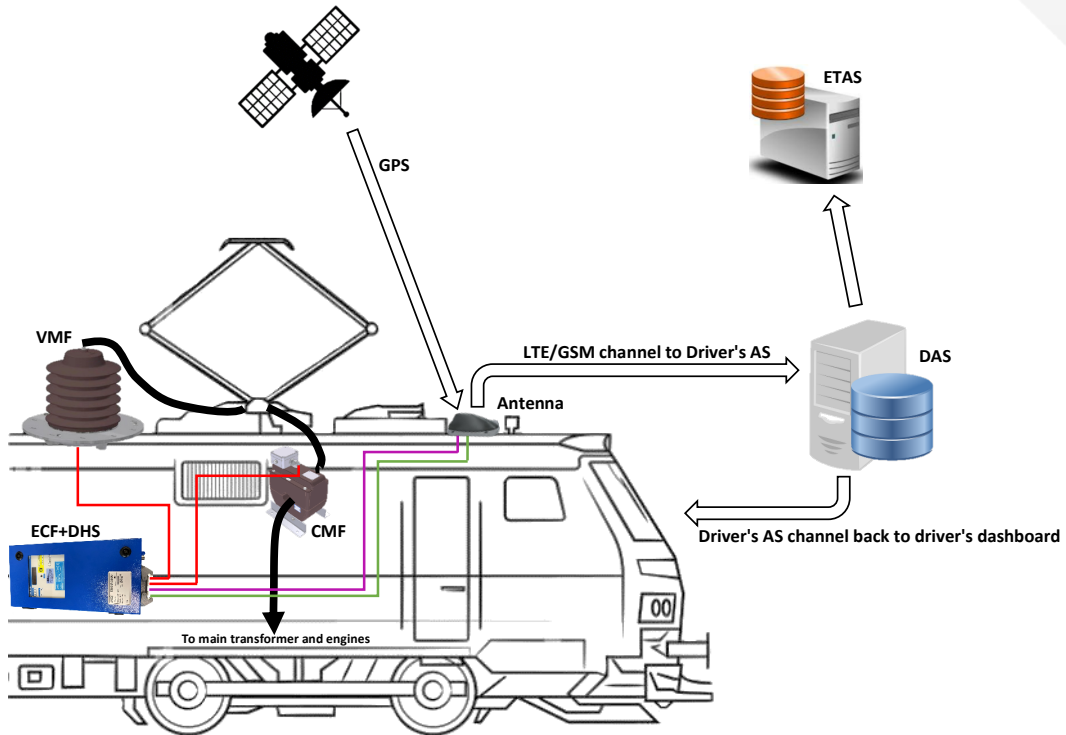
Single/Dual Energy Measurement System

System Architecture in Accordance with EN 50463:2017



Single/Dual Energy Measurement System

System Architecture in Accordance with EN 50463:2017





Pictures of CEGM-3000



Outputs from DCS - ETAS - Energy Tracking and Analysis System

- ETAS system interface enables analysis of measured energy values.
- The ETAS interface is accessible through the DCS web interface, where it has a dedicated section in the menu.
- The basic structure of the default pages of the ETAS interface is as follows:
 - **Unit report** - a page for generating tabular reports for individual units.
 - **Unit consumption** - pages for generating tabular or graphical reports of locomotive consumption.
 - **Type consumption** - pages for generating tabular or graphical reports of consumption by locomotive type.
 - **Tracks map** - a page for visualising consumption on tracks between stations.
 - **Route map** - a page for visualising consumption on a route between two selected points.

Outputs from DCS - ETAS - Energy Tracking and Analysis System

Unit report

Unit report Control

From: 01.06.2025 00:00



To: 02.07.2025 07:46



Update

Filter

Unit reports

Export as: JSON , XML , CSV , XLSX

cpid	days_total	days_cold	A+ [kWh]	A- [kWh]	catenary	catenary_avg	distance	distance_avg	speed_avg
TR_TCDD_1000002300191	32	0	225142.400	049203.500	695	21:44	143521.183	004485.037	155.538
TR_TCDD_1000002300271	32	0	311073.400	070685.800	669	20:55	150178.907	004693.091	162.755
TR_TCDD_1000002300351	32	0	506981.300	119357.000	612	19:08	136158.756	004254.961	147.561
TR_TCDD_1000002300431	32	0	276322.800	062042.800	680	21:16	151791.703	004743.491	164.503
TR_TCDD_1000002300501	32	0	143997.900	028810.700	718	22:27	136376.357	004261.761	147.798
TR_TCDD_1000004300151	32	0	178587.400	037749.400	708	22:08	144629.769	004519.680	156.741
TR_TCDD_1000004300231	32	0	153519.500	031423.600	714	22:19	146633.506	004582.297	158.915
TR_TCDD_1000004300311	32	0	311684.500	070871.300	670	20:57	124057.634	003876.801	134.448
TR_TCDD_1000004300491	32	0	366909.500	084596.500	654	20:28	142910.485	004465.953	154.882
TR_TCDD_1000006800151	32	0	406344.100	094256.900	643	20:07	153160.192	004786.256	165.990
TR_TCDD_1000006800231	32	0	341474.400	078308.700	662	20:41	272613.912	008519.185	295.448
TR_TCDD_1000006800311	32	0	109263.000	020439.300	728	22:46	146426.083	004575.815	158.692
TR_TCDD_1000006800491	32	0	540997.100	127531.000	616	19:15	153227.144	004788.348	166.062

Export as: JSON , XML , CSV , XLSX

Outputs from DCS - ETAS - Energy Tracking and Analysis System

Unit consumption

Consumption table Control

Period: From: To:

Selected Units

Add Unit: Remove Unit:

E23001

E23002

E23003

E23004

E23005

Selected Areas

Add Area: Remove Area:

Ankara

Sivas

Consumption table

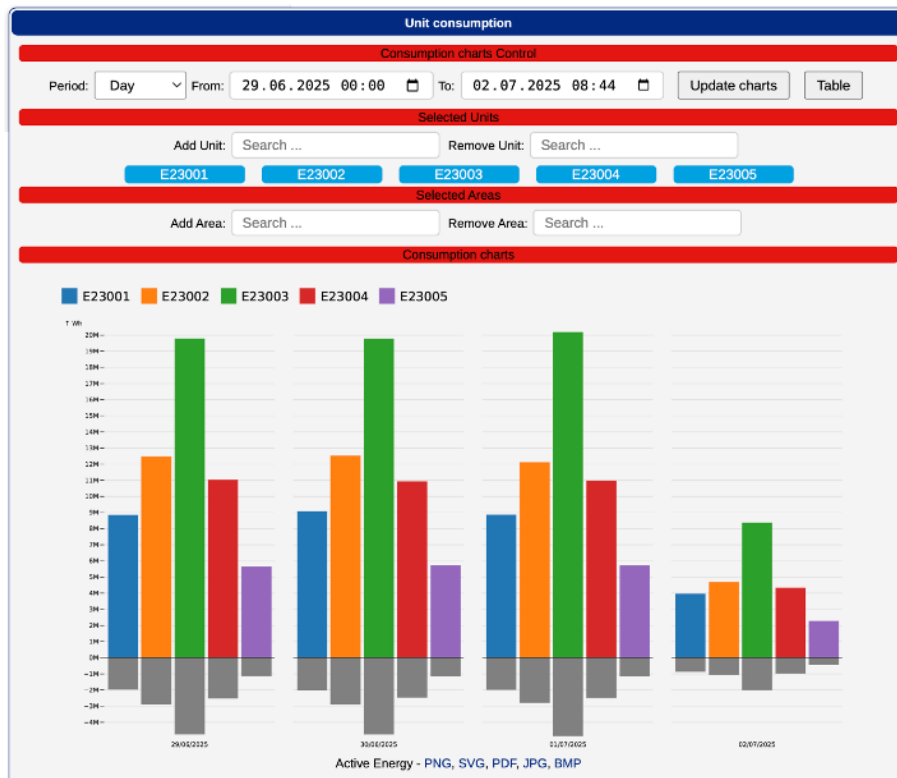
Export as: [JSON](#) , [XML](#) , [CSV](#) , [XLSX](#)

time	unit	area_id	A+ [kWh]	A- [kWh]	R+ [kvarh]	R- [kvarh]
06/2025	E23002	Sivas	084665.900	019533.500	023185.100	009017.100
07/2025	E23002	Sivas	004975.200	001193.300	001266.900	000550.200
06/2025	E23001	Ankara	039000.400	008391.100	010601.300	003874.400
07/2025	E23001	Ankara	002089.400	000460.900	000534.000	000211.700
06/2025	E23002	Ankara	018580.200	004241.300	005097.800	001955.800
07/2025	E23002	Ankara	001308.600	000310.100	000336.000	000143.100
06/2025	E23004	Ankara	037622.800	008624.800	010306.900	003983.100
07/2025	E23004	Ankara	002148.100	000497.800	000546.000	000230.200
06/2025	E23005	Ankara	056058.300	011384.200	015132.900	005259.300
07/2025	E23005	Ankara	003263.600	000681.500	000834.000	000315.100

Export as: [JSON](#) , [XML](#) , [CSV](#) , [XLSX](#)

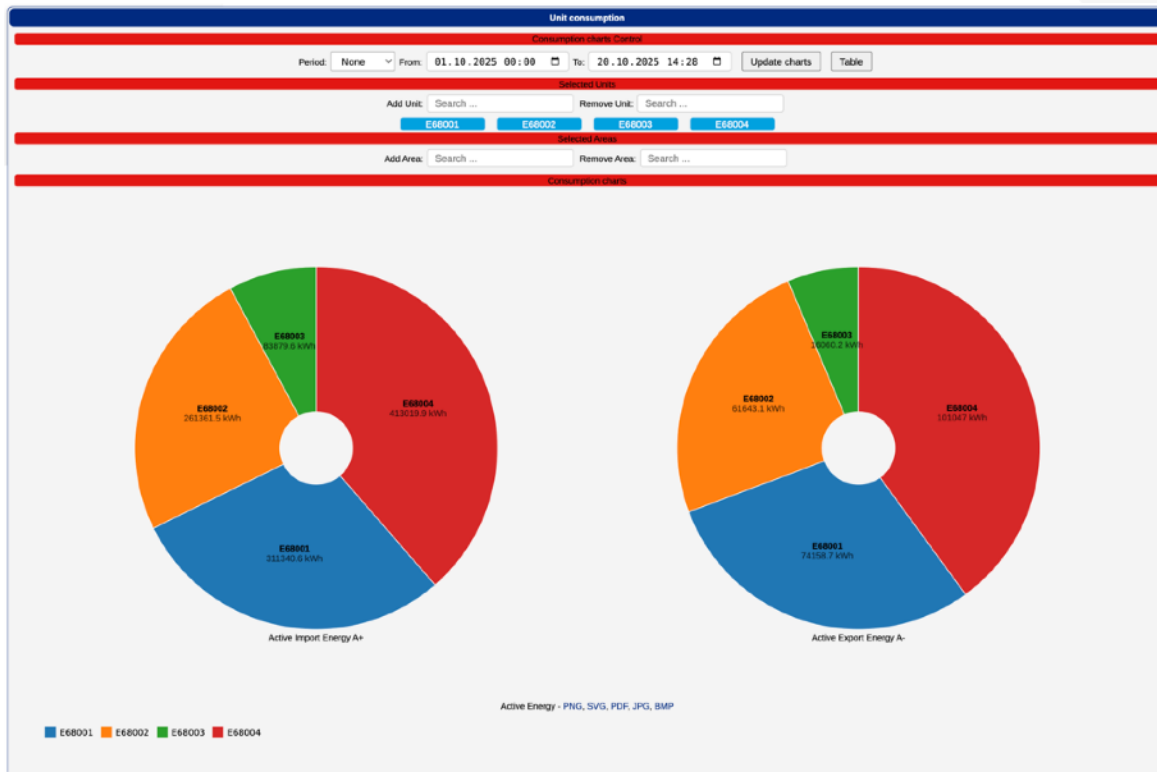
Outputs from DCS - ETAS - Energy Tracking and Analysis System

Unit Consumption Chart



Outputs from DCS - ETAS - Energy Tracking and Analysis System

Unit Consumption Chart



Outputs from DCS - ETAS - Energy Tracking and Analysis System

Type consumption

Consumption table Control

Period: From: To:

Selected Types

Add Type: Remove Type:

E23000

E43000

E68000

Selected Areas

Add Area: Remove Area:

Ankara

Sivas

Consumption table

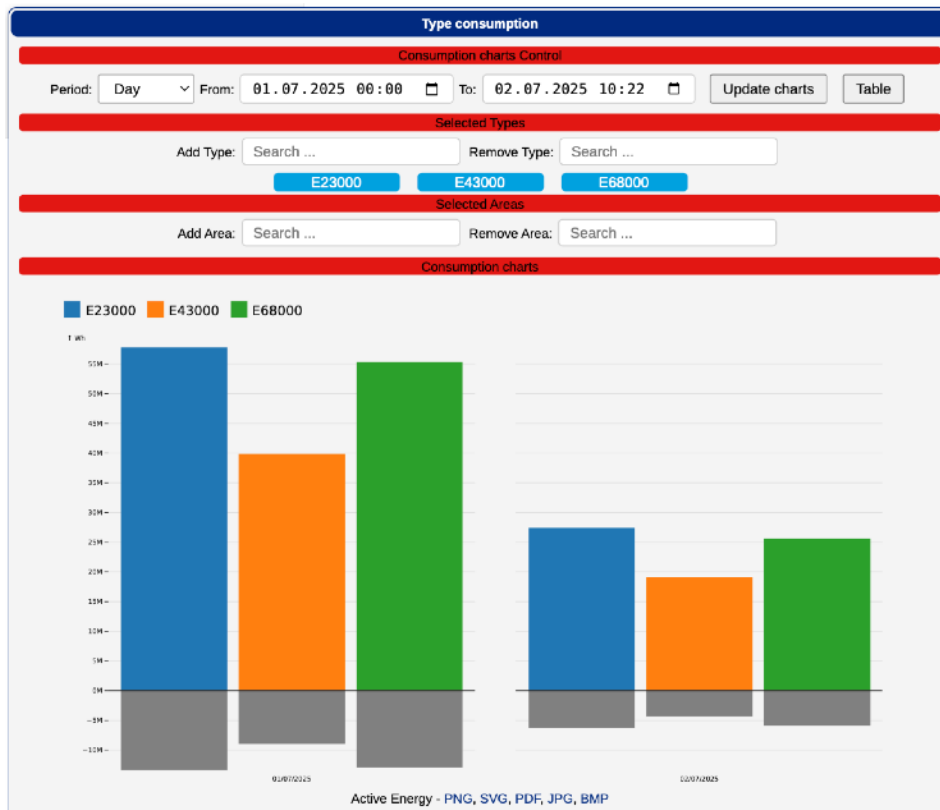
Export as: [JSON](#) , [XML](#) , [CSV](#) , [XLSX](#)

time	type	area_id	A+ [kWh]	A- [kWh]	R+ [kvarh]	R- [kvarh]
01/07/2025	E23000	Sivas	003951.300	000943.700	001006.900	000435.500
02/07/2025	E23000	Sivas	001983.900	000480.100	000504.500	000222.800
01/07/2025	E68000	Sivas	007968.900	001780.400	002038.500	000824.200
02/07/2025	E68000	Sivas	003788.100	000850.900	000966.000	000393.800
01/07/2025	E23000	Ankara	006340.100	001412.200	001619.300	000652.200
02/07/2025	E23000	Ankara	002732.700	000593.200	000697.900	000273.500
01/07/2025	E43000	Ankara	000203.500	000000.000	000050.200	000000.000
02/07/2025	E43000	Ankara	000070.300	000000.000	000017.100	000000.000
01/07/2025	E68000	Ankara	002834.800	000640.100	000723.400	000296.300
02/07/2025	E68000	Ankara	001398.800	000310.900	000357.200	000143.200

Export as: [JSON](#) , [XML](#) , [CSV](#) , [XLSX](#)

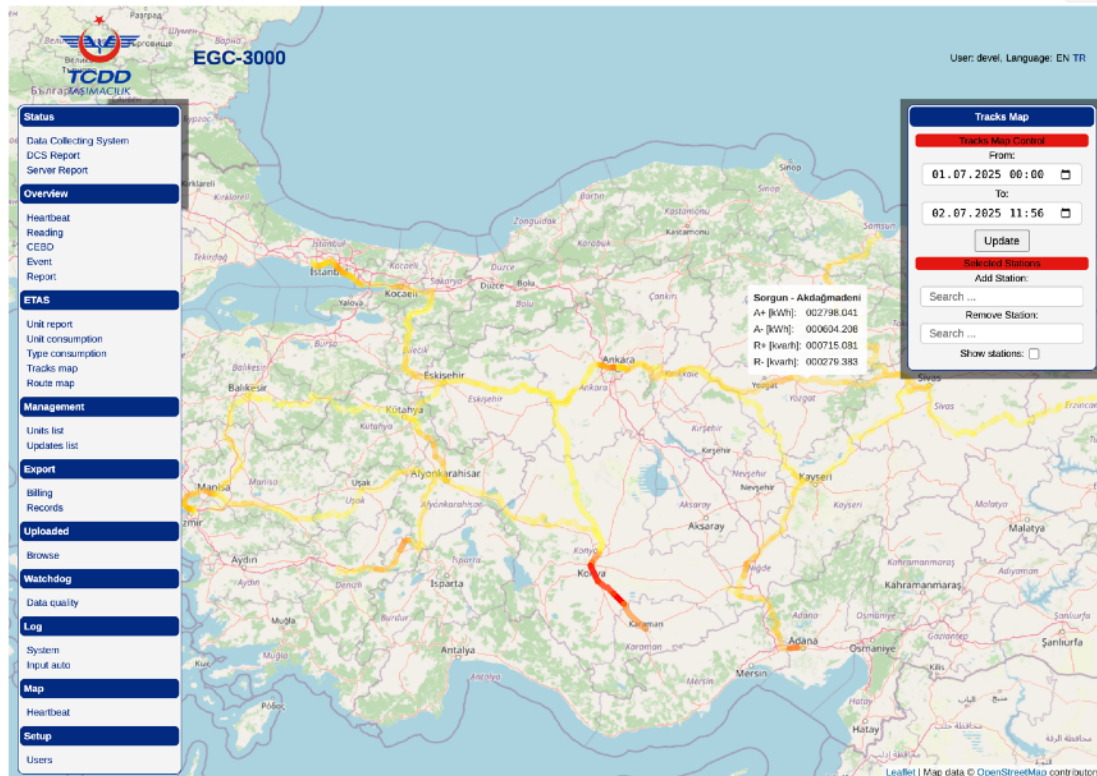
Outputs from DCS - ETAS - Energy Tracking and Analysis System

Type Consumption Chart



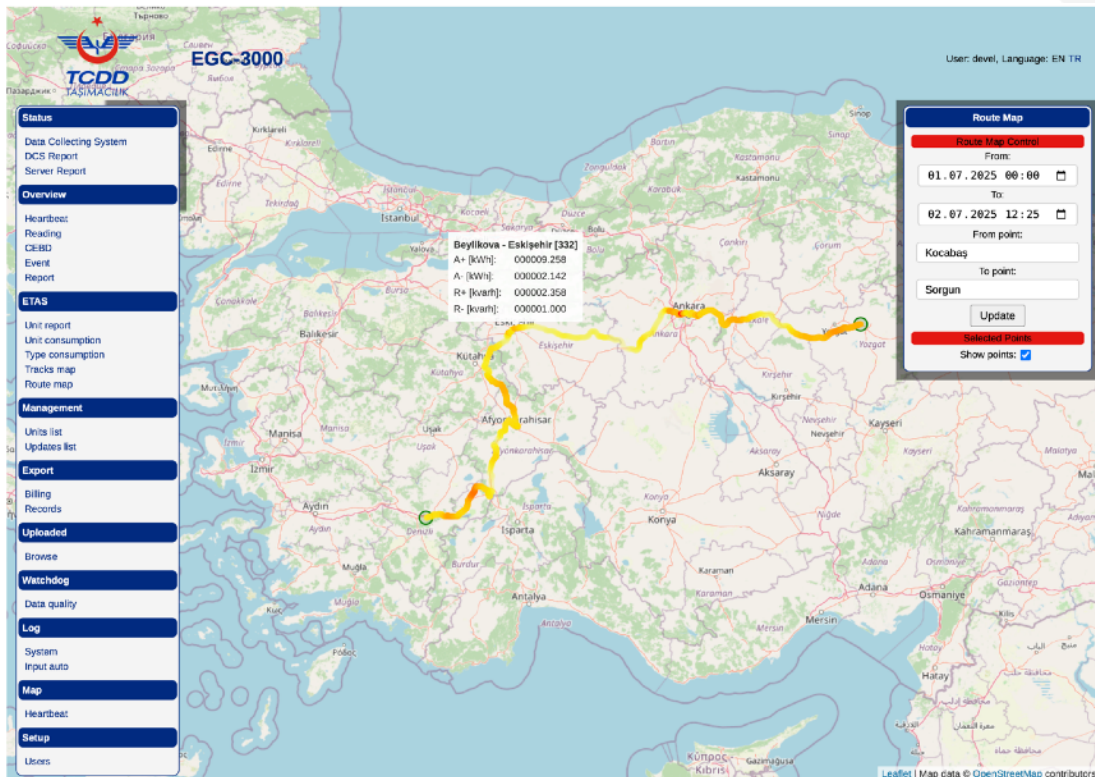
Outputs from DCS - ETAS - Energy Tracking and Analysis System

Tracks Map



Outputs from DCS - ETAS - Energy Tracking and Analysis System

Route Map



References

- **Správa železnic** - is the owner and provider of Czech national and regional railway infrastructure owned by the state www.spravazeleznic.cz. **POLL** has delivered **699 pieces** of EMS type CEGM-3000.
- **ŽSSK Cargo** - **POLL** has delivered of customised **182 pieces** of EMS type CEGM-3000.
- **Správa železnic** - **POLL** has delivered **DCS (Data Collecting System)**.
- **STADLER Polska – ADY FLIRT EMU IR Project**. **POLL** has delivered **19 pieces** of **EGM-3000** for Azerbaijan Railways
- **RELOC SA Romania** - **POLL** is actually delivering of **19 pieces** of EMS type CEGM-3000.
- **TCDD Taşımacılık A.Ş.** via TMS TREN BAKIM ONARIM A.Ş and Legend Technologies Mühendislik Teknoloji ve Danışmanlık San. Tic. Ltd. - **POLL** is actually delivering of **368 pieces** of customised EMS type **CEGM-3000** together with **DCS, BILLING and ETAS**

References – EMUs and Loco Engines

- ALSTOM Ferroviaria - Pendolino
- CRRC Sirius EMU 665
- PESA Elf.eu (series 654)
- SIEMENS VECTRON
- Bombardier TRAXX
- SKODA Loco Engines – almost complete portfolio used in Czech rep., Germany, Poland, Slovakia, Hungary railway
- SKODA EMUs – 13Ev, 14Ev2, 15Ev, 16Ev, 18Ev, 19Ev, 20Ev, 21Ev, 23Ev
- STADLER ADY FLIRT EMU IR, Azerbaijan Railways
- LE 5100 kW locomotives
- Under preparation:
 - HT65000 Train Set (6 Car)
 - HT80000 Train Set (8 Car)
 - HT80100 Train Set (8 Car)
 - E23000 Train Set
 - E32000 Train Set (5 Car)
 - E64000 Train Set (10 Car)
 - E44000 Train Set (5 Car)
 - E43000 Locomotive
 - E68000 Locomotive

Thank you for your attention

