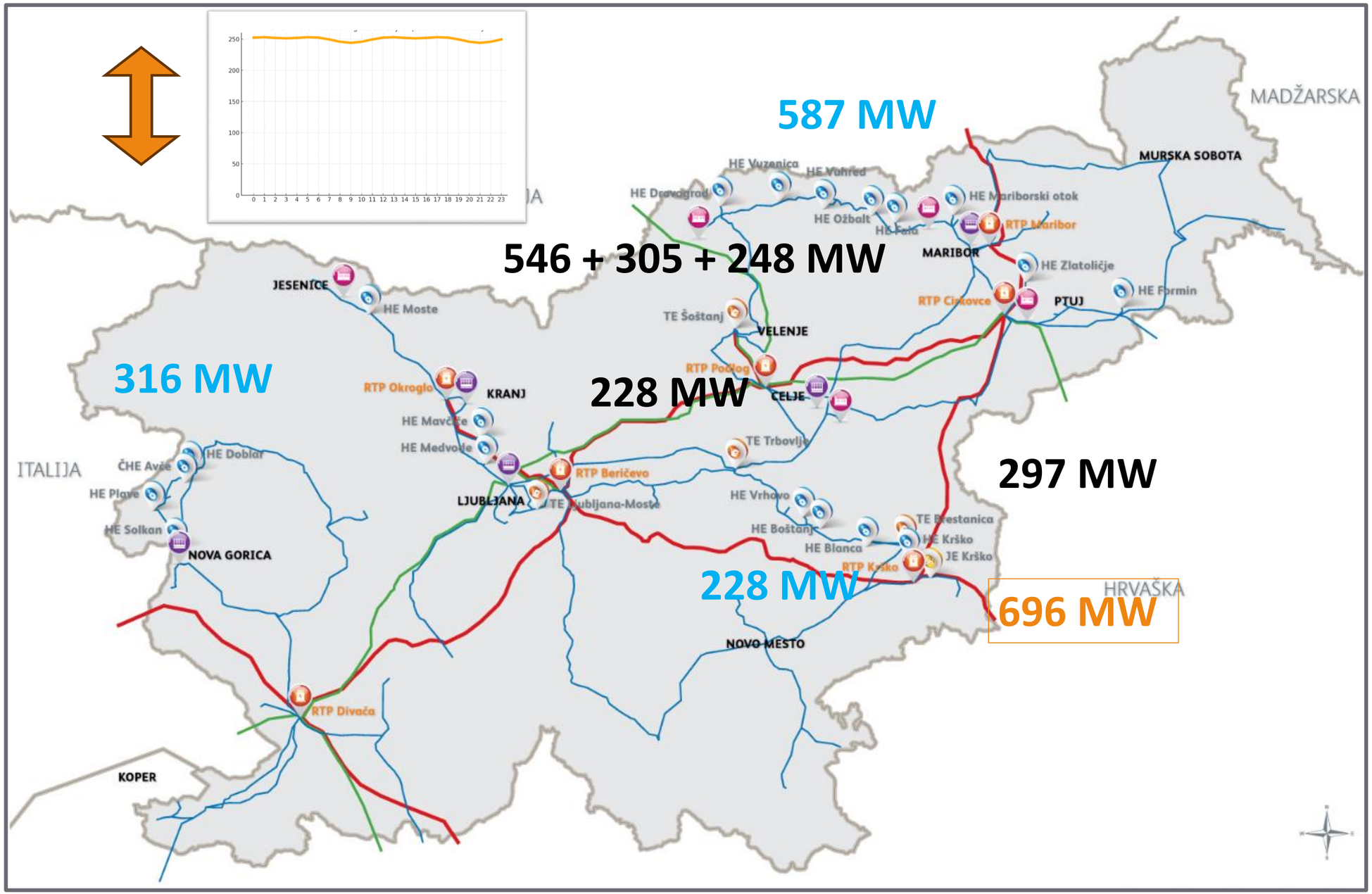
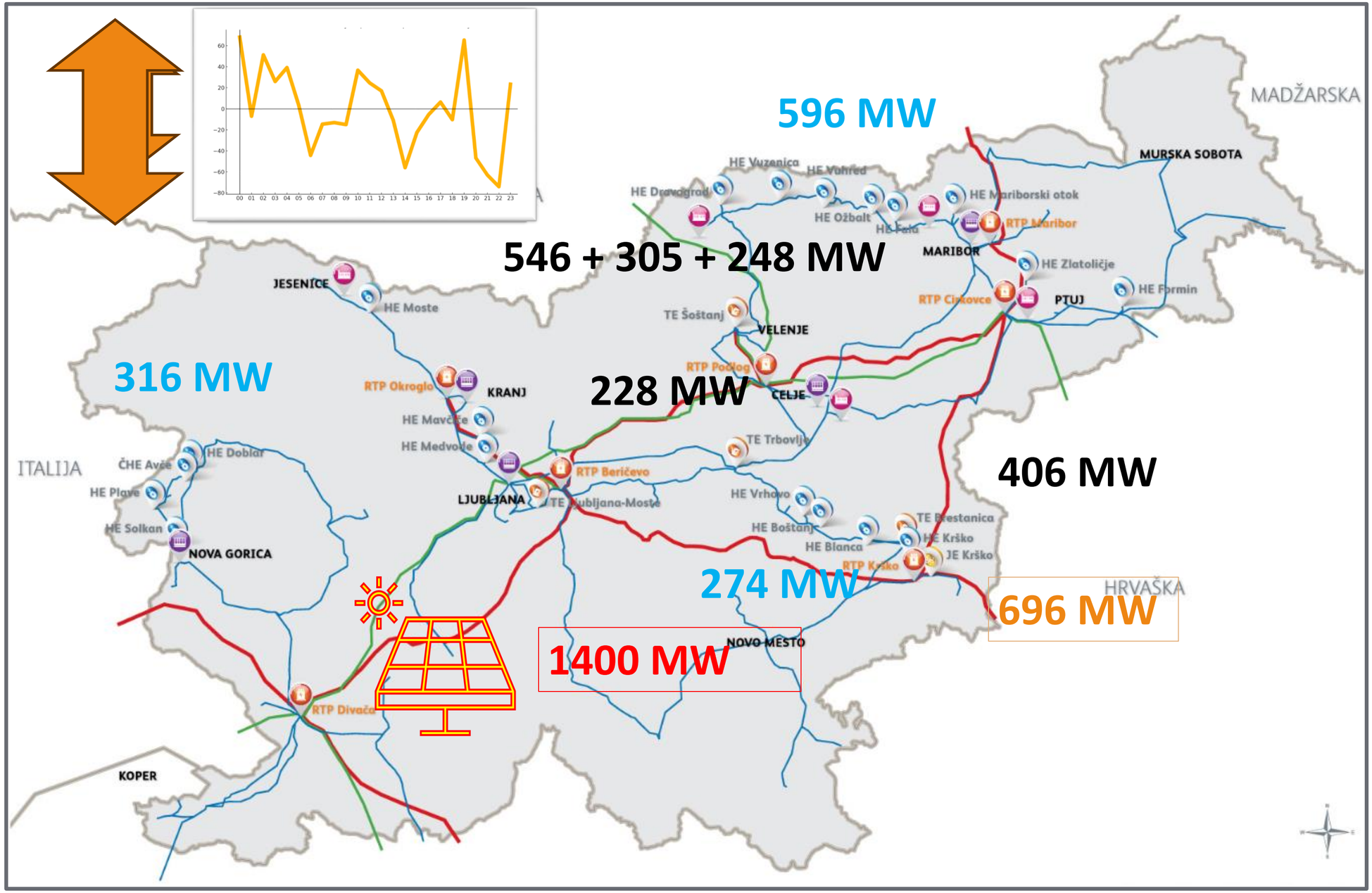
Ensuring Slovenian Transmission System Resilience in Response to Green Transition Challenge

Tadej Demšar
System operation

2015


587 MW
546 + 305 + 248 MW
316 MW
228 MW
297 MW
228 MW
696 MW
MADŽARSKA
HRVAŠKA
ITALIJA
MURSKA SOBOTA
MARIBOR
PTUJ
CELJE
VELENJE
KRANJ
JESENICE
NOVA GORICA
KOPER
NOVO MESTO
LJUBLJANA
HE Vuzenica
HE Vuhred
HE Dravograd
HE Ožbalt
HE Fala
HE Mariborski otok
RTP Maribor
HE Zlatoličje
HE Formin
RTP Ptuj
RTP Cirkovce
TE Šoštanj
RTP Podlog
HE Moste
RTP Okroglo
HE Mavčiče
HE Medvode
RTP Beričevo
TE Ljubljana-Moste
TE Trbovlje
HE Vrhovo
HE Boštanj
HE Blanca
TE Brestanica
HE Krško
JE Krško
RTP Krško
HE Doblar
ČHE Avče
HE Plave
HE Solkan
RTP Divača
250
200
150
100
50
0
0 1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23

2025


596 MW
546 + 305 + 248 MW
316 MW
228 MW
406 MW
274 MW
696 MW
1400 MW
MADŽARSKA
HRVAŠKA
ITALIJA
MURSKA SOBOTA
MARIBOR
PTUJ
CELJE
VELENJE
KRANJ
JESENICE
NOVA GORICA
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RTP Divača

How to deal with this changes?

- Flexibility
- Market design
- Investments
- Smart grid
- Operation

Devices for reactive power compensation

- Increase of RES > harder to control reactive power
- Goal to install own compensation devices
- SINCRO.GRID – EU project
- Less dependent on generators and have control over reactive power
- 400 kV and 220 kV
- High reactive power infeed form Balkan region

SINCRO.GRID
Compensation devices

Variable shunt reactor
- 150 Mvar / 400kV SS Divača

SINCRO.GRID

SINCRO.GRID

Compensation devices

Variable Shunt Reactor

- 150 Mvar / 400kV SS Cirkovce

SINCRO.GRID

SINCRO.GRID

Compensation devices

Mechanically switched capacitor with damping network

+ 100 Mvar / 400 kV SS Divača

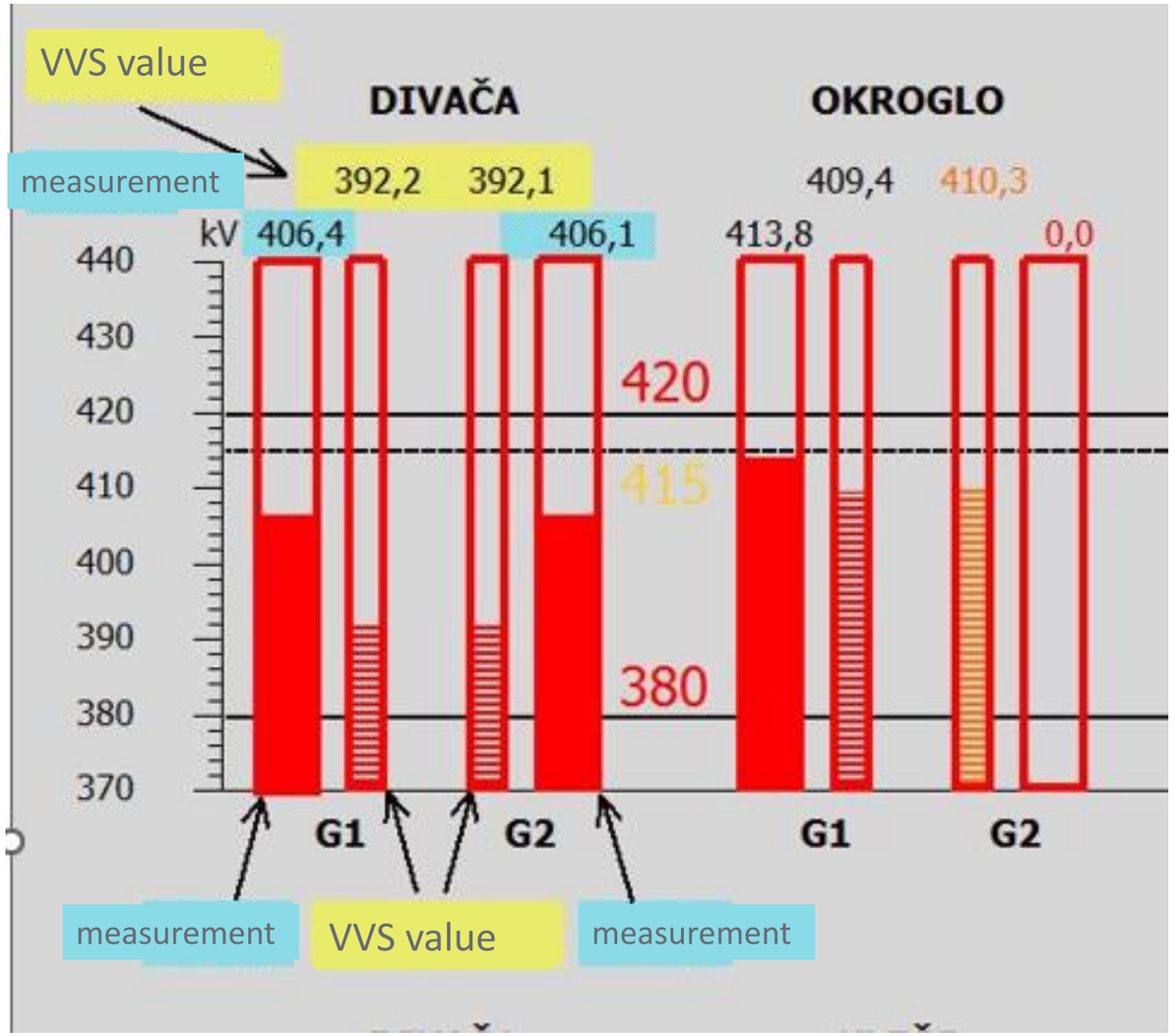
SINCRO.GRID
Compensation devices

Static synchronous compensator
+/- 150 Mvar / 400 kV SS Beričevo

SINCRO.GRID

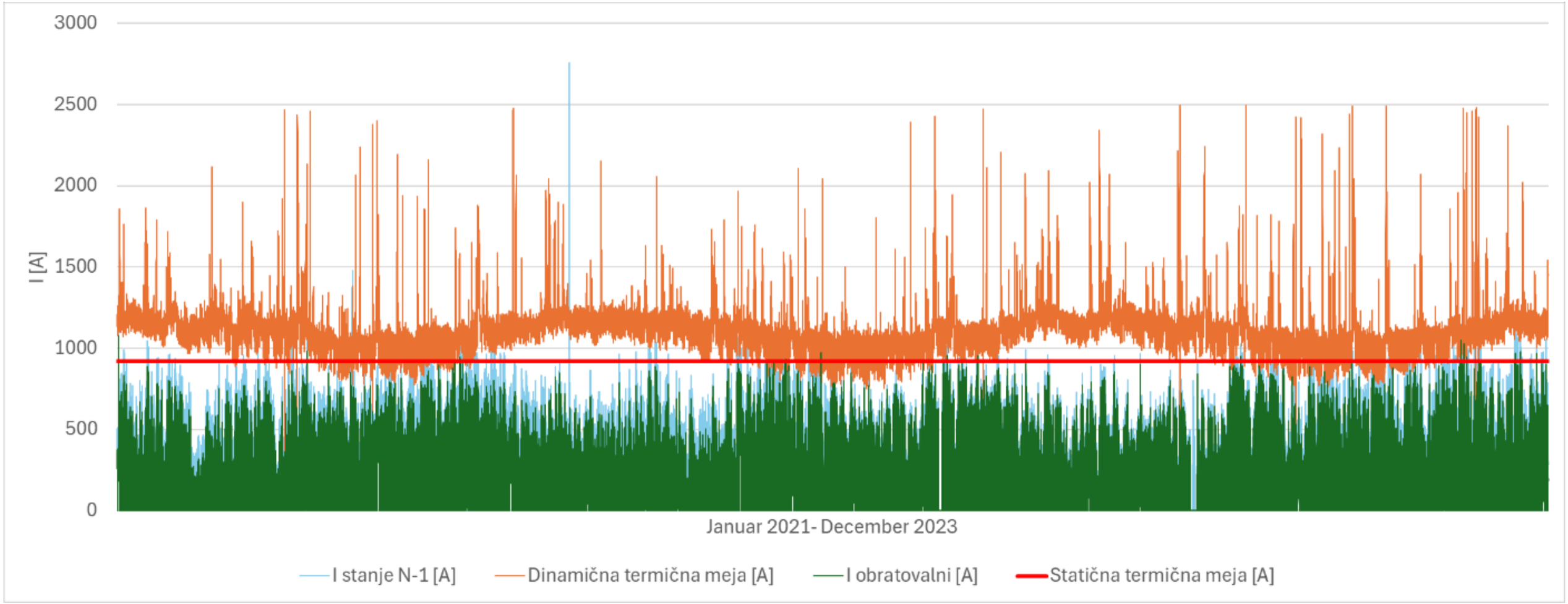
Voltage Var Scheduler – VVS

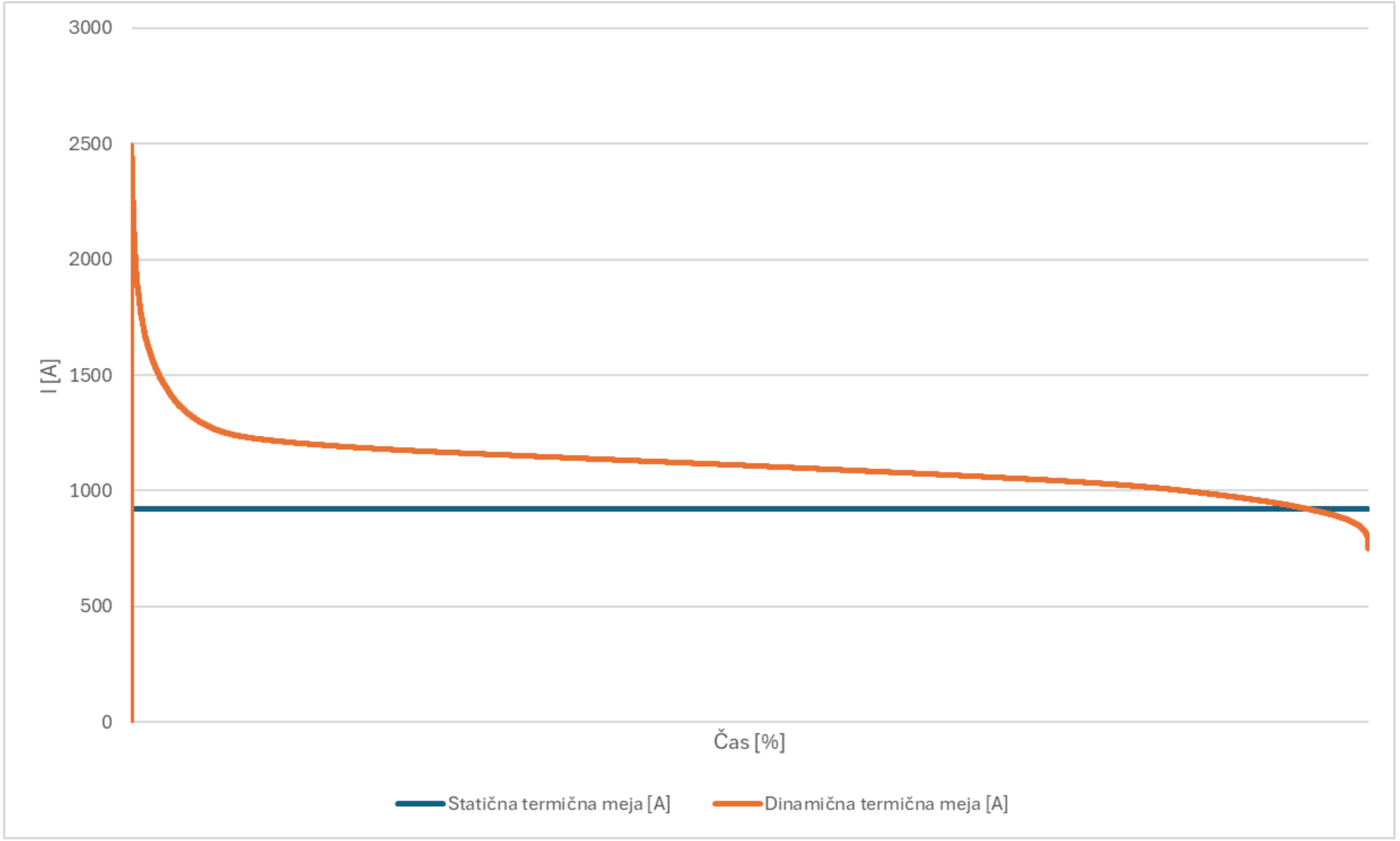
- Assist with optimize voltage profile in SI and HR grid
- Minimise losses and cross-border reactive power exchange between ELES and HOPS
- DACF and IDCF > Power Flow
- Optimal reactive power, settings from compensation devices,
- Actual time, SCADA snapshots, optimal settings, commands for operator



SUMO

- Modelling and calculating effects of environmental parameters on line
- Temp, wind are modelled, Weather stations on primary spans
- Max acceptable loading under new conditions
- N-1
- 4-quadrant visualization
- 92-96 % thermal limit is higher,
- Median increase 15-20 %
- Extreme weather conditions, heat waves, no wind > lower limit


3000
2500
2000
1500
1000
500
0
I [A]
Januar 2021- December 2023
I stanje N-1 [A]
Dinamična termična meja [A]
I obratovalni [A]
Statična termična meja [A]


3000
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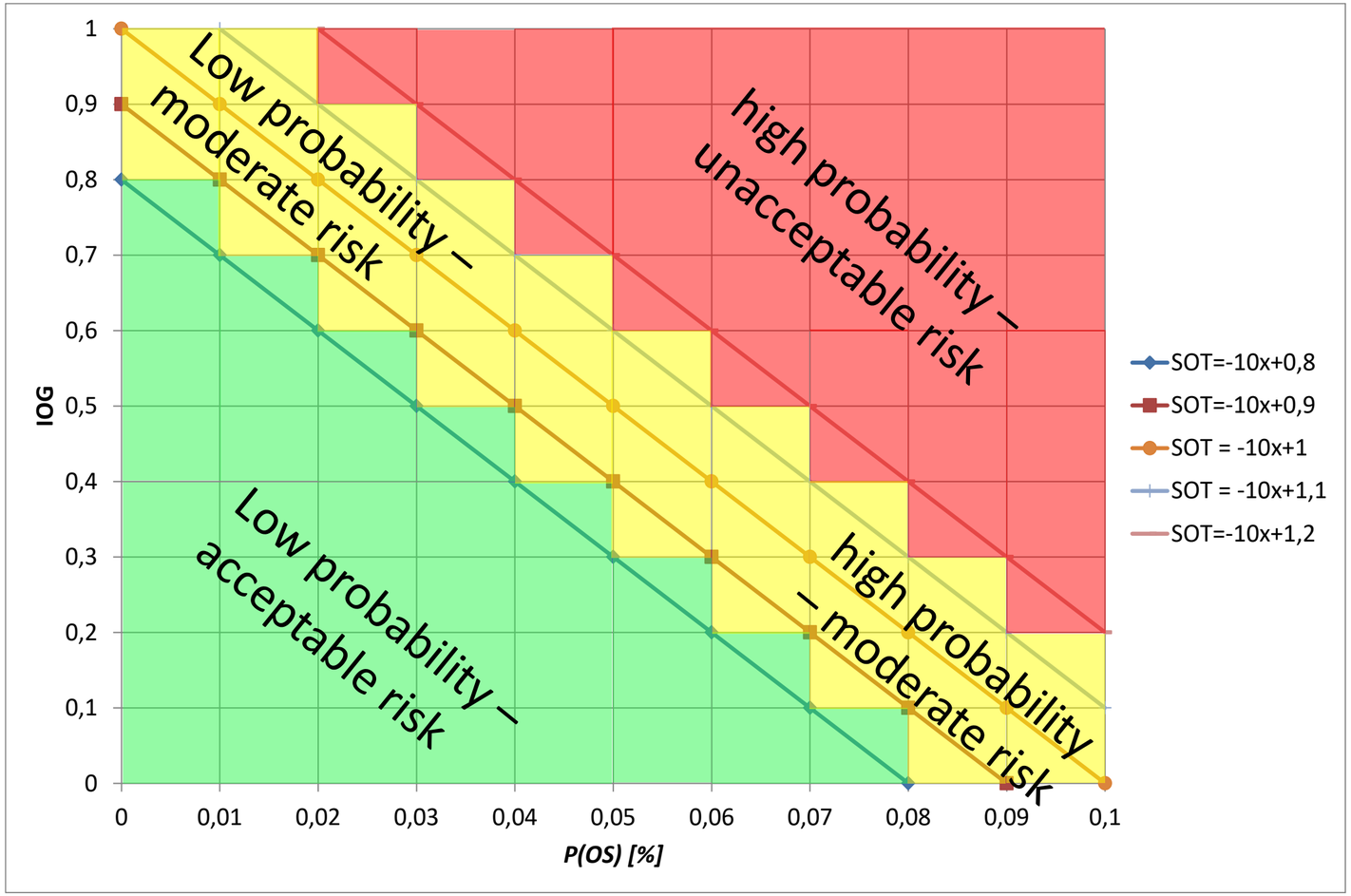
Čas [%]
Statična termična meja [A]
Dinamična termična meja [A]

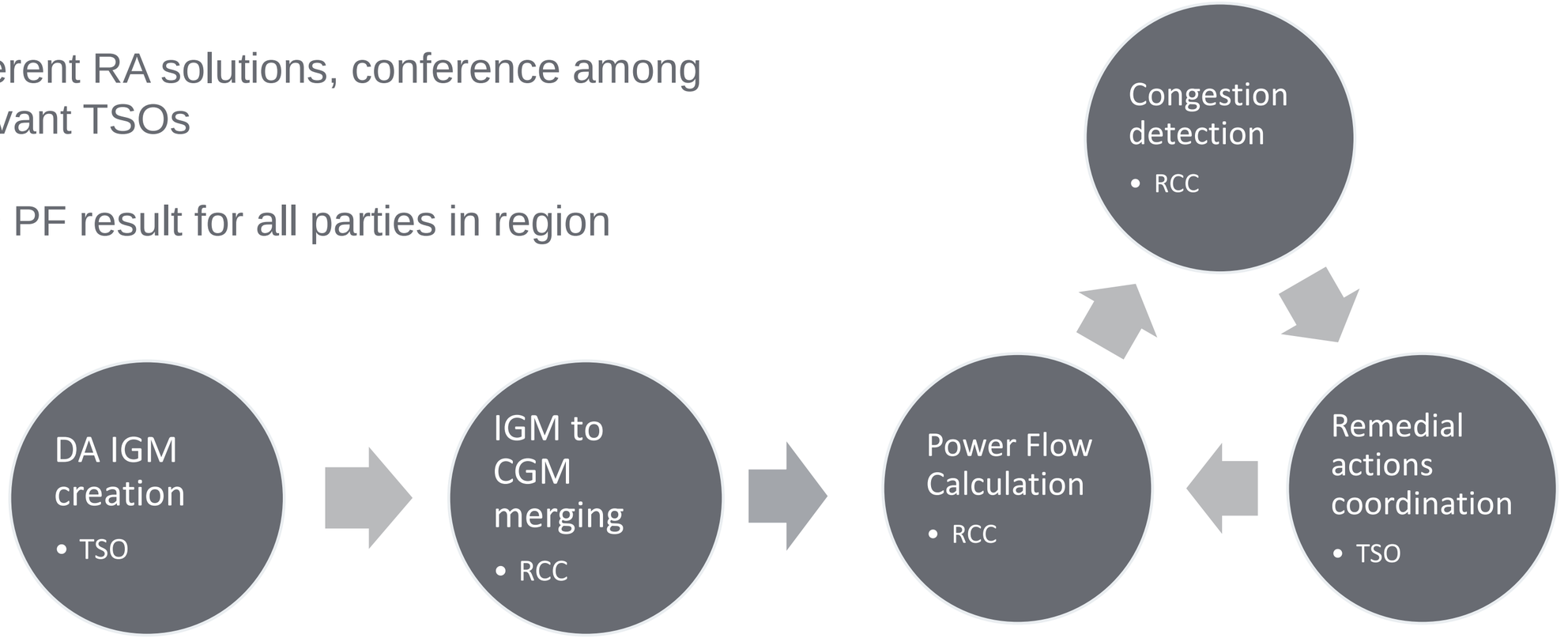
Real Time Risk Assessment

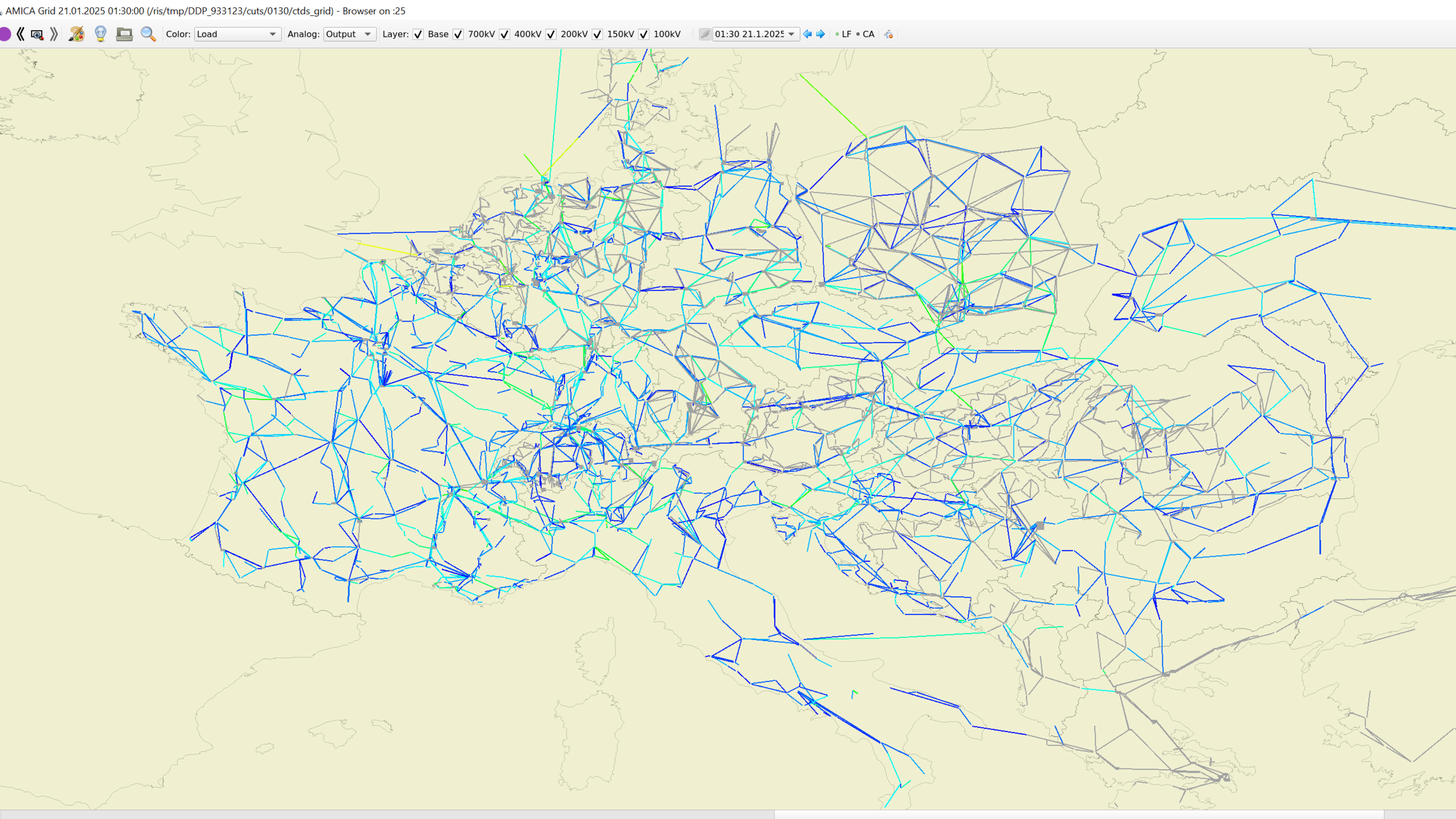
- 10 years of past data
- IOG (Impact on the Grid factor calculated from contingency analysis)
- In testing / developing phase



Coordinates security operation

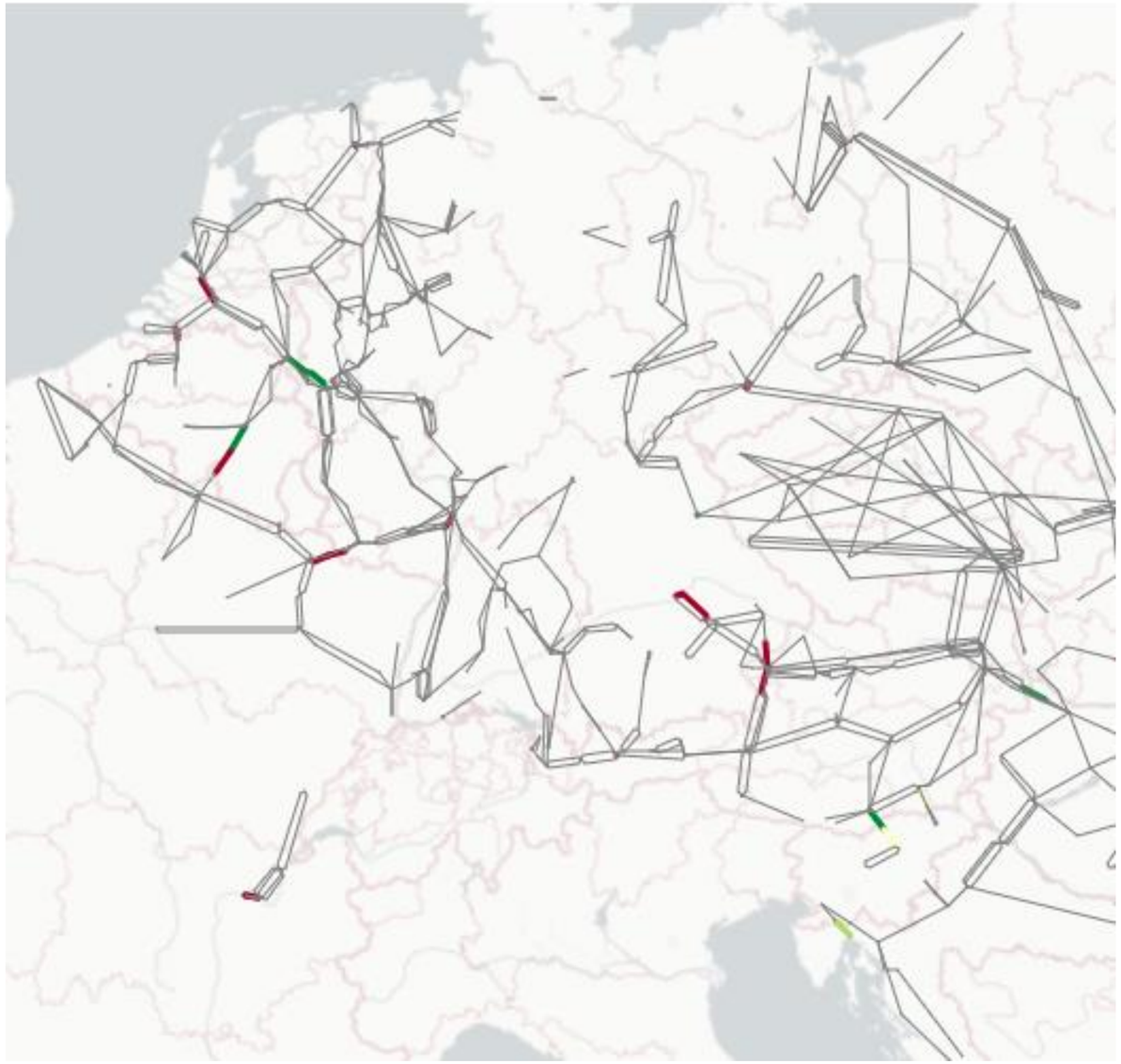
- DACF – all Continental Europe TSOs
- Continuous process, expected congestions
- Different RA solutions, conference among relevant TSOs
- One PF result for all parties in region




AMICA Grid 21.01.2025 01:30:00 (/ris/tmp/DDP_933123/cuts/0130/ctds_grid) - Browser on :25
Color: Load
Analog: Output
Layer: Base 700kV 400kV 200kV 150kV 100kV
01:30 21.1.2025
LF CA

Core Coordinated Capacity Calculation

- Coordinated process among all Core TSOs
- All tie-lines are Critical Network Elements with Contingency
- ELES: 12 tie-lines, 100 CNECs
- Calculated CBC ensure secure operation
- Max CBC available to market

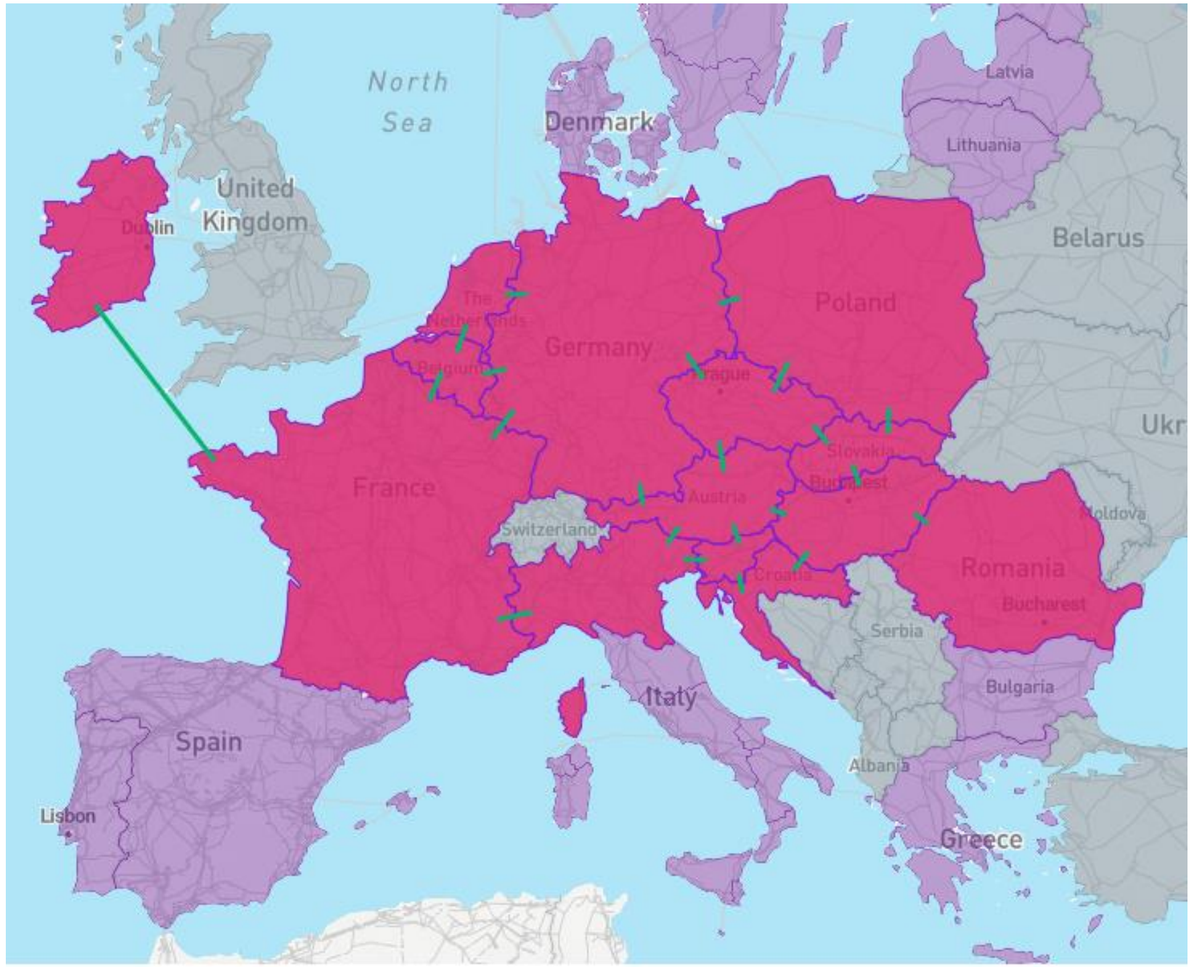


Coordinated PST operation in Italian border

- Close to real time PST operation
- SI <> IT flows affect all members of IN region
- Target flow
- In case of security issue > modification of flow > informing others
- TSOs can propose new TF during IDCF, all TSOs must agree, if not ➔ costly RA
- relieving critical congestions, minimizing redispatch or countertrading and more cross border capacities

Merging of Capacity Calculation Regions

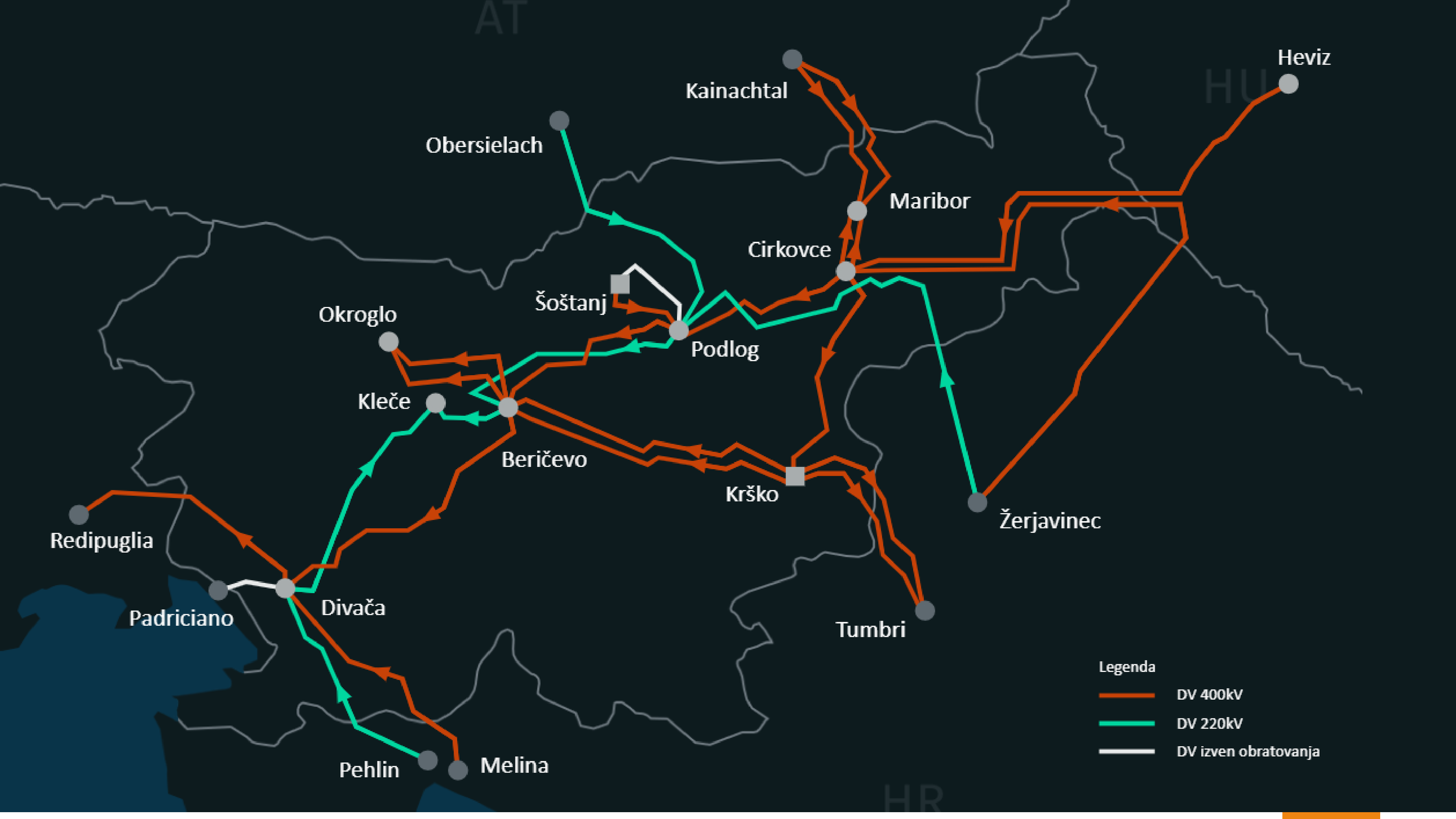
- APG, ELES and RTE operate in Core and Italy North CCR
- Core + Italy North = Central Europe
- Each Region operates with individual processes, methodologies and PST‘s coordination‘s
- One region > half processes, security operation
- Anomalies in flows, potential security concerns
- Optimal CC



New investments

- 2 new 400 kV lines in past 15 years
- SSSC on Okroglo - Obersielach 220 kV


AT
HU
HR
Heviz
Kainachtal
Obersielach
Maribor
Cirkovce
Šoštanj
Okroglo
Podlog
Kleče
Beričevo
Krško
Žerjavinec
Redipuglia
Padriciano
Divača
Tumbri
Pehlin
Melina
Legenda
DV 400kV
DV 220kV
DV izven obratovanja


AT
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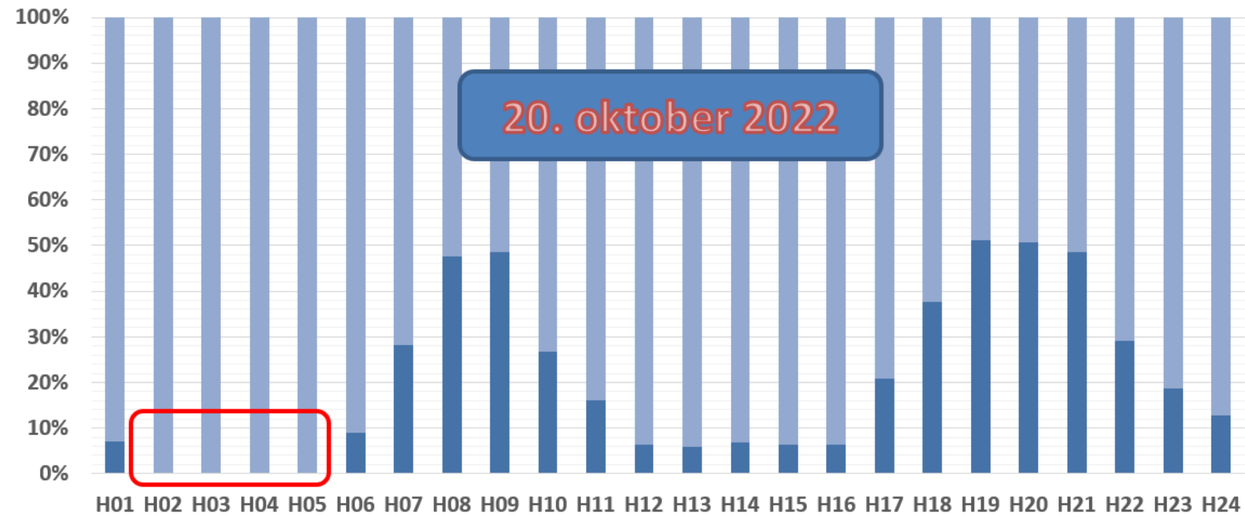
Melina
Legenda
DV 400kV
DV 220kV
DV izven obratovanja

Market design

- 2007 market liberalization
- Market coupling – physical and commercial flows
- Flow-based market coupling
- Security of supply
- Two large units > outage > easy to supply



Using new technologies for providing auxiliary services

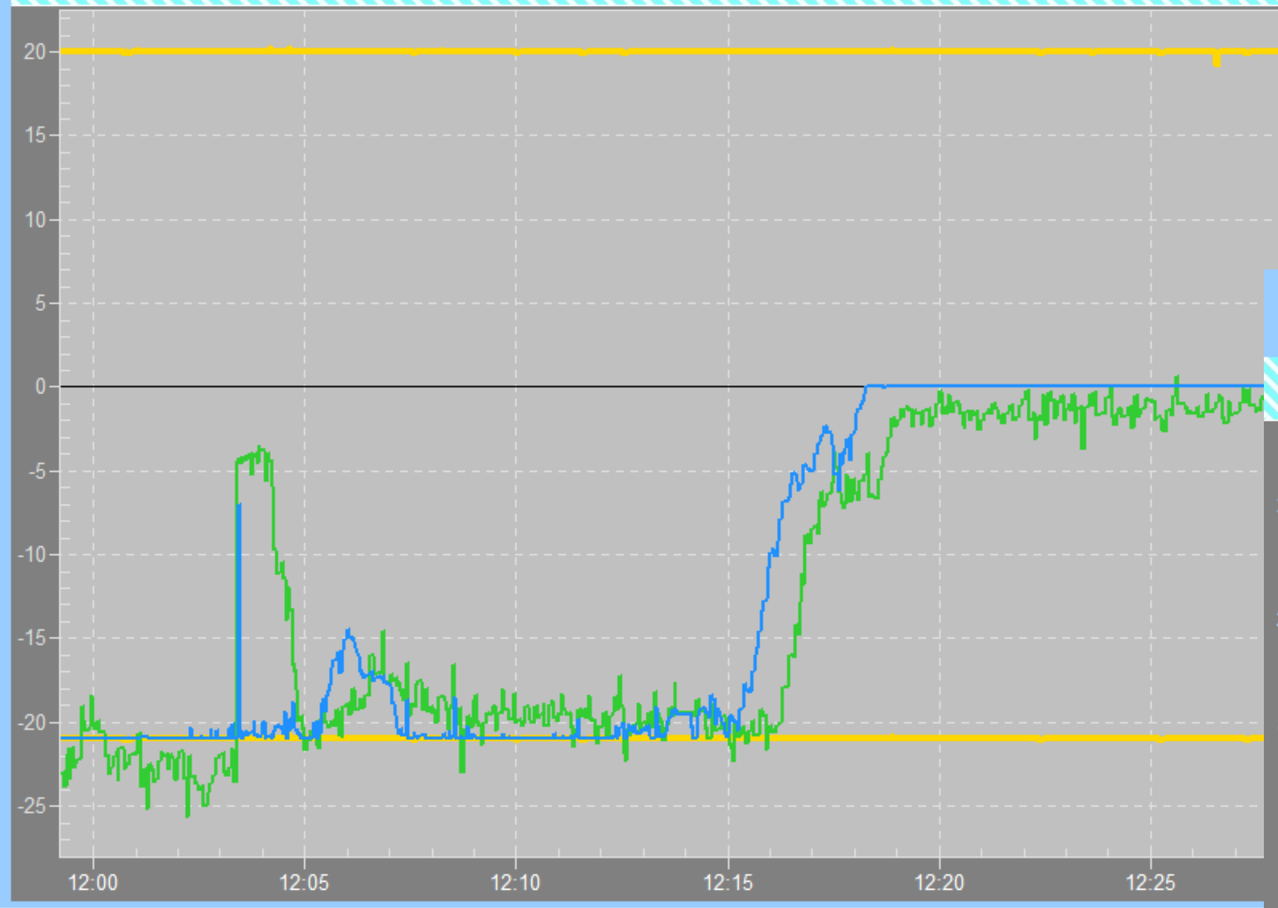
- Affordable new technologies (BESS, hybrid inverters, demand side management)
- New auxiliary providers, private equites – aFRR, mFRR
- One provider for aFRR in 2020, now 4

Year	Hydro+ coal	BESS
2020	60 / 60	0 / 0
2025	20 / 20	40 / 40

- 2025 – MARI and PICASSO

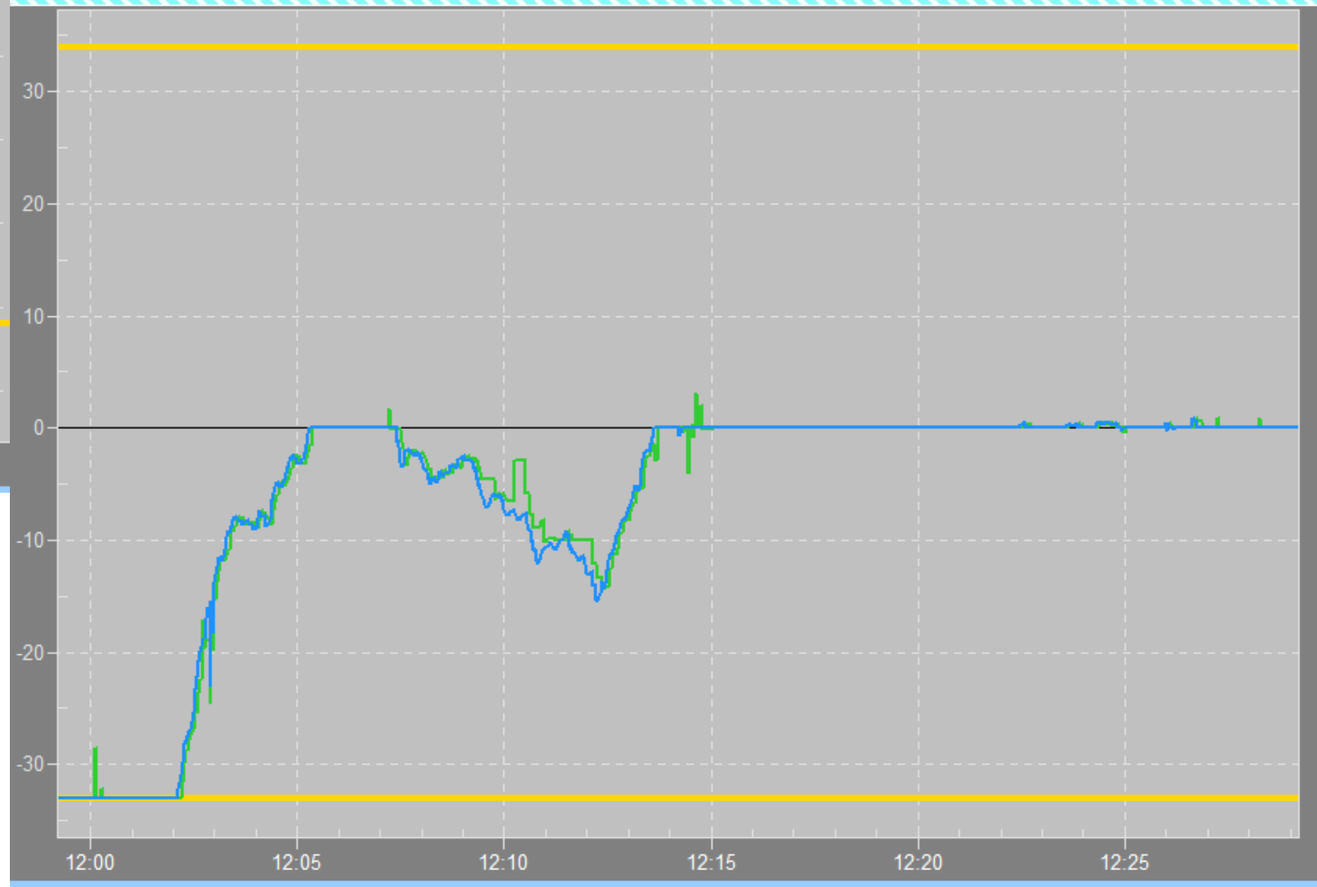
HYDRO

Rampa



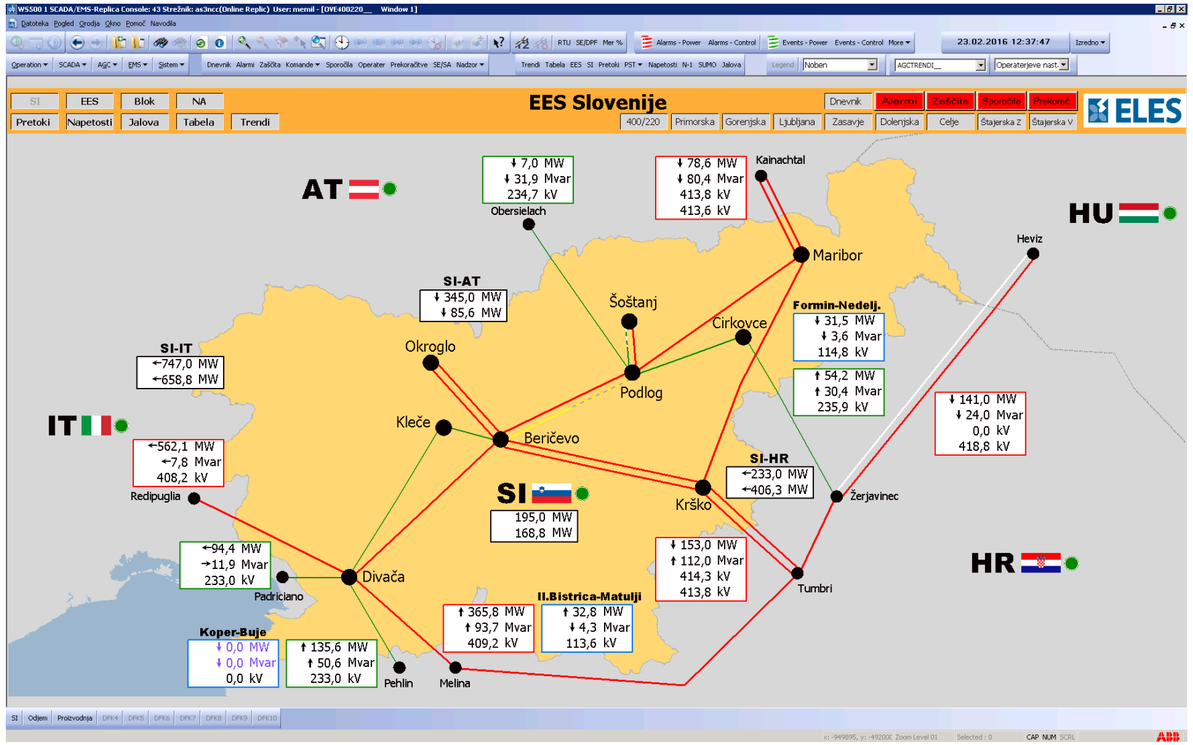
BESS - A

Rampa



Conclusions

- 10 years ago > today
- Less investments in power lines
- More smart solution
- Analytics




Thank you.