K. Naumoski

MEPSO Priority Transmission Projects

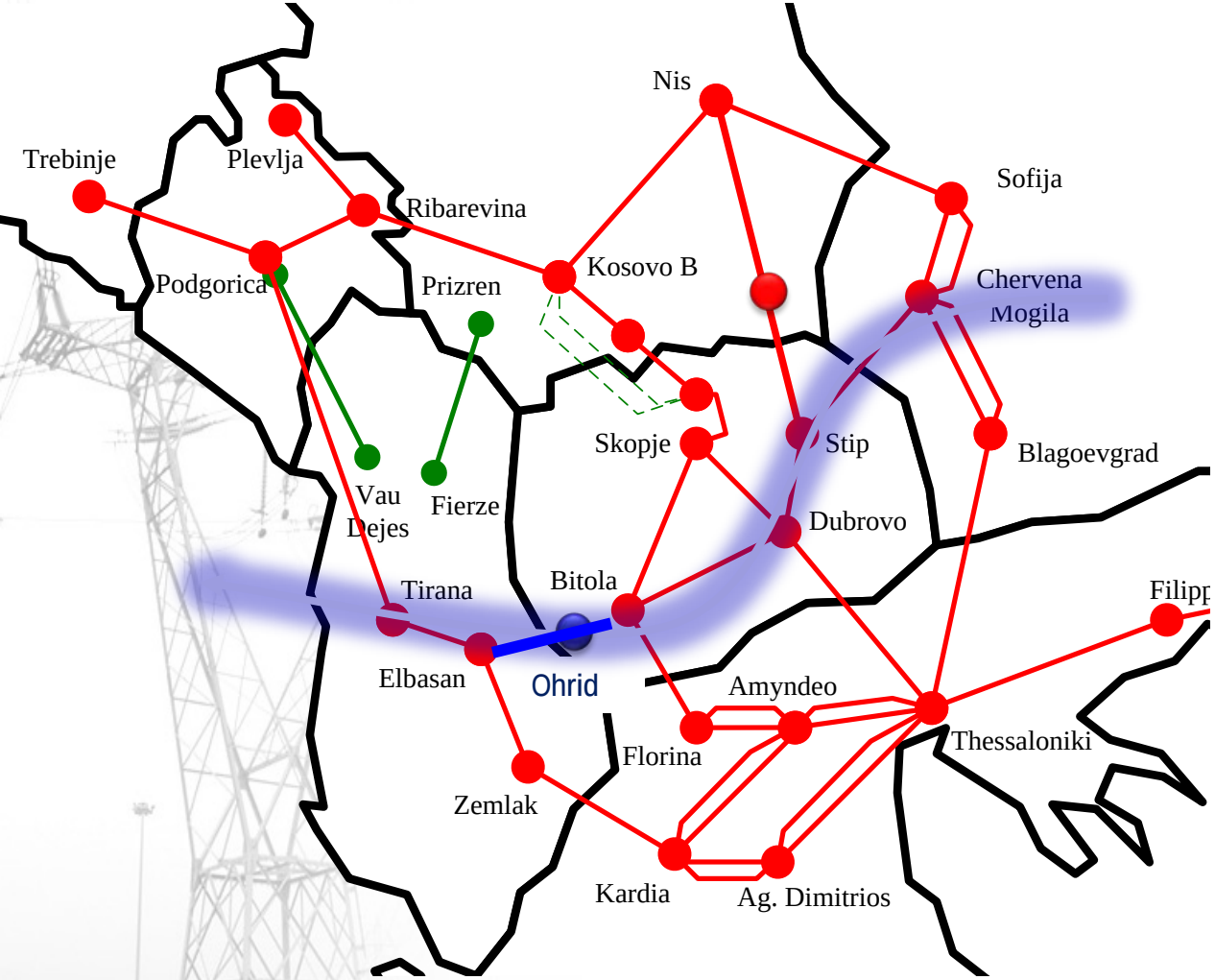
- showcasing -

MEПСО

showcasing

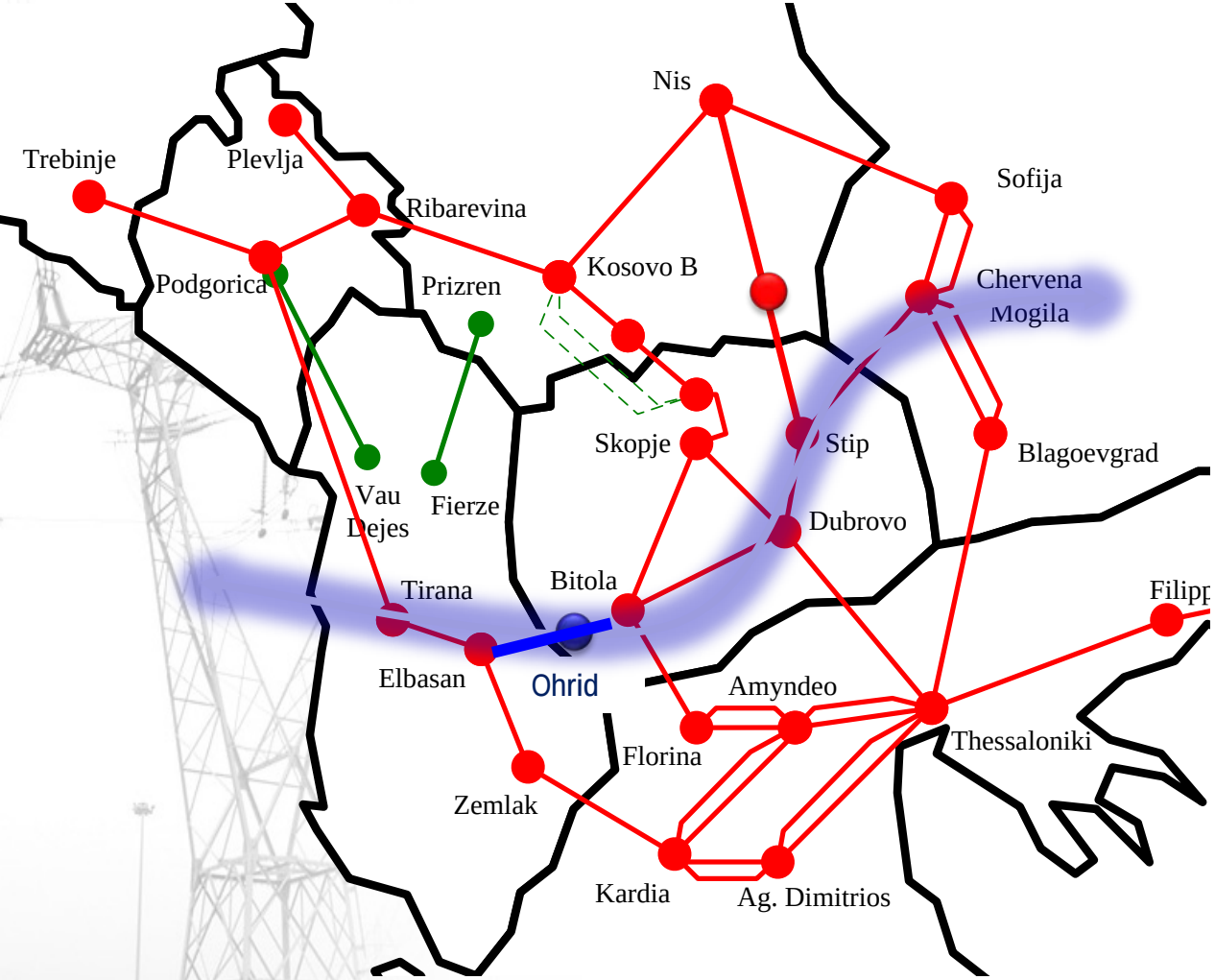
- 400 kV interconnection MK – AL
  - Interconnection at a glance
  - Project benefits
  - Project evolution
  - Investment & present status
- Strengthening the transmission grid in Southeastern MK region (new 400 kV SS Miletkovo project)
  - Challenges : RES integration & facing the “replacement wave”
  - Actions: WBIF Feasibility Study conclusions
- 150 MVAr shunt reactor in 400 kV Dubrovo
  - Challenges: dealing with high voltage profile in regional 400 kV grid
  - Actions: Conclusions of Regional voltage Study
  - Status of the project in MK and neighboring systems
  - Discussion with participants on the project evolution & open questions

400 kV interconnection MK - AL



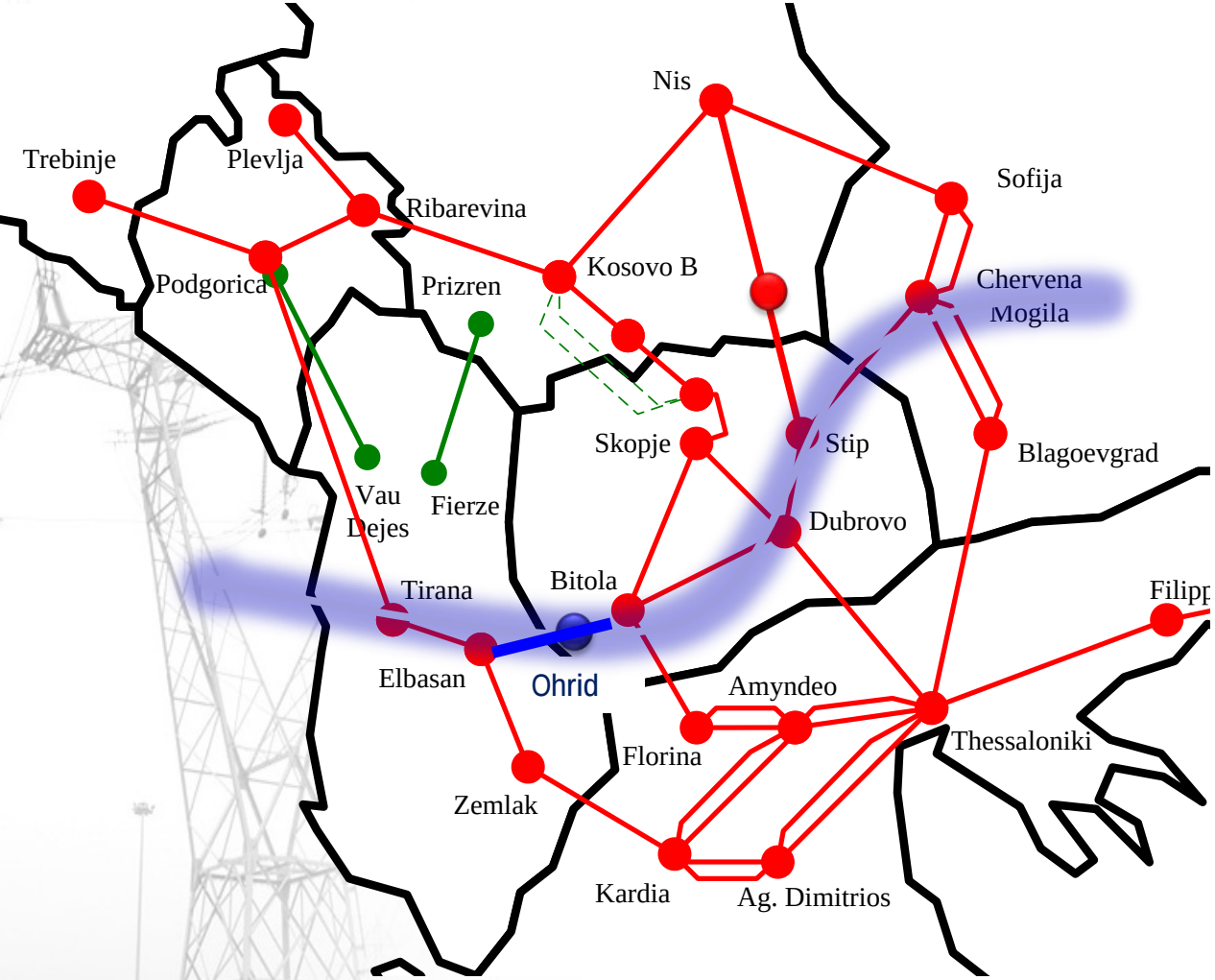
- MK-AL interconnection at a glance
  - 400 kV overhead line
    Bitola (MK) – Elbasan (AL), 150 km
  - New 400/110 kV substation
    Ohrid (MK), 300 MVA transformer
  - Extension of 400/220 kV substation
    Elbasan (AL), 120 MVAr reactor

400 kV interconnection MK - AL



- Project benefits
  - The last link of Corridor 8 (East-West)
  - 400 kV ring MK – AL – GR
  - Increased transmission capacity
  - Improved security, reliability & stability of national and regional grid
  - Optimization of complementary power systems MK-AL
  - RES integration on national & regional level
  - Electricity market integration

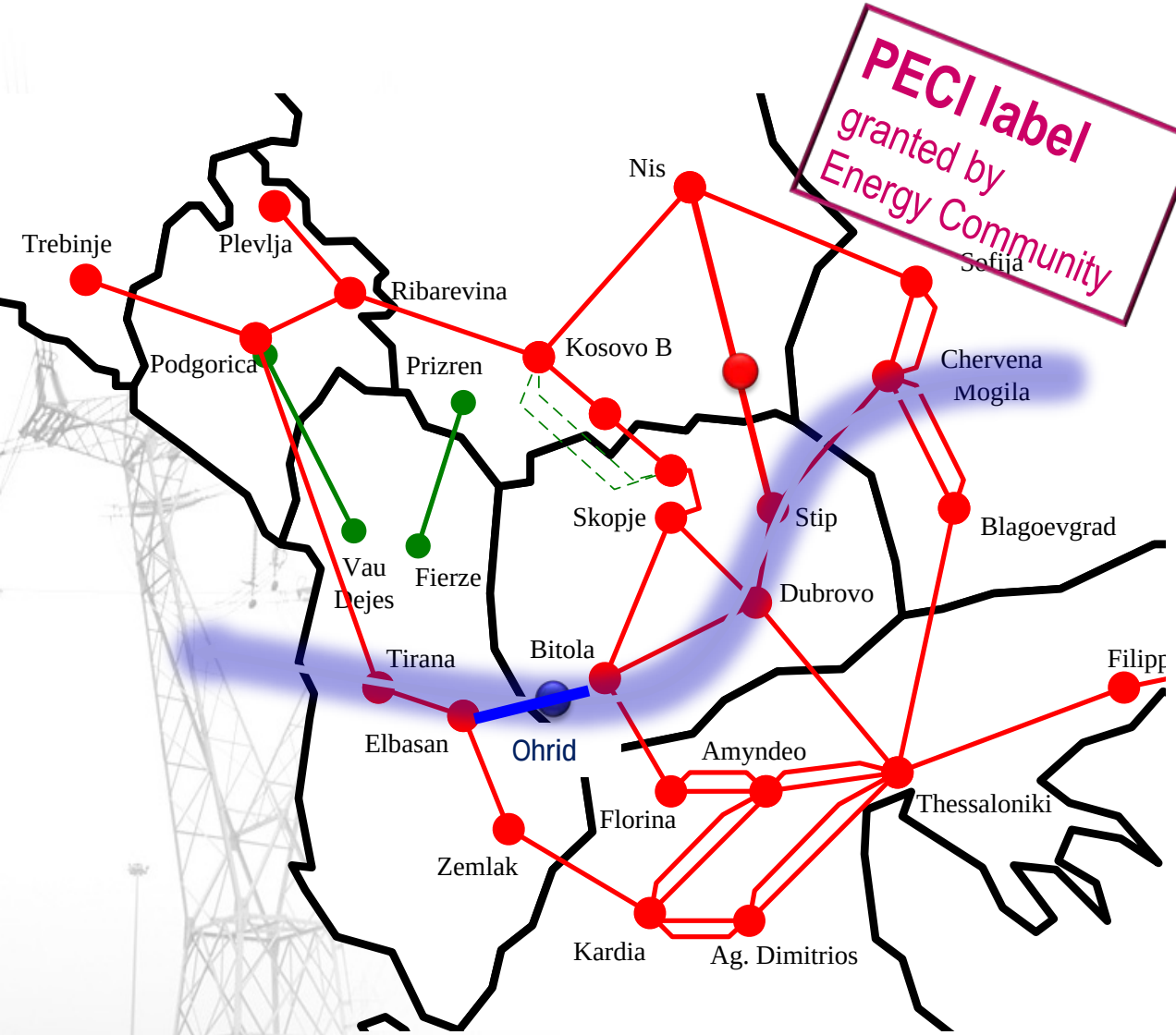
400 kV interconnection MK - AL



- Project evolution

2013:	Feasibility Study
2013:	ESIA – Environmental Impact Assessment Study
2015:	ESIA approval
2015:	Financial agreement with EBRD
2016/17:	ESIA additional investigations
2019:	Design and tender
2020:	Contracts award
2020:	Construction permit
2023:	Expected commissioning

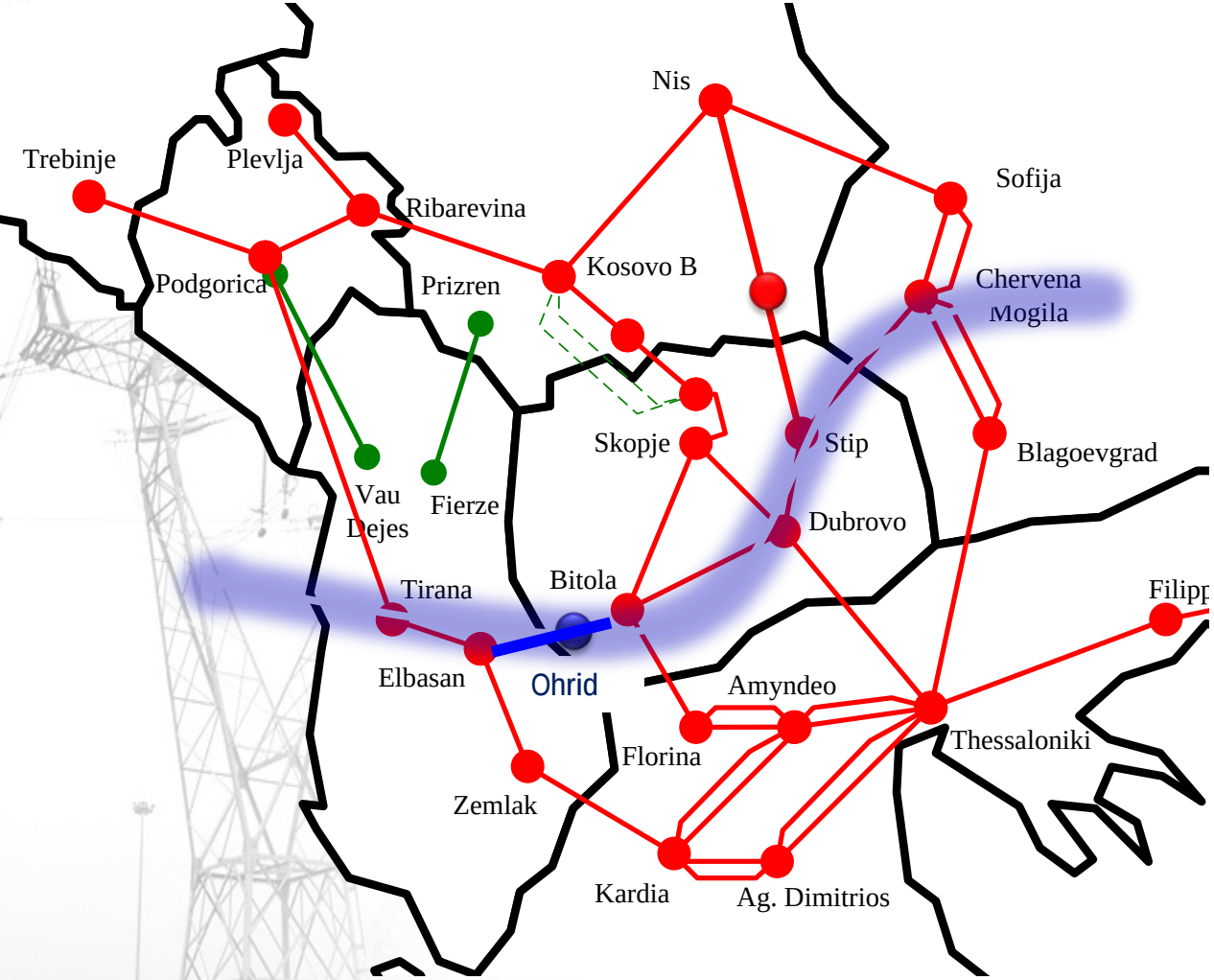
400 kV interconnection MK - AL



Investment (MK part)

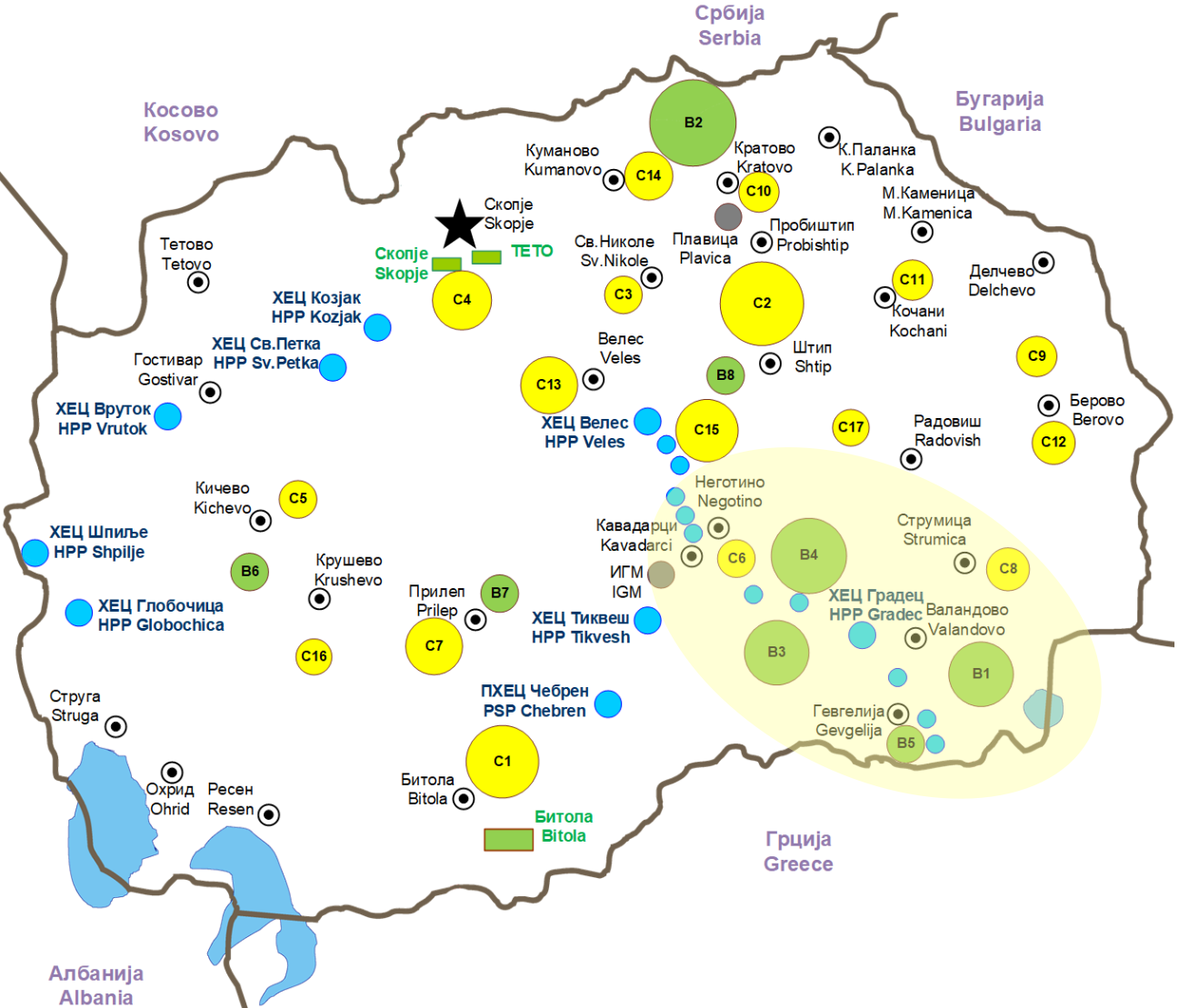
- WBIF TA – Technical Assistance grant
  - 0.8 MEUR for Feasibility & ESIA
  - 0.9 MEUR for Design
- WBIF INV – Investment grant
  - 9.0 MEUR for construction
  - 3.0 MEUR for smart grid projects
- EBRD loan
  - 37 MEUR
  - Repayment 15 years, grace period 3.5 years
- Construction cost
  - 29 MEUR for OHL and SS

400 kV interconnection MK - AL



- Status (MK part)
  - Delays in
    - preparation of technical documentation
    - supply of equipment
    - construction works
  - Shortage of qualified personnel
  - Impact of economic crises
    - claims on costs

strengthening the transmission grid in Macedonian Southeast region



Challenges

- Favorable wind, solar and hydro potentials in MK Southeast region
  - Efficient RES integration in the grid
- Facing the “replacement wave” of old 110 kV transmission grid
- ENTSO-E identification of system needs points new interconnection to BG/GR
- Increased capacity and efficiency of transmission grid by smart technology
  - Smart control of ampacity of overhead line (Dynamic Line Rating – DLR)
  - Software and hardware platform for asset management

strengthening the transmission grid in Macedonian Southeast region

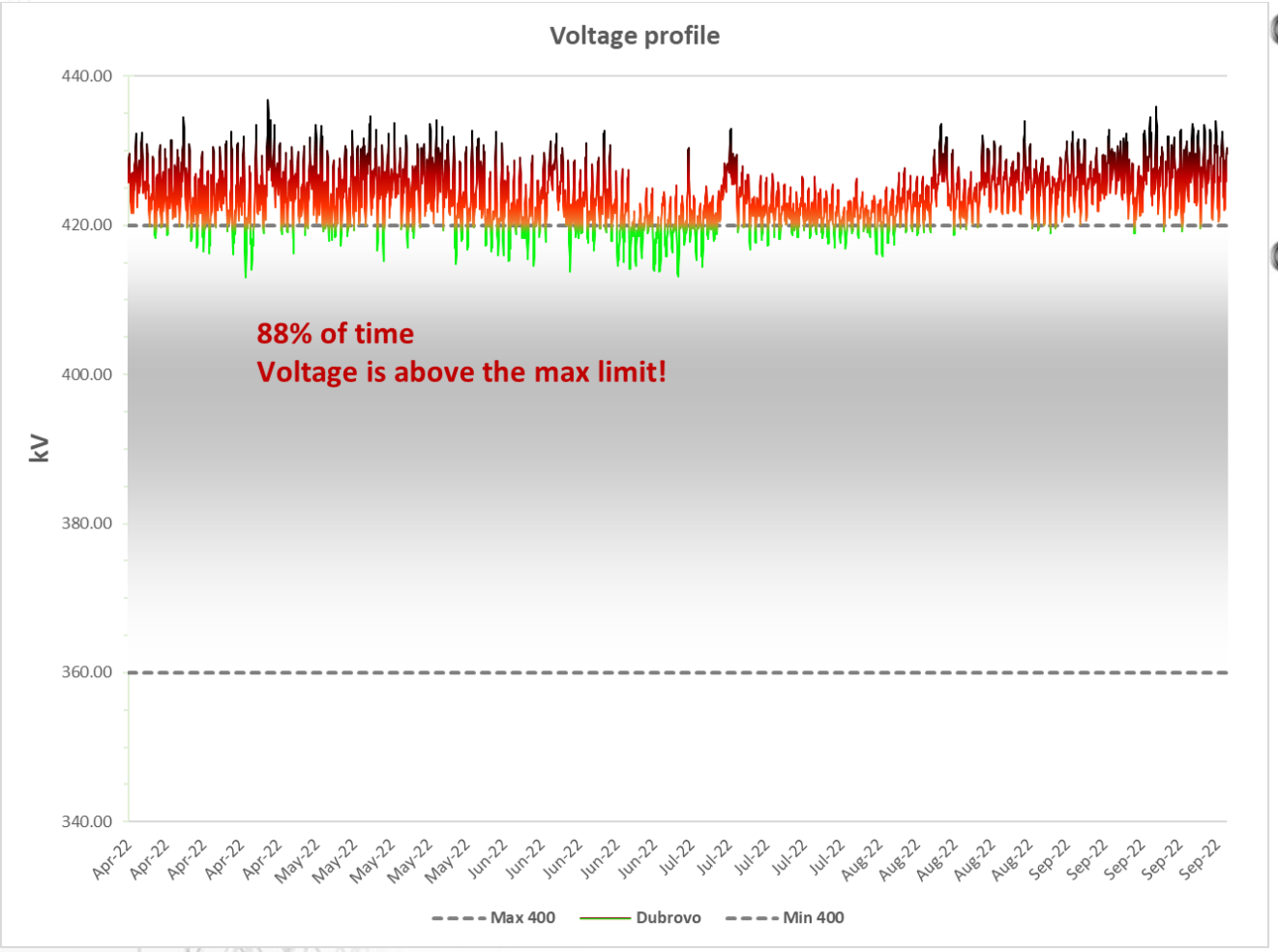
Actions

- Feasibility Study in preparation
  - WBIF TA grant: 0.8 MEUR
- Optimization of the variants is finished
  - New 400/110 kV substation Valandovo, 2 x 300 MVA
  - LILO connection on 400 kV OHL Dubrovo - Thessaloniki
  - Reconstruction of 110 kV OHL Valandovo - Strumica

strengthening the transmission grid in Macedonian Southeast region

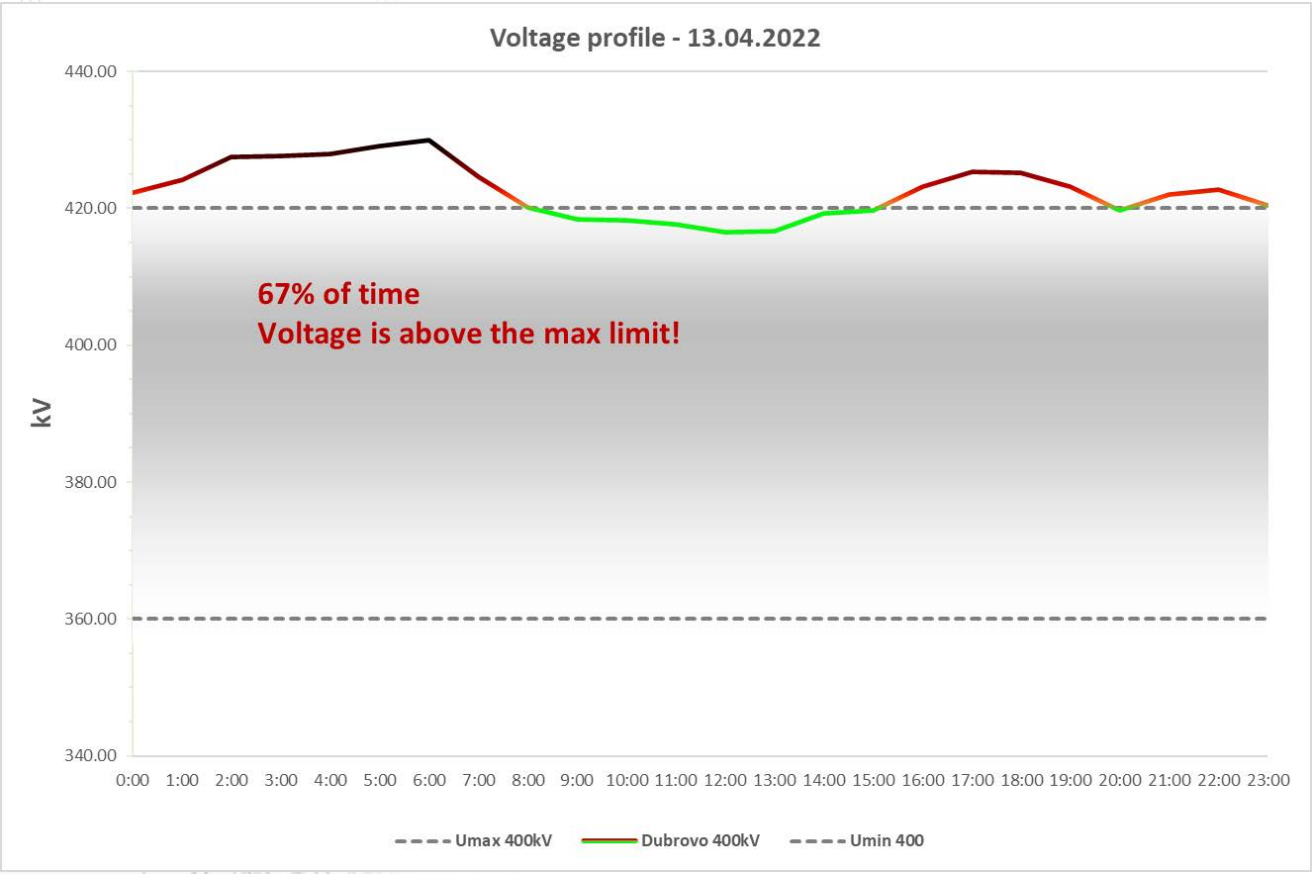
- Characteristics of selected option
  - Advantages
    - Easy access to location
    - Minor technical, environmental and social impact
    - High capacity for RES integration
  - Investment parameters
    - Cost: 31.6 MEUR
    - ERR: 14.7 %
    - Benefits/Costs ratio: 4.8
  - Next steps
    - Technical documentation and tender WBIF grant 0.510 MEUR
    - Application for loan and investment grant

150 MVAr shunt reactor in 400 kV Dubrovo



- Challenges
  - dealing with high voltage profile in regional 400 kV grid (north GR, MK, AL, XK, ME, south RS, BA)
- Origin of the problem
  - New 400 kV overhead lines
    - Reduce active power exchanges
    - Underloaded lines (< P_N) and reactive power generation
  - Changes in production profile
    - Decommissioning of significant conventional production capacities in north part of GR
    - Large scale RES integration that uses DC/AC inverters with limited capacity for voltage regulation
  - Large demand reductions in certain areas
  - Insufficient coordination of voltage control actions
  - Lack of equipment for voltage regulation (reactors)

150 MVAr shunt reactor in 400 kV Dubrovo



- KPIs for Voltage Control as an Ancillary Service*
  - regulatory framework (RfG & SOGL)
  - regional cooperation
  - technical and operational procedures
  - voltage quality monitoring
  - technical systems employed for voltage control

*Conclusions from Regional Feasibility Study for Voltage Profile Improvement

150 MVAr shunt reactor in 400 kV Dubrovo

- Installing reactive power compensation equipment*

PROPOSED SOLUTION	OST	CGES	EMS	KOSTT	NOS BIH/ EL.PRENOS BIH	MEPSO
Location	SS Elbasan***	SS Lastva SS Ribarevine*	SS Vranje	SS Ferizaj	SS Tuzla SS Mostar	SS Dubrovo SS Ohrid**
Shunt capacity	120 MVAr	250 MVAr 150 MVAr*	100 MVAr	150 MVAr	220 MVAr 120 MVAr	150 MVAr 100 MVAr**
Voltage level	400 kV	400 kV	400 kV	400 kV	220 kV or 400 kV	400 kV
Device type	Fixed shunt reactor	Variable shunt reactor	Variable shunt reactor	Variable shunt reactor	Variable shunt reactor	Variable shunt reactor

120 MVAr in Elbasan
status?

250 MVAr in Lastva
in CGES Investment Plan 2023-2025
implementation in 2023

100 MVAr in Vranje
in EMS Investment Plan 2023-2025

100 MVAr in Ferizaj
in KOSTT TYNDP, approved by ERC
implementation in 2024

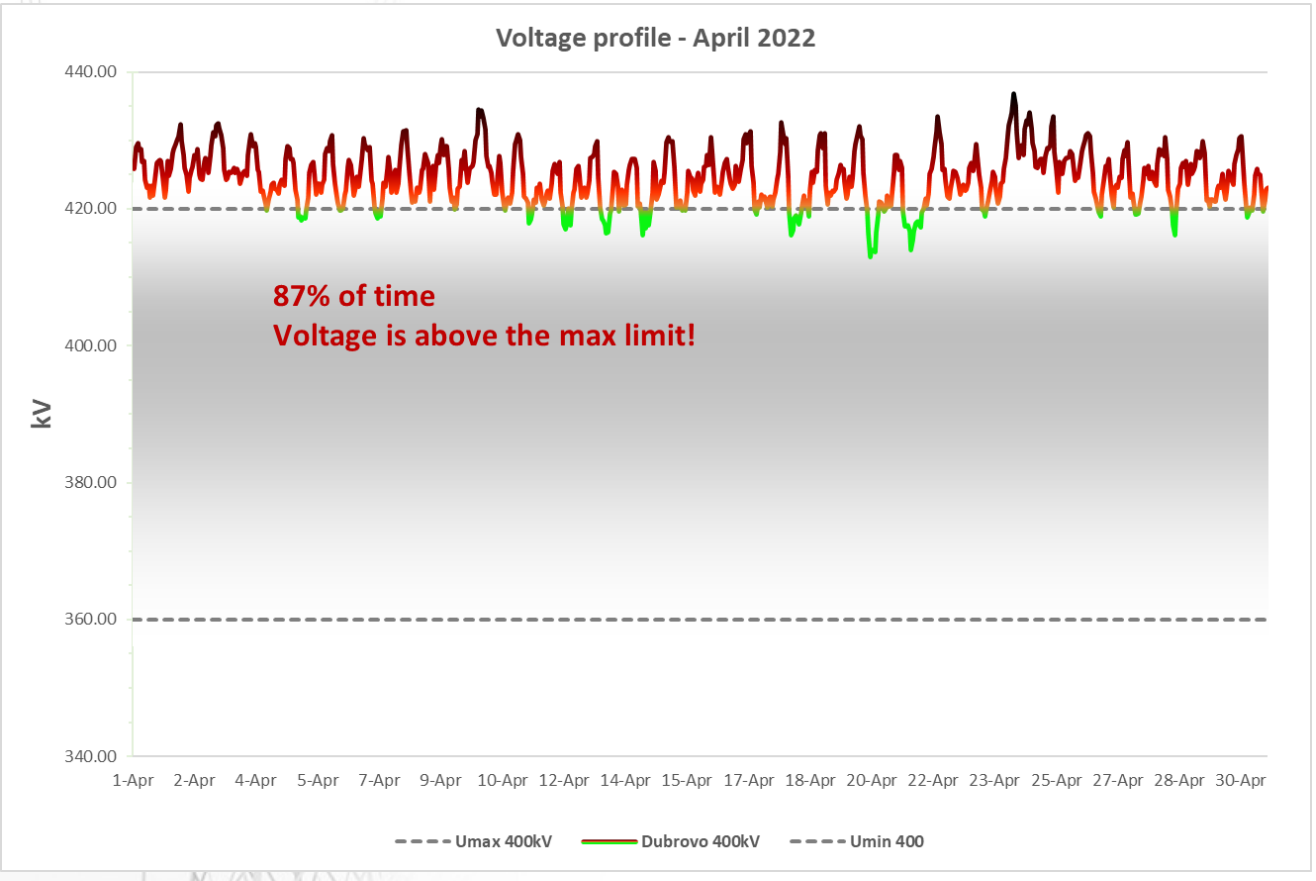
4 x 150 MVAr at 400 kV level
B.Luka, Mostar, Tuzla and Visegrad
tender is launched

150 MVAr in Dubrovo
in MEPSO Investment Plan 2023-2027,
commissioning in 2024

* Commissioning of Trans-Balkan corridor (400 kV OHLs Bajina Basta - Visegrad and Bajina Basta - Pljevlja) and second pole of HVDC cable will also require a reactor in SS Ribarevine at 400 kV voltage level (150 MVAr).
** A variable shunt reactor in SS Ohrid should be considered as a long-term measure and installed only if the available voltage control remedial actions are proven as insufficient to keep voltages in western MKD within the required limits.
*** A fixed shunt reactor in the SS Elbasan was not a result of this study – it has already been planned as part of the extension in the SS Elbasan aimed to accommodate new 400kV OHL Bitola (MK) – Elbasan (AL).

*Conclusions from Regional Feasibility Study for Voltage Profile Improvement

150 MVAr shunt reactor in 400 kV Dubrovo



- Open questions
  - Regulation of reactors
    - performance of reactors in other regimes (normal and high load regimes)
    - necessity and granularity of regulation, number of switching actions etc.
  - Procedure for voltage optimization
    - daily/weekly/monthly framework
    - snapshots (time-stamps)
  - Virtual regional voltage control centre (VRVCC)
    - Structure , functions, hierarchy, ICT needs
  - Market compatibility
    - duties and responsibilities of voltage regulation service providers
    - remuneration scheme for the service
  - Financing

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Thank You!

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