ENTSO-E Ten-Year Network Development Plan & Regional Investment Plans in 2014

- Grid Studies Methodology -

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Reliable Sustainable Connected

Content

Regional transmission system model

GTC calculation

Computation of active power losses

Evaluation of technical resilience and flexibility indicators

Regional Transmission System Model

Format coordination

- CIM/XML exchange format for WP2030, vision 1(4)
- NMD database

Validation

- Syntax validation (CIM compliance)
- Business validation (tie lines checked)
- PEMMDB validation (compliance of the network and market models)

Network characteristic of CSE

- Relatively small transmission systems
- Highly meshed structure
- Interdependence

CSE model includes also Slovakia and Austria
Simplified model has been used for Turkey

Area Name	Interchange (MW)
ALBANIA	350
SLOVAKIA	372
BOSNIA	-134
BULGARIA	1394
GREECE	595
CROATIA	-598
HUNGARY	-955
IT	-6985
MONTENEGRO	250
MACEDONIA	-613
ROMANIA	2539
SERBIA	-362
SLOVENIA	50
TURKEY	-494
AUSTRIA	3658
HU-UA	-557
RO-UA	-137
DC ME-IT	0
DC GR-IT	0
DC SI-IT	0
AT-DE	48
AT-CZ	-888
DC AL-IT	0
DC HR-IT	0
DC IT-TN	0
FR-IT	-122
CH-IT	1764
DC FR-IT	1000
CZ-SK	142
PL-SK	-164
AT-CH	-153

GTC – Grid Transfer Capability

Grid Transfer Capability – GTC

is the ability of the grid to transport electricity across a boundary
and represents maximum transfer capabilities
between two areas calculated under certain conditions

- Depends on consumption, generation and exchange,
  topology and availability of the grid
- GTC is oriented,
  across a boundary there may be two different values
- A boundary may be fixed (border between states or price zones),
  or vary from one horizon or scenario to another

Flow based approach

GTC is identical with real flows between systems
while maximal possible exchange is obtained and N-1 criterion is satisfied

GTC – Grid Transfer Capability

TOOT methodology

ΔGTC cluster X = GTC all clusters IN – GTC cluster X OUT

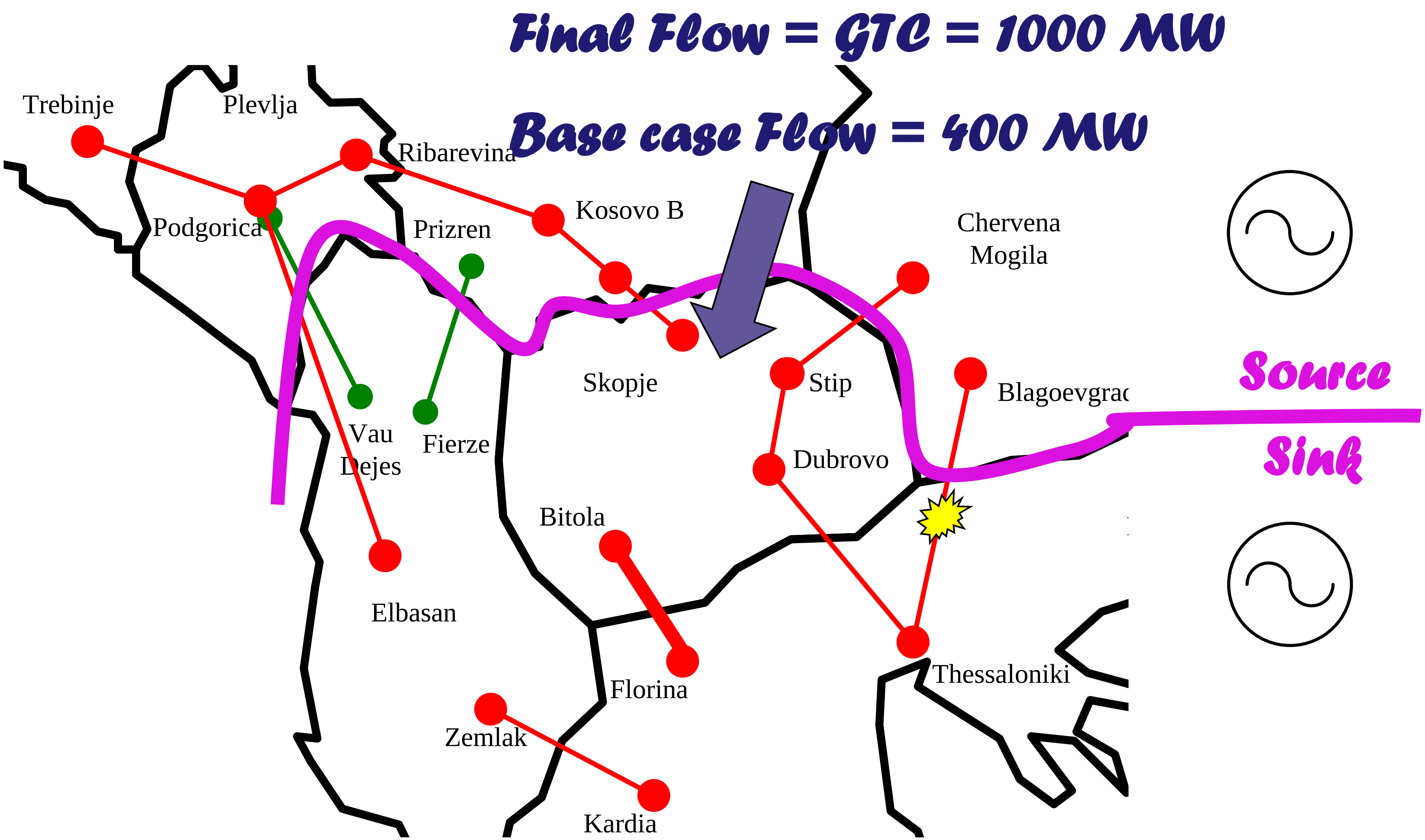
Generation shift ΔE

- Proportional to engagement
- PGmax ignored
  if surplus of power is exhausted in source area,
  additional artificial generation reserve are considered
- Composite approach for definition of source/sink area

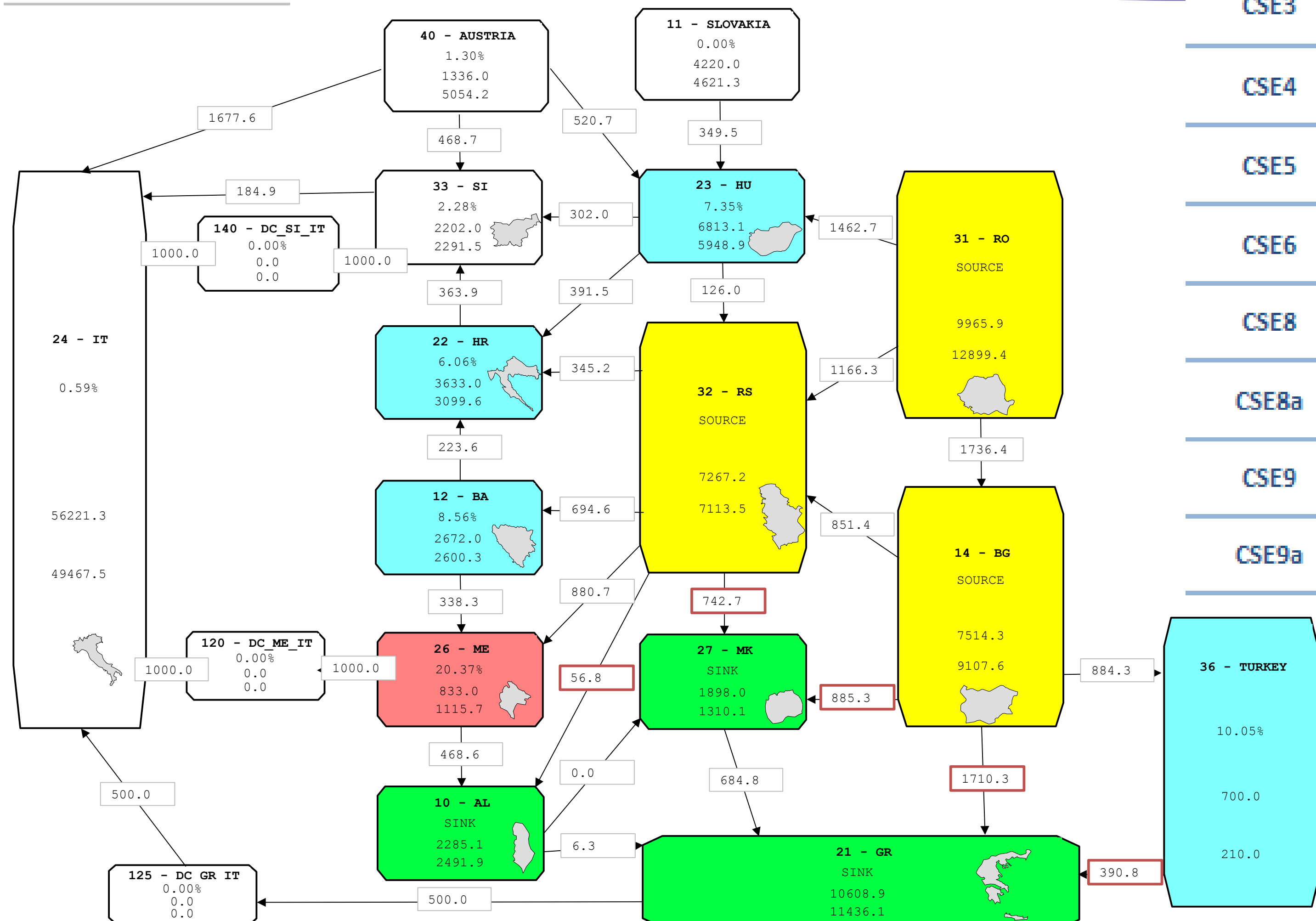
N-1 security (contingency and monitoring)

- All 400 kV & 220 kV internal elements
- All 400 kV & 220 kV tie-lines in the SEE
- For selection of critical contingency
  only the network in the vicinity of the boundary is considered

GTC – Grid Transfer Capability



GTC – Grid Transfer Capability



Cluster	ΔGTC	ΔGTC
CSE1	612 W->E	594 E->W
CSE2	1260 N - > S	2196 S -> N
CSE3	1085 W->E	765 E->W
CSE4	648 N->S	82 S->N
CSE5	65 N->S	NRL (-14) S->N
CSE6	453 W->E	737 E->W
CSE8	482 W->E	755 E->W
CSE8a		159 E->W
CSE9	1157 N->S	2709 S->N
CSE9a	224 N->S	364 S->N

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Transmission Losses

Variation of losses indicator

quantifies the contribution of each project to the electrical system efficiency

- To estimate annual average losses using as input the appropriate snapshots of regional network model
- The 4 characteristic snapshots are selected from load duration curve
- Each snapshot is representative of certain period of time during the year

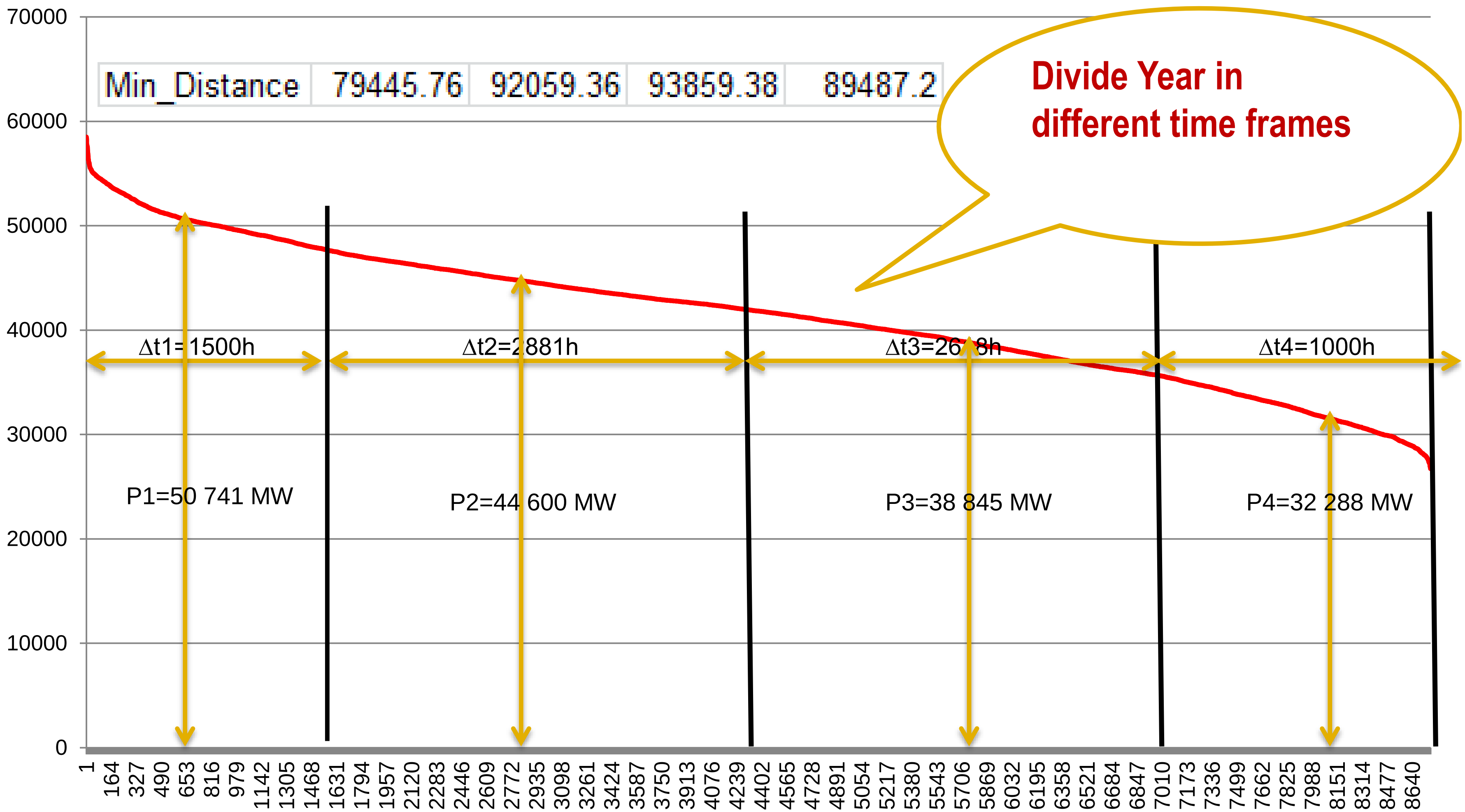
$$W_{loss} = P_{loss,1}\Delta t_1 + P_{loss,2}\Delta t_2 + P_{loss,3}\Delta t_3 + P_{loss,4}\Delta t_4 [GWh]$$

Selection of snapshots – minimal distance method

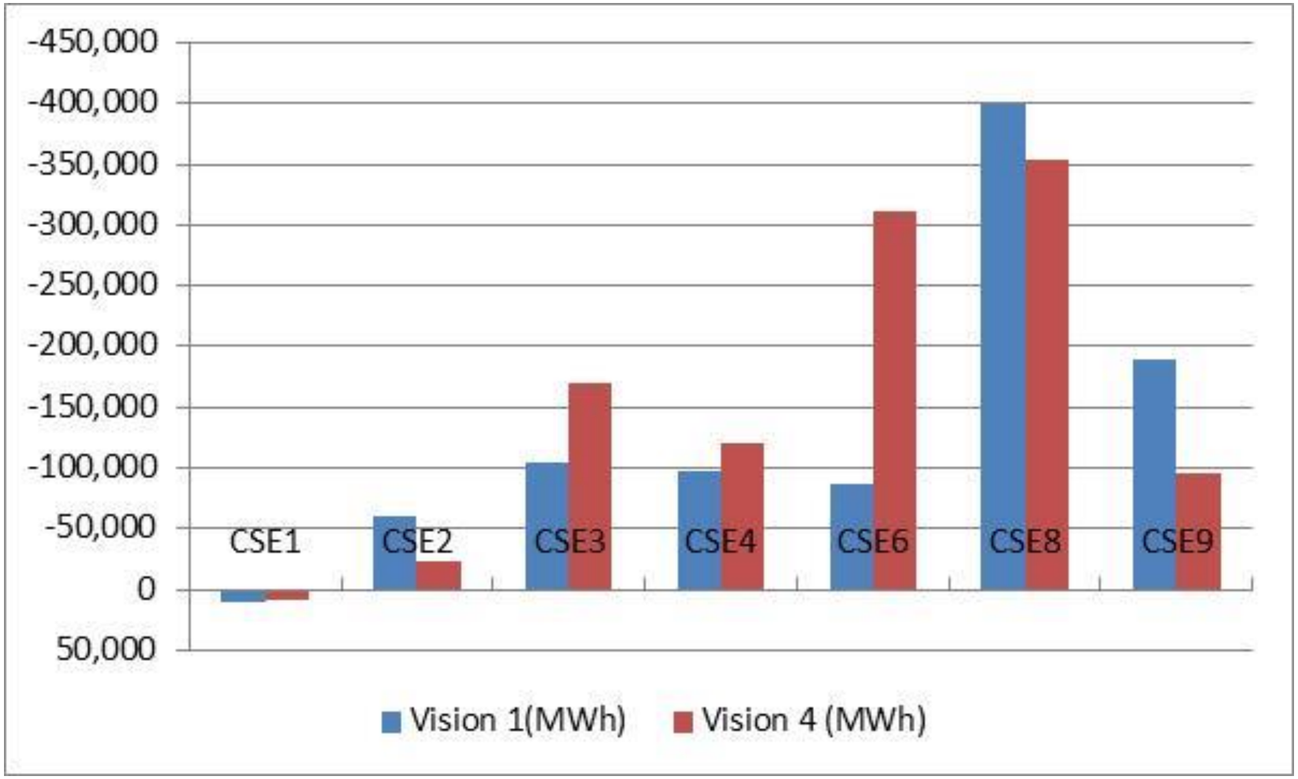
- Find appropriate values of load in hour i, $P\_(snapshot,i)$ for which distance between square of difference between that snapshot and individual snapshot in hour i, is minimal

$$\min\_dist^2 = \sum_{i=1}^{n} (P_{snapshot,i} - P_{individual\_hour,i})^2$$

Transmission Losses



Transmission Losses



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Technical resilience

Selection of extreme snapshots from market results regarding

- load
- RES penetration
- regional balance (bulk power transits)

Vision 1

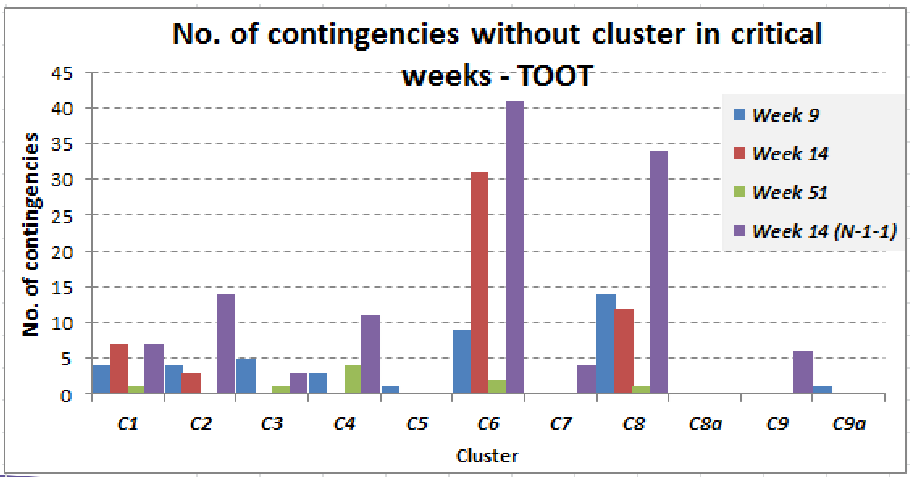
- High load- high RES penetration, Week 51 / 20h, Pwind = 13135 MW
- High load- low RES penetration, Week 50 / 91h, Pwind = 1587 MW
- Low load – high RES penetration, Week 14 / 30h, Pwind = 7512 MW
- High import/export, Week 9 / 5h, ~3.9 GW exports to Italy ~1.2 GW exports to Austria

Analyses with TOOT methodology

- Contingency analyses “N-1”
- Contingency analyses “N-1-1”
  set of disconnected OHLs in the region, relevant for time of maintenance

Technical resilience

Overloaded element	Outage	CLUSTERS											
		All	1	2	3	4	5	6	7	8	8a	9	9a
220kV OHL Divaca - Pehlin	OHL 380kV XLI_VO11 - VOLPAGO	110 %(1x)	110 % (1x)	110 % (1x)	115 % (3x)	110 % (1x)	110 % (1x)	110 %(1x)	110 % (1x)	156 % (7x)	110 % (1x)	110 % (1x)	110 % (1x)
TR2 Bucuresti Sud (RO)	TR1 Bucuresti Sud (RO)			108 % (1x)		100 % (1x)		101 % (1x)		100 % (1x)			
TR1 Bucuresti Sud (RO)	TR2 Bucuresti Sud (RO)			108 % (1x)		100 % (1x)		101 % (1x)		100 % (1x)			
220kV OHL Portile de Fier - Resita 1 (RO)	220kV OHL Portile de Fier - Resita 2 (RO)							105 % (1x)					
220kV OHL Portile de Fier - Resita 2 (RO)	220kV OHL Portile de Fier - Resita 1 (RO)							105 % (1x)					
220kV OHL Paroseni - BARU (RO)	OHL 400kV Brasov - Sibiu (RO)							103 % (2x)					
OHL 220kV RBARU 2 - RHAJD 2	OHL 400kV Brasov - Sibiu (RO)			100 % (1x)				104 % (2x)					
OHL 220kV RFILES2 - RBARBO2 1	OHL 400kV Gutinas - RINDEP1			107 % (1x)									
220kV OHL Gutinas - Dumitra (RO)	OHL 400kV Bacau - Roman (RO)					102 % (1x)	100 % (1x)	106 % (2x)		102 % (1x)			100 % (1x)
220kV OHL Divaca - Pehlin	OHL 400kV Divaca 4 - Melina (HR)				102 % (2x)					113 % (3x)			
220kV OHL Brinje - HE Senj (HR)	OHL 400kV Melina - Brinje (HR)				102 % (1x)					130 % (1x)			
220kV OHL Brinje - HE Senj (HR)	OHL 400kV Melina - Velebit (HR)				109 % (1x)								
220kV OHL HE Senj - Melina (HR)	OHL 400kV Melina - Brinje (HR)												
220kV OHL HE Senj - Melina (HR)	OHL 400kV Melina - Velebit (HR)		106 % (1x)										
TR Zerjavinec (HR)	OHL 400kV Tumbro - Zerjavinec (HR)				101 % (1x)								
TR Brinje (HR)	OHL 400kV Melina - Brinje (HR)				105 % (1x)					138 % (1x)			
220kV OHL Brinje - Konjsko (HR)	OHL 400kV Melina - Velebit (HR)		153 % (3x)										



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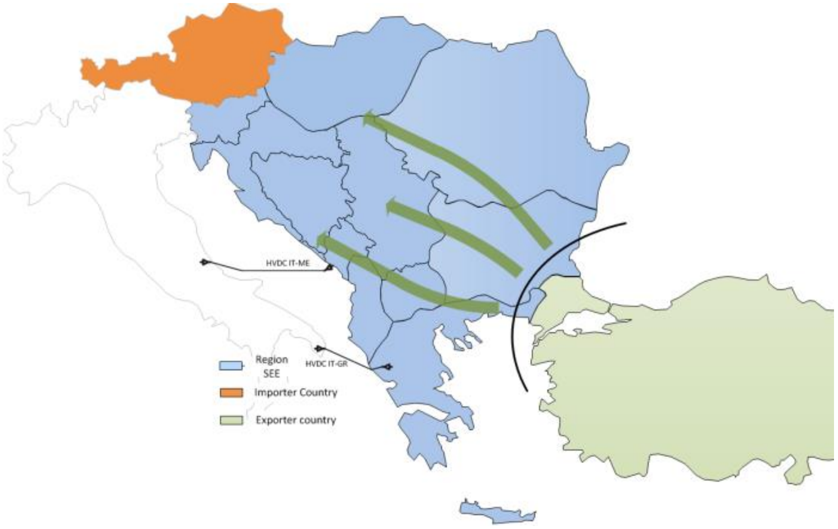
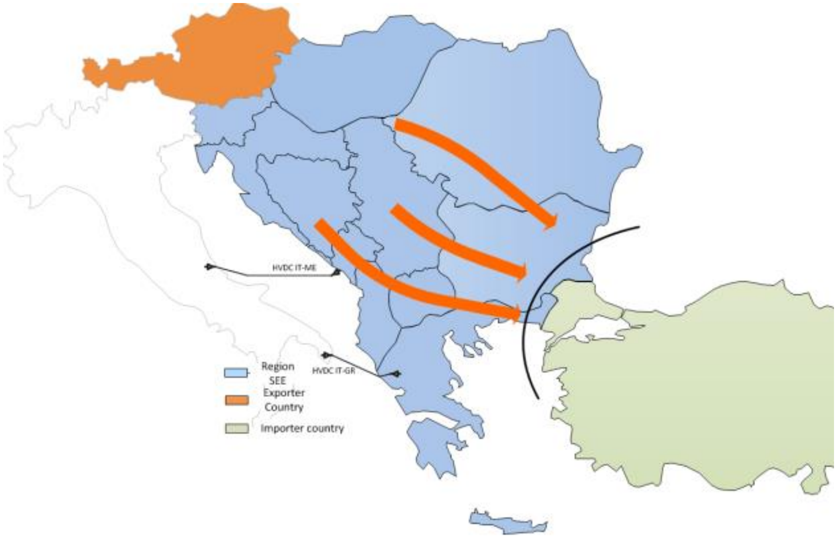
Flexibility

Sensitivity analysis with respect to the exchanges with Turkey





Base case: TR import 494 MW
TR is balanced 0 MW
TR export 500 MW
TR export 1000 MW

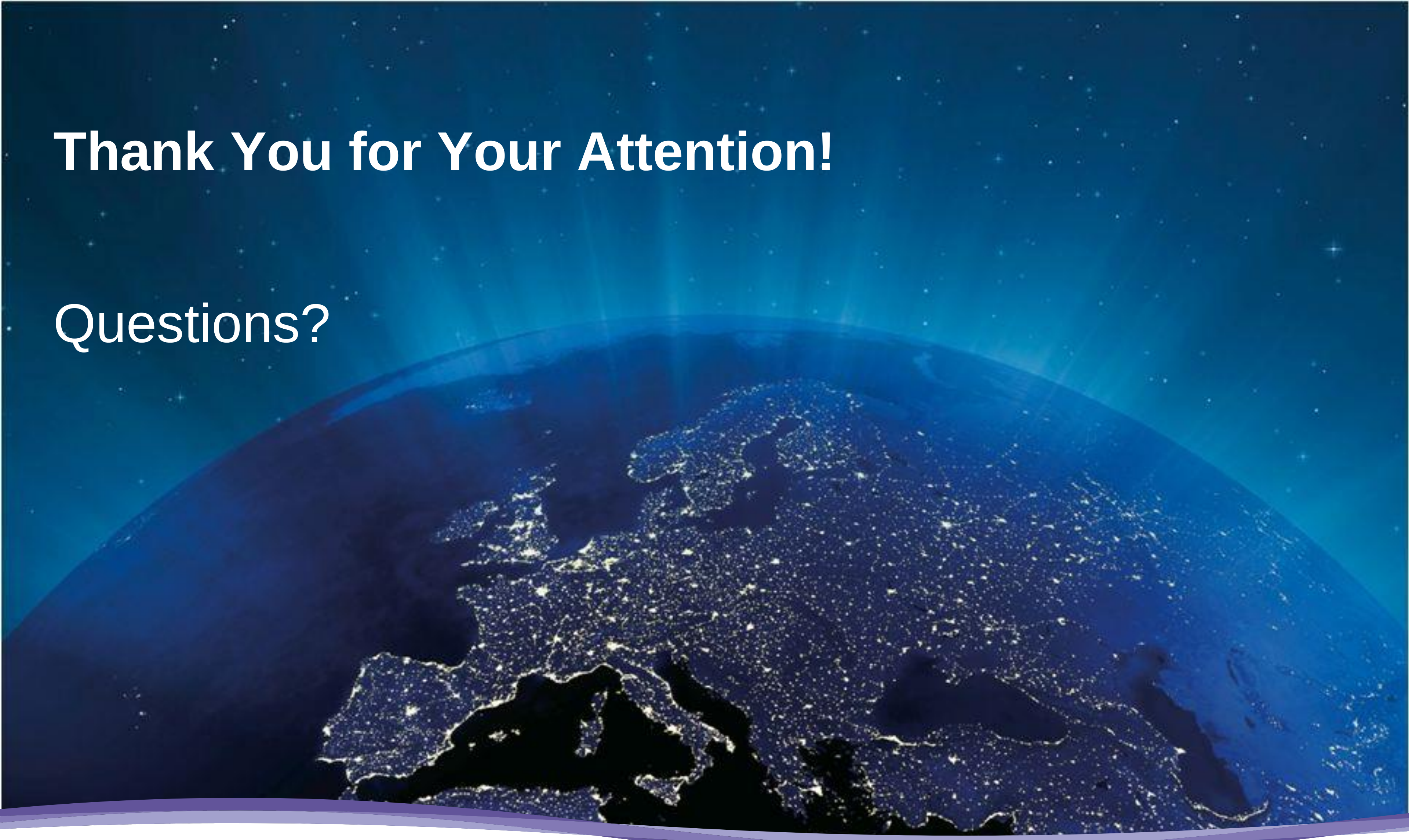
Base case: TR import 494 MW
TR import 1000 MW
TR import 1500 MW
TR import 2000 MW

Flexibility

KPI 1	**Project need** General rule: ++ if project needed in 4 visions + otherwise 0 if needed in only one vision In case there is a more relevant context to consider (ex: binary issue such as commissioning or not of one power plant), then 0
KPI 2	**Importance of investments** 0 if all investments are necessary to get a first benefit + if one (or more) investment is key (pre-requesite) to a first benefit ++ otherwise
KPI 3	**Balancing opportunities** 0 if internal to a control area + inside a synchronous area ++ if connection with other synchronous areas

Thank You for Your Attention!

Questions?



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