
Draft Results of the PEGI/PMI 2018 Assessment

Electricity Infrastructure Projects

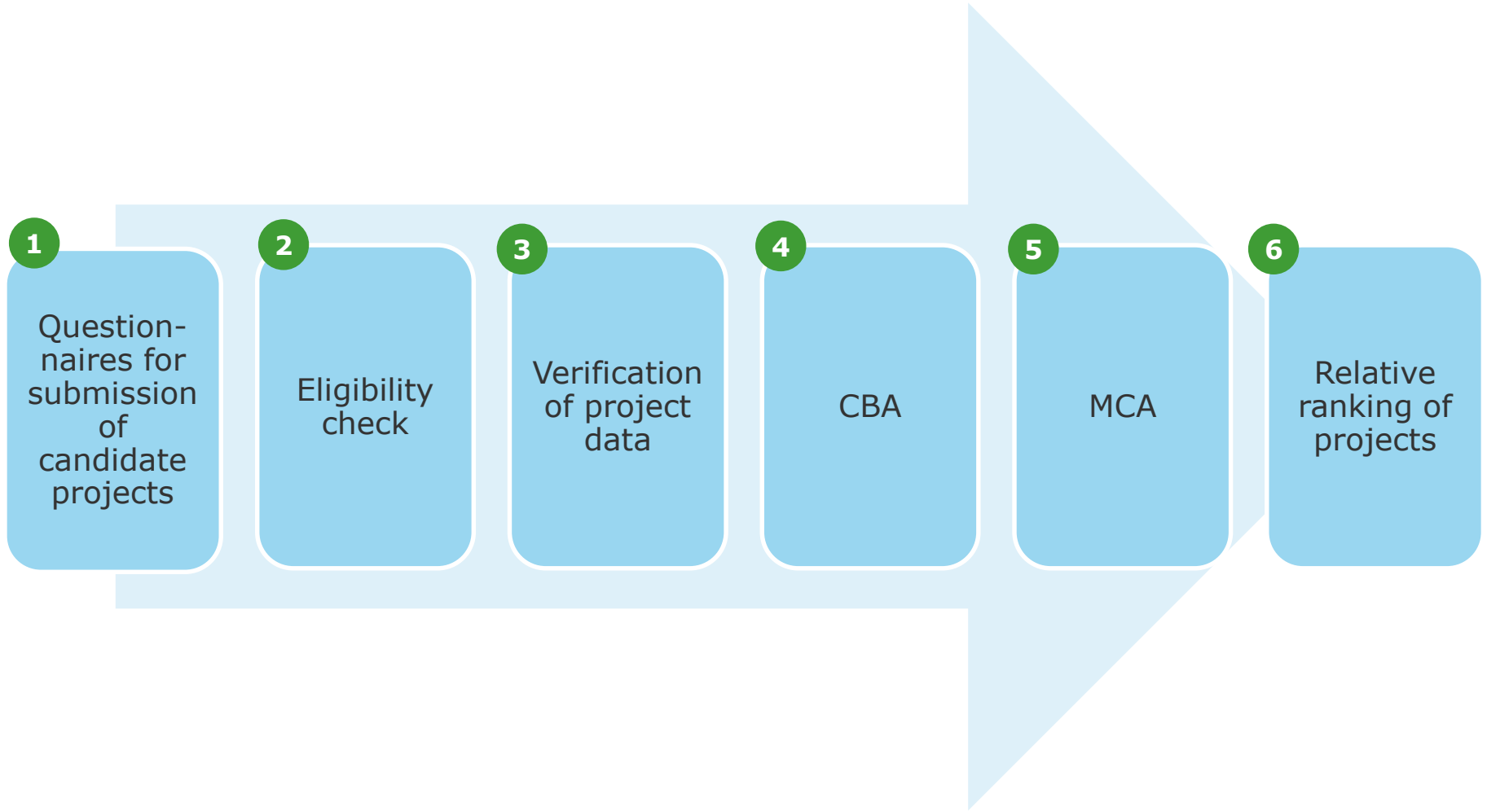
4th PEGI/PMI Electricity Group meeting, Vienna

22.05.2018

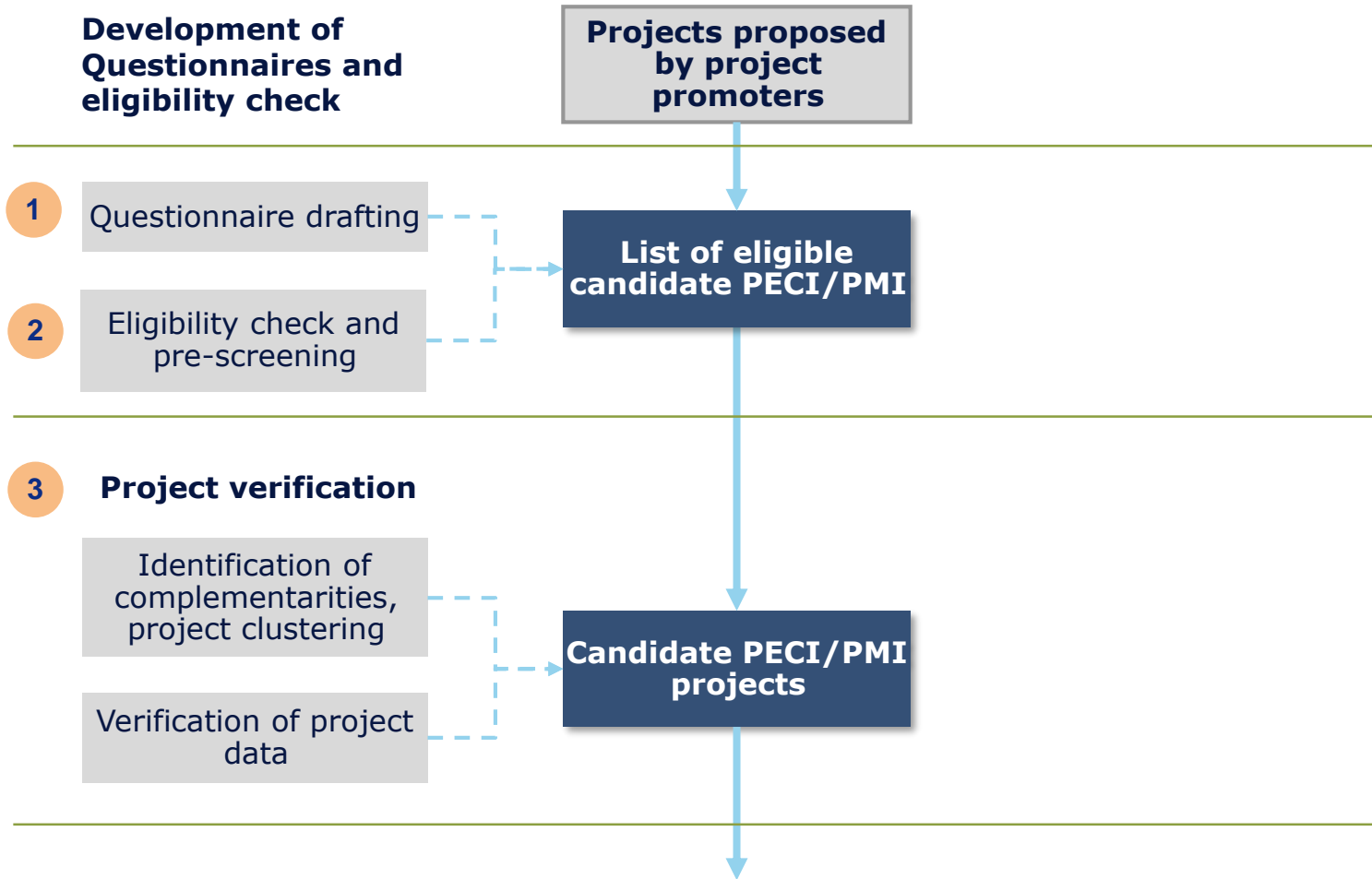
Agenda

1. Overview of Assessment Methodology
2. Reference scenario for CBA modelling
3. Results of cost-benefit analysis and sensitivities
4. Results of multicriteria assessment and relative ranking
5. Individual project results

Steps of the Project Assessment

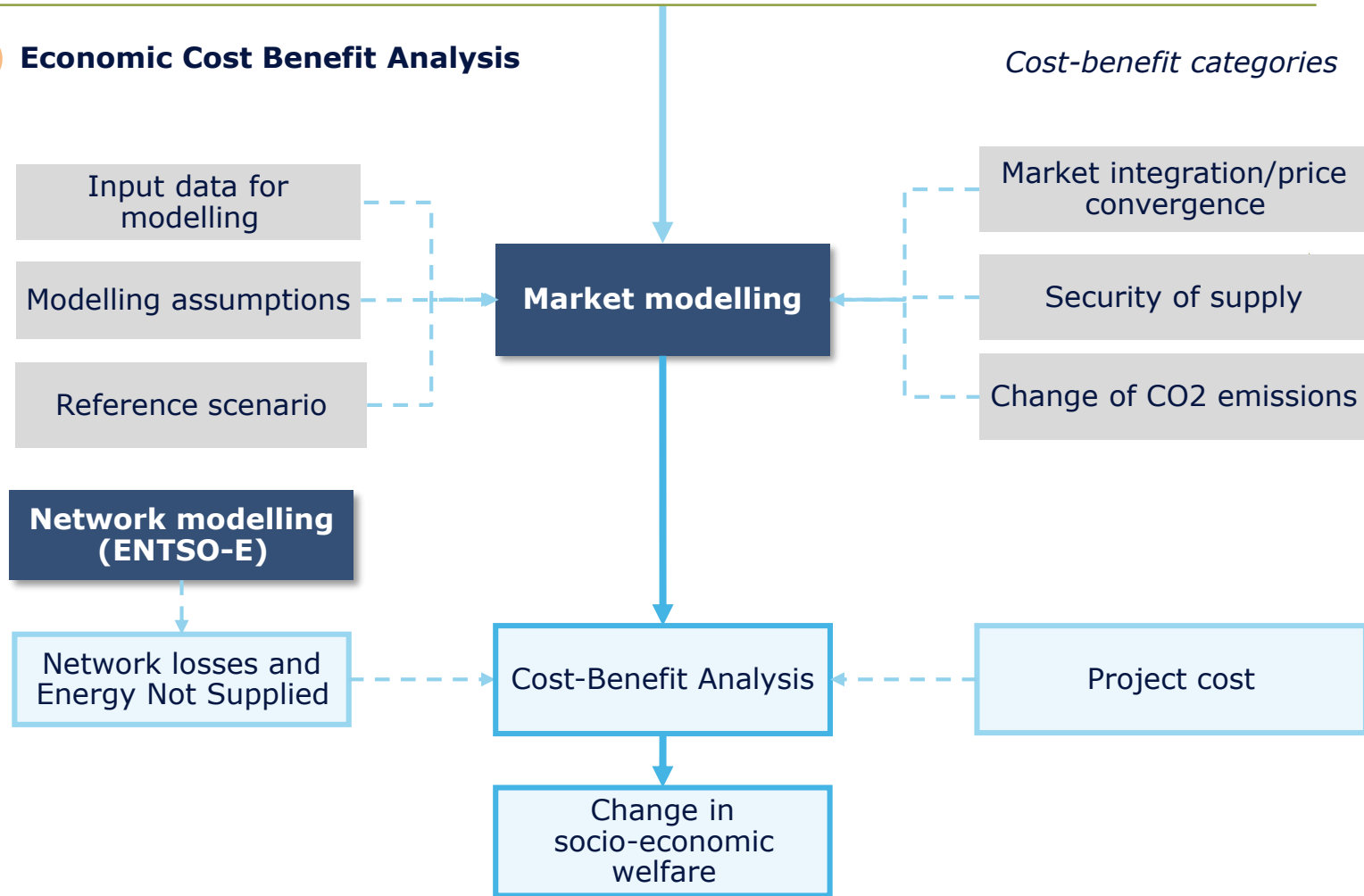


Overview of the Project Assessment Methodology

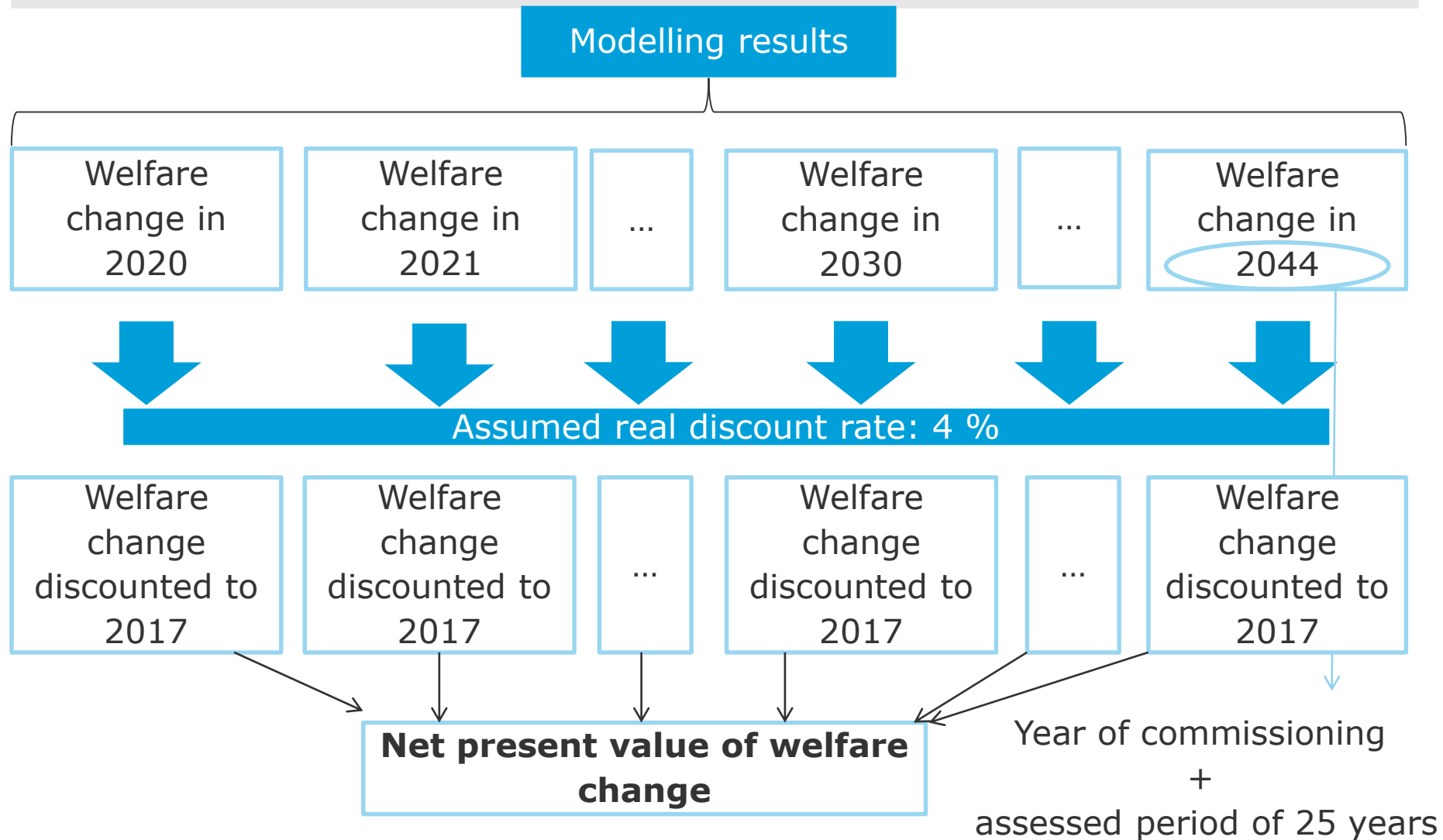


Overview of the Project Assessment Methodology

4 Economic Cost Benefit Analysis

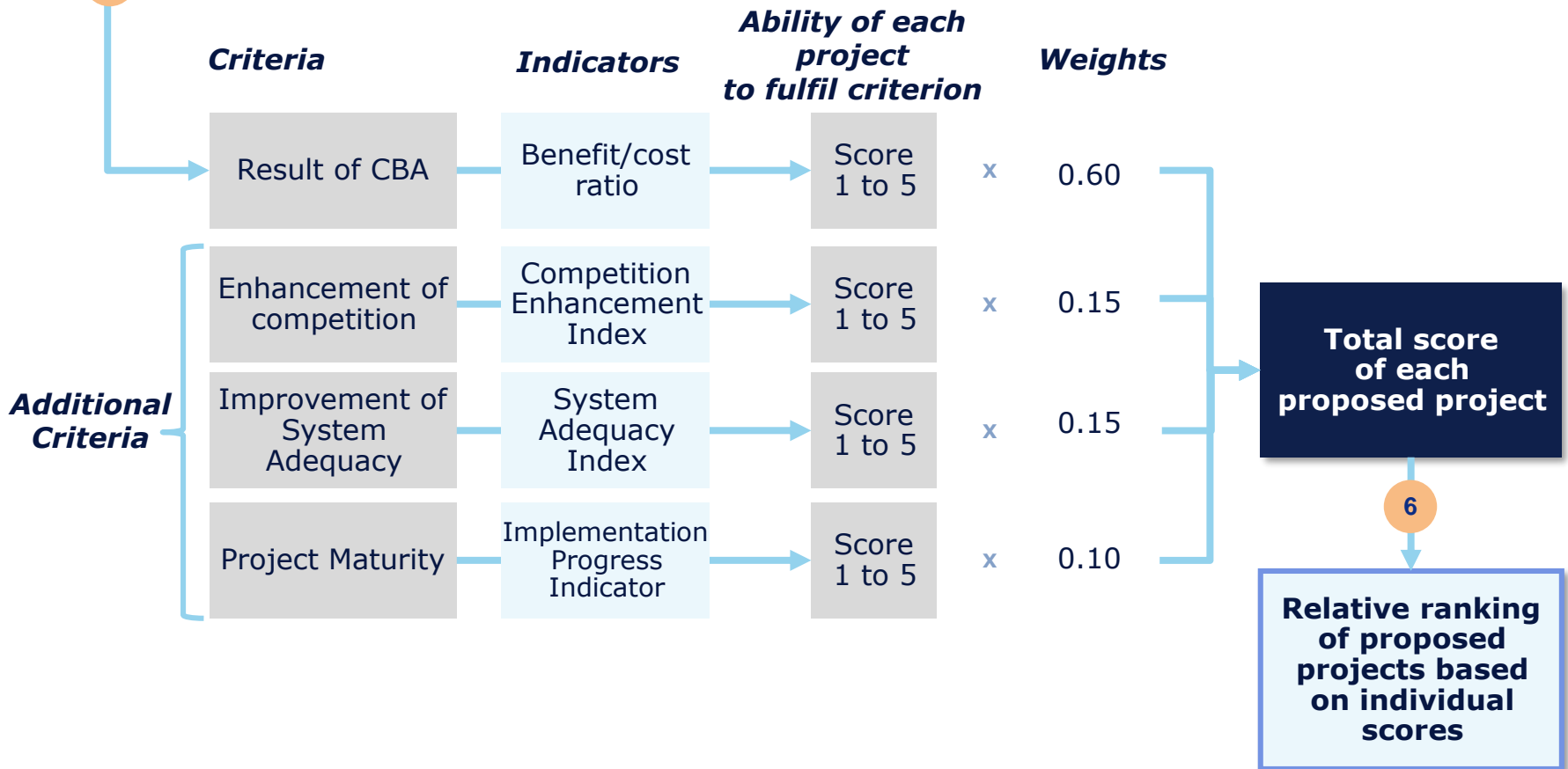


Calculating the Net Present Value of Social Welfare Changes



Overview of the Project Assessment Methodology

5 Multi-Criteria Assessment



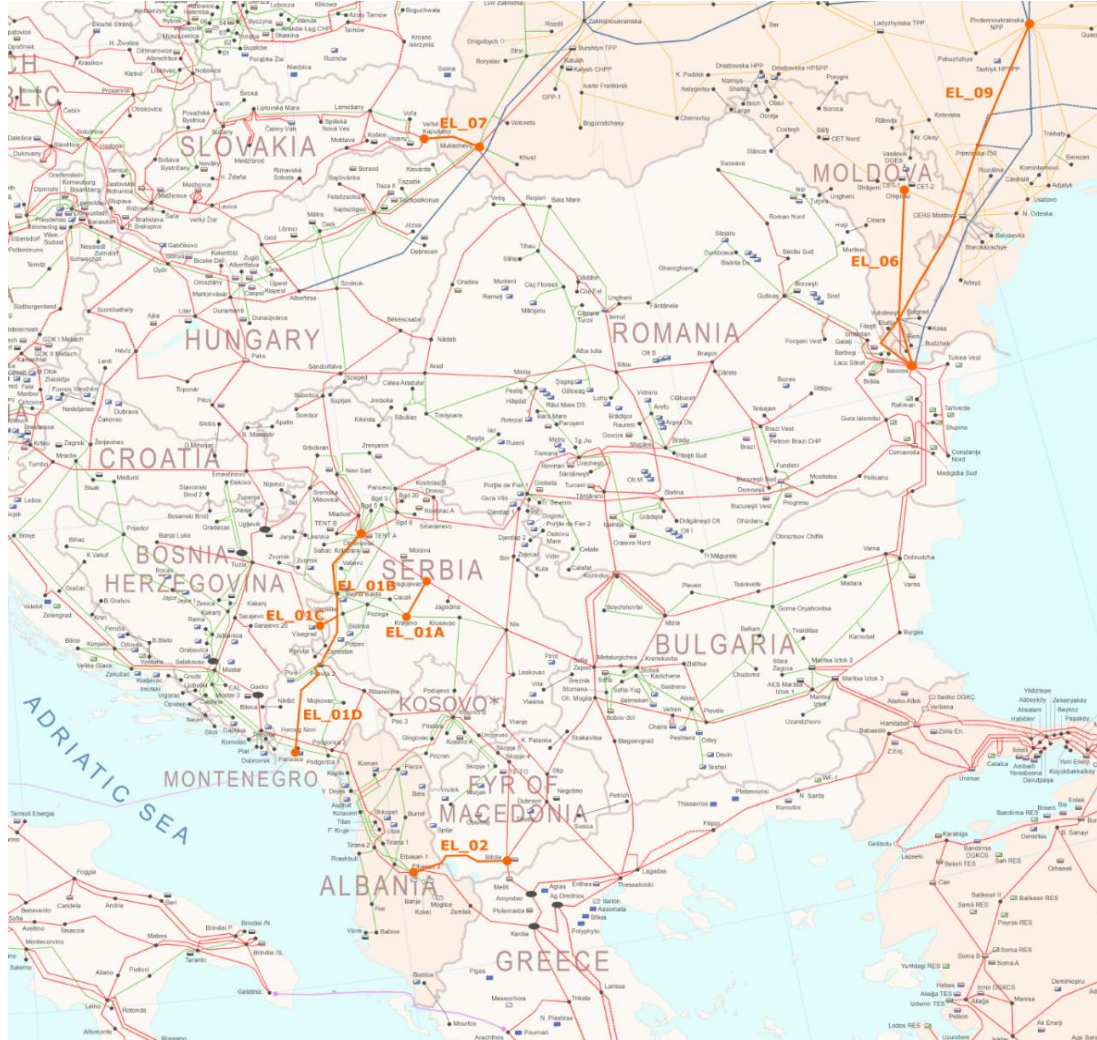
Summary of submitted infrastructure projects

	Electricity transmission	Electricity storage	Gas transmission	Gas storage	LNG	Smart grid	Oil	Total
Submitted projects (#)	11*	0	20	1	1	0	2	35
Submitted investment cost (million €)	963	0	19 351	69-74	6 294	0	381	c.a 27 061
Future investment need ** (million €)	758	0	7 907	69-74	6 294	0	381	c.a. 15 412

**The different parts of Transbalkan electricity corridor are considered as one project.*

***Investment cost of projects already under construction is excluded.*

Summary of eligible electricity projects



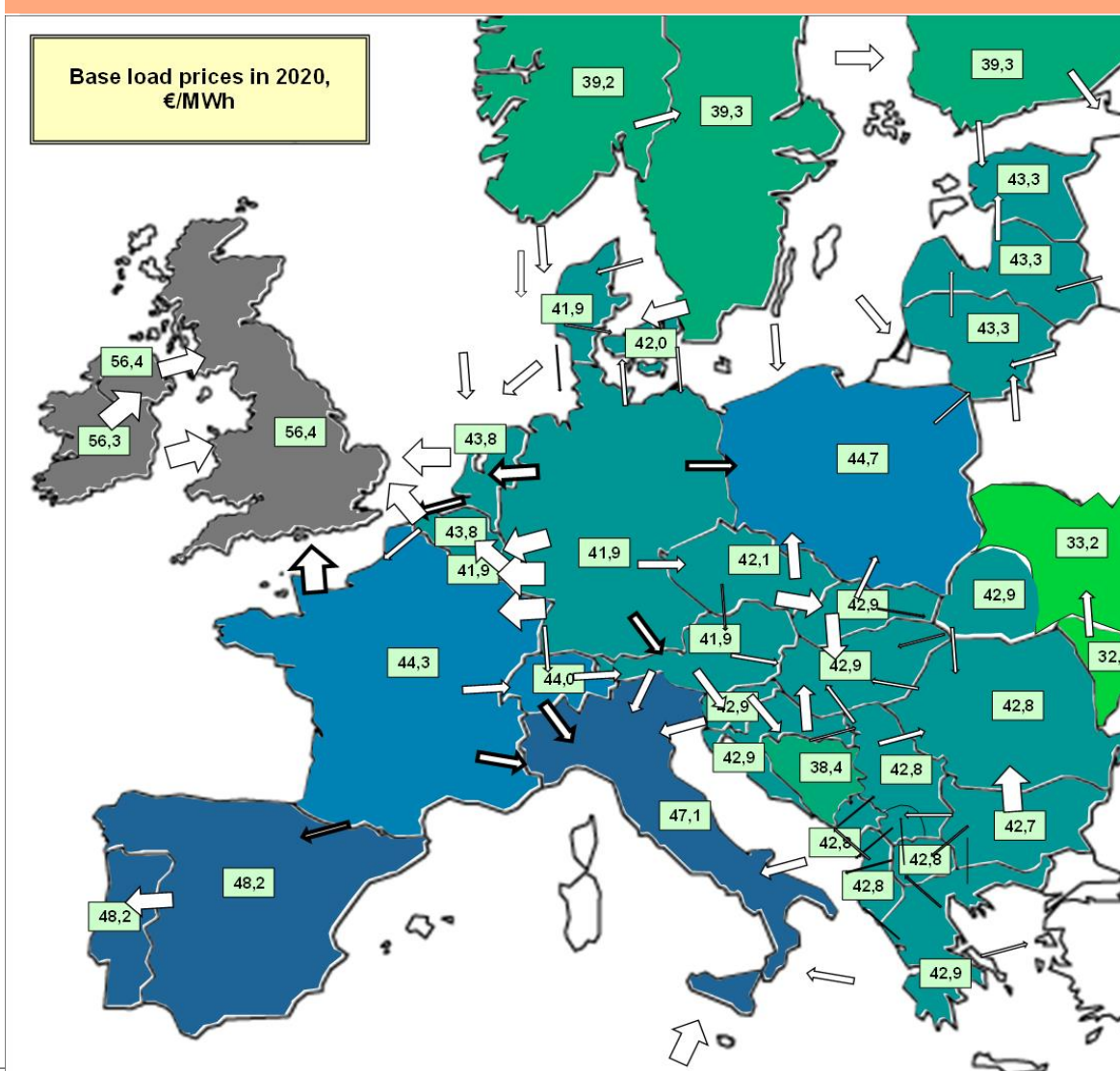
Summary table of eligible projects

Project code	Total cost (M€)	Commission date	NTC	NTC	NTC	NTC	NTC	NTC
			A-B	A-B	A-B	B-A	B-A	B-A
			2020	2025	2030 (MW)	2020	2025	2030
			(MW)	(MW)		(MW)	(MW)	(MW)
EL_01 (Montenegro-Serbia)			0 (Total: 200)	500 (Total: 700 MW)	500 (Total: 700 MW)	0 (Total: 300 MW)	500 (Total: 800 MW)	500 (Total: 800 MW)
EL_01 (Montenegro-Italy)	264	2024	0 (Total: 500)	500 (Total: 1000 MW)	500 (Total: 1000 MW)	0 (Total: 500 MW)	500 (Total: 1000 MW)	500 (Total: 1000 MW)
EL_01 (Serbia-Bosnia)			0 (Total: 462)	450 (Total: 912 MW)	450 (Total: 912 MW)	0 (Total: 566 MW)	200 (Total: 766 MW)	200 (Total: 766 MW)
EL_02 (Macedonia-Albania)	96	2020	1000 (Total: 1000 MW)	1000 (Total: 1000 MW)	1000 (Total: 1000 MW)	600 (Total: 600 MW)	600 (Total: 600 MW)	600 (Total: 600 MW)
EL_06 (Moldova-Romania)	272	2022	0 (Total: 0 MW)	600 (Total: 600 MW)	600 (Total: 600 MW)	0 (Total: 0 MW)	500 (Total: 500 MW)	500 (Total: 500 MW)
EL_07 (Ukraine-Slovakia)	23	2023	300 (Total: 700 MW)	1000 (Total: 1400 MW)	1000 (Total: 1400 MW)	300 (Total: 700 MW)	1000 (Total: 1400 MW)	1000 (Total: 1400 MW)
EL_09 (Ukraine-Romania)	231	2026	0 (Total: 0 MW)	0 (Total: 0 MW)	1000 (Total: 1000 MW)	0 (Total: 0 MW)	0 (Total: 0 MW)	1000 (Total: 1000 MW)

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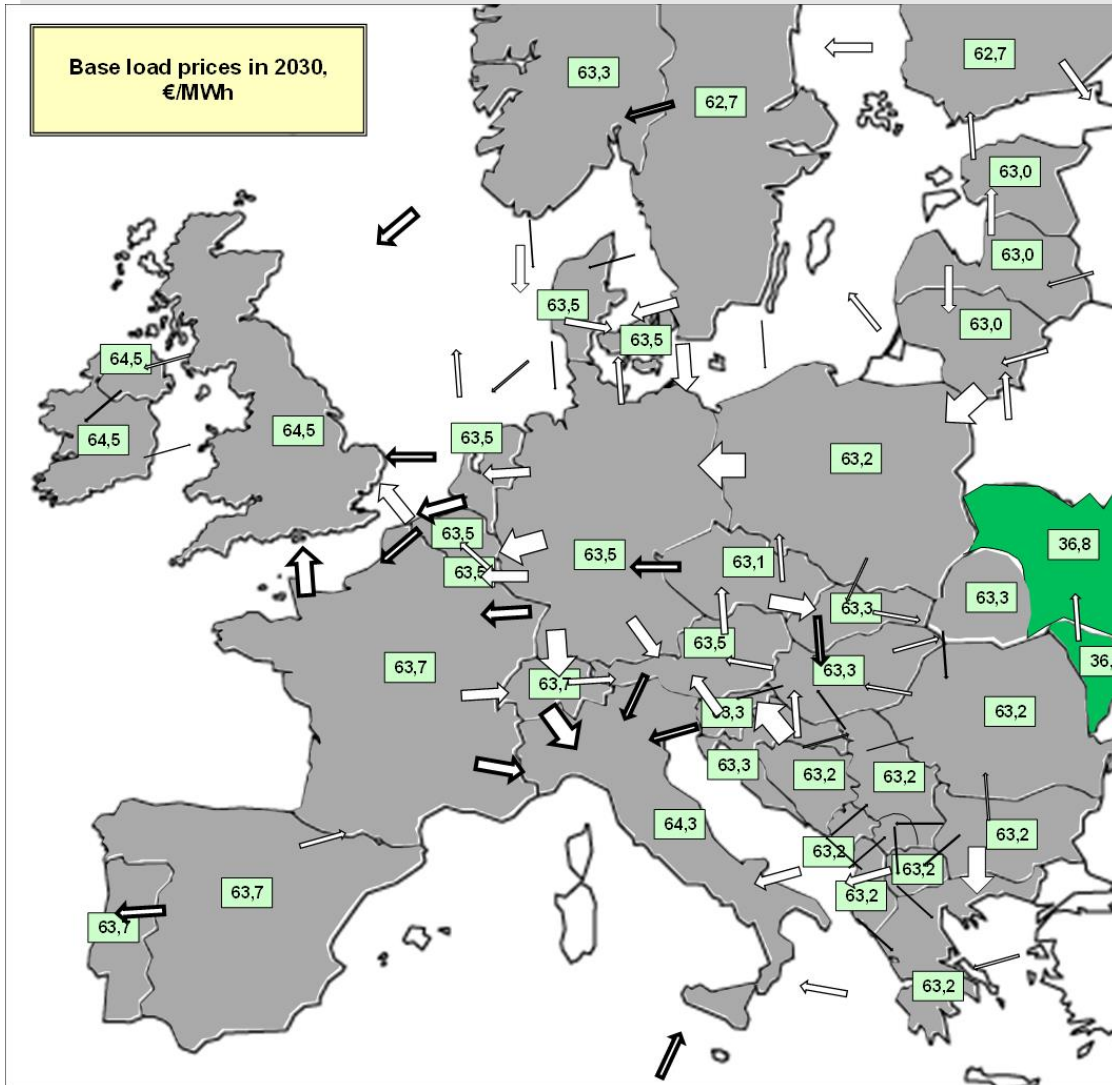
Reference scenario wholesale electricity prices in 2020



- Price convergence between WB6 and CEE countries
- BiH is an exception due to MTC bottlenecks
- Italy remains a high price zone
- Moldova connected to East Ukraine - no Carbon price assumed

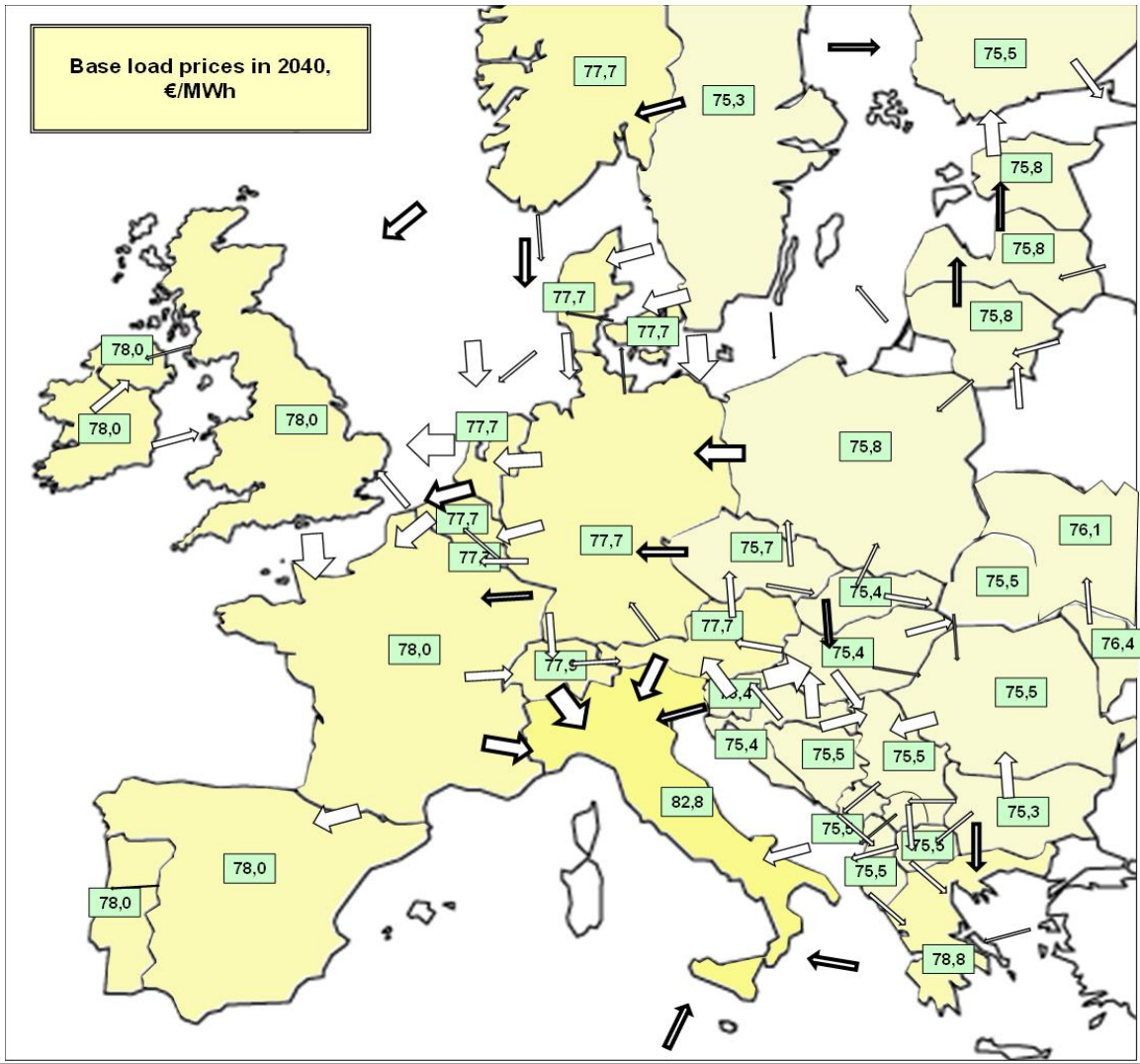
*the baseload wholesale prices are demonstrated in the boxes, arrows indicate the direction and volume (by its size) of electricity trade

Reference scenario wholesale electricity prices in 2030



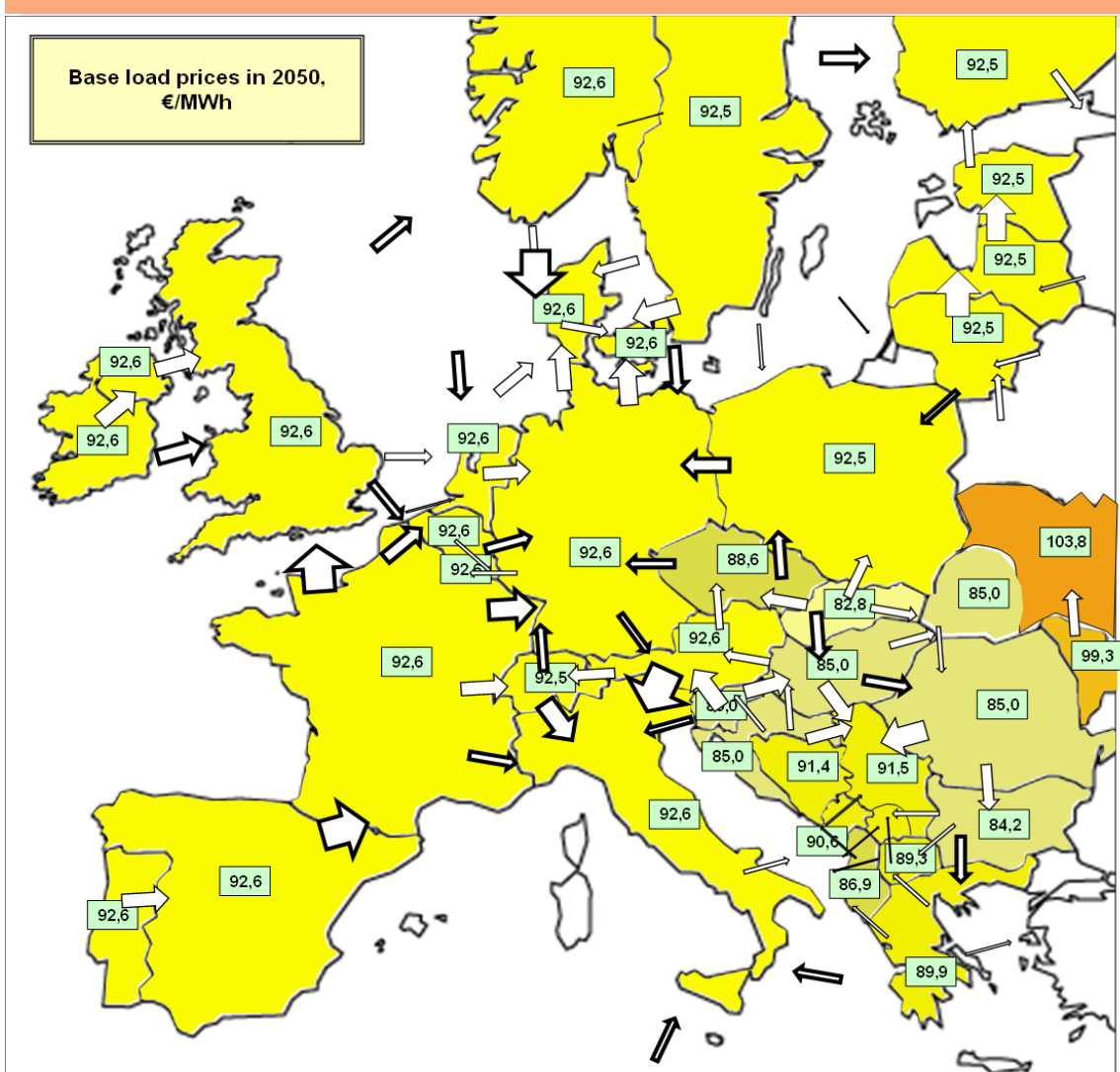
- This is the year when almost full price convergence between all ENTSO-E countries
- Increasing prices due to increasing CO2 price and natural gas price
- BiH joins this price convergence as well
- Italy remains a bit higher price zone, but only with small difference
- Moldova connected to East Ukraine – still no Carbon price assumed for these two countries

Reference scenario wholesale electricity prices in 2040



- Prices start to divert again. CEE together with WB6 have a price discount of 2 €/MWh
- Due to assumed nuclear developments in CEE
- Increasing prices due to increasing CO2 price and natural gas price
- Italy become again a higher price zone
- Moldova, East Ukraine now connected to the carbon scheme – they join the region in prices as well

Reference scenario wholesale electricity prices in 2050



- Prices further increase. CEE together with WB6 have a price discount of 6 €/MWh
- WB6 have a 5 €/MWh price mark-up compared to CEE – signaling network constraints
- Increasing prices (above 90 €/MWh) due to increasing CO2 price and natural gas price
- Moldova, East Ukraine even higher priced –due to constraints in generation and network connections

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Electricity CBA Results

Project code	Country	Welfare change, m€				Investment cost, m€	OM cost, m€	Transmission loss reduction benefit, m€	ENS benefit, m€	NPV, m€	Benefit /cost
		Consumer	Producer	Rent	Subtotal						
EI_01	ME-RS-BA	-4.9	323.2	-78.0	240.4	-245.6	-41.6	86.5	0.1	39.8	1.16
EI_02	MK-AL	-13.7	94.1	-67.0	13.4	-89.3	-6.1	-28.1	-8.1	-118.2	-0.32
EI_06	RO-MD	-2 532.8	2 495.9	1 136.7	1 099.8	-233.1	-46.2	-6.0	0.0	814.5	4.49
EI_07	UA_W-SK	7.5	-1.0	-4.8	1.7	-19.5	-3.9	-23.8	0.0	-45.5	-1.33
EI_09	UA_E-RO	-5 320.3	5 619.0	1 366.9	1 665.6	-182.0	-33.6	-33.2	0.0	1416.8	8.79

Discounted, aggregated values in 25 years period

Notes on Electricity CBA Results (I)

- Project EL_01 (Transbalkan Corridor)
 - Slightly positive NPV project with B/C value 1.16, indicating that the project brings benefits to the region
 - Social welfare is positive (both on the consumer and producer side) and the project brings the highest savings in Loss Reduction values amongst the assessed project
- Project EL_02 (South Balkan Corridor)
 - Close to realisation, but presents an overall negative NPV
 - Brings benefits for consumers through price reductions, the overall welfare change is only slightly positive
 - Socio-economic benefits do not outweigh the costs of the project

Notes on Electricity CBA Results (II)

- EL_06 project (Romania-Moldova)
 - Shows an overall positive NPV
 - Positive and significant social welfare benefits concentrated on the producer and rent side
- EL_07 project (Ukraine-West – Slovakia)
 - Negative NPV project with close to zero social benefits
 - As Slovakia would be connected to UA-West, the observed price differential is not sufficient to bring the project to positive NPV over the long term
- EL_09 project (Ukraine-East - Romania)
 - Presents high social benefits for the region, which are amongst the highest for the region
 - B/C value is well over the threshold level of 1
 - At this level even private investors might be able to undertake the project, and the fact that most welfare is concentrated at the generator and TSO side supports this consideration

Electricity CBA Sensitivity Results

NPV, m€		PINT	TOOT	Low CO ₂	High demand	Low demand	Low gas	High gas	Deep iteration
EI_01	ME-RS-BA	39.8	52.2	91.0	41.2	32.7	-121.8	197.1	-13.4
EI_02	MK-AL	-118.2	-121.4	-119.6	-129.6	-123.5	-122.7	-119.6	-122.6
EI_06	RO-MD	814.5	497.4	637.7	643.3	1 011.9	508.4	1 318.0	734.6
EI_07	UA_W-SK	-45.5	-45.6	-44.7	-48.1	-45.6	-44.5	-50.6	-45.6
EI_09	UA_E-RO	1 416.8	930.1	1 144.8	946.5	2 111.8	1 055.7	2 071.9	1 309.7

Benefit/cost ratio		PINT	TOOT	Low CO ₂	High demand	Low demand	Low gas	High gas	Deep iteration
EI_01	ME-RS-BA	1.2	1.2	1.4	1.2	1.1	0.5	1.8	0.9
EI_02	MK-AL	-0.3	-0.4	-0.3	-0.5	-0.4	-0.4	-0.3	-0.4
EI_06	RO-MD	4.5	3.1	3.7	3.8	5.3	3.2	6.7	4.2
EI_07	UA_W-SK	-1.3	-1.3	-1.3	-1.5	-1.3	-1.3	-1.6	-1.3
EI_09	UA_E-RO	8.8	6.1	7.3	6.2	12.6	6.8	12.4	8.2

- TOOT: Take out one at a time
- Low CO₂: using half of the reference CO₂ price
- High/low demand: yearly growth rates are 0.5% higher/lower compared to REF in all modelled countries
- Low gas/high gas: assuming +/-30% natural gas price change in all modelled countries
- Deep Iteration: natural gas prices and quantities were iterated between the gas and electricity market models in several runs

Notes on Electricity CBA Sensitivity Results

- The sensitivity results indicate that project assessment results are robust for all projects, with the exception of the Transbalkan Corridor (EL_01)
 - CBA results do not change sign in the sensitivity assessment (from positive to negative NPV or from negative to positive NPV)
 - Similarly confirmed for B/C ratios in the sensitivity assessment
 - Project assessment results are very robust for all these infrastructure projects
- For the Transbalkan Corridor, the reference results already indicate a project performance has a slightly positive NPV and a close to 1 B/C ratio
 - Even small changes in the project environment – analysed in the sensitivity run – can change project performance significantly
 - Sensitivity results confirm this, there are sensitivity runs (low gas price, deep iteration), where the project gets close to or below the break-even point
 - At higher natural gas values, the project becomes significantly positive, indicating high sensitivity of the project to the natural gas prices in the region
 - This sensitivity result also supports the consideration of this project for the PECCI /PMI list, as in most cases it remains in the positive NPV range

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Electricity MCA Results

Project Code	Countries	Change in Indicator due to Project				Scores of Indicators [Scale 1 (min) to 10 (max)]				Weighted Scores of Indicators				Total Score
		Benefit-Cost Ratio (B/C ratio)	System Adequacy Index (SAI)	Herfindahl-Hirschman-Index (HHI)	Implementation Progress Indicator (IPI)	B/C ratio	SAI	HHI	IPI	B/C ratio (60%)	SAI (15%)	HHI (15%)	IPI (10%)	
EL_01	ME-RS-BA	1,16	3,64	887,53	4,00	1,00	10,00	5,54	4,00	0,60	1,50	0,83	0,40	3,33
EL_02	MK-AL	-0,32	1,10	1602,66	6,00	0,00	3,47	9,65	6,00	0,00	0,52	1,45	0,60	2,57
EL_06	RO-MD	4,49	0,57	1205,20	4,00	4,93	2,11	7,36	4,00	2,96	0,32	1,10	0,40	4,78
EL_07	UA_W-SK	-1,33	1,40	1664,05	2,00	0,00	4,23	10,00	2,00	0,00	0,64	1,50	0,20	2,34
EL_09	UA_E-RO	8,79	0,14	98,62	1,00	10,00	1,00	1,00	1,00	6,00	0,15	0,15	0,10	6,40

Electricity Projects results summary

Rank	Project Code	Project Name	
1	EL_09	750 kV Pivdennoukrainska NPP (Ukraine) – Isaccea (Romania) OHL rehabilitation and modernisation	Positive NPVs
2	EL_06	400 kV OHL Vulcanesti (MD) - Issacea (RO)	
3	EL_01	Trans Balkan Corridor	
4	EL_02	400 kV OHL Bitola (MK) - Elbasan (AL)	Negative NPVs
5	EL_07	400 kV Mukacheve (Ukraine) – V.Kapusany (Slovakia) OHL rehabilitation	

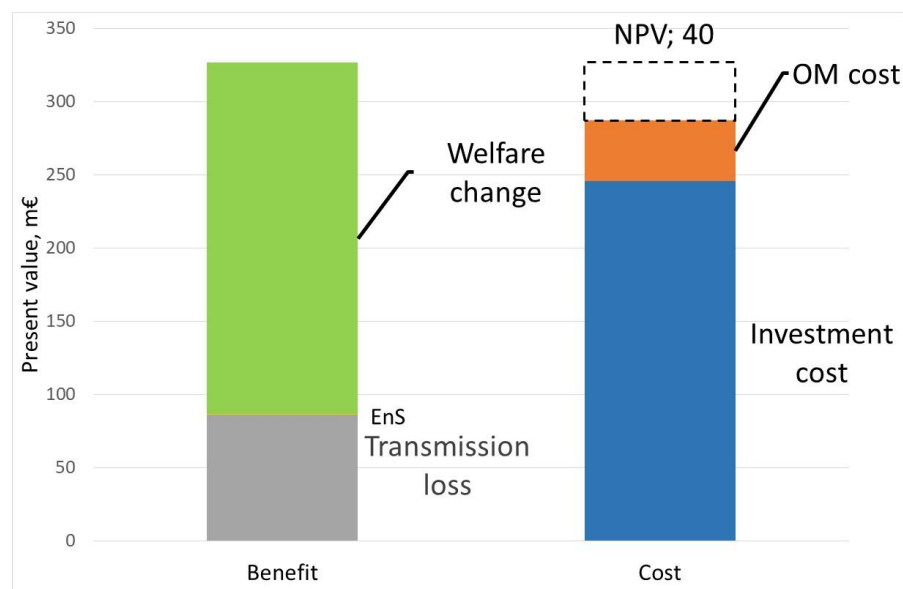
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El_01: Transbalkan

Origin	Destination	Year of commissioning	NTC: O->D (MW)	NTC: D->O (MW)
ME	RS	2025	500	500
ME	IT	2024	500	500
RS	BA	2024	450	200

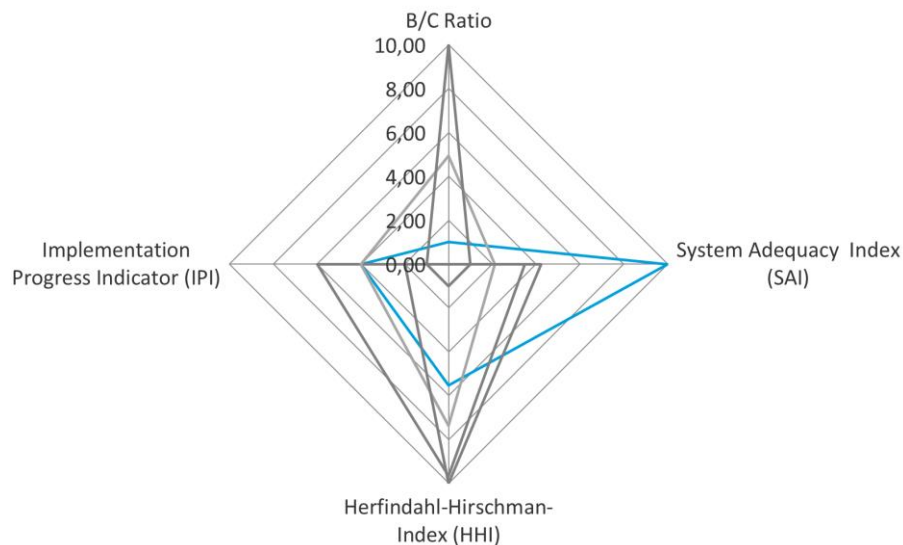
m€	Welfare change			
	Consumer	Producer	Rent	Total
AL	-24.7	41.9	-0.8	16.4
BA	-36.5	49.7	1.5	14.7
BG	-64.6	95.4	-2.1	28.8
GR	-50.7	51.3	-21.1	-20.5
HR	-31.2	46.7	-0.8	14.8
HU	-77.6	53.7	-2.8	-26.6
IT	666.2	-385.6	-106.6	173.9
KO	-17.5	19.4	0.2	2.1
ME	-13.6	17.8	51.4	55.6
MD	0.0	0.0	0.0	0.0
MK	-22.0	12.2	-0.4	-10.3
PL	-38.6	44.9	-2.6	3.7
RO	-134.5	134.0	2.3	1.9
RS	-101.2	73.6	1.8	-25.8
SK	-50.5	67.0	2.0	18.4
UA_E	0.0	0.0	0.0	0.0
UA_W	-8.0	1.1	0.1	-6.8
Region	-4.9	323.2	-78.0	240.4
EnC	-357.9	349.7	56.0	47.8
Hosted	-151.2	141.0	54.7	44.5



- Positive NPV: +40m€
- PI index:1.16

El_01: Transbalkan

	System Adequacy Index (SAI)	Herfindahl-Hirschman-Index (HHI)	Benefit / Cost Ratio (B/C)	Implementation progress Indicator (IPI)	Total Score	Ranking
Score	10	5,54	1	4	3,33	3
Impact (change of indicator)	3,64	887,53	1,16	4		

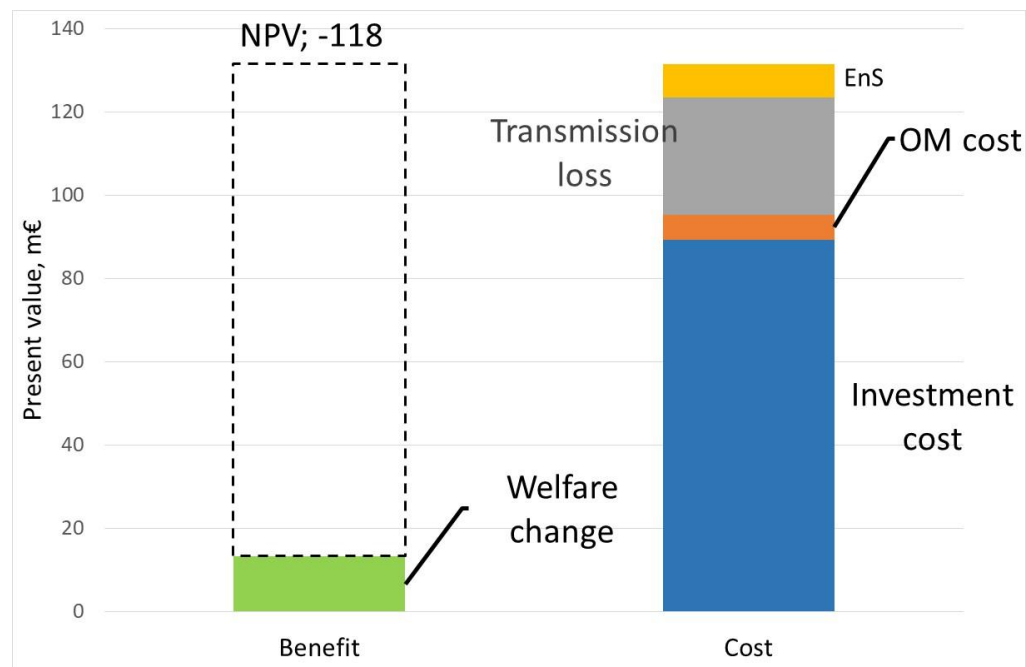


SAI and HHI values shown here represent the impact of a project (i.e. the difference without and with the individual project) in the countries on each end of the interconnector

EL_02: 400 kV OHL Bitola (MK) - Elbasan (AL)

Origin	Destination	Year of commissioning	NTC: O->D (MW)	NTC: D->O (MW)
MK	AL	2020	1000	600

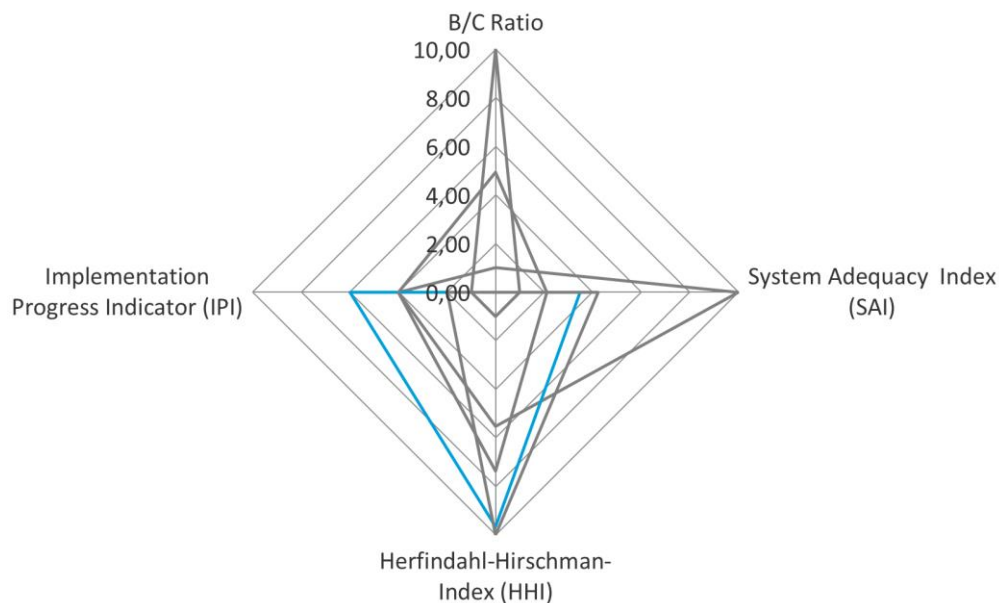
m€	Welfare change			
	Consumer	Producer	Rent	Total
AL	-43.2	82.0	-12.8	26.0
BA	-8.7	15.2	-0.3	6.2
BG	-1.8	3.4	-7.0	-5.4
GR	19.6	-19.7	0.4	0.3
HR	-0.9	1.4	-0.6	-0.2
HU	-1.5	1.1	1.2	0.8
IT	6.4	-3.2	-2.1	1.1
KO	-19.9	24.8	-14.6	-9.8
ME	-7.8	15.0	-9.4	-2.2
MD	0.0	0.0	0.0	0.0
MK	49.1	-26.5	-10.8	11.8
PL	-2.2	2.7	-0.2	0.4
RO	1.3	-1.8	0.4	-0.1
RS	-3.6	-0.6	-12.0	-16.2
SK	0.0	0.2	0.6	0.8
UA_E	0.0	0.0	0.0	0.0
UA_W	-0.4	0.0	0.2	-0.2
Region	-13.7	94.1	-67.0	13.4
EnC	-34.5	110.0	-59.8	15.7
Hosted	5.9	55.5	-23.6	37.9



- Negative NPV: -118m€
- PI index: -0.32

EL_02: 400 kV OHL Bitola (MK) - Elbasan (AL)

	System Adequacy Index (SAI)	Herfindahl-Hirschman-Index (HHI)	Benefit / Cost Ratio (B/C)	Implementation progress Indicator (IPI)	Total Score	Ranking
Score	3,47	9,65	0,00	6,00	2,57	4
Impact (change of indicator)	1,10	1602,66	-0,32	6,00		

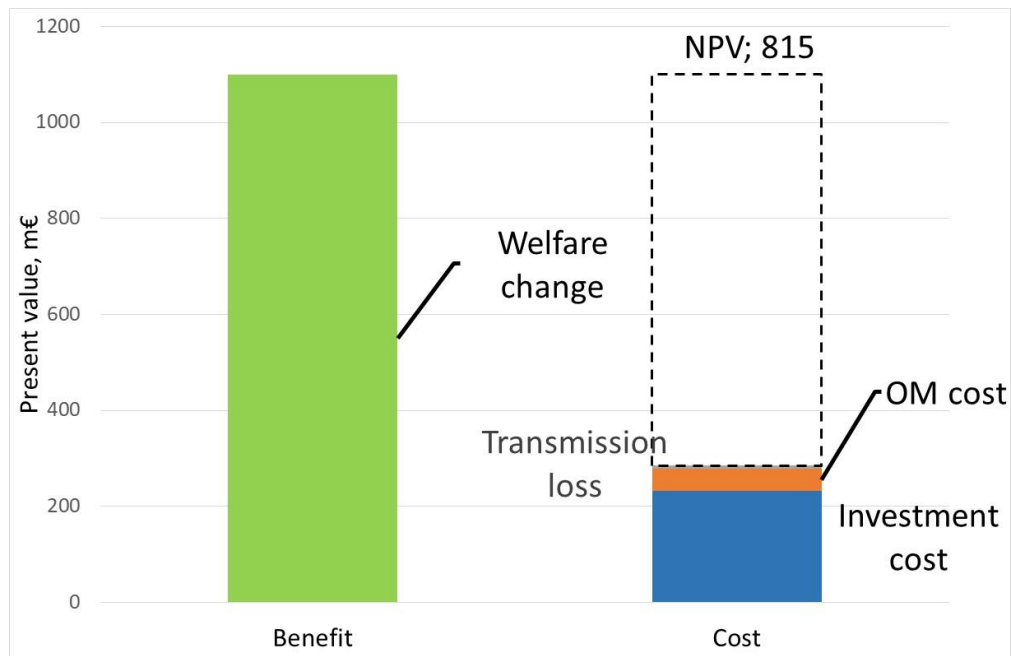


SAI and HHI values shown here represent the impact of a project (i.e. the difference without and with the individual project) in the countries on each end of the interconnector

EL_06: 400 kV OHL Vulcanesti (MD) - Issacea (RO)

Origin	Destination	Year of commissioning	NTC: O->D (MW)	NTC: D->O (MW)
MD	RO	2022	600	500

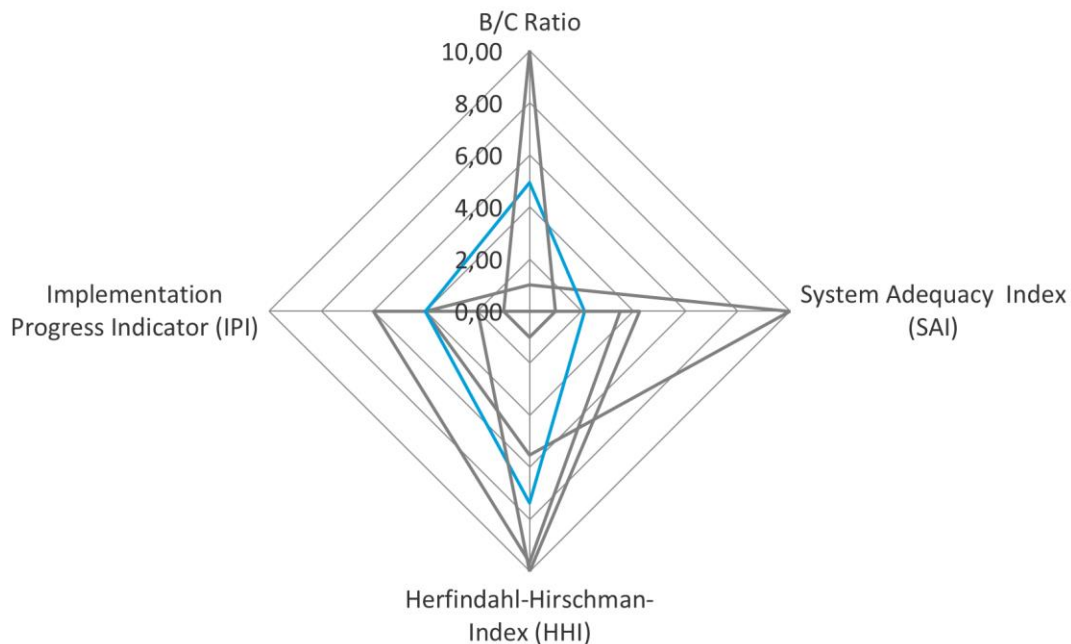
m€	Welfare change			
	Consumer	Producer	Rent	Total
AL	11.4	-11.3	-0.2	0.0
BA	10.4	-28.4	-1.7	-19.7
BG	43.8	-49.2	-4.3	-9.6
GR	87.0	-84.1	-3.5	-0.5
HR	2.6	10.3	3.4	16.2
HU	3.0	8.3	5.7	17.0
IT	42.4	-31.3	3.0	14.1
KO	9.2	-11.9	0.2	-2.5
ME	6.4	-10.4	2.1	-1.9
MD	-102.8	43.6	569.8	510.6
MK	11.8	-7.7	-0.7	3.4
PL	29.0	-28.8	-5.5	-5.3
RO	81.7	-79.8	488.4	490.2
RS	55.3	-64.9	3.0	-6.6
SK	4.2	11.4	-8.8	6.7
UA_E	-2828.5	2832.4	85.0	88.9
UA_W	0.4	-2.3	0.7	-1.2
Region	-2532.8	2495.9	1136.7	1099.8
EnC	-2826.5	2739.2	658.3	571.0
Hosted	-21.1	-36.2	1058.2	1000.9



- Positive NPV: 814m€
- PI index: 4.5

EL_06: 400 kV OHL Vulcanesti (MD) - Issacea (RO)

Benefit / Cost Ratio (B/C)	System Adequacy Index (SAI)	Herfindahl-Hirschman-Index (HHI)	Benefit / Cost Ratio (B/C)	Implementation progress Indicator (IPI)	Total Score	Ranking
Score	2,11	7,36	3,30	4,00	4,78	2
Impact (change of indicator)	0,57	1205,20	4,49	N/A		

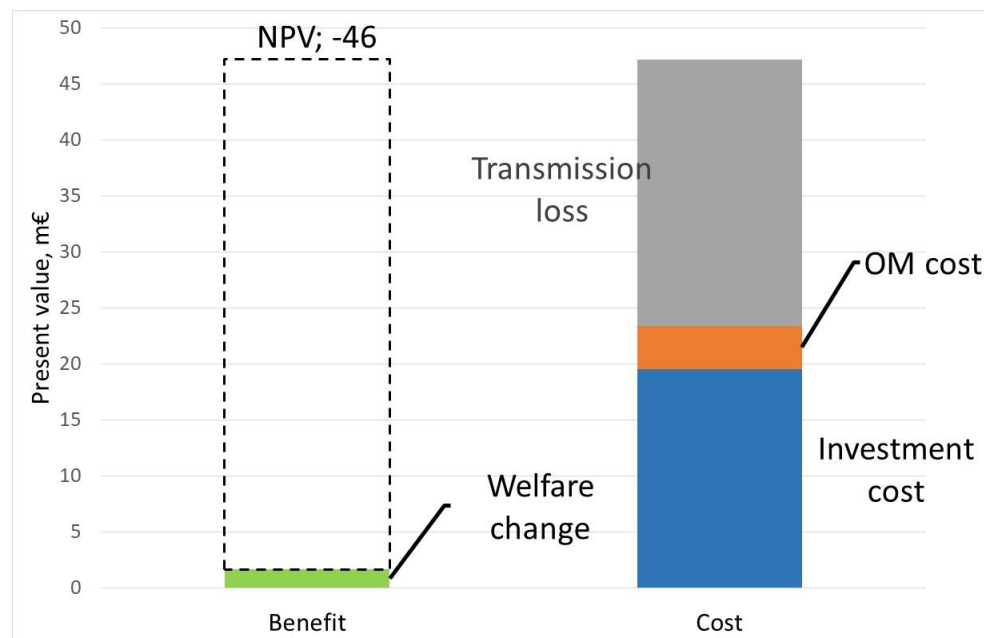


SAI and HHI values shown here represent the impact of a project (i.e. the difference without and with the individual project) in the countries on each end of the interconnector

EL_07: 400 kV Mukacheve (Ukraine) – V.Kapusany (Slovakia) OHL rehabilitation

Origin	Destination	Year of commissioning	NTC: O->D (MW)	NTC: D->O (MW)
UA_W	SK	2020	300	300
UA_W	SK	2023	700	700

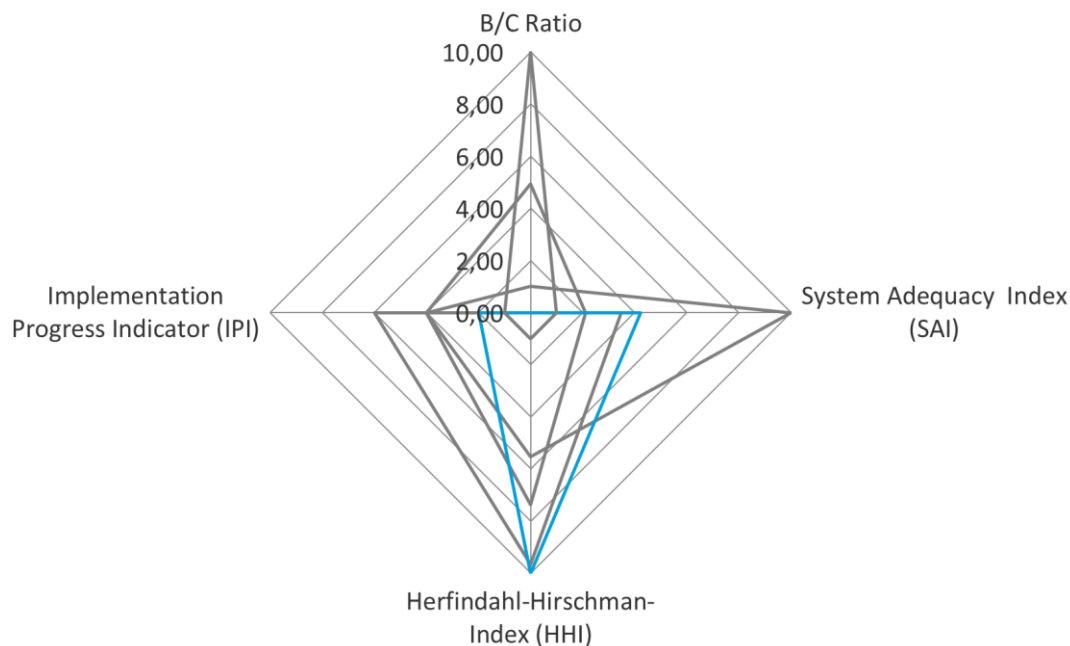
m€	Welfare change			
	Consumer	Producer	Rent	Total
AL	0.7	-1.3	0.1	-0.5
BA	0.7	-0.7	0.0	0.0
BG	3.5	-5.6	0.6	-1.5
GR	0.3	-0.2	0.7	0.7
HR	1.2	-2.0	0.1	-0.7
HU	3.1	-2.5	-3.3	-2.7
IT	0.1	-0.1	0.6	0.6
KO	0.5	-0.4	0.0	0.1
ME	0.3	-0.3	0.1	0.1
MD	0.0	0.0	0.0	0.0
MK	0.6	-0.3	0.1	0.5
PL	-6.8	8.6	-0.3	1.5
RO	6.0	-5.0	0.2	1.3
RS	2.8	-1.5	0.1	1.5
SK	-6.7	10.4	-3.0	0.7
UA_E	0.0	0.0	0.0	0.0
UA_W	0.9	0.0	-0.7	0.3
Region	7.5	-1.0	-4.8	1.7
EnC	6.7	-4.6	-0.4	1.8
Hosted	-5.8	10.3	-3.7	0.9



- Negative NPV: -46m€
- PI index: -1.3

EL_07: 400 kV Mukacheve (Ukraine) – V.Kapusany (Slovakia) OHL rehabilitation

Benefit / Cost Ratio (B/C)	System Adequacy Index (SAI)	Herfindahl-Hirschman-Index (HHI)	Benefit / Cost Ratio (B/C)	Implementation progress Indicator (IPI)	Total Score	Ranking
Score	4,23	10,00	0,00	2,00	2,34	5
Impact (change of indicator)	1,40	1664,05	-1,33	2,00		

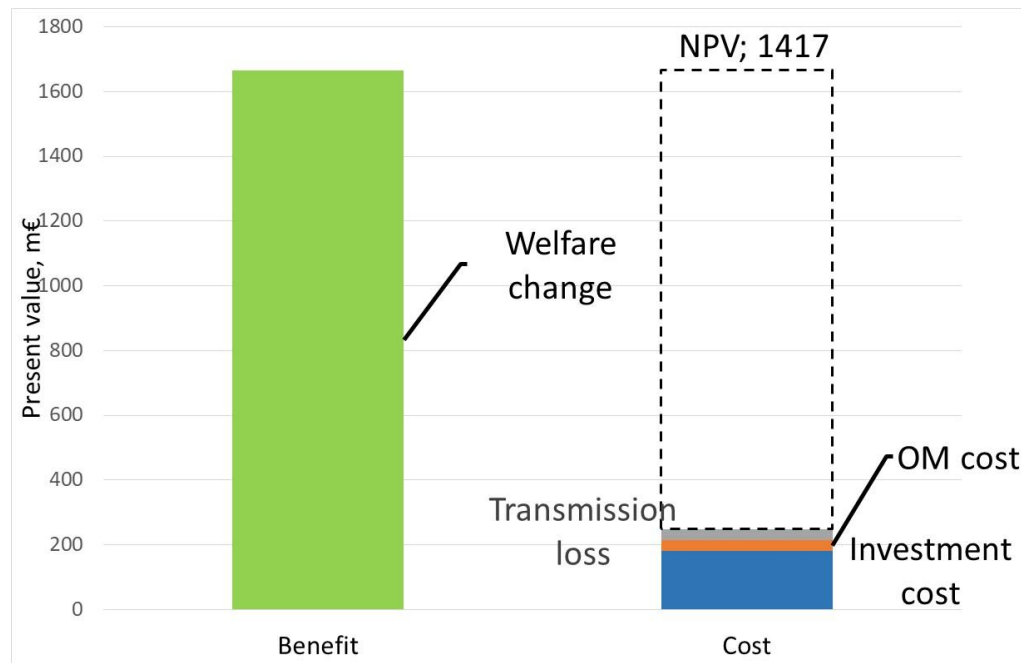


SAI and HHI values shown here represent the impact of a project (i.e. the difference without and with the individual project) in the countries on each end of the interconnector

EL_09: 750 kV Pivdennoukrainska NPP (Ukraine) – Isaccea (Romania) OHL rehabilitation and modernisation

Origin	Destination	Year of commissioning	NTC: O->D (MW)	NTC: D->O (MW)
UA_E	RO	2026	1000	1000

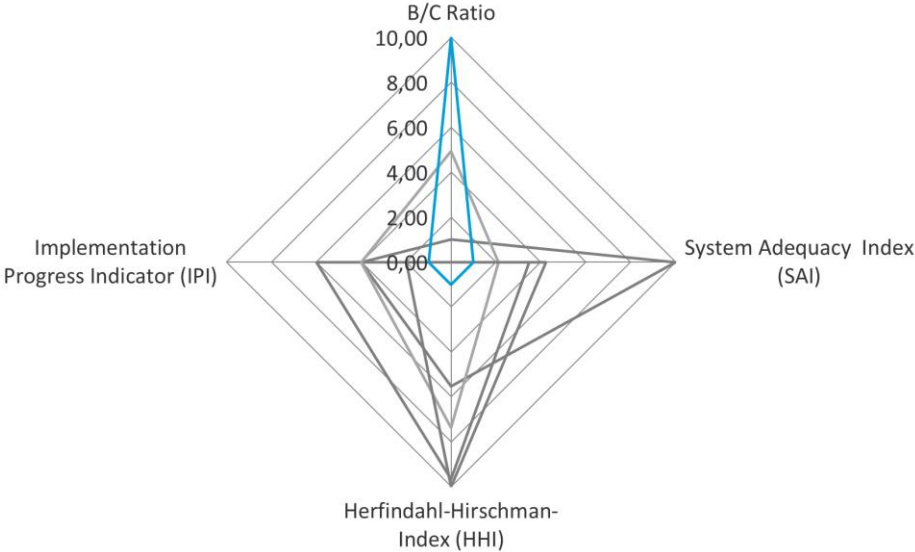
m€	Welfare change			
	Consumer	Producer	Rent	Total
AL	-3.5	13.9	0.1	10.5
BA	-16.0	2.1	-3.4	-17.3
BG	-14.5	55.8	-7.3	34.0
GR	76.3	-73.8	-17.4	-14.9
HR	-52.1	94.3	-2.6	39.5
HU	-134.9	130.0	2.6	-2.3
IT	28.4	-20.9	-19.3	-11.8
KO	-1.6	-0.8	1.1	-1.3
ME	-2.8	0.6	-0.1	-2.3
MD	-136.9	172.7	-3.5	32.3
MK	-1.8	1.0	-0.6	-1.3
PL	12.2	-13.8	-10.5	-12.0
RO	-114.3	102.3	729.7	717.8
RS	-20.0	-21.5	-8.1	-49.5
SK	-78.2	148.3	-13.8	56.3
UA_E	-4846.3	5031.1	718.0	902.8
UA_W	-14.5	-2.3	1.9	-14.9
Region	-5320.3	5619.0	1366.9	1665.6
EnC	-5043.3	5196.8	705.5	859.0
Hosted	-4975.1	5131.1	1449.7	1605.7



- Positive NPV: 1417m€
- PI index: 8.8

EL_09: 750 kV Pivdennoukrainska NPP (Ukraine) – Isaccea (Romania) OHL rehabilitation and modernisation

Benefit / Cost Ratio (B/C)	System Adequacy Index (SAI)	Herfindahl-Hirschman-Index (HHI)	Benefit / Cost Ratio (B/C)	Implementation progress Indicator (IPI)	Total Score	Ranking
Score	1,00	1,00	10,00	1,00	6,40	1
Impact (change of indicator)	0,14	98,62	8,79	1,00		



SAI and HHI values shown here represent the impact of a project (i.e. the difference without and with the individual project) in the countries on each end of the interconnector

Thank you!

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