REKK Regional Centre for Energy Policy Research

DNV·GL

Selection of Projects of Energy Community Interest (PECIs)

1st Meeting of the Electricity Group – Proposed Assessment Methodology

Presentation REKK / DNV GL

Vienna 11.12.2017

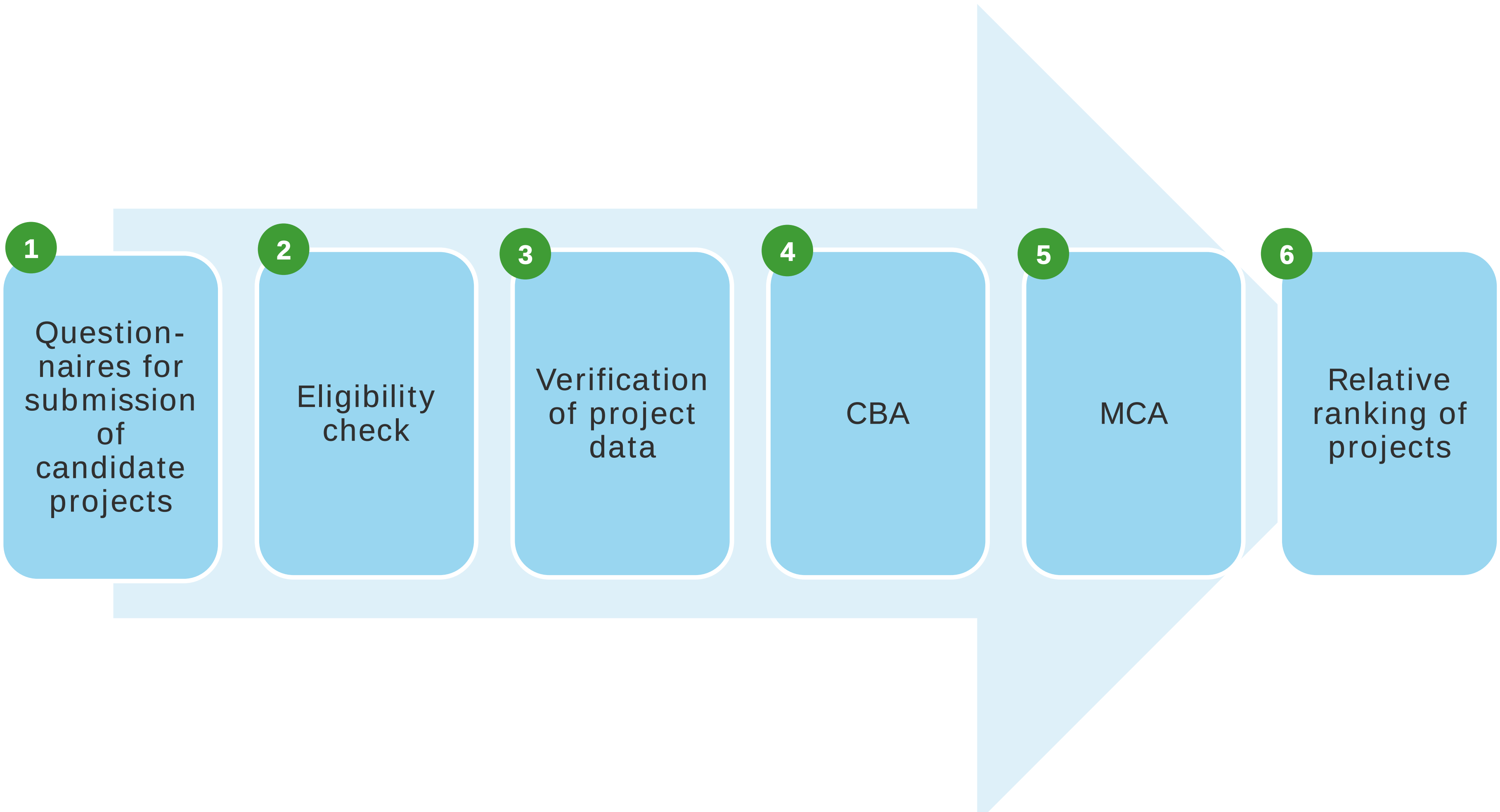
Agenda

1. Overview of general project assessment methodology
2. Cost-benefit analysis
3. Electricity market modelling (EEMM) and dummy project
4. Multi-criteria assessment methodology
5. Main assumptions

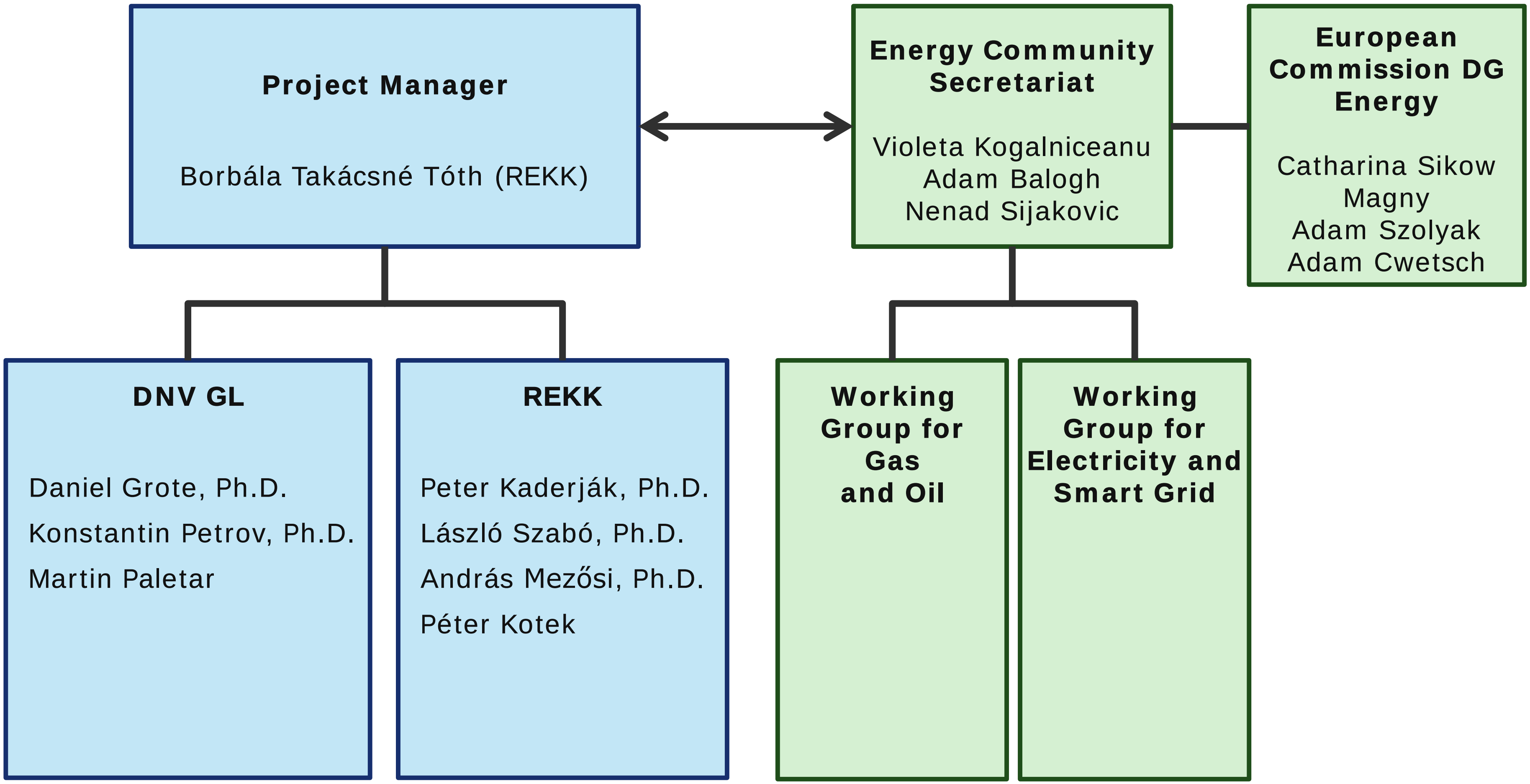
Project Objectives and Deliverables

- **Objectives**
  - To assess the candidate projects for electricity, gas and oil infrastructure, as well as for smart grids, in order to be able to identify those which bring the larges benefits for the EnC
  - To develop the electricity and gas market models for the Energy Community Contracting Parties needs and use these in the assessment of PECI AND PMI candidates;
  - To develop a multi criteria assessment methodology, using also the ENTSOE and ENTSOG methodology for cost benefit analysis where applicable;
- **Deliverables**
  - Interim report (by 02nd January 2018) containing:
    - the list of submitted projects, the result of the eligibility checks and data verification process, the description of the CBA methodology, indicators and weights used for the multi-criteria assessment
  - Draft final report (by 07th May 2018) containing:
    - description of the CBA methodology, indicators and weights used for the multi-criteria assessment, results of the CBA and multi-criteria assessment
  - Final report (by 11th June 2018), which incorporates the contents of the draft final report and reflects to the comments and feedback received by EnC Secretariat and project promoters.

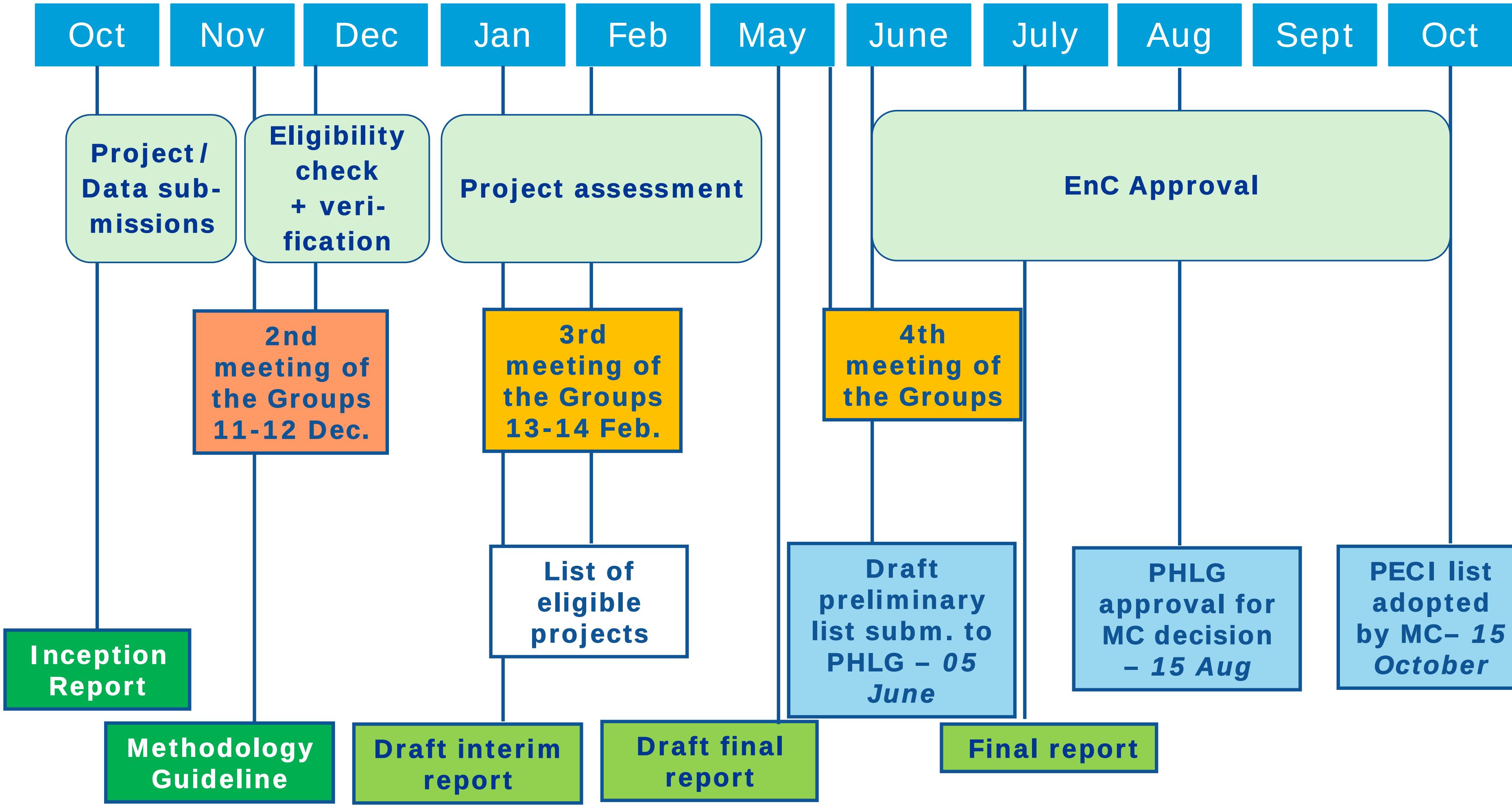
Project Workflow



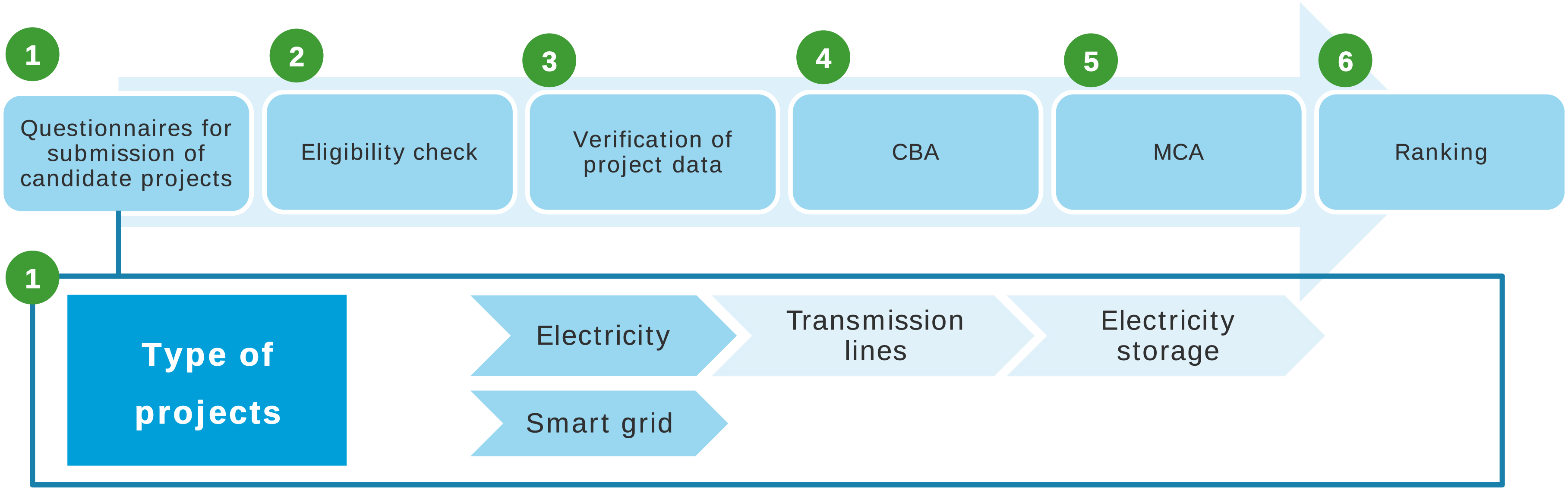
Project Team



Project Timetable



Step 1 – Questionnaires for Submissions of Candidate Projects



- Submitted Projects:
    - 14 transmission lines
    - No submitted electricity storage project
    - No submitted smart grid project
    - One power generation project

Step 2 – Eligibility Check

1. Questionnaires for submission of candidate projects
2. Eligibility check
3. Verification of project data
4. CBA
5. MCA
6. Ranking

2 – Eligibility check for further evaluation

- **Project type**: the project falls in at least one of the energy infrastructure categories
- **Potential benefits outweigh costs**: This criteria is checked during the evaluation
- **Location of the project**: involves at least two CPs or a CP and a MS by directly crossing the border; is located on the territory of one CP and has a significant cross-border impact

All eligible projects will be evaluated according to the same approach. The PCI status will be decided on in the final step of the decision making: selected projects will qualify as a PECI or as a Project of Mutual interest. (Art 4 para 5 and 6.)

Step 3 – Verification of Project Data

1. Questionnaires for submission of candidate projects
2. Eligibility check
3. Verification of project data
4. CBA
5. MCA
6. Ranking

3 Verification of project data

Check with PCI, PECI and TYNDP	In case of projects that were submitted to previous evaluations the data consistency will be checked
Check for project groups	In case projects are dependent on each other and has not been submitted jointly by promoters the project promoters are requested to join the project
Check of CAPEX and OPEX	Benchmarking of submitted costs based on ACER guidelines and other relevant literature
Check basic data requirement	In case of missing data project promoters will be asked to submit missing data / to accept assumed data suggested by consultant / to withdraw application

Key data needed for project assessment: capacity (at the border), cost, commissioning date

Step 4 – Cost-Benefit Analysis

An investment project would be beneficial to the investigated stakeholder group if the cost-benefit analysis provides a positive net benefit (i.e. a positive NPV)

- Costs and benefits of a project are assessed in the economic analysis by the Net Present Value (NPV) OR Benefit/Cost (B/C) ratio
- Calculation of the Net Present Value (NPV) and Benefit/Cost ratio of economic costs and benefits includes
  - the monetary costs and benefits of the investor
  - the costs and benefits to other stakeholders and the society as a whole affected by an investment project
- (Economic) NPV is the difference between the discounted total social benefits and costs
- Economic assessment of a project is positive if the NPV is positive (NPV > 0) OR if the B/C>1

Step 4 – Cost-Benefit Analysis

1. Questionnaires for submission of candidate projects
2. Eligibility check
3. Verification of project data
4. CBA
5. MCA
6. Ranking

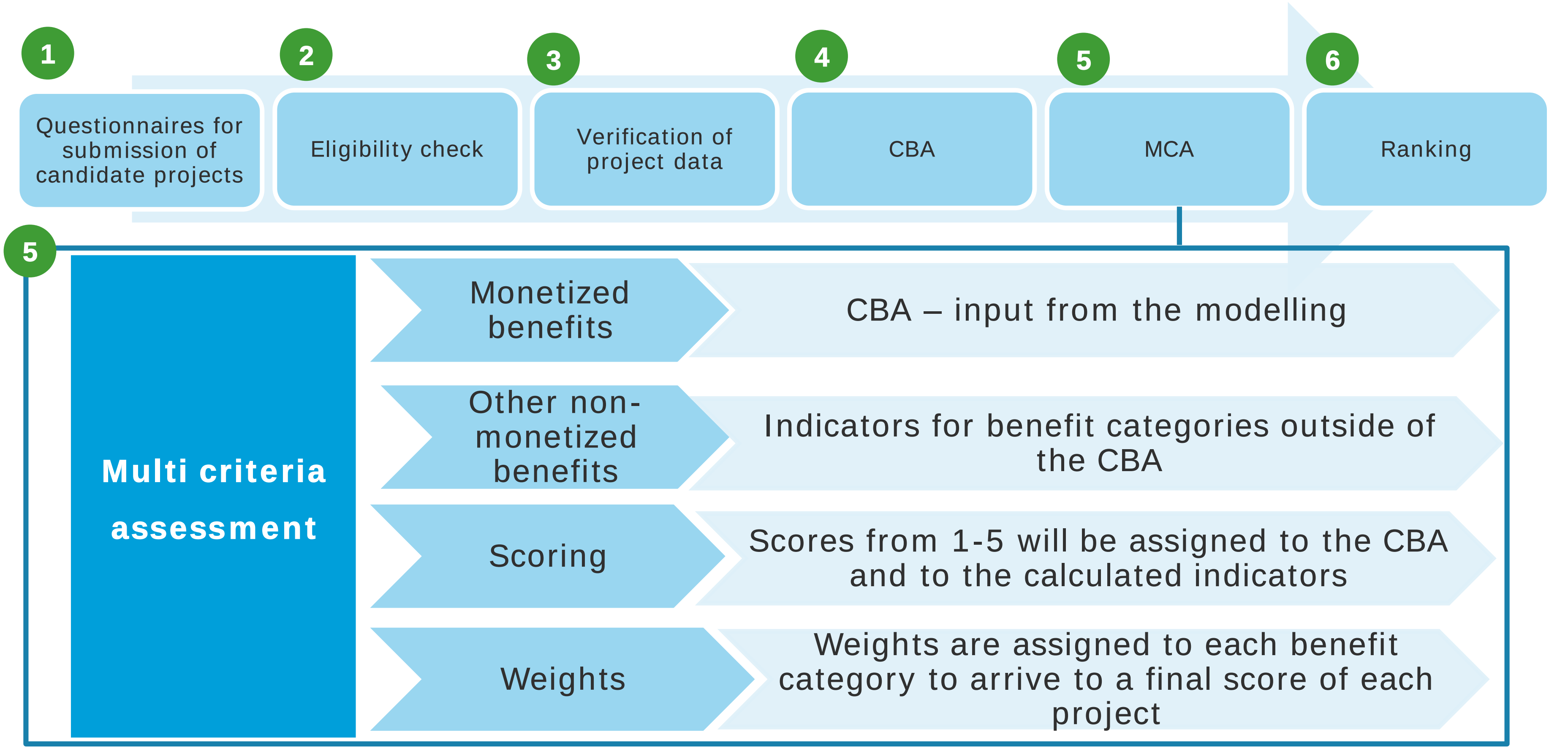
4

NPV calculations based on two modelling approaches

- PINT → Change in NPV (or B/C) when adding individual projects to the reference → Basic input for MCA
- TOOT → Change in NPV (or B/C)when removing individual projects from reference with all candidates → For sensitivity only

- PINT: put-in-one-at-a-time modelling
- TOOT: take-out-one-at-a-time modelling

Step 5 – Multi Criteria Assessment



- MCA allows integration of monetized benefits (result of CBA) with non-monetized benefits (assessment of additional quantitative and qualitative criteria)
- Outcome will be a relative ranking of all eligible projects (separate for electricity and gas projects)

Step 6 – Relative Ranking

1. Questionnaires for submission of candidate projects
2. Eligibility check
3. Verification of project data
4. CBA
5. MCA
6. Ranking

6

Relative ranking of projects

- Ranking
- Modelling based on PINT
- Indicators calculated
- MCA
- Indication of controversial projects
- Modelling based on TOOT
- Sensitivity analysis
- Supporting high level decision making

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General Approach to Cost-Benefit Analysis

- Takes the ENTSO-E CBA (February 2015) methodology as a basis, and monetizes the benefit categories where data availability allows it
- Monetised benefit values, together with the verified CAPEX and OPEX costs serve as input to the NPV calculation
- Reference scenario built up till 2050:
  - Network development according to ENTSO-E
  - Generation and demand in the Region is based on SEERMAP project
- All proposed and verified infrastructure elements are assessed individually – using the PINT (**P**ut-**IN** one at the **T**ime) approach
- All proposed and verified projects are also assessed using the TOOT (**T**ake-**O**ut **O**ne at the **T**ime) approach

Parameters of the Cost-Benefit Analysis

- Components of Net Present Value (NPV) calculation
  - NPV = CS + PS+ Rent + Value of losses – OPEX - Investment cost + (CO_2)
    - CS: Consumer surplus change in the countries of the area of analysis
    - PS: Producer surplus change in the countries of the area of analysis
    - Rent: Rent change in the countries of the area of analysis
    - Value of losses: Value of loss change in the countries of the area of analysis
    - OPEX: Operation and Maintenance cost change due to the project
    - Investment cost: verified investment cost
    - CO_2: Calculated according to the selected option
- Components of Benefit/Cost ratio (B/C) calculation
  - B/C = (CS + PS + Rent + Value of losses)/(Investment cost+OPEX)
- When calculating the NPV or B/C ratio 25 years of lifetime and a residual value of zero are applied → ENTSO-E methodology
- Values between 2017-2050 are modelled by EEMM
- Real social discount rate: 4 % → ENTSO-E methodology

Criteria Evaluated within CBA

	SoS	Socio-economic welfare	Variation of losses	Variation of CO2 emission
Measure	Expected Energy Not Supplied	Producer surplus change Consumer surplus change Cross-border rent change	Change of transmission losses	Change in the marginal cost of production
Method	Results of network modelling	EEMM modelling	Network modelling results and EEMM	To be Decided
Evaluation	Questionnaire TYNDP	NTC Change: Questionnaire and TYNDP Welfare changes: EEMM	Quantity: network results; Questionnaire, TYNDP Value: EEMM	EEMM

Evaluation of the Variation of CO2 Emissions

- There are two options to evaluate CO_2 emissions
- CO_2 emissions change based on the result of market model (EEMM)
  - Option A: Within the optimization of the market model -> this assumes a credible carbon taxation scheme, which is introduced in the modelling timeframe
    - ETS price: 7 €/tCO_2 in 2017 and 33 €/tCO_2 in 2030
    - From which point shall we apply the carbon price to CPs? Proposal: 2030
  - Option B: Calculate social cost of carbon as an extra item exogeneousy? No official value exist at EU level, nor ENTSO-E sets its level.

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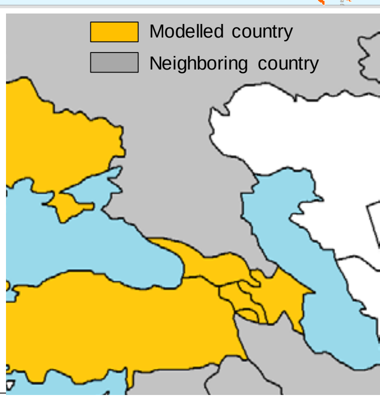
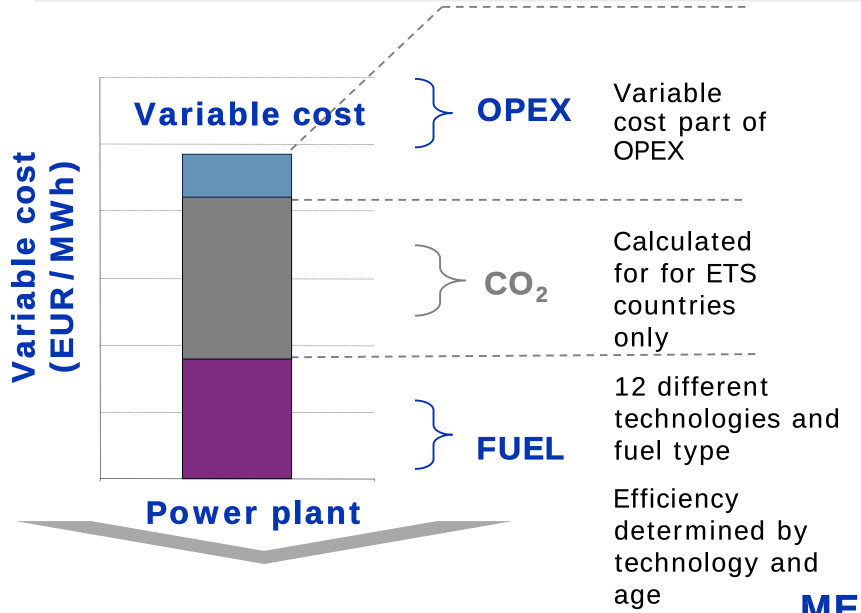
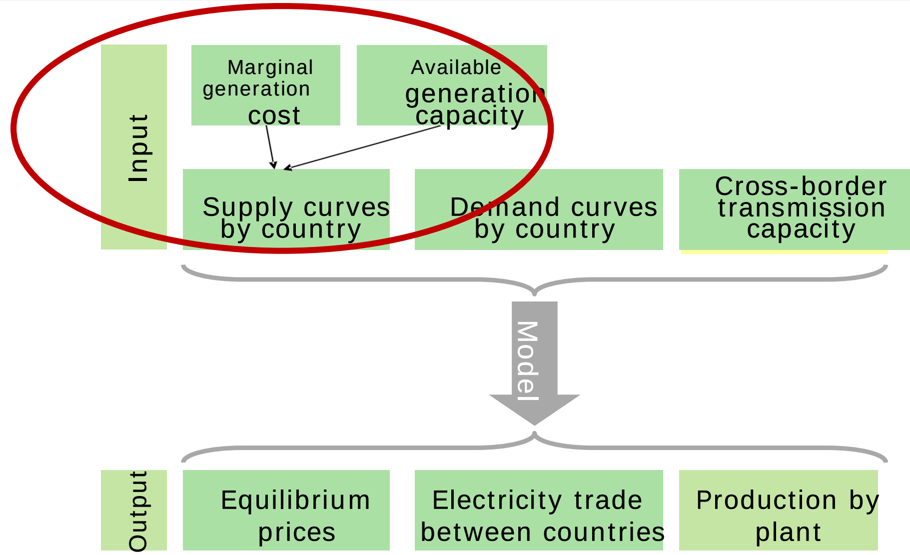
European Electricity Market Model – Functionality

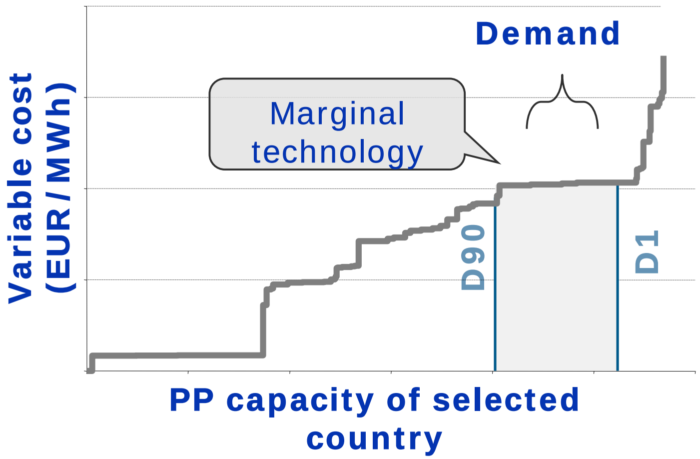


- The map shows the geographical coverage of the model in the South East European region:
  - 25 European Union countries handled by model (whole Energy Community region is covered)
- EEMM:
  - Competitive market equilibrium prices by countries
  - Electricity flows and congestions on cross-border capacities
- The exogenous power prices are reflecting the changes in fuel prices.
- Non ENTSO-E part of Ukraine and Moldova are also covered
- Georgia and their neigbours are also modelled (except Russia)
- The model calculates the marginal cost of more than 3500 power plant blocks and sets up the merit order country by country.
- Taking into consideration the merit order and exports/import, the model calculates equilibrium prices.
- Regional power flow is ensured by 104 interconnectors between countries.

Supply Side: Calculation of Variable Costs and Merit Order







MERIT ORDER

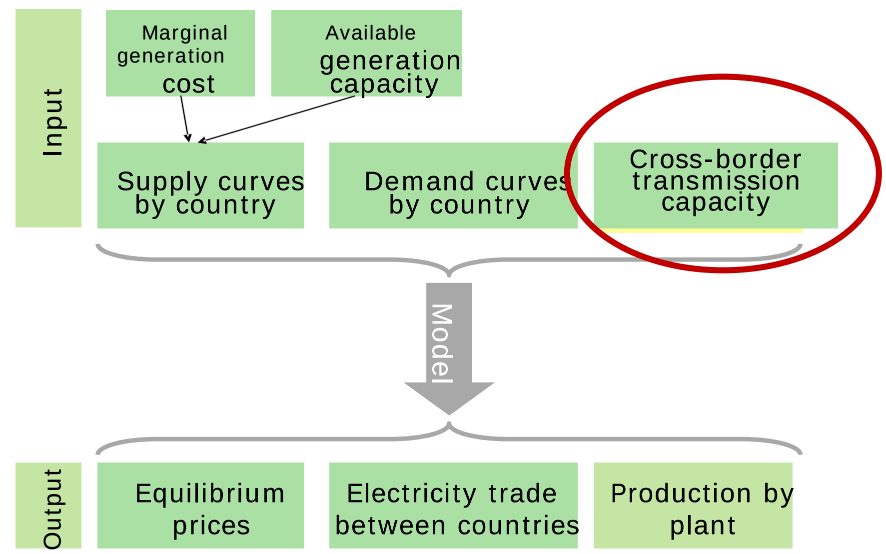
- Power plants with increasing marginal costs are ordered next to each
- The merit order as supply curve shows the competitiveness of different technologies/power plants in a given country
- Marginal power plant set by the actual demand determines the power price
- Due to the cross-border capacities and import/export between the countries, foreign power plants could set the domestic power prices in a given moment

Cross Border Trade and Demand Side

Cross border trade

- Based on Net Transfer Capacity (NTC) values
- Non-satisfied demand for capacity results in price differences amongst regions

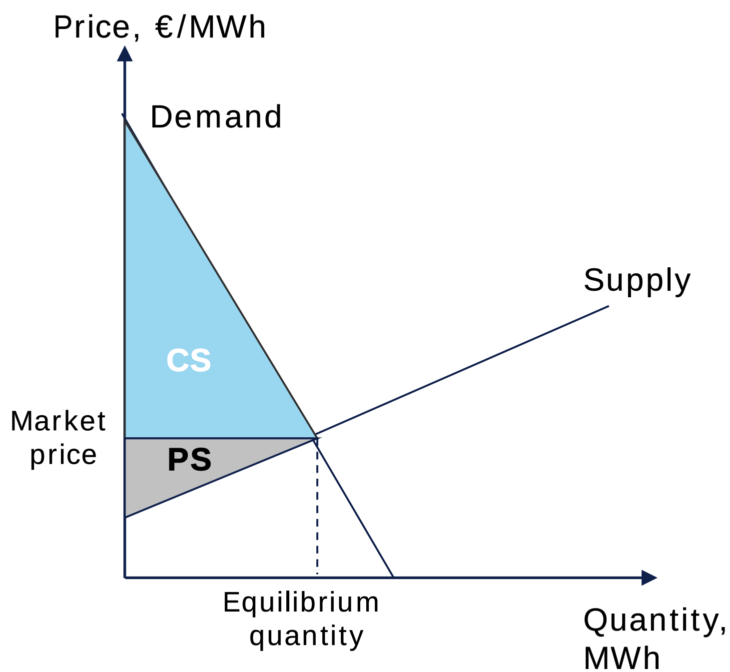
	Country A	Country B
Generation capacity	1000	500
MC	50	100
Consumption	400	400
Price	**50**	**100**
1.Case: 0 MW NTC	**50**	**100**
2.Case: 100 MW NTC	**50**	**100**
3.Case: 1000 MW NTC	**50**	**50**



Demand side

- Based on hourly modelling
- 90 representative hours, weighted to cover the year:
  - calculates baseload and peakload prices,
  - welfare effects

Welfare Components



Consumer surplus (CS):

Consumer surplus is the difference between the maximum price a consumer is willing to pay and the actual price they do pay.

Producer surplus (PS)

Market price multiply by the equilibrium quantity decreased by the total variable cost of production

Cross-border rent (RENT)

Price differentiate between two markets multiplied by the traded quantity

Total welfare

CS+PS+RENT

EGMM and EEMM interlinkages

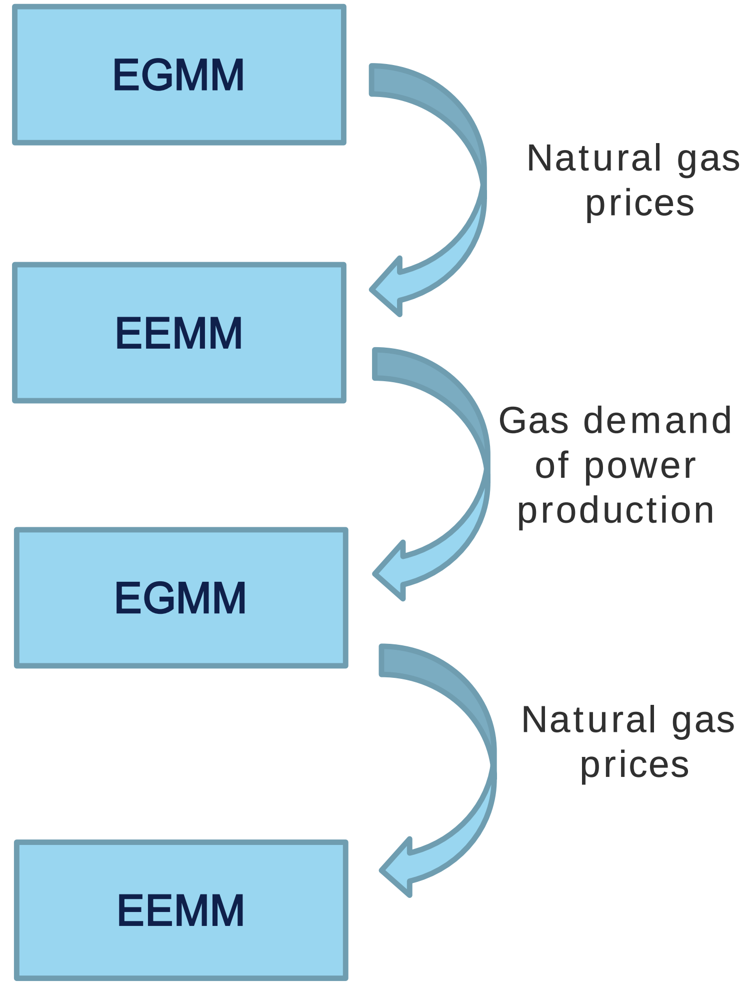
1. step: Gas market modelling -> PRIMES/Reference gas demand corrected by the EnC

2. step: Electricity market modelling with gas price based on the result of EGMM

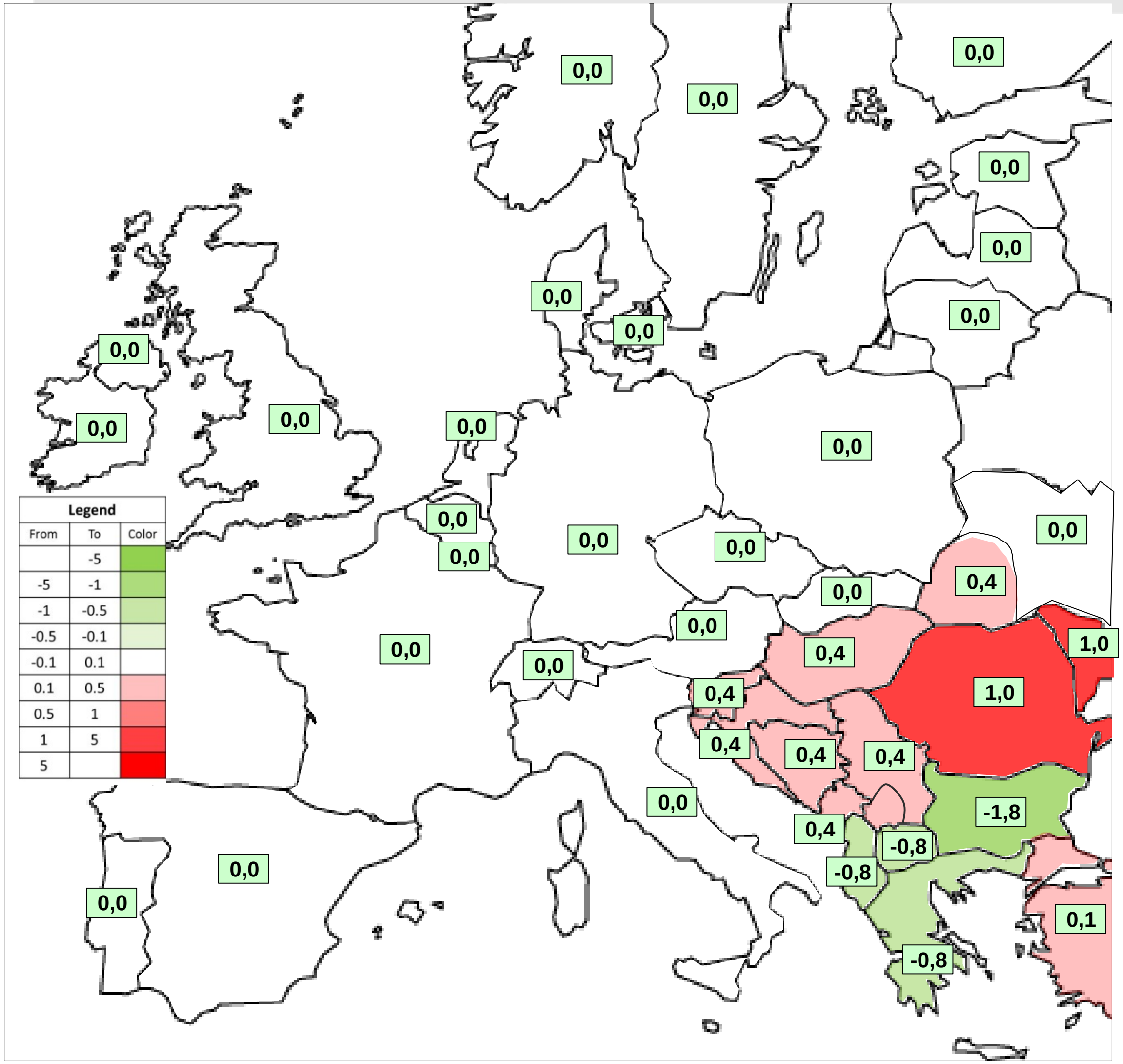
3. step: Modified gas demand data -> Reference gas demand +/- gas consumption changes in the power sector

4. step: New gas market modelling with updated gas demand -> this will be the reference gas scenario

5. step: New electricity market modelling with updated gas prices -> this will be the reference gas scenario



EEMM Modelling Results: Price Changes Due to Dummy Project in 2030, €/MWh



<u>Description of the dummy project:</u>

- New 400 kV OHL between RO-BG
- NTC increase by 1000 MW in both directions
- Year of commissioning: 2020

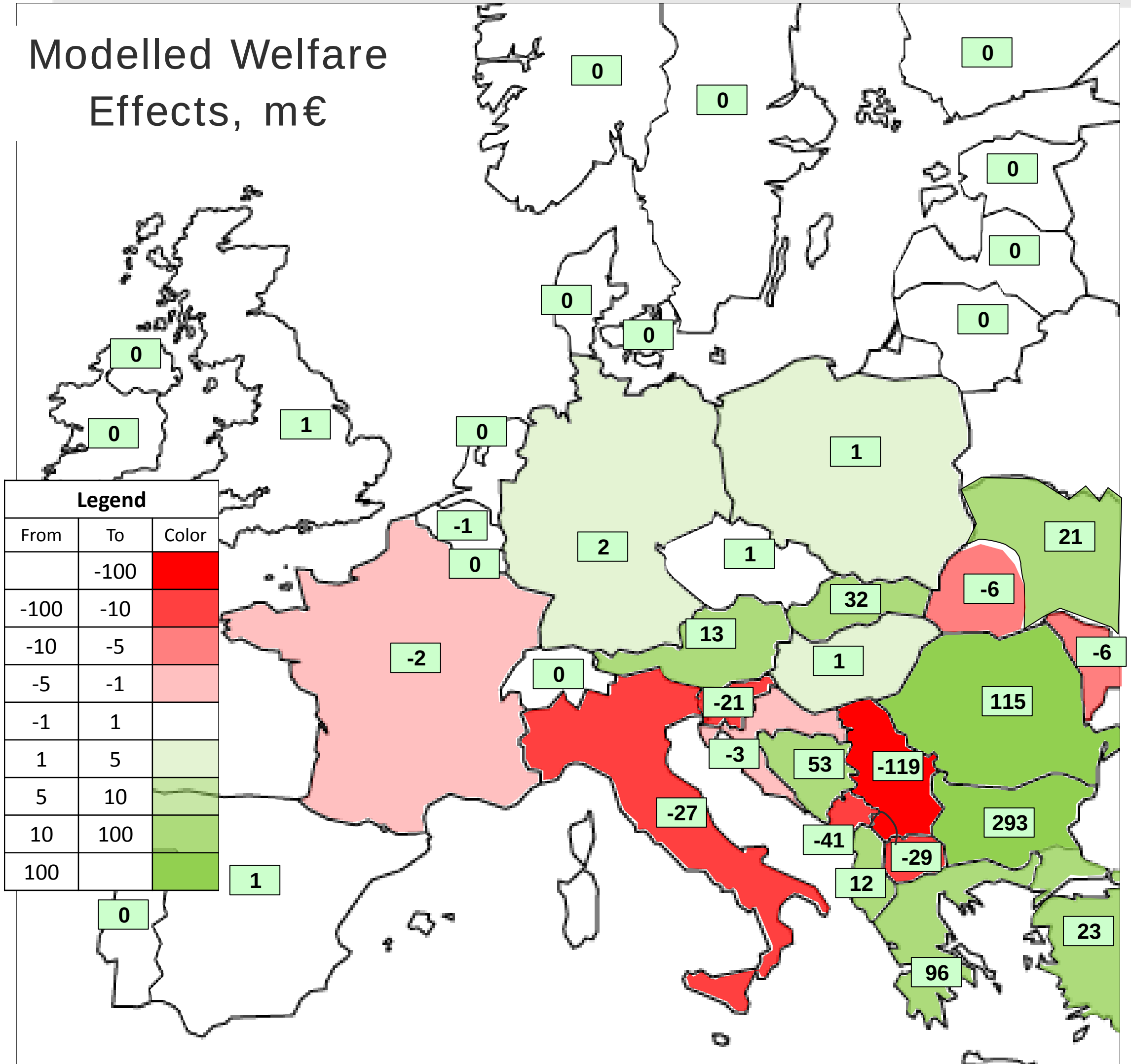
Social Welfare Effects in BG and in RO

- Due to the new OHL, wholesale price increases in Romania and reduces in Bulgaria
- Price reduction in BG results in a consumer welfare gain, but producers loose
- Price increase in RO results in a producer welfare gain, but consumers loose

	Unit (M€)	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030
BG	Consumer welfare change	8.4	14.1	29.6	58.6	153.5	359.6	410.5	65.8	56.1	78.2	75.9
	Producer welfare change	-8.3	-13.8	-27.2	-53.9	-91.4	-187.2	-207.2	-57.3	-49.6	-65.7	-62.7
	Rent change	-0.1	-1.1	-2.8	-6.1	-25.6	-71.7	-84.5	-1.0	1.9	0.8	1.5
	Total social welfare change	**-0.1**	**-0.9**	**-0.3**	**-1.5**	**36.5**	**100.7**	**118.8**	**7.5**	**8.4**	**13.3**	**14.8**
RO	Consumer welfare change	-2.5	-4.4	-14.4	-19.9	-36.6	-46.8	-43.1	-33.5	-29.7	-36.8	-65.8
	Producer welfare change	2.8	5.1	18.7	26.6	50.4	60.6	55.7	42.2	38.1	50.5	85.8
	Rent change	-1.1	-1.9	-4.4	-8.1	-12.0	-30.8	-32.2	-3.4	-0.2	-2.9	-1.0
	Total social welfare change	**-0.7**	**-1.2**	**0.0**	**-1.4**	**1.8**	**-17.1**	**-19.6**	**5.2**	**8.2**	**10.8**	**19.0**

Net Present Value of Total Social Welfare Changes, m€

Modelled Welfare Effects, m€



Legend		
From	To	Color
	-100	
-100	-10	
-10	-5	
-5	-1	
-1	1	
1	5	
5	10	
10	100	
100		

- Total welfare change in modelled countries in is **407 M€**
- Total welfare change in **BG+RO** is **408 m€**
- Total welfare change in **EnC+Neighbouring** countries is **385 m€**
- **Geographical coverage matters! Recommendation:**
  - **calculation to be based on EnC + neighbouring EU members**

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Monetization of Transmission Loss Changes

- Transmission loss change monetization steps:
  - 1. step: Determine the volume of transmission loss changes due to the project -> based on ENTSO-E TYNDP
  - 2. step: Calculate the yearly baseload price -> result of the market model, this price serves as a basis for valuing the loss changes
  - 3. step: Calculate the net present value of the yearly cost of transmission loss changes
- 1. step: Assumed transmission change is:
  - +100 GWh/year in BG; -50 GWh/year in RO
- 2. step: Baseload price between 2016-2044
- 3. step: Same method as in social welfare change: **NPV=48.5M€**

		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	...	2044
Baseload price, €/MWh	BG	40.3	42.6	47.0	49.3	56.7	61.0	64.7	64.2	67.6	69.9	75.1	...	75.1
	RO	40.1	42.4	46.1	48.2	52.3	54.0	57.4	60.3	62.7	64.1	68.2	...	68.2
Monetization of transmission loss changes, M€	BG	4.0	4.3	4.7	4.9	5.7	6.1	6.5	6.4	6.8	7.0	7.5	...	7.5
	RO	-2.0	-2.1	-2.3	-2.4	-2.6	-2.7	-2.9	-3.0	-3.1	-3.2	-3.4	...	-3.4
	Total	**2.0**	**2.1**	**2.4**	**2.5**	**3.1**	**3.4**	**3.6**	**3.4**	**3.6**	**3.8**	**4.1**	**...**	**4.1**

Monetization of Changes in Energy not Supplied

- **EENS change monetization steps**:
  - 1. step: Determine the volume of EENS due to the project (in MWh) -> based on ENTSO-E
  - 2. step: Monetize the EENS value by using the average yearly GDP figures of the EnC countries (GDP/electricity consumption, based on Eurostat Unit:€/kWh)
  - 3. step: Calculate the net present value of the yearly cost of EENS changes

Proposed values in calculations:

- 1. step: Assumed EENS change is (it will come from network modelling in the assessment):
  - 0.3 GWh/year in BG; 0.6 GWh/year in RO
- 2. step: ~1.04 € /KWh based on latest Eurostat figures
- 3. step: NPV calculation of benefits over 25 years: **NPV (BG)= 4.33 M€; NPV (RO)= 8.67 M€**

Net Present Value of Investment Cost and OM Cost

- Investment cost:
  - BG: 25 m€ in 2018; 25 m€ in 2019
  - RO: 25 m€ in 2018; 25 m€ in 2019
- The operation cost is 0.5 m€/year in both countries from 2020
- Net present value of investment cost:
  - Discounted each CAPEX value to 2016
  - **NPV** of investment cost is **-90.7 M€ (BG+RO)**
- Net present value of OM cost:
  - OM costs occur between 2020-2044 (assessment period of the project is 25 years)
  - Discounted OPEX costs value to 2016
  - **NPV** of OPEX cost is: **-13.8 M€ (BG+RO)**

Summary of Cost-Benefit Analysis of Dummy Project, m€

	Welfare change				Investment cost	OM cost	Trans. loss change	EENS change	**Total net present value**
	Consumer	Producer	Rent	Subtotal					
Modelled countries	-40	850	-403	407	-91	-14	49	13	**364**
EnC + Neighbours	746	56	-416	385	-91	-14	49	13	**342**

Net Present Value = 342 m€

Benefit/Cost ratio = (385+49+13)/(91+14)=4.25

This results is the input of the MCA

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Overview on Multi-Criteria Assessment Methodology

Rationale for MCA

- Not all dimensions of impacts may be monetised (which is necessary for inclusion within economic CBA)
- MCA allows to integrate qualitative criteria with results of the CBA

Step-wise methodology of Multi-Criteria Assessment

1. Identification and definition of criteria
2. Specification of indicators to measure criteria
3. Weighting of criteria (using the AHP approach)
4. Assessment of the fulfilment of each criterion by each investment project
5. Calculation of a final score for each project
   → Σ score of each criterion * weight of each criterion
6. <u>Relative</u> ranking of projects based on the project scores

Overview of Project Assessment Criteria

Source of criteria

- EU Regulation 347/2013 as adopted by the Ministerial Council Decision
- Assessment approach for EU Projects of Common Interest (PCI)
- ENTSO-E and ENTSOG methodologies with feedback provided from ACER
- Consultant's expertise from previous PECI 2016 selection

	Criterion	Indicator
Result of CBA	Change in socio-economic welfare	1 Net Present Value(NPV) or Benefit/Cost ratio
Additional Criteria of MCA	Improvement of System Adequacy	2 System Adequacy Index (SAI)
	Enhancement of competition	3 Herfindahl-Hirschman Index (HHI)
	Project Maturity	4 Implementation Progress Indicator (IPI)

Calculation and Scoring of Indicators

Calculation of Indicators	
SAI, HHI	▪ Indices calculated – with and without the individual project – for the year of commissioning of the project – as aggregate of the impacts in the countries on each end of the interconnector
IPI	▪ Index determined by project specific progress reported in questionnaire

Scoring of Indicators	
NPV, SAI, HHI	▪ Score of 1 and 10 assigned to projects with the smallest and largest change in the indicator respectively ▪ Scores of projects with changes in-between calculated by linear interpolation between min and max values of the change of the indicator
IPI	▪ Score of 1 assigned for each step completed by individual project

Project Assessment Criteria – Change in Socio-Economic Welfare

1

Change in socio-economic welfare

- Within the economic CBA, *incremental changes in socio-economic welfare from project implementation* measures the project's impact on:
  - **market integration** via the impact on wholesale price changes (convergence)
  - **security of supply** related benefits measured by reductions of outages and non-supplied electricity
  - variation of **CO_2 emissions** related to changes in regional electricity production patterns
  - variation of **network losses** related to changing load flow patterns
- The change in socio-economic welfare is measured by the net present value (NPV) or the Benefit/Cost (B/C) ratio
- The higher the NPV (or the B/C ratio) the larger the net benefit
- Score of 1 assigned to project with smallest NPV (or B/C ratio) above zero
- Project with NPV negative but close to zero, will be assigned a score of 0

Dummy project example Romania – Bulgaria interconnector

NPV values of dummy project and three other electricity infrastructure projects calculated within CBA

NPV	Value (m€)	Score
Project 1	700	10.00
Project 2	200	1.00
Project 3	400	4.60
IP RO-BG	**342**	**3.56**

Project Assessment Criteria – System Adequacy Index

3

Improvement of System Adequacy

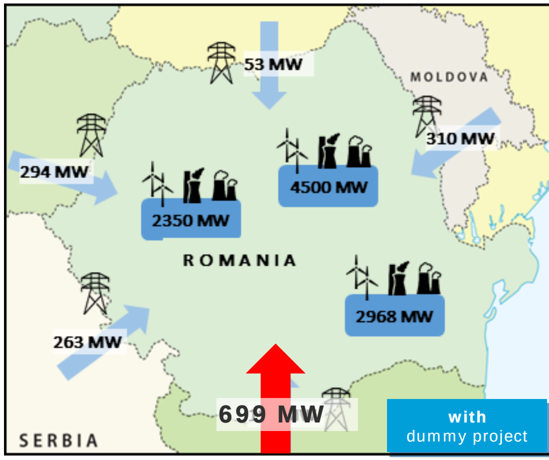
- The incremental *improvement of overall system reliability* accounting for the structural change of capacities by providing an additional source of supply is calculated as the change of the **System Adequacy Index (SAI)** with and without the individual project
- The higher the value of the index the higher system adequacy

$$SAI = \frac{(\text{generation} + \text{interconnection}) - \text{system peak demand}}{\text{system peak demand}}$$

Reasoning

- CBA incorporates only some aspects of security of supply
- Additional indicator to account for system adequacy and ability of the system to withstand extreme conditions
- SAI is widely used and respected indicator in assessing power systems

MCA Example of Dummy Project – System Adequacy Index



$$\frac{(9818 + 1119) - 8228}{8228} = 0.33$$

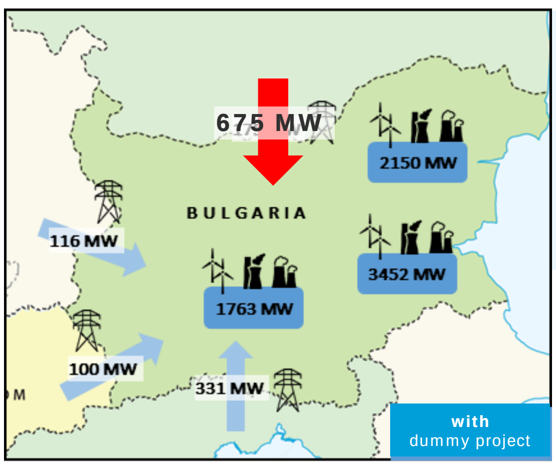
SAI for Romania without project

system peak demand of 8228 MW

$$\frac{(9818 + 1119 + 500) - 8228}{8228} = 0.39$$

SAI for Romania with project

Increase of SAI by 0.06 indicates improvement in adequacy due to implantation of dummy project



- Applying same approach for Bulgaria results in an increase of SAI by 0.08 (indicating an improvement of adequacy).
- Adding up both numbers results in an overall SAI impact of the dummy project of 0.14

	Change in SAI	Score
Project 1	0.06	1.00
Project 2	0.10	3.77
Project 3	0.19	10.00
IP RO-BG	**0.14**	**6.54**

Project Assessment Criteria – Herfindahl-Hirschman Index

2

Enhancement of Competition

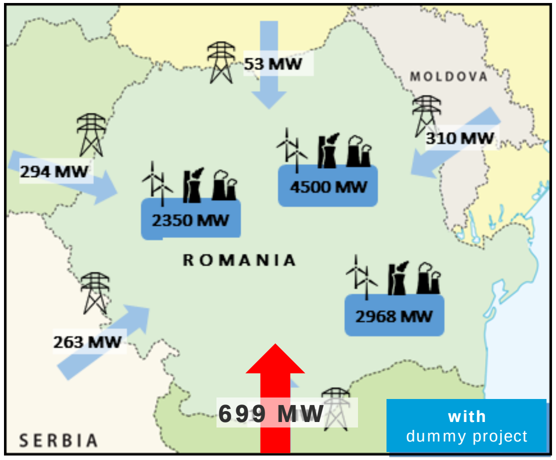
- *Incremental enhancement of competition* is calculated as change in the simplified **Herfindahl-Hirschman Index (HHI) that is** based on the national market shares in power generation and of the interconnection capacities.
- Index with and without the individual project as aggregate of the impacts in the countries on each end of interconnector
- All existing and proposed generation capacities are assigned according to ownership of power plants, interconnection capacities are considered as independent players on each border
- The higher the value of the index the higher the market concentration

$$HHI = \sum \left[(market\ share\ gen.A)^2 + (market\ share\ gen.B)^2 + \ldots + (market\ share\ \ interc.X)^2 + (market\ share\ \ interc.Y)^2 + \ldots \right]$$

Reasoning

- Interconnection projects may enhance wholesale competition by providing access to alternative import capacities
- Transfer of monopoly rents (i.e. price-mark-ups over production costs) gained by generators / importers / traders to consumers
- Market model (used in CBA) assumes competitive market equilibrium

MCA Example of Dummy Project – Herfindahl-Hirschman Index



$$[\,21.49^2 + 41.14^2 + 27.14^2 + 0.48^2 + 2.83^2 + 2.69^2 + 2.40^2 + 1.82^2\,] = 2916$$

market shares generation | "market shares" interconnection

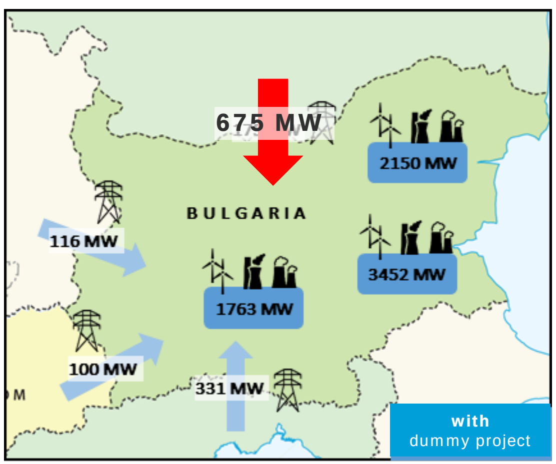
HHI for Romania without project

$$[\,20.55^2 + 39.35^2 + 25.95^2 + 0.46^2 + 2.71^2 + 2.57^2 + 2.30^2 + 6.11^2\,] = 2701$$

market shares generation | "market shares" interconnection

HHI for Bulgaria with project

Decrease of HHI by 215 indicates an increase of competition due to implementation of dummy project



- Applying same approach for Bulgaria results in a change of HHI of -109.
- Adding up both numbers results in an overall HHI impact of the dummy project of -324

	Change in HHI	Score
Project 1	1486	5.78
Project 2	785	2.90
Project 3	2513	10.00
IP RO-BG	**324**	**1.00**

Project Assessment Criteria – Implementation Progress Indicator

4

Implemen-tation Progress Index

- The **Implementation Progress Index (IPI)** assesses the preliminary implementation potential of each individual project based on information provided in questionnaires
- A score of 1 is assigned for each project implementation step already under-taken
- Evaluation is conducted separately for each proposed investment project
- Where project maturity is significantly different on each side of a border, progress of least developed part will be applied for calculation
- Favours projects which have a clear implementation plan and/or have already commenced their preparatory activities

Reasoning

- Criterion aims to test preliminary implementation potential
- Project (cost) data and implementation timeline of projects at a very early consideration phase is by nature more uncertain

MCA Example of Dummy Project – Implementation Progress Indic.

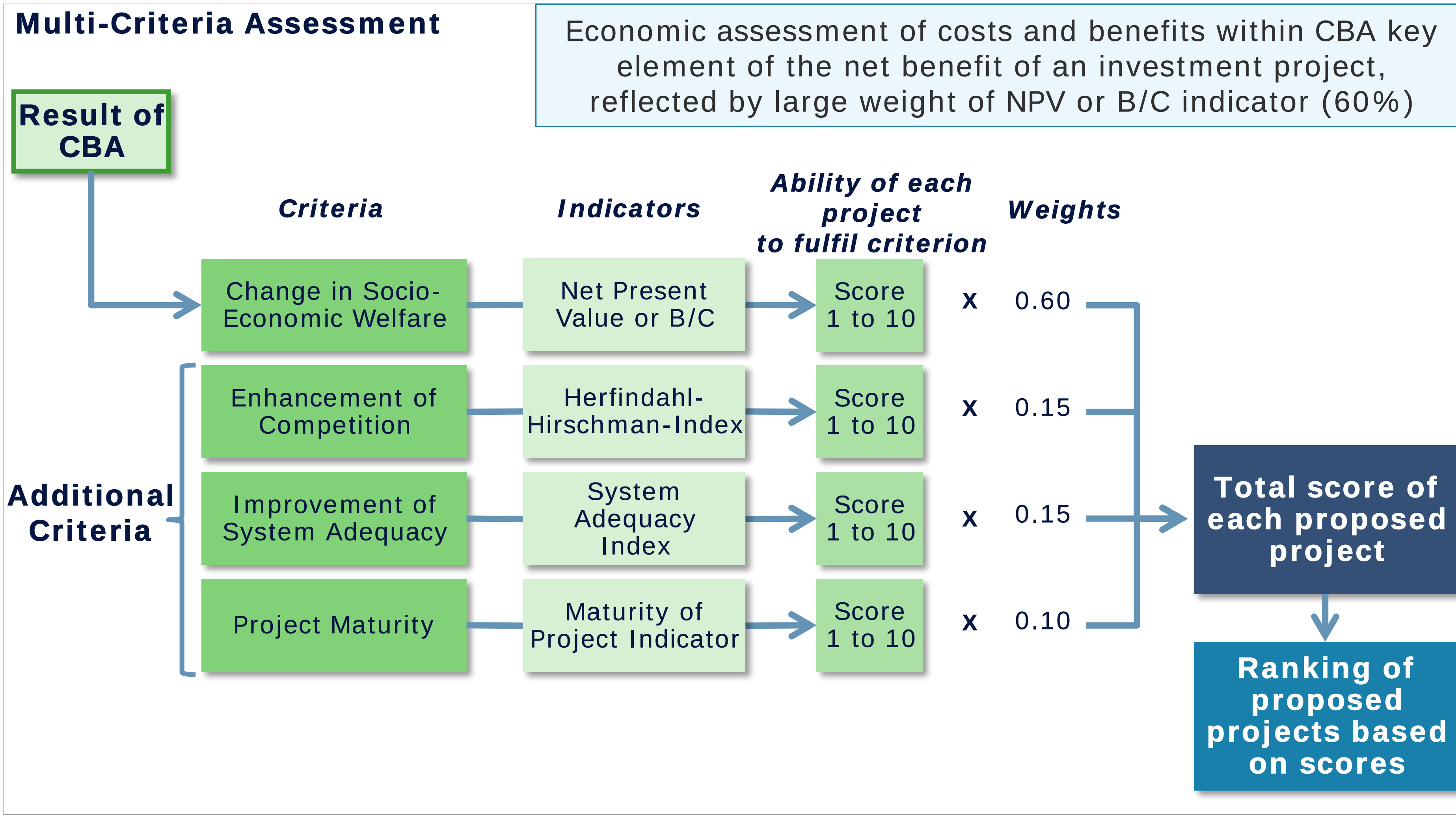
Dummy project example Bulgaria – Greece interconnector

Project implementation steps	Score
Consideration phase	✓ 1
Preparatory studies / pre-feasibility studies	✓ 1
Technical feasibility study / Environmental impact assessment	✓ 1
Economic feasibility study / cost-benefit analysis	1
Detailed design study (FEED/Main Design)	1
Financing secured	1
Planning approval / permitting	1
Approval by regulatory authority	1
Final investment decision	1
Tendering	1

Assumption only **“consideration phase”, “Preparatory studies”** and **“Technical feasibility”** have been completed and recorded in questionnaire for the whole project (i.e. sections located in both countries)

	IPI	Score
Project 1	1.00	1.00
Project 2	2.00	2.00
Project 3	2.00	2.00
IP RO-BG	**3.00**	**3.00**

Overview on Multi-Criteria Assessment Methodology



Relative Ranking of Projects

- Ranking is done by multiplying the score for each criterion, with the weight of each criterion a total score will then calculated for each project or project cluster (previous slide)
- Based on the calculated total scores of each individual project or project cluster a relative ranking of all eligible projects (i.e. a comparison of each individual project with the other submitted projects) will be provided in the final step

Dummy project example Romania – Romania Interconnector

Project	Indicators (Scores)				Weights				Indicators (Weighted Scores)				Total Score	Ranking
	Result of the CBA	Improvement of System Adequacy	Enhancement of Competition	Project Maturity	Result of the CBA	Improvement of System Adequacy	Enhancement of Competition	Project Maturity	Result of the CBA	Improvement of System Adequacy	Enhancement of Competition	Project Maturity		
	Net Present Value (NPV)	System Adequacy Index (SAI)	Herfindahl-Hirschman-Index (HHI)	Implementation Progress Indicator (IPI)	Net Present Value (NPV)	System Adequacy Index (SAI)	Herfindahl-Hirschman-Index (HHI)	Implementation Progress Indicator (IPI)	indicator * weight					
P 1	10.00	1.00	5.78	1.00	60%	15%	15%	10%	6.00	0.15	0.87	0.10	7.20	1
P 2	1.00	3.77	2.90	2.00	60%	15%	15%	10%	0.60	0.57	0.44	0.20	1.80	4
P 3	4.60	10.00	10.00	2.00	60%	15%	15%	10%	2.76	1.50	1.50	0.20	5.96	2
IP RO-BG	**3.56**	**6.54**	**1.00**	**3.00**	**60%**	**15%**	**15%**	**10%**	**2.14**	**0.98**	**0.15**	**0.30**	**3.57**	**3**

Agenda

1. Overview of general project assessment methodology
2. Cost-benefit analysis
3. Electricity market modelling (EEMM) and dummy project
4. Multi-criteria assessment methodology
5. Main assumptions

Assessed Geographical Area – Same for All Project Types

- *Ministerial Council Decision 2015/09/MC-EnC Annex IV./(6)*
  - „The area for the analysis of an individual project shall cover all Contracting Parties and Member States, on whose territory the project shall be built, all directly neighbouring Contracting Parties and Member States and all other Contracting Parties and Member States significantly impacted by the project."
  - Our proposal for the definition of area for the analysis:
    - All Contracting Parties
    - Neighbouring EU Member States (Bulgaria; Croatia; Greece; Hungary; Italy; Poland; Romania, Slovakia)

Main Market Model Assumptions – Demand Side

Gross electricity demand, GWh	2015	2020	2025	2030	2035	2040	2045	2050	Average yearly growth	Source
AL	8 017	9 346	9 945	10 548	11 180	11 787	12 444	12 908	1.4%	SEERMAP - 2017
BA	11 733	13 986	15 393	16 923	18 149	19 689	20 666	21 576	1.8%	SEERMAP - 2017
GE	10 636	11 385	12 187	13 045	13 964	14 948	16 000	17 127	1.4%	Black Sea Market Model - 2015
KO*	5 570	5 955	6 330	6 934	7 510	7 776	8 187	8 549	1.2%	SEERMAP - 2017
ME	3 426	3 815	4 093	4 440	4 612	4 863	5 106	5 320	1.3%	SEERMAP - 2017
MD	5 861	6 567	7 357	8 243	9 236	10 348	11 594	12 990	2.3%	PECI 2016
MK	8 170	7 658	8 164	8 544	9 017	9 649	10 193	10 474	0.7%	SEERMAP - 2017
RS	33 524	36 607	38 791	40 899	43 022	45 188	47 112	48 828	1.1%	SEERMAP - 2017
UA_E	143 915	157 628	161 608	165 689	169 872	174 162	178 560	183 069	0.7%	PECI 2016
UA_W	4 429	4 453	4 565	4 680	4 799	4 920	5 044	5 171	0.4%	PECI 2016

South East Europe Electricity Roadmap (SEERMAP):

- Goals:
  - Analyse the impact of the transition to a low carbon and energy secure pathway the electricity sector until 2050 in line with EU 2050 Roadmap
  - Develop of a Long Term Electricity Roadmap for the SEE region and effectively distribute the findings to the high level decision-makers - Promote a regional integration scenario
- Consortium Partners: REKK, TU Wien, OG Research, EKC
- Finished in September 2017

Main Market Model Assumptions – Installed capacities I.

AL									
Net installed capacity, MW		2015	2020	2025	2030	2035	2040	2045	2050
Coal, lignite	- Existing	0	0	0	0	0	0	0	0
	- New	0	0	0	0	0	0	0	0
Natural gas	- Existing	0	0	0	0	0	0	0	-200
	- New	0	200	360	460	460	460	460	460
Nuclear	- Existing	0	0	0	0	0	0	0	0
	- New	0	0	0	0	0	0	0	0
HFO/LFO		0	0	0	0	0	0	0	0
Hydro		1 801	1 866	1 866	1 977	2 274	2 638	3 032	3 413
Wind		0	0	0	0	28	200	784	1 066
Solar		2	2	2	2	29	78	249	585
Other RES		5	5	5	8	8	10	16	19
Total		1 808	2 073	2 233	2 447	2 799	3 386	4 540	5 343

GE									
Net installed capacity, MW		2015	2020	2025	2030	2035	2040	2045	2050
Coal, lignite	- Existing	13	13	13	13	13	13	13	13
	- New	0	0	0	0	0	0	0	0
Natural gas	- Existing	836	836	410	410	110	110	0	0
	- New	0	0	400	400	400	600	600	600
Nuclear	- Existing	0	0	0	0	0	0	0	0
	- New	0	0	0	0	0	0	0	0
HFO/LFO		0	0	0	0	0	0	0	0
Hydro		2 942	3 110	3 279	3 447	2 942	3 447	3 615	3 447
Wind		0	385	770	1 156	1 541	1 926	2 312	2 697
Solar		0	0	0	0	0	0	0	0
Other RES		0	0	0	0	0	0	0	0
Total		3 791	4 345	4 872	5 426	5 006	6 097	6 540	6 757

BA									
Net installed capacity, MW		2015	2020	2025	2030	2035	2040	2045	2050
Coal, lignite	- Existing	1 970	1 660	1 460	1 350	1 130	530	300	300
	- New	0	1 400	1 700	1 700	1 700	1 700	1 700	1 700
Natural gas	- Existing	0	0	0	0	0	0	0	0
	- New	0	0	0	0	0	0	0	0
Nuclear	- Existing	0	0	0	0	0	0	0	0
	- New	0	0	0	0	0	0	0	0
HFO/LFO		0	0	0	0	0	0	0	0
Hydro		2 155	2 179	2 221	2 263	2 364	2 738	3 060	3 297
Wind		0	41	41	31	113	338	900	1 988
Solar		9	44	44	44	58	93	189	370
Other RES		0	1	1	2	3	6	9	12
Total		4 134	5 325	5 467	5 390	5 368	5 404	6 157	7 667

KO*									
Net installed capacity, MW		2015	2020	2025	2030	2035	2040	2045	2050
Coal, lignite	- Existing	1 478	1 478	678	678	678	0	0	0
	- New	0	0	500	500	500	500	1 100	1 100
Natural gas	- Existing	0	0	0	0	0	0	0	0
	- New	0	0	0	0	200	300	300	300
Nuclear	- Existing	0	0	0	0	0	0	0	0
	- New	0	0	0	0	0	0	0	0
HFO/LFO		0	0	0	0	0	0	0	0
Hydro		49	75	87	136	191	254	311	359
Wind		1	1	1	1	0	60	240	814
Solar		0	38	38	38	56	104	238	504
Other RES		0	0	0	1	3	5	10	17
Total		1 528	1 592	1 304	1 353	1 628	1 222	2 199	3 094

ME									
Net installed capacity, MW		2015	2020	2025	2030	2035	2040	2045	2050
Coal, lignite	- Existing	219	219	0	0	0	0	0	0
	- New	0	0	250	250	250	250	250	250
Natural gas	- Existing	0	0	0	0	0	0	0	0
	- New	0	0	0	0	0	0	0	0
Nuclear	- Existing	0	0	0	0	0	0	0	0
	- New	0	0	0	0	0	0	0	0
HFO/LFO		0	0	0	0	0	0	0	0
Hydro		668	671	671	671	746	893	1 144	1 325
Wind		0	90	90	92	101	207	535	674
Solar		3	12	12	12	22	57	157	325
Other RES		0	0	0	0	0	0	0	2
Total		890	992	1 023	1 025	1 119	1 407	2 086	2 575

Main Market Model Assumptions – Installed capacities II.

MD

Net installed capacity, MW		2015	2020	2025	2030	2035	2040	2045	2050
Coal, lignite	- Existing	1 000	1 000	1 000	1 000	1 000	1 000	0	0
	- New	0	0	0	0	0	0	0	0
Natural gas	- Existing	1 605	306	306	306	66	0	0	0
	- New	0	0	0	0	0	0	0	0
Nuclear	- Existing	0	0	0	0	0	0	0	0
	- New	0	0	0	0	0	0	0	0
HFO/LFO		0	0	0	0	0	0	0	0
Hydro		64	64	64	64	64	64	64	64
Wind		0	149	324	498	673	848	1 023	1 198
Solar		0	0	0	0	0	0	0	0
Other RES		3	11	16	21	26	31	36	41
Total		2 672	1 530	1 710	1 889	1 829	1 943	1 123	1 303

RS

Net installed capacity, MW		2015	2020	2025	2030	2035	2040	2045	2050
Coal, lignite	- Existing	4 351	4 112	4 012	4 012	1 937	697	349	0
	- New	0	0	700	1 400	1 400	1 400	1 400	1 400
Natural gas	- Existing	0	0	0	0	0	0	0	-488
	- New	0	488	488	488	488	888	888	888
Nuclear	- Existing	0	0	0	0	0	0	0	0
	- New	0	0	0	0	0	0	0	0
HFO/LFO		0	0	0	0	0	0	0	0
Hydro		3 070	3 247	3 559	3 968	4 401	4 797	4 924	5 031
Wind		11	48	48	47	75	127	841	2 656
Solar		3	51	51	51	86	183	431	946
Other RES		11	34	42	50	83	118	191	298
Total		7 446	7 979	8 900	10 015	8 470	8 210	9 024	10 732

MK

Net installed capacity, MW		2015	2020	2025	2030	2035	2040	2045	2050
Coal, lignite	- Existing	800	675	450	0	0	0	0	0
	- New	0	130	130	330	330	330	330	330
Natural gas	- Existing	294	294	294	294	0	0	0	0
	- New	0	0	280	280	774	774	774	774
Nuclear	- Existing	0	0	0	0	0	0	0	0
	- New	0	0	0	0	0	0	0	0
HFO/LFO		210	210	210	0	0	0	0	0
Hydro		673	673	673	673	809	1 054	1 353	1 600
Wind		37	40	40	16	14	59	256	721
Solar		20	35	35	39	65	143	323	577
Other RES		7	11	12	13	12	14	27	47
Total		2 041	2 068	2 123	1 645	2 004	2 375	3 063	4 049

UA_E

Net installed capacity, MW		2015	2020	2025	2030	2035	2040	2045	2050
Coal, lignite	- Existing	19 568	16 316	11 051	4 227	2 467	625	0	0
	- New	0	0	0	0	0	0	0	0
Natural gas	- Existing	3 650	3 350	3 350	2 513	2 513	1 676	839	0
	- New	0	0	2 400	3 200	5 600	9 600	13 600	16 800
Nuclear	- Existing	13 835	13 835	13 835	13 835	13 835	13 415	9 000	2 000
	- New	0	0	2 000	2 000	2 000	2 000	2 000	2 000
HFO/LFO		0	0	0	0	0	0	0	0
Hydro		5 771	5 771	5 771	5 771	5 771	5 771	5 771	5 771
Wind		507	2 020	4 085	6 150	8 215	10 280	12 345	14 410
Solar		395	1 495	1 995	2 495	2 995	3 495	3 995	4 495
Other RES		2	179	419	659	899	1 139	1 379	1 619
Total		43 728	42 966	44 906	40 850	44 295	48 001	48 929	47 095

UA_W

Net installed capacity, MW		2015	2020	2025	2030	2035	2040	2045	2050
Coal, lignite	- Existing	2 335	1 945	0	0	0	0	0	0
	- New	0	0	0	0	0	0	0	0
Natural gas	- Existing	0	0	0	0	0	0	0	0
	- New	0	0	0	300	300	300	300	400
Nuclear	- Existing	0	0	0	0	0	0	0	0
	- New	0	0	0	0	0	0	0	0
HFO/LFO		0	0	0	0	0	0	0	0
Hydro		38	38	38	38	38	38	38	38
Wind		7	7	7	7	7	7	7	7
Solar		19	19	19	19	19	19	19	19
Other RES		0	0	0	0	0	0	0	0
Total		2 399	2 009	64	364	364	364	364	464

Interconnections – Net Transfer Capacity

- Present net transfer capacity (NTC) values are based on ENTSO-E; future cross-border capacity investments are based on Ten-Year Network Development Plan according to the Ministerial Council Decision 2015/09/MC-EnC

New cross-border capacities, NTC, MW					
From	To	Year of commissioning	O → D	D → O	TYNDP code
ME	IT	2019	500	500	28
ME	IT	2023	700	700	28
BA	HR	2022	650	950	136
RS	RO	2023	500	950	144
ME	RS	2025	400	600	146
AL	RS	2016	700	700	147a
AL	MK	2020	250	250	147b
RS	ME	2025	500	500	227a
RS	BA	2025	600	500	227b
BA	HR	2030	350	250	241
HR	RS	2030	750	300	243
RS	RO	2035	500	550	268
RS	BG	2034	50	200	272
RS	RO	2035	0	100	273
RS	BG	2034	400	1500	277

Origin and destination country		NTC values, MW	
Country A	Country B	From country A to country B	From country B to country A
BA	HR	699	652
BA	ME	459	467
BA	RS	529	529
BG	GR	500	341
BG	MK	202	100
BG	RO	265	178
BG	RS	350	177
HR	HU	1 000	1 200
HR	RS	515	516
HR	SI	1 466	1 466
HU	RO	610	643
HU	RS	702	800
HU	SK	552	703
HU	UA_W	450	581
MK	GR	261	350
MK	RS	159	291
ME	KO*	209	218
RS	ME	418	436
RS	RO	454	493
SK	UA_W	382	382
RO	UA_W	56	110
ME	AL	400	400
AL	GR	240	248
RO	MD	62	62
KO*	RS	no congestion	no congestion
UA_E	UA_W	0	0
KO*	MK	159	291
KO*	AL	208	219
AR	GE	225	275
AZ	GE	320	320
GE	TR	150	150
GE	RU	730	730
MD	UA_E	825	725
UA_E	RU	1175	125
UA_E	BY	350	0

Main Market Model Assumptions – Fuel Prices

Oil price	▪ Based on US Energy Information Administration (EIA), Brent Europe forecasts
Natural gas price	▪ Result of the EGMM Reference case
Coal price	▪ Hard coal price equal ARA price ▪ Coal price forecasts are based on Economist Intelligence Unit ▪ Lignite price = hard coal * 0.55
Nuclear	▪ Taken from literature, but irrelevant (never marginal)
HFO, LFO	▪ Indexed to crude oil price

Year	2016	2020	2025	2030	2035	2040	2045	2050
CO_2 price, €/t	8.6	15.0	22.5	33.5	42.0	50.0	69.0	88.0
Coal price, €/GJ	1.78	1.95	1.93	1.89	1.98	2.04	2.04	2.04

Sensitivity

- The parameters to be assessed:
  - Carbon price: +/- 50% change
  - Natural gas price: minimum and maximum gas price of the sensitivity analysis of the gas market modelling
  - Demand: change of +/- 0,5%/year
- Also applying the TOOT methodology is a special case of sensitivity assessment, where the reference network topology changes. The TOOT based assessment will help to identify which projects are competing in the proposed set of projects.
- Sensitivity assessment will be presented in the report in order to demonstrate the range of uncertainty in the modelling. Project NPVs will be calculated for all sensitivity cases in order to check the robustness of the ordering of projects.

Next steps

- Question to the Task Force:
  - NPV or C/B ratio to be applied? NPV tend to rank higher bigger sized projects.
  - What method and level of carbon price to be used?
  - Does network assessment exist for Georgia and Ukraine projects?
- INPUT DATA CHECK: Please check input data
- PROJECT DATA CHECK for eligibility and verification: Additional data request will be asked by Consultant from the Project promoters during December 2017 and January 2018.
- Promoters please send additional data to the Consultant as soon as possible, latest in a week after the request.
- Letter of support should be sent for interconnector projects in case the submission occurred from one country only. Investment cost of the other part of the project should be sent to the Consultant at the same time.

Thank you!

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Assessment of Smart Grid Projects – eligibility check

Evaluation	
	▪ The proposed methodology is based on our previous PECI project assessment and on the ministerial decision 2015/09/MC-EnC adopting 347/2013 Regulation ▪ We suggest to follow this approach and evaluate smart grid projects talking into account eligibility and specific criteria

Eligibility Criteria		
	1	Being implemented at a voltage level of 10kV or more
	2	Involving at least two Contracting Parties
	3	Involves transmission and distribution system operators
	4	Covering at least 50,000 users (producers, consumers and prosumers)
	5	Focusing on a consumption area of at least 300 GWh/year, of which at least 20% originate from non-dispatchable resources.

Assessment of Smart Grid Projects

Art. 4.2. (c) of Ministerial Decision 2015/09/MC-EnC adopting 347/2013 Regulation

Specific Criteria

1. Integration and involvement of network users with new technical requirements with regard to their electricity supply and demand
2. Efficiency and interoperability of electricity transmission and distribution in day-to-day network operation
3. Network security, system control and quality of supply
4. Optimized planning of future cost-efficient network investments
5. Market functioning and customer services
6. Involvement of users in the management of their energy usage