Cost-Benefit Analysis Methodology

General presentation of published methodologies

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Internal WS – 6 November2013

Background of CBA methodology

The role of CBA methodology drafted by ENTSOG

Energy System Wide Cost Benefit Analysis (ESW-CBA)

> To be applied by ENTSOG as part of subsequent TYNDP starting in 2015

> Three roles:

- List of **potential** PCI **candidates** (process based on promoters' initiative)
- Assessment of the impact of the whole list of PCIs
- Provide input data and reference assessment to enable project promoters to carry out their PS-CBA

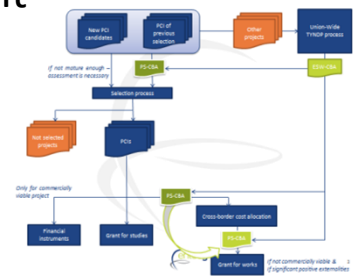
> Extend TYNDP time horizon from 10 to 20 years for a part of the report

Project Specific Cost Benefit Analysis (PS-CBA)

> To be applied by project promoters on mature projects in various instances

> It enables promoters to prove on 20 years of operation:

- That benefits exceed cost of the project
- That benefits spread farther than the country where the project is built
- The financial sustainability of the project



CBA methodology is not something new

Neither for project promoters...

- Often required by NRAs to authorize investment
- Carried out in case of support by financial institutions (e.g. EIB)

...nor for ENTSOG

- Union-TYNDP already assesses the impact of an infrastructure cluster on the infrastructure-related market integration using an incremental approach (this cluster is the full list of Non-FID projects)
- Some GRIPs will provide similar assessment on smaller infrastructure cluster (TAP+IGB)

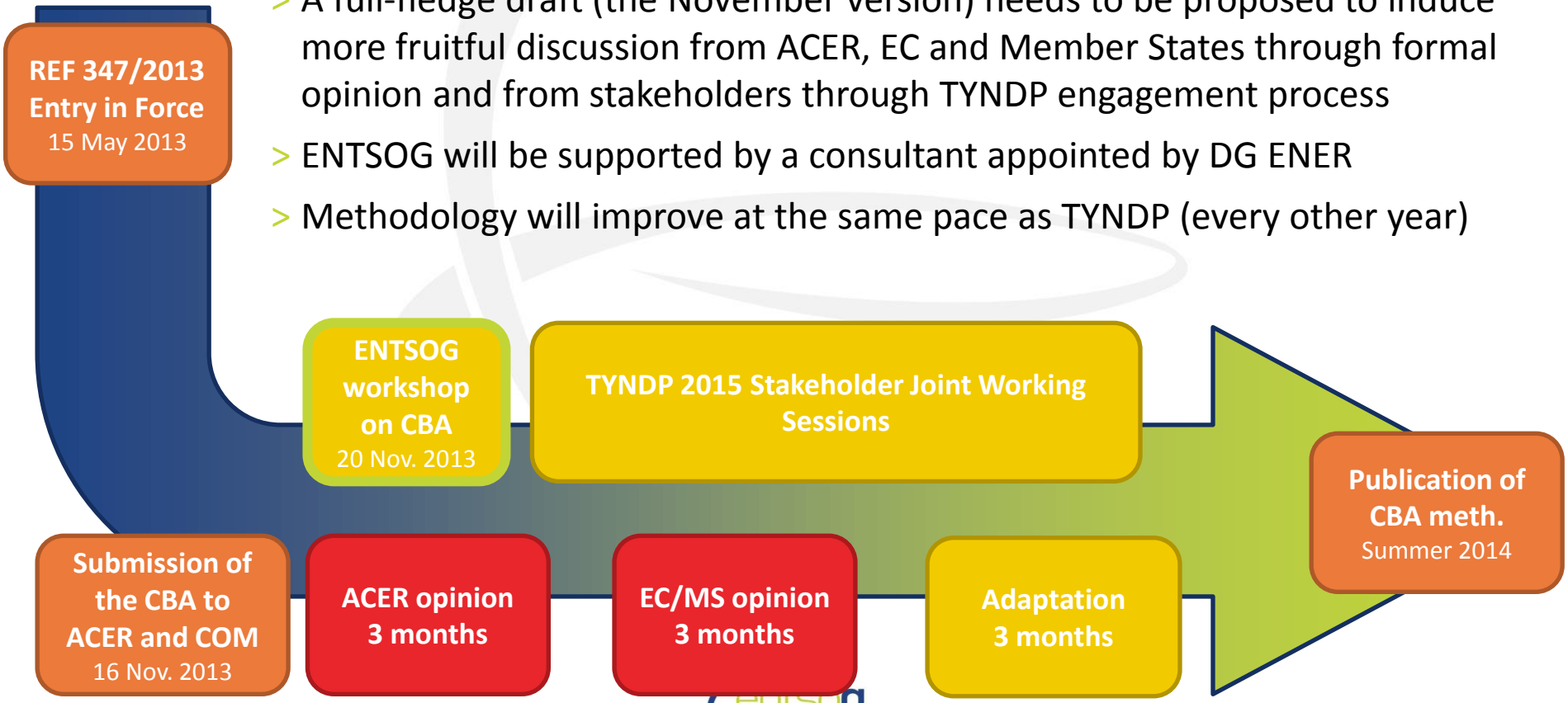
What is new?

- A common methodology (including input data) is required in order to guarantee a fair and transparent selection by Regional Groups (MSs, NRAs, COM and ACER)
- The methodology, in particular the PS-CBA, needs to be crystal clear as applied by around hundred project promoters (including many non ENTSOG members)
- Reflecting externalities and cross-border impact

At a turning point of the development

Like TYNDP, CBA methodology is a living organism

- Large stakeholder feedback has been analysed but feedback is often more about new questions than answers to our questions
- A full-fledge draft (the November version) needs to be proposed to induce more fruitful discussion from ACER, EC and Member States through formal opinion and from stakeholders through TYNDP engagement process
- ENTSOG will be supported by a consultant appointed by DG ENER
- Methodology will improve at the same pace as TYNDP (every other year)



Energy System Wide CBA methodology

One step beyond TYNDP 2013-2022

Reference assessments and input data for the PS-CBA

- Definition of a common dataset in order to ensure consistency and comparability of the PS-CBA of project promoters
- Assessment of the impact of the implementation of the full PCIs as resulting from previous selection
- Assessments of the European system under different scenarios of infrastructure development to serve as a basis for the incremental approach of the PS-CBA through:
  - Capacity-based indicators
  - Modelling-based indicators
  - Monetization (as input data set will have to include at least CO2 and fuel prices)

A task for ENTSOG

- Being part of TYNDP, ENTSOG will apply the methodology described in the document

ESW-CBA – Structure

1 – Definition of input data for the ESW-CBA

2 – Clustering of infrastructure

3 – Network and market modelling

4 – Economic Analysis

5 – Sensitivity Analysis

Definition of input data - 1

General framework

- Numeric data will be defined on a 20 year time horizon
- Yearly assessment has been replaced by 2 separate winter and summer cases in order to reflect seasonal specifics
- According to Regulation, data will have to be part of the methodology to be published Summer 2014
- Building the data set and the consensus around will be one of the main task of TYNDP SJWS first half 2014

Input data for the ESW-CBA		
Data Item	**Comment / Sources**	**Level of definition**
Existing infrastructure capacity		
Entry capacity	ENTSOG, GSE, GLE database as main sources	per IP and interconnected Zone
Exit capacity		
UGS injection and withdraw capacity		
UGS working gas volume		
LNG sendout capacity		
LNG tank volume		
Identification of the project		
Pipeline	Project Promoters	
IP Name and connected Zones		
Entry capacity		per IP and interconnected Zone
Exit capacity		
UGS		
Injection and withdraw capacity		per IP and interconnected Zone
Working Gas Volume		
LNG		
Send-out capacity		per IP and interconnected Zone
LNG tank volume		
Year of Commissioning		
PCI Status	As resulting from latest selection round	
Demand per situation		per Balancing Zone
High Daily Demand 1-day Design Case	TSOs best estimate	
High Daily Demand 14-day Uniform Risk		
Winter Average Day		
Summer Average Day		

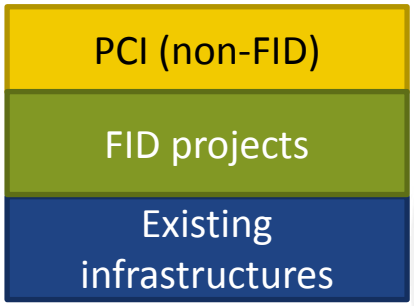
Definition of input data - 2

Input data for the ESW-CBA		
Data Item	**Comment / Sources**	**Level of definition**
Supply Data		per Balancing Zone
National Production	Deliverability per demand situation	per Balancing Zone
Import sources (Russia, Norway, Algeria, Lybia, LNG, Azeri...)		per source and/or import route
Prices	Well recognized references need to be identified and consensus built around them (e.g. WEO from IEA)	
Natural Gas		per source and/or import route
Coal		per fuel
Lignite		
Oil		
CO_2		for Europe
Physical Constants	Well recognized references need to be identified and consensus built around them (e.g. UN-IPCC)	
• Gross Calorific value of fuels		per Fuel
Natural Gas		
Coking Coal		
Lignite		
Residual Fuel Oil		
• Specific CO_2 emission of fuels/net energy released		
Natural Gas		
Coking Coal		
Lignite		
Residual Fuel Oil		
• Gross/Net Thermal efficiency of power plants		per Balancing Zone
Natural Gas		
Coal		
Lignite		
Fuel Oil		
Electricity Mix of Countries	Coordination with other references such like ENTSOE	per Balancing Zone
Installed Capacity		
Assumed utilization scenarios (for nuclear and renewables)		
Macroeconimic Data		
Currency exchange Rates		
Cost of Disruption per unit of energy		per Balancing Zone
Social discount rate		for Europe

Infrastructure Scenarios

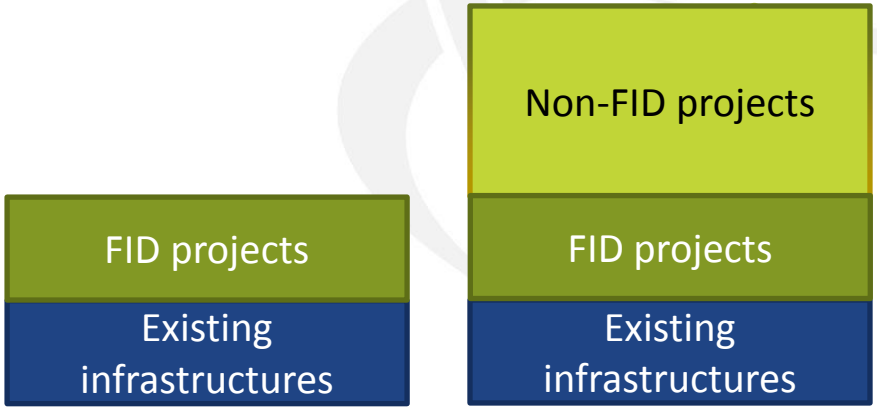
Building the bridge from one PCI selection round to the other

> PCI Scenario: Feedback on the latest selection to Regional Groups



- Introduce for the purpose of REG (EC) 347/2013
- Measure the overall impact of the existing PCI list

> Low & High Scenarios: Assessment of extreme infrastructure developments



- Equivalent to the FID and Non-FID scenarios of previous TYNDP
- As serving as a basis for next PCI selection, no difference is made between existing PCIs and other projects

Economic Analysis – Indicators - 1

Capacity-based indicators

> Import route diversification (used in TYNDP 2013-2022)

$$\sum_{l}^{Xborder}\left(\sum_{k}^{IP} \%\, IP_k\, Xborder_l\right)^2 + \sum_{j}^{Source}\sum_{i}^{IP}\left(\%\, IP_i\, from\ source_j\right)^2 + \sum_m \left(\%\, LNG\ terminal_m\right)^2$$

- Measure the diversification of infrastructure enabling the import of gas in a given zone

> N-1 as defined under REG (EC) 994/2009

$$\boldsymbol{N-1 = \frac{IP + NP + UGS + LNG - I_m}{Dmax} * 100}$$

- Listed by REG (EC) 347/2013 as part of the CBA (Regional calculation)
- No specific calculation, only reported where made available by Competent Authorities

Economic Analysis – Indicators - 2

Capacity-based indicators

> Seasonal Capacity Balance

- Summer Average

$$\frac{Min(EX \;; NP + \frac{N-1}{N} * IMP + LNG - \mathrm{INJ} - \mathrm{Dsa})}{\mathrm{Dsa}}$$

- Winter Average

$$\frac{Min(EX \;; NP + \frac{N-1}{N} * IMP + LNG + \mathrm{WITH} - \mathrm{Dwa})}{\mathrm{Dwa}}$$

- Design Case

$$\frac{Min(EX \;; NP + \frac{N-1}{N} * IMP + LNG + WITH_{max} - Dh)}{Dh}$$

- Measure the need of import and/or the potential for export under various climatic conditions
- Enable the definition of "flows" to support the Monetary Analysis in case modelling is not ready for the PS-CBA

Economic Analysis – Indicators - 3

Modelled indicators (all used in TYNDP 2013-2022)

> Remaining Flexibility

$$RF = 1 - \frac{\sum Entering\ Flow}{\sum Entry\ Firm\ Technical\ Capacity}$$

- Measures the availability of capacity to face change in demand or supply

> Supply Source Dependence

$$SSDEP = \frac{Flow\ from\ minimized\ supply\ source}{\sum Entering\ Flow}$$

- Measures the overdependence on a single source

> Supply Source Diversification

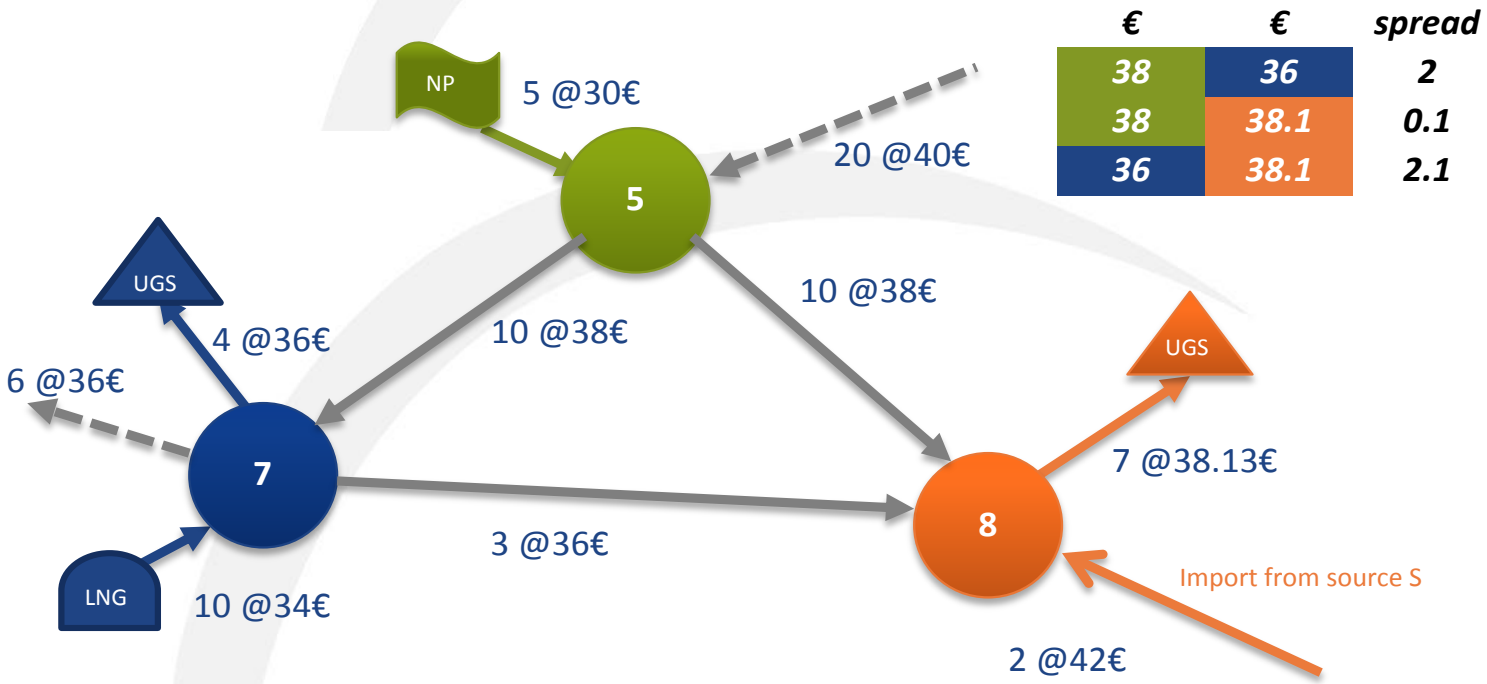
$$SSDIV = \sum_{i}^{maximized\ source} if(x_i > 5\%; 1)$$

- Measures the number of sources a country may have access non-simultaneously

Economic Analysis – Indicators - 4

Modelled indicators (new as REG 347/2013 requirement)

> Price convergence

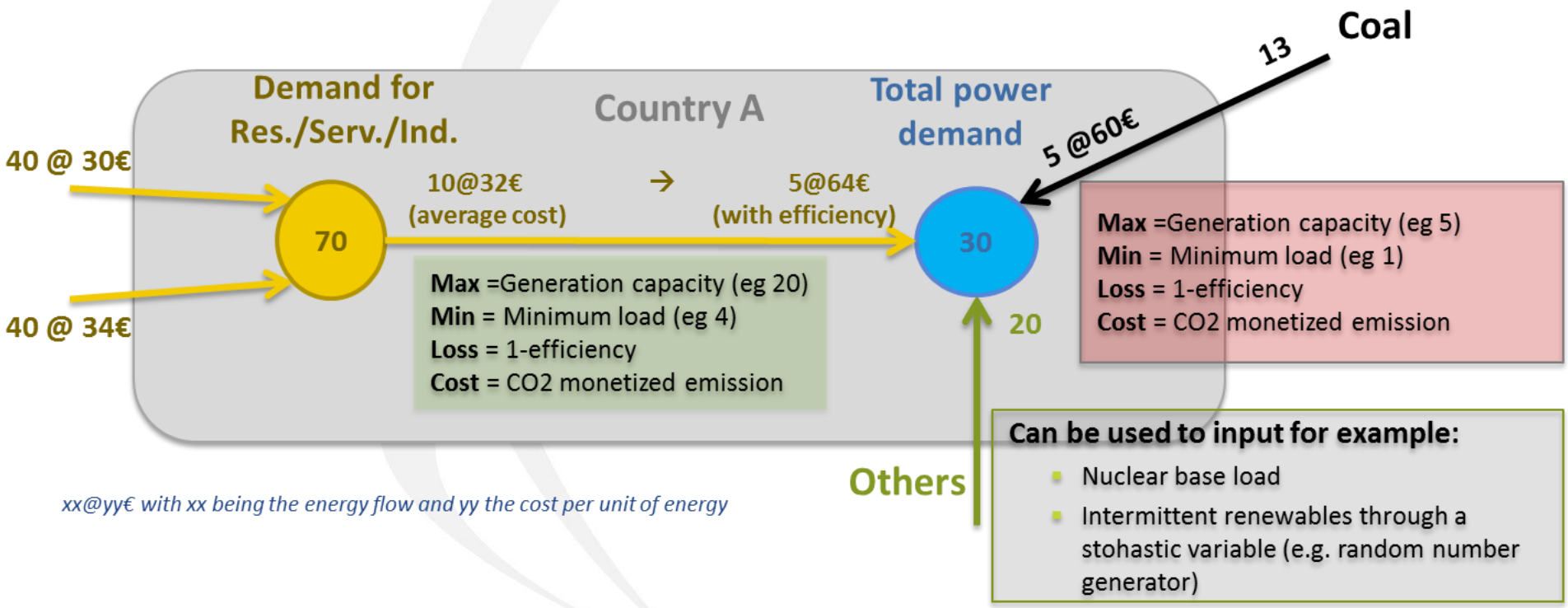


€	€	spread
38	36	2
38	38.1	0.1
36	38.1	2.1

> The approach is similar to the identification of supply source share in each Zone in TYNDP 2013, with the use of a supply price per source

Economic Analysis – Monetization - 1

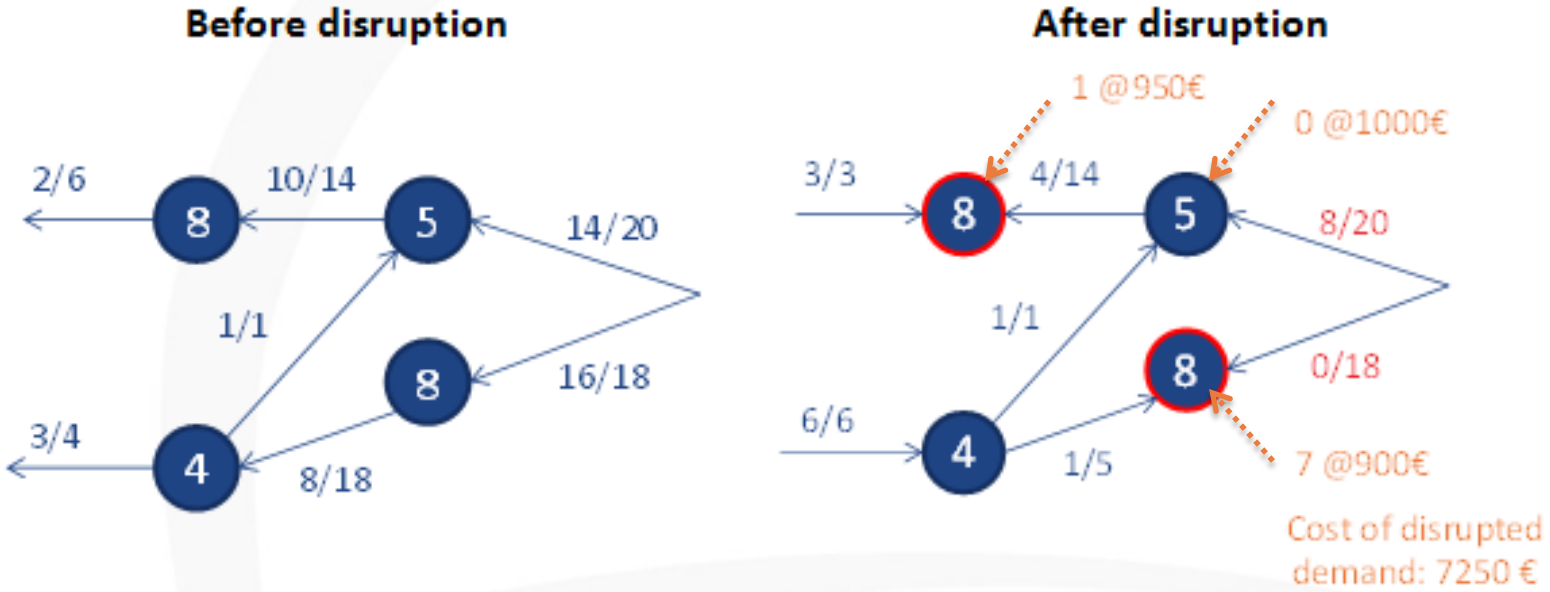
Power generation and CO2 emission costs



xx@yy€ with xx being the energy flow and yy the cost per unit of energy

Economic Analysis – Monetization - 2

Cost of disruption of gas demand



Cost of gas supply

The monetization of supply cost at zone level is an intermediate step of the price convergence indicator as defined previously

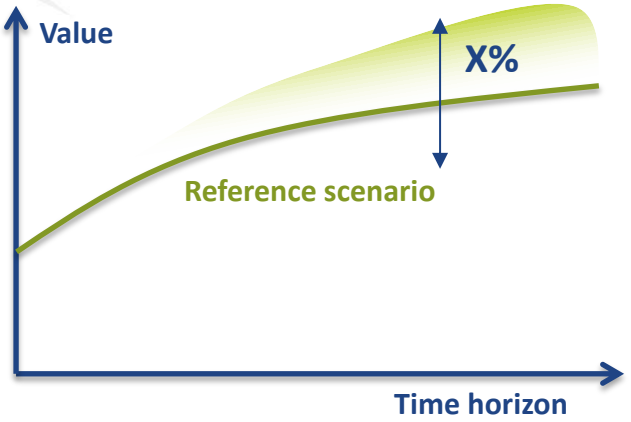
Sensitivity analysis

Classic sensitivity analysis

> A reference scenario is defined for a given data and robustness of Economic Analysis results is tested when the input data vary of ±X%

> Sensitivity is measured for input data one-by-one

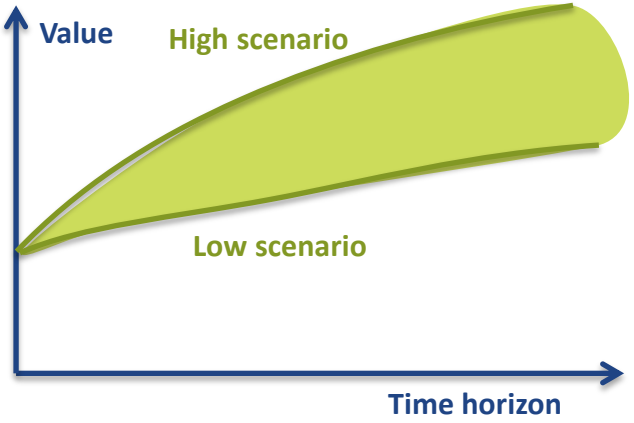
Data	Positive variation	Negative variation
Demand under 1-day Design Case	+5%	-5%
Demand under 14-day Uniform Risk	+5%	-5%
Demand under Average Winter Day	+5%	-5%
Demand under Average Summer Day	+5%	-5%
Fuel and CO2 prices (together)	450 ppm scenario	Current policies scenario



Multi-scenario approach

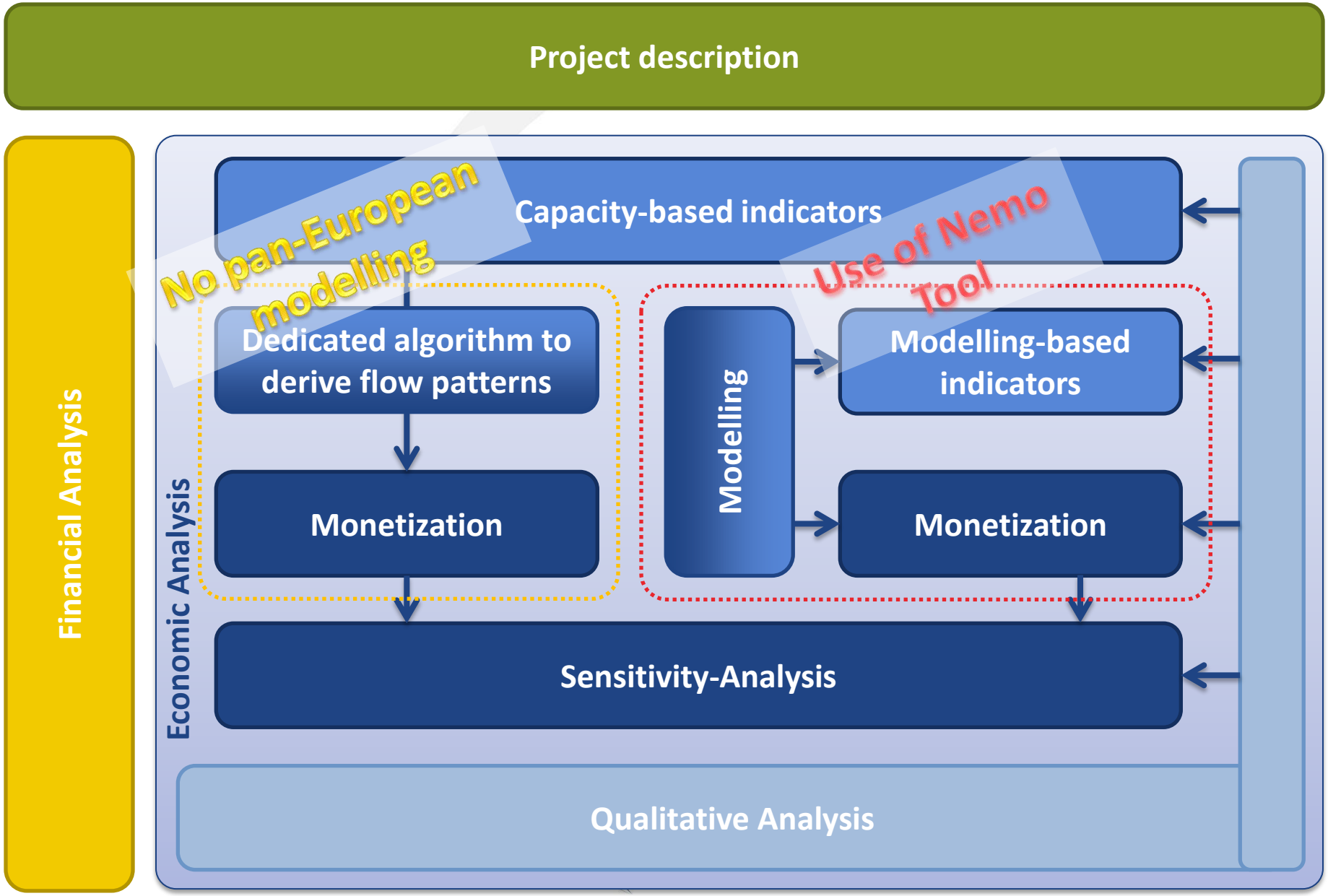
> For some input data there is no clear reference, in such case the Economic Analysis is carried-out for 2 scenarios defining a range of possible future

> When modelling will be fully used, this approach could be applied to Infrastructure Scenarios



Project Specific CBA methodology

Alternative structures for PS-CBA



Project definition & Specific data

Technical description of the project

Project Types	Data Description
Transmission Projects	Name of the pipeline section
	Type of pipeline project (Interconnector/Internal Project)
	Length of the pipeline in km
	Diameter (in mm)
	Compressor Power (in MW)
	Interconnected balancing zone and TSOs by the project
	Capacity created by the project per interconnection point and direction
LNG and CNG Terminal	Name of the terminal
	Send out capacity (GWh/d)
	Maximum Size of the ship (m^3 of LNG or CNG)
	Storage capacity (m^3 LNG or CNG)
	Interconnected balancing zone and TSOs by the project
UGS	Name of facility
	Type of storage
	Withdrawal Capacity (GWh/d)
	Injection Capacity (GWh/d)
	Working Volume (GWh)
	Interconnected balancing zone and TSOs by the project

Financial description of the project

Data item per year of time horizon
CAPEX
OPEX
Residual value
Financial discount rate

Background of the project

- Rational
- Objectives and meet criteria as defined in Regulation
- Preliminary identification of the Area of Analysis

Financial Analysis

Financial performance indicators illustrating the profitability and financial sustainability of the project

> Financial Net Present Value (FNPV)

$$\boldsymbol{FNPV = \sum_{t=0}^{n} a_t S_t = \frac{S_0}{(1+i)^0} + \frac{S_1}{(1+i)^1} + \cdots + \frac{S_n}{(1+i)^n}}$$

If FNPV exceeds 0 the project generates a net benefit and is financially desirable

> Financial Internal Rate of Return

It is the discount rate producing a 0 FNPV according the above formula

> Financial Benefit/Cost ratio

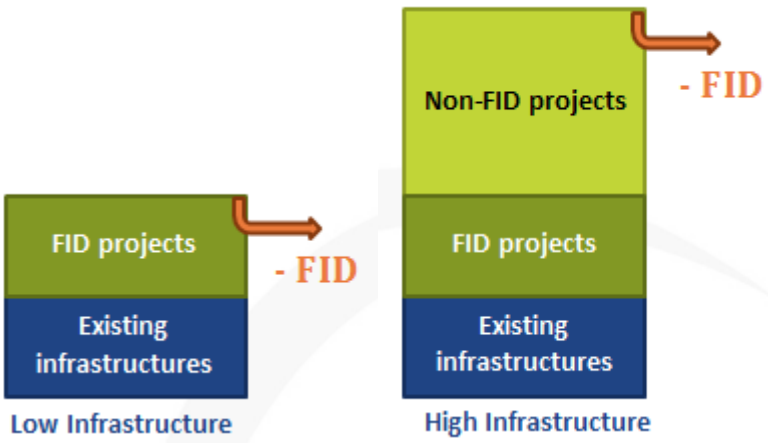
Ratio between discounted revenues and costs
If exceeds 1, the project is considered as efficient

Economic Analysis – Incremental approach

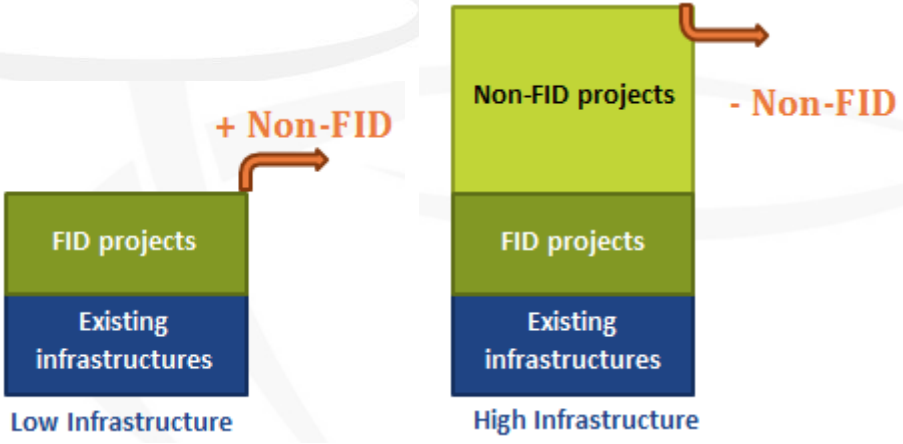
Identification of the marginal impact of the project

- This is done by carrying out both Quantitative and Monetary Analyses successively with and without the project
- Results will depend of the interaction with other infrastructures, this is the reason why 2 infrastructure scenarios have been developed
- The approach is applied differently depending on the FID status of the project but in both cases, half of the analysis is already done as part of the ESW-CBA

Approach for FID projects



Approach for Non-FID projects



Economic Analysis - Quantification

Bi-directional project indicator

> The indicator directly reflect the project increment and has to be calculated at both IP level:

$$Min\left(1; \frac{Added\ Capacity\ at\ IP\ to\ other\ direction}{Existing\ Pipeline\ capacity\ in\ prevailing\ direction}\right)$$

And cross-zone level:

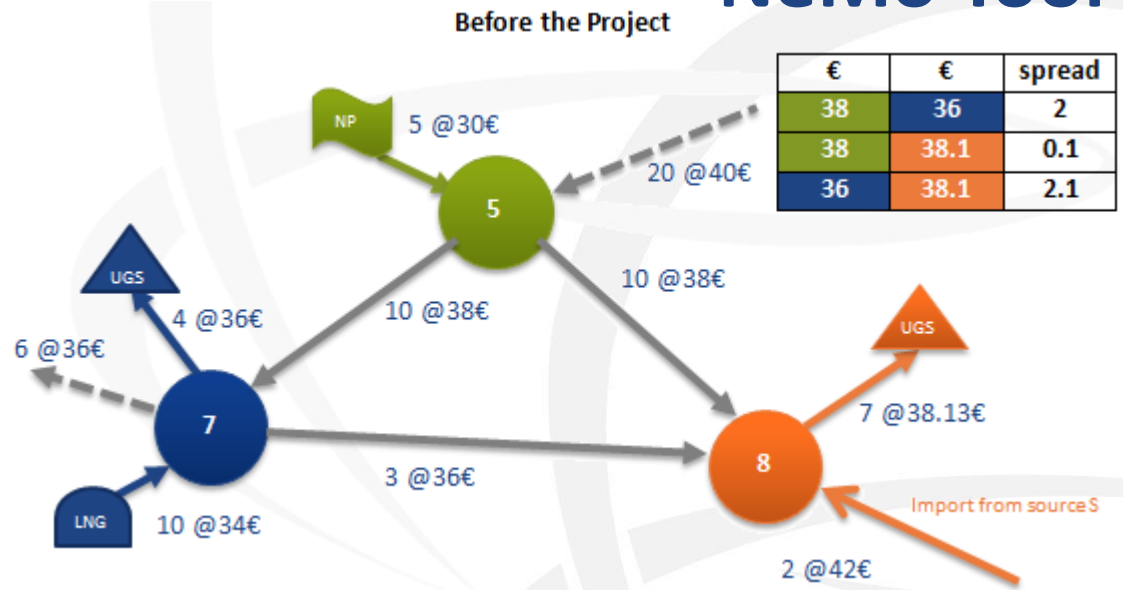
$$Min\left(1; \frac{Added\ Capacity\ at\ IP\ to\ other\ direction}{Existing\ Pipeline\ capacity\ in\ prevailing\ direction}\right)$$

Other indicators

> The other indicators are those used in the ESW-CBA

> They comparison of indicator calculation with and without the Project will show its impact (incremental approach)

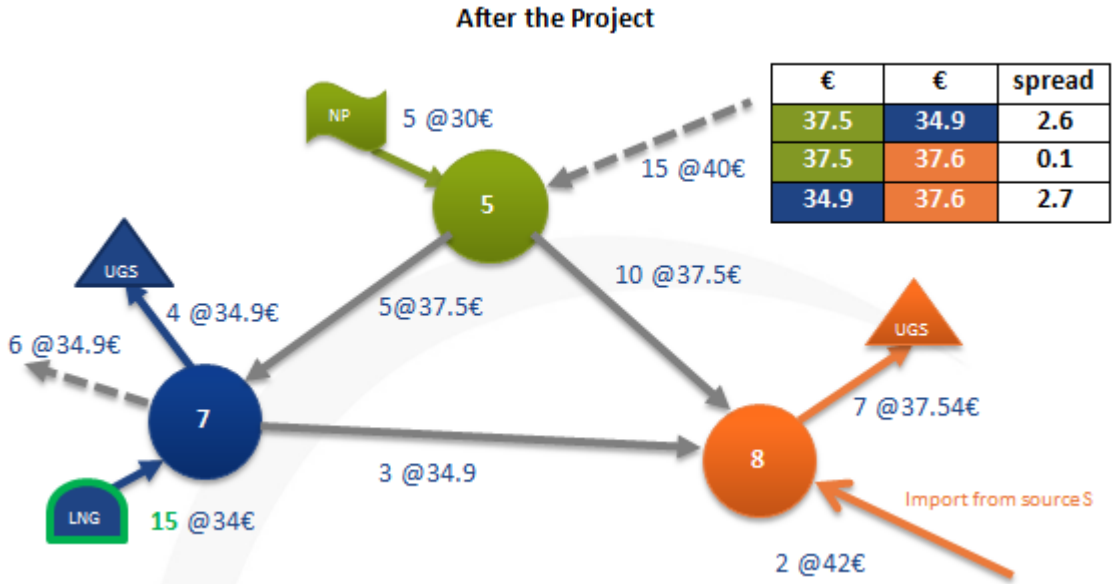
Economic Analysis – Monetization based on NeMo Tool - 1



€	€	spread
38	36	2
38	38.1	0.1
36	38.1	2.1

Measurement of price convergence

Spread between zones	Convergence
	+0.6
	0
	+0.6



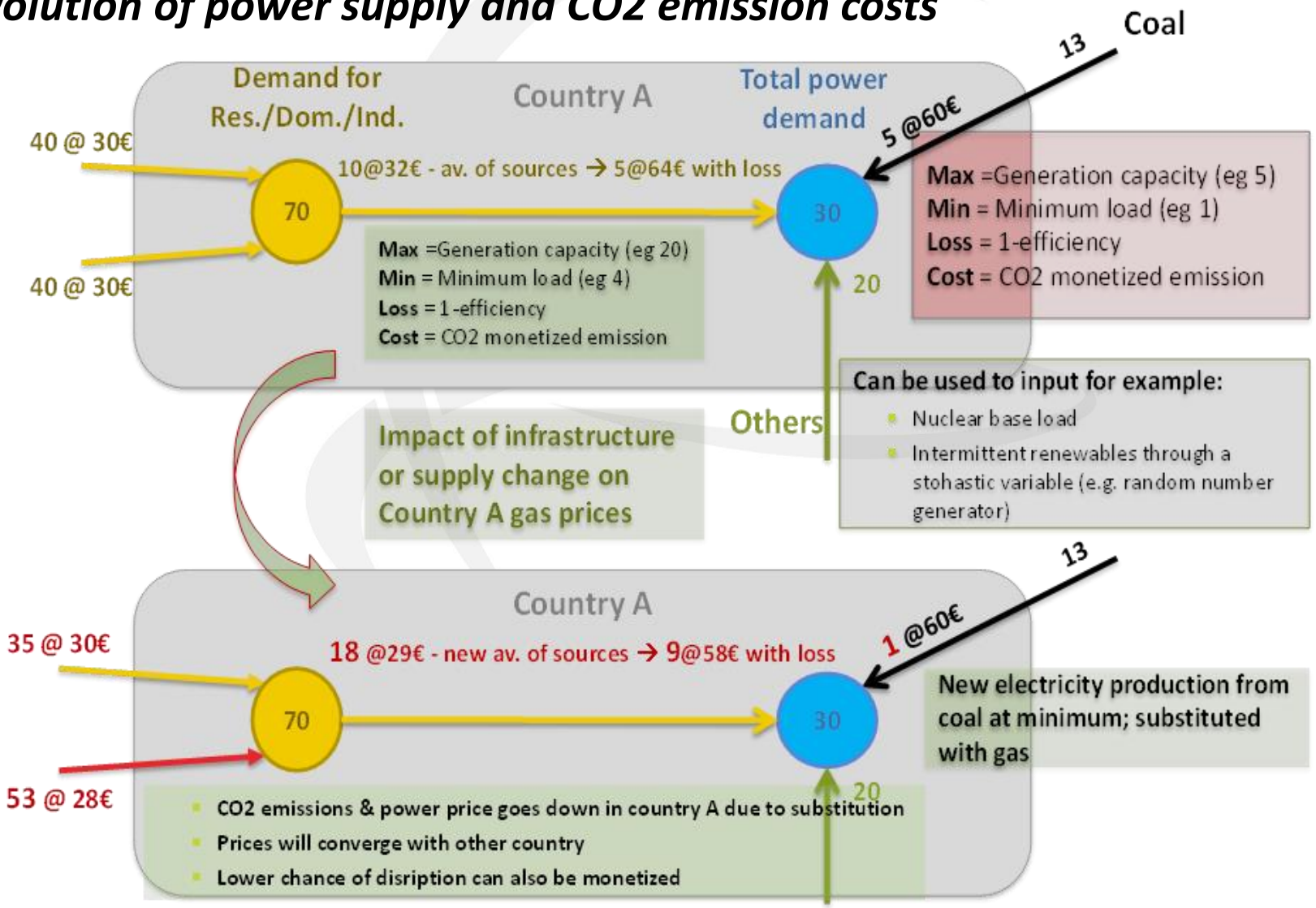
€	€	spread
37.5	34.9	2.6
37.5	37.6	0.1
34.9	37.6	2.7

Measurement of the evolution of gas supply cost

Supply cost	Evolution
	-0.5
	-1.1
	-0.5

Economic Analysis – Monetization based on NeMo Tool - 2

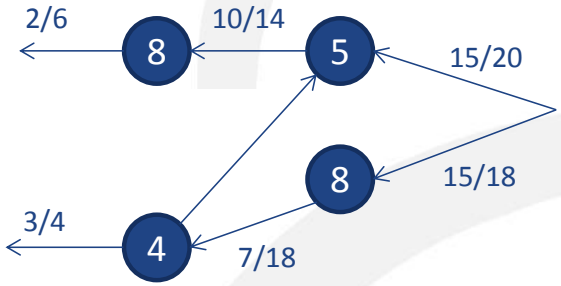
Evolution of power supply and CO2 emission costs



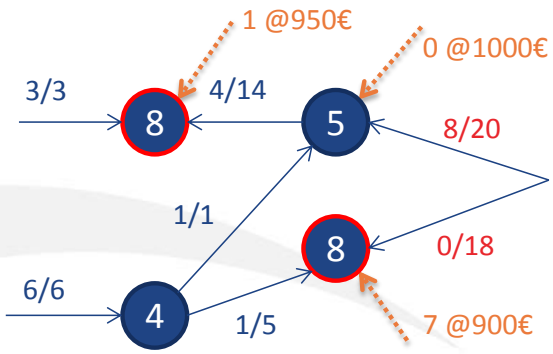
Economic Analysis – Monetization based on NeMo Tool - 3

Evolution of the cost of disrupted gas demand

Before disruption

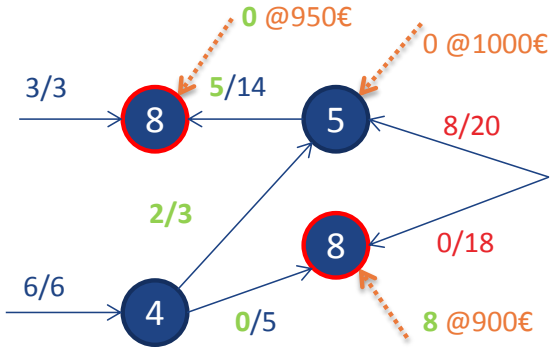


With disruption – without the project



Cost of disrupted demand: 7250 €

With disruption With project



Cost of disrupted demand **7200€**

Economic Analysis – Monetization without pan-European modelling

Until the modelling tool is fully usable for the ESW and PS-CBA an interim approach has been identified in order to define economic flows.

This approach will be illustrated in the Case Study presentation

Economic Analysis – Performance indicators

They follow the same logic than the financial ones

> Below indicators are calculated on the Economic Benefits and Cost flows (Bt and Ct) resulting from the previous monetization steps (with or without use of NeMo Tool)

> Economic Net Present Value (FNPV)

$$ENPV = \sum_{t=a}^{c+20} \frac{B_t - C_t}{(1+i)^{t-a}}$$

If FNPV exceeds 0 the project generates a net benefit and is financially desirable

> Economic Internal Rate of Return

It is the discount rate producing a 0 FNPV according the above formula

The project is considered as economically desirable if the value exceeds the Social Discount Rate

> Economic Benefit/Cost ratio

$$EB/C = \frac{\sum_{t=a}^{c+20} \frac{B_t}{(1+i)^{t-a}}}{\sum_{t=a}^{c+20} \frac{C_t}{(1+i)^{t-a}}}$$

Ratio between discounted revenues and costs
If exceeds 1, the project is considered as efficient

Sensitivity analysis

Assessed impact depends on input data

- As for TYNDP, there is a strong link between the input data and the possible conclusion
- In fact the link is even stronger than with the methodology
- The sensitivity-analysis is necessary to illustrate the robustness of the impact: does it materialize under any circumstances?
- The approach is the one of the ESW-CBA plus the consideration of project specific data:
  - CAPEX
  - OPEX
  - Commissioning data
  - Infrastructure scenario
  - Allocation schema (in case modelling is not used)

Qualitative analysis

Commenting part

- Project promoters shall provide their view on the background of the ESW-CBA
- Project Promoters will have to comment the Quantitative and Monetary Analysis results in order to make the link with the main aim of their projects as stated in the description of their projects

Complementing Quantification and Monetization

- Quantification and Monetization cannot provide a comprehensive view of project benefits
- Promoters may have their own views on input data scenario, in such case they are invited to comment on the impact of such alternative scenarios on the Economic Analysis
- Promoters shall describe the benefits of their projects in terms of:
  - Complementarity with other projects
  - Diversification of counterparties
  - Lifting isolation

Next steps

Challenges ahead

Adaptation process of the methodologies

- ENTSOG will received formal opinion from ACER, EC and Member States
- TYNDP 2015 process will be used to factor stakeholders' feedback in the process
- ENTSOG, supported by a consultant appointed by Commission, will check that the 2 above processes converge by Summer 2014

Methodology testing

- Part of the upcoming month will be used to test methodologies and their sensitivity to input dataset
- Indicators and modelling approach will be updated accordingly

Input data definition

- Development of the methodology beyond the one of TYNDP 2013-2022 will require the use of many more data to be defined with stakeholders
- Part of the methodologies for which data will not be available will have to be withdrawn in order to ensure applicability of the methodology

Thank You for Your Attention

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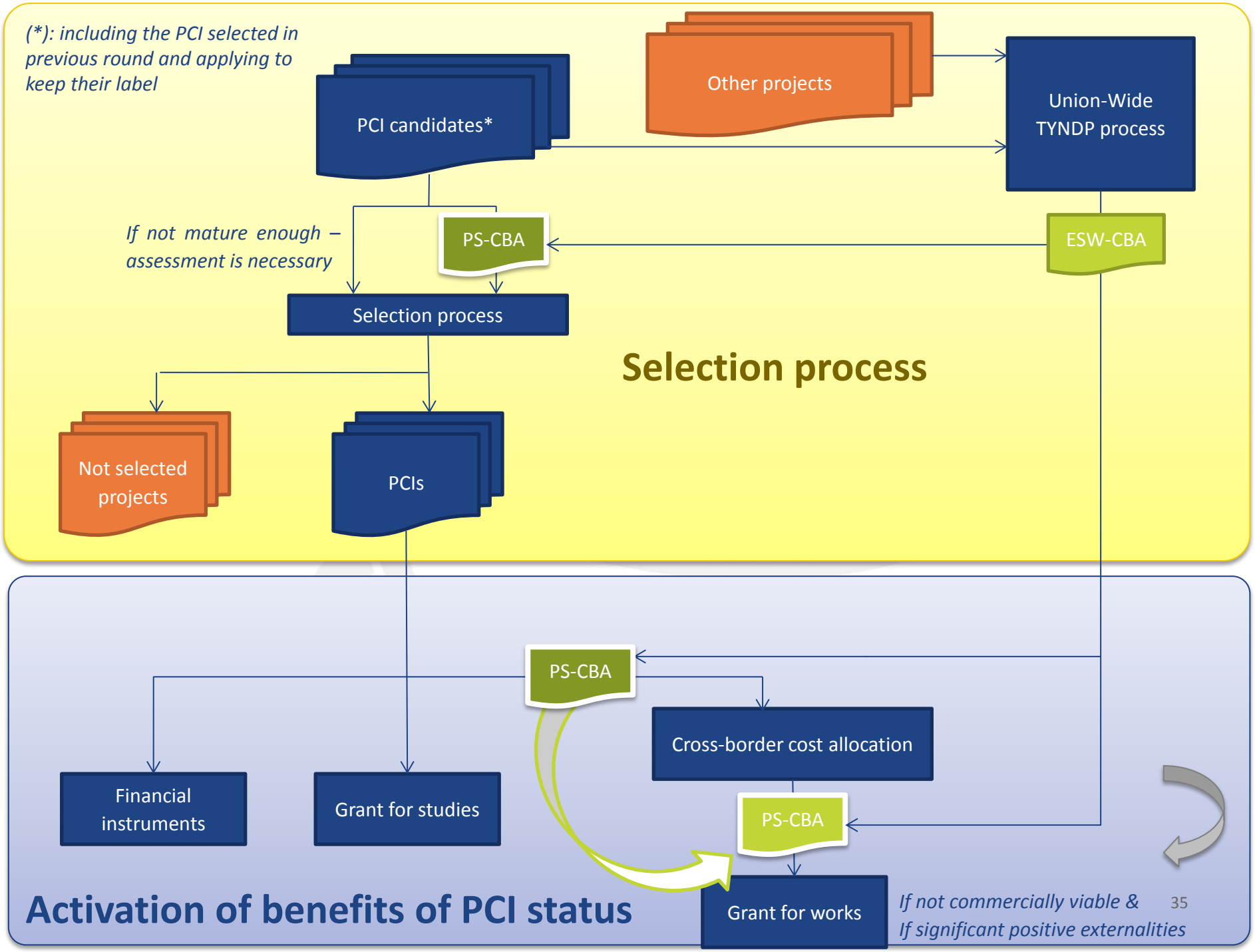
(*): including the PCI selected in previous round and applying to keep their label
PCI candidates*
Other projects
Union-Wide TYNDP process
If not mature enough – assessment is necessary
PS-CBA
ESW-CBA
Selection process
Selection process
Not selected projects
PCIs
PS-CBA
Cross-border cost allocation
Financial instruments
Grant for studies
PS-CBA
Grant for works
If not commercially viable &
If significant positive externalities
Activation of benefits of PCI status