Focus Study Interlinked Model
Joint ENTSOs Workshop

17th May 2018
ENTSOs premises, Brussels

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Workshop Agenda

10:30	Welcome
10:45	Scope of the Focus Study (ENTSOs)
	15 minutes break
12:00	Methodology used to perform the different tasks (consultant)
13:00	Lunch break
14:00	Stakeholder feedback - what are the critical elements? • Incl. comment by Eurelectric • Incl. comment by Eurogas
16:00	Closing remarks

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Scope of the Focus Study

Jean-Baptiste Paquel, Senior System Development Adviser, ENTSO-E

Louis Watine, System Development Project Manager, ENTSOG

Anne Boorsma, System Development Adviser, ENTSOG

Scope of the Focus Study

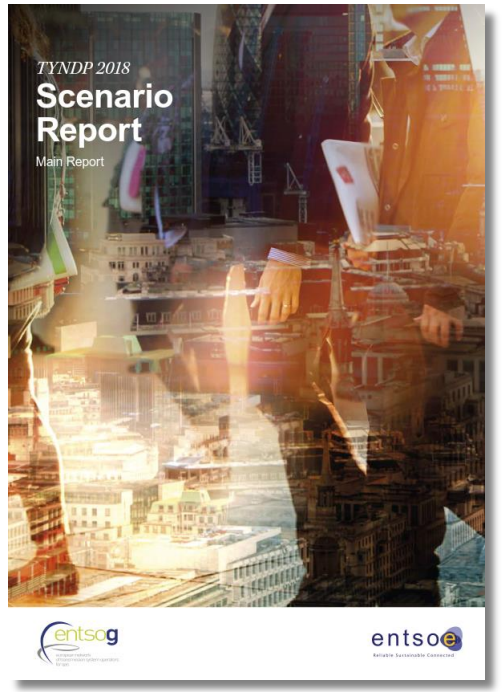
1. Introduction to ENTSOs Interlinked Model

Background

- In December 2016 the ENTSOs submitted their “ENTSOs draft consistent and interlinked electricity and gas model” (the **draft Interlinked Model**), based on TEN-E Regulation and interactions with EC and ACER
- It was focused on **joint scenario building**, identified as capturing the main interlinkages between electricity and gas
- It was applied for the first time ever to TYNDP 2018 and was welcomed by the stakeholders
- Based on ACER opinion and input from EC, the ENTSOs recognized the need to investigate the **relevance of further interlinkages** through a specific Focus Study

Joint ENTSOs Scenario Development

- For the first time for TYNDP 2018 ENTSOG and ENTSO-E engaged in joint scenario development
  - Combining their **expertise** and sectoral knowledge
  - Being a focus point for gathering **inputs from a wide range of stakeholders** interested in the energy sector
- A key step in interlinking gas and electricity TYNDP
- Joint scenario development captures highly relevant interlinkages between both sectors…
- … and ensures the consistent assessment of the two key energy networks of Europe against the same futures.

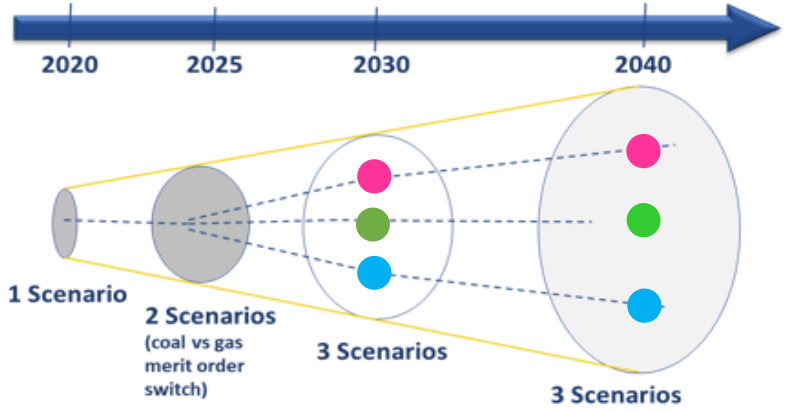


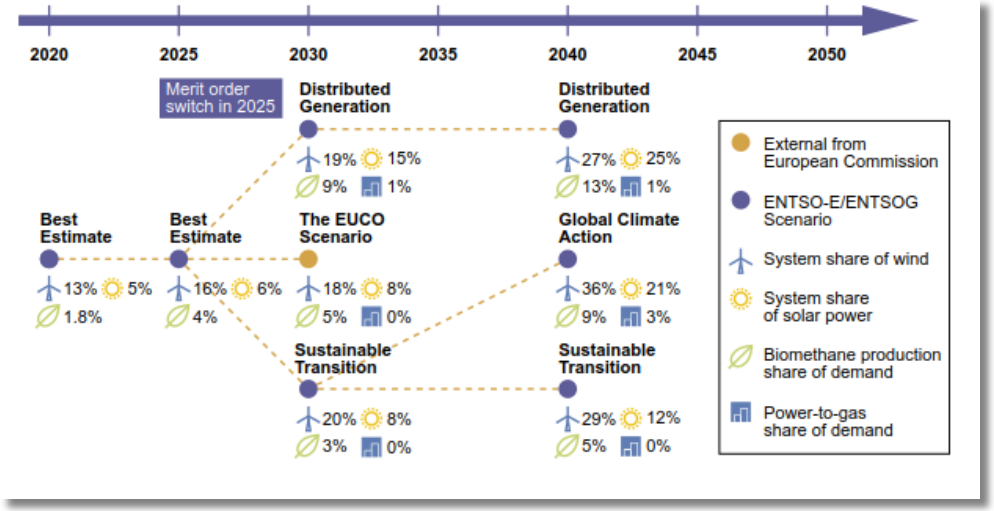
TYNDP 2020 scenario development is now starting. Join our Storyline Workshop in Brussels, 29th May

Joint Scenarios capture main interlinks

Long-term interlinkages between electricity and gas end-user demand

- Long-term energy switching dynamics in the heating, transport and industry sectors
- Consistent framework developed, which included use of an external scenario, the EUCO30 Policy Scenario

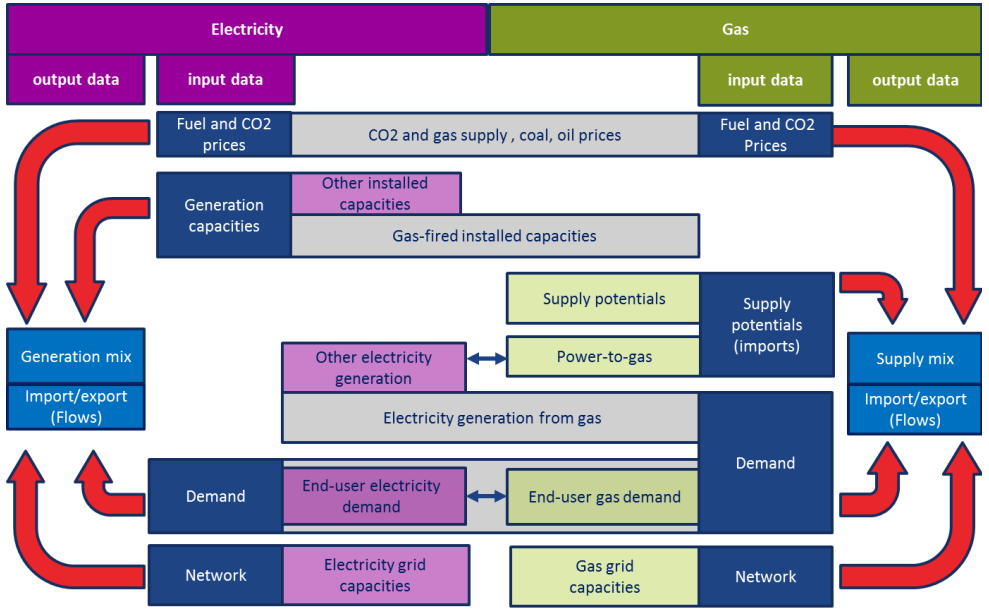




Joint Scenarios capture main interlinks

Scenarios determine gas and electricity sectors contribution to EU targets such as renewable energy share and CO2 emissions

- Capture the impact of fuels and CO2 prices on both sectors



Gas to power *derived from electricity market modelling and used as demand input for the gas sector*

Power to gas *with a first approach developed for TYNDP 2018*

Still further relevant interlinkages? To be investigated in upcoming ENTSOs Focus study

Scope of the Focus Study

2. Introduction of the study

Focus Study Goal

Goal

- Conceptually assess which electricity and gas interactions are relevant from a TYNDP perspective, including potential interactions between projects
- The study outcome will be used by ENTSOs for further adapting the Interlinked Model - which will form part of the CBA Methodology - and applying to relevant projects

Focus Study Tasks

- Generic mapping of all potential interactions between gas and electricity
- Qualitative analysis of potential interactions between gas and electricity infrastructure
- Quantification of interaction parameters
- Propose recommendations on screening approach to identify projects to be retained for gas/electricity interaction assessment

Governance and Stakeholder involvement

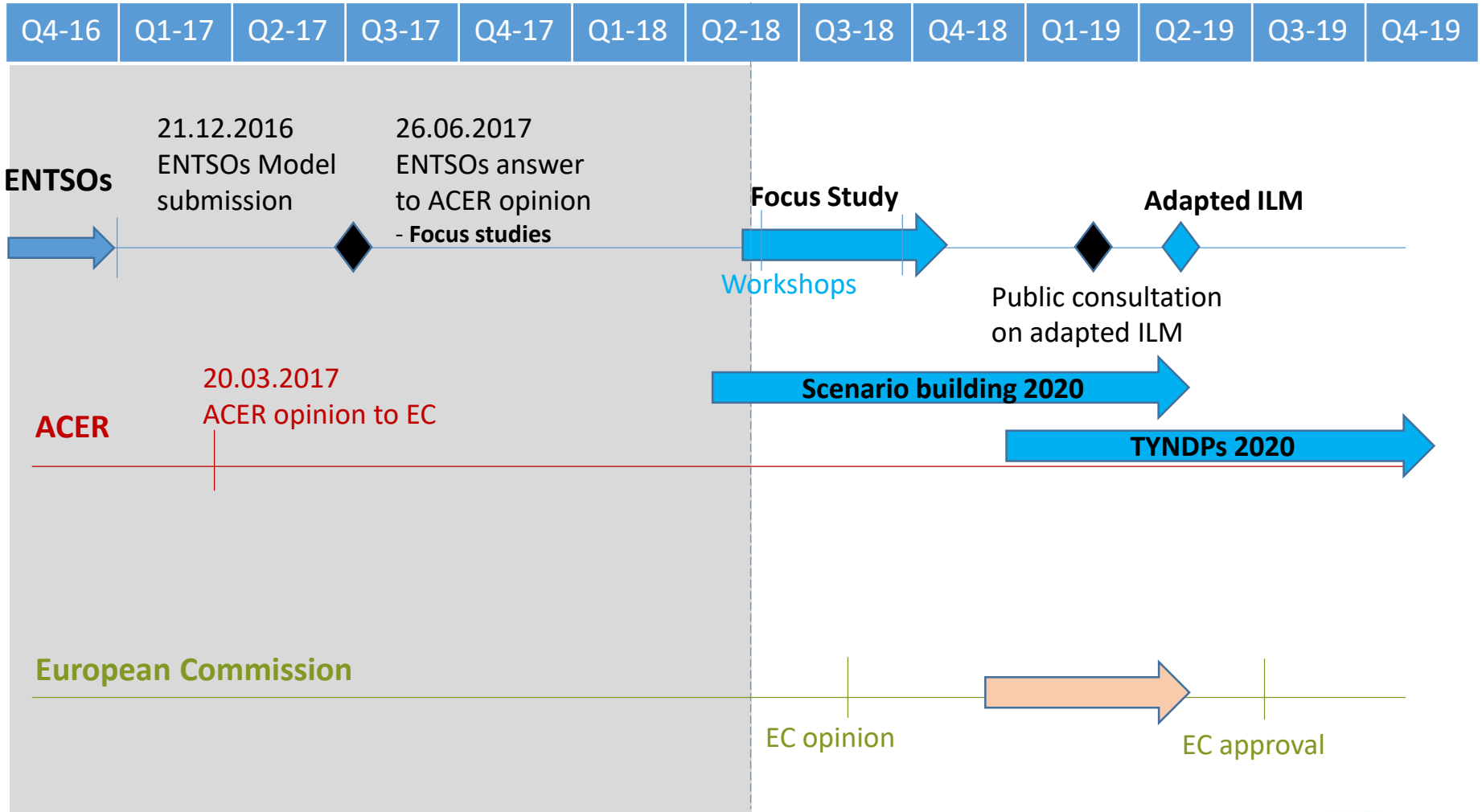
Governance

- Steering Committee (ENTSOs)
- EC and ACER to act as a Sounding Board and to be consulted on the outcome of each task

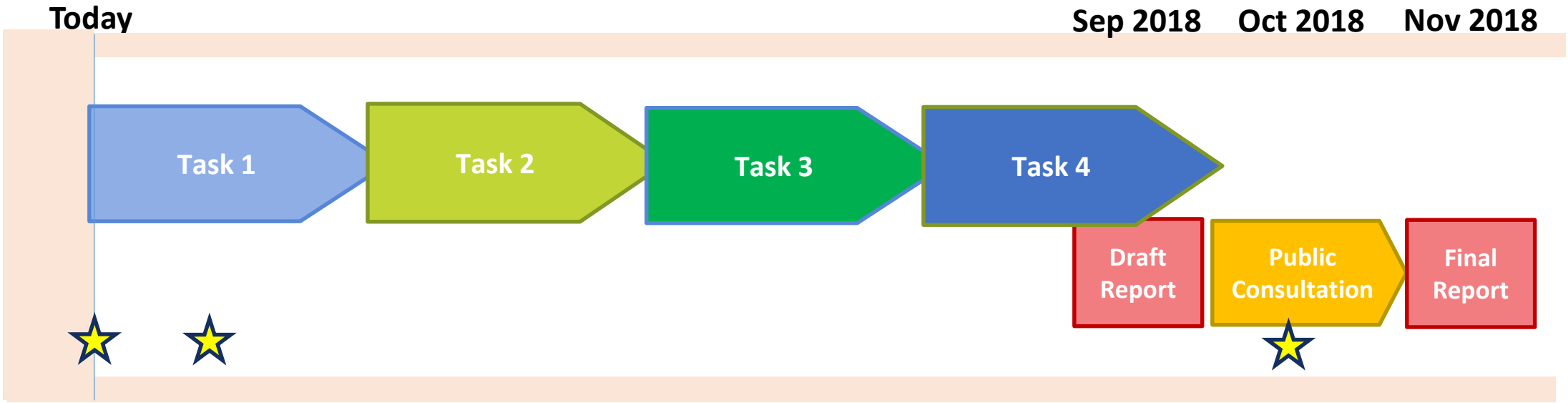
Stakeholder involvement

- As part of Task 1: initial stakeholder workshop (today, 17 May) and input from Copenhagen Forum (25 May)
- Conclusion stakeholder workshop on the outcome of the study (Oct 2018 tbc): feedback will be reflected in final report

Interlinked Model timeline



Focus Study timeline



Stakeholder engagements include:

- Workshop with stakeholders to kick off the focus study (17 May 2018)
- Presentation for the Copenhagen Forum (25 May 2018)
- Workshop with stakeholders to present the study outcome (Q4 2018)

Next steps

- Based on the study output, the ENTSOs will **adapt the Interlinked Model** in view of enhanced infrastructure project assessment starting from TYNDP 2020.
- Once approved, the Interlinked Model will form part of the CBA methodologies, warranting a better common perspective in regards to electricity and gas projects assessment.

Scope of the Focus Study

3. Purpose of the study

Study purpose

- With the focus study, the ENTSOs aim at better understanding which interlinked elements are relevant and are worth considering in methodologies or tools, and make the best of the joint ENTSOs TYNDP scenario building process.

- The study aims at investigating all possible interactions between
  - Gas and electricity systems
  - Gas and electricity projects

Study purpose

- To have substantiated elements and comprehensive analysis of synergies and competition between both energy systems

- Simple questions do not necessarily come with simple answers
  - Can you avoid building a new infrastructure by considering the existing infrastructure in both systems?
  - Can a project in gas or electricity compete with a project in the other sector?
  - …

- They require a deep understanding of the context in which projects are to be built
  - How much it depends on the areas they are connected
  - How specificities of the infrastructure in these areas influence on the interactions between the 2 systems
  - How future decisions (local and continental) can influence on the possible interactions
  - …

Study purpose

- Objective for the ENTSOs
  - To amend their interlinked model in view of its submission for Commission's approval, in line with the opinions received from ACER and Commission and in line with the regulatory process as set by Art 11.8 of Regulation (EU) 347/2013.
  - To improve their interlinked model
    - By investigating all possible interactions
    - By focusing on the relevant gas and electricity infrastructure interactions
  - To keep on improving their TYNDP and delivering thorough and comprehensive assessment of both energy systems and projects

Scope of the Focus Study

4. Technical specification

Specification

- Investigating the interlinkage between gas and electricity scenarios and infrastructure assessment

Task 1	Generic mapping of all potential interactions between gas and electricity
Task 2	Qualitative analysis of potential interactions between gas and electricity infrastructures
Task 3	Quantification of interaction parameters
Task 4	recommendations on screening approach to identify projects to be retained for gas/electricity interaction assessment

Task 1 – generic mapping of interactions

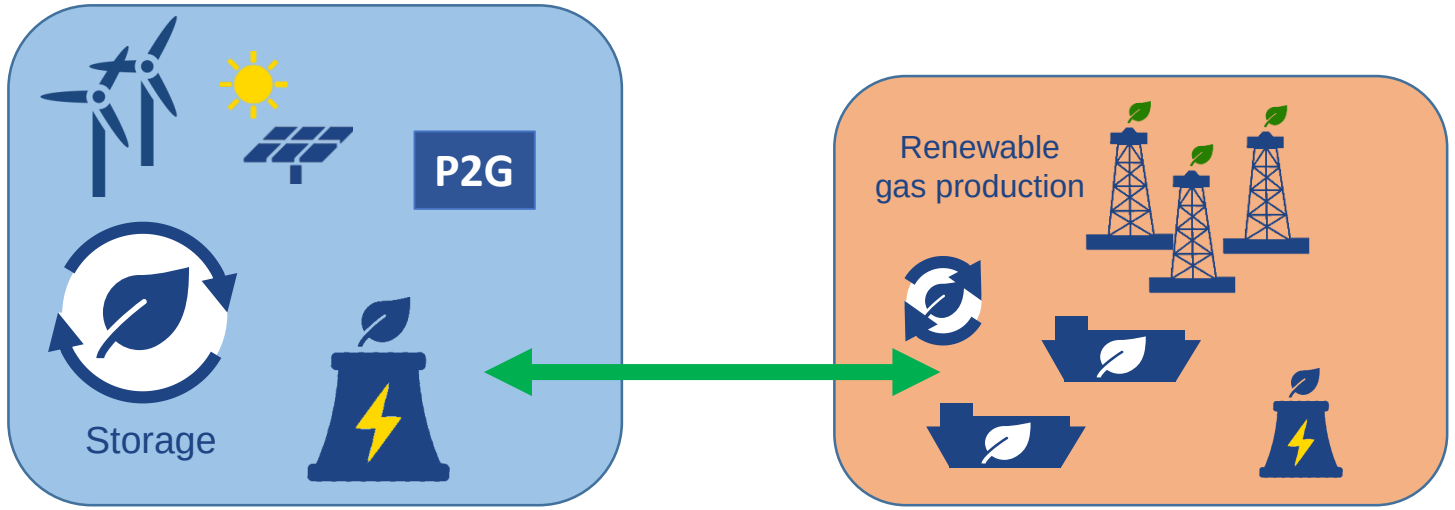
- Objective:
  - Identify, notably through literature review and stakeholder engagement, all possible interactions between the gas and electricity sectors
    - e.g. gas-fired power plants, electric-driven gas compressors, blending hydrogen into gas pipelines, power-to-gas facilities, hybrid heating and other energy use on the end-user side
  - Subsequently identify which of these interactions have a connection with:
    - ENTSOs Scenario Building exercise
    - Gas and electricity prices
    - Gas and/or electricity infrastructure projects.
  - Or, are simply of limited relevance.

Task 1 – generic mapping of interactions

- Sustainability: integrating RES into the energy system
  - By using only one of the energy systems
  - By converting energy from one system to an other system (eg. power to gas)
  - By using storages (short-term or long-term)
- Competitivity: building on complementarity in the energy system and optimisation of infrastructure investment needs
- Security of energy supply: ensuring and reinforcing SoS by complementarity

Task 2 - Qualitative analysis of potential interactions

- Project connecting 2 areas may have a different impact depending on
  - Demand levels
  - Demand technologies
  - Energy mixes
  - RES integration level
  - Type of integrated RES
  - Production level
  - Storage capacities
  - …

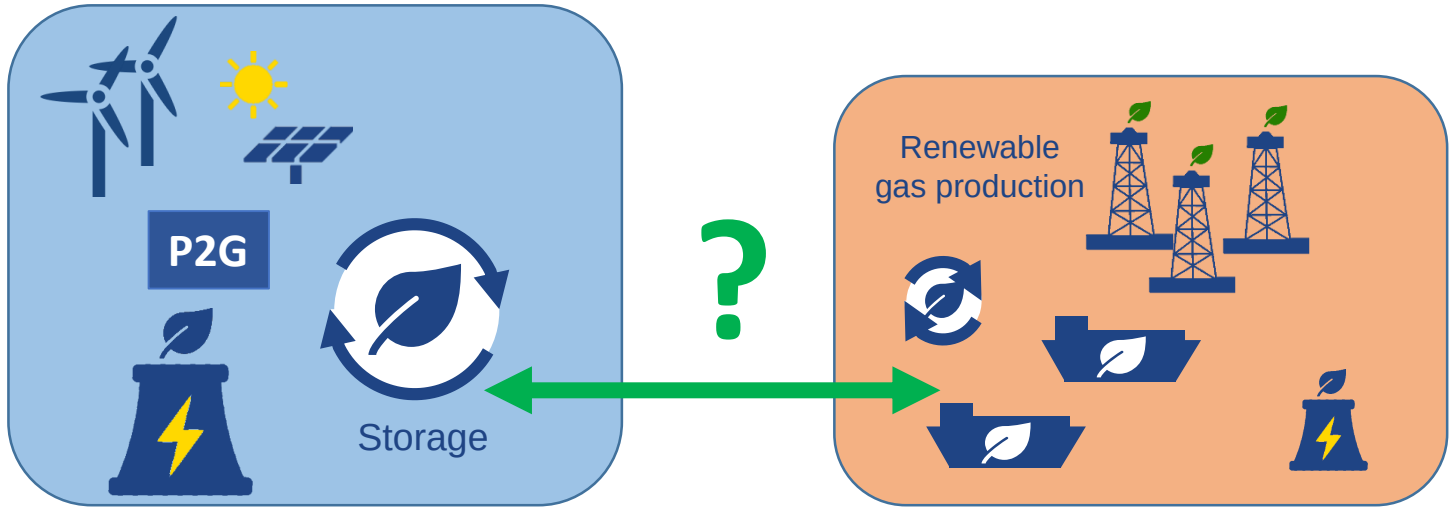


Task 2 - Qualitative analysis of potential interactions

- Under which conditions a project can be expected to have a significant impact on the other system (existing infrastructure or another project)?
- To what extent?
- What parameters are of relevance when assessing the potential interactions?

Task 3 - Quantification of interaction parameters

- For a given configuration
- For different types and combination of projects



- At which level those parameters would indicate possibilities for interactions?

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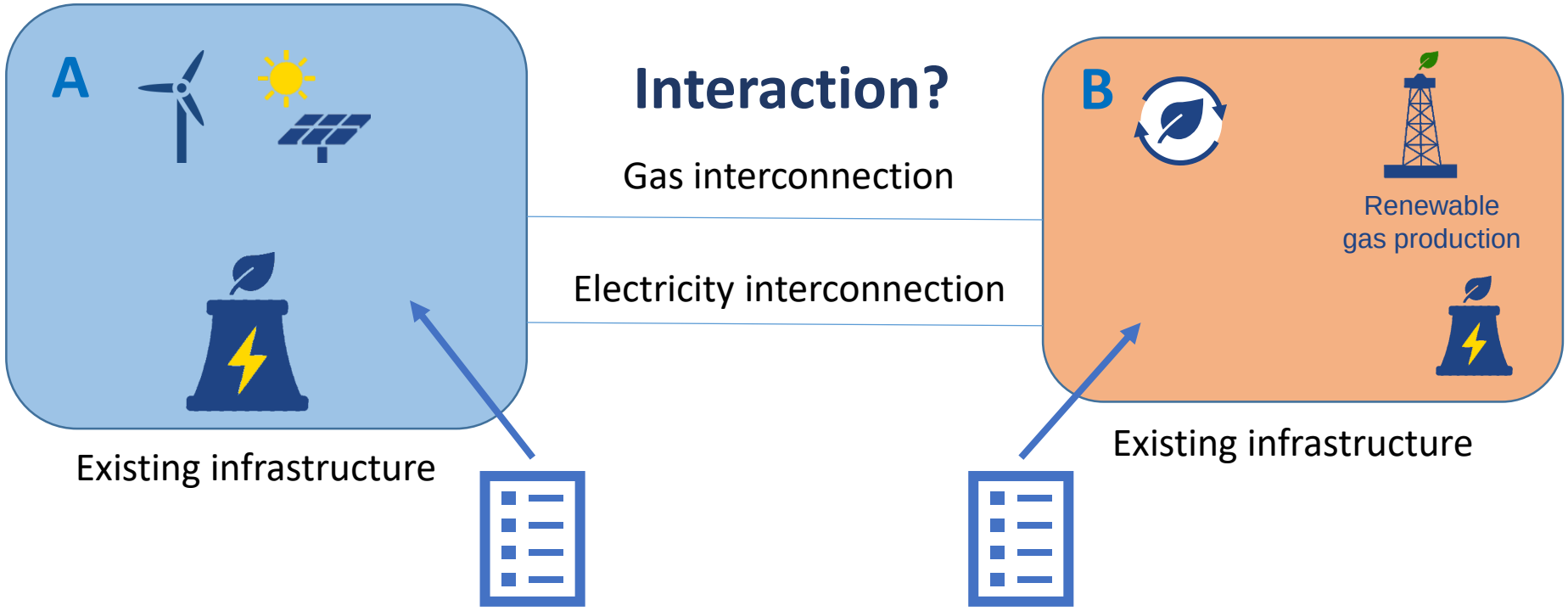
Task 3 - Quantification of interaction parameters

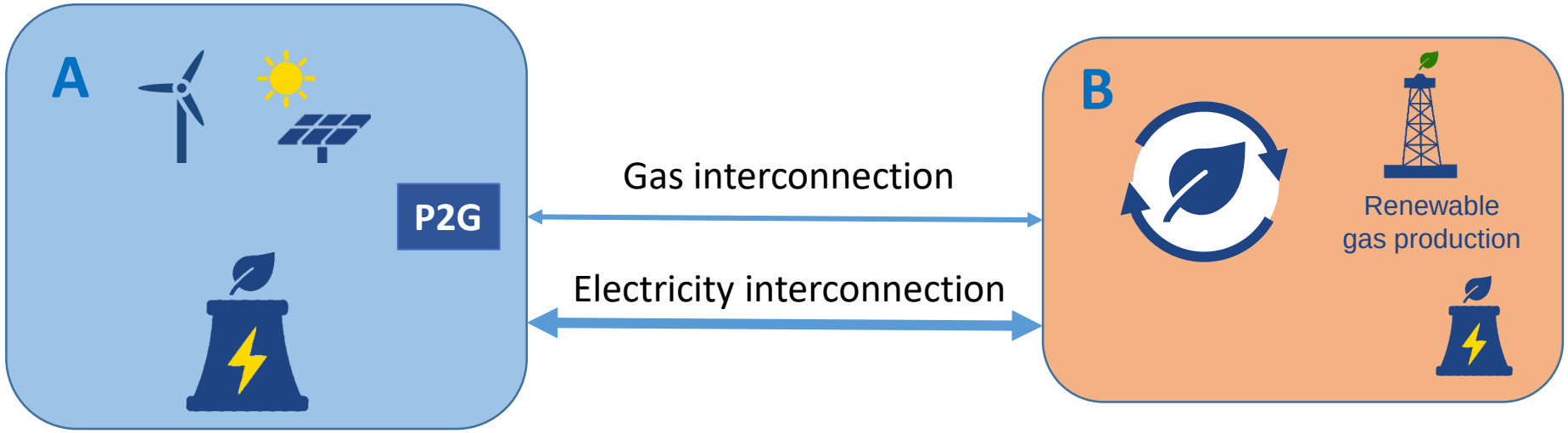
Example of RES integration

- Identify and quantify relevant parameters for identifying possible interactions between RES integration



Task 3 - Quantification of interaction parameters

- Example of RES integration
  - Development of P2G in A + development of storage in B + development of electricity infrastructure between A and B



- How parameters (threshold / cap) indicate that this configuration could create relevant interactions between the energy systems ?

Task 4 – screening of projects for gas/electricity interaction assessment

- Recommendations for efficient screening of gas and electricity projects submitted to TYNDPs to perform relevant additional assessment

SHORT BREAK

Methodology

Introduction by the Consultant

Christopher Andrey, Artelys

Scope of the study

- The goal of this study is to provide the ENTSOs with substantiated elements and comprehensive analysis of the interlinkages between gas and electricity systems and projects.

- Importantly, it is not the goal of this study to provide recommendations on the way to adapt the Interlinked Model in order to perform additional assessment of the screened projects. The ENTSOs will perform this task based on the outcomes of this study.

Structure of the study

Task 1 Generic mapping of all potential interactions between gas and electricity

Task 2 Qualitative analysis of potential interactions between gas and electricity infrastructures

Task 3 Quantification of interaction parameters

Task 4 recommendations on screening approach to identify projects to be retained for gas/electricity interaction assessment

Task 1 – Generic mapping

- **Objective** – Identify and characterise the interactions between the electricity and gas systems
- **Methodology**
  - Based on internal expertise, literature review and stakeholder engagement
  - Interactions will be clustered into the following categories:

Interdependence	Competition	Synergies
• CCGTs & OCGTs • Gas CHPs • Electricity-driven gas compressors	• Gas heating *vs* heat pumps • Power to H_2 (replacement of CH_4 use for steam reforming) • Electric mobility *vs* natural gas vehicles	• Power to H_2 (injected in natural gas infrastructure) • Power to CH4 • Hybrid heating (e.g. hybrid heat pumps or industrial gas furnaces with electric boilers)

Task 1 – Generic mapping

- **Methodology (cont'd)**
  - When describing the interlinkages, we will include an assessment of how these interactions may evolve in a period of stress on one of the networks

Electricity congestion	Gas congestion
Hybrid heat-pumps can switch to a gas condensing boiler mode.	Gas-fired CHPs can be stopped and oil boilers started in order to supply heat demand. This may have an impact on the level of electricity generated by CHPs

Task 1 – Generic mapping

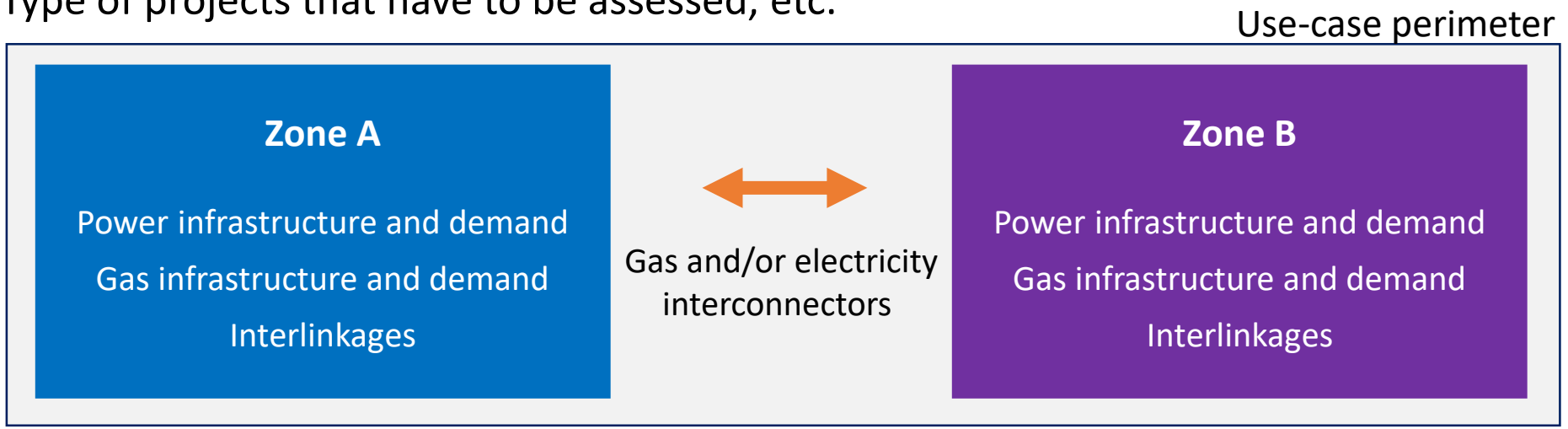
- **Methodology (cont'd)**
  - A traffic light assessment will be produced to characterise the relevance of the interactions for:
    - ENTSOs Scenario Building exercise,
    - Impact on gas and/or electricity prices,
    - Impact on the valuation of gas and/or electricity infrastructure projects
  - Finally, we will examine the role of the different interactions in:
    - **RES integration**: How interlinkages can e.g. help reduce network congestions
    - **Competitiveness**: How interlinkages can help decrease total costs and e.g. supply source dependence
    - **Security of supply**: How interlinkages can help meet security of supply objectives

Task 2 – Qualitative analysis

- **Objective** – Identify meaningful parameters measuring the potential interactions between gas and electricity infrastructures
- **Methodology**
  - Based on up to 6 **use-cases**
  - More precisely:
    - A use-case represents a generic/abstract situation that is close to cases that the ENTSOs may have to consider in the TYNDP process.
    - All use-cases will involve relevant interlinkages between the gas and electricity sectors.
    - A use-case is not a representation of a real part of the energy system (i.e. it should not be interpreted as representing a given region or country).

Task 2 – Qualitative analysis

- **Methodology (cont'd)**
  - Use-cases link to generic zones (A and B), which can differ in terms of:
    - Gas and/or electricity demand and its dynamics
    - Gas and/or electricity infrastructure (e.g. variable RES generation, presence of gas interconnector, etc.)
    - Type of projects that have to be assessed, etc.



Task 2 – Qualitative analysis

- **Methodology (cont'd)**
  - In our proposal we have identified 6 potential use-cases
  - Their final definition will be agreed upon with the ENTSOs and will benefit from stakeholders' feedback

#1 – RES-e integration	#2 – Biomethane integration	#3 – Supply source dependence
High RES-e capacity in region A and limited power export capacity. Both countries have high gas demand. Impact on the value of an electricity interconnector if P2G develops. A variant could be the use of P2G and gas infrastructure as a seasonal storage for RES-e integration.	High development of biomethane projects in region A, with gas network congestion between A and B. Analysis on how the development of local CHP or CCGT can impact the gas network investment needs.	One region with high RES potential and importing most of its gas from a single supplier. Comparison between P2G development and new gas supply routes.
#4 –Power security of supply	**#5 – Gas security of supply**	**#6 – Competitiveness**
High development of electric heating (heat pumps in the residential and industrial sectors). Comparison between adding new power import capacity and developing hybrid heating to switch to gas during power scarcity periods.	Disruption of a major source of gas supply in region A. Limited gas and power interconnection capacity between zones A and B. Evaluation if part of the gas to power generation in region A can be shifted to region B, while using existing power interconnector to import electricity from B to A.	One region with cheap gas supply but limited gas export capacity. Both regions have significant gas-fuelled power generation units. Analyse on how using synergies between power and gas systems allow to reduce whole system costs and impact infrastructure investment needs.

Task 2 – Qualitative analysis

- **Methodology (cont'd)**
  - Meaningful parameters measuring the interlinkages will be identified for all use-cases.
  - Different categories of parameters can be considered:
    - General scenario parameters (e.g. time horizon, CO_2 price, etc.).
    - Parameters specific to gas or power scenarios (e.g. RES shares, gas storage capacity, etc.)
    - Parameters characterising synergy potential (e.g. existing P2G capacity, investment cost for additional interlinkage, P2G/G2P conversion costs and yield, maximum frequency/duration of the conversion, etc.)
  - A first set of use-cases and parameters will be presented at the Copenhagen Infrastructure Forum on 25 May 2018.

Task 3 – Quantitative analysis

- **Objective** – Identify ranges of parameters for which the results of a joint gas and electricity assessment is likely to significantly differ from the ones of a gas-only or electricity-only assessment
- **Methodology**
  - We will simulate the 6 use-cases using Artelys Crystal Super Grid

- ✓ Gas-only model (national thermal gap)
- ✓ Electricity-only model (infinite gas flexibility)
- ✓ Fully coupled gas and electricity models

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Task 3 – Quantitative analysis

- **Methodology (cont'd)**
  - In order to detect the situations in which a further investigation of the gas-electricity interlinkages is recommended, we will compare the results (e.g. welfare/SoS/RES integration/CO2 emissions) in the following cases:
    - **Case 1** – Simulation with partial model (electricity model for electricity projects, gas model for gas projects). By design these models only partially take into account the interlinkages.
    - **Case 2** – Simulation with joint gas and electricity model with all relevant interlinkages.
  - If the results obtained in both cases are close: the partial model is well-suited to conduct the CBA of this kind of projects
  - On the other hand, if the results differ significantly, it means that the partial models (that are close to the ones currently used for CBAs by the ENTSOs) only partially reflect the impacts of the relevant interlinkages. As a consequence, we would advise that a further investigation of the interlinkages should be conducted for projects similar to the ones considered in this use-case.

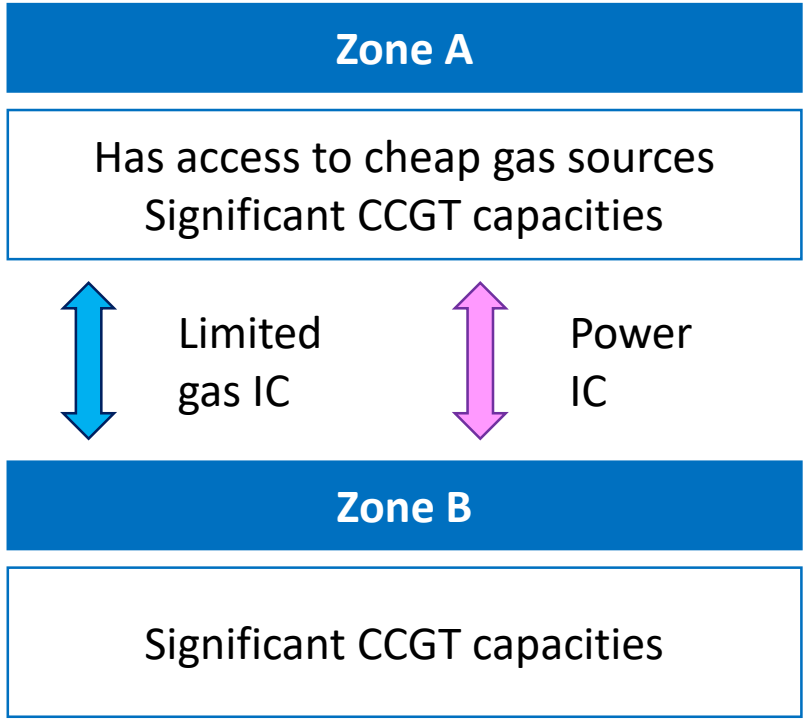
Task 3 – Quantitative analysis

- **Methodology (cont'd)**
  - For each use-case, we will therefore:
    - Collect a relevant **dataset** (including assumptions on technology costs and a consistent set of infrastructures for the power and gas systems).
    - Run the **power-only** and/or **gas-only** market models (independently) to assess the level of required investments and operational costs, from a purely power or purely gas perspective.
    - Model the infrastructure interaction and run the **joint gas and electricity model**, to assess the potential savings/additional costs driven by the interlinkage of both systems. The impact on CO_2 emissions, renewable energy integration and security of supply will be also assessed.
    - Run **sensitivity analyses** on parameters or combination of parameters identified in Task 2 to assess above which thresholds the interaction can generate significant impacts and indicate a need for a further investigation.

Task 3 – Quantitative analysis

Example 1
Gas interconnector valuation

- **Methodology (cont'd)**



List of simulation runs

- Step 1 – Power only: hourly dispatch with a fixed gas price to calculate thermal gap by zone
- Step 2 – Gas only: optimisation of the gas interconnection capacity (using the zonal thermal gap found in Step 1)
- Step 3 – Joint model: Gas price for CCGTs becomes endogenous. The model will favour using CCGTs of Zone A and export power to Zone B (via the existing power interconnector) when the gas interconnection is saturated, rather than investing in a gas IC

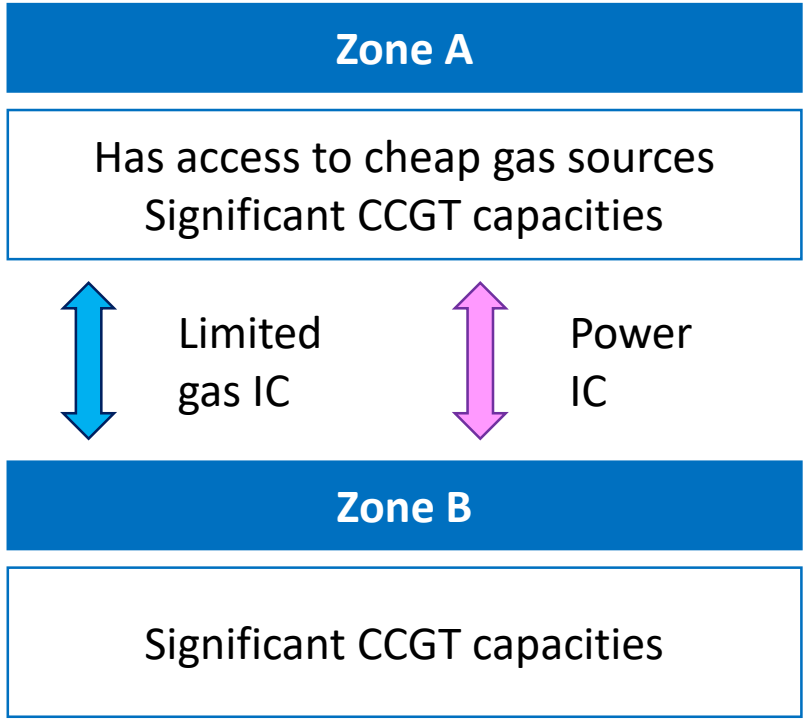
Sensitivity analysis

- Power interconnection capacity
- Gas storage capacity

Task 3 – Quantitative analysis

Example 1
Gas interconnector valuation

- **Methodology (cont'd)**



Potential results

A further investigation of the investment project is recommended if

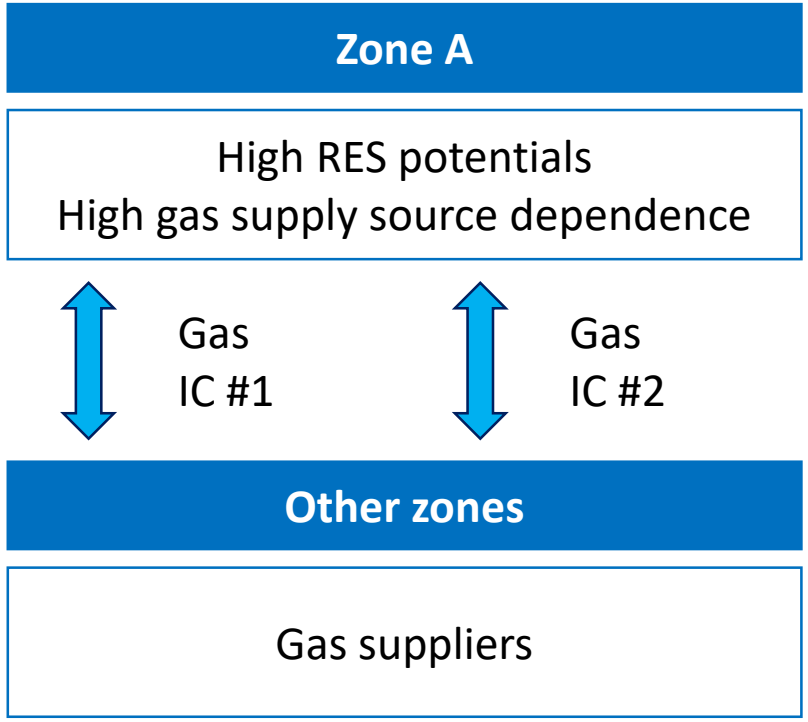
- In Zone A, gas import capacity > gas demand + export capacity
- Use of existing A -> B power interconnector is lower than **x** and gas to power capacity is higher than **y** in A and B

where the values of **x** and **y** are determined via the sensitivity analyses.

Task 3 – Quantitative analysis

Example 2
Power to gas

- **Methodology (cont'd)**



List of simulation runs

- Step 1 – Gas only: daily gas dispatch to assess supply source dependence to all suppliers
- Step 2 – Gas only: assessment of the cost of building a new route to import gas so as to decrease supply source dependence
- Step 3 – Joint model: assessment of the required investments in RES-e and P2G to achieve a similar reduction of supply source dependence

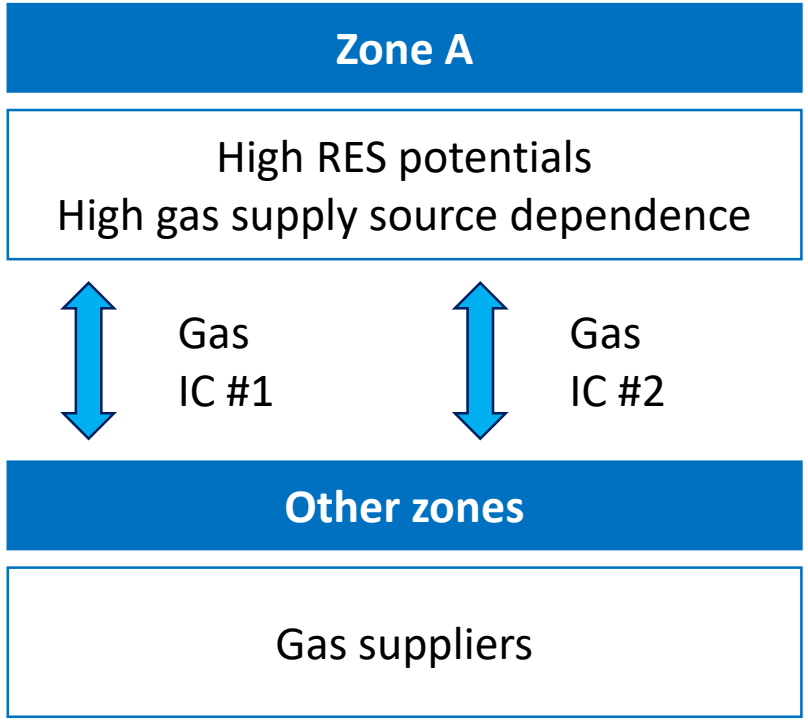
Sensitivity analysis

- P2G investment costs
- Solar PV and wind investment costs
- Gas storage capacity

Task 3 – Quantitative analysis

Example 2
Power to gas

- **Methodology (cont'd)**



Potential results

A further investigation of the investment project is recommended if

- Alternative route cost > α P2G CAPEX + β RES CAPEX

where the values of α and β are determined via the sensitivity analyses.

Task 4 – Screening recommendations

- **Objective** – Provide recommendations on the way to screen projects that should be subject to a further gas-electricity interaction assessment
- **Methodology**
  - Based on the results of Task 3, we will propose a set of rules based on values of parameters that can detect the project that should be subject to a further investigation
  - A qualitative analysis of the effectiveness of the rules will also be performed, so as to understand whether the number of rules can be reduced without compromising on the efficiency of the screening.

Stakeholder engagement

- The Sounding Board (EC and ACER) will be consulted during each of the tasks
- Beyond this initial workshop, stakeholders are invited to provide comments/suggestions/inputs after the presentation at the Copenhagen Infrastructure Forum (25 May 2018)
- Conclusion workshop to be held around October 2018. Stakeholders' feedback will be reflected in the final report.

Thank you for your attention!

Contact

christopher.andrey@artelys.com

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LUNCH BREAK

Stakeholder Feedback

What are the critical elements for interlinked assessment of infrastructure projects?

THANK YOU FOR YOUR ATTENTION

Contact and feedback:
Please refer to « focus study » in the subject

futuregrid@entsoe.eu

sysdev@entsog.eu