7th AIEE Energy Symposium
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ROBUSTNESS ANALYSIS OF POWER SYSTEMS WITH A HIGH SHARE OF RENEWABLES

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Section 1
Introduction

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Introduction

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- **Decarbonization** is a trend that is gaining more and more weight every year with governmental measures
- **Gas-fired power plants** is the main source to support renewables
- **Interdependence** between the electricity and gas systems
- Increase in renewables pose a serious problem that can affect the operation of the coupled grids

Research objectives

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Evaluate the behaviour of power systems with different levels of renewable energy share under contingencies in the electrical grid

Analyze the interdependence between the electricity and gas systems

Section 2
Method

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Method

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- Software **SAInt** (Scenario Analysis Interface for Energy Systems):
  - A mathematical formulation of models for electrical networks with a quasi-dynamic behavior
  - For gas networks with a time evolution of the fluid conditions in the pipelines
  - A formulation to represent the interconnections between both systems

- Electrical behavior (fast dynamics)
- Gas behavior (slow dynamics)
- Simulations are designed to represent the behavior of the networks during the 24 hours of a day.

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Section 3
Case Study

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Definition of case study

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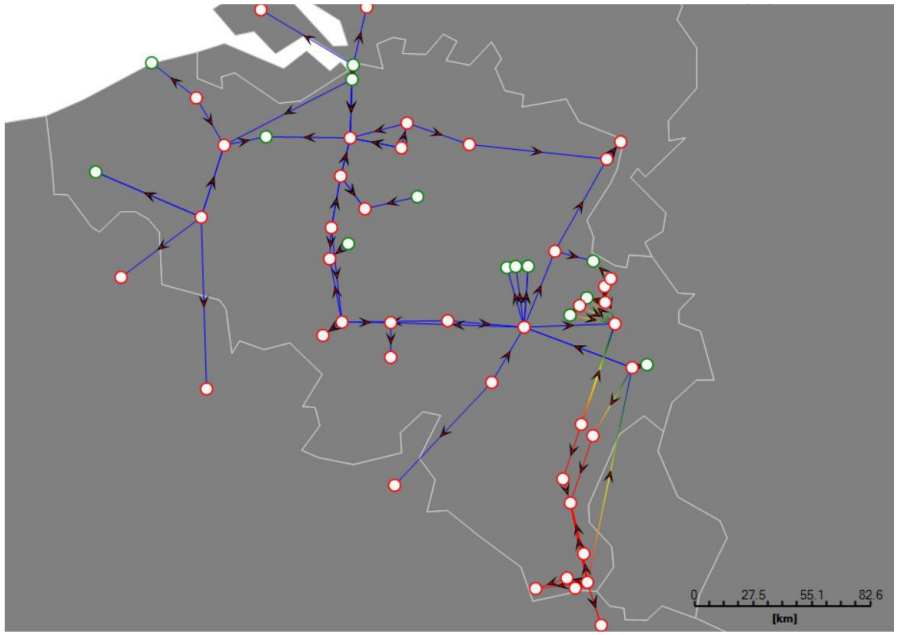
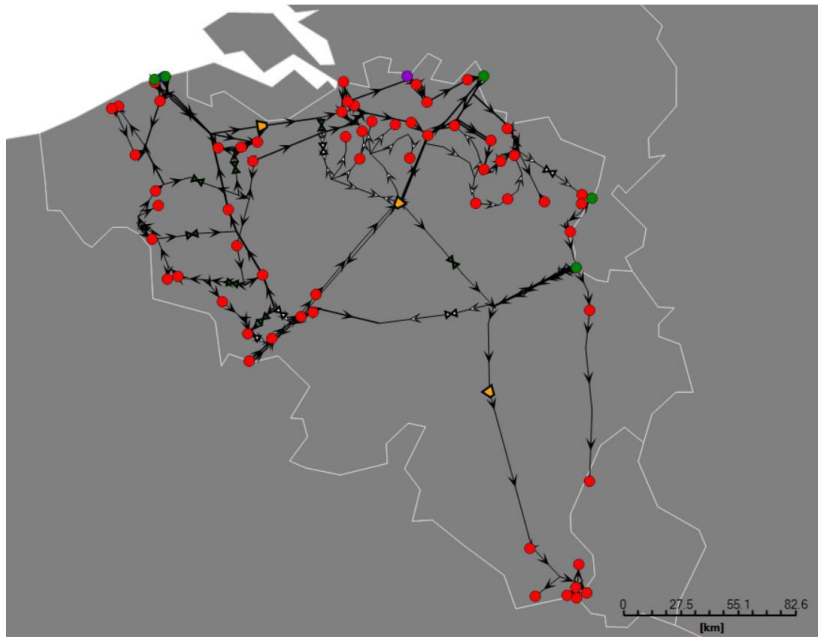
- Belgium infrastructures
- A critical day for electricity demand and gas consumption with low generation availability



Electricity transmission network



Gas transmission network

Definition of case study

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Case 1	Base case without contingencies
Case 2	Base case with contingencies
Case 3	Case with higher share of renewables and without contingencies
Case 4	Case with higher share of renewables and with contingencies

Base case: 21% renewable energy in electricity generation mix
Case with higher share of renewables: 38% renewable energy in electricity generation mix

Section 4
Results

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Results

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Simulations during 24 hours of a day

Comparison cases 1 and 2

- The electricity that could not be supplied in the network demand buses in each hour has been obtained.
- The gas not supplied in the consumption nodes of the gas network is also obtained.
- Case 2 presents an increase of 14% of the electricity not supplied regarding case 1 (line outages and generator shutdowns).
- The contingencies in the grid have a more significant effect on the gas system by affecting buses that fed compressor stations.

Results

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Simulations during 24 hours of a day

Comparison cases 3 and 4

- Cases with significant changes.
- Case 3 reduces average gas consumption.
- Impact on the fluid stored in the network's gas pipelines by 2% with respect to Case 1.
- Case 4 increases the electricity not supplied due to the lack of generation assets.

As renewable generation increases in the grid, more critical problems appear in the supply

Section 5
Conclusions

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Conclusions

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- ✓ A future consisting entirely of renewable generation is not possible with today's technology
- ✓ Robust energy infrastructures must remain in place
- ✓ Need for storage systems for energy transition

Future research works

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- ✓ Analyze the role of subway gas storage facilities
- ✓ Incorporation of hydrogen gas produced from electricity into networks

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