Understanding and valuing the co-simulation of electricity and natural gas network operations

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**Background**

**Electricity** & **Gas** networks are interconnected energy infrastructures whose operation and reliability depend on one another to a large extent.

**Gas fired power plants** as the main interconnecting element. They are generation entities in the power system, and at the same time they are demand entities (loads) in the gas network.

The interconnection and interdependency between power and gas networks has become stronger in the past decades with higher penetrations of **gas fired electricity generation**

High variable (and uncertain) **renewable energy** (wind and solar) penetrations impact how gas fired power plants interact with the **power system**, as well as how they interact with the **gas network**.

“When a large gas fired generator is dispatched to serve electric needs, the pull on the gas system can be great causing changes in pipeline pressures and reducing system flexibility to meet other customer needs” [AGA, 2016].
Project Goals

• To develop a new NREL capability to co-simulate power and natural gas network operations.

• To understand and to value the importance of considering natural gas network operations when simulating operations of power systems with high shares of both natural gas and variable renewable energy sources.
Development of a platform to co-simulate electricity and natural gas network operations:

- Bulk **power system operations** are simulated using PLEXOS
- Bulk **natural gas system operations** are simulated using **SAInt** (Scenario Analysis Interface for Energy Systems)
- The interconnection of the natural gas and electricity networks at natural gas fired power plants is simulated in a **co-simulation platform** between PLEXOS and SAInt
  - Currently: **fuel offtake of gas power plants** csv file exchange
  - In the future: DLL using OpenPlexos
Test System

Electricity Network:
IEEE 118-node test system
(CA generation mix)

Natural Gas Network:
GNET90 gas network

Interconnection:
25 natural gas fired power plants
Electricity System Scenarios

Wind & Solar Penetration Scenarios:

- 20%
- 30%
- 40%

Battery Storage Scenarios:

- 2.2% of peak load (4 hours) – similar to CA storage mandate
- 4.4% of peak load (4 hours)
No Coordination

Electricity (PLEXOS)

DA

RT

Natural Gas (SAlnt)

DA

RT

Hourly RT Natural Gas Fired Power Plants’ Fuel Offtakes

Potential Fuel Offtake Constraints/Challenges
DA Awareness

Electricity (PLEXOS)

DA

RT

Natural Gas (SAInt)

DA

RT

Potential Fuel Offtake Constraints/Challenges

Hourly DA Natural Gas Fired Power Plants’ Fuel Offtakes

Hourly RT Natural Gas Fired Power Plants’ Fuel Offtakes
DA Coordination

Electricity (PLEXOS)

DA

RT

Natural Gas (SAInt)

DA

RT

Hourly DA Natural Gas Fired Power Plants’ Fuel Offtakes

RT Fuel Offtake Constraints based on DA forecasted gas network conditions

Hourly RT Natural Gas Fired Power Plants’ Fuel Offtakes

Potential Fuel Offtake Constraints/Challenges
Electricity & Gas Coordination Scenarios (4)

DA Coordination

Electricity (PLEXOS)

DA

RT

Natural Gas (SAInt)

DA

RT

Hourly DA Natural Gas Fired Power Plants’ Fuel Offtakes

RT Fuel Offtake Constraints based on DA forecasted gas network conditions

Hourly RT Natural Gas Fired Power Plants’ Fuel Offtakes

RT Fuel Offtake Constraints based on RT gas network conditions

Potential Fuel Offtake Constraints/Challenges
Thank you very much! Any Questions?

Next: **SAInt Software**
Presenter: Kwabena Pambour (**cleaNRGi**)