Value of Gas Network Infrastructure Flexibility for Supporting Future Low Carbon Power Systems

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INTRODUCTION

- Electricity system balancing is expected to become more challenging in the future due to the integration of large volume of renewable energy sources [1].
- In this study, the benefits of multi-directional compressor units as the gas network infrastructure flexibility for joint operation of gas and electricity networks, in order to address electricity balancing challenges is evaluated.

INTEGRATED GAS AND ELECTRICITY NETWORKS MODEL

- Hour-by-hour dynamic capturing.
- In Sequential modelling; The electricity network operation is minimised and **then** the gas network operation is minimised.

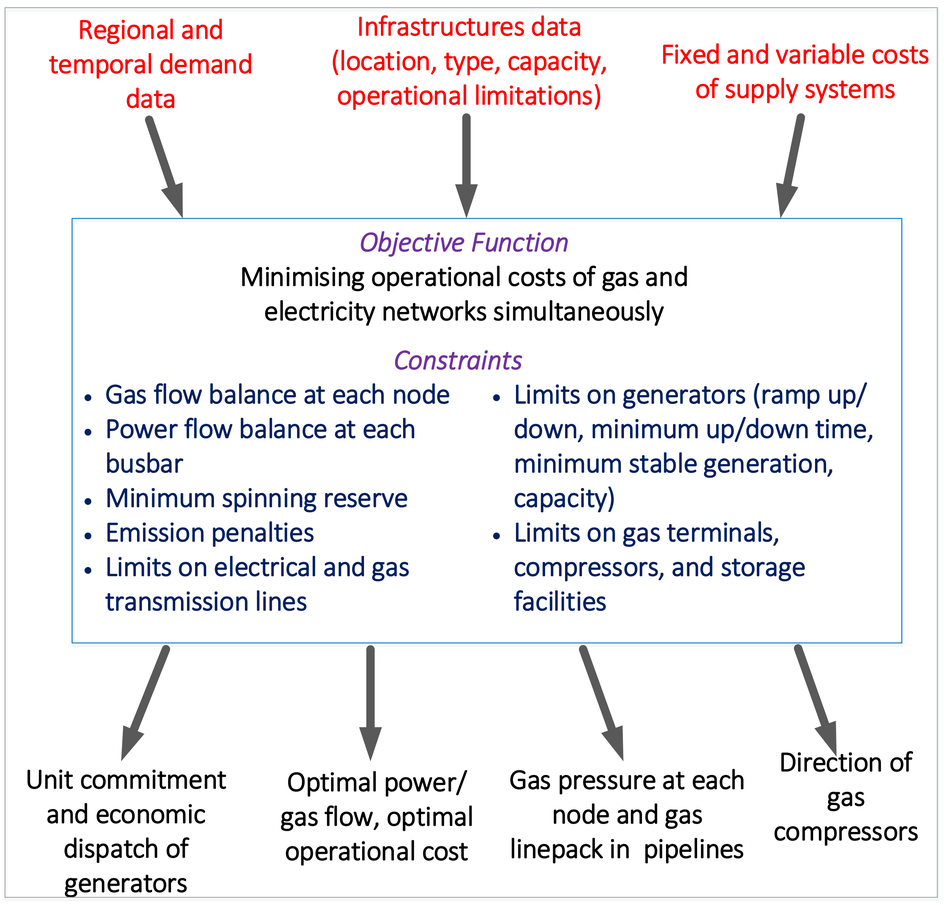

FIGURE 1. Structure of Integrated modelling based on [2]

CASE STUDIES

FIGURE 2: Great Britain gas and electricity networks in 2030.

TABLE 1: Generation capacity mix in 2030 [1]

Type	Wind	Gas	Interconnector	Nuclear	Coal with CCS	Pumped Storage	Hydro	Other
Capacity (GW)	52	33	11.5	9	4.5	2.7	1.1	1.2

RESULTS

Integrated vs Sequential Approach

In Integrated modelling
- Less gas plants generation (Figure 3).
- Cost improvement (Figure 4).

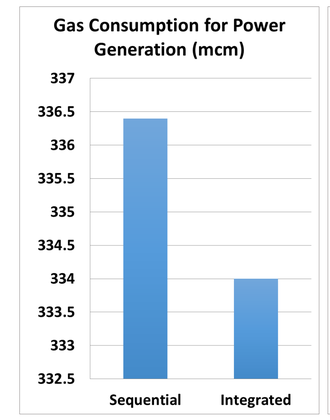

FIGURE 3

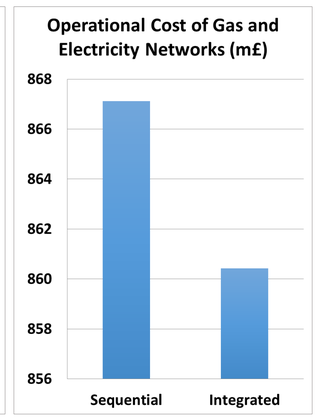

FIGURE 4

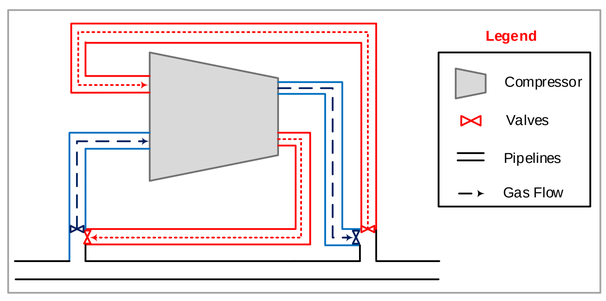

FIGURE 5: Structure of multi-directional compressor

Gas Network Flexibility

In presence of multi-directional compressors

1. Normal Operation:
   - Gas plants generation and pump storage injection ↗, power through interconnector ↘ (Figure 6)
   - Less operational cost
2. Partial Outage of Bacton Gas Terminal:
   - Gas plants generation ↗ **SO** use of Interconnectors (More expensive option) ↘.
   - Figure 7 is presented in *low wind-high demand* period.

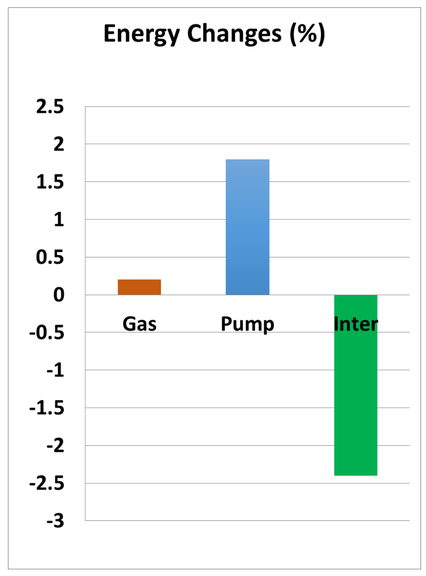

FIGURE 6

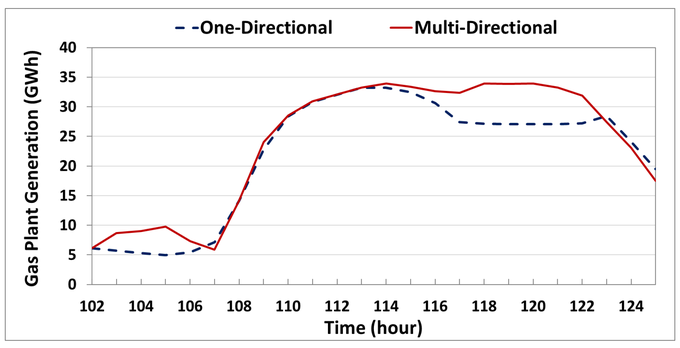

FIGURE 7

- Direction change of compressors in red colour (Figure 9).
- Less reduction of gas demand for other uses: 76.80 mcm (Table 2).
- Improvement in operational cost of the gas and electricity networks over the week: m£ 835.4 (~48%); Table 3.

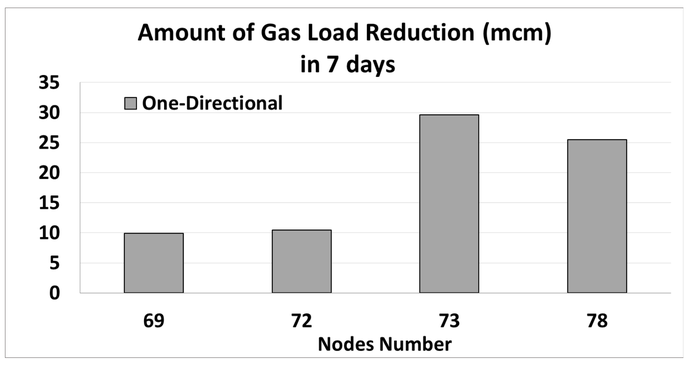

FIGURE 8: Gas load reduction in different nodes

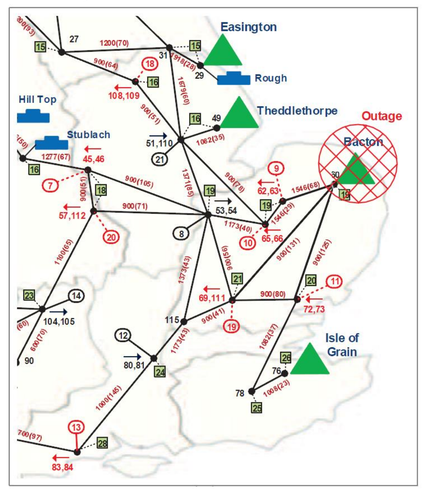

FIGURE 9

TABLE 2

Case Study	Gas Load Reduction (mcm)
One-Directional	76.80
Multi-Directional	0.00

TABLE 3

Case Study	Electrical Network (m£)	Gas Network (m£)	Total (m£)
One-Directional	96.8	1627.7	1724.5
Multi-Directional	86.7	802.4	889.1

CONCLUSIONS

- Through Integrated modelling the security of the networks is increased as all gas and electricity constraints are considered simultaneously.
- Installation of multi-directional compressor units in the gas network contributes to cope with the system-wide unbalanced situation of supply and demand.
- Using these units, reduce the total operational cost of the networks compared to one-directional compressors, due to the additional flexibility that is given to the network to deliver gas to the demand centres.

REFERENCES

1.National Grid, Future energy scenarios, 2014, Online at: http://www2.nationalgrid.com/UK/Industry-information/Future-of-Energy/FES/Documents-archive/

2.Chaudry, M., Jenkins, N., Strbac, G., 2008. Multi-time period combined gas and electricity network optimisation. Power Systems Research 78, 1265–1279.

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