# Evaluation Framework of the Operation of Integrated Energy Networks

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## 1. Overview

- A framework for evaluating the operation and the performance of the integrated energy networks to inform the decision makers.
- The evaluation will be **through the lens of energy trilemma**: Flexibility of operation, Security of supply, Affordability

## 2. Methodological framework for energy systems evaluation

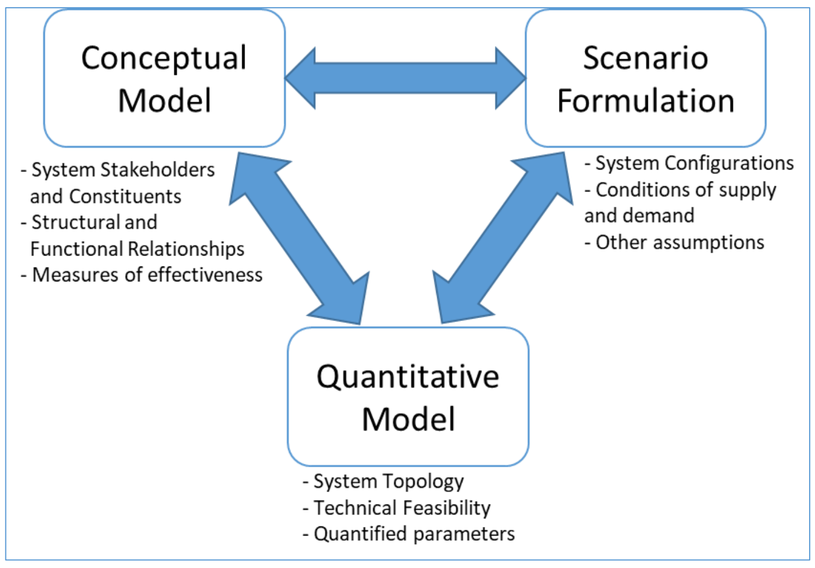


Figure 1: Evaluation framework implementation [1]

- **Scenario formulation** describes the energy system bearing in mind the scope and objective of the evaluation, the system configurations, other assumptions to the conditions surrounding the system such as for policies, markets, demographics and behavioural changes.
- **Conceptual system** model portrays the energy system through its stakeholders and subsystems, the structural and functional relationships within and across its subsystems, and the measures of effectiveness for evaluation.
- **Quantitative model** combines inputs from the two stages with the given system topology and physical constraints in mathematical terms, to identify the technical feasibility and provide quantified output parameters. The output parameters from the quantitative model are those needed to calculate the indicators as assigned in the conceptual model

## 3. Architecture of quantitative analysis model of integrated energy systems

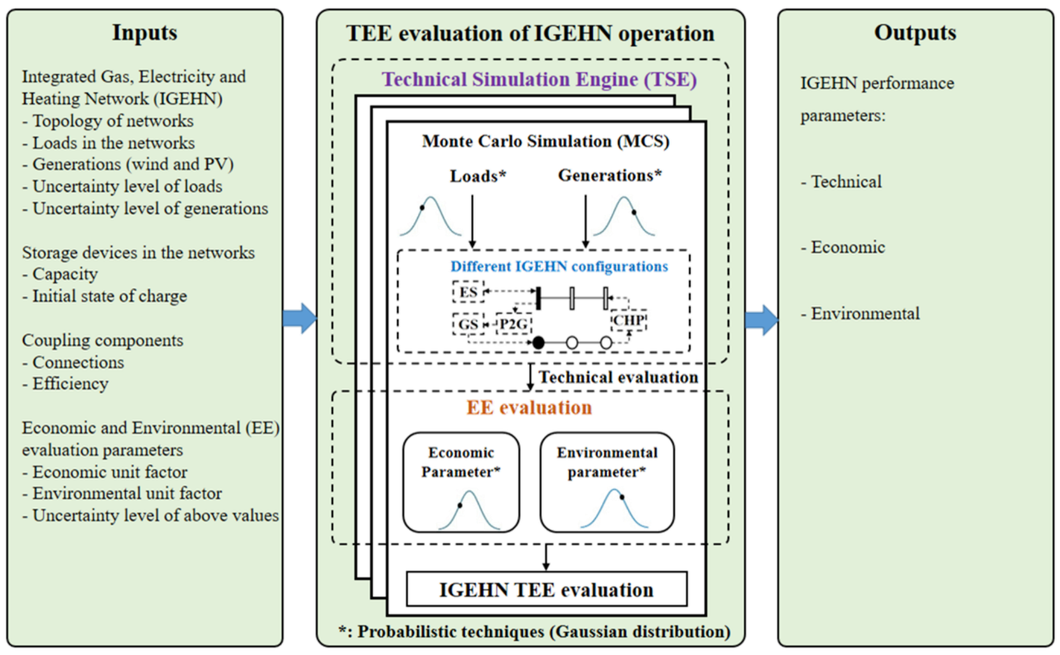


Figure 2: Architecture of the quantitative evaluation model for IENs [2]

## 4. Case Study: North of Tyne Region

- The region covers the local authority areas of Newcastle upon Tyne, North Tyneside, and Northumberland in the North East of England, UK. The region covers an area adding up to around 5277 $km^2$ and has an estimated population of 833,000 with more than 360,000 households.
- Energy figures highlights the need to decarbonise heating in the region, which makes up the majority of gas.
- Heating decarbonisation could benefit from the potential for renewable energy resources (RES) expansion in the region as well as for district heating. This raises the prospects of energy system integration as a pathway to achieve net-zero carbon emissions targets through coupling the multiple vectors of electricity, gas and heat.

## 5. Main findings of the case study

- Energy systems integration provides a direction towards achieving the energy transition objectives.
- Vector-coupling technologies, particularly Power-to-Gas, is an effective measure to enable more RES into the system while providing means for a viable network management
- Getting more RES reduces the operational

## 6. References

[1] Berjawi, A.E.H., Allahham, A., Walker, S.L., Patsios, C. and Hosseini, S.H.R., 2022. Whole Energy Systems Evaluation: A Methodological Framework and Case Study. In *Whole Energy Systems* (pp. 41-82). Springer, Cham.

[2] Hosseini, S.H.R., Allahham, A., Walker, S.L. and Taylor, P., 2021. Uncertainty analysis of the impact of increasing levels of gas and electricity network integration and storage on Techno-Economic-Environmental performance. Energy, 222, p.119968.