

Strategic Energy Infrastructure Investments Under Uncertainty: Coordinated Planning for Australia's Electricity & Gas Systems

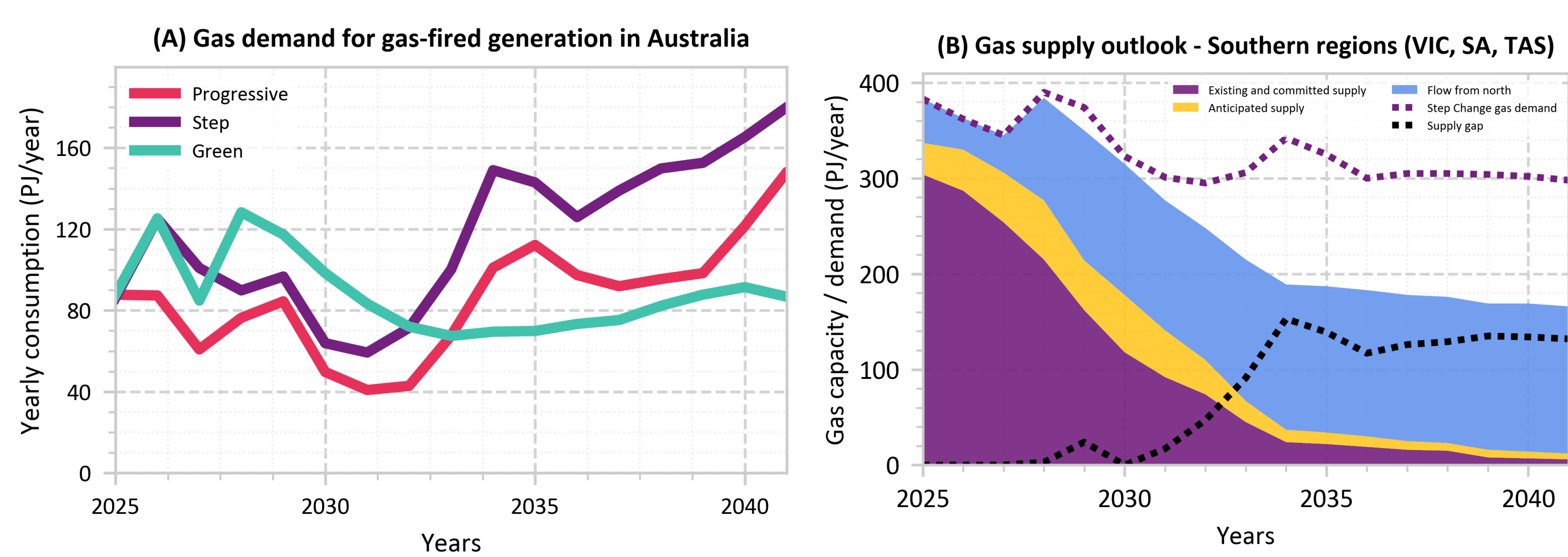
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I. Australia's electricity & gas landscape

- Australia's transition to a net-zero economy will likely require **gas-fired generation (GFG)** to back up renewables, especially in winter through late-2030s¹ (Fig. A²).
- Southeast Australia experiences depleting gas fields, posing **supply risks** for both gas and electricity systems (Fig. B²).
- Potentially **early coal plant retirements** and **delays in the deployment of new energy infrastructure** can drive higher gas demand, exacerbating uncertainty and thus supply adequacy risks.



II. Research motivation and objectives

What is the **least risky investment strategy** for expanding gas and electricity **supply infrastructure** under uncertainty?



Develop a high-resolution investment-operation model to **identify the optimal expansion pathway** for integrated electricity and gas systems (IEGS) under uncertainty



Apply a suitable algorithmic strategy to **handle the computational complexity** of investment planning for large-scale integrated systems



Provide actionable insights about the optimal planning strategy to **minimise investment risks** while **ensuring a reliable IEGS operation**

III. Modelling framework



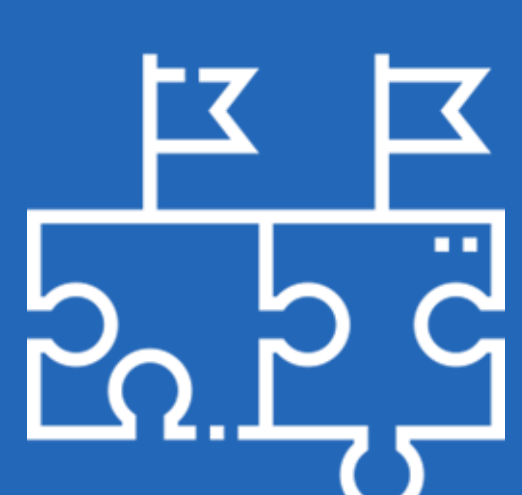
$$\min \mathbb{E} \left(\text{Total scenario cost} \right)$$

Multi-stage stochastic investment model
Ensures investment feasibility across all scenarios



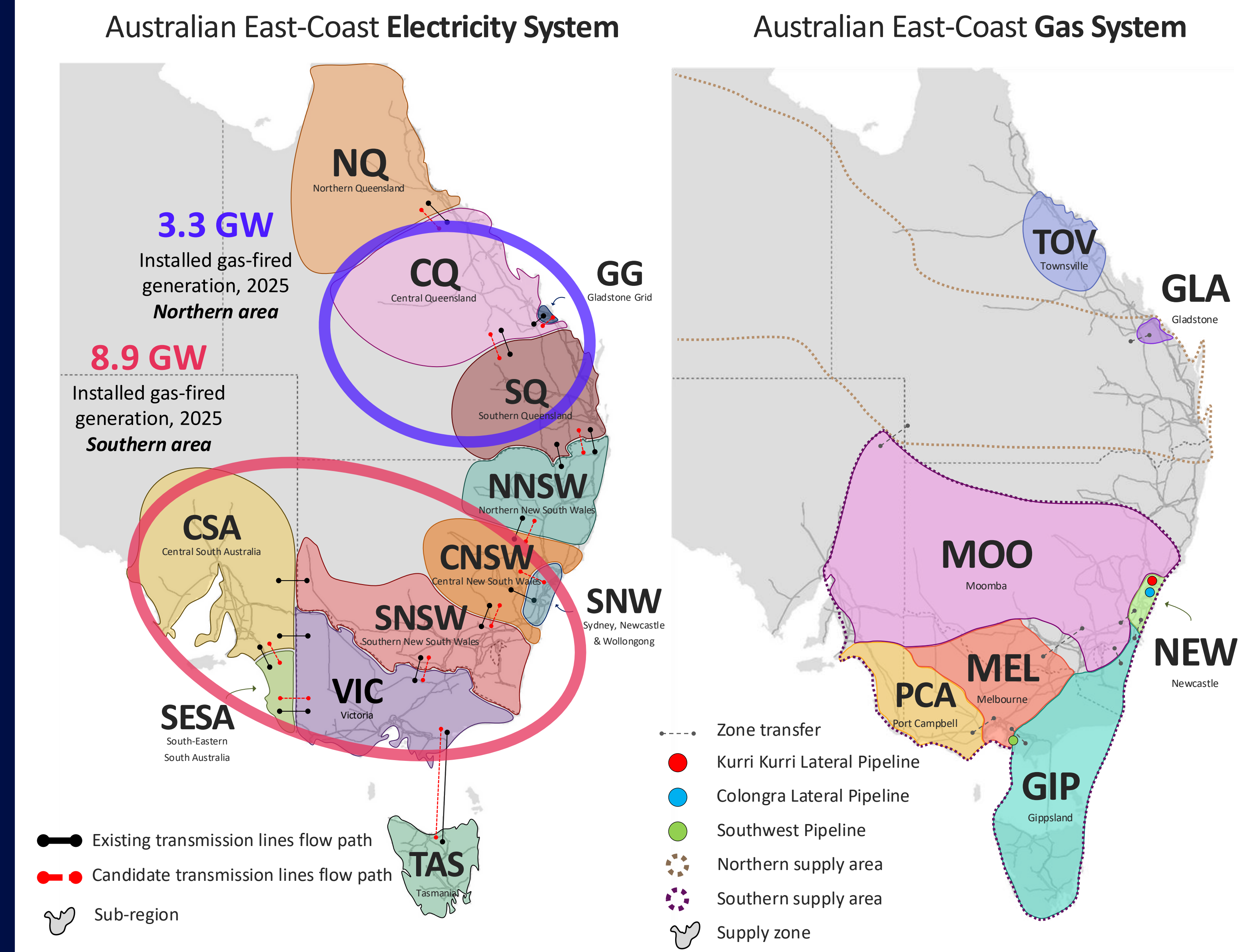
System constraints
Electricity
Gas

Integrated expansion-operation model
Accounts for investments, reliability and running costs

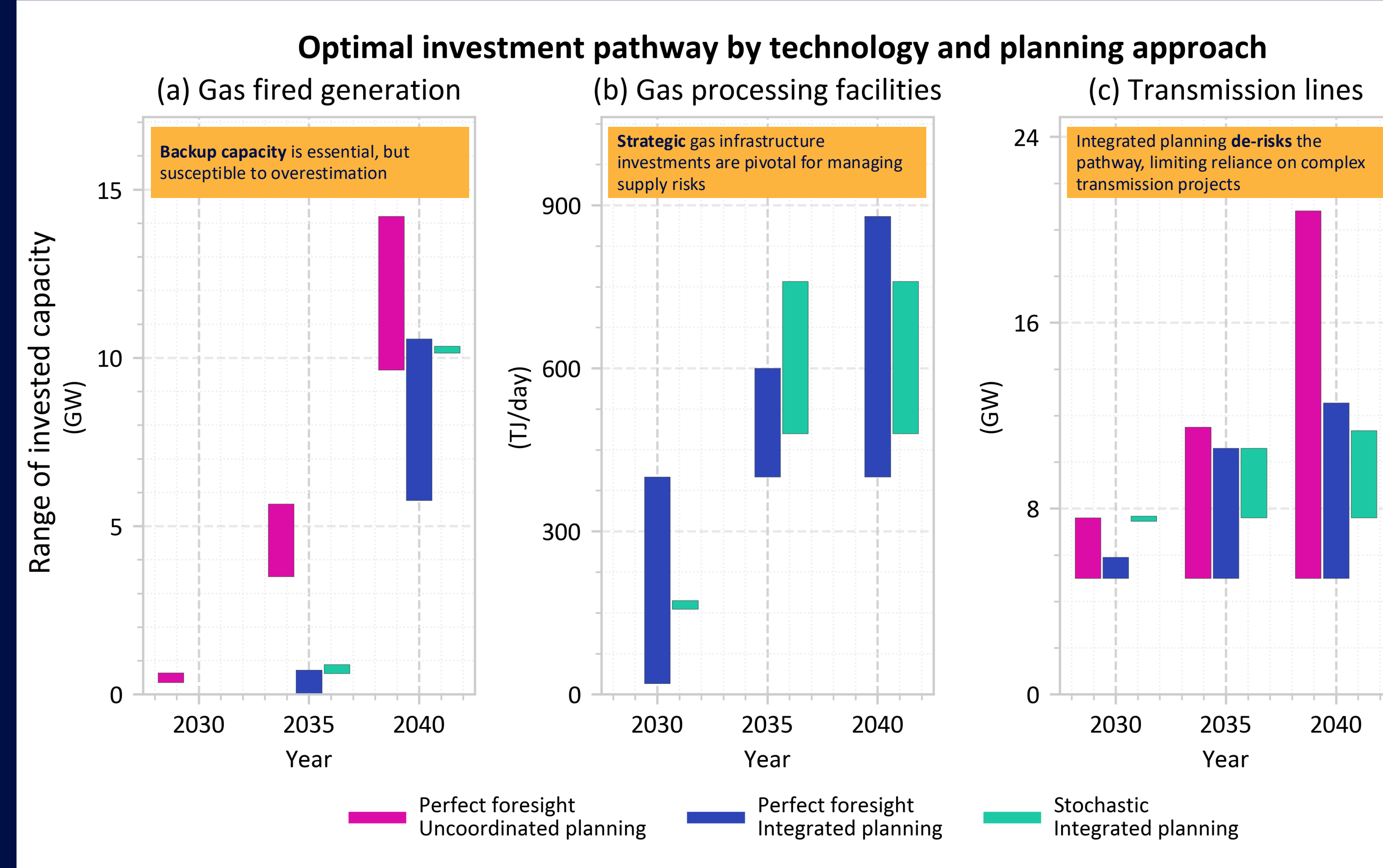


Scalable solution strategy via Column Generation
Breaks-down the problem, guaranteeing tractability

IV. Case study setup: Australian Energy System



V. Identifying an optimal investment pathway



VI. Key remarks

- Australia will need significant **anticipatory investments** in gas processing facilities to **ensure adequacy of supply** across IEGS
- Fuel supply infrastructure must be in place **before** deploying new electricity generation
- Non coordinated electricity-gas system planning** poses critical risks of **overinvestment** and **stranded assets** in the electricity system
- The proposed framework for IEGS planning captures the correlated uncertainties of electricity and gas, **providing a less risky plan**, granting a clear investment pathway for decision makers

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NSF EPICS Centre International Workshop, Newcastle, Australia

References

¹ Australian Energy Market Operator, 2026 Draft Integrated System Plan (ISP)

² Australian Energy Market Operator, 2025 Gas Statement of Opportunities (GSOO)