

Thermal Generation Futures of Isolated Island Systems



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Scope of Study

Unpredictability of thermal generation futures in the face of renewables deployment and smart grid developments

Context

Initial system dynamics modelling of a system without renewables and smart grids - A fossil fuel model

Case study of an isolated island electricity system emphasizing the long-term thermal capacity expansion outlooks of the system

Relevant Impacts

- Guide the thermal investment discussions and decisions for isolated energy system.
- Address the long-term thermal capacity additions to the system and the extent to which financial constraints and electricity demand rates influences these additions to the system.
- Capturing unintuitive and surprising opportunities within such system

Causal Loop Diagrams

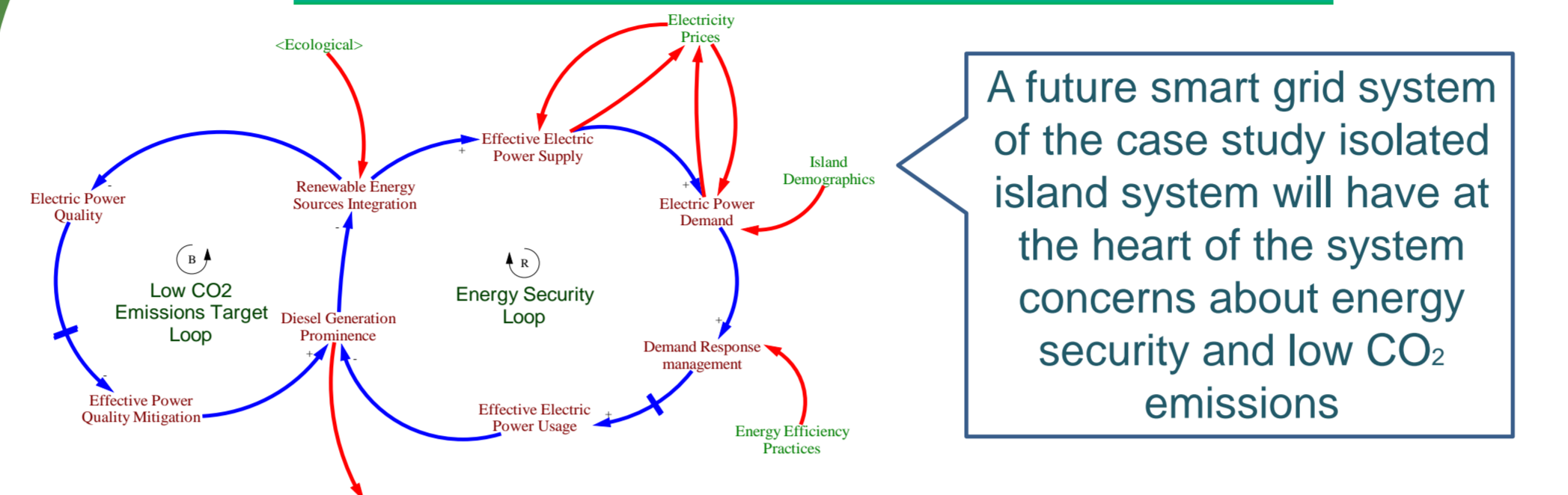


Figure 1. Mental model of smart grid island system

Without renewables thermal generation capacity will be dictated by the cost of generation and the demand for electricity: No demand supply pricing exists

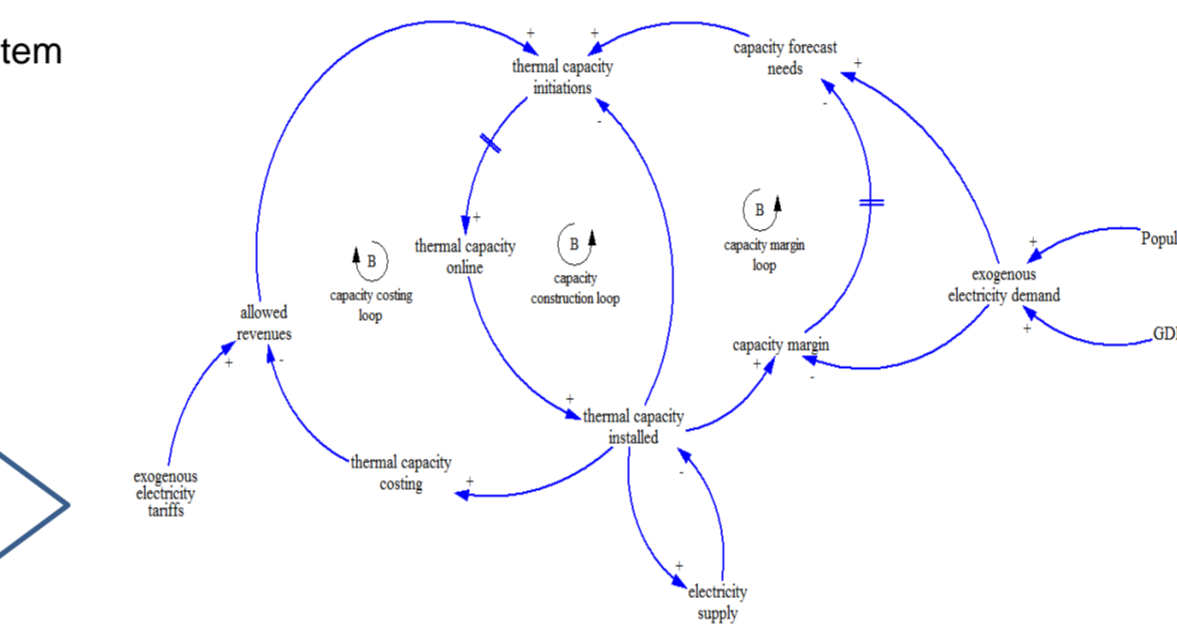


Figure 2. Dynamic hypothesis feedback loop of isolated island system

Stocks and Flows Diagrams

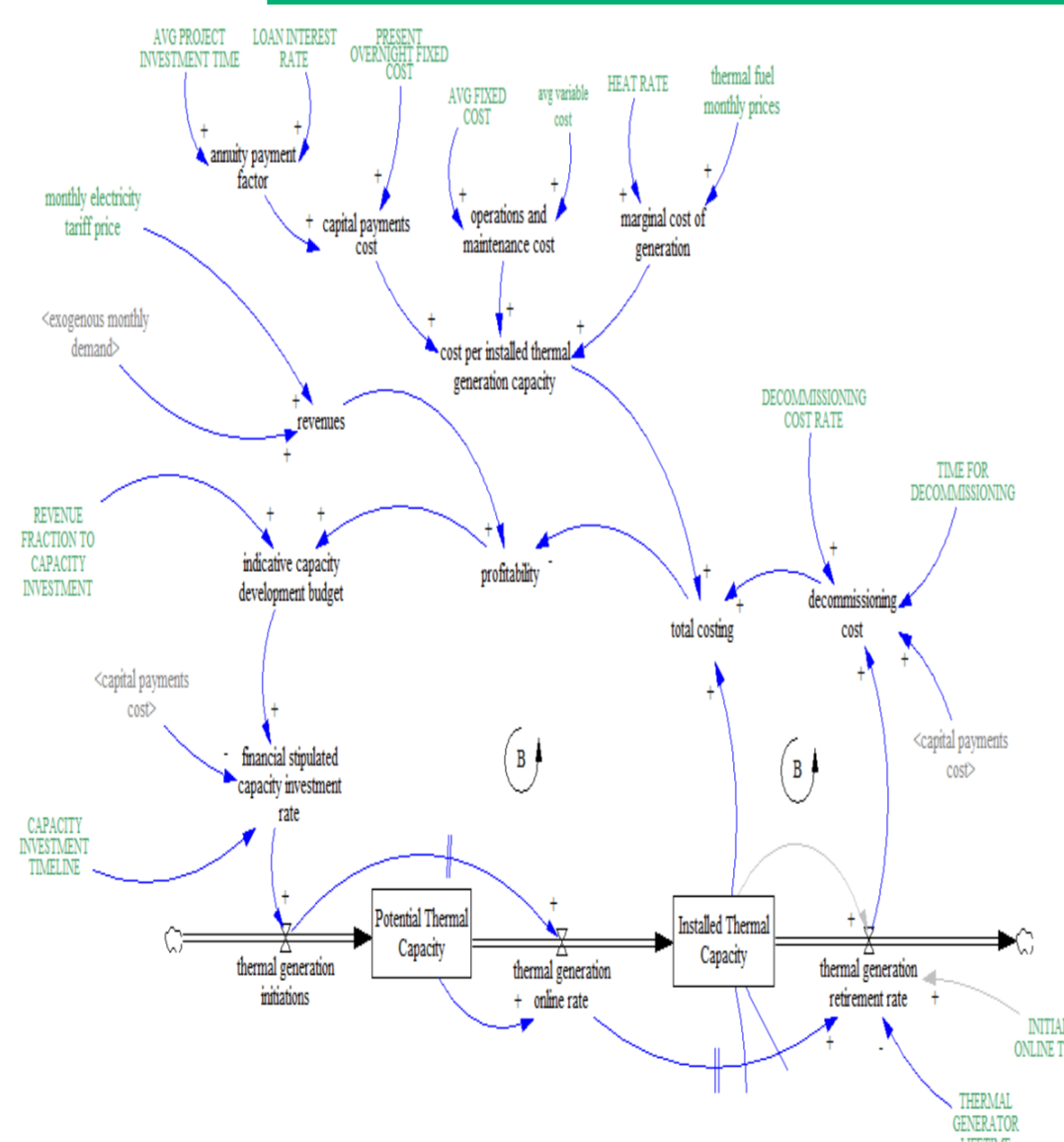


Figure 3. Formal diagram of financial aspects within the isolated island electricity system

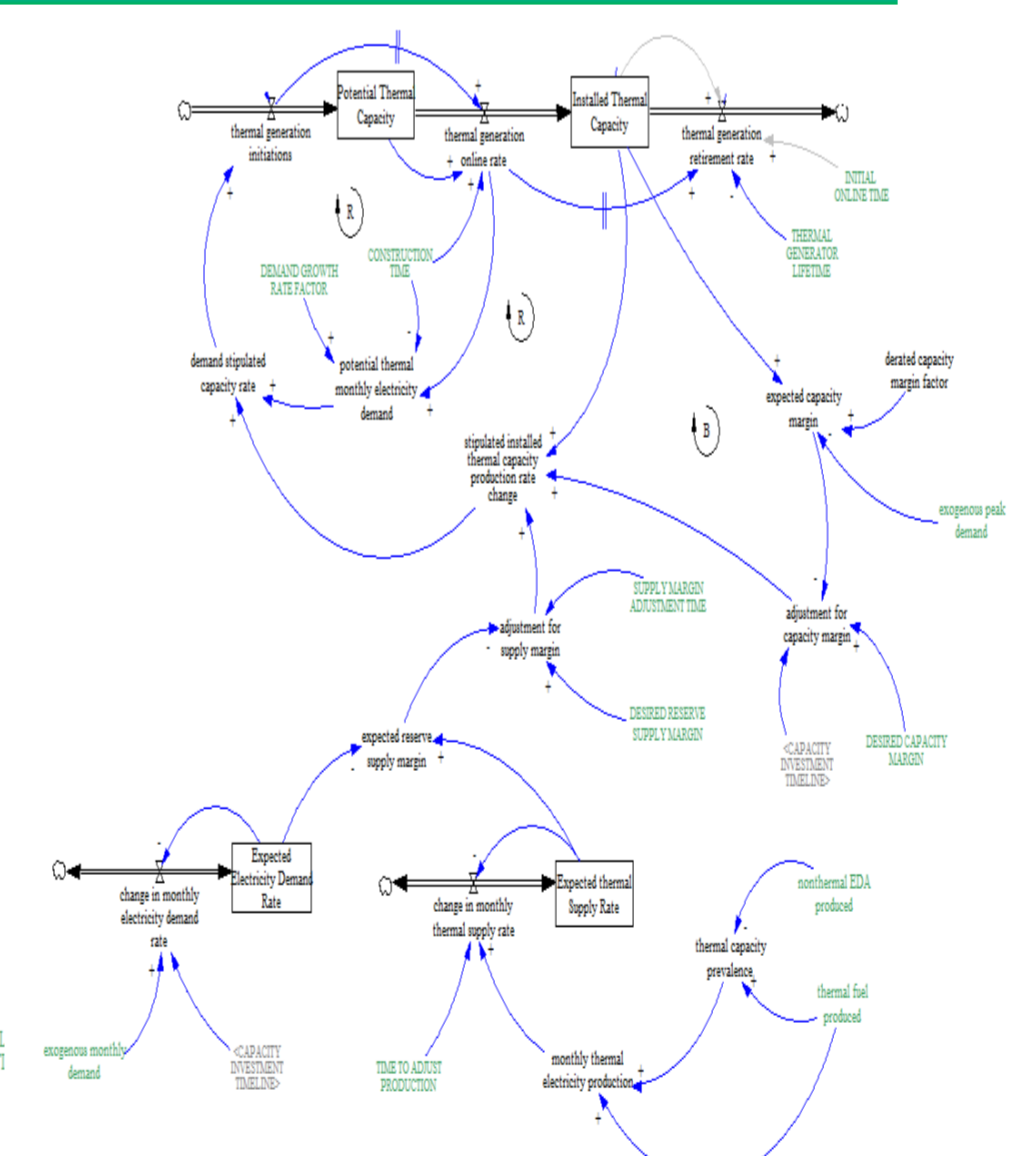


Figure 4. Formal diagram of capacity margin aspects within the isolated island electricity system

45 years model with a monthly time-step from 2005 to 2049

Initial Findings

Base scenario assumes the island with "business as usual" electricity demand rate of 3% per annum
Above average scenario assumes a greater than 3% per annum (variable) electricity demand rate
Below average scenario assumes a lower than 3% per annum (variable) electricity demand rate

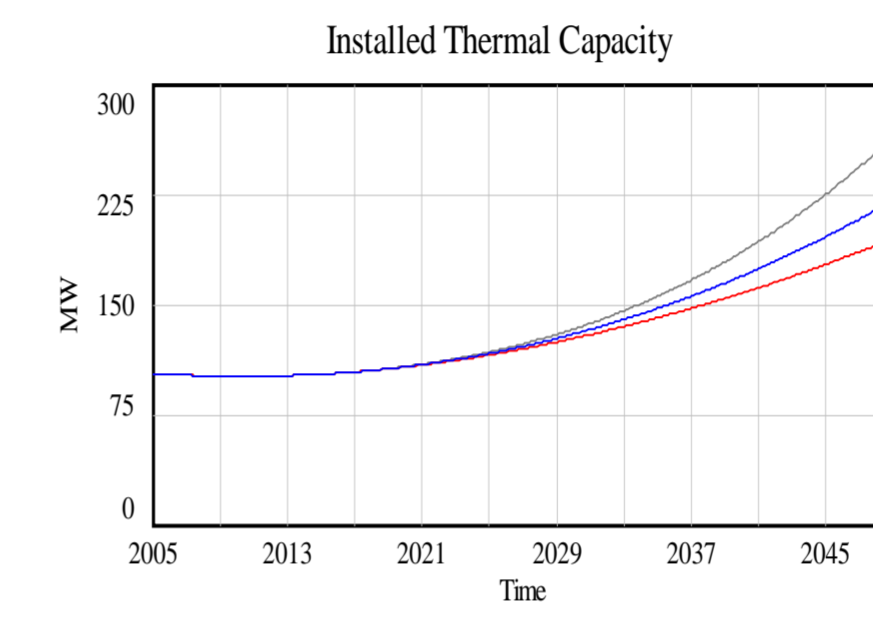


Figure 5. Thermal capacity installed for the three scenarios

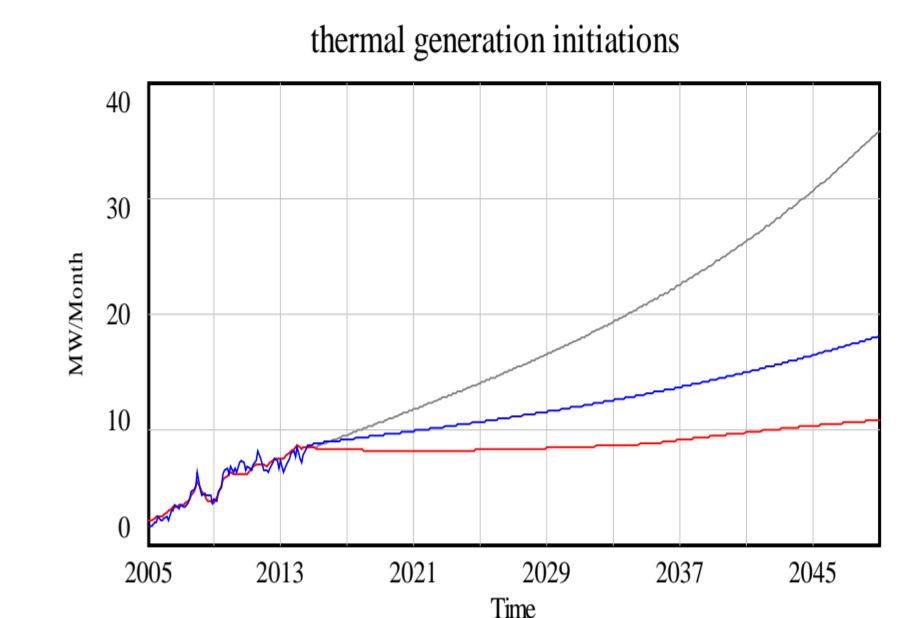


Figure 6. Thermal capacity initiations for the three scenarios

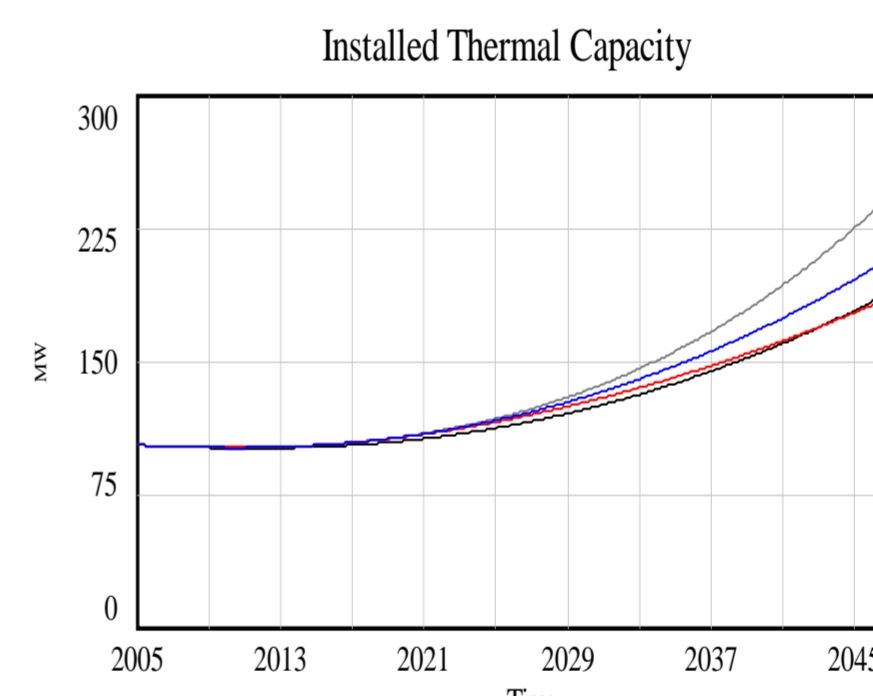


Figure 7. Thermal capacity installed for all scenarios to include capacity margin time adjustment of base scenario

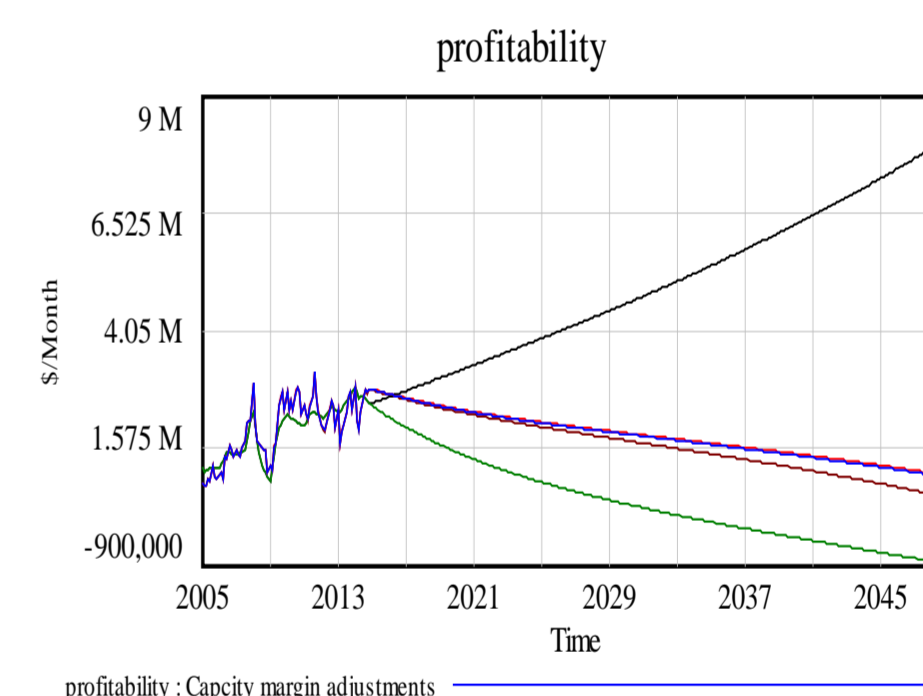


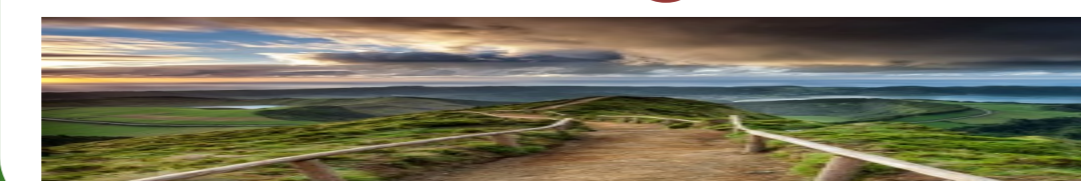
Figure 8. Profitability of installed capacity for all scenarios, includes capacity margin time adjustment of base scenario

- Exogenous prices are very influential
- Capacity margins does not pay a key role within the island
- The delay to perceive the capacity margin is critical for the installed capacity

Next Steps

- Further sensitivity testing of the model
- Renewables and energy efficiency sub-models

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