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Electricity grid stability: How to split the cost equitably

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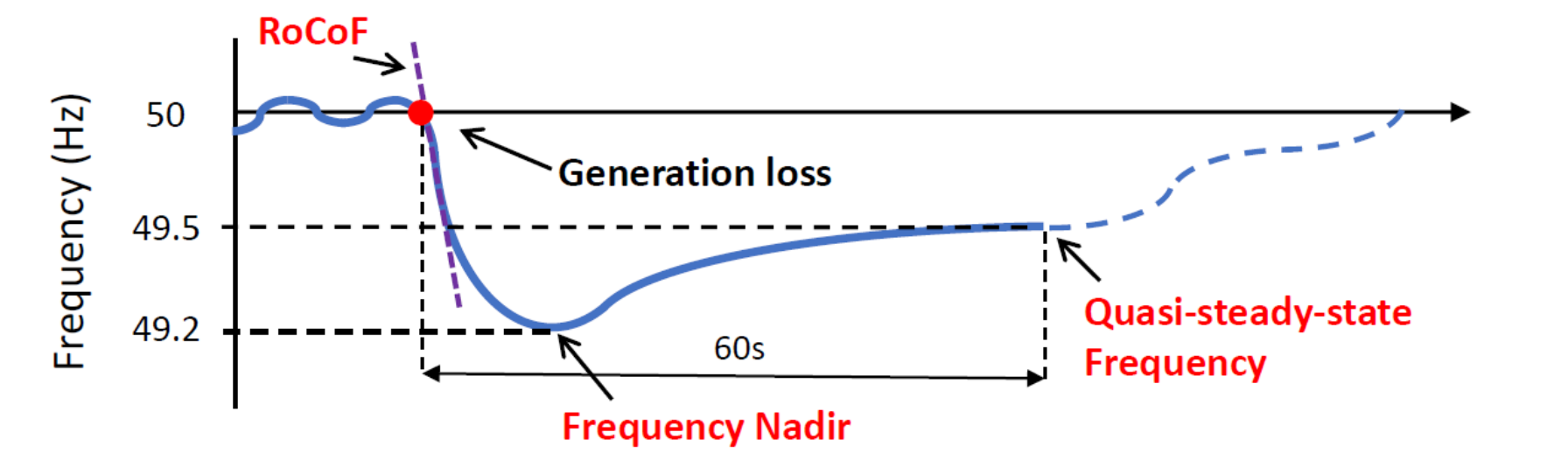
Introduction: frequency stability

- Frequency reserves and inertia are **'insurance' to prevent blackouts**



Key to keep frequency within
safe bounds to avoid load shedding!

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Why worry about who pays for frequency services?

- Currently **costs are socialized** in most countries (except Australia)
- Until recently, irrelevant who paid (**costs were small** due to high inertia)

Goal of moving towards a **'causer pays' framework**:

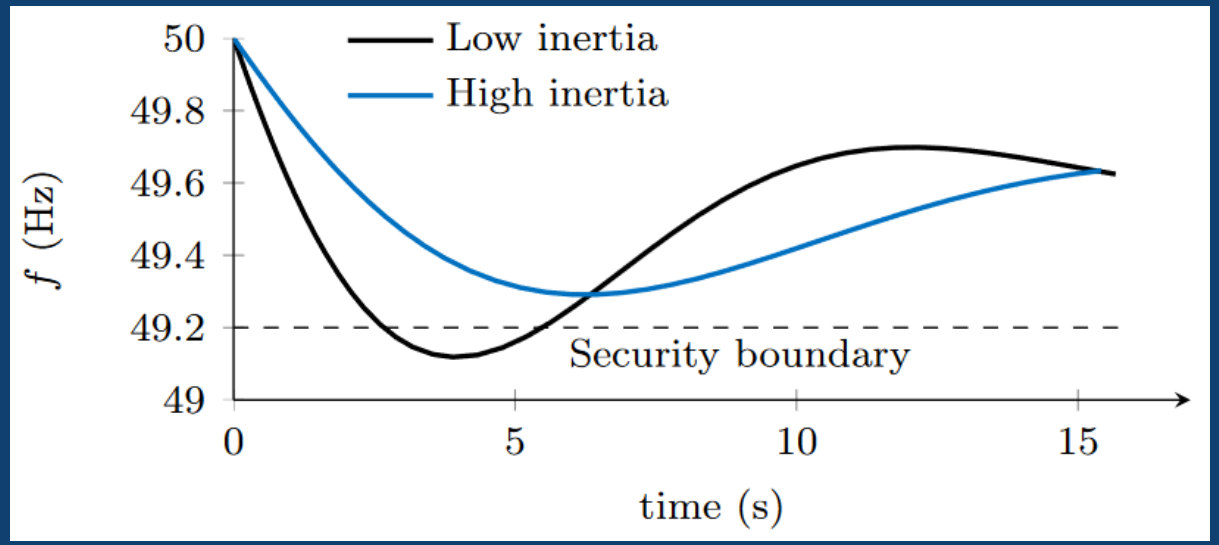
To create **incentives to 'do less harm'** to the grid

(in order to **reduce the cost of frequency services** for consumers)

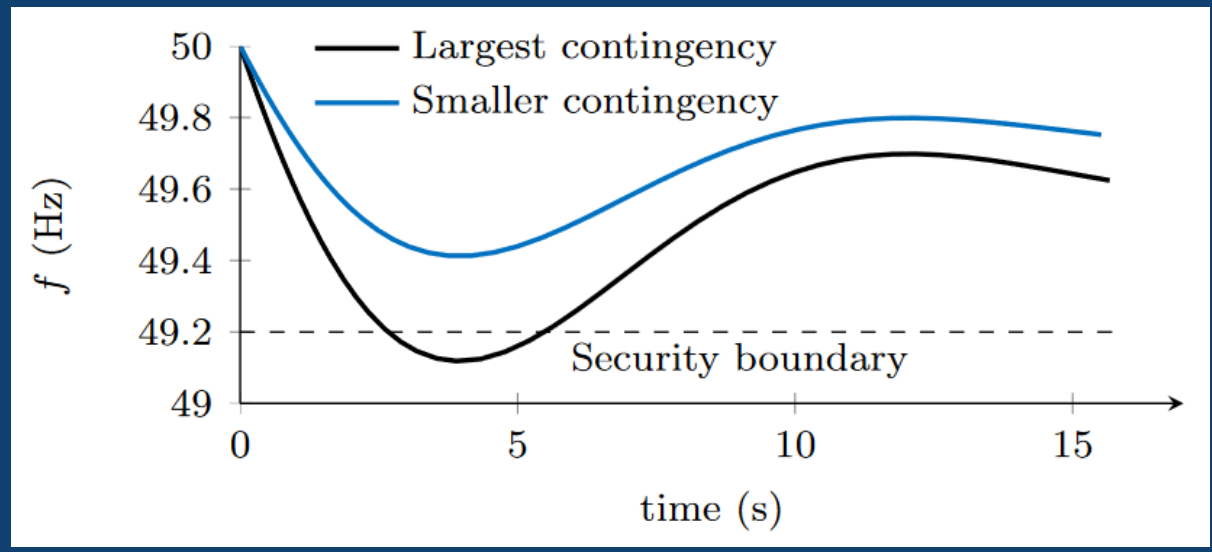
Who causes the need for frequency services?

- **Large units** do: a low-inertia system would do fine if all units were small (there would be no large, sudden power imbalances)

Large contingency – Impact of inertia



Low inertia – Impact of contingency



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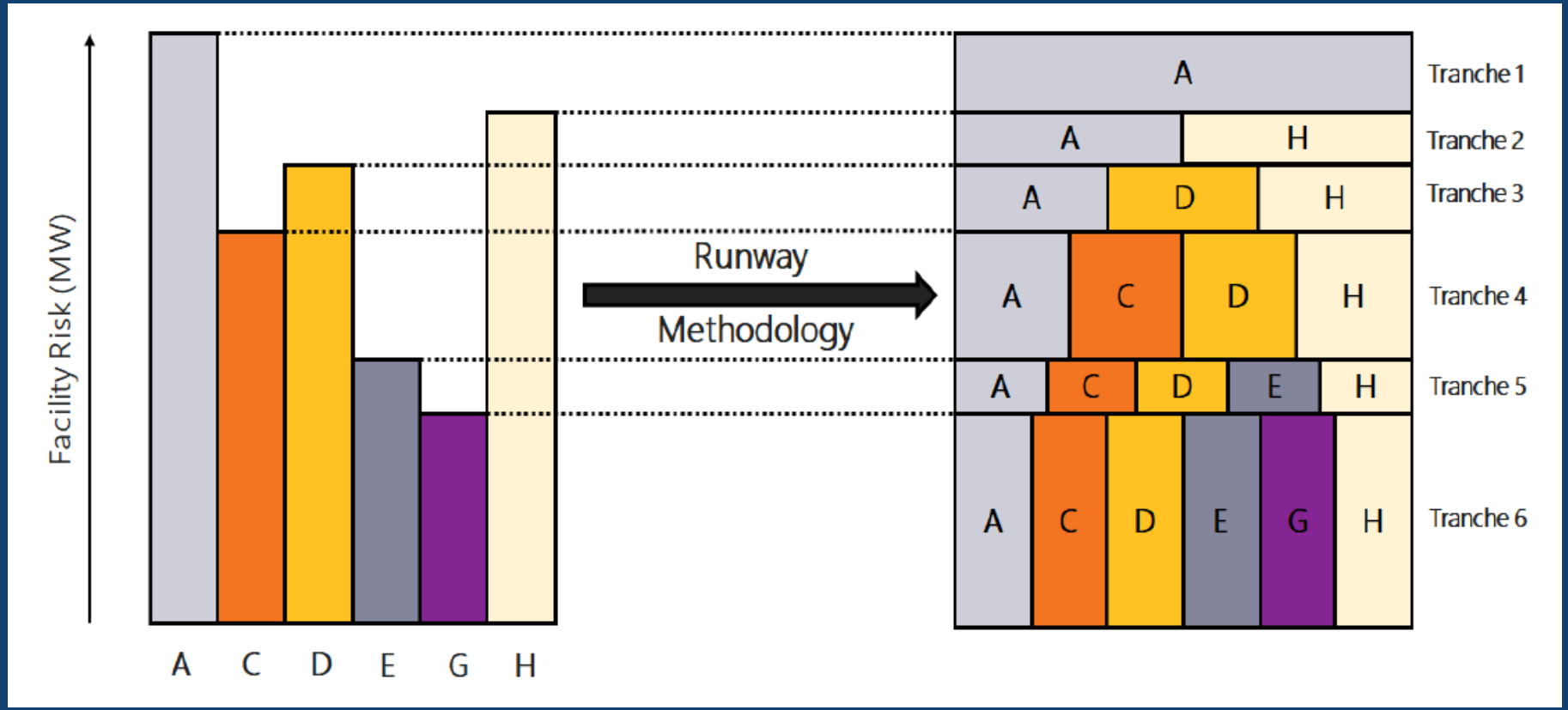
How to split the cost of frequency services?

- Option 1: **proportional cost allocation**
  - ✓ Easy to design: **each unit pays in proportion to its size**
  - ✓ Creates **incentive** for large units **to 'do less harm'**
  - **Problem**: it **maintains cross-subisidies**
    (small units still subsidize large ones)

- Option 2: **sequential cost allocation** (coming next)
  - ✓ Advantage: no cross-subsidies

Sequential cost allocation (Shapley value)

- Each unit pays for the **additional cost** that it creates



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Reference: "A report describing the Wholesale Electricity Market in the South West Interconnected System", Australian Energy Market Operator, September 2023

Benefits of the cost allocation

- To create **investment signals**
  - Large units would be responsible for their system-integration cost (*e.g.*, nuclear, offshore wind, HVDC)
  - Business case for distributed generation becomes more attractive in comparison
- To **incentivize flexibility**
  - Large units can reduce the cost they are allocated by reducing power output/demand during low inertia hours

Mitigation options for large market players

- For converter-interfaced generation (*e.g.*, offshore wind):

  To **provide** grid services such as **synthetic inertia**. Double positive effect:

  - Create a new revenue stream
  - Reduce the costs borne by these generators, as overall cost of frequency services would decrease in a grid with higher inertia

- For any generator/load:

  To **invest in** external 'grid-supporting assets', such as **synchronous condensers**. Same benefits as synthetic inertia

Some work to do

- Accurate quantification of the impact on future investments is needed, for any country considering to implement a ‘causer pays’ framework
  - ➢ Generation expansion planning models that incorporate this cost allocation mechanism should be developed

Particularly important to understand the consequences for critical technologies for decarbonization, such as offshore wind

Summary

- **Consumers currently subsidize large generators/loads** for frequency services
- A **more distributed grid would cope well** with low inertia (in terms of frequency stability)
- Making all units **internalize their system-integration costs** in terms of frequency services would bring important benefits
  - **Costs would still trickle down to consumers**, but appropriate economic signals for generation would be in place

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Thank you!

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https://badber.github.io/

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