

Who should pay for frequency-containment services?



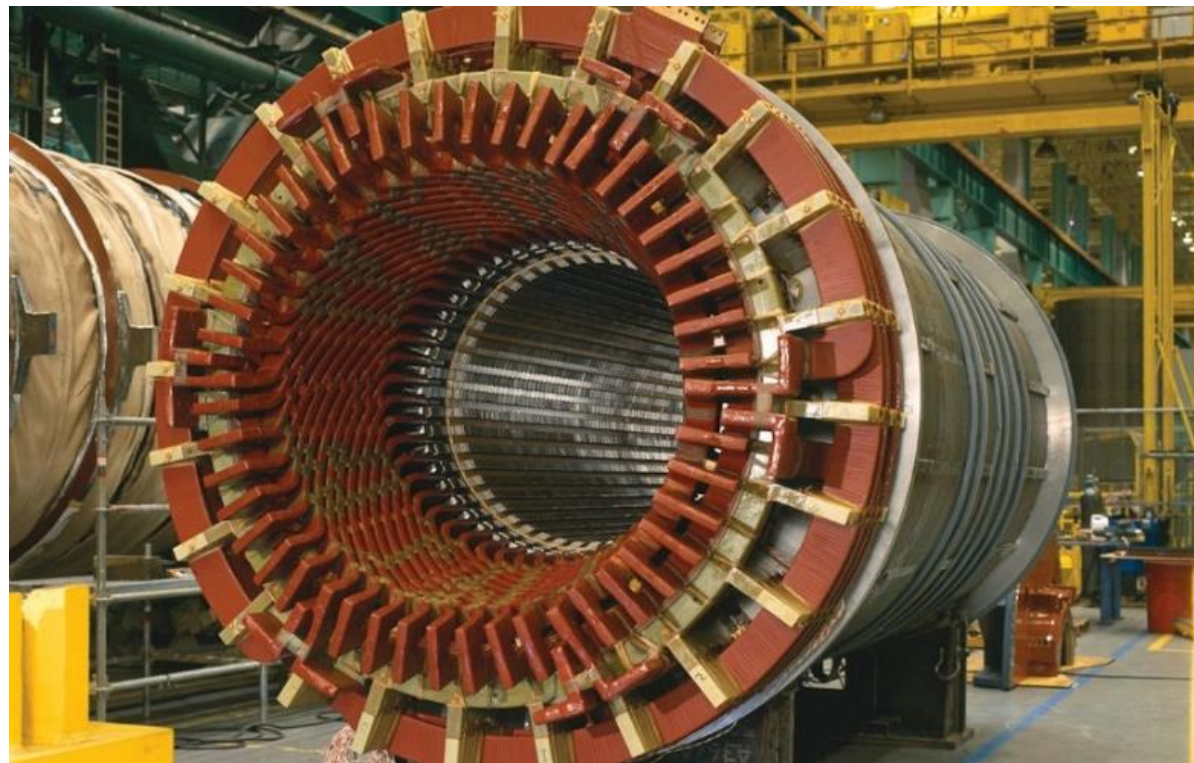
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Lower inertia on the road to lower emissions

Thermal generators
(nuclear, gas, coal...)



Inertia stores kinetic energy:

this energy gave us time to contain a sudden generation-demand imbalance

Most **renewables**:
no inertia

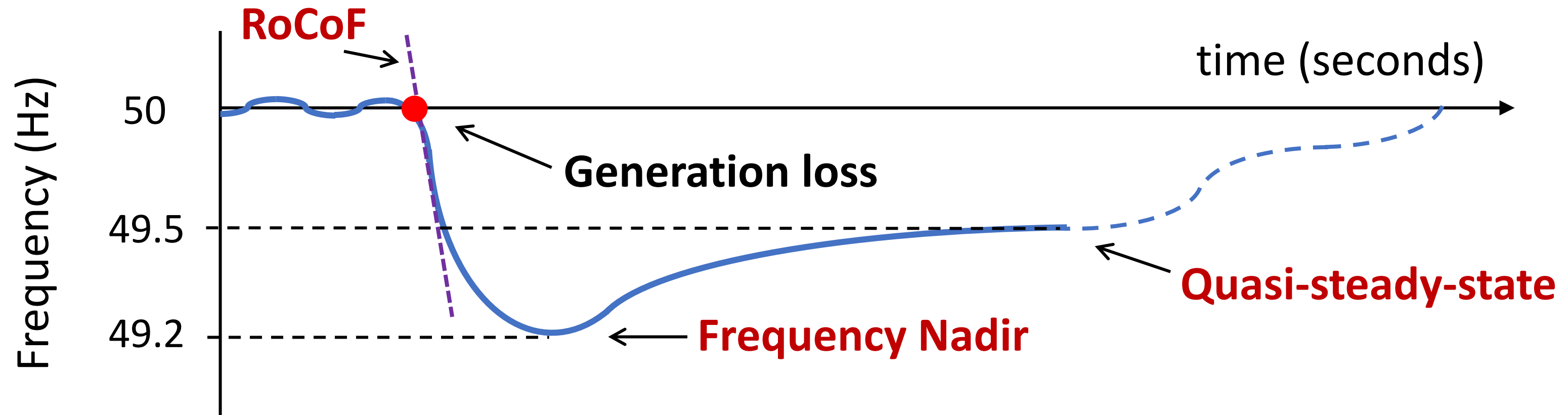


Decarbonization



The **risk of instability**
has increased!

Frequency stability



Key to keep frequency within safe limits to
avoid demand disconnection!

Cost allocation for stability services

Some **'services'** are needed to maintain grid stability, and **they have a cost**

1. Who should cover this cost?

- Generators?
- Consumers?
- Only a subset of the former?

2. How much should each market participant pay?



First, why worry about who pays?

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

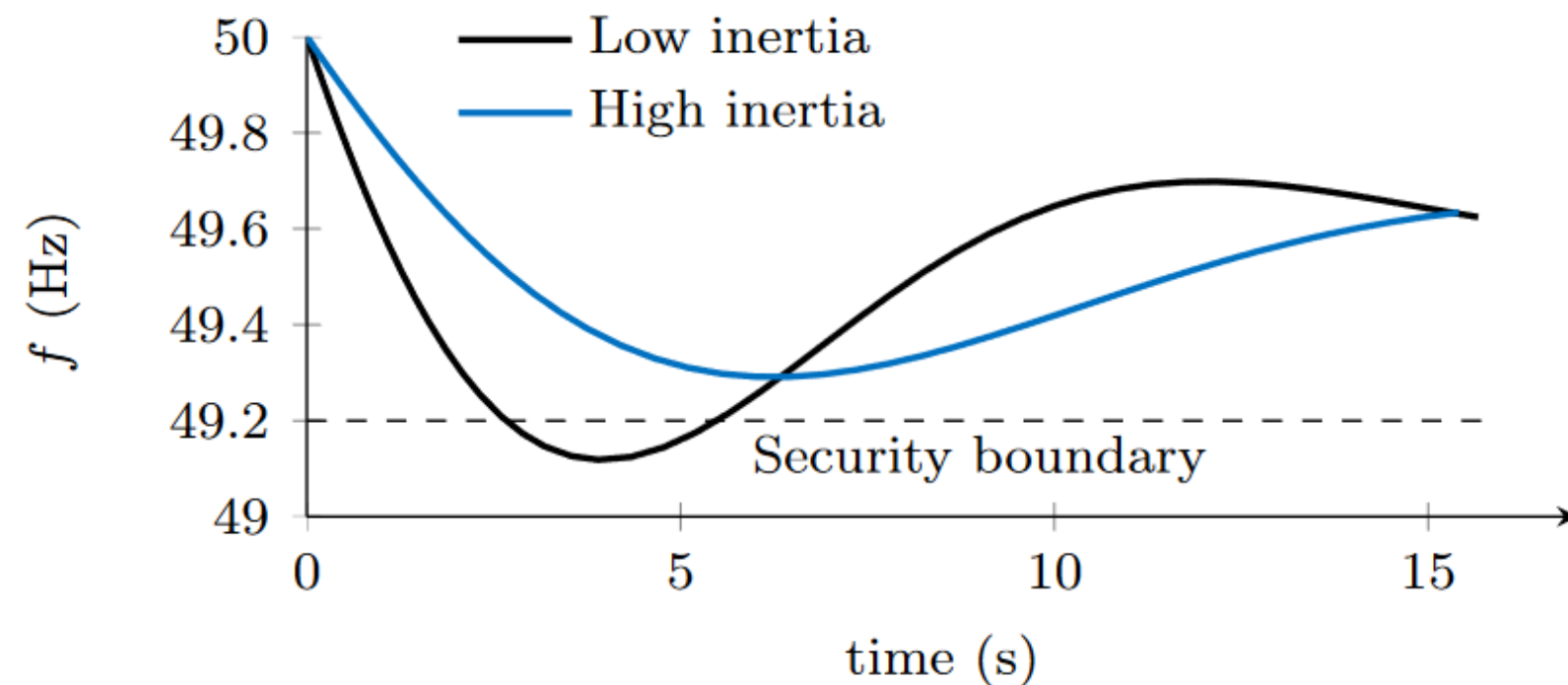
Goal of moving towards a **'causer pays' framework**:

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

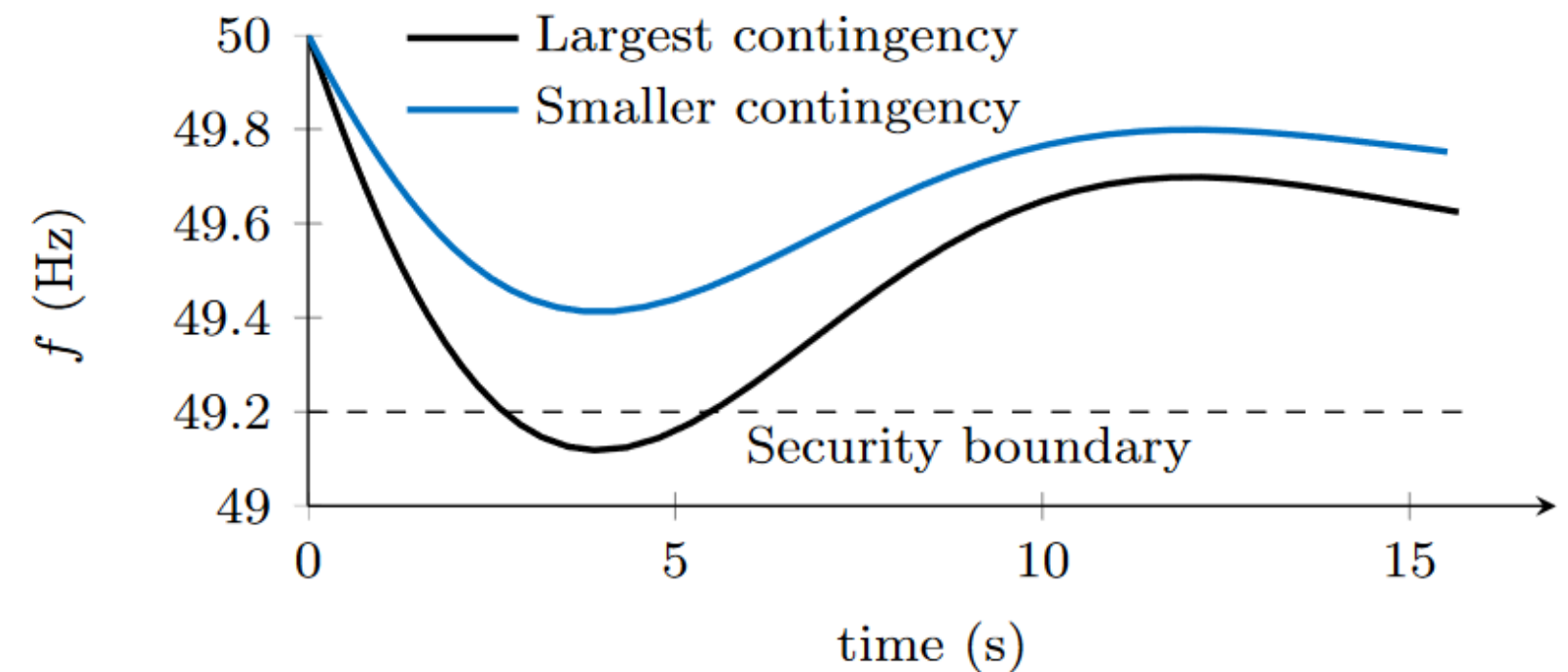
(in order to **reduce the cost** of frequency services for consumers)

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)



Impact of inertia
under a large contingency



Impact of contingency size
in a low-inertia system

Who causes the need for frequency services?

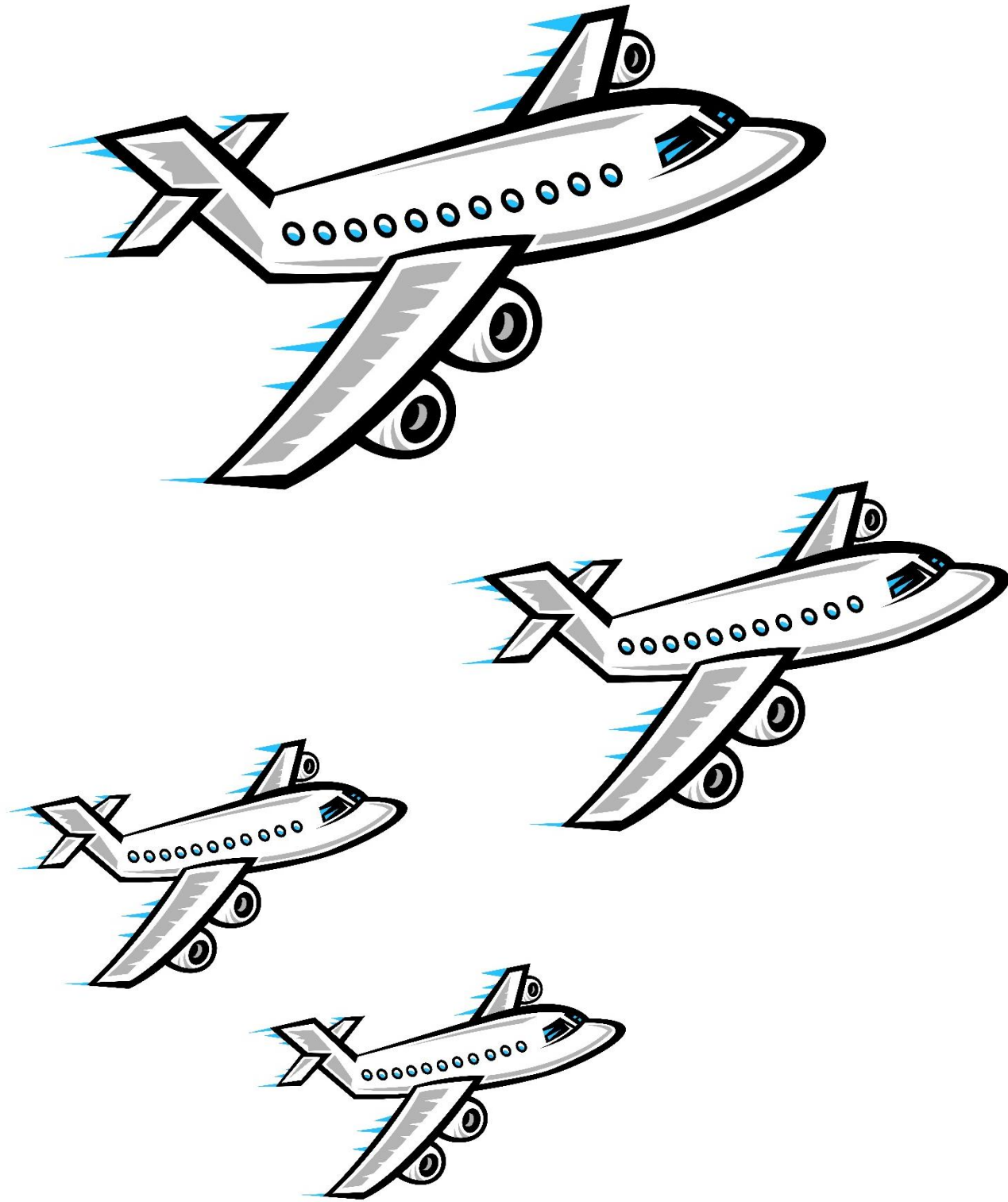
Large units do: a low-inertia system would do fine if all units were small (there would be no large, sudden power imbalances)

We rule out penalizing the **lack of inertia**

- Inertia is a service, it should be remunerated appropriately
- But lack of inertia is not a problem by itself

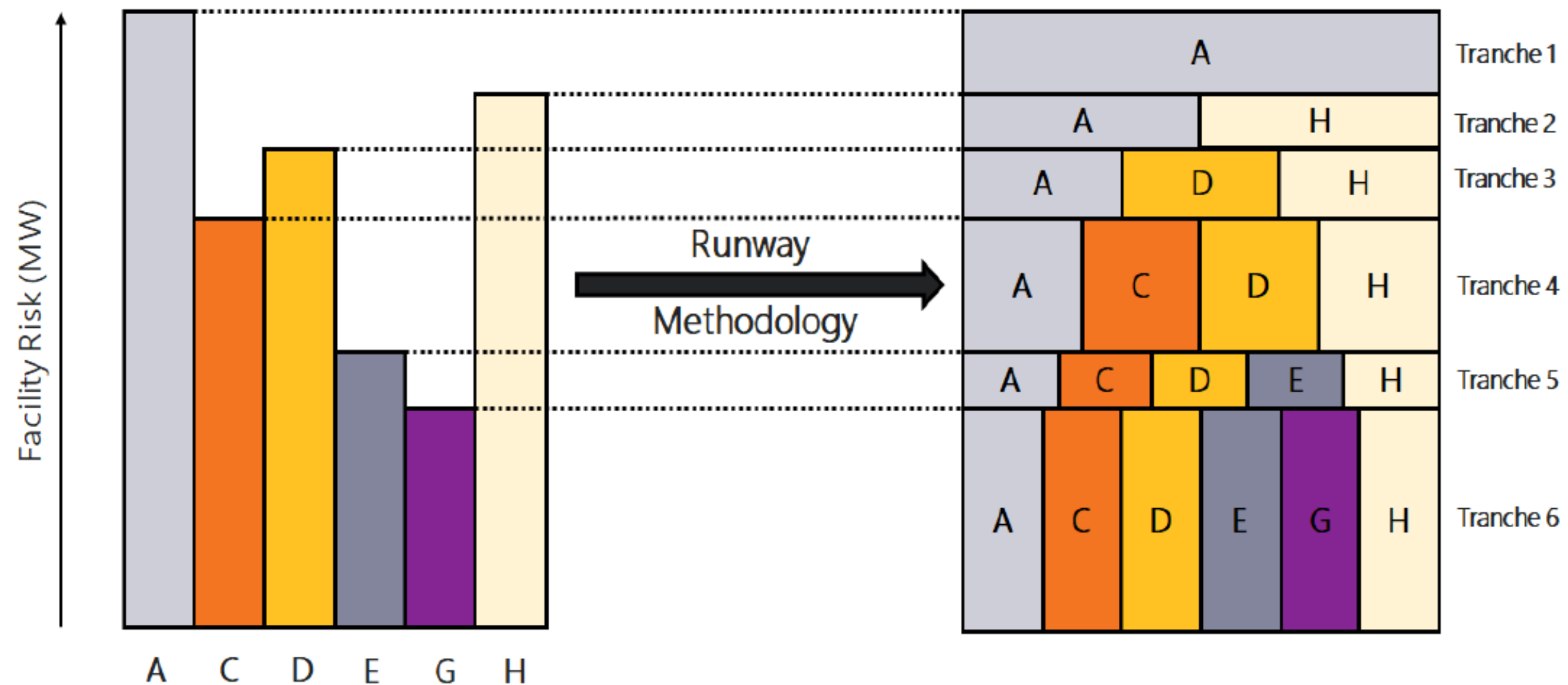
How to split the cost?

‘Airport problem’

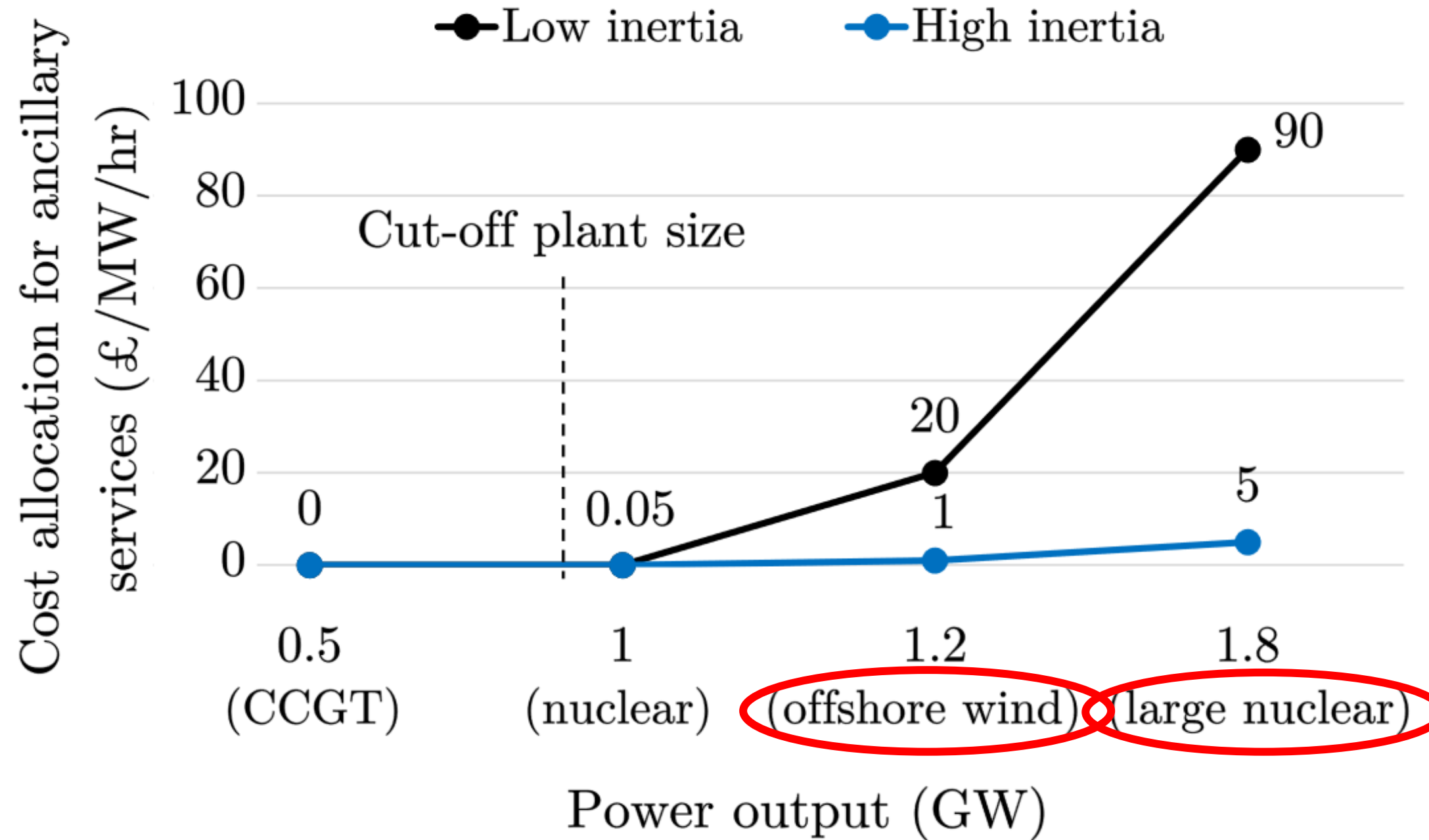


Sequential cost allocation (Shapley value)

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



Analysis for Great Britain



Benefits of the cost allocation

- To create **investment** signals

- Large units would internalize their **system-integration cost** (e.g., nuclear, offshore wind, HVDC)
- **Costs** would still **trickle down to consumers**, but appropriate economic signals for generation would be in place

- To **incentivize flexibility**

- Large units can reduce the cost they are allocated by reducing power output/demand

Thank you for your attention!