¿Quién debería pagar por la estabilidad de la red eléctrica?

Spoiler: tú, no 😁

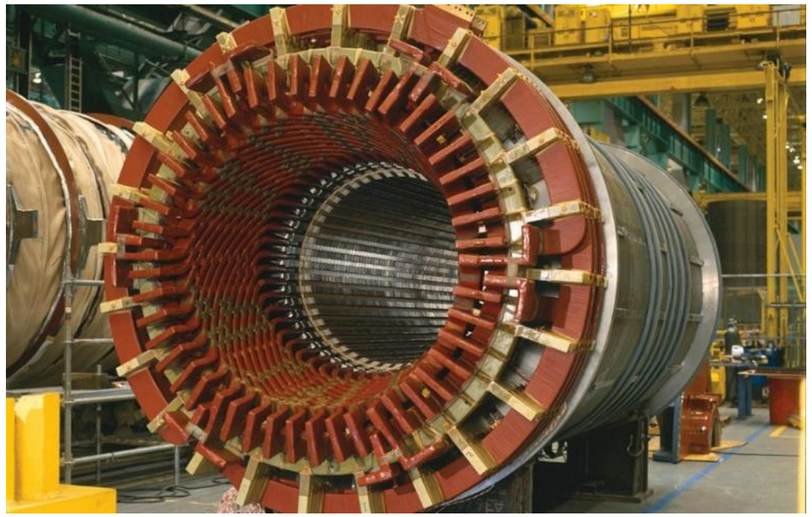
UNIVERSIDAD POLITÉCNICA DE MADRID

escuela técnica superior de ingeniería y diseño industrial

Imperial College London

Lower inertia on the road to lower emissions

Thermal generators
(nuclear, gas, coal…)



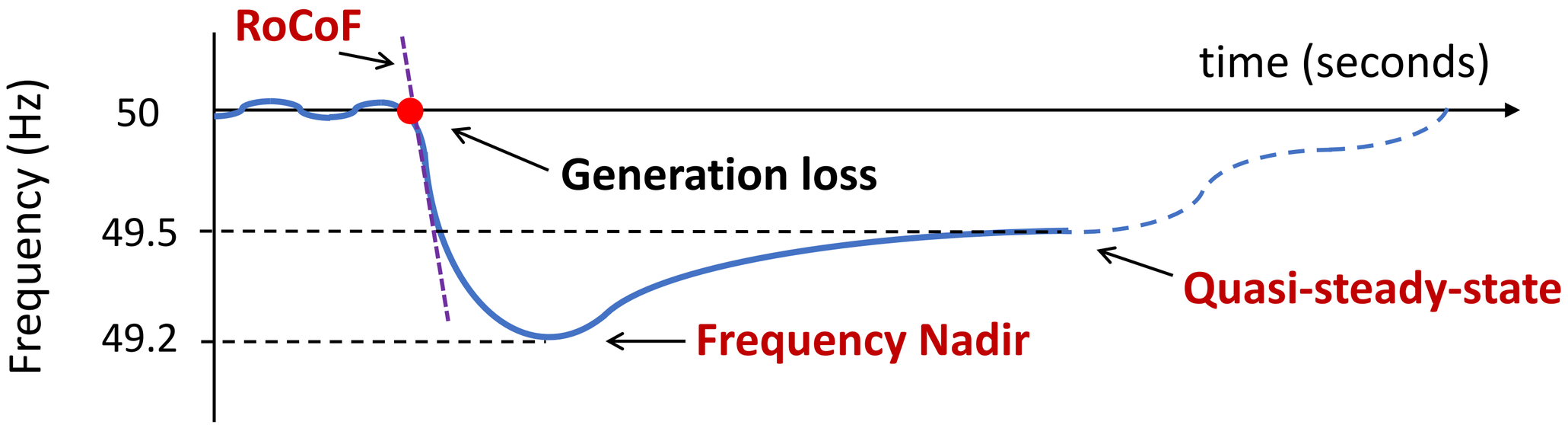
Decarbonization

Most **renewables**:
no inertia

The **risk of instability has increased!**

Inertia <u>stores kinetic energy</u>:
this energy gave us time to contain a sudden generation-demand imbalance

Frequency stability



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

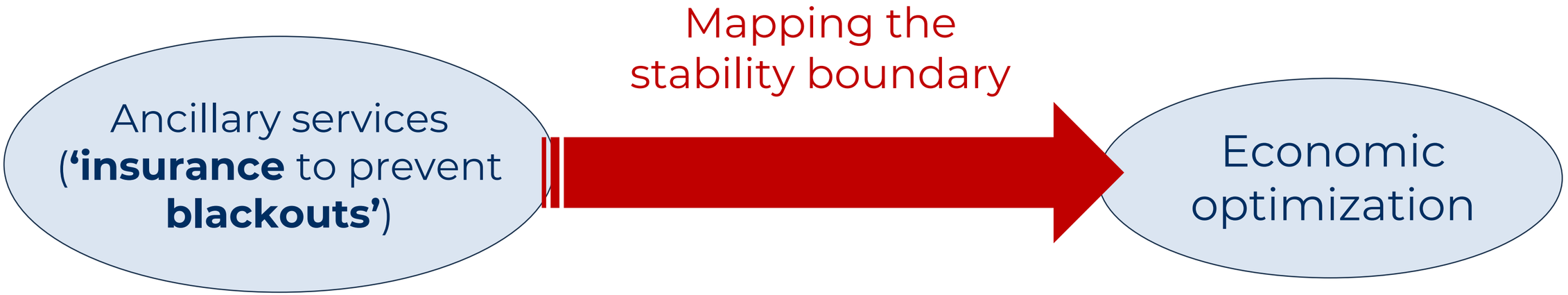
Cost allocation for stability services

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?**

Economics of stability



Described by
differential equations
(timescale of sub-seconds)

Based on
algebraic equations
(timescale of min/hours)

Goal:
Achieve **minimum cost** while
keeping **system stability**

First, why worry about who pays?

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

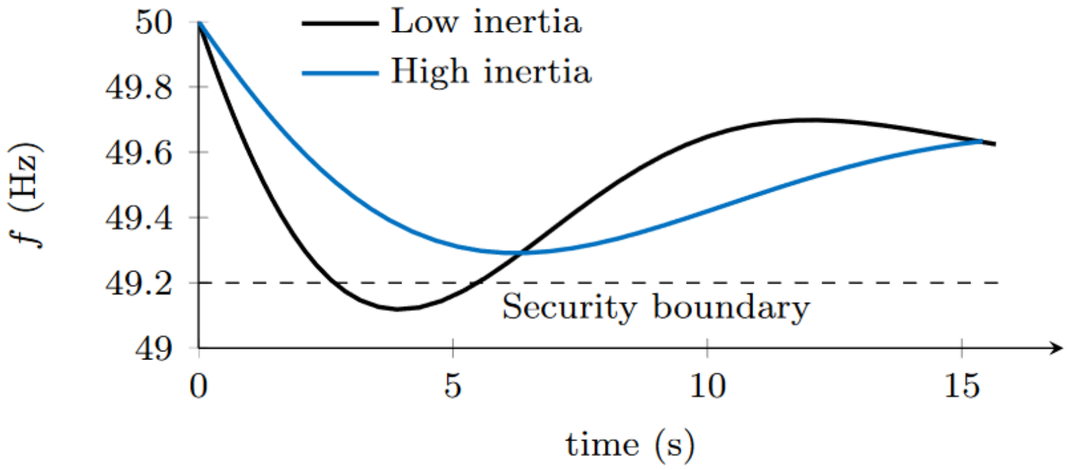
Goal of moving towards a **‘causer pays’ framework**:

To create **incentives to ‘do less harm’** to the grid

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

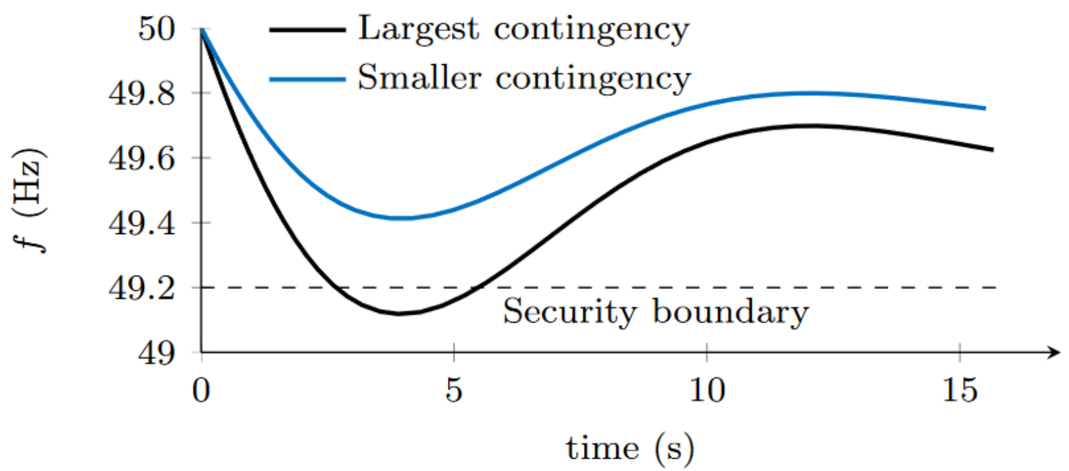
Who causes the need for frequency services?

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

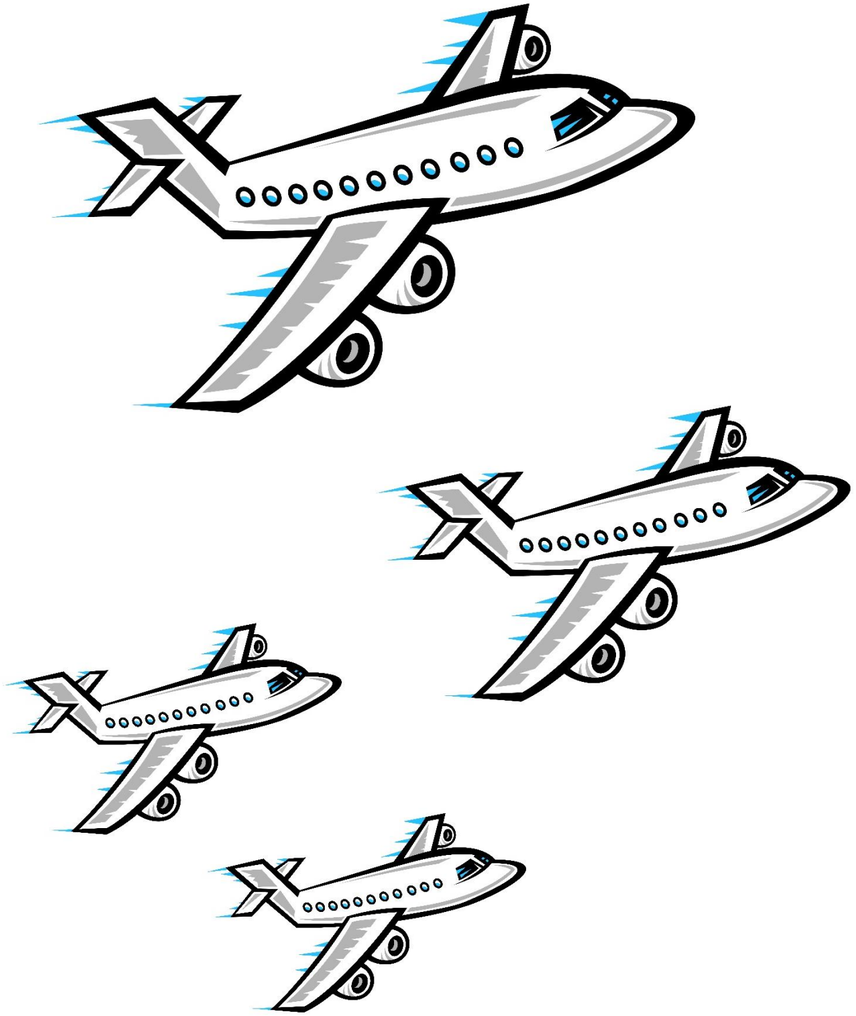
under a large contingency



Impact of contingency size

in a low-inertia system

How to split the cost? ‘Airport problem’



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

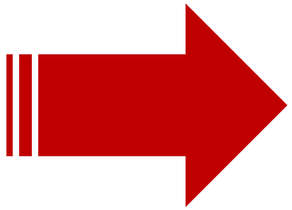
- To **incentivize flexibility**

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

What’s next in research?

Challenges

- Decision making under **uncertainty**
- **Market design** for decarbonized grids
- Planning of **multi-energy** Systems
- **Stability** of power-electronics based grids
- **Resilience** of power grids



Tools

- **Optimization**
- Artificial Intelligence (**AI**)
- **Physics**-based modelling
- **Economic** theory