

# **Operación económica de sistemas eléctricos nacionales con baja inercia**

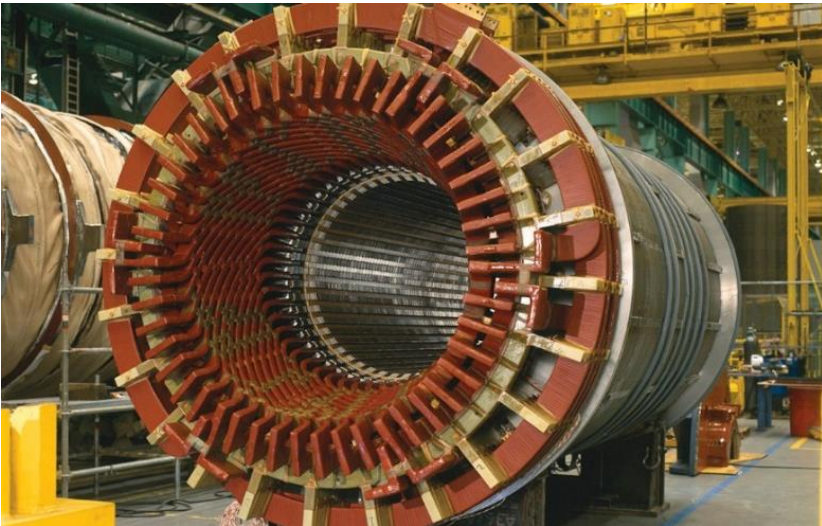
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# Lower inertia on the road to lower emissions

“Inertia” means a rotating mass

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



**Inertia stores kinetic energy:**

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

Decarbonization

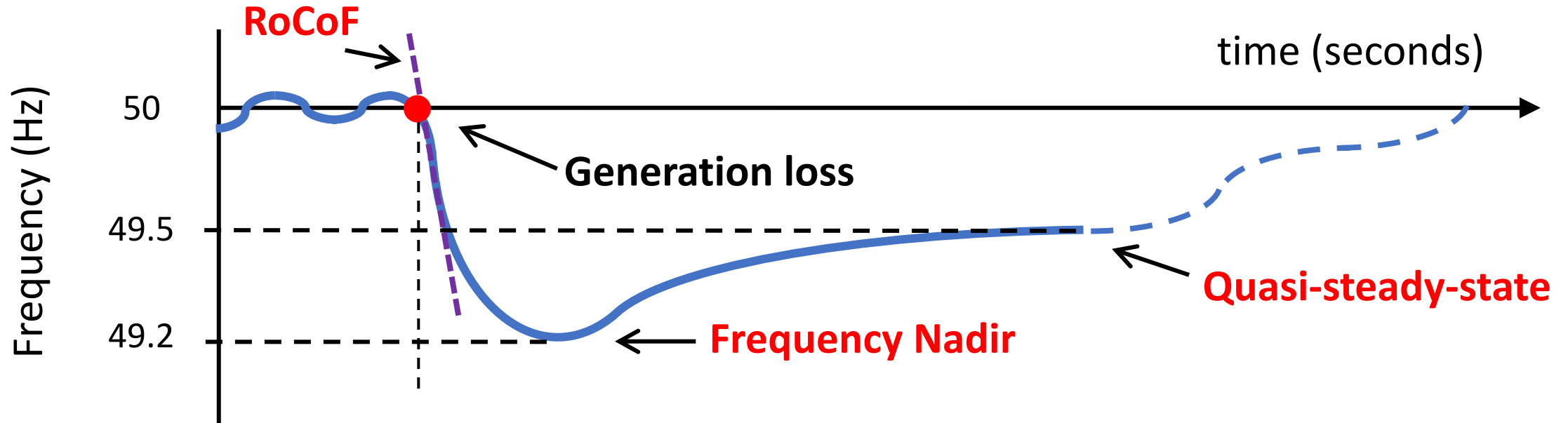


*Most renewables:  
**no inertia***



The risk of **instability**  
has increased!

# Why is frequency important?



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

# What can go wrong?

# Blackouts!

**theguardian** Fri 9 Aug 2019

## Transport chaos across England and Wales after major power cuts



**EL PAÍS** 24 jul 2021

## Una rotura de la conectividad eléctrica con Francia provoca un apagón en media España





# COVID impact on electricity grid stability

Supressed demand led to low electricity prices, resulting in this generation mix:

*Renewables*



+

*Nuclear*

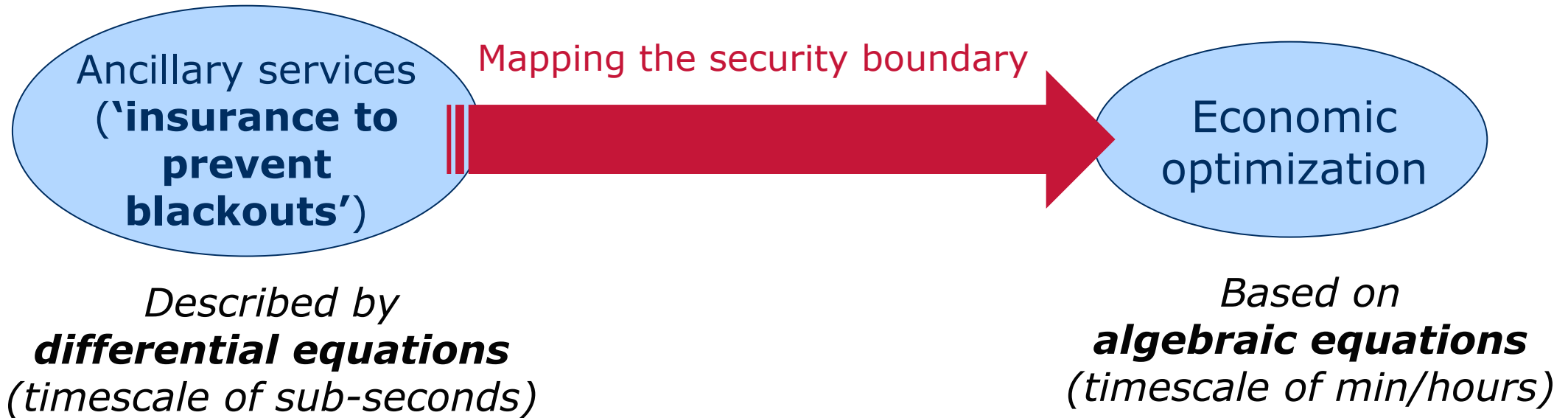


***This system lacked inertia,***  
*gas-fired plants had to be turned on simply for stability!*

***Inertia-related costs in GB were ~£300m*** during May to July 2020,  
***3 times more*** than in the same period in 2019

# My research in a nutshell

*How to optimally procure the ancillary services  
needed because of low inertia?*



## Goal:

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

# 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