



# Frequency control and stability requirements on hydro power plants

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# Outline

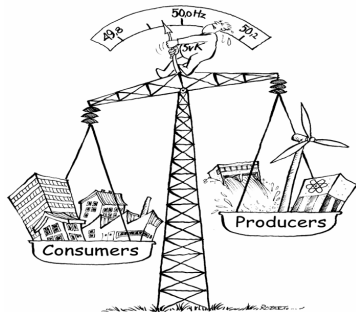


Problem

Solution

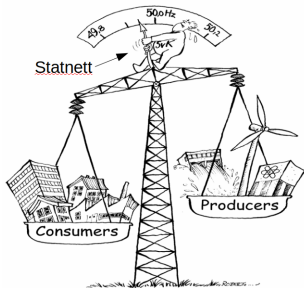
# Load and production balancing

- The power system frequency measures the power balance.



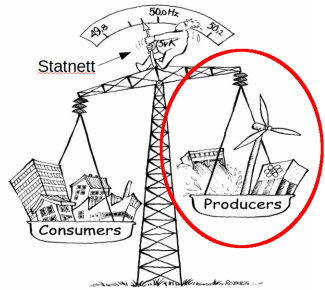
# Load and production balancing

- The power system frequency measures the power balance.
- It is the responsibility of Statnett to control the frequency.



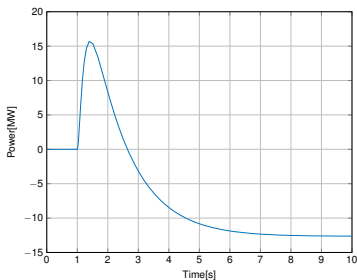
# Load and production balancing

- The power system frequency measures the power balance.
- It is the responsibility of Statnett to control the frequency.
- However, it is the power plant owners who can control the frequency.



# Buying frequency control

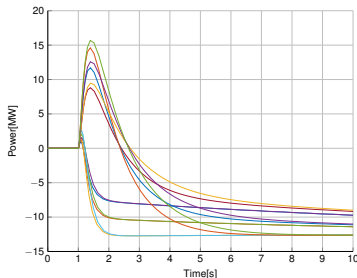
- Statnett pays all power plant owners to provide frequency control.



**Figure:** Frequency control response to step change in frequency

# Buying frequency control

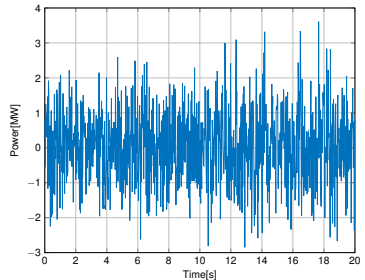
- Statnett pays all power plant owners to provide frequency control.
- However, they don't provide the same quality of service.



**Figure:** Frequency control response to step change in frequency

# Buying frequency control

- Statnett pays all power plant owners to provide frequency control.
- However, they don't provide the same quality of service.
- Renewable energy sources such as wind and solar don't contribute.

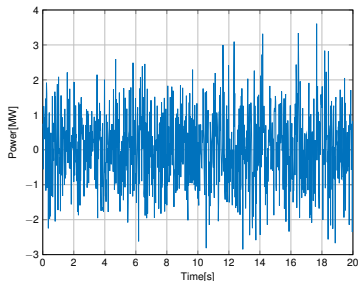


**Figure:** Frequency control response to step change in frequency



# Buying frequency control

- Statnett pays all power plant owners to provide frequency control.
- However, they don't provide the same quality of service.
- Renewable energy sources such as wind and solar don't contribute.
  - Barrier for energy transition



**Figure:** Frequency control response to step change in frequency

# Future of frequency control



- Power plants have to pass tests to get paid to provide frequency control.
- Only those who pass the tests get paid for the service.

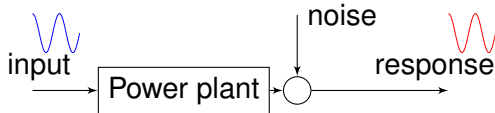


Figure: Test of power plant

# Tests proposed by the industry

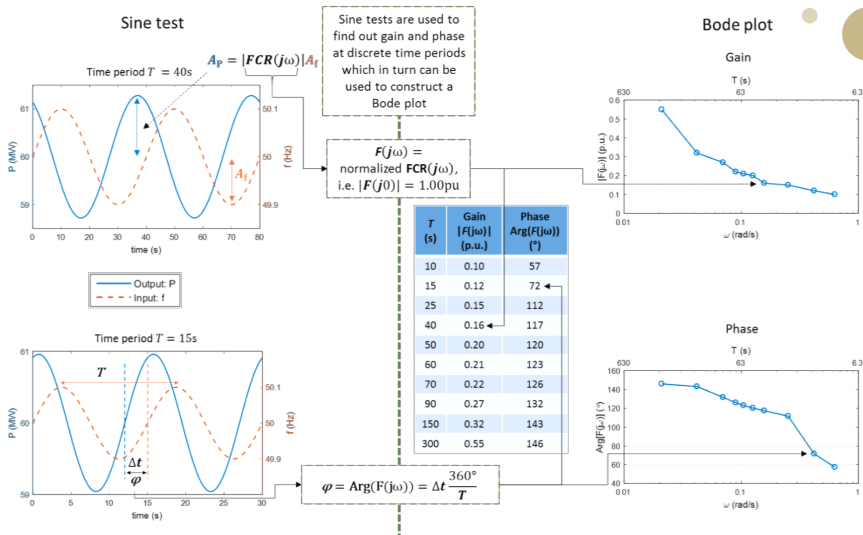
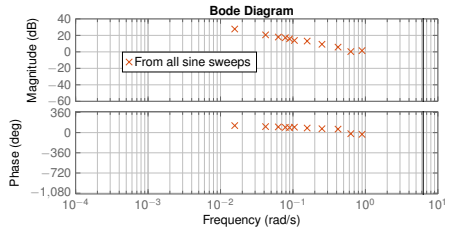
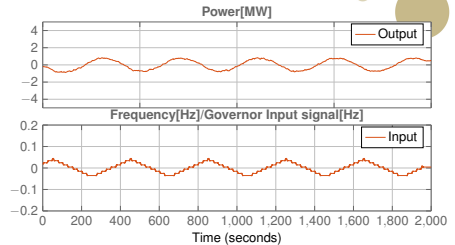


Figure: Testing procedure [source:ENTSO-E]

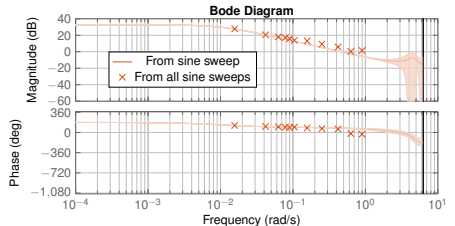
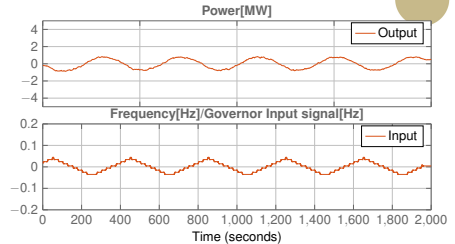
# Example from real tests

- The power plant needs to be disconnected
- Takes up to 20 hours.



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- The power plant needs to be disconnected
- Takes up to 20 hours.
- Only one sine test needed with model learning.



# Outline

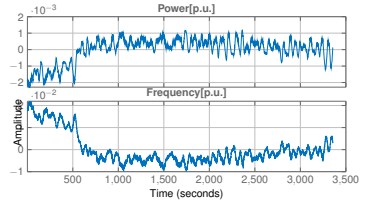


Problem

Solution

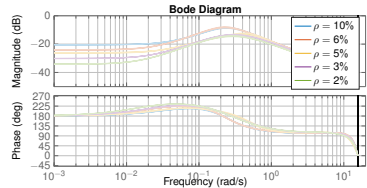
# Idea

- Can power plants be tested without testing?



# Idea

- Can power plants be tested without testing?
- Yes!





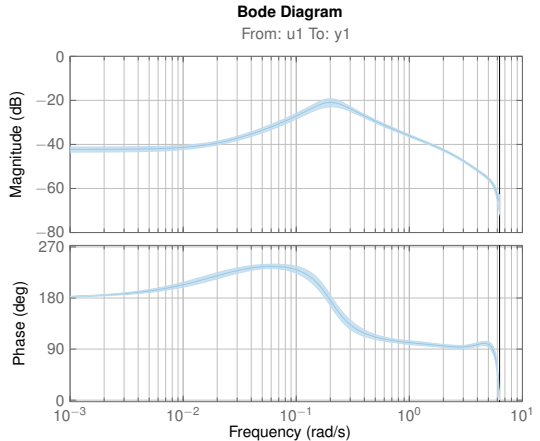
## Product



- A small pc with analog and digital input and output.
- Software for interfacing with turbine control systems and TSO measurements.
- Software for performing model learning and analysing results.

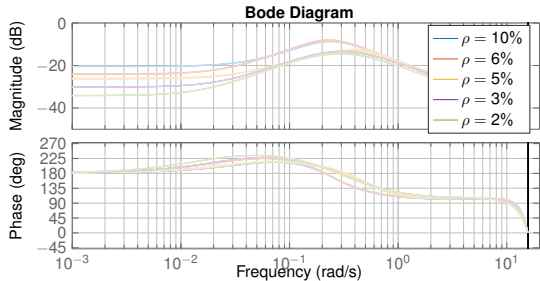
# Use cases

- Statnett can check plants using their own data.



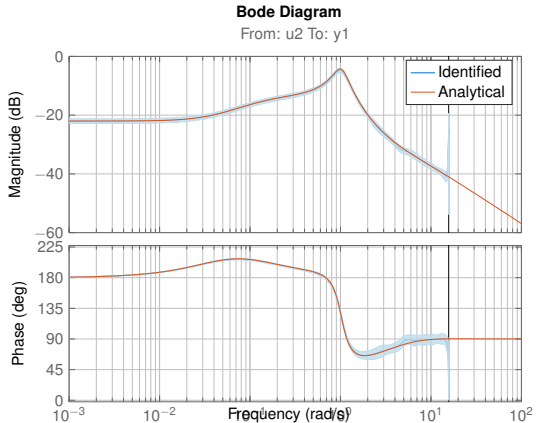
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- Power plant owners can test their plants continuously.



# Use cases

- Statnett can check plants using their own data.
- Power plant owners can test their plants continuously.
- Testing with defined accuracy.





Thanks for listening!