

# Balancing group deviation & balancing energy costs due to the provision of frequency containment reserve with a battery storage system in Germany

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## Introduction

Providing frequency containment reserve (FCR) is one key service to maintain grid stability. The power delivery for FCR services, including the degrees of freedom (DOF), is defined by characteristics curves, but leads to balance group (BG) deviations in the grid. This means that earnings from FCR provision and balance group deviations need to be equilibrated by the balance group manager (BGM).

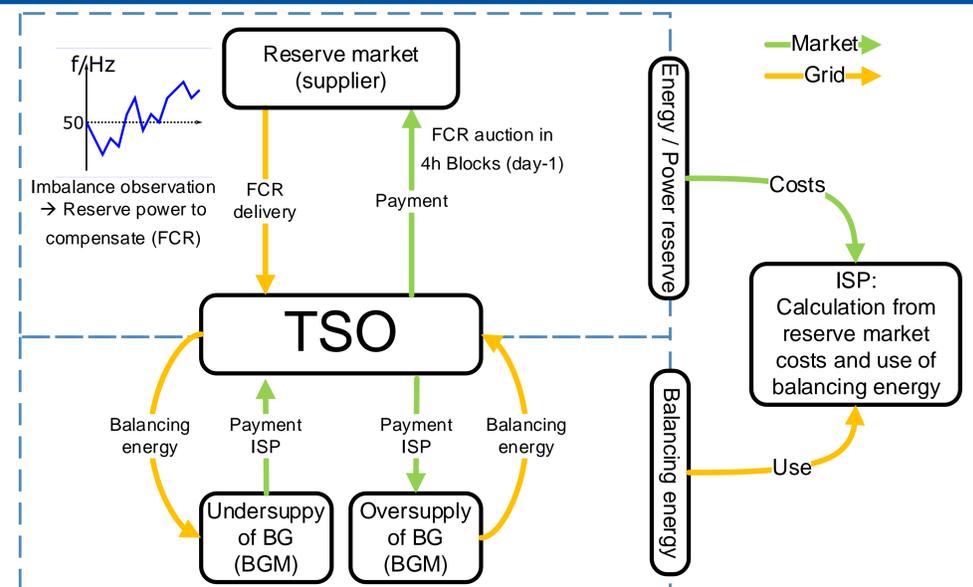
## Conclusion

The allowed DOFs for FCR services should be used by battery system operators providing FCR. The providers can lower their recharging costs and the balance group manager gains a profit due to balance group deviation. The overall benefit of using the DOFs is higher than the cost for additional balance group management.

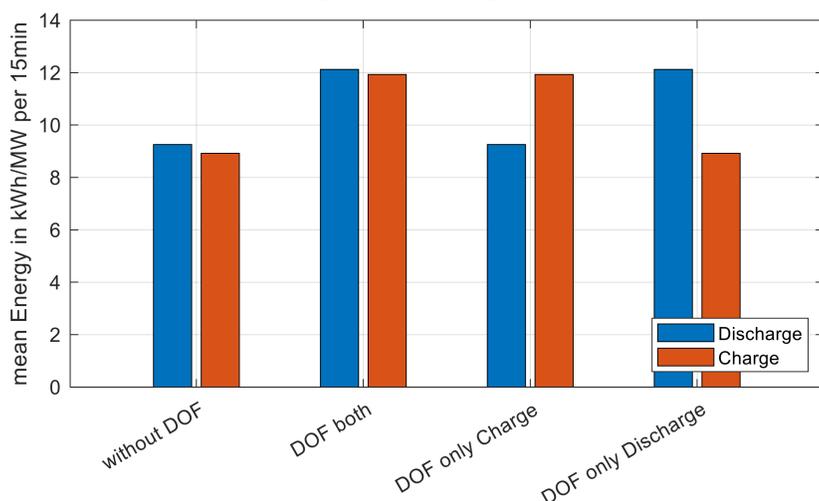
The simulation data match the field data precisely.

## German Imbalance Settlement Pricing

- ISP (Imbalance Settlement Price) depends on cost for reserve power
  - can be both positive or negative
- Payment between TSO (transmission system operator) and BGM (balance group manager)
  - undersupply in BG → payment from BGM to TSO
  - oversupply in BG → payment from TSO to BGM
- FCR providers create BG deviations
  - deviations are dependent on the use of DOFs



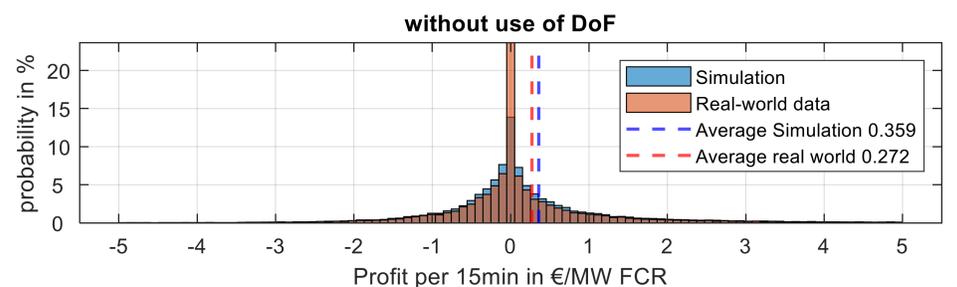
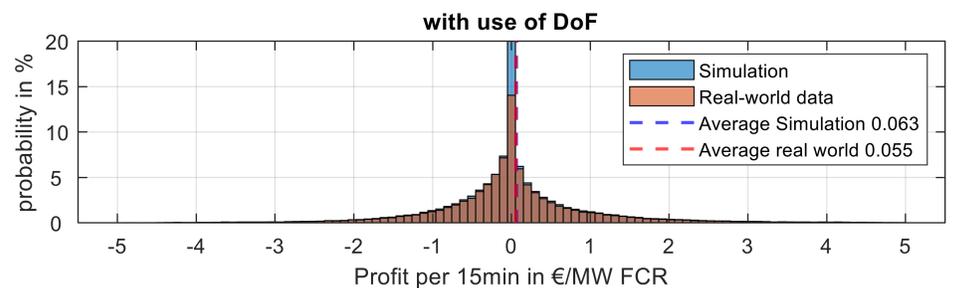
## Simulation: Energy throughput per MW FCR



- Dataset: 07/2018 until 06/2021
- Energy throughput per 15 min per MW FCR lies between 9-12 kWh
- Use of DOF increases the energy throughput by up to 3 kWh per 15 min which equals 1.2% of the reserved FCR capacity
  - 3kWh or 1.2% correspond to the possible maximum energy amount delivered by 1MW FCR in 15min

## Simulation vs. field data: Costs by balance group deviation

- Simulation and field data show similar results
- Balance group deviation caused by FCR generate profit
  - Largest profit for use of only Discharge DOF
- Monthly profit: ~615 €/MW FCR (without use of DOF)
- Annual profit: ~7,382 €/MW FCR (without use of DOF)



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### Acknowledgements

German Federal Ministry of Economic Affairs and Climate Action (BMWK) - M5BAT (FKZ: 03ESP265F) and EMMUseBat (FKZ: 03EI4034); Uniper SE



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