

Hybrid Solar and BESS Plants - To DC or not to DC?

Abigail Field – APEX 2024



Roadmap

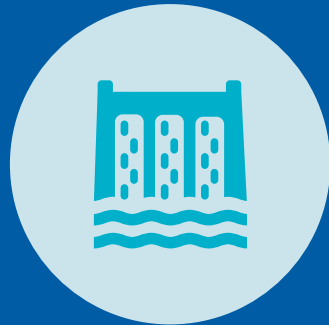
- Frequency Control Basics
- BESS Role in Frequency Control
- Introduction to Hybrid Plants
- DC vs. AC Coupling
- DC-coupling Connection Process

Frequency Control Basics

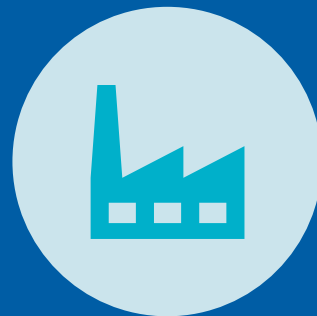
Why is Frequency so Important?



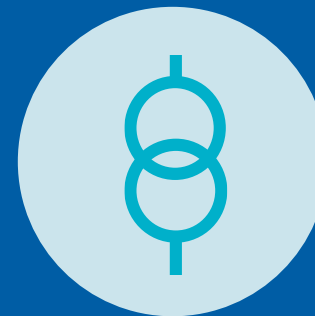
MOTORS



GENERATORS



INDUSTRIAL
PROCESSES

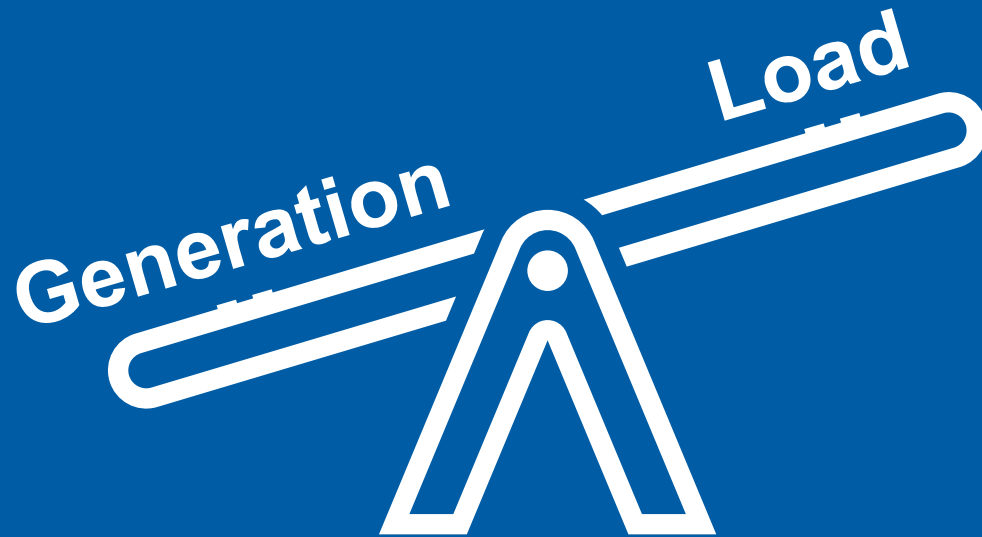


TRANSFORMERS



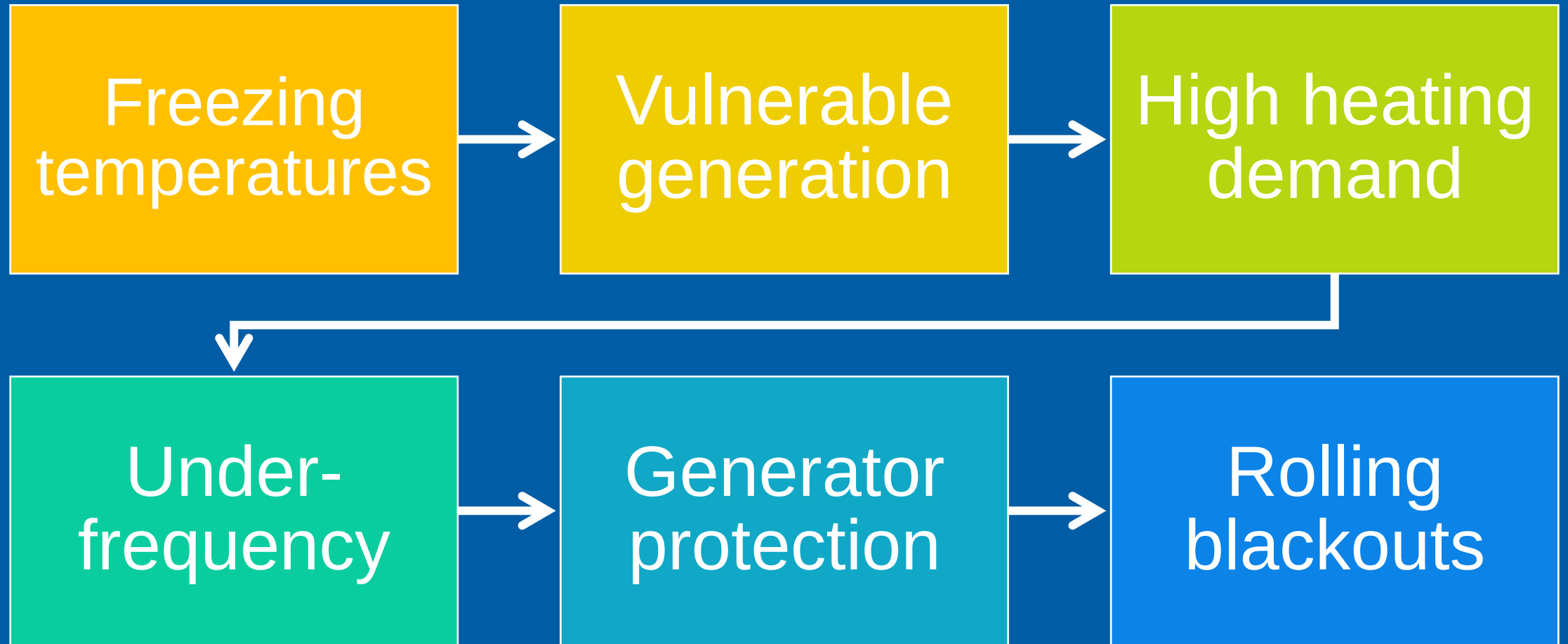
CLOCKS

Frequency and Active Power

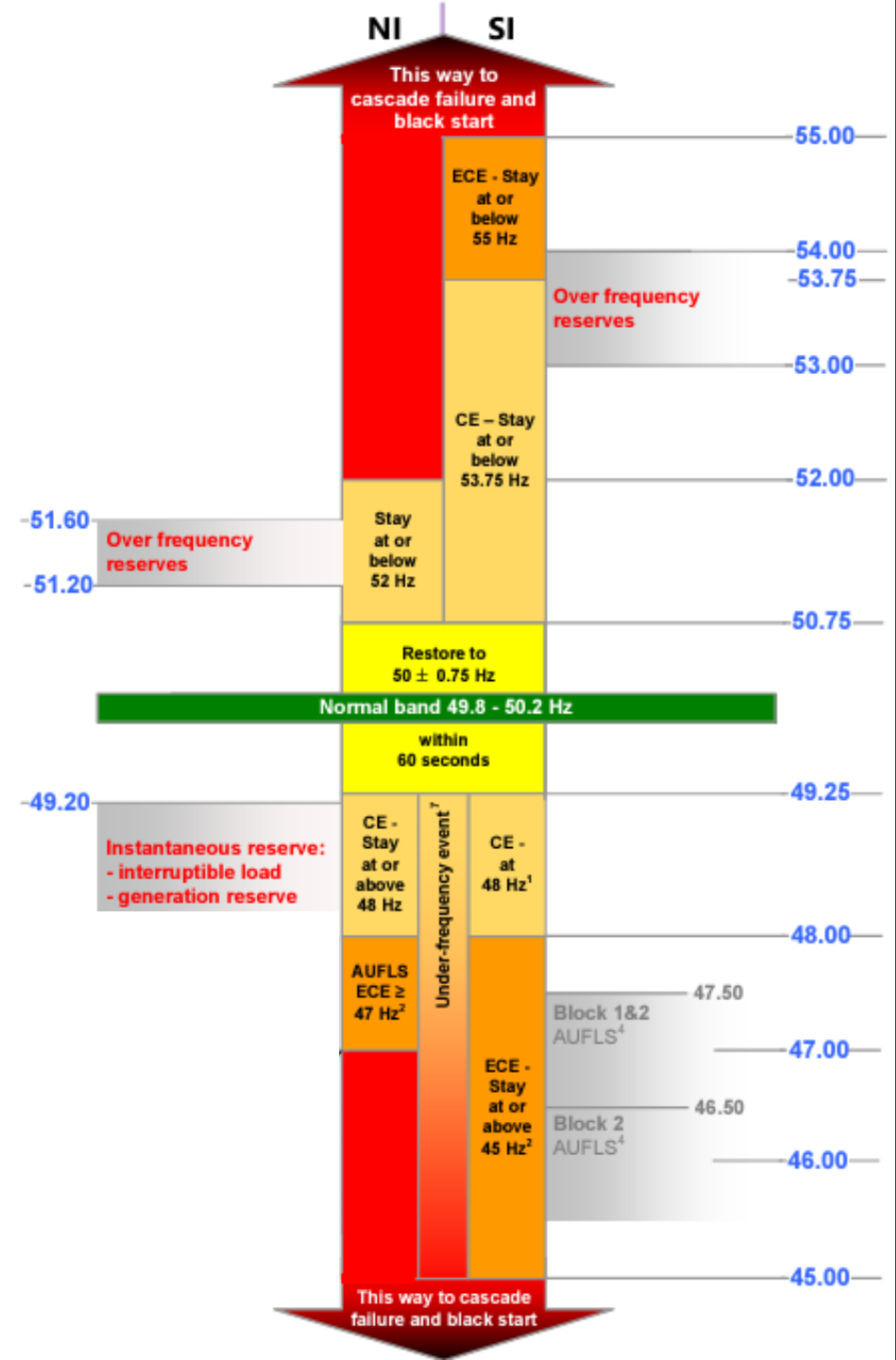


Frequency stability is dependent on the active power balance of the power system

Texas Power Crisis, Winter 2021



Transpower's Frequency Barometer



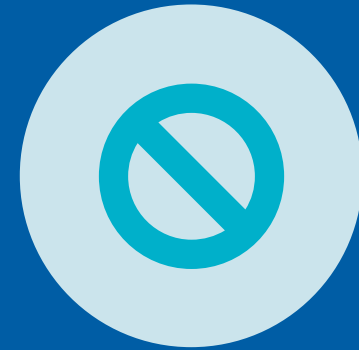
How do we Control Frequency?



**FREQUENCY KEEPING
RESERVE**



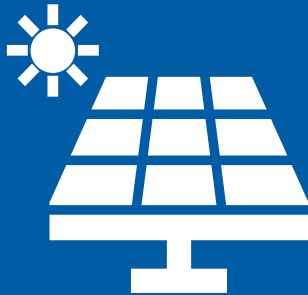
**INSTANTANEOUS
RESERVE**



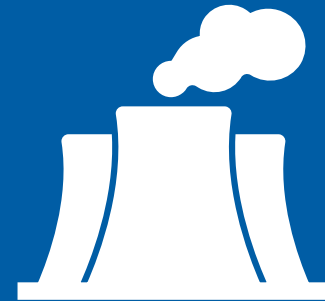
INTERRUPTIBLE LOAD

BESS' Role in Frequency Stability

Base Load



Frequency Keeping



BESS + Frequency Keeping

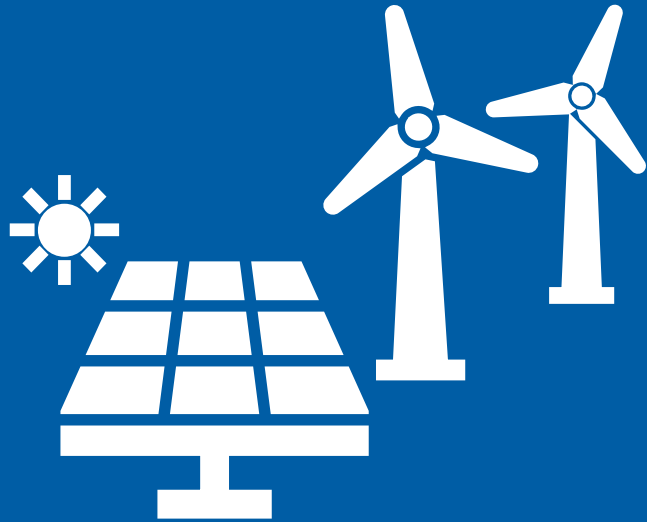
Frequency variation resilience

Black start capability

Energy arbitrage

Hybrid Plants

Hybrid Plants



Base Load Generation



Energy Storage

Why Connect as Hybrid?

- Resource consent
- Footprint
- Connection application
- Connection point

Hybrid Projects in Australia

Bulgana Green Power Hub:

- 194 MW Wind
- 20 MW BESS

Kennedy Energy Park:

- 43 MW Wind
- 15 MW Solar
- 2 MW BESS

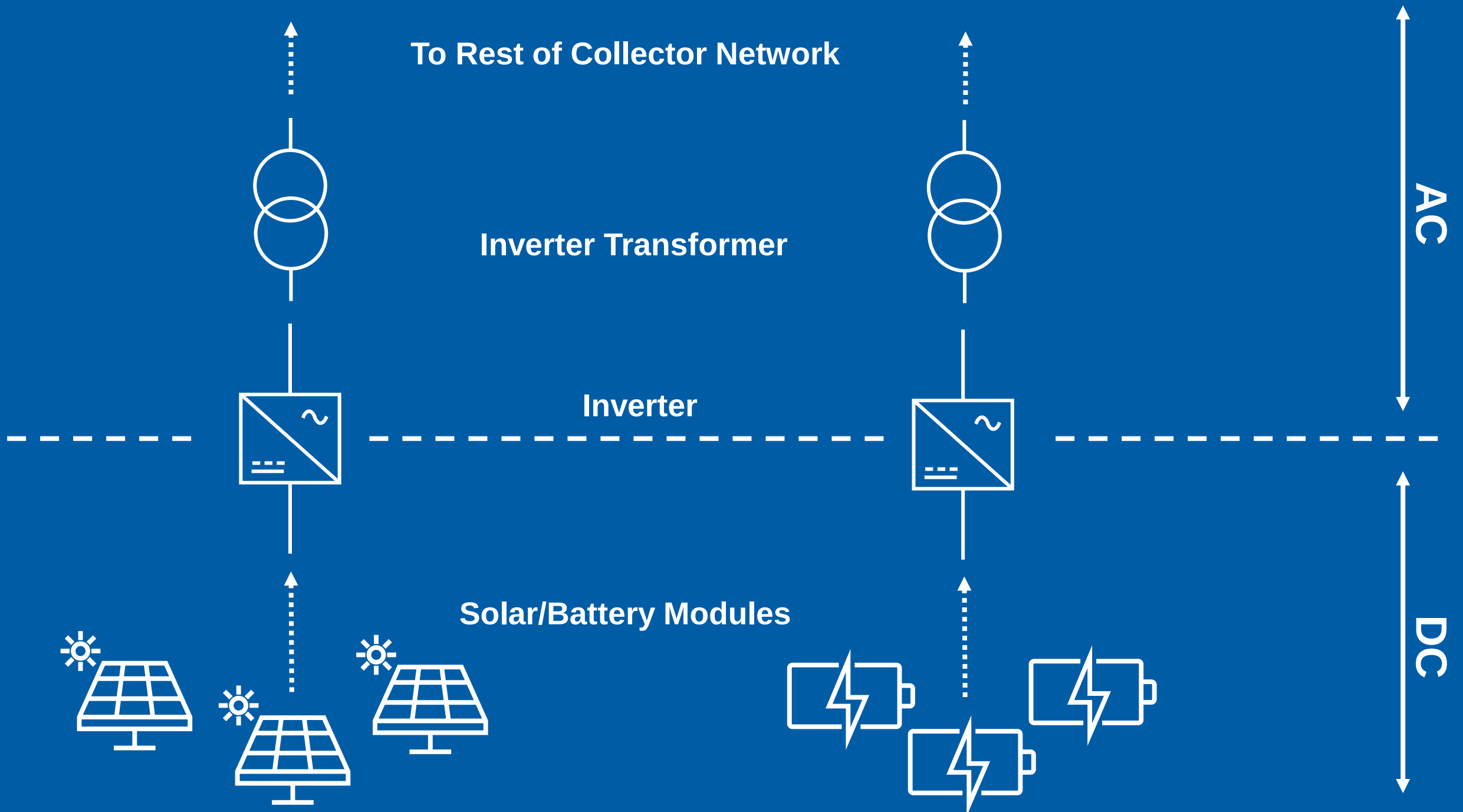
BULGANA
GREEN POWER HUB

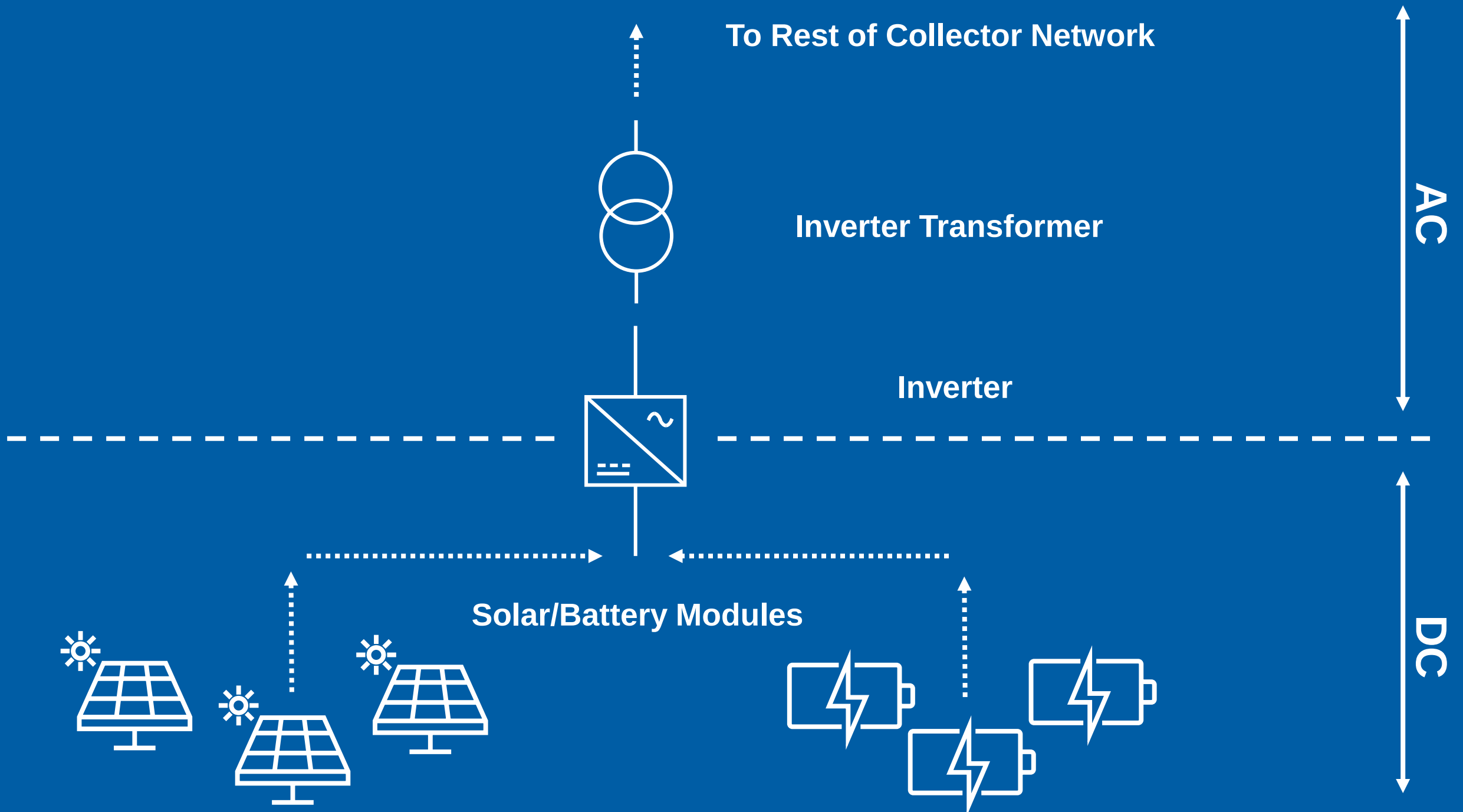


Hybrid Plants in NZ

None yet... But we're working on them!

AC vs. DC Coupling





AC vs. DC Coupling

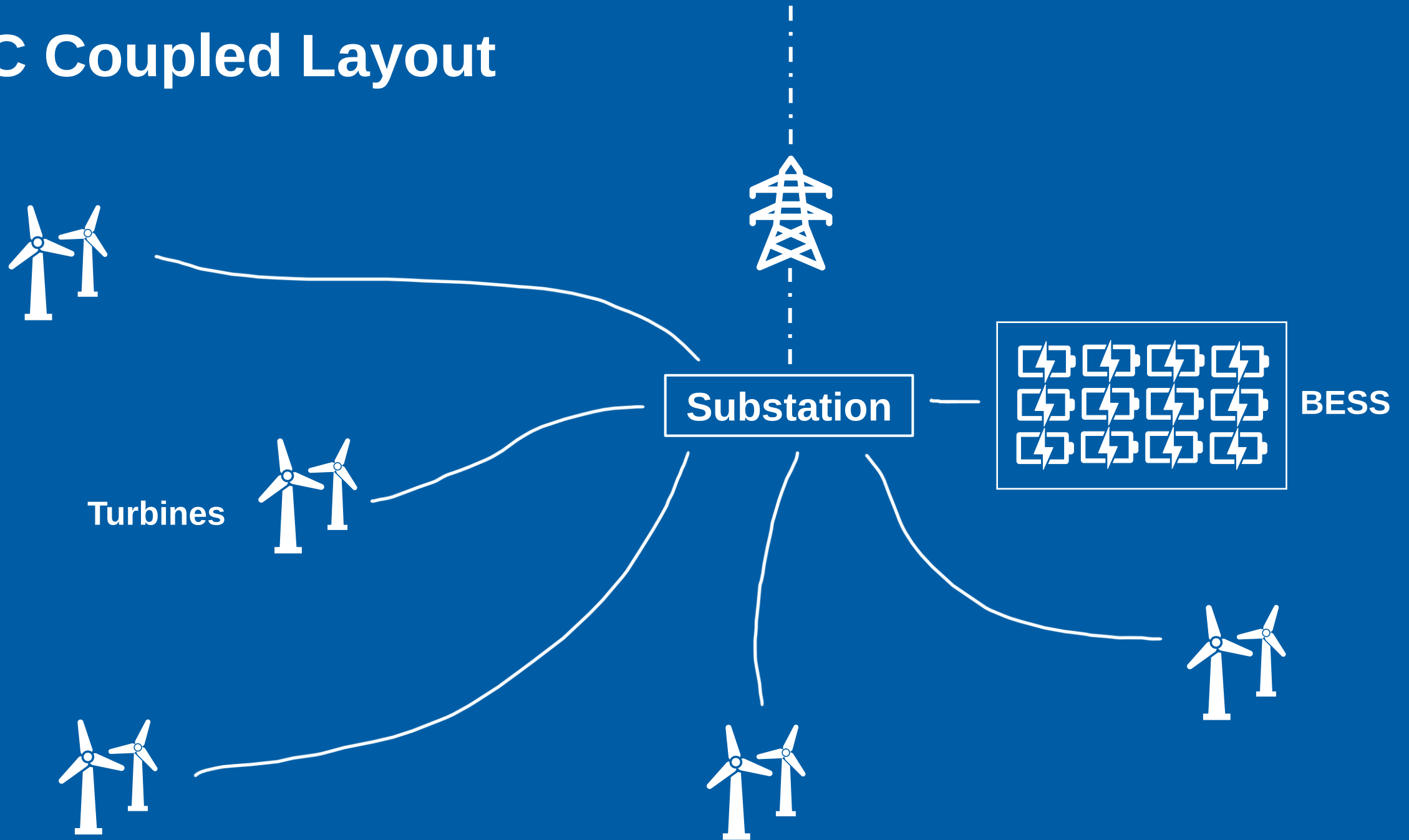
Pros:

- Instantaneous active power
- Number of inverters
- Direct battery charging

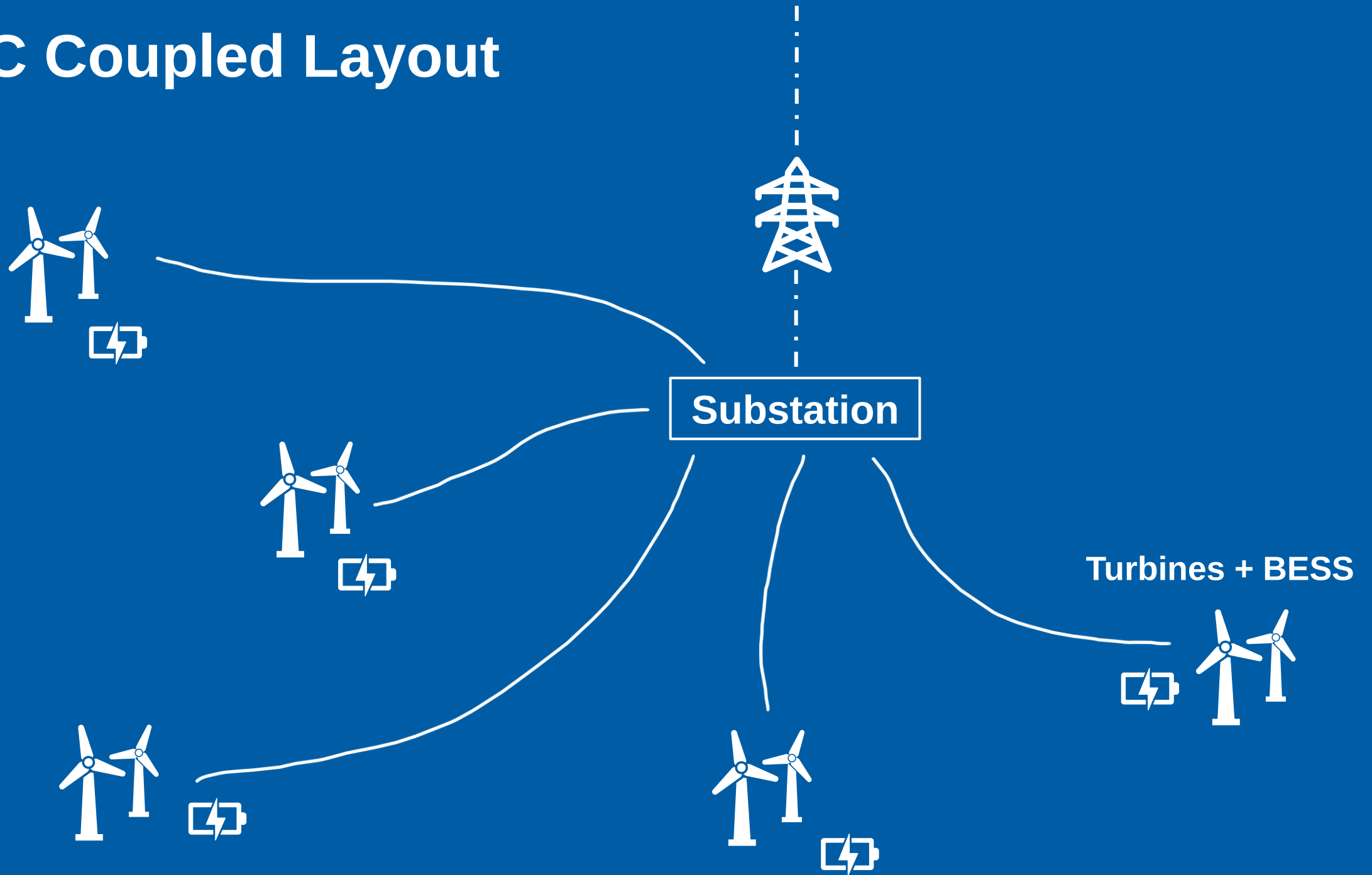
Cons:

- Not all manufacturers are offering DC-coupling
- Relatively new technology
- Spread layout of BESS
- Restrictions on DC-coupling – 500kW x 6

AC Coupled Layout



DC Coupled Layout



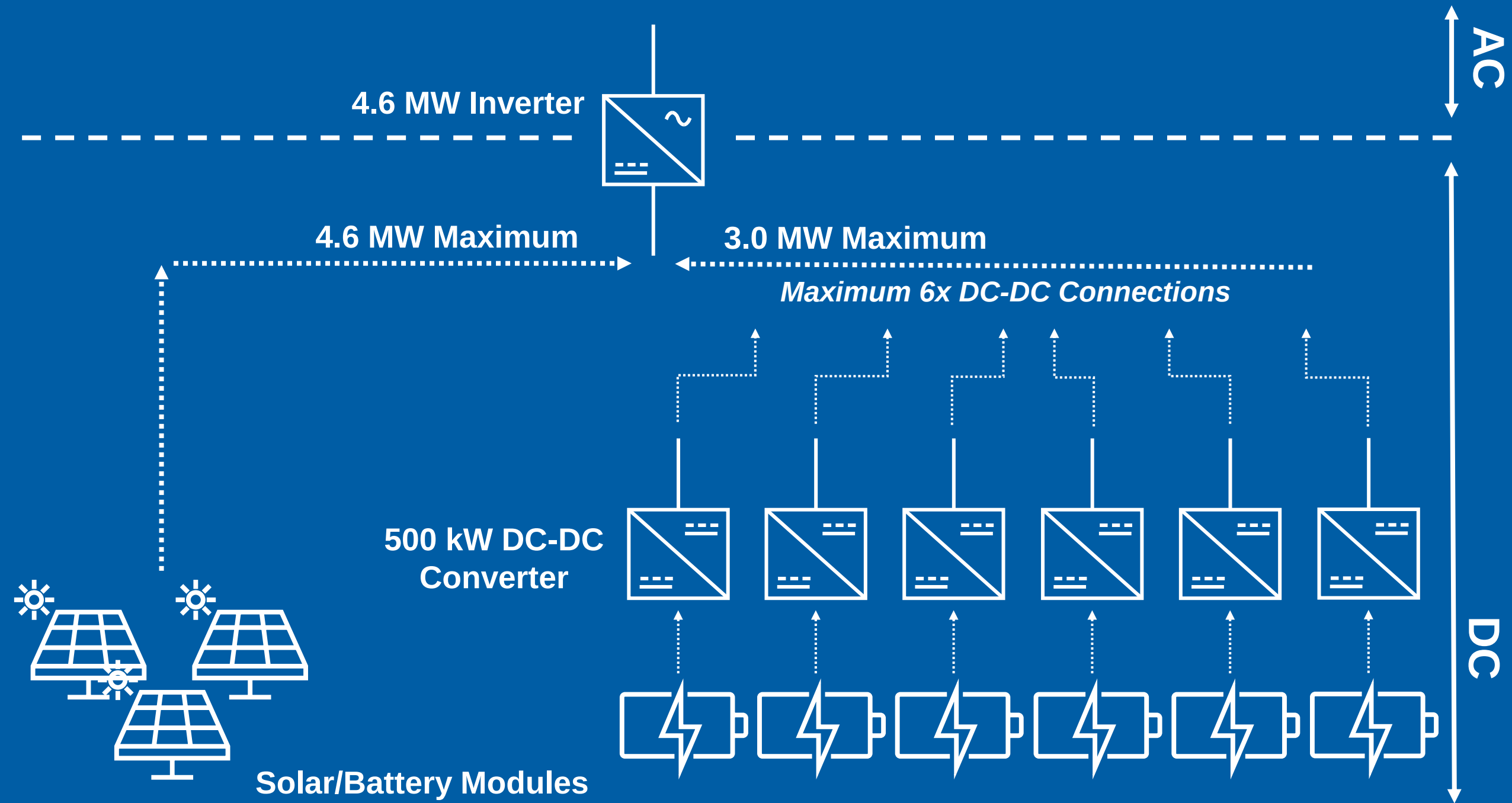
AC vs. DC Coupling

Pros:

- Instantaneous active power
- Number of inverters
- Direct battery charging

Cons:

- Not all manufacturers are offering DC-coupling on their inverters
- Relatively new technology
- Spread layout of BESS
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Connection Studies with Hybrid Plants

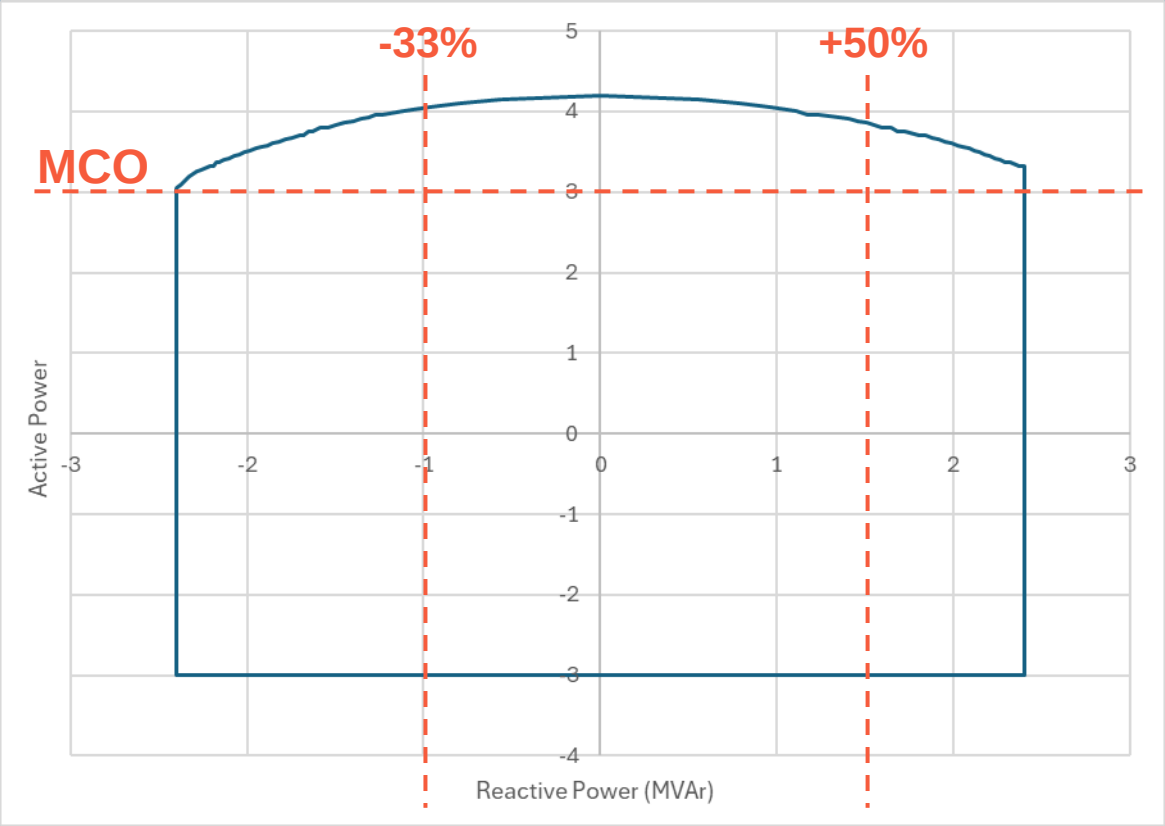
Connection Studies

- Transpower requires Connection Studies:
 - Prove compliance to the Code
 - No adverse impacts on Grid
- Similar in Australia: AEMO's GPS Studies



Connection study type
Power-flow study (Section 6.1)
Reactive power capability study (Section 6.2)
Frequency regulation and tuning study (Section 6.3)
Voltage regulation and tuning study (Section 6.4)
Short circuit study (Section 6.5)
Fault ride through study (Section 6.6)
Transient stability study (Section 6.7)
Harmonics distortion study (Section 6.8)

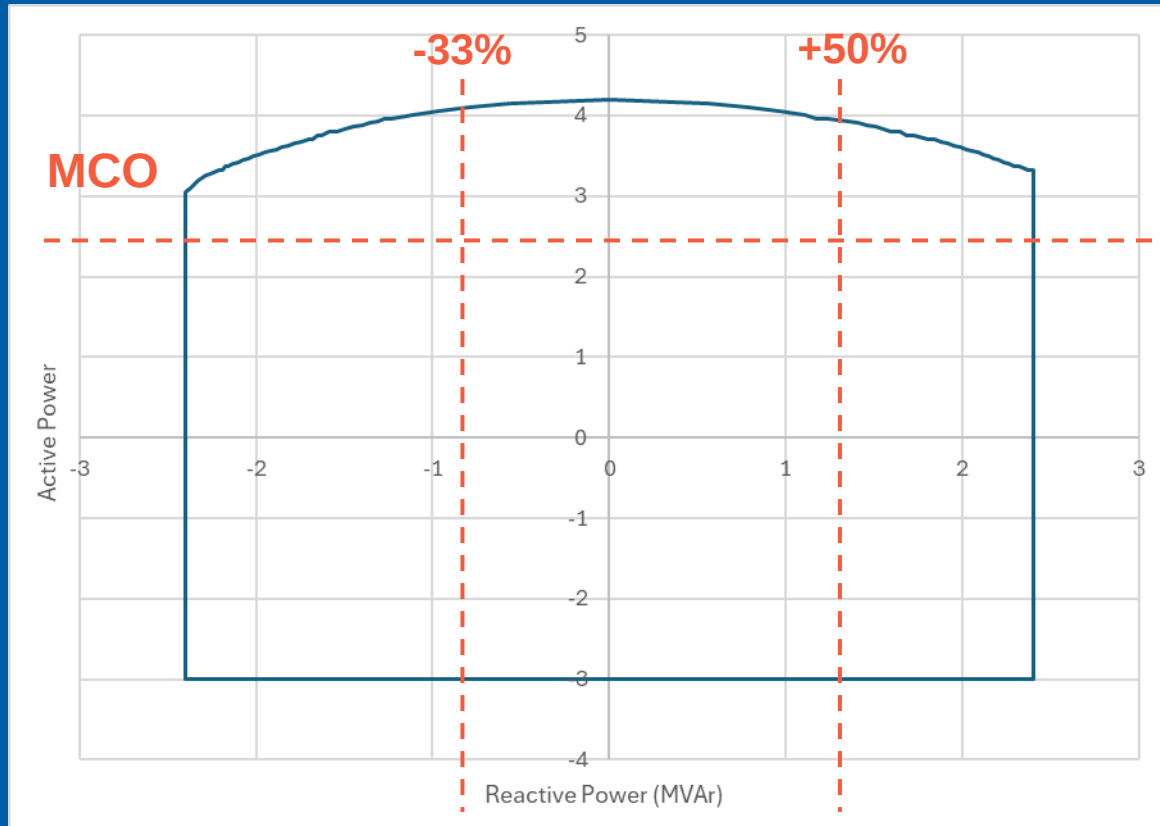
Reactive Power Capability



Operating Scenario	Pmax	Pmin
Solar + BESS	3 MW	-2.5 MW

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Reactive Power Capability



Operating Scenario	Pmax	Pmin
Solar Only	3 MW	0 MW
BESS Only	2.5 MW	-2.5 MW
Solar + BESS	3 MW	-2.5 MW

Connection study type

Power-flow study
(Section 6.1)

Reactive power capability study
(Section 6.2)

Frequency regulation and tuning study
(Section 6.3)

Voltage regulation and tuning study
(Section 6.4)

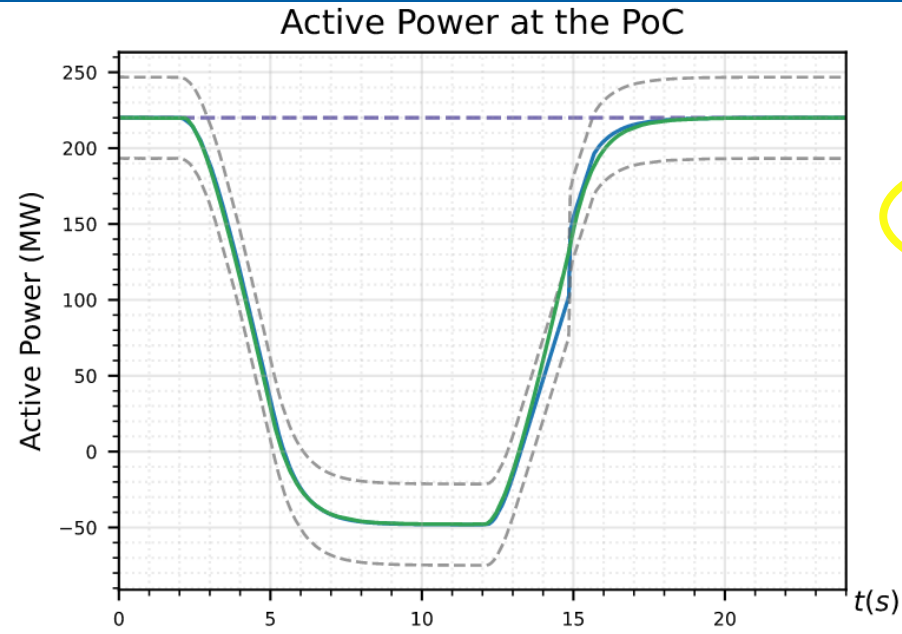
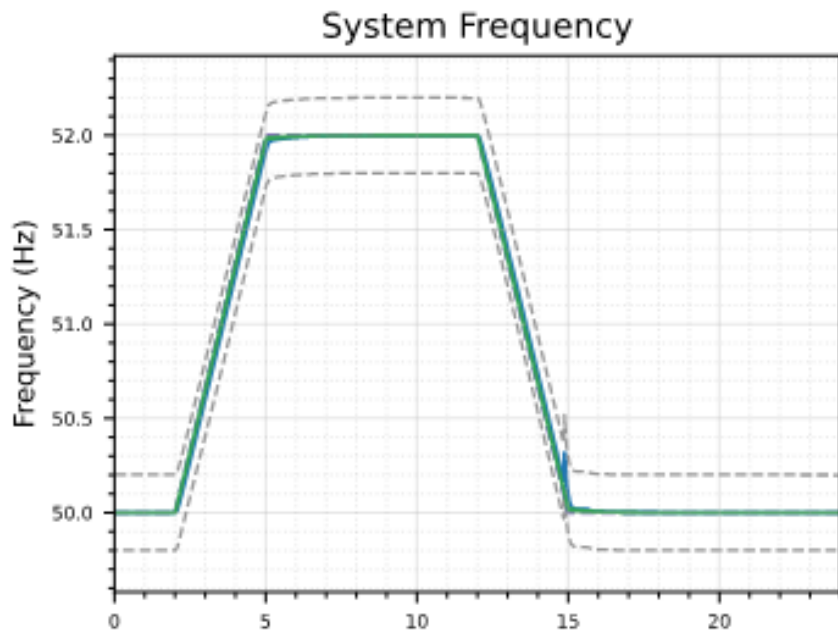
Short circuit study
(Section 6.5)

Fault ride through study
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Transient stability study
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Frequency Regulation + Tuning



Connection study type

Power-flow study
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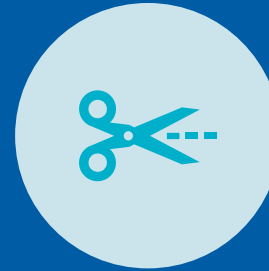
Concluding Remarks



**RENEWABLE
FREQUENCY
REMEDiation**



**FASTER
CONNECTIONS
WITH HYBRIDS**



**DC-COUPLING
ENABLING
SAVINGS**



**NEW PROCESS,
LOTS OF
LEARNING**

