

What is Inertia Based Fast Frequency Response?

The need for Fast Frequency Response

Fast Frequency Response (FFR) refers to the delivery of rapid active power increase or decrease by generation or load in a timeframe of 2 seconds or less, to correct a supply – demand imbalance and assist in managing power system frequency.

Due to the recent decline in mainland frequency stability, market bodies have made a rule change to require all scheduled and semi-scheduled generators in the NEM to meet the mandatory Primary Frequency Response (PFR) requirements, and a potential PFR market.

Goldwind's IBFFR is a cost-effective solution which may:

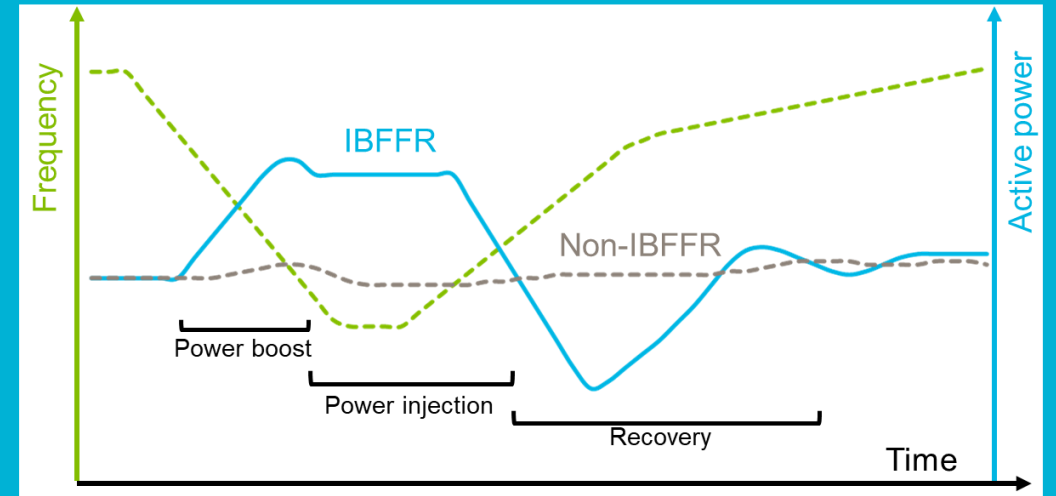
- Allow wind farms to satisfy a significant part of the PFR requirements in a cost-effective way
- Provide an opportunity to form part of fast raise/lower services in the Frequency Control Ancillary Services (FCAS) if they include FFR in the future



Goldwind's IBFFR

Goldwind's technology uses the rotor kinetic energy (inertia) of the wind turbine blades to boost the power output of wind farm in response to a drop in system frequency. This capability is named Inertia Based Fast Frequency Response (IBFFR). IBFFR can detect a frequency disturbance in the network and provide a rapid active power response in three main steps as follows:

1. **Power boost:** provide a short burst of active power by extracting the kinetic energy stored in the rotor and generator.
2. **Power injection:** as the speed of rotation is momentarily slowed, the rapid injection of additional active power is sustained for up to 10 seconds.
3. **Recovery:** a recovery period generally follows the power boost, during which active power is reduced as the blades reaccelerate to pre-event levels.



FFR technology capability

	Wind	Wind + IBFFR	Battery FFR	Traditional FR
Typical technology				
FFR				
Response time		~1s	<1s	>6s
Technology readiness				
Capital cost				
Retrofit to existing WTG				
Boost capability at full output				

+ Benefits

- Traditional synchronous plants provide inertia as well as PFR
- Faster response time than many traditional frequency raise providers
- Goldwind has validated the technology in the field
- Low incremental capital cost for PFR relative to Battery FFR
- IBFFR easily retrofitted to Goldwind WTG at modest incremental cost
- Up to 10% boost capability at max operating conditions without prior derating

Detailed analysis from the field trial is available in the accompanying Knowledge Sharing Report.

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