

# From Passive Loads to Proactive Supporters: AC Motor Drives Providing Reactive Power for Grid under Low-Voltage Ride-Through

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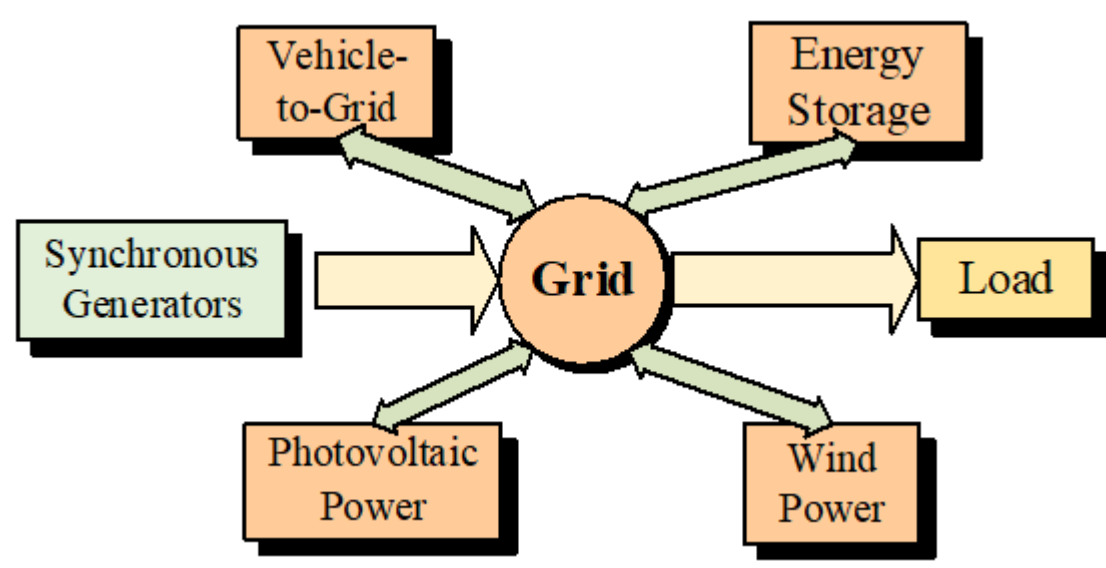
## INTRODUCTION

### Motivation

Renewable-heavy grids need fast voltage support during sags. AC motor drives are normally passive loads, but their converters can provide reactive support if the drive remains connected.

### Research question

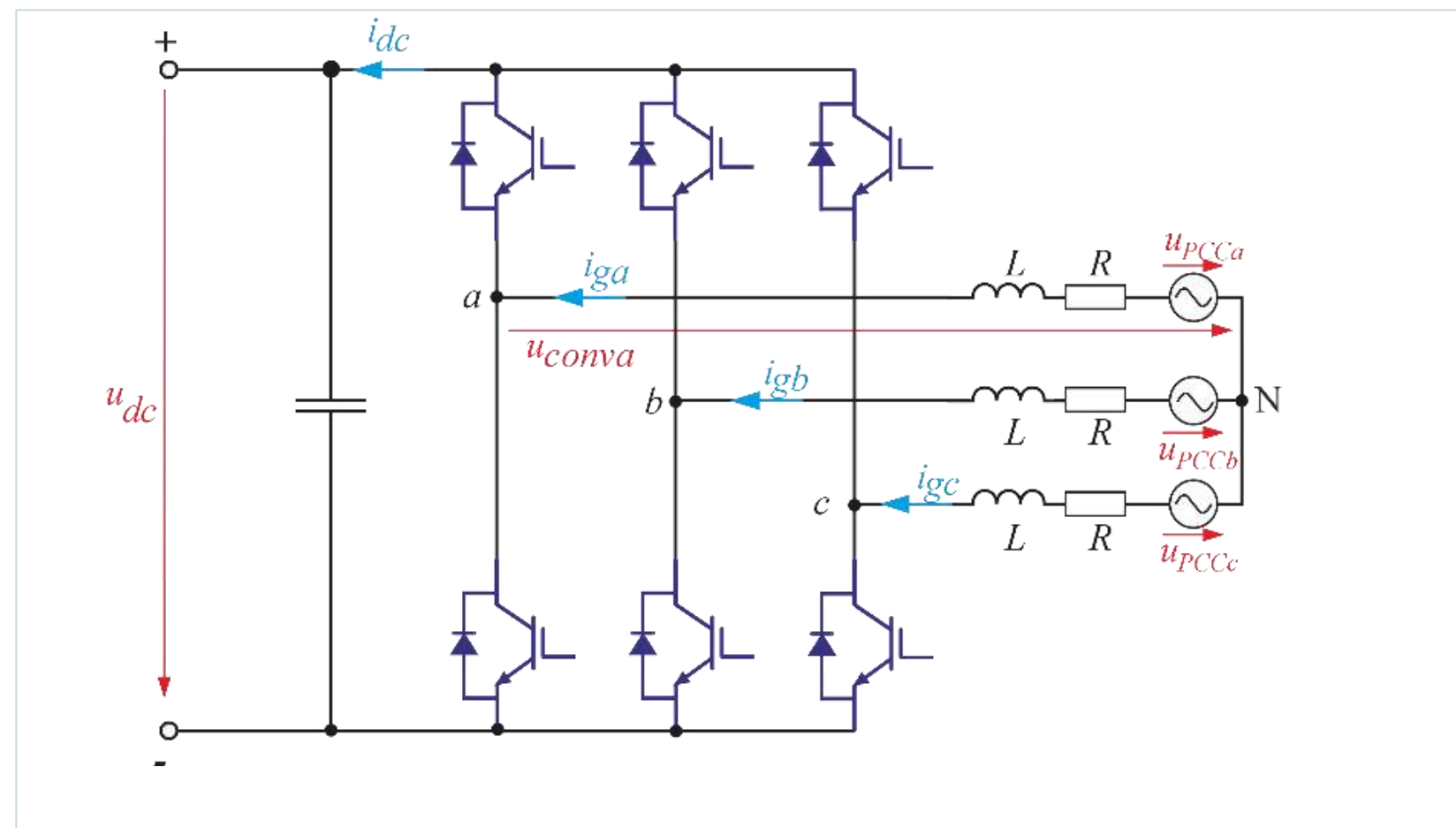
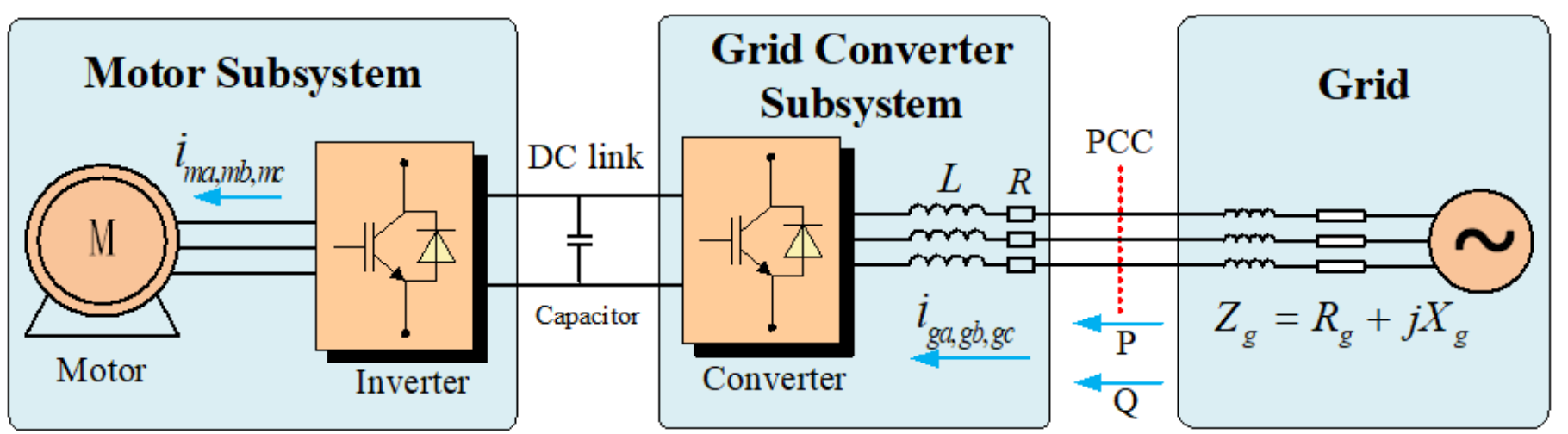
Can LVRT support keep the DC link and operation safe?



### Grid-support gap

Industrial drives can become controllable support during voltage sag.

### System connection



### Contribution

- Treat the drive as an active LVRT support unit.
- Prioritize motor continuity and DC-link protection.
- Use coordinated power allocation for reactive support.

### Key physical link

The DC link buffers motor-side relief and grid-side reactive injection.

### Poster takeaway

Grid support needs coordinated converter and motor-speed control.

### LVRT priority chain

1. Connected avoid trip.

2. Hold DC keep buffer nominal.

3. Release P use speed ramp.

4. Support Q inject reactive power.

### Introduction summary

Coordinated energy flow links active-power relief, reactive support, and DC-link safety.

### What changes from a normal drive

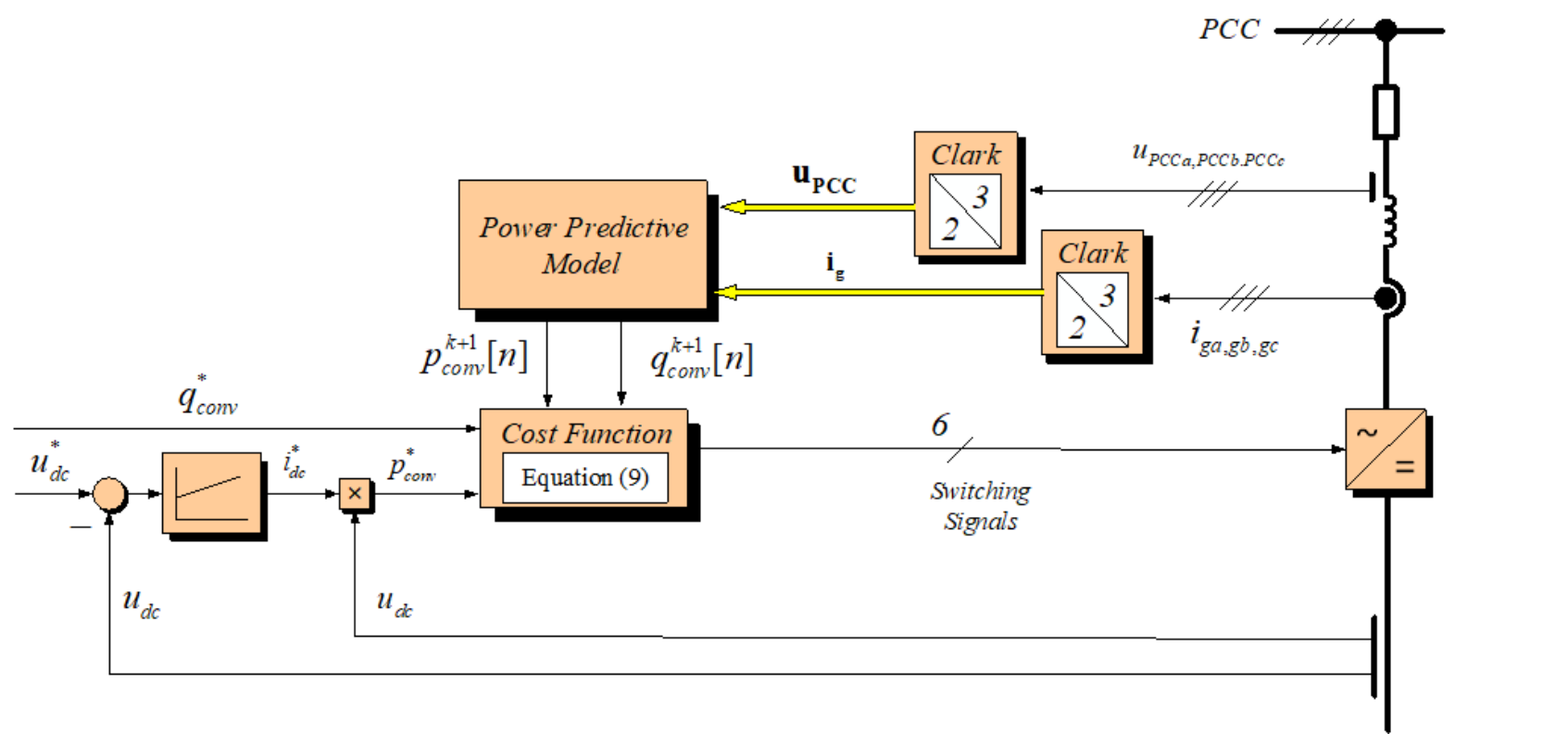
- Normal drive control mainly regulates operation.
- LVRT control must also satisfy grid-support behavior.
- Converter current becomes a temporary grid resource.
- Motor active power is reduced instead of tripping.
- DC-link energy is kept near its safe operating range.
- Reactive support is delivered while the drive stays available.

### Grid-value message

The drive becomes a controllable LVRT support unit.

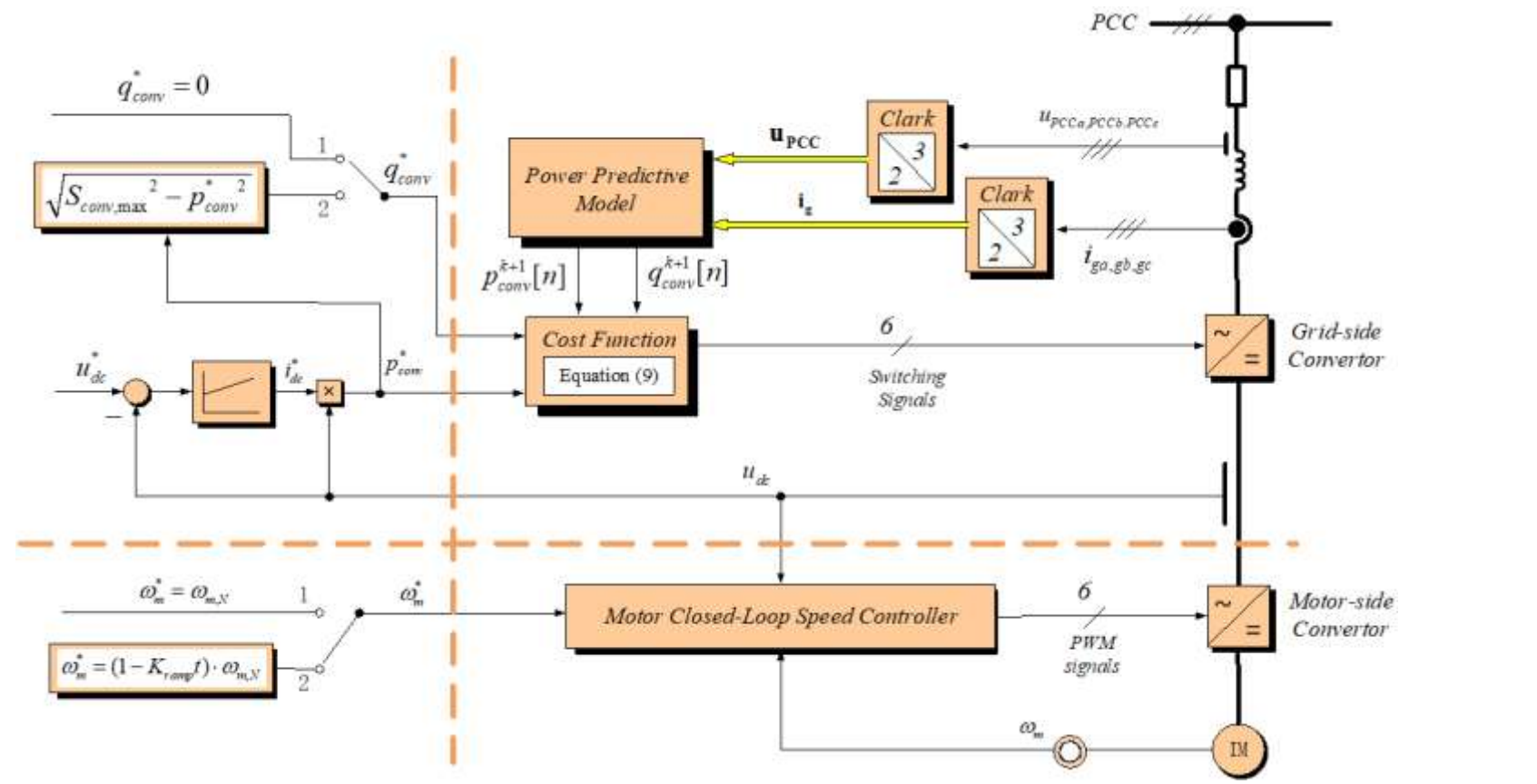
## METHOD

### Direct P/Q tracking by MPPC



- Predict active and reactive power for each switching state.
- Select the vector with the smallest tracking error.
- Avoid slow cascaded current-loop dynamics during LVRT.

### Coordinated control



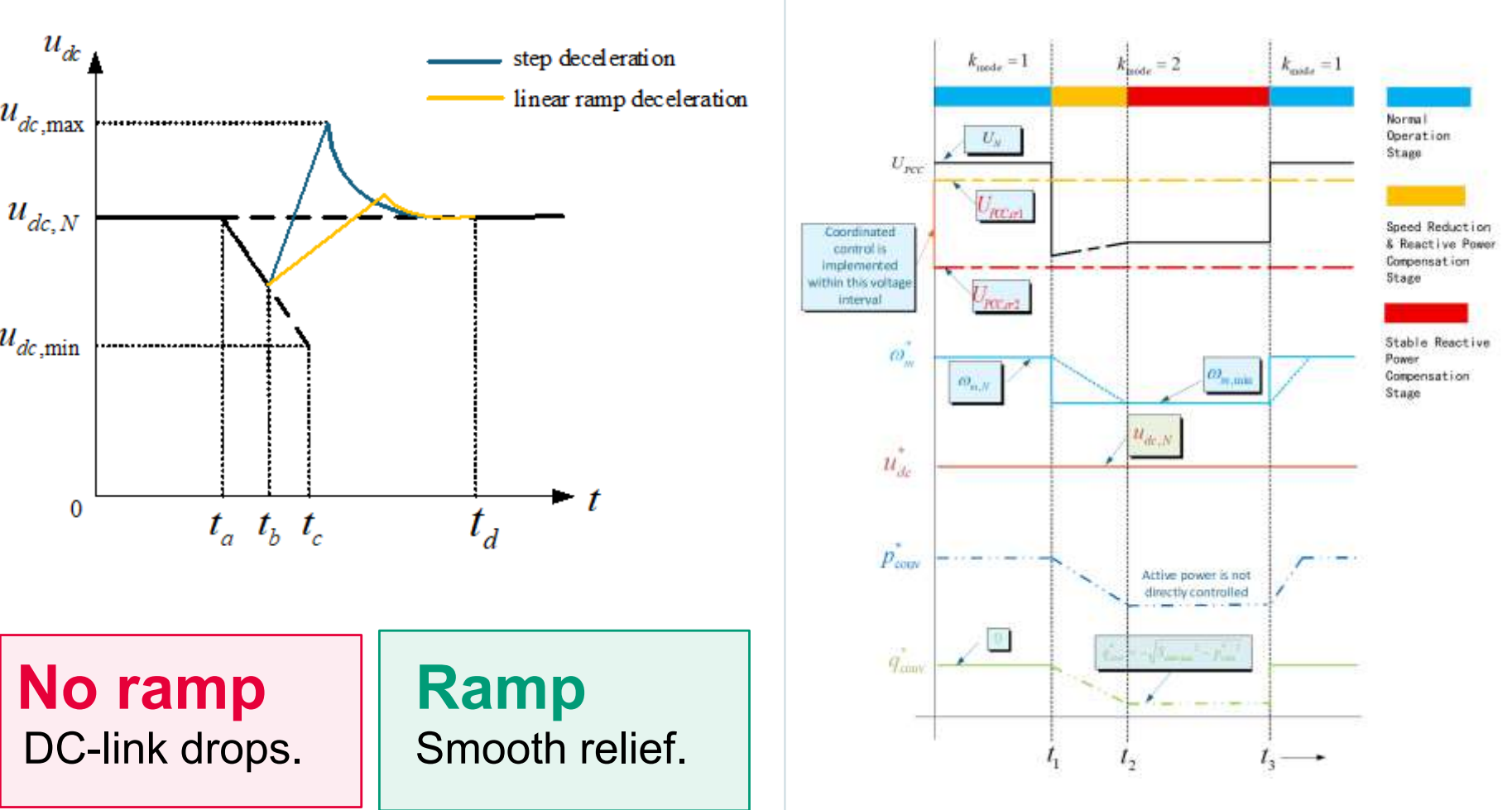
### Reactive reference

LVRT mode switches to reactive support.

### Active-power relief

Speed command ramps down to release capacity.

### DC-link protection logic



No ramp  
DC-link drops.

Ramp  
Smooth relief.

### Control sequence

Detect sag  
PCC enters LVRT.

Ramp speed  
active power drops.

Inject Q  
support the grid.

Recover  
references return.

### Method summary

Speed shaping and MPPC act as one energy-management loop.

### Implementation variables

- PCC voltage and grid current define the LVRT state.
- DC-link voltage closes the active-power balance loop.
- Motor speed ramp limits the braking-power shock.
- Reactive-power command uses remaining converter current capacity.

### Design target

Maintain 600 V DC link while injecting reactive power quickly.

Control meaning  
Both drive sides act together.

### Energy path

Active-power relief protects the DC link.

### Fast tracking

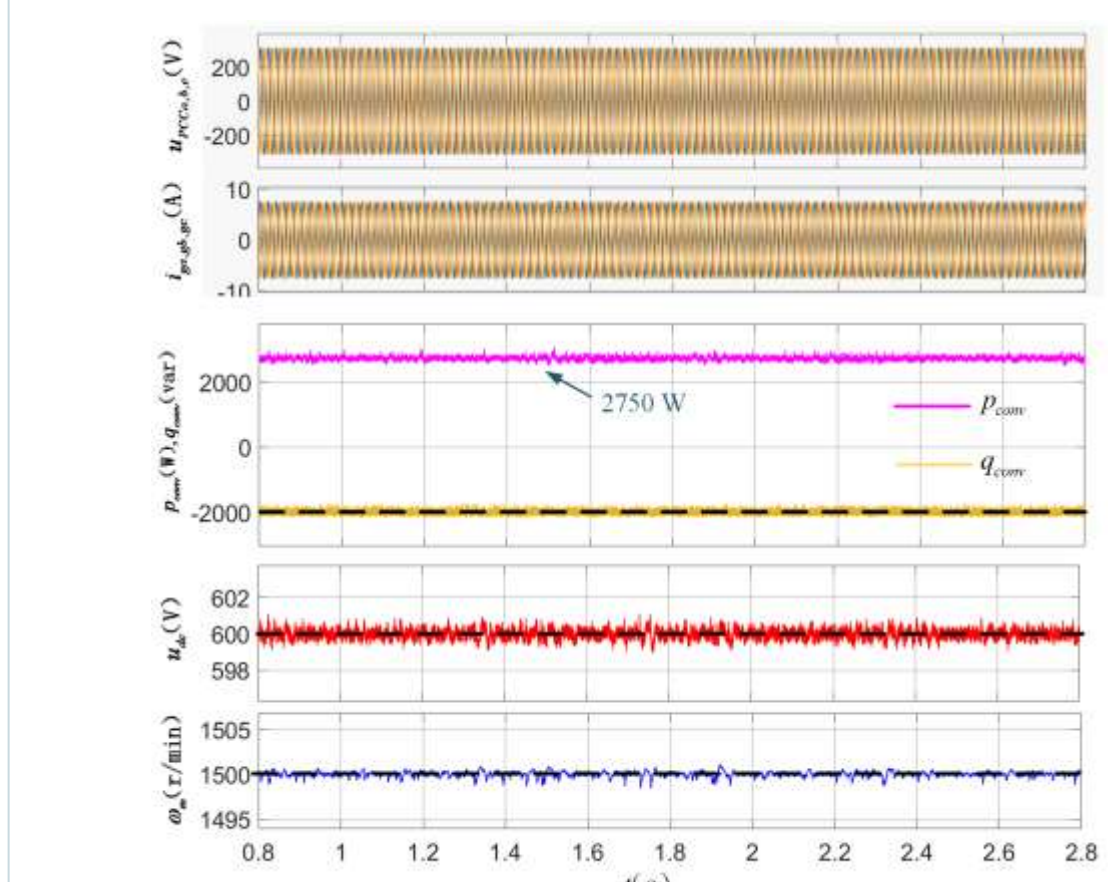
MPPC keeps grid-side power tracking fast during LVRT.

## SIMULATION

### Simulation verification

MATLAB/Simulink verifies reactive power injection, DC-link stability during LVRT, and PCC waveform quality within the required limit.

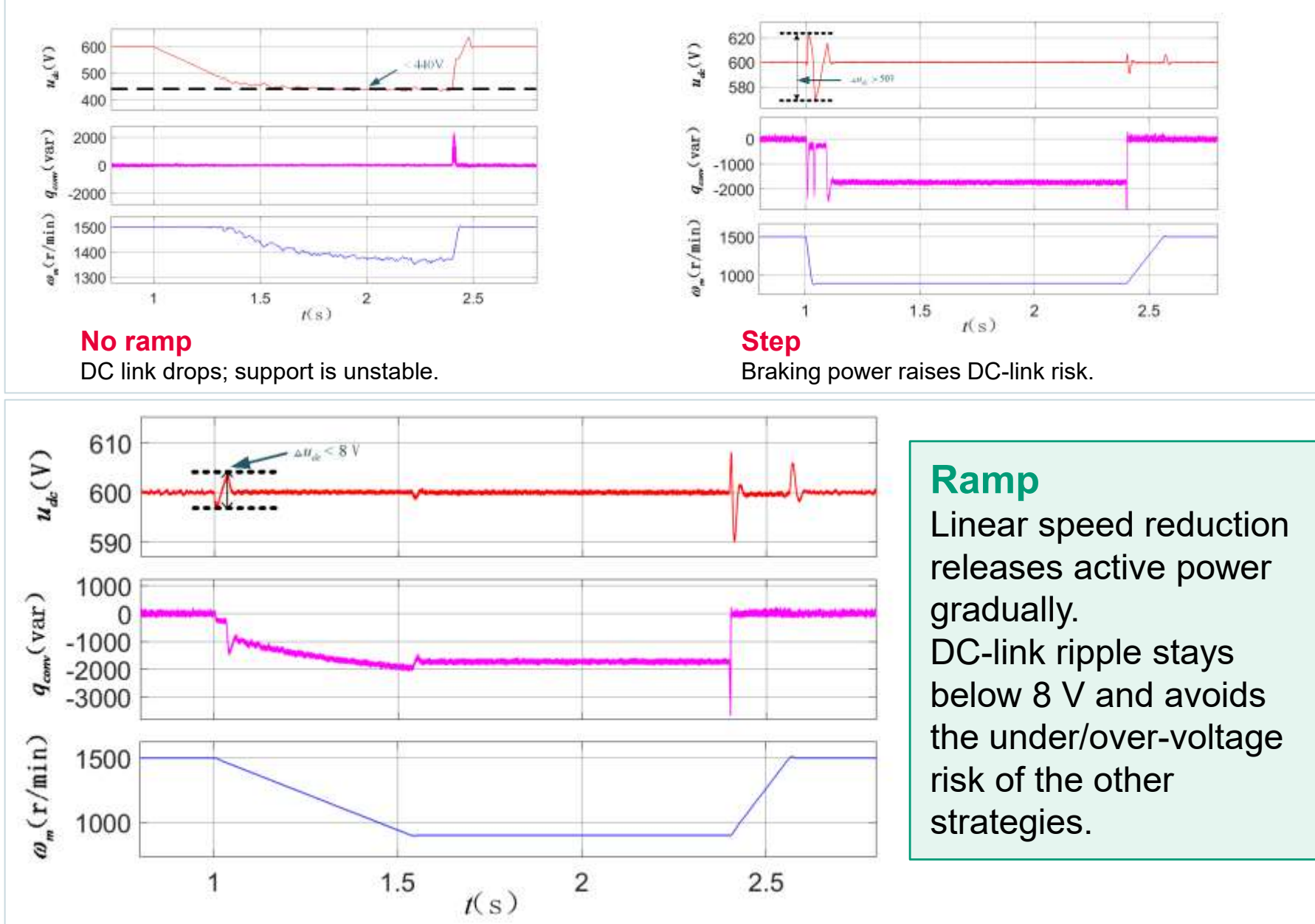
### Steady-state reactive support



### Steady support

Reactive power is injected while active power remains limited. DC-link stays near 600 V, so the drive keeps energy balance during support.

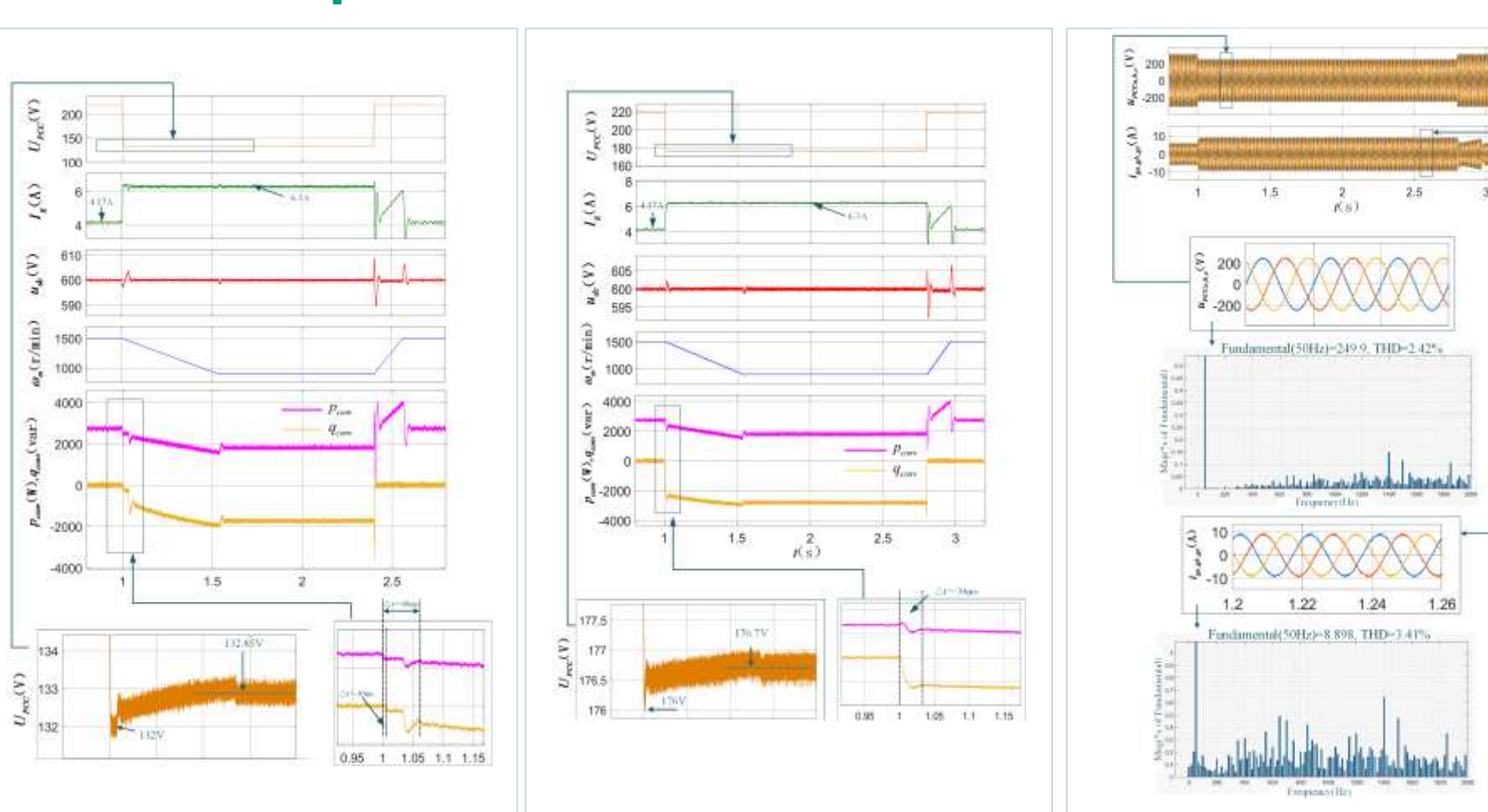
### Strategy comparison



### Best case

Ramp keeps DC-link ripple below 8 V.

### LVRT response and harmonics



### 0.6 pu sag

V/I THD: 3.74/3.72%

### 0.8 pu sag

V/I THD: 2.42/3.41%

### Conclusion

fast, safe support

### Final takeaway

AC motor drives become LVRT grid-support units when P relief and Q injection are coordinated.

### Validated behavior

- DC-link voltage remains near the rated value during sag.
- Active and reactive powers settle in about 30 ms.
- Current and voltage waveforms satisfy the 5% THD requirement.
- The motor-drive system remains available after the grid event.
- Tests connect method to LVRT behavior.

### Conclusion

Coordinated control enables dynamic grid injection without compromising drive safety. DC-link stability, fast response, and harmonic compliance are verified together.