



Frankfurt (Germany), 6-9 June 2011

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# Improved Requirements for the Connection to the Low Voltage Grid

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## Agenda

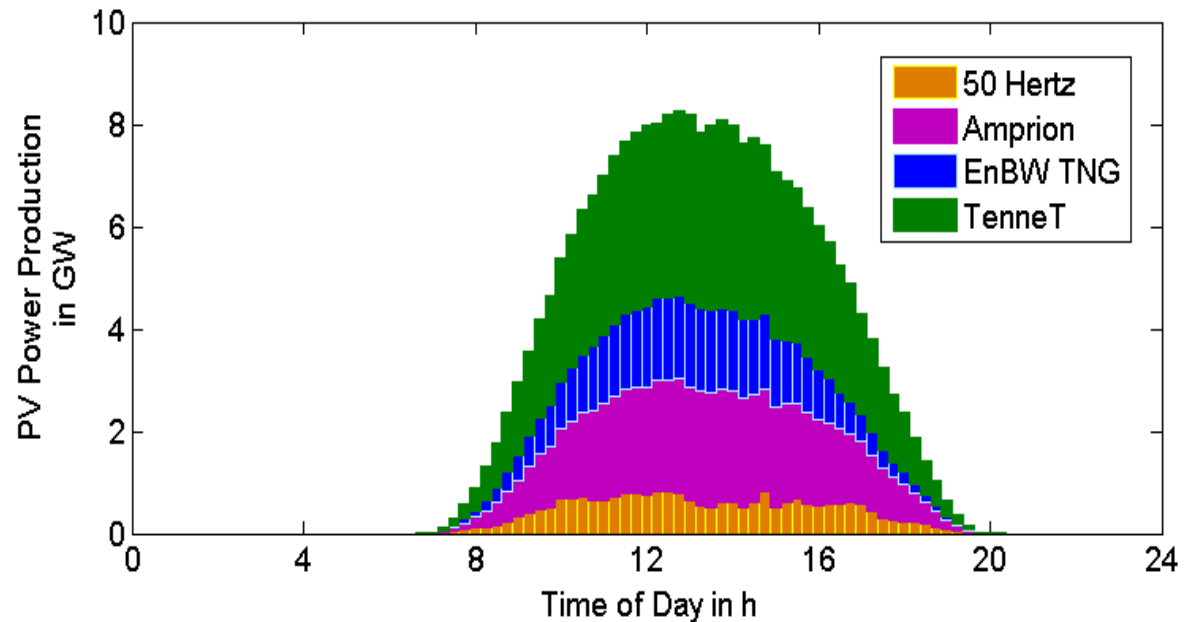
- Development of LV Feedings
- Risk of Major System Disturbance
- Simulation Results
- New Requirements
- Risk and Incident Management

## Development of LV Feedings

□ PV becomes system relevant

□ 17 GW<sub>peak</sub>

□ yearly  
growth  
> 100%



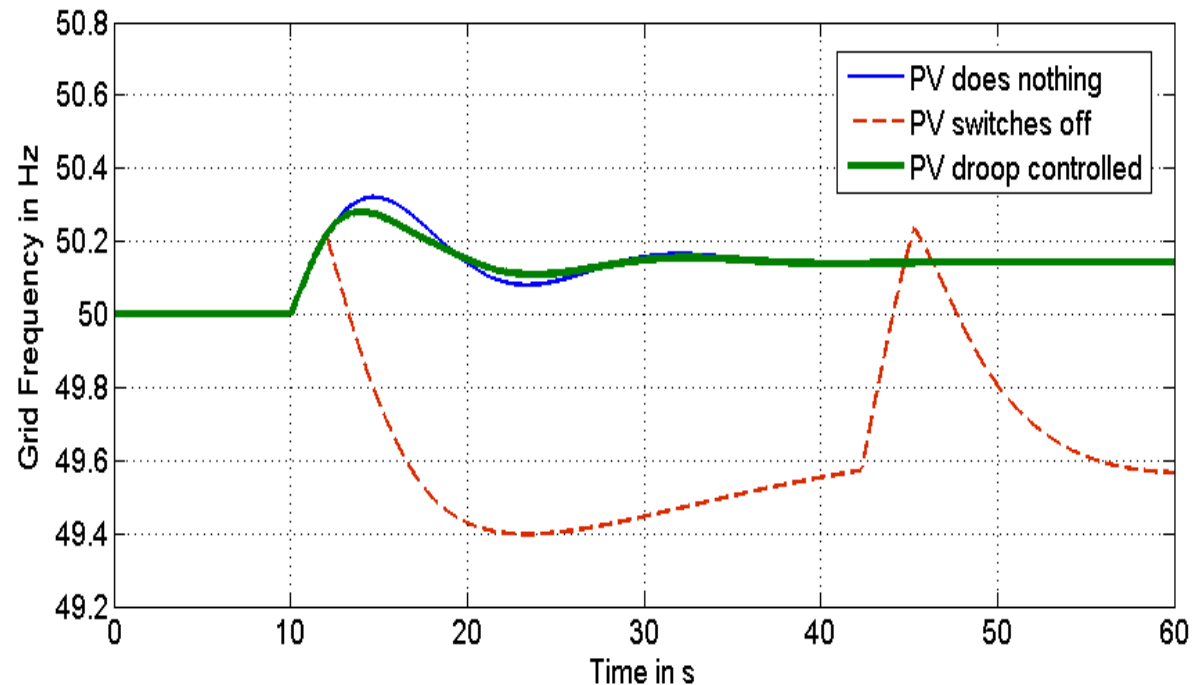
□ ~80% connects to LV

## Risk of Major System Disturbance

- Connection Requirement VDE 0126-1-1
- „How to build a non-linear oscillator: “
- Disconnect at 50,2 Hz
- Reconnect after 30s while  $f < 50,2$  Hz
- Used for disabling DERs during grid maintenance and islanding
- DERs were regarded as noise generators
- Now: noise is  $>10$  GW and coherent

## Simulation Results: Worst Case Scenario

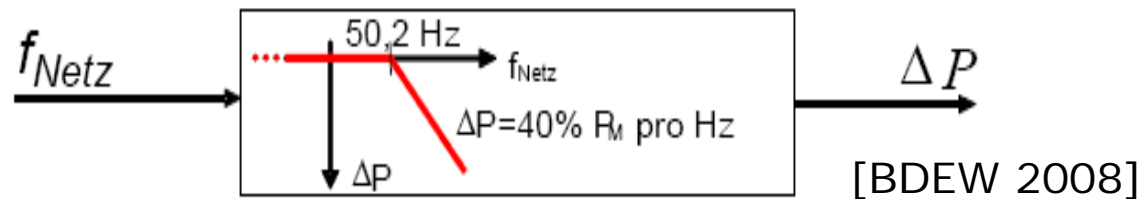
- Loss of Load: 5 GW
- 10 GW PV disconnects
- Reconnects ~ 30s later



- Yo-Yo effect until sunset?

## New Requirements: LV Grid Code VDE-AR-N 4105

- Similar frequency behaviour as MV and Transmission code



- Droop begins at 50,2 Hz with smooth power reduction
- Interim rule already in effect

## **New Requirements: Review of Other DG Standards**

- ❑ EN 50438 / TS 50549: European Standard with an over frequency threshold at 51 Hz
- ❑ IEEE 1547-2003: Over- and Under-frequency trigger level at 60,5 Hz/59,3 Hz
  
- ❑ ENTSO-E is drafting a Network Code for generators down to 400 W

## Risk and Incident Management

- Develop New Technical Guideline (✓)
- Reduce legacy volume (✓)
- Minimise Frequency Excursions
- Make the grid more resilient
  - Enhanced self-regulation effect
  - Synthetic inertia
- Have emergency plans (Policy 5) available for stabilising the yo-yo effect





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**Thank you for your attention,  
further questions will be answered by:**

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## Backup – Simulation Parameter

Netzlast 200GW, PV-Einspeisung 10GW

Selbstregelleffekt der Last 1,5%/Hz

Anlaufzeitkonstante 10s

Statik der Primärregelung 0,125,

Begrenzung der Primärregelung (+3GW / -50GW)

Lastabwurf einsetzend bei 49,2 HZ, Zeitverzögerung Lastabwurf 0,2s

Abwurf von Pumpspeicherlasten 1,6GW

(1,1GW bei 49,5Hz und 0,5GW bei 49,3Hz)

Kein Netzrauschen

Fehlerzeitpunkt 10s

Netzfrequenz 50Hz

erste PV Frequenz 50,2Hz

zweite PV Frequenz 51,0Hz

PV Abschalt Wartezeit 30s

PV Abschalt Verzögerung 0,2s