

Presentation for 4TH Workshop of IEA PVPS Task 14 "High-Penetration of PV Systems in Electricity Grids" Lecture Hall of 1st Building, IEE, CAS, Beijing

Grid-FriendlyTM PV Station Integration and Coordinated Operation in Power System

Zongxiang LU

Department of Electrical Engineering
Tsinghua University
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- Background of large scale PV station integration in China
- Technical barriers of integration large photovoltaic power stations into power grid
- Ideas about Grid-FriendlyTM PV Station
- Ideas about Coordinated Operation of PV stations and power grid



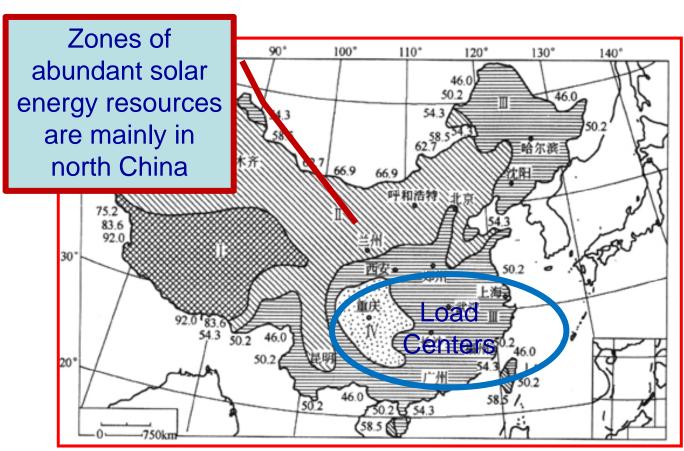
Why we need large gridconnected PV stations

- In Chinese electrical power planning
 - 2020, total installed capacity will reach 1.4 billion kW, but traditional power plants (thermal, hydro) can only supply 1.2 billion kW
 - the gap must be filled by renewable energy, specially relying on wind power and PV. Predicted installed capacity of wind power and PV are 150 and 25 million kW respectively
 - 2050, total installed capacity will reach 2.8 billion kW, and wind power and PV are 488 and 506 million kW respectively





Why we need large gridconnected PV stations



Main characteristics of PV technical roadmap of China:

- Large scale PV Stations
- Long distance transmission



Distribution of radiation dose in China

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Impacts of PV stations while integrating into power system

- The unique features of PV systems
 - fluctuating generation
 - inverter connection
- Impacts to power system
 - Voltage fluctuation directed by the output variability of PV system
 - Reduction of stability margin due to the PV system are current sources without rotating inertia
 - Making protection setting be more complex in distribution system



Grid integration demand and status of large PV stations

Request of power grid

Status of large PV stations

The active power is adjustable, and have ability of frequency regulation

Mainly using MPPT control strategy, and output is variable

Certain output of reactive power, and have ability of voltage regulation

Have few or even no reactive compensation devices in PV station

Island protection

have no coordinated control strategy of island detection among converters

LVRT

No LVRT, or this function is conflicted with island protection

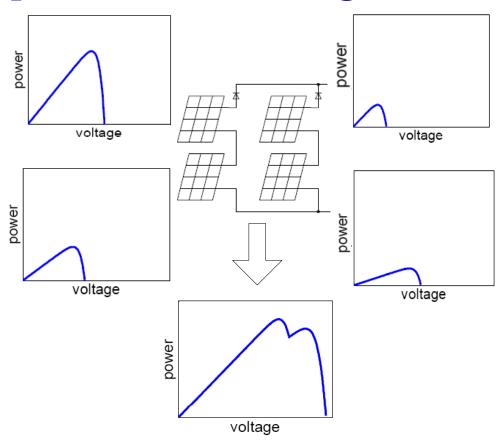
Can be looked as one unit to regulation in system operation

Converters have influences each other

High efficiency of transform, high power quality

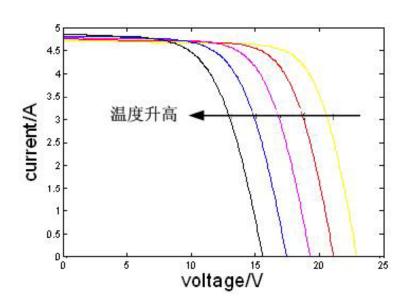
Efficiency of transform is poor, and harmonic exceeds bid 6

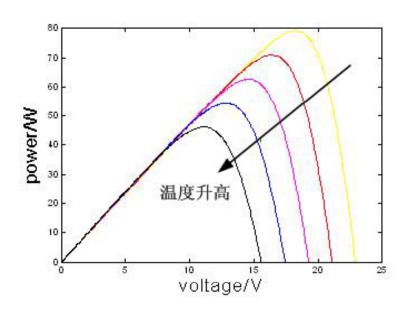
Multi-peak values of large PV array





Temperature characteristics of PV array

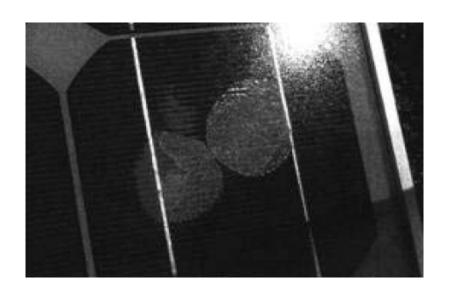




Output of PV array are high related to the temperature of environment



Hot spot effect of PV arrays

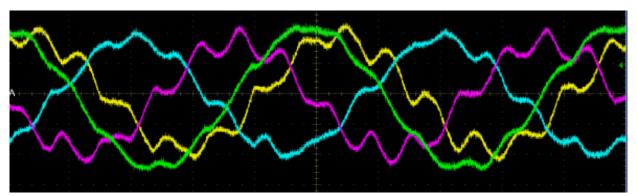




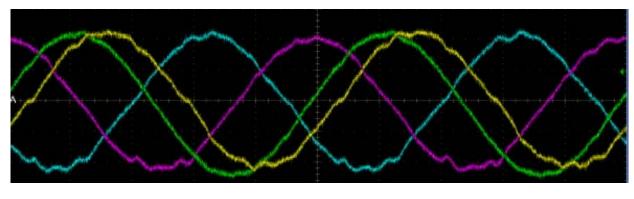
Hot spot effect leading to local failure Fire disaster of Buerstadt PV station in Germany, June.2009



Power quality



Low sunshine



High sunshine

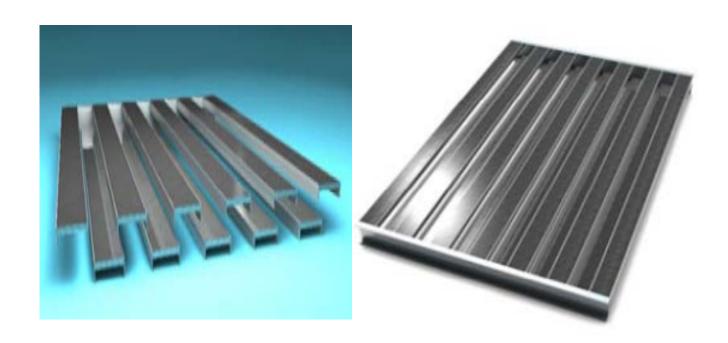


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Key Issues of Grid-FriendlyTM PV Station

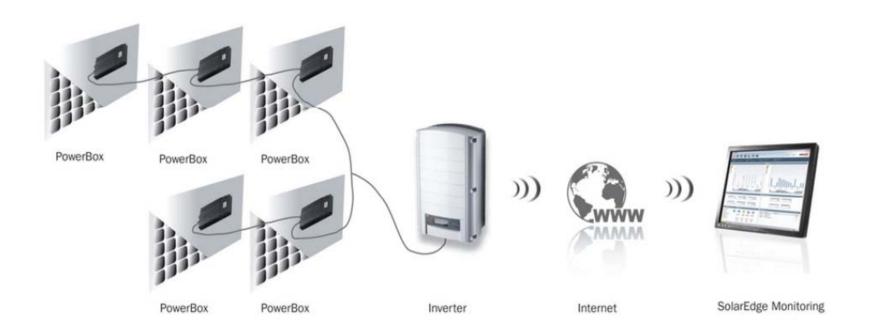
Concentrating PV modules





Key Issues of Grid-FriendlyTM PV Station

PV intelligent modules





Key Issues of Grid-FriendlyTM PV Station

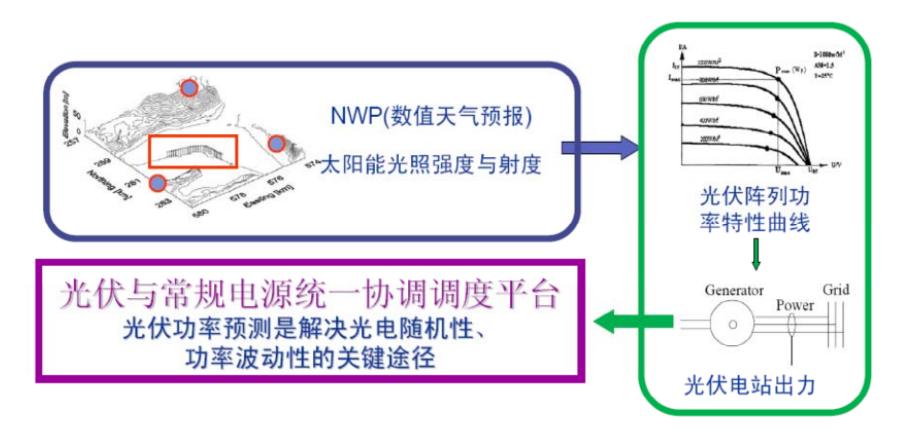
- High performance transform technology
 - Unified inner control in multiple converters to solve the conflict between island protection and LVRT function of PV systems
 - Unified outside control to response the request of power grid as one unit, such as power regulation, LVRT and so on



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Schematic diagram of PV station operation



New predictive dispatch schematic of power system with large PV stations basing power forecasting technology 16

Q&A

