中国南方电网
CHINA SOUTHERN POWER GRID

Experiences and future development for synchrophasor technology

China Southern Power Grid

1 Installation in China

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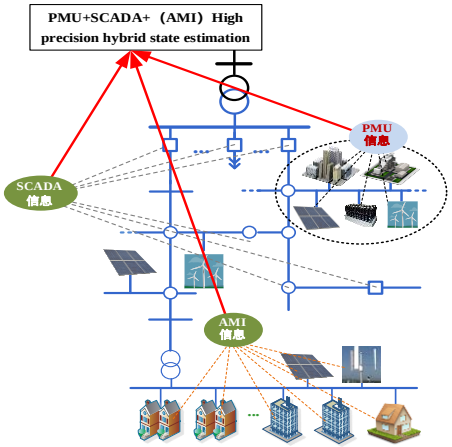
- ✓ The distribution of PMU should meet the requirements of power grid stability monitoring, analysis, warning and decision-making.
- ✓ About **5000** PMUs have been installed and put into operation in China.

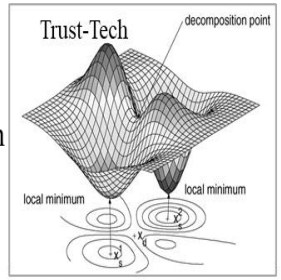
Substations and Plants	Specific Requirement on installation
Power plants	with unit capacity above 300MW or with total installed capacity above 500MW
Substation	500kV or with small hydropower capacity over 200MW
New energy power station	the wind farm, photovoltaic power station and STATCOM station connected to the system with 110kV voltage level or above
Other power plants and substations	with prominent stability problems

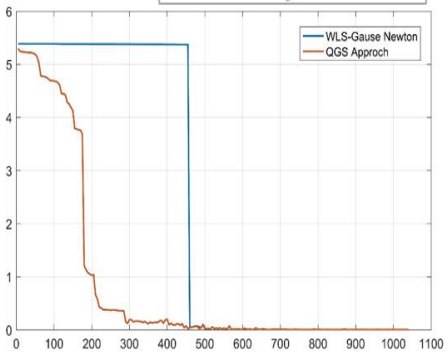
2 Experiences in Transmission Network

- ✓ **Online monitoring:** High precison **hybrid state estimation** realized by PMU, SACDA, AMI combination can ensure convergence in more than 99.99% scenarios, and obtain more than 95% local estimation accuracy based on measurement information.
- ✓ **Parameter identification:** Generator model, load model and topolygy validation based on PMU data can realize the identification of real time load model parameters.



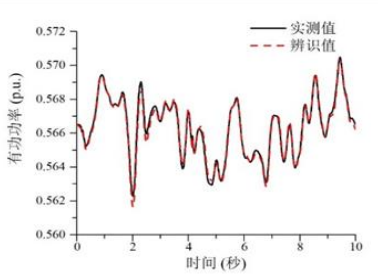
Trans-formation under Stability-retaining Equilibria Characterization



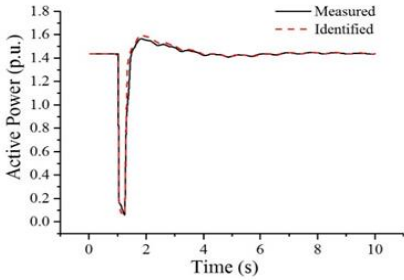


Hybrid state estimation

Power curve after small disturbance



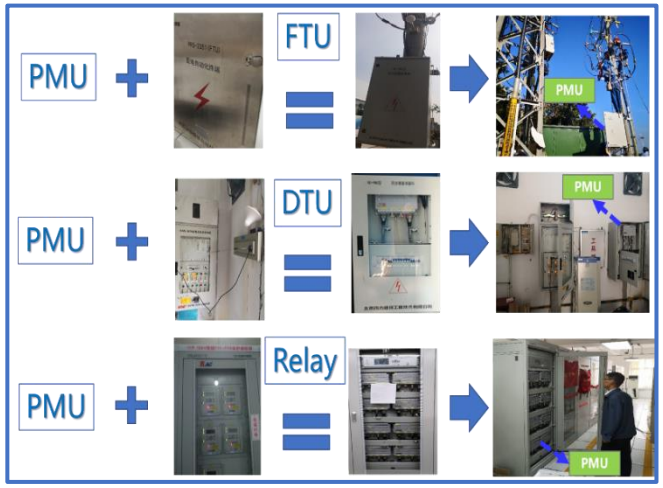
Power curve after large disturbance



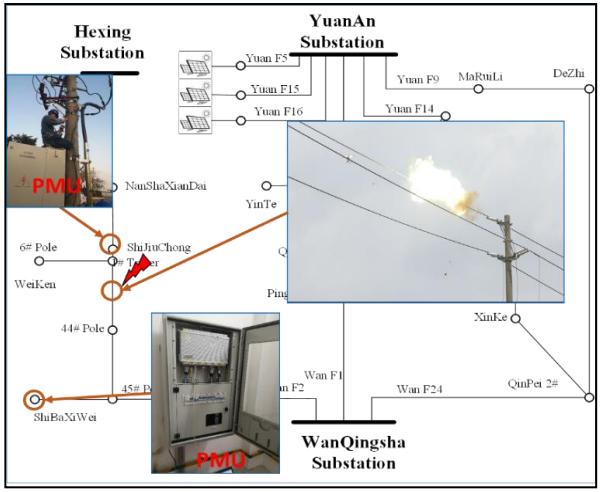
Parameter identification

3 Experiences in Distribution Network

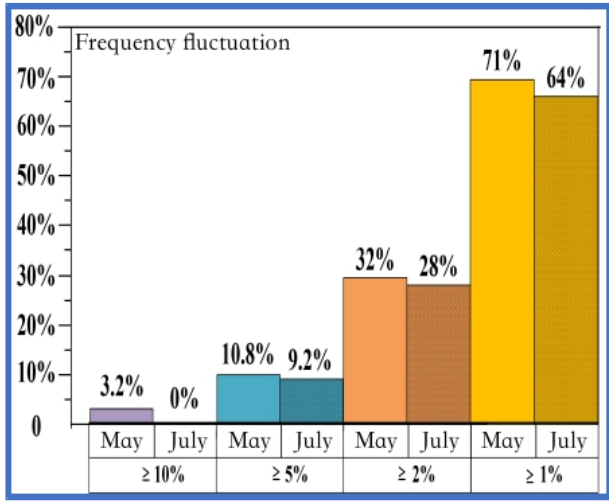
- ✓ **“PMU+”.** It integrates the rapidity, accuracy, reliability and expansibility with traditional primary devices, secondary devices, and advanced applications to create a new generation of devices, improve the productivity of distribution network.
- ✓ **Automatic fault positioning of distribution network**. Through the fault diagnosis and precise location technology based on panoramic inversion theory, the fault location accuracy is less than 0.2km, and the fault diagnosis accuracy is more than 99%. The actual fault waveform of the demonstration project is proved effective.
- ✓ **Automatic controls of demand response**. Under different photovoltaic output scenarios, the power fluctuation rate of the node is ≤ 10%.



PMU+



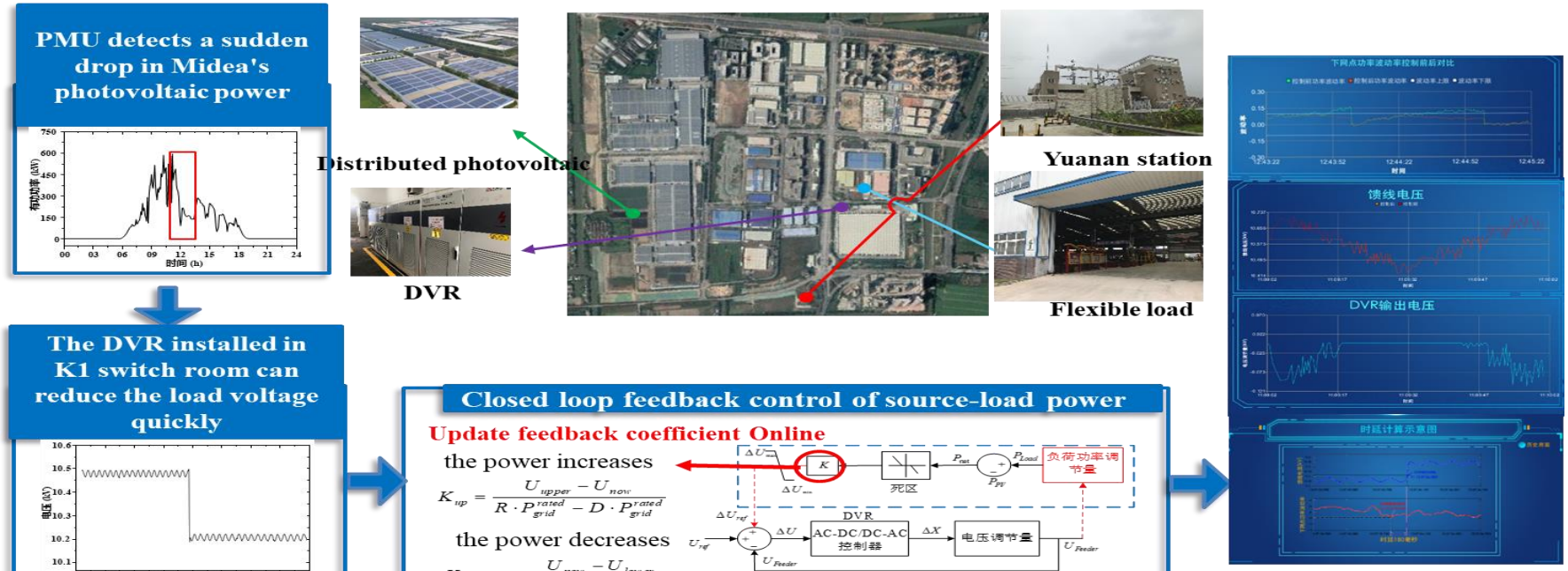
Automatic fault positioning



Automatic control

4 Future Development

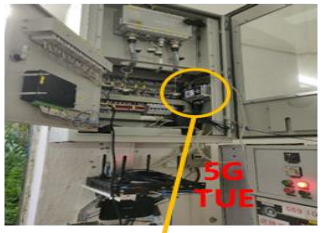
- ✓ **Power system wide-frequency measurement technology:** Monitor and measure low frequency oscillation, subsynchronous oscillation, hyper-synchronous oscillation in 100-300Hz wide-frequency range.
- ✓ **Multi-functional measurement and control device:** A multi-functional device which integrates PMU, metering unit, measurement and control unit. Used for **fast load power tracking**, improving feeder voltage qualification rate to ≥ 99.99%, and the maximum control delay of the system is less than 200 ms.

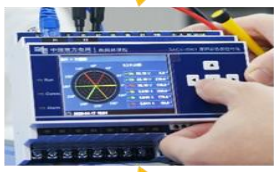


Fast load power tracking

5 5G and PMU

- ✓ In order to cope with the development of 5G technology in the future, the first field comprehensive test verification of 5G based PMU was completed in May 2019.
- ✓ In terms of time service accuracy, the error is within 300 nanoseconds.
- ✓ In terms of communication delay, the maximum bidirectional delay from the device to the master station is 14ms.





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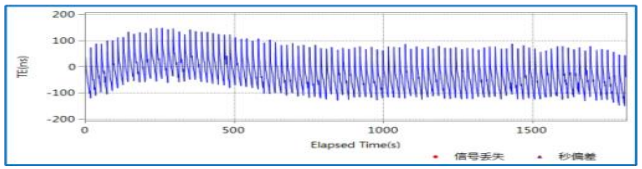
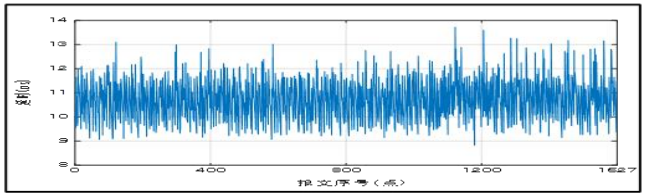
Field installation



100 nanosecond high precision time service



10 millisecond low delay and high reliability communication

Test result

Media publicity

Thank you