微电网与IEC标准

Microgrid and IEC Standard

张建华　教授、博导

Prof. Zhang Jianhua

华北电力大学

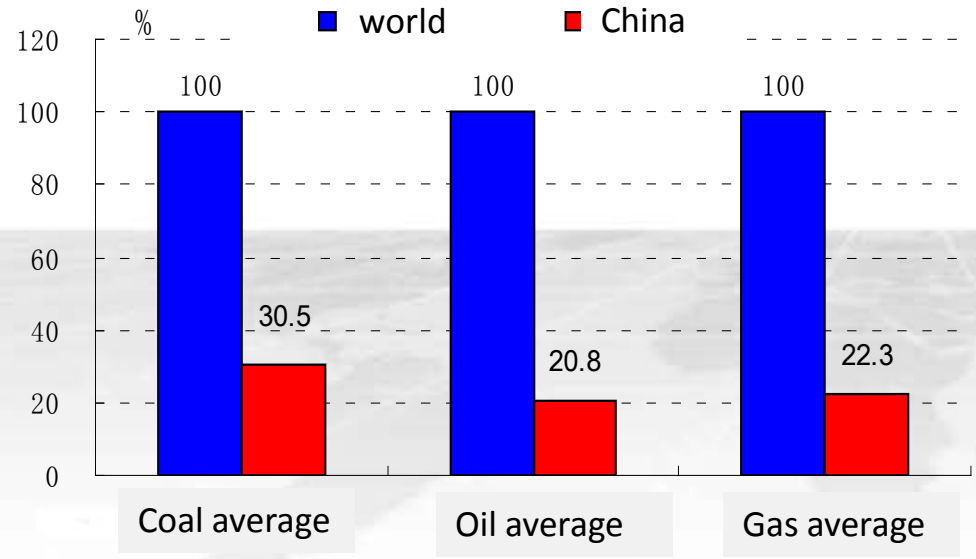
North China Electric Power University

Email: jhzhang001@163.com, Mobile: 13501118912

Monday, August 29, 2016

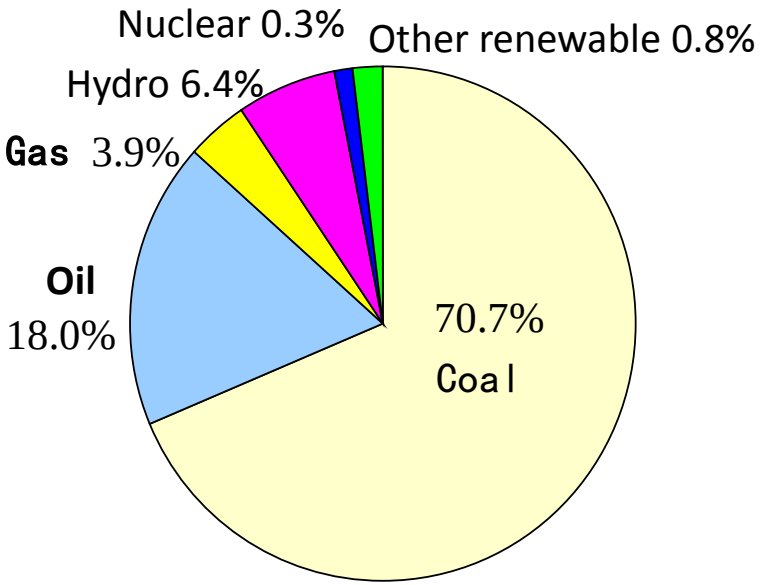
中国能源资源现状
Current situation of energy resources in China

	Total	Ratio in the world	Range
Hydro(亿千瓦, 100 GW)	4	17%	1
Coal(亿吨, 100 GT)	2020	12.6%	2
Oil(亿吨, 100 GT)	23	1.3%	10
Gas(10^{12} m^3)	2.23	1.3%	22



一次能源消费严重依赖化石能源

Severely relay on patrol energy

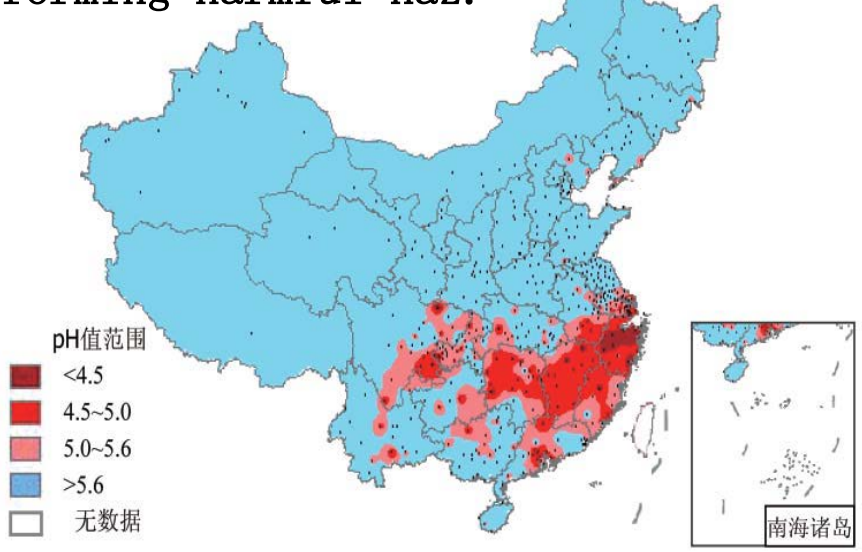


Major energy source is coal, and average energy source occupied per person is much lower than the average in the world.

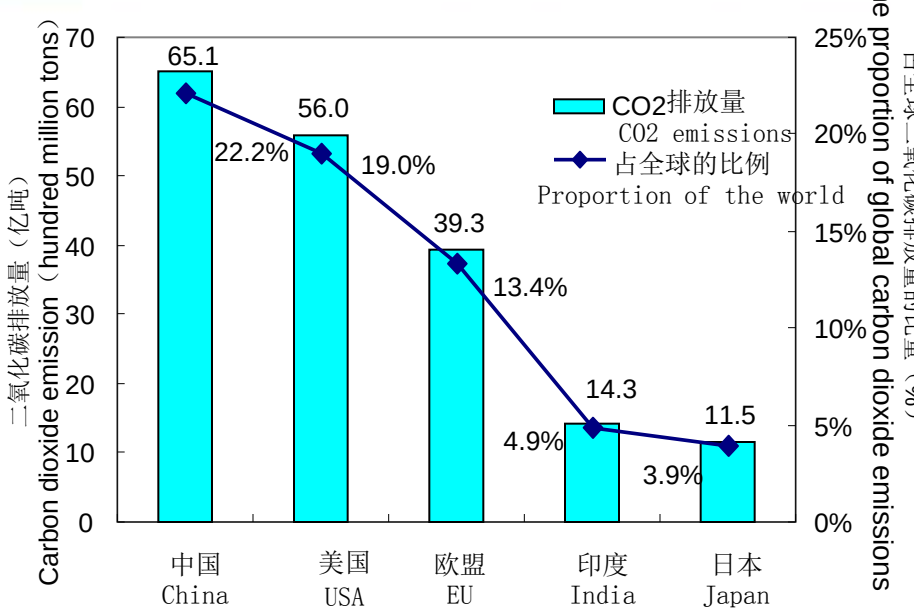
我国是世界二氧化硫排放第一大国，并已成为世界二氧化碳排放大国

China has became the largest country for sulfur dioxide and carbon dioxide emission.

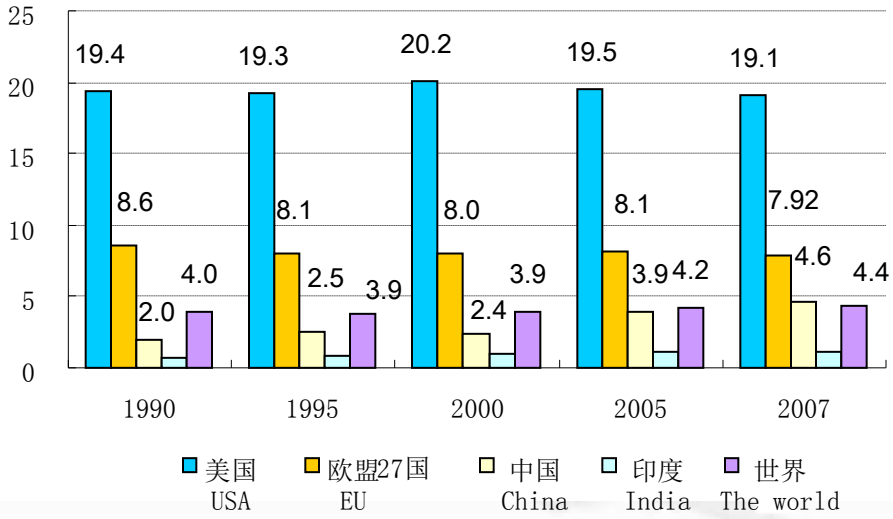
Severe prolusion has attacked more than 52.9% (258) cities, forming harmful haz.



From: IEA (2010)



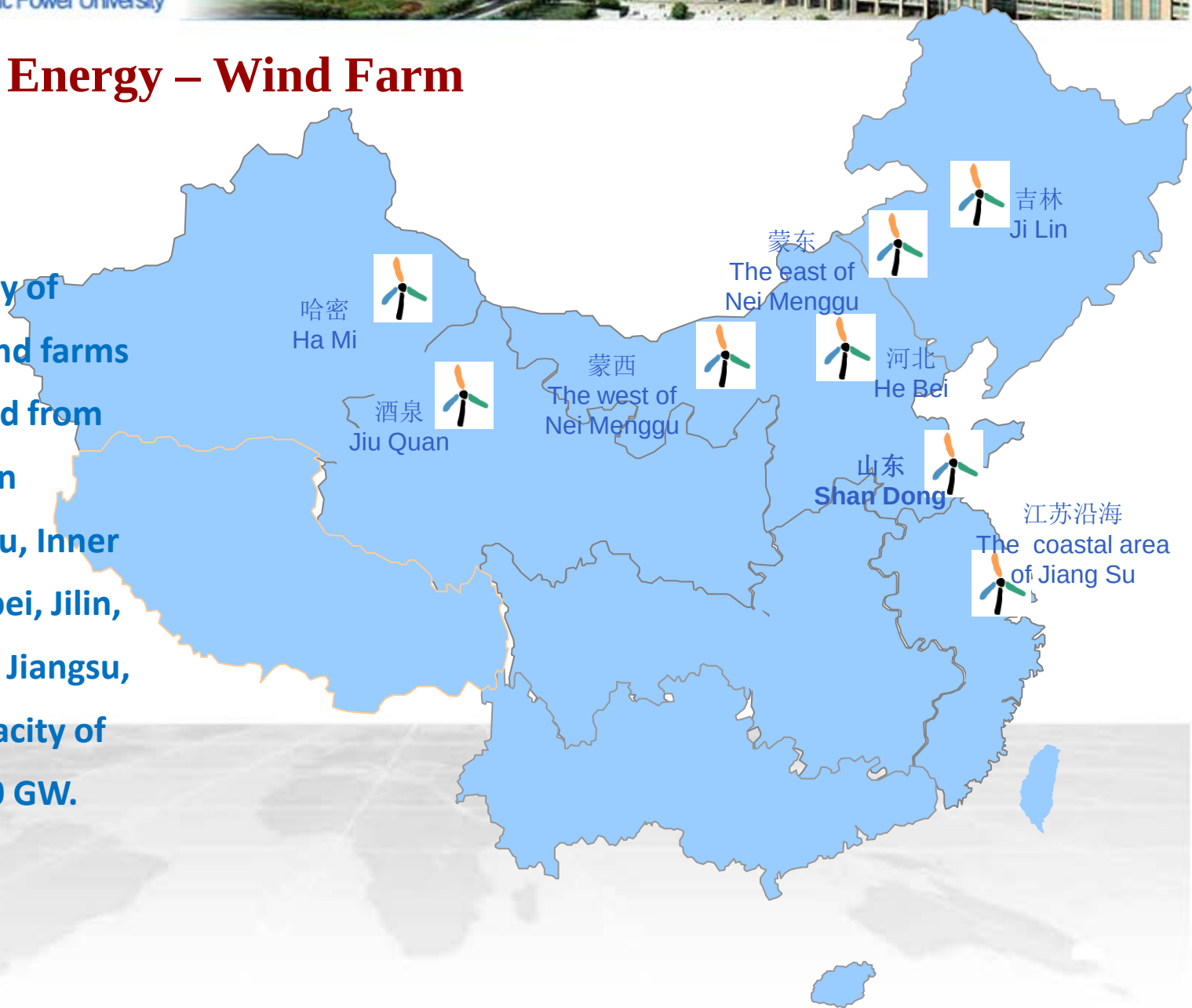
The amount of CO2 emission has exceeded 6*10^9 tones



人均排放量已超过世界平均水平

Renewable Energy – Wind Farm

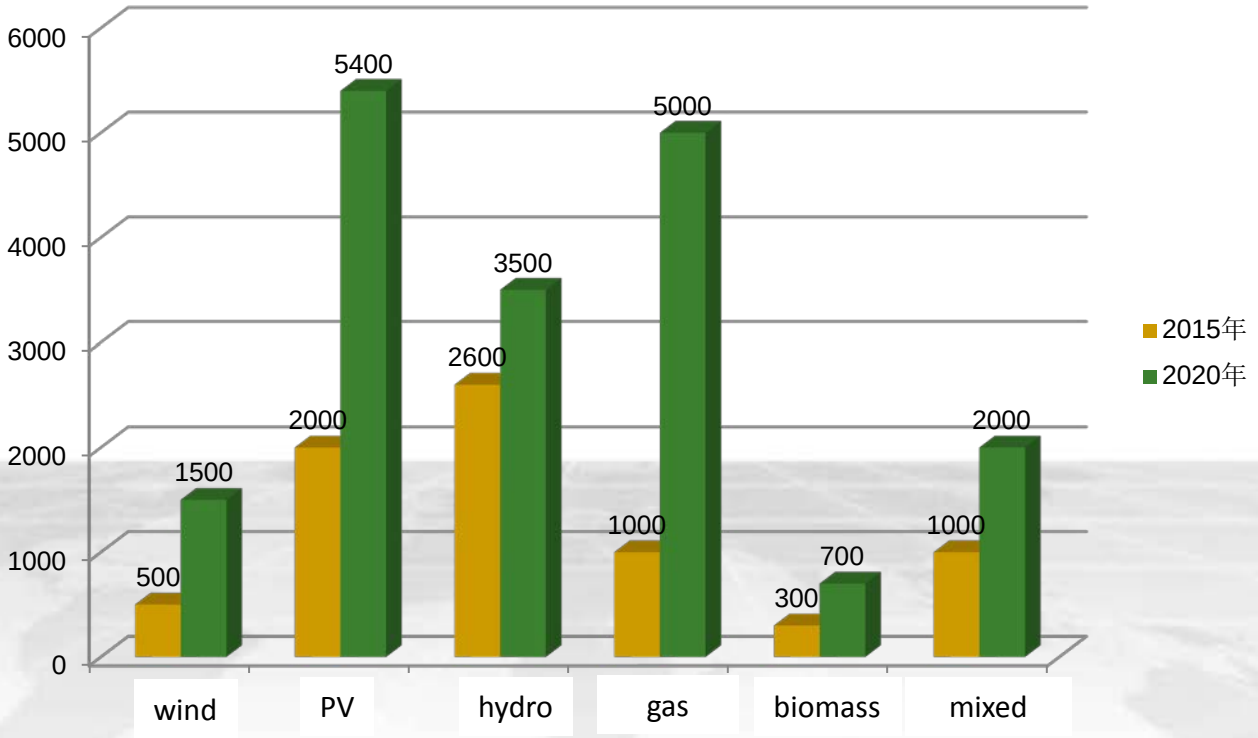
8 large capacity of centralized wind farms are constructed from 2010 to 2020 in Xinjiang, Gansu, Inner Mongulia, Hebei, Jilin, Shandong and Jiangsu, with total capacity of more than 150 GW.



中国分布式电源发展趋势

Development trend of Distributed generation in China

2015年：74GW
2020年：180GW



分布式能源并网和高效消纳 *Connection to the grid and high efficiency consumption for distributed energy resources*

1 如何实现对大范围接入的间歇性、波动性分布式电源（太阳能、风能、燃气轮机、电动汽车、分布式储能）的有效控制？

How to effectively manage the intermittent and fluctuant distributed resources?

2 如何满足客户对电网供电可靠性、电能质量等电力服务的各种日益提高的要求？

How to meet the customers' requirements for reliability and power quality?

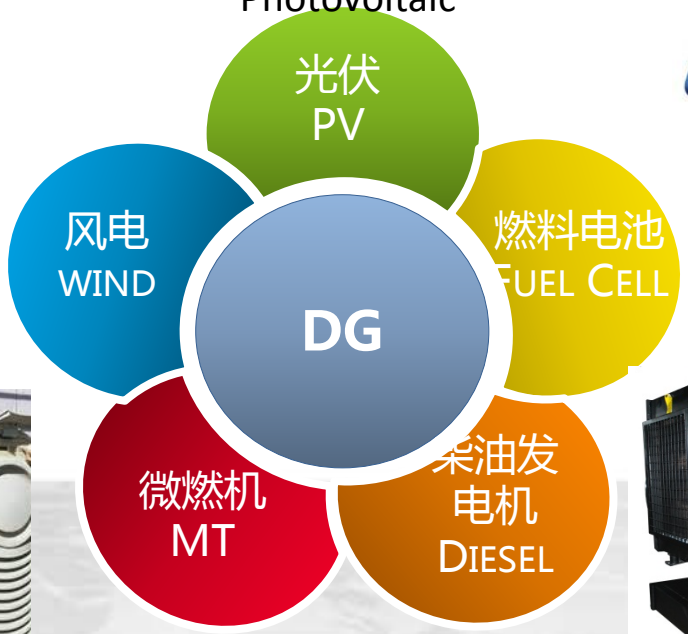
Microgrid

关键技术1：分布式发电技术
Key Tech 1: *Distributed Generation*

- 容量从几十千瓦到几十兆瓦
  Capacity from kW to MW
- 运行方式灵活
  Flexible operation mode
- 即插即用
  Plug and play
- 可靠性高
  High reliability
- 清洁环保
  Clean and environmental friendly

Wind turbine

Photovoltaic



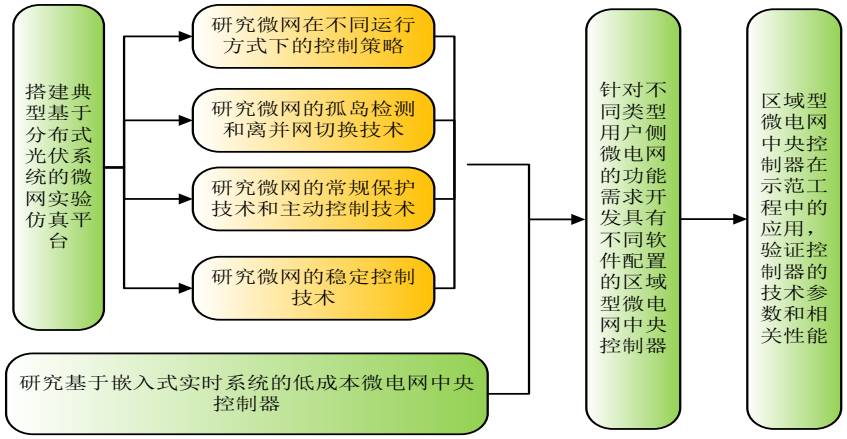
Fuel cell

Microturbine

Diesel engine

关键技术2：微电网控制与保护技术

Key Tech 2: *Microgrid Control and Protection*

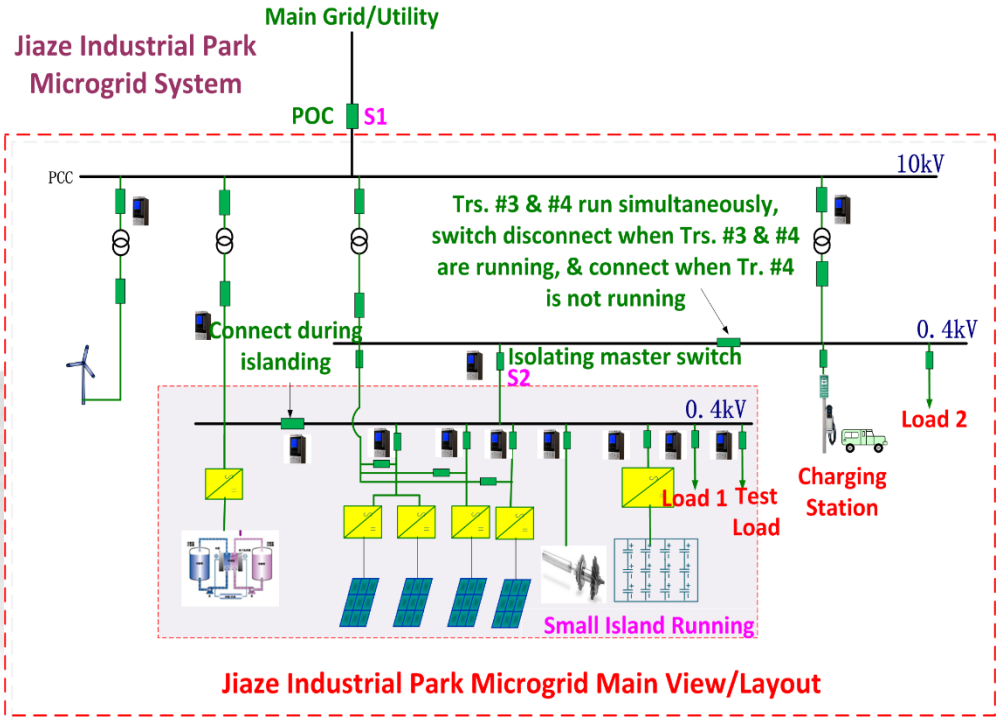


1. 不同供电模式下的微电网的**孤岛检测与运行控制**
   Island detection and control for MG in different power supply modes

2. 微电网的**保护与主动安全控制技术**
   Active protection and control technology for MG in customer side

3. 高渗透率场景下的微电网互联运行的**群组协调控制技术** **Group coordination control for interconnected microgrids under high permeability of DERs**

4. 适用于**微电网的集中/分散控制保护装置**
   Centralized/distributed controller and protection equipment



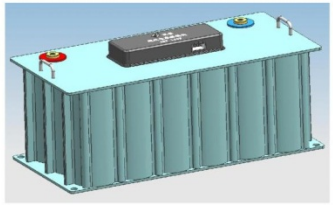
关键技术3：储能技术
Key Tech 3: Energy Storage

- 提高系统的经济性和灵活性
  Improve the economy and flexibility of the microgrid
- 平抑可再生能源的波动性
  Restrain the volatility of renewable energy
- 提高暂态过程中的稳定性
  Increase the stability during transient process

锂电池
Lithium battery

钒液流电池
Vanadium redox flow battery

电动汽车
Electric vehicle



超级电容
Supercapacitor

电动汽车将是未来电网中重要的储能形式。
The electric vehicle will be a very import type of energy storage in the grid of the future.

关键技术4：微电网能量管理系统

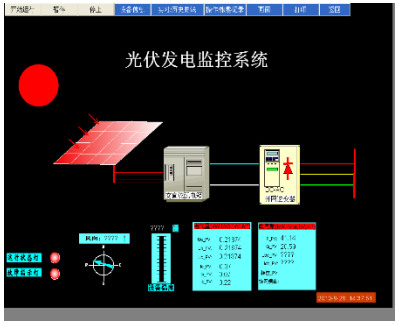
Key tech 4: *Microgrid Energy Management System*

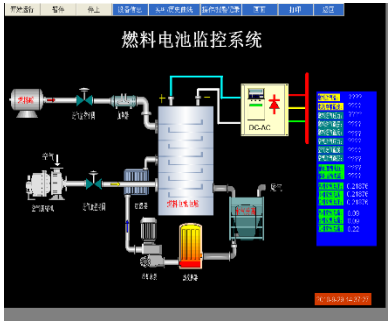
- 监视和预测微电网内各分布式电源、储能和负荷的状态

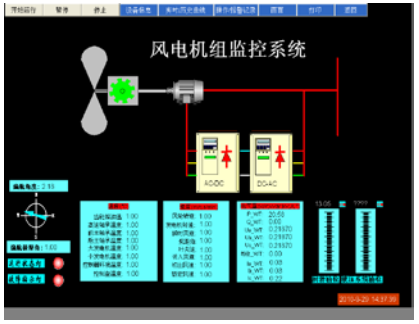
Monitor and forcast the DGs, energy storages and loads

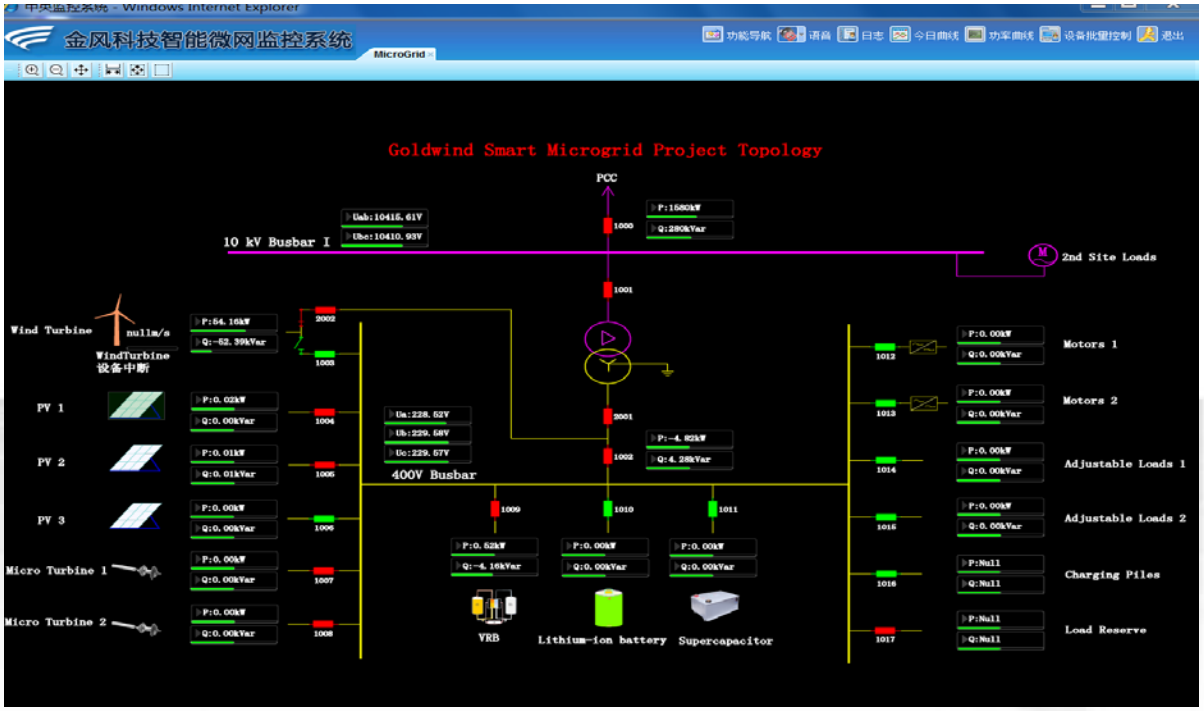
- 生成最优控制策略，实现微电网的稳定与经济运行

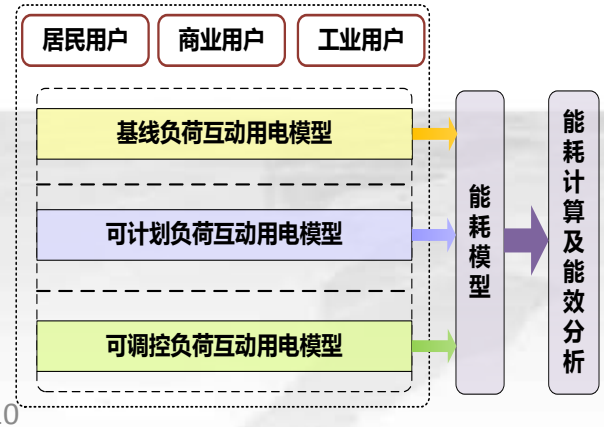
Generate the optimal control strategy and realize the stable and economic operation of the microgrid





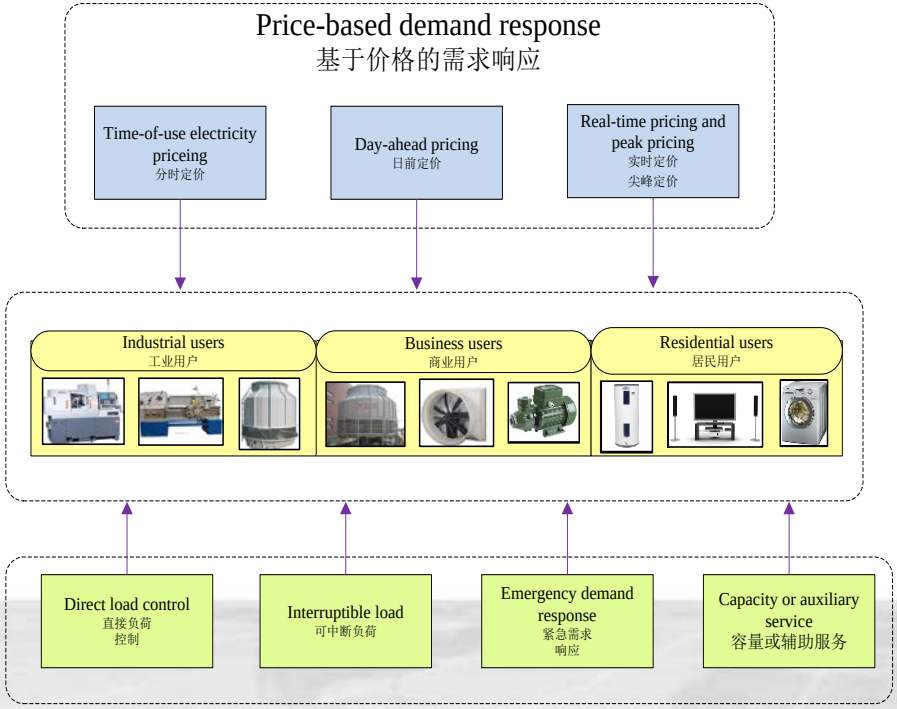






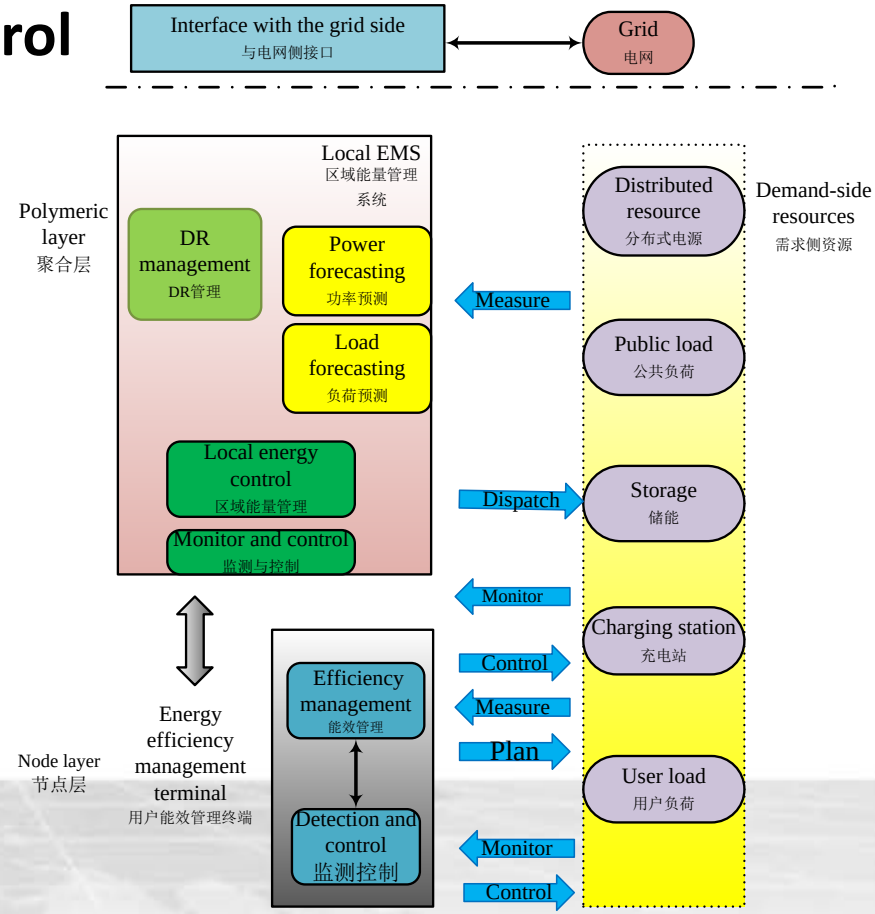
关键技术5：多微网协调控制技术

Key Tech 5: Coordination control among microgrids



基于价格的多微网协调

Price based coordination for microgrid



基于直接控制的多微网协调

Direct coordination control for microgrids

1 微电网的接入将使配电系统发生根本性变化

The connection of microgrid will make a fundamental change to the distribution system

微电网的接入使配电网从传统的单向辐射型无源网络变为潮流双向流动的有源网络

The connection of microgrids changes the distribution network from a radial, passive network to an active network with bi-directional power flow.

配电网的运行、控制和保护方式将发生重大变化

The operation, control and protection methods will change remarkably.

用户侧的灵活性使配电网的需求侧管理方式发生变化

New contents will be added to the distribution network demand side management because of the flexibility of the user side.

2 微电网的出现减少对配电网投资

The emergence of microgrid decreases the investment into the utility grid.

降低对配电系统电能的需求，减少配电网扩建费用

Reduce the energy demand from the distribution system, and decrease the expansion fee

微电网的削峰填谷、平衡负荷的作用，使现有发电输电设备的备用减少，利用率提高。

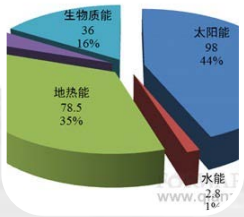
The peak load shaving and load balancing functions of the microgrid reduce the standby equipment in the distribution system.

3 微电网将对电力市场走向的最终格局产生深远的影响

The microgrid will have profound impact on the final pattern of the electricity market

电力公司和用户之间形成新型的关系，微电网既可以从配电网购电，也可以向配电网出售剩余电能和相关辅助服务

New relationship will be established between the grid companies and customers.



微电网打开了电力市场的大门，整个电力市场参与者大大增加，利益关系更加复杂，竞争更加激烈，配、售电环节更加开放

The microgrid open the door of the electricity market.

微电网运行与控制技术要求（IEC国际标准）

Technical Requirements for Operation and Control of Microgrids
（IEC TS 62898）

1. 标准启动 Initiation
2. 标准内容 Contents
3. 工作进展 Development
4. 预期成果 Estimated Results

1 标准启动 Initiation

2013年10月，IEC投票通过由中国主导制定两项IEC微电网国际标准。

OCT. 2013. IEC voted and decided that china lead the development of two IEC international standards about microgrids

2014年1月，IEC/TC8/WG7国内工作组成立，该工作组致力于IEC/TS 62898-1与IEC/TS62898-2两项标准的制定与组组织协调工作。

JAN. 2014. IEC/TC8/WG7 domestic work group, which devote itself to the development and coordinating of IEC/TS 62898-1 and IEC/TS 62898-2, is established.

IEC/TS 62898-1：微电网规划与设计导则

IEC/TS 62898-1:Guidelines for General Planning and Design of Microgrids

IEC/TS 62898-2：微电网运行与控制技术规范

IEC/TS 62898-2:Technical Requirements for Operation and Control of Microgrids

WG7 工作组成员名单

The members list of the WG7 working group

IEC/TC8/WG7 工作组现有专家共28人，两项标准的召集人分别为华北电力大学张建华教授与西安交通大学别朝红教授。

Now the working group of IEC/TC8/WG7 has 28 experts, the convenors of the two standards are professor Jianhua Zhang who comes from North China Electric Power University and professor Zhaohong Bie who comes from Xi'an Jiaotong University.

Function	Last_Name	First_Name	NC	Function	Last_Name	First_Name	NC
Convenor	**Bie**	**Zhaohong**	CN	Member	Rochereau	Hervé	FR
Member	Cammarota	Antonio	IT	Member	Santamaria	Giovanna	ES
Member	Chen	Zhigang	CN	Member	Seo	Jeong Il	KR
Member	Dell'Olio	Giuseppe	IT	Member	Sorokin	Dmitry	RU
Member	Funabashi	Toshihisa	JP	Member	Spillett	David	GB
Member	Garg	Ajay	CA	Member	Sun	Hao	CN
Member	Kaestle	Gunnar	DE	Member	Sweeting	David	AU
Member	Khatri	Amal	ZA	Member	Wang	Jianhui	US
Member	Komarnicki	Przemyslaw	DE	Member	WU	Ming	CN
Member	Kosslers	Sebastian	DE	Member	Xu	Xiaohui	CN
Member	Liang	Huishi	CN	Member	Yang	Xavier	FR
Member	Liu	Juncheng	CN	**Convenor**	**Zhang**	**Jianhua**	**CN**
Member	Meng	Zhaojun	CN	Member	Zhang	Ping	CN
Member	Newbury	John	GB	Member	Zheng	Dehua	CN

标准内容 Details of IEC/ST 62898-1

IEC/TS62898-1:*Guidelines for General Planning and Design of Microgrids*

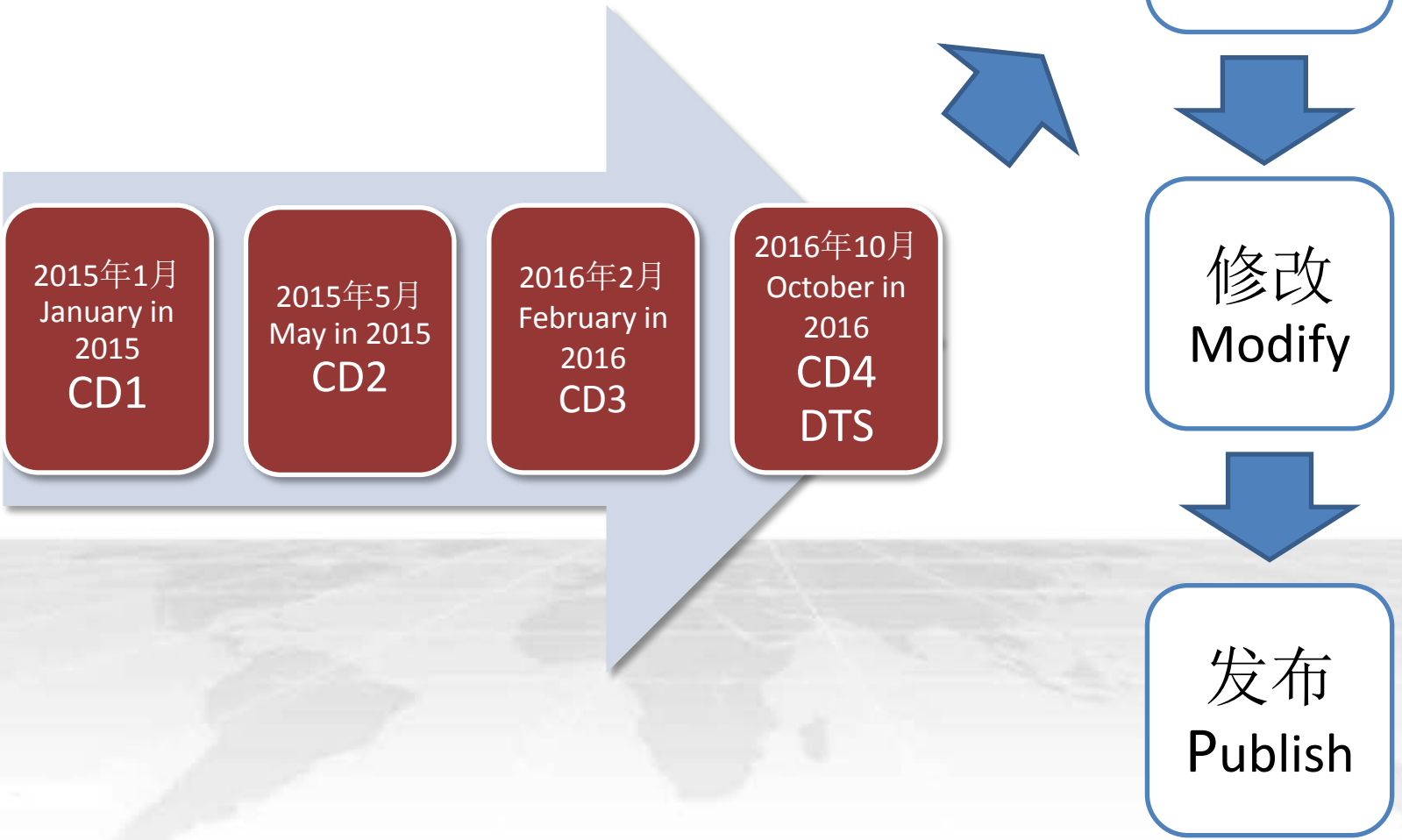
微电网的建设意义以及应用领域
Construction significance and application fields.
微电网规划的必要性，包括资源分析、负荷预测以及分布式电源规划
The necessity of planning, including resource analysis, load forecasting and DES planning.
微电网规划阶段所需满足的要求
Requirements need to be meet when plan the microgrids.
微电网评估中最优规划方案的选择
The choice of the optimal planning scheme when evaluate the microgrids.

标准内容 Details of IEC/ST 62898-2

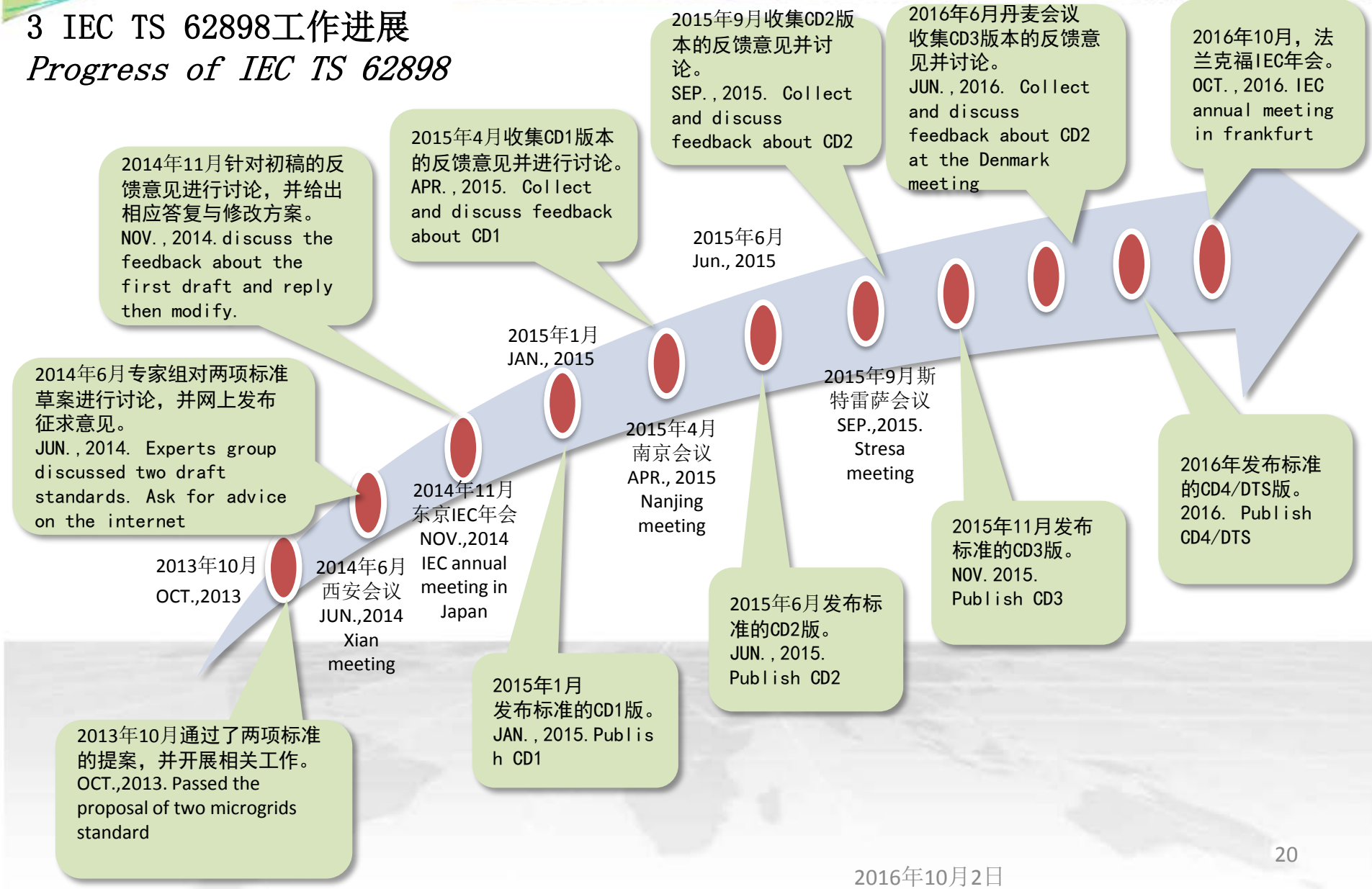
IEC/TS62898-2: Technical Requirements for Operation and Control of Microgrids

不同运行模式下（并网、孤岛及隔离型微网）的运行要求及控制目标
Operation requirements and control objectives in different operation modes.
不同运行模式下的基本控制策略和算法
Basic control strategy and algorithm in different operation modes.
不同模式下的储能系统、保护系统以及监测通信系统的运行要求
Operation requirements of ESS, protection, monitoring and communication system in diffe- rent operation modes
微电网的电能质量要求
Requirements of the power quality in microgrids

标准进程
The standard process



3 IEC TS 62898工作进展
Progress of IEC TS 62898



1. 2015年10月，国家能源局批准“微电网规划设计导则”与“微电网运行与控制技术规范”行业标准立项，2016年3月召开了国内行业标准启动会。**The national energy administration approved "micro power grid planning and design guideline" and "micro power grid operation and control technology standard" industry standard project, and held an opening meeting in March 2016 for domestic industry standards.**

2. 2016年3月，国标委立项支持微电网两项标准的编制。 **In March 2016, the national standard committee supported the compilation of the two standards of micro power grid project.**

3. 2016年4月，世界银行和中国可再生能源规模化发展办公室立项支持微电网两项IEC标准和国家行业标准的编制。**In April 2016, the world bank and the Chinese renewable energy scale development office support setting up the two micro grid IEC standards and the national industry standards.**

4. 经与TC8主席和IEC有关成员国协商，我们提出由中国主导制定“微电网保护技术规范”（ IEC TC62898-3-1）的建议，2016年6月17日将由IEC成员国网络投票表决，并陆续提交微电网系列标准（IEC TC62898-3-X）的提案。**After negotiated with the chairman of TC8 and members concerned with IEC, We proposed to develop "micro electrical protection technology specification"(IEC TC62898-3-1) which dominated by China, and it will be voted by the IEC member network on June 17, 2016, and later on submit the proposal of micro grid series standard (IEC TC62898-3 - X).**

微电网运行与控制技术要求（能源20150634）

Technical requirements of microgrid operation and control (Energy20150634)

简介 Introduction

1 范围 Scope

2 参考标准Informative standard

3 术语定义 Definition

4 运行模式及模式切换要求The requirements of operation mode and the mode transfer

4.1概述overview

4.2非隔离型微电网的并网运行模式 The non isolated parallel operation mode type of micro grid
- 4.2.1电压响应特性 The voltage response characteristic
- 4.2.2频率响应特性 Frequency response characteristic

4.3 非隔离型微电网的孤岛运行模式 The non isolated island operation mode type of micro grid
- 4.3.1电压响应特性 The voltage response characteristic
- 4.3.2频率响应特性 Frequency response characteristic

4.4非隔离型微电网的模式切换 Mode transfer of non isolated micro grid
- 4.4.1通则 General
- 4.4.2并网模式转孤岛模式 Grid connected mode
- 4.4.3孤岛模式转并网模式 Island mode to grid connected mode

4.5隔离型微电网运行要求 Operation requirements of isolated microgrid
- 4.5.1通则 General
- 4.5.2隔离型微电网的结构 Structure of isolated type of micro grid
- 4.5.3电压响应特性 The voltage response characteristic
- 4.5.4频率响应特性 Frequency response characteristic

5 微电网的控制要求

5.1 概述

5.2 非隔离型微电网并网模式的运行控制

5.2.1有功控制与频率管理

5.2.2无功控制与电压管理

5.3 非隔离型微电网孤岛模式的运行控制

5.4 隔离型微电网的运行控制

6 通信与监测要求

6.1 概述

6.2 微电网的通信

6.2.1微电网与大电网的通信

6.2.2微电网内部的通信

6.3 分布式电源的监测

6.4 非隔离型微电网开关设备的监测

6.5 隔离型微电网开关设备的监测

7储能系统要求

7.1概述

7.2并网模式的要求

7.3孤岛模式的要求

7.4模式切换要求

7.5隔离型微电网的要求

7.6储能管理系统

5 Control of microgrids

5.1 General

5.2 Operation control of the grid-connected mode

5.2.1 Active power control and frequency regulation

5.2.2 Reactive power control and voltage regulation

5.3 Operation control of the island mode

5.4 Operation control of the isolated microgrid

6 Communication and monitoring

6.1 General

6.2 Communications of microgrids

6.2.1 Communications with the utility grid

6.2.2 Communications inside the microgrids

6.3 Monitoring the distributed energy resources

6.4 Monitoring the switch devices for non-isolated microgrids

6.5 Monitoring the switch devices for isolated microgrids

7 Energy storage

7.1 General

7.2 Requirements for grid-connected mode

7.3 Requirements for island mode

7.4 Requirements for mode transfer

7.5 Requirements for isolated microgrids

7.6 Energy storage management system

8 微电网保护要求requirements of microgrid protection

8.1概述Summary

8.2微电网线路保护 Micro grid line protection
- 8.2.1并网模式线路保护 The protection of grid connected mode line
- 8.2.2孤岛模式线路保护 Protection of island mode line
- 8.2.3隔离型微电网线路保护 Protection of isolation type micro grid line

8.3微电网内分布式电源的保护
Protection of distributed power in micro grid
- 8.3.1 低压穿越要求 Requirements for low voltage ride through
- 8.3.2 高压穿越要求 Requirements for high voltage ride through

8.4微电网内变压器的保护
Protection of transformer in micro grid

8.5重合闸和同期问题
Reclosure and synchronization problem
- 8.5.1 重合闸 Coincidence gate
- 8.5.2 同期 Synchronism

8.6公共连接点的保护
Protection of common connection point
- 8.6.1电压保护 Voltage protection
- 8.6.2频率保护 Frequency protection
- 8.6.3逆功率保护 Reverse power protection

8.7过电压保护 Over voltage protection

8.8过电流保护 Over current protection

8.11故障清除能力 Fault removal ability

9 微电网的电能质量和电磁兼容（EMC）Micro grid power quality and electromagnetic compatibility

9.1非隔离型微电网电能质量要求 Non isolated micro grid power quality requirements

9.2隔离型微电网电能质量要求 isolation type micro grid power quality requirements

9.3微电网的电磁兼容要求 Electromagnetic compatibility requirements for micro grid

10 微电网维护和测试 Micro grid's maintenance and testing

10.1 维修 Maintenance

10.2 测试 Test

附录 Annex

微电网和能源互联网将为可再生能源高效消纳和优化运营做出贡献

Microgrid and energy Internet will contribute for the renewable energy efficient consumpsion and optimized operation.

谢 谢！

Thank you!