CHP AS A FLEXIBILITY RESOURCE

Northeast China's experience of renewable energy integration

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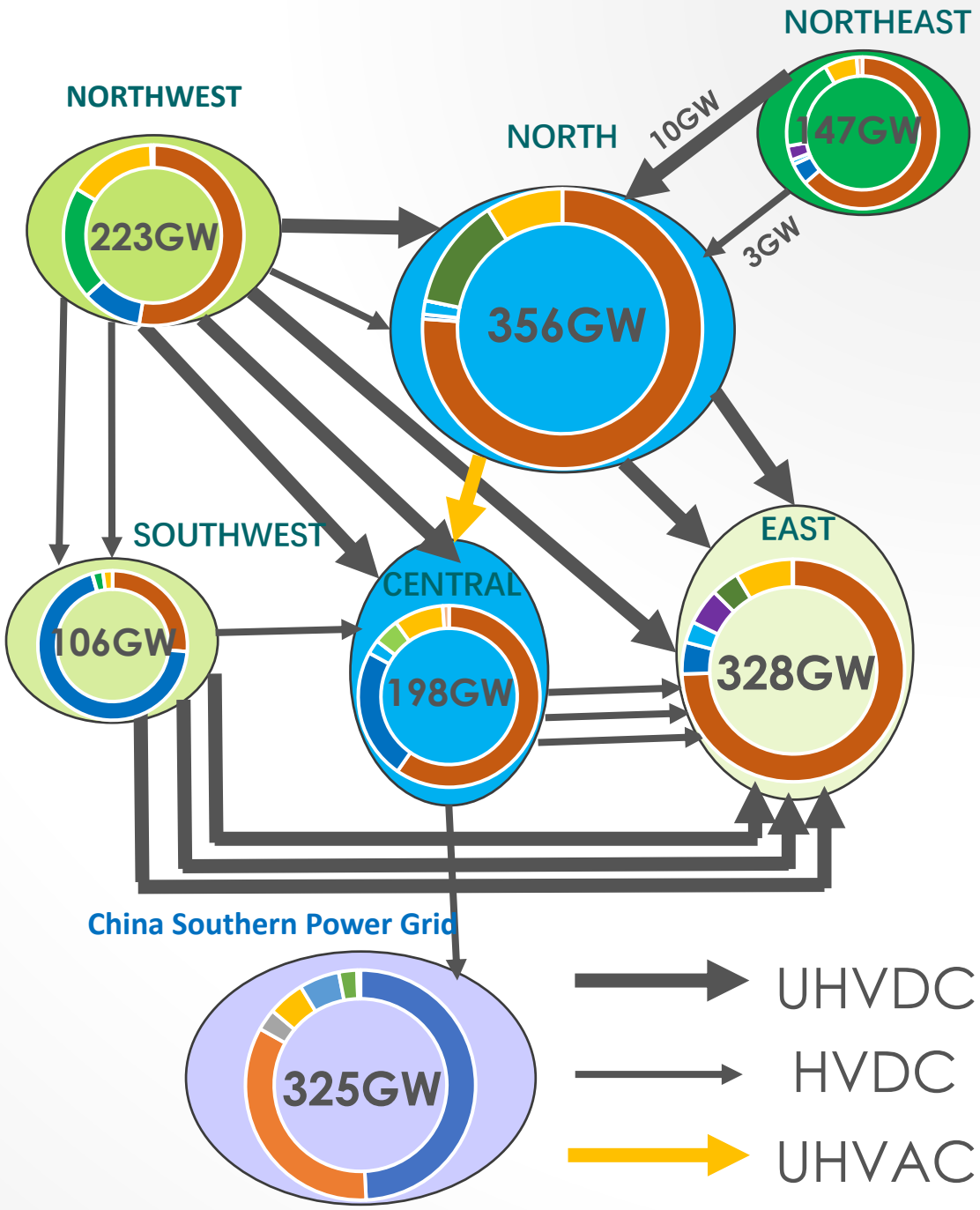
CONTENT

1.INTRODUCTION

State Grid Corporation of China Branches

SGCC Ranks second in Fortune Global 500,serves over 88% of China’s territory.

1.INTRODUCTION



Regional Grid Capacity,MW

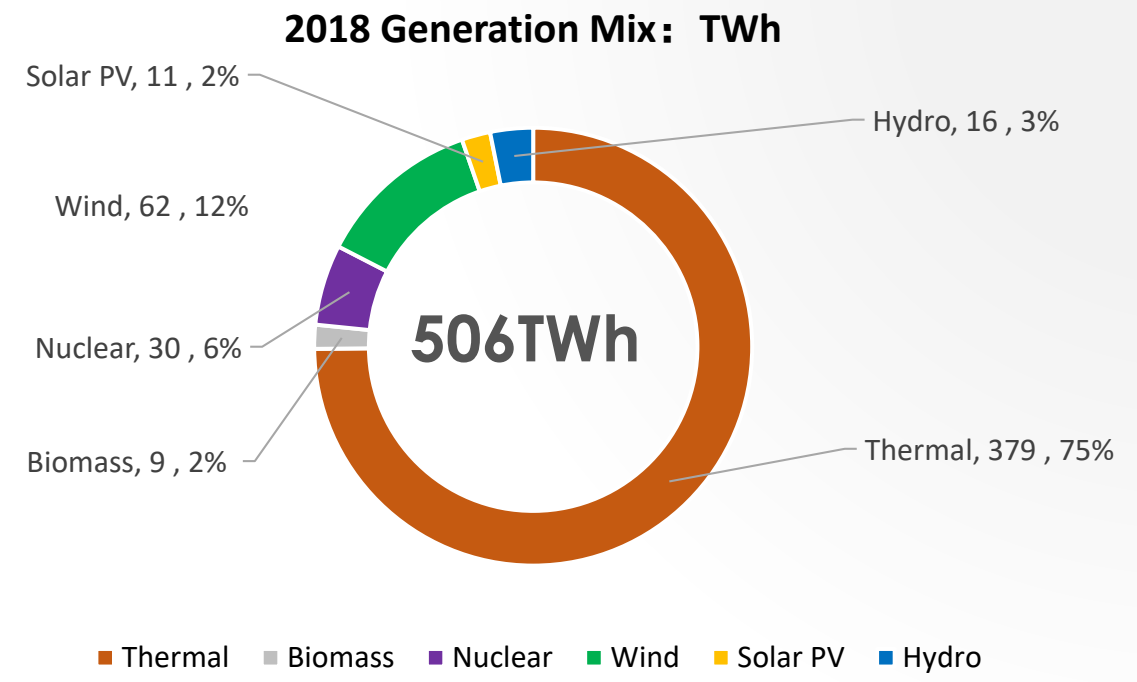
REGION	Thermal	Hydro	Pump	Nuclear	Wind	Solar PV	Biomass	TOTAL
NORTH	271,065	1,912	5,620	25	45,681	31,775	0	356,078
EAST	244,672	15,119	10,060	17,286	13,307	27,592	419	328,455
CENTRAL	118,043	46,192	4,990	0	9,180	17,420	2,226	198,051
NORTHEAST	**93,294**	**6,720**	**1,500**	**4,475**	**28,746**	**10,172**	**1,836**	**146,743**
NORTHWEST	117,292	23,936	0	0	45,315	35,348	1,118	223,009
SOUTHWEST	28,008	73,648	90	0	2,432	2,238	0	106,416
CHINA SOUTHERN POWER GRID	160,000	110,200	9,800	16,770	18,380	8,330	1,580	325,060

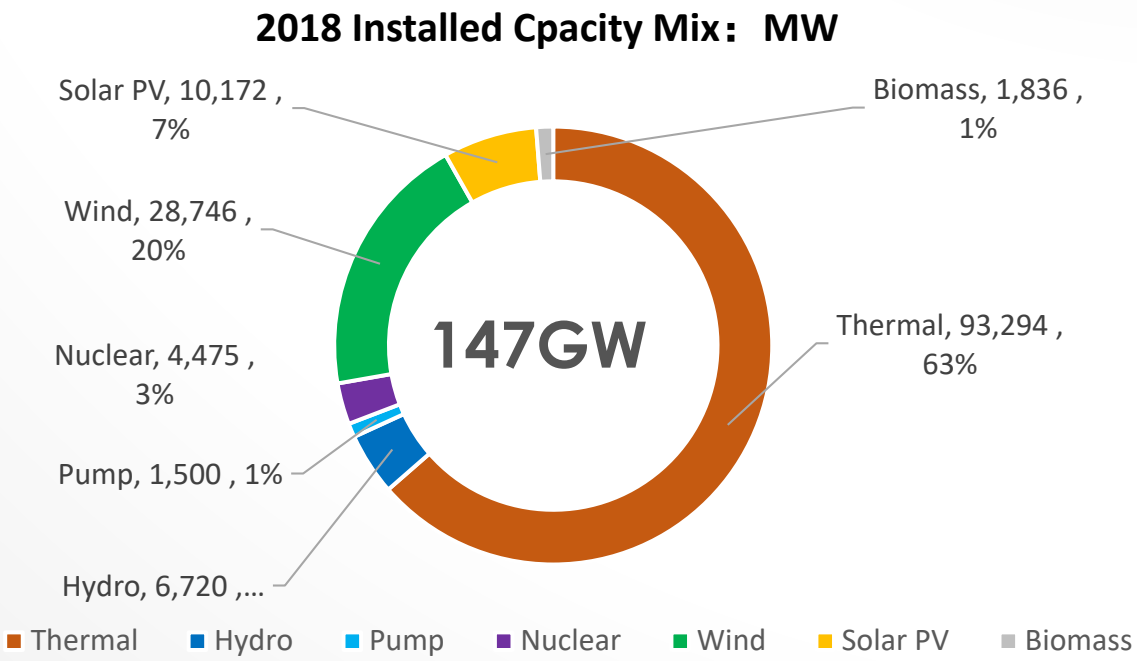
1.INTRODUCTION

- **226** 500kV lines， **23,544** km in length, longest AC line is 367km.
- **78** 500kV substation, transform capacity is **116,253**MVA.
- **2,038** 220kV lines,**59,632** km in length
- **655** 220kV substation, transform capacity is **167,095**MVA.

1.INTRODUCTION

- Maximum Generation: **69,945MW** 2018.08.03
- All Time Peakload: **63,984MW** 2010.08.03
- **28GW** of Wind ,**10GW** of Solar PV
- Renewable Energy(wind+solar pv+hydro)Installed capacity ratio:**33.37%**
- 2018 Renewable Energy(wind+solar pv+hydro) Penetration:**19.2%**
- 2018 Wind+Solar PV penetration to total generation： **14.28%** ,to total consumption: **15.62%**
- Wind+Solar PV record output penetration to generation:**32.63%**, to consumption **34.88%**
- 2018 Wind+Solar PV curtailment ratio: **3.87%**
- 2018 Wind full load hours： **2,875**
- 2018 Solar PV full load hours： **1,324**





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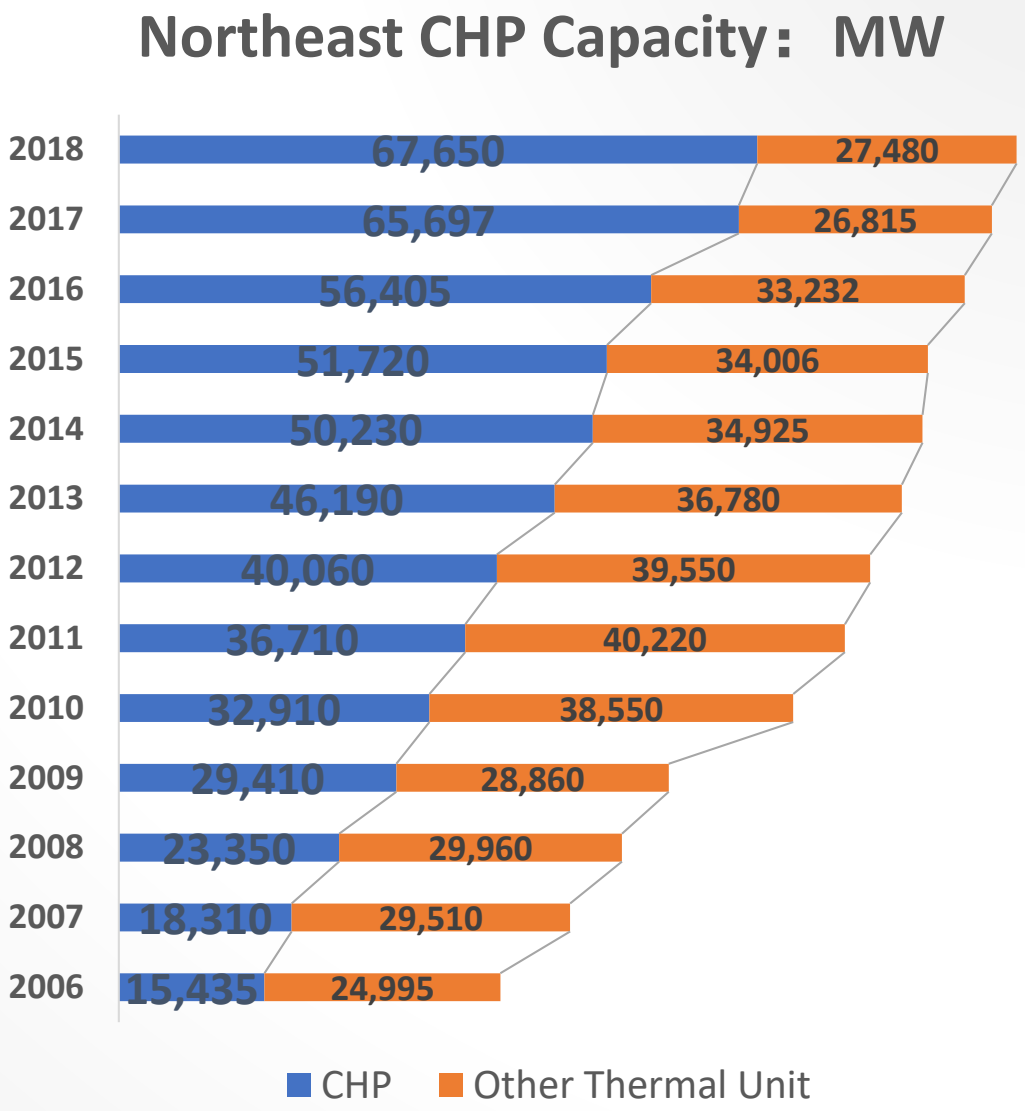
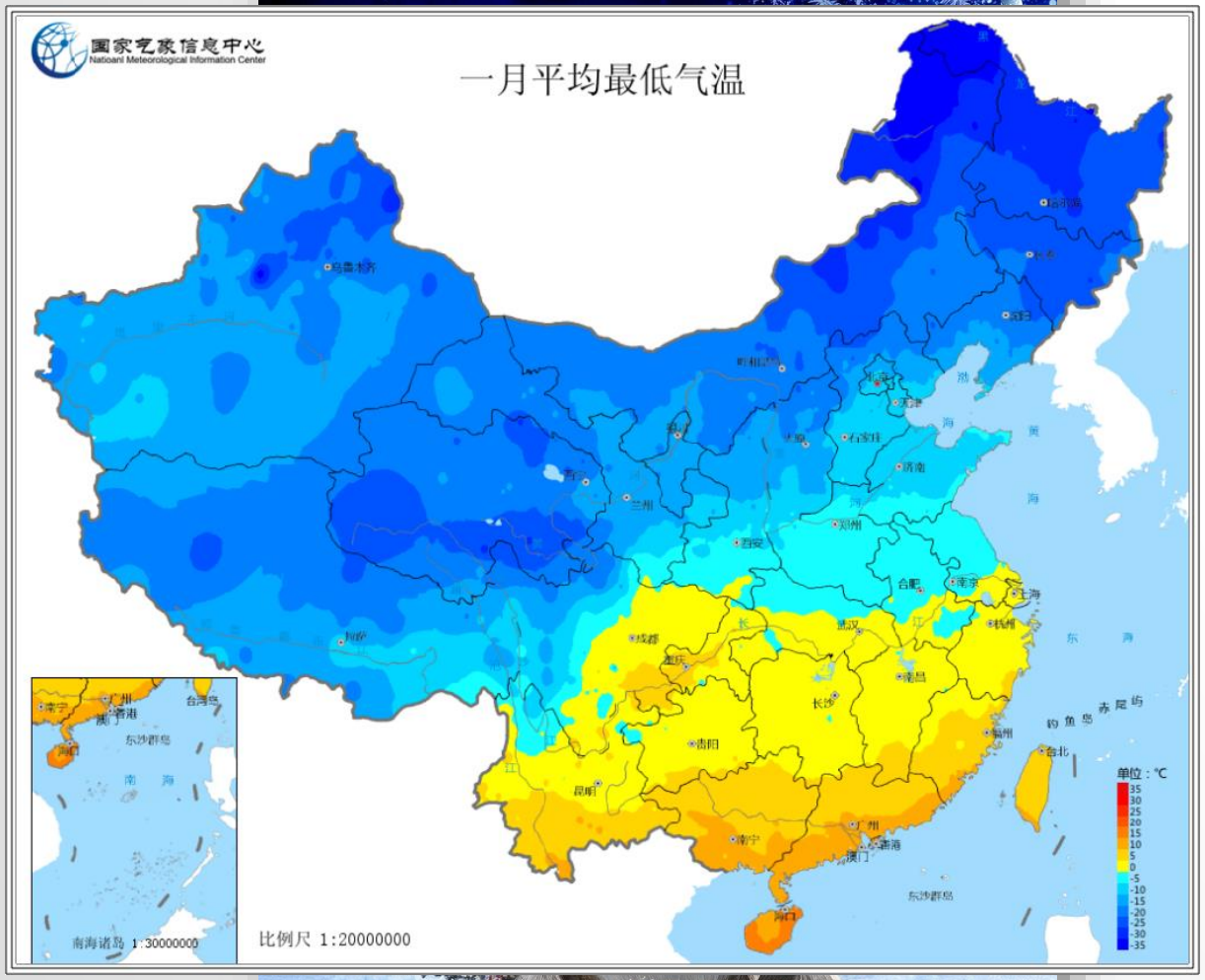
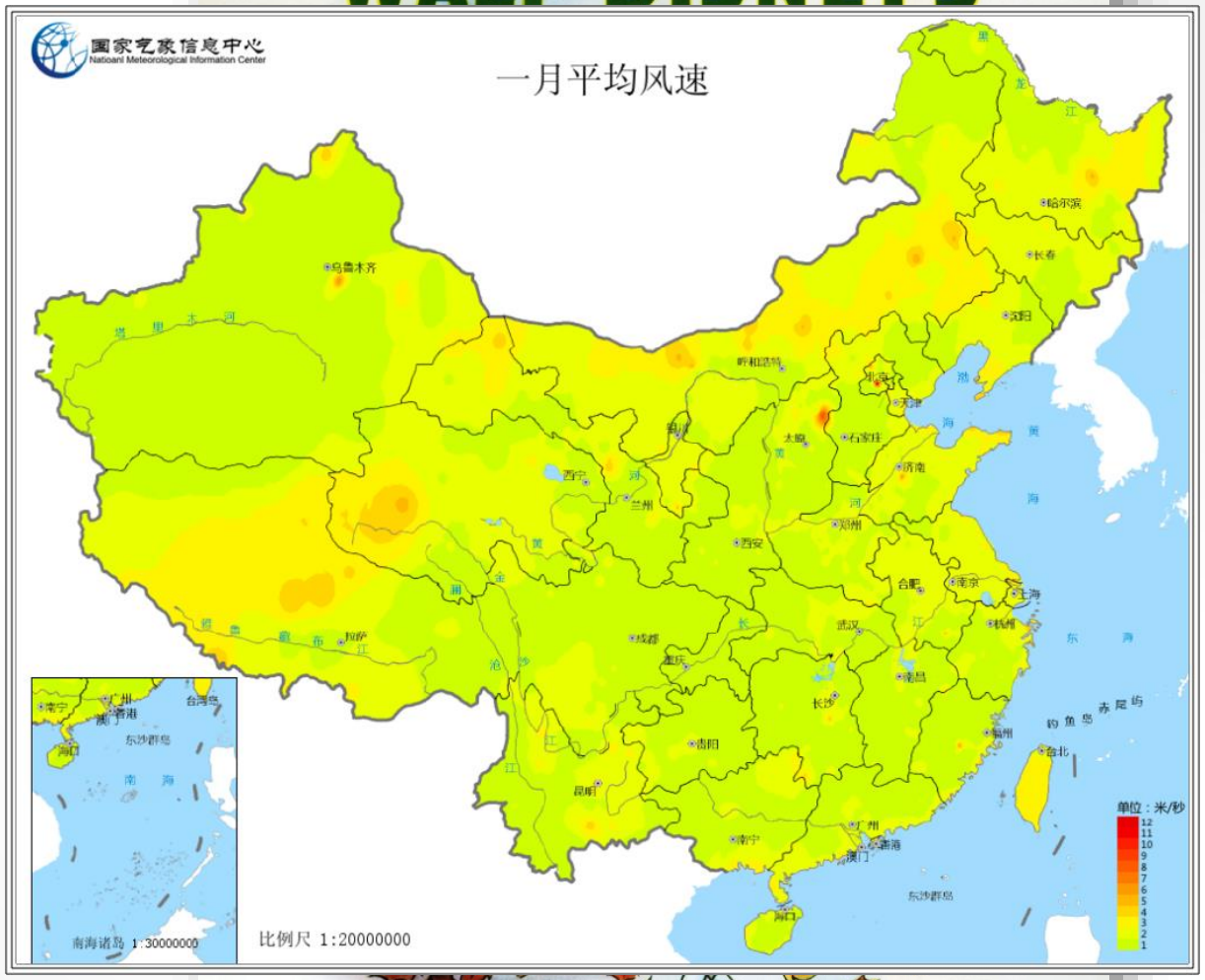
2. CHP VS RENEWABLE ENERGY INTEGRATION



Average Lowest Temperature of Jan.1982~2010



Average wind speed of Jan.1982~2010



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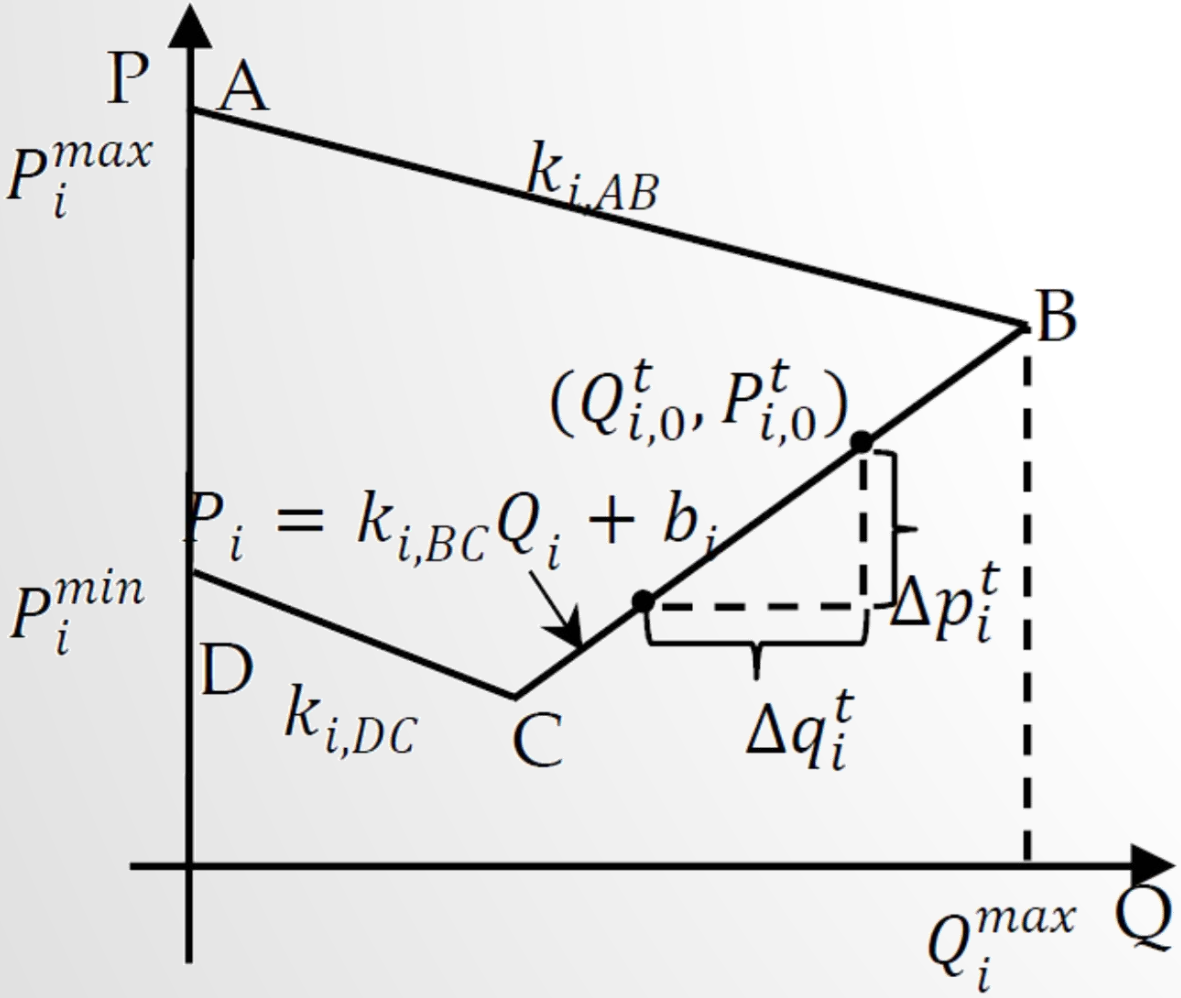
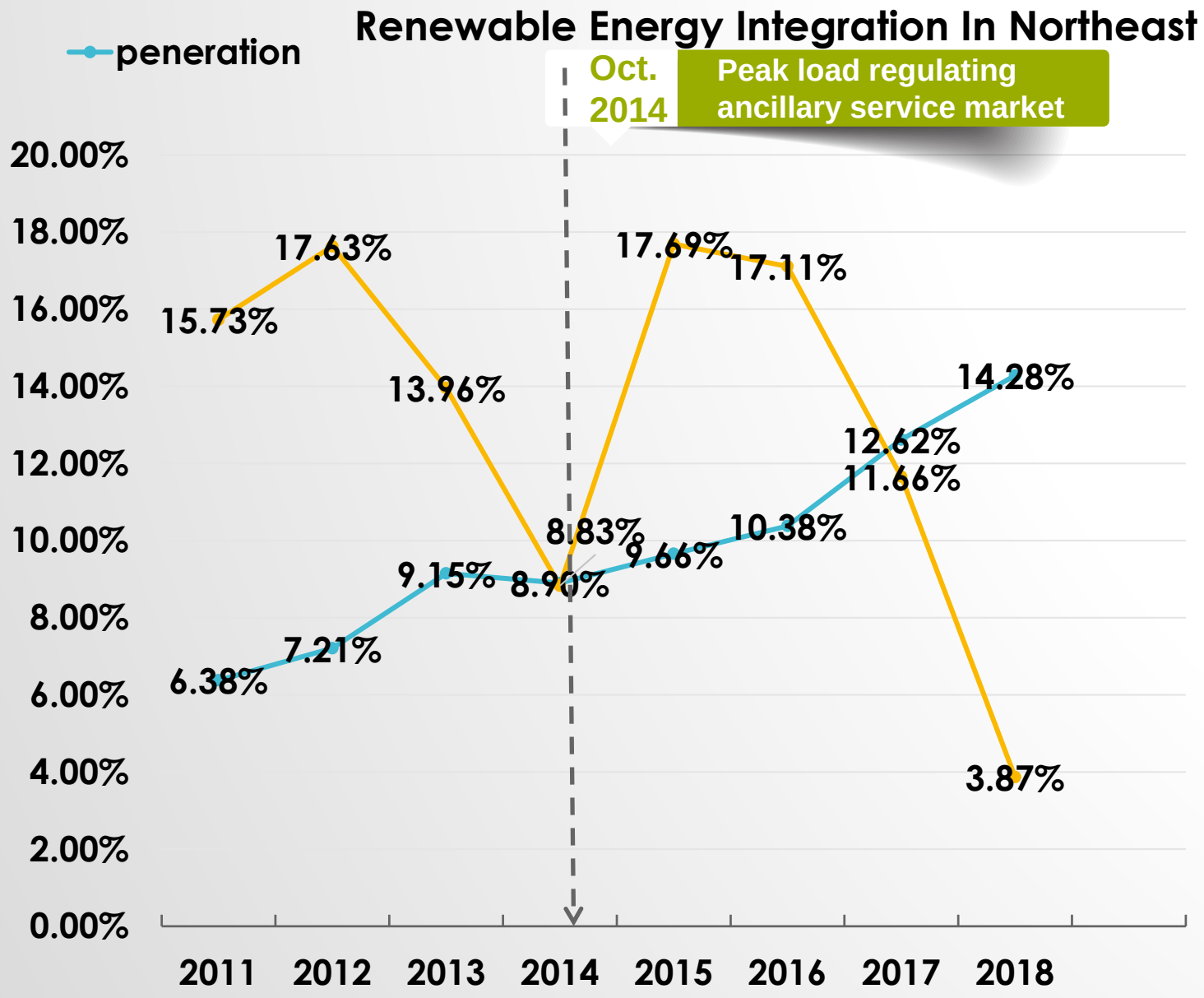


70% curtailment occurred in heating period

[1] Yanjuan Yu, Hongkun Chen and Lei Chen Comparative ,Study of Electric Energy Storages and Thermal Energy Auxiliaries for Improving Wind Power Integration in the Cogeneration System,Energies, 23 January 2018

[2] WANG Wen-ying, GUO Liang-dan, LU Sheng-yang , WANG Zhi , HAN Zhong-he , Analysis of Peak Shaving Performance and Coal Consumption of Cogeneration Unit, TURBINE TECHNOLOGY Dec.2018

2. CHP VS RENEWABLE ENERGY INTEGRATION



Measures to mitigate curtailment

- red flag warning mechanism
- cross-region incremental spot market pilot project
- Strengthening of grid connections and reduction of bottlenecks in the transmission grid.
- Launch of down-regulation markets
- Pilot projects involving investments in flexibilization of existing coal power plants

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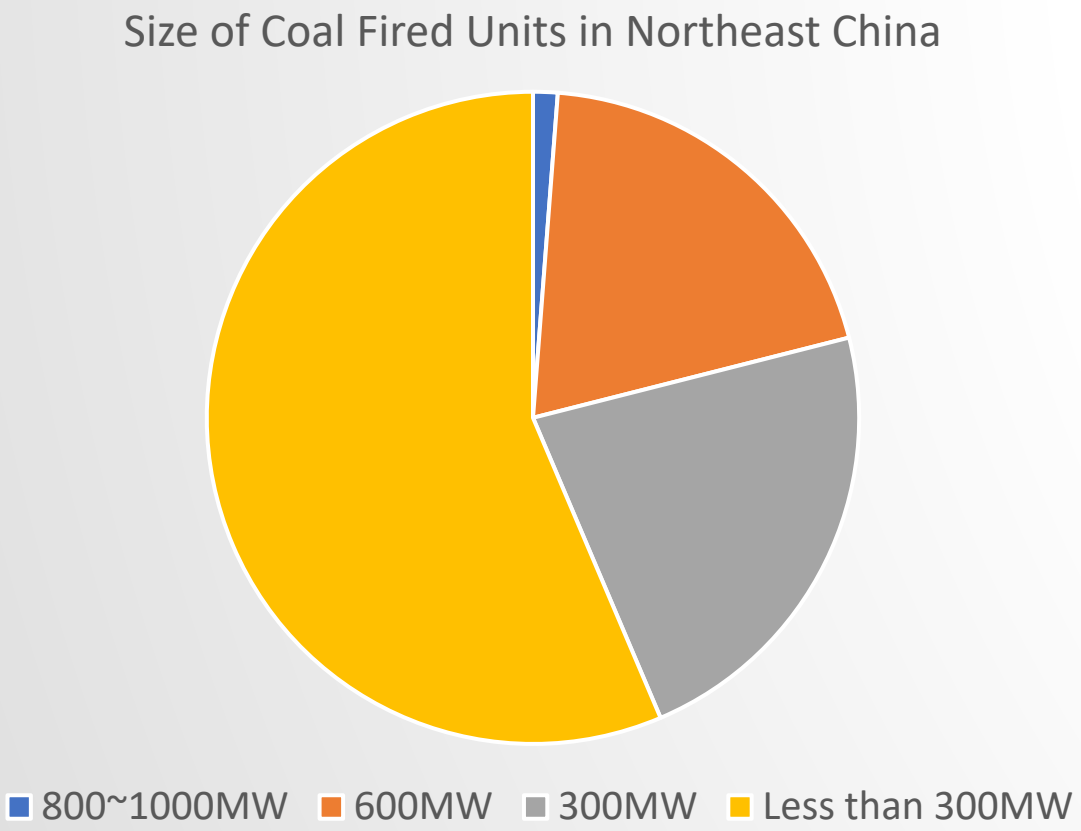
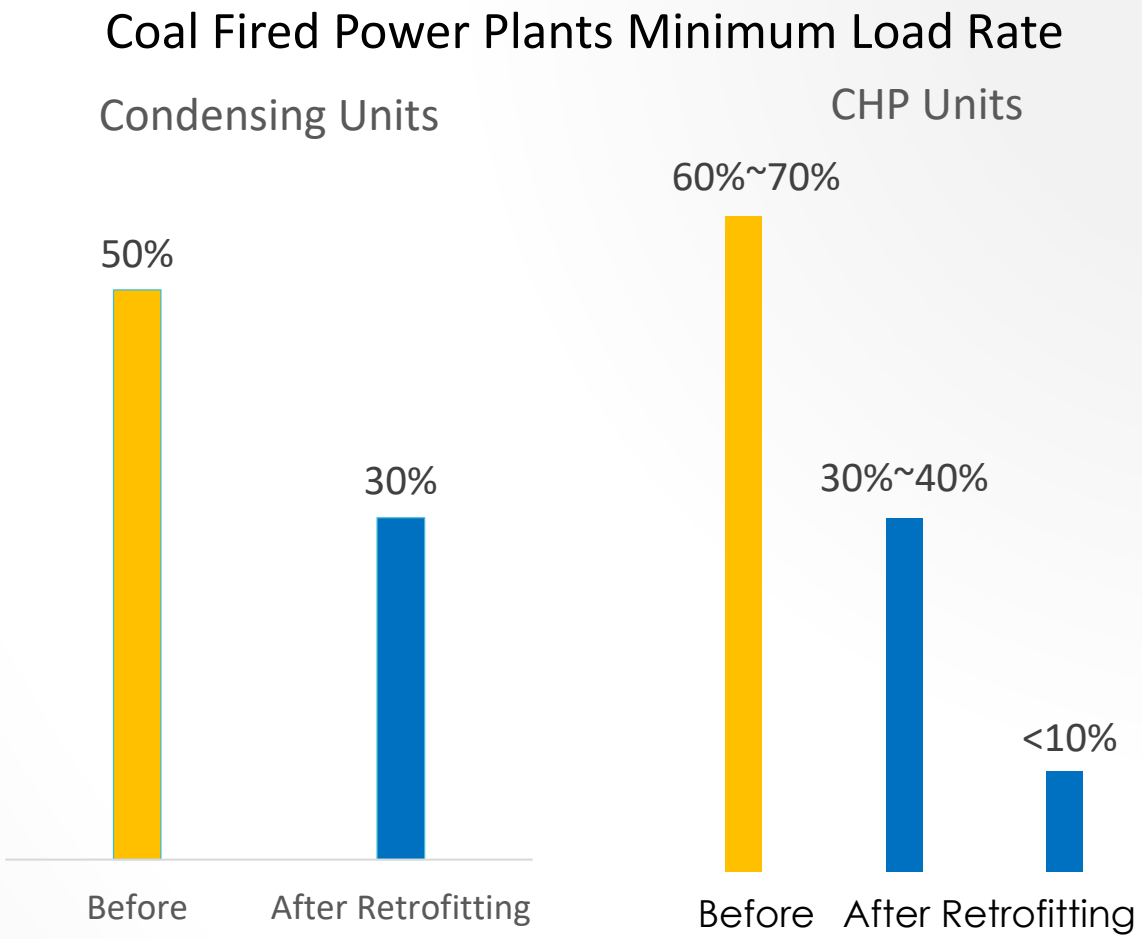
3. FLEXIBLE CHP

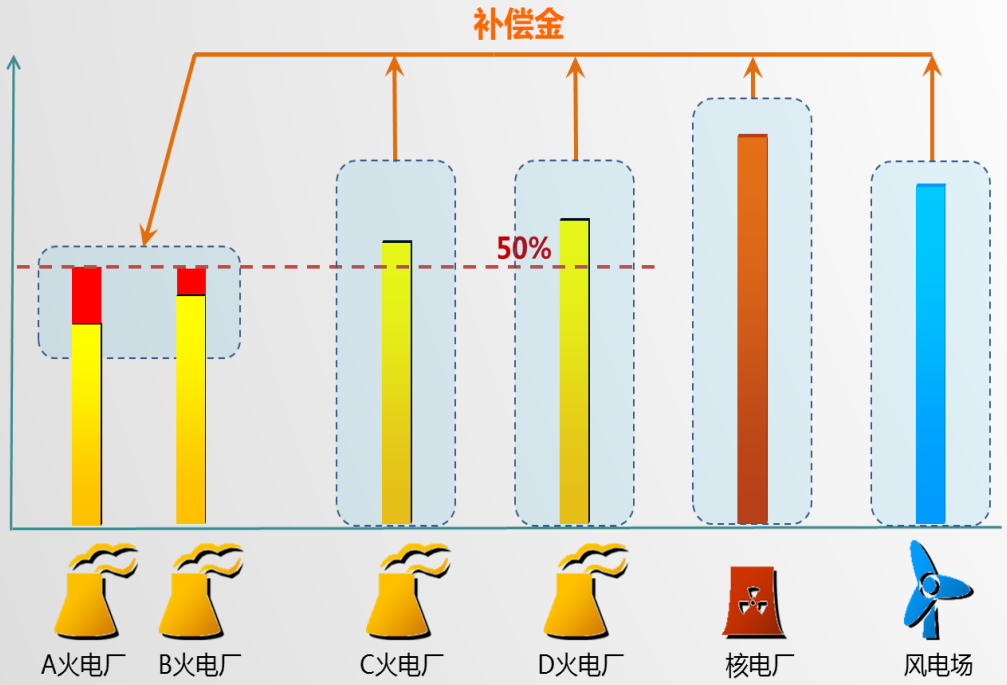




- 55% of the coal-fired units in Northeast China are less than 300 MW .
- Usually operate in a load rate ranging from 50% to 100%.
- 22 power plants nationwide joined the demonstration flexibility retrofitting project launched by National Energy Administration (NEA) in mid-2016.

3. FLEXIBLE CHP

The peak load regulating ancillary service market



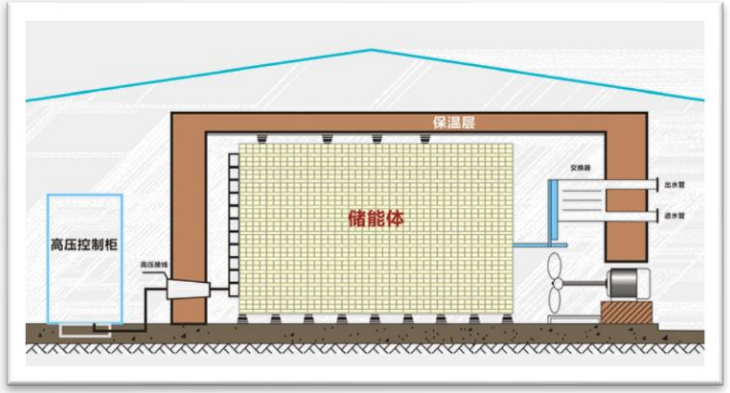
- Since the open of the market in Oct.2014,54 coal fired power plants got 5.8 billion RMB revenue from selling their flexibility capabilities. Highest revenue for a single power plant is 4.65 hundred million RMB.
- 42 TWh of Wind generation has been expanded thanks to the market.The cost for every MWh of expanded wind generation is 63RMB，while annual average price of wind generation is 500RMB.

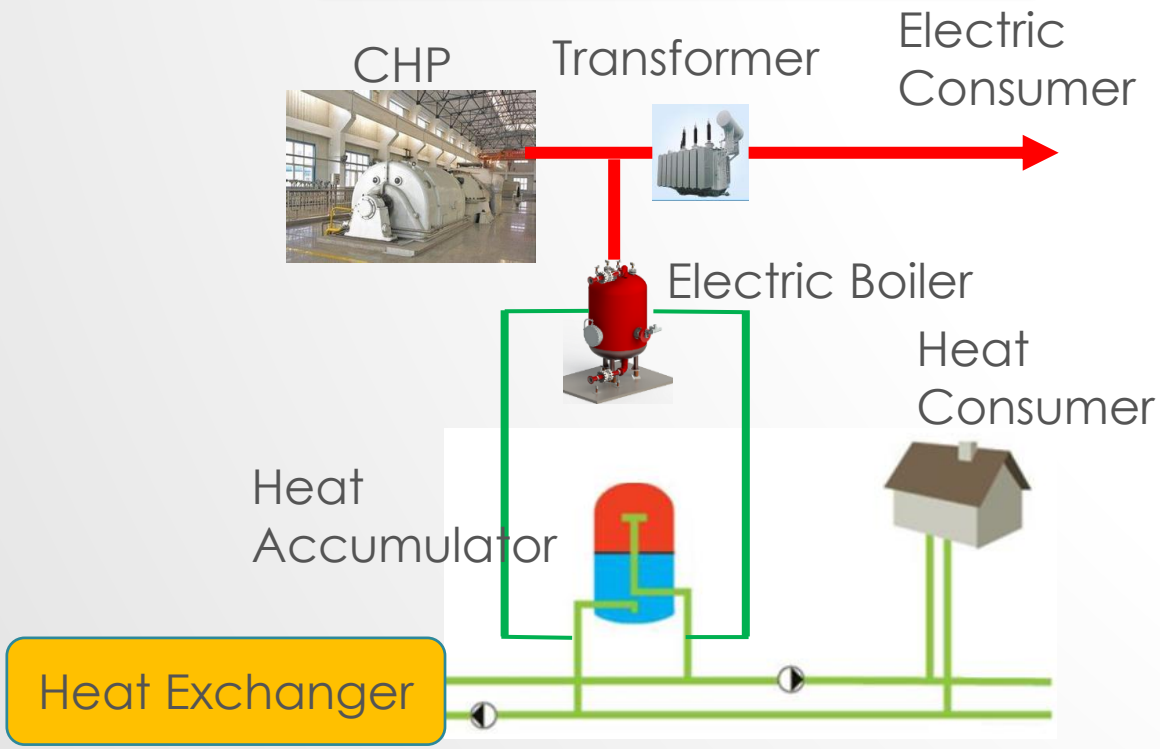
3. FLEXIBLE CHP

Technical Solutions:

- **Optimization of turbine operation mode**
- **Electric Boiler+Heat Accumulator**
- **Systematic retrofitting**
- **Electric Heater +Solid-medium Heat storage**
- **Turbine LP Cylinder Bypass**
- High Back Pressure Retrofit
- Extra Heat Exchanger
- Heat Accumulator

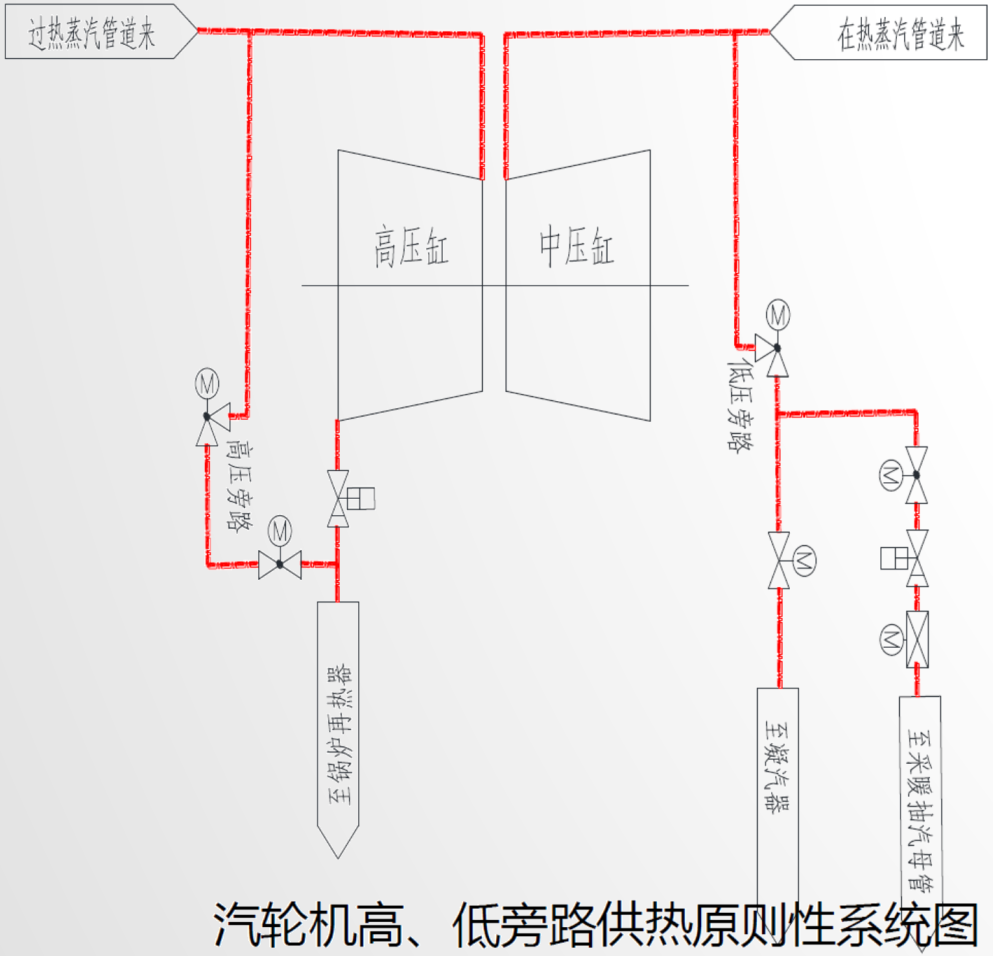
3. FLEXIBLE CHP



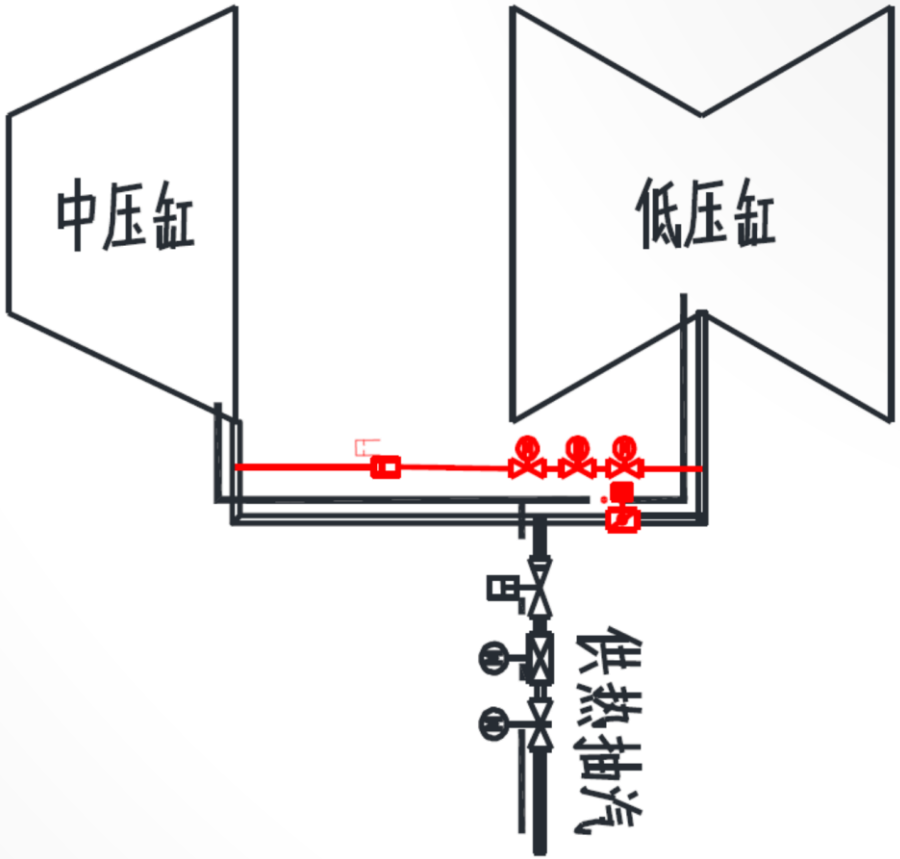


Electric Heater +Solid-medium Heat storage/ Electric Boilerr Heat Accumulator

3. FLEXIBLE CHP

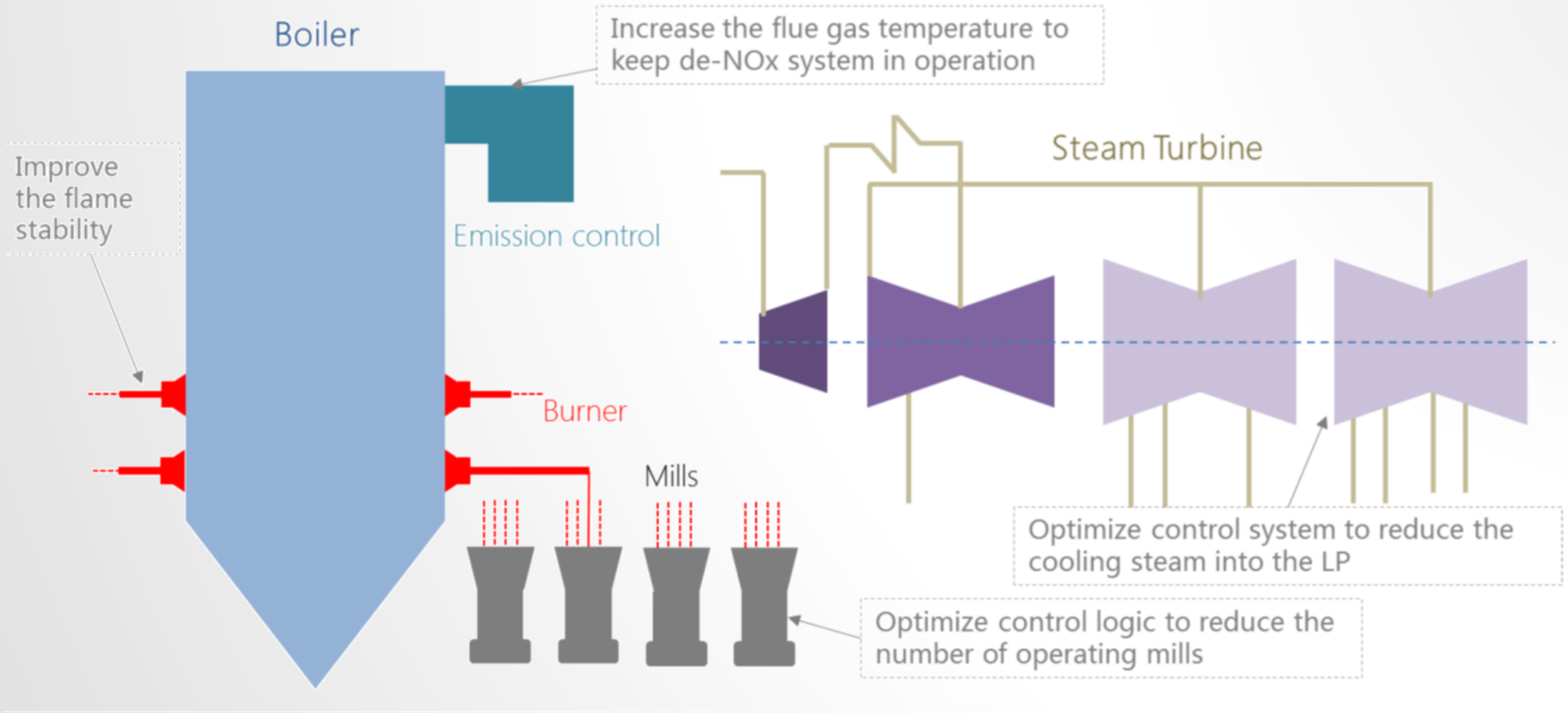


汽轮机高、低旁路供热原则性系统图



Optimization of Turbine Operation Mode /Turbine LP Cylinder Bypass

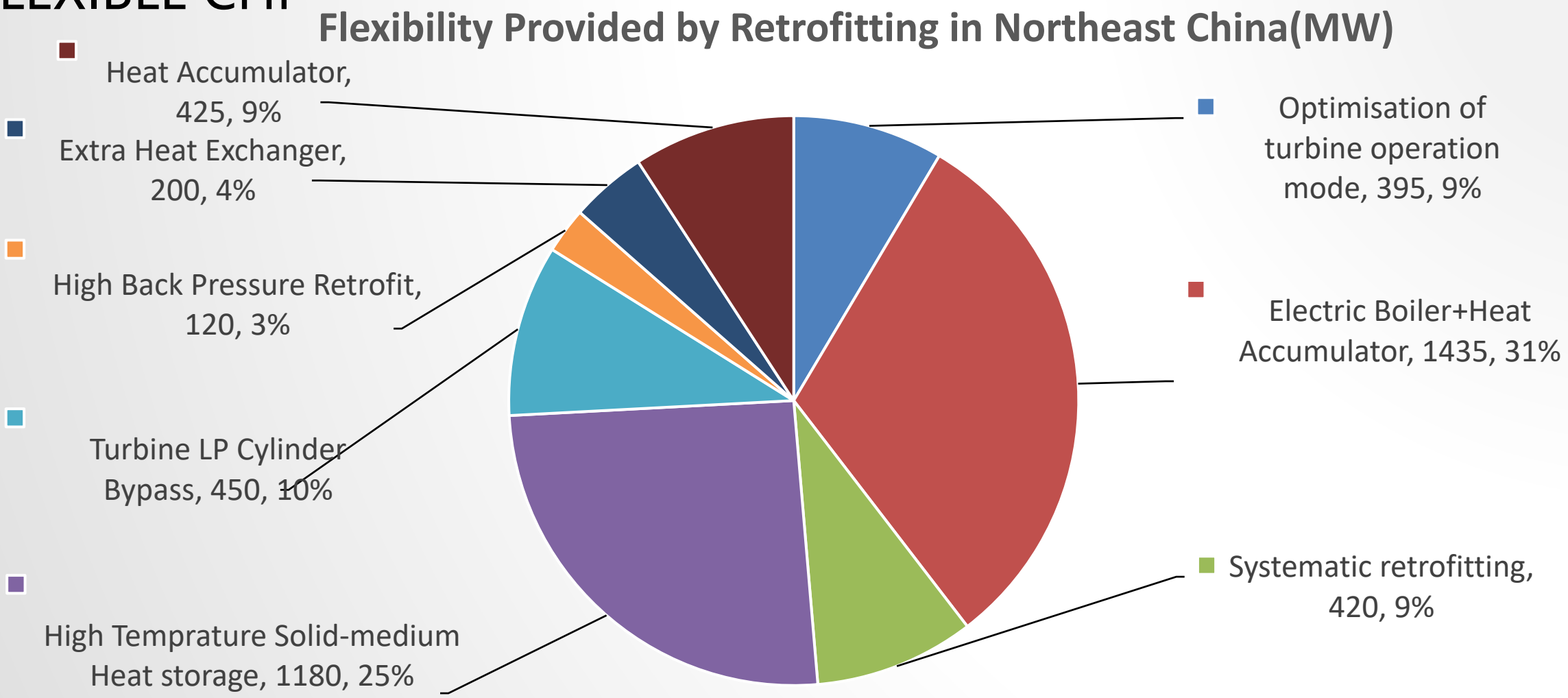
3. FLEXIBLE CHP



Systematic retrofit of condensing unit

Thermal Power Plant Flexibility, a publication under the Clean Energy Ministerial campaign (2018).

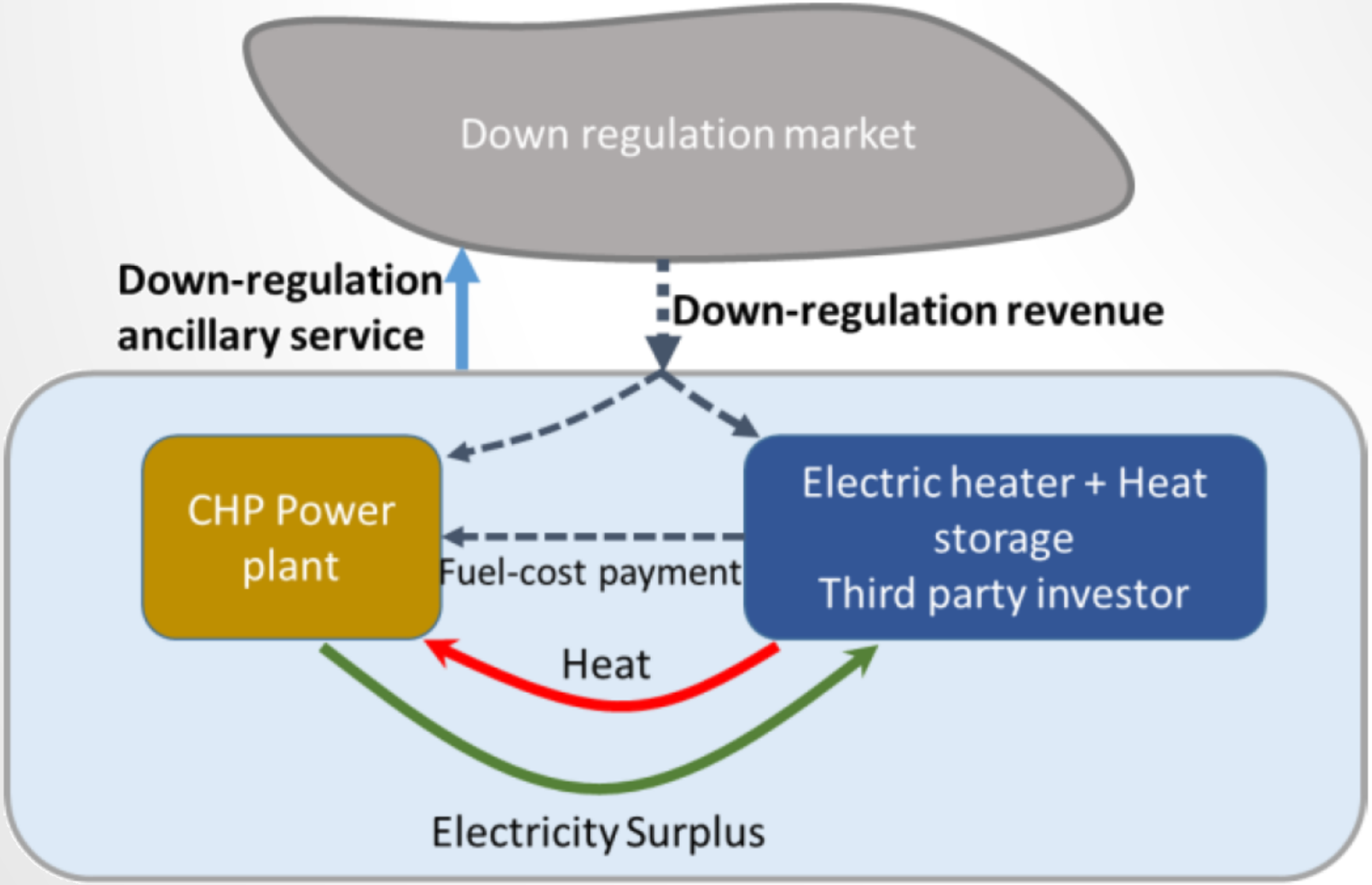
3. FLEXIBLE CHP



27 coal-fired power plants ,
4625 MW flexibility Provided by Retrofitting until Feb.2019

No.1	Power Plant	Capacity(MW)	Minimum output after retrofitting	Technical Solutions	Flexibility(MW)
1	No.2 Fulaerji 富二厂	6×200	47.50%	Optimization of turbine operation mode	75
2	Yanshanhu 燕山湖发电厂	1×600	50%	Extra Heat Exchanger	200
3	Baicheng 白城发电厂	2×600	45%	Electric Boiler+Heat Accumulator	50
4	Jingke 京科热电厂	1×330	36%	Electric Boiler+Heat Accumulator	120
5	Dandong Jinshan丹东金山热电厂	2×300	30%	High Temperature Solid-medium Heat storage	260
6	Changchun CHP长春热电厂	2×350	8.60%	High Temperature Solid-medium Heat storage	320
7	Diaobingshan调兵山煤矸石发电厂	2×300	Close to 0%	High Temperature Solid-medium Heat storage	280
8	Yichun 伊春热电厂	2×350	Close to 0%	High Temperature Solid-medium Heat storage	320
9	Dalian Zhuanghe大连庄河发电厂	2×600	30%	Systematic retrofitting	100
10	Dongfang 东方发电厂	2×350	35%	Turbine LP Cylinder Bypass	160
11	Dakai大开厂	1×350	40.00%	Systematic retrofitting	100
12	Sujiatun苏家屯厂	1×220	30.00%	Turbine LP Cylinder Bypass	70
13	Ganjingzi甘井子厂	1×300	40.00%	Turbine LP Cylinder Bypass	20
14	Shenxi沈西厂	2×300	40.00%	Optimisation of turbine operation mode	60
15	Dalianwan大连湾厂	1×350	40.00%	High Back Pressure Retrofit	20
16	Fuxin阜新电厂	2×200+2×350	30%	Electric Boiler+Heat Accumulator	400
17	Benxi本溪发电厂（新建）	2×350	35%	Turbine LP Cylinder Bypass	160
18	Jiangnan江南热电厂	2×330	46.20%	Heat Accumulator	80
19	Hongyang红阳煤矸石热电厂	2×300	50%	Turbine LP Cylinder Bypass	200
20	Hapingnan哈平南电厂	2×300	40%	Optimisation of turbine operation mode	120
21	No.1 Haerbin哈尔滨第一热电厂	2×300	43%	Electric Boiler+Heat Accumulator	100
22	Huolinhe pithead 霍林河坑口厂	2×600	5%-20%	Electric Boiler+Heat Accumulator	240
23	Hegang鹤岗厂	2×300+600	37%	Optimisation of turbine operation mode	140
24	No.2 Tongliao通辽第二发电厂	1×600	33%	Heat Accumulator	225
25	Liaoyuan辽源发电厂	2×330	40%	Heat Accumulator	80
26	Chifeng Xincheng赤峰新城热电公司	2×300	Close to 0%	Electric Boiler+Heat Accumulator	200
27	Panjin盘锦	2×350	Close to 0%	High Back Pressure Retrofit	525
28	Shengfa盛发热电有限责任公司	2×135	Close to 0%	Electric Boiler+Heat Accumulator	60
29	Shuangyashan双鸭山电厂	210+2×600	30%	Systematic retrofitting	240
30	Jiamusi佳木斯电厂	2×300	50%	Heat Accumulator	160
31	Dandong丹东电厂	2×350	20%	Heat Accumulator	380
32	No.2 Fulaerji富二厂	6×200	43%	Turbine LP Cylinder Bypass	105
33	Haerbin哈热厂	2×300+350	40%	Turbine LP Cylinder Bypass	60
34	Jinzhou锦热厂	2×300	30%	Optimisation of turbine operation mode	280
35	Shenhai沈海厂	3×200	Close to 0%	High Pressure Solid-medium Heat storage	210

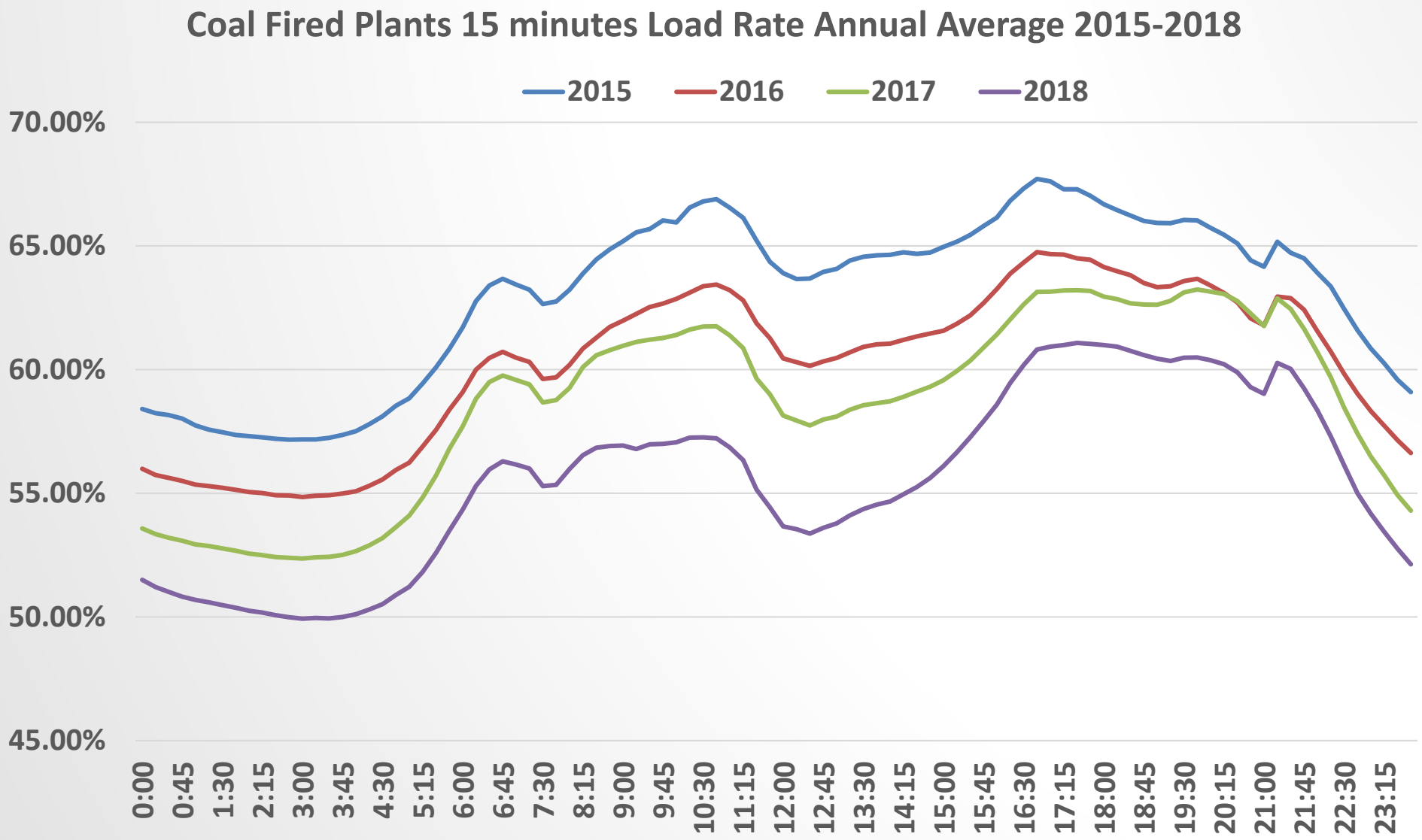
3. FLEXIBLE CHP



Business Mode for heat storage of CHP

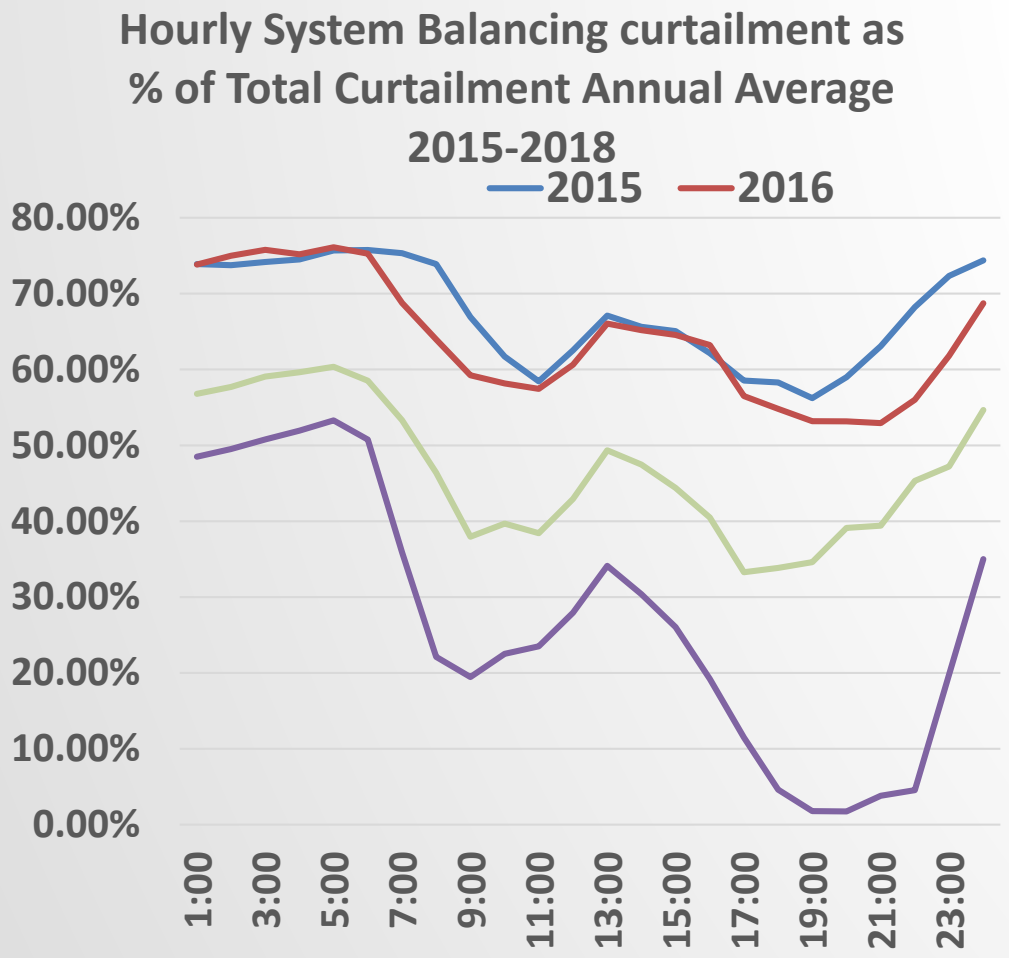
Thermal Power Plant Flexibility, a publication under the Clean Energy Ministerial campaign (2018).

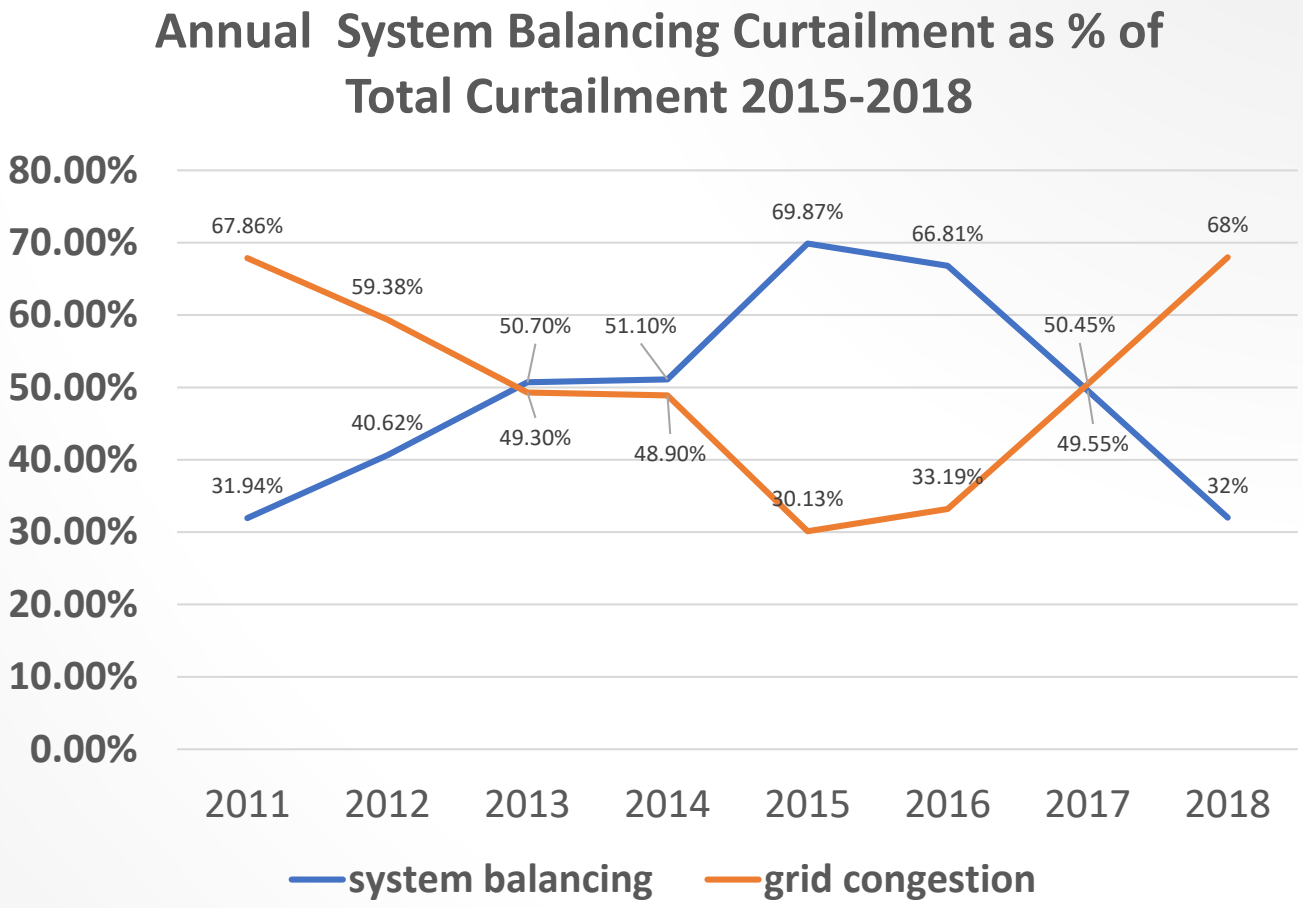
3. FLEXIBLE CHP



Significant drop of coal fired power plants load rate In load valley,58%-50%

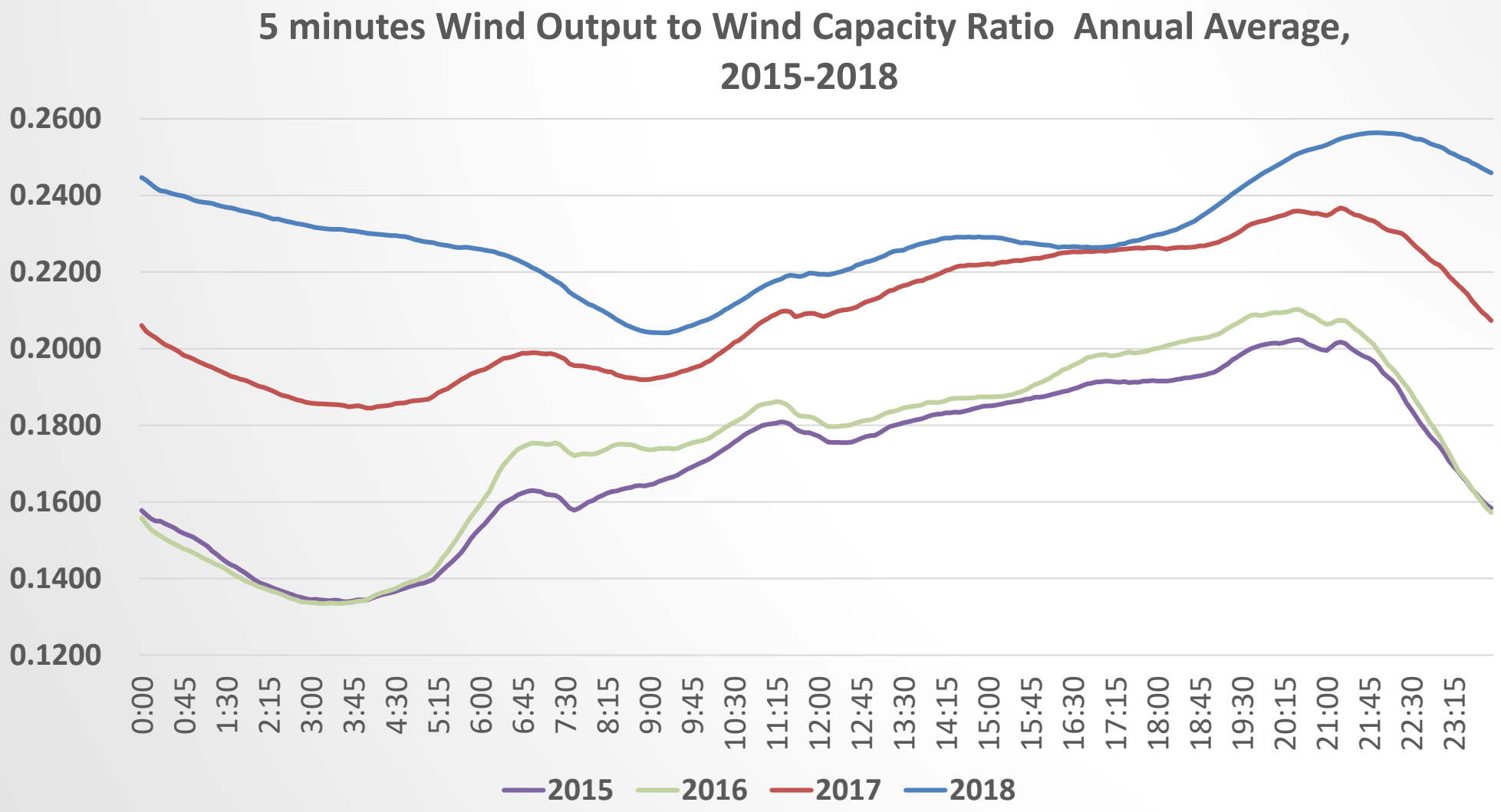
3. FLEXIBLE CHP





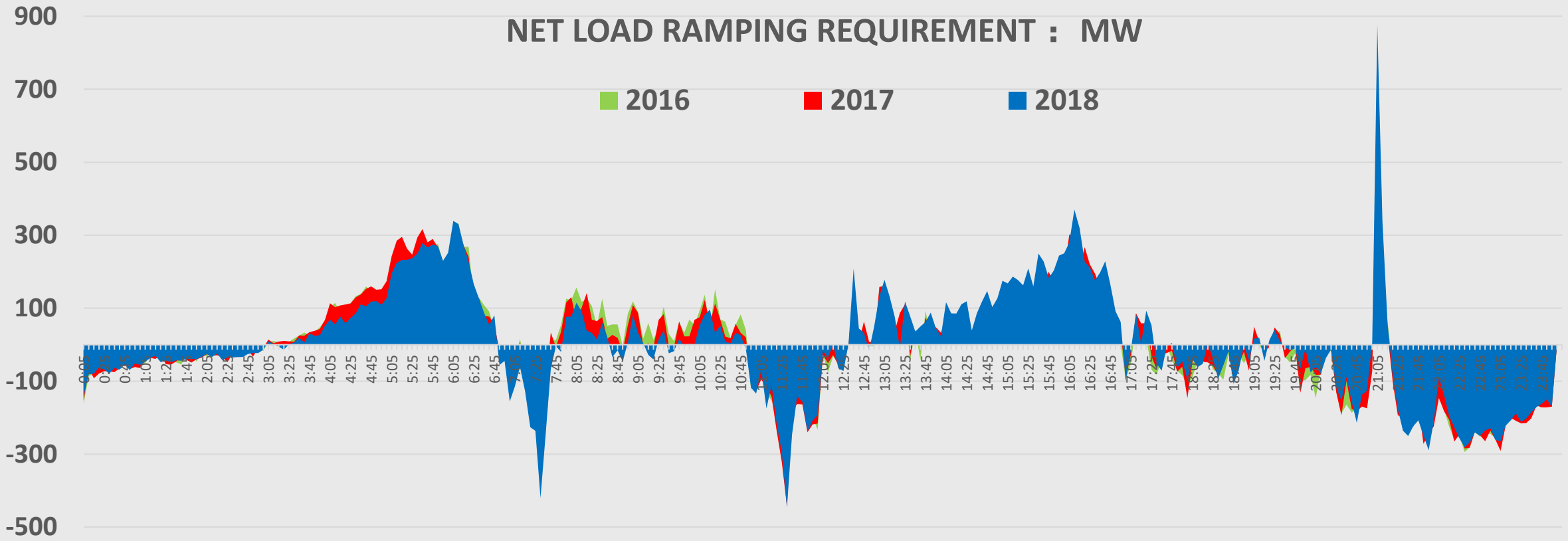
Main cause of curtailment has shifted from system balancing to grid congestion

3. FLEXIBLE CHP



Wind Integration Capability Increased especially from 00:00~05:00

3. FLEXIBLE CHP



Average Afternoon Net Load Ramping up： MW

Year	14：00—15：00	15：00—16：00	16：00—17：00	Total
2016	522	1528	1740	**3789**
2017	934	1911	2024	**4868**
2018	1336	2421	2332	**6089**

Average Morning Net Load Ramping up： MW

Year	08：00—09：00	09：10—16：00	10：00—11：00	Total
2016	3183	586	545	**4314**
2017	2868	398	359	**3625**
2018	2458	-3	122	**2577**

CONTENT

4. SUMMARY AND FUTURE OUTLOOK

- With well designed market, CHP can push the flexible frontier to the edge of technology.
- Renewable energy will benefit from flexible CHP.
- In the trend of reducing coal consumption and retire of coal fired power plants, flexible CHP units may provide flexibility as their essential function.
- Energy Systems Interconnection and Integration might be the key to 100% renewable energy.
- IoT might find its proper position in energy systems Interconnection.
- China's power sector will experience an overhaul reform in recent years, especially in electric power marketization. Spot market is at reach in 3 or 5 years.

Thank you!

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