

# 优先发展柔性低碳电力系统

# Low Carbon Flexible Power System Should Be the Priority

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江亿  
Yi Jiang

清华大学建筑节能研究中心  
Building Energy Research Centre,  
Tsinghua University

# 可再生能源出现革命性变化

## A Revolution Change in Renewable Power

- **低碳能源转型：**由化石能源转为可再生是必须完成的任务
- **光伏和风电的成本已经接近燃煤发电：**
  - 光伏电池的成本：从2000年的50元/W 下降到低于 2元/W
  - 风电装备的成本：已经低于5元/W
  - 虽然光电和风电的年发电小时数仅分别为 1500 小时和 2500 小时，仅分别为燃煤火电的 1/3 和 1/2 ，但发电成本已接近燃煤，远低于燃气发电
- **Low carbon energy transformation：**renewable replaces fossil
- **The cost of wind power & PV is down to near thermal power：**
  - Cost of PV component: down from RMB50/W at 2000 to RMB2/W now
  - Cost of wind power equipment: lower than RMB5/W
  - Annual operation hour: PV 1500 hours, wind 2500 hours; only 1/3 and 1/2 of coal fire power, However both the cost of kWh of PV and wind is near coal fire power, much lower than gas power



# 发展可再生电力的制约瓶颈：安装空间和接纳能力 (I)

## The Bottleneck of Developing Renewable Power (I)

- **发展光电和风电所需要的自然资源：安装空间，由于他们属低密度能源**
  - 城市建筑屋顶和部分可接受太阳辐射的垂直表面：50亿 m<sup>2</sup>，500 GW，5000亿kWh/年
  - 农村建筑和设施屋顶：200 亿 m<sup>2</sup>，2000GW，2万亿kWh/年
  - 城市屋顶光伏可生产的电量仅为约 1/6 城市建筑用电
  - 农村屋顶光伏可生产的电量约为5倍的农村生活用电
  - 中国未来低碳能源需要 25~35 亿kW PV & 风电，4万亿kWh/年，建筑表面可提供其约 40%
- **The resource for PV & wind power development: space for installation**
  - Roof of urban building & some vertical surfaces: 5 billion m<sup>2</sup>, 500 GW, 500TWh
  - Roof of rural building & facility: 20 billion m<sup>2</sup>, 2TW, 2000TWh
  - Power generated by roof PV of urban building is about 1/6 of the demand of urban buildings
  - Power generated by roof PV of rural buildings is as more as 5 times of rural building demand
  - China low carbon energy needs 2.5~3.5 TW PV & wind power, 4000TWh annually, building surface can contribute about 40%

# 发展可再生电力的制约瓶颈：安装空间和接纳能力（II）

## The Bottleneck of Developing Renewable Power（II）

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- **电网容量已充分发展，缺少足够的灵活电源是电网难以接纳更多的可再生电力的主要原因**

- 水电和抽水蓄能电站容量远不能满足接纳光电风电的平衡需求
- 城市建筑目前的用电模式导致电力日间与夜间的用电峰谷差相差几乎一半
- 为了有效接纳光电风电，需要发展足够大容量的灵活用电负载
- 灵活负载：可以根据供给侧的需求改变负载状况，例如：蓄电池，智能充电桩，等

- **In sufficient of flexible power is the key problem to receive PV & wind rather than the capacity of power grid**

- Hydraulic power capacity is far from the need to balance the variation of solar and wind
- Urban buildings cause the electricity load variation day and night for more 50%
- To receive the PV & wind power, it is necessary to develop enough flexible electricity load
- Flexible load: It can vary the load in accordance with the requirement of supply side, e.g. battery smart charging pile etc.

# 打破发展可再生电力的瓶颈 (I)

## Crack the Bottleneck of Renewable Electricity (I)

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### • 加速电动汽车、电动摩托的发展

- 巨大的电池容量可以有效平衡光伏与风电，并缓解负荷侧的用电峰谷差变化
- 如果发展2亿辆小轿车，则可有100kWh充电容量，一天充放电一次，一年可充放电3.5万亿kWh，这些汽车年耗电约0.4万亿kWh，尚存3万亿可用容量。仅用其剩余的2/3 即可有效平衡城市电力日间与夜间的峰谷差

### Speed up the development of electric cars, elec.-motorcycle etc.

- Huge batteries are the resource for receive PV & wind power, relieve the pressure of load variation of the grid
- 200 millions elec. cars, 10TWh capacity, 3500TWh annual capacity if once a day, while the consumption is only 400TWh annually, 88% of capacity remained, the grid only needs 2/3 of the remained capacity to balance the load variation between day and night

# 打破发展可再生电力的瓶颈 (I)

## Crack the Bottleneck of Renewable Electricity (I)

- **改变城市居住建筑和办公建筑的配电系统，使其成为柔性用电建筑**

- 新的建筑柔性用电系统：**PV+DC+蓄电+智能终端 +智能充电桩**
- 缓解负荷侧的日夜间峰谷差，增加电网接纳光电风电的能力

- **在农村建立新型电力系统，可再生电力成为农民新的增收途径**

- 发展屋顶光伏和零星风电，满足生活用电，并通过需求侧响应模式为电动农机供电、满足充电车辆的充电等
- 富裕电力还可以经过蓄电池平衡后，稳定地上网送电

- **Renovation for flexible electricity load of residential & office buildings**

- New type of flexible power system:  
**PV+DC+Battery+smart\_terminal +smart\_piles**
- Allay the variation day & night, raise the reception capacity for PC & wind power

- **Build new type of rural power system, new channel for rural income**

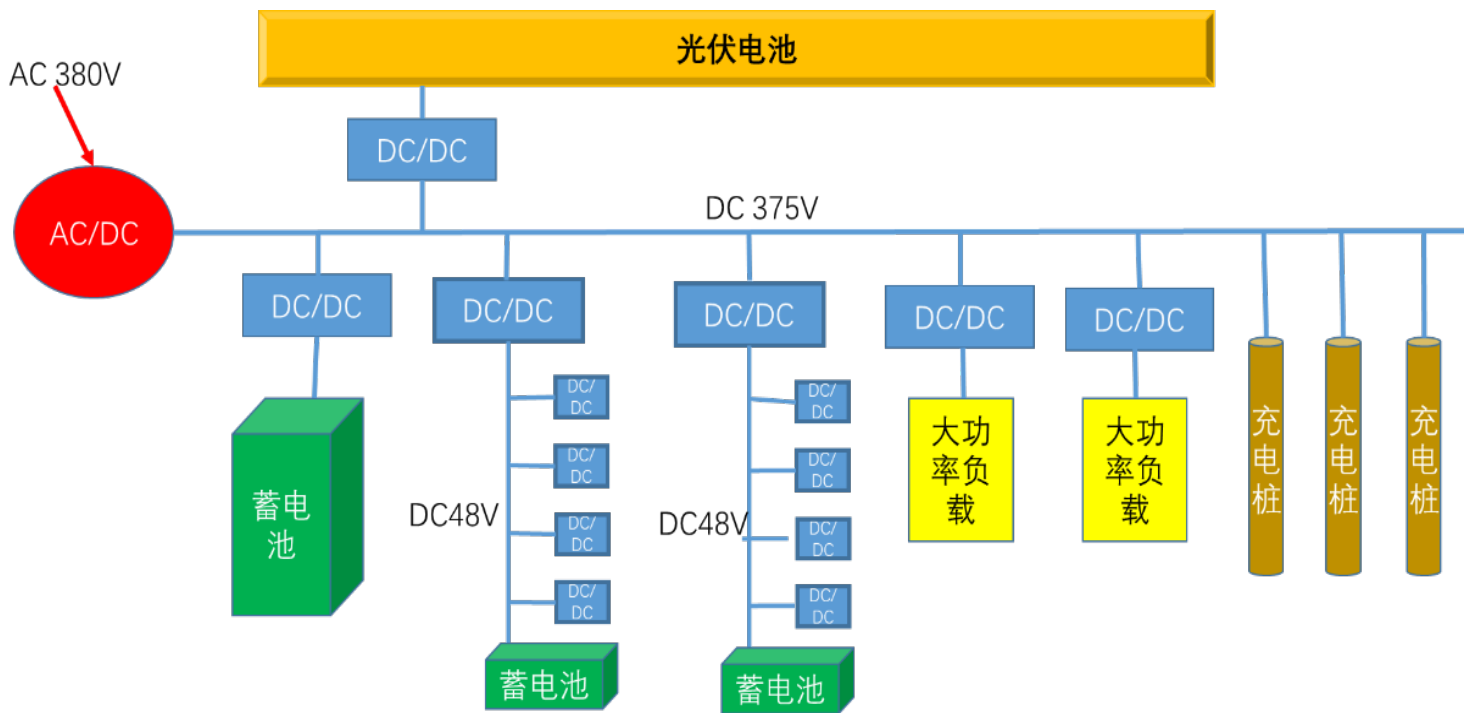
- Develop roof PV and sporadic wind powers, elec. farmer facilities can be powered at demand response mode in addition of charging elec. cars etc. so to receive the renewable power
- Additional power generated can be send to the grid through the balance of batters

# 城市居住建筑和办公建筑的柔性用电系统

## Residential and Office Buildings: Flexible Elec. Load

- 恒功率从网上取电或根据供给侧需要取电
- 由于夏季空调和冬季取暖用电，春秋季节取电量要低于冬夏季
- 日夜间取电量不再变化
- 外电网容量可显著降低
- 可在建筑大修或重新装修时进行
- 每户成本在2万元左右（不包括光伏和充电桩）

- Constant power receive from grid or demand response
- Due to cooling & heating in summer & winter, load in summer & winter may be higher than spring & autumn
- The variation between day and night in urban elec. load can be removed
- Distribution capacity of low voltage grid can be reduced greatly
- It can be carried out during the building overhaul or re-decoration
- Cost is about 20k RMB per home excluding PV and charging piles



# 在农村发展直流微网的新电力系统

## DC Micro Grid in Rural Villages

- 家庭：DC 系统，2~3kWh 蓄电池，8~10kW PV，足够满足生活和充电要求
- 公共用房和设施（养鸡场、养猪场）屋顶PV，零星风电，可满足农业设施按照需求侧响应模式的用电、车辆充电，多余量还可发电上网
- 发电上网部分：
  - 500W PV，400W 风电，0.5kWh 蓄电池，初装费 3500元
  - 可向电网连续供电 150W，每天3kWh，1.5元/天，全年售电 500元
  - 可吸引社会投资共建
- 示范项目：山西芮城
- 投资费用接近目前的农网增容改造费用，但其效果完全不同！
- In home：DC system，2~3kWh battery，8~10kW PV，enough for daily life and elec. car charging
- PV at roof of public buildings、facilities (hennerly、hoggery etc.)，sporadic wind power，satisfy for famers facilities and vehicles charging，additional power can also be send to the grid
- Power send to grid：
  - 500W PV，400W wind power，0.5kWh battery，initial cost RMB3500
  - Supply 150W to grid continually，3kWh per day，RMB 1.5，annual income RMB 500
  - Social capital can be received as investment
- Demonstration project：Rui Cheng county，Shanxi
- The cost is little bit higher than the cost of expending the rural grid，however the benefit will be completely different



# 建设新型电力系统，推动疫情后的经济发展

## Develop New Power System to Pushing Economic after COVID-19

- 在十四五开始启动新型柔性电力系统的建设：城市居住建筑和办公建筑的柔性用电，农村的直流微网
- 城市建筑投资：70% 住宅和办公建筑 需要 4万亿 规模，
- 农村微网建设投资规模：70% 村落建设需要 3万亿规模
- 建成后每年可提供电力2万亿kWh, 约为 2019 全国电力消费的18%
- 提供约10亿kW的可再生电力接纳能力，为进一步全面发展风电光电提供了基础条件，其投资远低于大规模压缩空气蓄能方式
- 新的电力系统建成后，将可提供廉价电力支持未来高端制造业的发展，其投资效益远优于进一步发展房地产
- **Start up the large scale development of flexible elec. load buildings in urban and new type power system in rural**
- The investment is at 4000 billion RMB scale for 70% residential and office buildings in urban
- 3000 billion RMB is for new type of power systems in 70% rural villages
- 2000 TWh elec. can be provided, about 18% of 2019 China total power
- About 1 TW reception capacity for PV and wind power, It provides the infrastructure for us to further development of PV and wind power, the benefit-investment ratio is far better than large scale of energy storage through air- compressed
- New type of power system will provide cheap electricity for the high-end manufacturing after 10 years. The benefit is much higher than real estate

# 新的电力系统将促进一大批新的产业发展

## New Type of Power System Promotes New Industries

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- PV 元件、风电装备
  - 电力-电子器件，功率型集成电路
  - 新型蓄电池技术，蓄电池产业
  - 新的低压配电装置，如：直流变压器、  
逆变器、非接触开关、新型继电保护装置等
  - 电动汽车，智能充电桩
  - 直流建筑电器
  
  - 这都属于朝阳产业，我国在相关领域  
目前大多数技术上处于并跑地位
- PV element、wind power equipment
  - Power-electronics device, power type IC chip
  - New types of battery technologies, battery industry
  - New type of low voltage equipment industry, DC/DC transformer、Contactless switches、new type protection relay
  - Elec. cars industry, smart charging piles
  - DC elec. appliances
  
  - **As the sunrise industries, those domestic techniques are at the similar level as abroad**

# 煤改气？煤改可再生能源？

## Coal to Gas? Coal to Renewable?

- 去煤是解决大气污染和实现低碳所必须完成的任务
- 煤改气也需要万亿投资，去开发建设输送、储存、终端设备等，但可能不到20年后又要被替换
- 无论是低碳还是解决PM2.5，天然气最终也只能起辅助作用
- 煤改气可以促进产业发展吗？
  - 中国天然气产业大约比西方落后10年
  - 无论输配、储存还是末端的燃气轮机、内燃机，目前大多在技术上处于跟跑地位
  - 这些相关产业是朝阳产业还是夕阳产业？
- 无论从输送、储存、终端装置等，燃气能源所需要的建设内容与可再生电力系统完全不同，并非逐步过渡。那么，如果我们不愿意重复建设，为什么不能直接向可再生电力系统迈进？
- Remove coal is the key task both for air pollution and for low carbon
- Coal to gas needs thousand billions RMB to build gas system for transportation, storage and terminal equipment, but the life may no more than 20 years, due to the low carbon requirement
- Either for low carbon or for PM2.5, natural gas cannot exist for ever
- Can coal to gas promote some industry development?
  - Chinese natural gas relative industry is about 10 years behind developed countries
  - Either transportation, storage, gas engine, etc. Current Chinese level is about run after
  - Are the relative techniques sunrise industry or sunset industry?
- Comparing on the energy transportation, storage and terminals, electricity system is completely different from gas system. **If we don't want to repeat construction, why not go to the renewable electricity system directly?**

谢谢！  
Thank you !

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[jiangyi@tsinghua.edu.cn](mailto:jiangyi@tsinghua.edu.cn)