DC Microgrid in buildings in China

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Secretary of PEDF of China Association of Building energy Efficiency

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北京建筑大学 BEIJING UNIVERSITY OF CIVIL ENGINEERING AND ARCHITECTURE
中国建筑节能协会 光储直柔专业委员会 Committee of Photovoltaic Energy storage Direct current and Flexibility

CONTENT

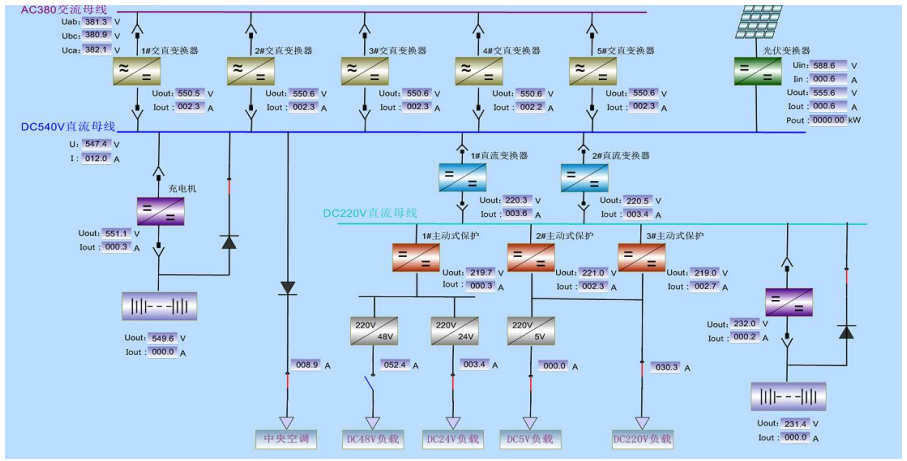
1. Who we are

Alliance of Direct Current Building (ADB) was established in **January 2018 – the hardest time**

U.S.-China Clean Energy Research Center（CERC）Joint Research Projects on Building Energy Efficiency

2016-2017

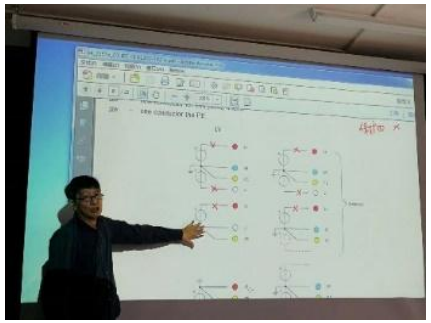

CERC BEE demonstration



- NO Design Standard
- NO Experience
- NO partner
- Few DC Products
- ……

- Opinion changing

2018-2019



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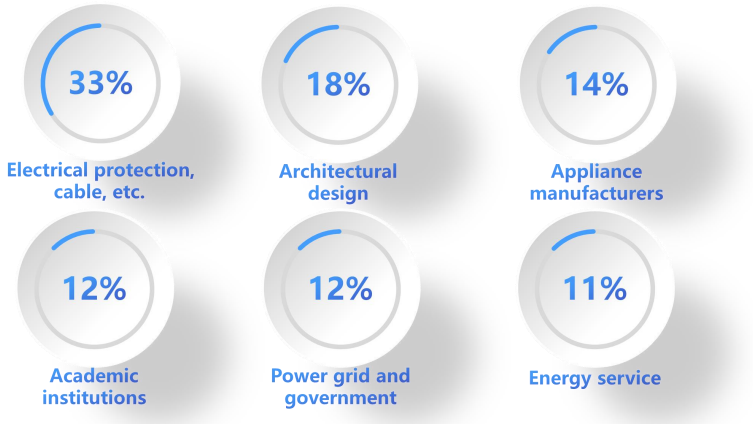
中国建筑节能协会 光储直柔专业委员会 Committee of Photovoltaic Energy storage Direct current and Flexibility

1. Who we are

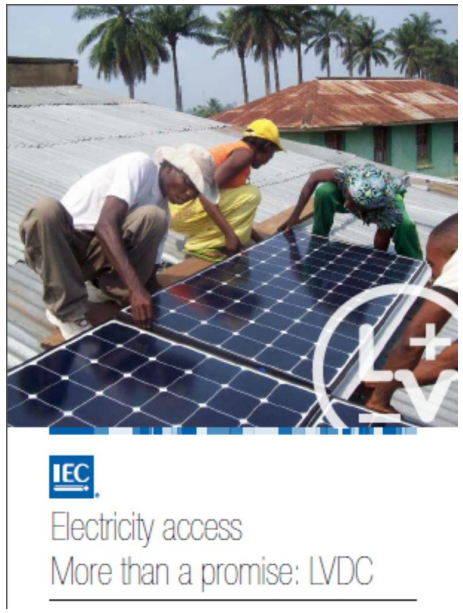
The Committee of PEDF, which is an authorized technical committee, was established in **September 2021** in China according to the national policy of carbon neutrality, and **more than 100 members** have joined, including institutes, universities, equipment manufacturers, power grid enterprises, etc.

中国建筑节能协会
光储直柔专业委员会
Committee of Photovoltaic Energy storage Direct current and Flexibility

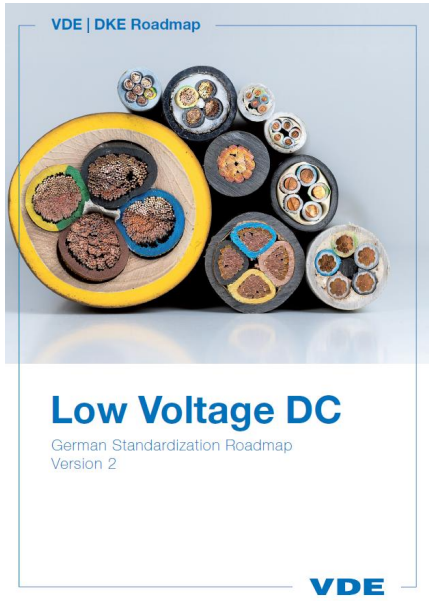


1. Who we are

As early as 2018, the international community conducted technical research and standardization on LVDC (LVDC standardization roadmap, 2018).



2018



2018

2018

2020

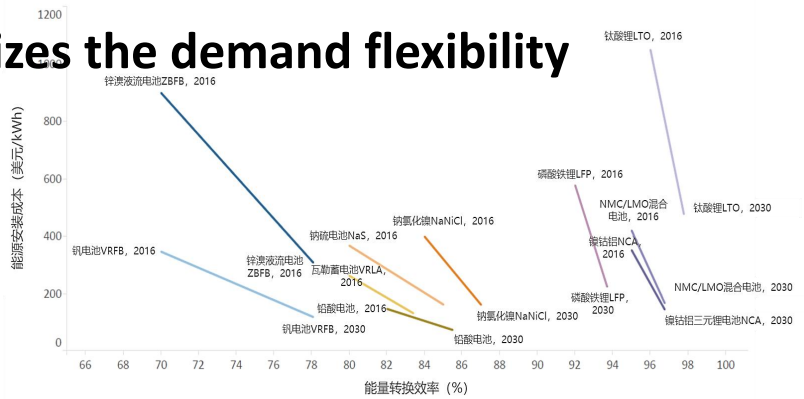
1. Who we are

What is PEDF?

DC microgrid, integrated Distributed PV and energy storage, realizes the demand flexibility

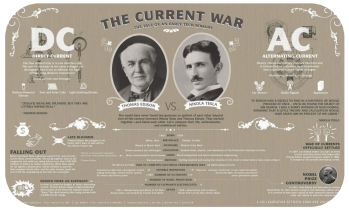
Solar PV

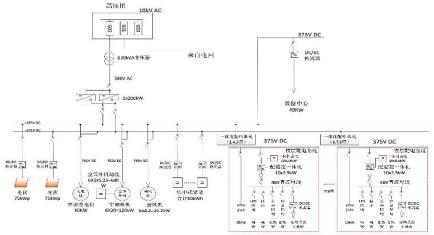
Energy storage



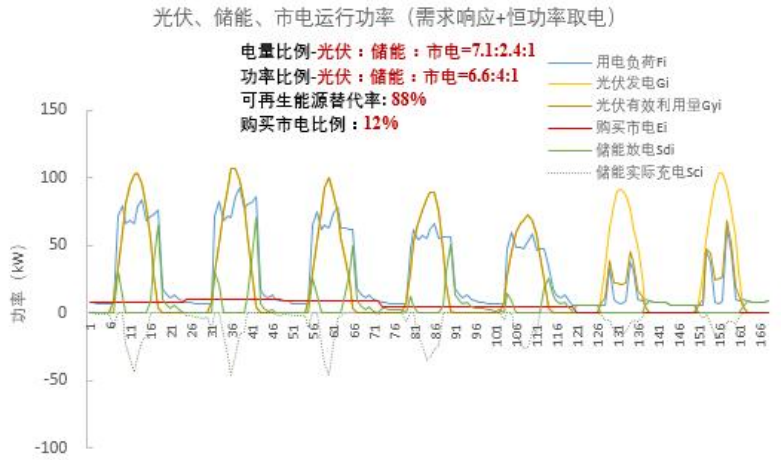
IRENA，Electricity storage and renewables: Costs and markets to 2030

DC



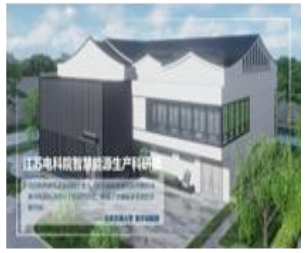


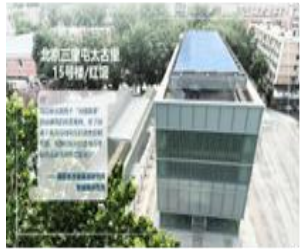
Flexibility



1. Who we are

PEDF continuously promotes more 300 hundreds LVDC demonstration projects.







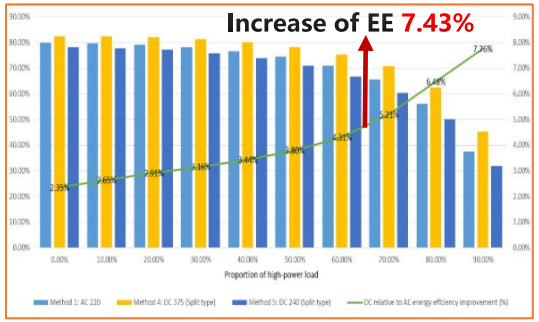
CONTENT

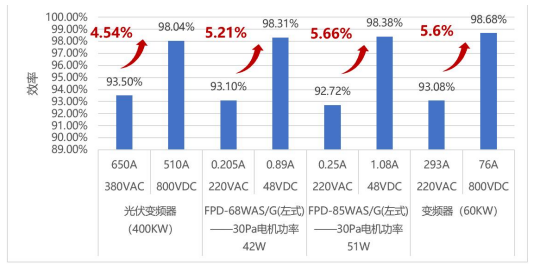
2. Background of LVDC in Buildings

➢ Advantages of LVDC in building

LVDC supplies **50%** appliances/
50% energy consumption

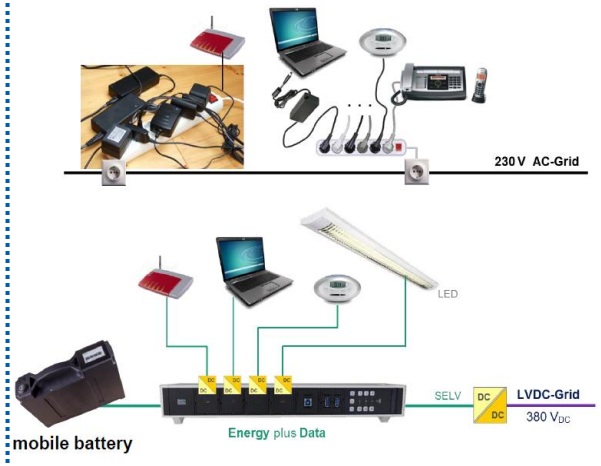
Energy efficiency increasing



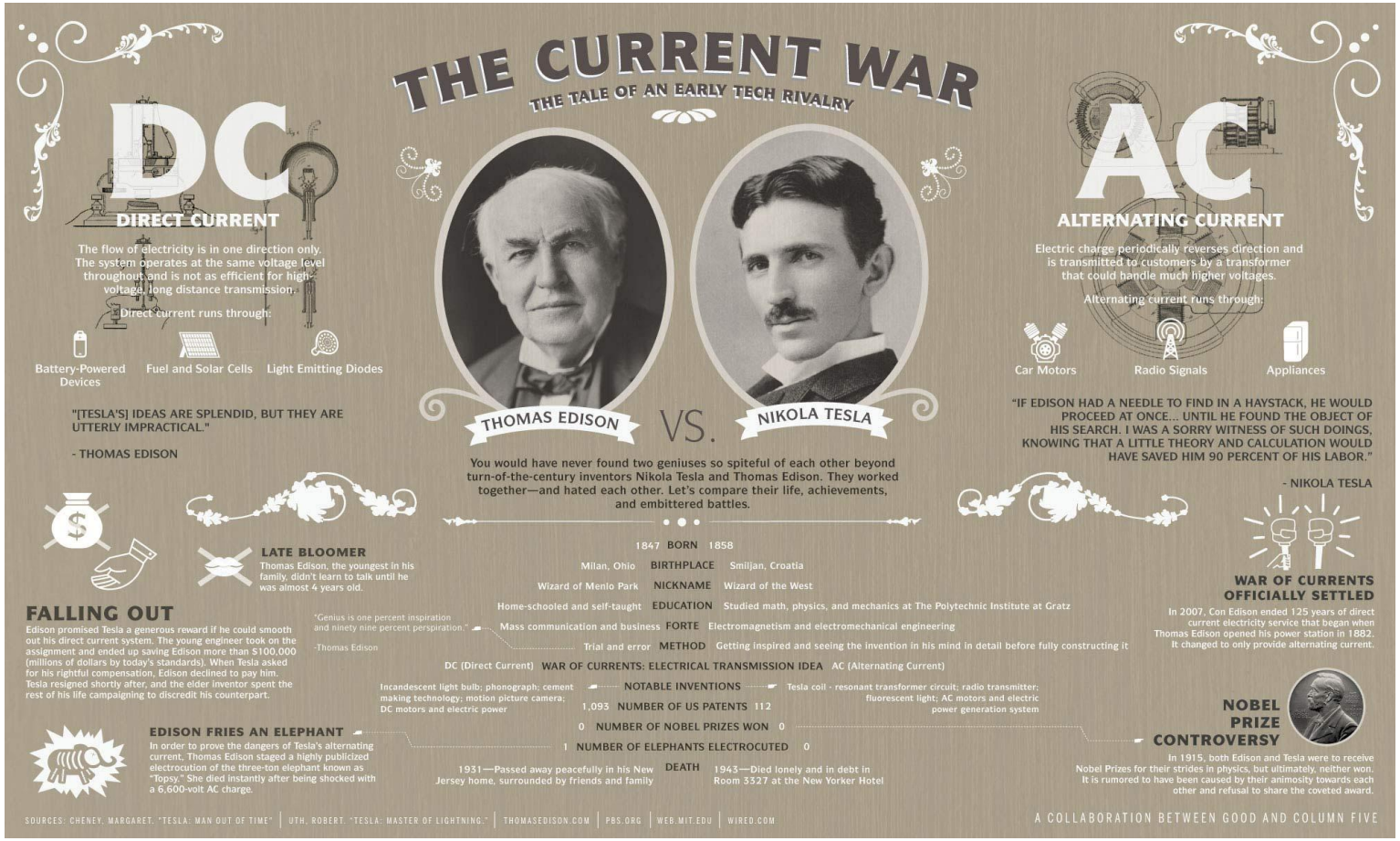


离心式水机直流化能效比

More simple and safe



2. Background of LVDC in Buildings



LVDC

Not only for

- **Efficiency**
- **Safety**
- **Affordability**
- **Convenience**

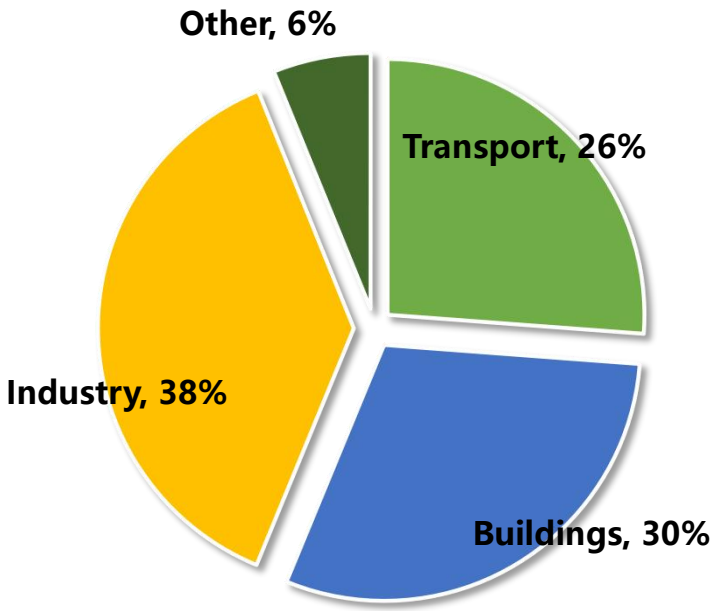
But

- **High penetration of RE**
- **Improve the load flexibility**
- **Joint Zero CO2 Emission**

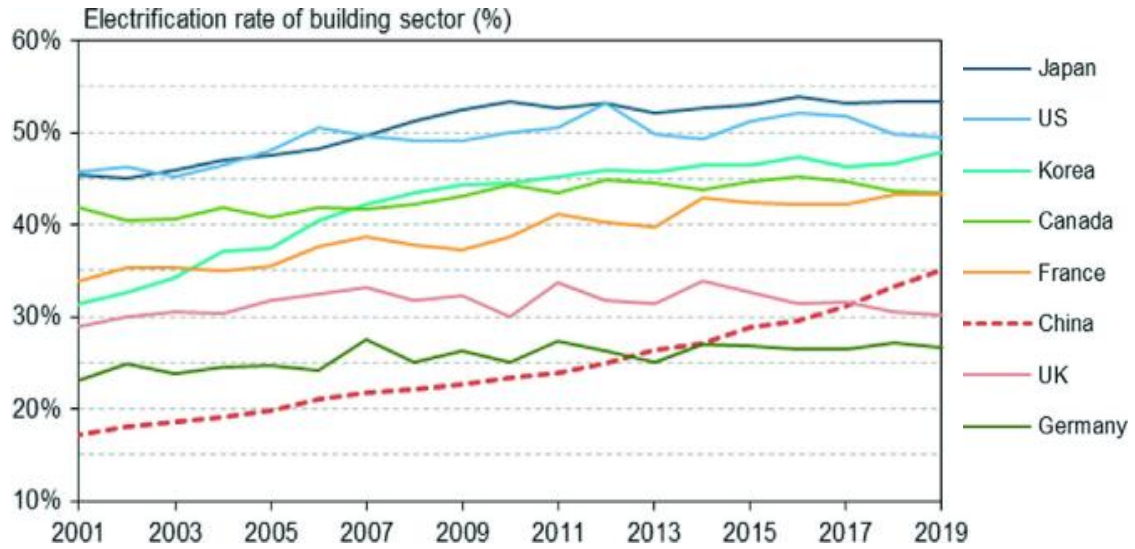
2. Background of LVDC in Buildings

➢ **Building electricity consumption brings challenges to energy saving.**

Building sector accounts **30%** in total final energy consumption worldwide



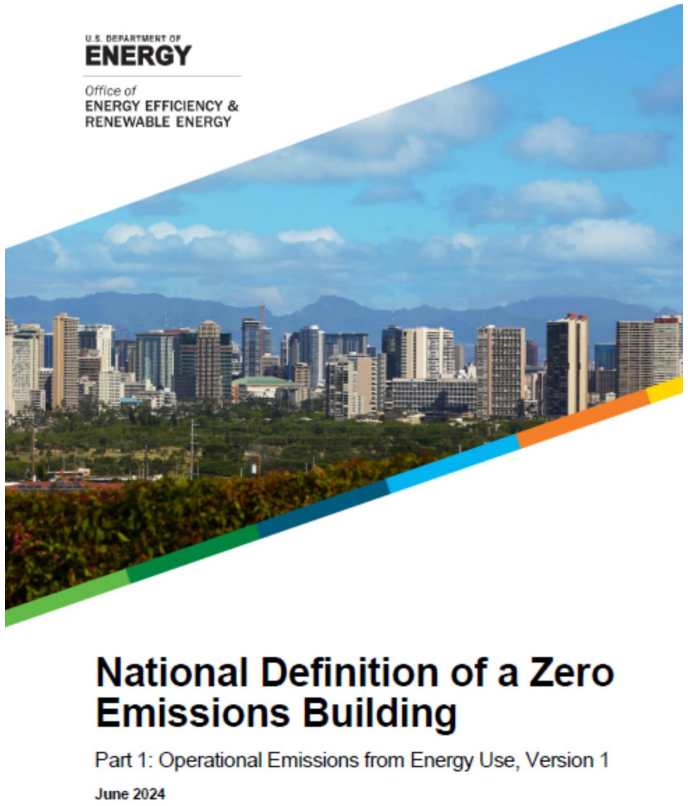
Building electrification has been on the rise over the past two decades (especially in China)



Source: IEA World energy outlook 2023
China's Building Energy Use and GHG Emissions, 2022

2. Background of LVDC in Buildings

➢ **Toward ZEB -** How does the building sector achieve carbon neutrality?



Criteria

At a minimum, a building that achieves zero operational emissions from energy use meets the following criteria:

1. **Energy efficient:** The building is among the most efficient.
2. **Free of on-site emissions from energy use:** The building's direct GHG emissions from energy use equal zero.
3. **Powered solely from clean energy:** All the energy used by the building, both on-site and off-site, is from clean energy sources.

2. Background of LVDC in Buildings

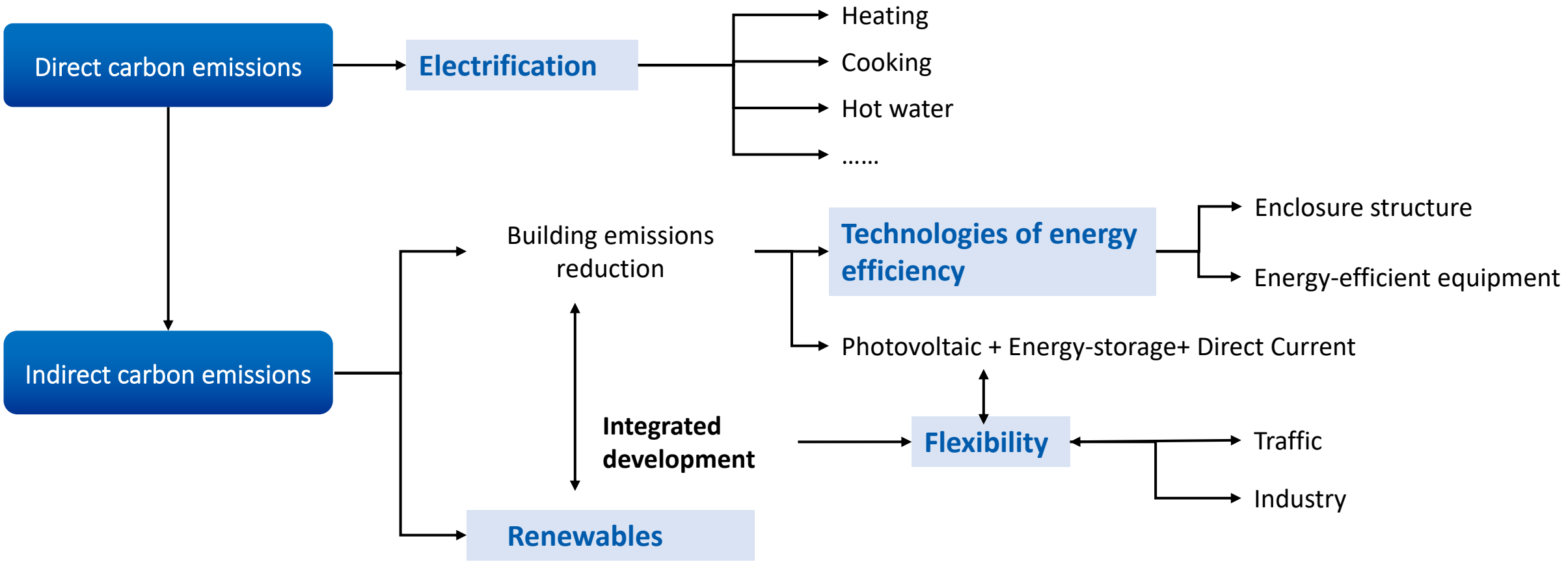
➢ EU ZEB

- **All new buildings to be zero-emission buildings (ZEBs):**
  - From 2028 public buildings owned by public bodies
  - From 2030 all new buildings
- **ZEB will require:**
  - **Zero on-site emissions from fossil fuels**
  - **A very low amount of energy with a view to cost-optimal level but at least (NZEB -10%)**
  - Supplied by:
    - **renewables from onsite, nearby, renewable energy communities**
    - **energy efficient DH&C**
    - **energy from carbon-free sources**
  - Life cycle GWP calculation (from 2028 for new bdgs >1000m2 useful floor area, from 2030 for all new buildings) and disclosure through EPC
- **Explanatory video:** Zero-emission buildings - the new EU standard

European Commission

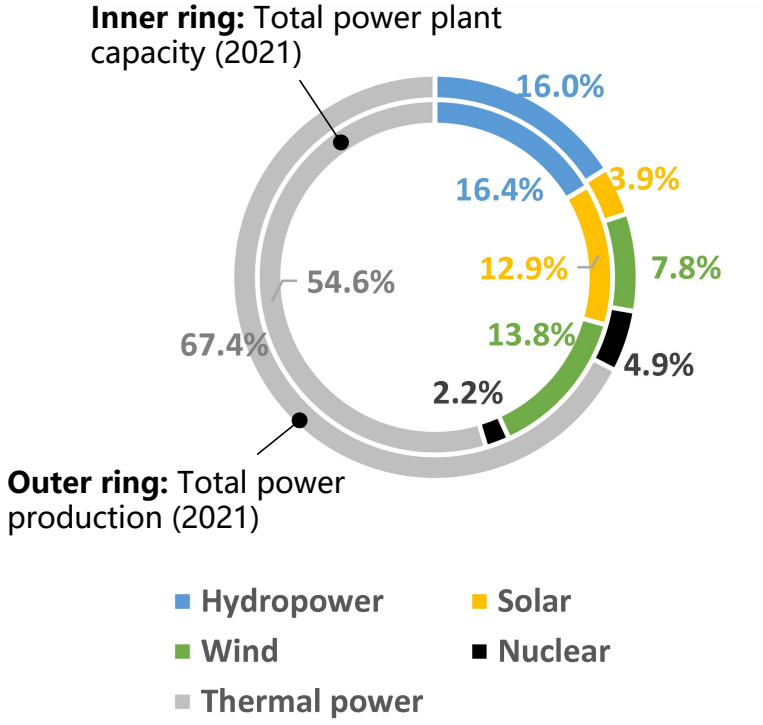
2. Background of LVDC in Buildings

➢ **Toward ZEB -** How does the building sector achieve carbon neutrality?



2. Background of LVDC in Buildings

➢ **Where the ZCE electricity comes from?**



2050-2060

Power resources	Capacity (GW)	Production (GWh)	Peak shaving (GW)	Description
Nuclear	200	1.5×10^6	/	
Hydropower	500	2.0×10^6	900	
Pumped storage	400	/		
Wind/Solar power plant	7000	9.0×10^6	500	Peak shaving by renewable energy generation
Thermal power plants	700	1.5×10^6	700	Only adjust seasonal power balance
Total	8800	14.0×10^6	**-4900**	

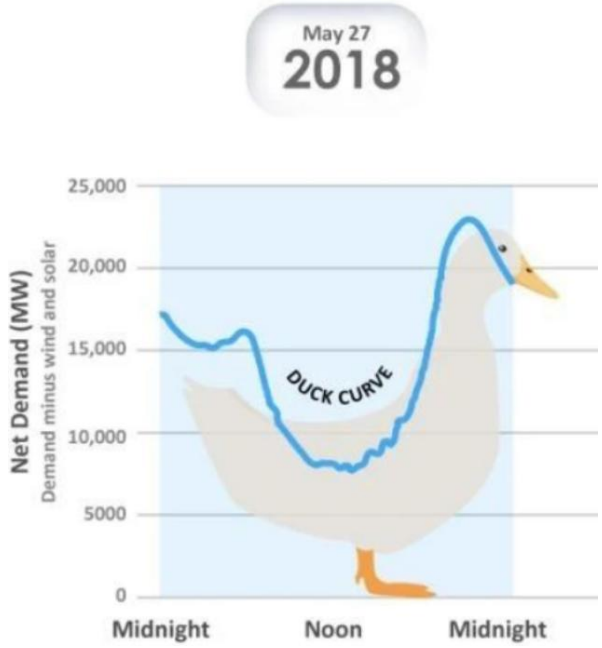
80%

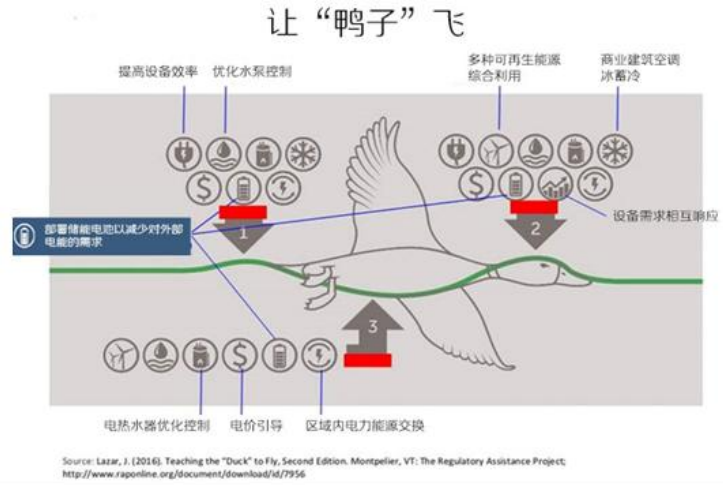
60%

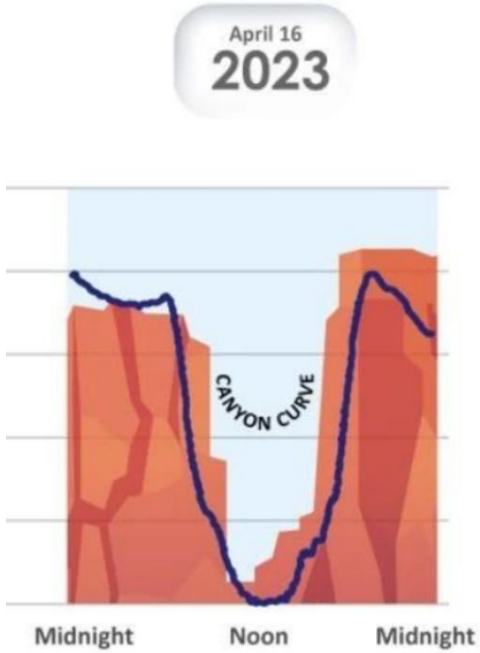
Resource: Tsinghua University

2. Background of LVDC in Buildings

- **Where the ZCE electricity comes?100h**





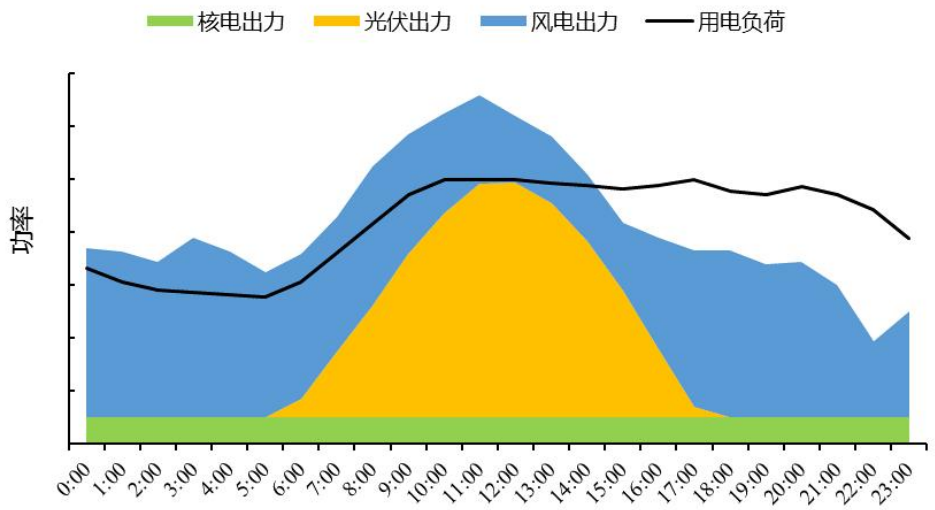


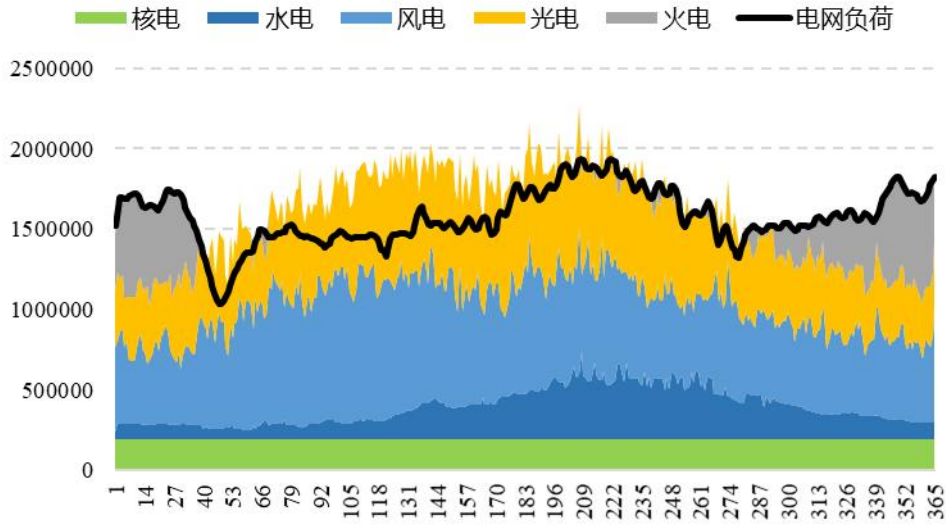
Resource: CAISO

Duck Curve & Canyon Curve

2. Background of LVDC in Buildings

- **Where the ZCE electricity comes? 8760h?**

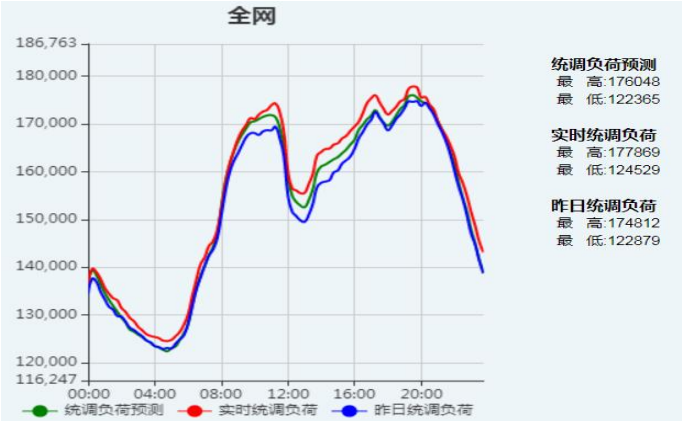




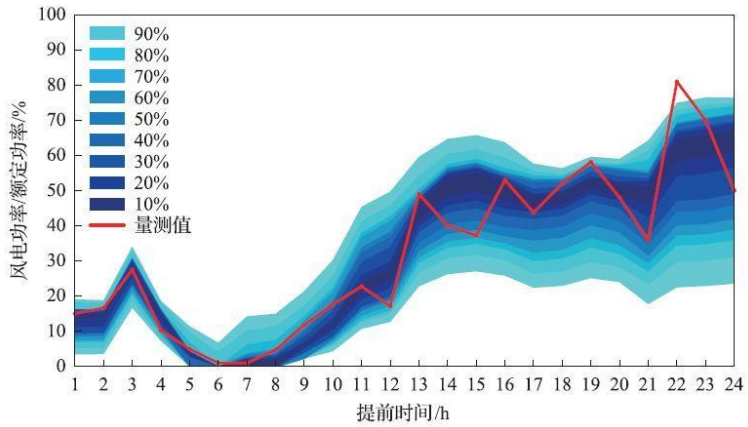
Day and annual curve of outputs of High penetration of wind and solar

2. Background of LVDC in Buildings

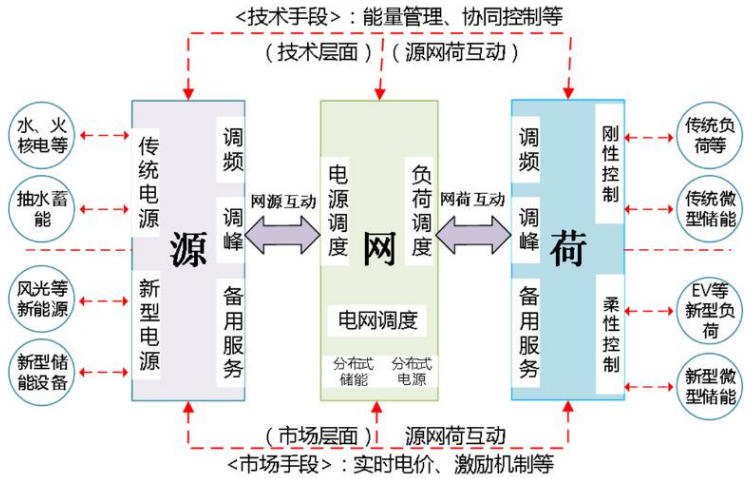
- **Where the ZCE electricity comes from? - To predict renewables is more difficult than to predict load**



Uncertainty of load prediction



Uncertainty of renewable generation

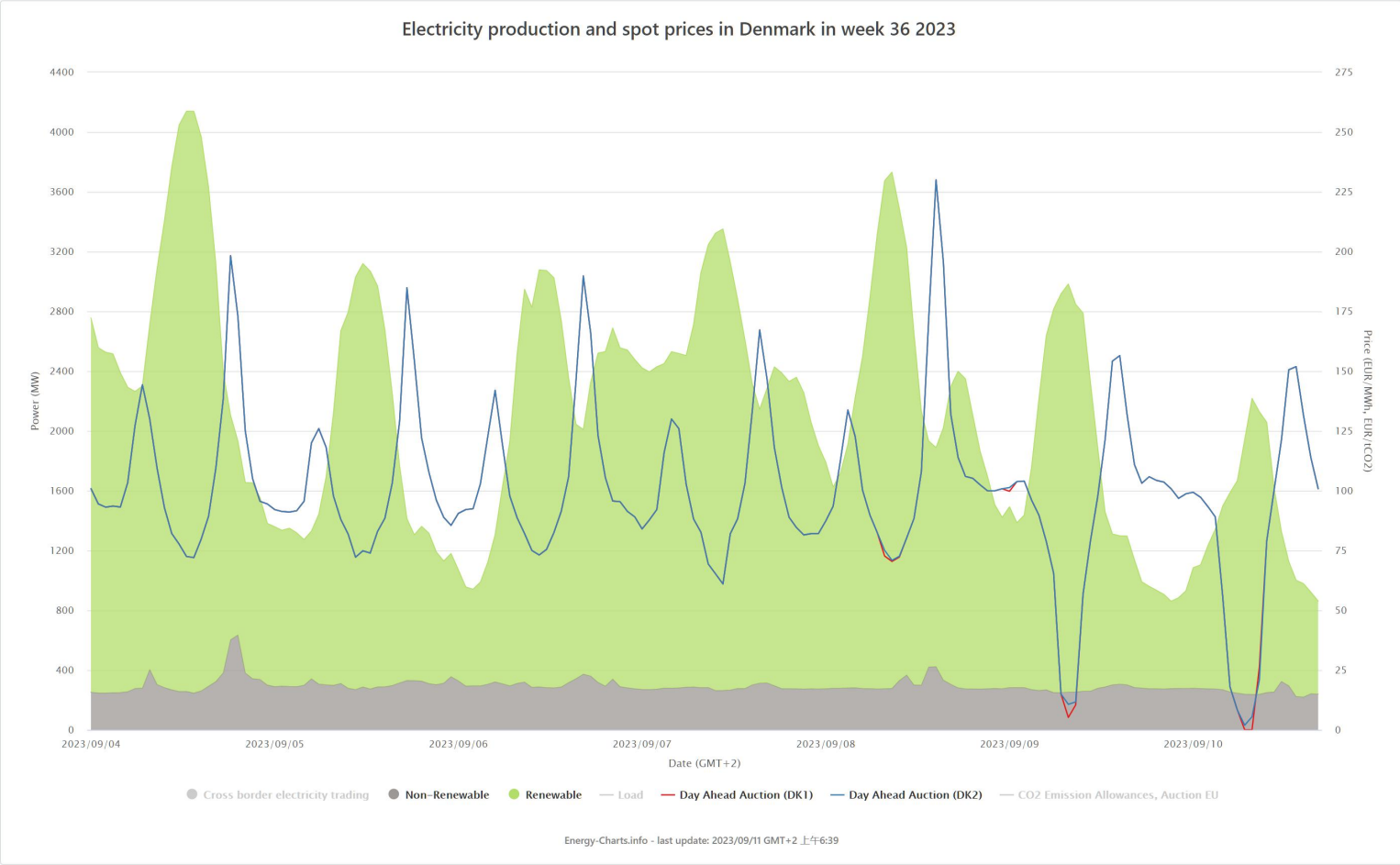


Hybrid methods to achieve energy balance

The relation between supply side and demand side is changing.

2. Background of LVDC in Buildings

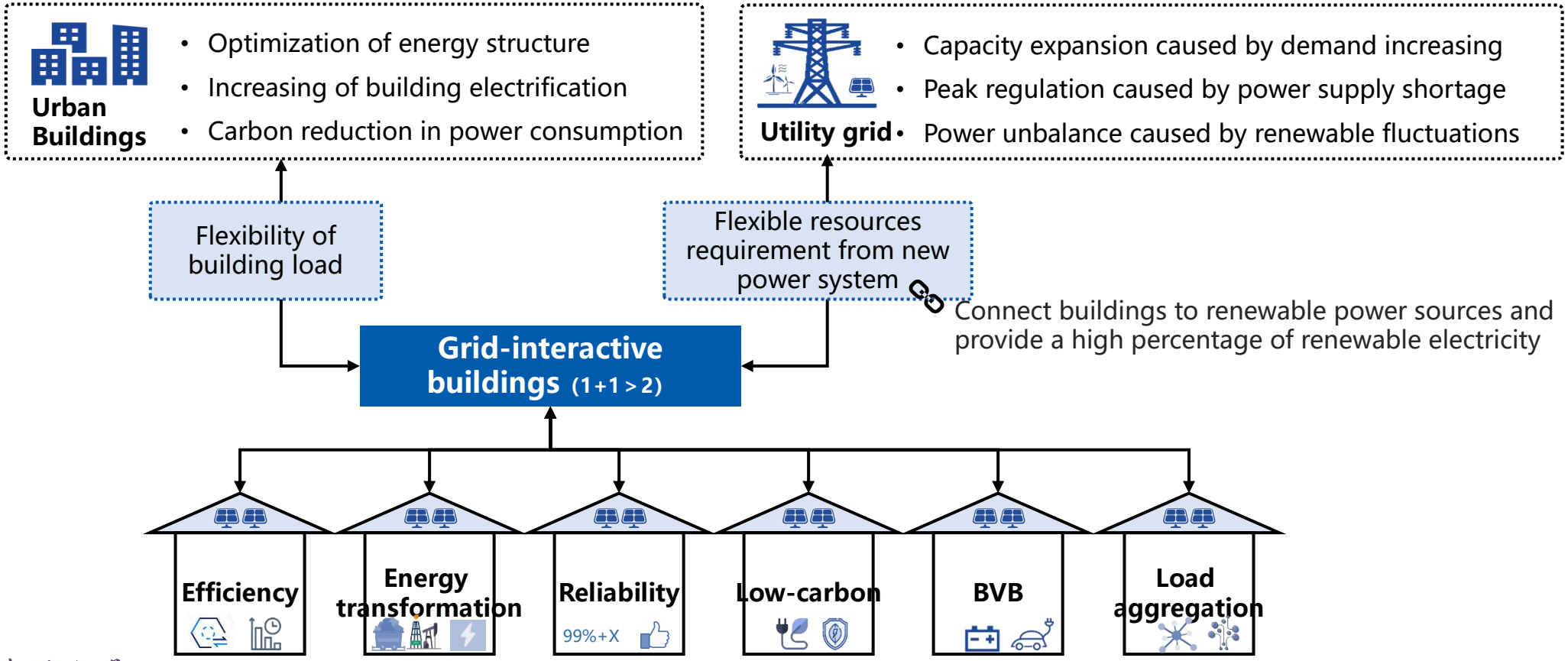
➢ What happen if we do nothing?



2. Background of LVDC in Buildings

Joint to reduce CO_2

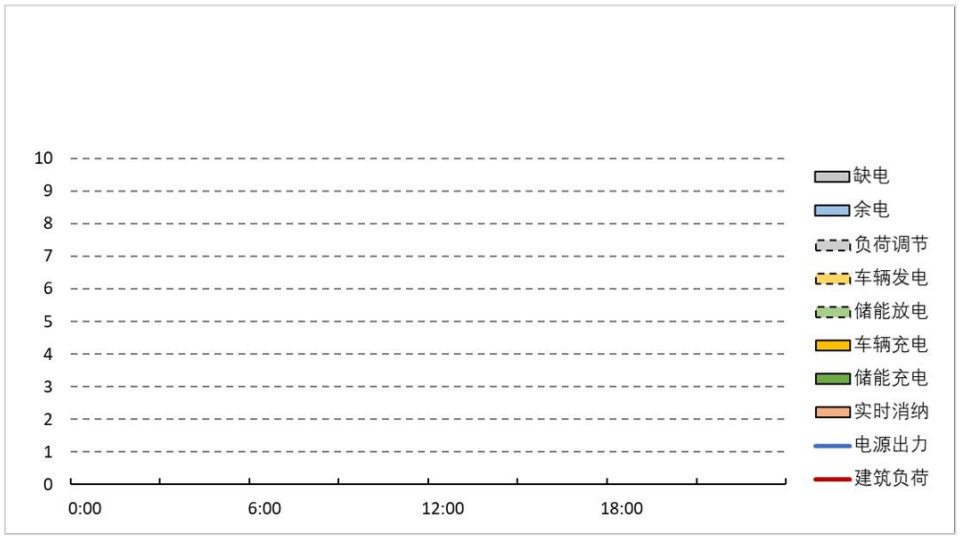
Buildings + Power Grids



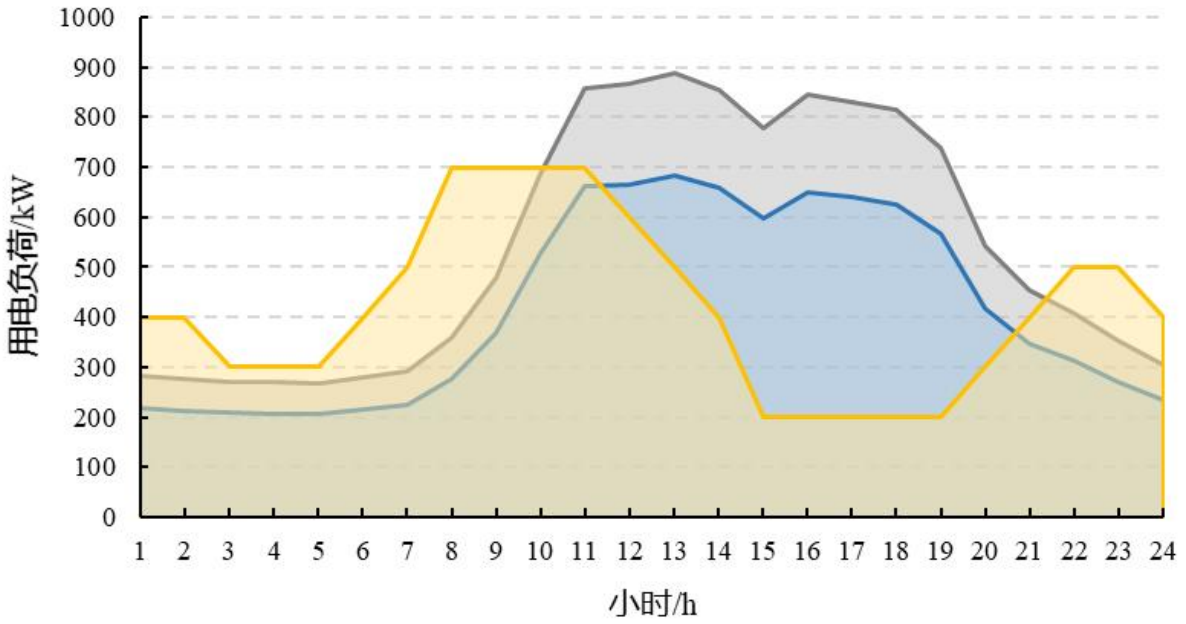
CONTENT

3. Research, products and demonstrations

➢ **Building load is flexible, and easy to follow the random of renewables.**



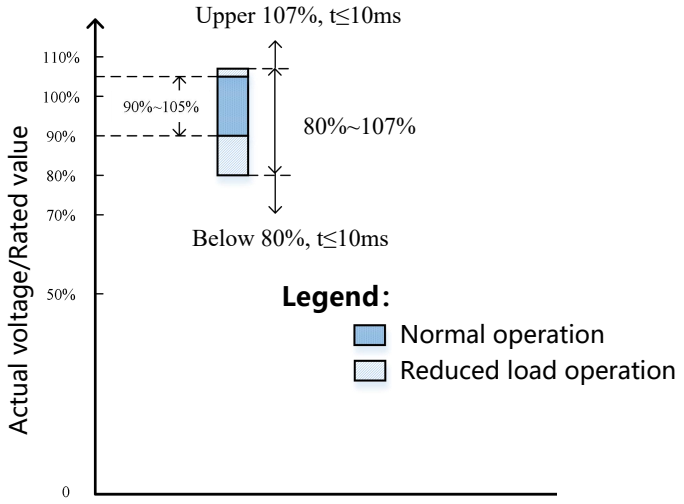
Schematic diagram Building load flexibility

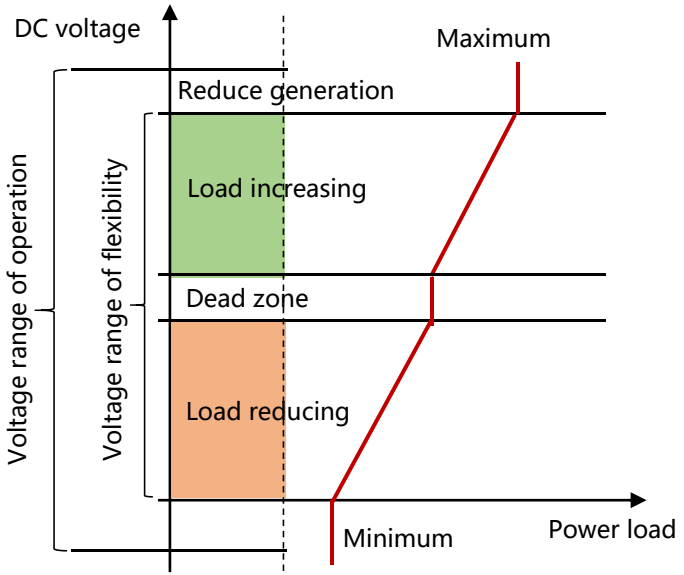


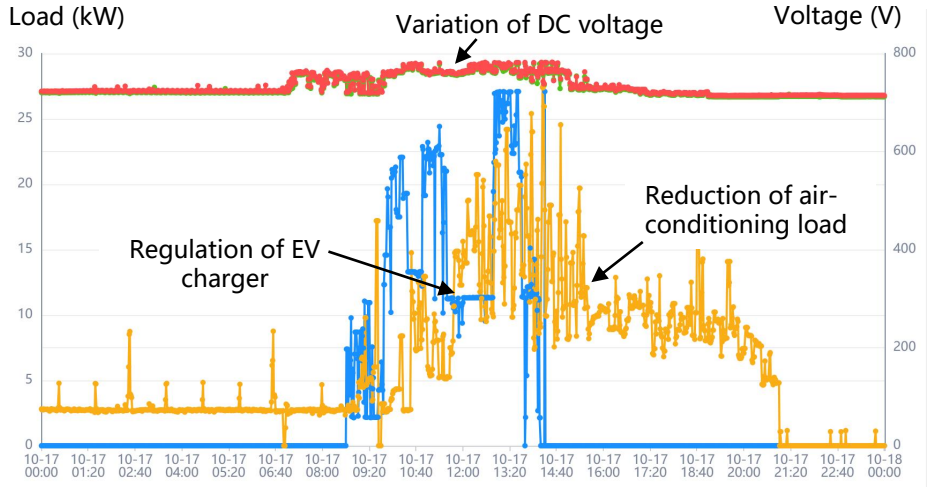
3. Research, products and demonstrations

➢ LVDC and Flexibility

DC equipment → **Energy flexibility** → **Building load regulation**







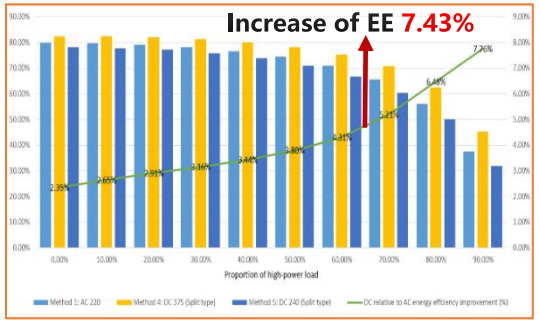
3. Research, products and demonstrations

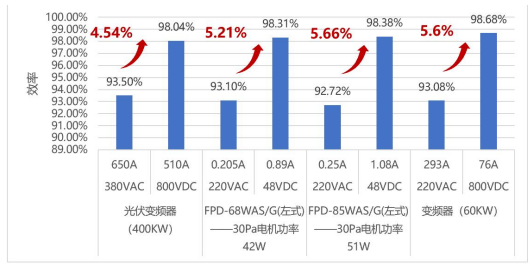
Research | Standards and codes | Products | Demonstrations

➢ Advantages of LVDC in building

LVDC supplies **50%** appliances/ **50%** energy consumption

Energy efficiency increasing





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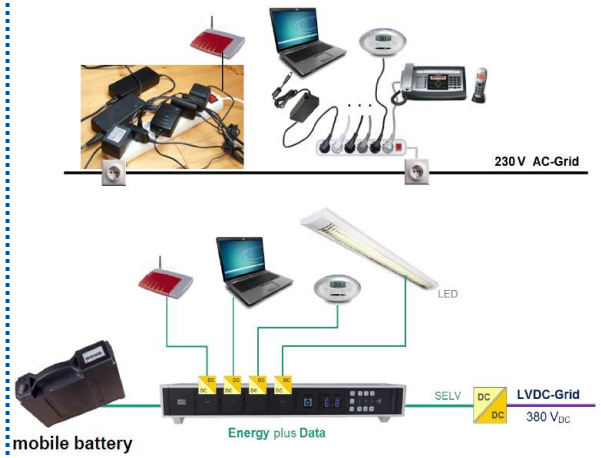
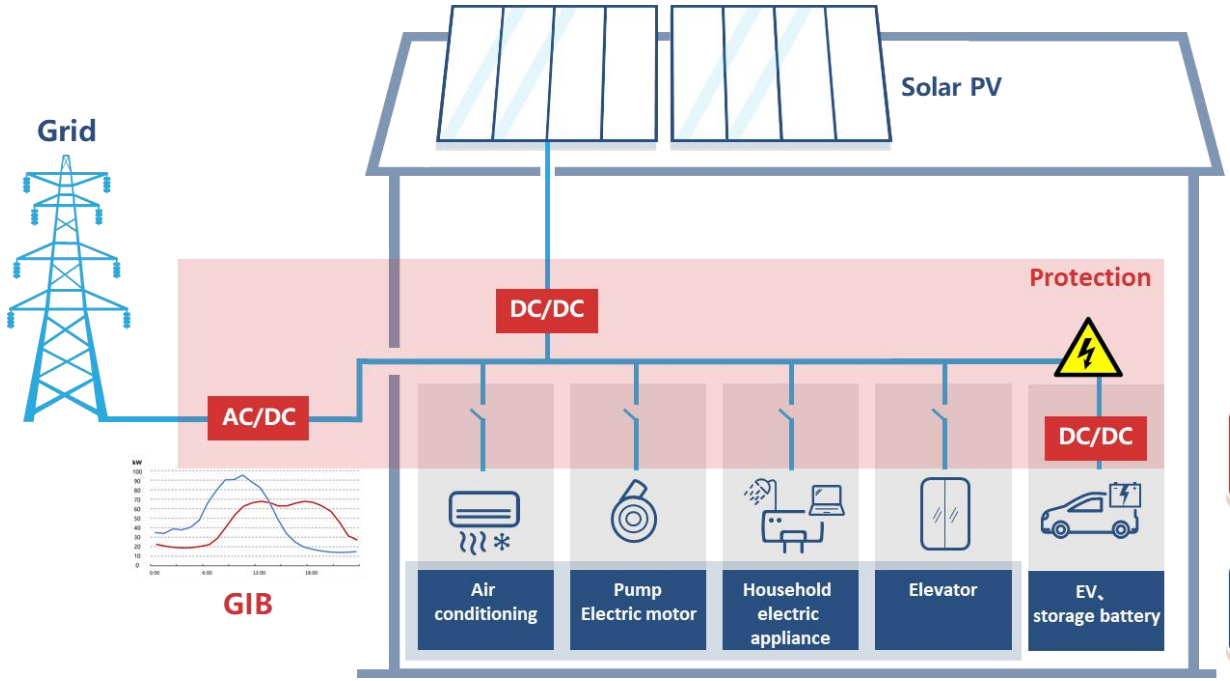


3. Research, products and demonstrations

Research | Standards and codes | Products | Demonstrations

- LVDC technology development is supported by **National Key R&D Program of China**, which is highest research funding in China.



- **100+** DC electromechanical equipment products by 2025
- **20+** DC power converters and electrical protection equipment products by 2027

Distribution system

DC electromechanical equipment in PEDF buildings

Execution period: 2022~2026

End usese

DC power distribution technologies in PEDF buildings

Execution period: 2023~2027

3. Research, products and demonstrations

Research | **Standards and codes** | Products | Demonstrations


ICS 90.040
CCS P33
中国建筑节能协会团体标准
T/CABEE 030—2022
民用建筑直流配电设计标准
Design standard for direct current power distribution of civil buildings
2022－01－05 发布 2022－03－01 实施
中 国 建 筑 节 能 协 会 发 布

T/CABEE 030-2022
***Design standard* for direct current power distribution of civil building**


ICS 91.040
中国建筑节能协会团体标准
P 33 T/CABEE 055-2023
建筑光储直柔系统评价标准
Assessment standard for Photovoltaics, Energy storage, Direct current and Flexibility(PEDF) system in buildings
2023-12-01 发布 2024-02-01 实施
中 国 建 筑 节 能 协 会 发 布

T/CABEE 055-2023
***Assessment standard* for PEDF system in Buildings**


ICS 90.040
中国建筑节能协会团体标准
P33 T/CABEE 063-2024
建筑光储直柔系统
变换器通用技术要求
General technical requirements for converter of PEDF system in buildings
2024-03-29 发布 2024-06-01 实施
中 国 建 筑 节 能 协 会 发 布

T/CABEE 063-2024
General technical requirements for converter of PEDF system in buildings

3. Research, products and demonstrations

➢ **Power distribution devices** include converters, DC plus and socket, DC protection equipment.

DC plus and socket

DC protection equipment

DC converter

3. Research, products and demonstrations

- **DC appliances** in China's market including air-conditioning, LED lighting, DC EV charger, refrigerator, rice cooker, etc.

DC Air conditioning

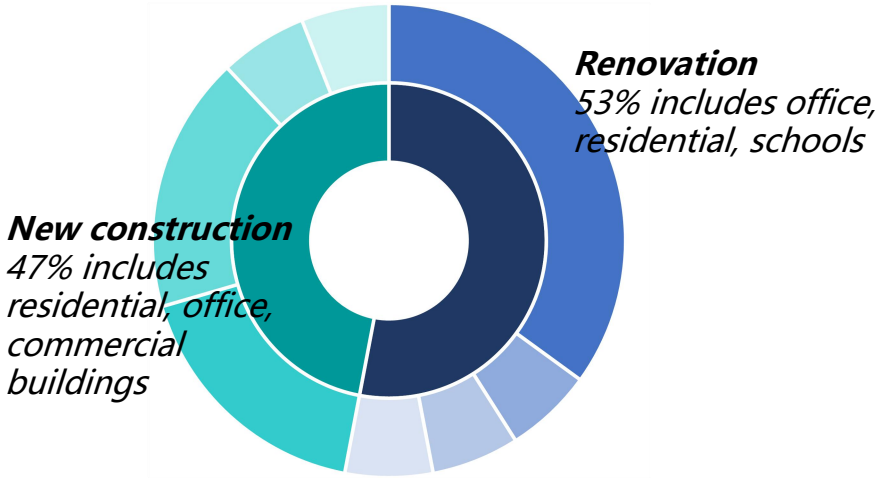
LED lighting

EV bidirectional charger

Refrigerator fans etc.

3. Research, products and demonstrations

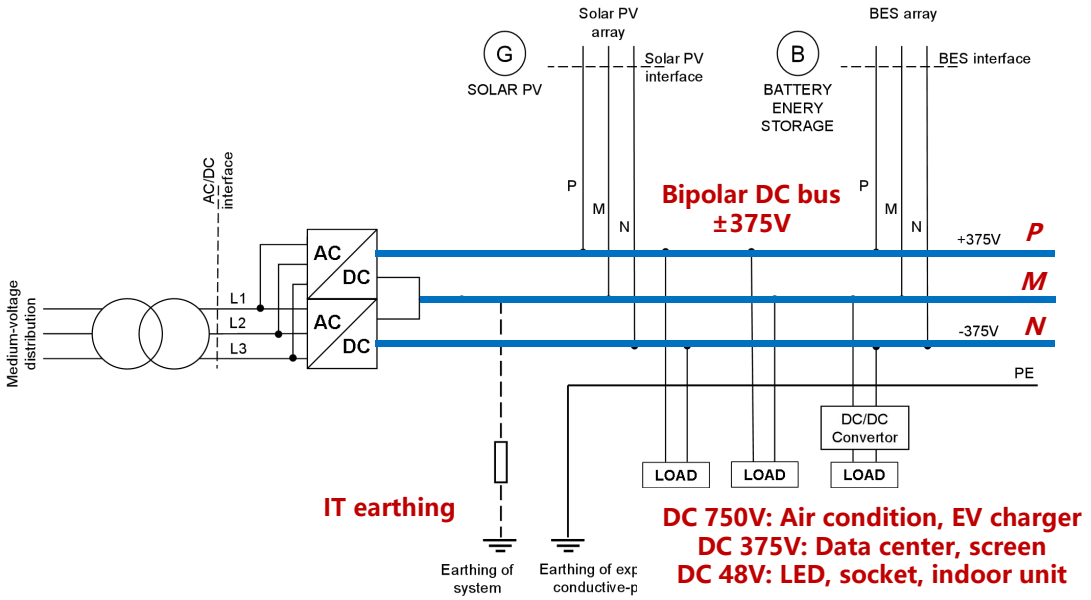
- PEDF system in buildings developed rapidly. **More than 200 projects** have applied PEDF technologies, including commercail buildings, residential buildings, transportation stations, industrial parks, etc.



Distribution of PEDF project in China

3. Research, products and demonstration projects

Research | Standards and codes | Products | **Demonstrations**

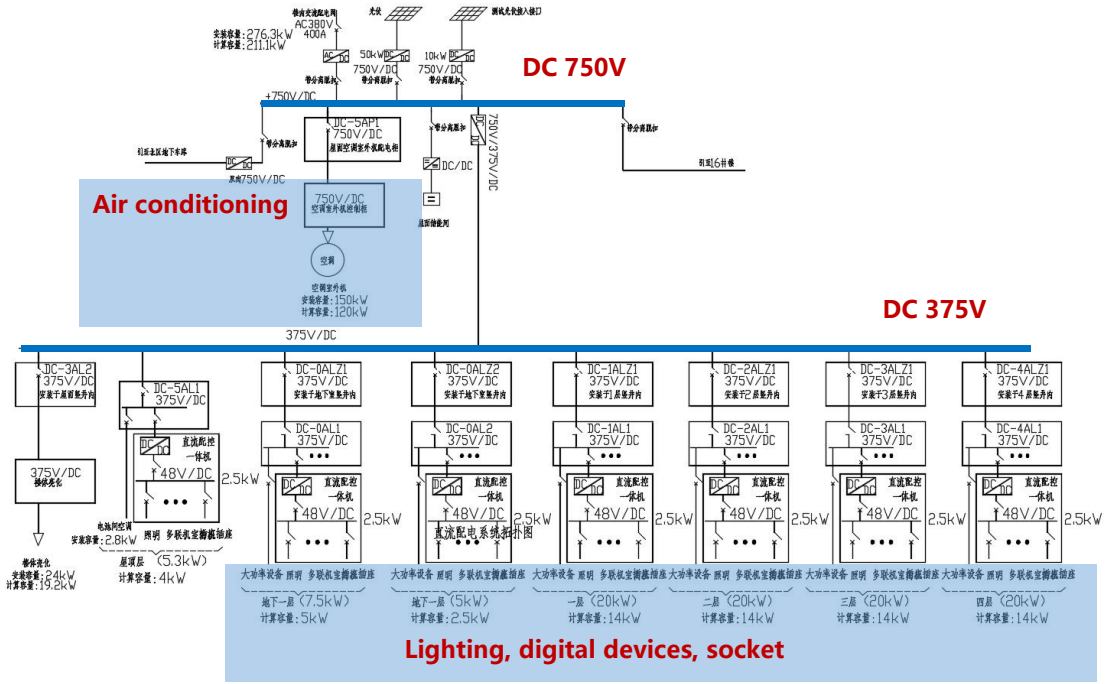


The IBR Future Complex (Shenzhen, China)

Building type	Office, Laboratory
Demonstration	Gross area: 6259m². The first LVDC building with large-scale in China. Bipolar DC bus distribution, IT earthing, voltage control approach, etc., are integrated in this building to supply DC power and explore the best solution for LVDC in buildings.
Owner	Shenzhen Institute of Building Research Co., Ltd

3. Research, products and demonstration projects

Research | Standards and codes | Products | **Demonstrations**

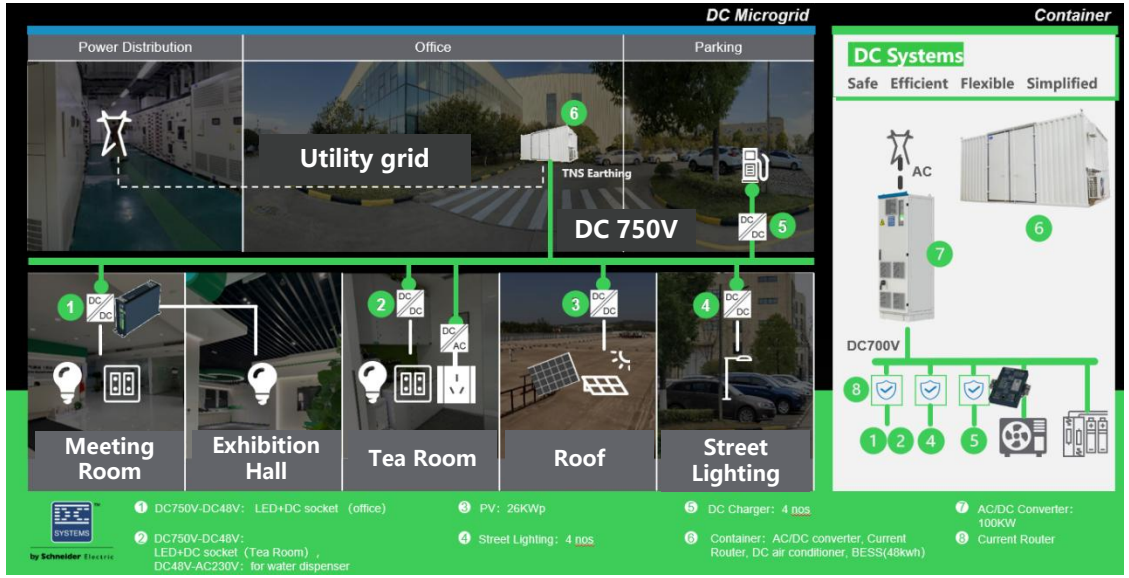


TaiKoo Li Sanlitun PEDF building (Beijing, China)

Building type	Commercial
Demonstration	Gross area: 3500m². The first commercial property renovation project of PEDF building in China. Using BIPV, energy storage and flexible load to achieve ZCB.
Owner	Swire properties

3. Research, products and demonstration projects

Research | Standards and codes | Products | **Demonstrations**

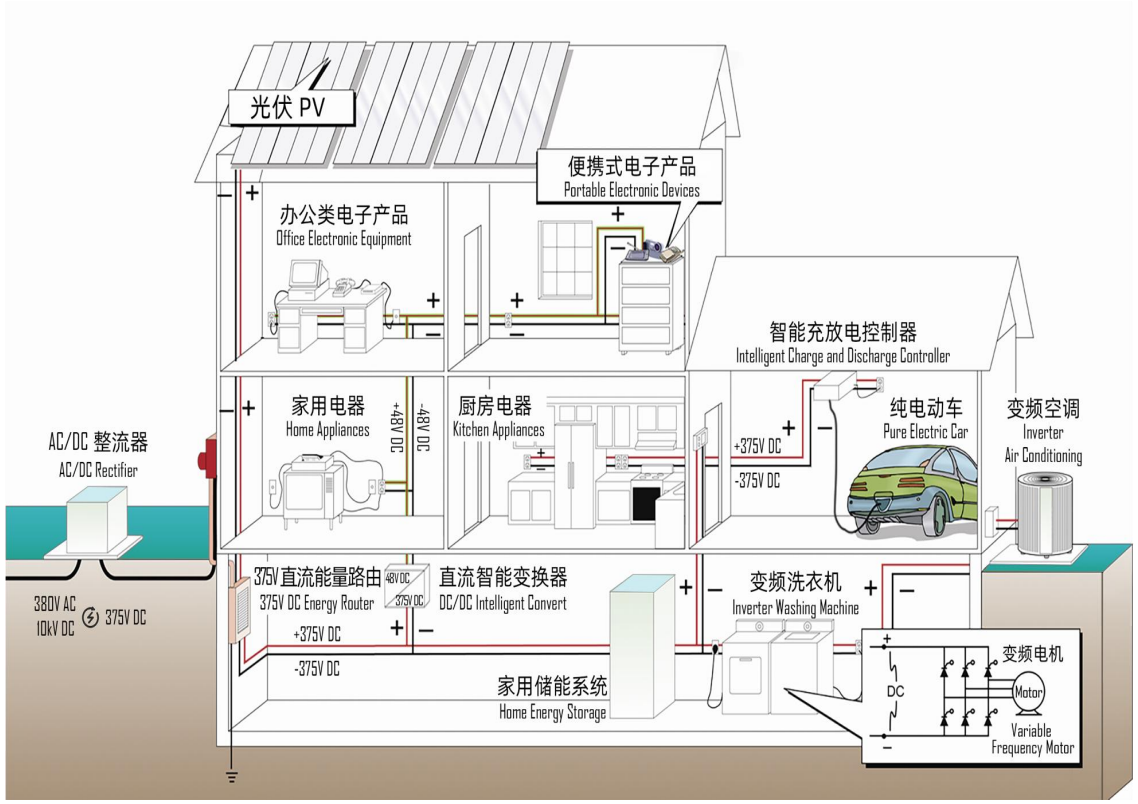


Schneider Electric PEDF Research Center (Wuhan, China)

Building type	Office
Demonstration	Gross area: 200m². The PV panels deployed on the roof achieve 100% green power supply for building load such as LED lighting, DC air conditioning, and EV-chargers. The performance of DC protection devices is verified.
Owner	Schneider Electric SAS (China)

What the future building would be?

- Distributed solar PV
- Distributed Energy storage
- BVB (Building-EV-Building)
- DC microgrid
- Demand flexibility
- APR （active power response/Grid interactive）



One for all was yesterday, all for all is the future.

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