中国建筑用能状况和节能途径
Building Energy use in China & the Roadmap for future energy saving

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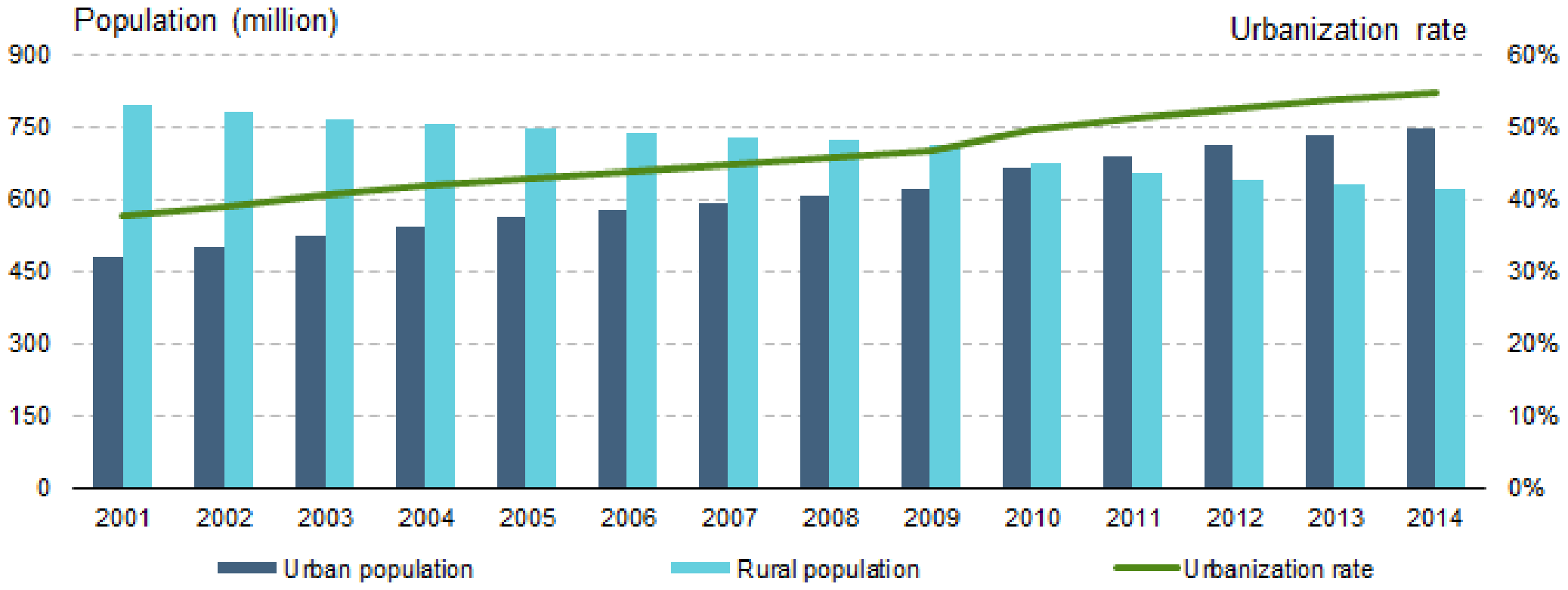
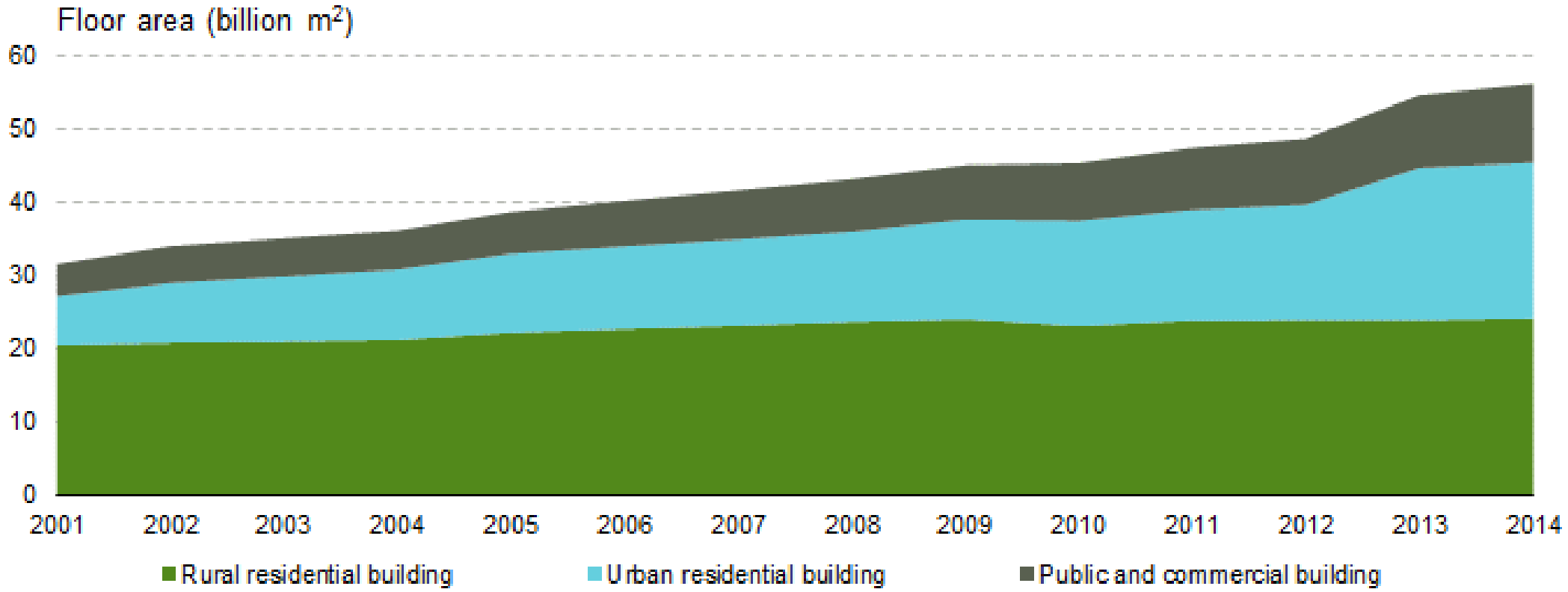
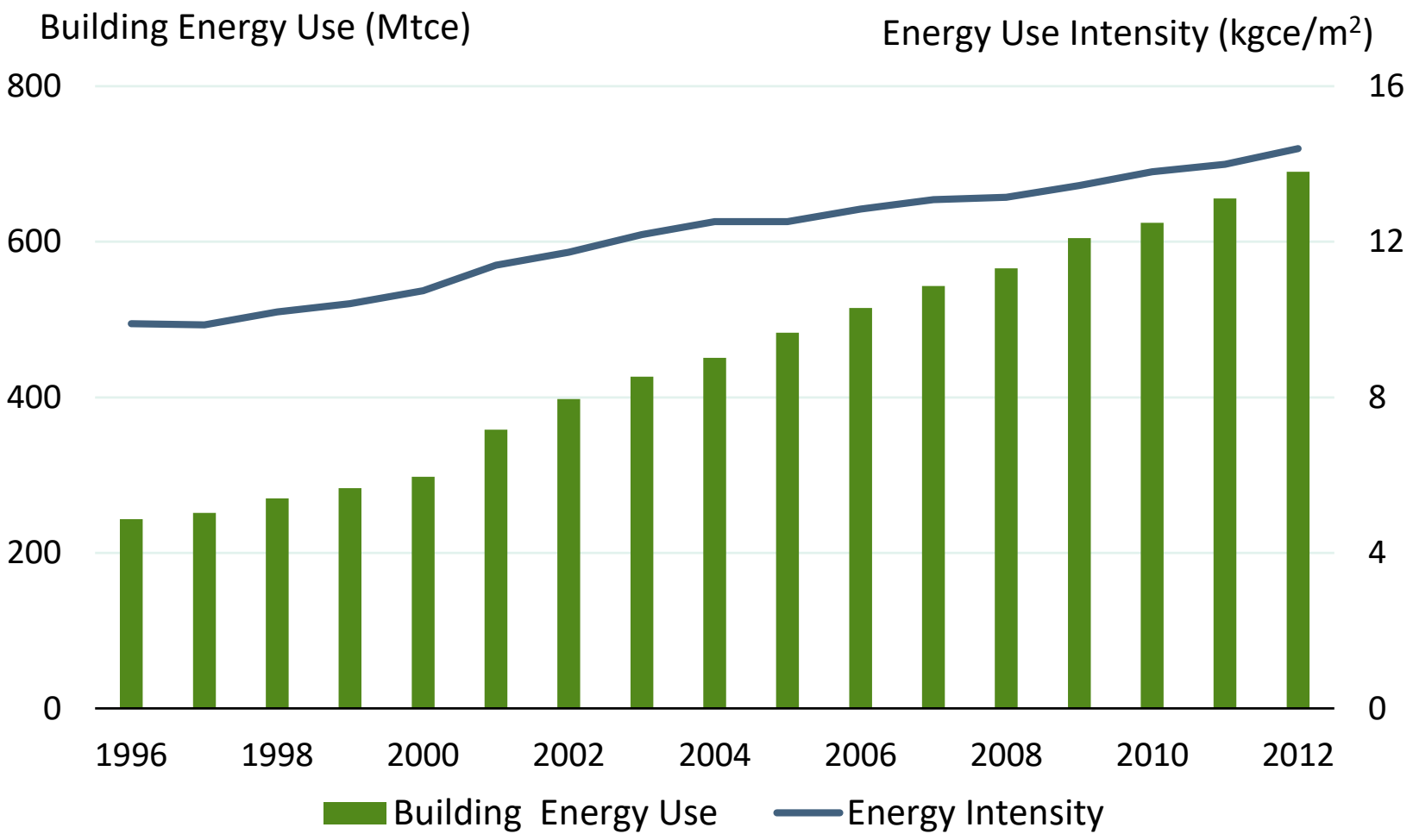
Population and urbanization growth in China



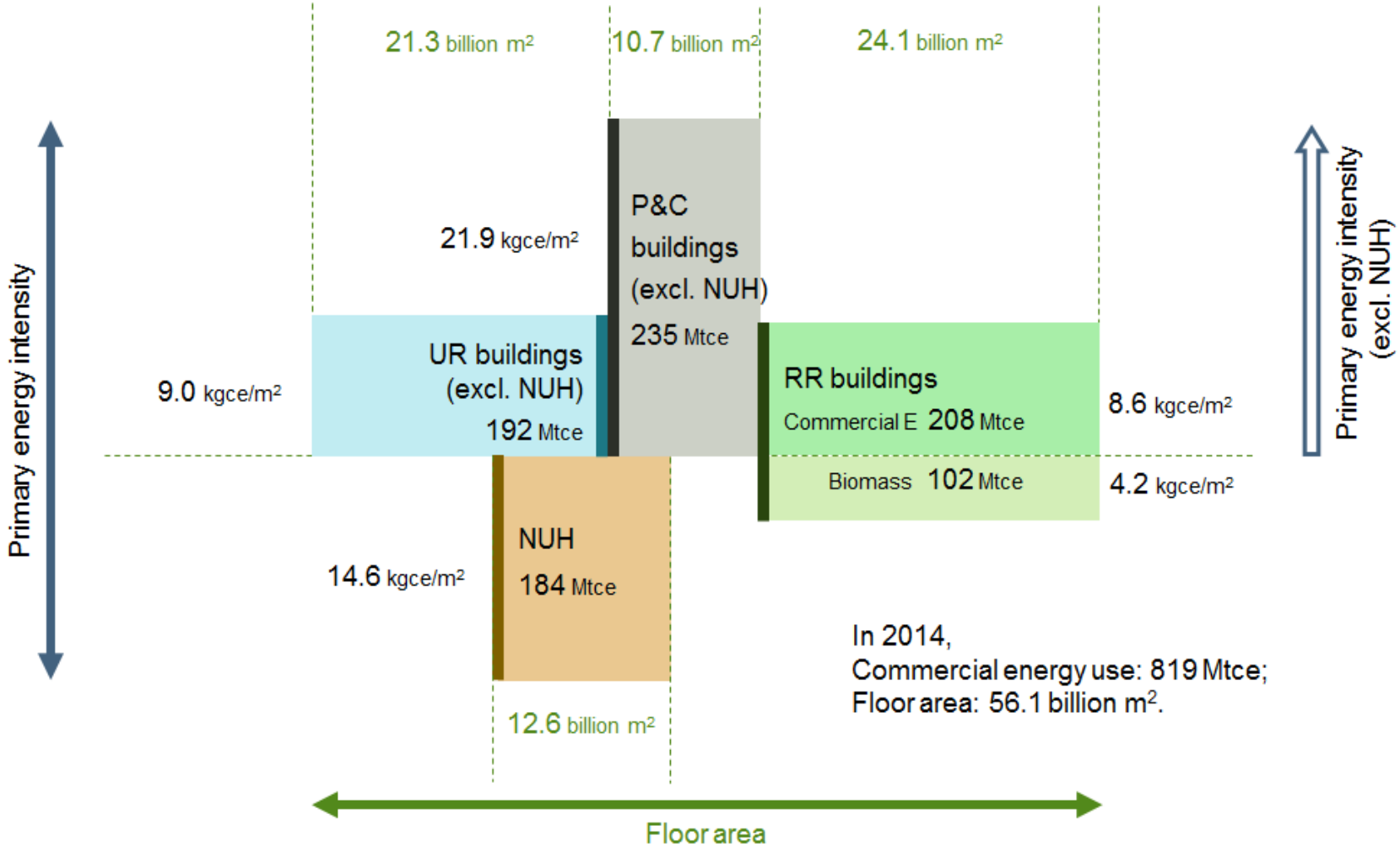
Floor area growth in China



Building energy use growth in China



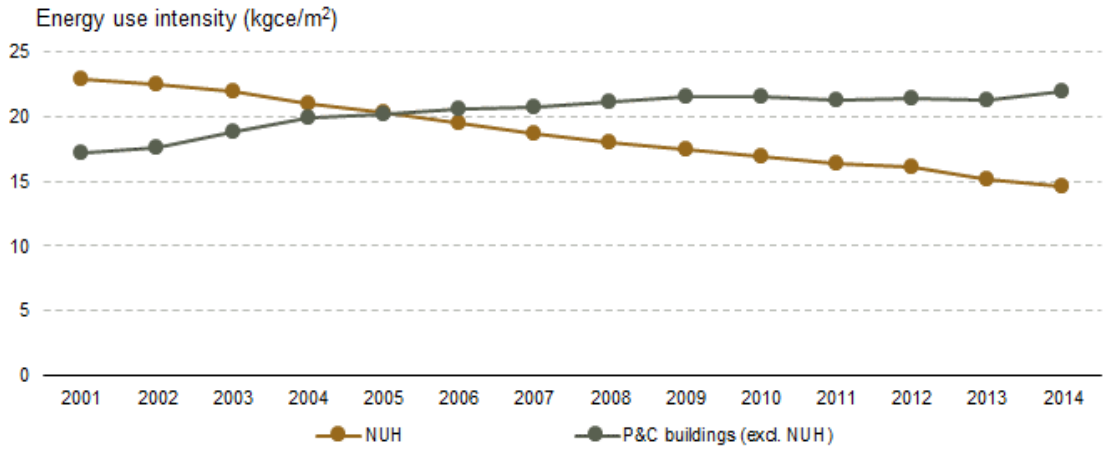
China's buildings energy use



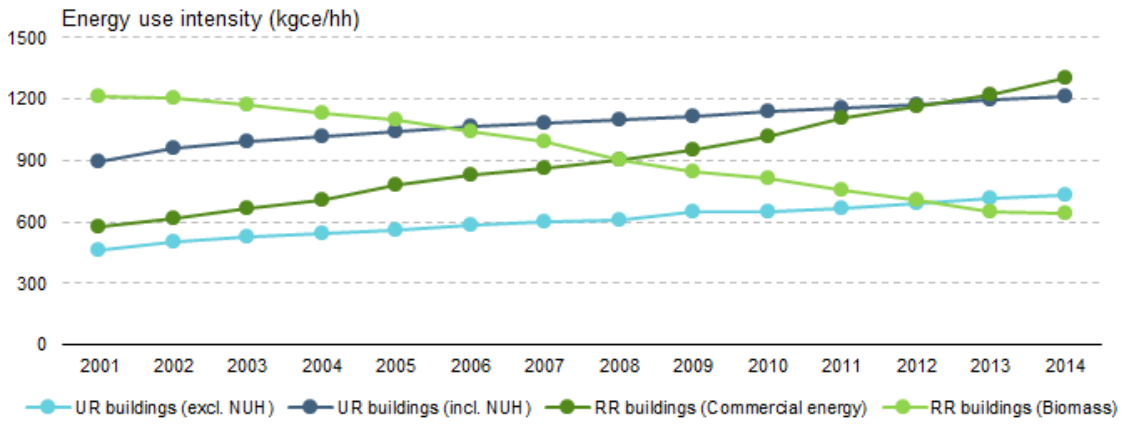
In 2014,
Commercial energy use: 819 Mtce;
Floor area: 56.1 billion m².

China’s buildings energy use

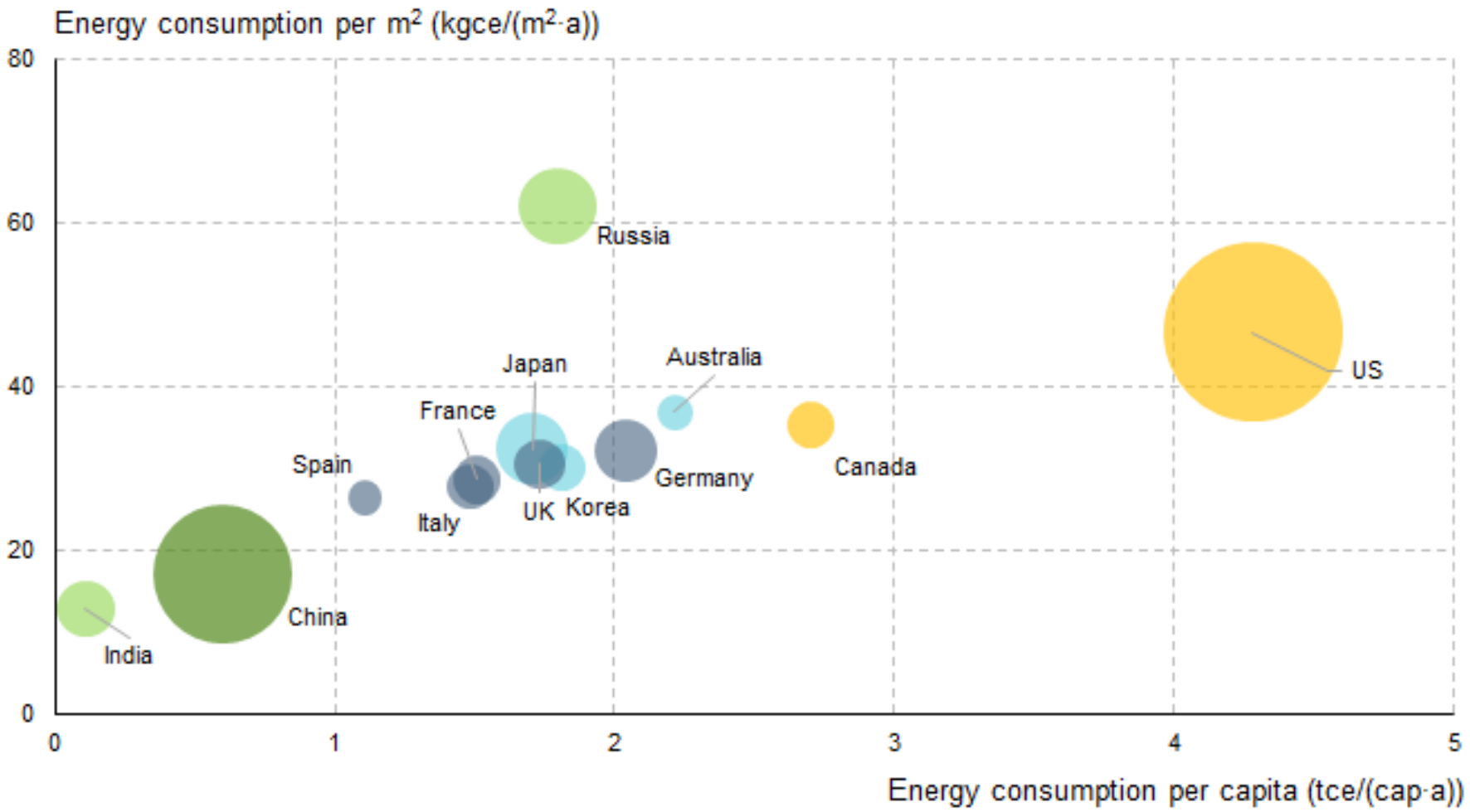
- Energy intensity of NUH and P&C
- Per floor area



- Energy intensity of UR and RR
- Per household

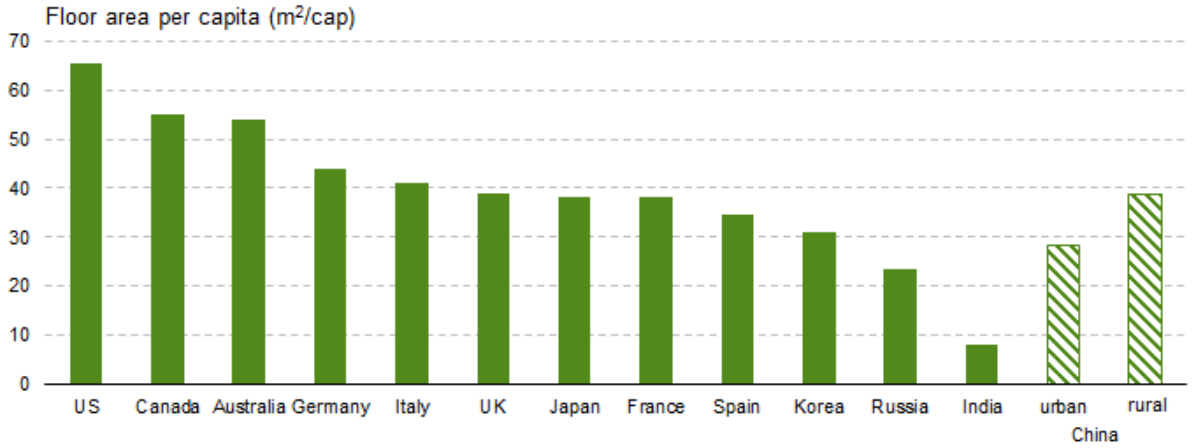


Global Building Energy Use Comparison



Comparison of residential buildings

Per capita floor area comparison



Case study of US and China families

	US case 1	US case 2	US case 3	China case 1	China case 2
Location		Raleigh		Beijing	
Floor area	182 m^2	228 m^2	164 m^2	135 m^2	100 m^2
Annual electricity Use	7595 kWh	22380 kWh	12040 kWh	3800 kWh	3216 kWh
Annual gas use	1880 m^3	3053 m^3	1025 m^3	135 m^3	316 m^3
Cooling use intensity	9.3 kWh/m^2	34.0 kWh/m^2	24.8 kWh/m^2	7.1 kWh/m^2	1.1 kWh/m^2
Heating use intensity	12.3 kgce/m^2	13.1 kgce/m^2	5.6 kgce/m^2	17.4 kgce/m^2	

Comparison of commercial buildings

China. Office 1
4650m^2，34kWh/m^2·a

China. Office 2
64 000m^2，65.7kWh/m^2·a

China. Government 1
16 000m^2，70.1kWh/m^2·a

China. Government 2
37 000m^2，113kWh/m^2·a

Commercial
287 000m^2，215kWh/m^2·a

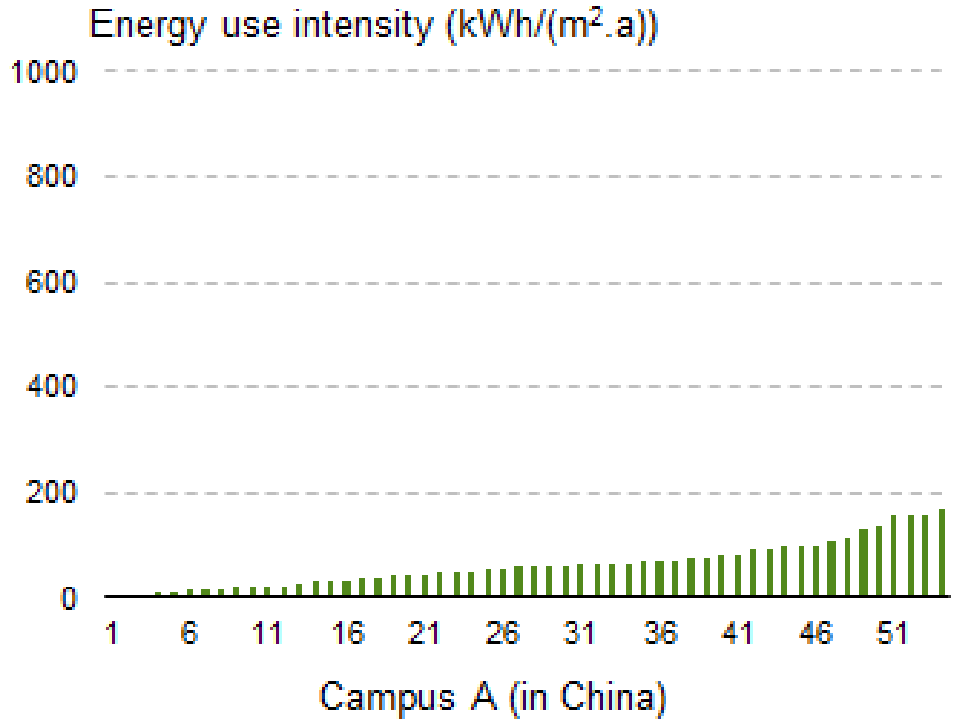
US. Office1
6425m^2，364kWh/m^2·a

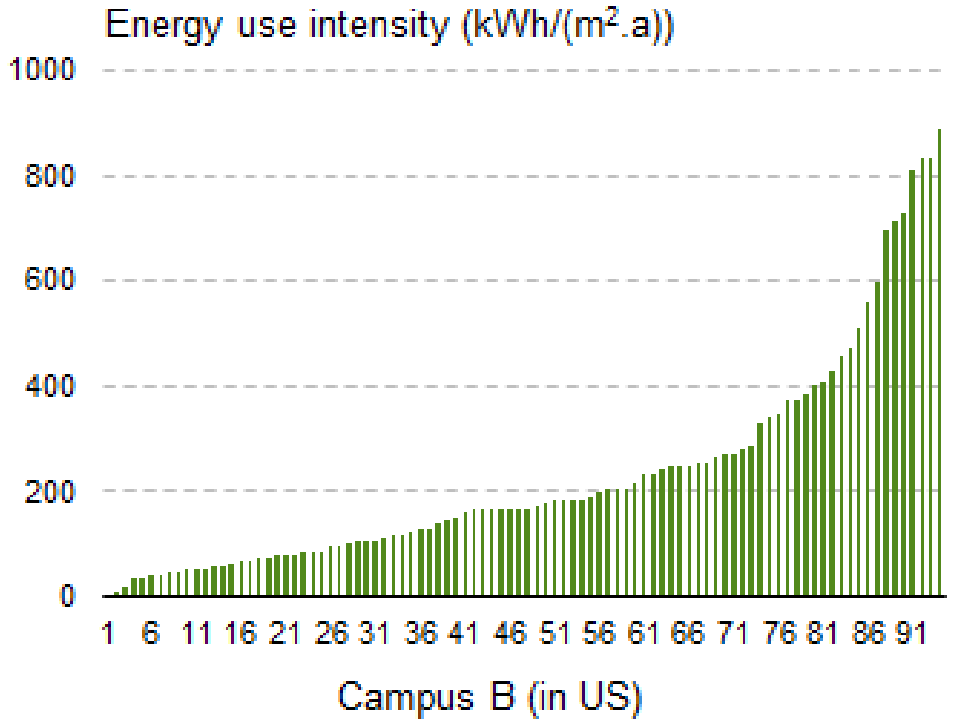
US. Office 2
3 000m^2，356kWh/m^2·a

France office
17 000m^2，165kWh/m^2·a

Comparison of commercial buildings

Case study of US campus and China campus



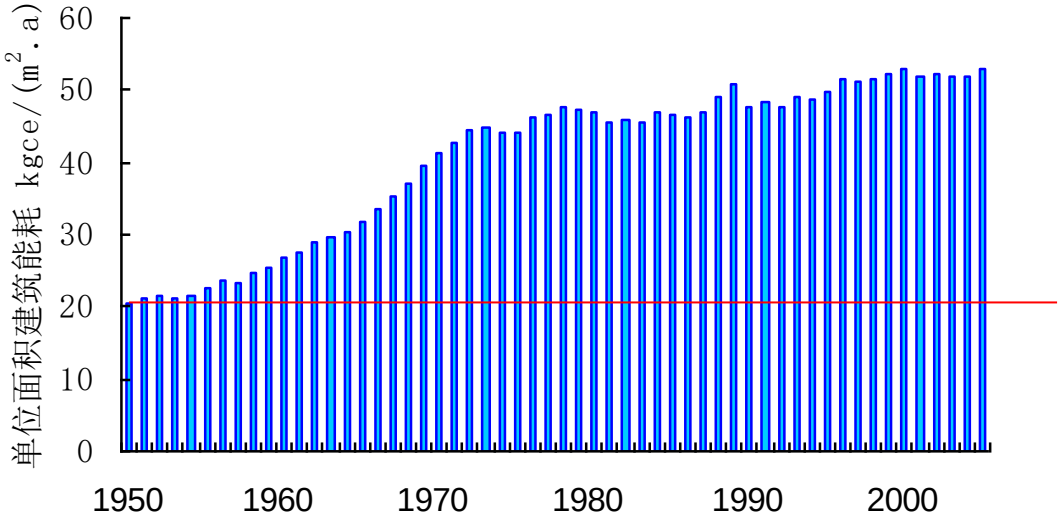


Major reasons for the difference of energy use

- Part time & part space / full time & full space **service provided**
- Natural / mechanical **ventilation, lighting**
- Central / decentralized **service systems, such as AC, hot water**

- Difference in service level provided. However what service level should we provide?

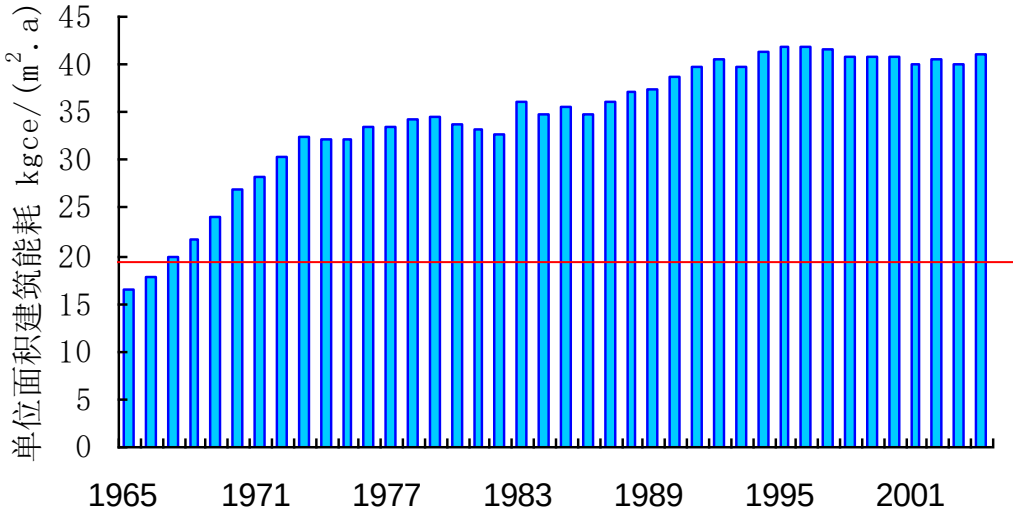
History and trend: energy in buildings



China current level

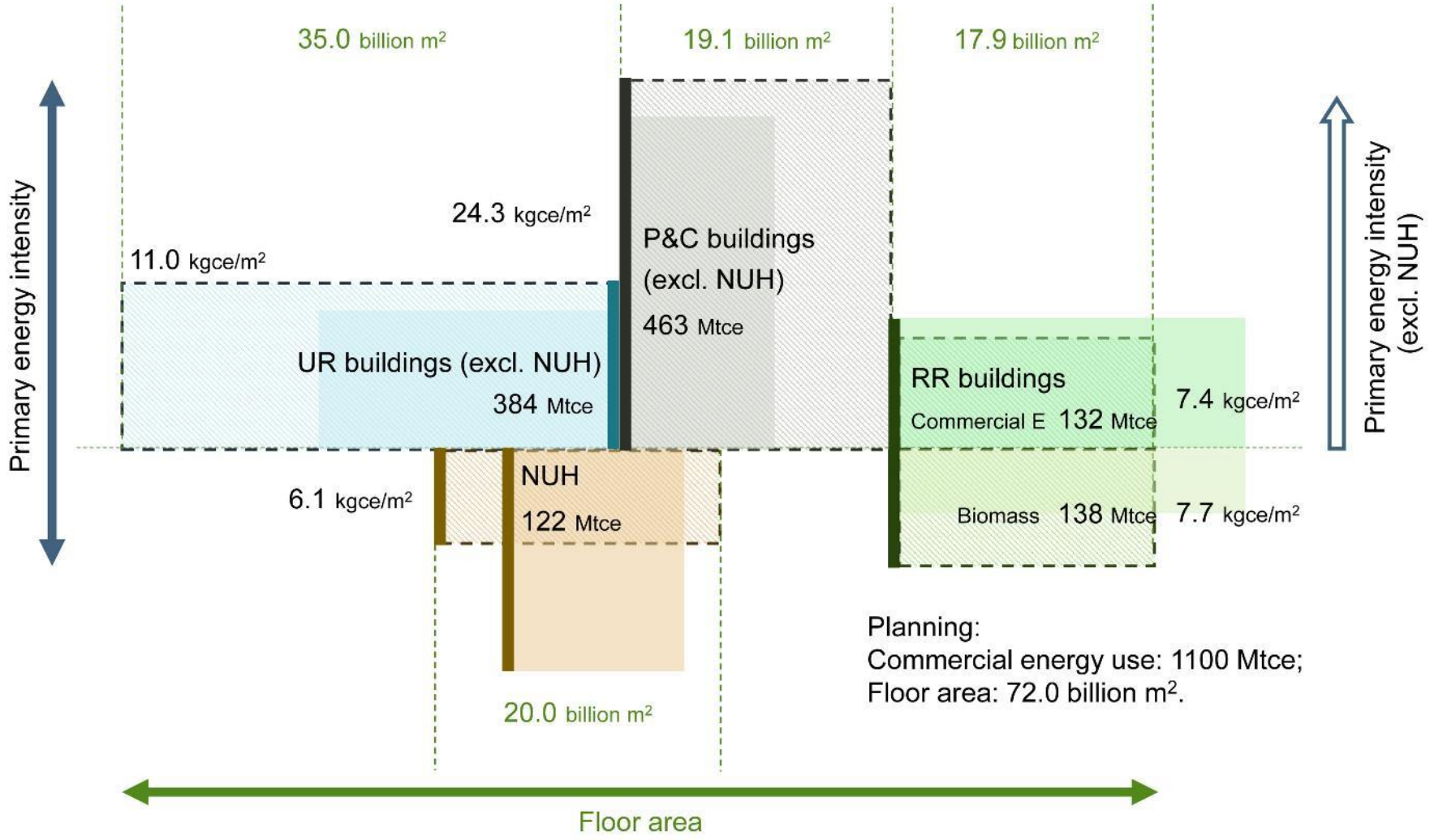
USA: kgce/m2.a

Japan: kgce/m2.a



Where the new economic group countries such as India, Brazil, and China, with 3 billion populations will go?

Target of China's building energy use



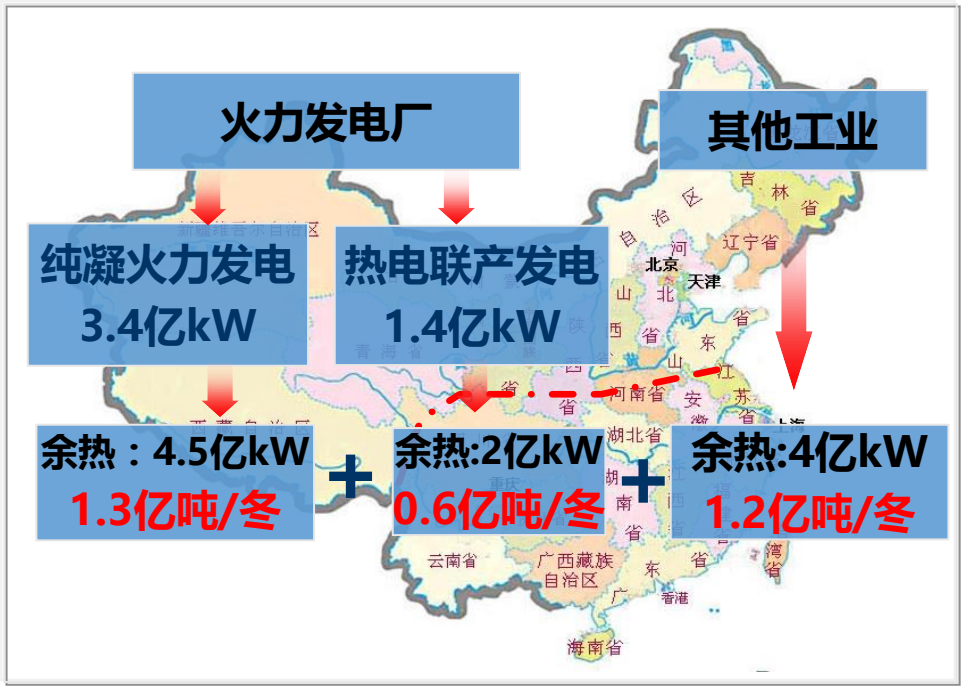
Approaches to reach the building energy target

- 居住建筑节能（不包括北方供暖）： Residential (excl. HNU)
  - 维持绿色、节约的生活方式，避免高能耗建筑和系统形式
  - 提倡高效节能装置（照明、电器），抵制高能耗产品（如：烘干机）
  - 通过高效、分散的方式解决长江流域冬季采暖问题
  - 实行用能梯级价格制
- 公用和商业建筑节能（不包括北方供暖）： Commercial (excl. HNU)
  - 抵制“奇奇怪怪的建筑”，反对奢华，提倡绿色、节能的建筑形式
  - 推广支持分散独立可调的系统方式和技术，慎重采用集中系统
  - 通过用能总量控制、定额管理实现节能效果
- 农村居住建筑节能 Rural residential
  - 发展以生物质能源、太阳能和风能的新型能源系统
  - 实现“无煤村”

北方城镇供暖具有最大的节能潜力
HNU: the most potential sector for energy saving

- 用能强度可以从目前的15kgce/m2.a降低到6.5kgce/m2.a
- Cutting down energy use from current 15kgce/m2.a to 6.5kgce/m2.a
- 途径：Approaches
  - 继续围护结构保温改造，并提高气密性，平均供暖需热量降到0.2GJ/m2.a
  - Further improve on insulation
  - 改善末端调节，避免“过量供热” Overcome “over heating”
  - 改变热源方式，充分利用各类低品位余热 Revolution in heat sources
  - 充分完善和发挥目前在各个城市已建成的供热管网，形成能源互联网
    Connect current district heating network so to build the “energy internet”

热源在哪里？ Where is the heat sources?



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潜 力

余热：10亿kW
3.0亿吨/冬

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需 求

北方采暖：7.5亿kW
2.0亿吨/年

150亿m2

实现供热系统新的热源方式
Innovation heat sources for district heating

- 热电厂余热　CHP
- 规模以上工业生产余热　Industry exhaust
- 获取以上余热的70%，即可为未来北方地区120亿m2集中供热网提供40W/m2的基础热量 70% of CHP plus industry exhaust can provide 40W/m2 as base load for 12billion m2 building
- 利用天然气在末端调峰，平均提供10W/m2热量，用气1m3/m2，北方城镇共需要调峰用天然气120亿m3/年，仅为目前北京用量

Use gas boiler at terminal for peak load regulation: 10W/m2 heat, only 1m3/m2.a gas is needed. 12 billion m3/a gas can meet the total demand for whole North China

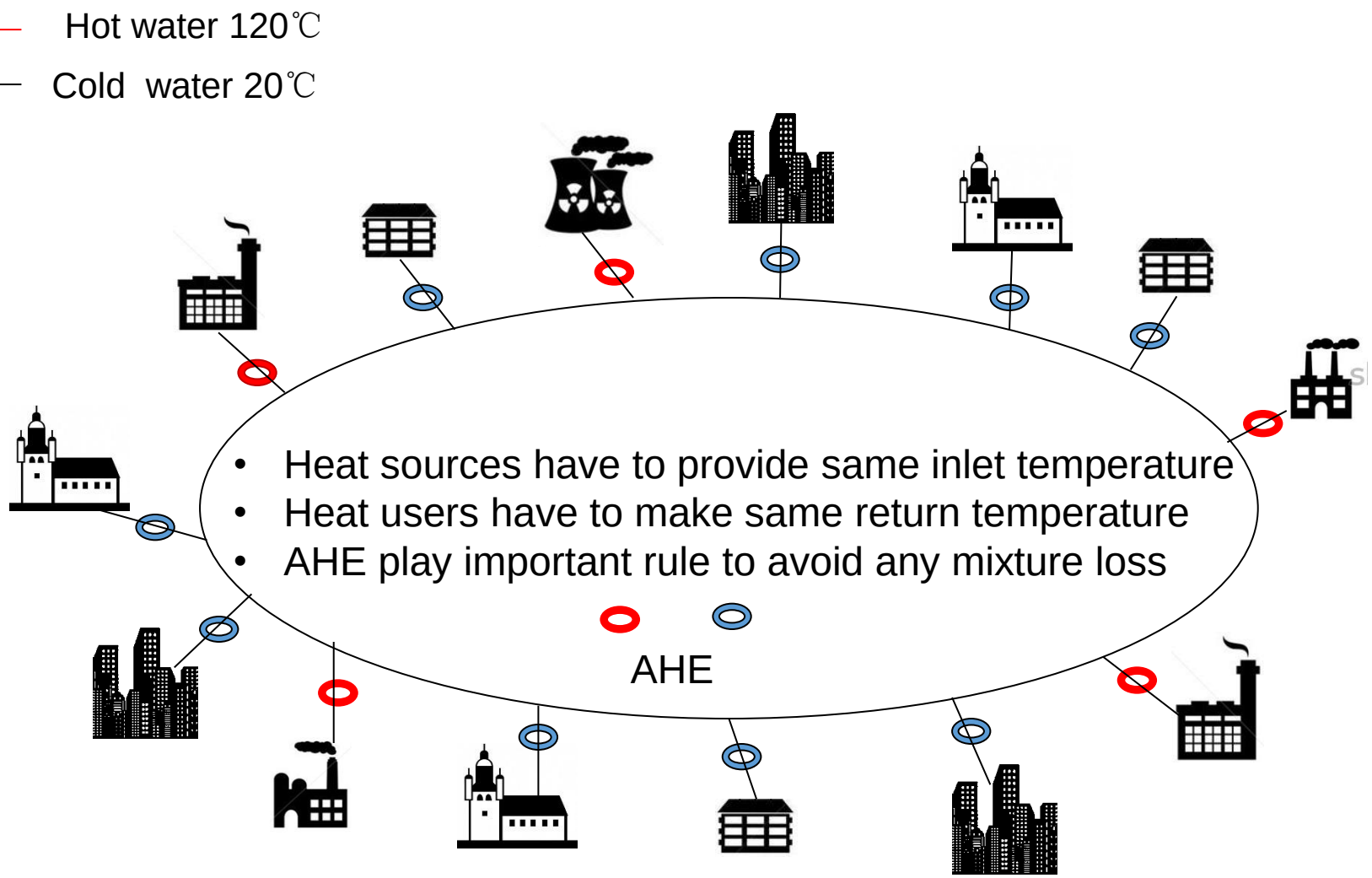
- 必须解决的问题 Problems have to be solved
  - 电力调峰　peak regulation of electricity
  - 工业生产与供热需求的关系　Industry production and heating demand
  - 热源与需求区域分布的矛盾　Heat sources and demand are in different regions

可以实现的电力调峰效果
The result of CHP plant regulating power peak

- 改变目前CHP电厂的“以热定电”运行模式，通过CHP+蓄能罐+电动热泵， 可以实现高效的能源转换和电力调峰，并可根据电力负荷变化，在锅炉主蒸汽量不变的条件下，实现对输出电力的连续调节，实现CHP的**热电协同**

- 京津唐电网目前用电峰谷差为13GW，为峰值负荷的25%
- 如果60%的热电厂改为电力调峰型热电联产电厂，可实现调峰能力17GW，完全可以实现调峰要求，并为进一步接纳风电留下调峰容量400万kW，基本等于目前坝上风电厂发电的峰谷差

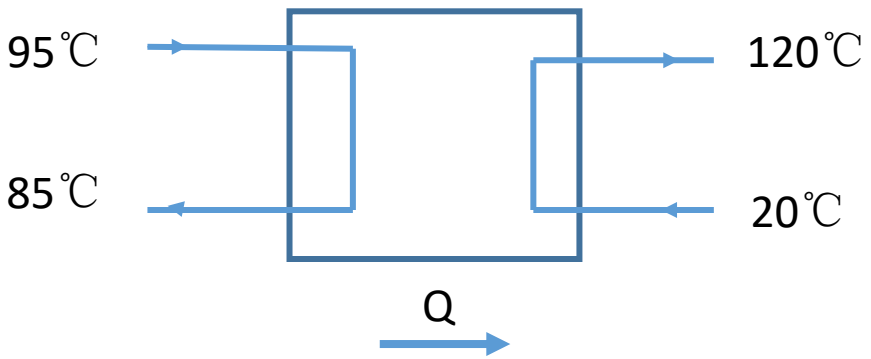
多热源联网运行，协调供需关系
The distributed energy system

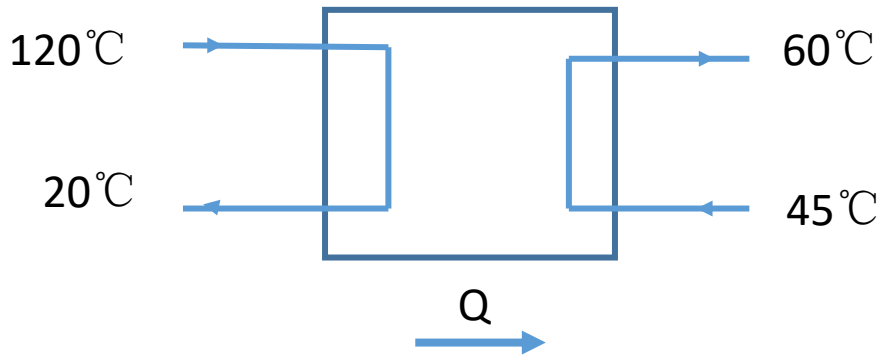


调整热量品位，统一供回水温度
Uniformed supply/return temperature

- 多热源、多热汇，必须统一供回水参数，否则冷热掺混，浪费巨大
- 所有热源（热电厂、余热工厂）必须输出相同温度的热量，既制备相同的供水温度
- 所有热汇（建筑等用热点）必须返回相同温度的回水

- 通过热量变换装置可以实现上述要求

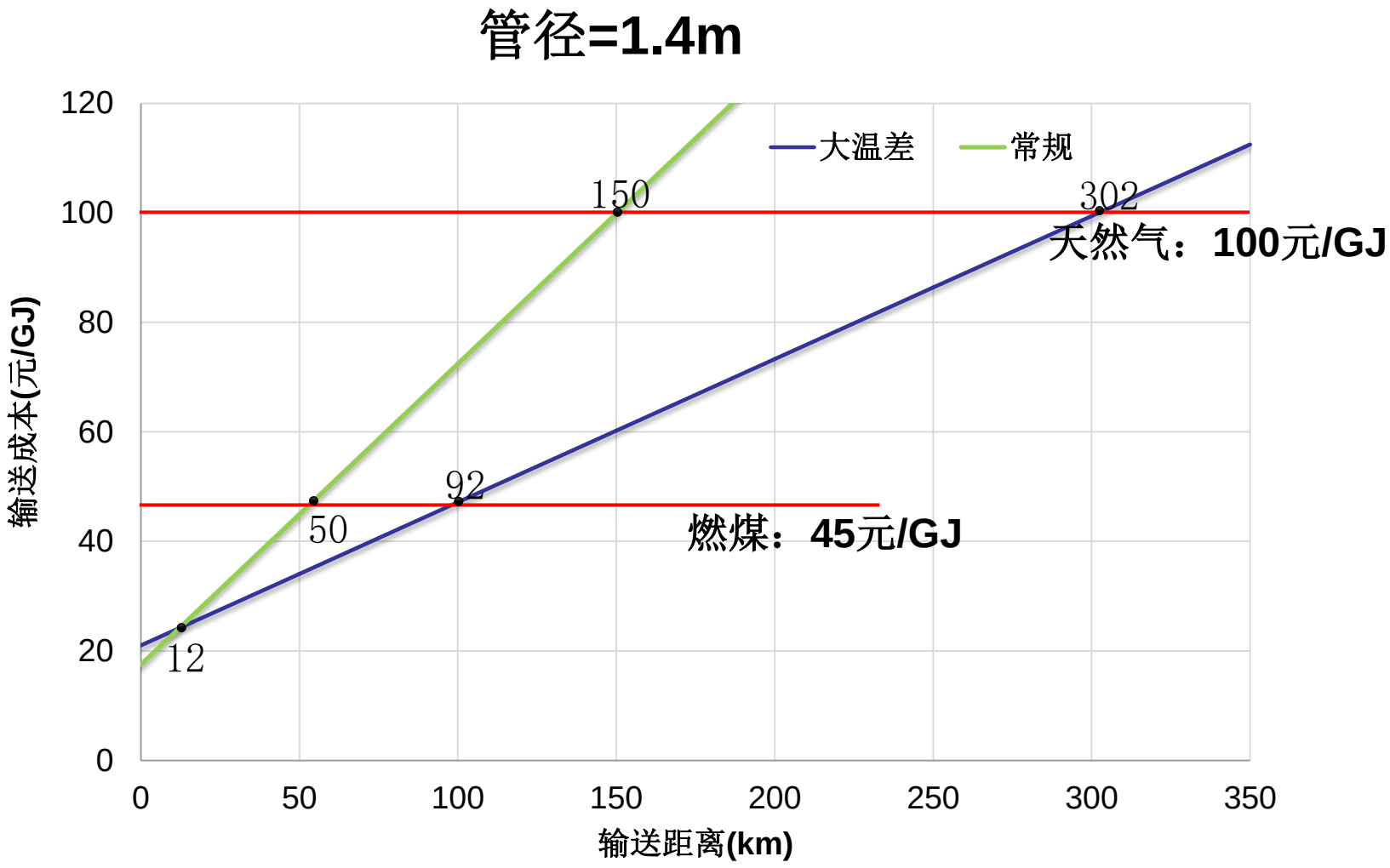




长途输送的经济性：解决热源与需求的地域差

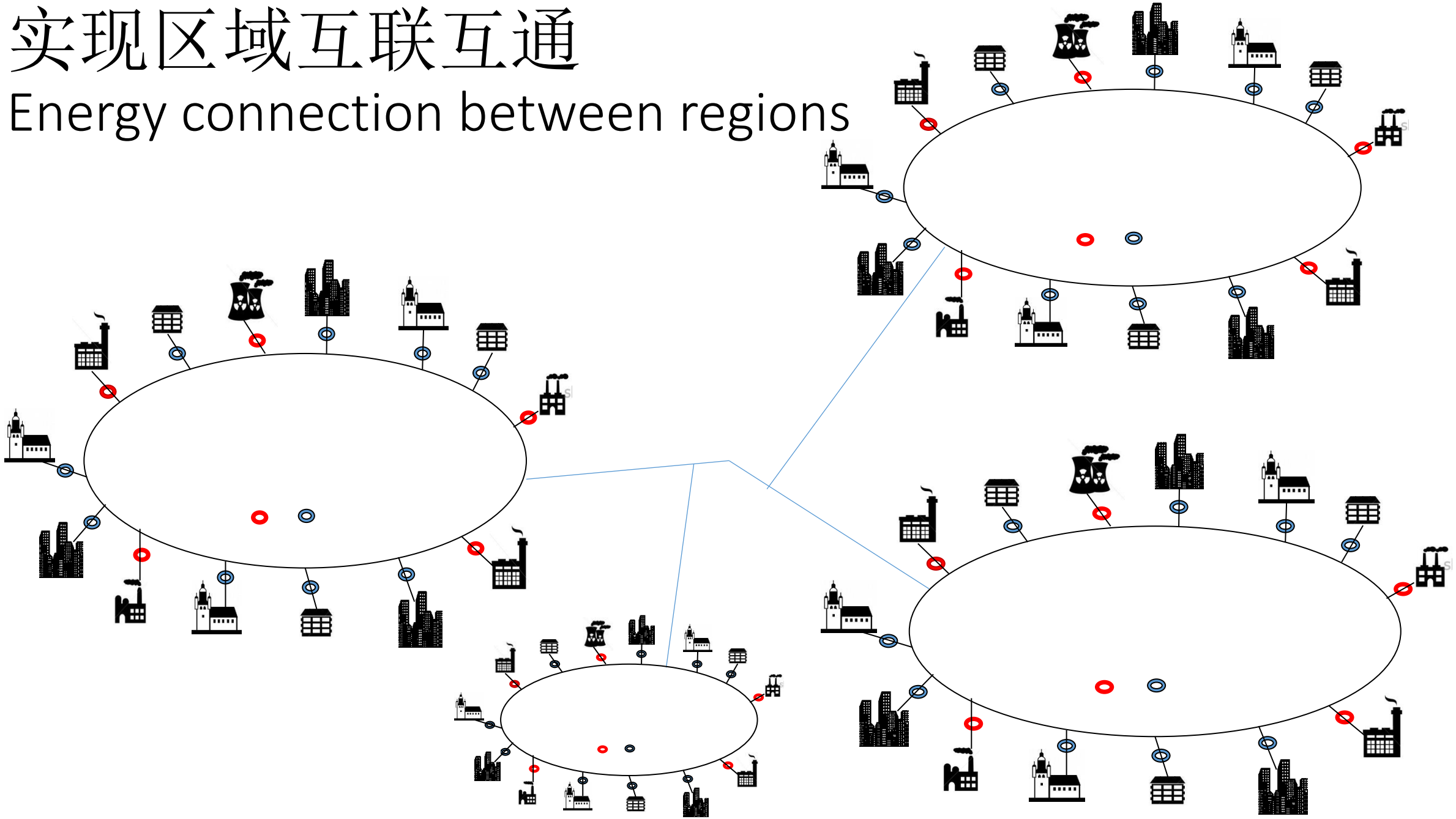
The economy of heat long distance transportation

- 经济输送距离与$D^{1.3}$成正比
- 能源价格上涨、钢铁价格下跌，经济输送距离加大
- 加大供回水温差，同样流量输送的热量增加，单位热量成本下降



实现区域互联互通

Energy connection between regions



未来的城市能源系统
The future urban energy system

- 热源：热电联产和工业低品位余热+天然气末端调峰

  Heat sources: CHP + industry exhausts + gas (for peak load)
- 系统：多热源协调，缓解供与需之间的不平衡；

  System: multi-sources to balance suppliers and demands
- 区域：跨区域互联，解决源与汇之间地域的不均衡

  Region: Connection over regions to balance sources and sinks in different regions
- 统一供回水参数：通过变温式换热器，实现热量变换

  Uniformed supply/return temperature: through heat convertors
- 热电协同：热电联产通过蓄热为电力调峰

  Thermoelectric synergy: CHP+ heat storage for power peak regulation
- 热气协同：燃气调峰解决供热的季节差，热力惯性缓解燃气日差

  Heat & gas synergy
- 通过新系统新方式，全面实现清洁、低碳、节能，满足城镇化需要

Thank you & Question?

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