时间利用与低碳管理

Time use and low-carbon management

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Outline

- Background 背景
- Research perspective 研究视角
- Time-use pattern 时间利用模式
- Future forecast 预测未来

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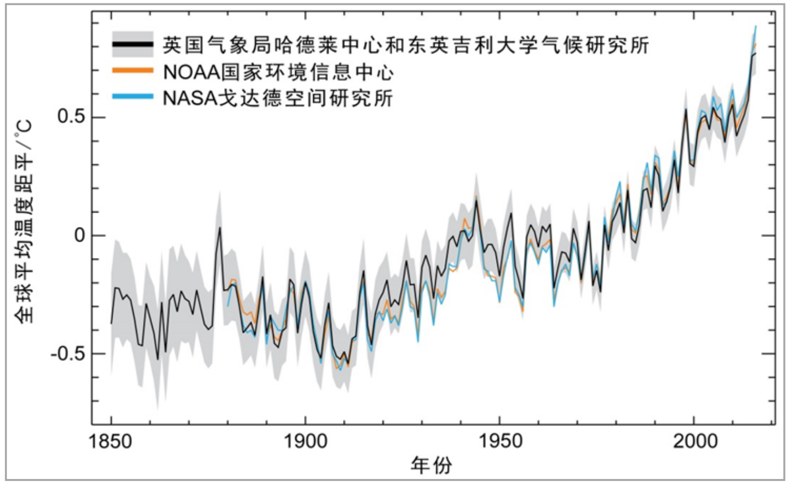
气候变化加剧全球危机

Climate change has become the global crisis

- **The global temperature grows 0.2±0.1°C every decade (IPCC, SR1.5°C)**
  全球每十年升温 0.2±0.1°C (IPCC, SR1.5°C)
- **Following this trend, the global temperature rise will likely to exceed 1.5℃ in 2040 compared with pre-industrial levels. Once this tipping point is exceeded, the frequency and intensity of climate disasters will increase substantially, causing a huge irreversible risk**
  照此趋势，相比于工业化前全球温升可能在2040 年突破1.5℃。一旦突破1.5℃临界点，气候灾害发生的频率和强度将大幅上升，引发长期不可逆的巨大风险 （IPCC AR6）

持续影响



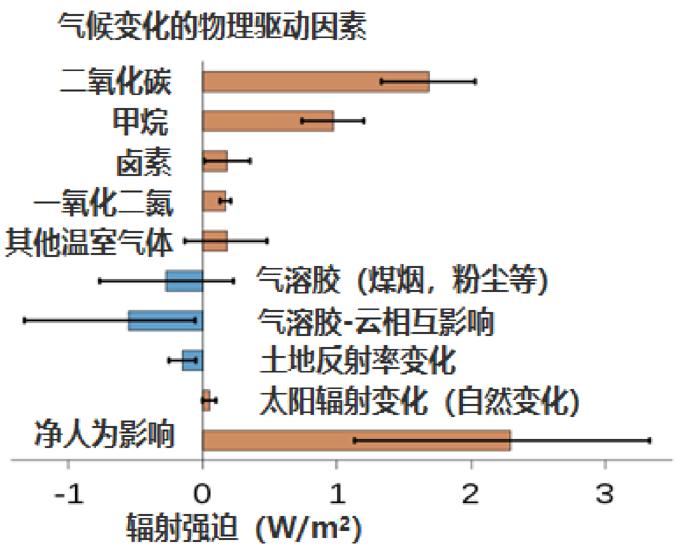
全球温度持续升高（来源：NASA）

（来源：Internet）

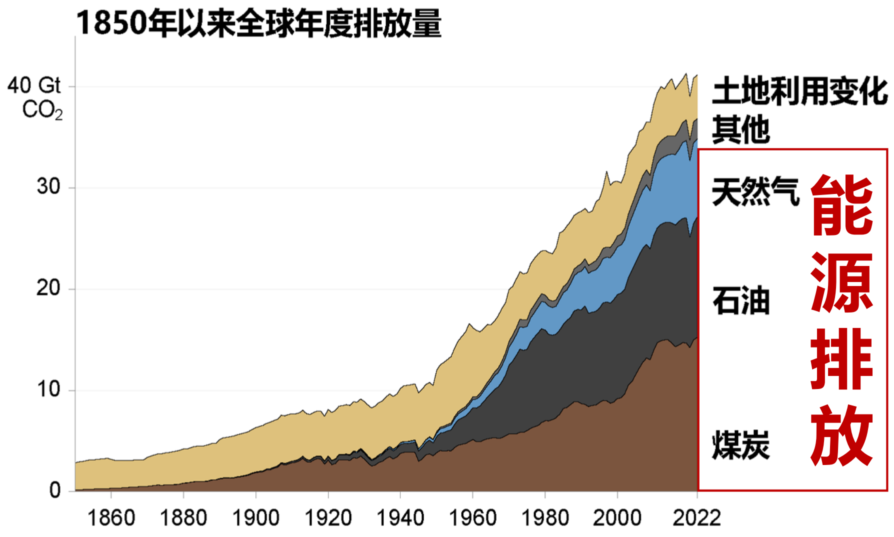
减少化石能源消费是应对气候变化的关键

Reducing fossil energy consumption is the key to mitigate climate change

- **The large amount of GHG emissions generated by human activities is the main cause**
  人类活动产生的大量温室气体排放是全球气候变化的主因
- **GHG emissions mainly come from the burning of fossil fuels such as coal, oil and natural gas**
  温室气体排放主要来自煤炭、石油和天然气等化石燃料的燃烧



IPCC（2014）



GCP（2023）

- **Climate change is the greatest risk to global development**

气候变化是全球最大风险

(*World Economic Forum*, 2023)

- **Addressing the climate challenges has attracted international attention**

应对气候变化已经成为全球热点

(*INFORMS*, 2012; *AER*, 2015)

气候变化位列第一

Global Risks Landscape

WORLD ECONOMIC FORUM
COMMITTED TO IMPROVING THE STATE OF THE WORLD

Source: Global Risks Report 2020, World Economic Forum

联合国提出了17个可持续发展目标

(UN SDG 2015)

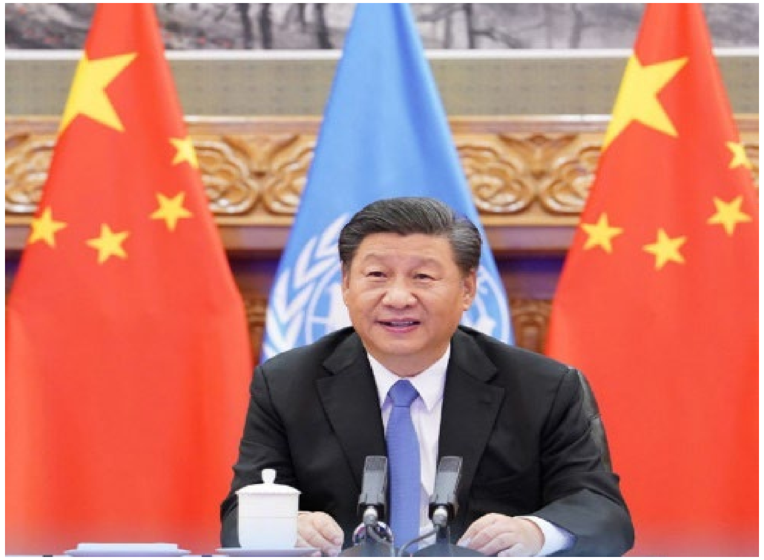
碳中和已经成为全球战略

Carbon neutrality has become the global strategy

- **More than 150 countries, accounting more than 90% economies, have proposed the carbon neutrality target**
- **全球150多个国家提出碳中和目标，占世界经济体的90%以上**

- **Most of them plan to neutralize the CO_2 by 2050, including EU, UK, New Zealand, Canada, Japan, South Africa, etc.**
- **大部分国家提出在2050年碳中和，如欧盟、英国、新西兰、加拿大、日本、南非等**

China’s Promise -中国承诺



On 22nd September in 2020, President Xi announced:

“We aim to have CO_2 emissions peak before 2030 and achieve carbon neutrality before 2060”

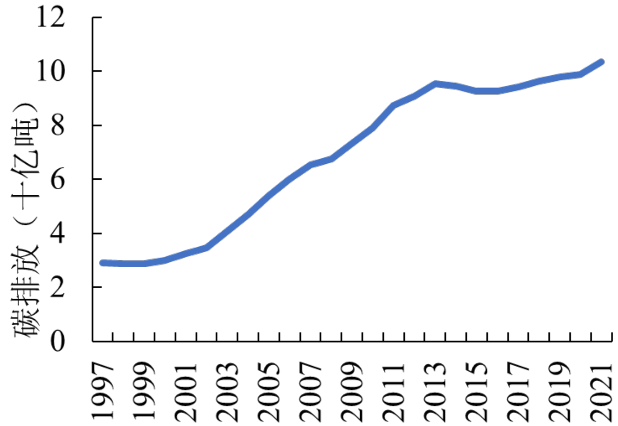
中国在第七十五届联合国大会一般性辩论上宣布：

- **中国二氧化碳排放力争于2030年前达到峰值、努力争取2060年前实现碳中和**

绿色生产生活方式是实现双碳目标的重要途径

Green production and lifestyle are important ways to achieve the goal of carbon peak and carbon neutrality

- 《十四五规划和2035年远景目标纲要》强调，**广泛形成绿色生产生活方式**
- “Outline of the 14th Five-Year Plan and the Long-term Vision for 2035” emphasized the extensive development of a green production and green lifestyle.



如何通过改变人们的行为来减少碳排放?

How to change people’s behavior to reduce the carbon emissions?

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转变视角：消费视角→时间视角
Consumption perspective → Time use perspective

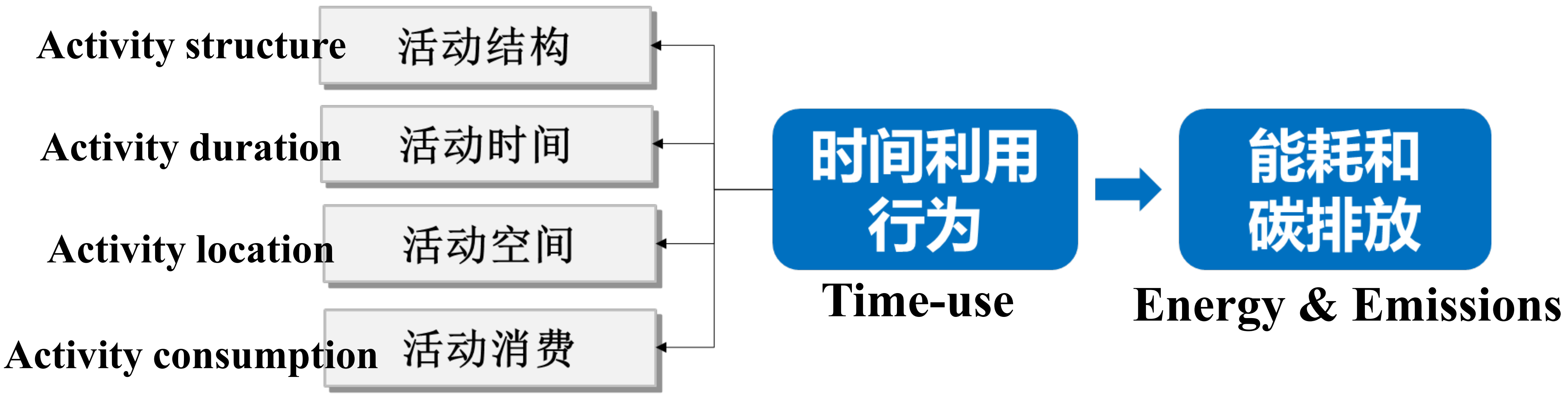
- **People consume goods and services to fulfill their daily activities in 24 hours a day** (Jalas, 2002; Druckman and Jackson, 2016)
  人们消费物质商品和服务是用于完成每天24小时要开展的各种**生产和生活活动**

- **Activities – rather than consumption – finally result in consumers' energy consumption and carbon dioxide emissions** (Yu et al., 2018).
  活动，而不是物质消费，**引发了能源消耗和碳排放**

时间利用行为 (Time-use perspective)

- Turn to understand **what people will do and how they will do it as keys** to how much emissions will be generated and changed in the future (Jalas, 2002; Druckman and Jackson, 2016; Yu et al., 2018), in other words, time-use behavior is the key.
  转向理解人们做什么和怎么做，作为揭示能耗和 CO_2排放成因的关键，即**从时间利用行为视角来分析其中的根本原因**

- Define four dimensions for time-use behavior (时间利用行为定义为四个维度)：
  What, When+How long, Where, What to use+How much



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揭示行为特征：数据基础

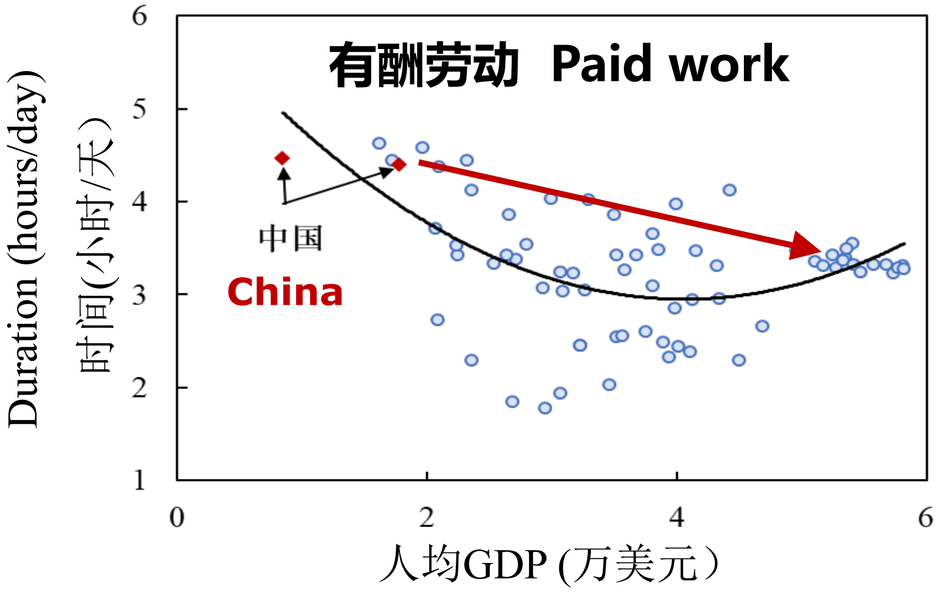
Reveal behavioral patterns：Data

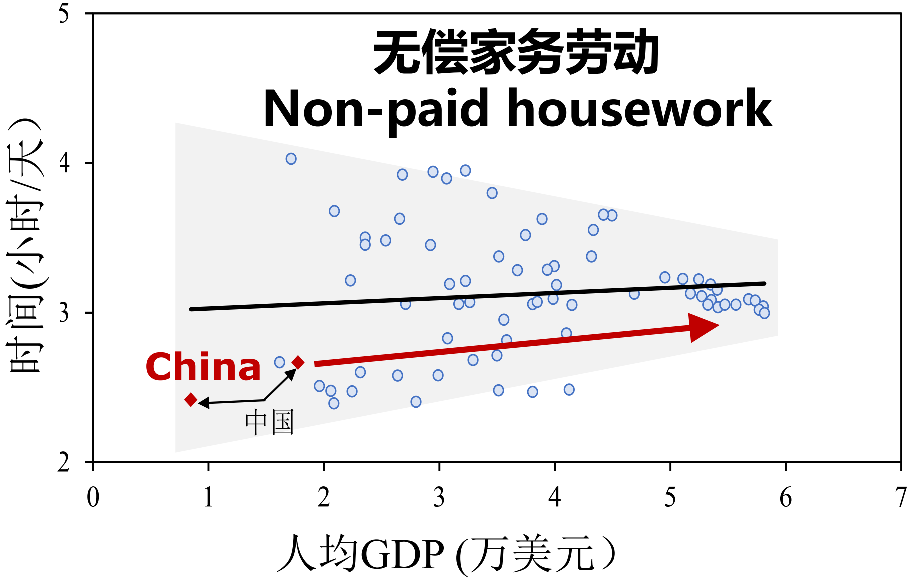
Country **国家**	**Time-use survey year（Global 71 large-scale surveys）** **全球71次大规模时间利用调查**
法国 France	1966 年、1974 年、1998 年、2009 年
芬兰 Finland	1971 年、1987 年、1999 年、2009 年
韩国 Korea	1999 年、2004 年、2009 年、2014 年、2019年
日本 Japan	1976 年、1981 年、1986 年、1991年、1996 年、2001 年、2006 年、2011 年、2016 年、2021年
荷兰 Netherlands	1975 年、1980 年、1985 年、 1990 年、1995 年、2000 年、2005 年
加拿大 Canada	1971 年、1981 年、1986 年、1992 年、 1998 年、2005 年、2010 年
意大利 Italy	1980 年、1989 年、2002 年、2008 年
英国 UK	1974年、1983 年、1987 年、1995 年、2000 年、2005 年、2014 年
美国 U.S.	1965 年、1975 年、 1985 年、1993 年、1995 年、1998 年、2003～2022 年
中国 China	2008年 、2018年

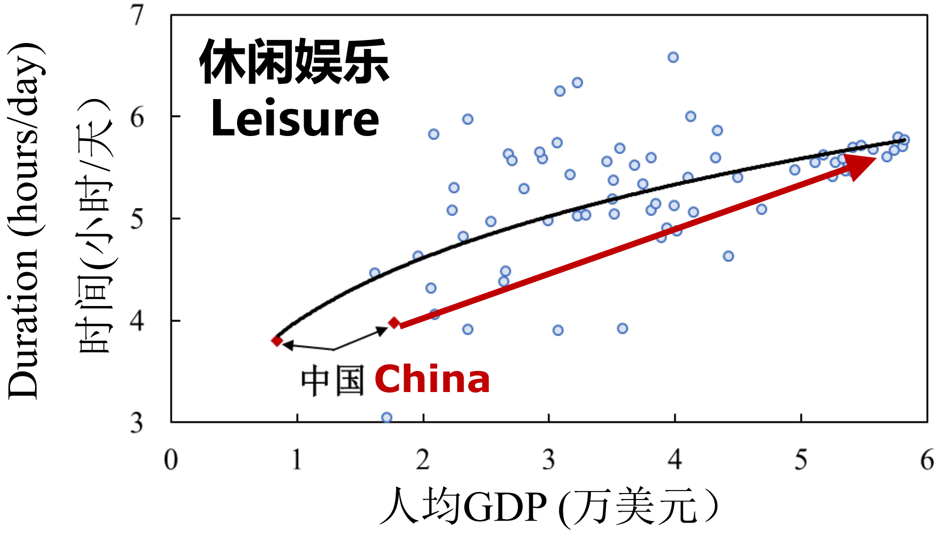
Data source：MTUS, IPUMS, KOSIS, SBJ

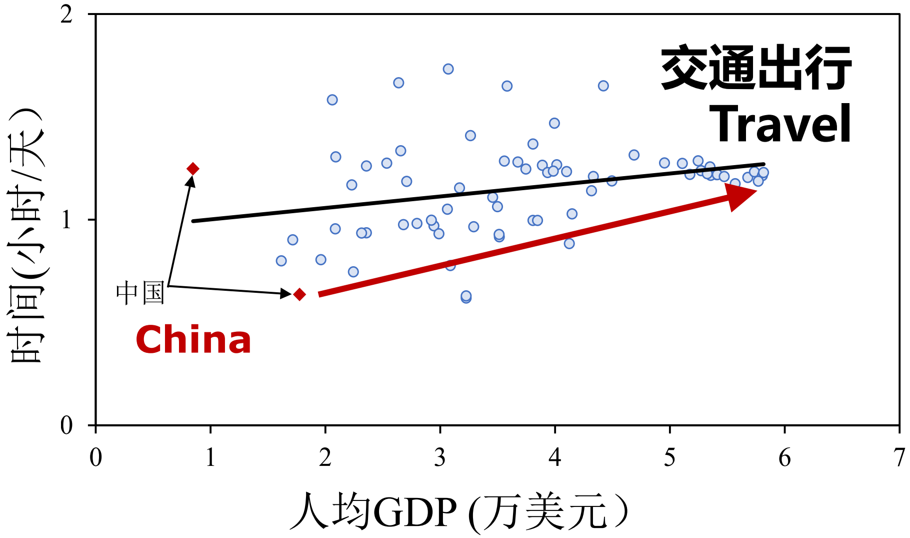
行为特征：随人均GDP变化

Behavioral patterns：Change with GDP per capita



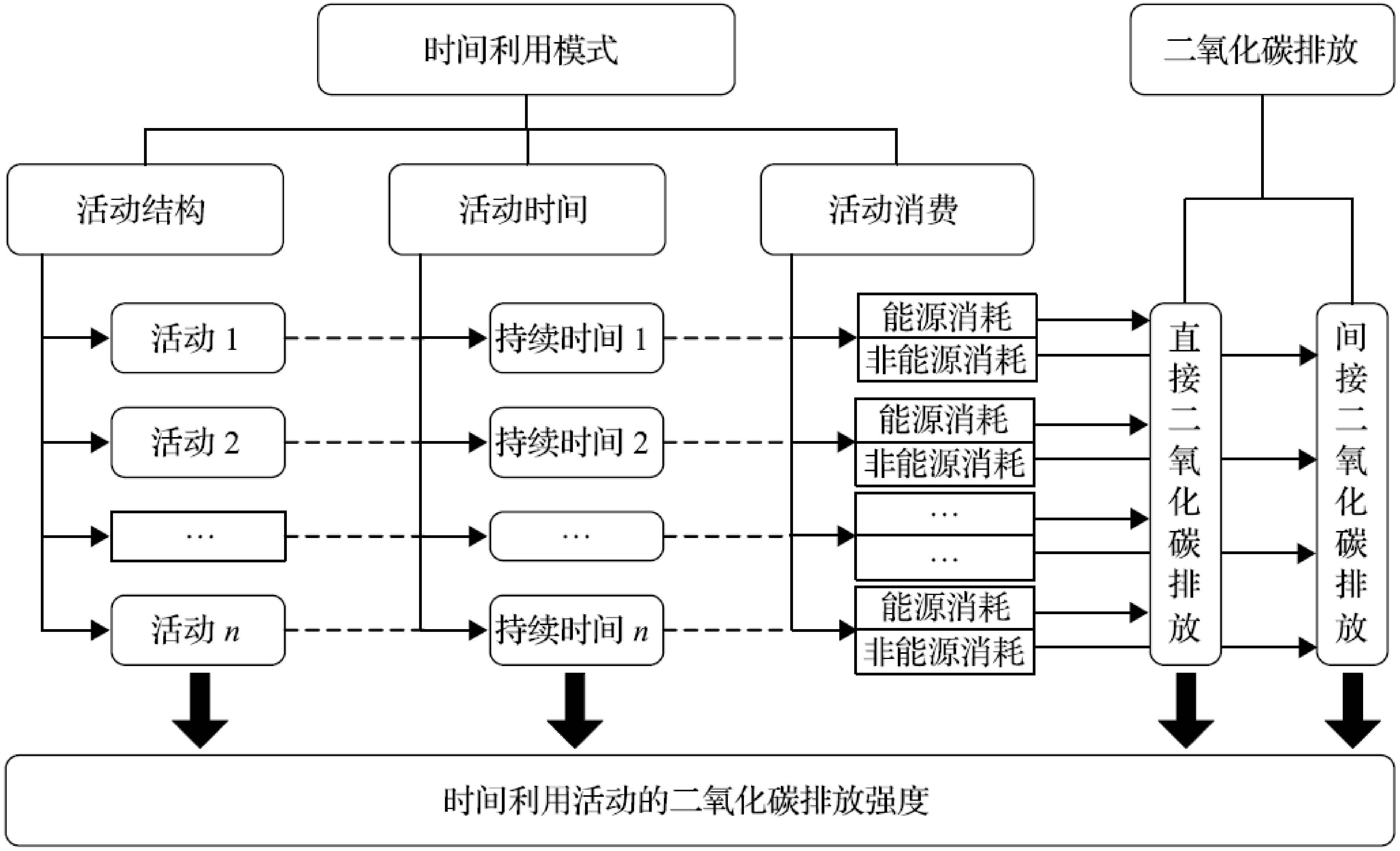






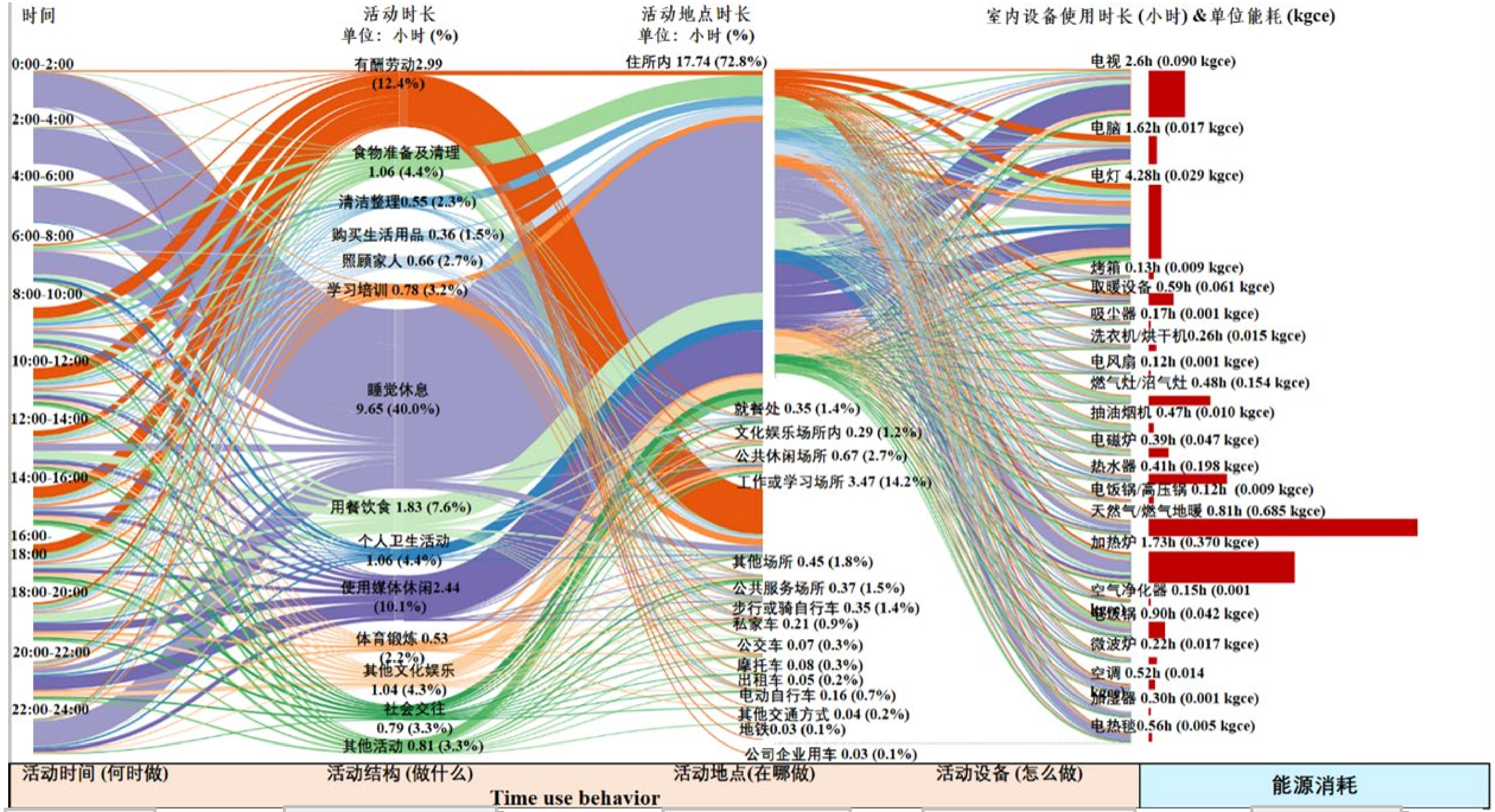
建立行为和碳排放的关联

Link time use with energy and carbon emissions



时间利用行为与直接能源消耗

Time-use behavior and residents' direct energy consumption

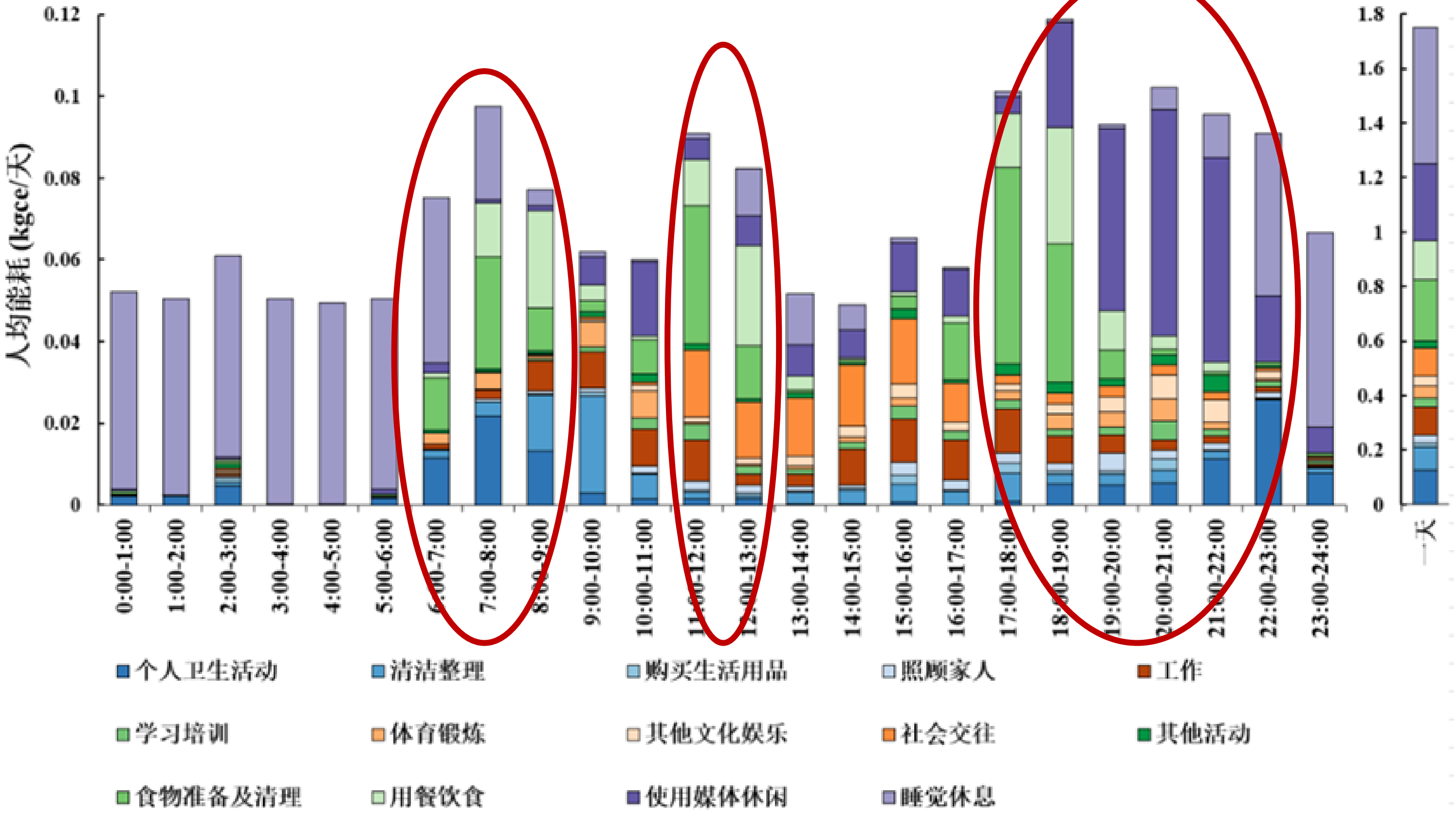


Time | Structure Duration | Location | Device use time | Energy

居民直接能耗较高时段 Residential energy intensive periods

- 6~9点、11~13点和17~23点是消耗能源较多的几个时间段

6:00 ~ 9:00, 11:00 ~ 13:00, and 17:00 ~ 23:00 time periods are the time periods with the highest energy consumption



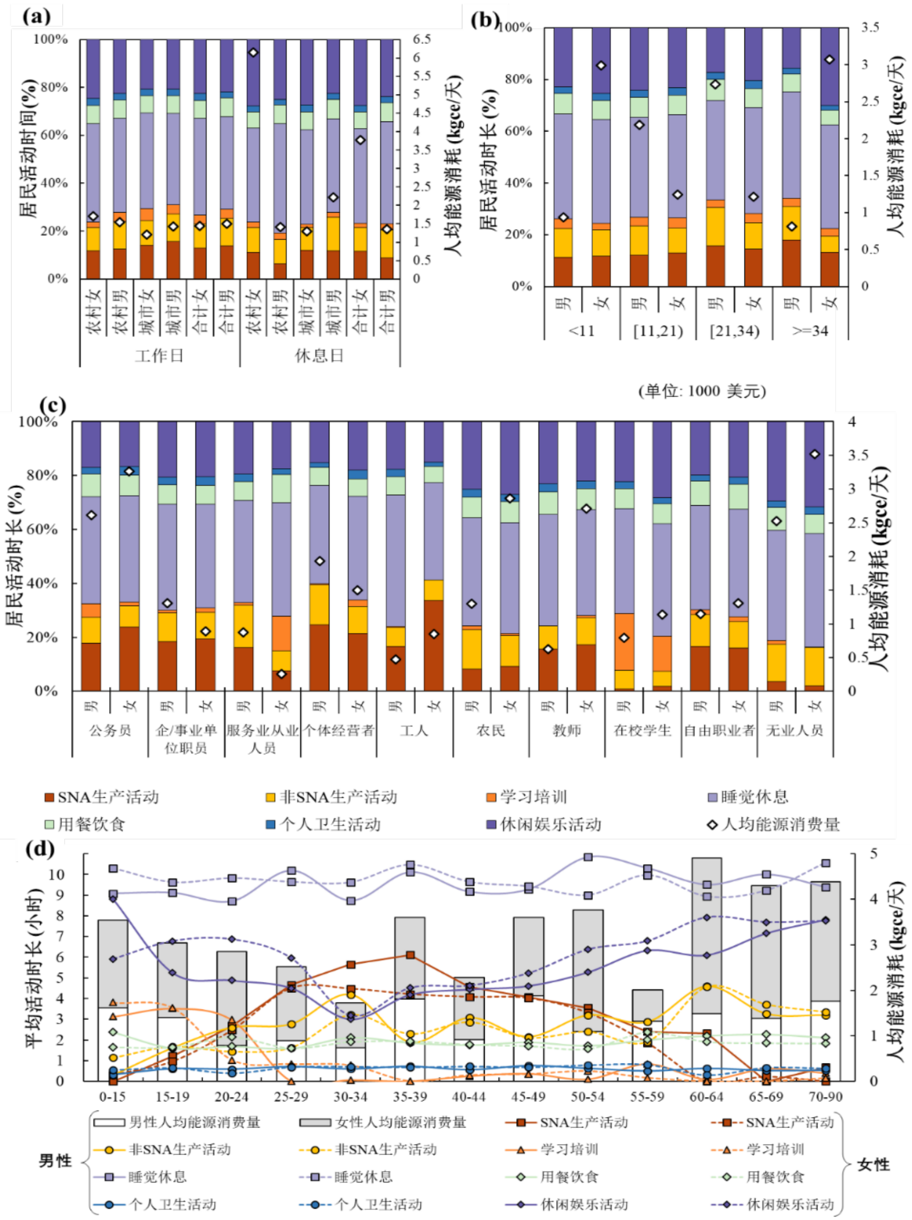
居民直接能耗较高群体 Residential energy intensive group

- 女性公务员、女性教师和失业人员是耗能量较高的群体

  Female civil servants，female teachers and unemployed people are groups with high energy consumption

- 60岁以上的居民比其他年龄段的居民具有更高的居民能源消耗量

  Residents over 60 years old have higher energy consumption



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Social + Economic +Technological change
社会+经济+技术变化

基于时间利用行为视角已开展的预测研究
Some research we have done

① E-life 影响 (Impact of E-life on CO2)

② 远程办公影响 (Impact of telecommuting on CO2)

③ 物联网技术影响 (Impact of IoT on CO2)

④ 人口转型影响 (Impact of demographic on CO_2)

⑤ 弹性工作政策影响 ((Impact of flexible working hours on CO_2)

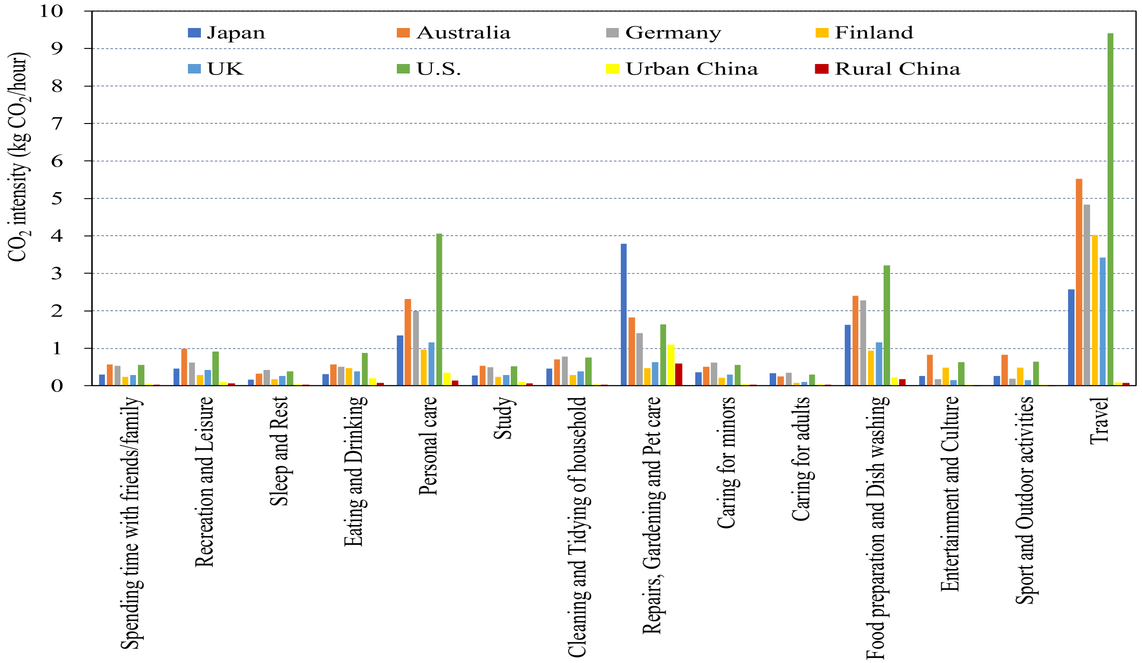
Book publication: 余碧莹等 (2022), 时间利用行为与低碳管理, 北京：科学出版社.

1

按照发达国家趋势可能出现的变化

Potential change following the trend of developed countries

- 日本和芬兰居民大多数活动的单位时间碳强度最低，而美国居民相对更高
- 在所有发达国家，个人护理、维修 园艺和宠物护理、食物准备和清理、交通出行等活动的单位时间碳强度相对较高
- Most time-use activities show the lowest intensities in Japan and Finland, while most activities show the highest intensities in the U.S.
- Activities including *Personal care, Repairs, Gardening and Pet care, Food preparation and Dish washing, and Travel* have relatively higher CO2 intensities in all developed countries.

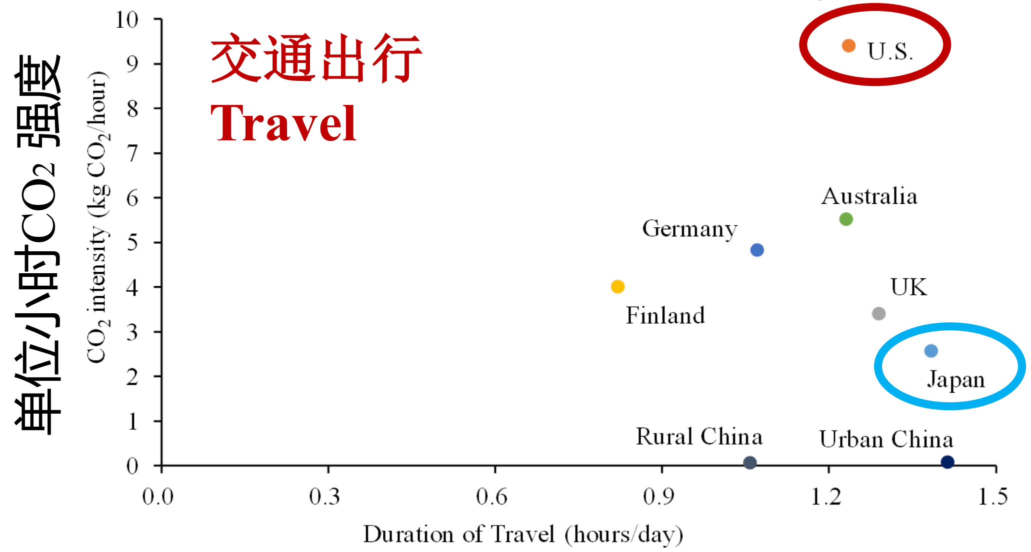


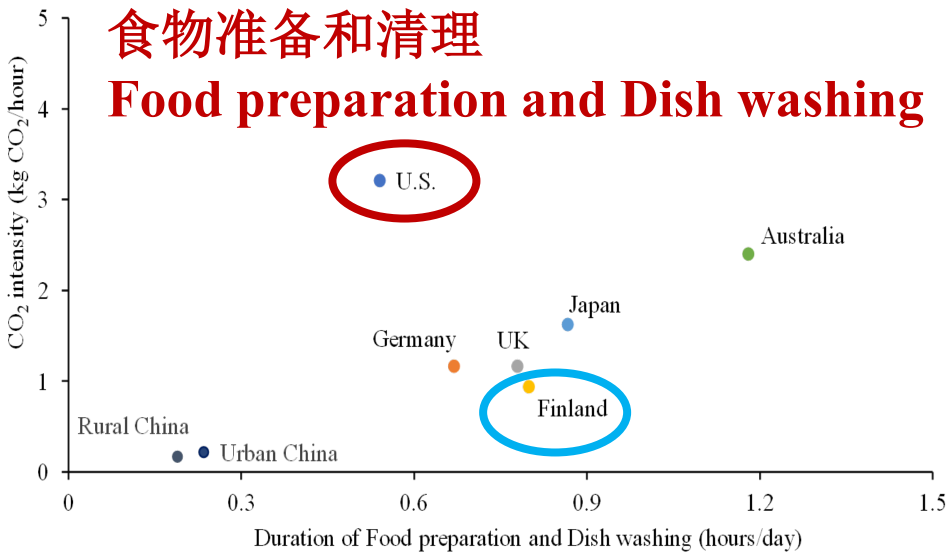
发达国家单位时间碳强度

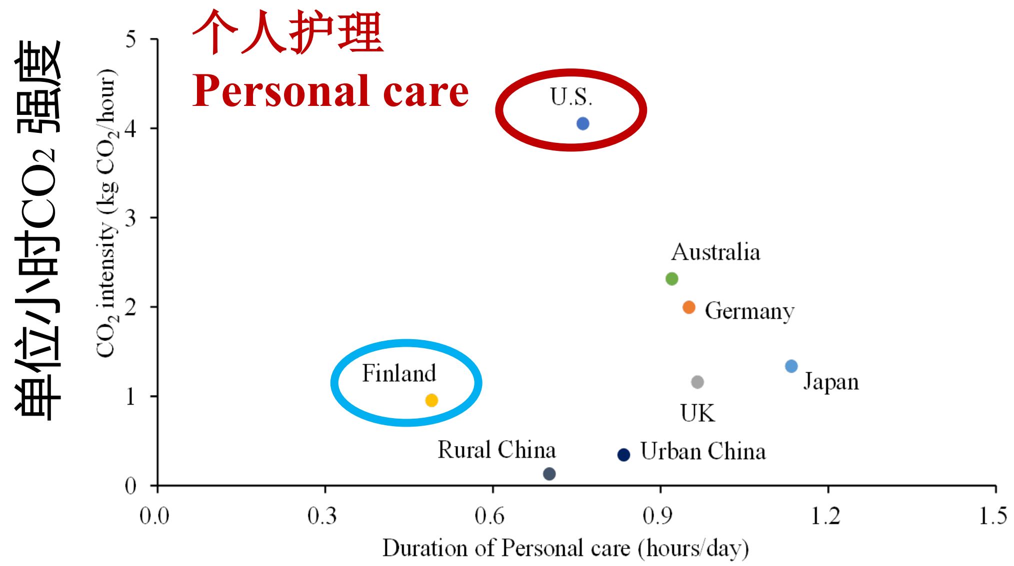
Carbon intensity per hour for the developed countries

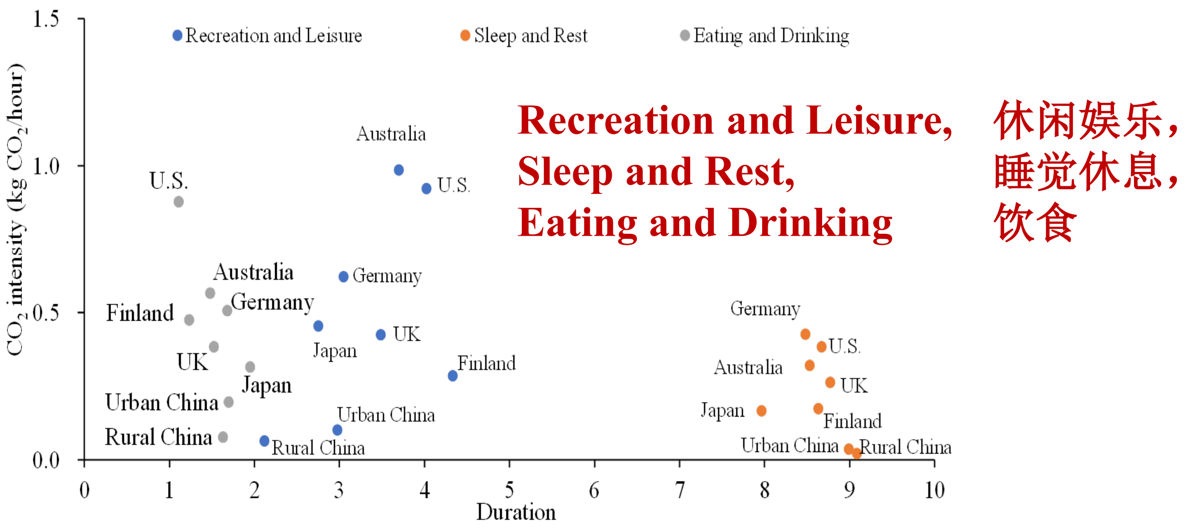
发达国家单位时间碳强度

Carbon intensity in the developed countries





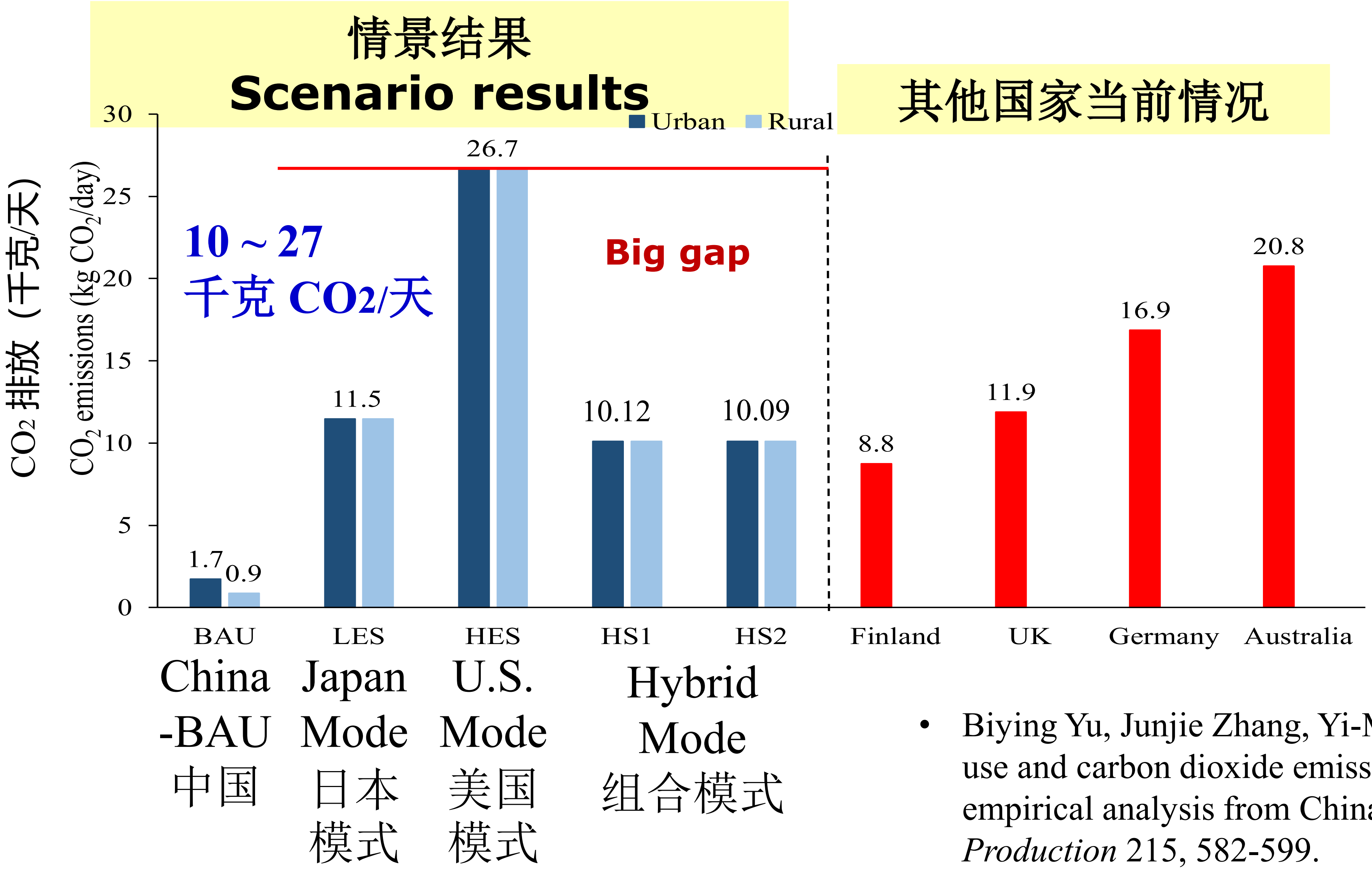




未来可能的时间利用模式 Potential Time-use Pattern Scenarios

情景 Scenario		活动模式 Activity pattern	活动碳强度 Carbon intensities of activities
Both activity pattern and consumption pattern keep the same 保持不变			
BAU	Urban China	China in 2008	China in 2008
	Rural China	China in 2008	China in 2008
Both activity pattern and consumption pattern shift to Japan 转向日本低碳模式			
Low-emission scenario	Urban China	Japan	Japan
	Rural China	Japan	Japan
Both activity pattern and consumption pattern shift to U.S. 转向美国高碳模式			
High-emission scenario	Urban China	U.S.	U.S.
	Rural China	U.S.	U.S.
Activity pattern shift to Japan and consumption pattern shift to hybrid 组合 1			
HS1	Urban China	Japan	Hybrid scenario
	Rural China	Japan	Hybrid scenario
Activity pattern shift to U.S. and consumption pattern shift to hybrid 组合 2			
HS2	Urban China	U.S.	Hybrid scenario
	Rural China	U.S.	Hybrid scenario

碳排放潜在变化 Potential change of CO_2 emissions per day



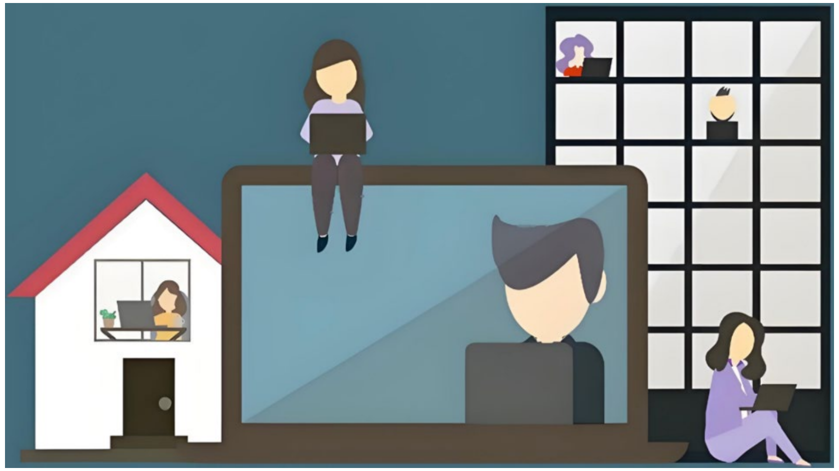
- Biying Yu, Junjie Zhang, Yi-Ming Wei (2019). Time use and carbon dioxide emissions accounting: An empirical analysis from China. *Journal of Cleaner Production* 215, 582-599.

2

E-life 对能耗的影响

Impacts of E-life on energy use

- 数字化技术改变了人们活动的时间、地点、消费商品，因此改变了直接和间接能耗以及排放。那么到底影响有多大呢?
- IcTs changed people's activity duration, location, and consumpiton goods, thus leads to the change on direct and indirect energy use and emissions. So how much is the impact?



- Biying Yu, Feihu Sun, Chen Chen, Guanpeng Fu, Lin Hu (2022). Power demand response in the context of smart home application. *Energy* 240, 122774.
- Biying Yu, Xiaojuan Yang, Qingyu Zhao, Jinxiao Tan (2020). Causal Effect of Time-Use Behavior on Residential Energy Consumption in China. *Ecological Economics* 175, 106706.

E-life 对能耗的影响 Impacts of E-life on energy use

尽管 E-life 能够减少交通能耗，但E-life的普及仍将导致家庭能耗增加18%

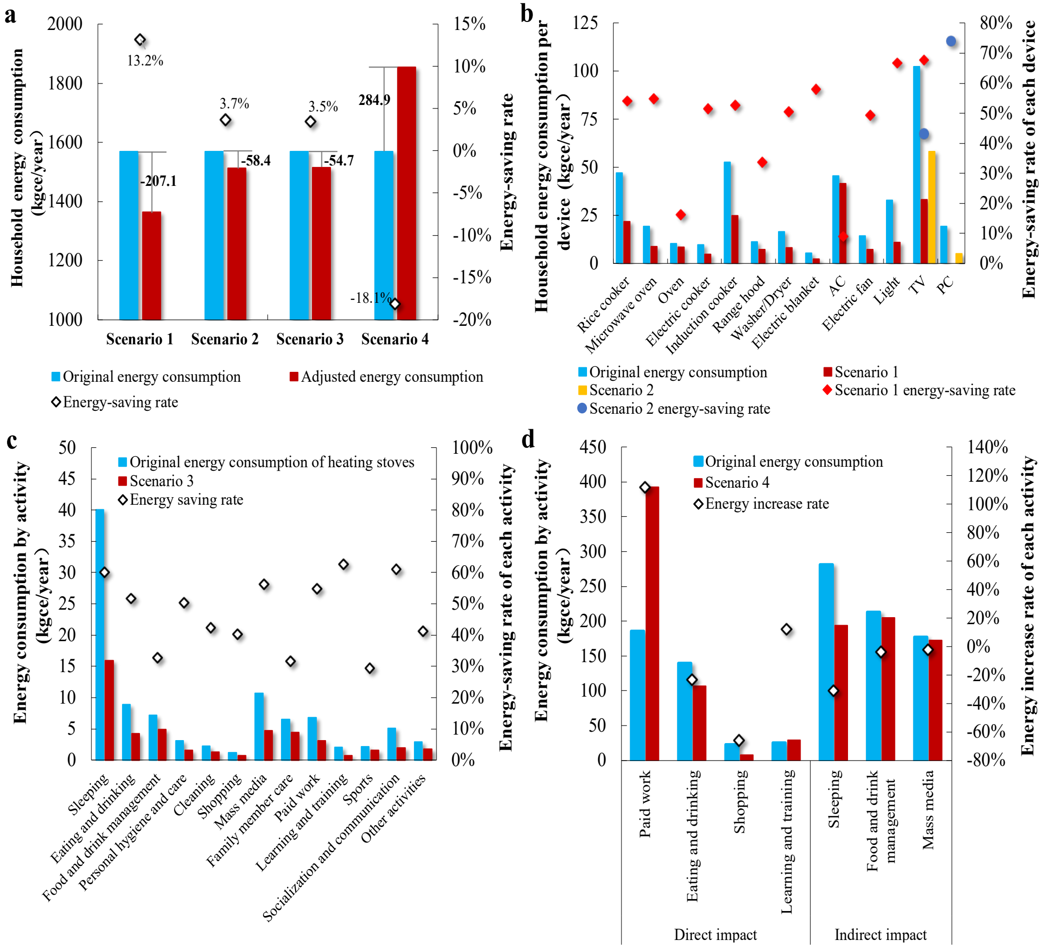
The increasing popularity of E-life would increase the residential energy consumption by approximately 18.1% even after avoiding the energy consumption of the related travel

情景1 Scenario 1 (-13.2% ↓):
推广节能设备
promoting energy-saving equipment

情景2 Scenario 2 (-4% ↓):
减少设备不必要的使用
eliminating the dispensable usage of equipment

情景3 Scenario 3 (-3.5% ↓):
提高取暖设备电气化水平
improving the electrification of heating equipment

情景4 Scenario 4 (18.1% ↑): 推广E-life popularizing E-life



物联网智能家居的影响 Impact of smart home

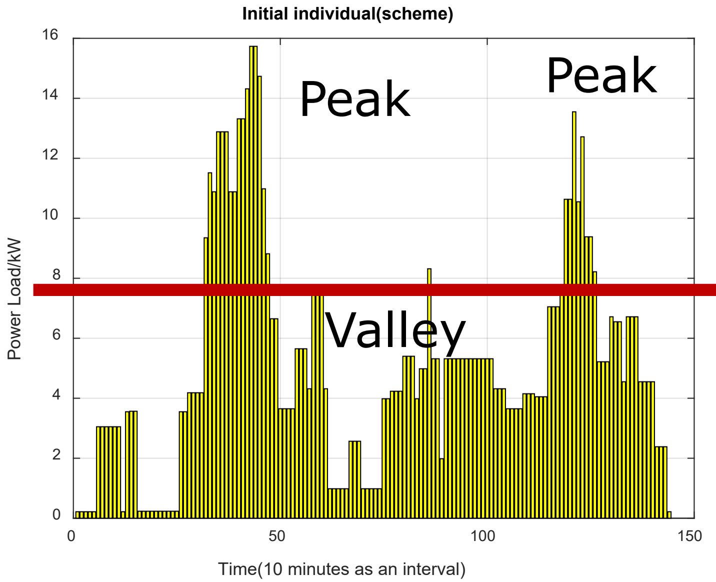
- 通过智能家居实现需求侧响应，在满足居民用电设备需求的前提下改变设备的运行时间，从而最小化电力负荷的峰谷差
- 我们的结果表明，智能家居最多可以减少一半的电力负荷

A smart home can arrange residents’ demand on the appliance use with more flexible time by minimizing the peak and off-peak gap for power load

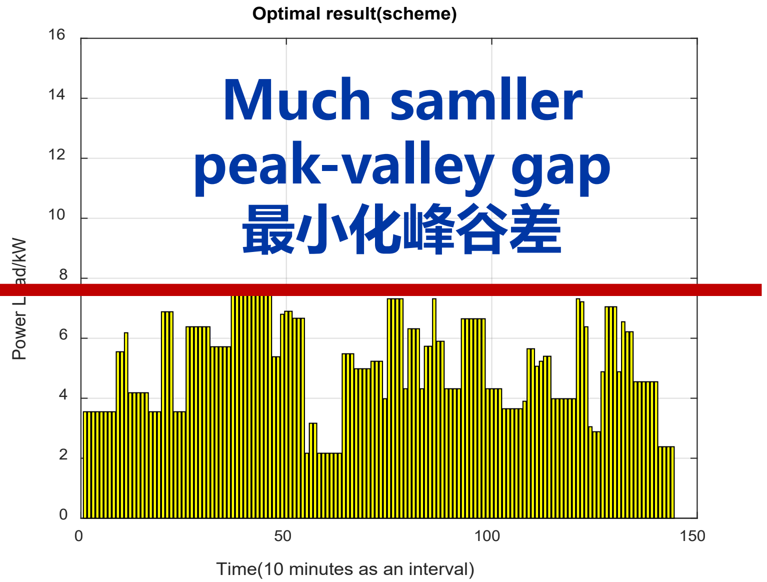
Our results show **at most half of the power load can be reduced by smart home**

No smart appliance case

Big gap between peak and valley



设备没有互联时，即刻使用



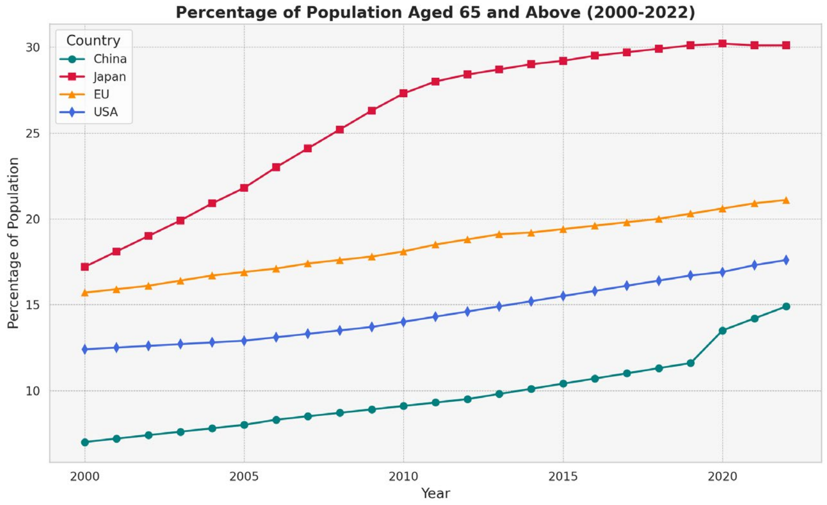
IoT下设备互联，在最佳时间窗内运行设备

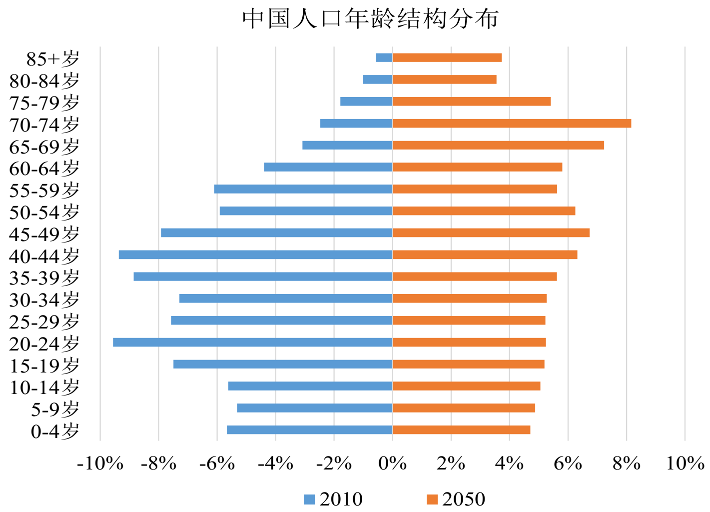
Smart appliance control case

人口结构转型对碳排放的影响

Impact of demographic transition on carbon emissions

- 人口结构变化已经成为发达国家和发展中国家共同面临的发展问题
- Demographic transition has become a worldwide issue
- **人口结构变化多个维度：人口数量变化、老龄化、家庭规模小型化、城镇化等**
- **Demographic transition (DT) includes: population change, aging, small households, urbanization, etc.**





Source: 全国第七次人口普查；
OECD 数据库

Biying Yu, Yi-Ming Wei, Gomi Kei, Yuzuru Matsuoka (2018). Future scenarios for energy consumption and carbon emissions due to demographic transitions in Chinese households. *Nature Energy* 3, 109-118.

人口结构转型对碳排放的影响

Impact of demographic transition on carbon emissions

- 时间利用模式重构（工作时间、休闲时间、家庭活动时间重新分配）

Reallocation of working time, leisure time and household activity time

- 家庭组成和年龄对生产活动的影响（劳动力供给和收入变化）

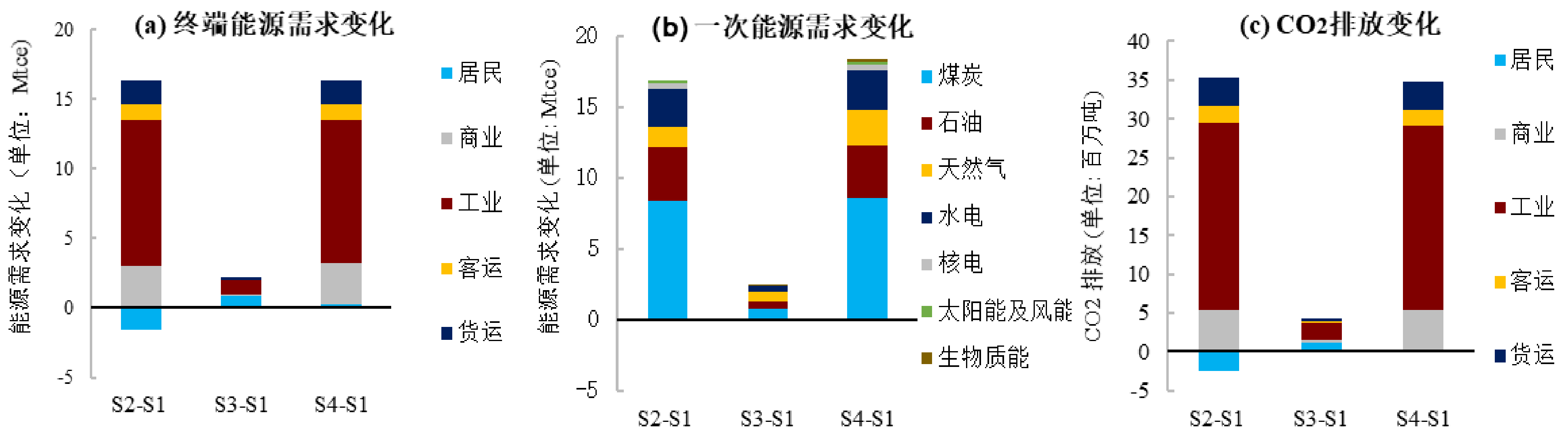
Labor supply change and the corresponding income change

- 家庭组成和年龄变化导致对商品和服务消费需求的变化 Consumption pattern change

人口结构转型对碳排放的影响

Impact of demographic transition on carbon emissions

- 传统研究不考虑人口转型带来的行为变化，会导致对能耗和碳排放的预测结果被显著低估（S3-S1）
- Ignoring the behaviral change due to DT will underestimate the impact on energy and emissions （S3-S1）

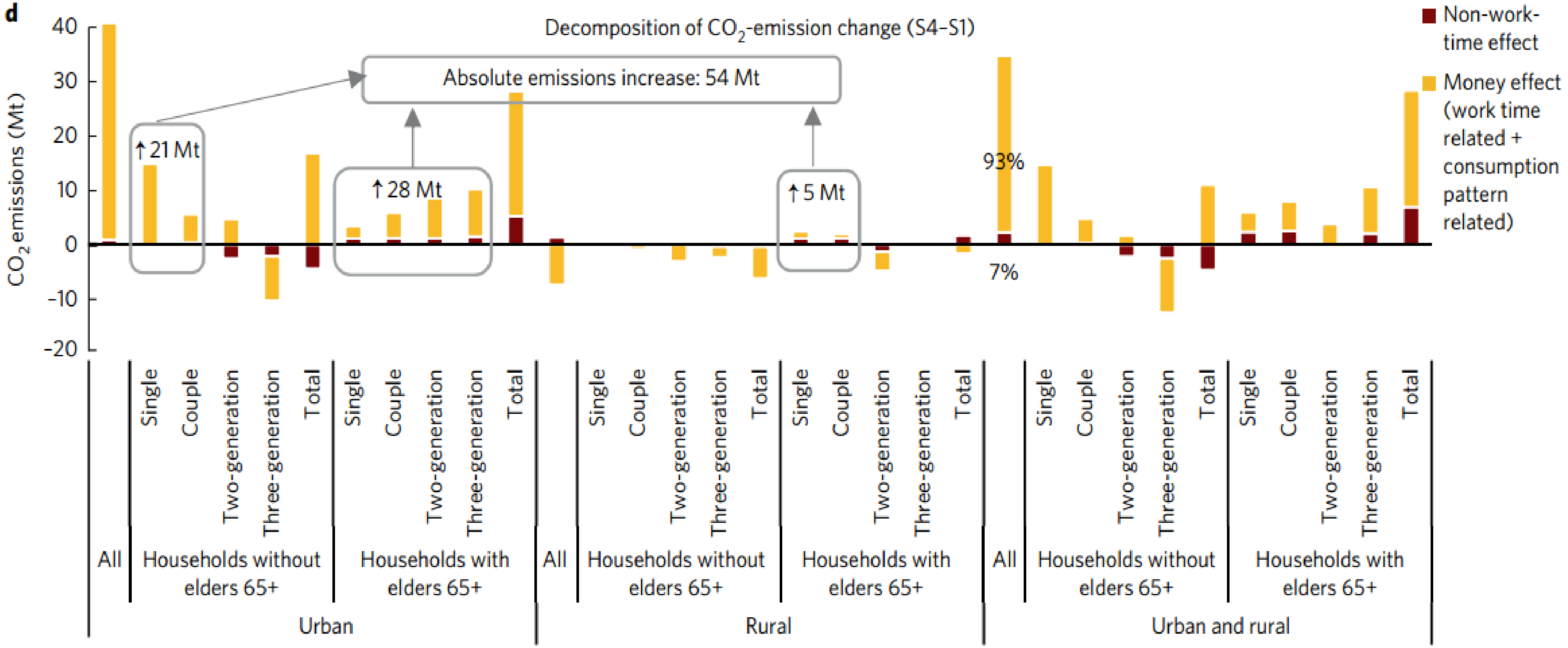


人口结构转型对碳排放的影响

Impact of demographic transition on carbon emissions

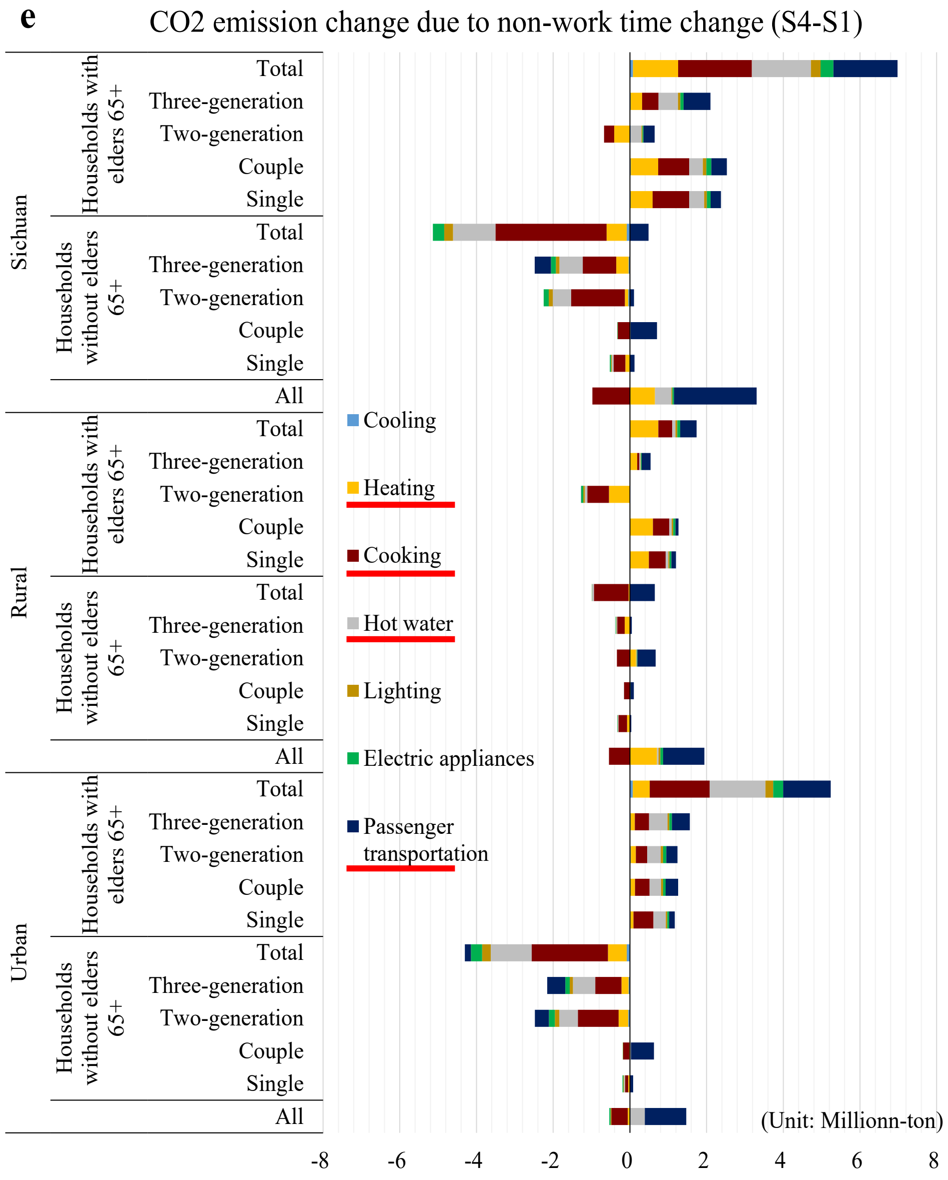
人口结构转型将**增加全社会的碳排放（7%）**，主要是由于人口结构变化伴随的工作时间变化和非工作时间变化所引起的 （93%）

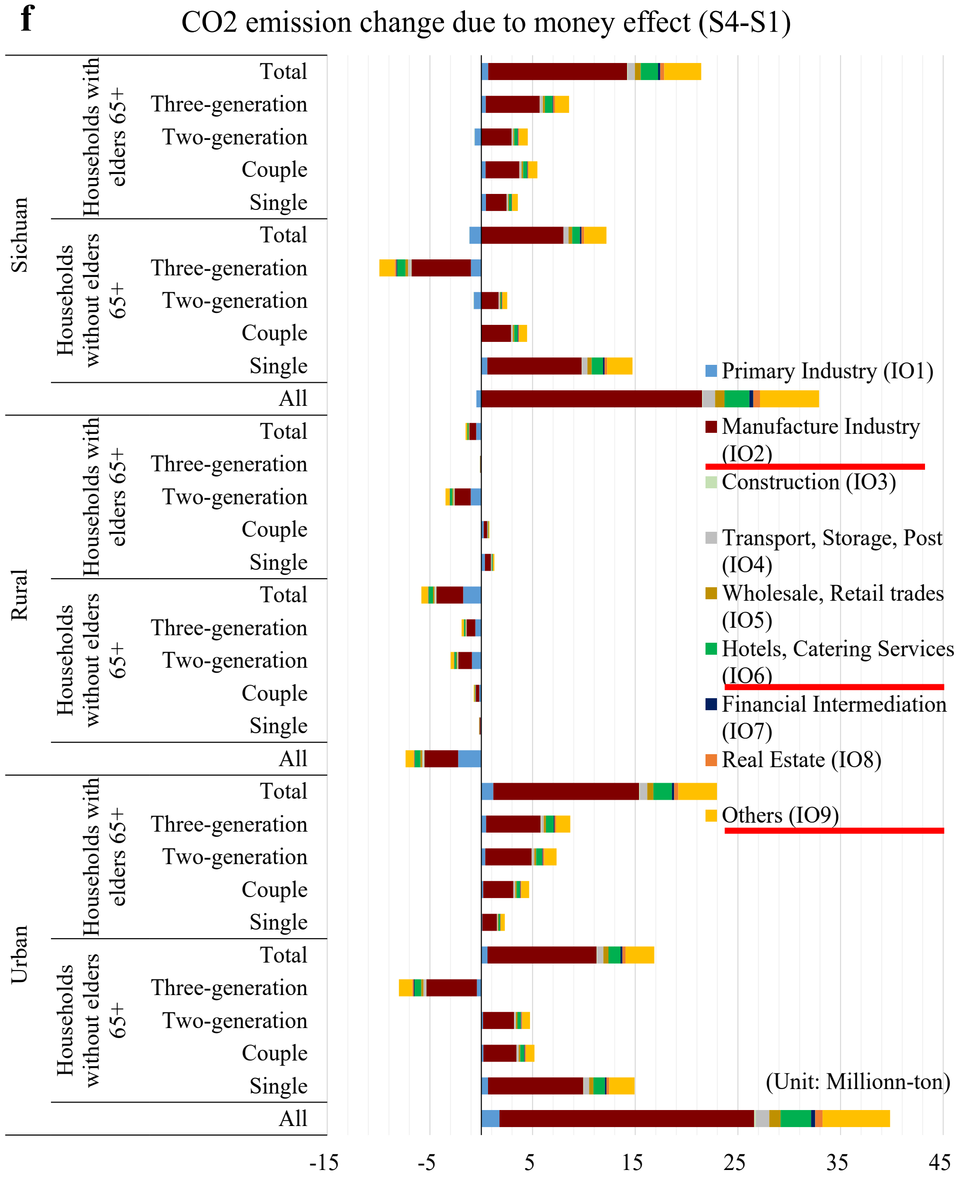
Demographic transition will **increase carbon emissions by 7%**, mainly because of the working tie and nonworking tine change (93%)



人口结构转型→时间利用→产品/服务需求→排放

DT→Time use behavior→Goods and service demand→CO_2





4

缩短工作时间政策的设计与选择

Design and selection of policies for shorten working hours

问题

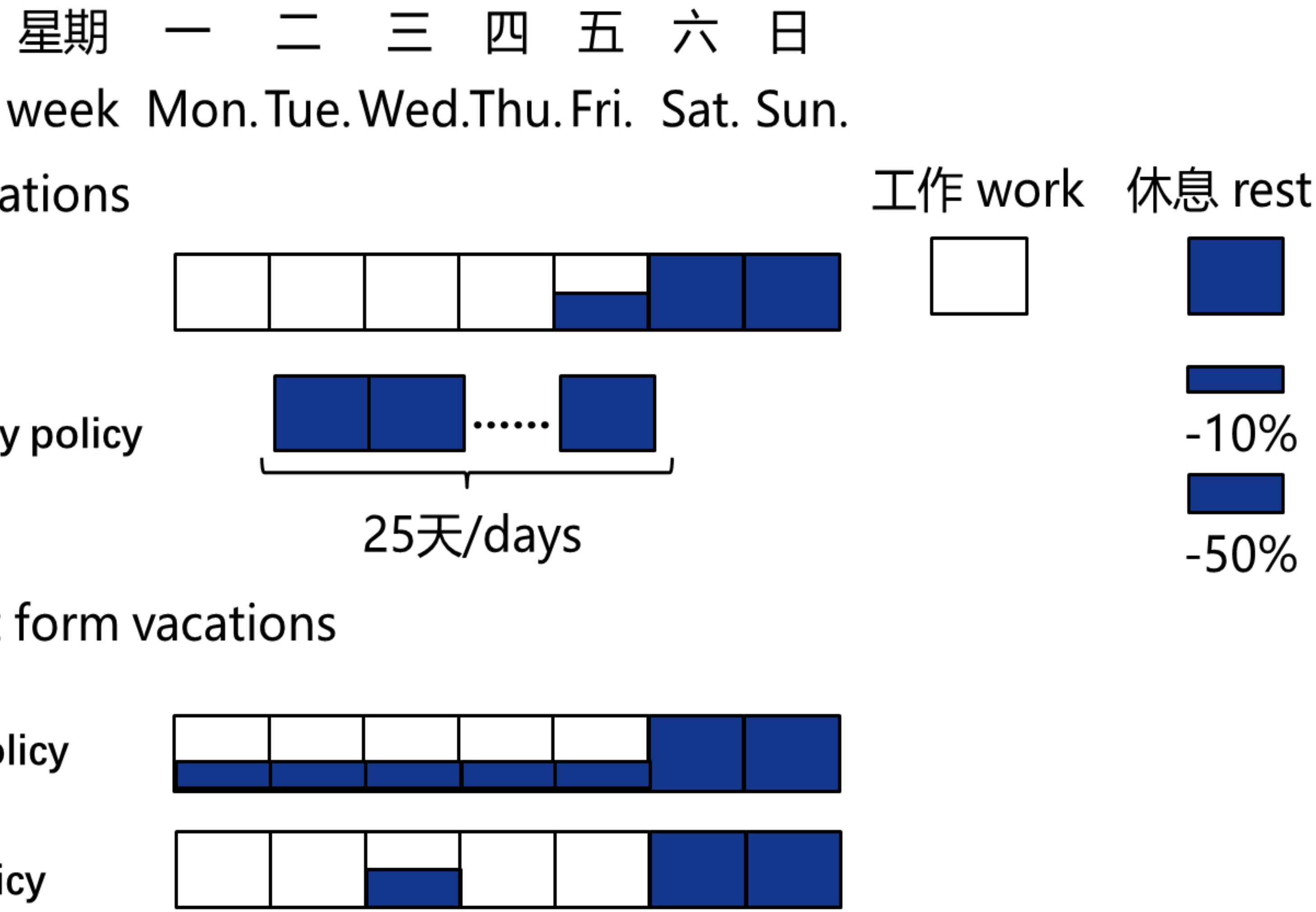
- 《关于进一步促进旅游投资和消费的若干意见》鼓励“有条件的地方和单位，为职工周五下午与周末结合外出休闲度假创造有利条件”
- 不同缩短工作时间方式将对人们的时间利用、消费、出行产生不同影响，这会对经济、就业和碳排放产生什么影响？

Problems

- The "Several Opinions on Further Promoting Tourism Investment and Consumption" encourages qualified regions to create favorable conditions for employees to go out for leisure and vacation on Friday afternoons and weekends.
- Different ways of shortening working hours differently affect people's time use, consumption, and travel, what will be the impacts on the economy, employment and carbon emissions?

缩短工作时间政策的设计与选择

Design and selection of policies for shorten working hours



- 形成连续假期 policies that form vacations
  - ✓ **2.5天周末政策 2.5-day weekend policy**
  - ✓ **增加法定假期政策 increasing public holiday policy**
- 未形成连续假期 policies that do not form vacations
  - ✓ **工作日减少政策 10% workday reduction policy**
  - ✓ **周三半天休息政策 half Wednesday off policy**

缩短工作时间政策的设计与选择

Design and selection of policies for shorten working hours

- 基于多指标综合评价方法，如果偏好经济影响，最大化总产出指标，2.5天周末政策是可取的；如果偏好社会影响，最大化就业指标，2.5天周末政策也是可取的；如果偏好环境影响，那么最大化排放指标（碳排放反而最小），周三半休政策是可取的；如果综合来看，2.5天周末政策是可取的
- Based on the multi-index comprehensive evaluation method, if preferring the economic output, 2.5-day weekend policy is better due to maximum d1; if preferring the social impact, the 2.5-day weekend policy is better due to d2; if preferring the environmental impact, the half Wednesday off policy is better due to d3; if preferring a comprehensive perspective of socio-economic and environmental impact, the 2.5-day weekend policy is considered better due to d4.

指标	总产出 d1 Economic output	就业 d2 Employment	碳排放d3 Carbon emissions	综合d4 Comprehensive
周三半天休息	0.321	0.374	0.564	0.420
工作日减少	0.272	0.294	0.522	0.362
2.5天周末	0.750	0.750	0.500	0.667
增加法定假期	0.496	0.303	0.415	0.404

基于时间利用的幸福度评估

Evaluation of Well-being Based on Time Use

中国人民变得更幸福了吗?

Have the Chinese People Become Happier?

全部图片来源于网络

Yu Biying, Zhao Lijing, Hu Lin, Sun Feihu, Peng Xiaohan, Shi Caiyun (2021). Research on Improving People's Well-being from the Time Use Perspective. *JOURNAL OF BEIJING INSTITUTE OF TECHNOLOGY (SOCIAL SCIENCES EDITION)* 23(4), 72-81. (In Chinese)

基于时间利用的幸福度评估

Evaluation of Well-being Based on Time Use

基于时间利用的幸福度评估
Evaluation of Well-being Based on Time Use

- ✓ 个体属性 Individual Attributes
- ✓ 外界环境属性 External Environmental Attributes
- ✓ 三阶段最小二乘法（3SLS） Three-Stage Least Squares (3SLS)

幸福度评估方法
Methods for Assessing Well-being

- ✓ 2008年时间利用调查数据 2008 Time Use Survey Data
- ✓ 2018年时间利用调查数据 2018 Time Use Survey Data

2008年与2018年中国居民主观幸福感比较
A Comparison of Subjective Well-being of Chinese Residents between 2008 and 2018

- ✓ 整体居民 Overall Residents
- ✓ 分性别 By Gender
- ✓ 分城乡 By Urban and Rural Areas
- ✓ 分收入 By Income Level
- ✓ 分婚姻状况 By Marital Status
- ✓ 分年龄 By Age Group

基于时间利用的幸福度评估

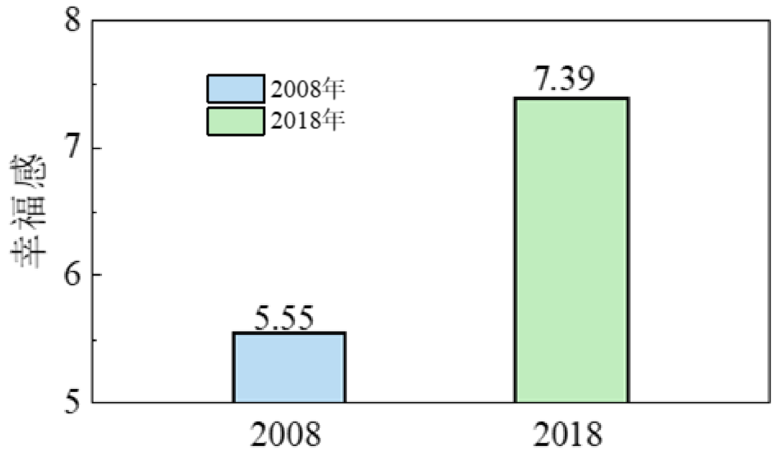
Evaluation of Well-being Based on Time Use

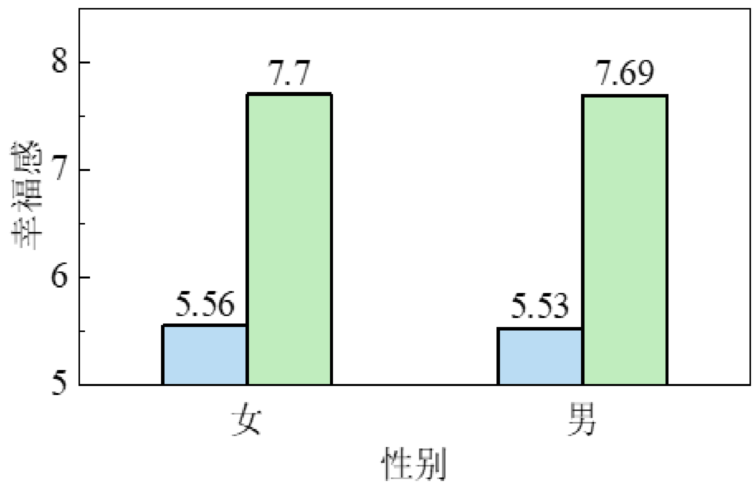
- 2008~2018年，中国居民的幸福感有了显著提升，提升了33%

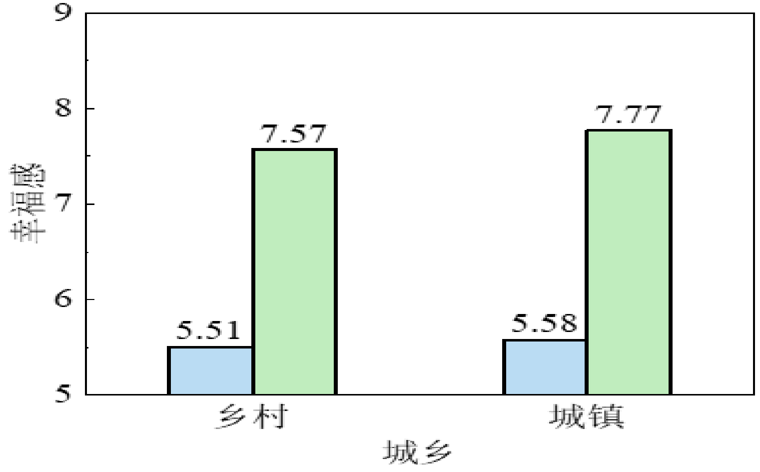
  From 2008 to 2018, the well-being of Chinese residents significantly improved, by 33%.
- 男性和女性的幸福感都有所提升，提升幅度在38%以上，女性的幸福感始终略高于男性

  The well-being of both men and women has improved, with an increase of over 38%. Women's well-being has consistently been slightly higher than that of men.
- 城镇居民幸福感始终高于农村居民，但农村居民的幸福感增长率为37.40%，较城市居民更高

  Urban residents have consistently had higher well-being than rural residents, but the well-being growth rate of rural residents is 37.40%, which is higher than that of urban residents.







基于时间利用的幸福度评估

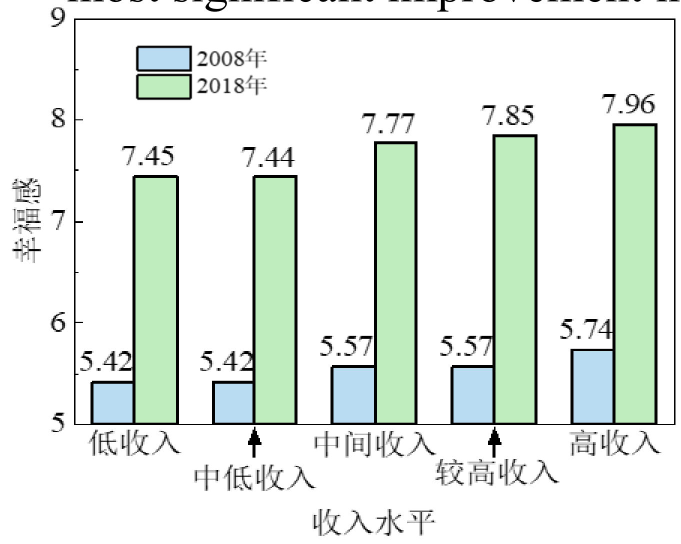
Evaluation of Well-being Based on Time Use

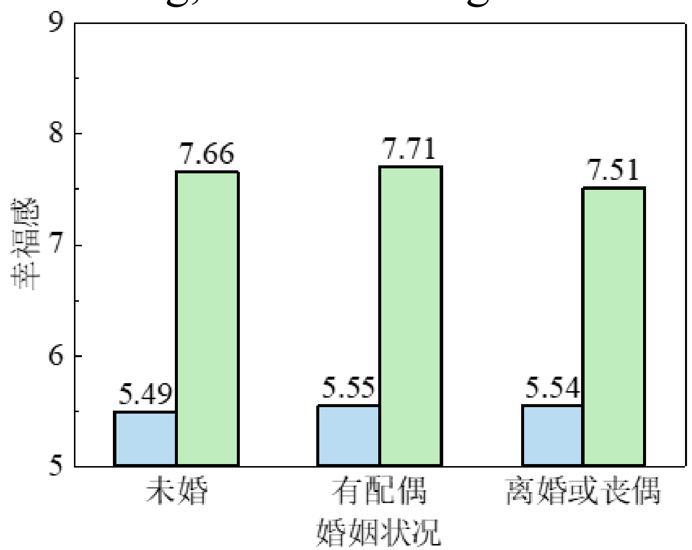
- 2008~2018年，各收入群体居民幸福感都有了显著提升，低收入和中低收入居民幸福感较低，高收入居民幸福感始终最高

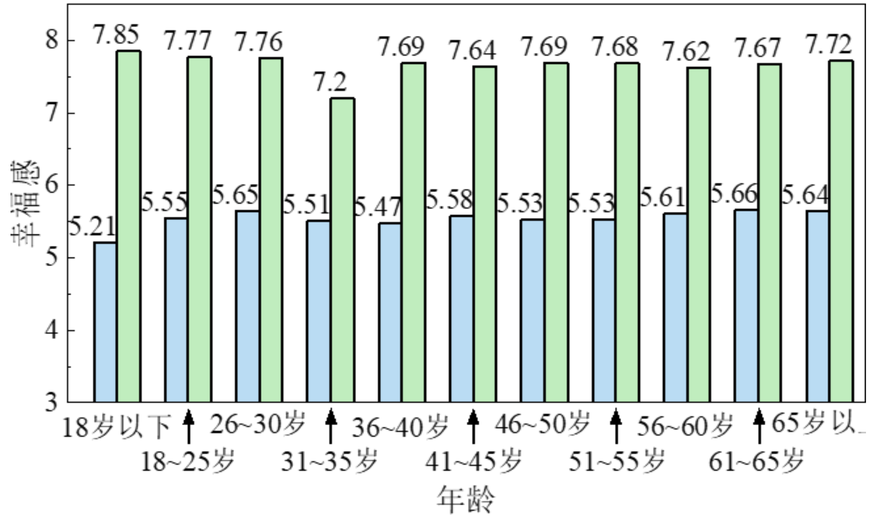
  Between 2008 and 2018, the well-being of residents across all income groups significantly improved. However, low-income and lower-middle-income residents had relatively lower well-being, while high-income residents consistently had the highest well-being.

- 不同年龄居民幸福感均不同程度提高，18岁以下居民幸福感提升最多，36~45岁人群幸福感偏低

  The well-being of residents across all age groups increased to varying degrees. Residents under 18 experienced the most significant improvement in well-being, while those aged 36-45 had relatively lower well-being.







Center for Energy & Environmental Policy Research, BIT

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碳中和系统工程北京实验室

Beijing Laboratory for System Engineering of Carbon Neutrality

能源经济与环境管理北京市重点实验室

Beijing Key Laboratory of Energy Economics and Environmental Management

碳中和系统与工程管理国际合作联合实验室(教育部)

Joint international Research Laboratory of Carbon Neutrality System and Engineering Management

Global Ranking of CEEP-BIT

能源经济: 世界排名 8	环境经济: 世界排名 9	全球智库: 世界排名 14
1 未来资源研究所 (RFF)	1 未来资源研究所 (RFF)	1 美国国家经济研究局 (NBER)
2 美国国家经济研究局(NBER)	2 世界银行 (World Bank)	2 德国劳动经济学研究所 (IZA)
3 世界银行 (World Bank)	3 美国国家经济研究局 (NBER)	3 英国经济政策研究中心 (CEPR)
4 国际货币基金组织 (IMF)	4 伦敦经济学院	4 布鲁金斯学会（Brookings Institution）
5 麻省理工学院 (MIT) 经济系	5 国际货币基金组织 (IMF)	5 慕尼黑经济研究中心信息与研究所 (IFO)
6 伦敦经济学院(LSE)	6 麻省理工学院 (MIT) 斯隆管理学院	6 德国经济研究所(DIW Berlin)
7 麻省理工学院 (MIT) 斯隆管理学院	7 耶鲁大学经济系	7 彼得森国际经济研究所 (IIE)
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11 哈佛大学经济系	11 芝加哥大学经济系	11 德国劳动力市场与职业研究所（IAB）
12 澳大利亚国立大学公共政策学院	12 图卢兹经济学院(TSE)	12 爱尔兰经济社会研究所（ESRI）
13 哈佛大学肯尼迪学院	13 澳大利亚国立大学公共政策学院	13 莱布尼茨学会哈雷经济研究所 (IWH)
14 耶鲁大学经济系	14 巴黎经济学院	14 北理工能源与环境政策研究中心

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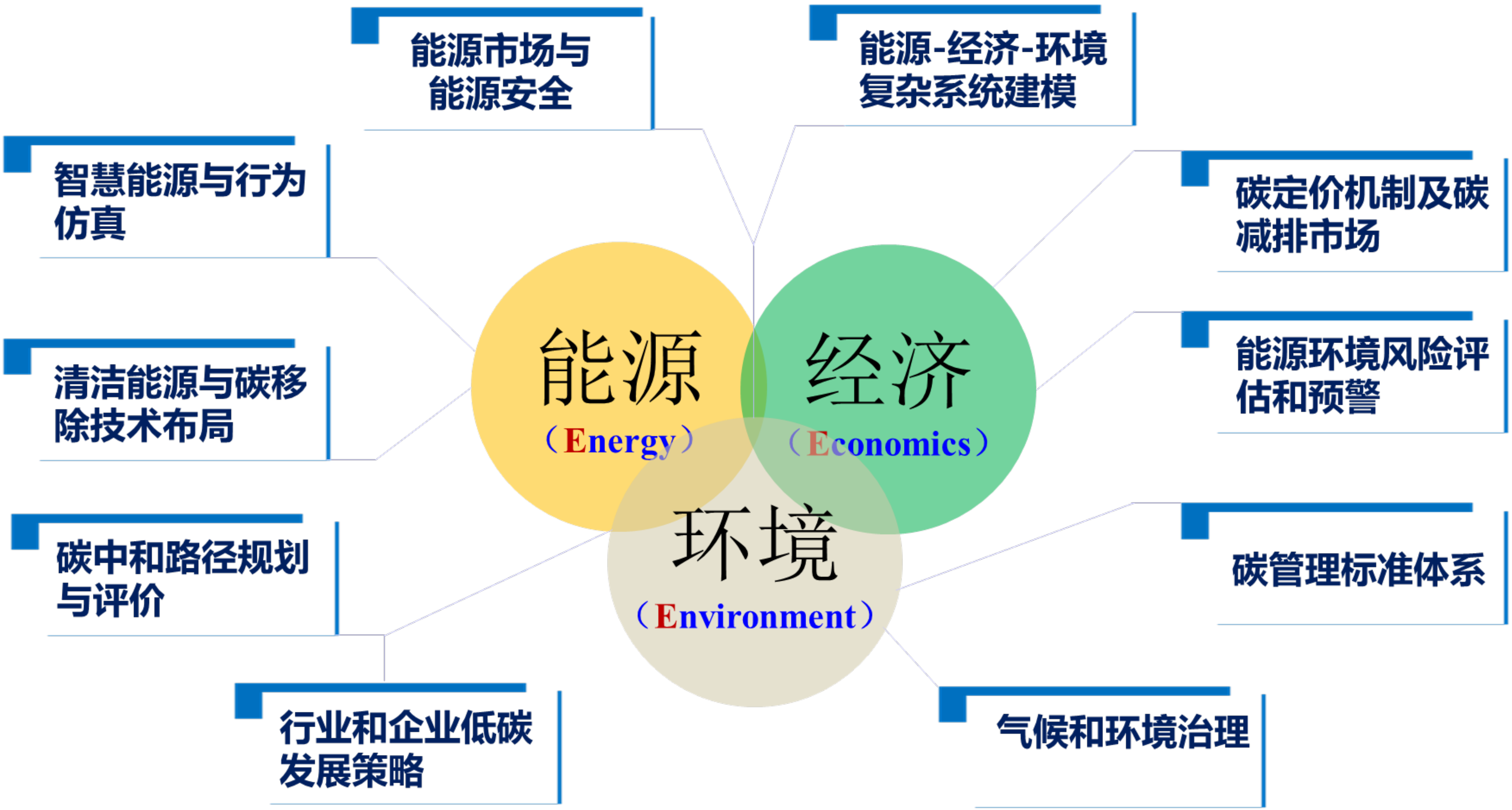
Ten Research Fields 十大研究领域



Relevant Publications

Book：

- 余碧莹等 (2022), 时间利用行为与低碳管理, 北京：科学出版社.

Paper：

- Biying Yu, Yi-Ming Wei, Gomi Kei, Yuzuru Matsuoka (2018). Future scenarios for energy consumption and carbon emissions due to demographic transitions in Chinese households. *Nature Energy* 3, 109-118.
- Biying Yu, Feihu Sun, Chen Chen, Guanpeng Fu, Lin Hu (2022). Power demand response in the context of smart home application. *Energy* 240, 122774.
- Biying Yu, Xiaojuan Yang, Qingyu Zhao, Jinxiao Tan (2020). Causal Effect of Time-Use Behavior on Residential Energy Consumption in China. *Ecological Economics* 175, 106706.
- Biying Yu, Junjie Zhang, Yi-Ming Wei (2019). Time use and carbon dioxide emissions accounting: An empirical analysis from China. *Journal of Cleaner Production* 215, 582-599.
- Biying Yu, Junyi Zhang and Akimasa Fujiwara (2013). A household time use and energy consumption model with multiple behavioral interactions. *Environment and Planning B 40(2)*, 330-349.
- Yu Biying， Zhao Lijing， Hu Lin， Sun Feihu， Peng Xiaohan， Shi Caiyun (2021). Research on Improving People’s Well-being from the Time Use Perspective. *JOURNAL OF BEIJING INSTITUTE OF TECHNOLOGY (SOCIAL SCIENCES EDITION)* 23(4), 72-81. (In Chinese)

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谢 谢！ Thank you!

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