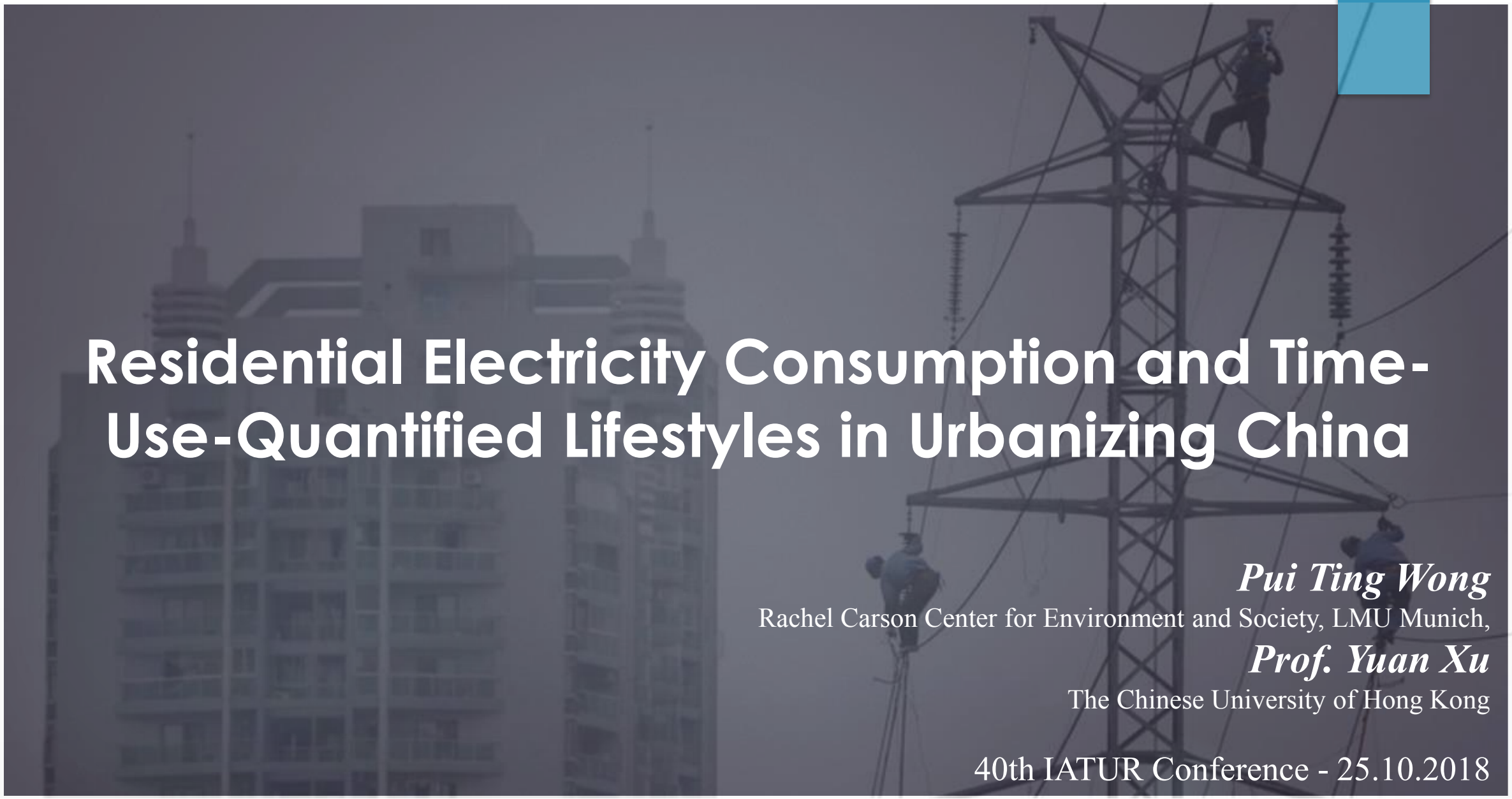

Residential Electricity Consumption and Time-Use-Quantified Lifestyles in Urbanizing China

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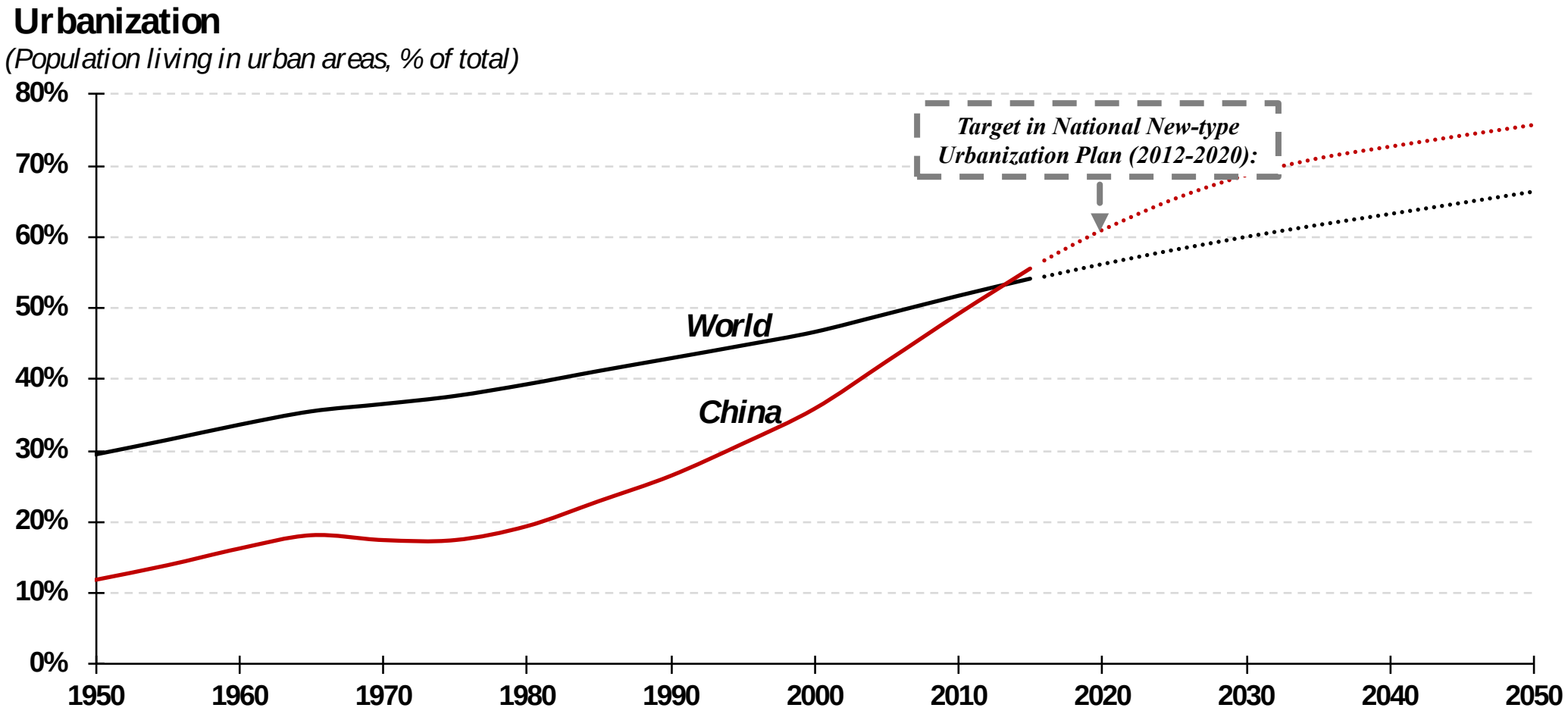
OUTLINE

- Introduction
- Research framework and Methodology
- Reconstructing activity-based residential electricity consumption patterns
- Quantifying the impacts on residential electricity consumption induced by lifestyle difference in urbanizing China
- Conclusion

Introduction

Introduction

Will the rapid urbanization in China affect in reaching its NDC goals submitted in the Paris Agreement?



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http://climateanalytics.org/hot-topics/ratification-tracker.html

Introduction

Research Questions

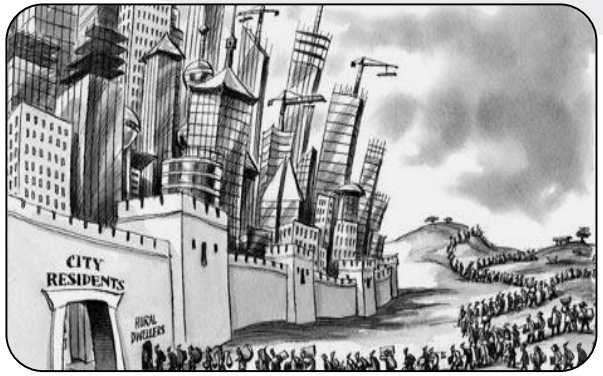
- **What are the implications of urbanization on residential electricity consumption in the perspective of individual lifestyle?**

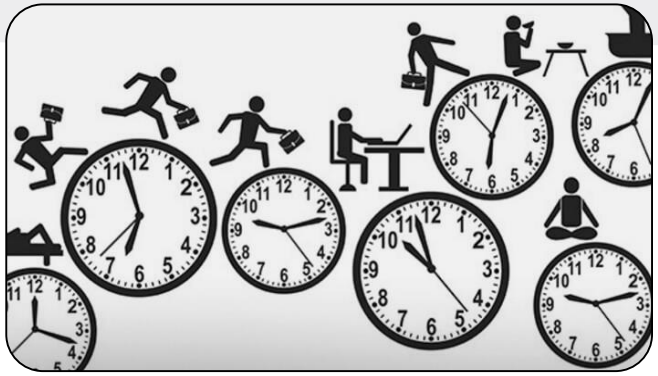
  i. What is the electricity consumption on the residential level embedded in the individual lifestyles of urban and rural regions in China?

  ii. How does lifestyle differences between urban and rural residents in China affect their residential electricity consumption?

Introduction

Definition of Three Major Key Terms





Urbanization:

- Absolute Population
- Share of Population
- Lifestyle and behaviour

Lifestyle

- Money Expenditure
- Time Use Pattern

Residential Electricity Consumption

- Electricity directly consumed in residential buildings per person per day

Methodology

Methodology

Theoretical Framework

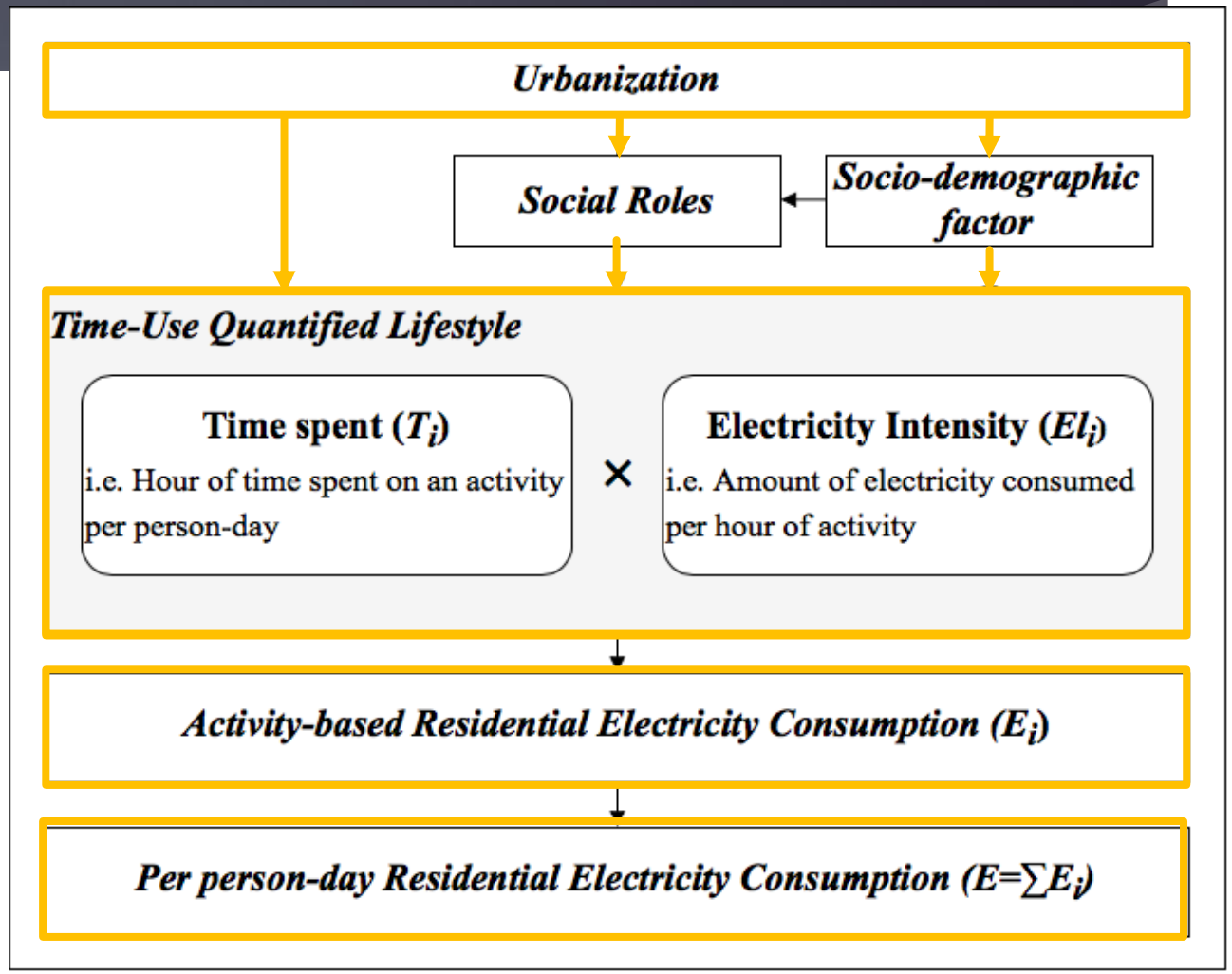
- ***Presumption:***

  Lifestyle is socially-constructed

- **Quantified lifestyle in the perspective of time-use:**

$$E = \sum_{i}^{N} E_i = \sum_{i}^{N} T_i \cdot \frac{E_i}{T_i} = \sum_{i}^{N} T_i \times EI_i$$

E: Per person-day residential electricity consumption
E_i: Per person-day residential electricity consumption for activity *i;*
T_i: Hour of time spent on activity *i* per person per day
EI_i: Electricity intensity of activity *i*, i.e. electricity consumption per hour of activity *i*



Methodology

Two primary datasets analyzed

Time Spent on activity *(T_i)*:
Chinese Time Use Survey

Administered by: National Bureau of Statistics Social Science Division

Time: May, 2008

Sample: 37142 individuals from 10 provinces

Data: Time use diary in a interval of 10minutes, detailing

- Type of activity
- Location
- Duration of activity
- Weekday/Weekend
- Person whom involved in the activity
- Secondary Activity

} Activity-based

Electricity intensity of activity *(EI_i)*:
Chinese Residential Energy Consumption Survey

Administered by: The Renmen University of China

Time: 2012

Sample: 1450 households

Data:

- Number of appliance owned
- Year of purchase
- Type of appliance
- Appliance energy efficiency grade
- Appliance energy intensity
- Frequency of usage
- Average time per usage

} Appliance-based

Task 1

- *Reconstructing activity-based resident electricity consumption pattern*

$$E = \sum_{i}^{N} E_i = \sum_{i}^{N} T_i \cdot \frac{E_i}{T_i} = \sum_{i}^{N} T_i \times EI_i$$

Bottom-up Reconstruction of Electricity Intensity of Activity

- **Appliance-based → Activity-based**

Reconstructing activity-based residential electricity consumption pattern

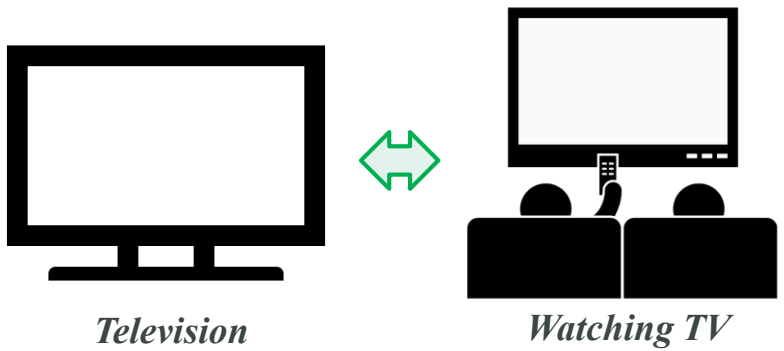
Bottom-up reconstruction Approach

To generate common variable based on their linkage to occupancy pattern

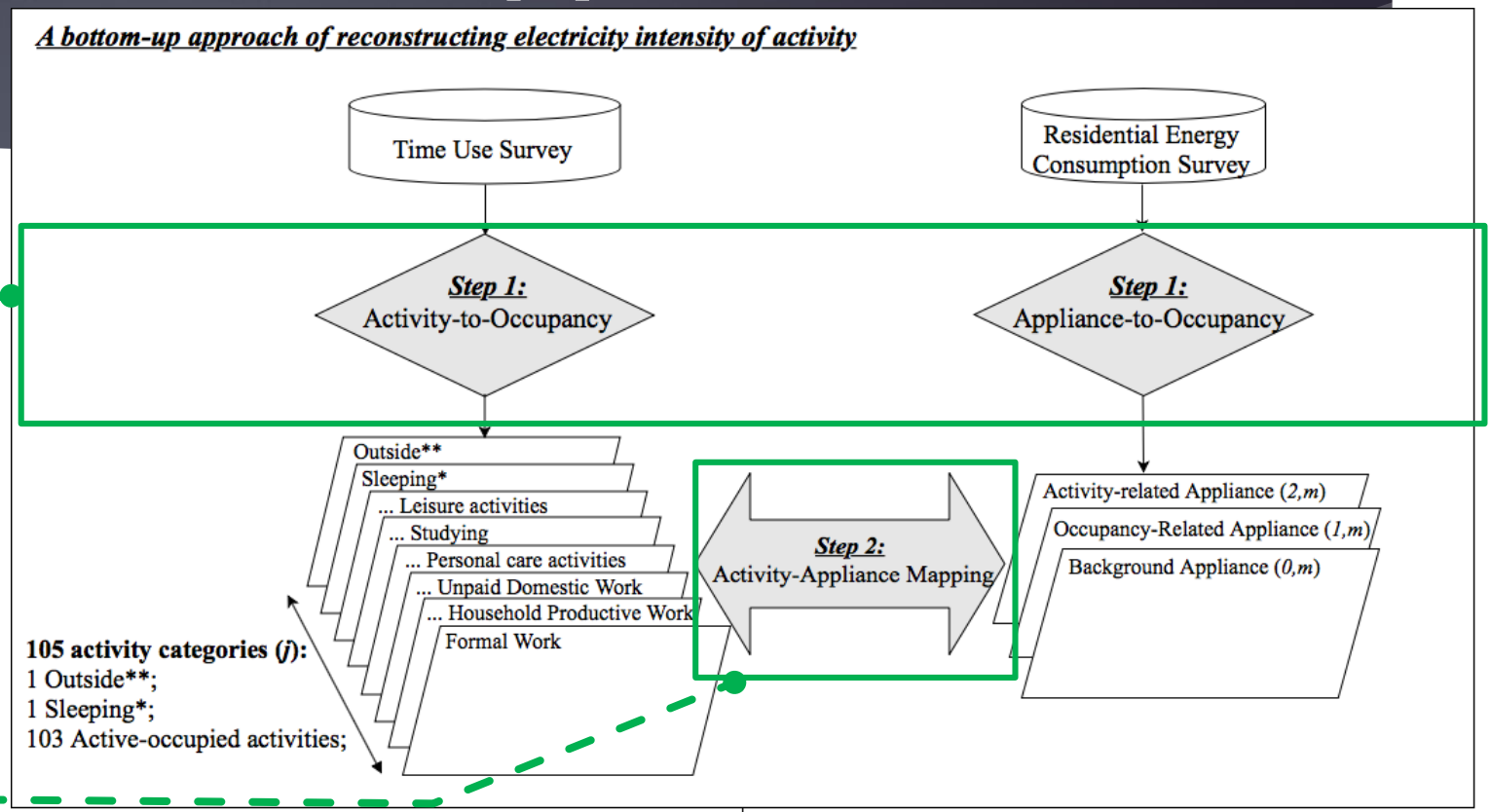
- Outside: Not at home
- Passively-occupied: At home, but asleep
- Actively-occupied: At home, and awake

To match household electrical appliance to time-use activities based on logical assumptions, e.g.

Activity-related Appliance (2,m) , e.g.



Television *Watching TV*

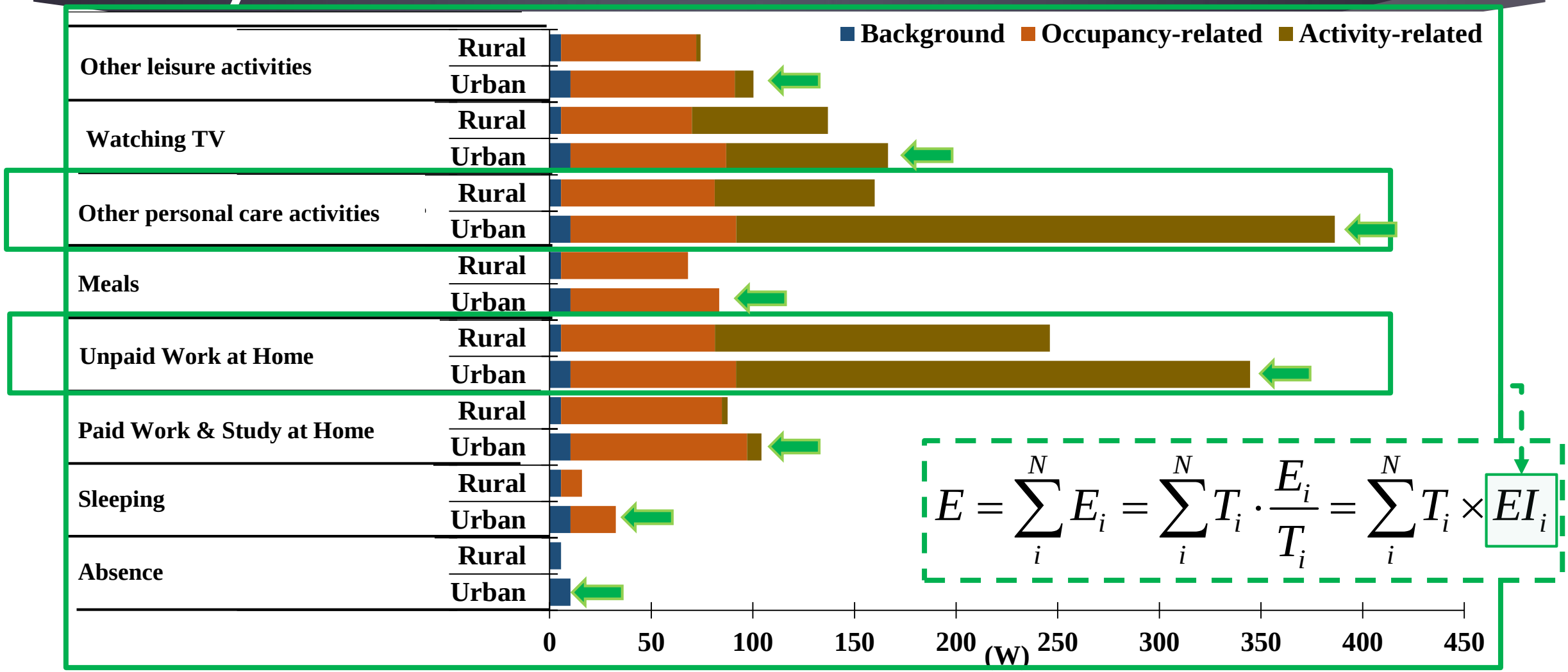


Output: *Activity intensity of activity category j (EIj)*
i.e. sum of the electricity intensity assoicated with the use of appliance *m* of occupancy group (0,1,2) during activity *j*

$$EI_j = \sum_m (EI_{0,m,j} + EI_{1,m,j} + EI_{2,m,j})$$

Reconstructing activity-based residential electricity consumption pattern

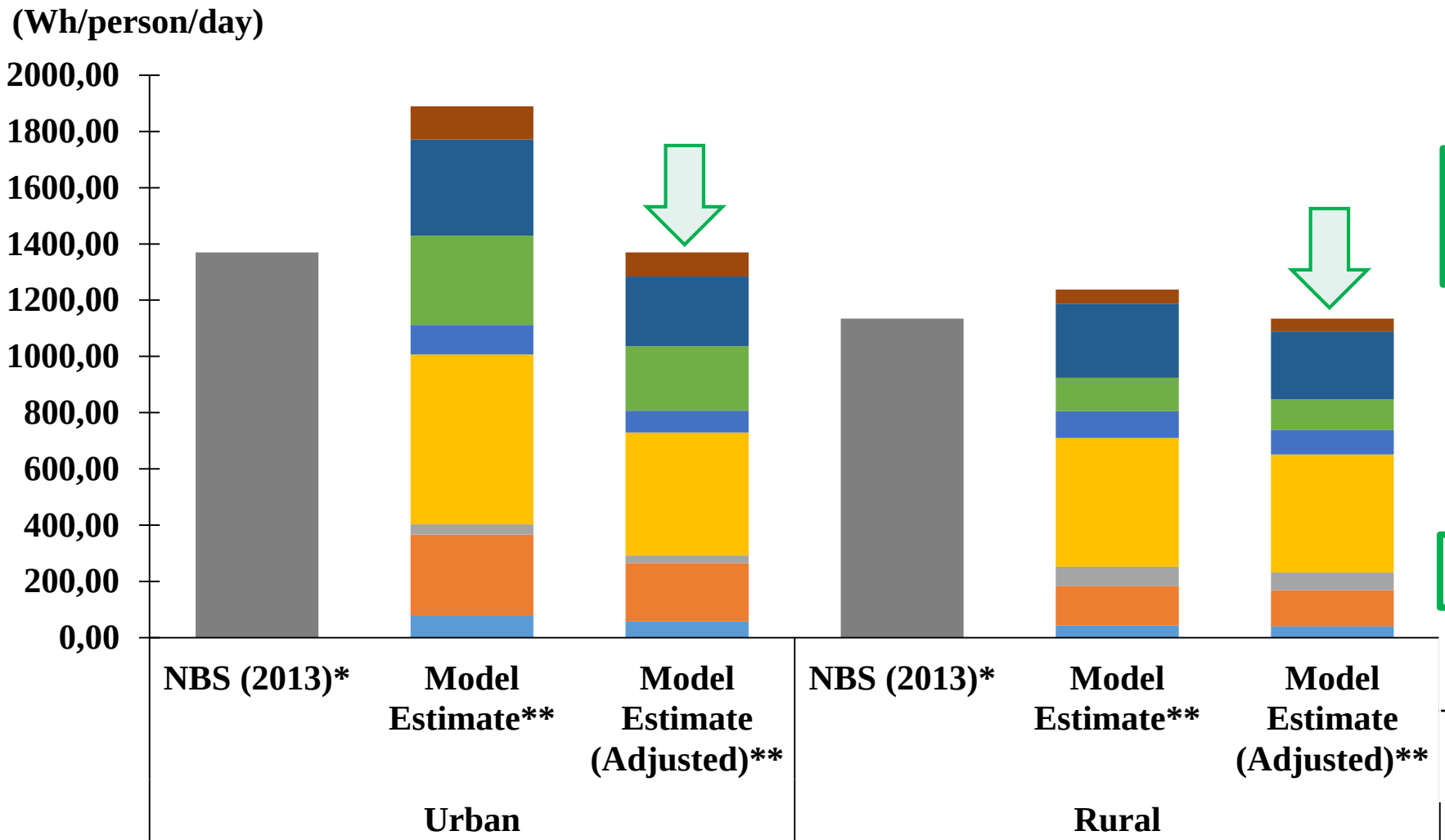
Result: Reconstructed electricity intensity of activity



Reconstructing activity-based residential electricity consumption pattern

Reconstructed residential electricity consumption & validation

(Urban-Rural)



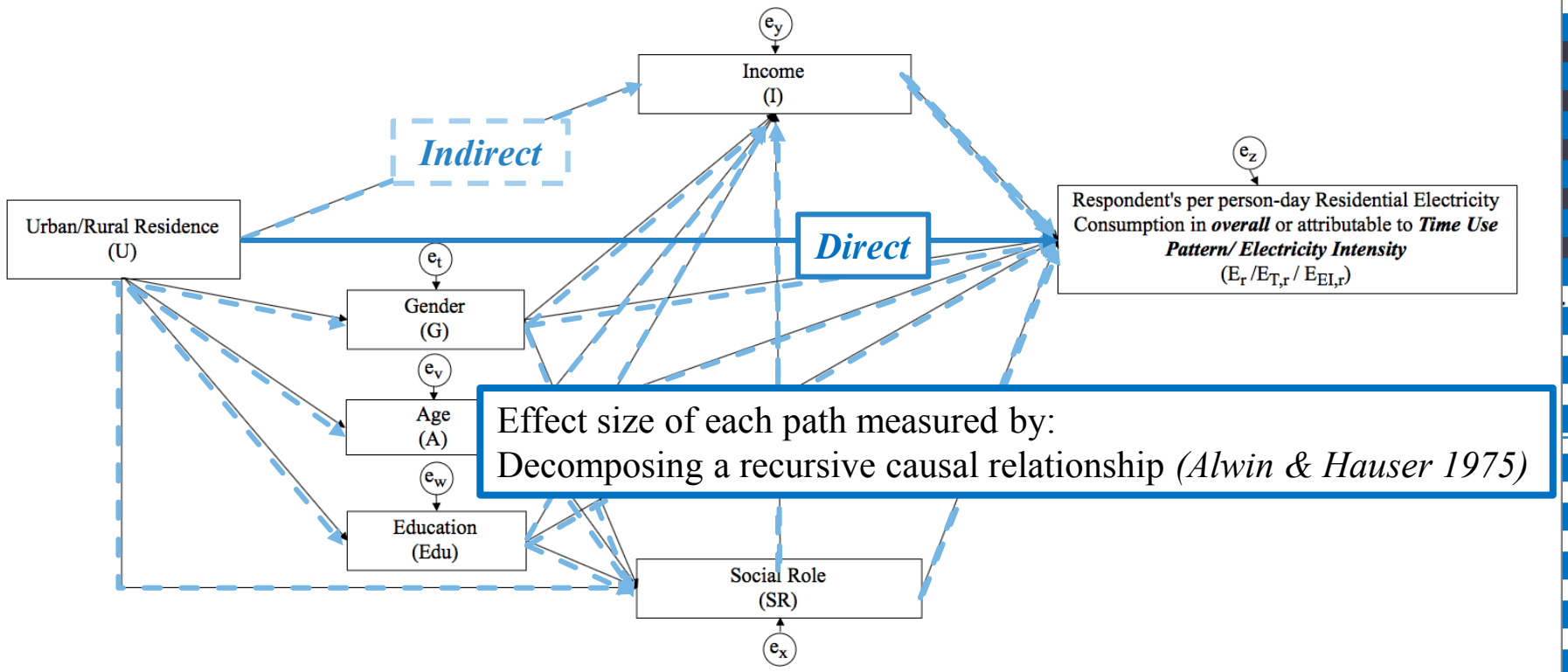
Other leisure activities**	40.0
Watching TV**	6.5
Other personal care activity**	120.5
Meals**	-10.1
Unpaid Work at home**	18.0
Paid Work & Study at home**	-36.5
Sleeping**	79.2
Outside**	17.9
Total*	235.4

Task 2

- ***Quantifying the impacts on residential electricity consumption induced by lifestyle differences in urbanizing China***

ced by lifestyle

ndividuals ($\triangle E$)



Effect size of each path measured by:
Decomposing a recursive causal relationship *(Alwin & Hauser 1975)*

(IDA) *(Ang, 2003)*

Index Decomposition Approach

- Time Use Effect
- Electricity Intensity effect

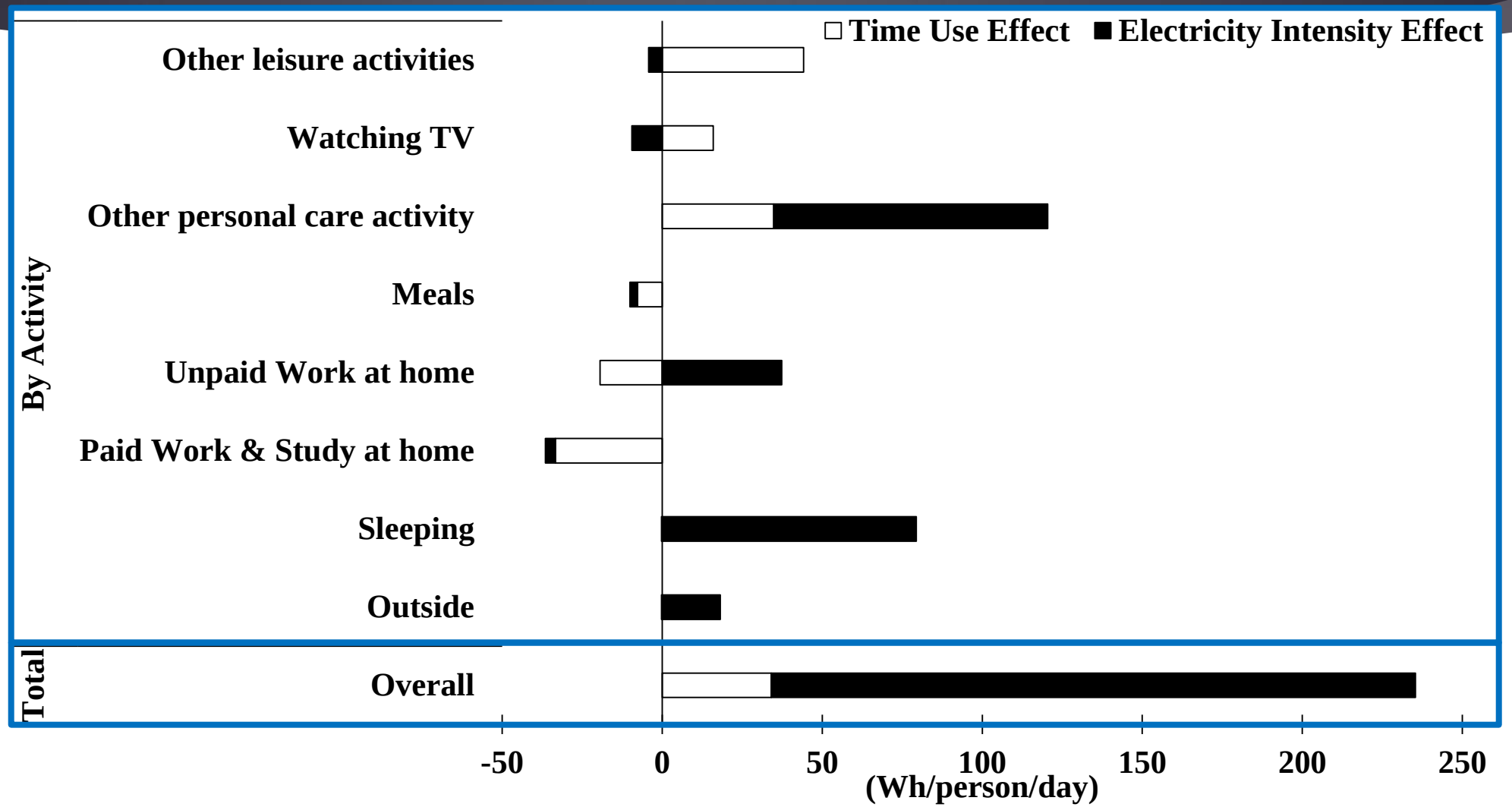
$$\Delta E_T = \sum_i \sum_j \frac{E_{ij}^U - E_{ij}^R}{InE_{ij}^U - InE_{ij}^R} In\left(\frac{T_{ij}^U}{T_{ij}^R}\right)$$

$$\Delta E_{EI} = \sum_i \sum_j \frac{E_{ij}^U - E_{ij}^R}{InE_{ij}^U - InE_{ij}^R} In\left(\frac{EI_{ij}^U}{EI_{ij}^R}\right)$$

$\Delta E_T; \Delta E_{EI}$: Difference in residential electricity consumption attributable to i) time use and electricity intensity effects, respectively;
Subscript $_U$ & $_R$: urban & rural residents, respectively.

Quantifying the impacts on residential electricity consumption induced by lifestyle differences in urbanizing China

Aggregate level analysis: **Electricity intensity of activity is the key**

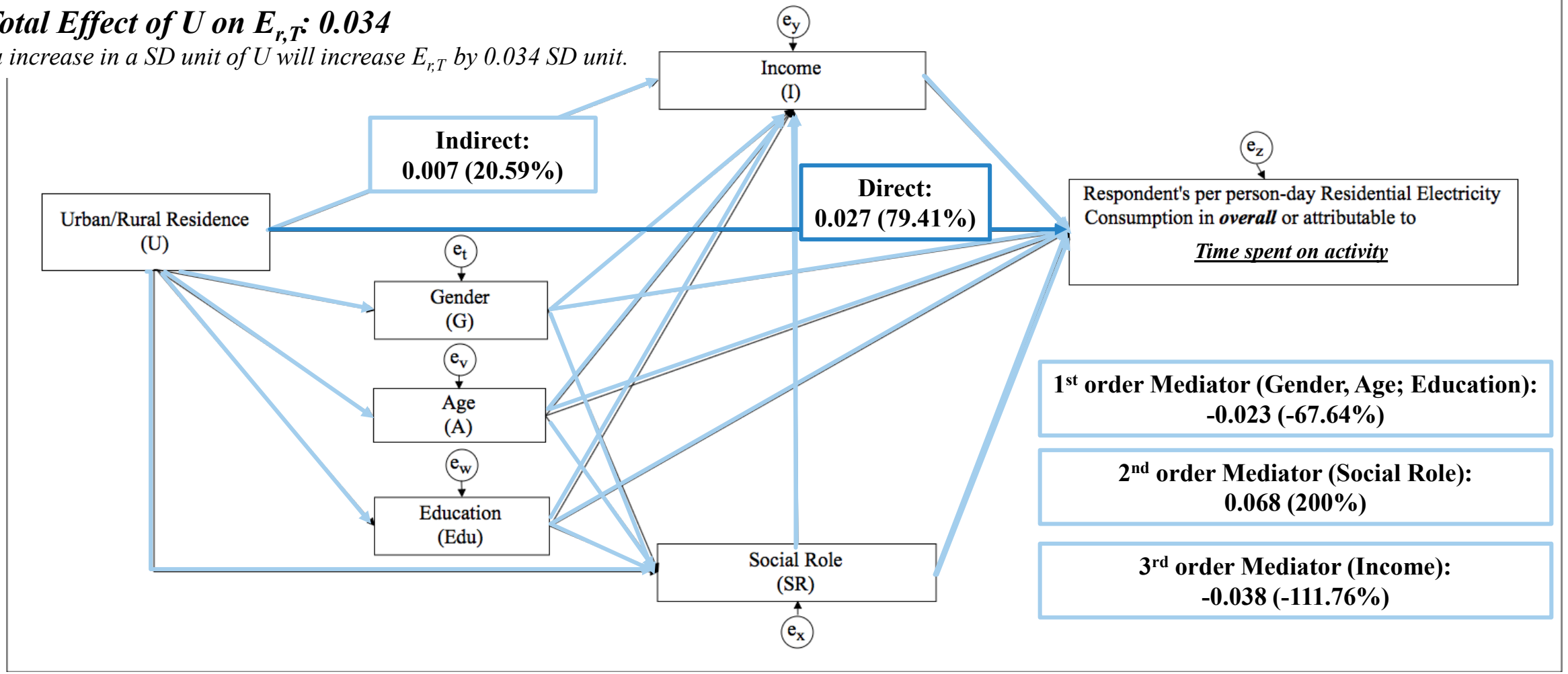


Quantifying the impacts on residential electricity consumption induced by lifestyle differences in urbanizing China

Disaggregate level analysis: **Direct *impacts* of *U* was more influential on *E* in term of time-use pattern**

Total Effect of U on $E_{r,T}$: 0.034

(a increase in a SD unit of U will increase $E_{r,T}$ by 0.034 SD unit.

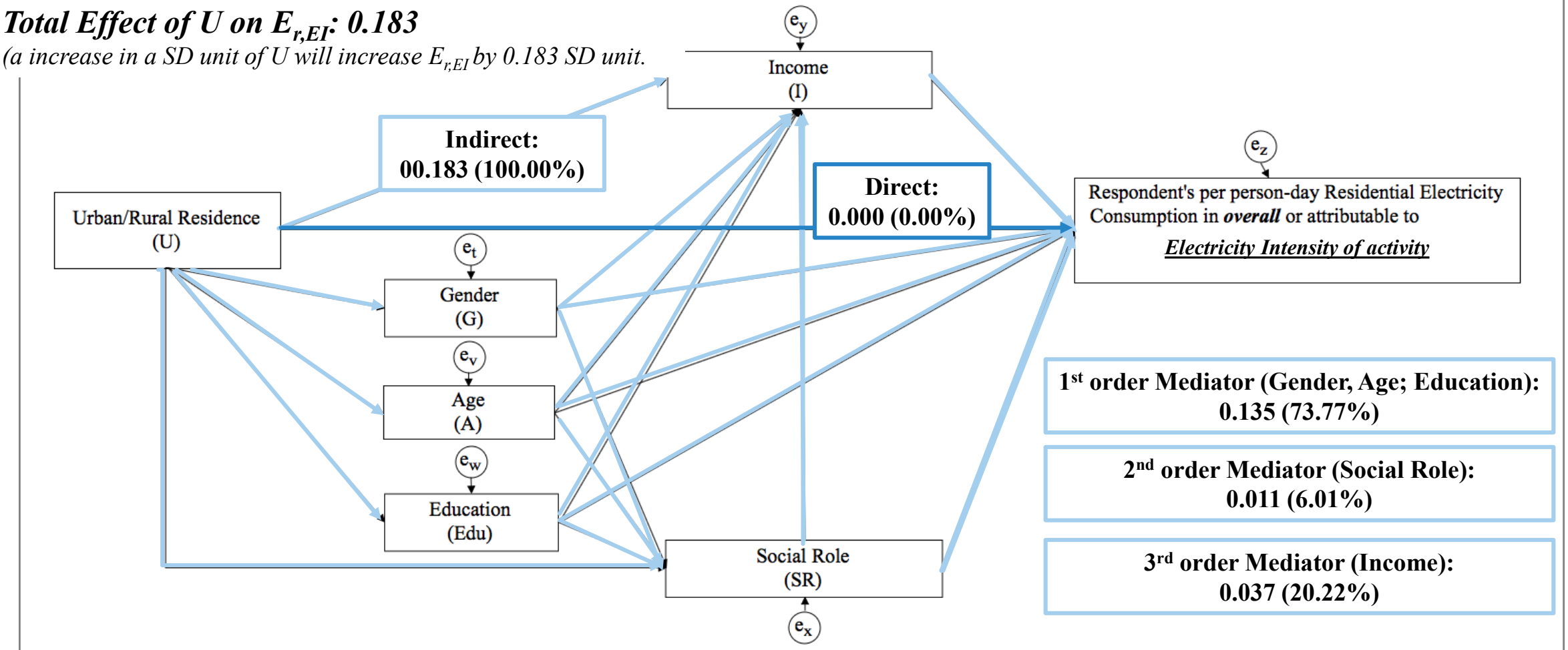


Quantifying the impacts on residential electricity consumption induced by lifestyle differences in urbanizing China

Disaggregate level analysis: **Impacts of U on $E_{r,EI\ is}$ is fully mediated by socio-demographic factors**

Total Effect of U on $E_{r,EI}$: 0.183

(a increase in a SD unit of U will increase $E_{r,EI}$ by 0.183 SD unit.

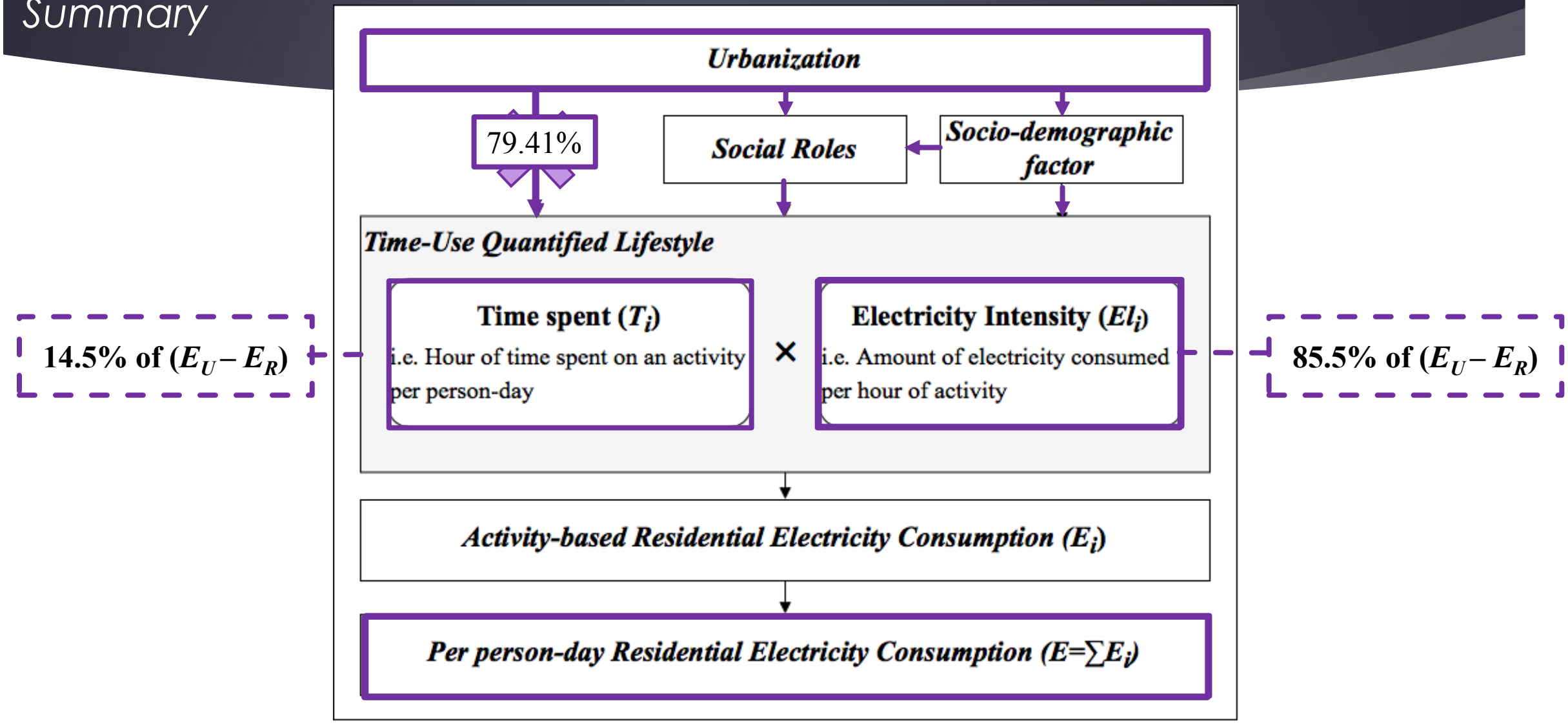


Chapter 6

- *Conclusion & Discussion*

Conclusion

Summary



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