Energy service demand in Japan's household sector

The 21th AIM international workshop @ NIES

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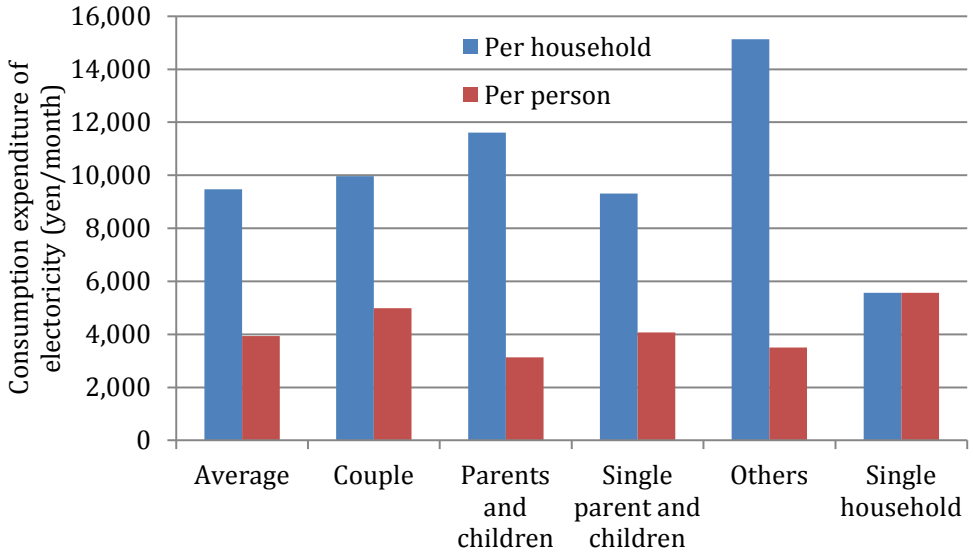
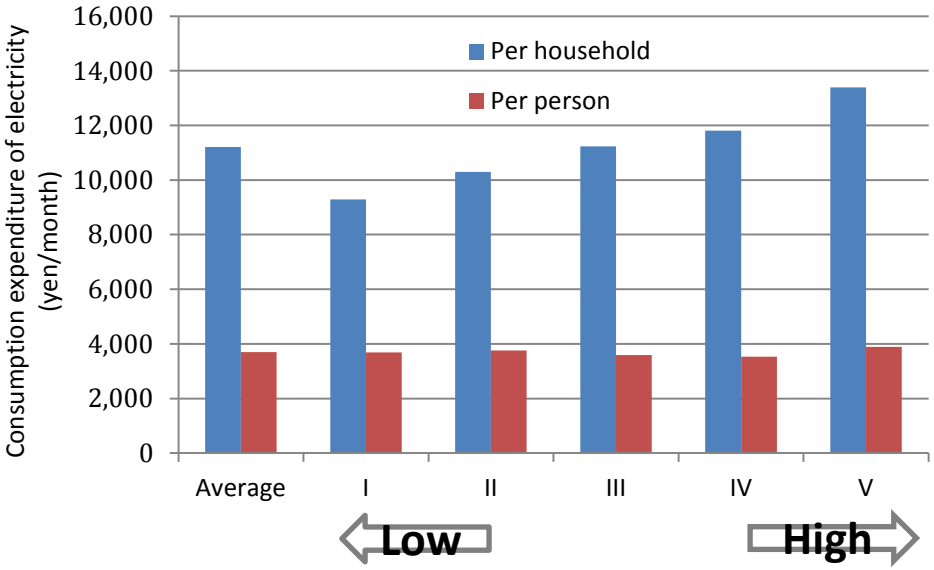
Characteristics of Japan's household sector energy consumption



By household type (All household)



By household income (Two or more person household)

※Family income and expenditure survey

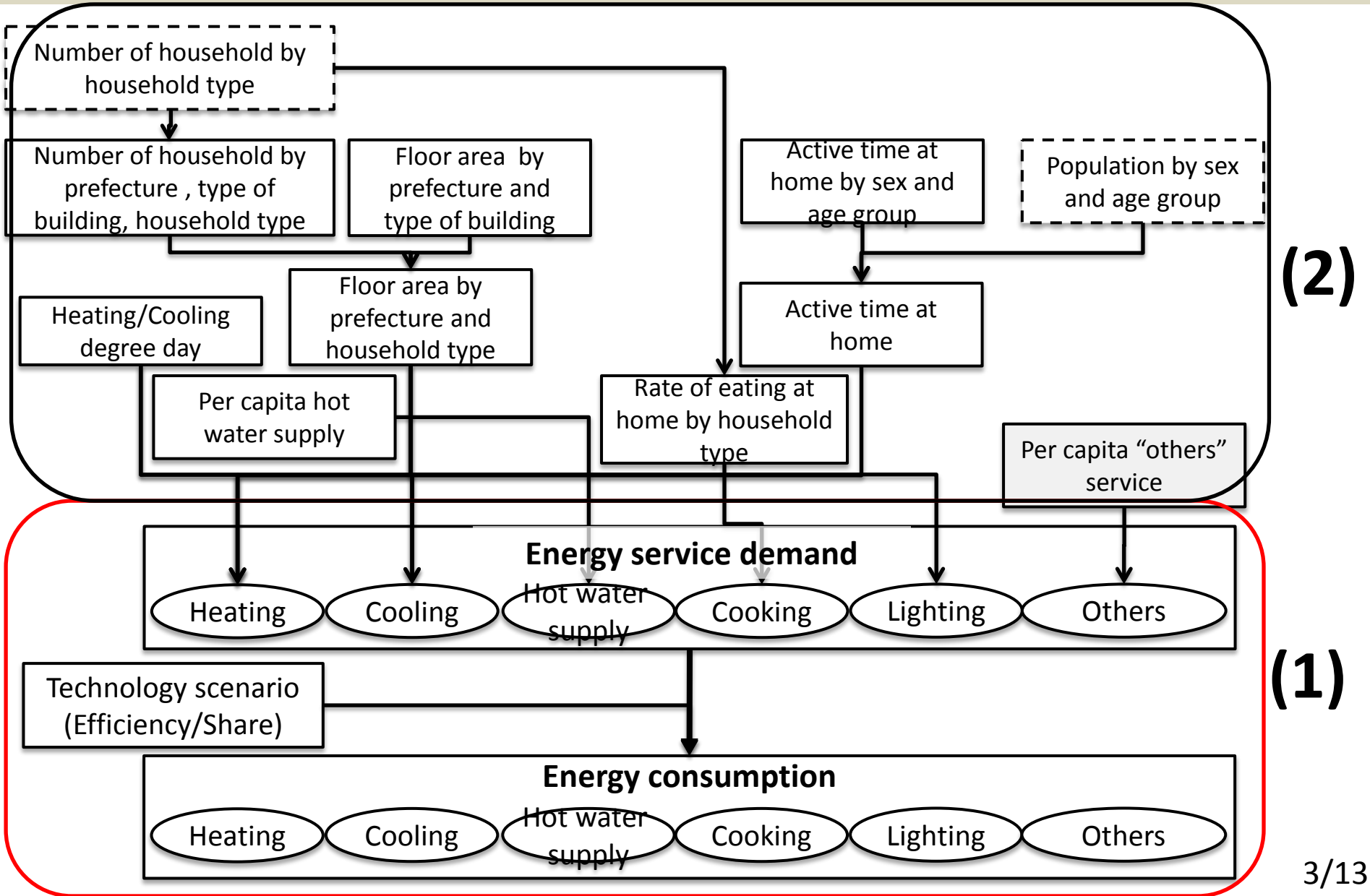
- Various factors are associated with energy consumption in household sector.
  - Household type, income level, number of household members, climate and building type etc.

Outline of estimation

- **Aim of the research**
  - Develop model to estimate energy service and consumption in household sector considering household characteristics.

- Target area: Japan
- Target year: 2035 (Base year: 2010)
- Energy: Electricity, gas, heat
- Energy service: 6 type (Heating, cooling, hot water supply, cooking, lighting, others)

Estimation flow



Estimation method (1)

- Relationship between energy consumption and energy service

Energy service demand

Device share

$$\sum_{k \in SK(s)} cnv_r^{s,k} = 1$$

$$E_r^l = \sum_k E_r^{k,l} = \sum_s \left(D_r^s \cdot \sum_{k \in SK(s)} cnv_r^{s,k} \cdot ef_r^{k,l} \right)$$

Energy consumption

Device efficiency

$$ef_r^{k,l} = E_r^{k,l} \Big/ D_r^{k,l}$$

Estimation method (2)

- Energy service demand

Energy **service demand** =

Energy service **size** × Energy service **time** × Energy service **intensity**

Energy service	Size	Time	Intensity
Heating	Floor area	Active time at home	Heating degree day Heating temperature
Cooling	Floor area	Active time at home	Cooling degree day Cooling temperature
Hot water supply	Hot water supply per capita	Number of hot water use	Hot water temperature
Cooking	Size of meal	Rate of in-home dining	Power of stove
Lighting	Floor area	Active time at home	Illumination intensity
Others	GDP per capita		

* Gray factors are not considered in this research.

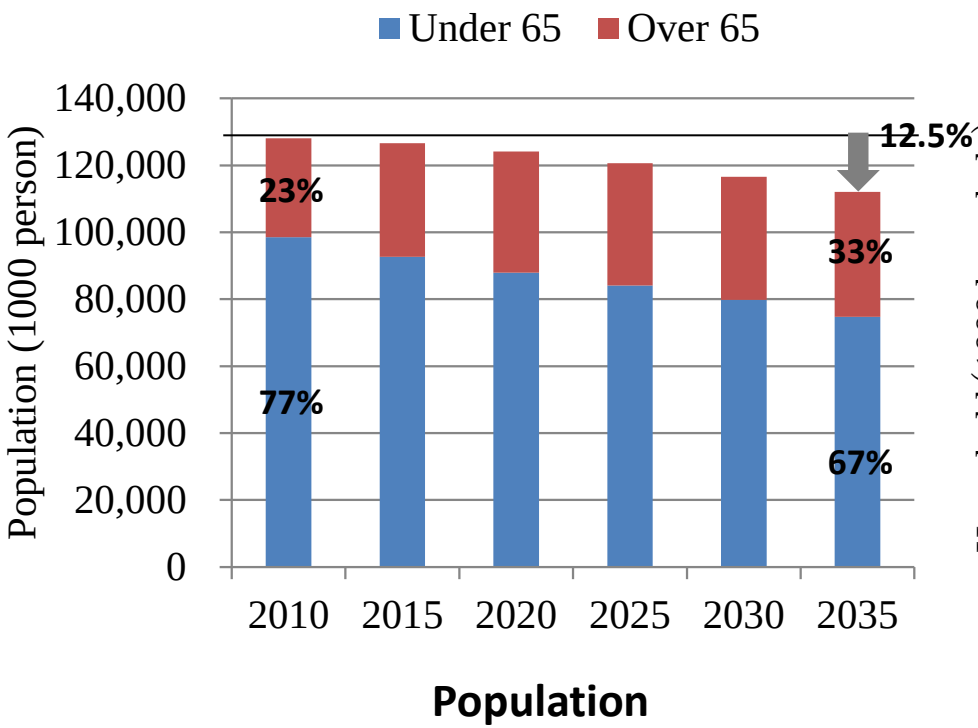
Social economic scenario (1)

- Population and number of household (1)
- Floor area(2)
- Active time at home(1)
- Rate of eating at home(1)
- Hot water supply per capita (2)

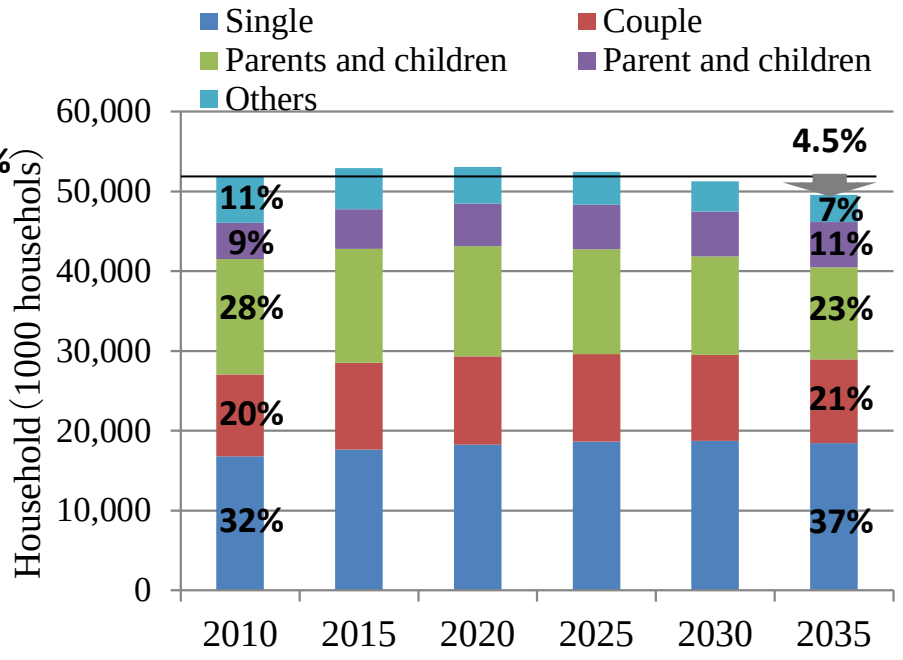
(*) : * shows number of case

Socio economic scenario (2)

- **Population, number of household**



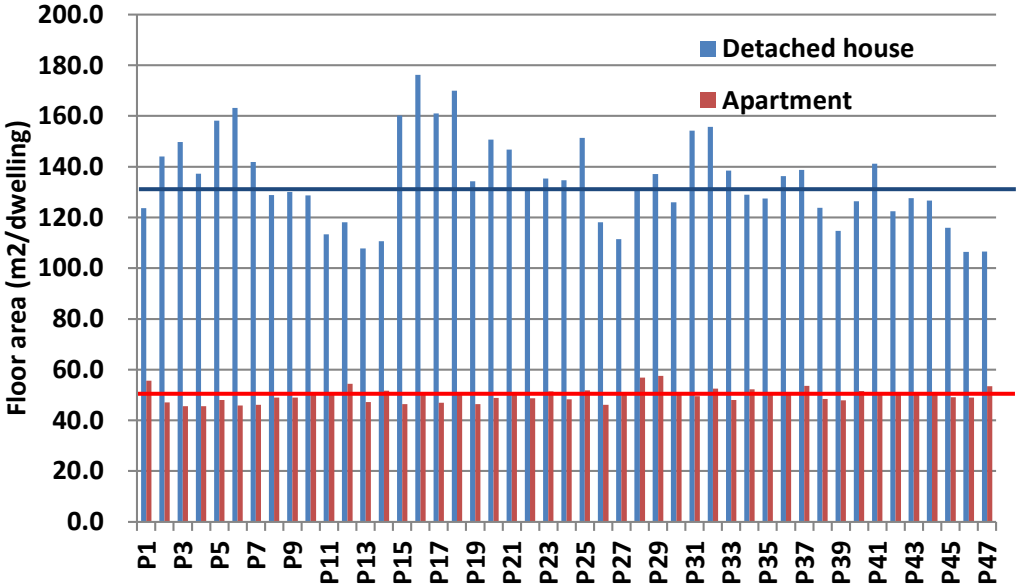
Population



Number of household

※National institute of population and social security research

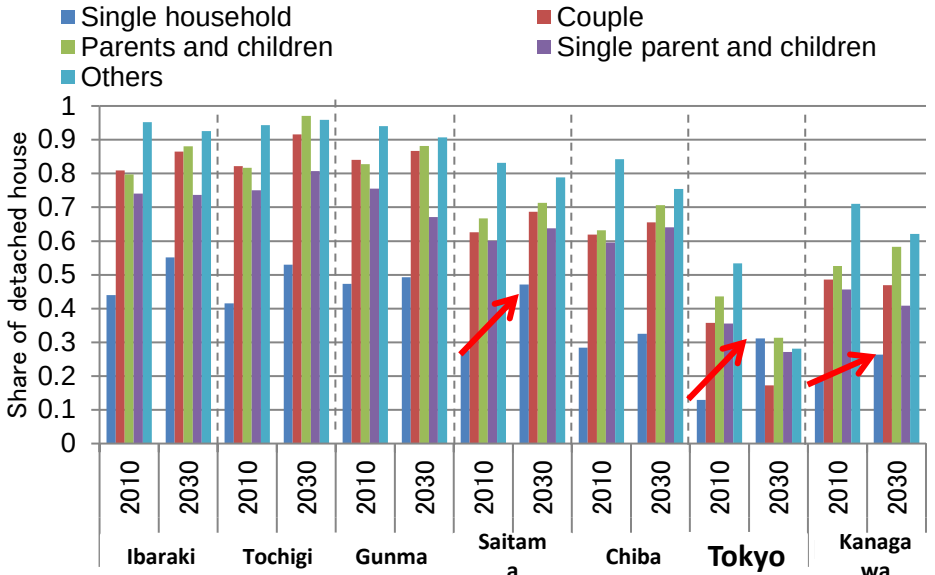
Socio economic scenario (2)



- **Floor area by building type and prefecture**
  - There are big differences about average floor area among prefecture.
  - Average floor area of detached house in Tokyo is about 110 m²

- **Share of building type:**
  - BaU: Keep change rate of the share in 2008-2013 by prefecture, household type and building type
  - LCS: Keep share of detached house at 2008 level

  ⇒A certain number of aged person will move from detached house to collective house



Socio economic scenario(3)

- **Rate of home-meal replacement and eating outside**

	Home-meal replacement	Eating outside
Single male household over 65	16.1	23.7
Single female household over 65	12.4	13.2
Others	12.3	19.1

※Family income and expenditure survey, Japan statistics bureau

- **Active time at home（Unit: min/week）** **※1 week=10080 min**

	10-19	20-29	30-39	40-49	50-59	60-69	Over 70
Male	2685	2437	2356	2321	2660	3631	4676
Female	2726	3002	3791	4090	4311	4768	5183

■ Aged people stay at home for a long time.

※National time use survey (NHK Broadcasting Culture Research Institute)

- **Per capita hot water supply**

■ Water use of shower per capita will decrease. (Water-saving shower will become popular and people will try to decrease 10% of water use.

Technology scenario

- Energy efficiency of device… (1) Efficiency in 2035 was set and (2) linear interpolation using 2010 and 2035 data
  - **AC**：Unit energy consumption of device will be **2/3 compared with 2010** level
  - **Gas and oil devices** ： Unit energy consumption of device will be **90% compared with 2010** level.
  - **Lighting and other devices**: Unit energy consumption of device will keep 2010 level

- Share of device…Electrification and shift to energy efficient device.
  - Heating: Share of air conditioner will increase by about 30%
  - Hot water supply: Share of hear pump water heater will increase by about 20%
  - Cooking: Share of electric cooking stove will increase by about 15%

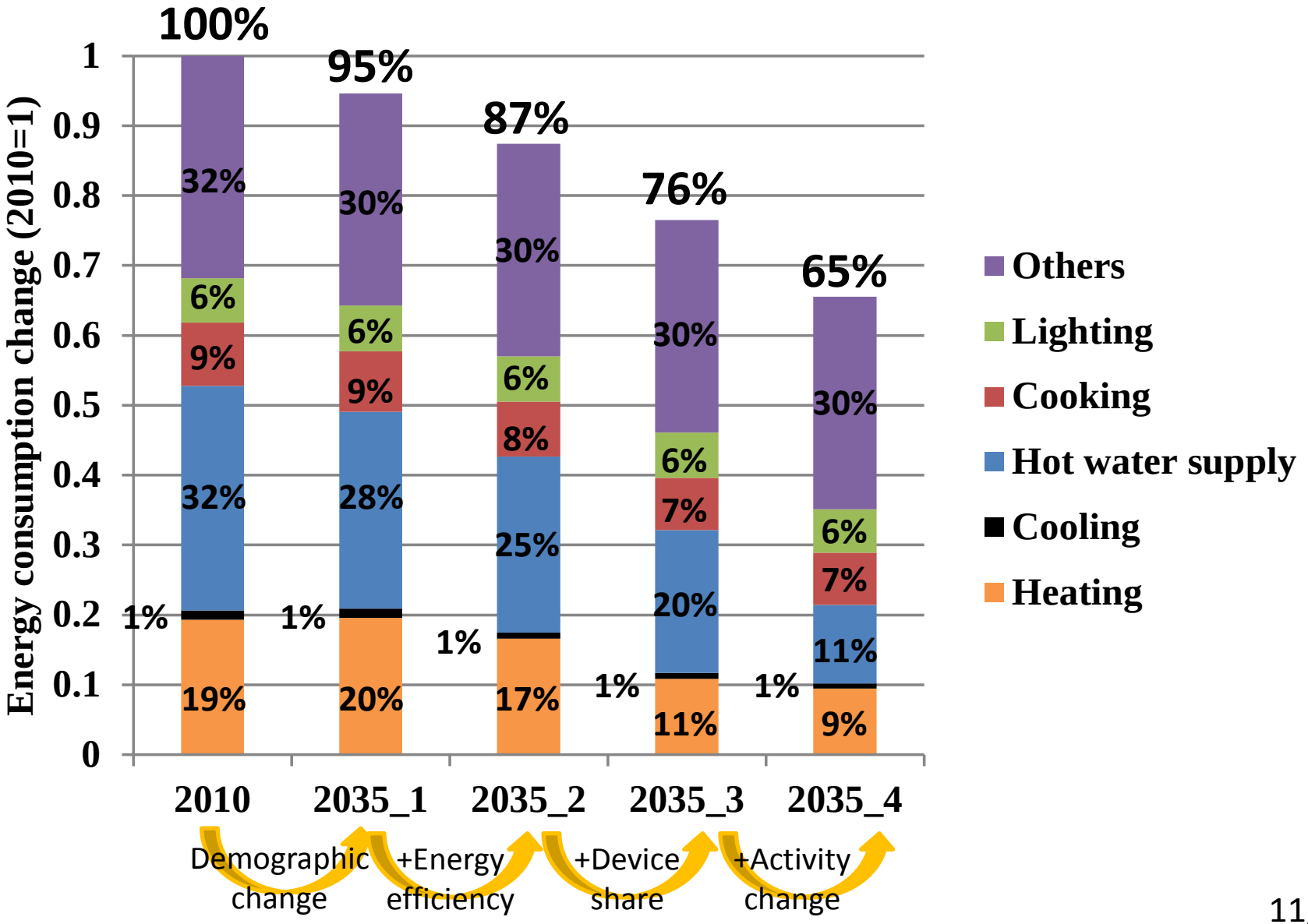
Estimation scenario

- Based on technology scenario and socio economic scenario, 4 estimation scenario are set.

	Energy efficiency	Device share	Lifestyle change
Case 1	×	×	×
Case 2	○	×	×
Case 3	○	○	×
Case 4	○	○	○

Only population and household composition change are considered.

Result: Energy consumption by service



Future tasks

- (1) How to estimate “Others energy service” appropriately?
  - “Others” includes various kind of devices such as refrigerator, TV …
  - All kind of devices have different penetration level, energy efficiency improvement speed.
- (2) How to estimate aged people’s energy consuming activity?
  - Lower device replacement demand
  - Time allocation / Share of consumption expenditure

Thank you for your attention !

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