

23rd APEC Workshop on Energy Statistics

An Overview of the Japanese Household CO₂ Emission Survey

*official name: Survey on Actual Conditions of CO₂ Emissions from the Household Sector

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Background: Trends in energy consumption in the residential sector of Japan

- Energy consumption in the residential sector was on the rise until the mid-2000s, but has been on a downward trend since then, especially since 2011.
 - The number of households has been steadily increasing, that is why the energy consumption per household has been on a downward trend since the mid-1990s, and in 2023, it is 74% of the 1990 level (a 23% decrease compared to 2013).
- ⇒ To promote effective energy conservation, it is essential to comprehend not only the total consumption but also its detailed structure.

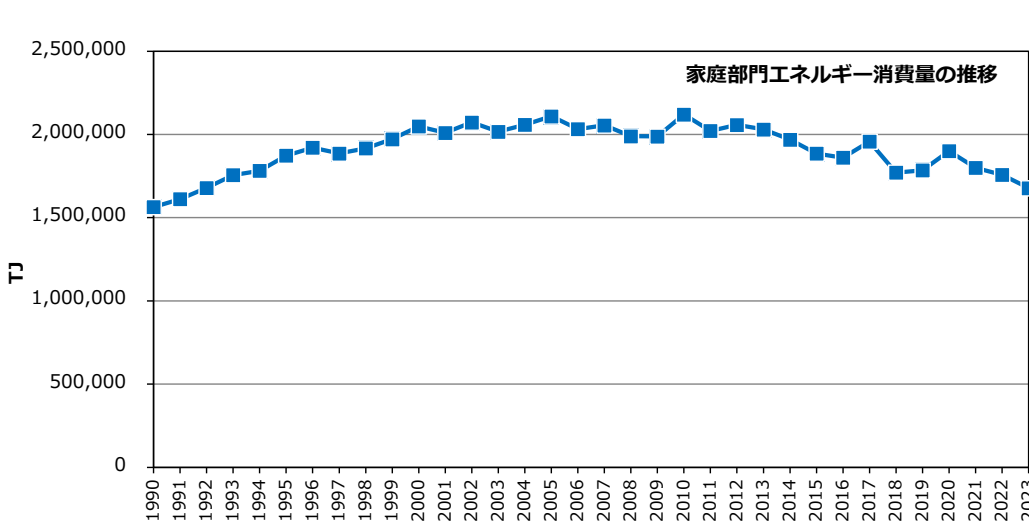


Figure : Trends in the energy consumption in the residential sector (1990-2023)

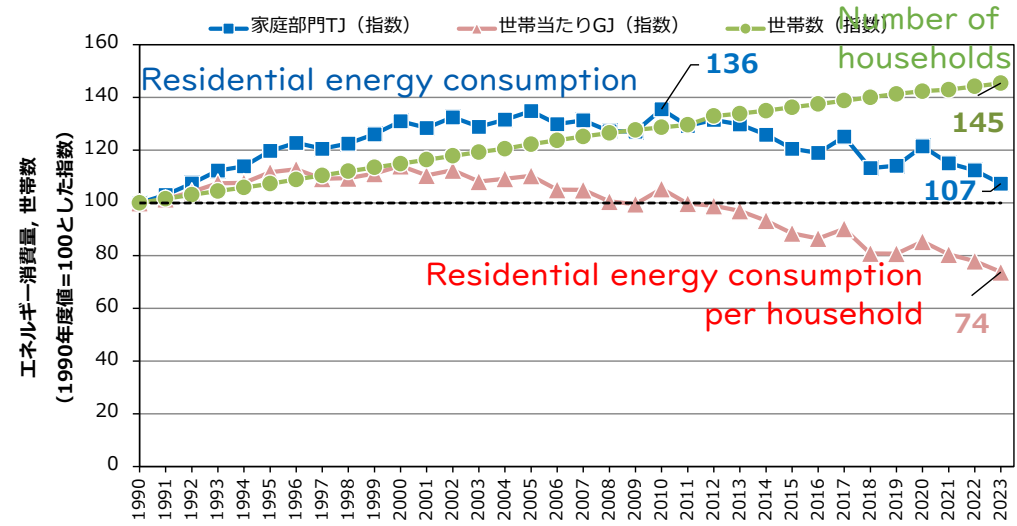


Figure : Trends in the energy consumption per household and number of households
* Index based on 1990 value=100 (1990-2023)

(Source 1) Agency for Natural Resources and Energy, Comprehensive Energy Statistics (2025)

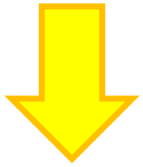
(Source 2) Ministry of Internal Affairs and Communications, Population, Population Dynamics and Number of Households Based on the Basic Resident Register (2025)

Concept of “Household CO₂ Emission Survey (HCES)”

Official name: Survey on Actual Conditions of CO₂ Emissions from the Household Sector



- Previously, comprehending household energy consumption required integrating data from multiple sources.
- Many assumptions and estimations are required.



- To accurately capture the structure of energy consumption, it is necessary to collect all relevant items in a single survey and build a comprehensive database.

Organizer:

- Decarbonized Society Promotion Office, Global Environment Bureau, Ministry of the Environment, Japan

Implementers:

- Intage, Inc. (research company)
- Jyukankyo Research Institute, Inc.

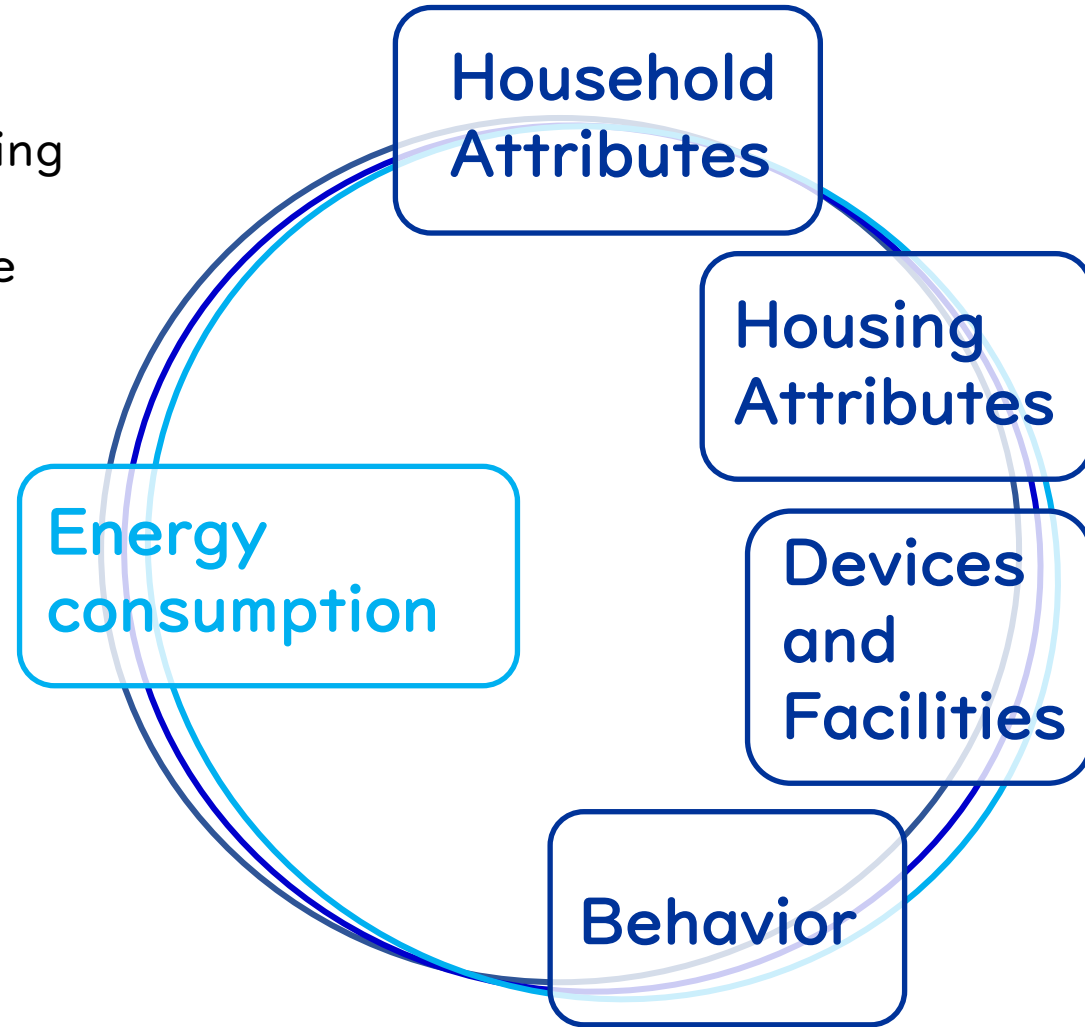
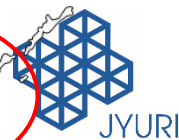


Figure: The information required to comprehend the residential energy consumption structure

History of the HCES

Hokkaido



Period (FY)

Implementation details

2010-2011

Preliminary study

2012 to 2013

Trial survey #1

Survey areas : Hokkaido and Kanto-Koshin

Survey method : Internet monitor survey (IM survey)

Survey size : Approximately 3,000 households

2014-2015

Trial survey #2

Survey areas : 10 regions nationwide (Hokkaido, Tohoku, Kanto-Koshin, Hokuriku, Tokai, Kinki, Chugoku, Shikoku, Kyushu, and Okinawa)

Survey method : A combination of random sampling survey and online panel survey
(When compiling the results, the data from both surveys were integrated on a 1:1 basis)

Survey size : 16,400 households

2016

Publication of results of trial survey #2,
and preparation for full survey.

2017 ~

Full survey

Survey areas : 10 regions nationwide (Hokkaido, Tohoku, Kanto-Koshin, Hokuriku, Tokai, Kinki, Chugoku, Shikoku, Kyushu, and Okinawa)

Survey method : A combination of investigator surveys and IM surveys
(When compiling the results, the data from both surveys were integrated on a 1:1 basis)

Survey size : 13,000 households

* No survey was conducted in FY2024. From FY2025 onwards, the survey will be conducted every other year.

Overview of the HCES



Survey methodology	<p><u>(1) Random Sampling Survey (RSS)</u>: Conducted with randomly selected households from the Basic Resident Register.</p> <p><u>(2) Online Panel Survey (OPS)</u>: Conducted with respondents recruited from a commercial internet panel.</p>
Survey subjects	<p>Households living in homes</p> <p>* Student dormitories and boarding houses are excluded.</p>
Survey period	<p>April to March of the following year</p> <p>* Survey is conducted continuously over 12 months.</p>
Number of households surveyed	<p>(1) RSS : 6,500 households</p> <p>(2) OPS : 6,500 households</p> <p>* 13,000 households in total</p>
Survey items	<ul style="list-style-type: none">• Monthly energy consumption and payment amounts (electricity, gas, kerosene, gasoline, and diesel)• Monthly solar power generation, electricity sold, and revenue from power sales• Attributes (household attributes, housing attributes, equipment usage, vehicle usage, energy-saving behavior, etc.)

Number of households surveyed (FY2023)

City Class I: Prefectural capitals and ordinance-designated cities

City Class II: Cities with a population of 50,000 or more

City Class III: Cities and towns with a population of less than 50,000

Area	City Class I	City Class II	City Class III	Total
Hokkaido	441	398	280	1,119
Tohoku	391	479	320	1,190
Kanto-Koshin	1,009	1,032	167	2,208
Hokuriku	441	398	248	1,087
Tokai	439	723	167	1,329
Kinki	608	764	125	1,497
Chugoku	430	517	231	1,178
Shikoku	472	248	355	1,075
Kyusyu	598	395	318	1,311
Okinawa	239	489	278	1,006
Total	5,068	5,443	2,489	13,000

Main survey items of the HCES

Household attributes

- Number of people in household
- Employment status (including the status of telework implementation)
- Weekday daytime presence at home
- Household income per year

Housing attributes

- Housing type (detached house or apartment)
- Structure (wooden or non-wooden)
- Whether or not renovation work is being carried out
- Ownership (owner, rental, public corporation, etc.)
- Year of construction
- Total floor area

Equipment usage status, etc.

- Types of heating, cooling, hot water, kitchen stoves, and lighting used and frequency of use
- Usage status of HEMS, battery storage, cogeneration system, and snow-melting system
- The type and number of vehicles used
- Public Transportation Usage
- The types and number of home appliances used
- Status of Energy-Saving Actions and Reasons for Implementing Energy-Saving Actions

etc...

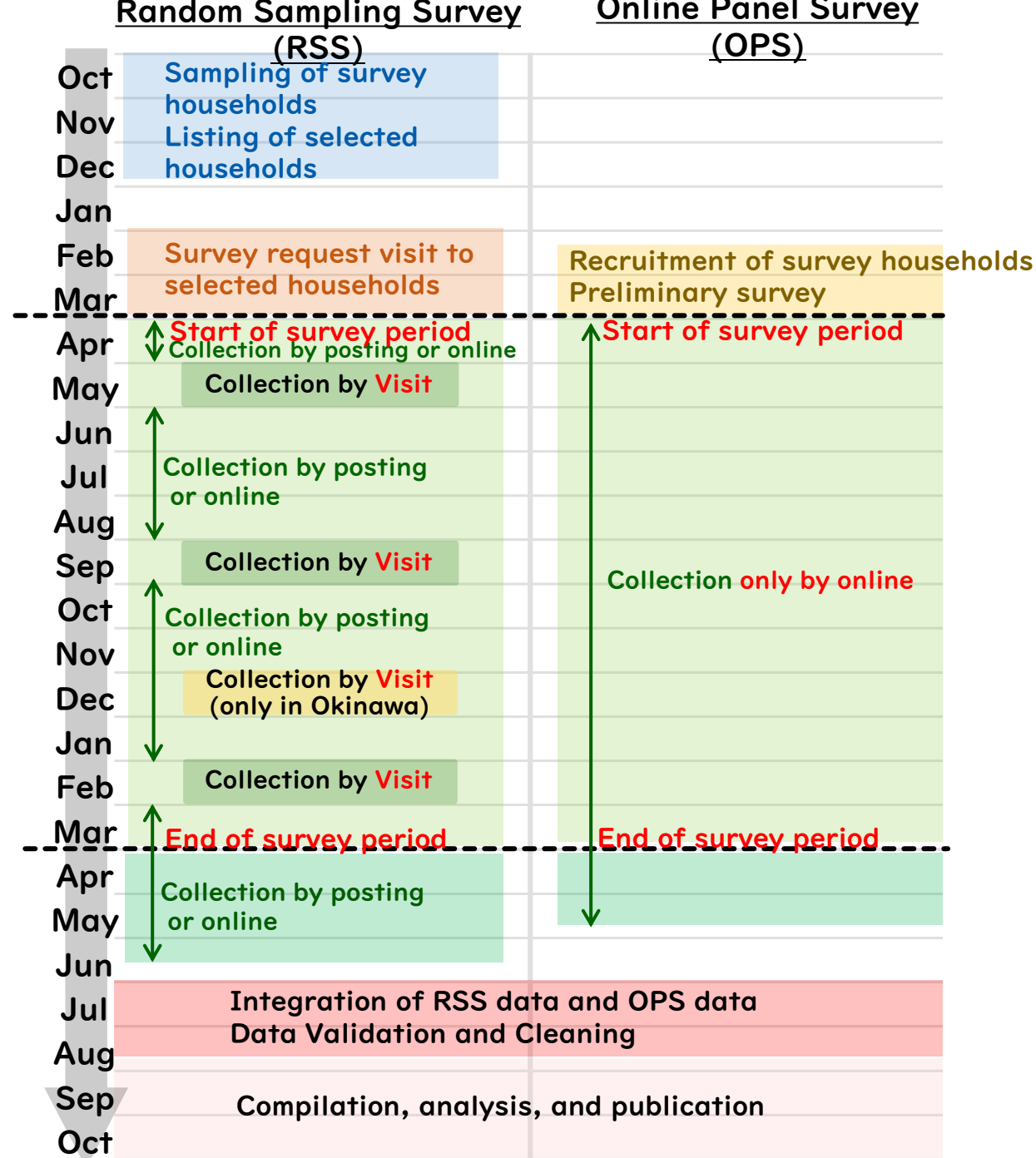


Energy, CO₂ and Payment amounts

- Annual consumption of **electricity, natural gas, LP gas, kerosene, gasoline, and diesel**, along with the corresponding CO₂ emissions, and payment amounts
- **solar power** generation, power sales, and sales amounts
- Estimated annual energy consumption and CO₂ emissions by use (**room heating, room cooling, hot water supply, cooking, lighting, and appliances**)

For details, please see the questionnaire.

Process of the HCES



Data validation and cleaning

Due to the frequency and complexity of the HCES, the burden on participating households is considerable.

- **Inconsistencies** between questions or between questionnaires
- Responses with **low plausibility**.

ex) Some households report “using gas appliances” with providing no data on their gas consumption.

Review the collected survey data and, when necessary, **exclude or correct problematic entries**

Compiling all valid data

Data on 12 months of energy consumption and payment amounts is prone to **containing uncertain values or missing values**.

Appropriate **imputation** methods for missing or uncertain values have been developed and implemented.

Number of validly responding households (FY2023)



Area	City Class I	City Class II	City Class III	Total
Hokkaido	333	322	204	859
Tohoku	282	369	242	893
Kanto-Koshin	721	721	124	1,566
Hokuriku	332	281	193	806
Tokai	303	511	120	934
Kinki	431	518	78	1,027
Chugoku	330	379	181	890
Shikoku	362	171	258	791
Kyusyu	409	270	221	900
Okinawa	160	297	168	625
Total	3,663	3,839	1,789	9,291

*** Valid response rate: 71.5 %**
(= 9,291 / 13,000)

Current issues

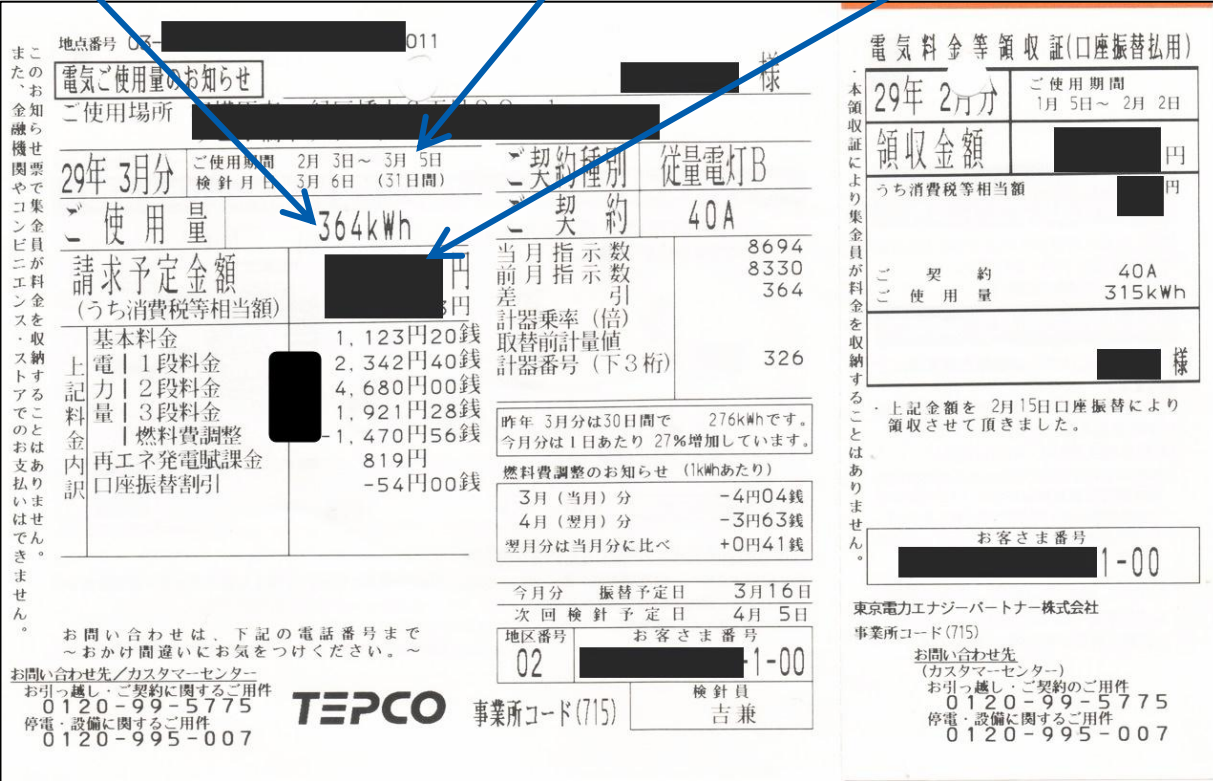
Previously, as for electricity and gas, paper bills were sent monthly, which contain monthly energy consumption and payment amounts.

With the spread of smart meters, paper bills have been phased out.

Consumers now need to log in to a website in order to obtain information regarding consumption and payment.

A certain number of people are unable to adapt to this change, which leads to a decline in the responding rate.

Electricity consumption Consumption period Payment amounts



請求予定金額 (うち消費税等相当額)	円
基本料金	1,123円20銭
電力1段階料金	2,342円40銭
電力2段階料金	4,680円00銭
電力3段階料金	1,921円28銭
燃料費調整	-1,470円56銭
再エネ発電賦課金	819円
口座振替割引	-54円00銭

3月(当月)分	-4円04銭
4月(翌月)分	-3円63銭
翌月分は当月分比	+0円41銭

電気料金等領収証(口座振替払用)
29年2月分 ご使用期間 1月5日~2月2日
領収金額 円
うち消費税等相当額 円
契約 40A
使用量 315kWh
お客さま番号 1-00
東京電力エナジーパートナー株式会社
事業所コード(715)
お問い合わせ先
(カスタマーセンター)
お引越し・ご契約のご用件
0120-99-5775
停電・設備に関するご用件
0120-995-007



Official HCES website (only in Japanese)

<https://www.env.go.jp/earth/ondanka/ghg/kateiCO2tokei.html>

Thank you for your attention.

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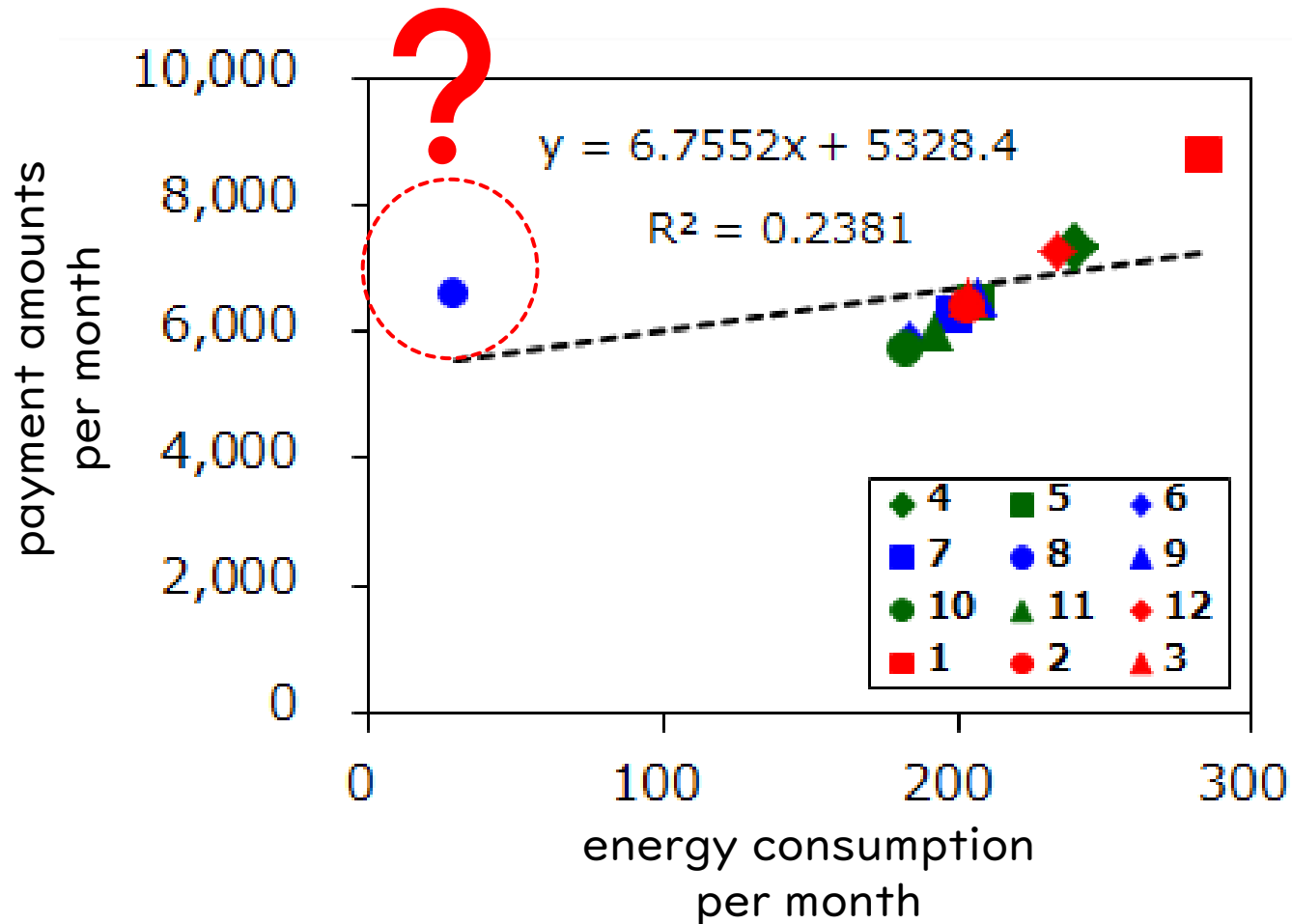
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appendix

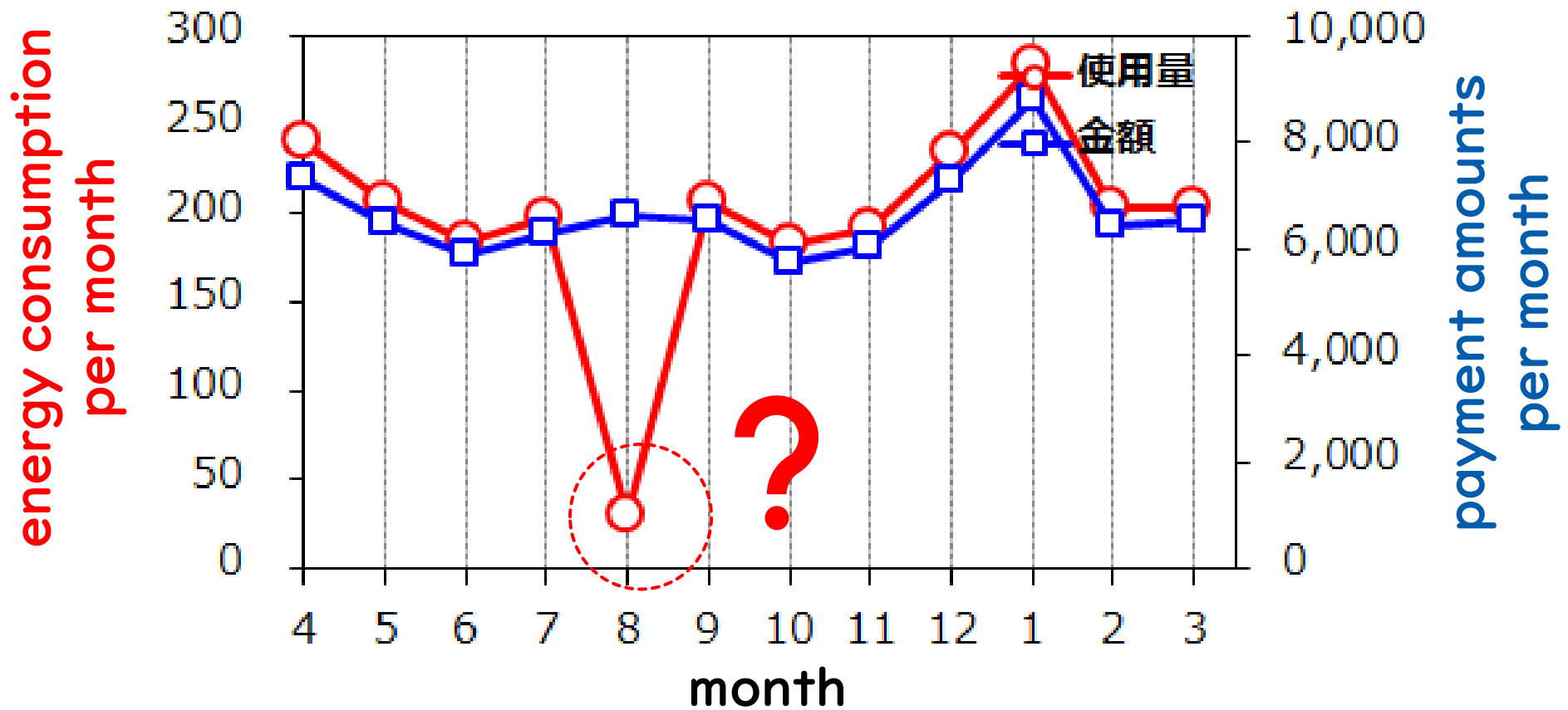
Examples of uncertain data (I)

Are there any outliers in the energy unit prices?
Is the correlation between amount and usage reasonable?



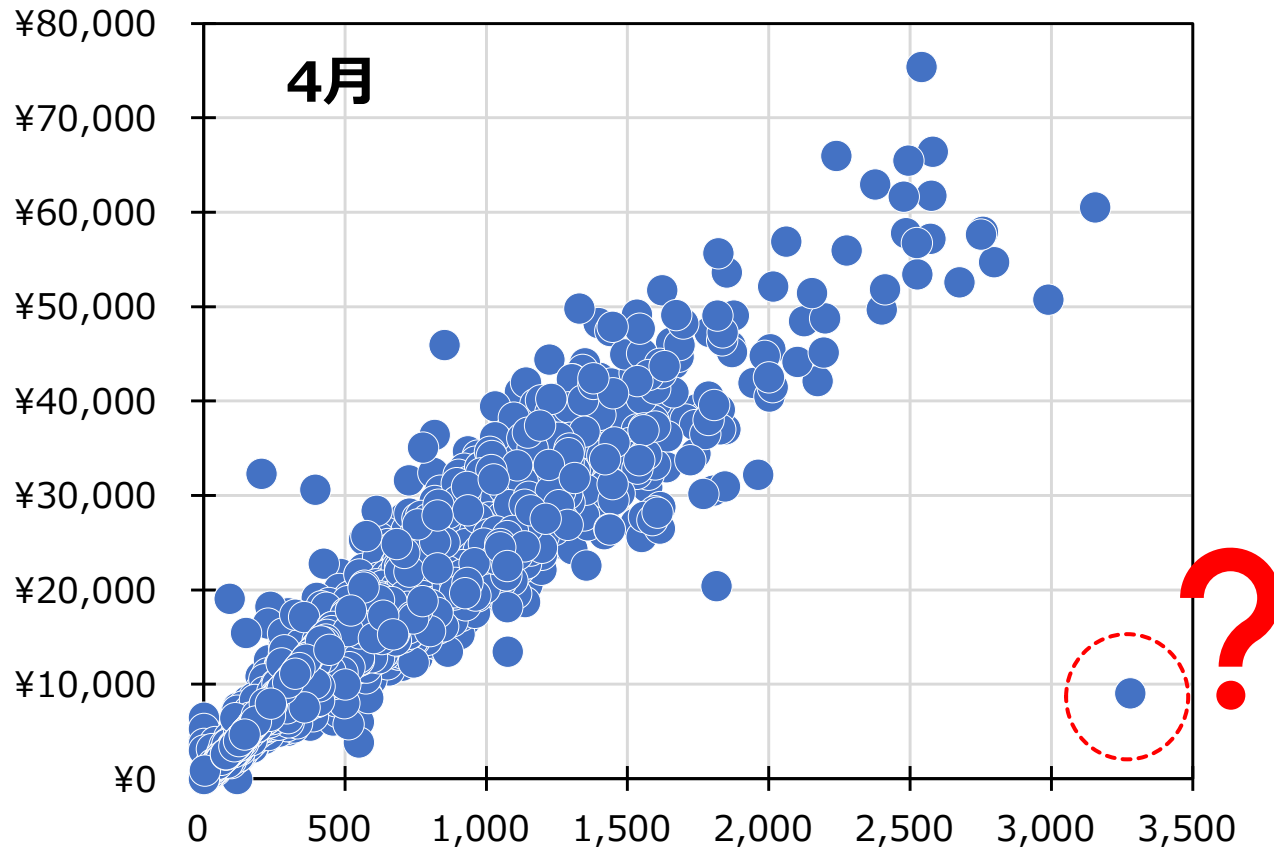
Examples of uncertain data (2)

Are there any outliers in the energy unit prices?
Is the correlation between amount and usage reasonable?

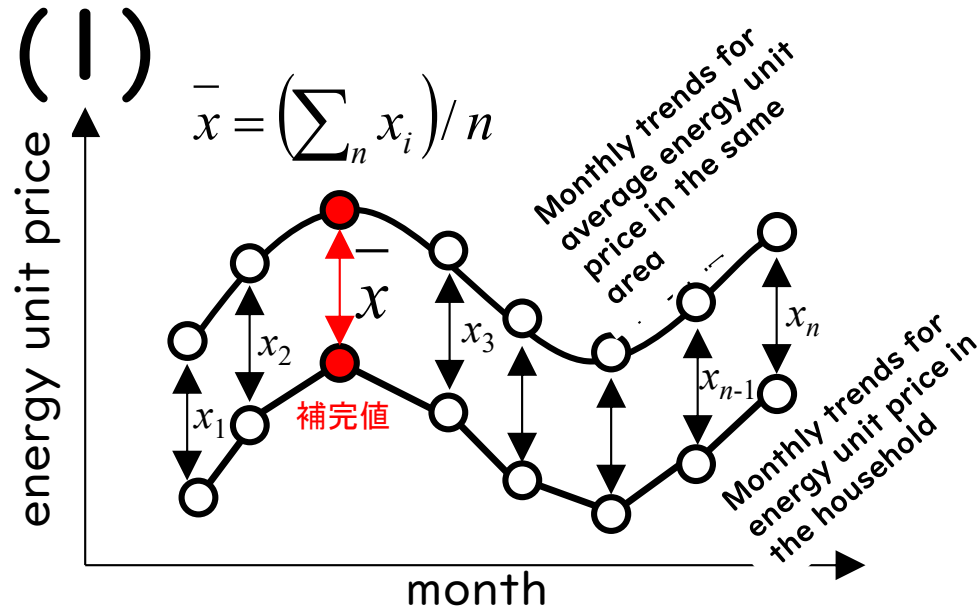


Examples of uncertain data (3)

Are there any outliers in the energy unit prices?
Is the correlation between amount and usage reasonable?



Imputation methods



- (1) Method using regional average unit prices
- (2) Method using regression equation for gas consumption and payment amount in the household
- (3) Method using trends in the most similar households

