



# Presentation on data collection methods and modelling: HOUSEHOLDS

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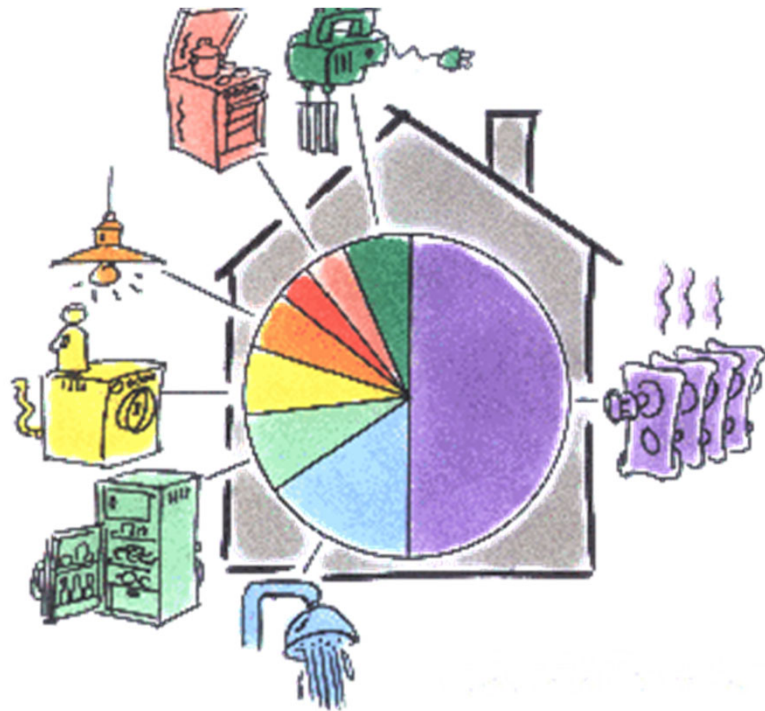
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# Content

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1. Introduction
2. Data collection concept
3. Modelling concept and model example
4. Conclusions



# Introduction

STARTING POINTS, DATA SOURCES  
(SURVEYS), MODELLING  
TECHNIQUES

# Baseline

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- IEA, UNSD, EC EUROSTAT, IAEA and other organisations cooperate jointly to improve and harmonise data and indicators on energy consumption in households;
- **The key indicators in households:** total energy consumption, energy consumption by end-uses: **space heating, space cooling, cooking, water heating, lighting and electrical appliances (total and by selected appliances);**
- The requirements for new indicators are constantly increasing due to the changes in energy production and consumption pattern.

# Key data sources for estimating EEI

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- Energy Balance;
- National Statistics: Census on population and households; Statistics on buildings; Regular National Statistical Surveys: Household Budget Survey, Living Standard Measurement Survey; Surveys on annual energy consumption; Comprehensive periodical surveys on energy consumption for modelling end-use consumption, etc.
- Administrative data, Reports from energy utilities; Metering & Scientific researches and publications; Other

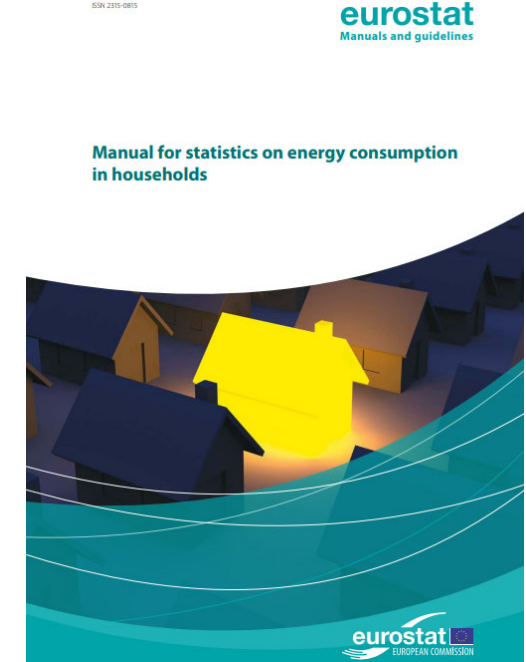
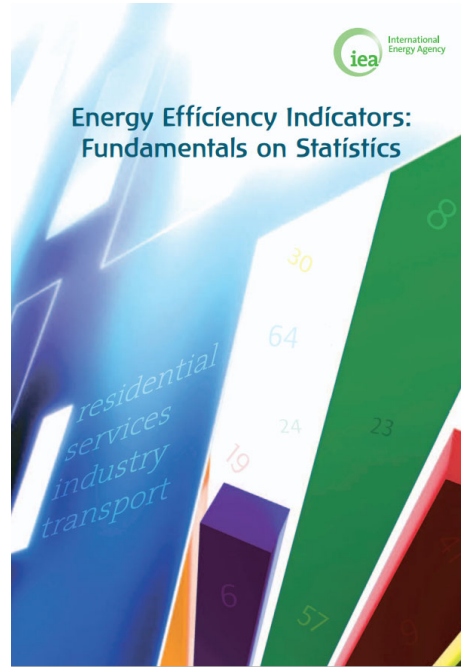
Comprehensive surveys on energy consumption are still the most widely used source for end-use consumption modelling.

# The overall aims and goal of surveys

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- Improvement of the data on final energy consumption **for energy balance compilation**;
- Assessment of energy consumption on **local/regional levels** (not only at national level);
- Development of the **end-use energy consumption, energy (efficiency) indicators**; monitoring and evaluation of energy policies; etc.
- **Energy demand forecasting**; short, mid and long-term
- Analysis of the costs for energy and **fuel poverty** in households, international comparisons, etc.

Each target above requires specific data and modelling techniques!



Supporting manuals and recommendations  
- International Energy Agency & EUROSTAT



# Surveying concept

1. SIMPLE SURVEYS FOR ENERGY  
BALANCE

2. COMPLEX SURVEYS FOR  
DISAGGREGATION ON ENERGY  
END-USES



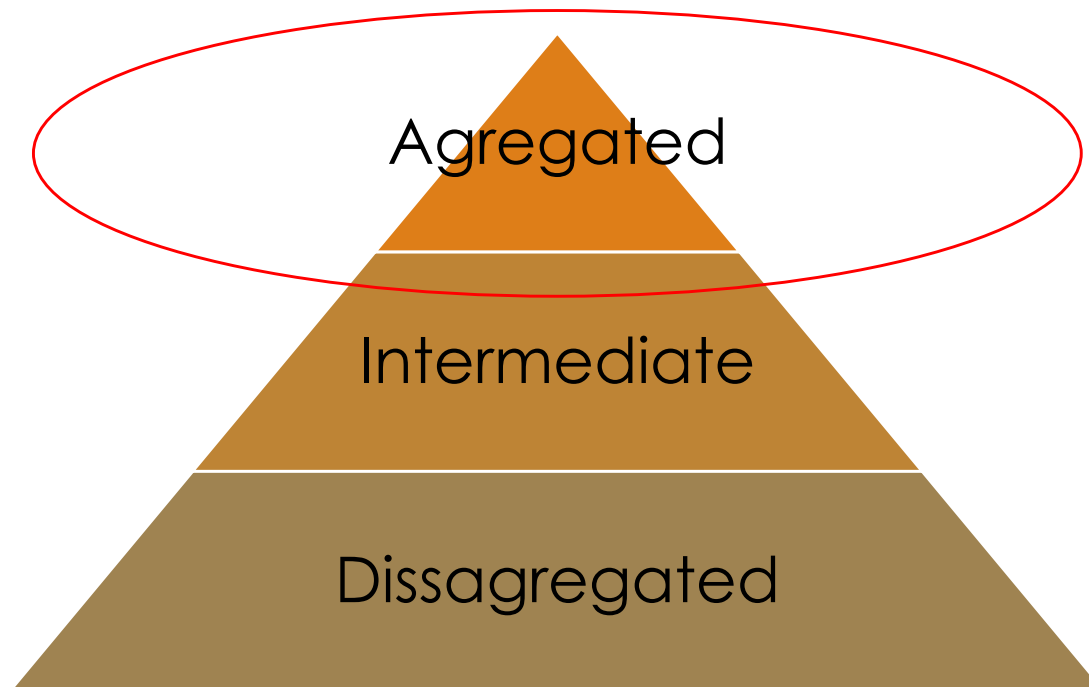
# The annual „simple” survey

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- The main aim: identification of **total annual fuel consumption in households of all energy forms**;
- The main goal: **improvement of national energy balance accuracy and all estimates which are derived from energy balance**
- Simple statistical procedure requested; can be merged with regular researches in households in National Statistics Institutes (Household Budget Survey, Living Standard Measurement Survey, Consumption in Households, ....)
  - „time and costs efficient survey”; can be implemented every 1-5 years

# The purpose of simple survey

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# Questionnaire in simple survey

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## Only one question/table:

- Annual consumption in quantities and related costs\* of following forms:
  - Electricity (kWh)
  - Natural gas (m<sup>3</sup>)
  - Heat from district heating (TJ, kcal or kWh)
  - Liquid petroleum gas (kg); Light fuel oil (lit), Fuel oil (kg)
  - Coal (t), Coal brickets, (kg), Charcoal (kg)
  - Fuel wood (m<sup>3</sup>), Wood residues (m<sup>3</sup> or kg), Pellets, brickets (kg), Manure (kg)
  - Solar heat use (m<sup>2</sup> or kW); Solar PV (m<sup>2</sup> or kW);
  - Other
- Warning\*: Some energy costs do not reflect real consumption (e.g. fuel wood)
- Question 1. How many participants know their monhly/annual energy/fuel consumption?
- Question 2. Any experience in collecting data on fuel wood consumption, problems?

# Interviewers & Manuals

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Example, LPG – Liquefied Petroleum Gas

- Definition – different from natural gas
- Distribution: **bottles/cylinders (2,5,10,15... kg) and in tanks (1750, 2700 i 4850 lit)**



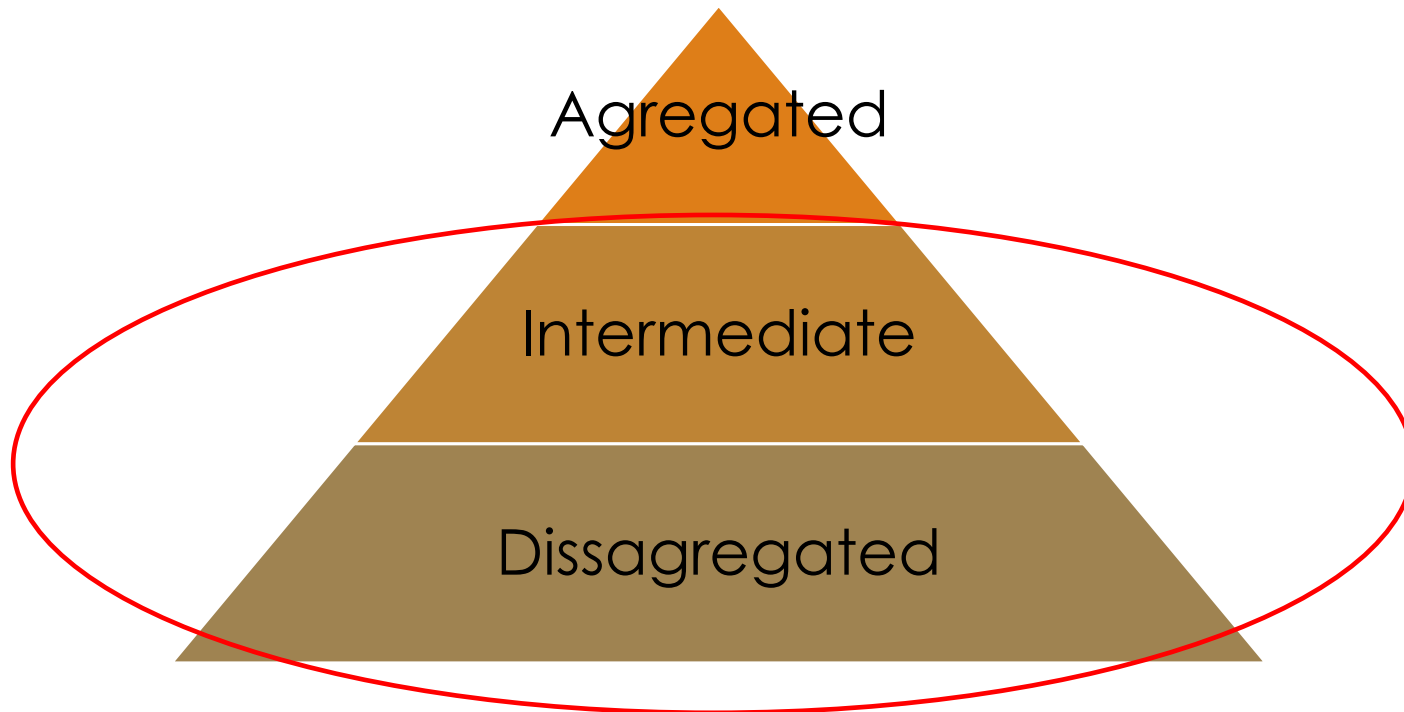
# The purpose of the complex survey

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- The aim and purpose: to collect **ACTIVITY data** for different end-uses by type of equipment and energy use but also data for estimating **SPECIFIC CONSUPTION PER END-USE**;
- Reference period: calendar year
- Target population: primary occupied dwellings (not vacant dwellings)
- Sample size: Canada – 6.500 buildings, Austria -16.000, Spain – 10.000,

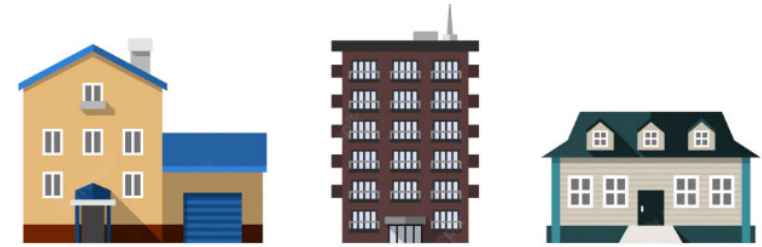
# The purpose of complex surveys

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# Questionnaire design (1/6)

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## 1. General information on the household:

- Gender of respondent, [household size](#), age of household members, living status
- This data can be compared with data from Census

## 2. Information on dwelling

- [Type of dwelling](#): house, semi-detached house, multifamily building, ....
- Year of construction and year of renovation
- [Floor area, m<sup>2</sup>](#)
- Building materials, windows performances, roof performance ....

# Questionnaire design (2/6)

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## 3. Activity data on space heating

- **Type of heating in dwelling:** not heated, individual heating units, central heating using own boiler, district heating, “split” systems, .....
- **Main and alternative source for central heating/individual heating units**
- Age of boiler/heaters used for central heating
- **Installed capacity of “split” systems**, energy efficiency (according to the product specifications)
- **Heated floor area, m<sup>2</sup>**
- Average indoor temperature of dwelling during heating season, °C



# Questionnaire design (3/6)

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## 4. Activity data on water heating

- Technologies and energy products used for water heating;
- Age and capacity of technologies (electricity, gas)
- Size and capacity of solar water heaters

## 5. Activity data on cooking

- Energy products used for cooking: (1) on the plate and (2) in the oven
- Age of cooking stove
- Frequency of meal preparation

# Questionnaire design (4/6)

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## 6. Activity data on lighting

- Approximate number, type and Watts of lighting bulbs
- Average daily use of all lights

## 7. Activity data on cooling

- Type of cooling system: district cooling, individual cooling system
- Installed capacity of individual cooling system, year of installation
- Average daily duration and average number of days/year in use
- Cooling floor area, m<sup>2</sup>

# Questionnaire design (5/6)

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## 8. Activity data on electrical appliances

- Use of freezer, refrigerator, washing machine, dish washer, TV, microwave, PC, iron, water pump, .....
- Number and age of appliances

## 9. Activity data on personal cars - FOR TRANSPORT MODEL !!!

- fuel/engine type (diesel, gasoline, LPG, electricity, other)
- average fuel consumption lit/100km; annual millage, km/year
- year of production

# Questionnaire design (6/6)

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10. Activity and consumption data on **agriculture and activities (for others)**

11. **TOTAL FINAL ENERGY CONSUMPTION and COSTS BY ENERGY PRODUCTS**

- As in simple survey
- Annual and monthly

12. **Average monthly income of all households**

- Source of income

# Usual questions and dilemmas

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- What is difference between households and dwellings?
- How to collect fuel wood data which are produced/collected by households?
- What exactly floor area is accounting?
- What about detached dwellings and buildings (garages)?
- How to treat rooms which are used as offices in private dwellings?
- Where to account specific appliances such as lawn movers? Fans? Grass cutter?



# Modelling

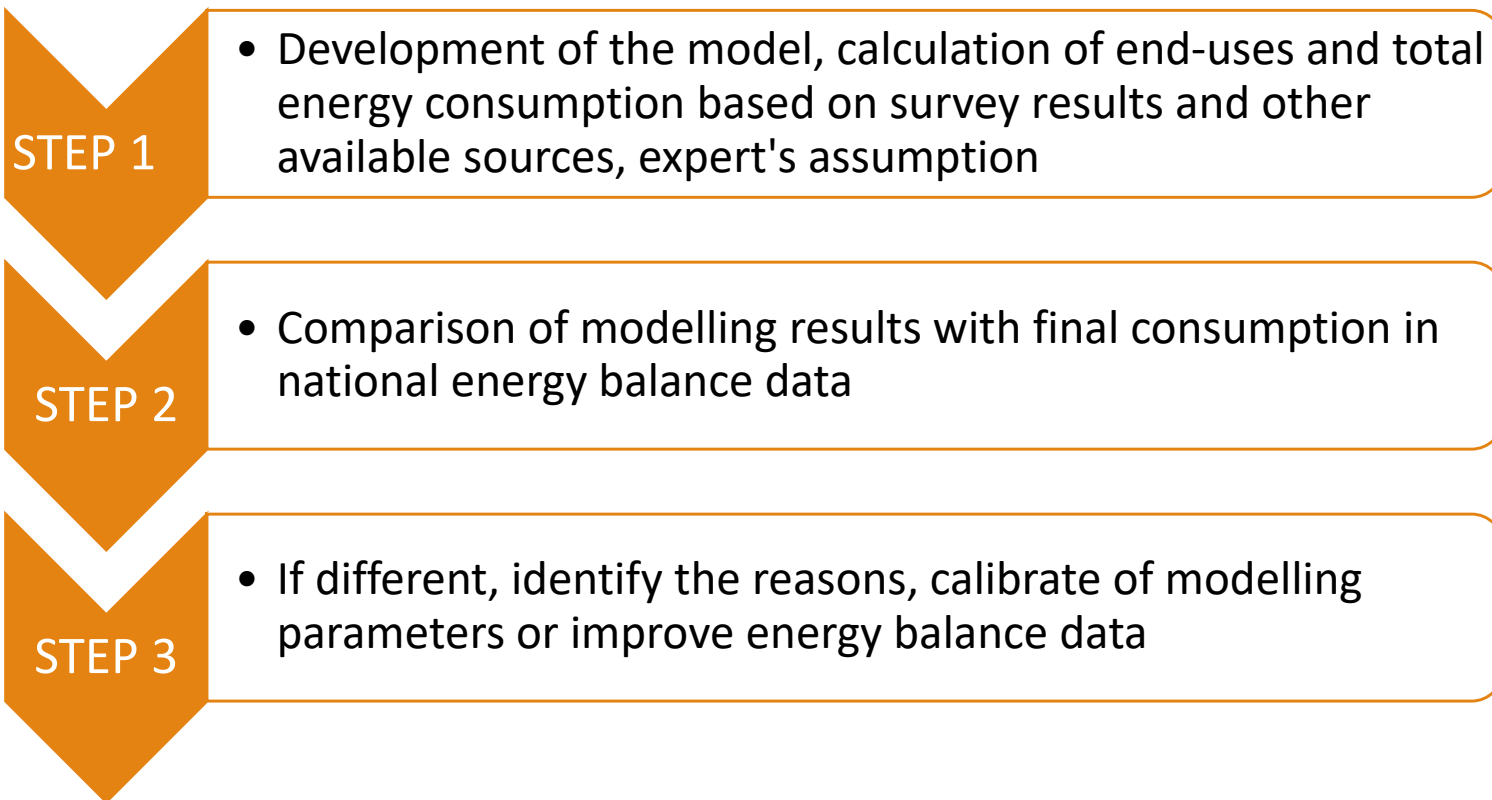
WHAT IS MODELLING??

END-USE CONSUMPTION, ACTIVITY  
DATA, SPECIFIC CONSUMPTION  
DATA,

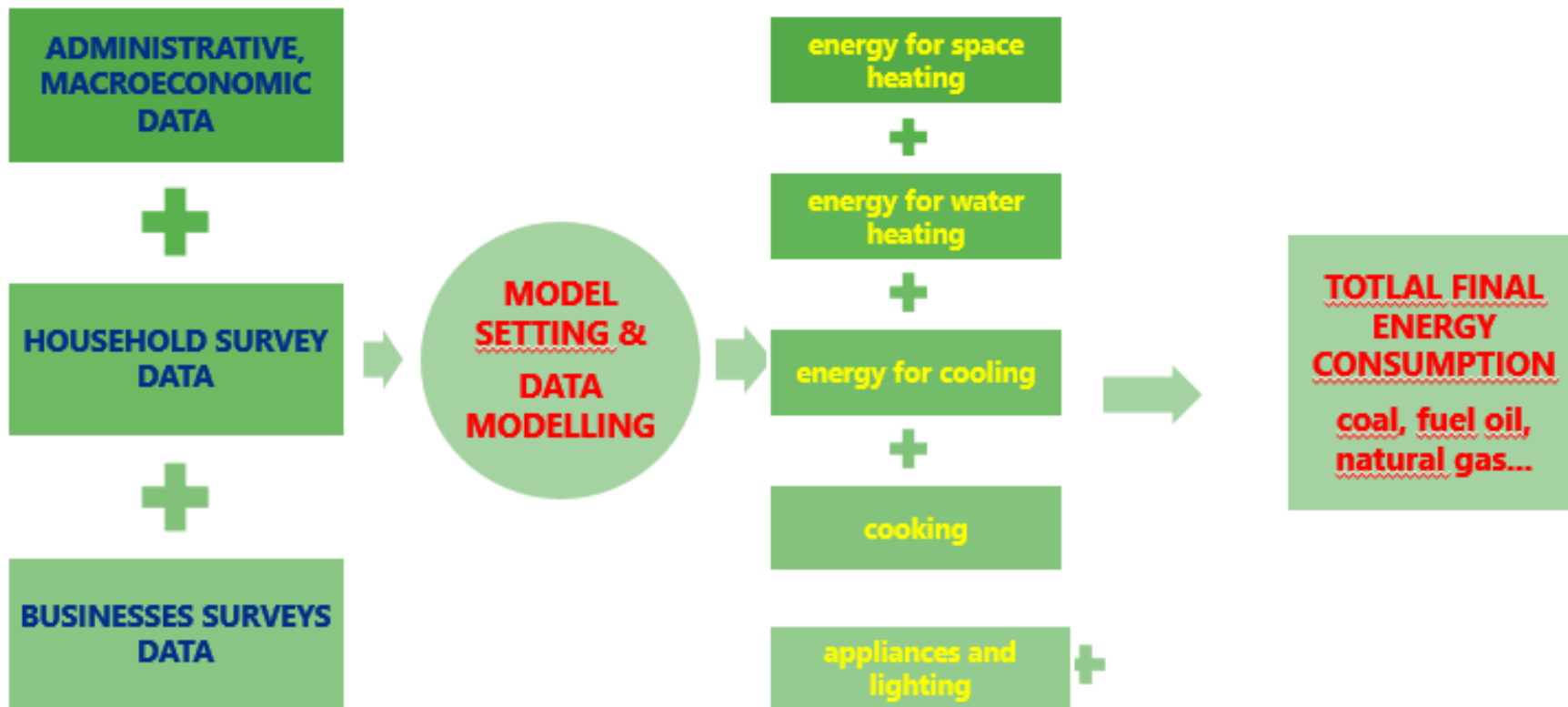
CALIBRATION

# Steps in modelling HH energy end-use

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# Step 1 Model development





# End-uses calculation

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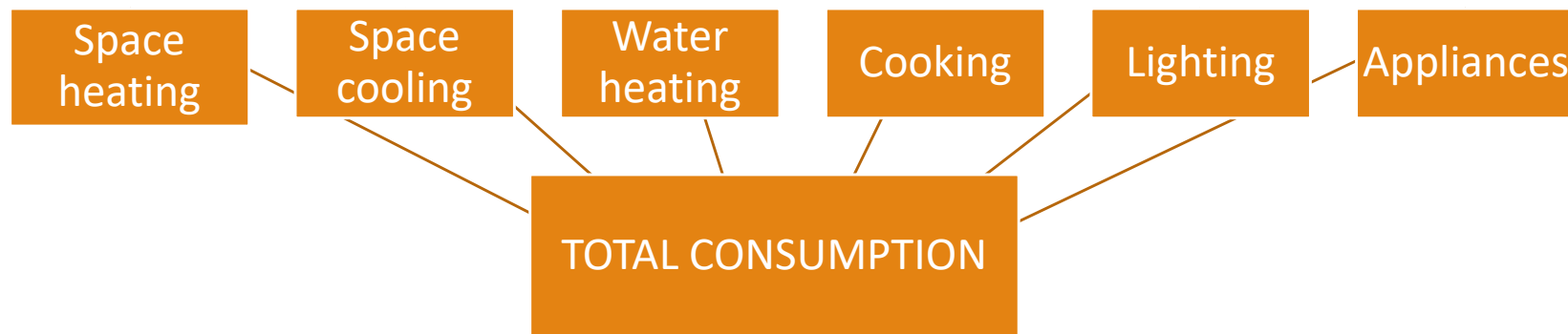
Each end use is calculated based on formula, example heating

$$\text{END USE} = \% \text{ of HH} * \text{TOTAL HH} * \text{ACTIVITY} * \text{Spec. end-use}$$

- % of HH = share of households participating in end-use consumption (survey)
- Total HH = total number of households (macroeconomy)
- ACTIVITY = driving parameter of end-use, for heating it is floor area, m<sup>2</sup> (survey)
- Spec. end-use = specific consumption per activity, kWh/floor area (survey or measurement)

# End-uses and modelling concept

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$$\text{END USE} = \% \text{ of HH} * \text{TOTAL HH} * \text{ACTIVITY} * \text{Spec. end-use}$$

- % of HH = share of households participating in end-use consumption
- ACTIVITY = driving parameter of end-use, for heating it is floor area, m<sup>2</sup>
- Spec. end-use = specific consumption per activity, kWh/floor area

# STEP 1. Development of model, heating

## MODEL DEVELOPMENT

HEATING	Share of HH	Activity1	Spec. end-use	End-use	End-use
Equipment and energy used	%	m <sup>2</sup> /HH	kWh/m <sup>2</sup>	TWh	PJ
District heating	50	60	210	6.300	22,7
Individual central heating sysetm					
Light fuel oil/kerosene					
Natural gas	20	70	150	2.100	7,56
LPG					
Fuel wood					
Electricity					
Solar					
Other					
Individual stoves					
Light fuel oil					
Natural gas					
LPG					
Fuel wood	25	75	300	5.625	20,25
Electricity					
Solar					
Other					
No heating	5				
<b>Total</b>	<b>100</b>	<b>-</b>	<b>-</b>	<b>14.025</b>	<b>50,5</b>

MACROECONOMY DATA		
<b>Country:</b>	"CRO"	
Total number of households:	1	mil.
Total number of population:	2,9	mil.
<b>LEGEND:</b>		
<b>Share of HH:</b>	% of household paticipating in end-use sub-category <b>Data source:</b> survey, energy enterprises, statistical publ.	
<b>Activity1:</b>	Average heated floor area per HH for equipment and energy, m <sup>2</sup> <b>Data source:</b> survey, energy enterprises, statistical publ.	
<b>Spec. end-use:</b>	Consumption per unit of activity, kWh/m2 <b>Data source:</b> survey, energy enterprises, statistical publications, modeling, expert estimates, assumptions	
<b>Total end-use:</b>	Total No. of HH * % of HH * Activity 1 * Spec. end-use, GWh <b>Data source:</b> FORMULA	

**Repeat process for all the end-uses!!!**

# STEP 1. Summarization of results by end-uses

	SPACE HEATING	WATER HEATING	COOK.	SPACE COOLING	APPL.	LIGHT.	TOTAL
	PJ	PJ	PJ	PJ	PJ	PJ	PJ
District heating	22,7	1,1					23,8
Light fuel oil/kerosene							0,0
Natural gas	7,6						7,6
LPG			7,00				7,0
Fuel wood	20,3						20,3
Electricity		3,2		0,81	7,2	0,9	12,1
Solar		0,5					0,5
Other							0,0
<b>Total</b>	<b>50,5</b>	<b>4,8</b>	<b>7,00</b>	<b>0,81</b>	<b>7,2</b>	<b>0,9</b>	<b>71,2</b>

# Step 2. Comparison with EB and plan for interventions

Energy balance and modelling data should be equal!!

	END-USE MODELLING	ENERGY BALANCE	Difference	Conclusions	Intervention
	PJ	PJ	%		
District heating	23,8	22,5	-5,4%	EB includes exact data on DH heat supply	Model
Light fuel oil/kerosene					
Natural gas	7,6	7,8	3,2%	EB includes exact data on natural gas	Model
LPG	7,0	7,9	12,9%	Survey provides more accurate data	EB
Fuel wood	20,3	11,0	-45,7%	Survey provides more accurate data	EB
Electricity	12,1	11,0	-9,2%	EB includes exact data on electricity	Model
Solar	0,5	0,5	0,0%	Survey provides more accurate data	EB
Other					
<b>Total</b>	<b>71,2</b>	<b>60,7</b>	<b>-14,7%</b>		

# Step 3. Calibration of the model, e.g. heating

HEATING	share of HH	Activity1	Spec. end-use	Total end-use
Equipment and energy used	%	m <sup>2</sup> /HH	kWh/m <sup>2</sup>	TWh
District heating	50	60	198	5.940
Individual central heating sysetm				
Coal				
Light fuel oil/kerosene				
Natural gas	20	70	155	2.170
LPG				
Fuel wood				
Electricity				
Solar				
Other				
Individual stoves				
Coal				
Light fuel oil				
Natural gas				
LPG				
Fuel wood	25	75	300	5.625
Electricity				
Solar				
Other				
No heating	5			
<b>Total</b>	<b>100</b>	<b>-</b>	<b>-</b>	<b>13.735</b>

Calibrated values

Calibration is performed in all end-uses!

## Step 4: Final end-uses

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	SPACE HEATING	WATER HEATING	COOK.	SPACE COOLING	APPL.	LIGHT.	TOTAL
	PJ	PJ	PJ	PJ	PJ	PJ	PJ
District heating	21,4	1,1					22,5
Light fuel oil/kerosene							
Natural gas	7,8						7,8
LPG			9,0				9,0
Fuel wood	20,3						20,3
Electricity		2,9		0,7	6,5	0,8	11,0
Solar		0,5					0,5
Other							
<b>Total</b>	<b>49,4</b>	<b>4,5</b>	<b>9,0</b>	<b>0,7</b>	<b>6,5</b>	<b>0,8</b>	<b>71,0</b>

# Step 4. Final comparison conclusions

Energy balance and modelling data should be equal!!

	END-USE MODELLING	ENERGY BALANCE	Difference
	PJ	PJ	%
District heating	22,5	22,5	0,1
Light fuel oil/kerosene			
Natural gas	7,8	7,8	-0,2
LPG	9,0	7,9	-12,2
Fuel wood	20,3	11	-45,7
Electricity	11,0	11	0,0
Solar	0,5	0,5	0,0
Other			
<b>Total</b>	<b>71,0</b>	<b>60,7</b>	<b>-14,6</b>

} should be reflected in energy balance !!!





Reports Table Chart

EEI RESIDENTIAL ⓘ

Other: PRODUCT/FLOW - Per floor area TC energy intensity (GJ/m2) ⓘ

COUNTRY	Australia	Japan	Korea	New Zealand	Chinese Taipei
TIME	↑↓	↑↓	↑↓	↑↓	↑↓
2010	0.14	0.12	0.29	0.08	0.11
2011	0.12	0.12	0.28	0.09	0.10
2012	0.13	0.11	0.28	0.08	0.10
2013	0.13	0.11	0.27	0.09	0.07
2014	0.16	0.11	0.26	0.08	0.09
2015	0.12	0.11	0.26	0.08	0.11
2016	0.13	0.12	0.27	0.09	0.16
2017	0.12	0.11	0.27	0.08	0.14
2018	0.12	0.11	0.27	0.08	0.11
2019	0.12	0.11	0.26	0.09	0.03
2020	0.11	0.12	0.24	0.08	..

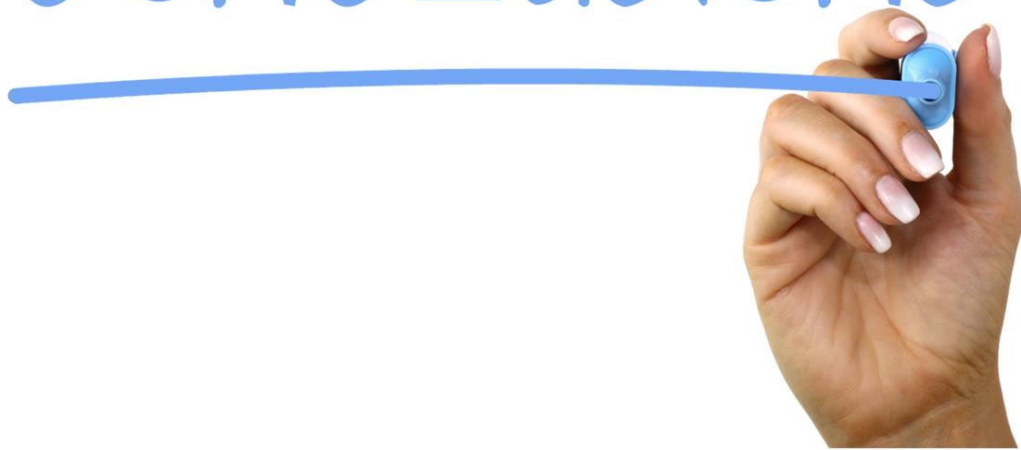
Reports Table Chart

EEI RESIDENTIAL ⓘ

Other: PRODUCT/FLOW - Per dwelling TC energy intensity (GJ/dw) ⓘ

COUNTRY	Australia	Japan	Korea	Chinese Taipei
TIME	↑↓	↑↓	↑↓	↑↓
2010	1.97	0.93	0.67	..
2011	2.45	0.79	1.04	..
2012	2.57	0.68	0.70	..
2013	2.26	0.78	0.46	..
2014	2.11	0.65	1.39	..
2015	2.30	0.87	1.18	3.69
2016	2.01	0.84	0.74	..
2017	2.15	0.85	0.74	..
2018	2.06	0.97	0.69	..
2019	2.05	0.86	0.76	..
2020	2.17	0.84	0.85	..

# CONCLUSIONS



....and  
recommendations

# Conclusions and recommendations

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1. Energy balance and end-use modelling are **dependent and dynamic processes**
2. **Surveys are still the most suitable data sources** for modelling end-uses, other administrative data or data from energy companies should be used for data verification
3. Modelling of end-use consumption **should be fully adjusted to national specificities**
4. Comprehensive energy surveys are time consuming and costly, should be repeated after 5 years
5. Modelling end-uses **in years between surveys can be based on extrapolation**, but taking into consideration heating degree days (HDDs) and cooling degree days (CDDs)
6. It is suggested to develop benchmarks with other country and compare development processes

# Content

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LOREM IPSUM DOLOR SIT AMET,  
CONSECTETUER ADIPISCING ELIT.



NUNC VIVERRA IMPERDIET ENIM.  
FUSCE EST. VIVAMUS A TELLUS.



PELLENTESQUE HABITANT MORBI  
TRISTIQUE SENECTUS ET NETUS.