2nd Regional Exchange of Modelling Experts involved in the Development of Integrated National Energy and Climate Plans (NECPs) in South-Eastern European Countries

Modelling of useful energy demand in households

MODEL MARKAL-MACEDONIA

MODELING TEAM OF THE RESEARCH CENTER FOR ENERGY AND SUSTAINABLE DEVELOPMENT – MACEDONIAN ACADEMY OF SCIENCES AND ARTS

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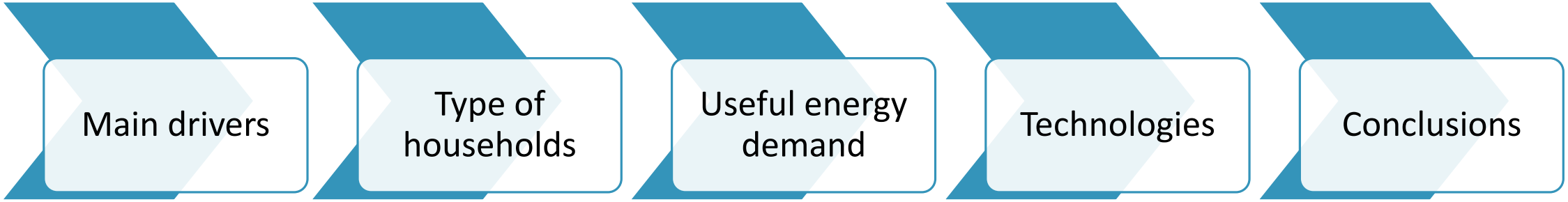
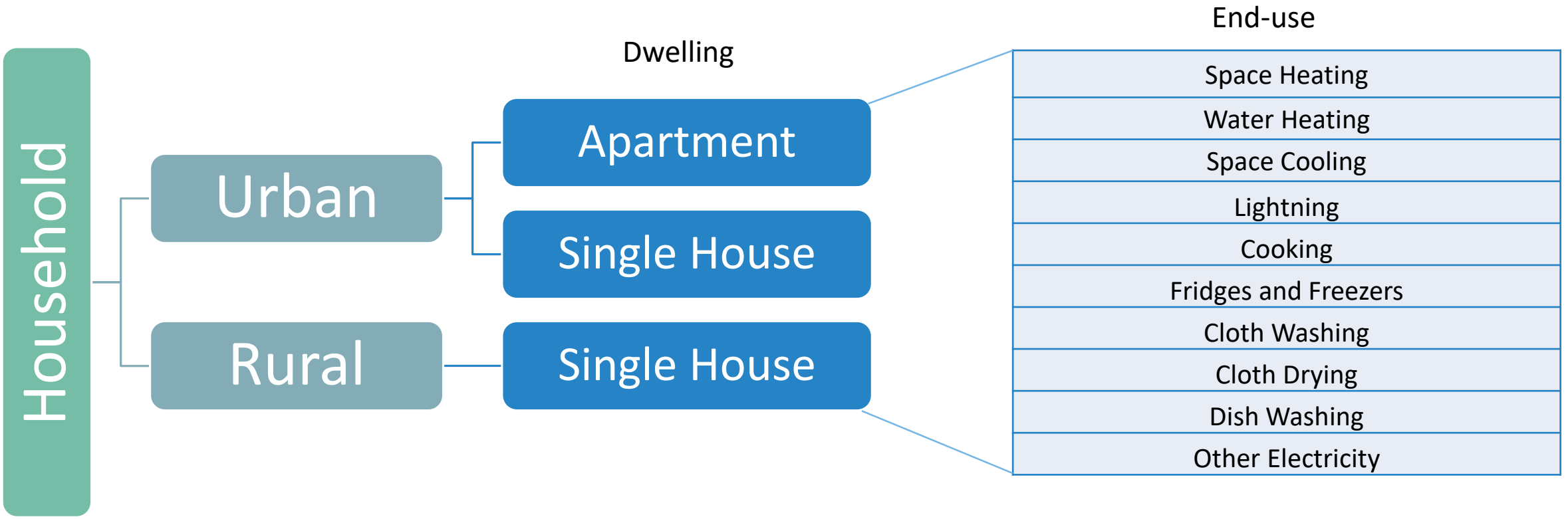
Outline


Main drivers
Type of households
Useful energy demand
Technologies
Conclusions

Main Drivers

- Population
- Number of person per household
- Number of dwellings
- Degree days: heating and cooling
- Base year demand – based on SSO Energy balances and HH energy consumption survey
  - Allocation per type of household
  - Allocation per end-use
    - Hourly load profile – to capture seasonal and intraday variations - 9 time periods: Summer (day, night, peak), Winter (day, night, peak), Intermediate - (day, night, peak)

Type of households



Useful energy demand

Base year estimation of all end-use demand

- Space heating (as an example)
  - For each type of dwelling:

$$UE_{SH(tch)} = Eff_{(tch)} \cdot FE_{(tch)} = Eff_{(tch)} \cdot FE_{SH(fuel)} \cdot Share_{tch(fuel)}$$

Final energy for space heating by fuel

Useful energy by technology

Technology efficiency

Final energy by technology

Share of technology by fuel

Total useful energy for space heating per type of dwelling:

$$UE_{SH} = \sum_{All\ tch} UE_{SH(tch)}$$

Useful energy demand projection

I. Number of dwellings per type
- Projection of total number of HH (Population and Number of persons per HH)
- Allocation per dwelling type
  - Existing (old) HH (destruction rate)
  - New HH
    - Share of passive dwellings

II. Useful energy demand - space heating
- Dwelling size per type of dwelling – *A* (m^2)
- Fraction of dwelling size heated – *hs* (%)
- Heat demand per heated area – *HDs* (kWh/m^2)
- Space heating demand per dwelling type – UE_{SH} (KWh)

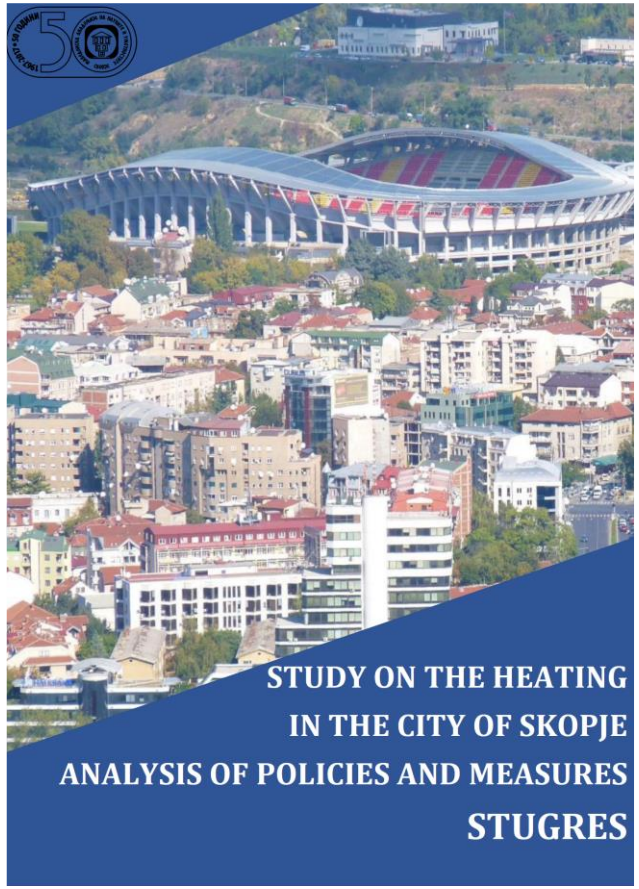
$$UE_{SH} = HDs \cdot \text{Number of dwellings} \cdot A \cdot hs \text{ (for each dwelling type)}$$

Technologies

End - use	Technology	Fuel	Type of dwelling		
			U-A	U-SH	R-SH
Space Cooling	Heat Pumps	Electricity	✓	✓	✓
Space Heating	Furnace	Biomass, electricity, gas, LPG	✓	✓	✓
	Furnace (for space and water heating)	Biomass, electricity, gas	✓	✓	✓
	Stove	Biomass, pellets, electricity, gas, oil	✓	✓	✓
	Heat pump	Electricity	✓	✓	✓
	District heating	Low-thermal heat (LTH)	✓		
	Solar collectors (for space and water heating)	Solar		✓	✓
Water heating	Boilers	Electricity, gas, LTH, LPG	✓	✓	
	Dual boilers	Solar+ electricity		✓	✓
	Combined systems	District heating+ solar +electricity	✓		
Other	Cloth drying machine	Electricity		✓	
	Cloth washing machine	Electricity		✓	
	Dish washing machine	Electricity		✓	
	Cooker	Biomass, electricity, natural gas, LPG		✓	
	Lighting	Electricity		✓	
	Refrigerator and Freezer	Electricity		✓	

- Available as life extension of existing, base technologies, advanced technologies, best available technologies

Modeling on local level



- Heating demand at the level od the City of Skopje
- Survey by households
-Local pollutant assessed

Conclusions

- Long-term modeling of useful demand is data extensive process
- Reliable data sources are crucial
  - existing data
  - projections
- Good allocation of data is necessary
  - per type of households
  - per end-use, by technologies and by fuel
- Availability of diverse efficient technologies at demand side is important (as cost-effective options for selection by the model)