



Developing the energy inventory

Hera Neofytou
Andriana Stavrakaki
George Konstantopoulos
(ICCS)



Co-funded by the European Union under project ID101076088. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.



1. Regio1st tool - Energy Inventory & “Advanced Inventory tool”
2. Methodology & Examples
 - a) Horizontal considerations
 - b) Sectors
3. Energy consumption analysis

Regio1st tool - Energy Inventory

[illegible]

Regio1st tool - “Advanced Inventory tool” (Data types)



BUILDINGS, EQUIPMENT/FACILITIES AND INDUSTRIES									
		Total Number	Total Floor area	Renovation status	Type of heating system	Use of RES	Building type	Age classes	Building energy benchmark per building type
<u>Municipal buildings, equipment/facilities</u>									
	Public lighting	√		√					
	Municipal buildings	√	√	√	√	√	√	√	√
	Municipal facilities	√		√		√	√		√
<u>Tertiary (non municipal) buildings, equipment/facilities</u>									
	Institutional buildings	√	√	√	√	√	√	√	√
	Commercial	√	√	√	√	√	√	√	√
<u>Residential buildings</u>		√	√	√	√	√	√	√	√
Industry	Non-ETS	√				√			√

Regio1st tool - “Advanced Inventory tool” (Data types)



TRANSPORT							
		Number, type, class of vehicles	Number of vehicle per vehicle type	Number of vehicle per fuel type	Number of passengers per journey type	Mileage per vehicle type	Length of lines/roads/routes
Regional/ Municipal fleet							
	Road	√	√	√		√	√
Public transport							
	Road	√	√	√	√	√	√
	Rail	√			√	√	√
	Other	(√)	(√)	(√)	(√)	(√)	(√)
Private and commercial transport							
	Road	√	√	√	√	√	√
	Rail	√			√	√	√
	Bikelanes	√			√	√	√
	Other	√				√	√
Transport not allocated							

Methodology & Examples – Horizontal considerations



Measurement units

- ✓ What energy measurement units the data sources use?
- ✓ What energy measurement units do we need?
- ✓ Do we need conversions? What type?

Usual energy units:
KWh, MWh



Methodology & Examples – Horizontal considerations



Metric prefixes

-Kilo
-Mega
-Giga

Prefix	Symbol	Multiplier	
Kilo	K	10 ³	1,000
Mega	M	10 ⁶	1,000,000
Giga	G	10 ⁹	1,000,000,000
Tera	T	10 ¹²	1,000,000,000,000

Fuel type	Net calorific value [TJ/Gg]	Net calorific value [MWh/t]
Motor Gasoline	44.3	12.3
Diesel Oil	43.0	11.9
LPG	47.3	13,1
Natural Gas	48.0	13.3

To	TJ	Mtoe	GWh	MWh
From	Multiply by:			
TJ	1	2.388 x 10 ⁻⁵	0.2778	277.8
Mtoe	4.1868 x 10 ⁴	1	11,630	11,630,000
GWh	3.6	8.6 x 10 ⁻⁵	1	1,000
MWh	0.0036	8.6 x 10 ⁻⁸	0.001	1

Energy units

-Wh
-Joule
-Toe

Source: CoM Guidelines

Diesel (KWh/lit)	Gasoline (KWh/lit)
10,00	9,20

$$d=m/V$$

- d: density (kg/lit)
- m: mass (kg)
- V: volume (lit)

Fuel quantity

-Litre (volume)
-tn (mass)

OR

Methodology & Examples – Sectors

overview



Residential Buildings



Tertiary Buildings



Municipal Buildings



Street Lighting



Municipal fleet



Public Transport



Private Transport



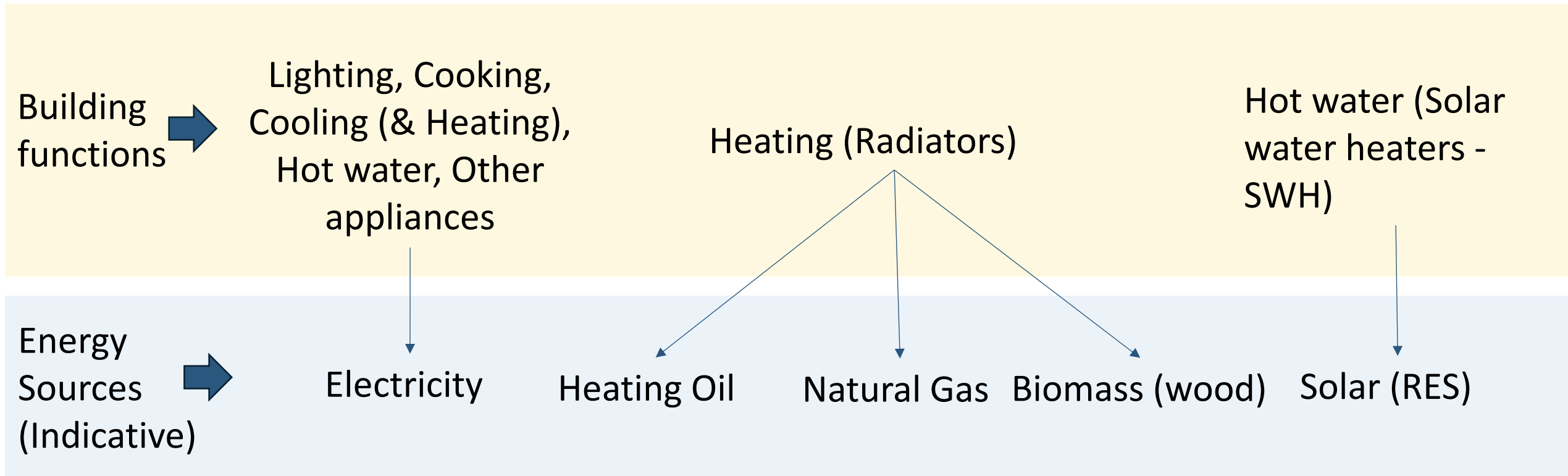
Agriculture Sector



Renewable Energy Sources

Methodology & Examples - Residential

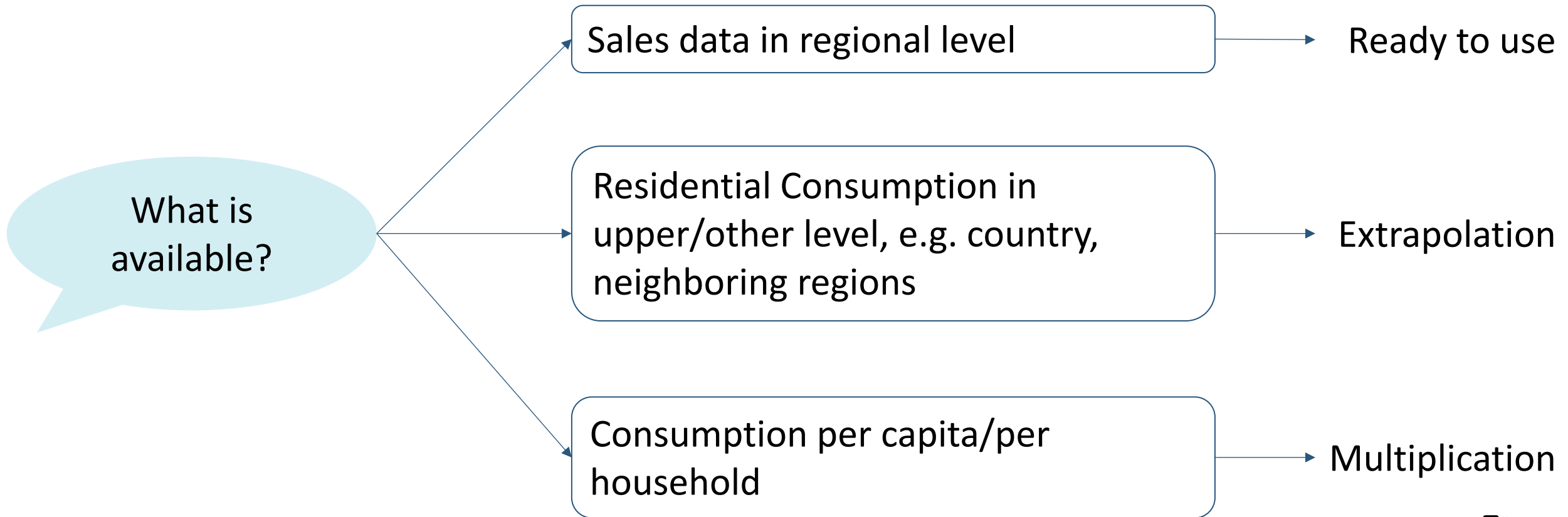
Residential buildings (Inhabited houses – detached/apartments)



Methodology & Examples - Residential



Electricity in Residential buildings



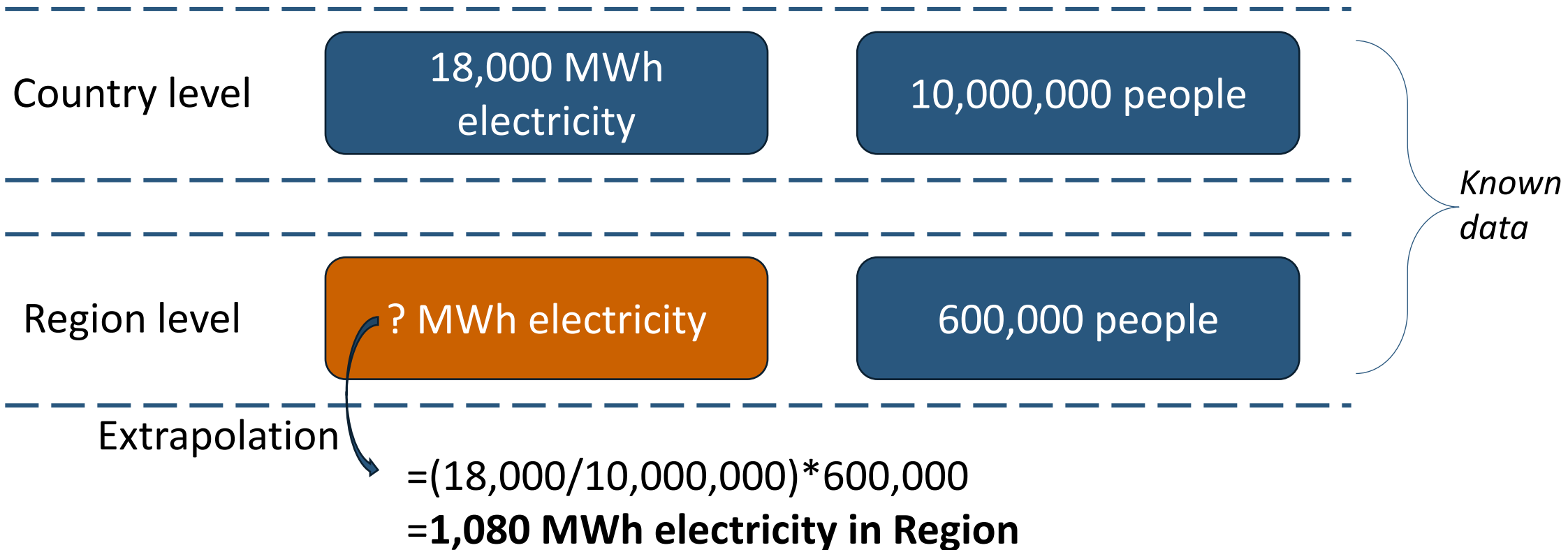
Methodology & Examples - Residential



Electricity in Residential buildings

Example: Consumption in upper level, e.g. country

Simple method

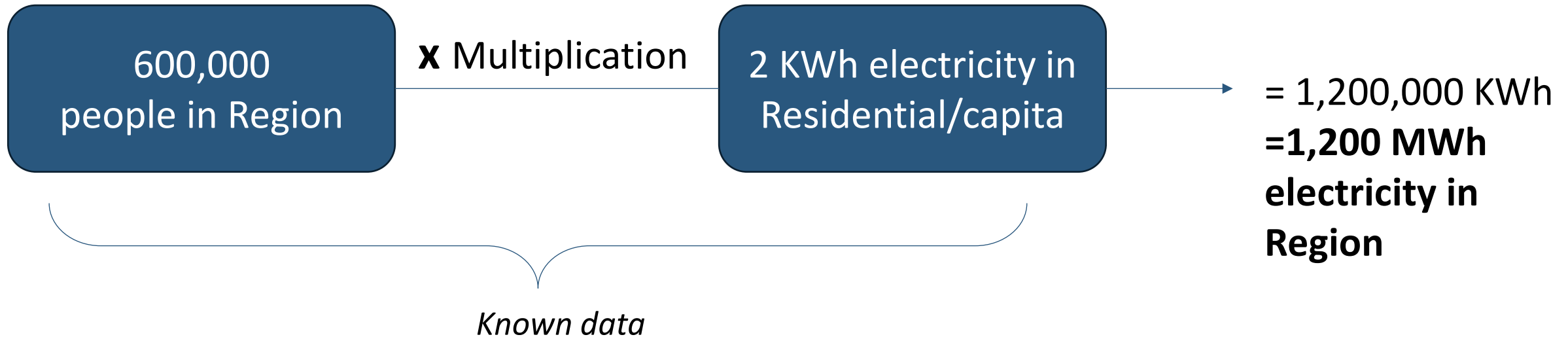


Methodology & Examples - Residential



Electricity in Residential buildings

Example: Consumption per capita (/per household)





Heating in Residential buildings

What is available?

Sales data in regional level

Ready to use

Residential Consumption in upper level e.g. country

Extrapolation (as previously)

Consumption per capita/per household

Multiplication (as previously)

A variety of data to combine





Heating in Residential buildings

Example: A variety of data to combine

Examples of useful data

Indicators for heating demand per house based on buildings' characteristics

Type of fuel (heating oil, natural gas etc.)

Coefficient rate of fuel

Number of households

Number of households with wall/window insulation

Number of buildings' floors





Heating in Residential buildings

Example: A variety of data to combine

Known data:

Indicative heating oil consumption, for a specific region, of a house belonging in:

Detached house <i>Without thermal insulation</i>	Detached house <i>With thermal insulation</i>	Apartment Building <i>Without thermal insulation</i>	Apartment Building <i>With thermal insulation</i>
18 lt/m ²	6 lt/m ²	13 lt/m ²	4 lt/m ²

What do we need?



- Number of buildings per type (apartment buildings and detached houses)
- Number of buildings with thermal insulation
- House area





Heating in Residential buildings

Example: A variety of data to combine

Known data:

What do we have?

- Total number of houses (residences) using heating oil for heating (central heating systems)= 10,000
- 70% of the houses belong to apartment buildings
- 60% of the houses have thermal insulation
- Average house area in detached houses=100 m², Average house area in apartment buildings=80m²



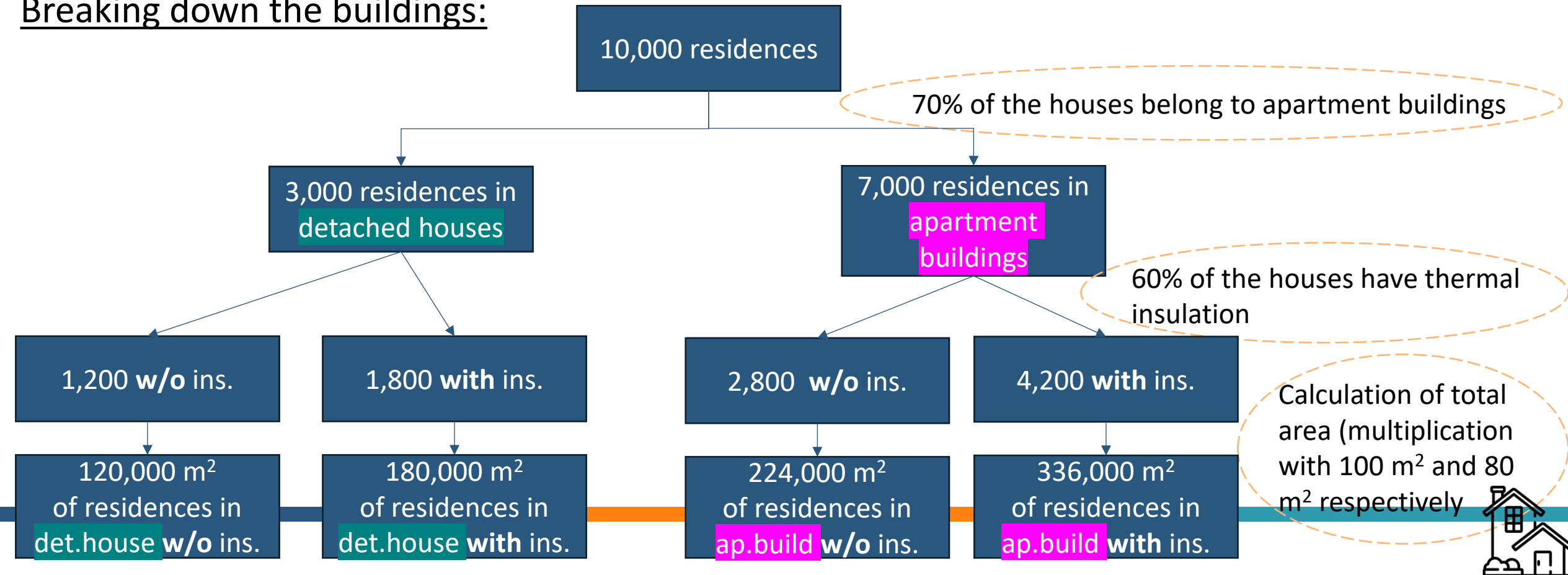
Methodology & Examples - Residential



Heating in Residential buildings

Example: A variety of data to combine

Breaking down the buildings:



Methodology & Examples - Residential



Heating in Residential buildings

Example: A variety of data to combine

	Detached house <i>Without thermal insulation</i>	Detached house <i>With thermal insulation</i>	Apartment Building <i>Without thermal insulation</i>	Apartment Building <i>With thermal insulation</i>	
	18 lt/m ²	6 lt/m ²	13 lt/m ²	4 lt/m ²	x
Total area per category →	120,000 m ²	180,000 m ²	224,000 m ²	336,000 m ²	
	2,160,000 lt	1,080,000 lt	2,912,000 lt	1,344,000 lt	sum
	Total heating oil consumption= 7,496,000 lt				Conversion(1lt=10 KWh)
	Total heating oil consumption= 74,960,000 KWh= 74,960 MWh				





Hot water in Residential buildings

What is available?

- Population using solar water heaters
- Average needs per person for hot water

- Solar radiation factor (KWh/m² of house) (based on location)
- Number of houses with solar water heaters
- Total floor area of houses

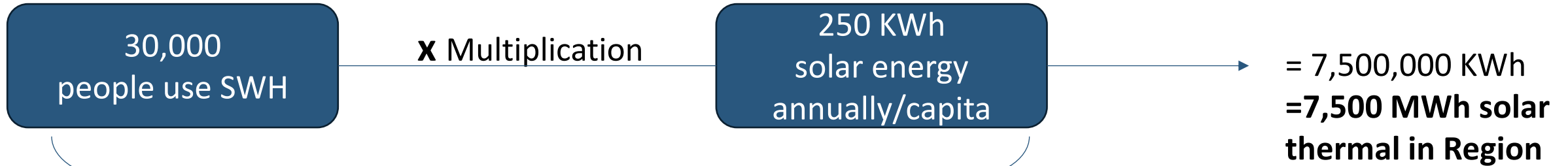


Methodology & Examples - Residential

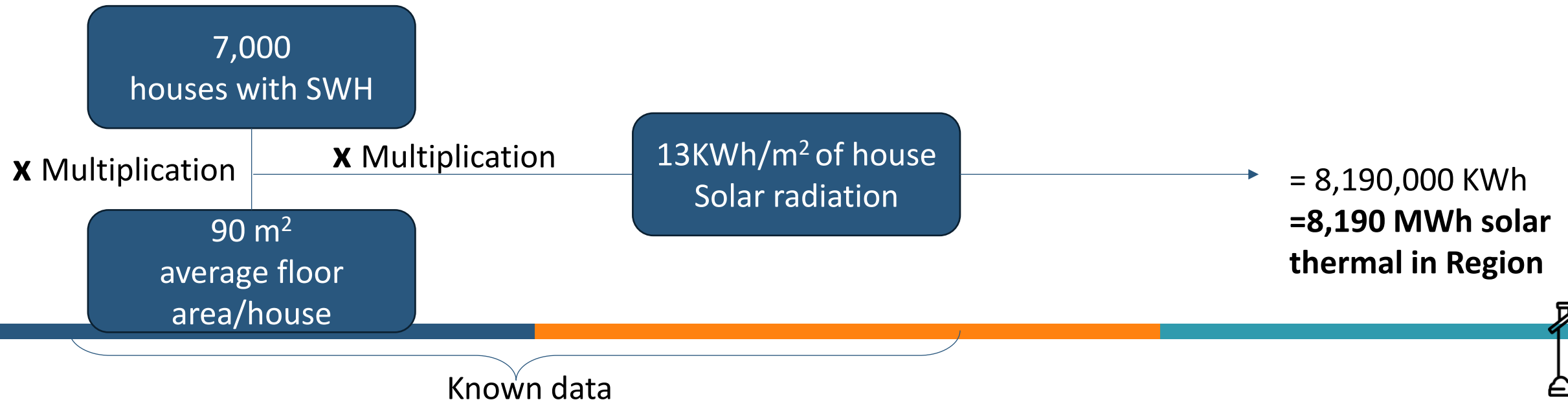


Hot water in Residential buildings

Example 1

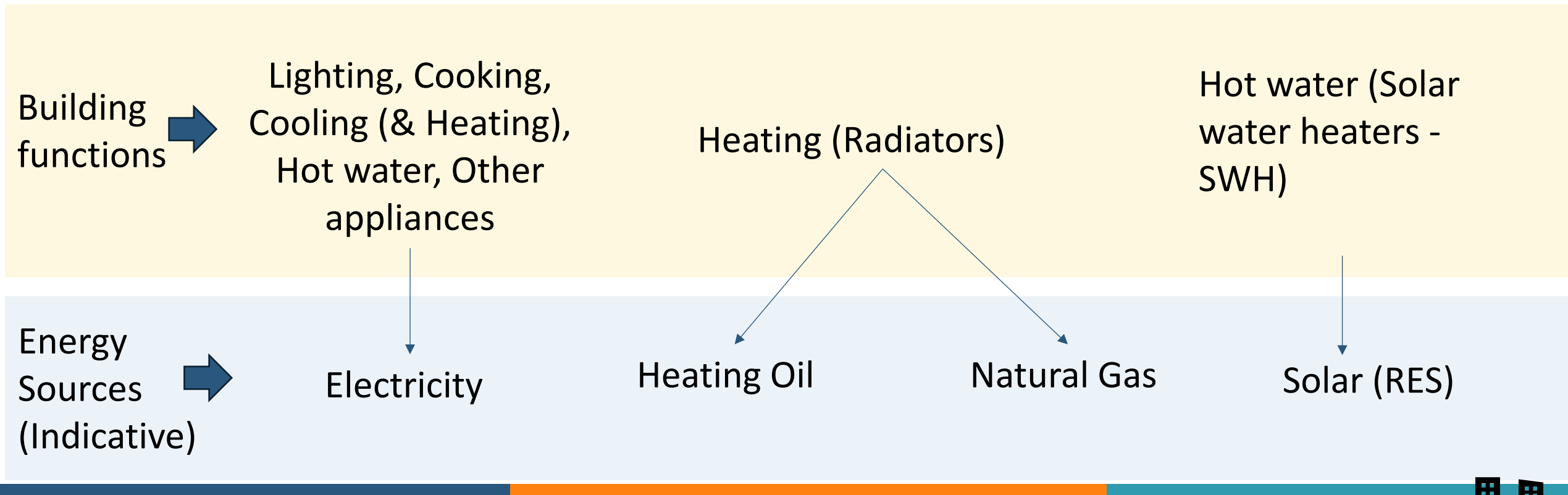


Example 2



Methodology & Examples - Tertiary

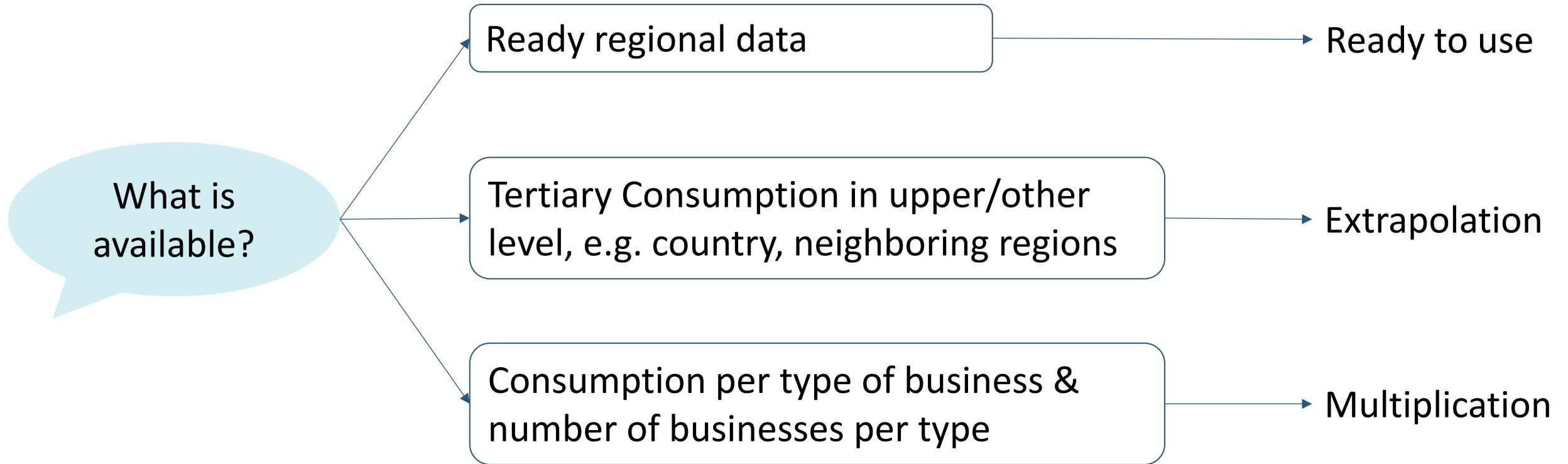
Tertiary buildings (Offices, hotels, restaurants, shops)



Methodology & Examples - Tertiary



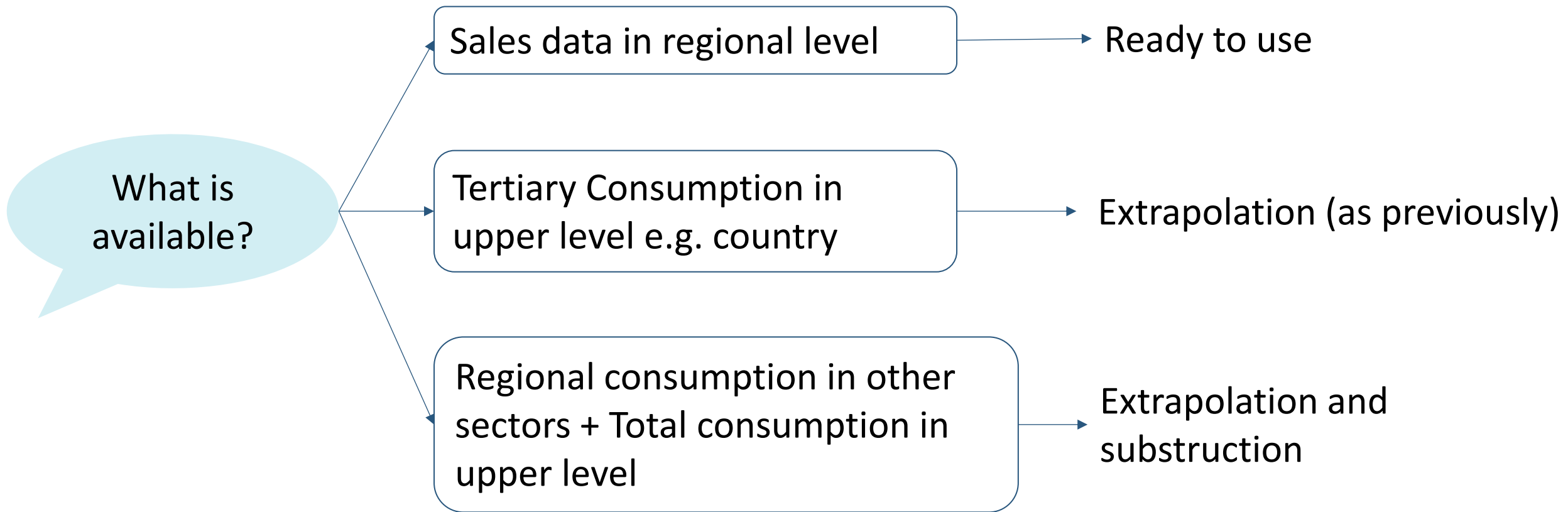
Electricity in Tertiary buildings



Methodology & Examples - Tertiary



Heating in Tertiary buildings

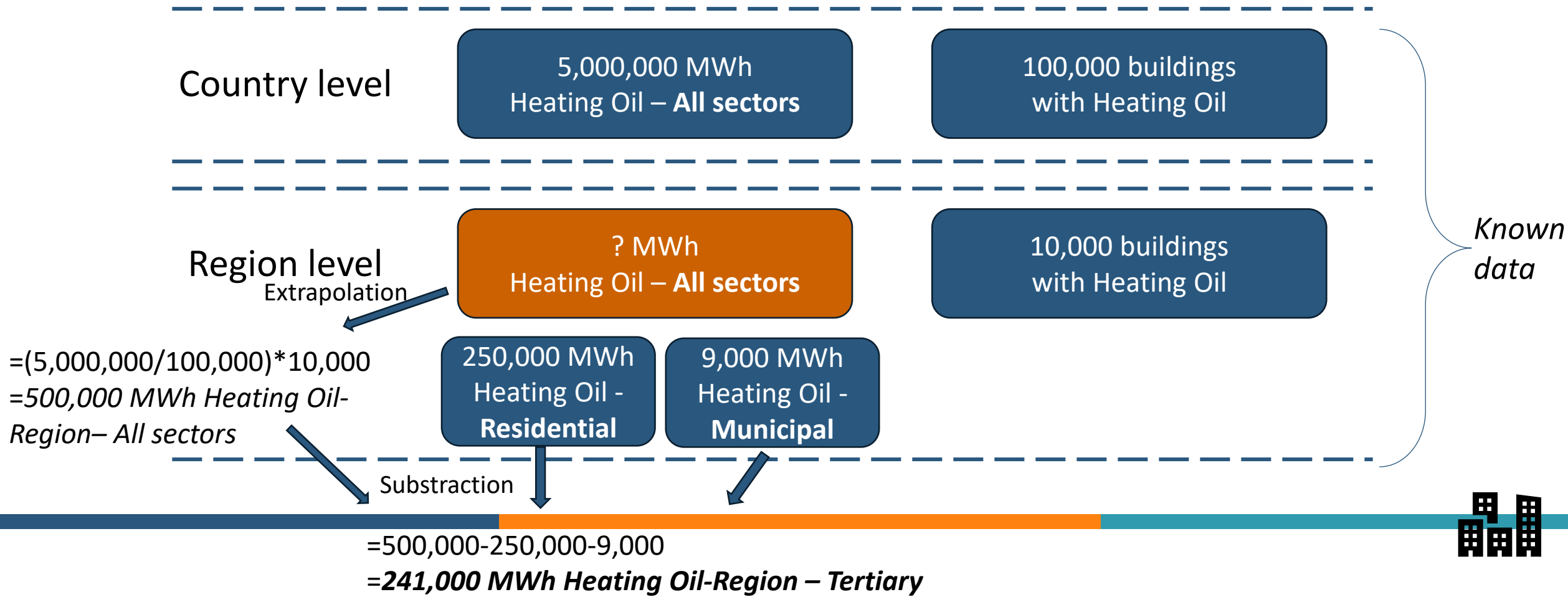


Methodology & Examples - Tertiary



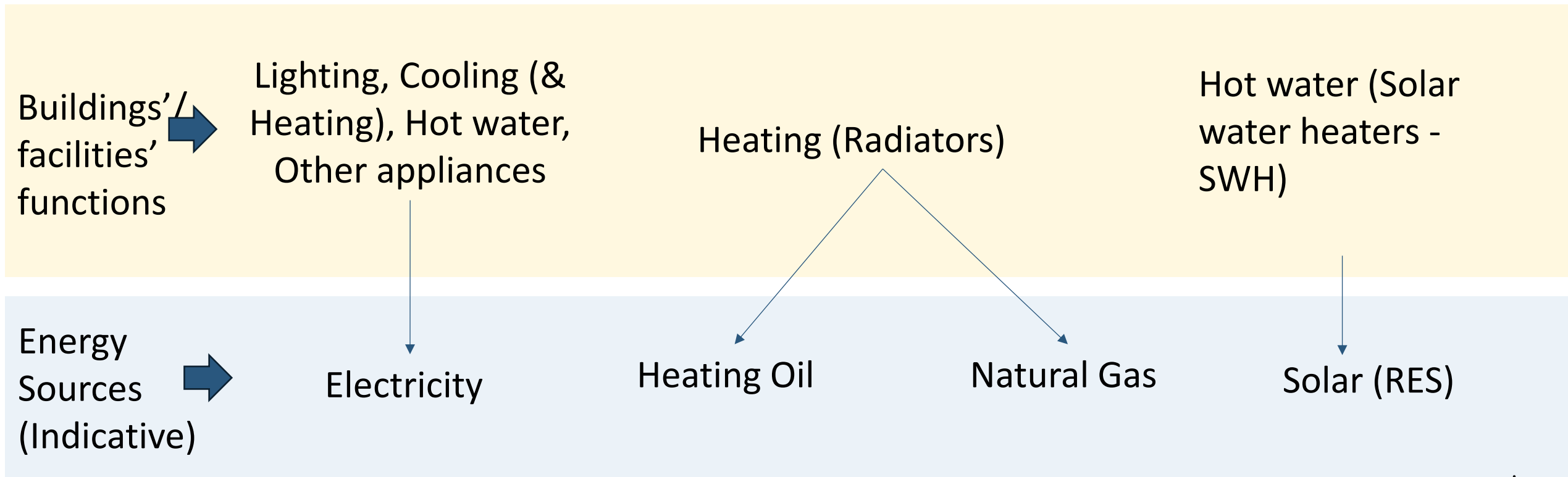
Heating in Tertiary buildings

Example: Regional consumption in other sectors + Total consumption in upper level



Methodology & Examples – Municipal Sector

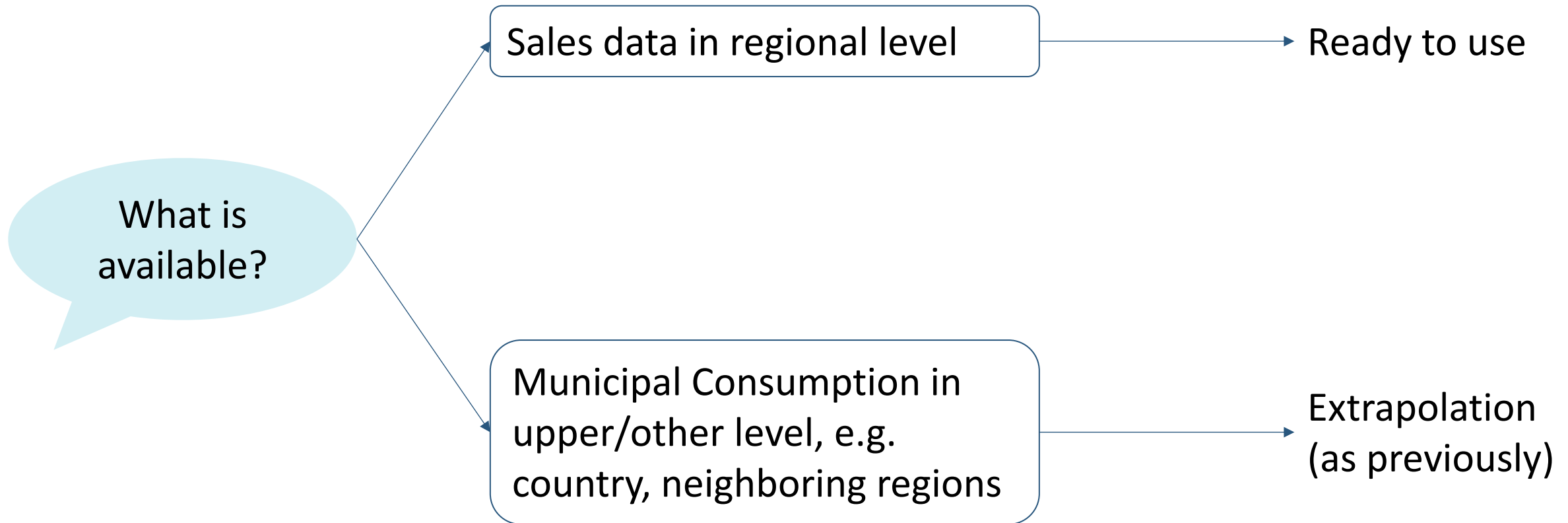
Municipal buildings (e.g. offices, schools, libraries) and facilities (e.g. stadiums)



Methodology & Examples – Municipal Sector



Electricity & Heating in Municipal buildings



Methodology & Examples – Public Lighting

Street & Square lighting



Electricity



What is available?

Sales data in regional level

Ready to use

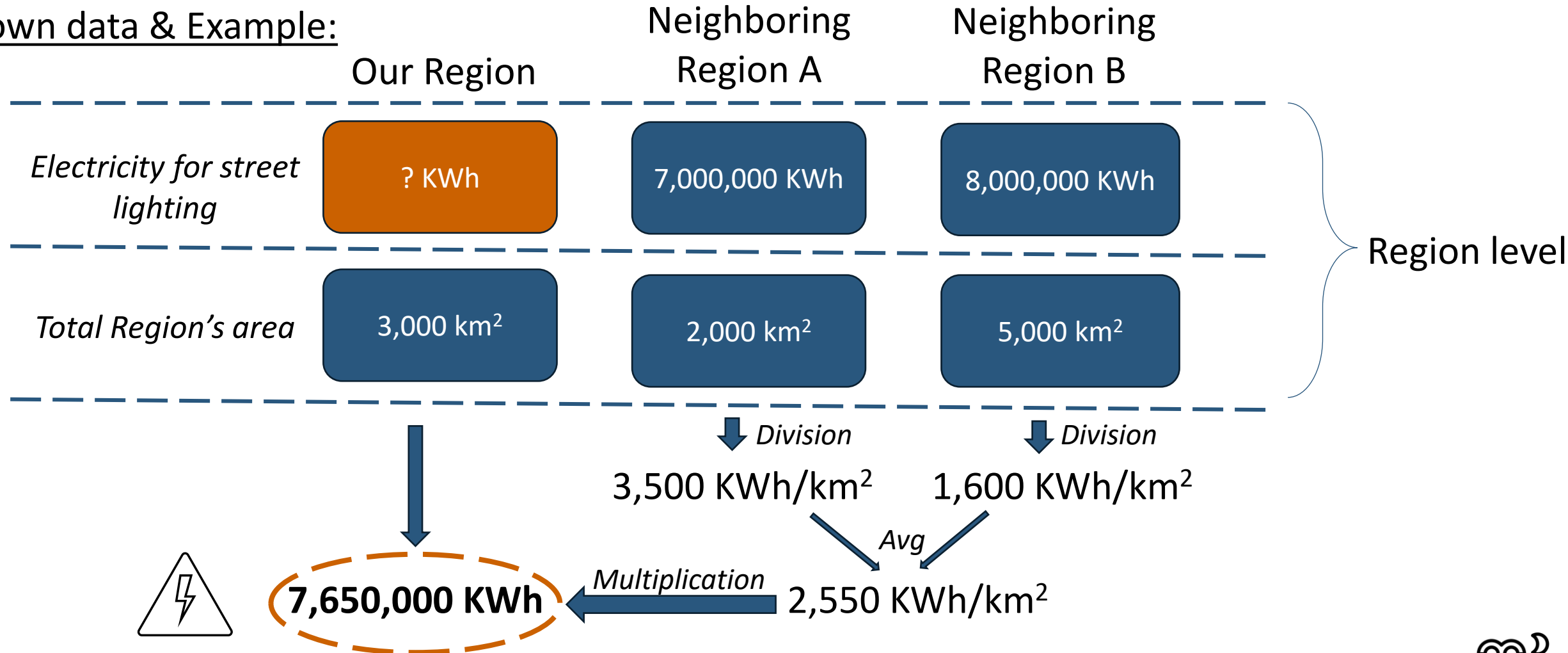
Consumption in upper/other level, e.g. country, neighboring regions

Extrapolation
/consumption
per m²



Methodology & Examples – Public Lighting

Known data & Example:



Methodology & Examples – Municipal Fleet



Fuel consumption (Gasoline and Diesel) in Municipal Fleet

What is available?

Sales data in regional level
(per fuel type)

Ready to use

Sales data in municipal level
(per fuel type)

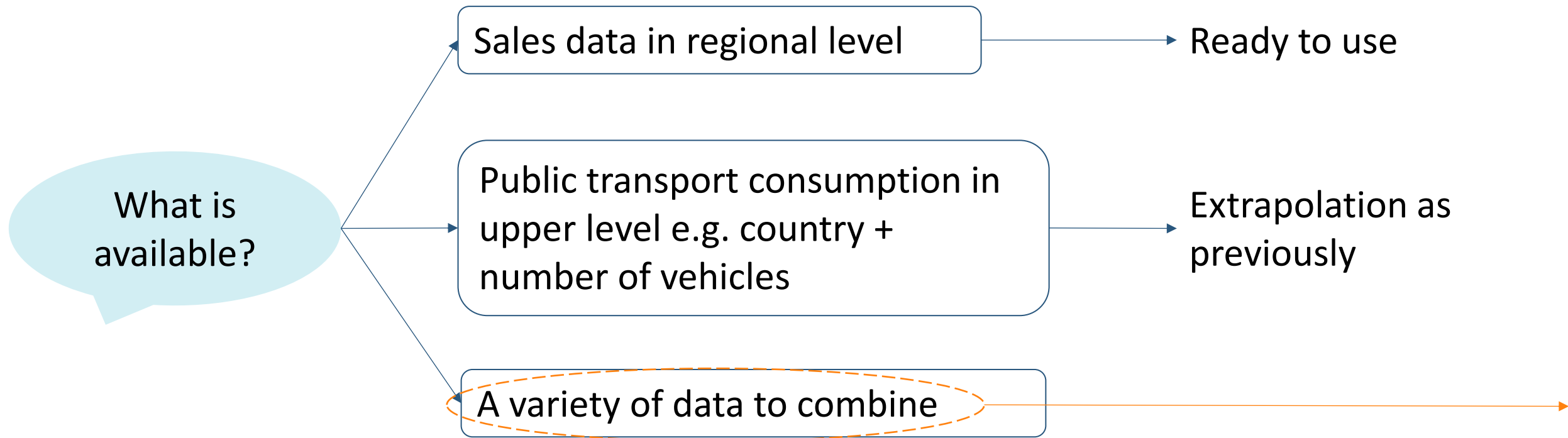
Sum



Methodology & Examples – Public Transport

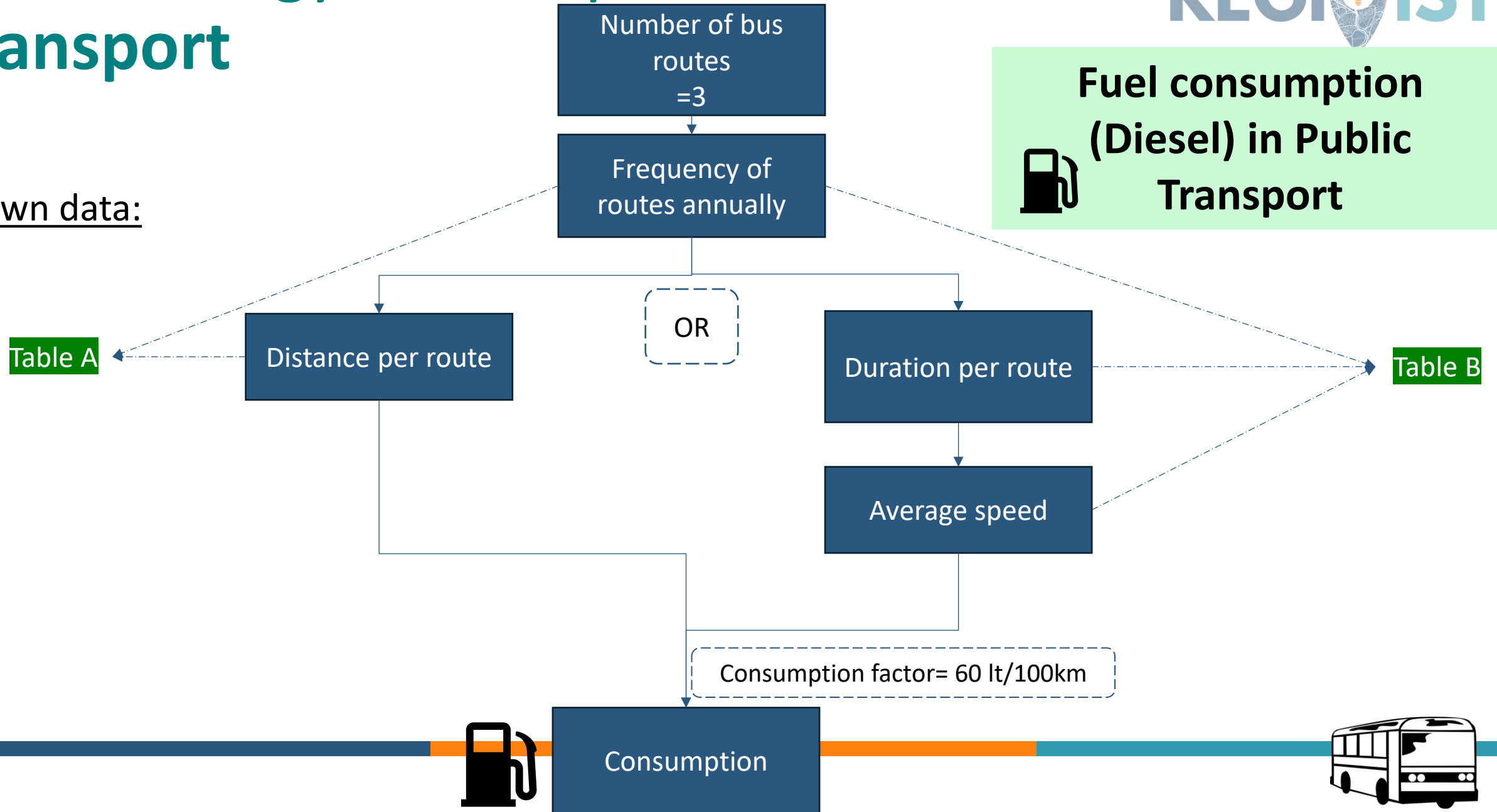


Fuel consumption (Diesel) in Public Transport



Methodology & Examples – Public Transport

Known data:



Methodology & Examples – Public Transport



Fuel consumption (Diesel) in Public Transport

Example 1:

Table A

Routes	Frequency	Average distance (km)
Route 1	500	10
Route 2	200	15
Route 3	1000	30

Multiplication



Total distance (km)
5,000
3,000
30,000

60 lt/100km



Total Diesel Consumption (lt)
3,000
1,800
18,000



Sum

22,800 lt



Conversion 1lt diesel=10 KWh

228,000 KWh



Methodology & Examples – Public Transport



Fuel consumption (Diesel) in Public Transport

Example 2:

Table B

Routes	Frequency	Duration per route (min)	Average speed (km/h)
Route 1	500	40	50
Route 2	200	30	55
Route 3	1000	35	60

Multiplication



Total distance (km)
16,666
5,500
35,000

60 lt/100km



Total Diesel Consumption (lt)
10,000
3,300
21,000



Sum

34,300 lt



Conversion 1lt diesel=10 KWh

343,000 KWh



Methodology & Examples – Private Transport



Fuel consumption (Gasoline & Diesel) in Private Transport

What is available?

Fuels consumption for transport (vehicles in general) in upper level e.g. country + number of vehicles

Extrapolations & Substruction



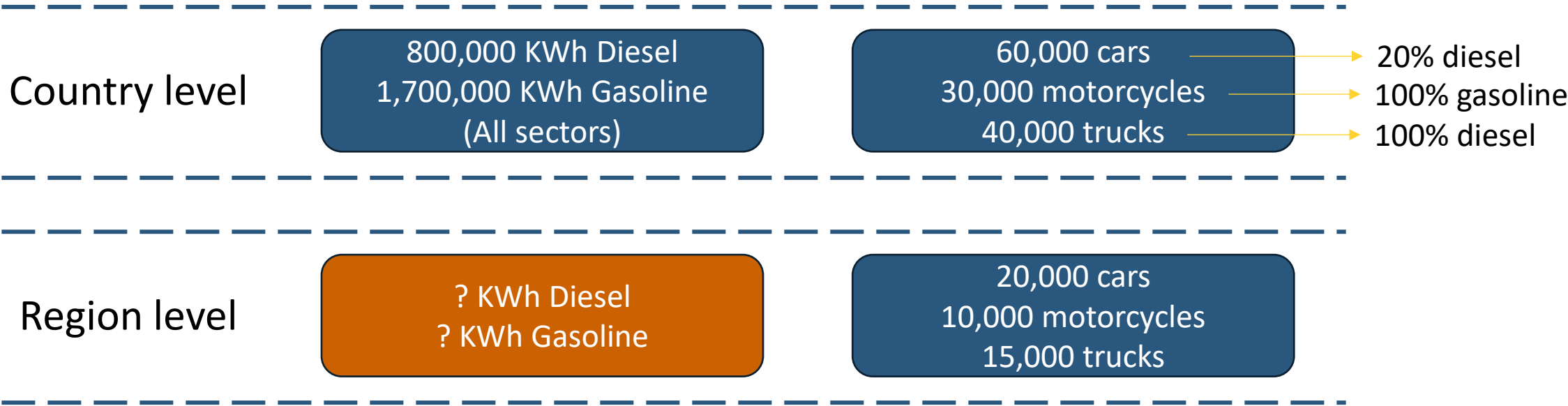
Methodology & Examples – Private Transport



Fuel consumption (Gasoline & Diesel) in Private Transport

Example:

Known data:



Also Known data:

Region level	Municipal fleet	Public Transport	Agriculture Sector
Diesel (KWh)	25,000	40,000	10,000
Gasoline (KWh)	20,000	-	-

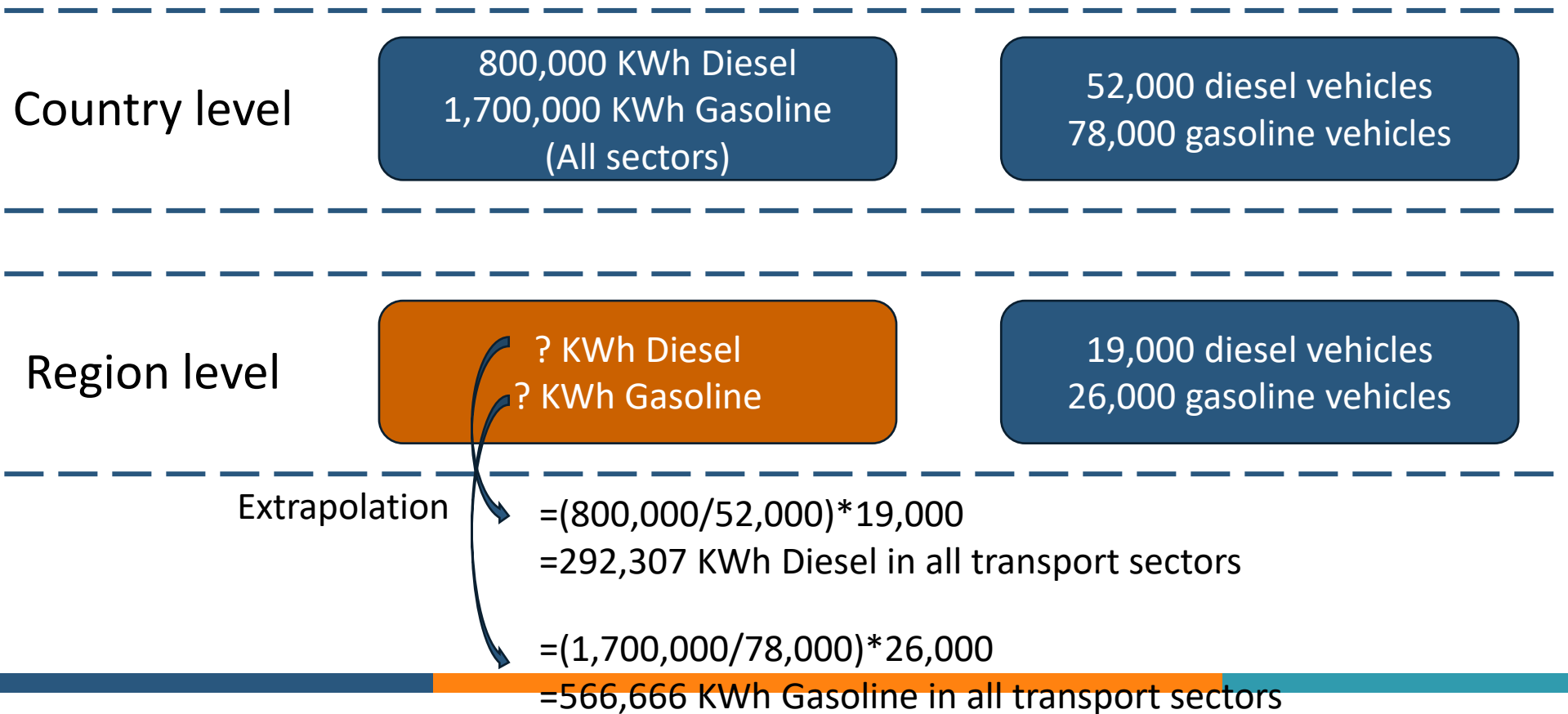


Methodology & Examples – Private Transport



Fuel consumption (Gasoline & Diesel) in Private Transport

Results:



Methodology & Examples – Private Transport



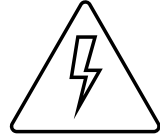
Fuel consumption (Gasoline & Diesel) in Private Transport

Results:

Region level	Municipal fleet	Public Transport	Agriculture Sector	All sectors	Substruction ➡	Private Transport
Diesel (KWh)	25,000	40,000	10,000	292,307		217,307 KWh Diesel
Gasoline (KWh)	20,000	-	-	566,666		546,666 KWh Gasoline



Methodology & Examples – Agriculture Sector



Electricity in Agriculture Sector

What is available?

Ready regional data

Ready to use

Consumption in upper/other level, e.g. country, neighboring regions + cultivated area in both levels

Extrapolation



Diesel in Agriculture Sector

What is available?

Ready regional data

Ready to use

Consumption in upper/other level, e.g. country, neighboring regions + cultivated area in both levels

Extrapolation

Type and area of crops & consumption factors

Multiplication



Methodology & Examples – Agriculture Sector

Example:



Diesel in Agriculture Sector



Type of crop	Area (acres)	Consumption factor (lt/acre)
Vineyards	1000	14
Olive trees	200	10
Grains	500	15

Multiplication



Total diesel consumption (lt)
14,000
2,000
7,500

Sum

=23,500 lt

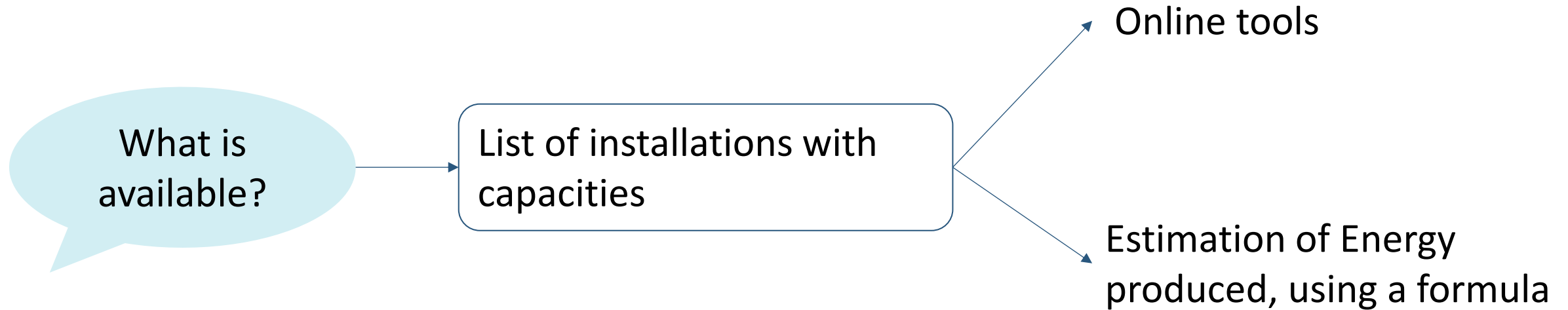
Conversion
10 KWh/lt

=235,000 KWh
diesel for crops

Same method for animals
in livestock farming

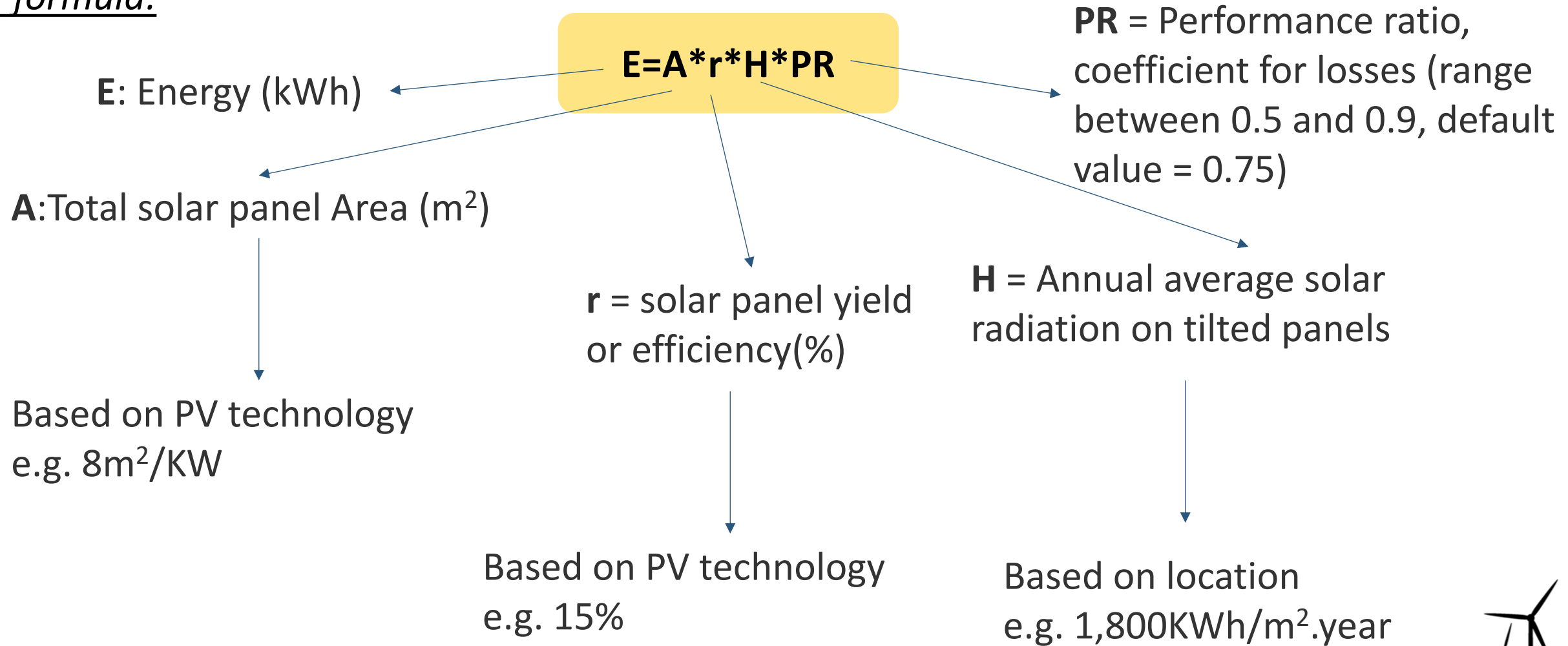


Methodology & Examples – RES



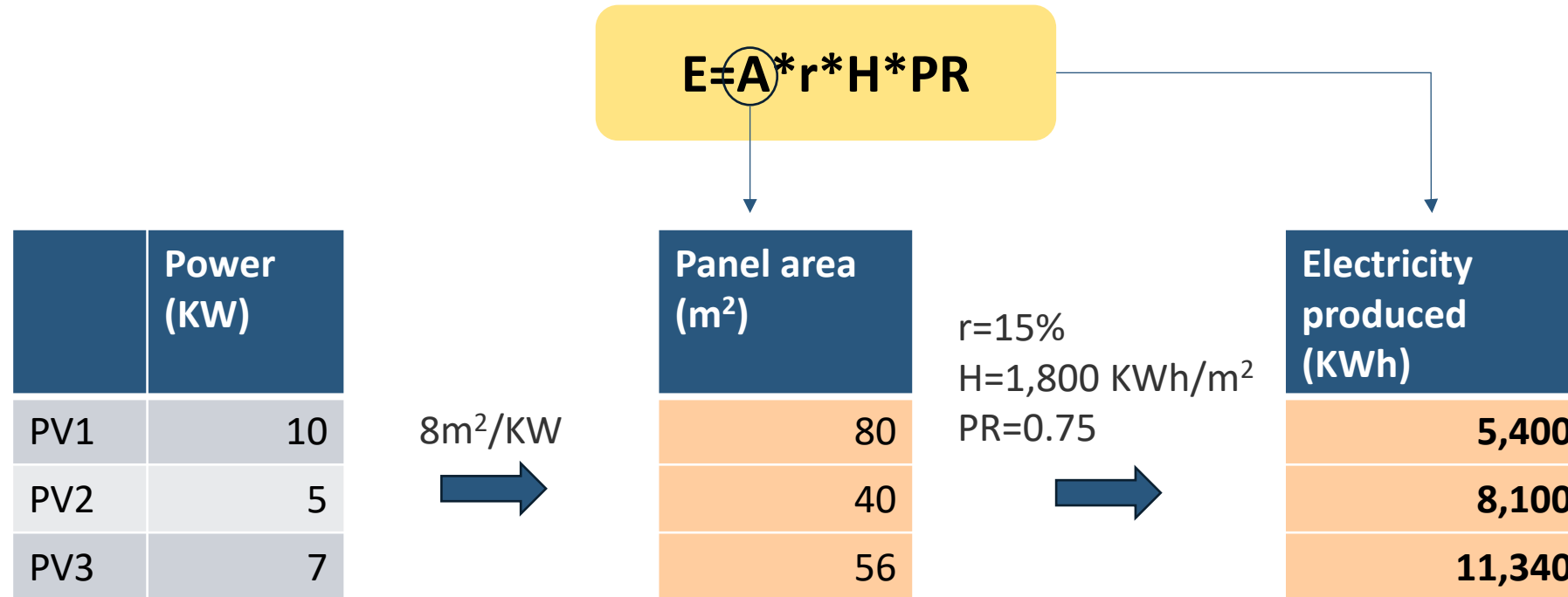
Methodology & Examples – RES

PV formula:

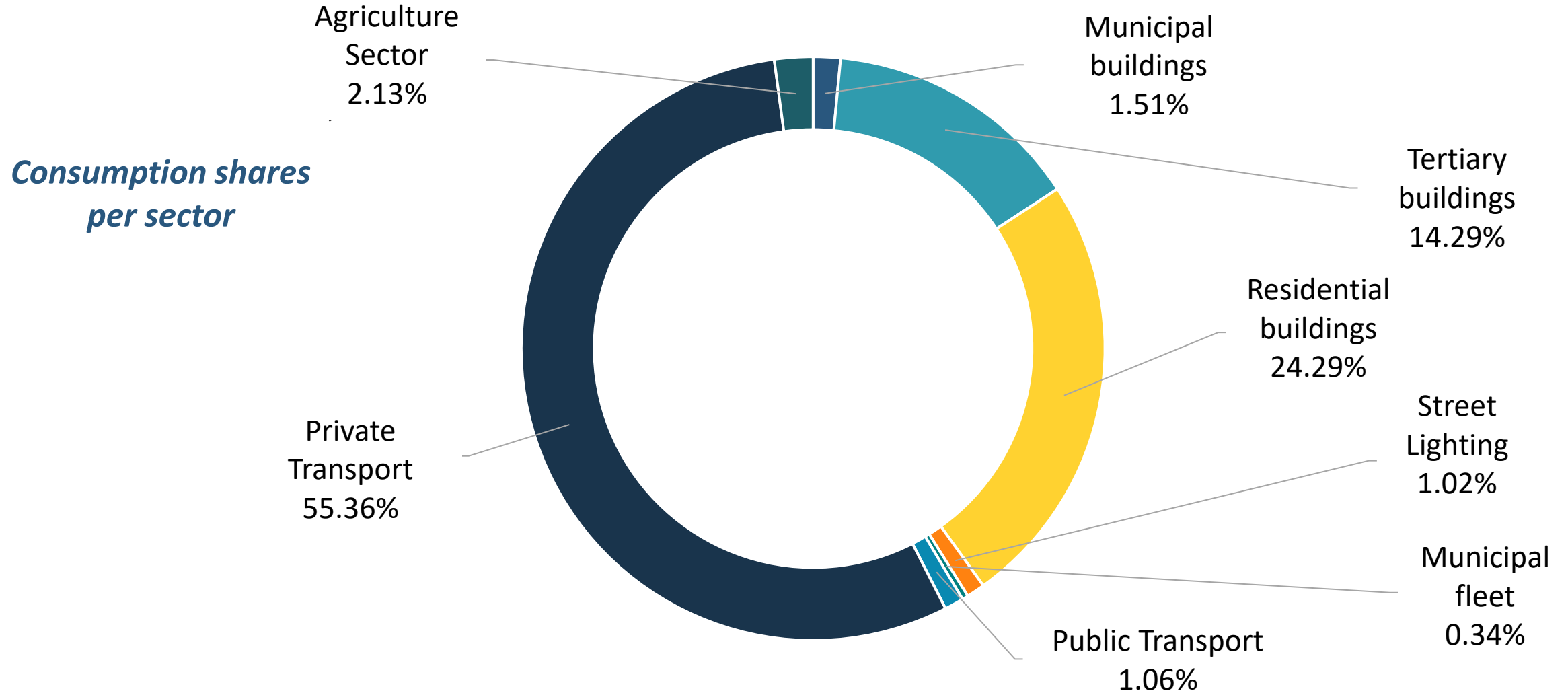


Methodology & Examples – RES

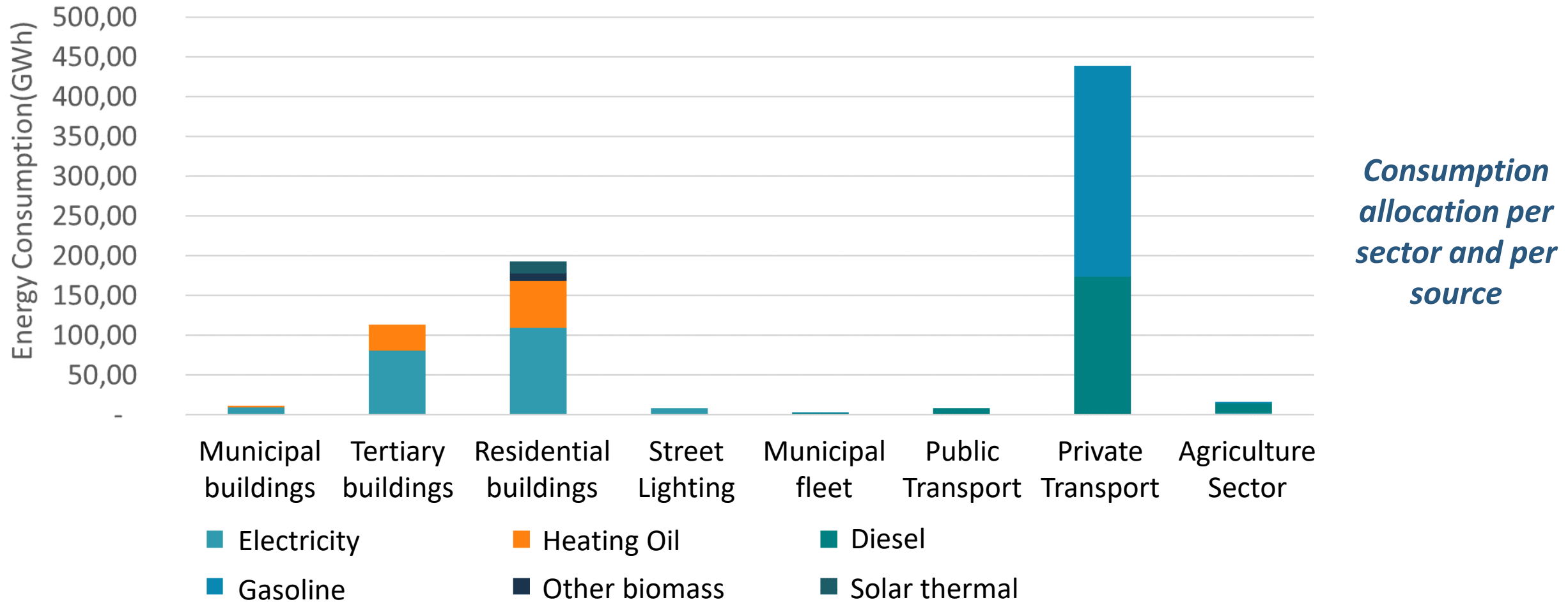
Example:



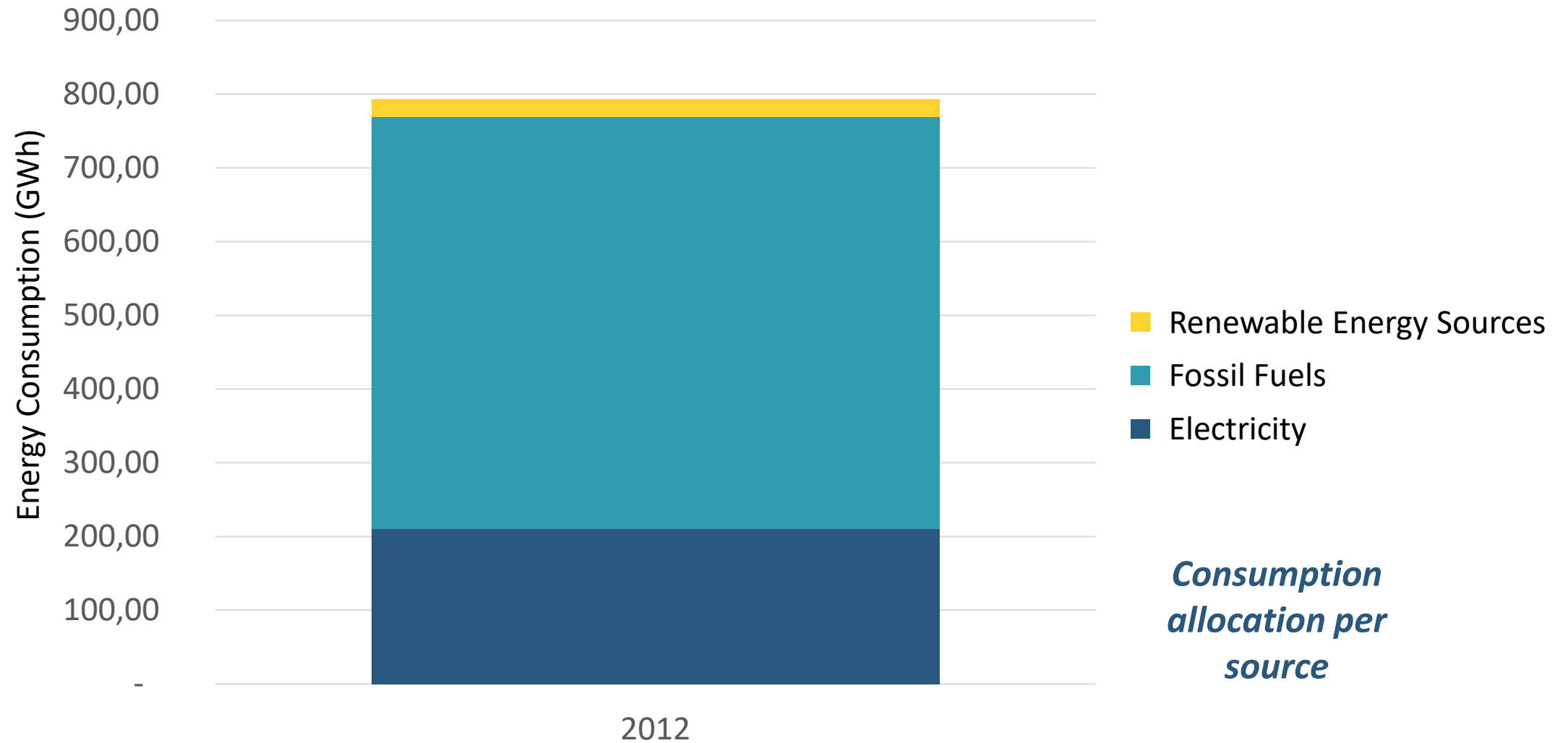
Energy consumption analysis



Energy consumption analysis



Energy consumption analysis



Energy consumption analysis

Useful factors

- Energy consumption/capita (e.g. Heating Oil in Residential/capita)
- Total energy consumption/capita (e.g. Regional Electricity/capita)
- Energy consumption/household (e.g. Electricity in Residential/residence)
- Energy consumption/car (e.g. Gasoline/private car)
- Energy consumption/area (e.g. Electricity in Street Lighting/km²)

Thank you!

Hera Neofytou

Decision Support System Laboratory (ICCS - NTUA)

hneofytou@epu.ntua.gr



Co-funded by the European Union under project ID101076088. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.

For more info, follow our hashtag **#regio1st**, visit our website or contact us:



[Get Started | Regio1st-planning-framework \(fedarene.org\)](https://fedarene.org/regio1st-planning-framework)



[Regio1st - Fedarene](mailto:info@fedarene.org)



Co-funded by the European Union under project ID101076088. Views and opinions expressed are however those of the author(s) only and do not necessarily reflect those of the European Union or CINEA. Neither the European Union nor the granting authority can be held responsible for them.