ASSESSING THE IMPACT OF ENERGY POVERTY IN THE ENERGY SYSTEM THROUGH THE APPLICATION OF A REGIONAL TIMES MODEL: LESSONS FROM A CASE STUDY IN GAUTENG, SOUTH AFRICA

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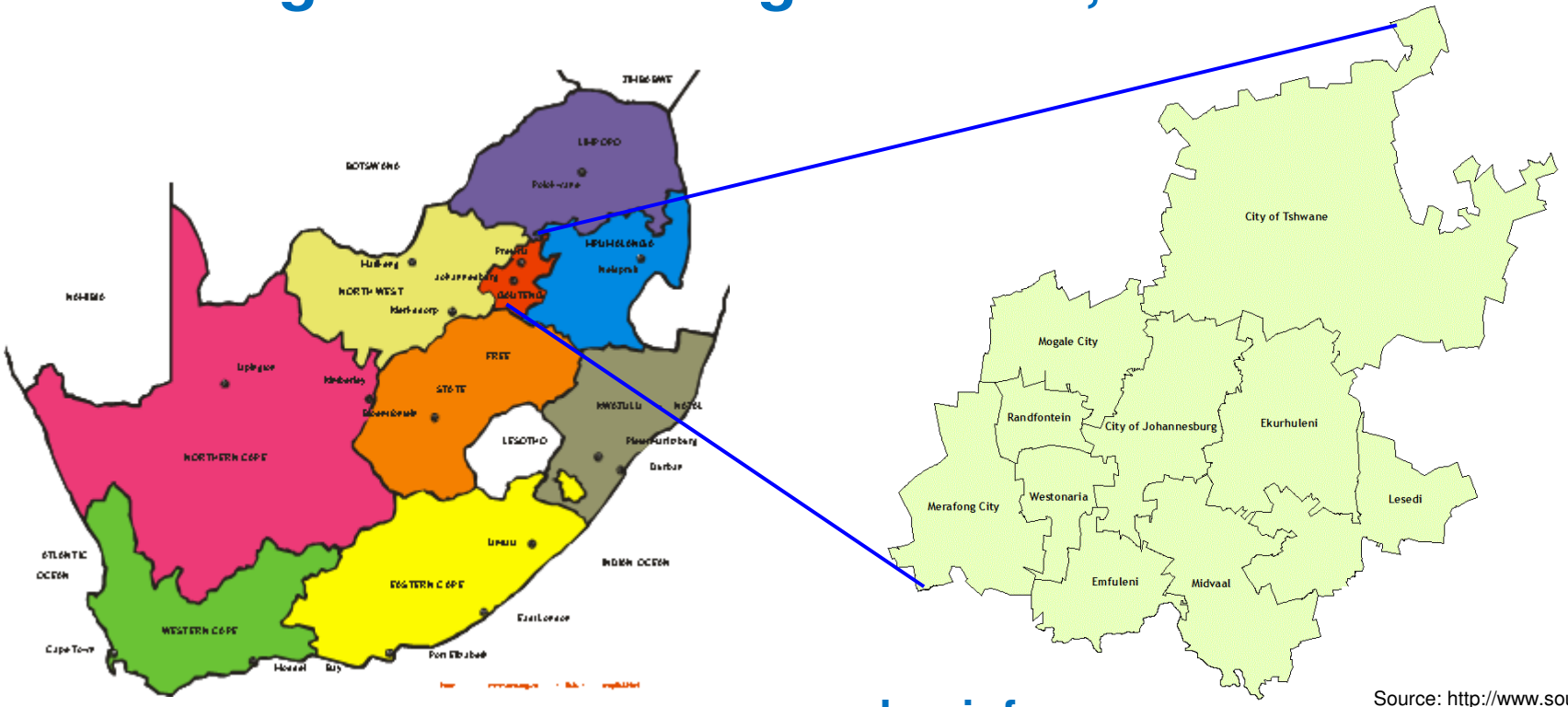
Background: Gauteng Province, South Africa

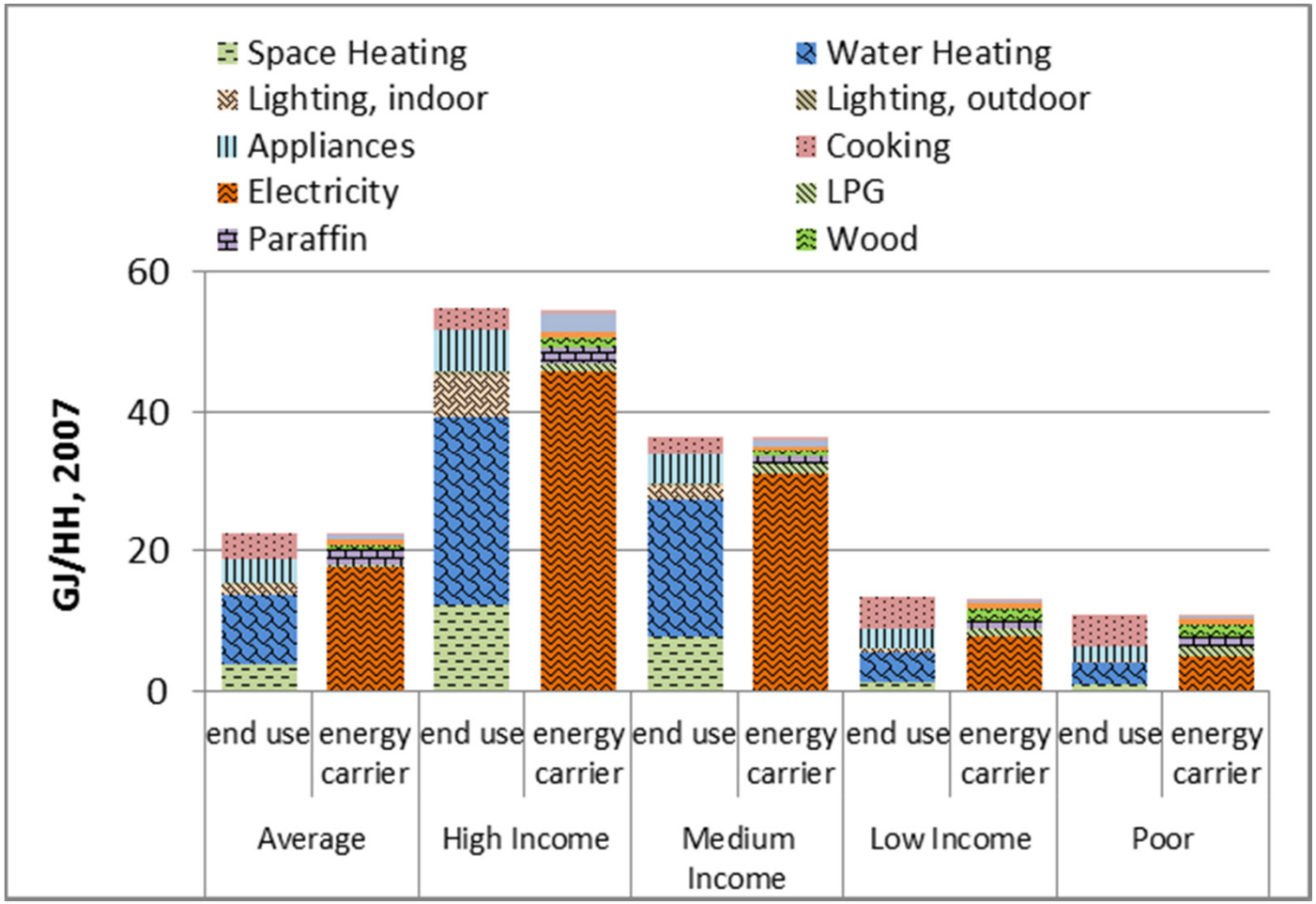


Source: http://www.southafrica.info

www.enerkey.info

Gauteng	
Population	10.4 mil
Households	3.2 mil
Urbanisation	98%
Electrification	84%

Residential energy consumption



Residential sector – Assumptions and drivers of energy demand

Income group	Poor-Income	Low-Income	Mid-Income	High-Income
Annual Income	R1 – R9,600	R9,601 – R76,800	R76,801 – R307,200	R307,201 +
Number of HH	705,224	1,430,872	651,292	388,191
% HHs	22.2%	45.1%	20.5%	12.2%
% total Energy use	4.2%	22.3%	32.2%	41.3%
GJ/HH/a	12.3	13.9	34.7	51.5
Dominant Energy carriers	Electricity (60%), paraffin	Electricity (71.5%), paraffin	Electricity (86.4%), LPG	Electricity (89.1%), LPG
Energy service priorities	cooking, water heating, appliances	cooking, water heating, appliances	water heating, space heating, appliances	water heating, space heating, lighting

Future demand dependent on population and income

Living standards characteristics

DEMOGRAPHICS

- income
- GDP
- population
- households
- ...

POLICIES

- Renewable energy
- Energy efficiency
- Carbon emissions
- Access to energy
- Energy subsidies
- ...

HOUSING TYPE / building materials

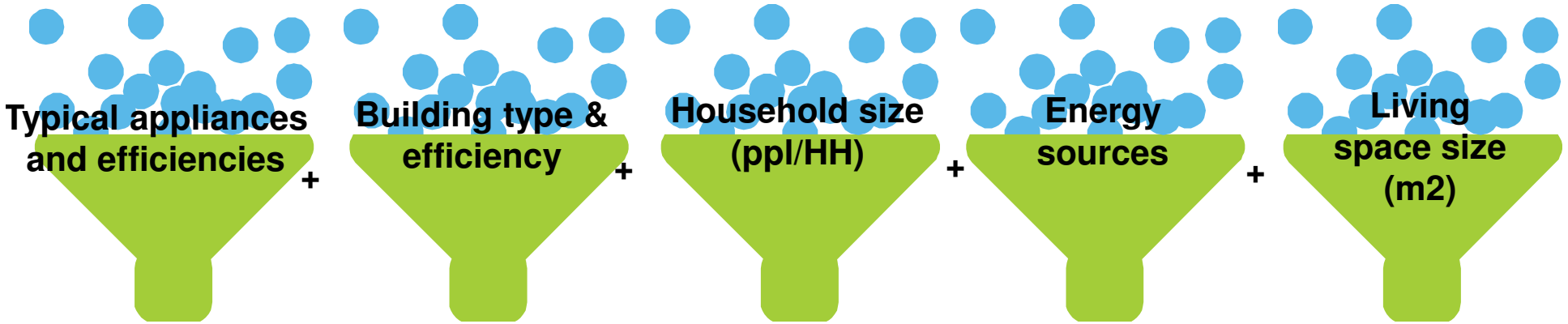
- Free standing
- Semi-detached
- Flats
- Informal
- ...

TECHNOLOGIES / end-uses

- COOKING
  - Gas stove
  - elec stove
- SPACE HEAT
  - Elec
  - GAS
- WATER HEATING
  - Elec geyser
  - SWH
- ...

FUELS

- Electricity
- Gas
- Wood
- Oil
- Solar
- ...



Typical consumption profiles for end-use for each of the different housing types, income groups, living standards (hot water, space heating, cooking profiles)

Residential sector energy system

Energy supply ⟷ **Energy demand**

4. Energy carriers

- Electricity
- Gas/LPG
- Paraffin
- Coal
- Wood
- Solar
- Biomass, other

3. Income specific technologies

For example, income specific SWH, elec. geyser, other technologies

2. Income specific building types, income specific consumption profiles

A House on separate stand

B
- Traditional dwelling
- Flat or apartment in a block of flats
- Semi-detached
- House in backyard
- Room / Flatlet
- Workers' Hostel
- Other (caravan, tent, boat etc.)

C
- Informal in backyard
- Informal in informal settlement

1. Four income groups

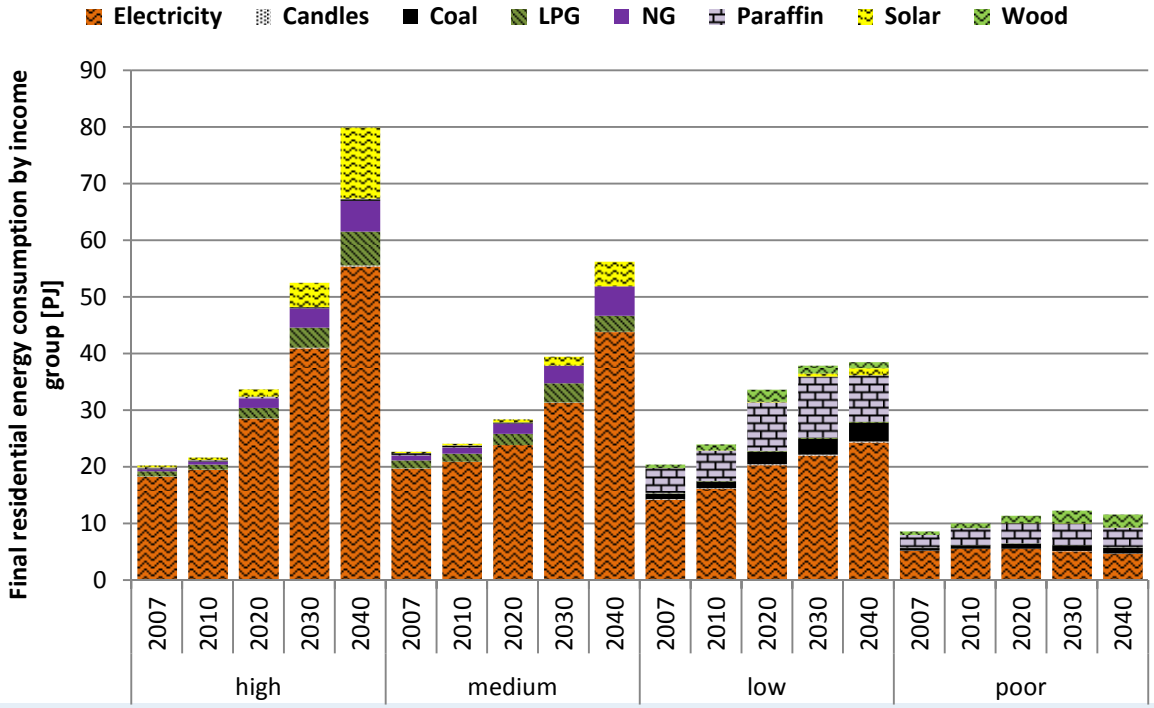
- High income
- Medium income
- Low income
- Poor income

Other factors influencing behaviour

Barriers	Impact
Access	Policies impacting fuel choice (e.g., subsidies, VAT removal)
	Infrastructure (electrification, gas)
Acceptance	Perception / cultural tradition (e.g. smoke)
	Perception (e.g., SWHs)
	perception (e.g., gas is dangerous)
Affordability	High upfront costs of efficient technologies
	Lifestyle choices and purchasing priorities
	Suppressed demand and disposable income

Modelled with a mix of user constraints and discount rates

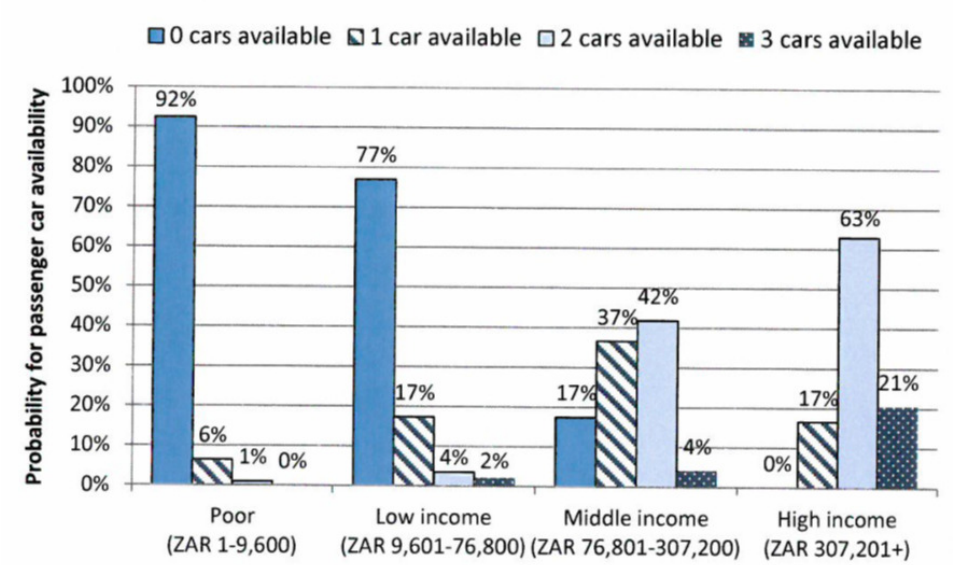
The reference scenario: Residential results

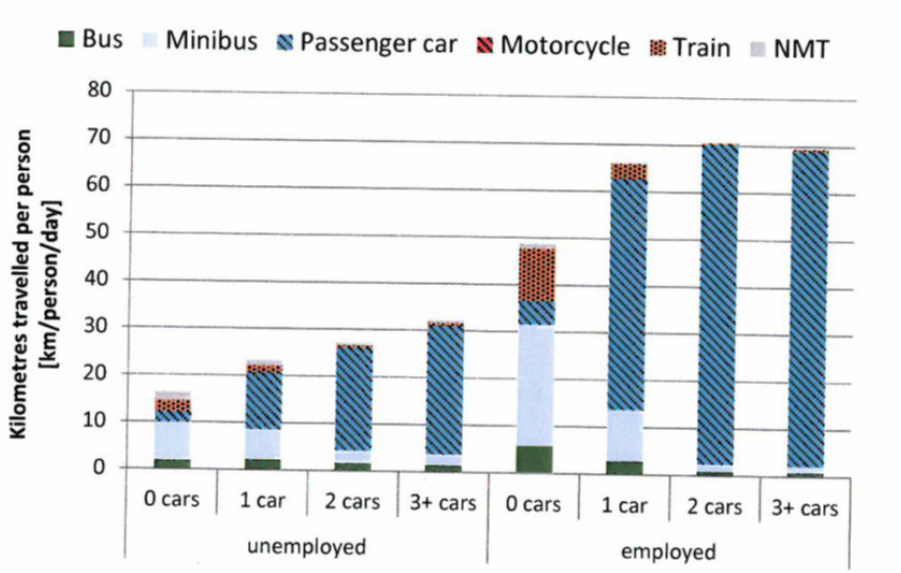


- Different solutions for different income groups
- Each income group has a different motivation for engaging – higher income groups can afford to meet GHG targets, become more efficient, increase comfort and act as forerunners, while lower income households are trying to afford a better living standard and want to save money
- The best solutions are still not necessarily what people do. (e.g. SWH).

Income specific transport characteristics

- Analysis of availability of passenger cars by income class
- Assessment of mode of transport by employment level
- Travel demand characteristics





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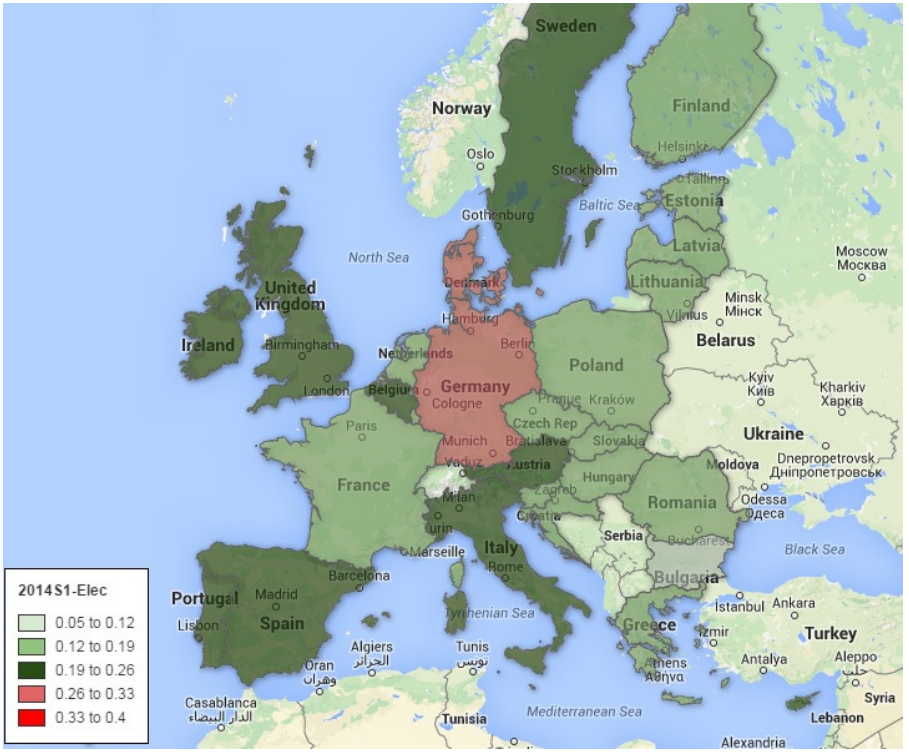
Transferability to German context

- Currently population represented as homogenous
- Available data disaggregation possible by:
  i. type of building,
  ii. number of people per household,
  iii. energy carrier,
  iv. end-use
- **but** not all in combination with income -> data gymnastics required
- Current monitoring of effect of energy transition on energy **affordability** done through means of „sample households“ with the same energy consumption but with a different household income

What do we know about energy poverty in Germany?

Residential electricity prices in Germany

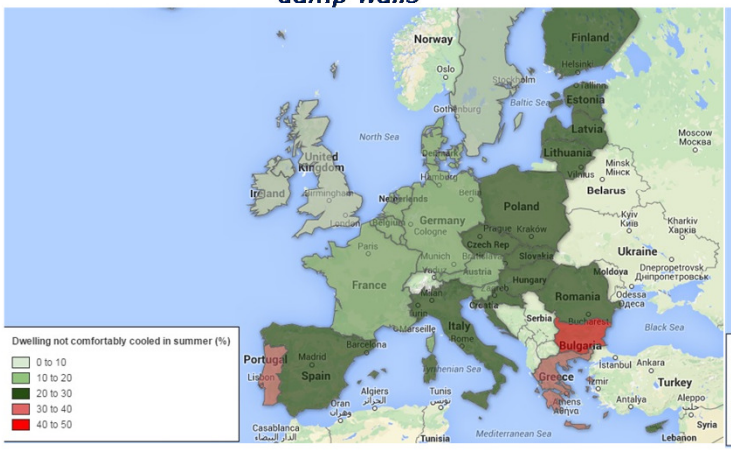


Sources: Prognos 2014, BMWi 2014, VZBZ 2014, Eurostat 2014

Geographical mapping of proxy energy poverty indicators

Share of population with dwellings with leakages and damp walls

Share of population with arrears in accounts



Share of population unable to keep comfortably cool

Share of population unable to keep adequately warm

Germany estimated 5.5 – 11 million people in energy poverty

EU estimated 50 – 120 million ppl

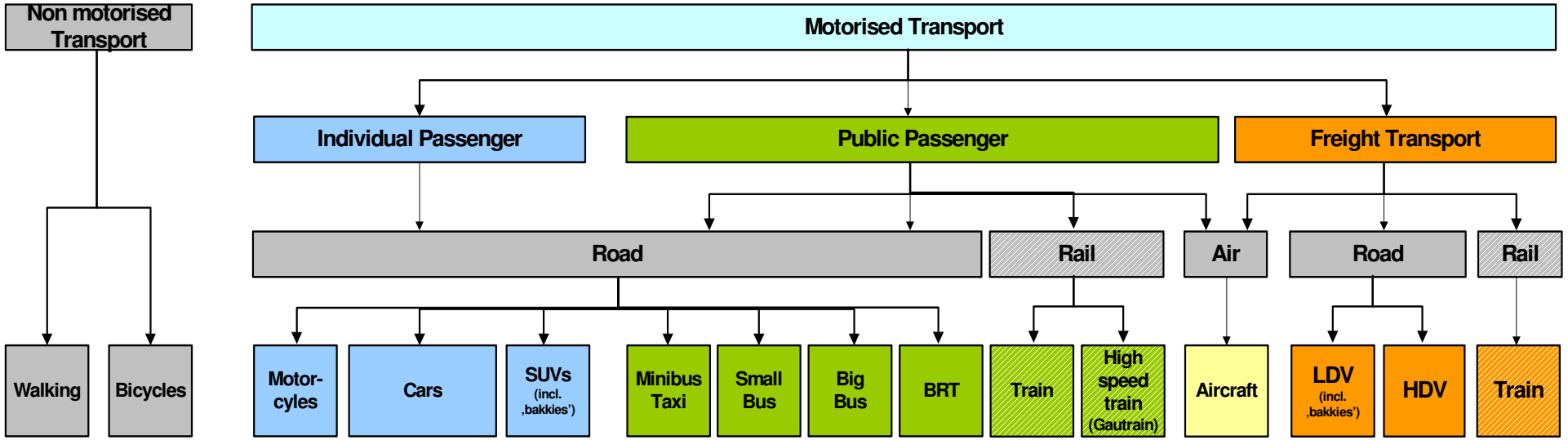
INSIGHT_E project
http://www.insightenergy.org/

Conclusion

- Value in disaggregation
- Income specific recommendations for households and/or countries (?)
- Scale to best capture aspects of energy poverty considering data requirements/availability
- Highlights implications for energy planning and monitoring of the energy transition


Thank you

Transport sector:
modes considered



Source: Tomaschek, 2013

Integration of Gauteng specific transport modes: e.g. minibuses, BRT and Gautrain




TIMES-GEECO: The transport sector

Fuels	Petrol				Diesel				Ethanol (E85)	Biodiesel (B100)	LPG	CNG/SNG	Electricity		Hydrogen		Kerosene
Vehicle technology/ powertrain	Combustion engine	Mild hybrid	Full hybrid	Plug-in hybrid	Combustion engine	Mild hybrid	Full hybrid	Plug-in hybrid	Combustion engine	Combustion engine	Combustion engine	Combustion engine	Battery electric	Trolley/ Grid	Combustion engine	Fuel-cell electric	Jet turbine
Motorcycle	✓																
Car (small)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
Car big (SUV)	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
Minibus	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
Bus (small)	✓				✓	✓	✓	✓		✓	✓	✓	✓		✓	✓	
Bus (big)	✓				✓	✓	✓	✓		✓	✓	✓			✓	✓	
BRT					✓	✓	✓	✓		✓	✓	✓		✓	✓	✓	
Train (passenger)					✓									✓			
Light rail (Gautrain)														✓			
LDV	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓	
Truck	✓				✓	✓	✓	✓		✓	✓	✓			✓	✓	
Train (freight)					✓									✓			
Aviation																	✓

LPG = liquefied petroleum gas
SNG = substitute natural gas
CNG = compressed natural gas

H_2 = Hydrogen

Advanced features:

- Driving profiles
  - i. Highway
  - ii. Urban
  - iii. Rural
- Transport infrastructure investments
  - i. Bus rapid transit
  - ii. High speed train
  - iii. Trolley bus
- Carbon capture and storage (CCS)
- Vehicle-to-grid (V2G) energy storage