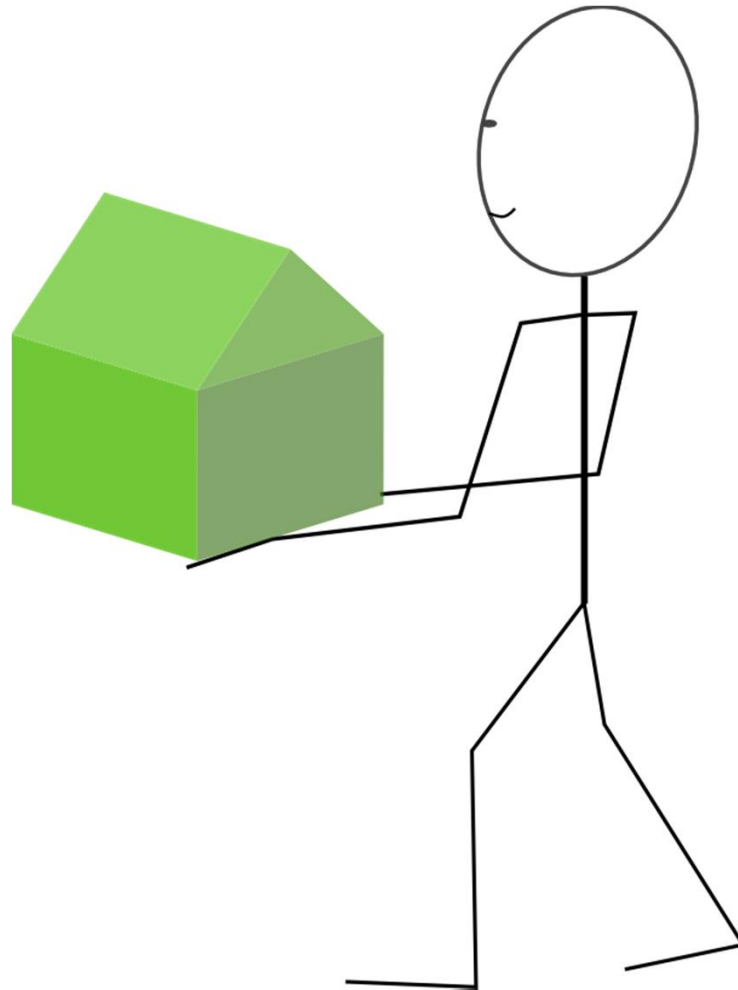
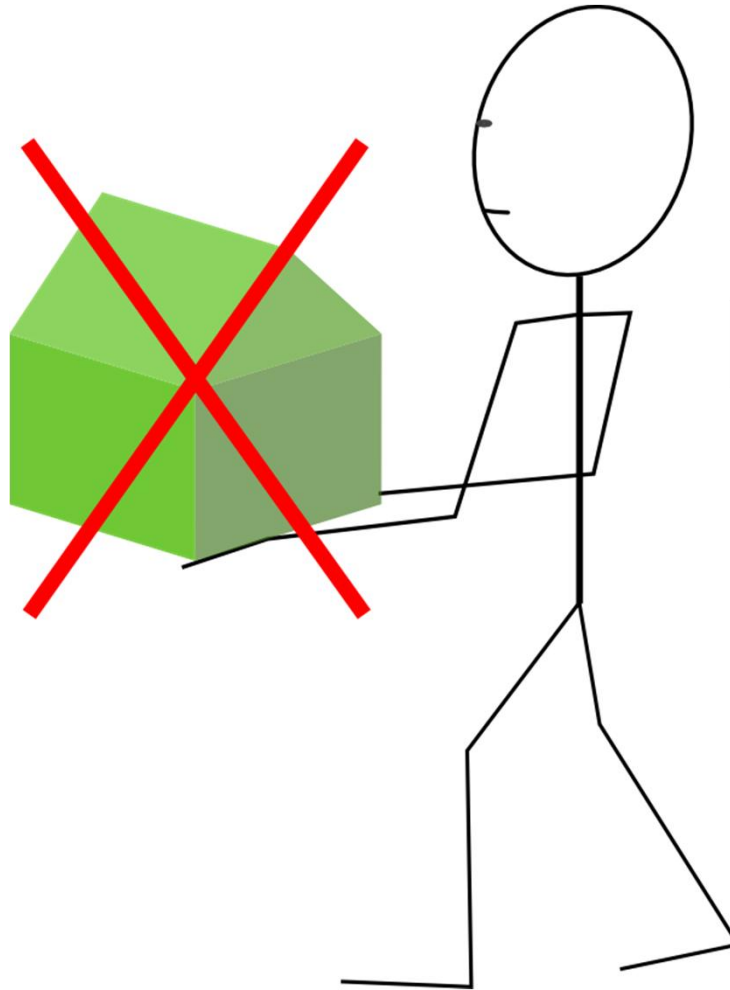

People
move,

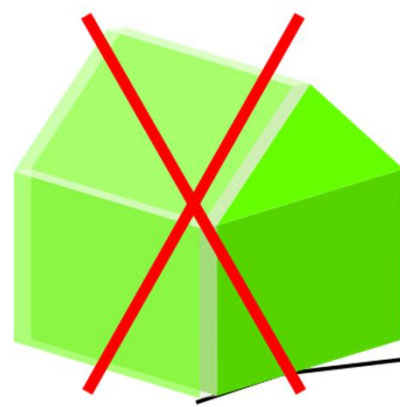


People
move,



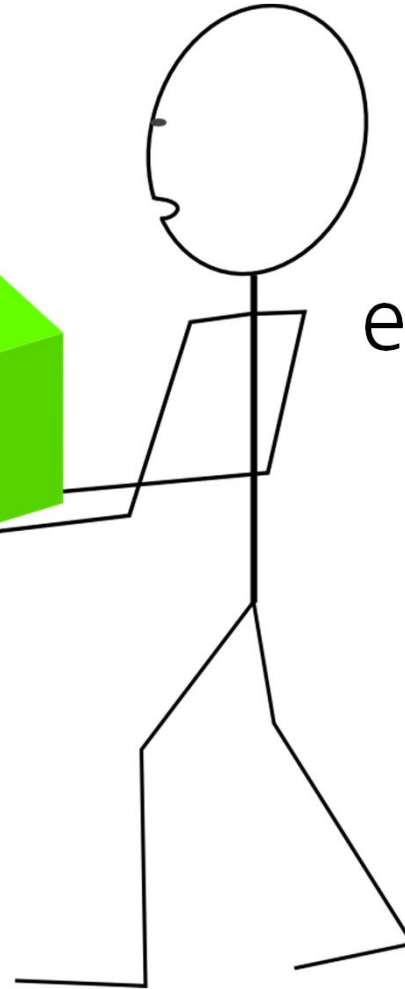
buildings
don't

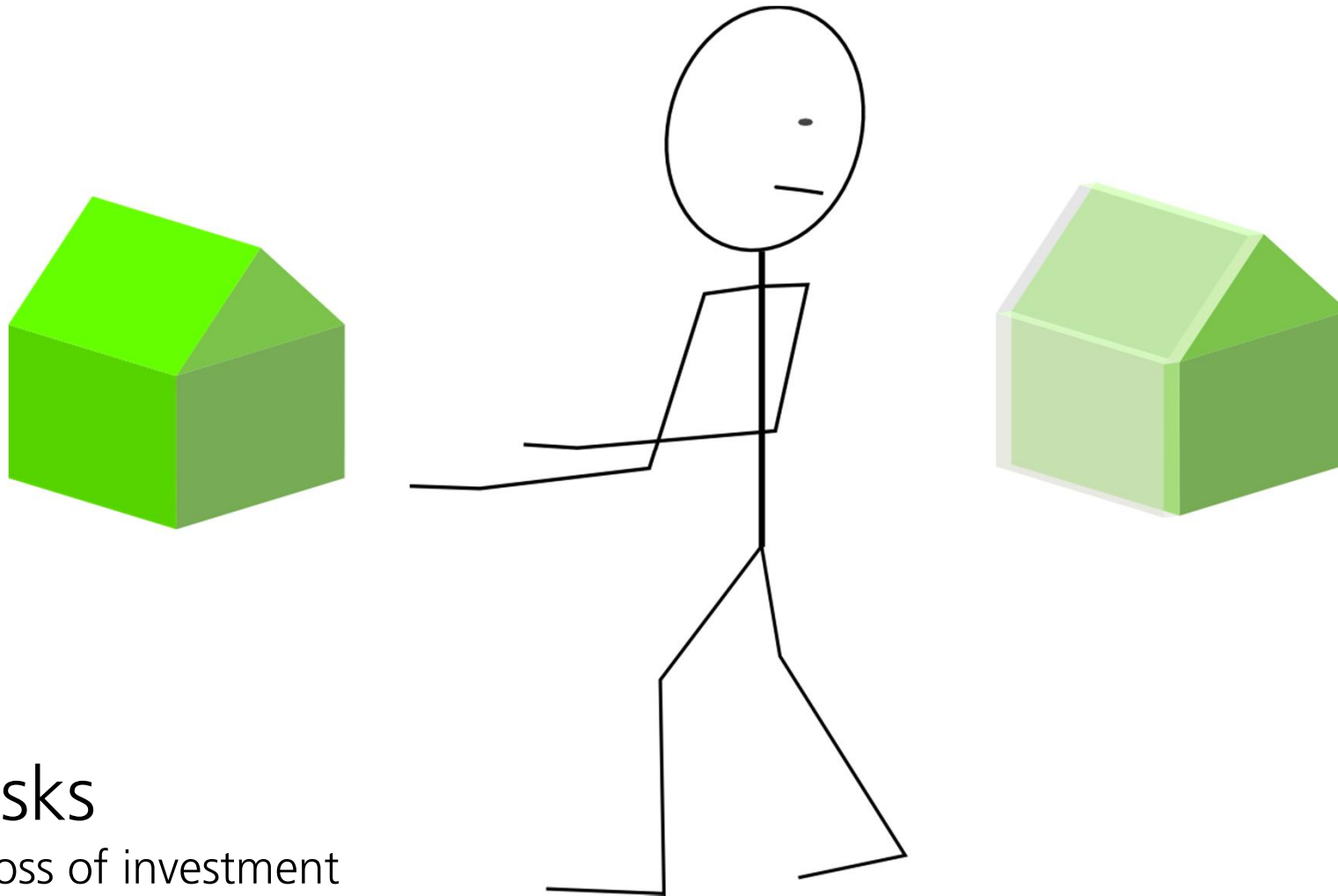
People
move,



energy saving
installations
don't

What is the effect on
energy demand?





Risks

- Loss of investment
- Loss of energy savings
- Possibly subsidised with governmental funds

HOW LOCAL CONDITIONS AS **DEMOGRAPHIC MIGRATION** AND **BUILDING STRUCTURE** AFFECT **ENERGY EFFICIENCY** IN **BUILDINGS**

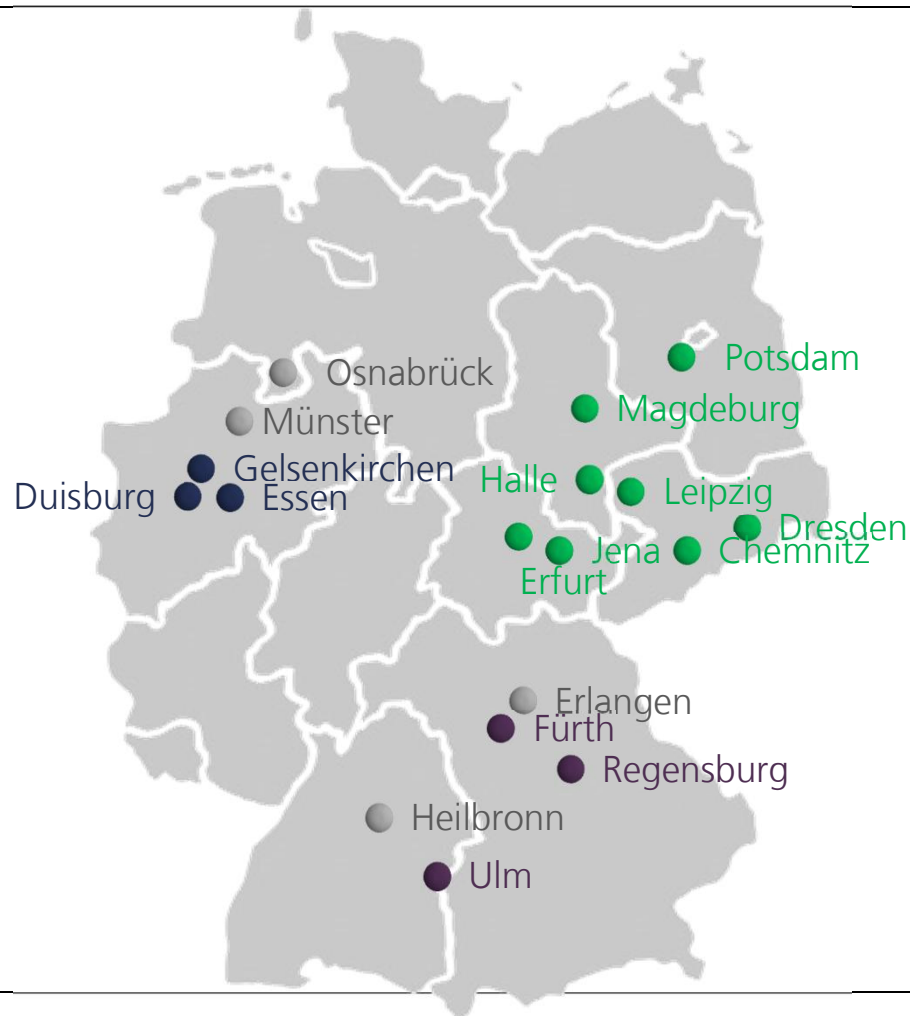
An analysis on major German cities.

Judit Kockat
Panel 3: Local Action

Migration and Building Retrofit

- Evidence the importance of migration for building retrofit by showing 2 main points:
 1. How does **energy demand change** due to migration?
 2. **Rebound**: Why demand rises when population shrinks?
 3. Change in investment and loss potential.
- Outlook: How can energy savings benefit from migration processes?

Aspect 1 How does energy demand change due to migration

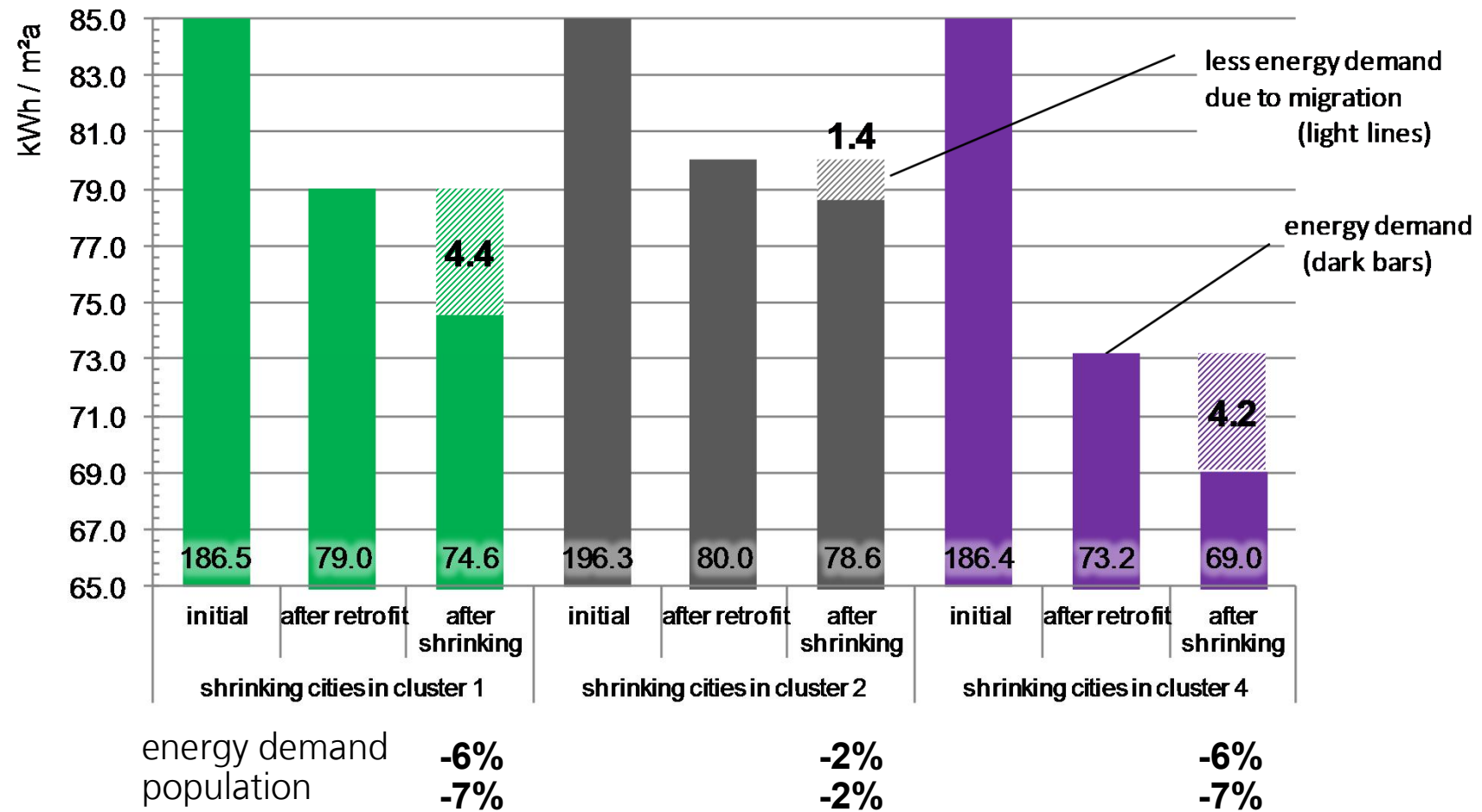


city clusters based on
building stock (age, type)

Separating the Clusters'
growing &
shrinking shares

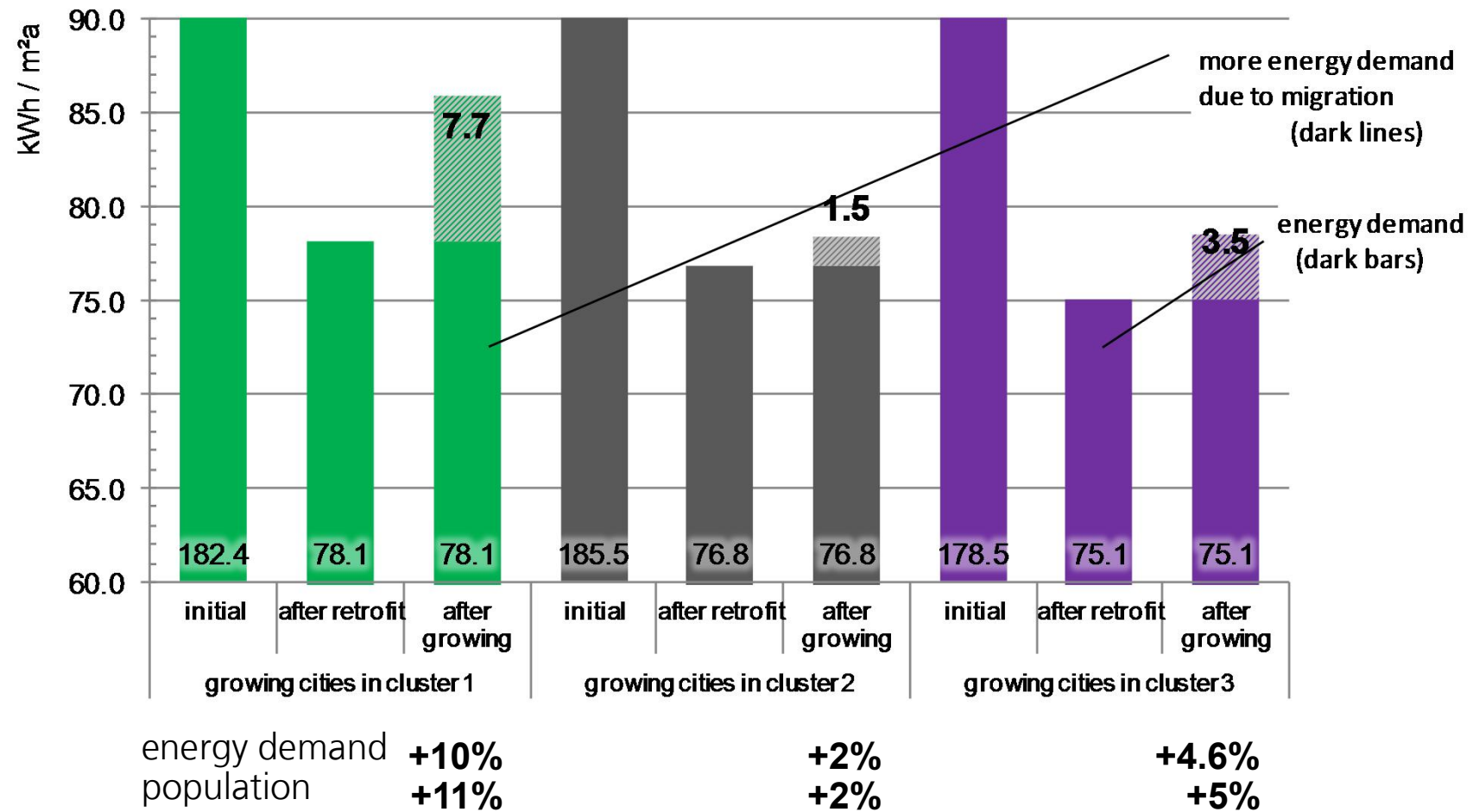
Aspect 1 How does energy demand change due to migration

shrinking cities



Aspect 1 How does energy demand change due to migration

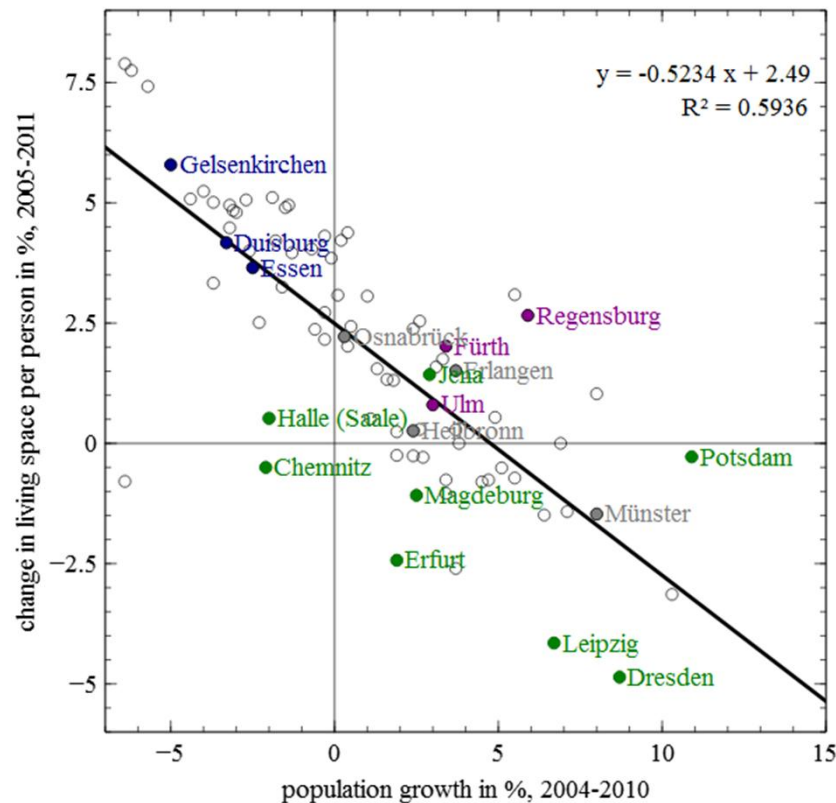
growing cities



up to 10% additional demand in growing cities,
7 – 10% of that due to structural change in building stock

Aspect 2

Why demand rises when population shrinks



Rebound: correlation between population growth and space use intensity

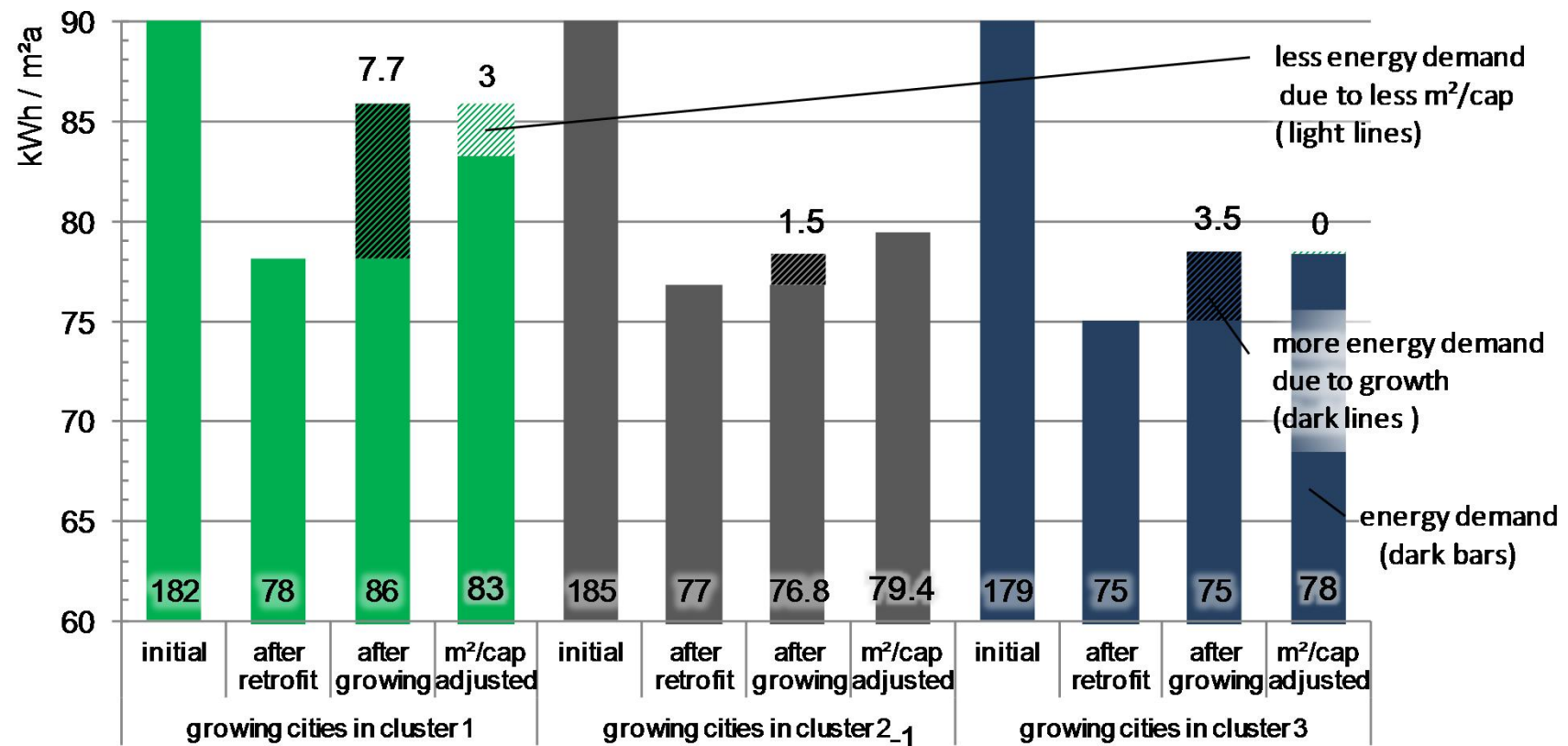
results from multiple, overlapping effects, for example

- Growing m² per person due to shrinking household sizes
- Shrinking m² per person due to

based on wegweiser-kommune.de, 2014

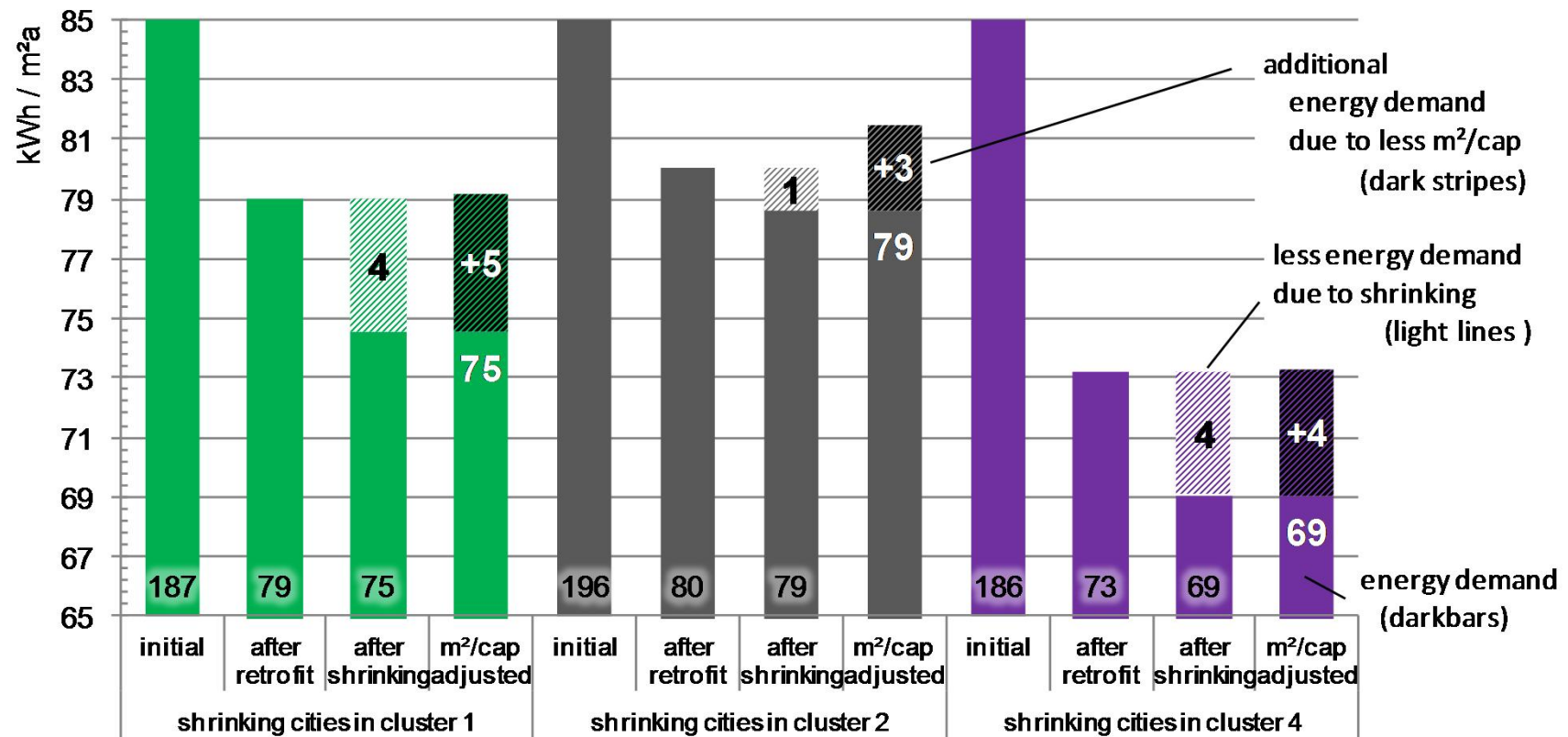
Aspect 2 Why demand rises when population shrinks

growing cities

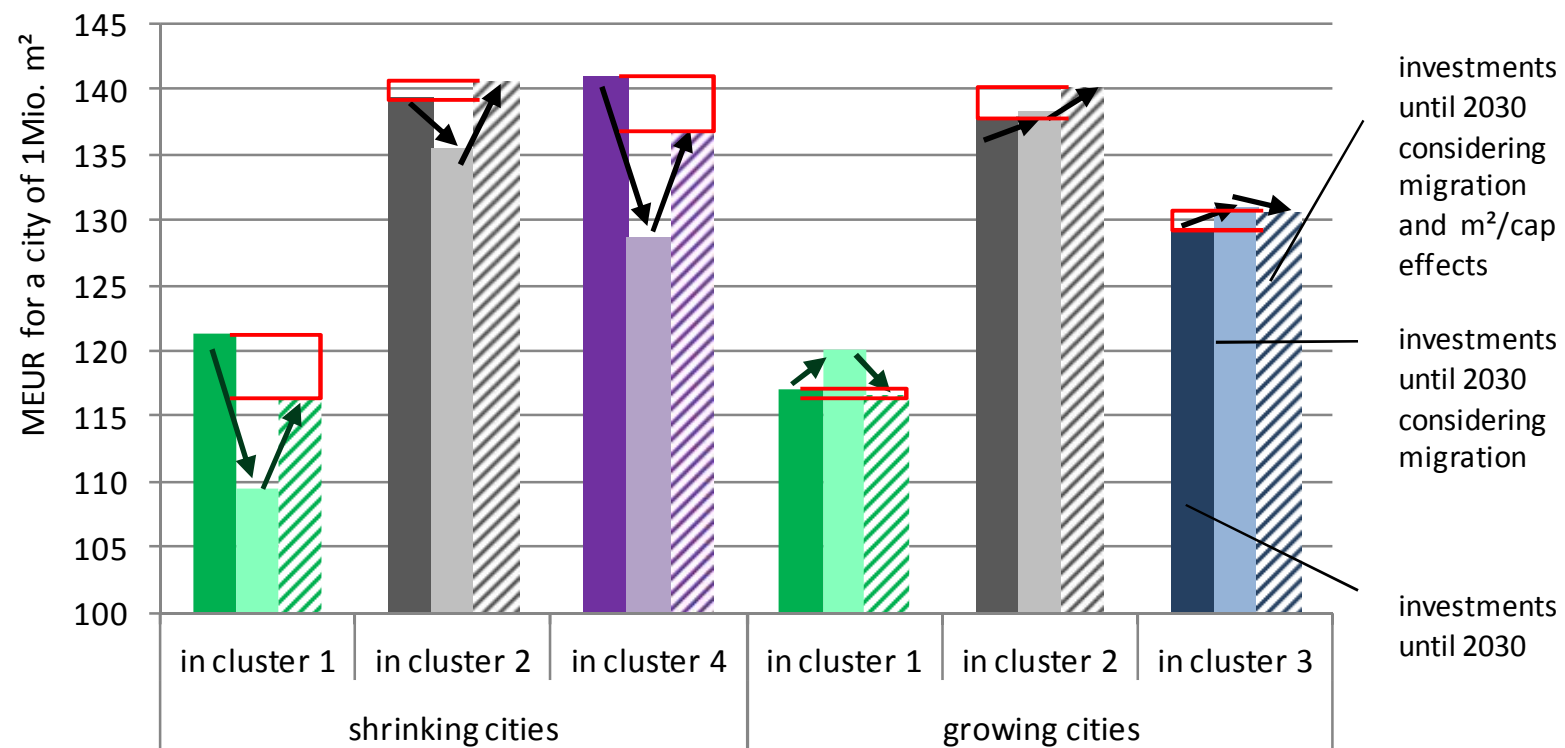


Aspect 2 Why demand rises when population shrinks

shrinking cities



Aspect 3 What investments are endangered to be misplaced?



Aspect 3 What investments are endangered to be misplaced?

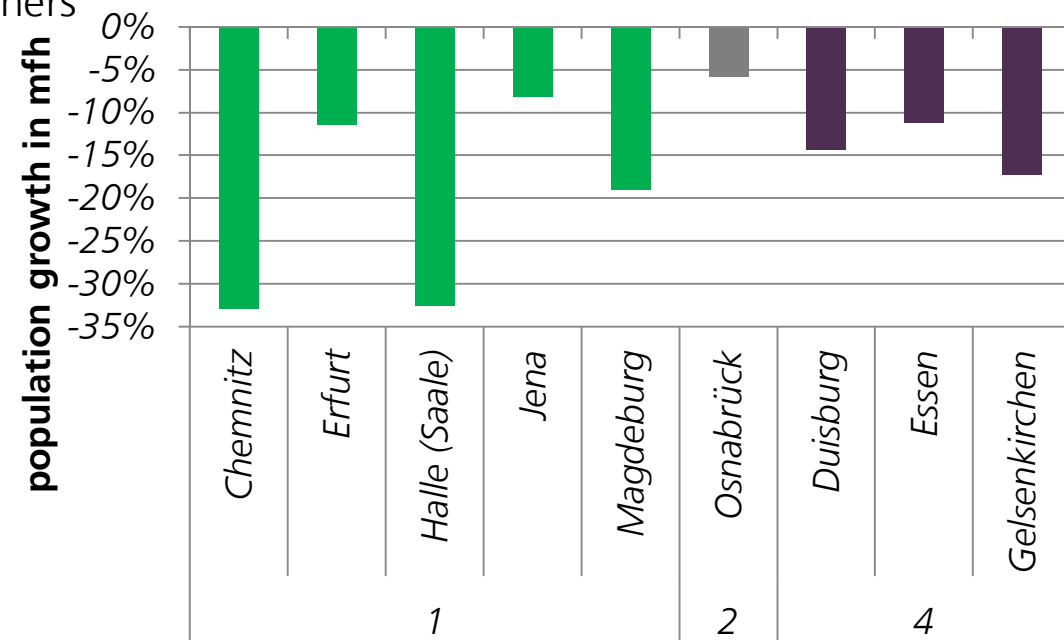
Shrinkage takes place in **multifamily homes** built between **1949 and 1978**, because these are usually

- far away from the city center
- rented
- unattractive surrounding

Certain actors more affected than others



Judit Kockat
© Fraunhofer ISI



Conclusion

We have seen

- the impact of demographic migration is significant **locally** and **by actor**
- a risk of misguided investment is existent
- building stock structure/ shift has a minor influence

Outlook : What can we do to benefit from migration? What do we still need to learn?

- Completely identify the **points of interaction**, where policy and the city can lead the development initiated by demographic migration
- Can investment risk be reduced i.e when urban planning informs about:
Which city parts will be shrinking most? Where is investment wanted?
- Consider the replacement of old buildings by new ones.
- Consider the migration within political targets.
- Avoid the rebound effect with designated political instruments.

wegweiser-kommune.de, 2014. *database query on demand*.

Aktualisierung der Bevölkerungsvorausberechnung: Methodische Erläuterungen. http://www.wegweiser-kommune.de/documents/10184/21656/Erlaeuterungen_Bevoelkerungsvorausberechnung_2030.pdf/14d2b9fe-d88e-4055-a3b1-de8a0bd35b70

Gemeindetypisierung – Wegweiser Kommune: Methodisches Vorgehen und empirische Befunde. http://www.wegweiser-kommune.de/documents/10184/21656/Methodik_Clusterung.pdf/05a1b137-7dbf-4bf4-828d-9a097a4f3805

Statistisches Bundesamt, 2014. ZENSUS 2011 (2014) - Gebäudezahlen nach Baualtersklasse, Wohneinheiten, Außenwände und Eigentümerstruktur: *database query on demand*.

Repenning, J. et al, 2014. **Klimaschutzszenario 2050**. Studie im Auftrag des Bundesministeriums für Runde 1. Bundesministerium für Umwelt, Naturschutz, Bau und Reaktorsicherheit, Berlin. <http://www.oeko.de/oekodoc/2019/2014-604-de.pdf>, <http://www.oeko.de/oekodoc/2065/2014-638-de.pdf>

Diefenbach, N., Loga, T., 2011. Basisdaten für Hochrechnungen mit der Deutschen Gebäudetypologie des IWU. Neufassung August 2011; Institut Wohnen und Umwelt GmbH, 2003. Deutsche Gebäudetypologie: Systematik und Datensätze 05/03, Darmstadt, 9 pp.

Kranzl, L., Hummel, M., Müller, A., Steinbach, J., 2013. Renewable heating: Perspectives and the impact of policy instruments. Energy Policy 59, 44–58. 10.1016/j.enpol.2013.03.050. www.invert.at

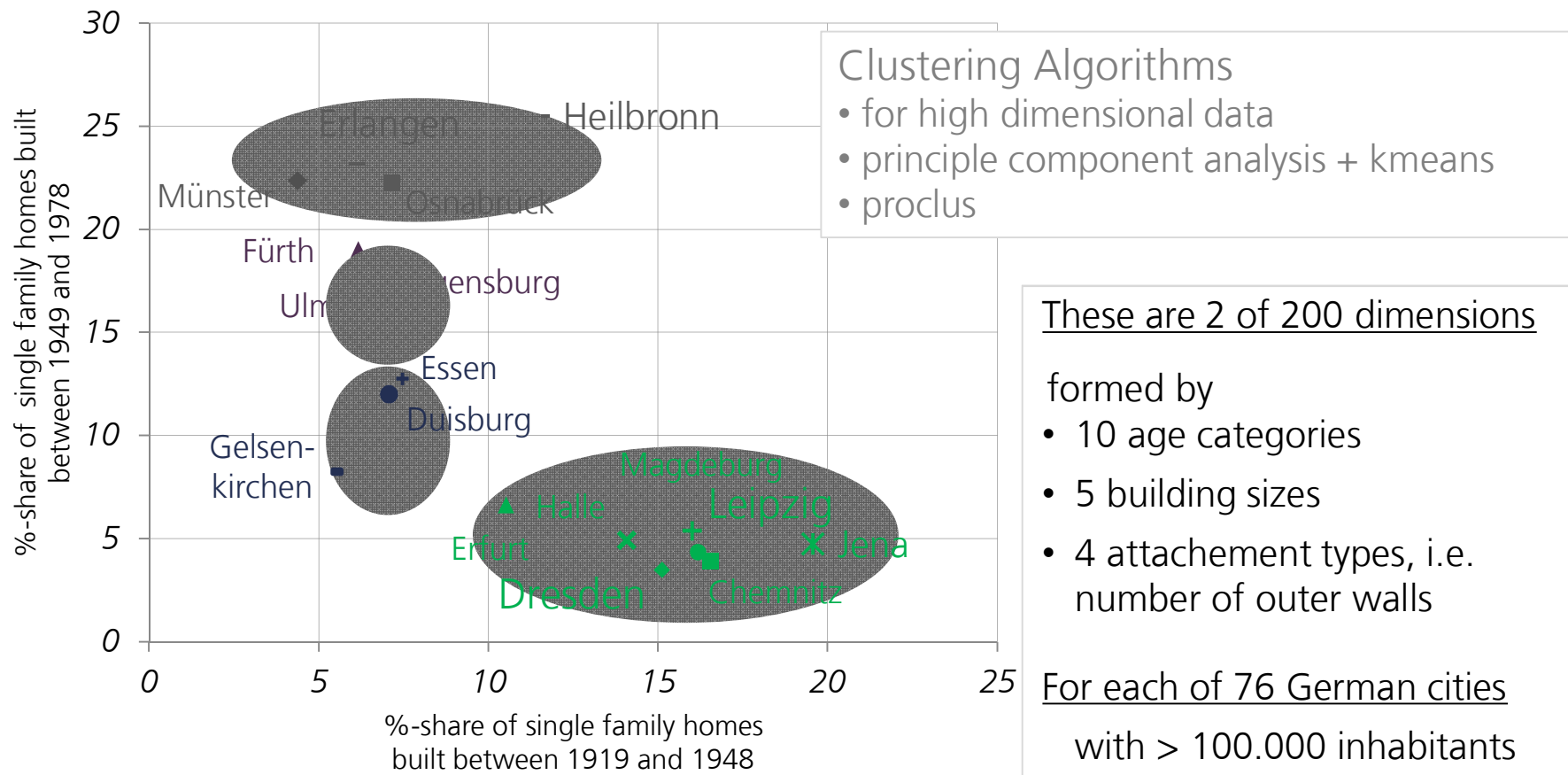
Questions?

THANK YOU FOR YOUR ATTENTION.

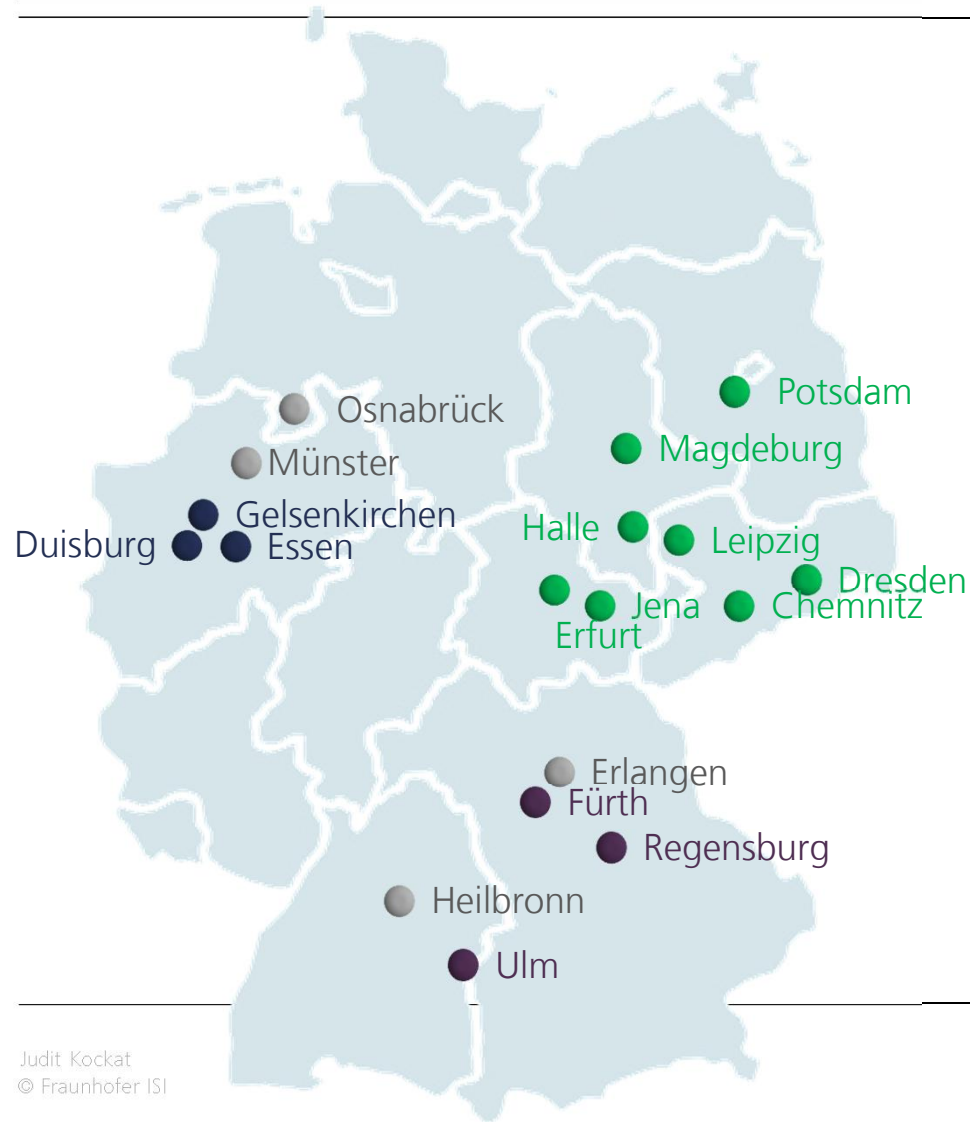
Back-up

Cities with similar building stock

allow the comparison of the energy demand's behavior



Clustering Algorithms and Results



Clustering Methods

- PCA + kmeans
- Proclus, an algorithm for high dimensional data

Tools

KNIME, elki, RealStatistics

Pre-war & prefabricated

Rapid growth until 80th

60s peak Ruhr

Moderate durable growth

Approach to determine the *Migration effect on energy savings in buildings*

Step 1:

City Clustering

Cluster German cities with respect to their building stock

Building stock:
age, building sizes,
attachment types

Step 2:

Energetic Retrofit

Compare

i) energy demand

ii) energy savings

ii) Investments for
energetic retrofit
without and

Step 3:

Migration Effect

with migration

Step 4: Impact on Macro Economy

Step 5:

Suitable Policies

Analyse policy
instruments and
strategies that are
suitable to direct the
effect of the
migration in a
desired manner

Step 6:

Policy Effects

Diskuss the effect of
suitable policies



Energetic retrofit options and their costs

implemented
policy

<i>Energetic quality</i>	average u-value roof	average u-value wall	average u-value window	average u-value floor
Wohngebäude				
Bestand				
unsaniert	0.58	0.77	2.00	0.70
Sanierungsoption ab 2009 EnEV09	0.24	0.36	1.30	0.43
Sanierungsoption ab 2020	0.21	0.30	1.04	0.37
Sanierungsoption ab 2030	0.18	0.25	1.04	0.31

<i>Costs by building class</i>		flächenspezifische Kosten Instandsetzung pro m ²	Kosten Standard Renovierung pro m ²	Kosten Renovierung 1 pro m ²	Kosten Renovierung 2 pro m ²
Index	Envelope quality name				
295	EFH_dooo_2005_reno_EnEV09	99	281	331	562
296	EFH_dooo_2006_reno_EnEV09	86	242	285	485
297	EFH_dooo_2007_reno_EnEV09	86	244	287	489
298	EFH_dooo_2008_reno_EnEV09	86	243	286	486
299	EFH_dooo_ab 2009_reno_EnEV09	70	199	234	397
300	RH_fooo_bis 1918_reno_EnEV09	68	192	226	385
301	RH_fooo_1919 - 1948_reno_EnEV09	69	196	230	392
302	RH_fooo_1949 - 1957_reno_EnEV09	72	203	239	407
303	RH_fooo_1958 - 1968_reno_EnEV09	66	187	220	374

Heating demand

$Q_h =$ heat losses

$Q_h =$ transmission losses

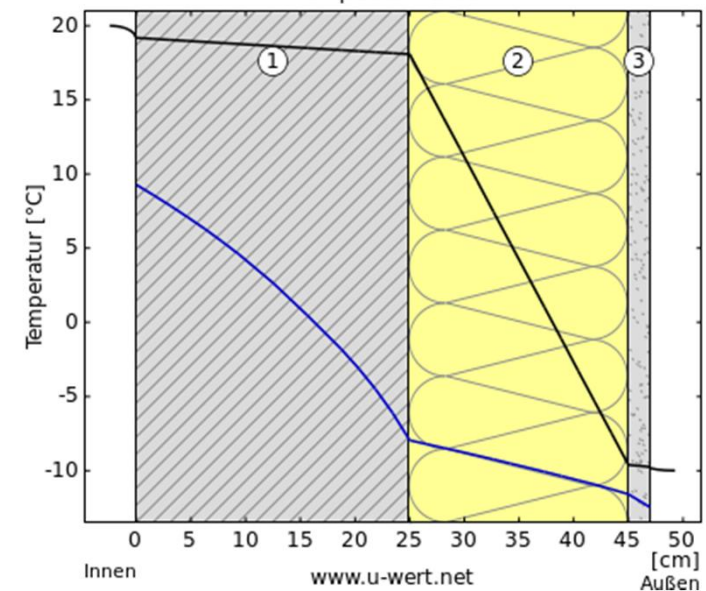
$$Q_h = \sum [t (\vartheta_{i,h} - \vartheta_e) \times (\sum (f_i A_i U_i))]$$

varied for different scenarios

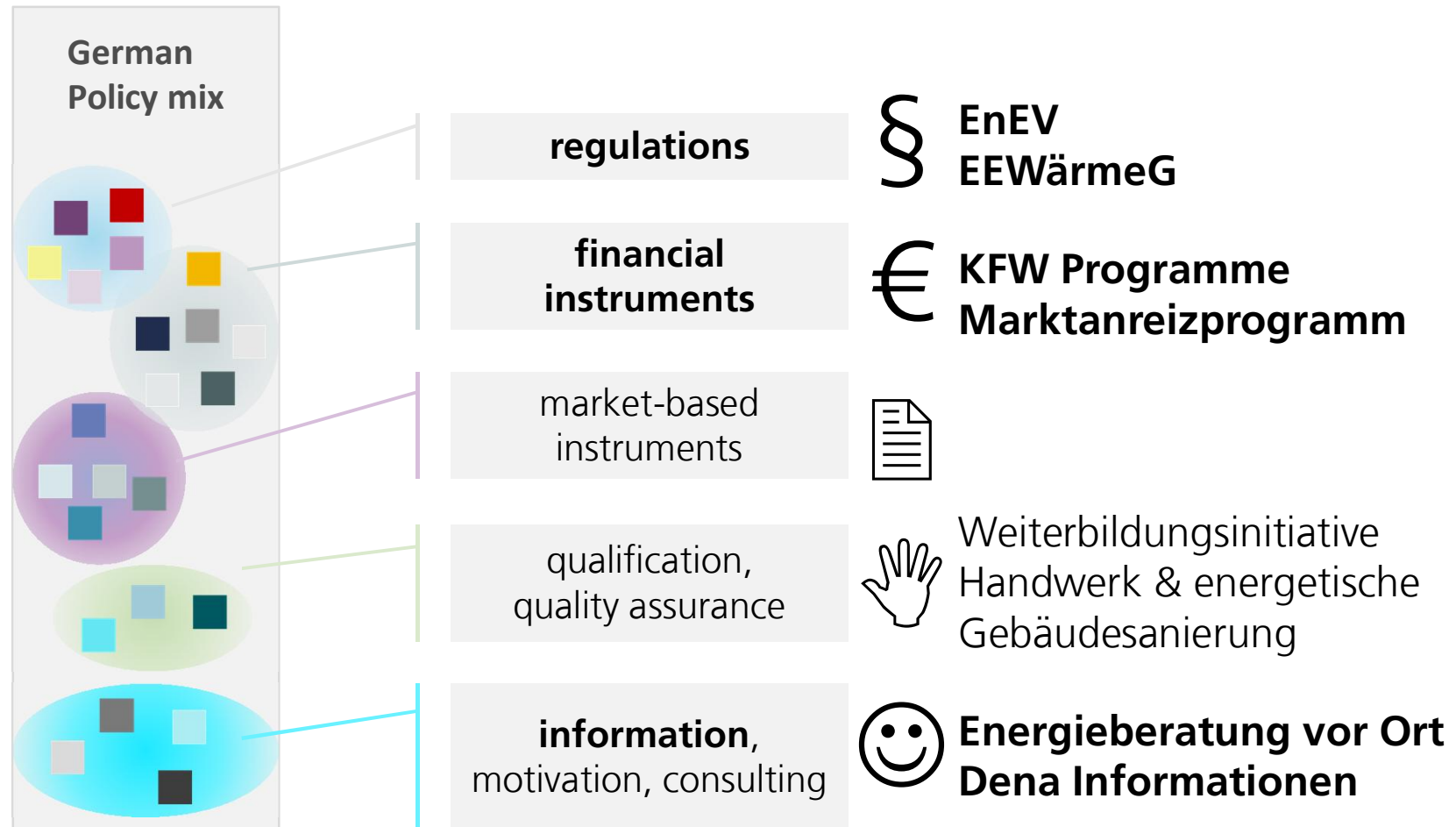
- The heat transfer coefficient (U, U-value) of an insulation layer depends on the thermal conductivity (λ) and on the thickness of the layer (d) ab:

$$U = \frac{\lambda}{d}$$

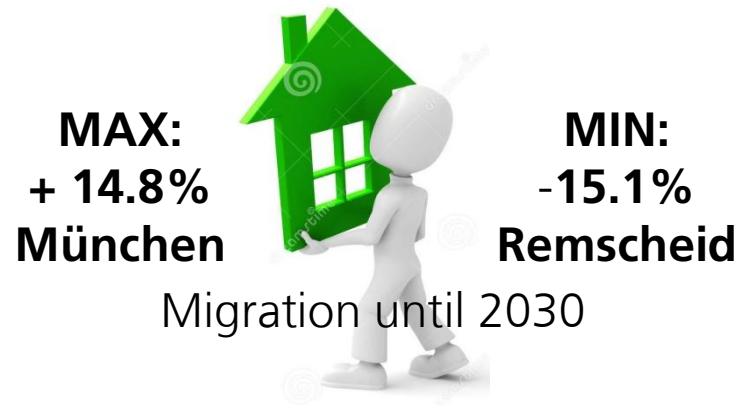
(source: aggregated from DIN V 4108-6 and 4701-10)



National **policies implemented** in Invert/EE-Lab



Possible effects of migration on energy demand and efficiency efforts



when a city grows

space **use** is **intensified**

new buildings

price levels increase

ambitious renovations
become **feasible**

when a city shrinks

risk of vacancy rises

renovated building may become vacant

energy **savings are not realized** as projected
cost are **not recovered**

risk **increases financing** cost

Fewer/ less ambitious renovations remain feasible

negative investment signal due to risk

**What is the dimension of the
migration effect?**

Take away

up to 10% additional demand in growing cities,

7 – 10% of that due to *structural change in building stock*

up to 6% less demand in shrinking cities ,

19 – 23% of that due to structural change in building stock

Hence, there is a strong link to migration, however, the building stock influence is 7 – 23%.

Certain housing associations face an increased risk in shrinking cities.

The dimensions of the effect of growth on energy demand are significant, thus there is a need to *integrate urban and energy planning*.

Future research:

How can a city's **urban planning unit support retrofit actors** in reducing the investment risk?

- *Price levels and investment amounts*
- empirical evidence on, *what city parts/ buildings become vacant* first