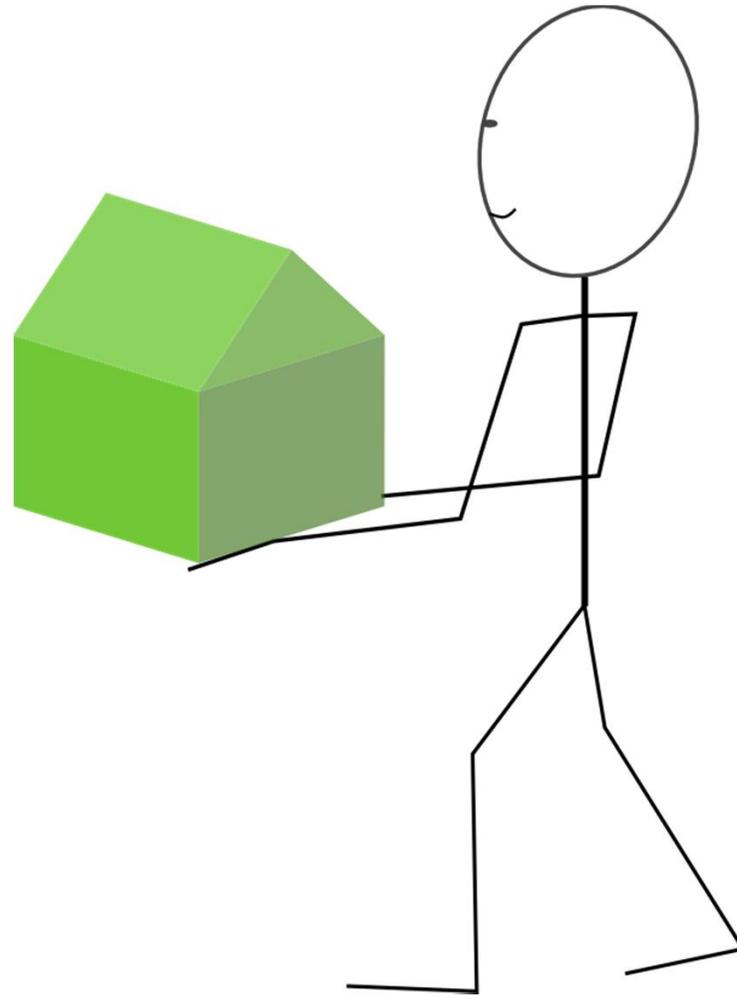


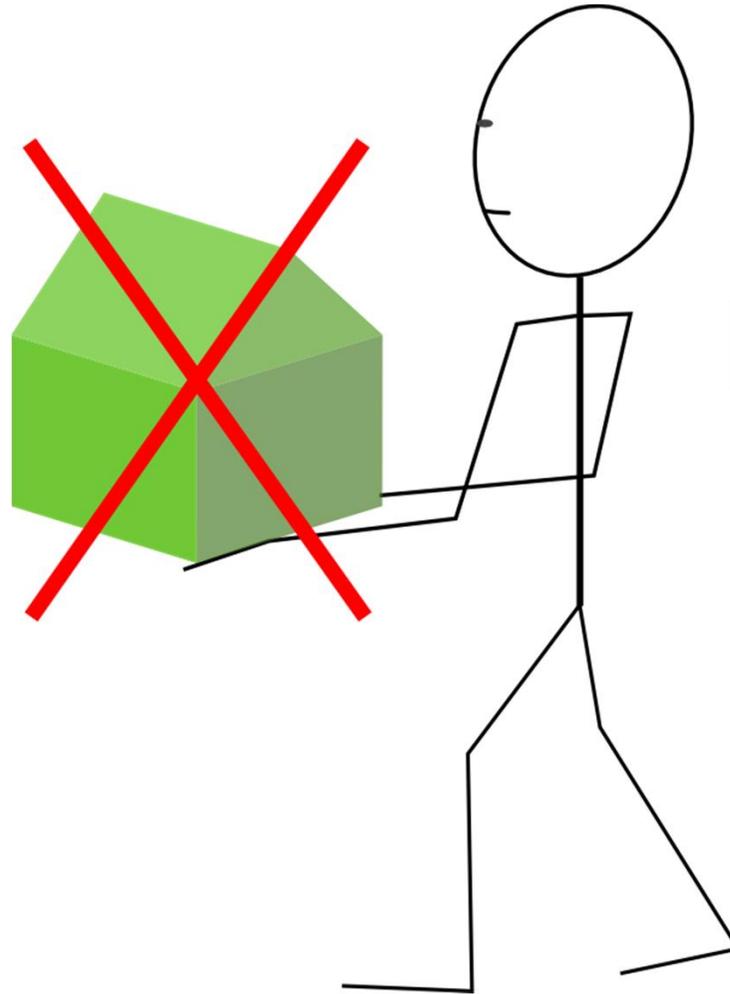
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People  
move,



---

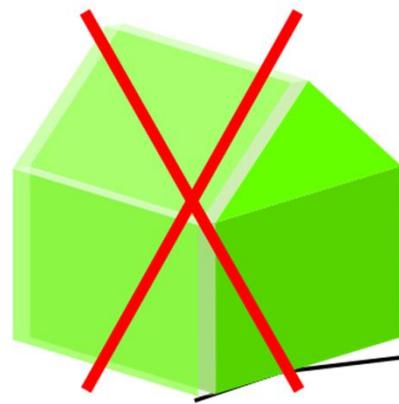
People  
move,



buildings  
don't

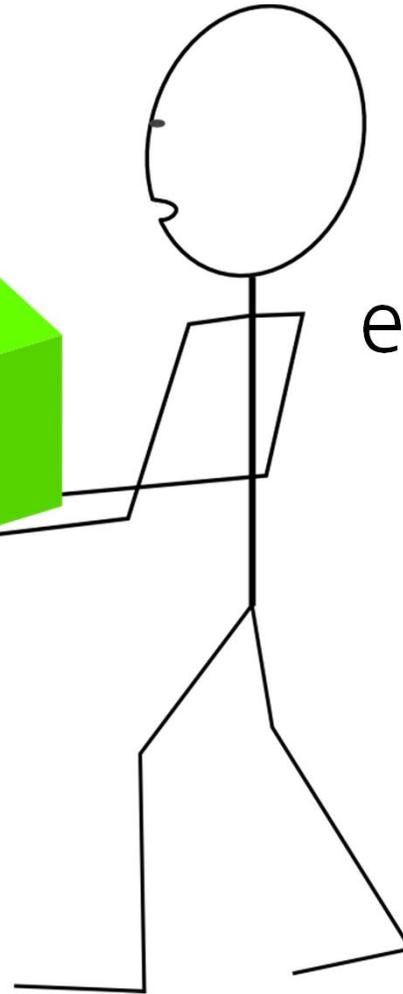
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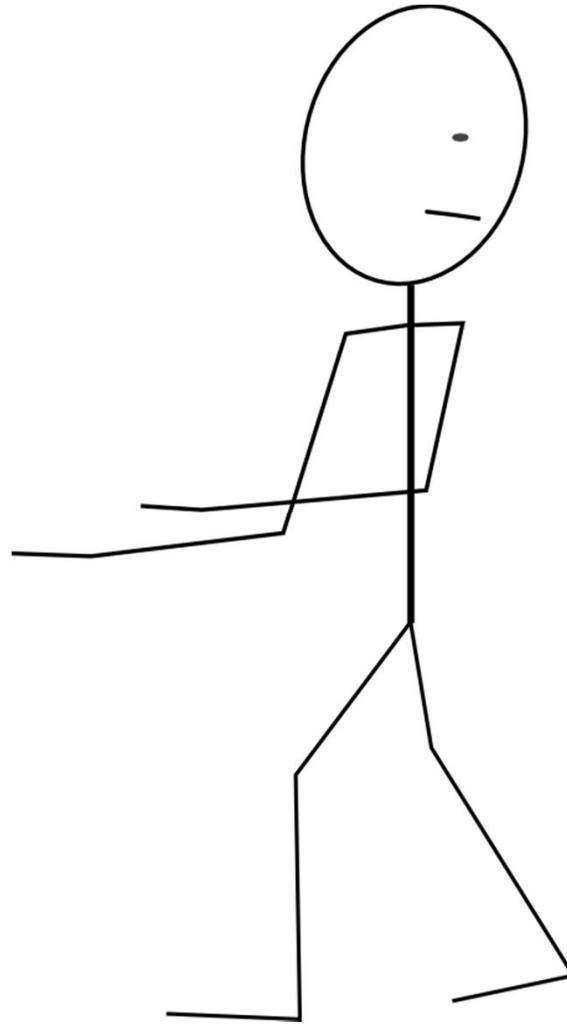
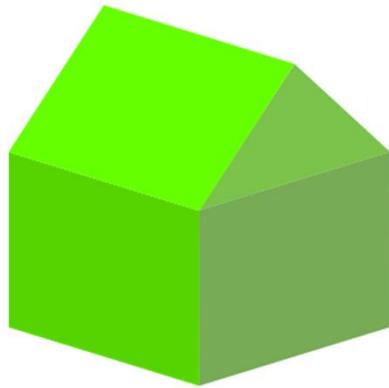
People  
move,



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

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

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An analysis on major German cities.

Judit Kockat  
Panel 3: Local Action

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# Migration and Building Retrofit

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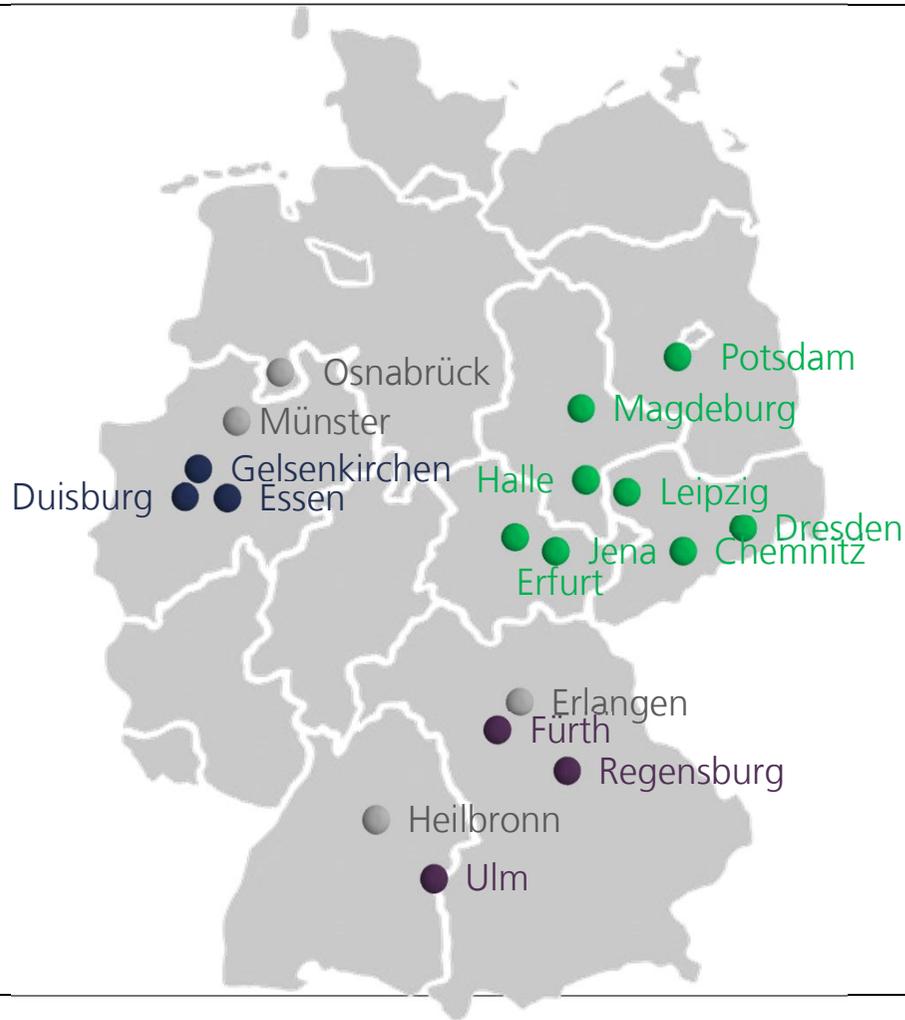
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- Evidence the importance of migration for building retrofit by showing 2 main points:
  1. How does **energy demand change** due to migration?
  2. **Rebound**: Why demand rises when population shrinks?
  3. Change in investment and loss potential.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

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# Aspect 1 How does energy demand change due to migration

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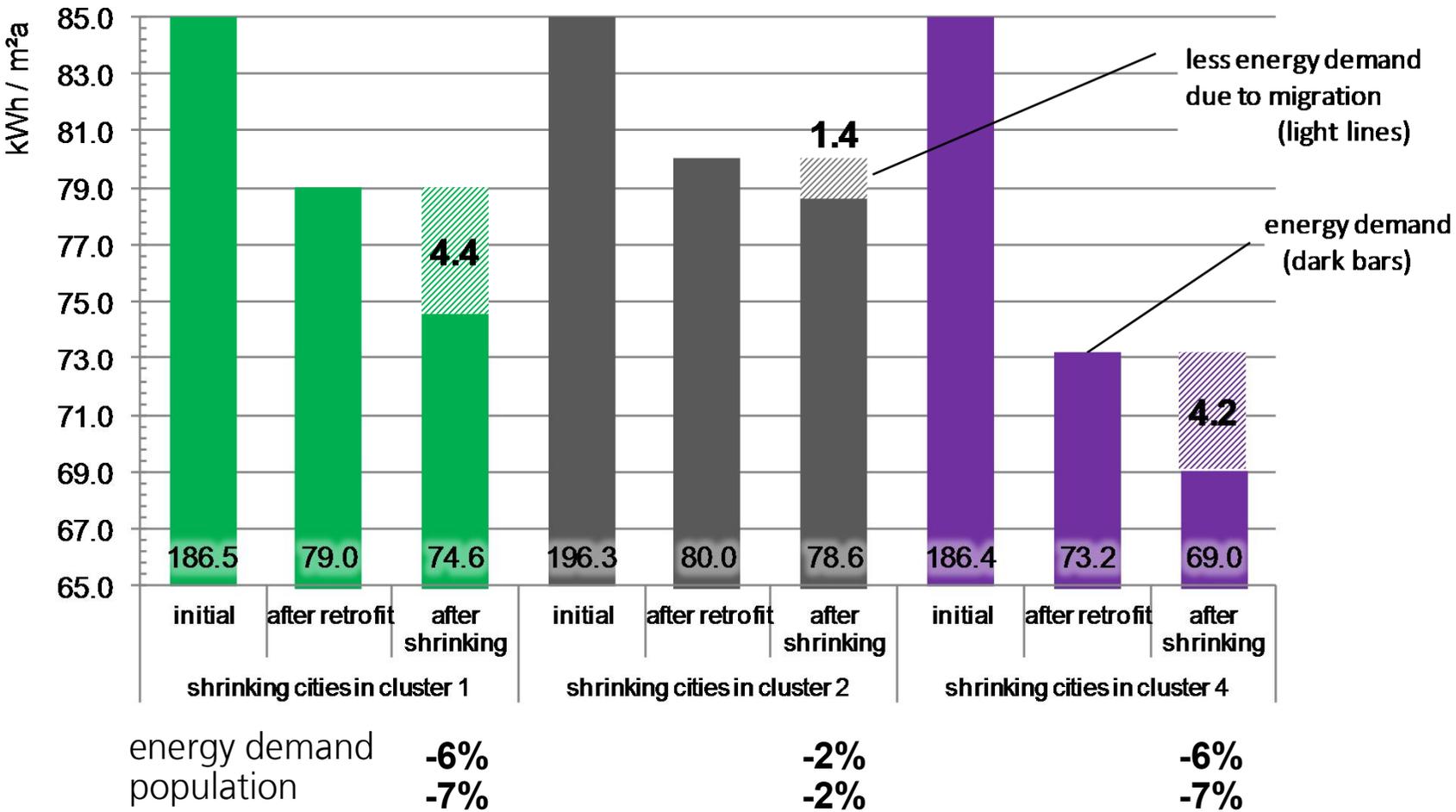


city clusters based on building stock (age, type)

Separating the Clusters' growing & shrinking shares

# Aspect 1 How does energy demand change due to migration

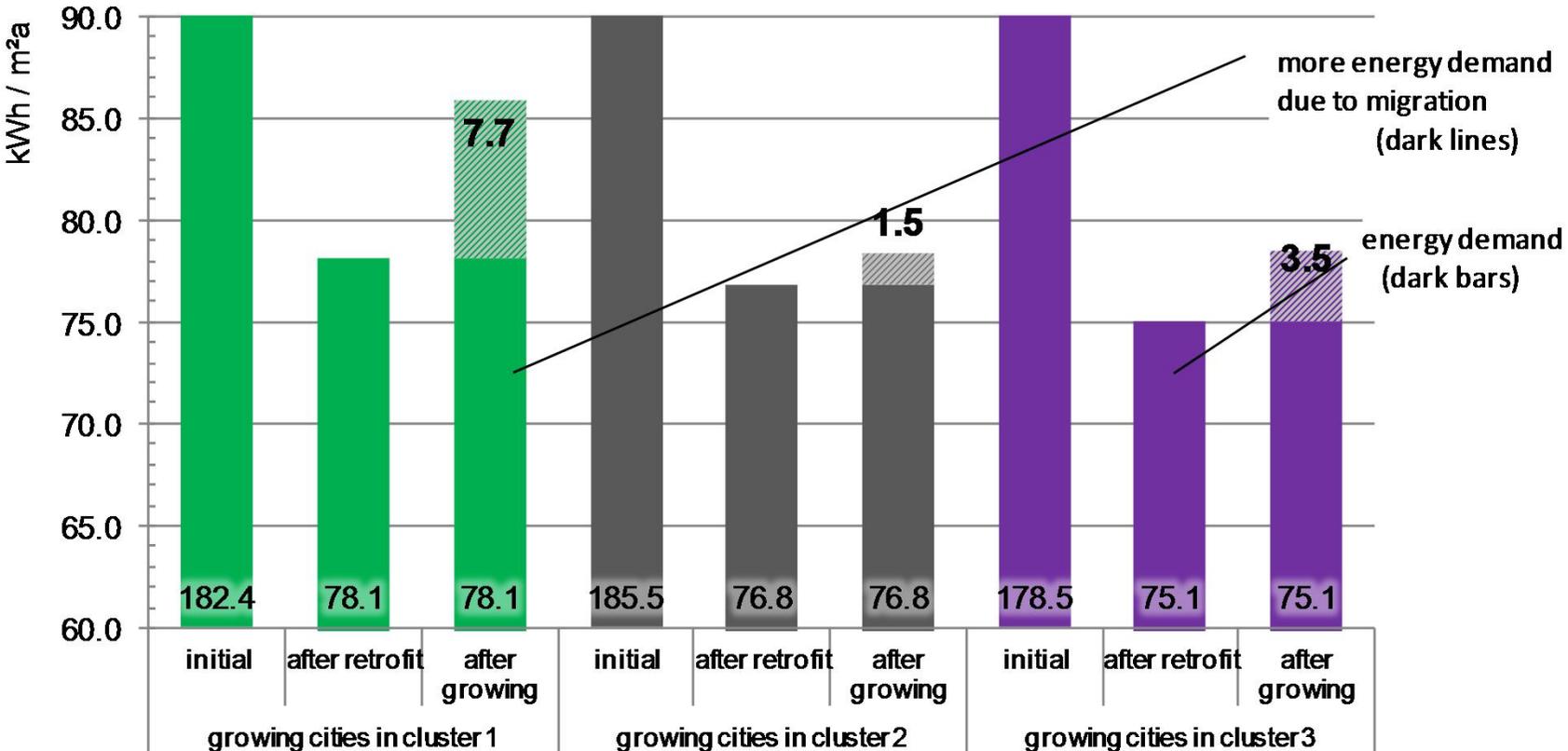
shrinking cities



up to 6% less demand in shrinking cities,  
19 – 23% of that due to structural change in building stock

# Aspect 1 How does energy demand change due to migration

growing cities

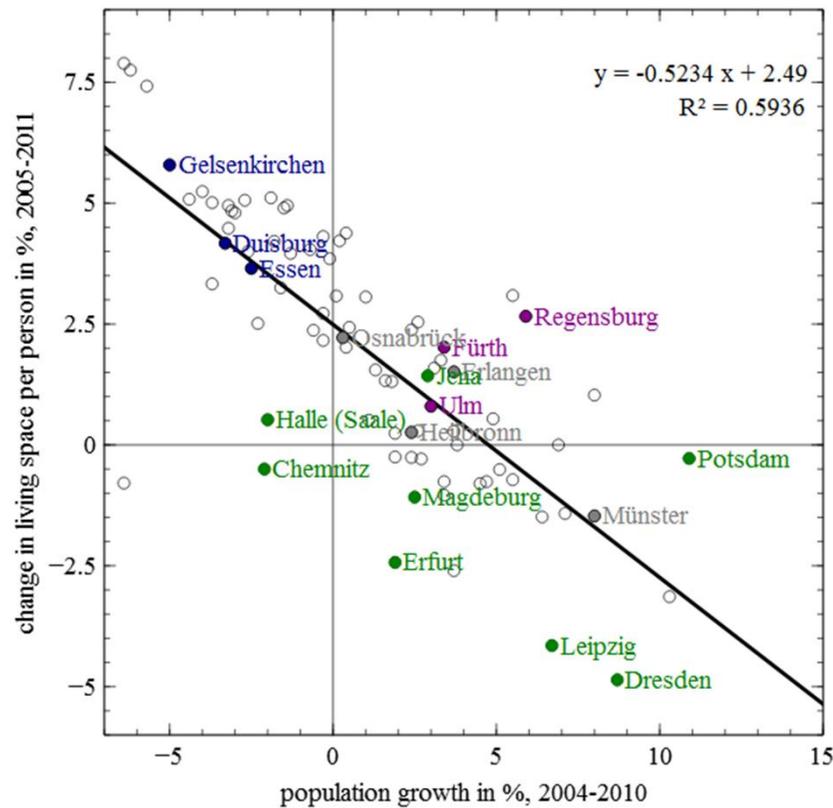


Cluster	Energy Demand Change	Population Change
growing cities in cluster 1	+10%	+11%
growing cities in cluster 2	+2%	+2%
growing cities in cluster 3	+4.6%	+5%

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

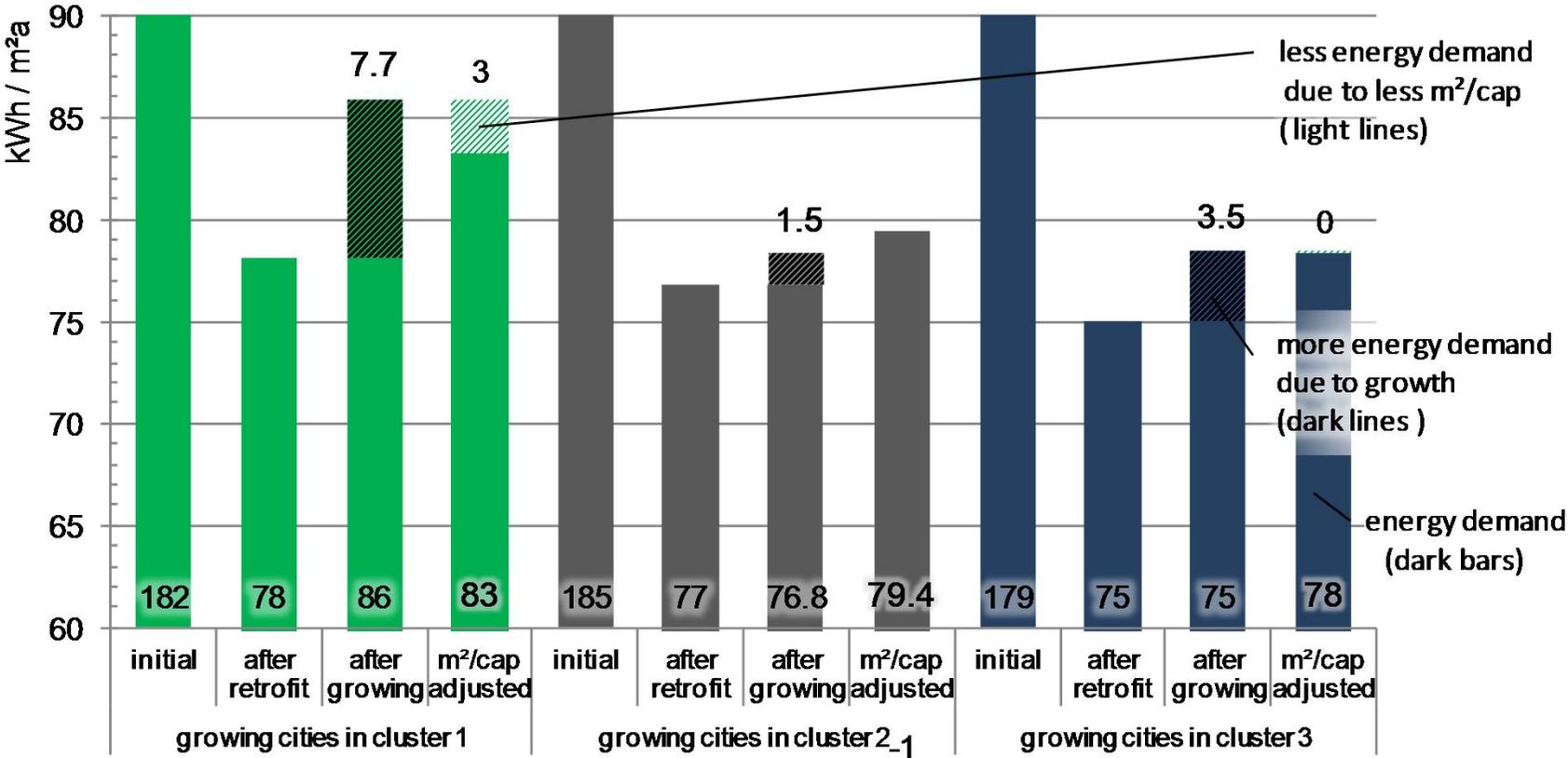
*results from multiple, overlapping effects, for example*

- Growing m<sup>2</sup> per person due to shrinking household sizes
- Shrinking m<sup>2</sup> per person due to

based on [wegweiser-kommune.de](http://wegweiser-kommune.de), 2014

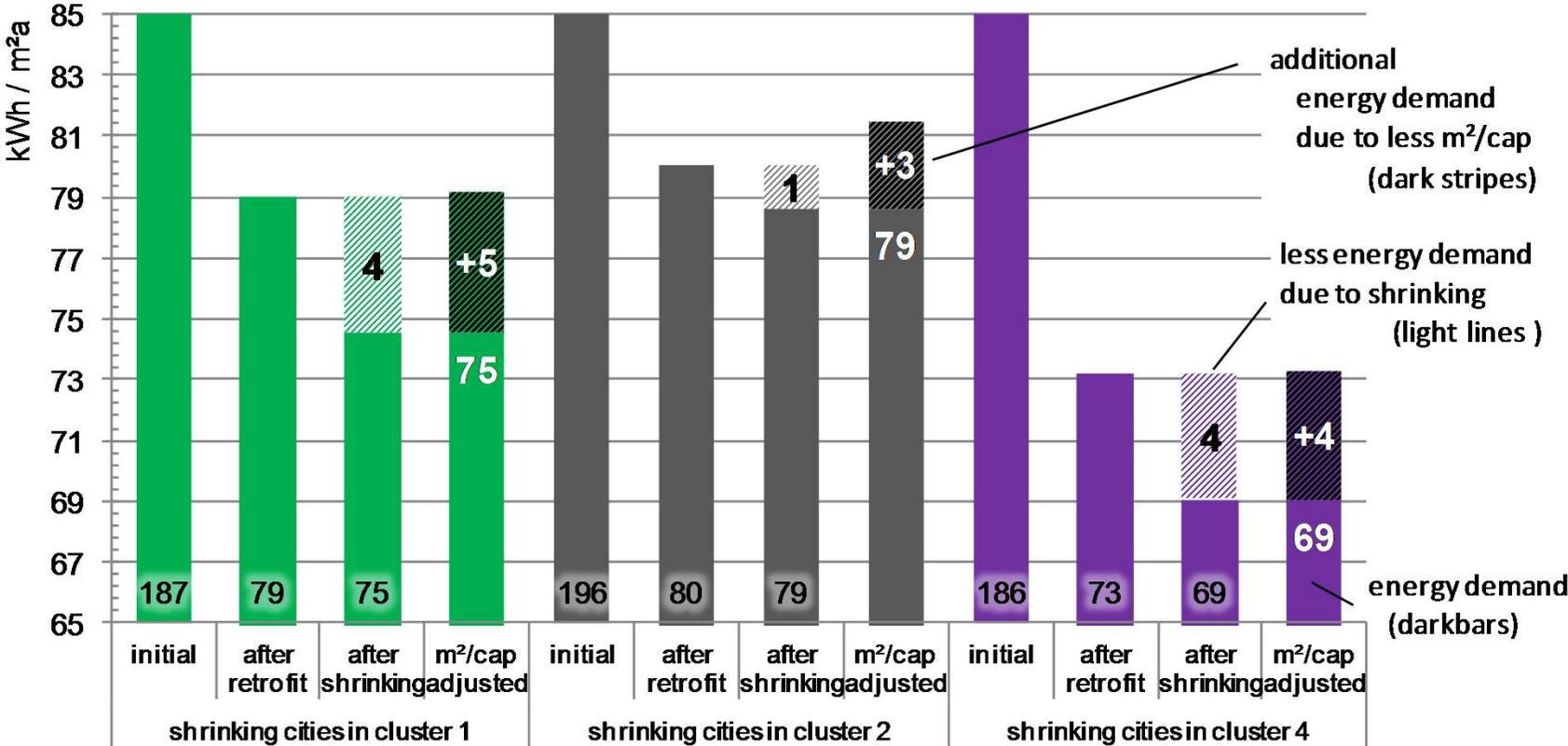
# Aspect 2 Why demand rises when population shrinks

growing cities

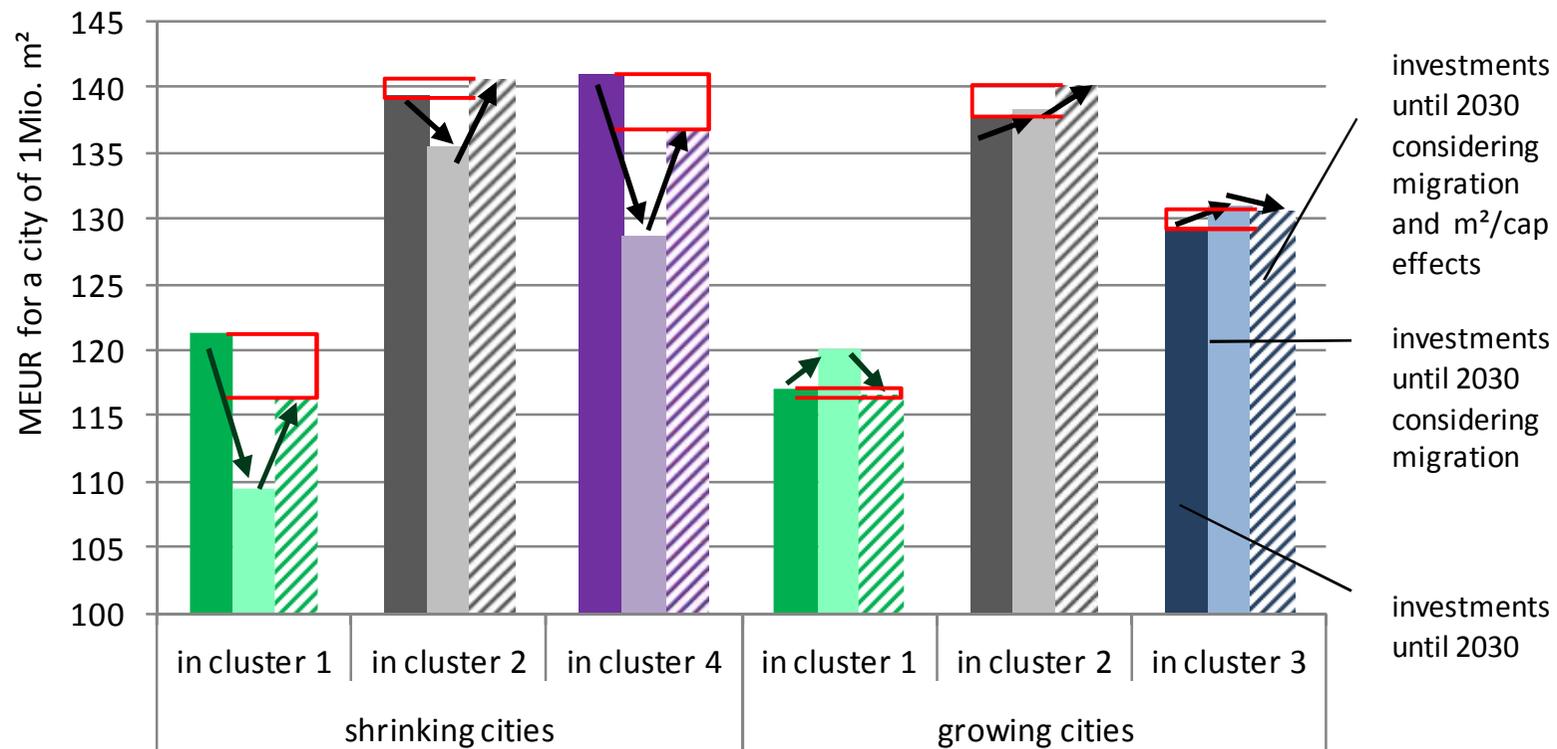


# Aspect 2 Why demand rises when population shrinks

## shrinking cities



# Aspect 3 What investments are endangered to be misplaced?



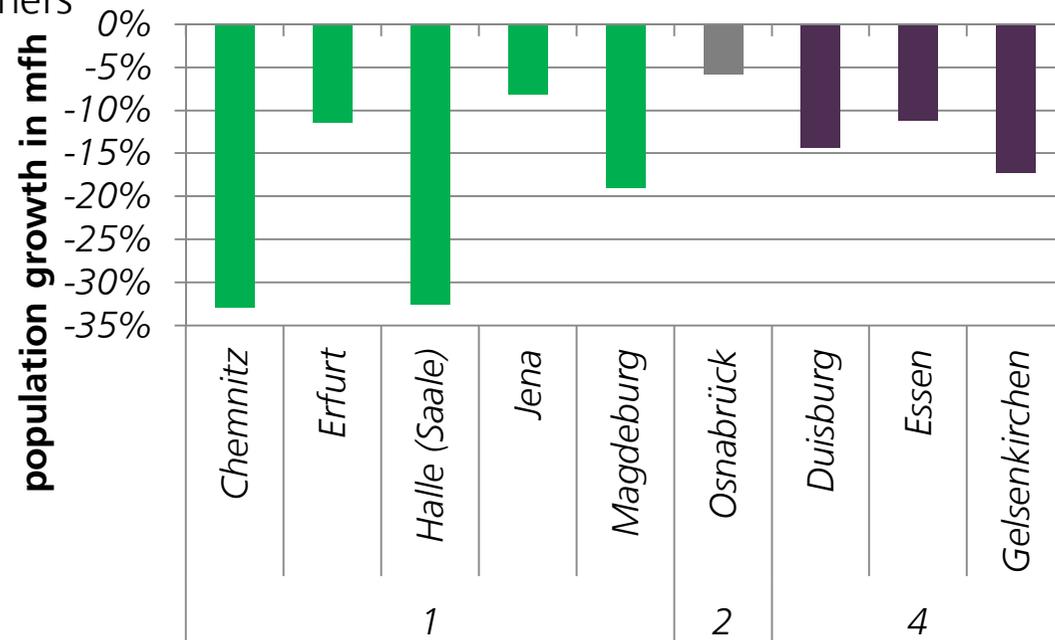
# Aspect 3 What investments are endangered to be misplaced?

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



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# Conclusion

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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.

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**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](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](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](http://www.invert.at)

Questions?

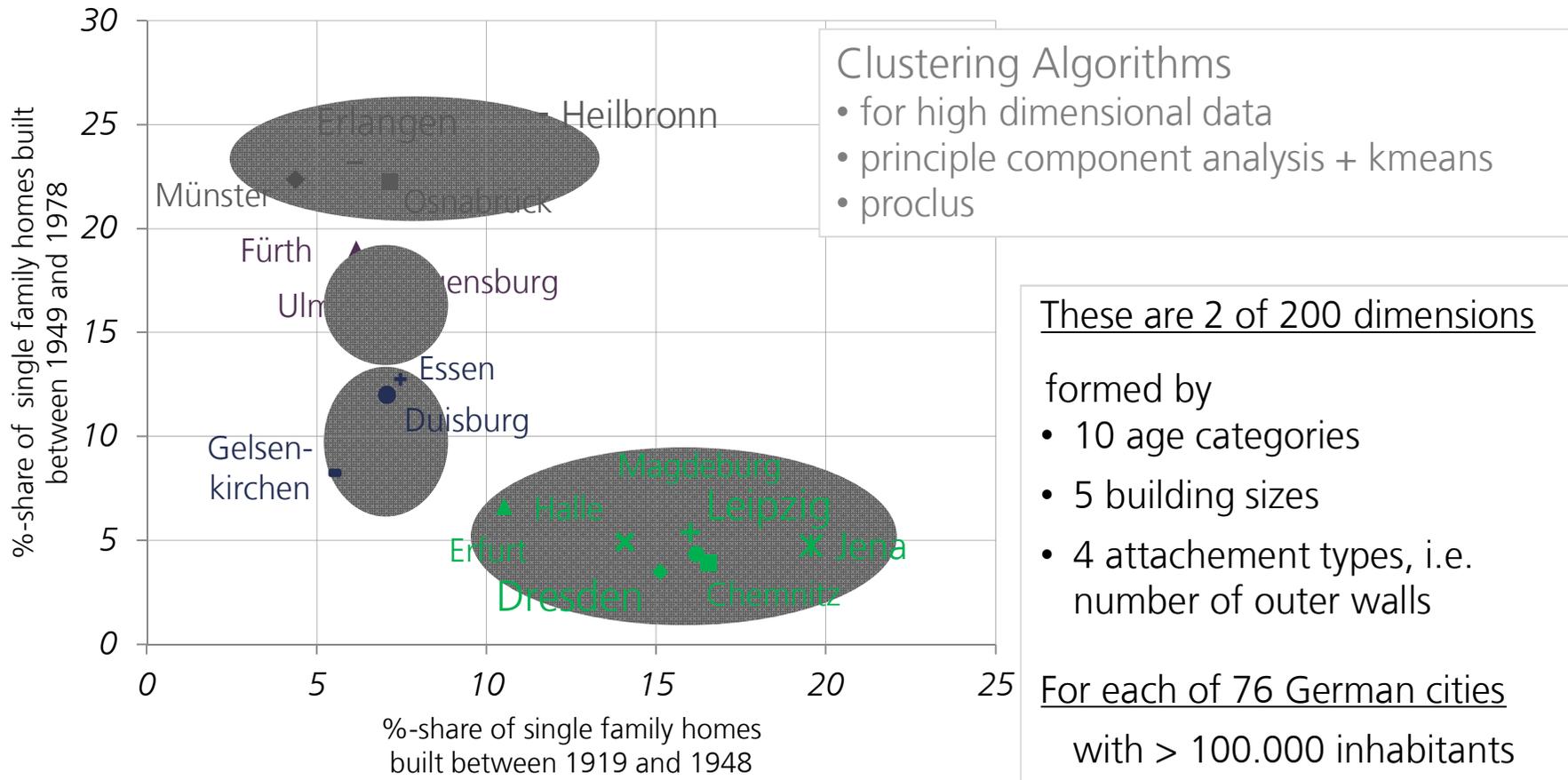
**THANK YOU FOR YOUR  
ATTENTION.**

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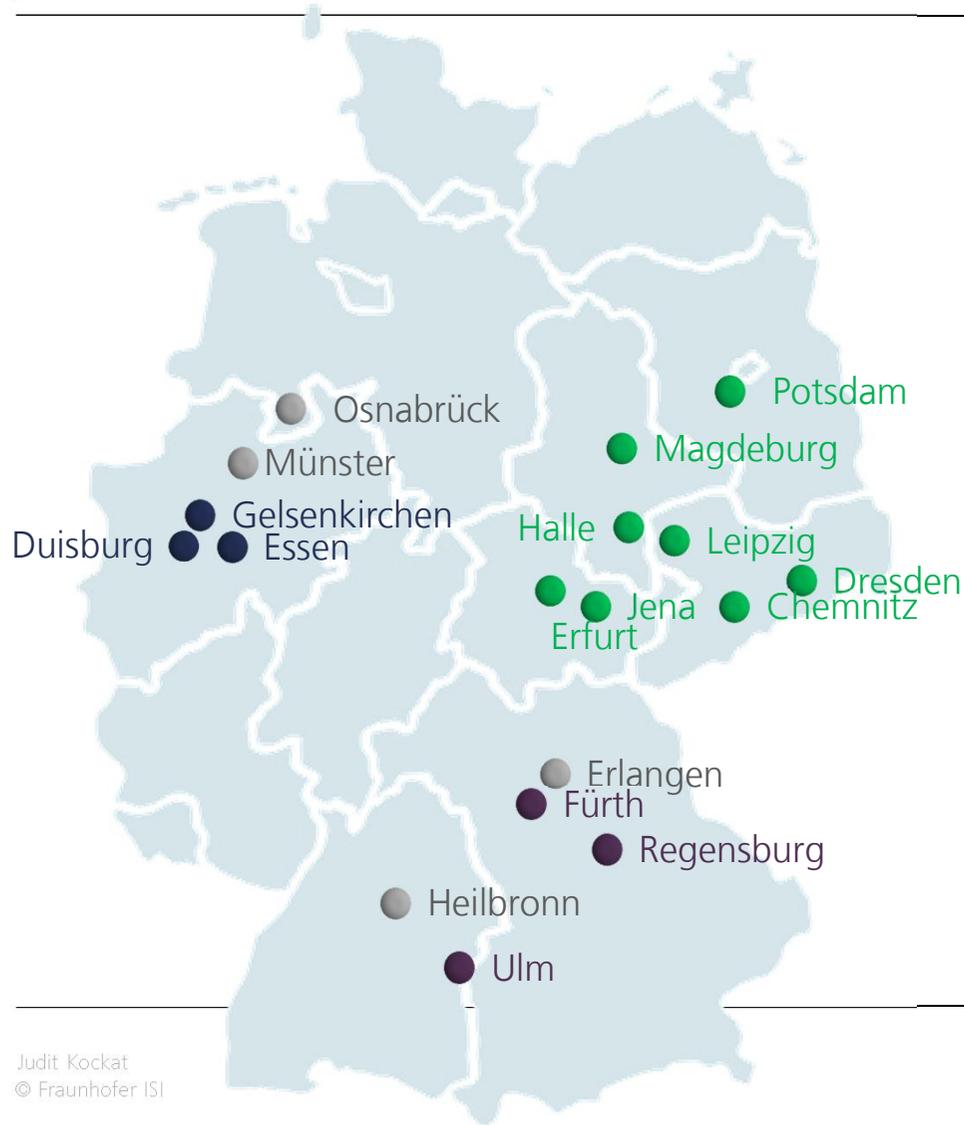
# Back-up

# 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*

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## 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

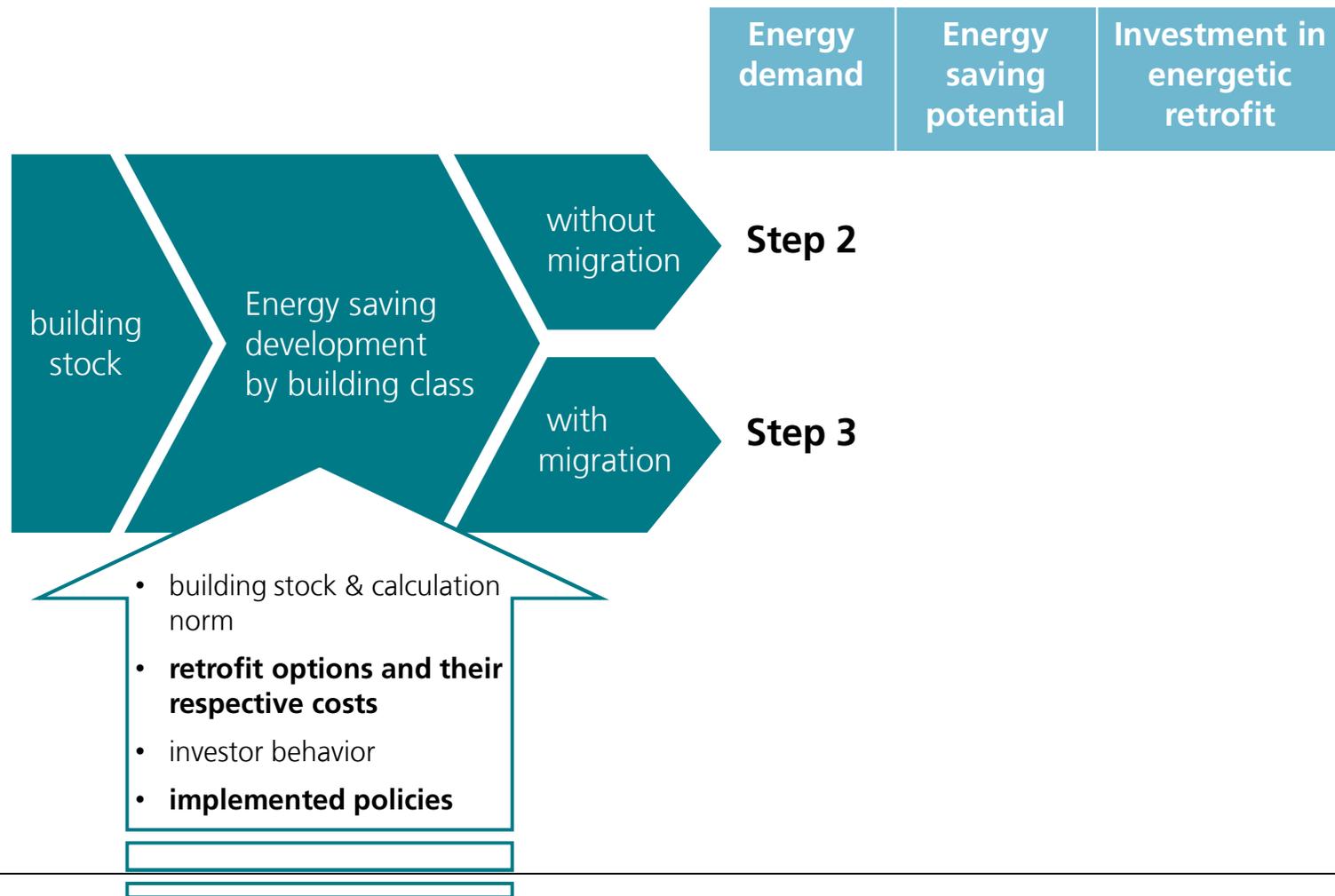
Analyse policy instruments and strategies that are suitable to direct the effect of the migration in a desired manner

## Step 6:

### Policy Effects

Diskuss the effect of suitable policies

# Simulating Energetic Retrofit and **quantifying** the **effect** of **Migration**



# 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
<b>Sanierungsoption ab 2020</b>	<b>0.21</b>	<b>0.30</b>	<b>1.04</b>	<b>0.37</b>
<b>Sanierungsoption ab 2030</b>	<b>0.18</b>	<b>0.25</b>	<b>1.04</b>	<b>0.31</b>

<i>Costs by building class</i>		flächenspezifische Kosten Instandsetzung pro m <sup>2</sup>	Kosten Standard Renovierung pro m <sup>2</sup>	Kosten Renovierung 1 pro m <sup>2</sup>	Kosten Renovierung 2 pro m <sup>2</sup>	
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

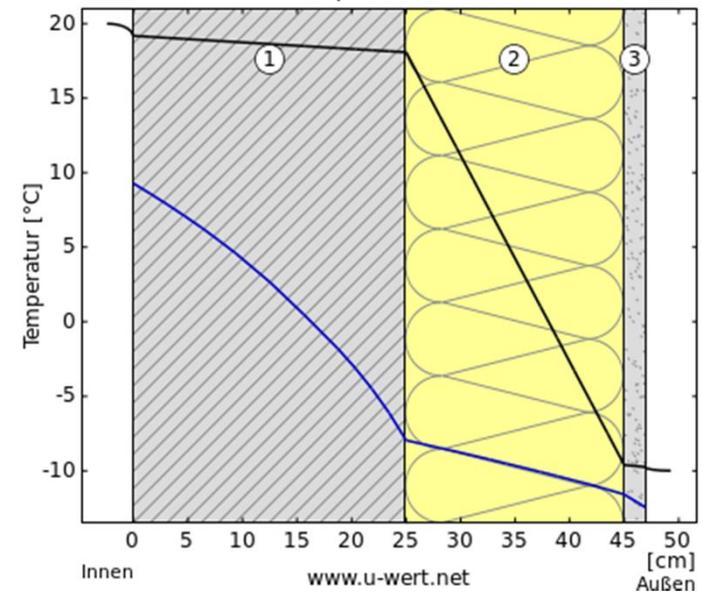
$$Q_h = \Sigma [t (\vartheta_{i,h} - \vartheta_e) \times (\Sigma (f_i A_i U_i))]$$

varied for different scenarios

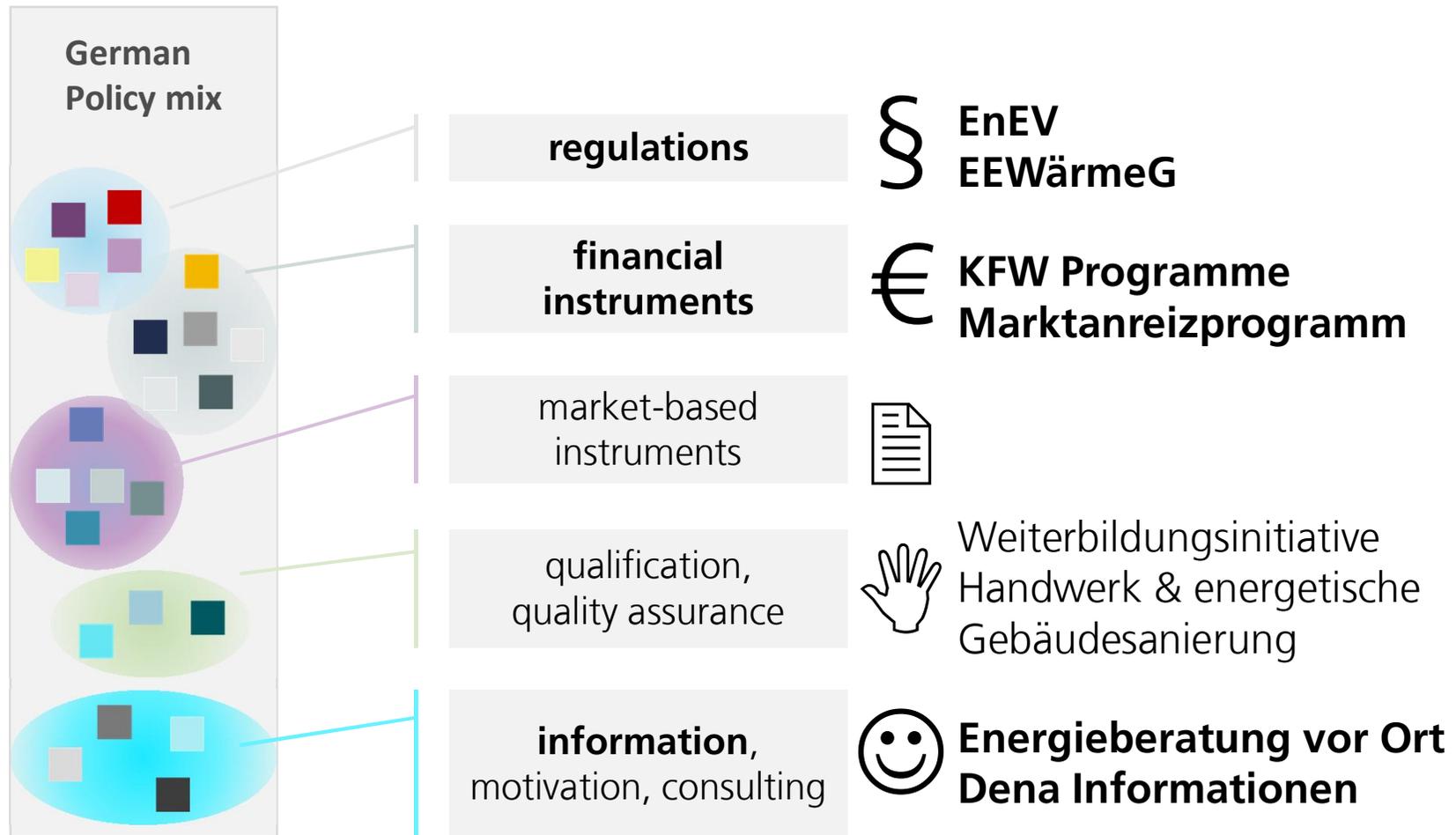
- The heat transfer coefficient (U, U-value) of an insulation layer depends on the thermal conductivity ( $\lambda$ ) and on the thickness of the layer (d) ab:

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

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



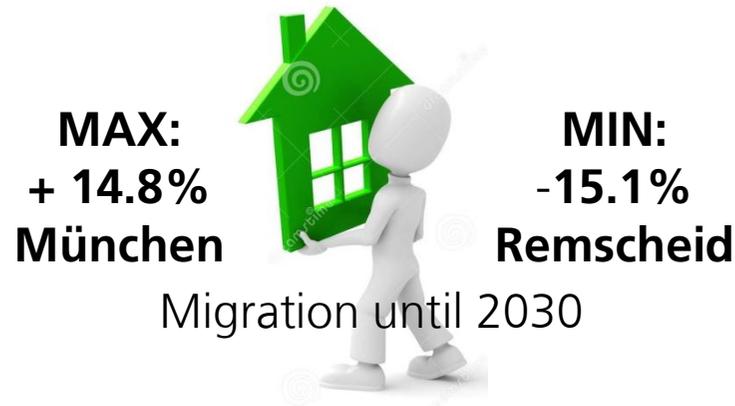
# National **policies implemented** in Invert/EE-Lab



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# Possible effects of migration on energy demand and efficiency efforts

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## 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?**

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# Take away

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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