TECHNISCHE UNIVERSITÄT DRESDEN

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Buried infrastructure in shrinking cities

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“Coping with City Shrinkage and Demographic Change – Lessons from around the Globe”
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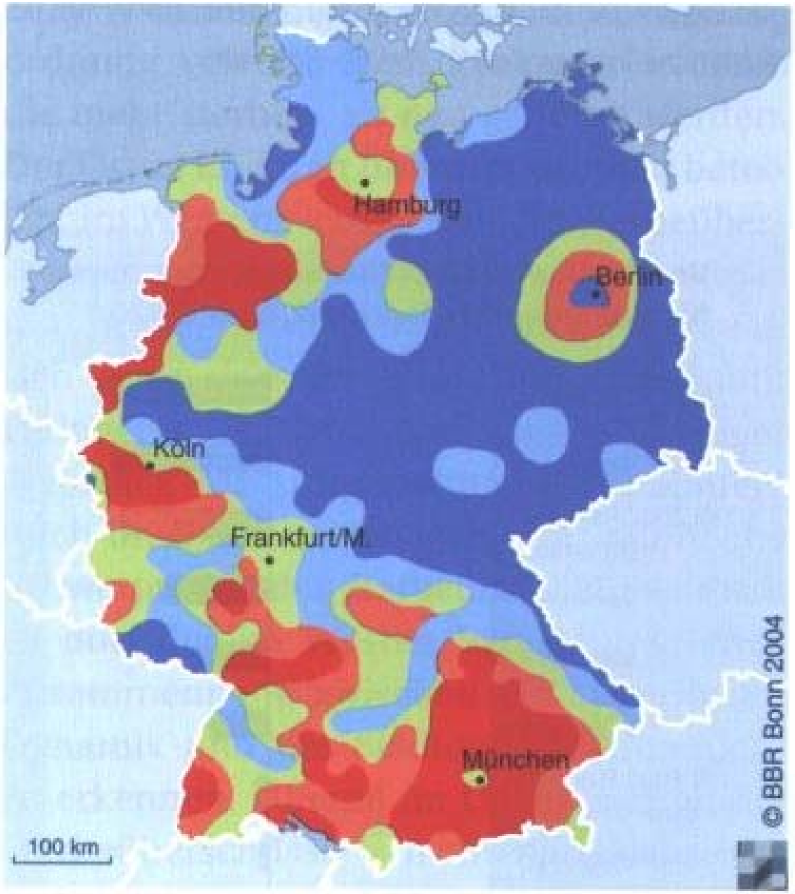
Buried infrastructure in shrinking cities

1. The urban shrinking process
    - Forms of urban shrinkage
    - Consequences of urban shrinkage
    - Urban management instruments
2. Consequences for buried infrastructure
    - Water supply system
    - Wastewater system
    - Energy supply system
    - Adaptation capabilities
    - Financial consequences
3. Conclusions and recommendations

Demographic trend in Germany up to 2050



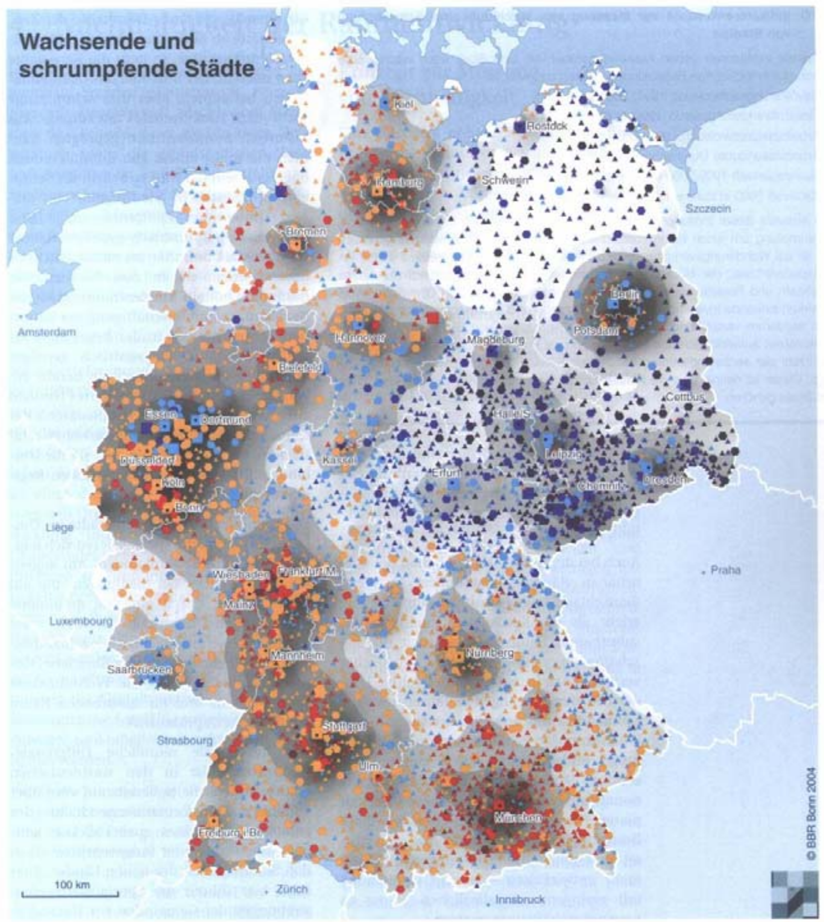
2005: ~ 83 Mio people
2050: ~ 70 Mio people

Strongly declining	>10%
Slightly declining	5-10%
Stable	+/- 5%
Slightly increasing	5-10%
Strongly increasing	>10%

Source: Spatial Development Report 2005, BBR

- Population (2)
- Employment
- Income
- Tax revenue
- Purchasing power

Growing and shrinking German cities



growth

	5-6	indicators
	3-4	in upper quintile
	1-2	
	1-2	
	3-4	indicators
	5-6	in lower quintile

shrinkage

Accessibility potential

[1000 people within 100 km radius]

- > 1000
- 500 – 1000
- 350 – 500
- 200 – 350
- 100 – 200
- < 100

Source: Spatial Development Report 2005, BBR

Urban shrinking patterns

Uncontrolled:

- perforation of urban landscape
- suburbanization
- degradation of living quarters
- attenuation of property values
- ***diminishing densities***

Controlled:

- contraction around centres and along infrastructure corridors
- urban redevelopment
- constraints for suburban low density development
- creation of urban green space
- ***diminishing densities***

Decline of water consumption

System design for full occupancy and high density
designed for specific demand of 150-200 l/pd
Shrinkage
→ Attenuation, decline of household size, vacancies
+ reduction of water consumption to 80–100 l/pd

Example

Full occupancy 4 P/DU,	design value 200 l/pd	→	100 %
Full occupancy 2 P/DU,	consumption 100 l/pd	→	25 %
Vacancy rate 20 %		→	20 %
Leakage rate 20 %		→	25 %

→ Drinking water stays 4-5 times longer in the network

Risk of germination, incrustation, discolouration
→ Flushing, reduction of diameters with rehabilitation

Decline of wastewater production

Less drinking water → less sewage
Modifications of combined and separate system → less sewage
Storm water retention, use and infiltration → less sewage
→ smaller pipe diameters and wastewater treatment plants

Impacts on existing sewers:

Reduced flow velocity, filling height, tractive force
- → sedimentation
- → anaerobic digestion → hydrogen sulphide
- → biogenic sulphuric acid attacking concrete sewers

Consequences:

- → more intensive routine maintenance, flushing
- → reduction of service life: more repair, earlier rehabilitation
- → reduction of diameters with rehabilitation (relining)

Decline of heating energy consumption

Distant heat delivery systems are economically viable only for densely built-up areas, due to high unit cost of energy transport.
Floor space ratio >1.0 → (Double-)pipe length <1.0 m/DU

Improved insulation of buildings (requirements, control)
→ Reduction of heating demand per m² of floor space
→ Reduction of installed heating energy from >100 to <50 W/m²
Further reduction by vacancies, planned demolition

<u>Common adaptation strategies</u>

- System extension into lower density areas (at lower efficiency)
- Substitution by gas (→ transaction costs)
- Shift from large-scale to small-scale heat delivery systems (→ transaction costs, loss of economies of scale)
- Combining distant heating with distant cooling (new market)

Growth of electricity consumption

Electricity is the most convenient form of energy.

Demand for electricity rises with level of civilization due to an increasing number and use of electrical devices, most recently particularly in information technology.

Unfortunately, electricity production is quite inefficient and heavily relies on non-renewable sources of primary energy.

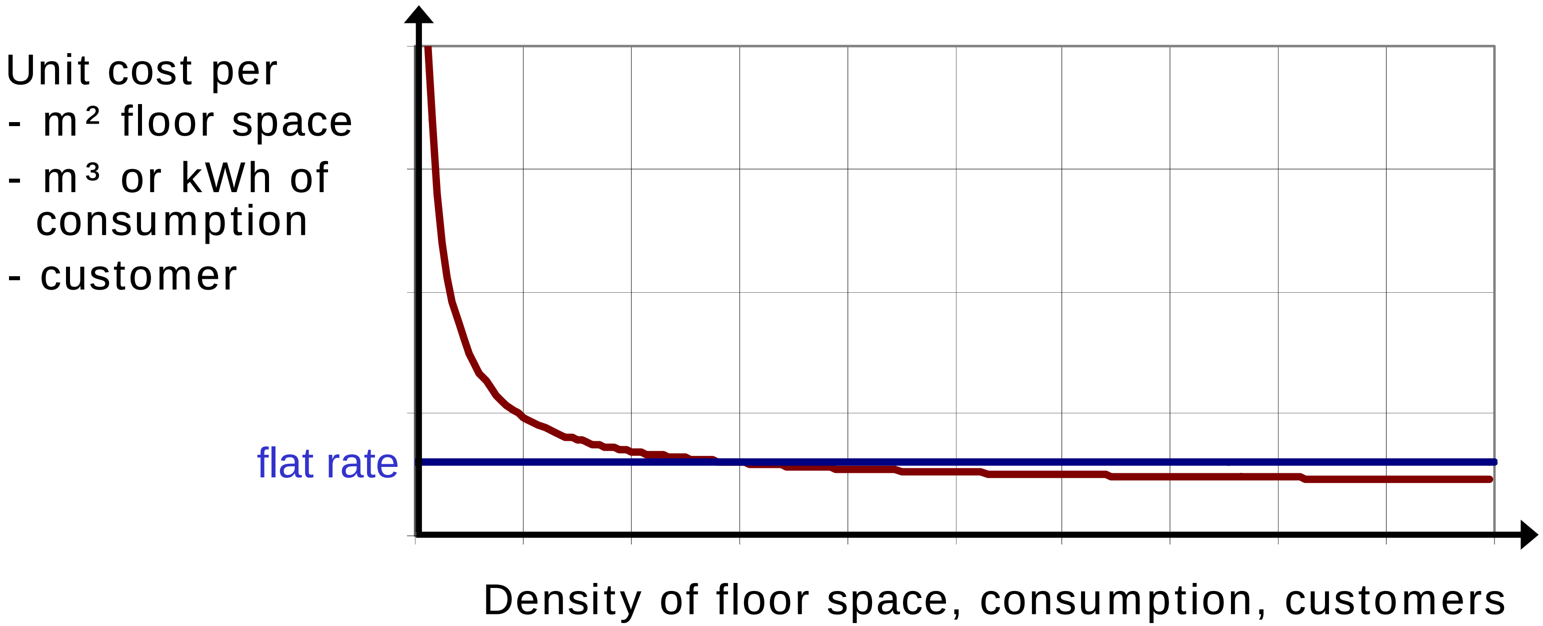
This is not a sustainable solution.

Electricity should be substituted by other forms of energy.

Cable networks can adapt relatively easily to changing demand.

Declining population densities affect the efficiency of networks.

Infrastructure unit cost at different densities



- Unit costs increase progressively with declining densities
- With flat rates, high unit costs of infrastructure services in low density suburban areas are subsidized by customers living in high density urban quarters.

The infrastructure cost trap

Reduced consumption leads to increased rates

~ 80% of infrastructure costs are fixed cost (capital, staff), which must be recovered by a declining number of customers.

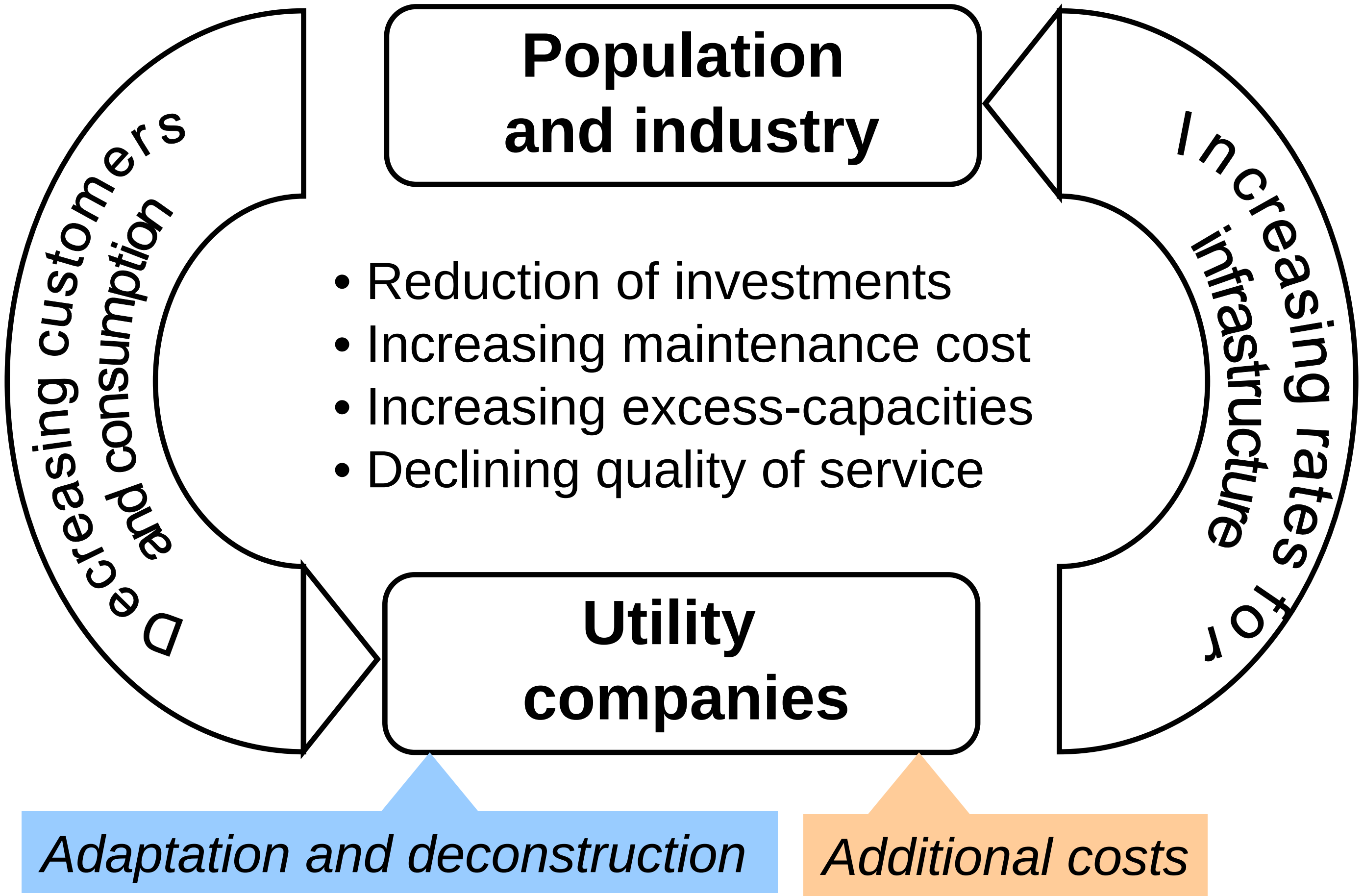
If customers reduce their consumption (by saving water, energy), this will lead to further increase of service rates.

Example:

	Cost recovering rate at the outset	100 %
	Reduction of customers by	20 %
	Reduction of per capita consumption by	20 %
	→ Reduction of demand	64 %
	Company cost reduction	0 %
(due to high fixed costs and increased maintenance costs)		

→ Rate increase by 100 / 0.64 = 156.25 %

Vicious circle of shrinkage



Perspectives

Essentially, long-lived infrastructure will survive (strand).

However, infrastructure systems must be adapted to demographic ageing and shrinking processes.

Infrastructure networks are more difficult to adapt to diminishing demand than infrastructure plants.

Operational adaptation is limited and associated with loss of efficiency. Major decline (>50%) requires investments. Adaptation by investments is always in steps.

In default of continuous adaptation, long-lived infrastructures suffer from excess capacities during shrinking processes. This may be associated with additional maintenance cost.

Perspectives

Diminishing densities of demand for infrastructure services such as drinking water, wastewater and heating energy reduce the efficiency of these public services.

A decline of the number of customers in combination with a decline of per capita demand leads to a progressive increase in infrastructure service rates.

With or without shrinking processes, due to age and condition of infrastructure assets, investments must be shifted from extension to rehabilitation. (>2% of stock per annum!)

Infrastructure rehabilitation provides chances for reducing over-sized pipelines, particularly by no-dig technologies!


Thank you
for your attention