THE WEIGHT OF CITIES
RESOURCE REQUIREMENTS OF FUTURE URBANIZATION

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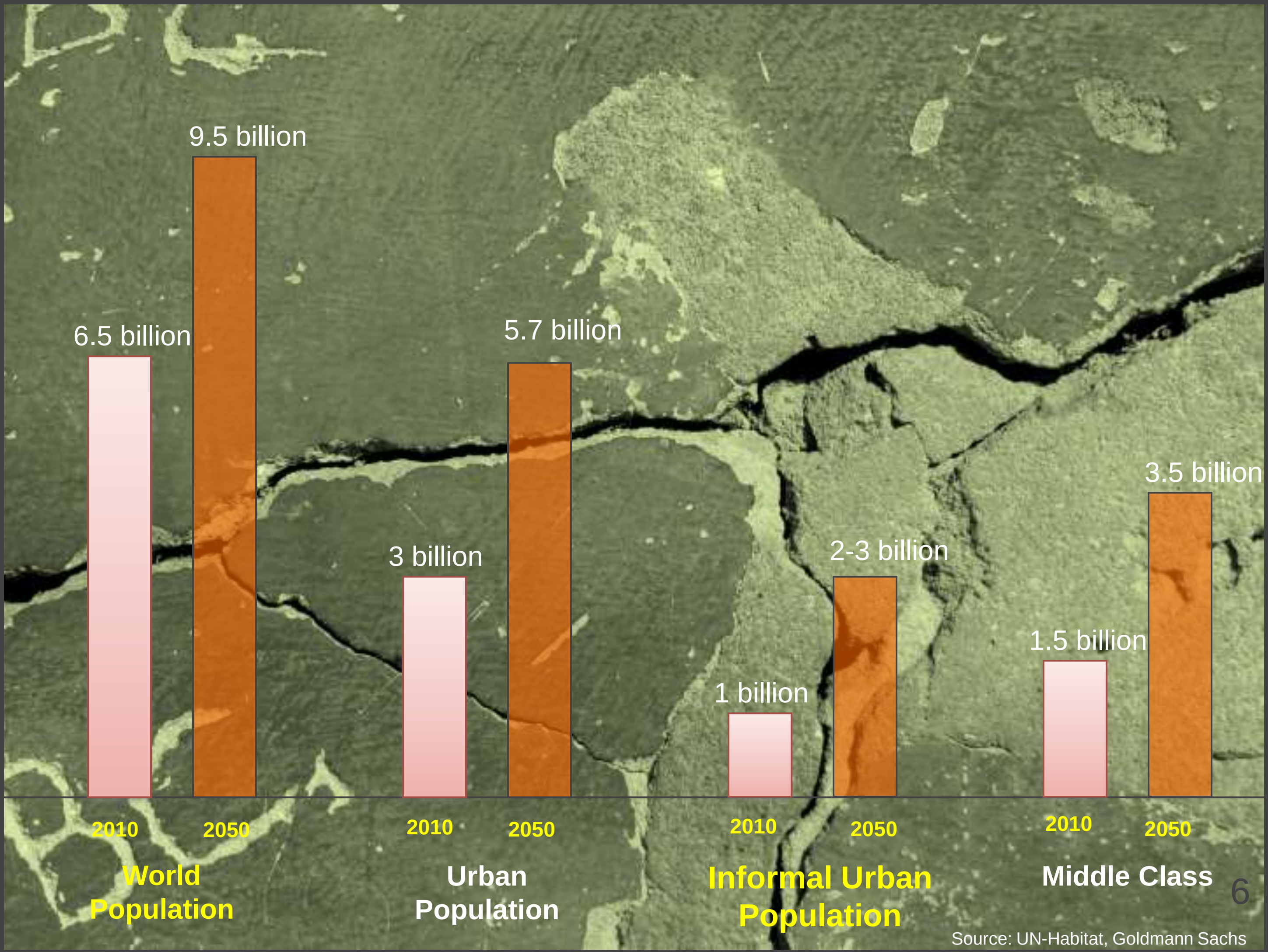
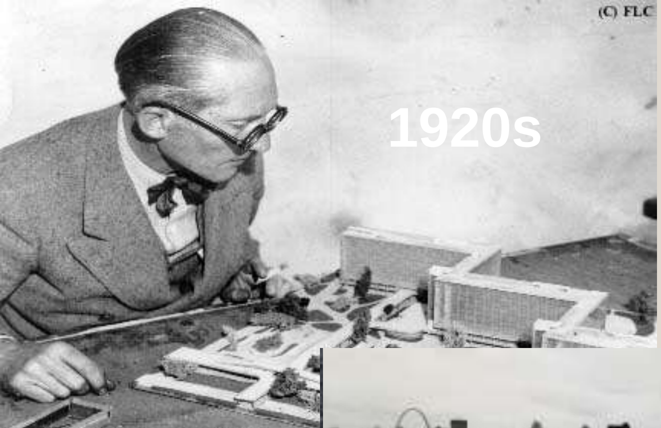


Source: UN-Habitat, Goldmann Sachs


COLACEM
HRS 1

China used more cement in 2011-2013 than the U.S. used in the entire 20th century.

SOURCES: USGS, Cement Statistics 1900-2012; USGS, Mineral Industry of China 1990-2013



1954

1968

1972

Now

1992

And when?

Recommendations

Urban Metabolism

1. Shift from ‘linear’ to ‘circular’ metabolisms
2. Urban metabolisms must be monitored to inform strategic planning
3. Relationships between GDP, population and land/material/energy use must be measured and targets developed by city types

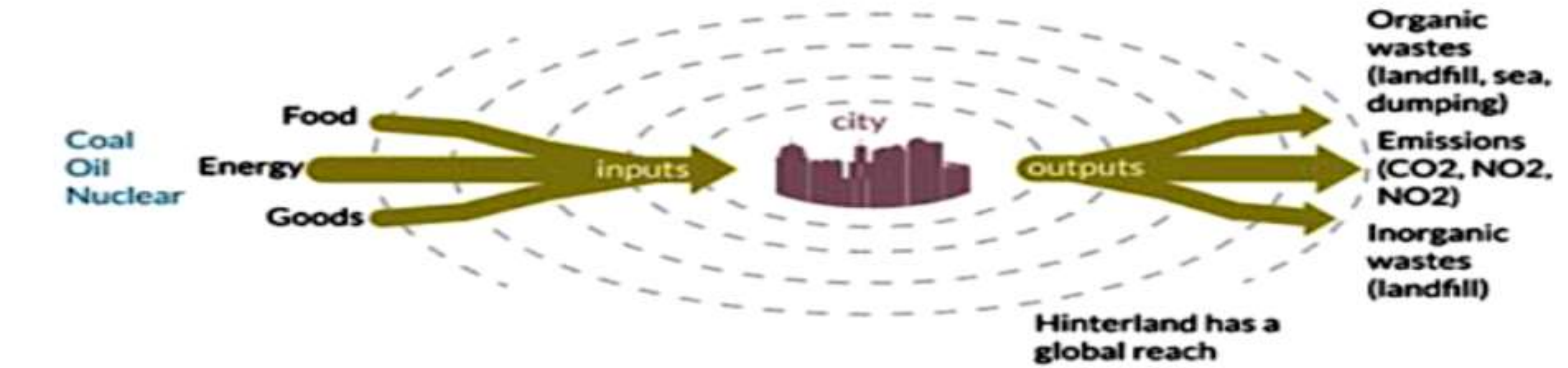
Pathways of Change

4. Change city planning ‘defaults’ toward 5D framework
5. Use urban infrastructure investments as catalysts for change
6. Link infrastructure & land use policy (regional and neighborhood)
7. Promote appealing mixed-income mixed-use city cores; prevent suburbanization
8. Attractive business propositions to support infrastructure transformation

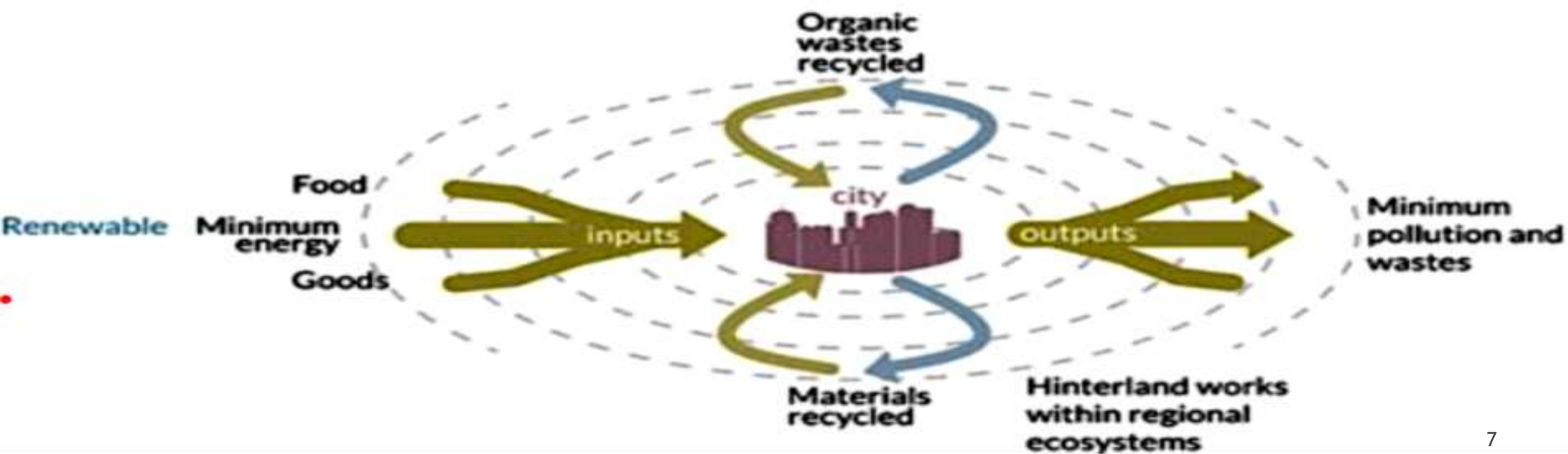
Governance

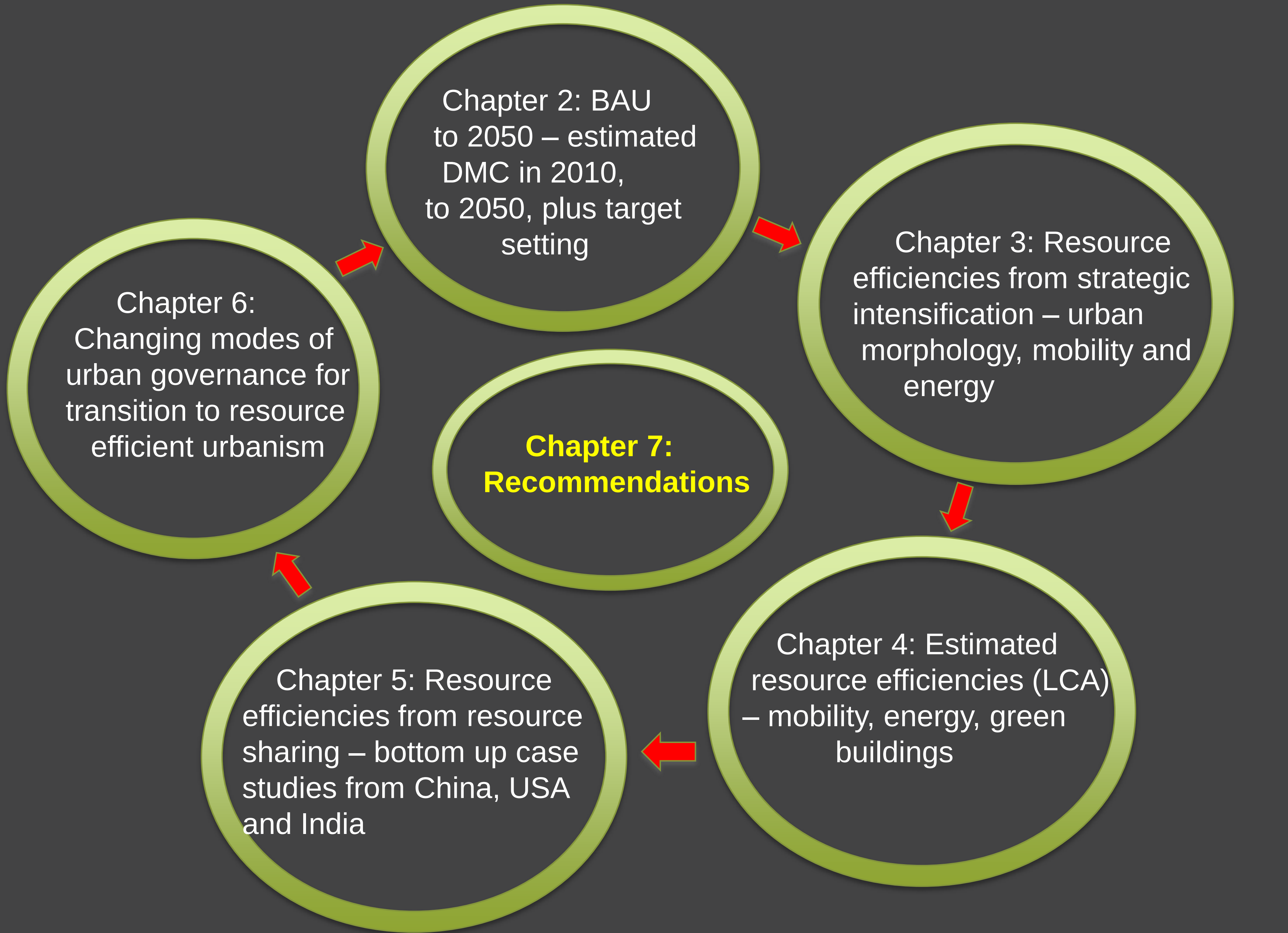
9. Leverage the power of ‘experimentation’ to re-imagine futures in practice
10. Foster inter-city learning networks
11. Secure support from higher levels of government

Linear metabolism cities consume resources and create waste and pollution at a high rate

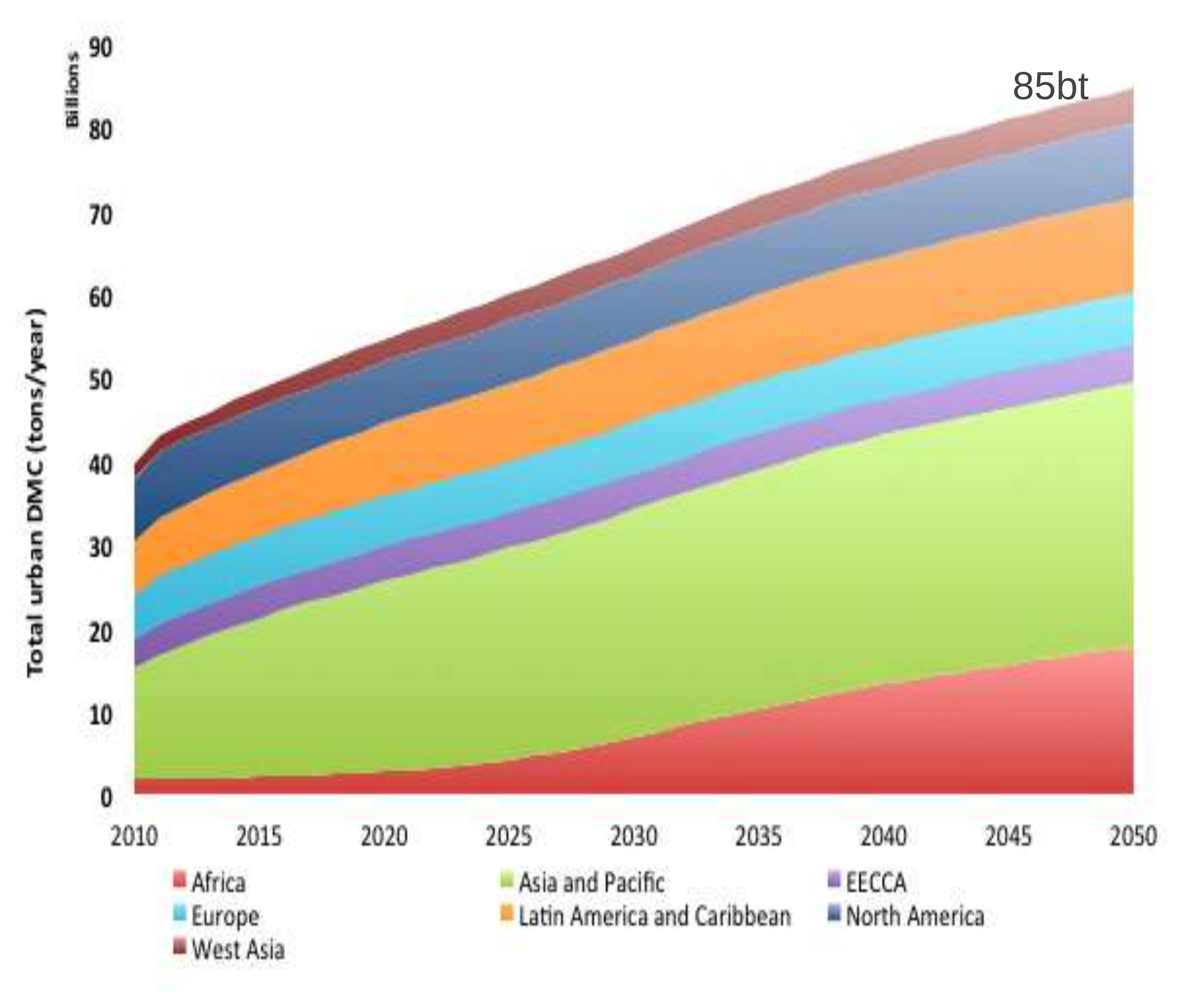


Circulative metabolism cities reduce consumption and pollution, recycle and maximise renewables




Chapter 2: BAU to 2050 – estimated DMC in 2010, to 2050, plus target setting
Chapter 3: Resource efficiencies from strategic intensification – urban morphology, mobility and energy
Chapter 4: Estimated resource efficiencies (LCA) – mobility, energy, green buildings
Chapter 5: Resource efficiencies from resource sharing – bottom up case studies from China, USA and India
Chapter 6: Changing modes of urban governance for transition to resource efficient urbanism
Chapter 7: Recommendations

Chapter 2: Measuring the Weight of Cities



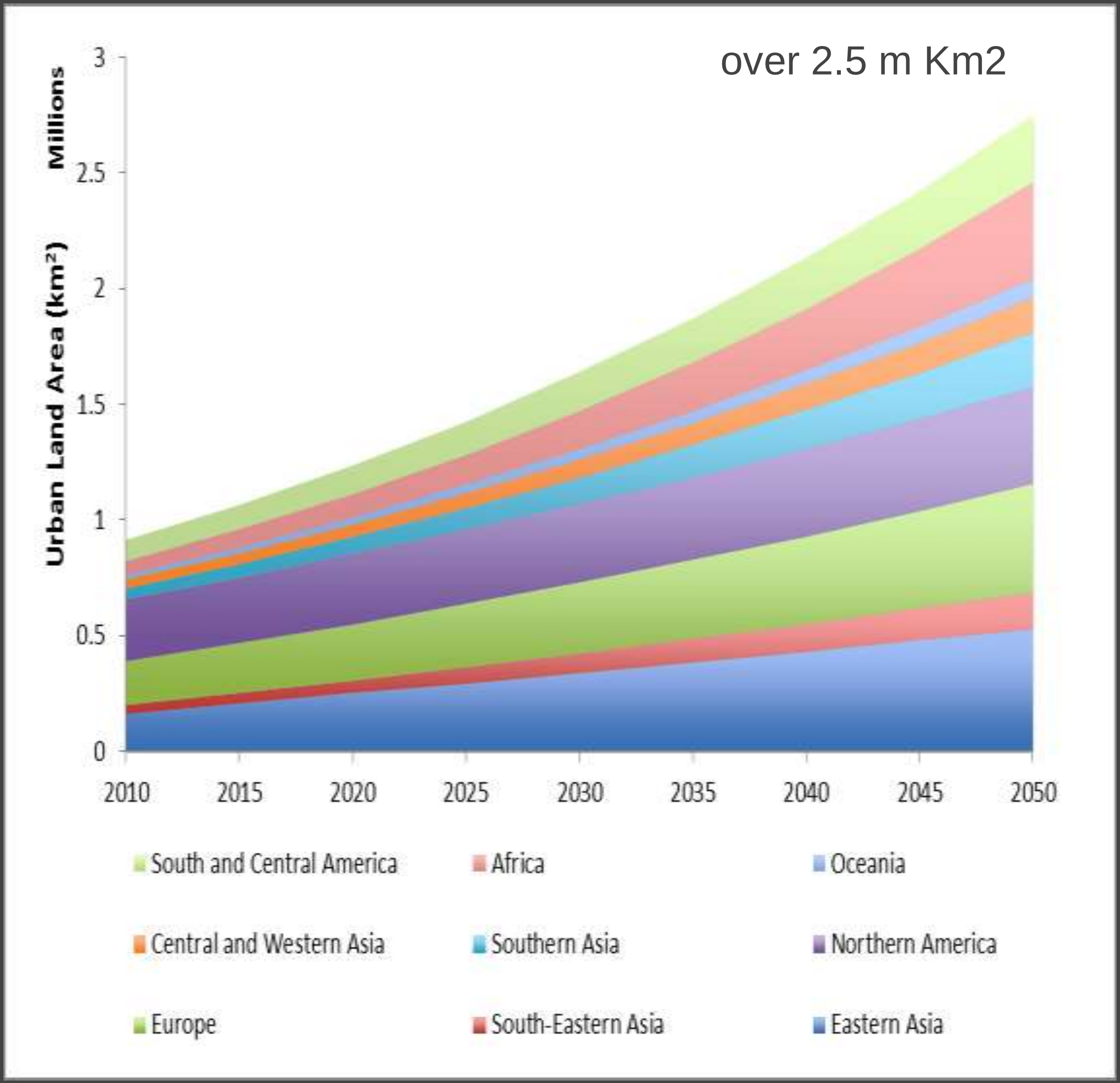
Urban DMC = 60% of total DMC in 2010 (i.e. 40bt)

BAU to 2050 = 90bt will be required – more than doubling

Consequence: consumption rises to 8-17 t/c/yr

urban pop increases by 78% compared to 2010

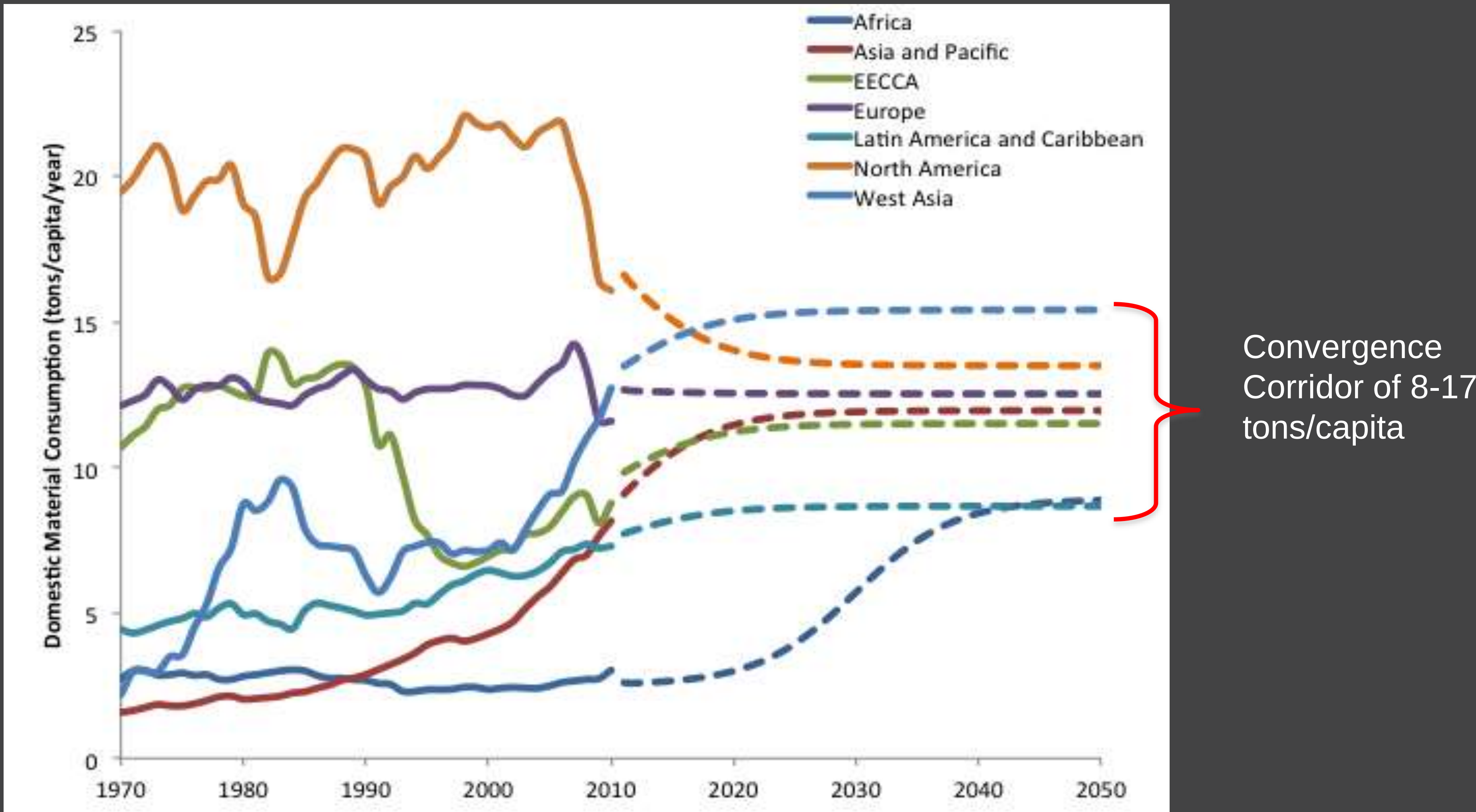
Baseline assumptions for each region: population; income growth; land-use and density; DMC/cap & total



Growth in urban land area by region and globally, 2010-2050 if historic trend of de-densification of -2% pa continues

-much of the most intensively farmed land surrounds the cities

-target: remain within the 1m – 1.5 m Km2 boundary



Urban domestic material consumption (DMC) in aggregate world regions – converging in a corridor of 8-17t/c/y by 2050

Target for urban DMC by 2050

- IRP target proposed to Open Working Group on SDGs: 6-8 t/c/y
- Reduction from 8-17 t/c/y to 6-8 t/y/c = reduction of 44 billion tons from 90 bt to 46 bt
- 51% reduction in resource use
- more equal? more inclusive? – depends on governance

‘who-is-using-what-flows-where-to-do-what’

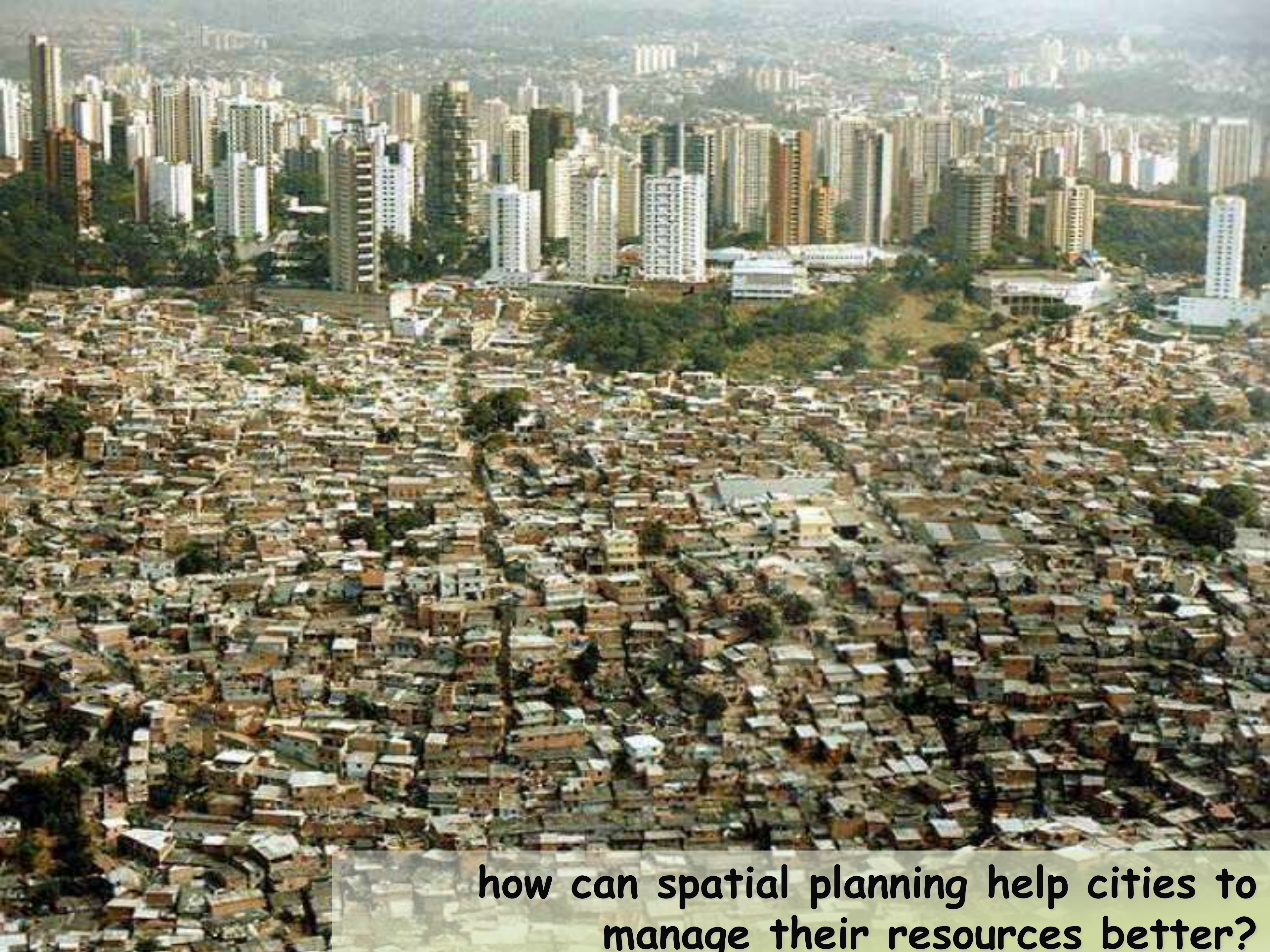
(Pincetl et al. 2012:199)

But there are pathways of change…

Key Pathways:

- **Chapter 3:** strategic intensification to create a network of high density nodes interconnected with efficient and affordable transit
- **Chapter 4:** sectoral improvements in resource efficiency
- **Chapter 5:** resource efficient urbanism via infrastructure reconfigurations
- **Chapter 6:** entrepreneurial modes of urban governance to foster urban experimentation

Chapter 3: Pathway #1 Land Use and Strategic Intensification

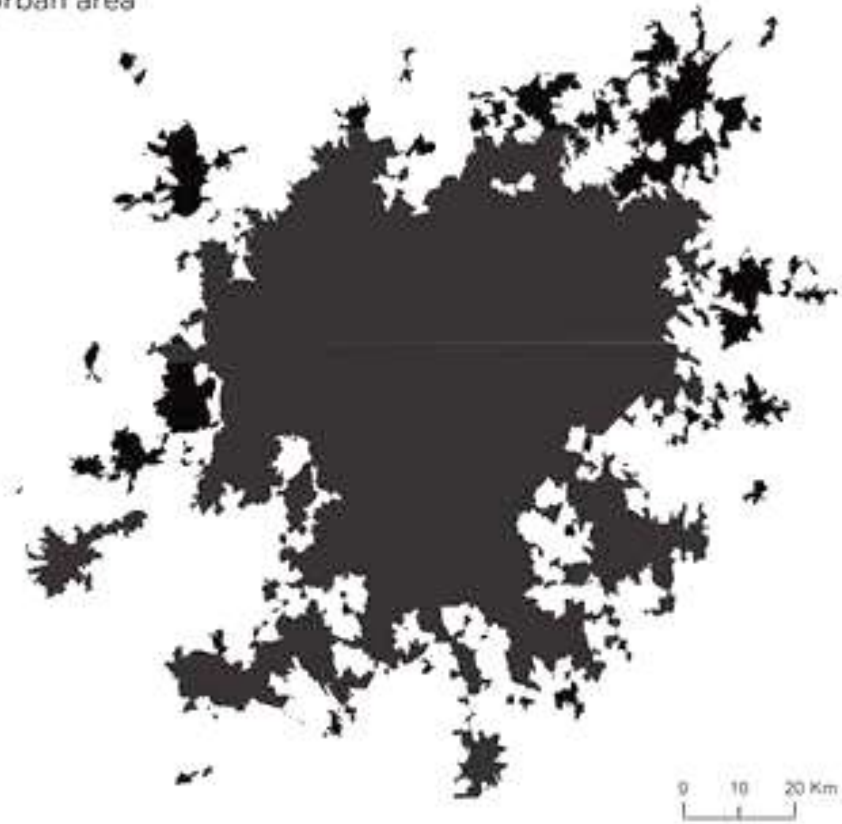

how can spatial planning help cities to manage their resources better?

Design criteria for limiting sprawl:

- forget about average densities – leads to compact city notion that can be dysfunctional
- hierarchical network of high density nodes interconnected with mass transit – average densification becomes an emergent outcome, not a policy objective
- minimum of 15 000 people/km2
- Narrow streets, short blocks, 5-8 stories – no superblocks, no wide streets
- 80-100 intersections/km2
- high floor - land area - ratios

ATLANTA

Urban area



Population **5.3** million

Urban area **7,692** km²

Transport carbon emissions p.c **6.9** tonnes

BARCELONA

Urban area

Population **5** million

Urban area **648** km²

Transport carbon emissions p.c **1.16** tonnes

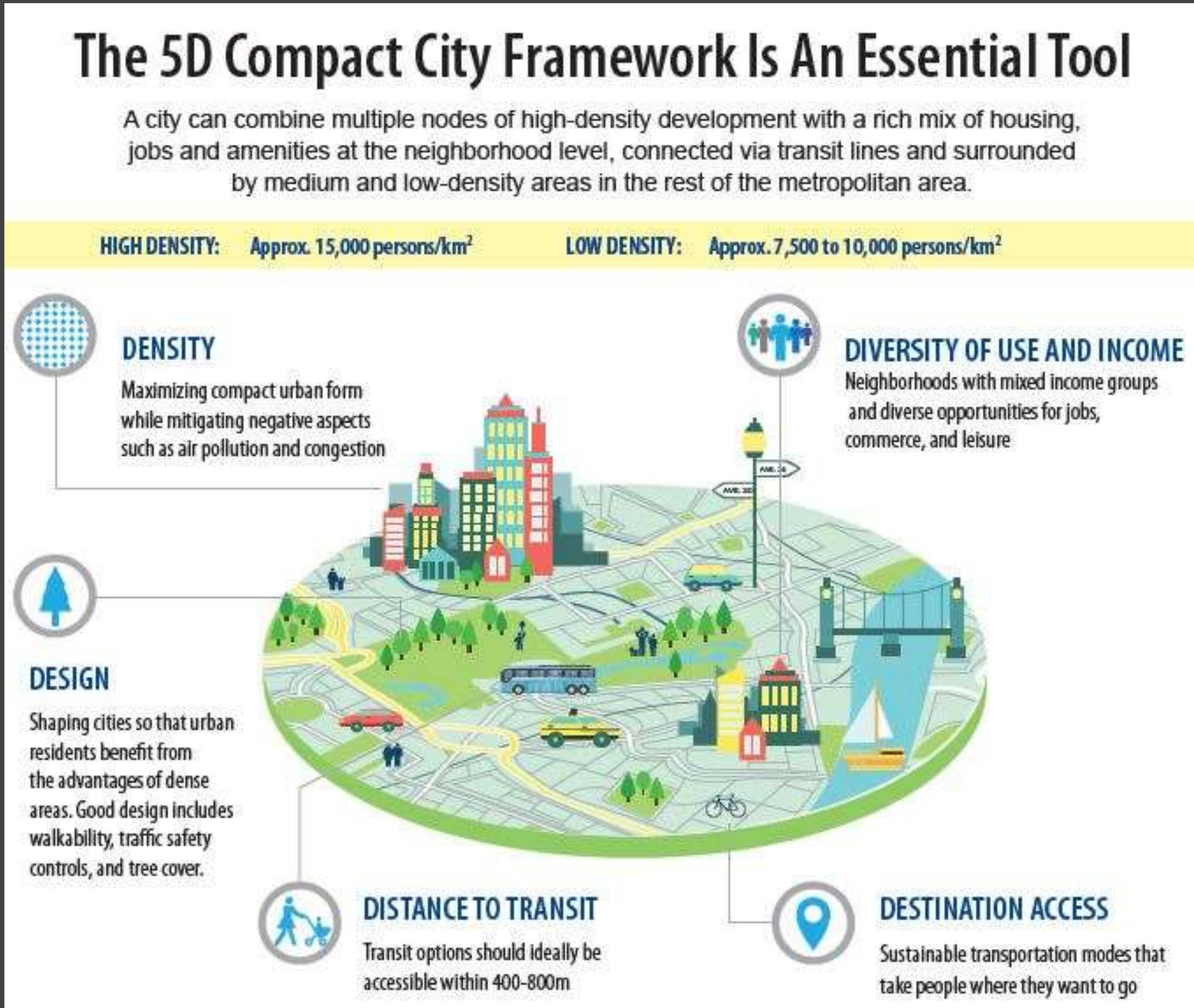
Source: LSE Cities 2014

More compact development can reduce transport emissions by an order of magnitude.

The effect of strategic intensification…

- Network of high density nodes interconnected with affordable transit nodes, mixed-use & ecologically designed: energy efficiencies = 0.5 x BAU (factor 2)
- Energy-efficient buildings: reductions in energy demand = 0.5 x BAU (factor 2)
- Maximum use of renewable energy with integrated demand-supply management: efficiency 20% = 0.8 x BAU
- Human behavior change: efficiency = 0.5 x BAU
- The cascading multiplicative impact of measures applied to each of the four levers is a multiplication by 0.5 x 0.5 x 0.8 x 0.5 = 0.1, i.e. a 10-fold reduction in energy use compared to BAU

A potential reduction of a factor 10



UNEP (2018). Sustainable Urban Infrastructure Transitions in the ASEAN Region: A Resource Perspective. UN Environment.

Chapter 4: Pathway #2 Sectoral Improvements

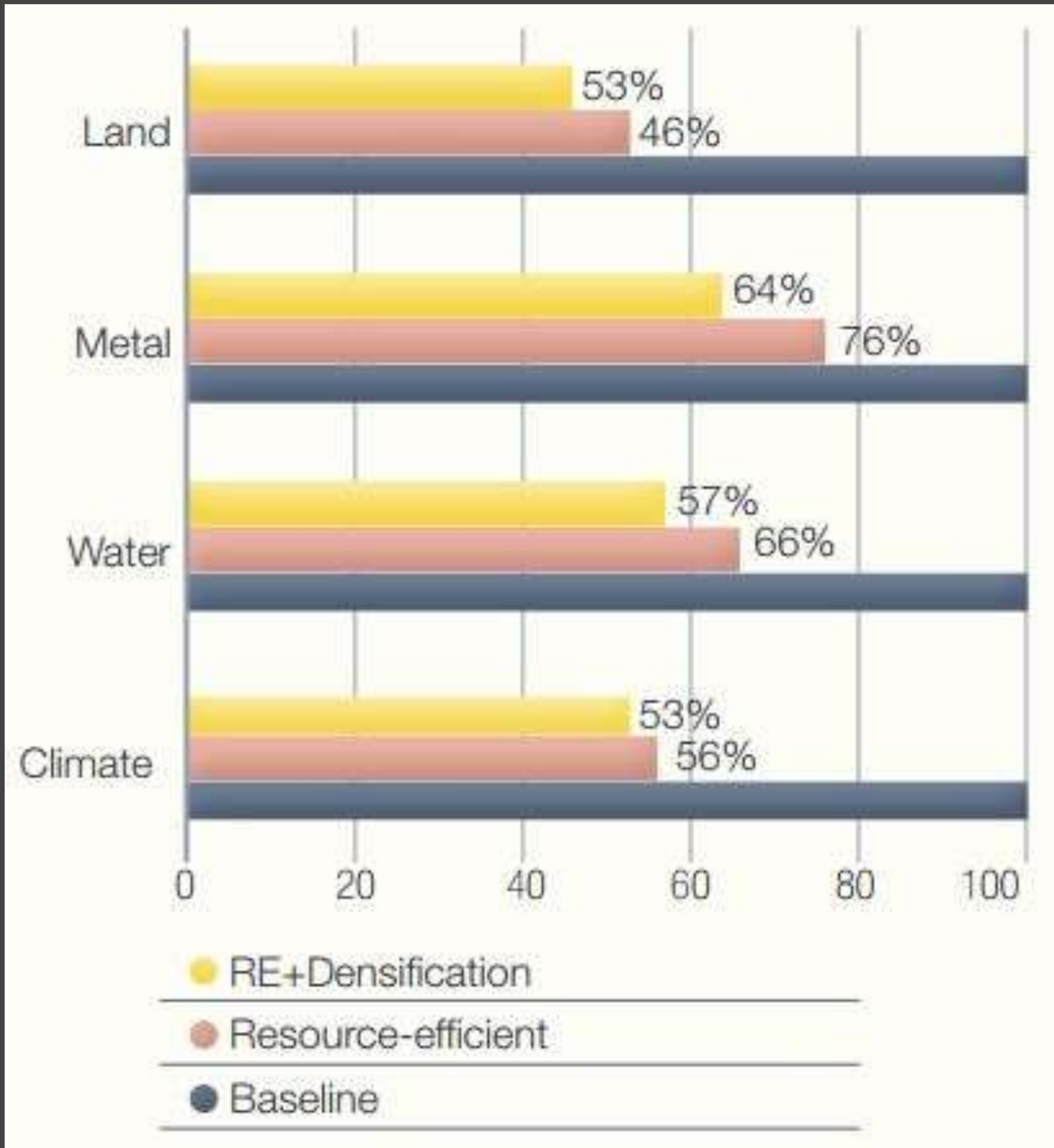
LCA of infrastructure alternatives to assess resource efficiency potential:

- literature review
- model of 84 cities
- with and without densification

BRT

Picture: Dan Chatman

- Energy efficient commercial buildings
- Bus rapid transition systems
- District energy systems
- Waste – not enough data



- implementation of resource efficient technologies **WITHOUT densification** in 84 global cities: **24 - 47% reduction** in the life cycle environmental and resource impacts by 2050 compared to Baseline Scenario
- implementation of resource efficient technologies **WITH densification** in 84 global cities: **36 - 54% reduction** in the life cycle environmental and resource impacts by 2050 compared to Baseline Scenario

Chapter 5: Pathway #3 Cross-Sector Whole City Efficiency

Case studies – USA, India and China

Inter-sectoral infrastructure interventions in selected cities using actual bottom-up data on resource flows in the follow sectors:

- building and construction sector
- energy supply sector focusing on electricity supply
- heat energy supply, incorporating pre-utilization of waste heat from industrial resources
- travel behaviors and transportation
- water and wastewater treatment
- waste management

Case studies:
1) Minneapolis, USA
2) Beijing, China
3) Kaifeng, China (Highly industrialized northern city)
4) Delhi, India

Minneapolis - Stable Population Growth

- Strategic densification and infill in transit-related nodes
- Energy efficient buildings
- 65% of all energy provided by 2050 from renewables
- extended mass transit services
- 4th generation district energy systems
- Advanced timber construction

Result by 2050:

- 33% reduction in GHG
- 62% saving in mineral construction materials
- 40% reduction in energy for heating and cooling

Beijing and Kaifeng - Fast Growing Cities

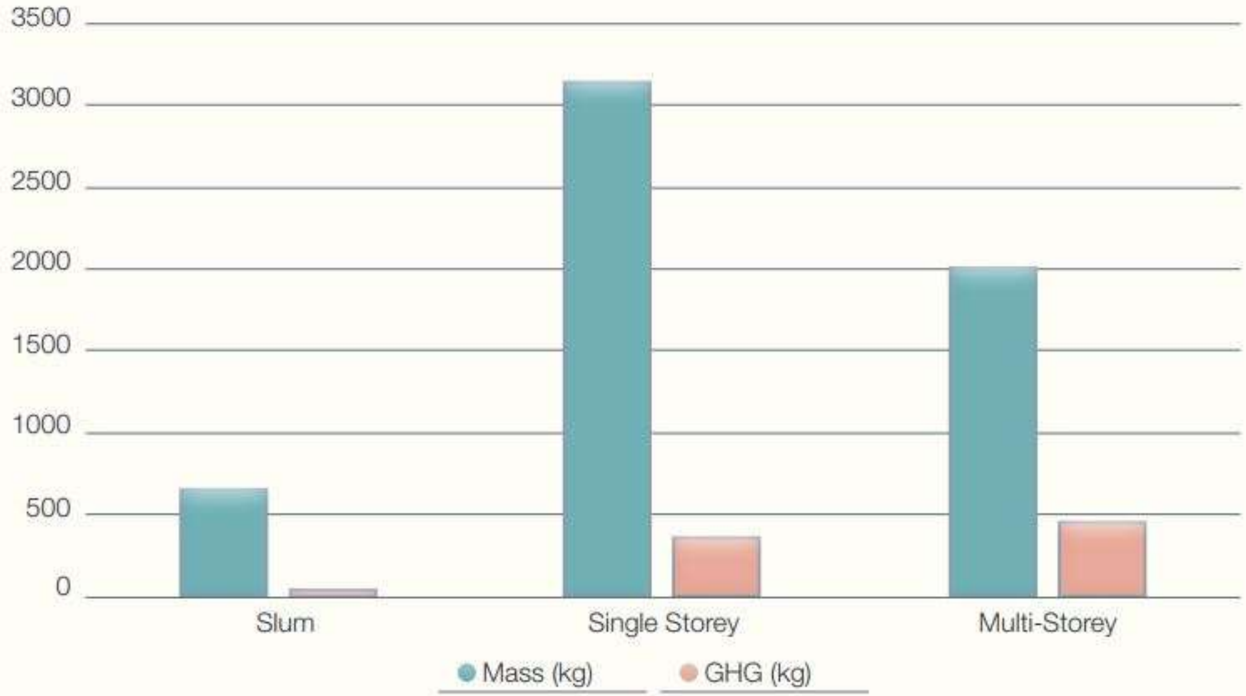
- Industrial efficiency – Top 10 000 Program
- 4th generation district energy systems
- Industrial waste heat re-utilization
- Energy efficient buildings
- Combined Heat and Power
- Waste to energy
- Material exchange/substitution – flyash/cement & slag/cement

Result: 40% reduction in GHG within 4 years, plus material savings

Delhi & Ahmedabad - Low Cost Housing & Slum Upgrading

- Rehabilitation of slums by building multi-story buildings in the inner city reduces material use by 36% (compared to single story construction), reduces motorized travel demand & improves access to employment, i.e. drives densification

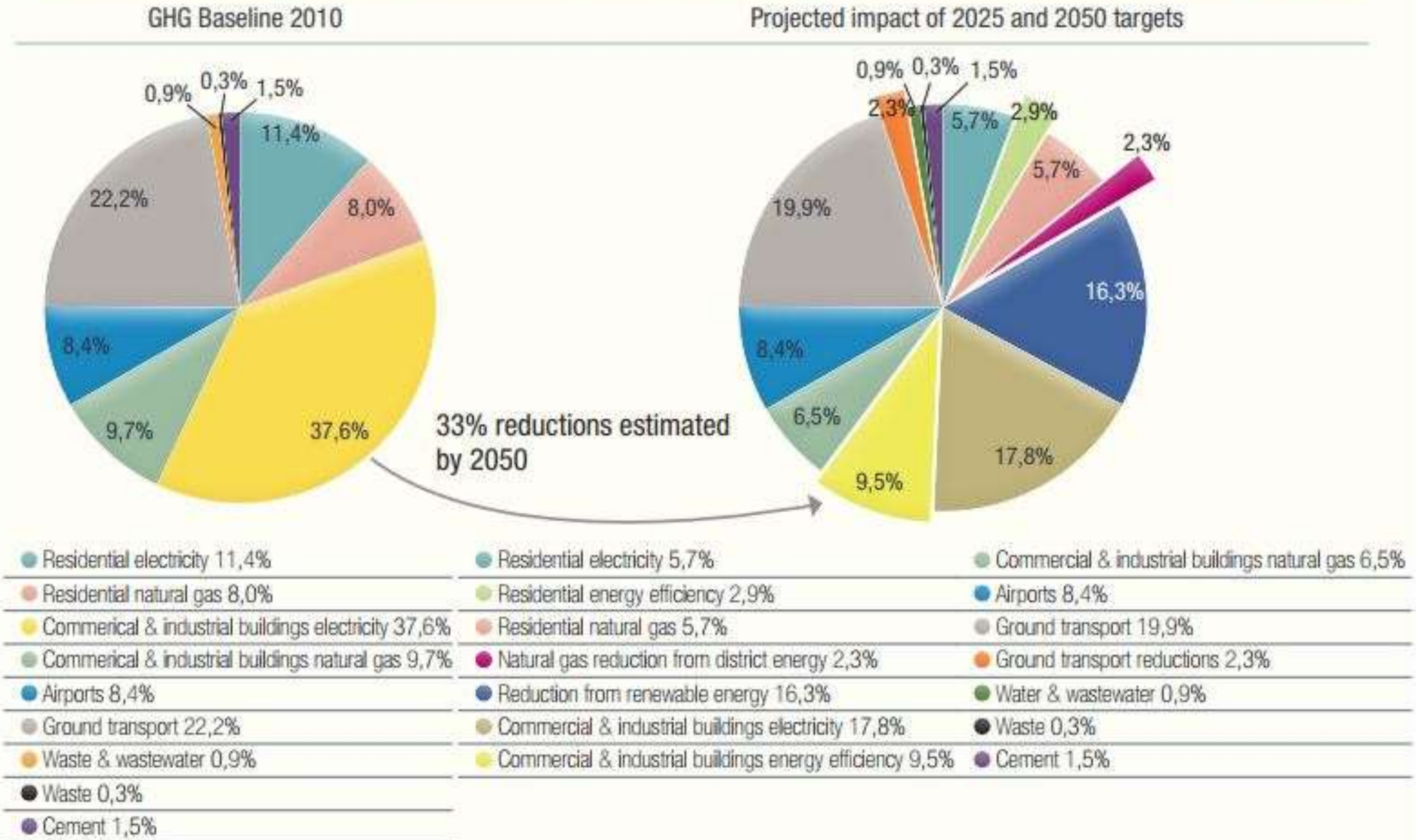
Figure 7: Housing material by mass and by embodied GHG emissions for Multi Family (MF) homes. Single-story and multi-story designs are derived from real-world structurally code-compliant buildings in India.



(Source: Nagpure et al., 2018)

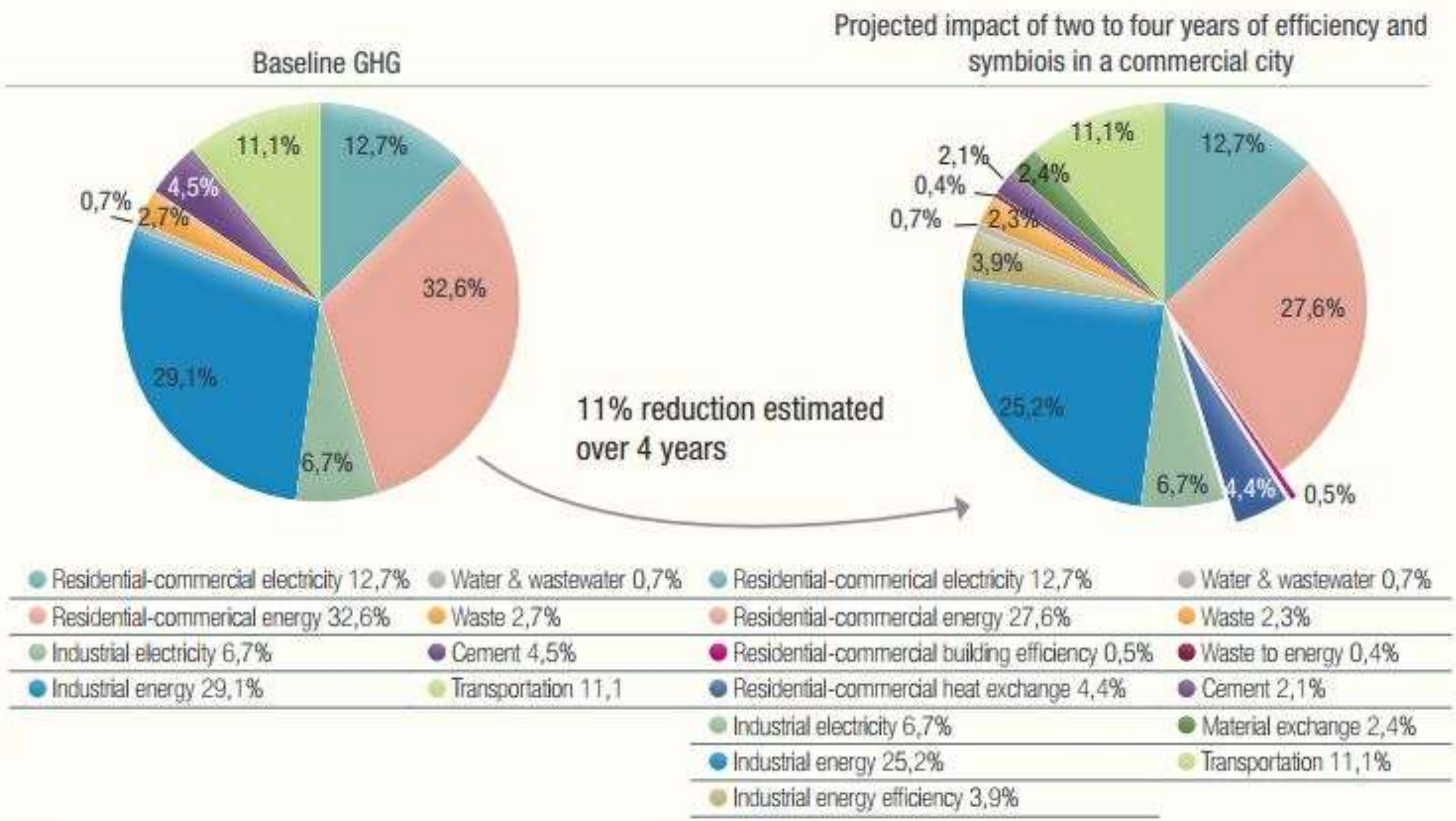
Case Study: Minneapolis

Figure 5: GHG emissions baseline and reductions associated with multiple infrastructure provisions in Minneapolis, USA. Year 2010 baseline emissions from Hillman and Ramaswami (2010); efficiency estimates of multiple infrastructure interventions are based on year 2025 and 2050 targets proposed by the city and other policy actors.



Case Study: Beijing and Keifeng

Figure 6: Anticipated Scope 1 and 2 GHG benefits in a period of two to four years based on modest policies already included in China's FYP, complemented by urban industrial symbiosis



(Data and models from Ramaswami *et al.*, 2017 and Tong *et al.*, 2017).

Chapter 6: Pathway #4 New Governance - Entrepreneurial governance

Global outbreak of urban experimentation

taking seriously the evolutionary potential of the present……

Urban Experimentation…

- Urban Experimentation: "An inclusive, practice-based and challenge-led initiative designed to promote system innovation through social learning under conditions of deep uncertainty and ambiguity." (Sengers *et al* in *The Experimental City*, 2016 – Evans, Karvonen, Raven (eds.)
- 21 case studies: state-led, market-led, citizen-led, technology-led mark

Entrepreneurial State (Mariana Mazzucato) – state investment in R&D *and* in risk reduction during the early phases of the innovation cycle

$90 trillion expenditure on urban infrastructure 2015-2030: 5% extra to decarbonize it – Global Commission on Climate and Economy

	Clientelistic	Corporatist	Managerial	Pluralist	Populist	Entrepreneurial
Governing Relations	particularistic personalised, exchange	Exclusionary Negotiation	formal, bureaucratic /contractual	brokering or mediating among compe-ting interests	Inclusionary negotiation	state-led innovation-oriented knowledge partnerships
Governing logic	reciprocity	consensus building	authoritative decision-making	conflict management	mobilization of popular support	urban experimentation/ **Integrated planning**
Key decision makers	politicians & clients	Politicians & big business	politicians & civil servants	politicians & organized power blocs	politicians & community movement leaders	politicians, entrepreneurs, researchers, innovators, NGOs
Political objectives	Material gain for elites	Purposive - urban regeneration /sprawl	Material - inclusionary	purposive - conflict resolution	symbolic, redistributiv e	Change/ Sustainability

A shift is required…

From **corporatist urban governance**/competing cities paradigm (race to the bottom, unequal)

→

To **entrepreneurial urban governance** of urban experimentation in well-ground cities rooted in inclusive foundational & eco-economies

Recommendations

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Urban Metabolism (items 1–3)

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Pathways of Change (items 4–8)

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Governance (items 9–11)

Thank you

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