

URBAN FORM AND CLIMATE MITIGATION

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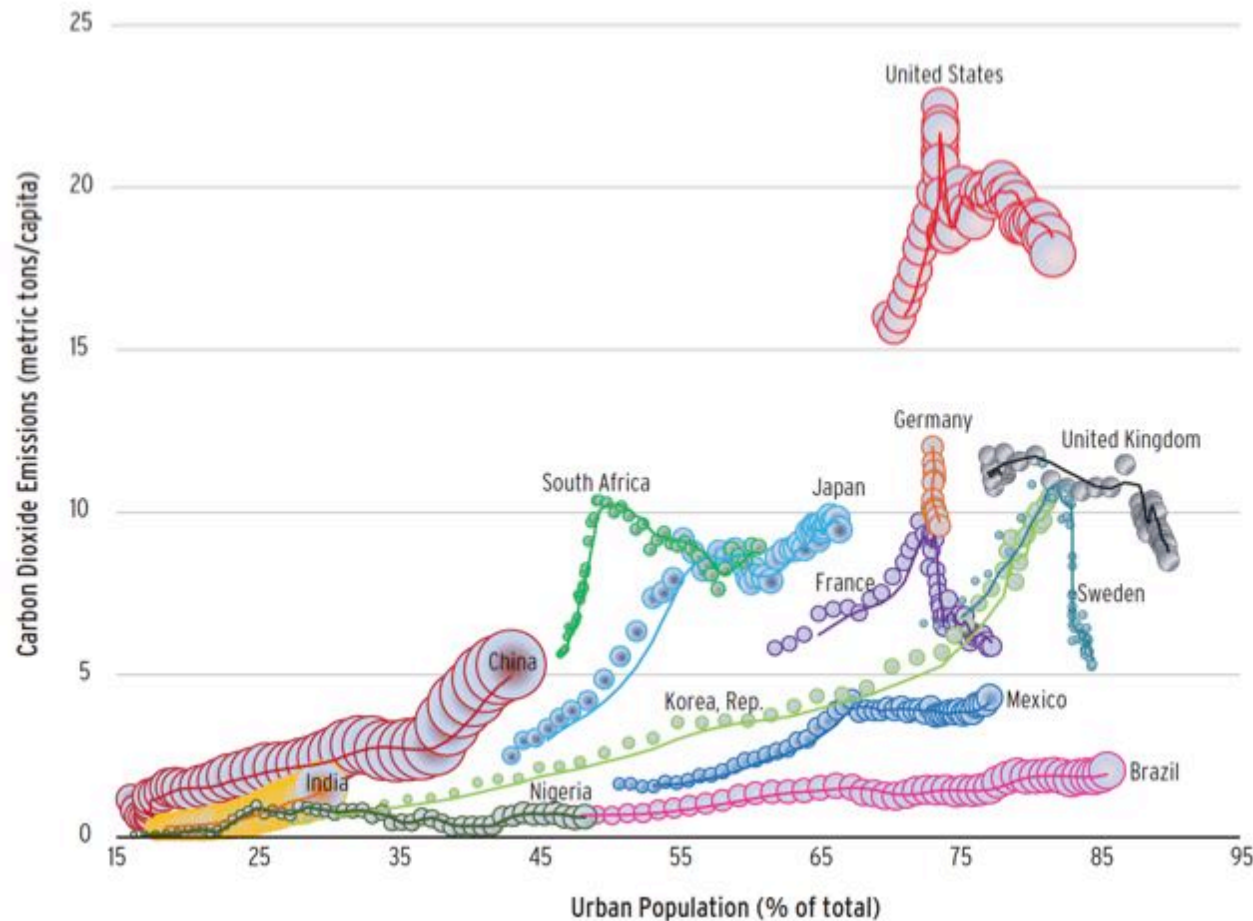
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IHS, Erasmus University, Rotterdam

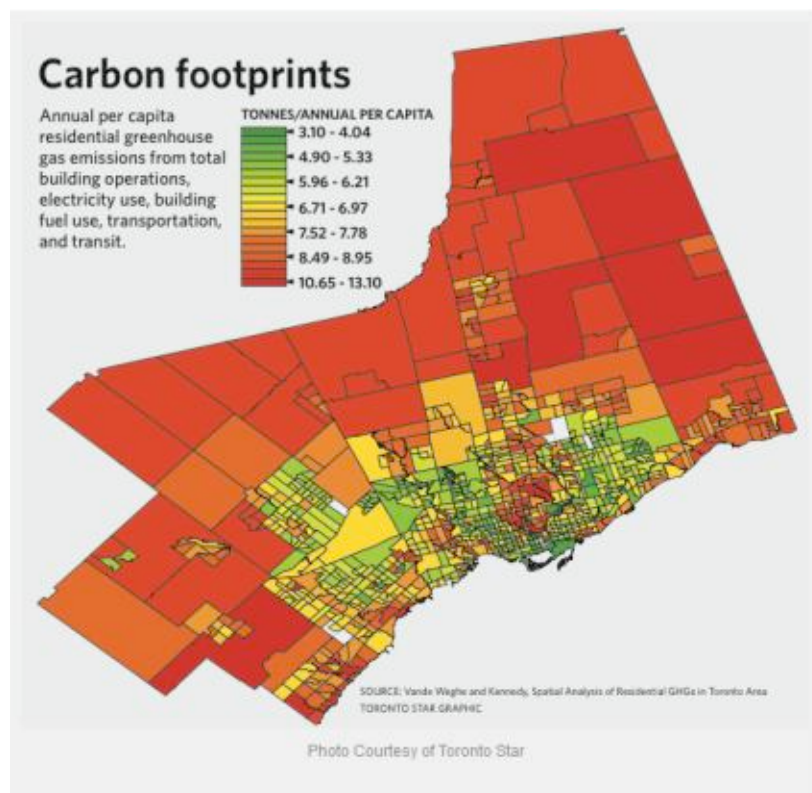
Urbanization and GHG emissions



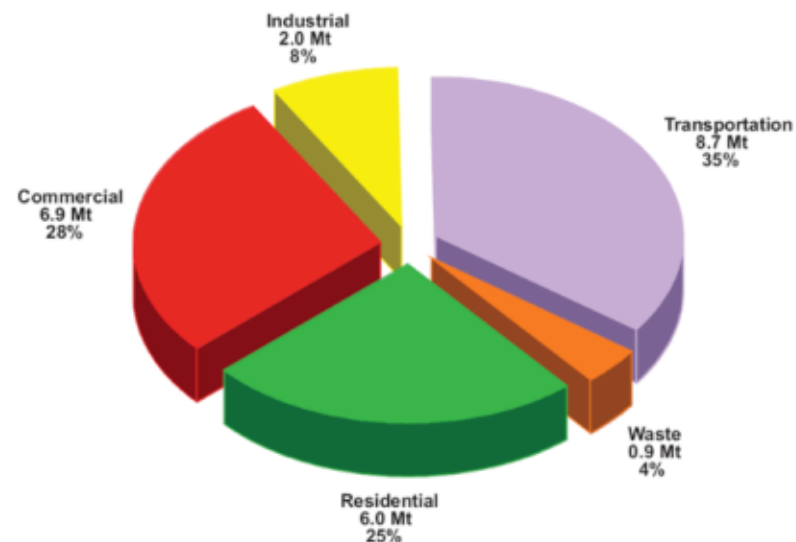
National GHG trajectories are the result of the energy intensity and size of the economies, of energy policies, fossil fuels used, import & export patterns, etc.

source: Building Sustainability in an Urbanizing World, World Bank, 2013

70 % of GHG emissions are urban

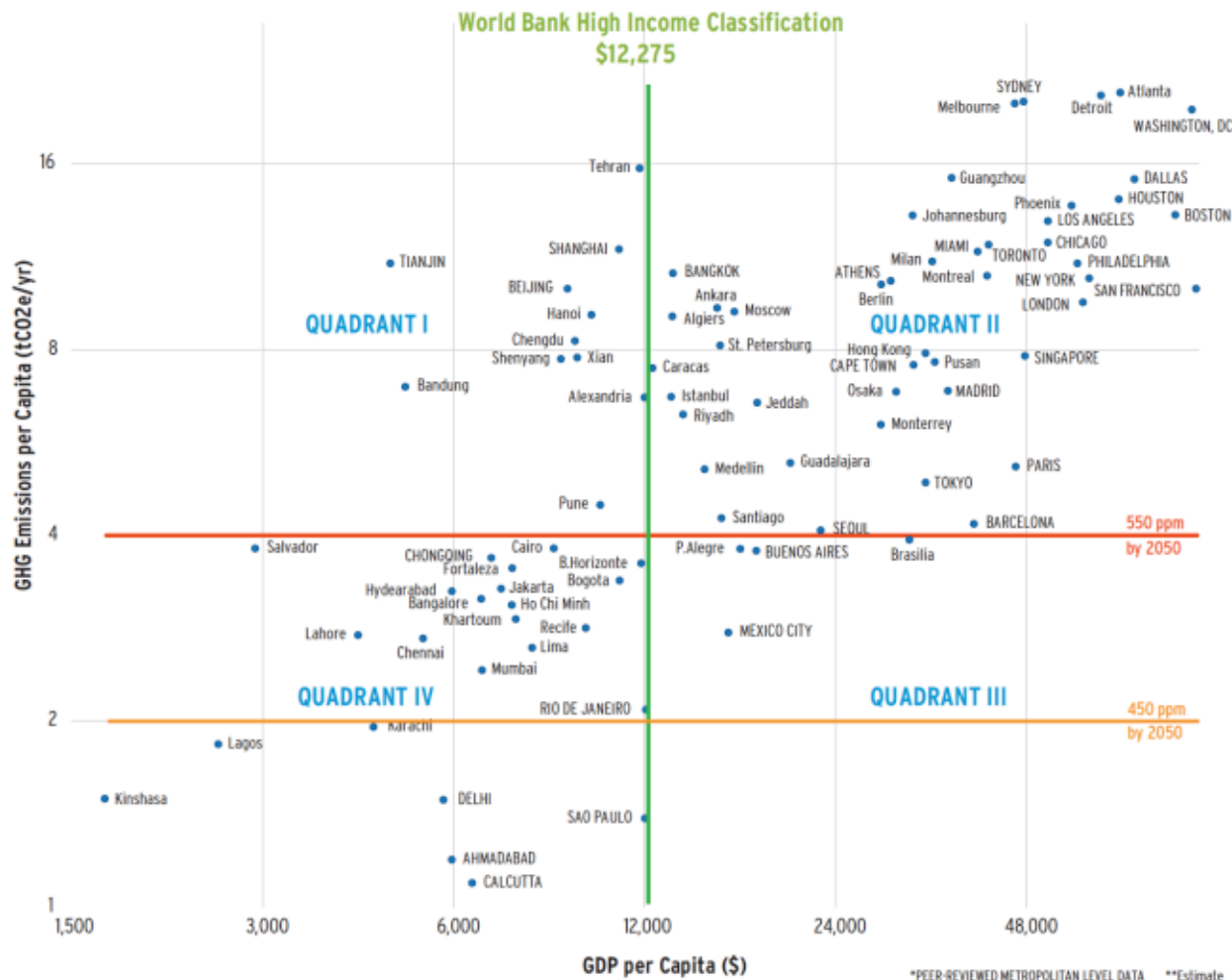


Metro Toronto GHG emissions showing higher emissions in the suburban areas
source: Vande Weghe and Kennedy, 2011



Sectors contributing to Toronto's GHG emissions
Source: www.toronto.ca

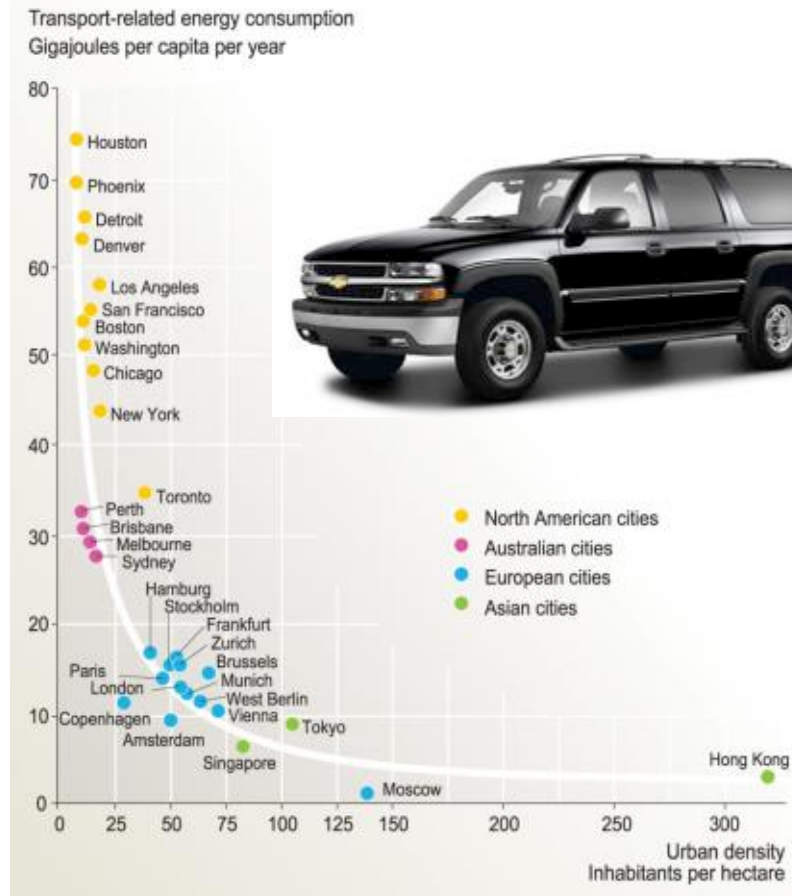
GDP and urban GHG emissions



Despite the overall correlation of GDP and GHG emissions, cities at the same level of GDP per capita may have very different GHG emissions per capita.

source: Building Sustainability in an Urbanizing World, World Bank, 2013

Factors behind urban GHG emissions

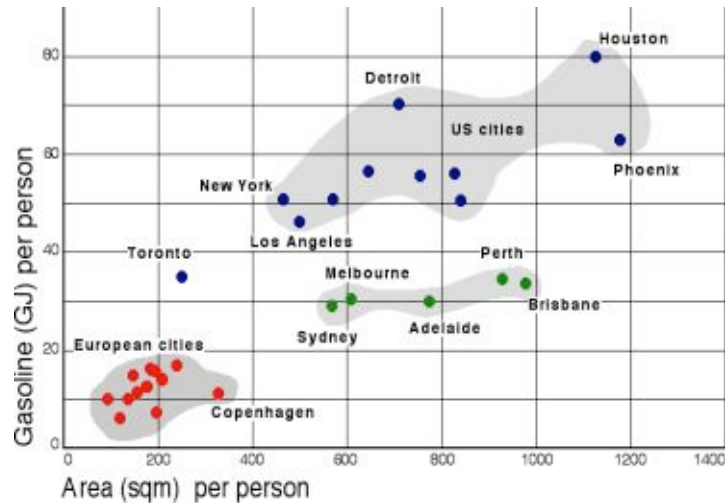


source: Newman and Kenworthy, 1999



Density, urban form, transport systems, lifestyle, economic activities and consumption, land use, local climate and geographic location, sources of energy determine level of urban GHG emissions in addition to GDP per capita

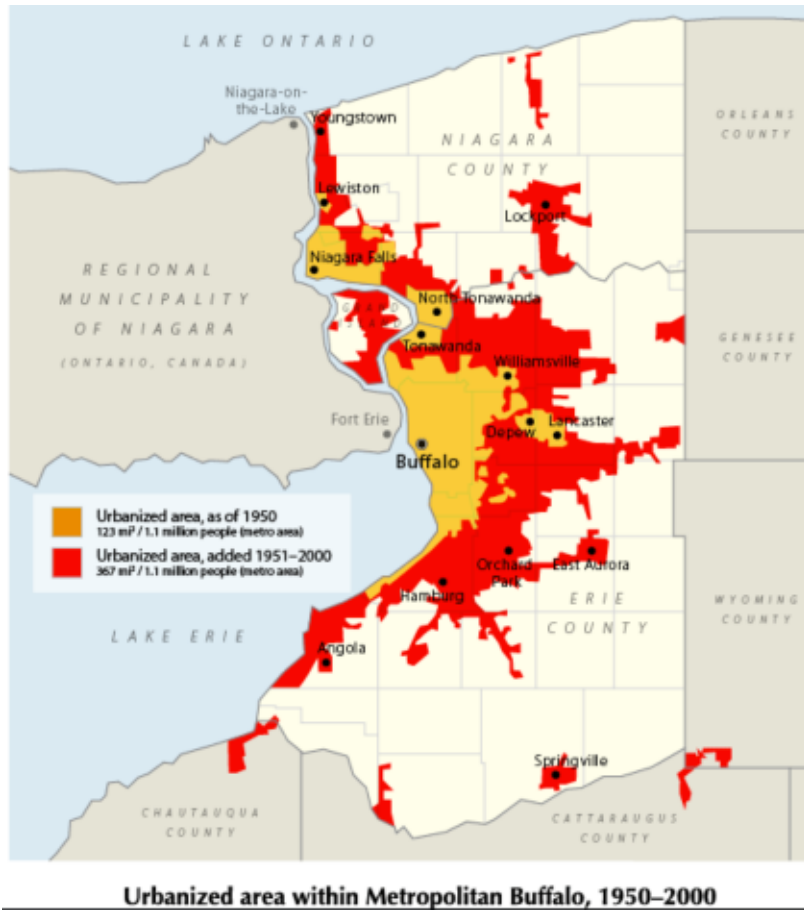
Urban density and GHG



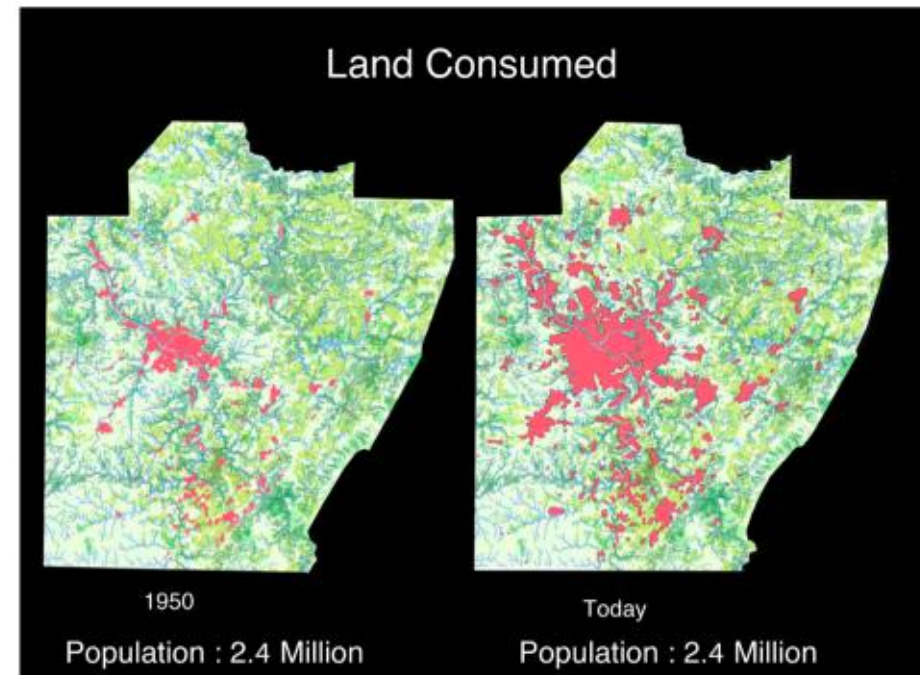
Density affects size of dwelling units, per capita area, distance between residential and productive areas, VMTs, with direct consequences on levels of urban GHG emissions



Sprawl – or decreasing density



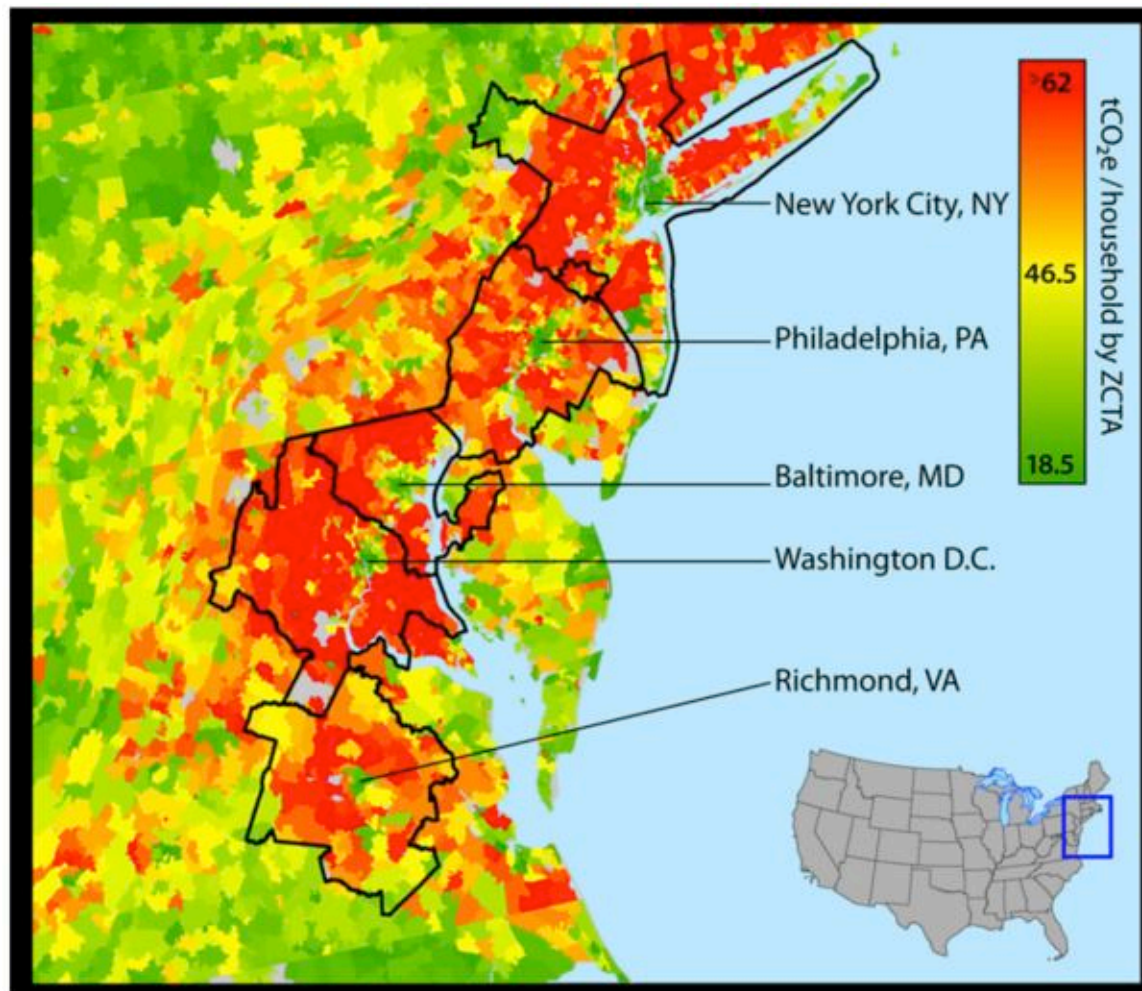
www.urbanophile.com



Pittsburgh

The "footprint" of cities is increasing even at a faster rate than urbanization worldwide, locking us into an even higher carbon-dependent future

US East Coast, sprawl and GHG

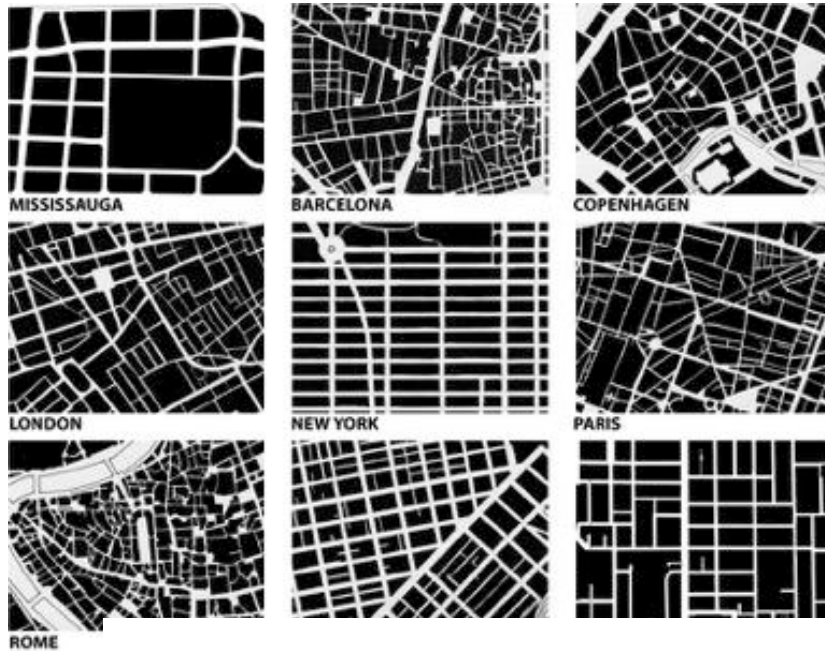


KEY FINDING

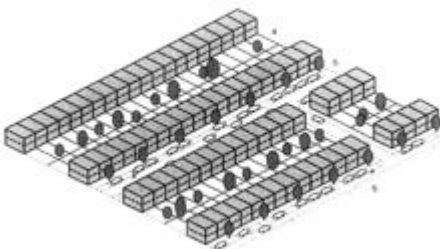
Household emissions are **MUCH LOWER** in the central urban areas, and **MUCH HIGHER** in the suburban, metropolitan areas (due to higher transport emissions)

Source: Cool climate calculator, Berkeley

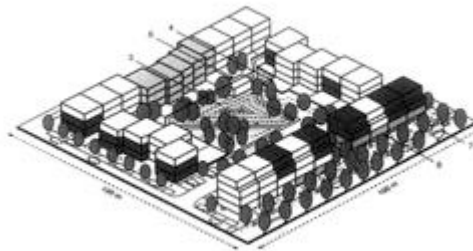
Urban form and GHG implications



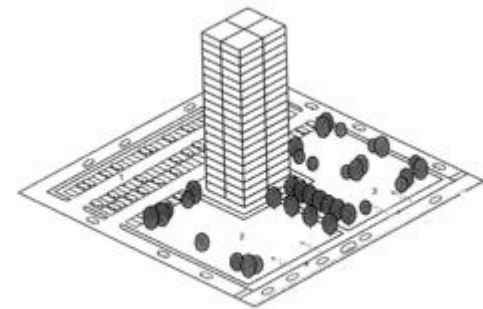
The **design** of urban fabric, street patterns, scaling of buildings, street grid, # of intersections, **isolation or mix** of urban functions, role of public spaces, forms of **urban mobility** (cars, transit, bikes, pedestrian) greatly influence levels of GHG emissions.



75 dwellings per hectare



75 dwellings per hectare



75 dwellings per hectare

Compact Urban Form – definitions

- **New urbanism (Gehl, etc.):**
Walkable, bikable, transit
connected, mixed-used,
human-scaled urban design
- **IPCC AR5, WGIII, Ch.12:**
Density, Mixed Land-use,
Connectivity, Accessibility
- **New Climate Economy:**
Compact urban growth
Connected infrastructure
Coordinated governance
NCE report, 2014, Ch. 2



Drivers of Compact Urban Form

- Agglomeration economies
- Lower infrastructure costs
- Higher productivity and innovation
- Lower use of materials
- Higher protection of natural space and agricultural land
- Lower energy usage, pollution
- **Lower GHG emissions**

Ahlfendt, G. Pietrostefani, E. The effects of Compact Urban Form, Coalition for Urban Transitions, 2017

Dodman, D. Urban Density and Climate Change, UNFPA 2009

- Multiple reviews show a high correlation between urban density, CUF and lower GHG emissions.

Lee, S. and Lee, B. The Influence of Urban Form on GHG Emissions in the U.S. Household Sector. Energy Policy 68, 2014

- However, sprawl continues unabated worldwide with rising middle-class incomes, mass automobile dependency, perverse fuel subsidies, and antiquated urban planning regulations that do not factor in carbon dependency.

Carbon: a new driver of urban change

- **Productivity**, economies of agglomeration
- **Livability** and quality of life for residents
- **Competitiveness** in a globalized world
- **Sustainable** urban development
- **Decarbonization**



CUF via land-use and urban policies



- **METROPOLITAN SCALE**
containing urban footprint and greenfield expansion, favoring densification.
- **CITY SCALE**
Transit Oriented Development, regeneration of brownfields and waterfronts, infill operations, eco-neighborhoods.
- **PROJECT SCALE**
mixed-use developments, pedestrian zones, NMT.

Interrelated urban policy options

Sector-specific policies

- Energy
- Transport
- Buildings
- Water and waste
- Manufacturing
- Ecosystem services
- ICT – “smart cities”

Urban planning policies

- Building codes
- Mixed-use zoning
- Transit oriented dev.
- Growth boundaries
- Urban regeneration
- Density and CUF
- Eco-neighborhoods

High-emitting, low-emitting cities

High-carbon cities generally in **mature and emerging economies. The challenge** is to maintain high living standards while reducing emissions



Low-emitting cities are mostly in **low-income countries. The challenge** is to increase quality of life while avoiding GHG-intensive growth



Key IPCC policy messages

FOR EXISTING CITIES

Reworking urban systems to reduce energy use and GHG emissions, optimizing assets and access, efficiency gains



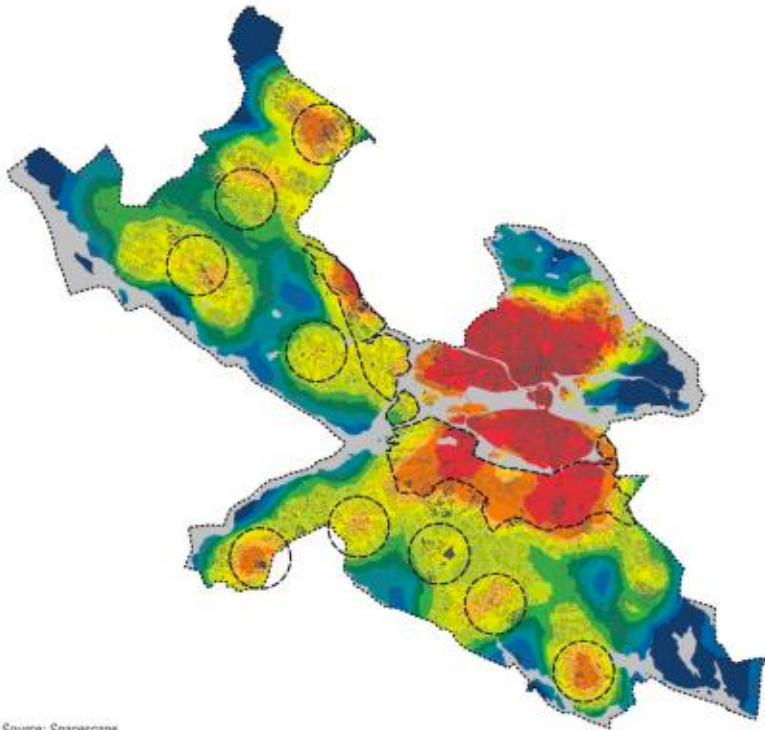
FOR EXPANDING CITIES

Land-use and urban planning to promote density and forms that reduce dependency on high-energy usage for urban life



Stockholm: CUF and GHG mitigation

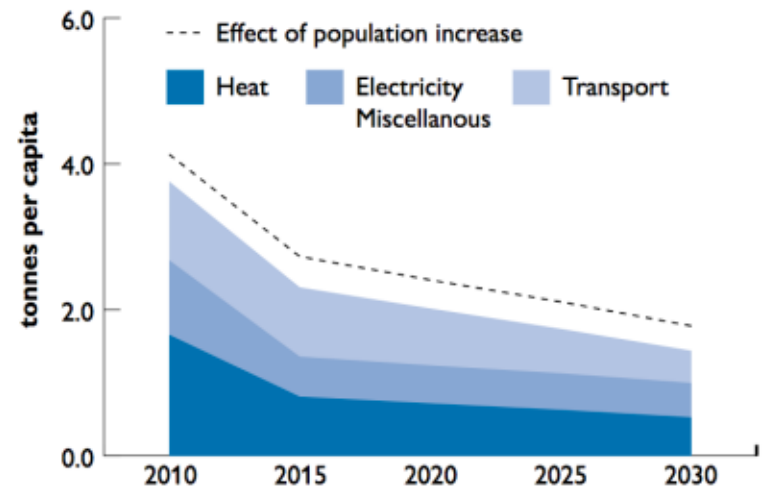
- 30 years of policies for density and CUF



Source: Spacescape

- GHG ABATEMENT

- 2009: - 23% over 1990
- 2015: - 43% “ “
- 2050: -100% “ “



Unique low-carbon cities -- Masdar

- UAE \$20b investment project, 50,000 people, 1,500 businesses, 2.3sq miles to be developed by 2025
- Zero-carbon, zero-waste, renewable energy only
- Connected by light-rail and metro to Abu-Dhabi metro area
- Designed by Foster and partners, UK

www.masdar.ae



Decarbonizing global cities -- Paris

Plan Climat 2007 goals for
2020 over 2004 baseline
with “Bilan Carbone” method

-25% GHG
-25% energy use
+25% renewable energy

2004-2014 results

-9.2% GHG
-7% energy use
+15.6% renewable energy

Paris 2014 results by sector

- ❑ Buildings -15%
- ❑ Urban mobility -23%
- ❑ Transport of goods -10%
- ❑ Waste -13%
- ❑ Materials -30%

Using the GPC protocol,
emission reductions in Paris
have gone down by 14%.

tCO₂e/hab. = 2.42

California's low-carbon urban planning

Assembly Bill 32 of 2006 stipulates GHG abatement by 2020 at 1990 levels, reductions in transportation, buildings, power generation, industry, agriculture, and **urbanism**

SB375 of 2008 stipulates: “regions will work to integrate **development patterns and the transportation network in a way that achieves the reduction of GHG** while meeting housing needs and other regional planning objectives”

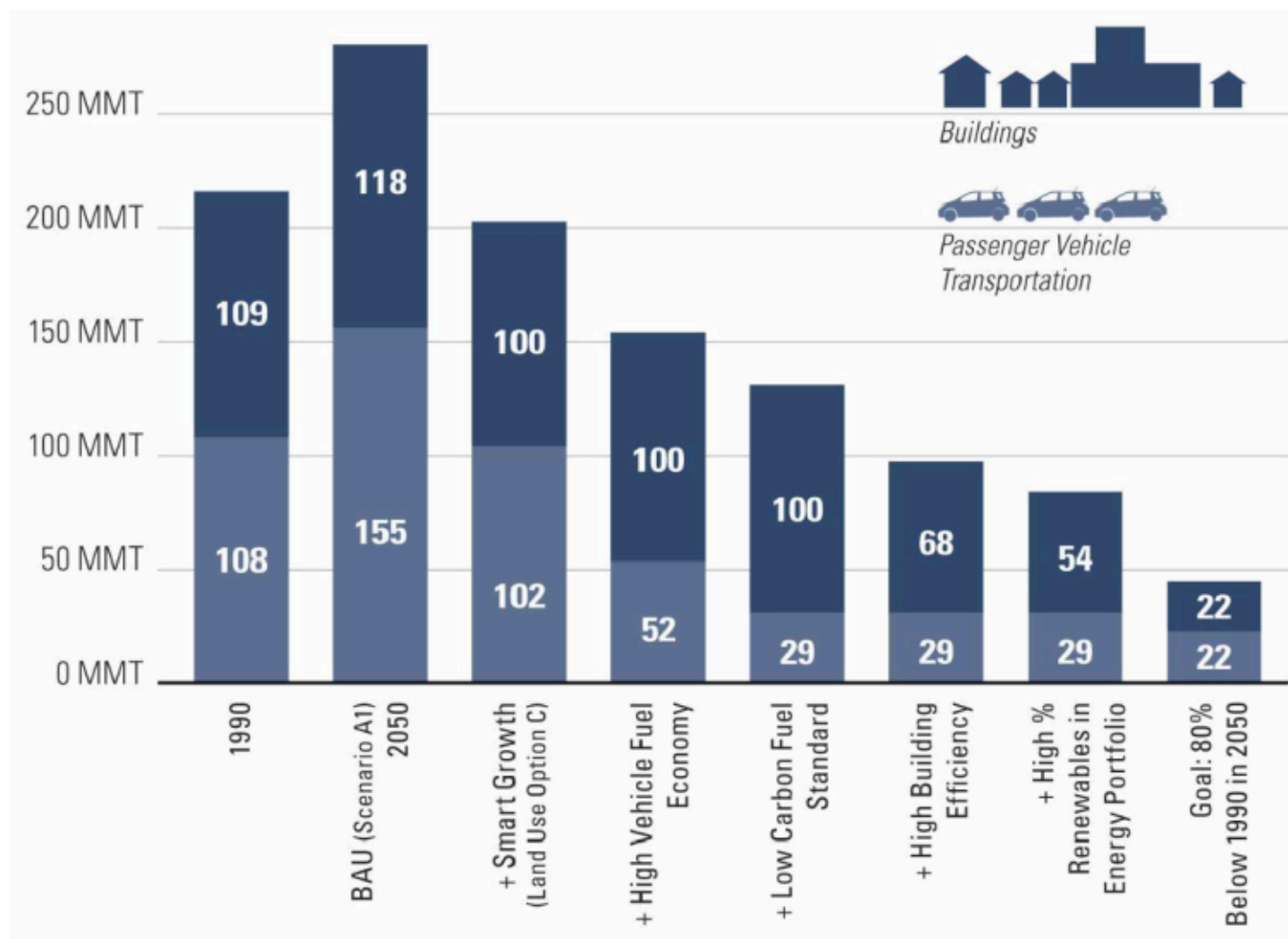
OBJECTIVES:

- 33% R.E. of energy mix
- Cap-and trade to achieve 20% of reductions
- Auto efficiency to achieve 27% of reductions
- Energy-efficiency in buildings to achieve 15% (California's buildings twice as efficient as rest of USA)
- **Land-use and urban planning to deliver the balance of GHG reductions**

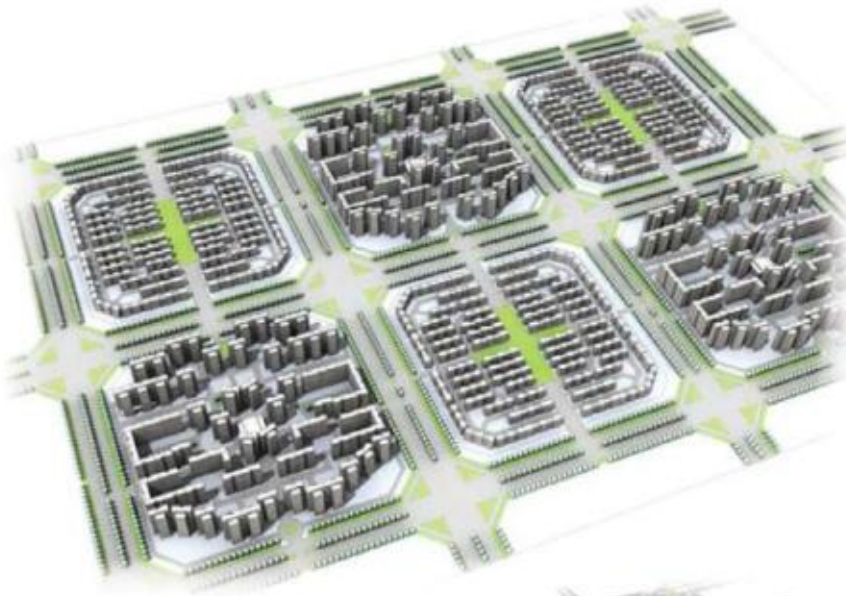
Modeling CUF and GHG forecasts

- CALIFORNIA: +10m population 2010 to 2050
- SMART GROWTH vs. BAU
 - 1/3 land consumption
 - 2/3 VMT
 - 1/2 household costs for transportation and utilities
 - **1/3 GHG emissions !!!**
- Smart growth: 35% urban, 55% compact, 10% sprawl
- Calthorpe Associates “Vision California”, 2011, using Rapid Fire and Urban Footprint mapping and GHG forecasting software
- Very high co-benefits of CUF for climate action coupled with other critical drivers of sustainable urban growth.
- Research agenda for cities & climate change should include more applied work on the linkages of CUF and GHG mitigation.

Vision California integrated policies



Chongqing -- urban futures 2035



Superblock urban development (BAU)



People Oriented Development (POD)

Image source: Calthorpe and Associates

China and other rapidly urbanizing nations have the opportunity to formulate better urban futures by moving away from business-as-usual urban planning models and regulations and adopting more human-centric mixed-use Compact Urban Forms.

Co-benefits of urban GHG mitigation

Sustainable development



Urban mitigation actions must integrate broader agenda of low ecological foot-print, conservation natural resources

Resilience and adaptation



Synergies needed also with actions aimed at preparing the city and its systems against natural and climatic impacts