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Siemens Corporate Technology | September 2013

I&C technologies in vertical applications – smart cities

We are in the "urban millennium"

Facts about cities

Population

- 2009: 50% of the world's population lives in cities
- 2030: urban population will grow from 3.5 billion to 4.7 billion

Economy

- 51% of global GDP is produced in 600 cities
- By 2025, middle-weight cities in emerging markets will generate 40% of GDP growth

Environment

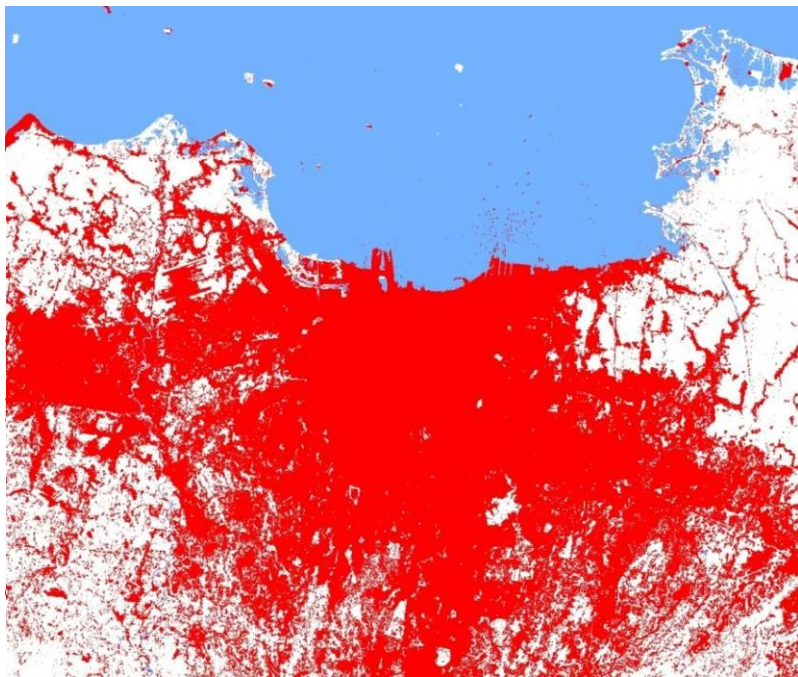- Cities consume two-thirds of the world's energy, and 60% of its drinking water
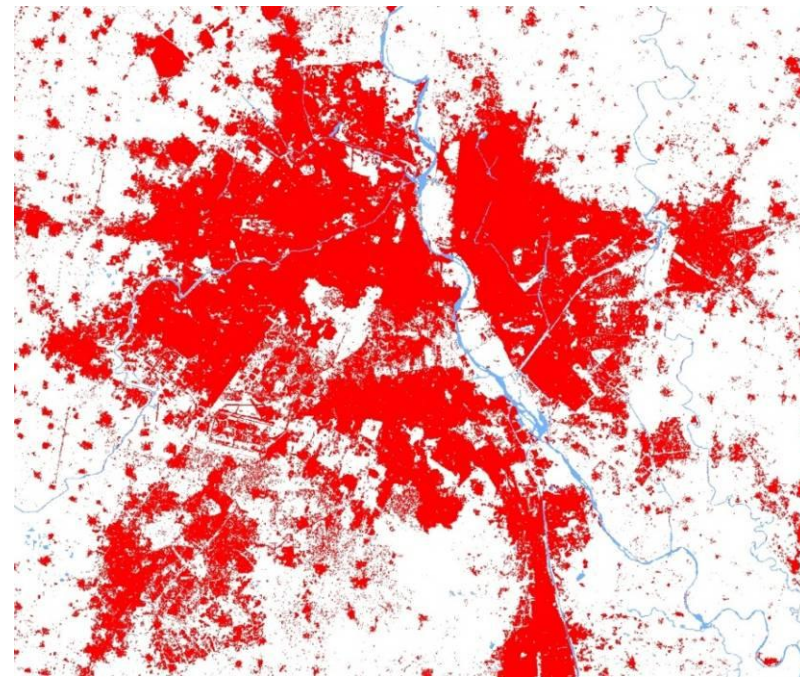- Cities generate up to 70% of its CO_2 emissions

Population:
City population grows by 2 inhabitants per second

Illustration of city population growth: Jakarta and Delhi

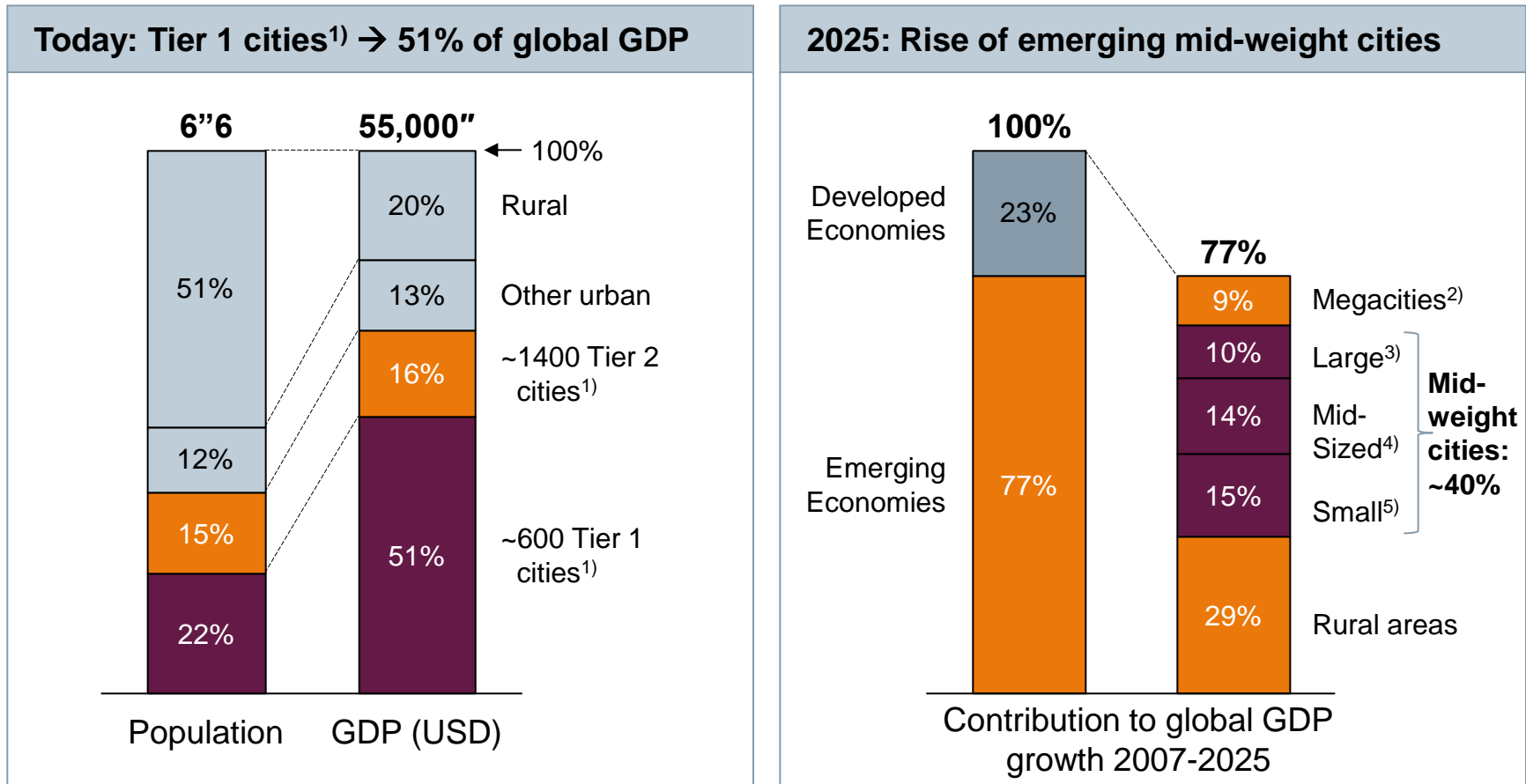Greater Jakarta 2010—28 Mio

Greater Delhi 2010—22 Mio

Source: Deutsches Zentrum für Luft- und Raumfahrt, UN World Urbanization Prospects: The 2009 Revision

Economy: Emerging markets middleweight cities play a crucial role in future growth

GDP per city size – today and tomorrow

Today: Tier 1 cities[1) → 51% of global GDP

6"6   **55,000"**

← 100%

Population	GDP (USD)	
51%	20%	Rural
	13%	Other urban
12%	16%	~1400 Tier 2 cities[1]
15%		
22%	51%	~600 Tier 1 cities[1]

2025: Rise of emerging mid-weight cities

100%

77%

Developed Economies — 23%

Emerging Economies — 77%

9%	Megacities[2]
10%	Large[3]
14%	Mid-Sized[4]
15%	Small[5]
29%	Rural areas

Mid-weight cities: ~40%
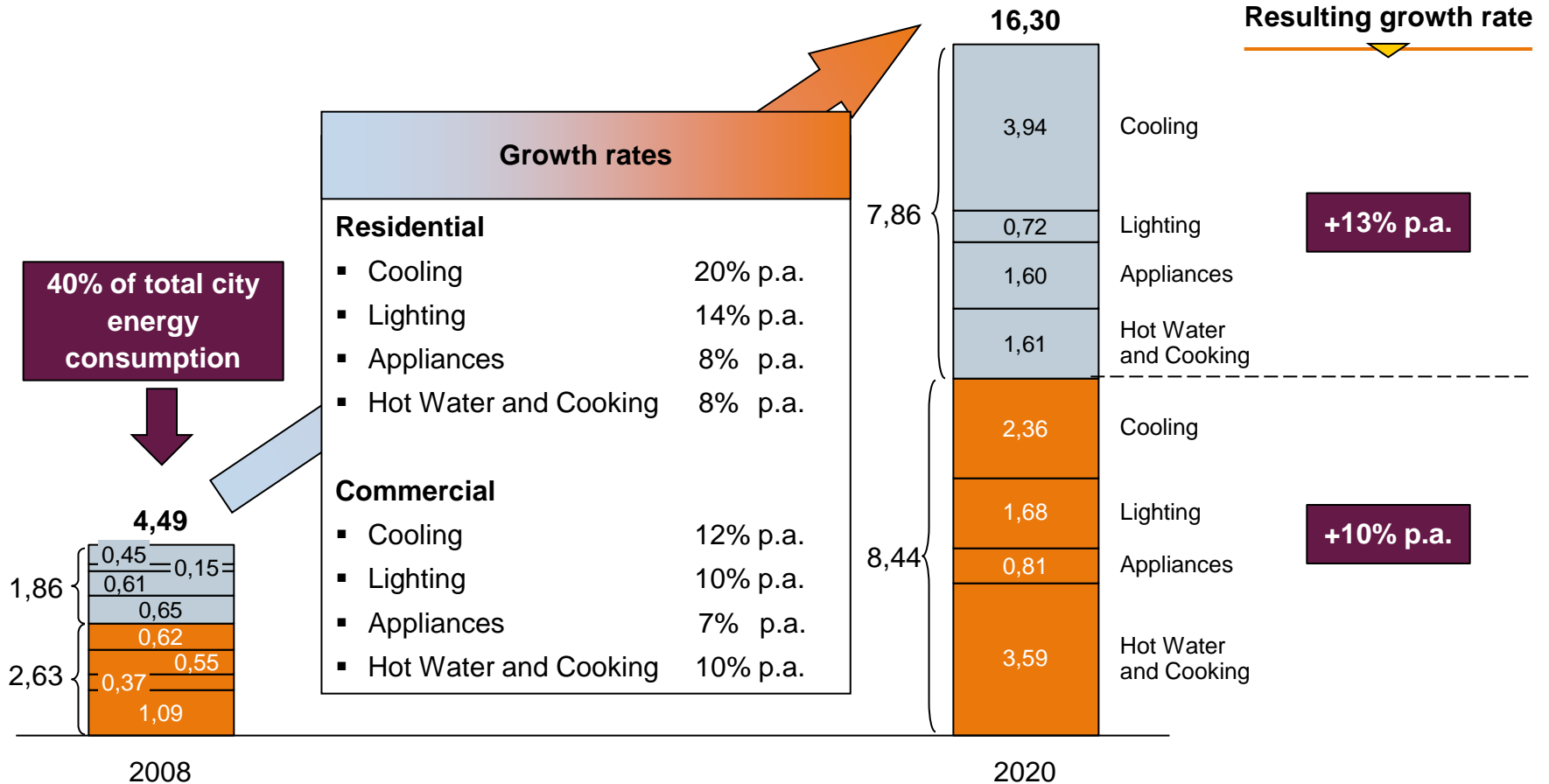
Contribution to global GDP growth 2007-2025

1) Tier categorization based on population, economic development and political importance of the respective cities
2) Megacities: >10 million inhabitants; 3) Large mid-weights: >5 million; 4) Mid-size mid-weights: >2 million 5) Small mid-weights: >0,15 million;
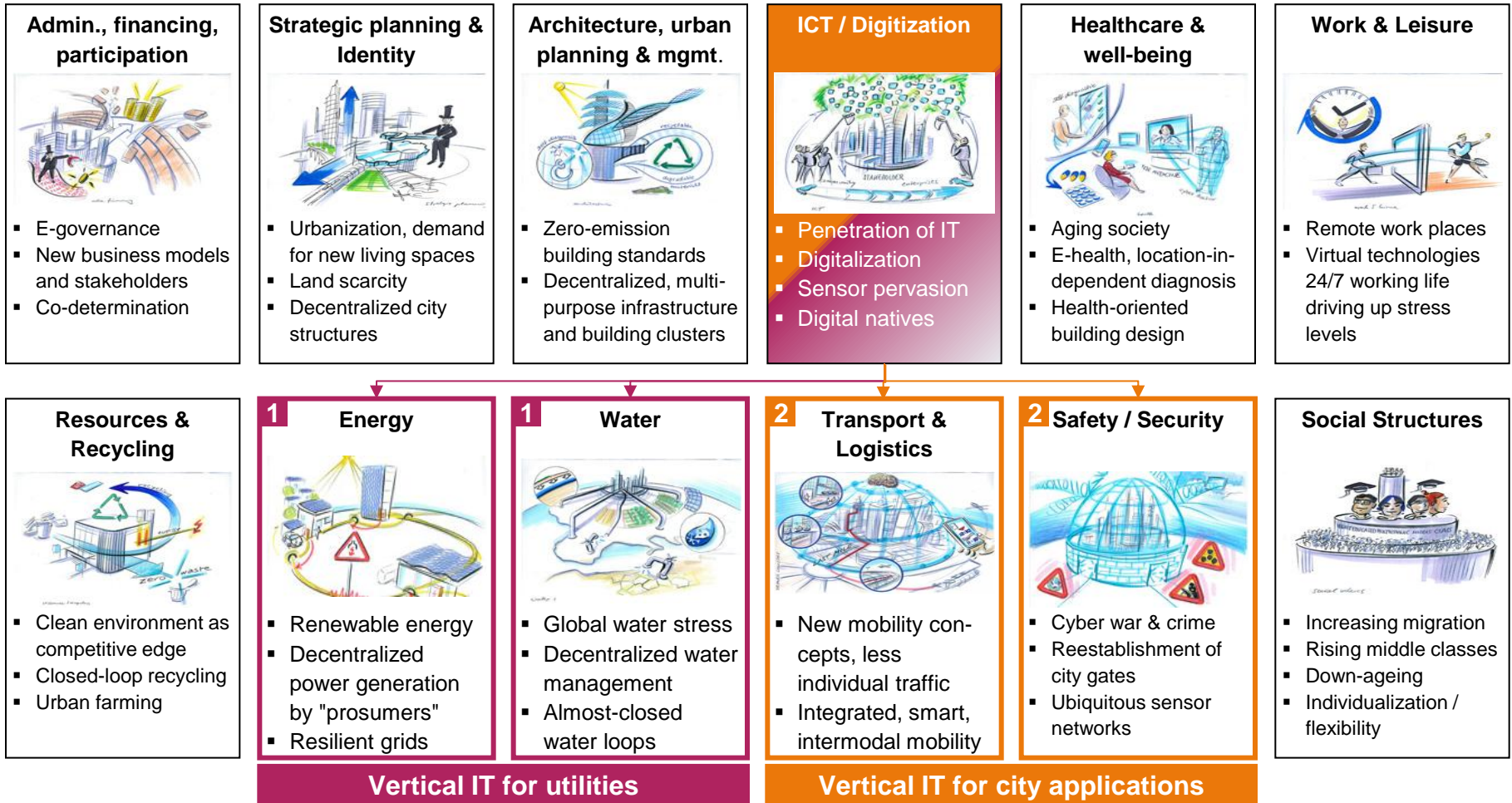Source: McKinsey

Environment: Impact of cities on energy consumption and environment will grow even further

Example: Building energy consumption of an Asian mega city, 2008 to 2020, in million tons SCE

Resulting growth rate

16,30

	2020	
3,94	Cooling	
0,72	Lighting	
1,60	Appliances	
1,61	Hot Water and Cooking	7,86

+13% p.a.

	2020	
2,36	Cooling	
1,68	Lighting	
0,81	Appliances	
3,59	Hot Water and Cooking	8,44

+10% p.a.

40% of total city energy consumption

Growth rates

Residential
- Cooling 20% p.a.
- Lighting 14% p.a.
- Appliances 8% p.a.
- Hot Water and Cooking 8% p.a.

Commercial
- Cooling 12% p.a.
- Lighting 10% p.a.
- Appliances 7% p.a.
- Hot Water and Cooking 10% p.a.

4,49

0,45	0,15	
0,61		1,86
0,65		
0,62		
0,55		
0,37		2,63
1,09		

2008

2020

Residential ▢   Commercial ▮

Source: Siemens project team

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Cities mayors are facing a diverse playing field – Vertical IT is both a challenge and an enabler

Trends and challenges faced by cities

Admin., financing, participation	Strategic planning & Identity	Architecture, urban planning & mgmt.	ICT / Digitization	Healthcare & well-being	Work & Leisure
▪ E-governance ▪ New business models and stakeholders ▪ Co-determination	▪ Urbanization, demand for new living spaces ▪ Land scarcity ▪ Decentralized city structures	▪ Zero-emission building standards ▪ Decentralized, multi-purpose infrastructure and building clusters	▪ Penetration of IT ▪ Digitalization ▪ Sensor pervasion ▪ Digital natives	▪ Aging society ▪ E-health, location-independent diagnosis ▪ Health-oriented building design	▪ Remote work places ▪ Virtual technologies 24/7 working life driving up stress levels

Resources & Recycling	**1** Energy	**1** Water	**2** Transport & Logistics	**2** Safety / Security	Social Structures
▪ Clean environment as competitive edge ▪ Closed-loop recycling ▪ Urban farming	▪ Renewable energy ▪ Decentralized power generation by "prosumers" ▪ Resilient grids	▪ Global water stress ▪ Decentralized water management ▪ Almost-closed water loops	▪ New mobility concepts, less individual traffic ▪ Integrated, smart, intermodal mobility	▪ Cyber war & crime ▪ Reestablishment of city gates ▪ Ubiquitous sensor networks	▪ Increasing migration ▪ Rising middle classes ▪ Down-ageing ▪ Individualization / flexibility

Vertical IT for utilities   **Vertical IT for city applications**

Source: Siemens Pictures of the Future "Cities"

Electricity – the lifeblood of a city

■ Milestones in city electrification

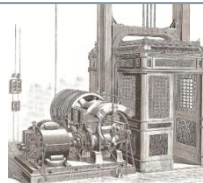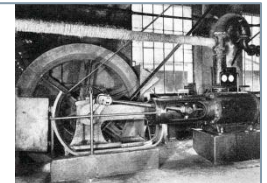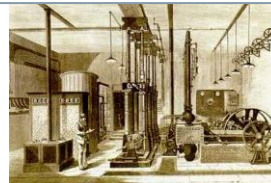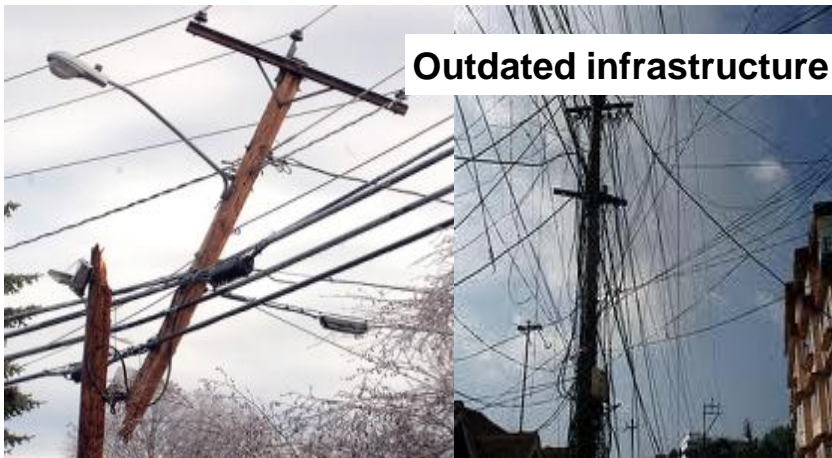|	
1844: 1st electric street light (Paris)	**~1890-1920:** Electric cars flourishing in Europe and the US
1879: 1st electric train (Siemens, Berlin)	**From ~1930:** Electric ovens
1880: 1st electric elevator (Siemens, Berlin)	**1938:** 1st deployment of heat pumps (Zurich)
1882-1885: First power plants in Germany (Stuttgart, Berlin)	**2008:** 1st modern electric car in serial production (Tesla Roadster)
1885: 1st public utility in Germany (AG Städtische Elektrizitätswerke, Berlin)	**2010:** 1st all-electric regular bus service (Seoul)

Modern day challenges: Resilient energy supply against a rising number of threats

■ Modern-day grid challenges (examples)

Outdated infrastructure

Rise of the "prosumer"

„Non-technical losses"

22% 20%

21% 9%

18% 5%

21% 10%

12% 3%

Distribution losses

Non-technical losses

E.g. Brazil:

- NTL: 23 TWh p.a. (5.8% of total)

- Economic loss of 1" EUR p.a.

Capacity problems with potentially disastrous impact
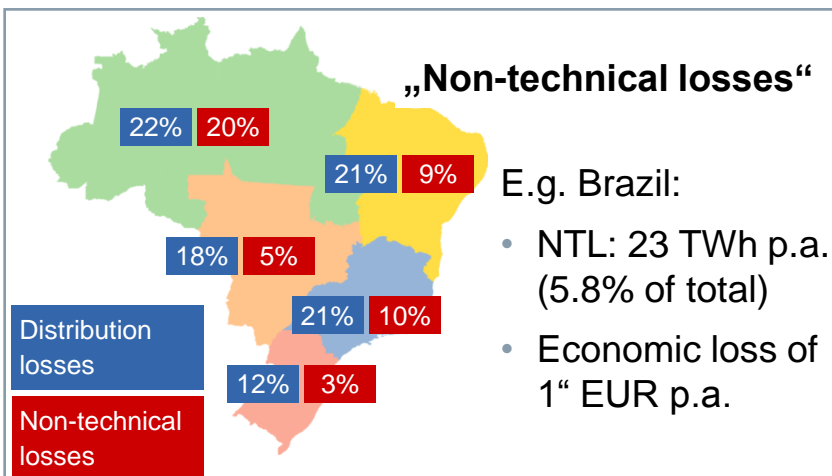
IT-driven smart grid applications are increasingly vital to keep the lifeblood flowing

■ Smart grid solutions

Challenges in changing energy systems → **Smart Grid Solutions**

Challenges in changing energy systems	Smart Grid Solutions
Renewable and distributed generation	Balancing generation & demand, new business models
Limited generation and grid capacity	Load management & peak avoidance
Aging and/or weak infrastructure	Reliability through automatic outage prevention and restoration
Cost and emissions of energy supply	Efficient generation, transmission, distribution & consumption
Revenue losses, e.g. non-technical losses	Full transparency on distribution level and automated loss prevention

Step-wise development towards multi-modal energy grids

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■ Intelligent energy grids: Development steps

| Power grid	Power grid + building	Multi-modal energy systems
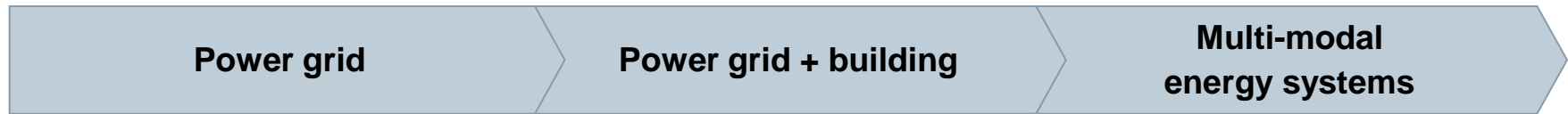
Power grid
- Integration of renewable energy (in-feed, storage and trade)
- Microgrids
- Example: Project IRENE [1] (Siemens, Hochschule Kemp-ten, Allgäuer Überlandwerke)

Power grid + building
- Integration of intelligent residential, commercial and industrial premises (private power generation, intelligent consumptions)
- Island grid, nano grid
- Example: Project "Seestadt Wien / Aspern"
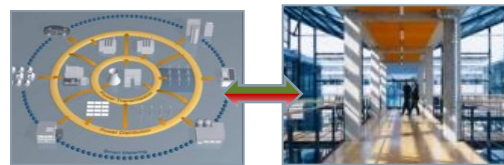
Multi-modal energy systems
- Integration of all energy carriers and converters (district heating and cooling, heat pumps, boilers, etc.)

Heat | Water pump
Water | Climate
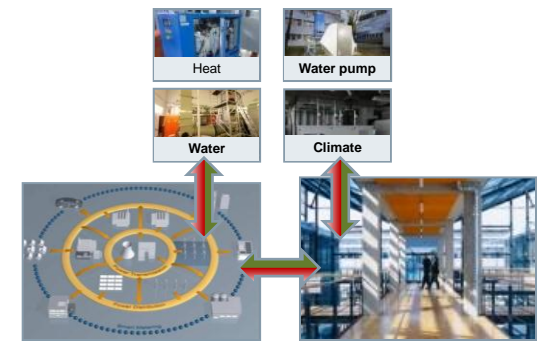
⟷ Exchange of energy and data

1) Integration of renewable energy sources and electric vehicles

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Tianjin Eco-City and Seestadt Wien Aspern – unique chances to research on live infrastructures

■ Projects "Tianjin Eco-City" (TEC) and "Seestadt Wien-Aspern"

- SEIT: Research JV between SSTEC[1] and Siemens Limited China
- Goal: Development of need-based innovation solutions in connection with new eco-technologies
- Research topics:
  - Smart green buildings
  - Intelligent renewable energy systems
  - Etc.

- Research JV between Siemens AG and Vienna city
- Goal: Sustainable greenfield development of Aspern (20,000 apartments, 20,000 work places)
- Research topics:
  - Data analytics of grid data
  - Intelligent building management, optimization of building vs. grid mgmt.
  - Sensor-supported energy distribution management
  - End user information systems

1) Sino Singapore Tianjin Eco-City Investment & Development Co. Ltd

City applications break down into different use cases, and usually aim for improved quality of life

■ City applications: Use cases (overview)

Monitor and Control	Integrate and facilitate	Analyze and optimize
Seamless optimization, e.g. • Safety and security management • Traffic management	• City administration portal • Integrated public transportation platform	Minimized use of central grid (and costs) • Utility tariff design • Image-based loss analysis
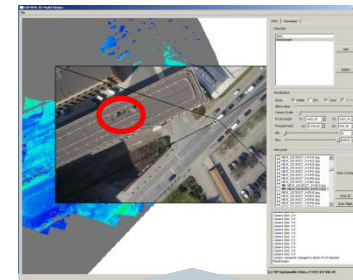
Underlying trends

• Internet of things – pervasive deployment and availability of sensors and computing power

• Advanced analytics of increasing amounts of data

• "Digitally native" population

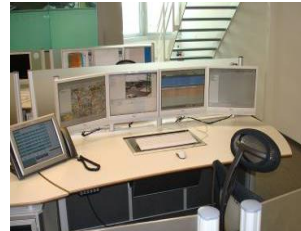# Use case "Monitor and Control" – example city security (Siemens Sieveillance)

■ Example "Siemens Sieveillance"

| Intervention forces | | Integrated **command and control** solution to coordinate and dispatch emergency forces |

| Critical Infrastructure | | Intelligent **management** systems to ensure critical infrastructures remain secure and run smoothly |

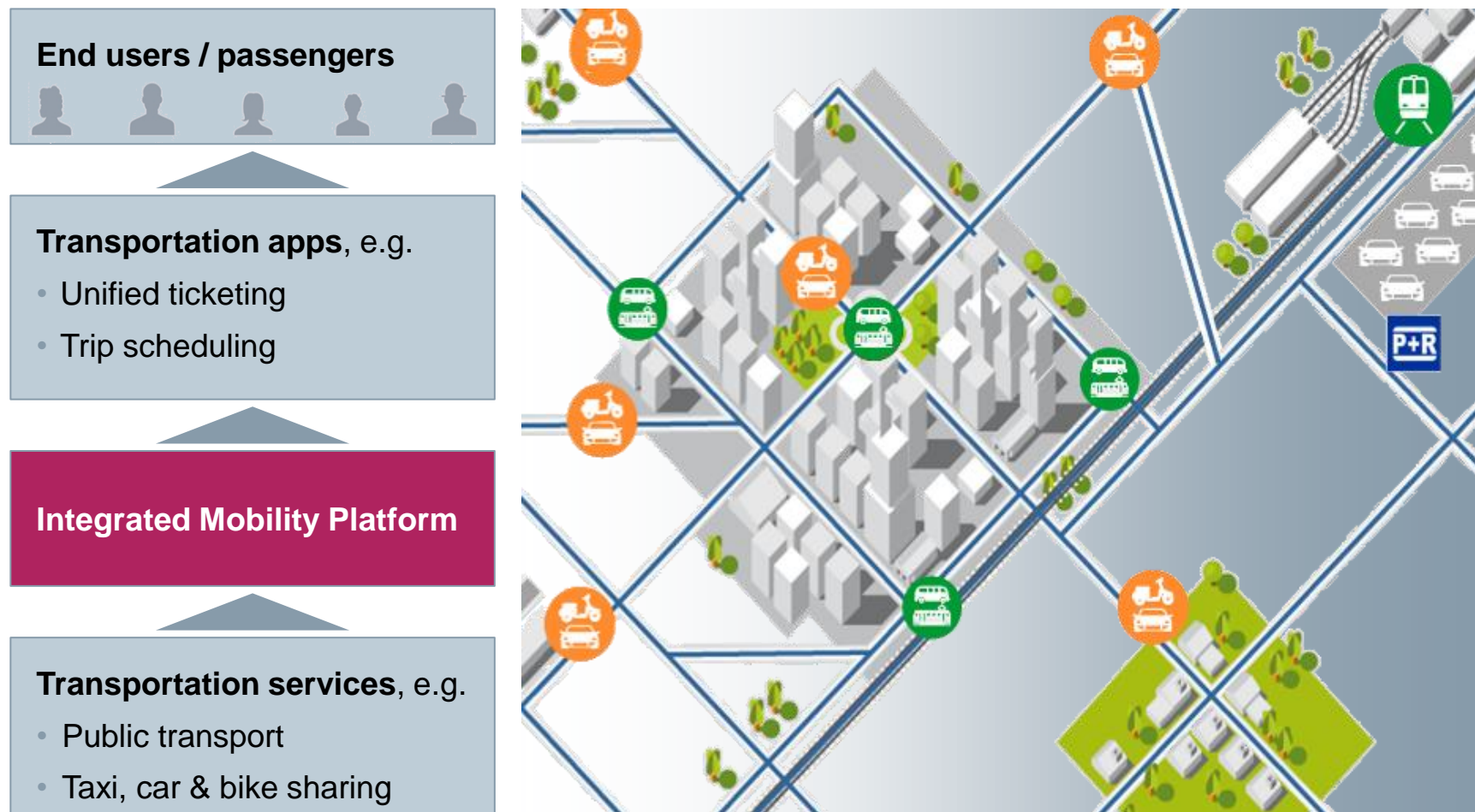| Corporate | | Sophisticated **control** system to meet corporate security challenges |

| Buildings | | An extensive range of inter-operable **field devices** create the basis of our security solution |

Use case "Integrate & Facilitate" – example intermodal traffic management

Example "Integrated Mobility Platform"

End users / passengers

Transportation apps, e.g.
- Unified ticketing
- Trip scheduling

Integrated Mobility Platform

Transportation services, e.g.
- Public transport
- Taxi, car & bike sharing

P+R

The next step – an integrated city operating system?

"City operating system": Idea sketch

From a collection of vertical IT solutions …

Power, water	Traffic	Trans-port	City admin	Etc.

- Individual, stand-alone IT solutions
- Operated by different city departments
- Addressing the obvious needs of citizens and city administrations

… to an integrated city operating system?

Power, water	Traffic	Trans-port	City admin	Etc.
Unified data model and communication standards				
3rd party app.	3rd party app.	3rd party app.	3rd party app.	Etc.
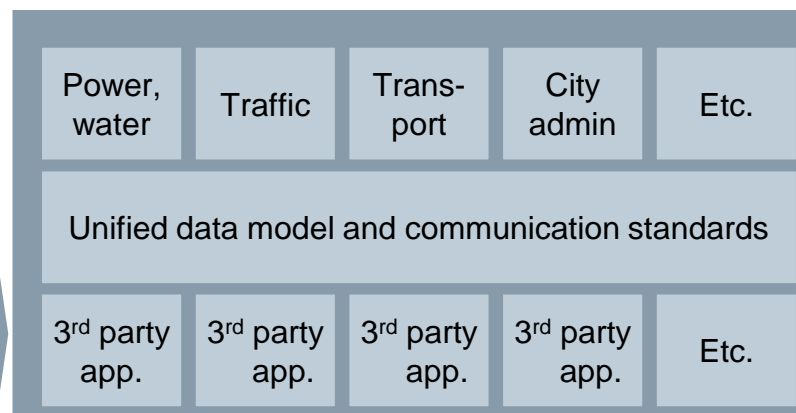
- "Eco-system" of city-related platforms and applications from city and 3rd parties
- Cloud-based storage of openly accessible, interoperable data
- Cross-domain views (city cockpit, simulation)

Key takeaways

- Cities are growing all around the globe – especially middleweight cities in emerging markets will play a crucial role in future growth

- The impact of cities on energy consumption and environment will grow even further

- Cities mayors are facing a diverse playing field, with multiple challenges e.g. in the areas of energy, water, transport & logistics, security & safety – many of which can be addressed with vertical IT solutions

- Vertical IT for utilities is increasingly essential to assure even the most basic services

- City IT applications – which break down into different use cases – mostly aim for improving quality of life

- Siemens already works on and provides a variety of vertical IT solutions for intelligent urban environments

- The next step in the evolution towards smart cities might be the development of city operating systems, which integrate standalone vertical IT solutions