Smart Sustainable Cities – Trends & Definitions

sustainability
creating more, wasting less

Leveraging ICTs for Smart Sustainable Cities (SSC)

Sept 29 – Oct 02, Bangkok, Thailand

Sekhar Kondepudi Ph.D

Associate Professor
Smart Buildings & Smart Cities

Vice Chair
Focus Group on Smart Sustainable Cities

Urbanization

..... refers to a process in which an increasing proportion of a society live in cities and the suburbs of cities. Historically, it has been closely connected with industrialization.

Sustainability

Definitions of Sustainability

Sustainable Development (SD)

Meeting the needs of the present generation without compromising the ability of future generations to meet their own needs.

-- Brundtland Commission, 1987 –

Sustainability

The possibility that human and other forms of life on earth will flourish forever.

-- John Ehrenfeld, Professor Emeritus. MIT –

Sustainable Development (SD)

Enough - for all – forever.

-- African Delegate to Johannesburg (Rio+10) --

A Planet of Cities

In 2007, for the first time in history, the majority of the world's population 3.3 billion lived in cities. By 2050, city dwellers are expected to make up 70% of Earth's total population, or 6.4 billion people.

Focus Group on Smart Sustainable Cities (FGSSC)

- Established at ITU-T Study Group 5 meeting in Geneva in February 2013 –Will Conclude in May 2015.

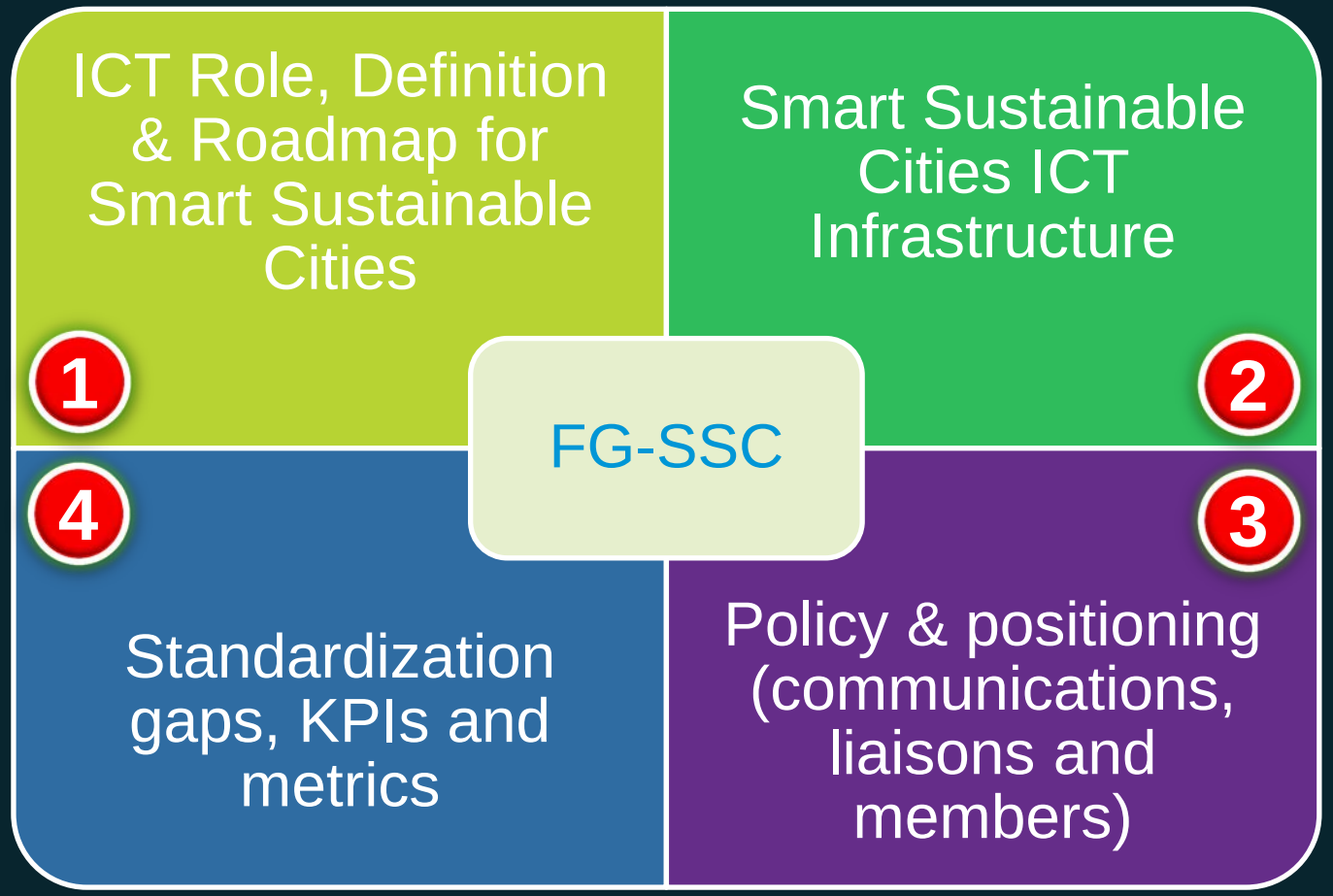
- As an **open platform** for smart-city stakeholders to exchange knowledge in the interests of identifying the standardized frameworks needed to support the integration of ICT services in smart cities.

- **Participation is open to all**.

FG SSC Tasks & Deliverables

- **Defining the role of ICTs in environmentally sustainable smart cities**, and identifying the ICT systems necessary to their development;
- **Identifying or developing a set of Key Performance Indicators (KPIs)** to gauge the success of smart-city ICT deployments;
- **Establishing relationships and liaison mechanisms** with other bodies engaged in smart-city studies and development including related activities at the ITU, other SDOs such as IEC, ISO and relevant civic, municipal and governmental organizations, idustry consortia and academic / research institutions.
- **Identifying future smart-city standardization** projects to be undertaken by its parent group, ITU-T Study Group 5;
- **Developing a roadmap for the ICT sector's contribution to Smart Sustainable Cities**, providing cohesion to the development and application of technologies and standards.

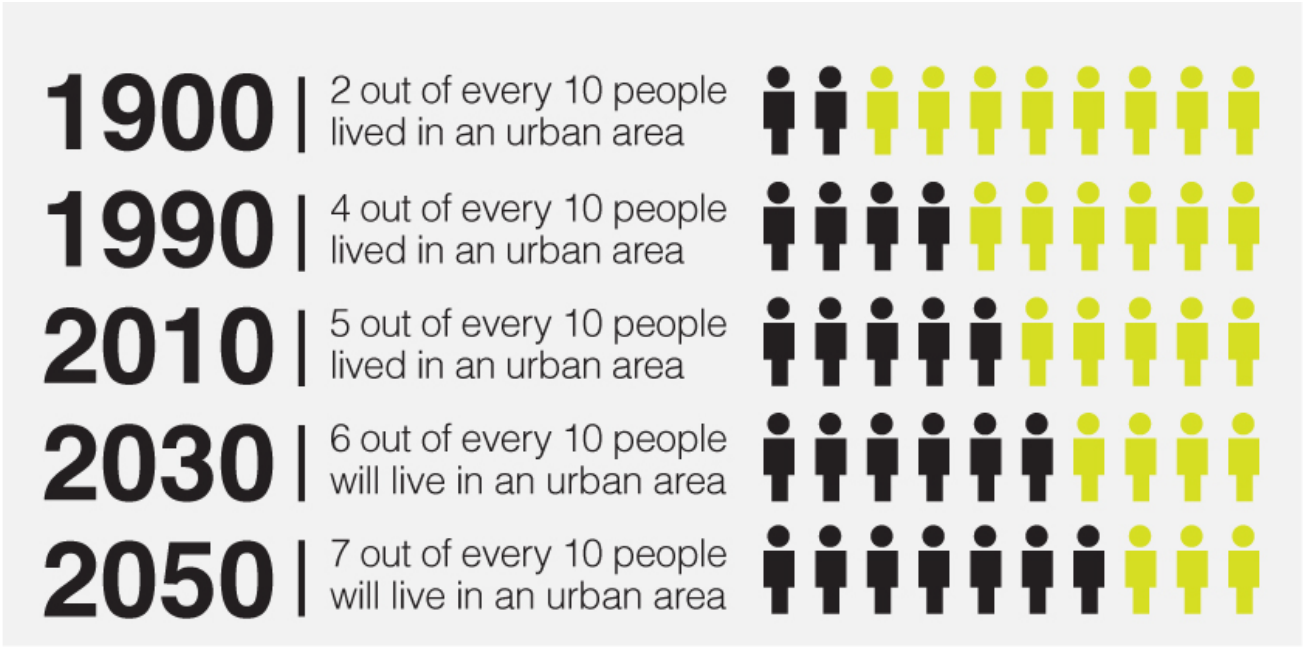
Focus Group Working Group Structure



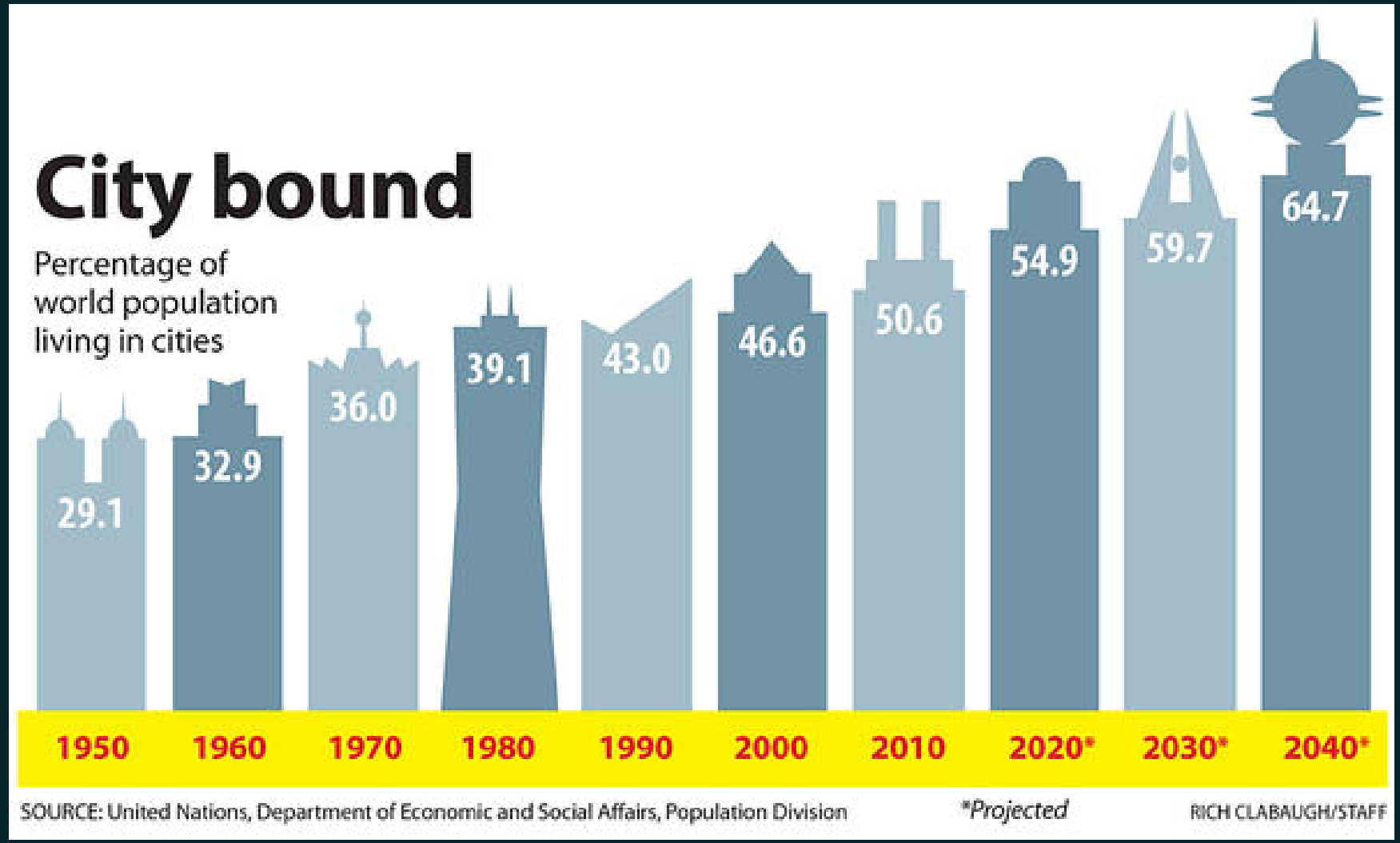
Agenda

Agenda

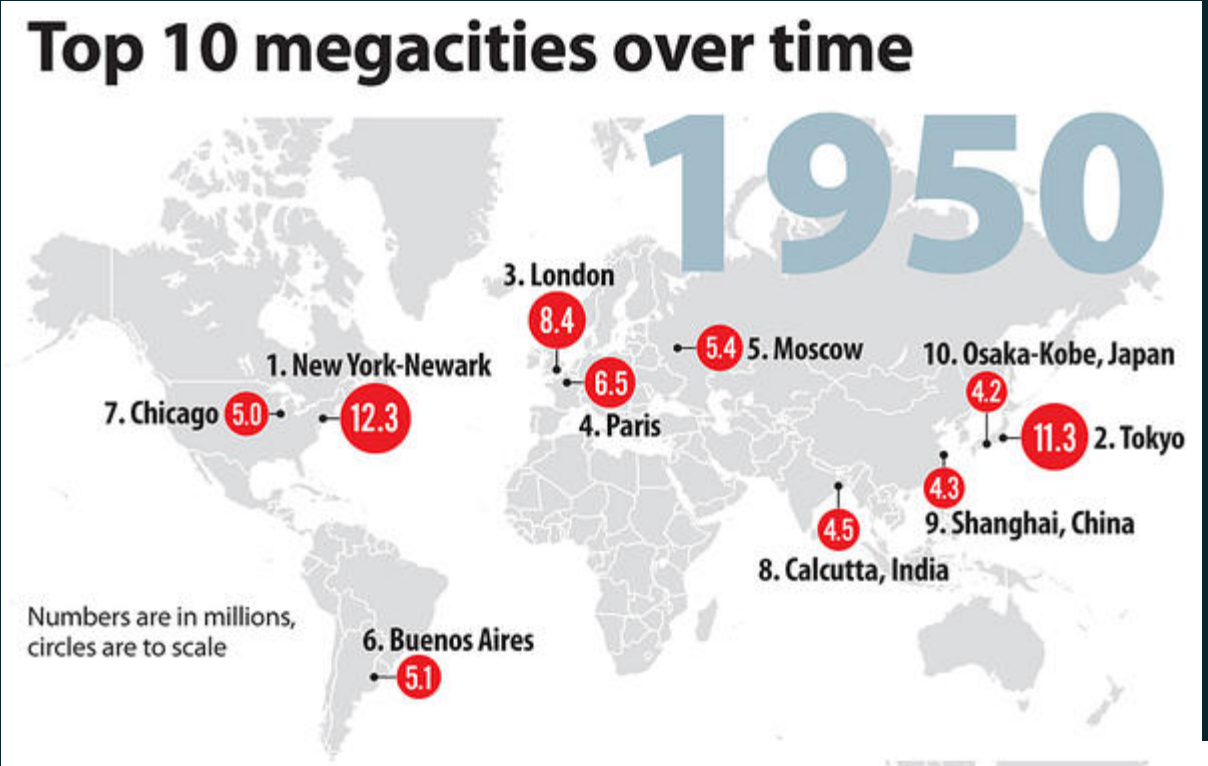
Urbanization Trends

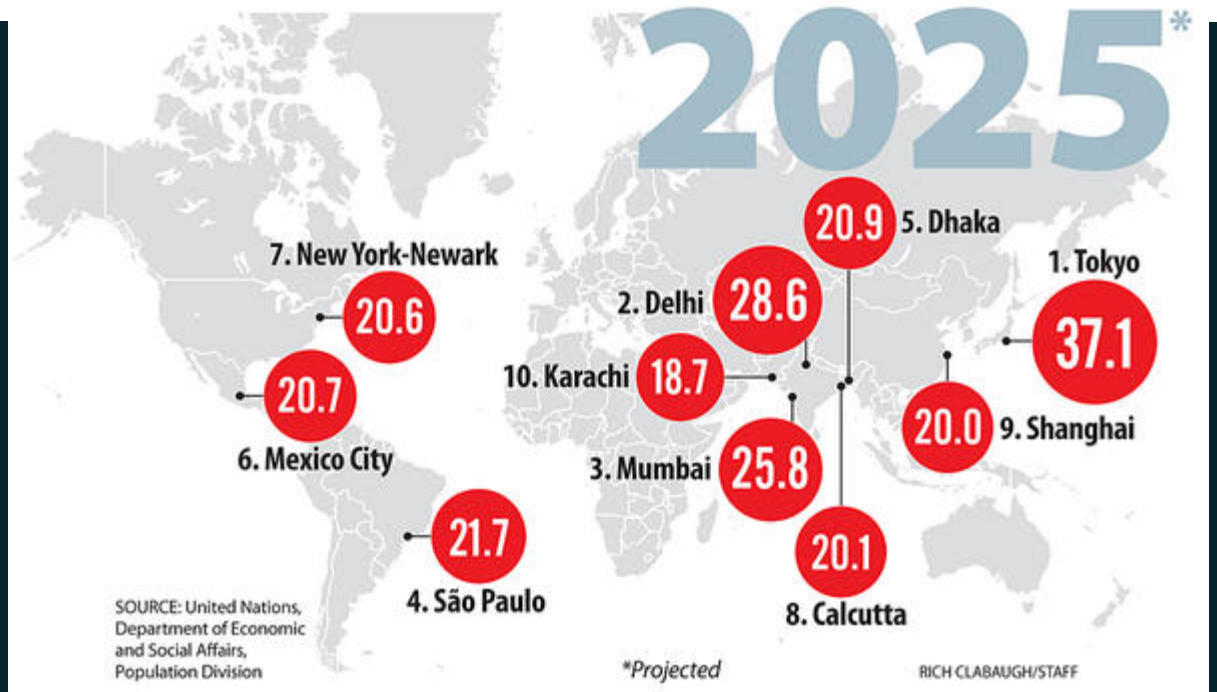


Defined by UN HABITAT as a city with a population of more than 10 million


City bound
Percentage of world population living in cities
29.1
32.9
36.0
39.1
43.0
46.6
50.6
54.9
59.7
64.7
1950
1960
1970
1980
1990
2000
2010
2020*
2030*
2040*
SOURCE: United Nations, Department of Economic and Social Affairs, Population Division
*Projected
RICH CLABAUGH/STAFF

Top 10 megacities over time





RISE OF THE MEGACITIES

According to the UN almost 180,000 people move into cities every day – an estimated 2 people a second

1.5 billion (22% of the population) people live in 600 cities

Set to rise to 2 billion by 2025

These 600 cities generate 60% of global GDP

In Africa and Asia, the urban population is expected to double between 2000 and 2030

50% of Africa's population will be urban by 2050. The figure currently stands at 38%

TOP FIVE CITIES BY GDP IN 2025

1. New York
2. Tokyo
3. Shanghai
4. London
5. Beijing

There are currently 23 megacities with populations over 10 million ... (from highest population to lowest)

1. Tokyo
2. Mumbai
3. Mexico City
4. New York
5. São Paulo
6. Shanghai
7. Kolkata
8. Delhi
9. Beijing
10. Chongqing
11. London
12. Dhaka
13. Buenos Aires
14. Los Angeles
15. Karachi
16. Cairo
17. Rio de Janeiro
18. Paris
19. Rhein-Ruhr
20. Osaka
21. Manila
22. Moscow
23. Istanbul

... by 2025 there will be 36

77% of the Latin American population is urban and urbanisation rates keep rising

According to the UN World Urbanisation Prospects, Kinshasa in the Democratic Republic of the Congo is expected to see its population increase from **8.75m** in 2010 to **15.04m** in 2025

Urban population, 2030 forecasts

1bn CHINA

590m INDIA

By 2030 China will have...

221 Cities with 1 million or more inhabitants and **23** Cities with five million or more

TOP FIVE CITIES BY POPULATION IN 2025

1. Tokyo
2. Mumbai
3. Shanghai
4. Beijing
5. Delhi

By 2030 India will have...

68 cities of more than 1 million

13 with more than 4 million

6 mega cities with more than 10 million

These will need 2.5bn square metres of paved roads and 7,400 kilometres of metros and subways – 20 times what has been built in the last 20 years

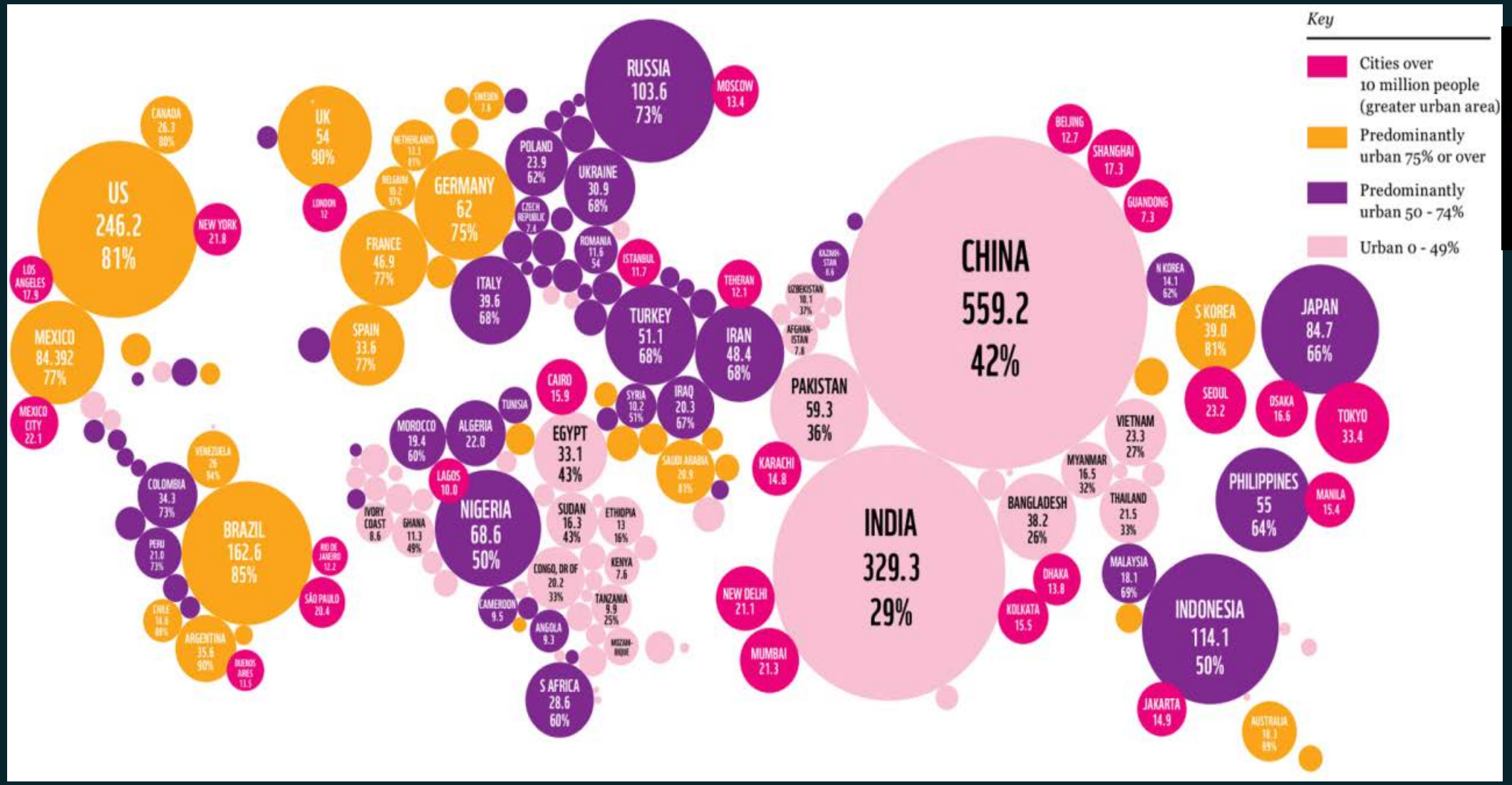
Global urban growth between 2005 and 2025 to come from China and India **40%**

In 20 years, China's cities will have added 350 million people – more than the entire population of the United States today

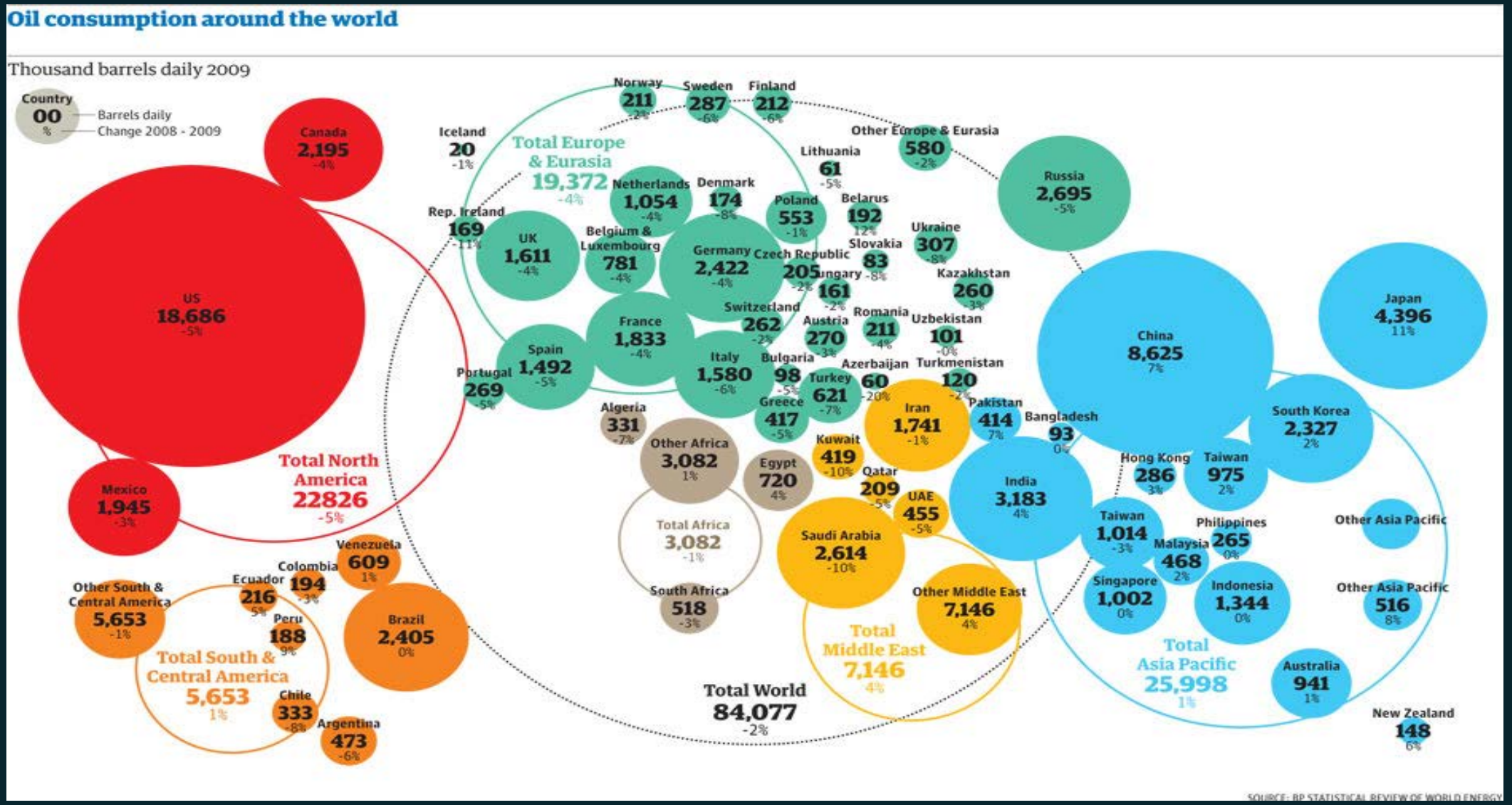
75% Percentage of Indian urban population earning an average of 80 rupees (approximately £1) per day

In 2030 numerous Indian cities will have larger economies than many countries. Mumbai's GDP is projected to reach **$265bn**

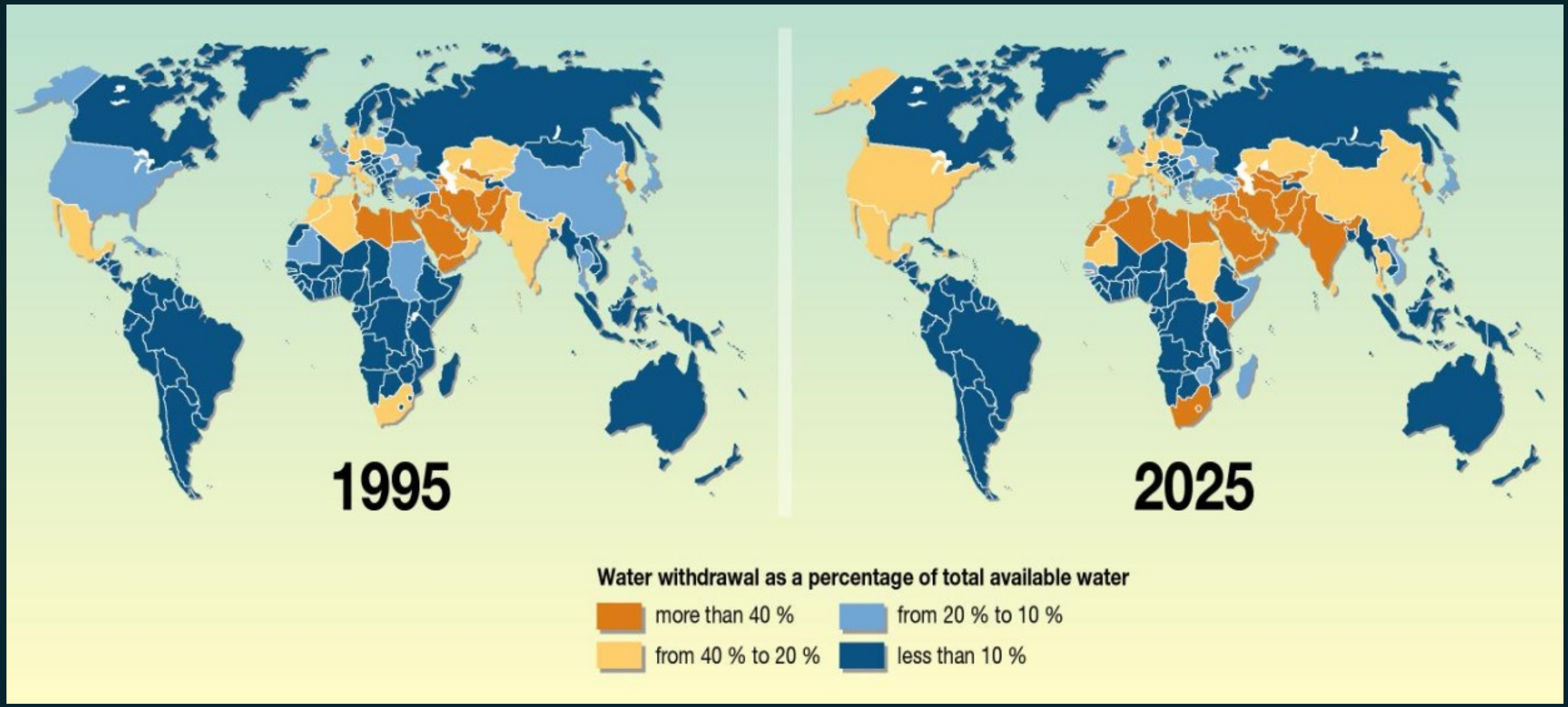
Population



Energy



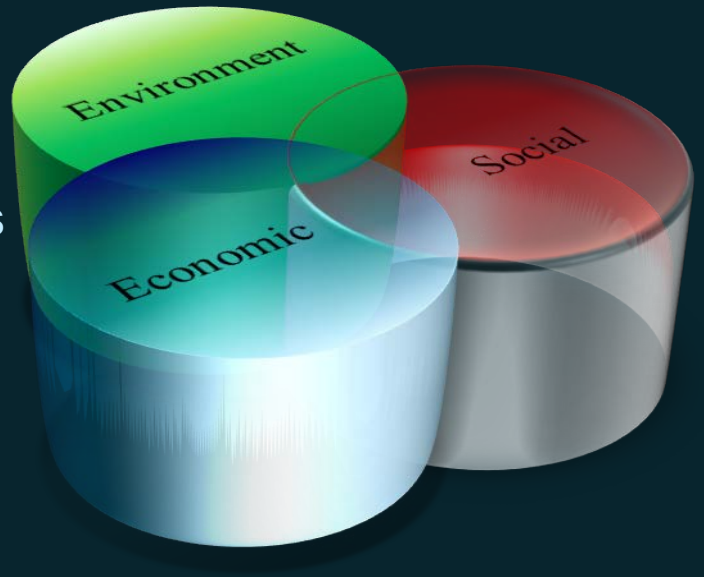
Water



Triple Bottom Line

Saving PLANET

Future Generations

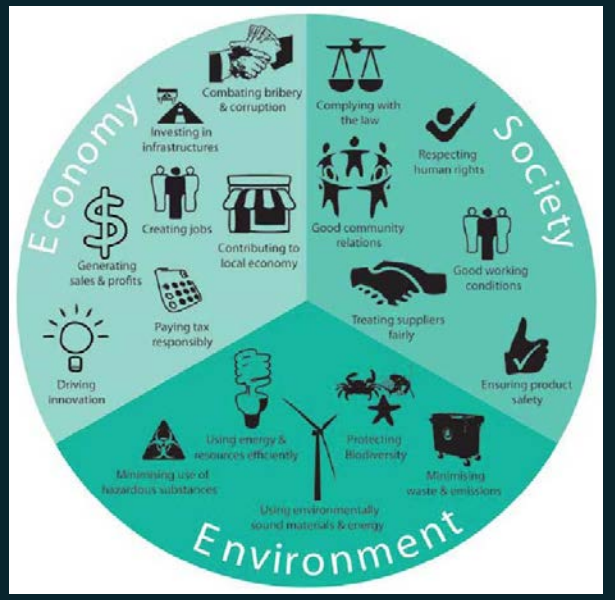


PEOPLE

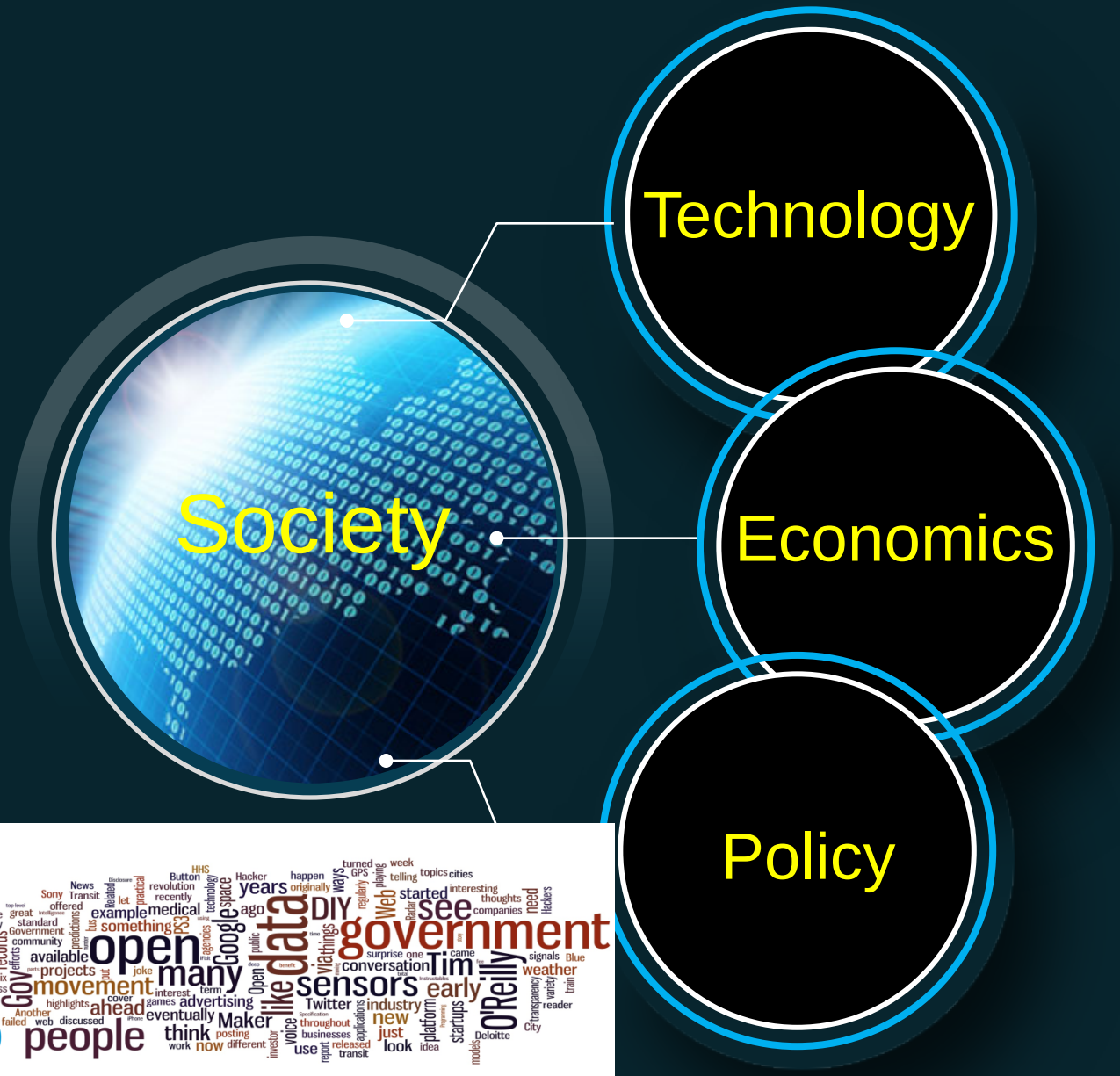
Quality of Life

REVENUES

Increased Job growth



Landscape



- Data Convergence
- Sustainability & Green
- Internet of Things

- Aging Workforce,
- Need for Renewed Infrastructure
- Evolving Business Models

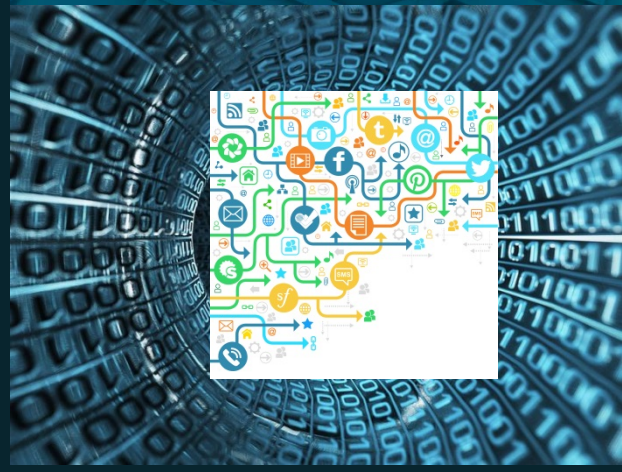
- Regulatory Framework
- Global Standards
- Incentivization

Scope of ICT Today

Sekhar Kondepudi

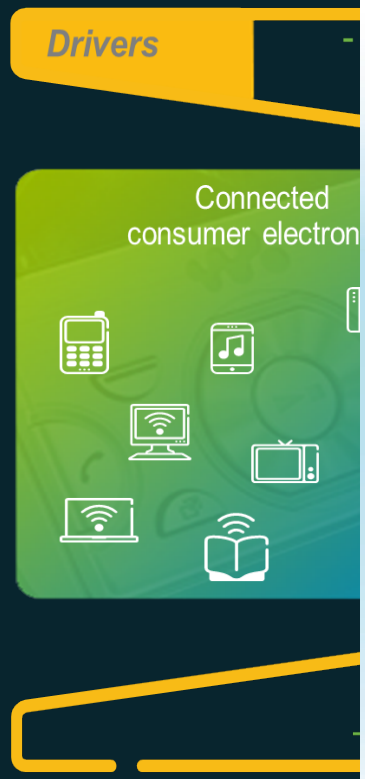
BIG DATA

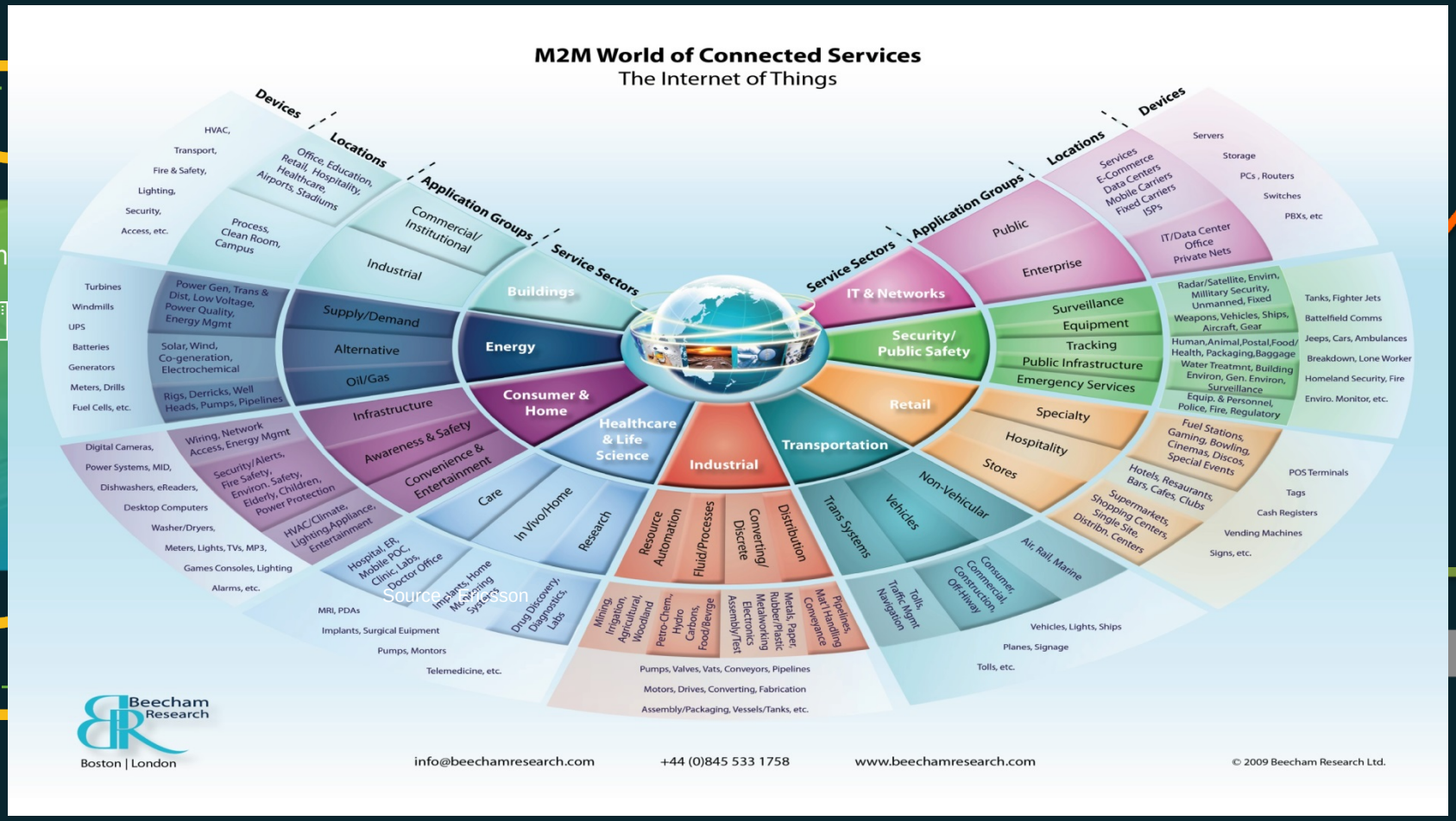
- Every day, the world creates 2.5 Quintillion (?) bytes of data
- 90 % of all the Data today has been created in the last 2 years (2011-2012)
- In the 11 years between 2009 and 2020, the size of the "Digital Universe" will increase __ (?) fold. That's a 41% increase in capacity every year.
- In addition, only 5% of this data being created is structured and the remaining 95% is largely unstructured, or at best semi-structured.
- Sources of this data : Sensors, social media posts, pictures posted, videos posted, comments, transactions, GPS data etc.



The Little Book of BIG DATA (2012), Norleen Burlingame

Everything Will be Connected – Internet of Things

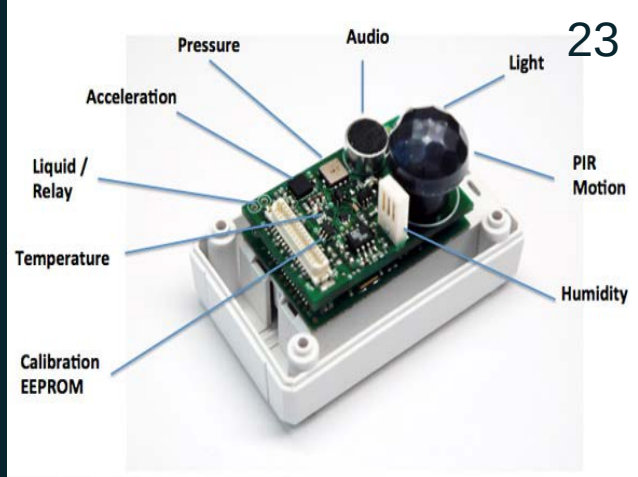


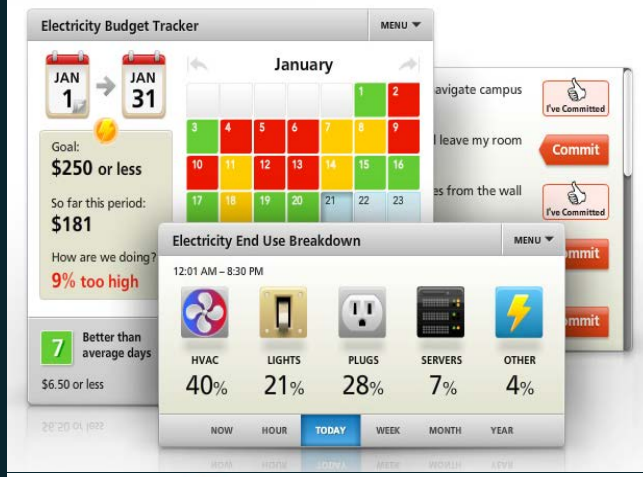


Source - CISCO

Analytics, Informatics & Dashboards

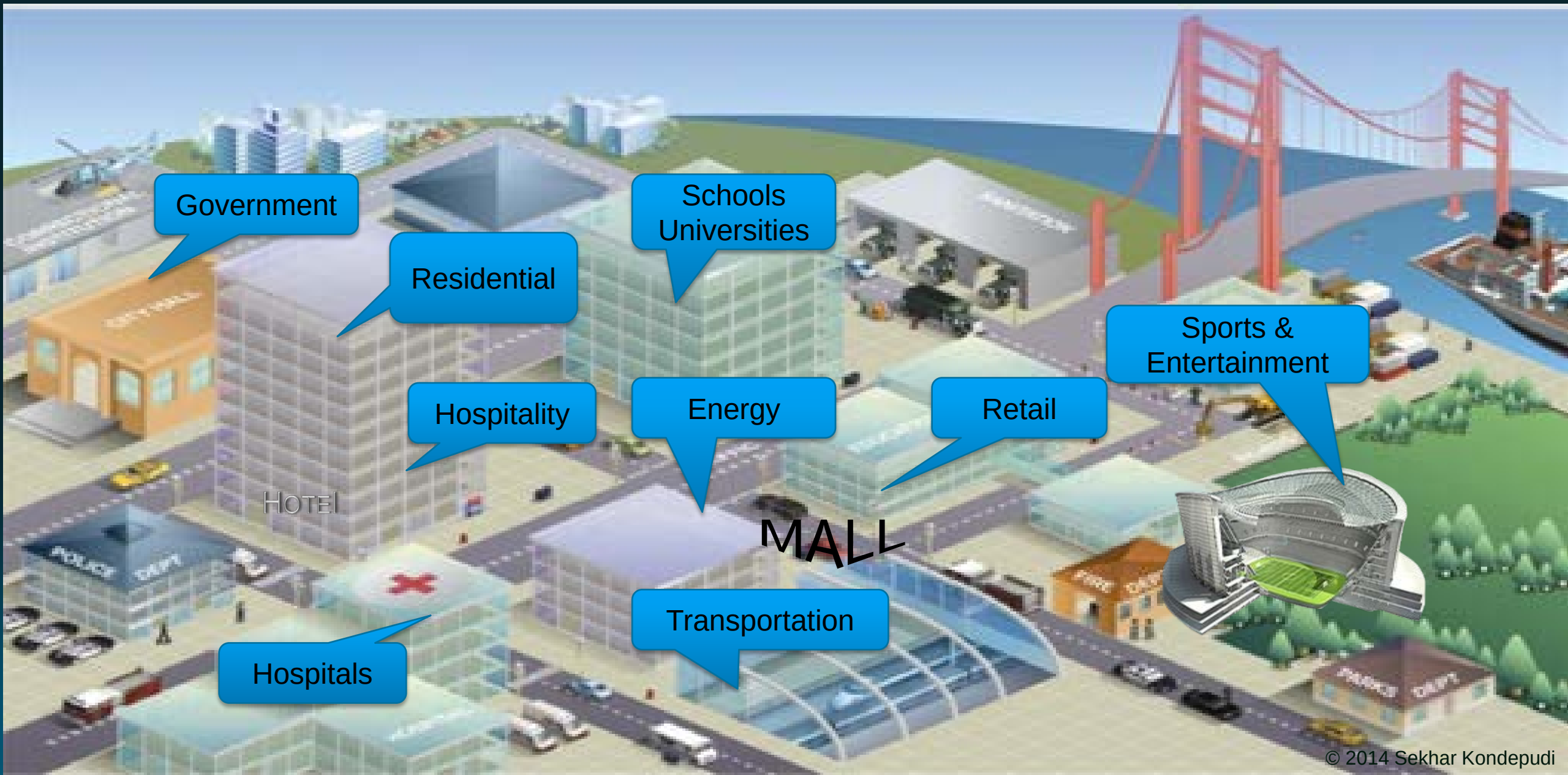
- Wireless Sensor Networks
- Energy & Environmental Data
  - View, Compare, Share
- Analytics
  - Prediction
  - Energy Savings Strategies
  - Operational Optimization
- Real-time Information / “Pulse”





Agenda

City / Community = $\sum$ Buildings



Attributes of a “Smart City”

MOBILITY

SUSTAINABILITY

LONGEVITY

SECURITY

RELIABILITY

TECHNOLOGY

FLEXIBILITY

EFFICIENCY

INTEROPERABILITY

SCALABILITY

Smart Cities as a Network

Smart Cities are well managed, integrated physical and digital infrastructures that provide optimal services in a reliable, cost effective, and sustainable manner while maintaining and improving the quality of life for its citizens.

"Internet of Things" (IoT) for cities

Foundational Aspects

Economy

- Employment
- GDP
- Market – GLocal
- Viability
- Investment
- PPP
- Value Chain
- Risk
- Productivity
- Innovation
- Compensation

Governance

- Regulatory
- Compliance
- Processes
- Structure
- Authority
- Transparency
- Communication
- Dialog
- Policies
- Standards
- Citizen Services

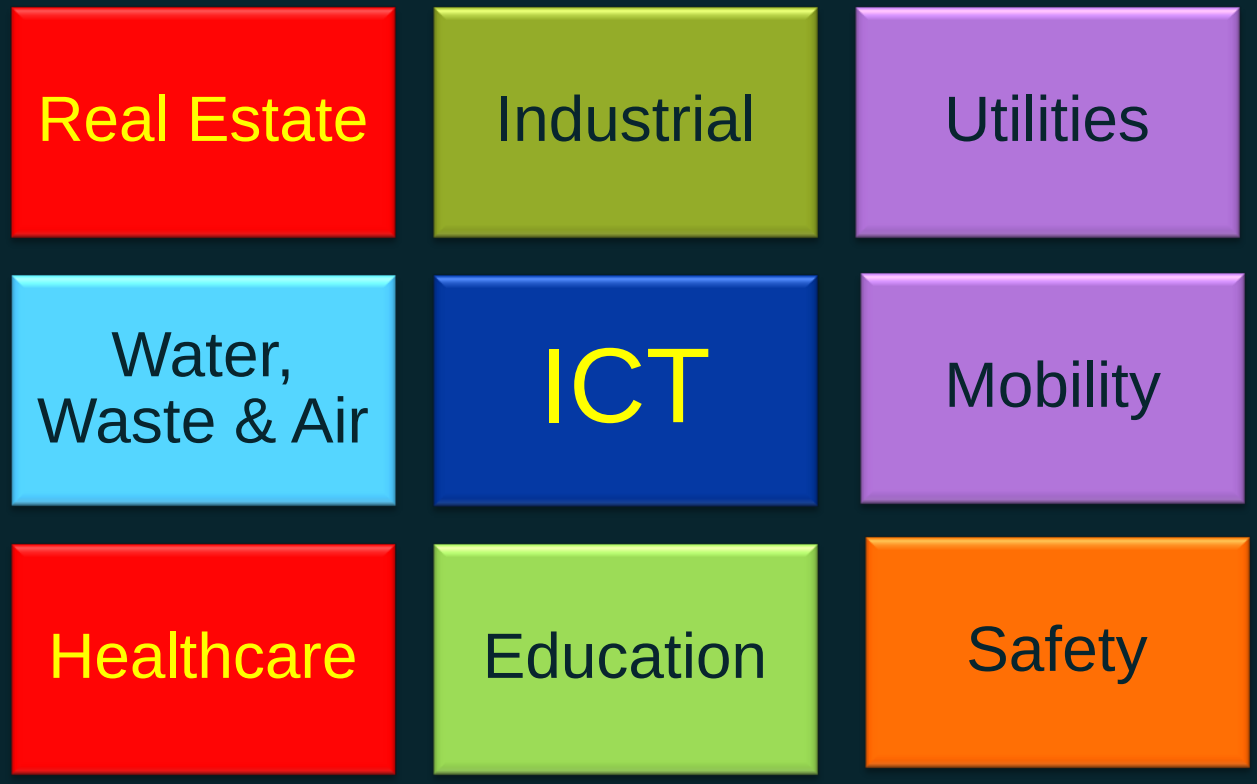
Environment

- Sustainable
- Renewable
- Land Use
- Bio-Diversity
- Water / Air
- Waste
- Workplace

Society

- People
- Culture
- Social Networks
- Tech Savvy
- Demographics
- Quality of Life
- User Experiences
- Equal Access
- End Consumers
- Community Needs
- The City as a Database

'Vertical Infrastructure – What's Missing ?



Some of these infrastructure verticals are "obvious"

What additional verticals should we consider that are missing ?

Infrastructure	Example Components
Real Estate & Buildings	• Synergies between energy efficiency, comfort and safety and security …. • Building as a Network – Integration of Multiple Technologies (HVAC, Lighting, Plug Loads, Fire, Safety, Mobility, Renewable, Storage, Materials, IAQ etc) • Software – Efficiency, Automation & Control , Analytics & Big Data Management
Industrial & Manufacturing	• Data Interoperability • Sustainable Production & Zero Emissions • Networked Sensors & Cloud Computing • Factories of the Future
Energy & Utilities	• Smart Grid & Smart Metering – Generation / Distribution / Measurement • Wireless Communications • Analytics & Policies • Load Balancing, Decentralized and Co-generation
Air, Water & Waste Management	• Water Information Systems (WIS) • Integrated Water, Waste and Energy Savings Optimization Schema • Sensor Networks for Water and Air Systems
Safety & Security	• Video Surveillance & Video Analytics • Seamless Communication during Natural & Man Made Disasters
Healthcare	• Smart Hospitals • Real Time Healthcare including Analytics • Home & Remote HealthCare incl. Monitoring • Electronic Records Management
Education	• Flexible learning in an interactive learning environment • Accessing world class digital content online using collaborative technologies • MOOCs
Mobility & Transportation	• Intelligent Transportation Technologies in the Age of Smart Cities: • Traffic Management – Monitoring & Routing • Real Time Linkage to Emissions, Traffic Patterns, Reduced Fuel Consumption .

Real Estate & Buildings

Real Estate & Buildings

- … solutions that turn buildings into living organisms: networked, intelligent, sensitive and adaptable …
- … synergies between energy efficiency, comfort and safety and security ….
- Building as a Network – Integration of Multiple Technologies (HVAC, Lighting, Plug Loads, Fire, Safety, Mobility, Renewable, Storage, Materials, IAQ etc)
- Software – Efficiency, Automation & Control , Analytics & (Big ?) Data Management
- Integration with Smart Grid
- Distributed Energy
- Coexist with Productivity, Efficiency, CSR, Sustainability and GHG reduction goals

Industrial & Manufacturing

Industrial & Mfg

- Data Interoperability
- Sustainable Production
- Zero Emissions
- Plant Optimization
- Networked Sensors
- Cloud Computing
- Intelligent & Integrated Processes
- Factories of the Future

Utilities - Electricity & Gas

Utilities – Electricity & Gas

- Smart Grid – Generation / Distribution
- Smart Meters – Measurement & Integration of smart capabilities
- Wireless Communications
- Analytics & Policies
- Decentralized and Co-generation
- Load Balancing
- Increased Efficiency
- Communications networks— utility-wide voice and data communications networks and services
- Intelligent utility network

Waste, Water & Air Mgmt

Waste, Water & Air Management

- Smart Water
  - New Distribution Approaches for Stable and Continuous Water Supply
  - New Water Purification Technologies
  - Water Treatment / Re-Use / Re-Cycle
  - Wireless Sensors / Smart Metering for Optimal Usage / Analysis
- Smart Air
  - Pollution Sensors – Outdoor Air Quality
- Waste Management
  - Sensors to detect toxicity
  - Improving Efficiency of Waste Collection
  - Auto Sorting / Tracking - Reuse & Recycling
  - Bio-Medical Waste

Mobility

Mobility

- Intelligent Transportation Technologies in the Age of Smart Cities:
- Traffic Management – Monitoring & Routing
- Smart Charging
- Intelligent Public Transit
- Real Time Travel Information
- Transit signal priority
- Centralized fleet vehicle management
- Real Time Linkage to Emissions, Traffic Patterns, Reduced Fuel Consumption

Safety & Security

Safety & Security

- Video Surveillance
- Video Analytics
- Workflow
- Situational Awareness
- Enhanced Emergency Systems
- Natural Disasters
- Intra-Agency Communications

Healthcare

Healthcare

- Smart Hospitals
- Gaining real-time line of sight and responses to individualized health information.
- Smart” Communications – Patient to Clinician
- Intelligent & Efficient Public Health
- Real Time Healthcare including Analytics
- Privacy and protection of patient information
- Home & Remote HealthCare incl. Monitoring
- Health Waste Management
- Electronic Records Management

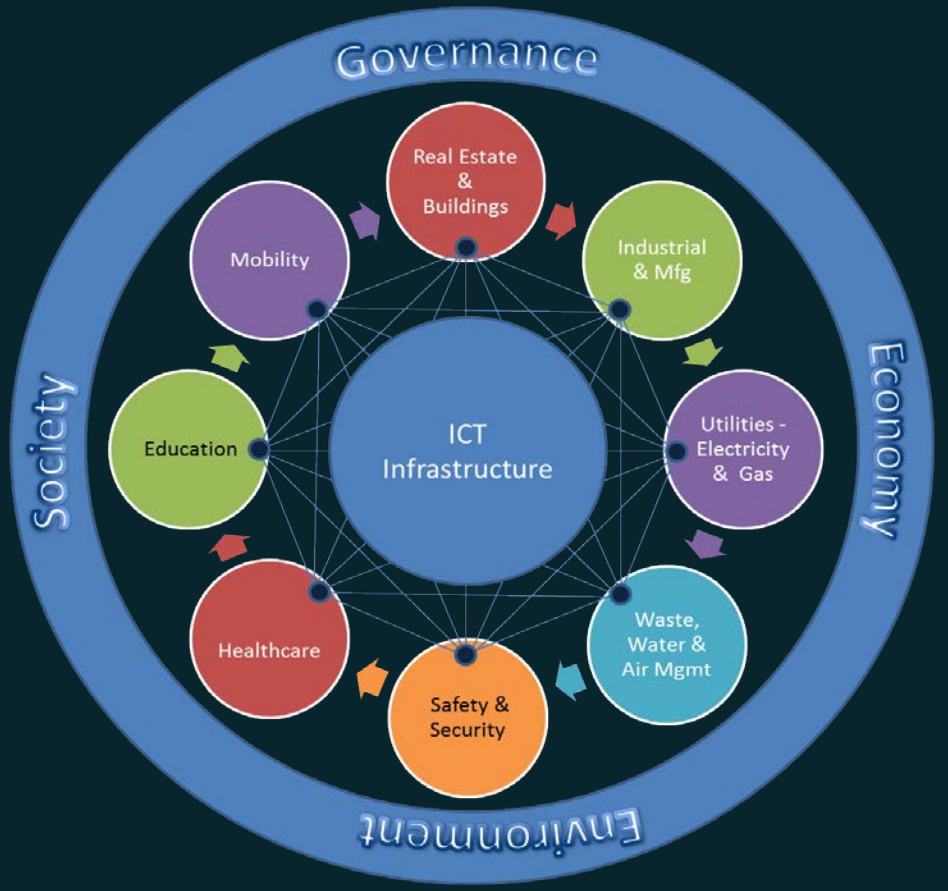
Education

Education

- Flexible learning in an interactive earning environment
- Delivering education through different devices – from televisions to ipods to mobile phones to netbooks – beyond our schools and into homes
- Accessing world class digital content online
- Adaptive learning programs and learning portfolios
- Collaborative technologies and digital learning resources
- A digital learning portfolio including online learning & testing that gives students, teachers and parents an integrated view
- MOOCs

ICT - The City as a Network

- The multiple systems within a city can be thought of as sub-networks of a larger network ie “System of Systems” or a “network of networks”
- When these sub-systems are integrated with one another, they can be thought of as the “Internet of Things” (IoT) for cities.
- All of these systems comprise of sub-systems, components & devices which have nodes, end points and behave like a network in terms of their end use characteristics and interactivity with other nodes.
- This is completely analogous to an IT or DataCom network



ICT is at the CORE acting as the “NERVE CENTER”

Role of ICT in Smart City Solutions

- Data Analytics
  - Prediction
  - Accessibility
  - Management
- ICT Infrastructure
  - ICTs Specific to Smart Sustainable Cities.
  - Internet of Things
  - Ubiquitous Sensor Networks.
  - Data Security.
  - Mobile Broadband

- Physical & Service Infrastructure
  - Smart Energy
  - Smart Buildings
  - Smart Transportation
  - Smart Water
  - Smart Waste
  - Smart Physical Safety and Security
  - Smart Healthcare
  - Smart Education

Smart ICT based Technologies in City Infrastructure

Infrastructure	Example “Smart” Technologies
Building Management	• Building Automation • Building Control • IT Network Systems • Crisis Management Solution (power, infrastructure damage...)
Data Communications & Security	• Voice/Video/Data • Structured Cabling • TCP/IP/BAS Protocols • Remote VPN Access • Computer & Network Access • Firewalls & Managed Security Services • Mobile Broadband • Mobile Security • Data Security Infrastructure
Smart Grid / Energy / Utilities	• Energy Logistics / Distribution (electricity, water, gas) • Heating & Cooling • Lighting • Back-Up Power • Leakage Monitor
Physical Safety and Security	• Access Control • Video Surveillance Intrusion Detection • Biometrics • Perimeter and Occupancy Sensors • Fire Alarm Panels • Detection (Smoke/Heat/Gas/Flame) • Fire suppression
Emergency Response	• Integrated Fire Department • Police and Medical Services • Centralised and Remote Command and Control • Scalable Decision Making Process
Traffic and Transportation (Mobility)	• Traffic Control & Monitoring (rail, underground, buses, personal vehicles) • 24/7 Supply Management (logistics)

The Connected Society

Connected homes

Connected healthcare

Connected buildings

Connected charging station

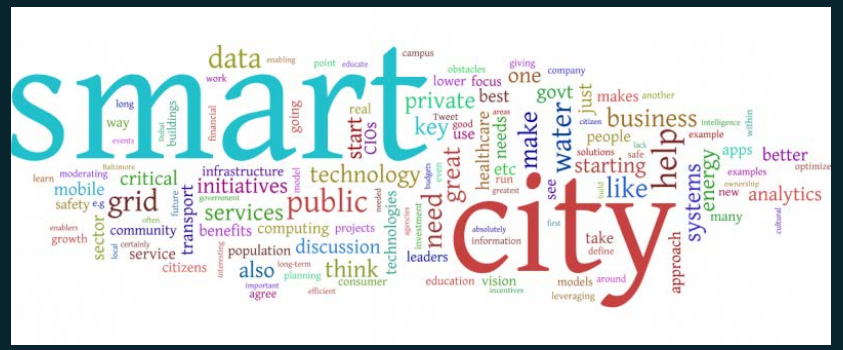
Connected micro generation

Connected truck

Connected meters

Connected bus

Connected service organizations



Connected consumers, enterprises & organizations

Connected car

Standardized technology

Identification and authentication

Payments

Source - Ericsson

Agenda

definition

Need for a Comprehensive Definition

- There is a lack of agreement on the definition and on the specific parameters that characterise a smart sustainable city.

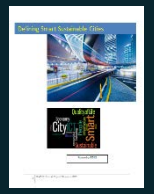
- Need to
  - provide an overview of the main attributes that make cities smart and sustainable
  - explore the role and potential of ICTs within SSCs
  - acknowledge, the key ICT infrastructure need to enable SSC strategies

- 3 Key Pivots
  - Smartness or Intelligence
  - Sustainability and the Environment
  - Cities – An Urban Landscape.

3 Different Approaches in Literature

- Technology based approach: The technology based approach focuses on the use of hardware. It emphasizes that ICT infrastructure should be the basis for the development of a city.
- Human centric approach: This approach focuses on investment in human and social capital for the establishment of smart cities. This would mainly include the involvement of the ICT based entrepreneurs capable of developing innovative products and processes.
- The integrated approach: This approach is focused on improving the quality of living of the citizens by integrating technological and social innovation. It aims to improve the performance of sectors including transport energy, urban safety, energy use, waste disposal with the application of ICT while maintaining cities as an integrated network rather than a set of individual sectors.

Objectives & Methodology



- Objective to develop a comprehensive definition for a smart sustainable city, which incorporates the different perspectives for different key stakeholders, addressing key indicators and attributes.
- Audience for this study is anyone who would like to get a fundamental handle on what constitutes a Smart Sustainable City and what attributes; indictors and characteristics are typical.
- The project sourced over 100 definitions and descriptors for Smart Sustainable Cities from different sources
  - Academia & Research Communities
  - Government Initiatives including the EU
  - International organizations such as the United Nations, ITU
  - Corporate / Company Profiles
  - Market Research Vendors
  - Trade Associations
  - Standards Development Organizations
- A detailed analysis of different key words and attributes along with indicators, rankings and perspectives from these diverse sources was performed.

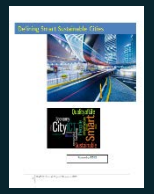
Sample Definitions (Total 120)

Source	Definition	Keywords
Hitachi. "Smart City Overview." *Smart Cities : Hitachi*. Hitachi, Web. Last Accessed 9 Feb. 2014. http://www.hitachi.com/products/smartcity/vision/concept/overview.html .	Hitachi's vision for the Smart Sustainable City seeks to achieve concern for the global environment and lifestyle safety and convenience through the coordination of infrastructure. Smart Sustainable Cities realized through the coordination of infrastructures consist of two infrastructure layers that support consumers' lifestyles together with the urban management infrastructure that links these together using IT.	Coordinated infrastructure, lifestyle safety, lifestyle convenience, urban infrastructure, IT
Meijer, Albert, and Manuel Pedro Rodríguez Bolívar. "Governing the Smart City: Scaling-Up the Search for Socio-Techno Synergy." T EGPA 2013 (Edinburgh, September) Permanent Study Group on E-Government, 2013, Web. Last Accessed 8 Feb. 2014. https://www.scss.tcd.ie/disciplines/information_systems/egpa/docs/2013/BolivarMeijer.pdf	“We believe a city to be smart when investments in human and social capital and traditional (transport) and modern (ICT) communication infrastructure fuel sustainable economic growth and a high quality of life, with a wise management of natural resources, through participatory governance.”	ICT High quality of life, Natural resource management, Participatory governance, Transport infrastructure, Communication infrastructure, Economic growth, Sustainability

Logical Groupings

Category	% Occurrence
Quality of Life & Lifestyle	6%
Infrastructure & Services	18%
ICT, Communication, Intelligence, Information	26%
People, Citizens, Society	11%
Environment & Sustainability	16%
Governance, Management & Administration	9%
Economy & Financials	8%
Mobility	5%
Total	**100%**

Criteria



- ICT
- Smart Living
- Smart People
- Smart Environment & Sustainability
- Smart Governance
- Smart Mobility
- Smart Economy

- ICT / Communication / Intelligence / Information
- Infrastructure & Services
- Environment / Sustainable
- People / Citizens / Society
- Quality of Life / Lifestyle
- Governance / Management / Administration
- Economy / Resources
- Mobility
- Efficiency
- Improving / adaptable / flexible

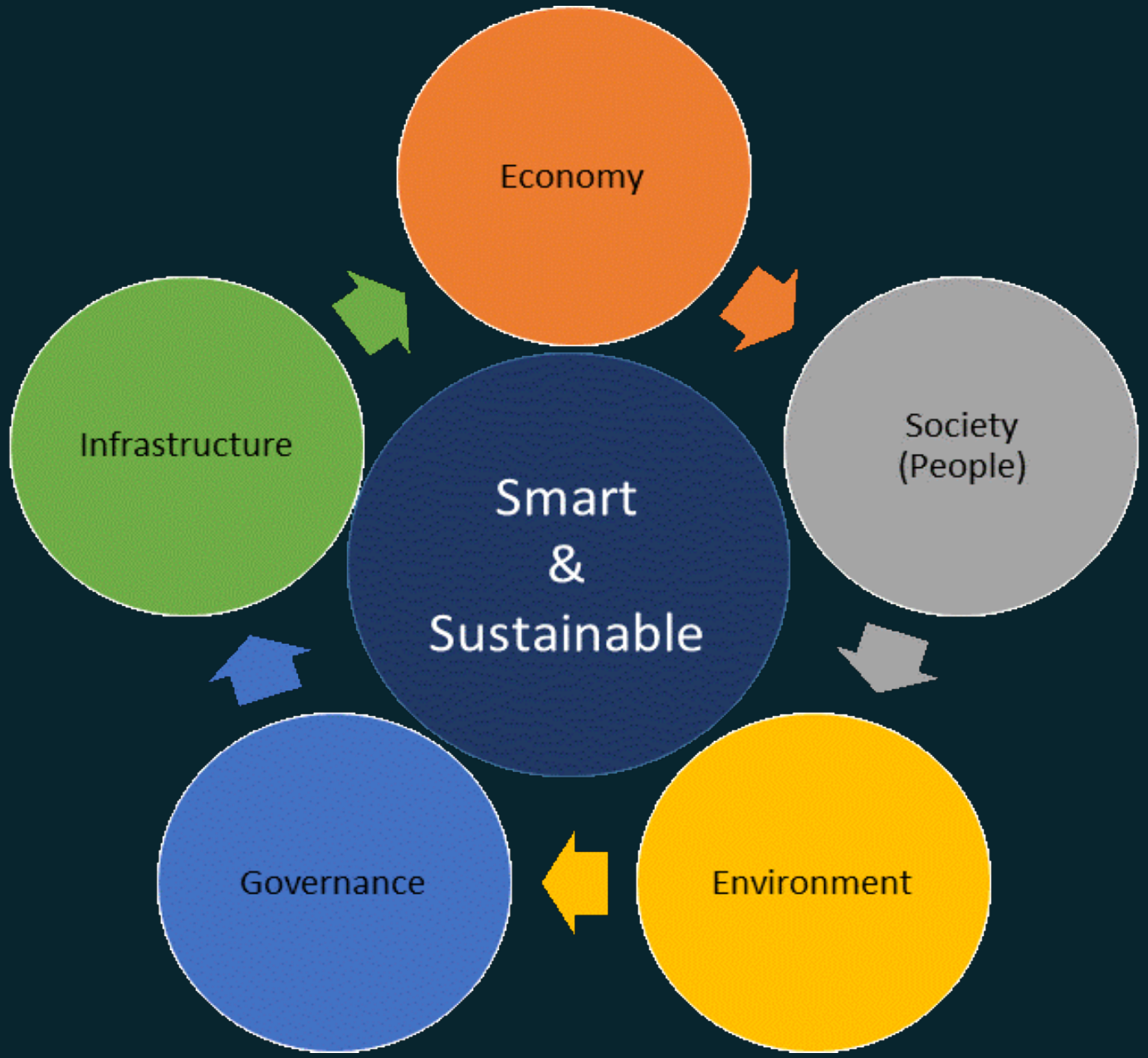
30 Key Terms

- ICT
- Adaptable
- Reliable
- Scaleable
- Accessible
- Security
- Safe
- Resilient
- Economic
- Growth
- Standard of Living
- Employment
- Citizens
- Well Being
- Medical
- Welfare
- Physical Safety
- Education
- Environmental
- Physical & Services Infrastructure
- Transportation & Mobility
- Water
- Utilities & Energy
- Telecommunications
- Manufacturing
- Natural & Man Made Disasters
- Regulatory & Compliance
- Governance
- Policies & Processes
- Standardized

Agreed Definition from FG SSC

"*A smart sustainable city is an innovative city that uses information and communication technologies (ICTs) and other means to improve quality of life, efficiency of urban operation and services, and competitiveness, while ensuring that it meets the needs of present and future generations with respect to economic, social and environmental aspects*".

Agenda




Governance
Economy
Environment
Society
Real Estate & Buildings
Industrial & Mfg
Utilities - Electricity & Gas
Waste, Water & Air Mgmt
Safety & Security
Healthcare
Education
Mobility
ICT Infrastructure

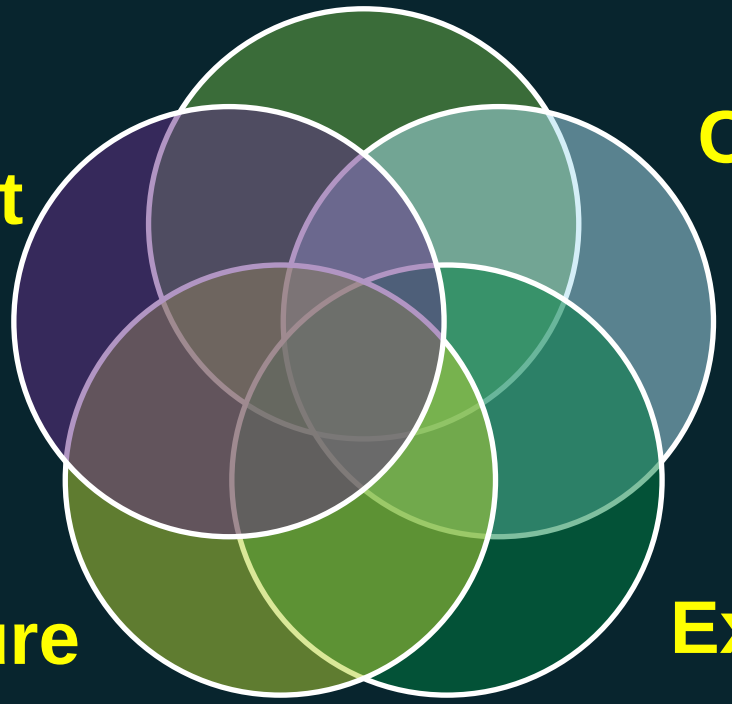
Cities of the Future

Recognizes you and customizes itself based on your preferences

Intelligent

Efficient

Uses hard & soft resources optimally while increasing productivity



Collaborative

Ensures that you stay connected to the right people & the right information in real time

Secure

Assures both information & physical security at all times

Experiential

Delivers goodness in the way you work & live

Discussion