Smart and Circular Cities: Status, Trends, Opportunities

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Changing world

• Population growth
  • ~10 Billion in 2050

• Aging population growth
  • 10% of population 80+ years old by 2050 (~4% now)

• Resource limitations
  • +55% water demand, +60% food demand
  • 60% of global population will have water problems by 2050
  • +37% energy demand by 2040
  • 52% agricultural land already degrading (moderate to severe)

• Climate change
  • +50% GHG
  • Climate change affects biodiversity, health, ..

• Data from OECD Science, Technology and Innovation Outlook 2016
Changing cities

• Urban population growth
  • From 746 Million in 1950 to 3.9 Billion in 2014 to more than 6 Billion by 2045 (UN Data)
  • ~60% by 2050

• Cities growth – Mega-cities
  • 1990: 10 Mega-cities (> 10 Million population) – 153 Million people – 7% of global urban population
  • 2014: 28 Mega-cities - 453 Million people – 12% of global urban population
    • 16 in Asia, 4 in Latin America, 3 in Africa, 3 in Europe, and 2 in Northern America
  • 2030 (projection): 41 Mega-cities

• Infrastructure growth
  • Experts estimate that over $40 Trillion are being invested in urban infrastructure between 2010-2030

• Cities contribute to climate change.. But suburbs more..
  • In the USA, suburbs account for ~50% of total U.S. HCF
  • Cities about half of that
    • Lower Manhattan average HCF 32.5 tCO2e (tonnes of CO₂ equivalent) vs. Montclair Essex County, NJ average HCF 68.3 tCO2e
Smart and Circular Cities

• Cities offer opportunities for solutions to global problems
  • Economic development, access to basic services (health care and education), public transportation, housing, electricity, water and sanitation
  • International Data Corporation (IDC) estimates that European spending on smart cities reached $19 billion in 2018

• Pervasiveness of digital technologies
• Digital platforms
• Smart and environment-neutral cities
Circular Economy
Circular Economy in Cities

The Economics and Governance of Circular Economy in Cities

Megatrends
- Demographic growth
- Urbanisation
- Climate change
- Economic trend

Opportunities
- Technological
- Socio-economic
- Environmental

System change
- People
- Policies
- Places

9.7 billion by 2050
By 2050, 70% of the world population will be urban

Availability and quality of natural resources at risk

4.5 trillion dollars potential for economic growth by 2030

CO2 emission reduction by 40% globally from plastic, steel, aluminium, cement

50,000 jobs in Île-de-France

9.7 billion by 2050
By 2030, 6.7 trillion per year of investment needs in infrastructure

4.5 trillion dollars potential for economic growth by 2030

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CO2 emission reduction by 40% globally from plastic, steel, aluminium, cement

Survey
- In depth case studies
- Peer-to-peer review
- Action plan
- Indicators
- Scoreboard
- Self-assessment
- International events


Figure downloaded from: https://circulareconomy.europa.eu/platform/sites/default/files/ecesp_2019_workshop_4_oecd.pdf
Smart City – Helmont, Netherlands

Energy and mobility
Smart City – Haaksbergen, Blauwestad, Netherlands

- Energy and mobility
  - Integrated
Smart City – Ljubljana, Slovenia

• Clean mobility from clean buildings
Smart City – Copenhagen, Denmark

Clean energy with fun park
Smart City – Barcelona, Spain

- Smart City 3.0
- Integrated approach
  - Street lighting
  - Waste disposal
  - Public bus system
  - Irrigation system
  - Superblocks (building blocks)
  - Smart subway elevators
Smart City - Singapore

- Smart Nation initiative with 5 key national strategic projects:
  - National Digital Identity framework
    - Digital transactions conveniently and securely
  - e-Payments drive
    - Simple, fast, seamless and safe payments
  - Smart Nation Sensor Platform
    - Accelerated deployment of sensors and IoT devices
  - Smart Urban Mobility
    - Enhancing public transportation by leveraging data and digital technologies
  - Moments of Life
    - Bundled government services at citizens’ key life moments (one-stop shop)
Need for a holistic approach

- Infrastructure
  - Multi-disciplinary engineering
- Management
- Governance
- Policy

• Key: multi-factor integration and successful business plan!
Smart City Challenges
ICT challenges

• Embedded and cyber-physical computing
• Systems of systems
• Communications
• Social computing
• Cybersecurity
• Safety and privacy
• Artificial Intelligence
• ...

Energy

McKinsey, 2010, GHG Abatement Cost Curve
Energy

• Measures that improve energy efficiency
  • Insulation, lowering demand (lights, HVAC)

• Adoption of more greenhouse gas-efficient technologies
  • Wind power
  • Carbon capture and storage

• Reduction of emissions
  • Protecting, planting, or replanting tropical forests
  • Agricultural practices with greater greenhouse gas efficiency
Transportation - mobility

• Route adjustment
• Traffic management
• Parking
• EV charging
Waste management

• Collection route optimization
• Real-time collection route management
• In-time collection
• Efficient sensing
• Monitoring and effective management
Cyber-physical computing

• Embedded computing
• Systems of systems
• Dependability
• Internet-of-Things (IoT) and Industrial Internet-of-Things (IIoT)
• Edge computing and AI
• Robotics and AI
Communications

• Access saturation of cellular network infrastructure
• Envisaged solutions
  • Machine Type Communication – Machine to Machine
  • Optimization of access protocols (simplified access for data collection in 5G, access mutualization and virtualization, network slicing)
  • Network of networks 5G approach based on heterogeneity comprising variety of interfaces, protocols, bands, access node classes, and network types
  • IoT dedicated infrastructures
  • Densification and agile management
Urban wireless network challenges

• Energetic autonomy (more flexible deployment, lower transmission power)
• Enable urban IoT operators
• How to leverage urban infrastructure: toward hybrid architectures (capillary networks mixing long range and multi-hop; leverage diverse networking opportunities – short vs long range, complementarity instead of competition, security challenges; take data where relevant and bring where necessary – multi-hop, traffic offloading, energy harvesting optimization)
• Practical & legal challenges (service level agreement, multi-application energy optimization, enforcement of privacy, data property and security)
Social computing

• People first
• People 2 people
• Government 2 people
• Business 2 people

• Technologies
  • Data mining
  • Sentiment analysis
Cybersecurity – Safety & Privacy

- Service availability and security
- Process security and safety
- Data safety and privacy
- Cloud security
- Transportation safety
- Energy security
- Public safety
And more..

- Data dependability
- Open data
- End-to-end trust
- Artificial intelligence and machine learning everywhere
- Acceptance by humans
  - Concerns for AI and ML
  - Questions about automation vs. jobs
  - Understanding and modeling human behavior
- Standards?
Conclusions

• Smart cities are emerging

• Business plans are necessary

• Investments are large and increasing

• Opportunities are significant

• People are key
Thank you!