

# Carnegie Mellon University

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**TESC**

**11 December 2019**



# Smart Cities & The Built Environment

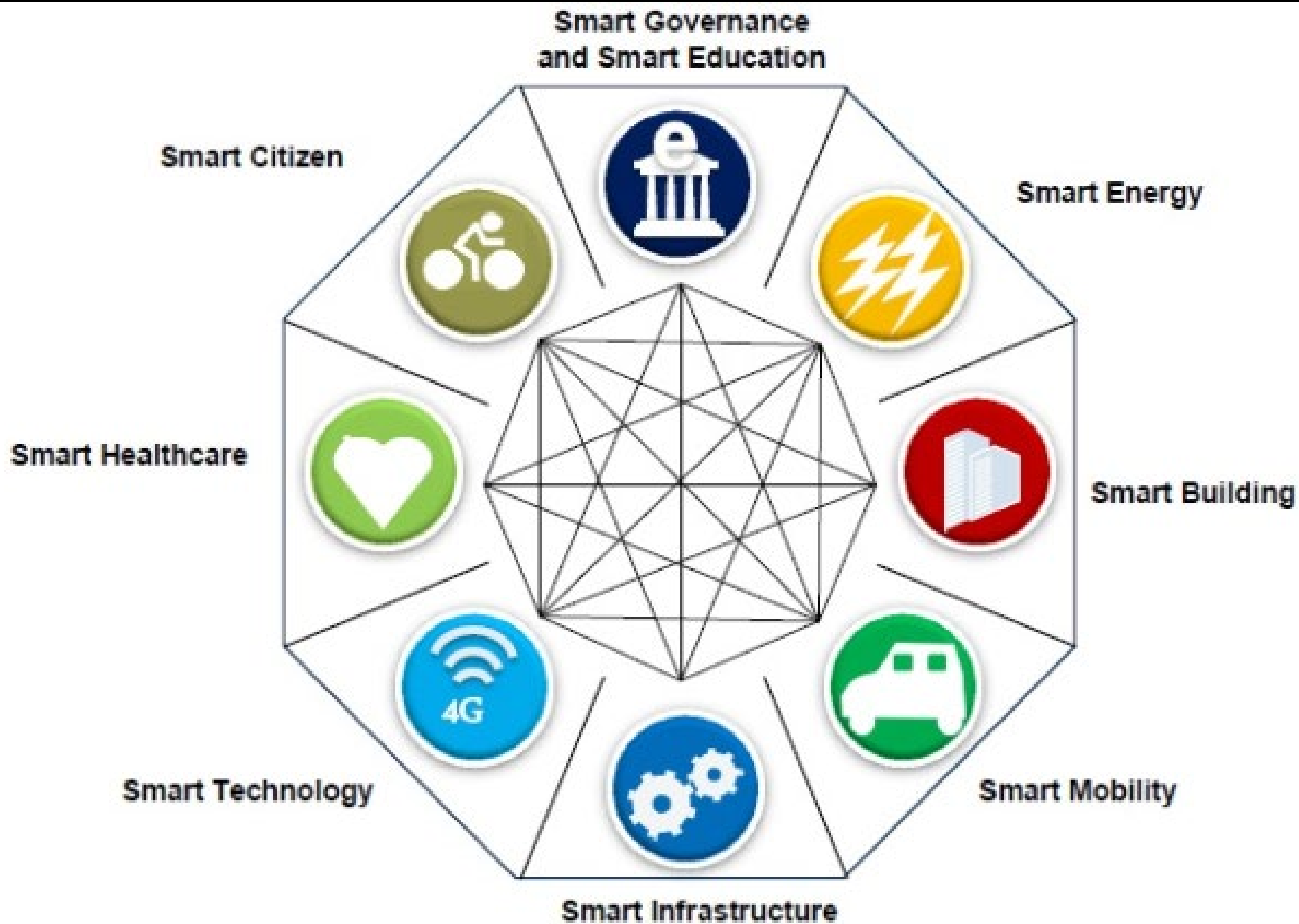
Donald K. Carter, FAIA FAICP LEED AP  
Senior Research Fellow, Remaking Cities Institute  
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# What is a Smart City?

"Smart Cities are places where information technology is combined with infrastructure, architecture, everyday objects, and even our bodies to address social, economic, and environmental problems."

Anthony Townsend, *Smart Cities*





# Infrastructure Spending Globally (2015-2025)

- \$250 trillion for roads, bridges, sewers, utilities
- \$100 billion for digital smart infrastructure


# Companies

- IBM
- Cisco
- Microsoft
- Intel
- Google
- GE
- Toyota
- Ericsson



# Building a Smarter City and State

The Commonwealth of Massachusetts, The City of Boston and IBM are working together to transform the region's physical infrastructure, engage citizens, reduce costs and improve efficiency. Do you know where technology is at work where you live?




- Buildings:**  
The state of Massachusetts owns 72 million square feet of property. Software helps improve maintenance, space and management across public sector buildings.
- Traffic:**  
Approximately 1.9 million commuters travel by car a day in Boston. Officials examine how Big Data technology makes transportation more efficient and reduce pollution.
- Airport:**  
Tens of millions of travelers pass through Logan Airport every year. Software helps the Port Authority better manage maintenance operations for equipment such as air conditioning, doors and escalators at Terminal A.
- Physical Assets:**  
Boston has more than 60,000 streetlights and 13,000 fire hydrants. Software helps city officials better manage and maintain physical assets.
- Special Events:**  
More than half a million people attend events such as the Boston Marathon and July 4th fireworks every year. Software can integrate and visualize critical information across city departments including fire, police and emergency responders to help coordinate and plan special events.
- Water:**  
Massachusetts Water Resource Authority (MWRA) serves 2.5 million people in 61 communities. Using software, MWRA decreased corrective maintenance and project work orders by 38 percent.

IBM

SOURCES: CISCO / REUTERS / WASTE ADVANTAGE

# THE CITY OF THE FUTURE: SMART AND CONNECTED

According to ABI Research, \$39.5 billion is projected to be spent on smart city technologies in 2016. From public transportation to shopping, the city of the future has the potential to significantly transform urban living—and might be closer than we think. This interactive experience not only explores technologies down the road, but also offers examples of specific technologies being deployed right now in the Cisco smart city project of Songdo, South Korea.



CISCO

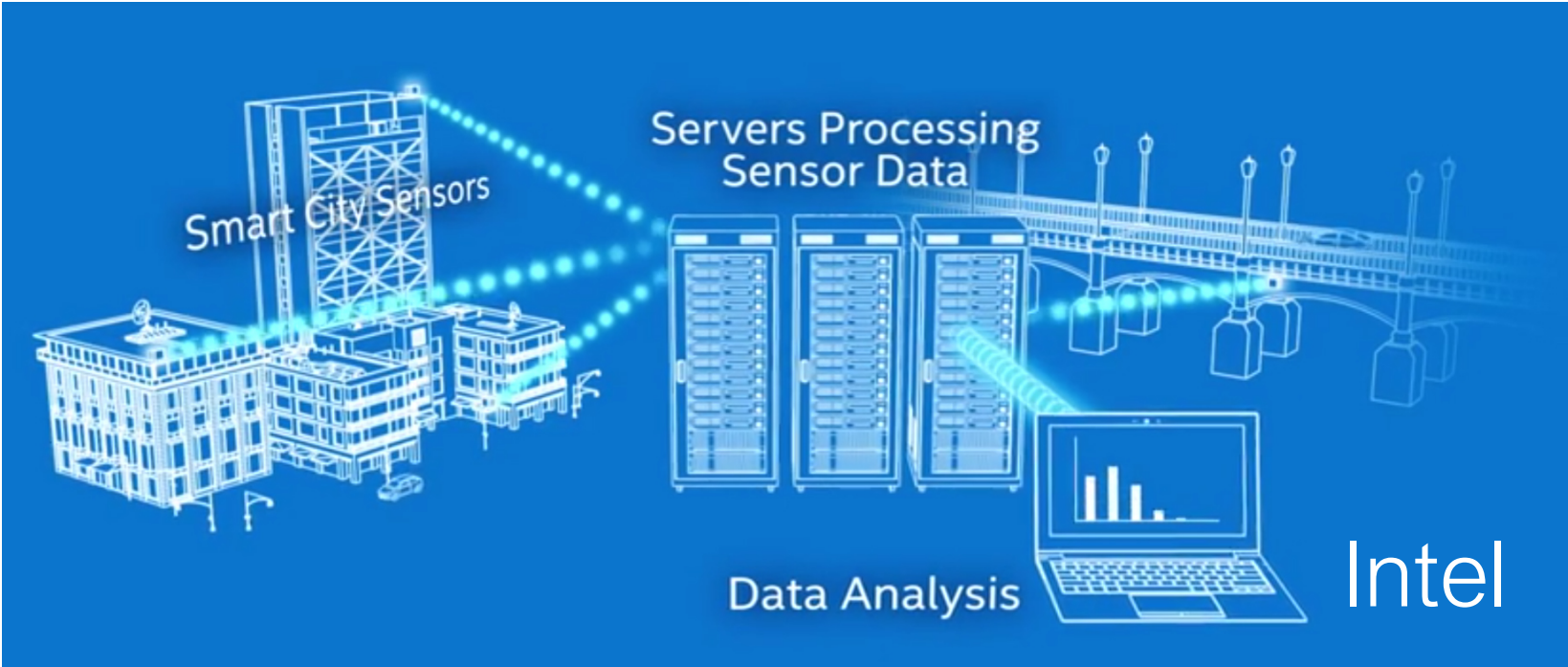
Cisco

# Smart Secondary City Project Indonesia



Microsoft LKY Lee Kuan Yew School of Public Policy

Microsoft



Smart City Sensors

Servers Processing Sensor Data

Data Analysis

Intel

Intel



# TOYOTA's Activities towards SMART MOBILITY SOCIETY

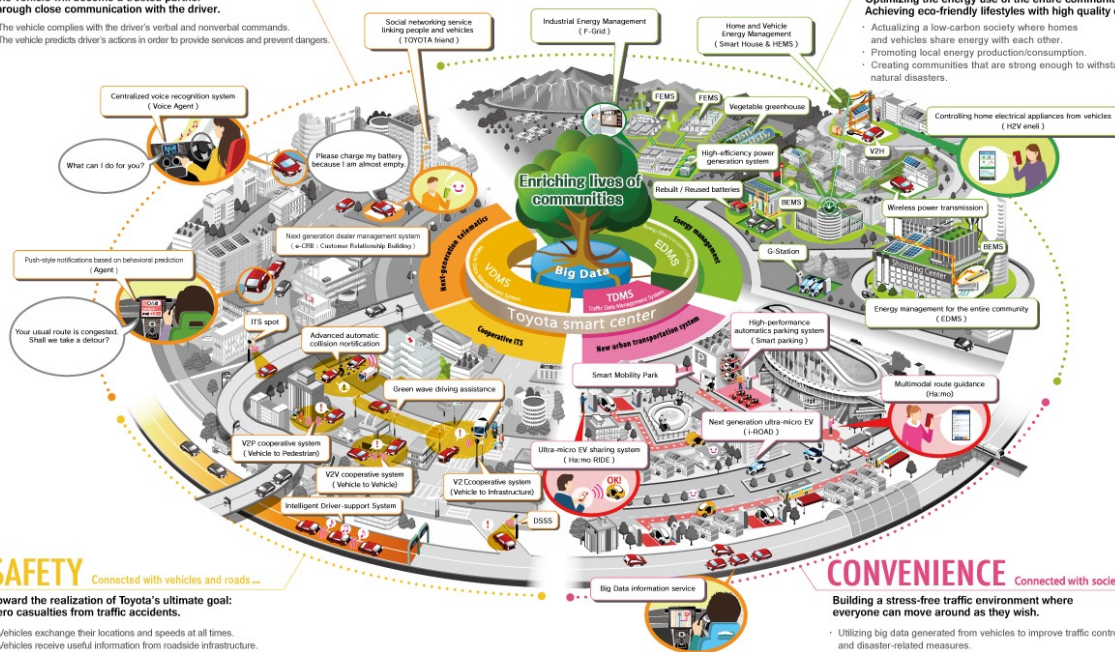
Toyota aims to create a smart mobility society where people feel secure and happy in transport and everyday life.

## COMFORT

Connected with people...

The vehicle will become a trusted partner through close communication with the driver.

- The vehicle complies with the driver's verbal and nonverbal commands.
- The vehicle predicts driver's actions in order to provide services and prevent dangers.



## SAFETY

Connected with vehicles and roads...

Toward the realization of Toyota's ultimate goal: zero casualties from traffic accidents.

- Vehicles exchange their locations and speeds at all times.
- Vehicles receive useful information from roadside infrastructure.

## ECOLOGY

Connected with the community...

Optimizing the energy use of the entire community Achieving eco-friendly lifestyles with high quality of life.

- Actualizing a low-carbon society where homes and vehicles share energy with each other.
- Promoting local energy production/consumption.
- Creating communities that are strong enough to withstand natural disasters.

## CONVENIENCE

Connected with society...

Building a stress-free traffic environment where everyone can move around as they wish.

- Utilizing big data generated from vehicles to improve traffic control and disaster-related measures.
- Implementing an ultra-micro EV sharing service integrated with public transportation.

# Toyota

# Intelligent Environments for Cities

All over the world, cities face some tough and costly challenges.

Connecting a city to the Industrial Internet drives the change that can help turn those challenges into opportunities.



# GE

# LEVERAGING ICT IN SMART SUSTAINABLE CITIES



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MASTER RESEARCHER,  
SUSTAINABILITY ASSESSMENTS

GREEN STANDARDS WEEK 2013  
HIGH LEVEL SEGMENT ON SMART SUSTAINABLE CITIES  
SEPTEMBER 2013

# Ericsson

Caution #1



“The notion of the Smart City in its full contemporary form appears to have originated with companies rather than with any party, group, or individual recognized for their contributions to the theory and practice of urban planning.”

Adam Greenfield

*Against the Smart City*

# 3 Thresholds in 2008

- Urbanization
- Untethered from the grid
- The Internet of Things

# 3 Thresholds in 2008

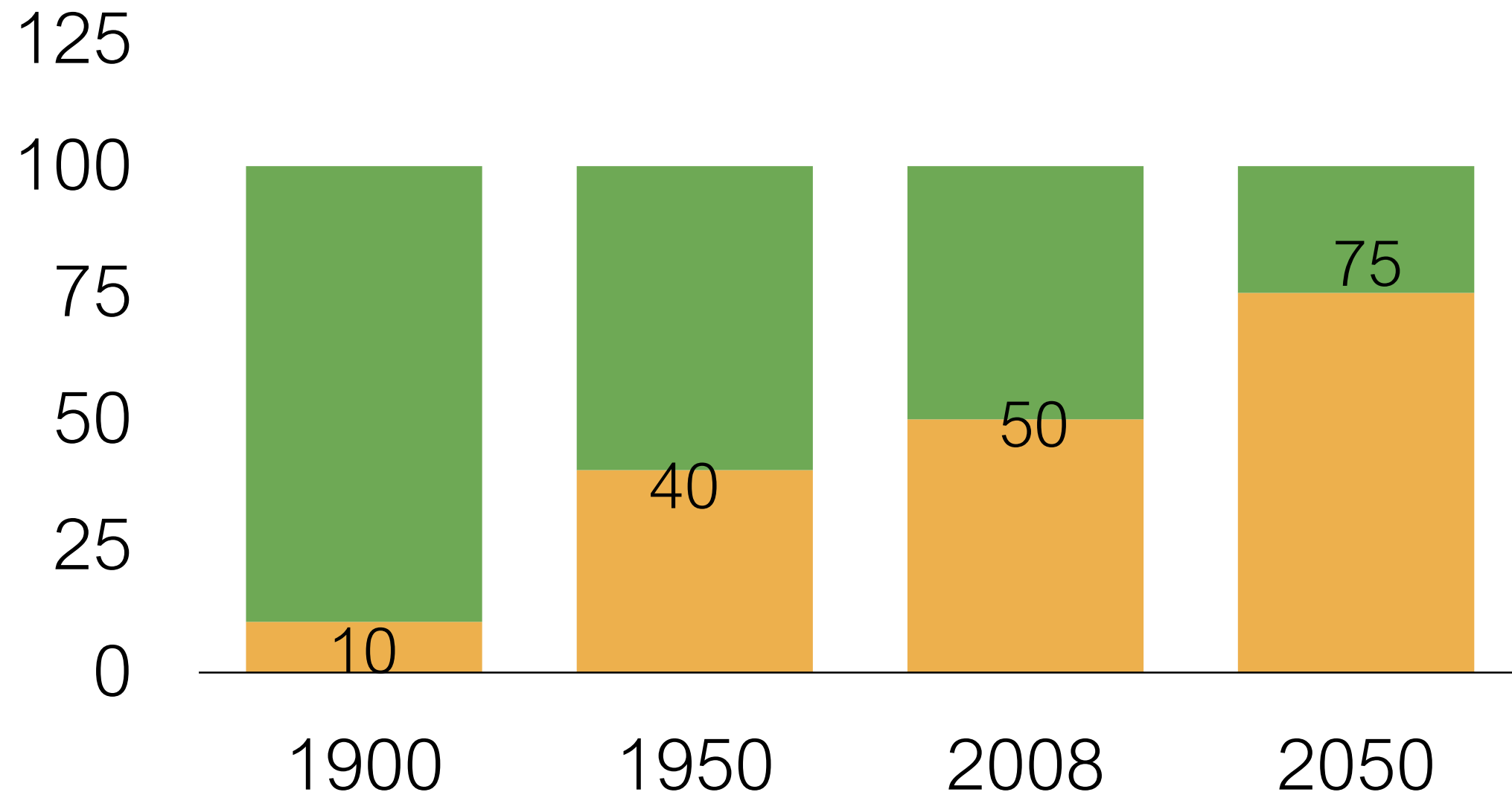
- Urbanization
- Untethered from the grid
- The Internet of Things



# % Global Population

Urban

Rural





# Shenzhen, China





# 3 Thresholds in 2008

- Urbanization
- Untethered from the grid
- The Internet of Things



In 2008 for the first time  
wireless connections to  
the internet surpassed  
connections by cable,  
DSL, or fiber.

# Mobile Devices

- 1973 1G phone
- 1991 2G phone
- 1993 text messaging
- 1996 Nokia 9000
- 1997 Palm Pilot
- 1998 Blackberry
- 2001 3G phone
- 2007 Apple iPhone
- 2010 4G phone
- 2010 Apple iPad
- 2015 Apple Watch
- 2018 5G phone

# Mobile phones in use

- 4.7 billion mobile phones worldwide (2019)
- of which 2.7 billion are smart phones



iPhone



# 3 Thresholds in 2008

- Urbanization
- Untethered from the grid
- The Internet of Things

The **Internet of Things (IoT)** is the network of physical objects or "things" embedded with electronics, software, sensors, and network connectivity, which enables these objects to collect and exchange data.



# Internet Milestones

- 1969 ARPANET (DoD)
- 1990 World Wide Web
- 1994 Internet Explorer
- 1994 Amazon
- 1998 Google
- 2004 Facebook
- 2005 YouTube
- 2006 Twitter
- 2007 Netflix Streaming
- 2010 Instagram
- 2011 Snapchat
- and many more

# Devices connected to the Internet by 2020

- 26 billion (Gardner, Inc.)
- 30 billion (ABI Research)
- 50 billion (Cisco)

# Measuring and recording:

- temperature
- pollution
- traffic
- energy use
- sound
- street lights
- bridge structures
- water use
- water quality
- radiation

# Issues with IoT

- cost
- “basket of remotes”
- privacy

# CCTV Video Cameras

- 350 million worldwide
- 200 million in China
- 50 million in the US





London has  
500,000  
cameras

1 for every  
14 residents



# Capturing and recording:

- traffic congestion
- pedestrians
- crowds
- accidents
- natural disasters
- crime
- terrorism

# Capturing and recording:

- traffic congestion
- pedestrians
- crowds
- accidents
- natural disasters
- crime
- terrorism
- and you

16:37:38



Caution #2



The background of the entire image is a dark, monochromatic photograph of several surveillance cameras mounted on a wall. The cameras are of various models, some with protective covers and others with exposed lenses. The lighting is dim, creating a somber and surveillance-themed atmosphere.

# Big Brother is watching you.

George Orwell

quote fancy



**Big** data

# Issues with Big Data

- access
- security
- privacy
- ownership
- reliability
- accuracy
- out dated info
- storage
- protocols
- compatibility



Caution #3

“The people it really speaks to are the city managers who can say, ‘It wasn’t me who made the decision, it was the data’.”

Usman Hague  
Umbrellium

# Five Smart City Deployments

- Masdar City, Abu Dhabi
- Hangzhou, China
- Hammarby, Sweden
- Songdo, South Korea
- Toronto, Canada



**Abu Dhabi**

**Masdar City**





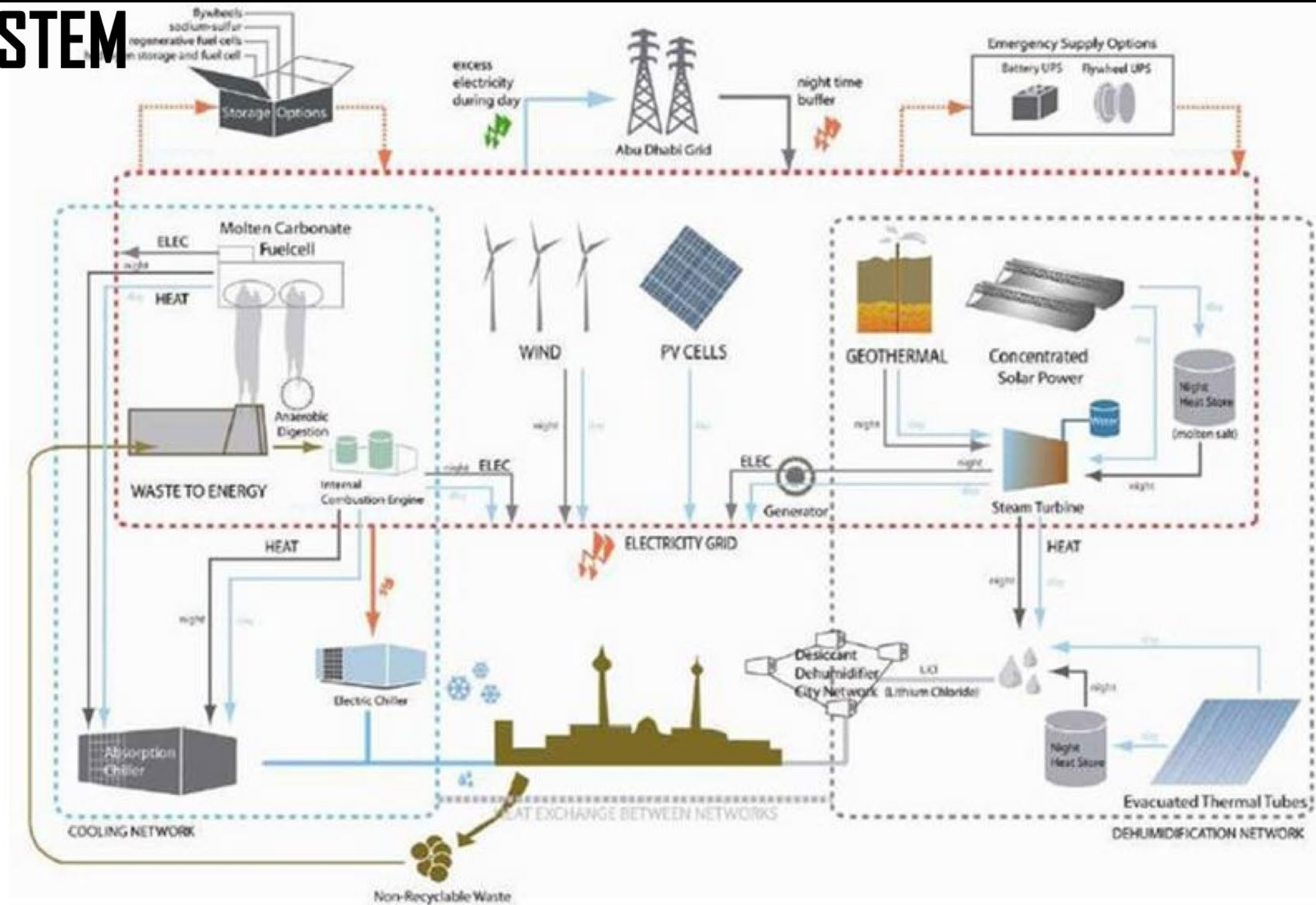
Abu Dhabi

Masdar  
CITY





# ENERGY SYSTEM



- Zero Waste
- Emission Free













Hangzhou, China





Hangzhou

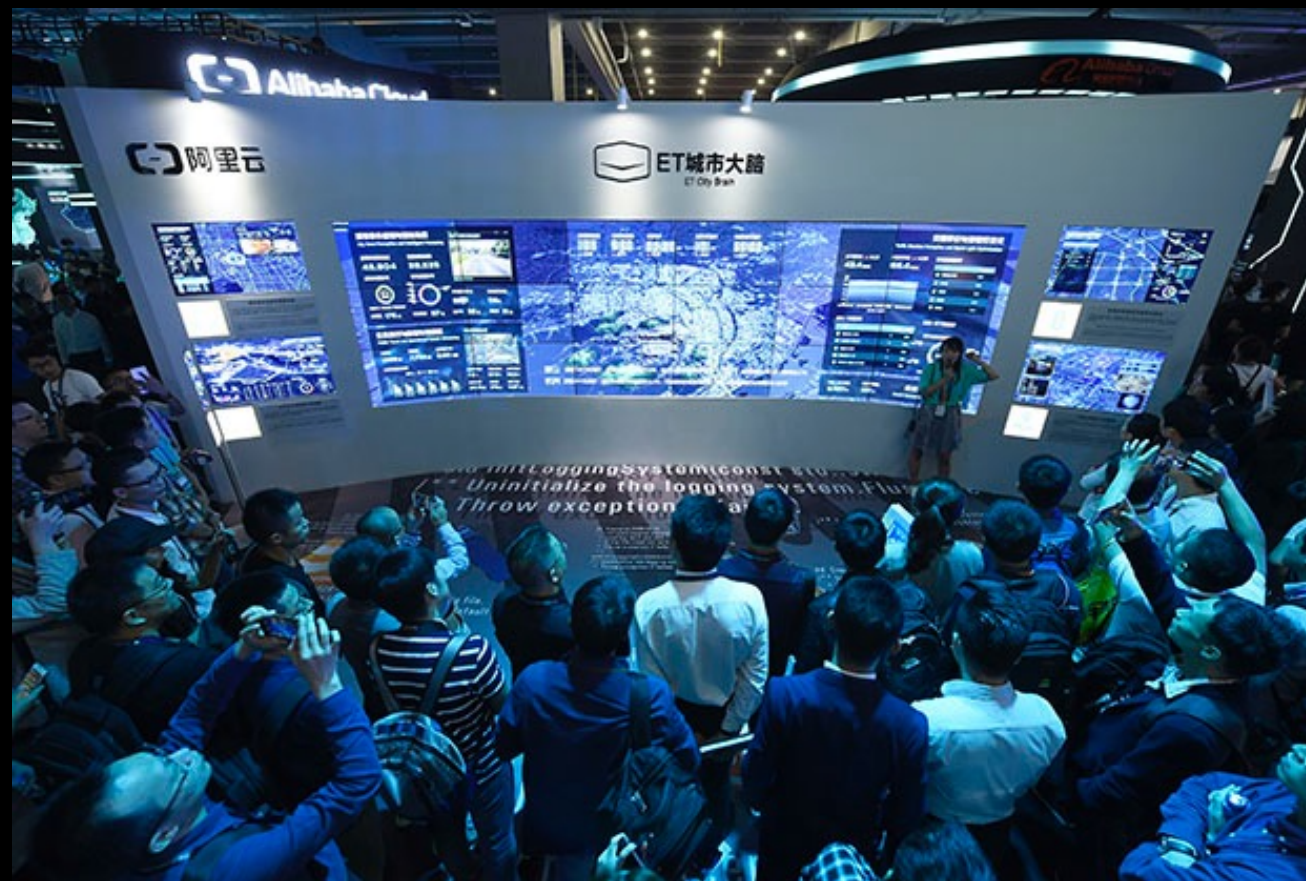




# CITY BRAIN









# Hammarby Stockholm, Sweden









### LEGEND

INFRASTRUCTURE NOT OWNED BY WDI
 EMS WIRELESS DATA TRANSMITTER

SITE BOUNDARY
 PHASE I BOUNDARY

#### WASTE SYSTEMS

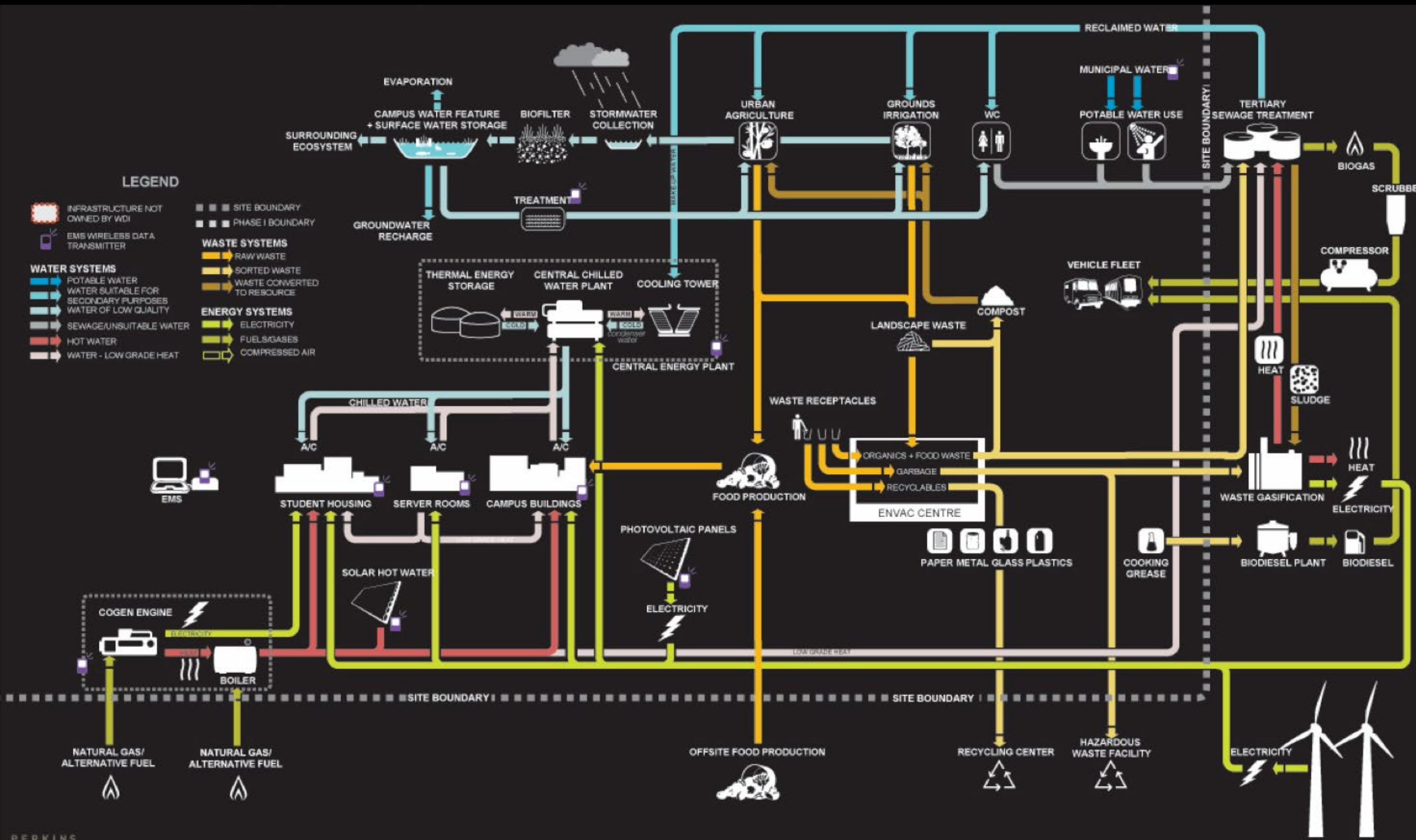
 RAW WASTE
 SORTED WASTE
 WASTE CONVERTED TO RESOURCE

#### ENERGY SYSTEMS

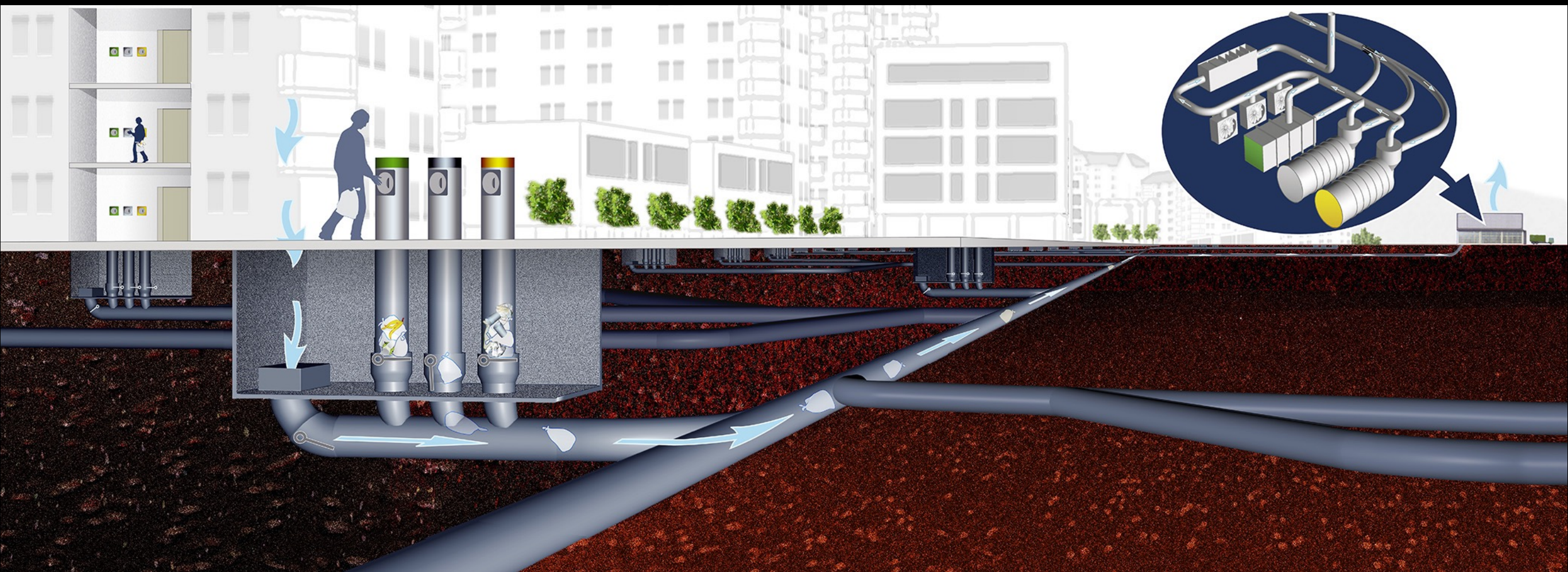
 ELECTRICITY
 FUELS/GASES
 COMPRESSED AIR

#### WATER SYSTEMS

 POTABLE WATER
 WATER SUITABLE FOR SECONDARY PURPOSES
 WATER OF LOW QUALITY
 SEWAGE/UNSUITABLE WATER
 HOT WATER
 WATER - LOW GRADE HEAT

















Pyongyang ☆ NORTH  
KOREA

Incheon ☆ Seoul

▣ Gangneung

**Songdo International  
Business District**

SOUTH  
KOREA

▣ Jeonju

▣ Daegu

▣ Gwangju

▣ Busan







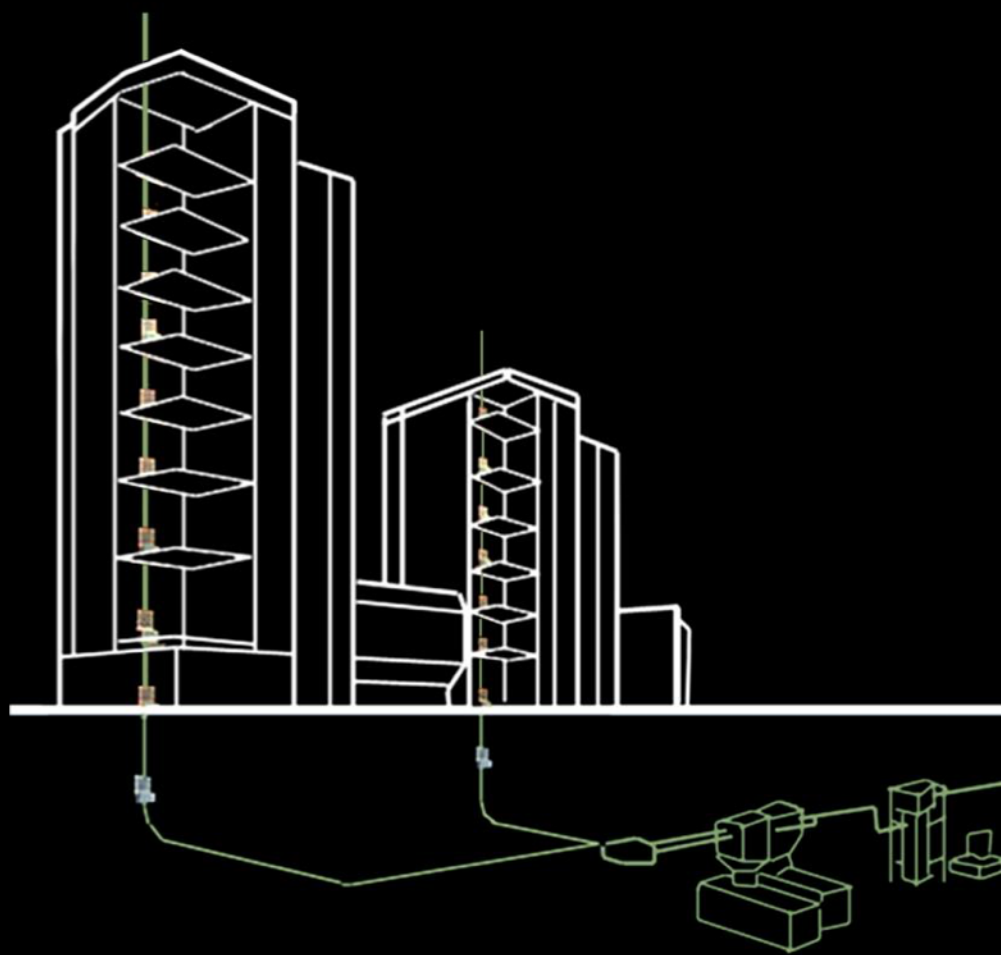
# Songdo International Business District (Songdo IBD)



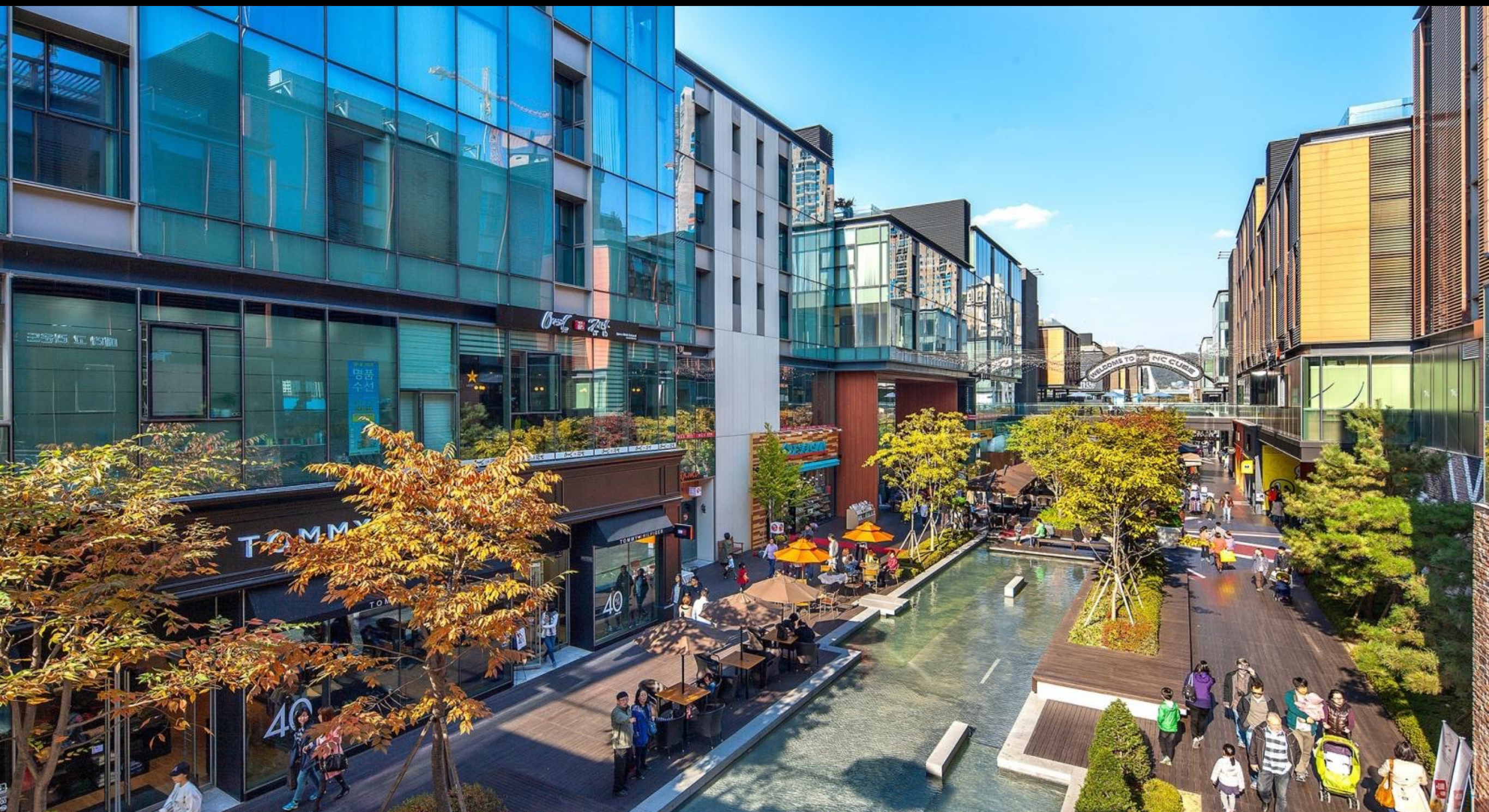




# Automated Waste Management















Toronto, Canada





**SIDEWALK LABS**







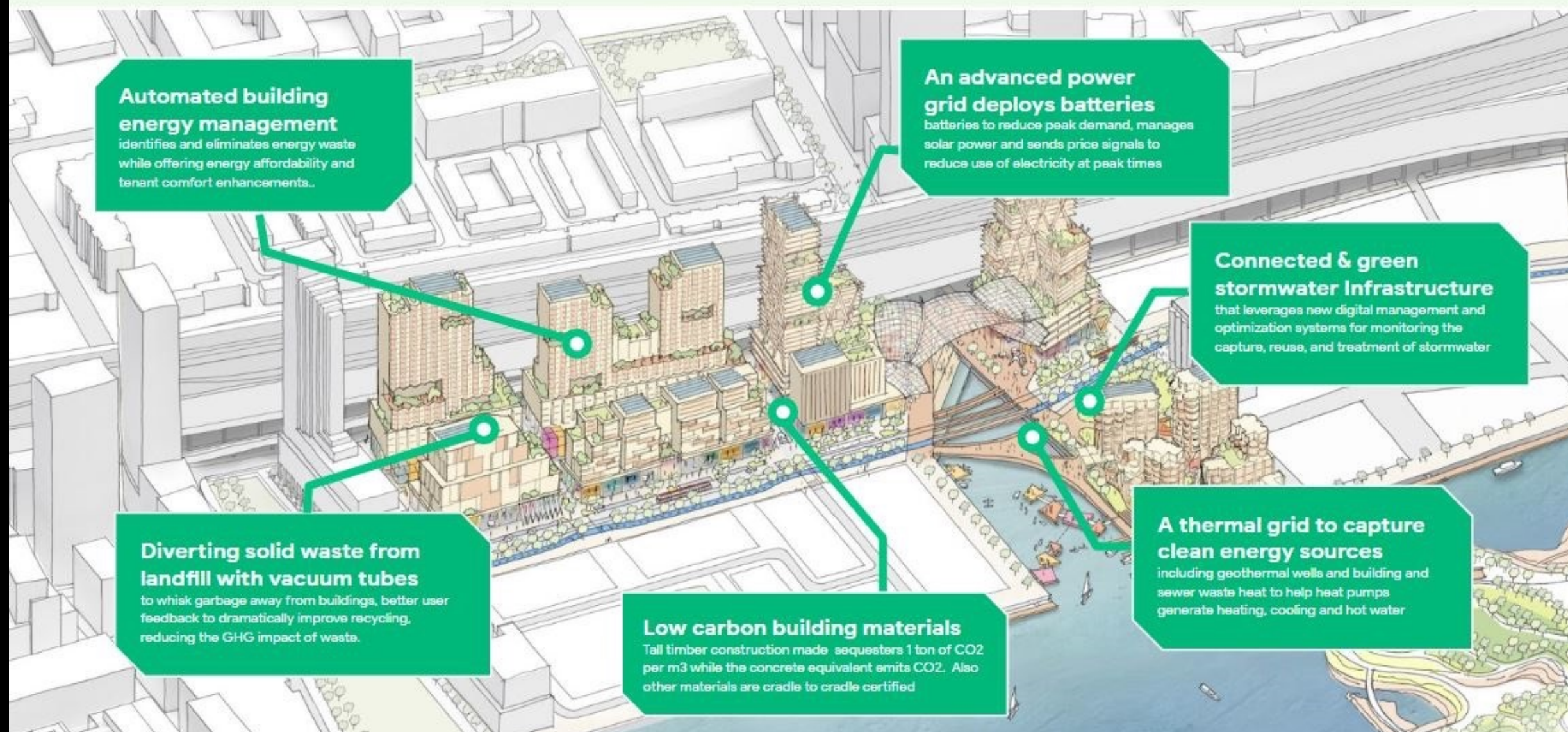








# Creating a Blueprint Climate Positive Neighbourhood



## Automated building energy management

identifies and eliminates energy waste while offering energy affordability and tenant comfort enhancements.

## An advanced power grid deploys batteries

batteries to reduce peak demand, manages solar power and sends price signals to reduce use of electricity at peak times

## Connected & green stormwater infrastructure

that leverages new digital management and optimization systems for monitoring the capture, reuse, and treatment of stormwater

## Diverting solid waste from landfill with vacuum tubes

to whisk garbage away from buildings, better user feedback to dramatically improve recycling, reducing the GHG impact of waste.

## Low carbon building materials

Tall timber construction made sequesters 1 ton of CO<sub>2</sub> per m<sup>3</sup> while the concrete equivalent emits CO<sub>2</sub>. Also other materials are cradle to cradle certified

## A thermal grid to capture clean energy sources

including geothermal wells and building and sewer waste heat to help heat pumps generate heating, cooling and hot water



**PHYSICAL LAYER**

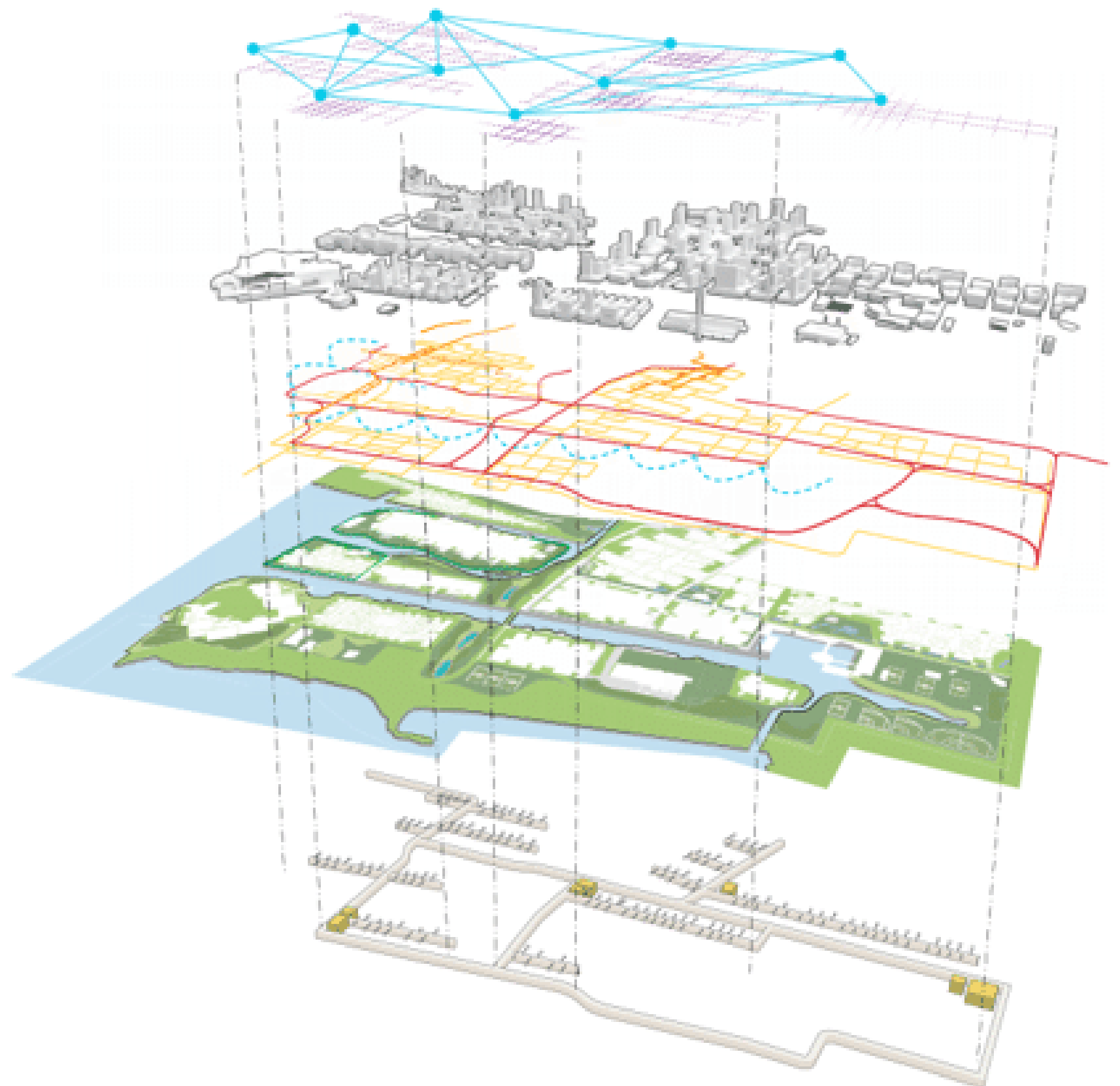
**Digital Layer**

**Buildings**

**Mobility**

**Public Realm**

**Infrastructure**



# Surveillance City?





Bianca Wylie

“Data produced by the public should be publicly owned and managed transparently.”



“A lot of the urban problems that smart-city projects propose to address don’t require a technological solution. Toronto’s affordable housing crisis isn’t going to be solved with more data.”

**A final caution**



“The more successful smart cities programs become, the more they risk diverting resources into problems that can be solved with technology, rather than grappling with issues that can't be easily fixed with an app.”

Courtney Humphries

*The Too-Smart City*

The Boston

So it's not all about  
technology and  
artificial intelligence.



# Market Square Pittsburgh





“What is the city but  
the people?”

William Shakespeare

Coriolanus, Act III, Scene 1



# Carnegie Mellon University

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Thank you.



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