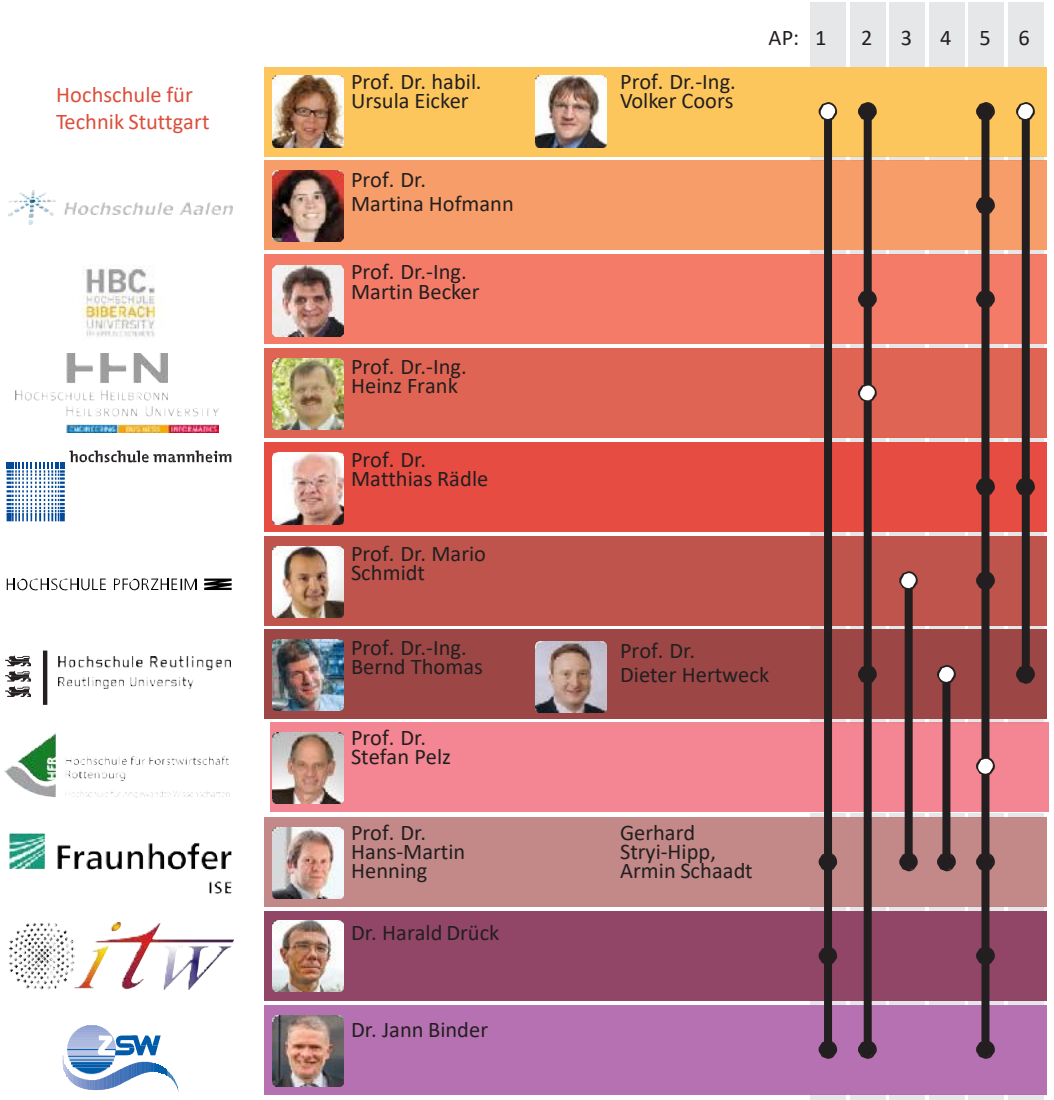
ENsource -

Zentrum für angewandte Forschung
Urbane ENergiesysteme und Ressourceneffizienz

Prof. Dr. habil. Ursula Eicker, Prof. Dr. Dieter Hertweck, Dr. Jann Binder
Stuttgart, 23.06.2015



Team ENsource

- 8 Hochschulen für angewandte Wissenschaften
- 3 (außer-) universitäre Partner

weitere 12 Verbundpartner:

- 2 Kommunen
- 2 Regionalverbände
- 8 Unternehmen

Qualität der Forschungspartner

- Alle ENsource HAW Partner sind Mitglied im BW Center of Applied Research
  - dauerhaft qualitätsgesichertes Netzwerk
  - 13,8 Mio € Forschungsdrittmittel und 387 Publikationen in den letzten 3 Jahren der 10 HAW Professoren

- Förderung des wissenschaftlichen Nachwuchses (Promotionen) durch intensive Kooperation der Projektpartner mit den Universitäten und dem Know-How der Unternehmen

- Forschung Energiesektor: größte und wichtigste (außer-) universitäre Partner in Baden-Württemberg: ZWS, Fraunhofer Gesellschaft ISE, Universität Stuttgart, KIT

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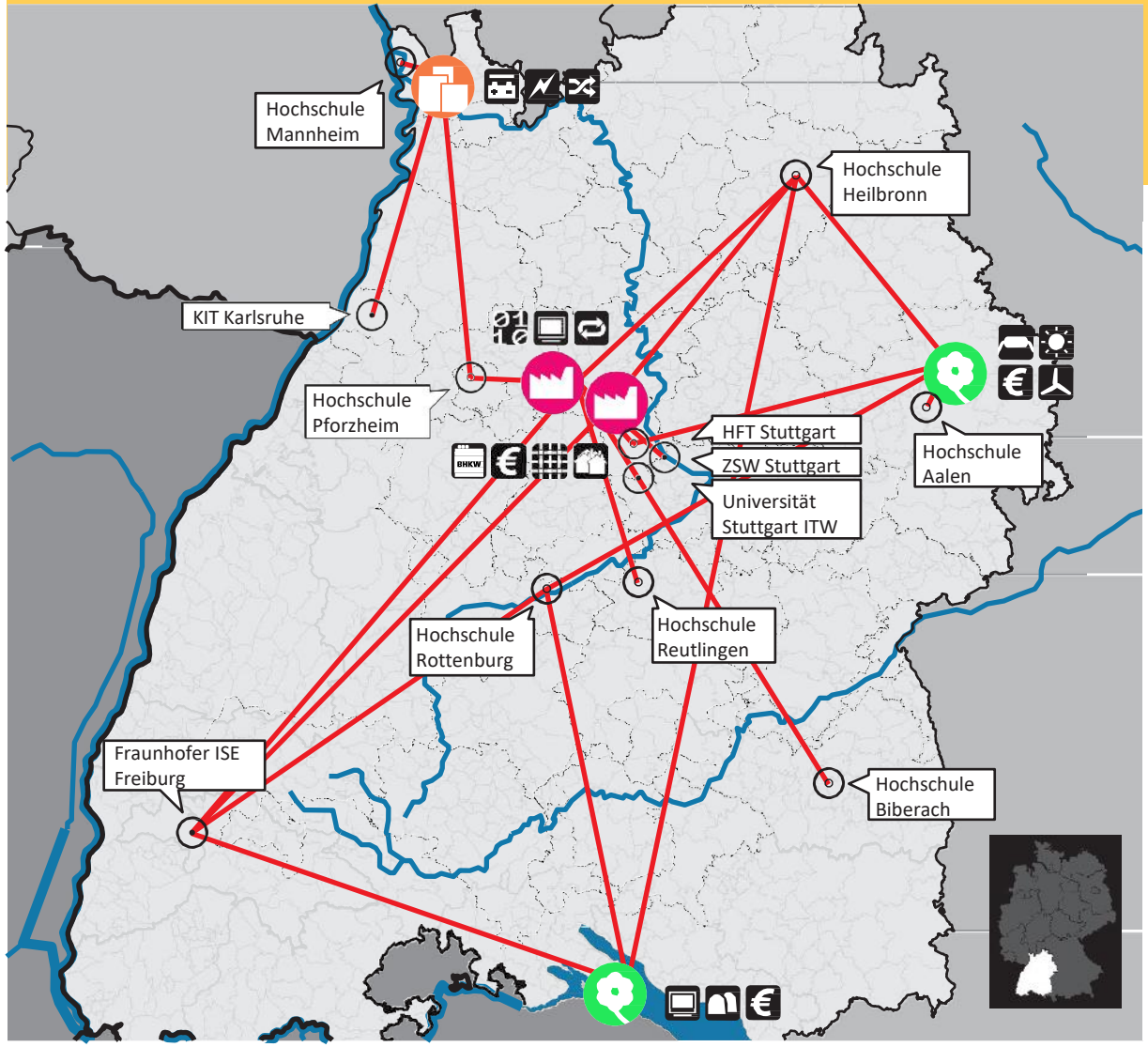


Vernetzung ENsource

Siedlungstypen

- Fallstudie, gewerblich
- Fallstudie, ländlich
- Fallstudie, städtisch

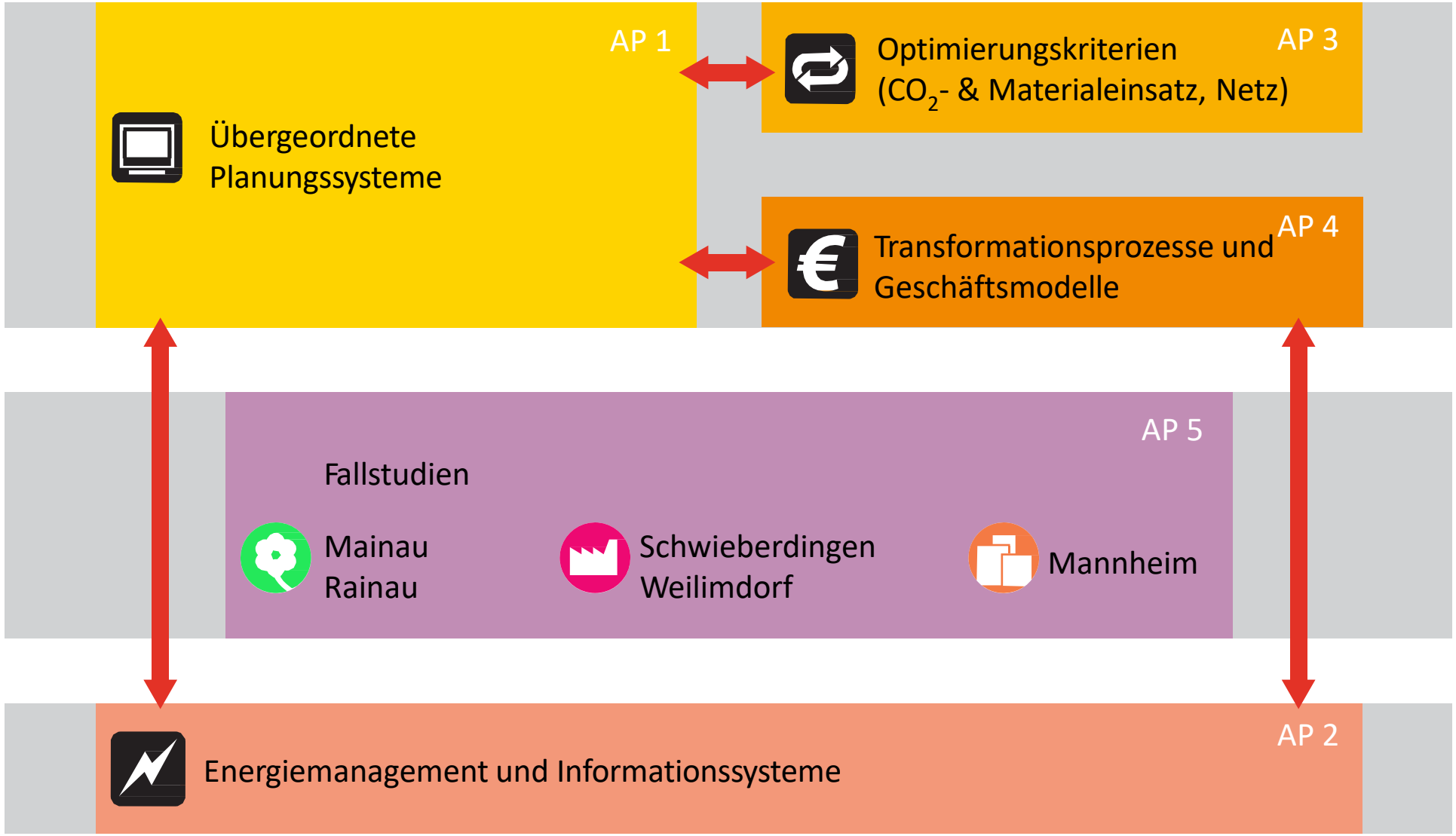
Kooperation

- kooperierende Hochschule
- Kooperations-partner

Aktivitäten

- Biomasse
- Energiekonzepte
- Energiemanagement
- Geschäftsmodelle
- Kraft-Wärme-Kopplung
- Methanisierung
- Nahwärmenetz
- Photovoltaik
- Prozessoptimierung
- Quartierkonzept
- Software
- Speicherung
- Wind
- BHKW

Lösungsansatz:




Canada Excellence Research Chair
Prof. Dr. Ursula Eicker
NEXT-GENERATION
CITIES
INSTITUTE
concordia.ca/next-gen/cities
Concordia University
CONCORDIA

Next-generation cities at Concordia

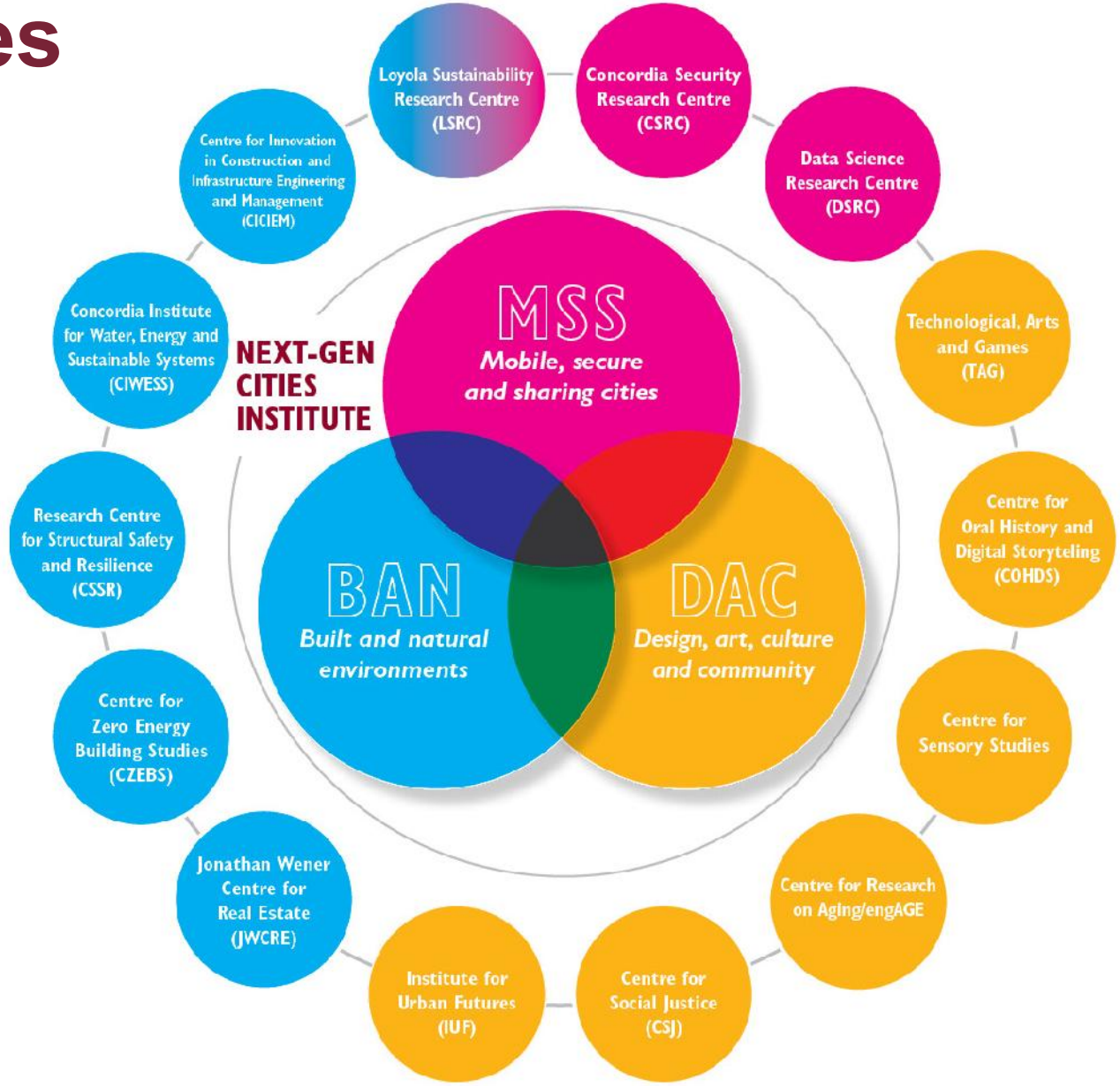
Concordia has emerged as a world leader in next-generation cities research and expertise.

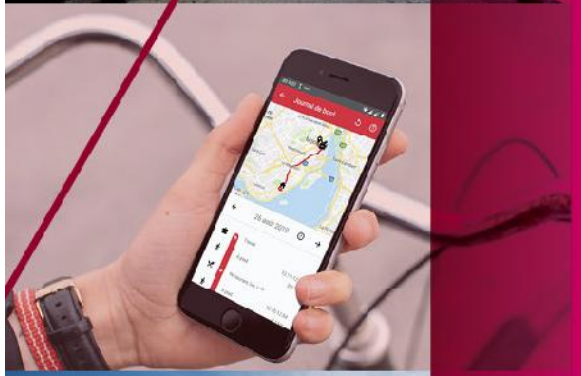
- The Next-Generation Cities Institute harnesses the knowledge and resources of more than 200 researchers and 14 research centres.
- Canada Excellence Research Chair in Smart, Sustainable and Resilient Cities and Communities.
- Tackling some of society's biggest challenges: sustainable development, zero carbon cities and buildings, cyber security and artificial intelligence, climate change and preserving natural ecosystems, art-based urban interventions, transportation and mobility.

NGCI research centres

NGCI groups all academics into three research clusters that overlap, yet have distinct identities:

- Built and natural environments as the hardware…
- Mobile, secure and sharing cities as the software…
- And design, art, culture and community as the experience of the city





High impact research

- Transform Lachine-East industrial site into a zero-carbon neighborhood
- Smartphone application MTL Trajet to support the Ville de Montréal’s transportation decisions
- To sprawl or not to sprawl: Envisioning urban development in Montreal for 2050
- Micro transit demand management (microTDM) system
- La Ville Extraordinaire as oral history research-creation
- Creative Living Lab to engage older adults
- Bâtiment 7 for community mobilization

What is a next-generation city?

- Next-generation cities are inclusive, connected, collaborative, ecological, healthy, mobile, and encourage engagement to ensure communities are empowered, resilient, prosperous and equitable.
- Critically engages with the smart city idea and asks “Who is the city built for?”
- Focus on transforming and creating cities built for the next-generation — cities that are sustainable and livable communities where people can thrive.

Smart cities today

“Communities that are building an infrastructure to continuously improve the collection, aggregation, and use of **DATA** to improve the life of their residents”

Means:

- ICT to solve public problems (energy, waste management, transportation, healthcare, security)
- Innovate organizational and governance structures

White House Federal Research initiative 2015

Global businesses like Siemens, Cisco, IBM, Microsoft drive smart city development, creating a global market of $1.4 trillion by 2020.

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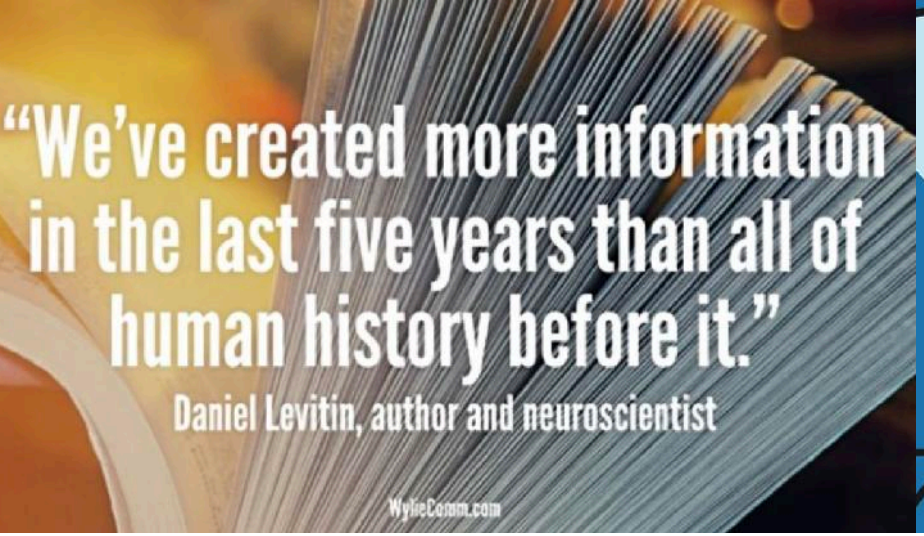
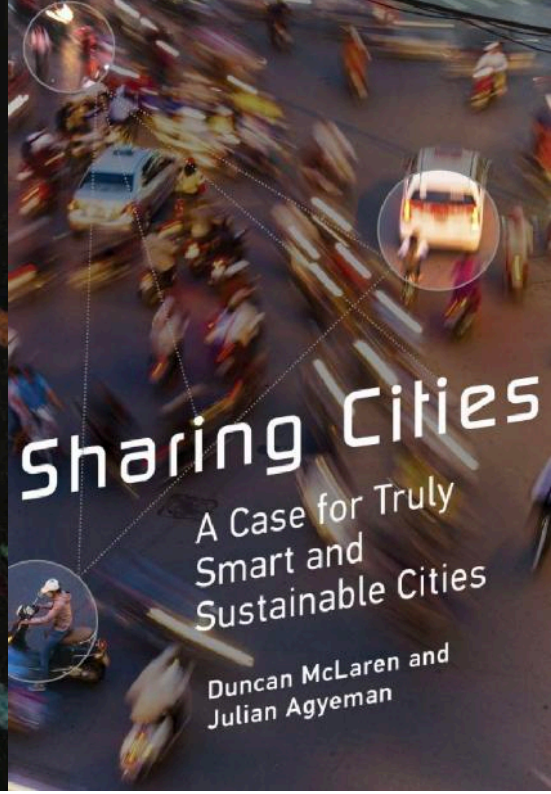



Smart city problems

- Tech overload: weakened decision making, feeling overwhelmed from information, insomnia from smartphone use, growing narcissism from social media use, less empathy of kids with high computer use
- Real city infrastructure problems are not addressed by sensors and urban data
- Surveillance and social control: brave new world…



Emerging changes in smart city definition

- Human centric cities, Human smart cities
- Emphathic buildings and communities
- Sharing Cities: A Case for Truly Smart and Sustainable Cities

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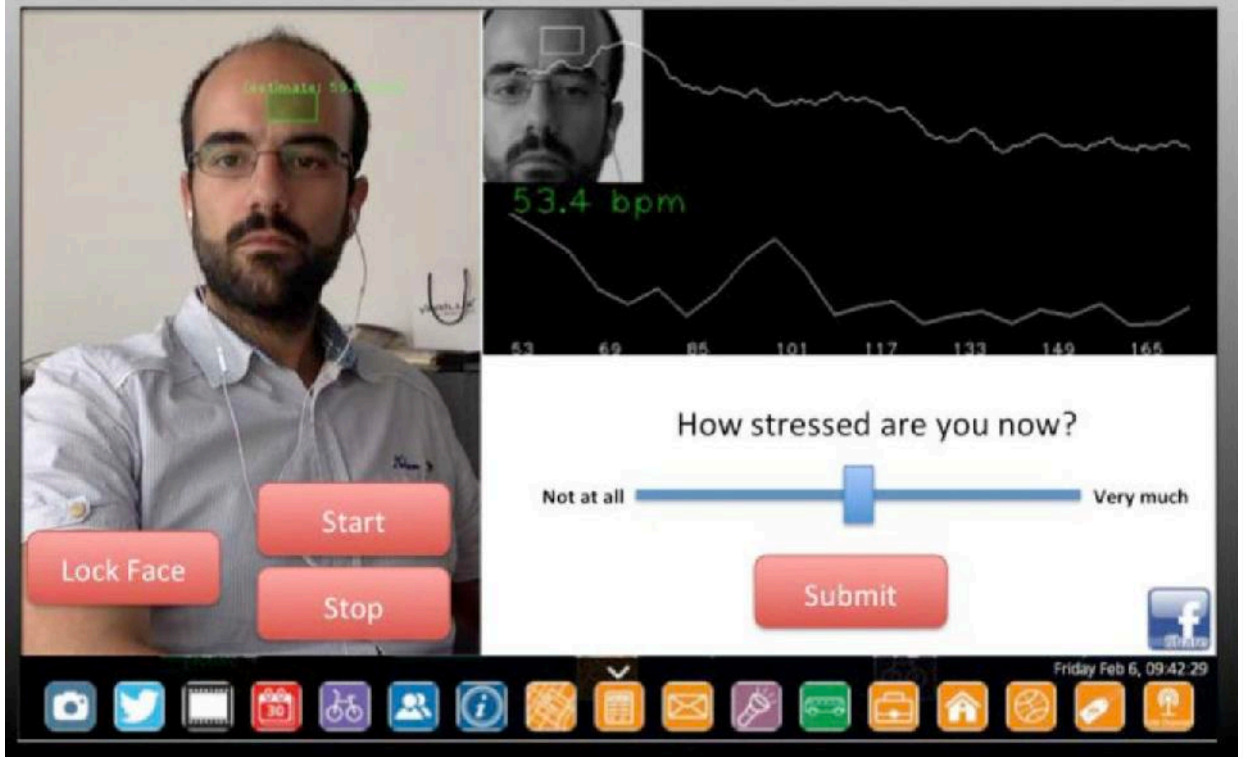

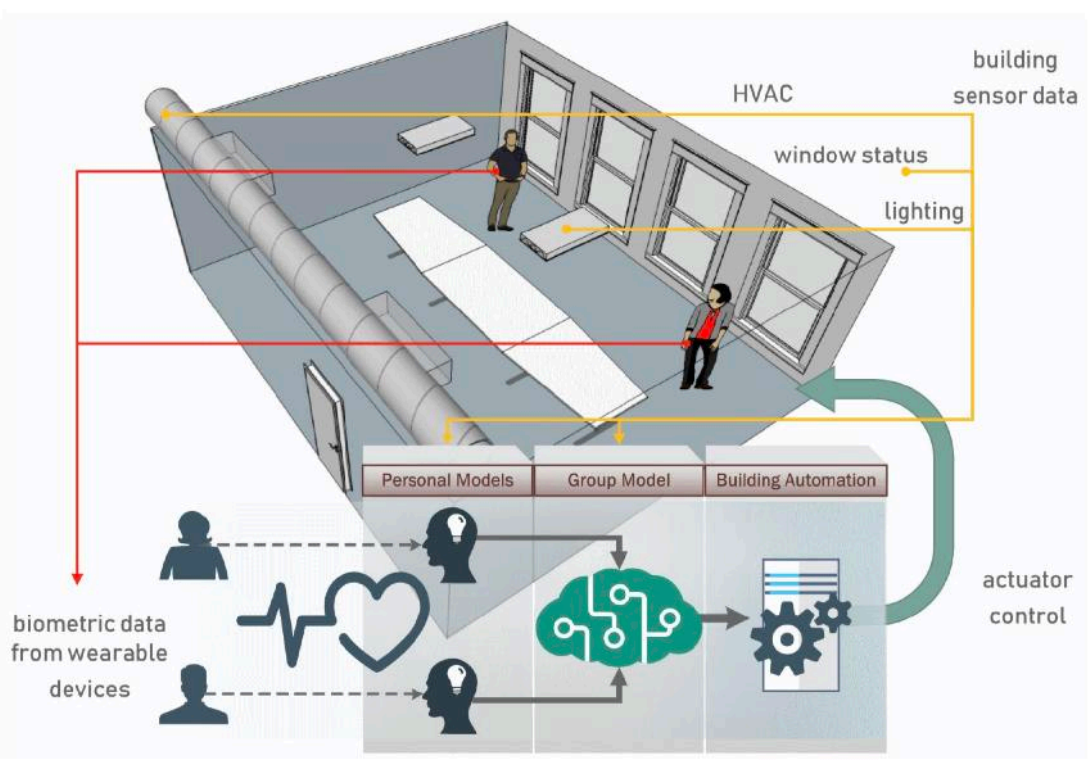

Empathic building

Towards the Empathic Building - Detection and recognition of well-being of individuals and groups

Jan Budke[1], Mario Cichonczyk[1] and Dominic Becking[1]

Buildings reacting to their users:

- Improve comfort (++)
- Increase energy efficiency (++)
- Increase surveillance (--)

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Sharing supports empathy

New “sharing paradigm”: models of sharing that are not always commercial but also communal, encouraging trust and collaboration.

The Broad Territory of the Sharing Paradigm			
	Things	Services	Activities
Individual	Swapping, bartering, gifting	Ridesharing, couchsurfing	Skill sharing
Collective	Car clubs, tool-banks, fab-labs	Childcare, credit unions, time-banks, crowdfunding	Sports clubs, social media, open-source software
Public	Libraries, freecycling	Health services, public transit	Politics, public space

Duncan McLaren, Julien Agyeman: Sharing Cities

The founding cities of the Sharing Cities Alliance (2012) are New York City, Amsterdam, Seoul, Copenhagen and Toronto

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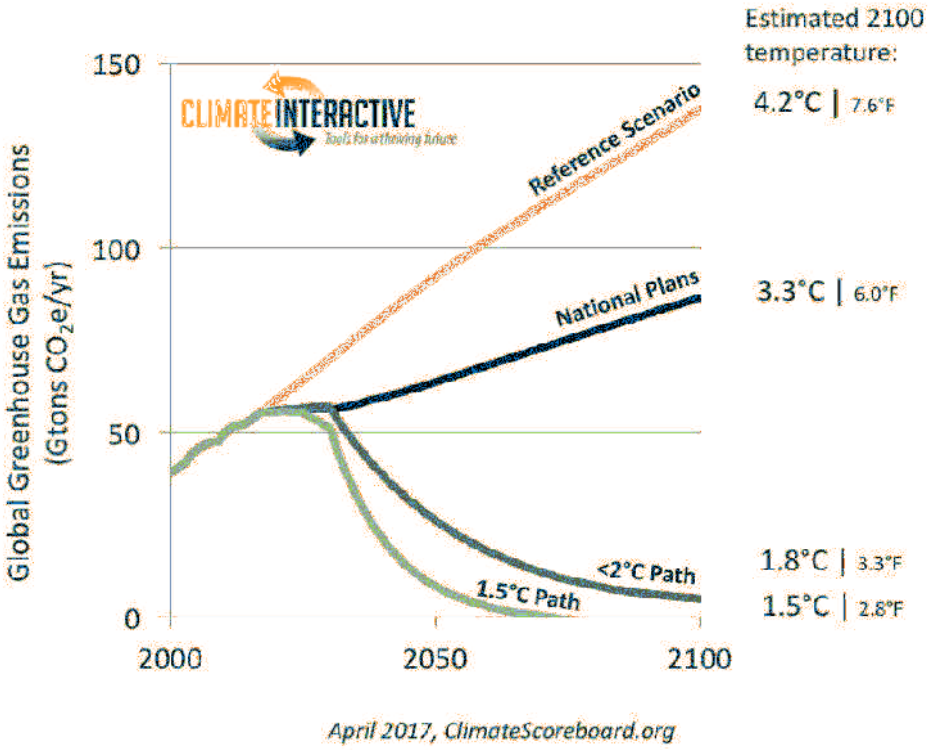
Next Generation Cities

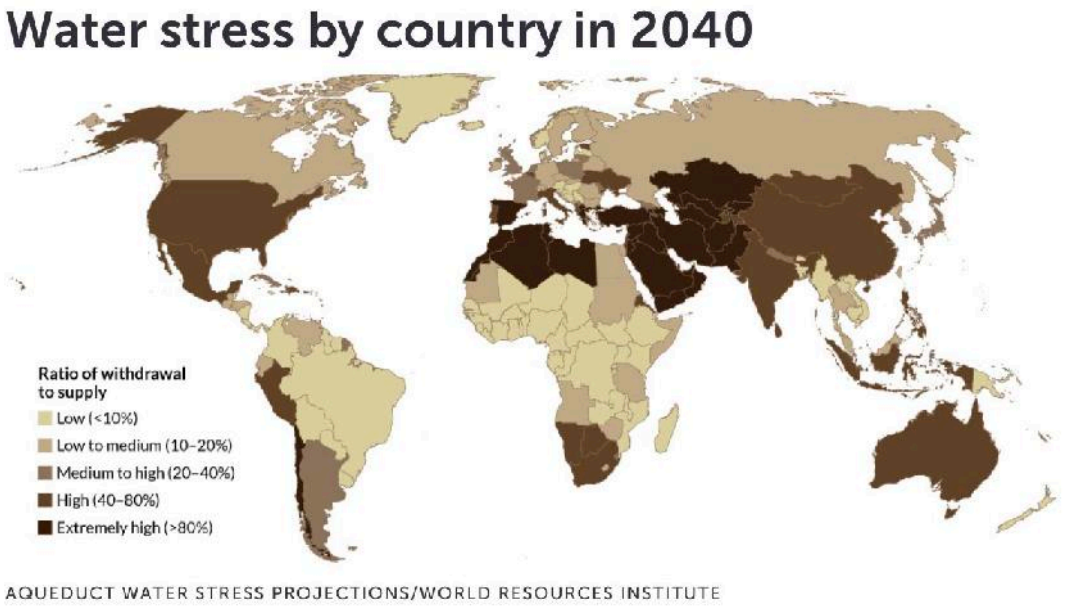
Cities challenges

Climate change & collapsing ecosystems
Waste overload
Gentrification, social injustice

- 3.2 billion people live in coastal areas
- 146 million people within 1 m height
- By 2040, about 4 billion people around the world will live with limited access to water
- 1.550 billion people will experience average temperatures above 35° C for 3 months in a row (2100)

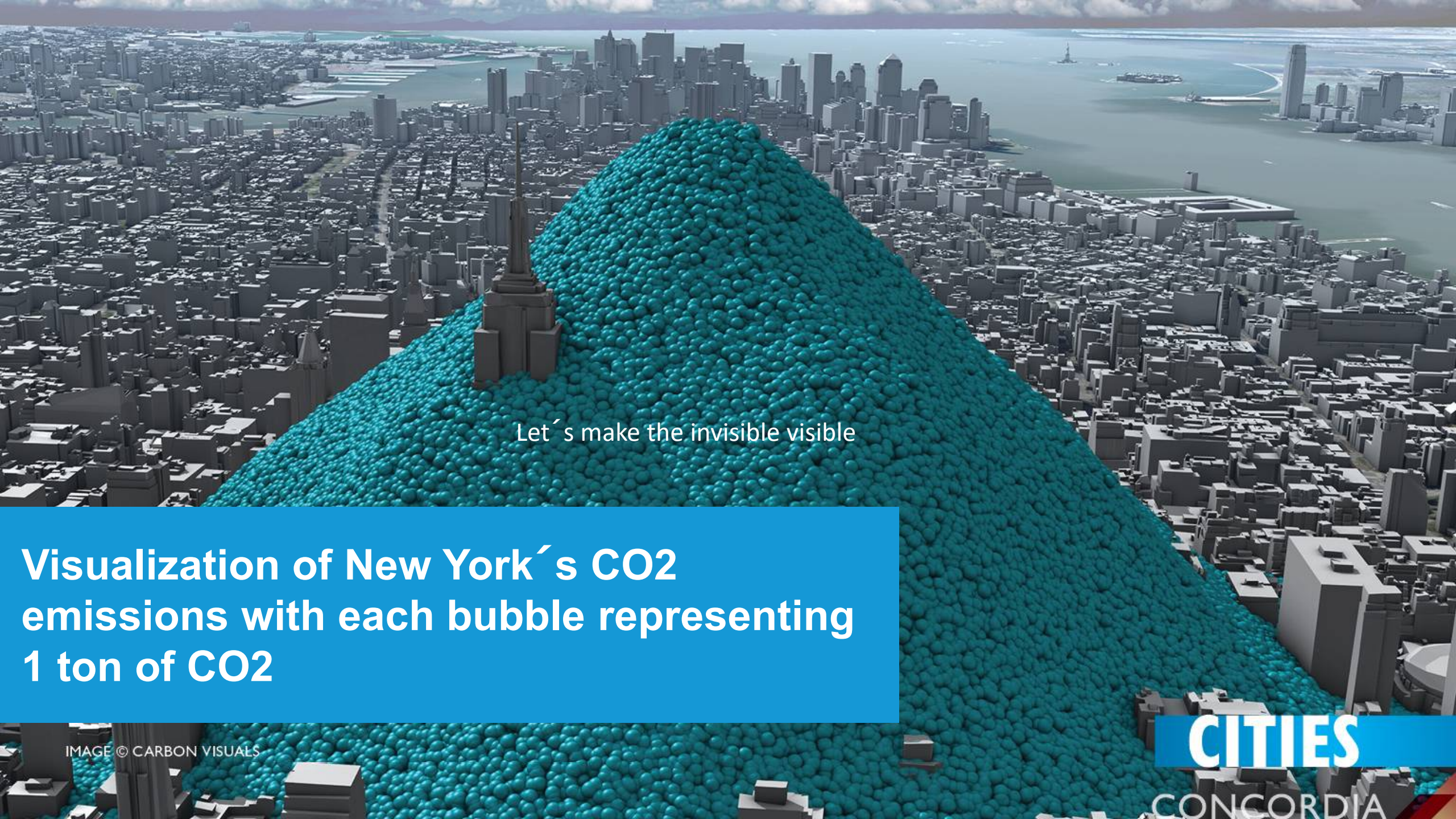


April 2017, ClimateScoreboard.org




Why does nothing happen?

- Lobby of fossil fuels, conventional construction and transportation industry
- Related jobs in energy, transport and construction heavily affected
- Resulting unwillingness of political action, too much short term thinking
- No binding international agreements (pledges, free will)
- An „invisible“, abstract and far away problem, at least for the developed world



Visualization of New York´s CO2 emissions with each bubble representing 1 ton of CO2

IMAGE © CARBON VISUALS

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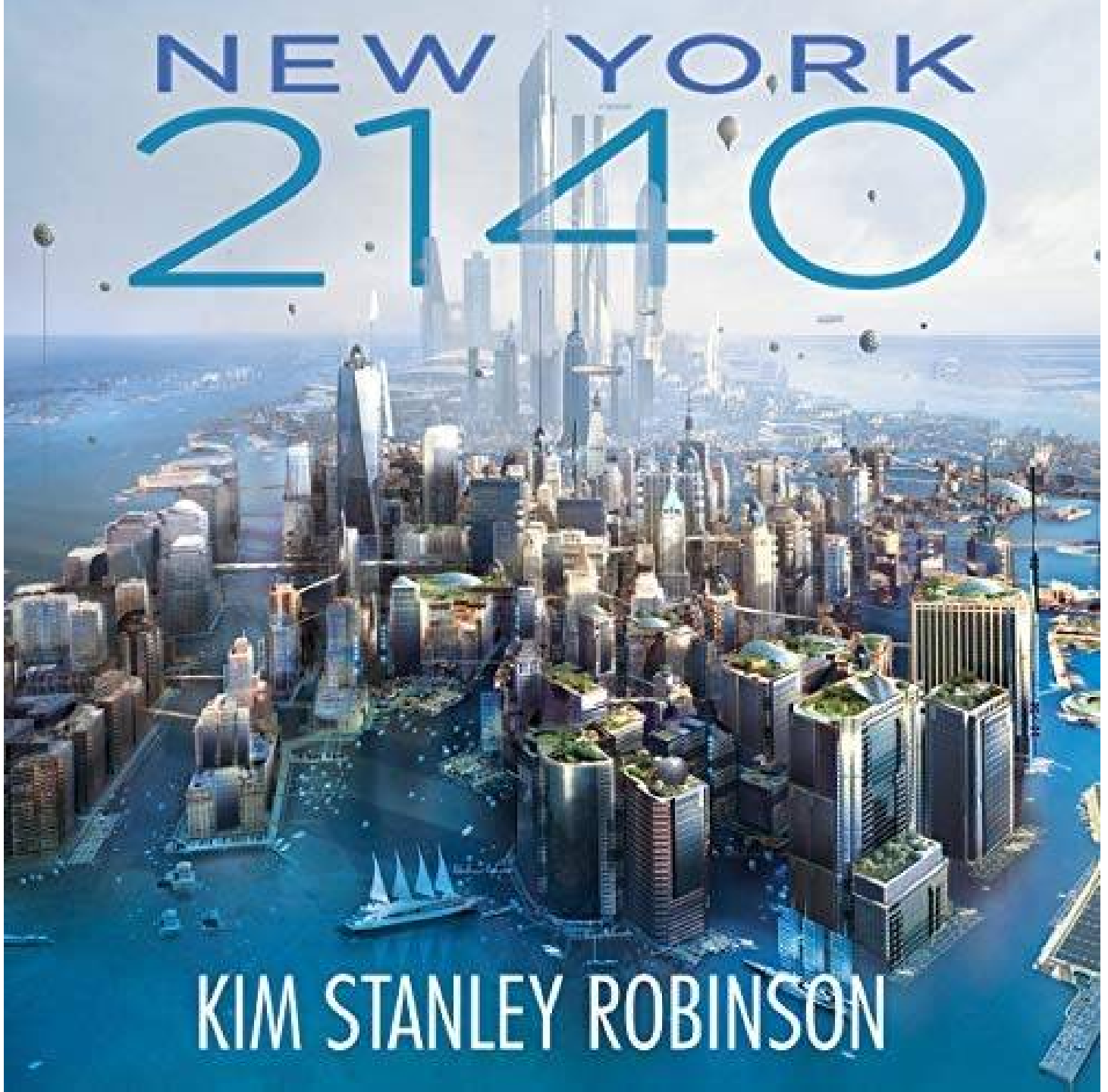
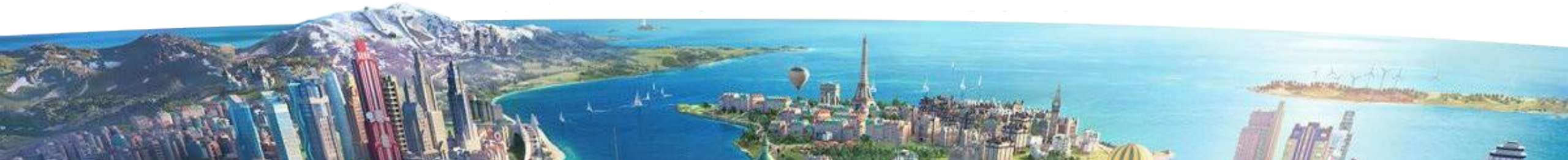


GAMIFICATION

"Design with emphasis on Human-Motivation" *Yu-Kai Chou - Gamification Guru - Octalysis*



Urban resilience as a major trend

URBAN RESILIENCE HUB by UN-HABITAT

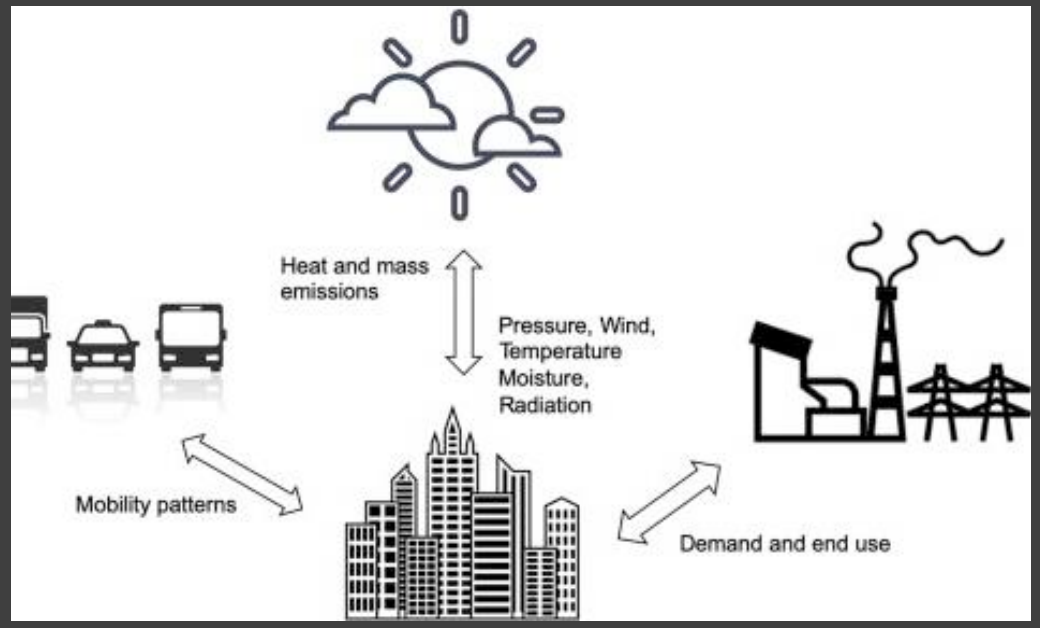
Definition of Global Resilient Cities Network:
Capacity of individuals, communities, institutions, businesses and systems to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience

Chronic stress:
Climate change (heat waves, flooding)
Social injustice, Gentrification, Affordability
Waste overload, Collapsing eco-systems

Acute shocks:
Pandemics, extreme weather events

Cities as integrated systems

“Buildings play a central role in the final energy demand estimations. However, buildings are not the only contributors.”

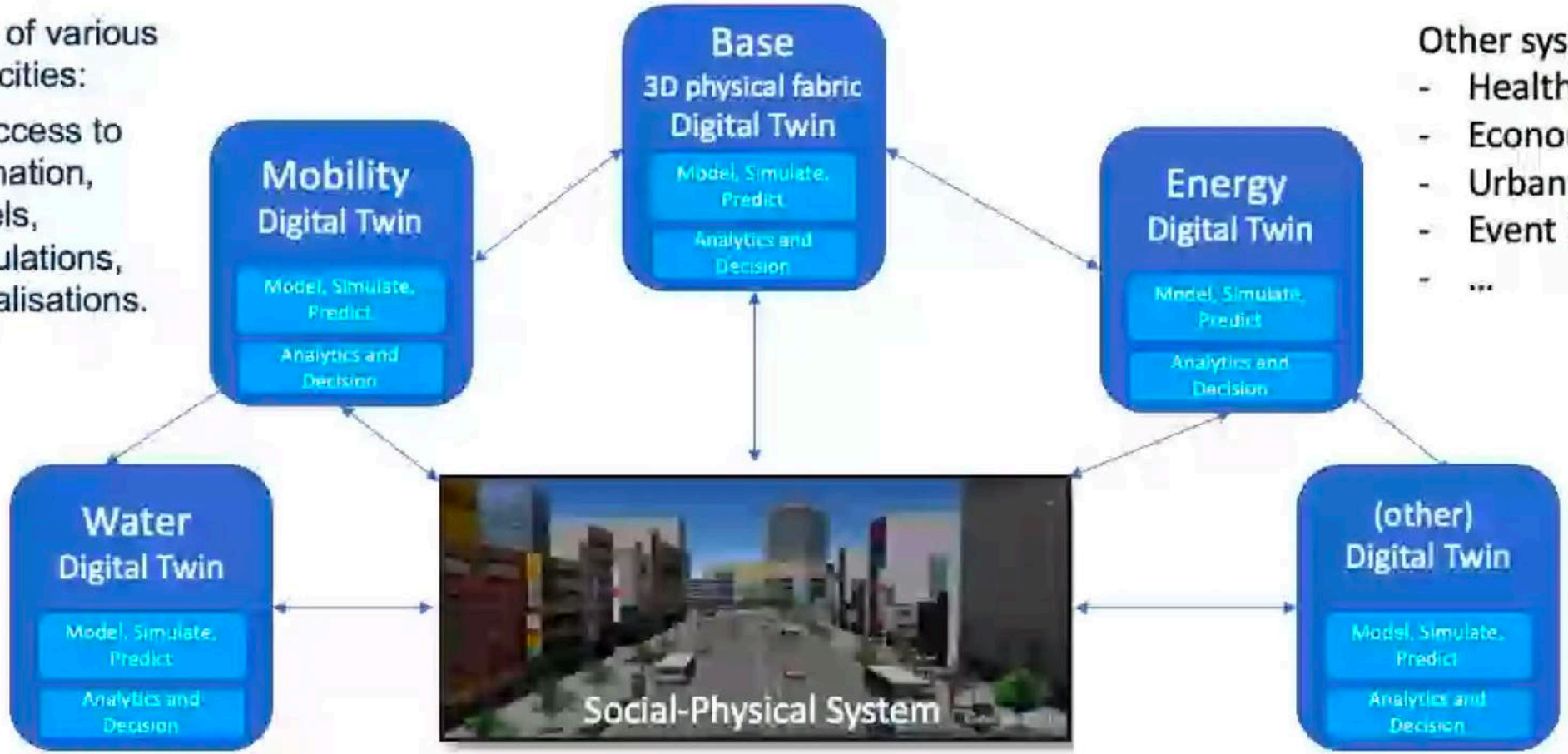


Multiple Themes for Urban Digital Twins

OGC

Digital replicas of various aspects of the cities:

Giving users access to thematic information, services, models, scenarios, simulations, forecasts, visualisations.

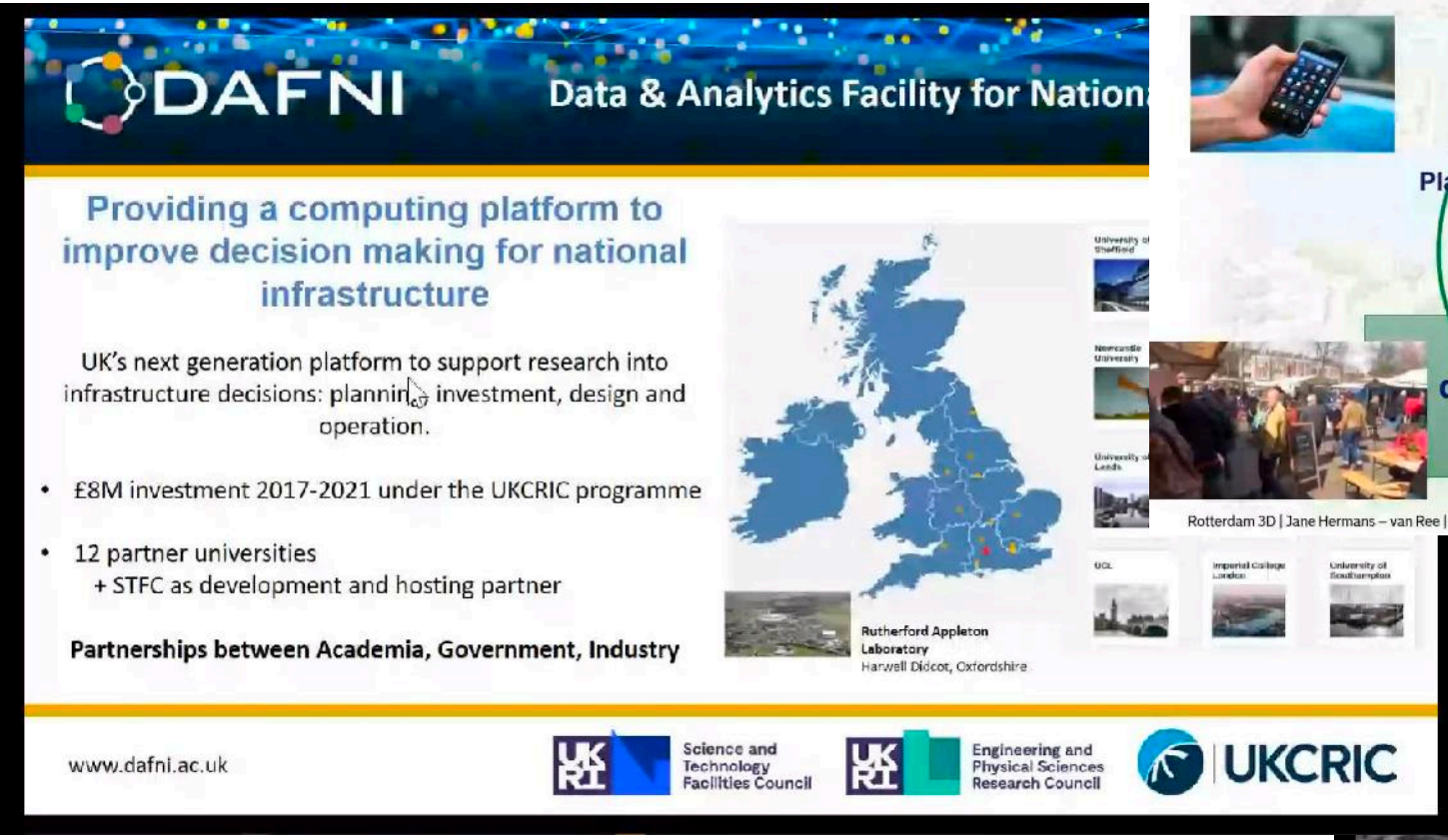


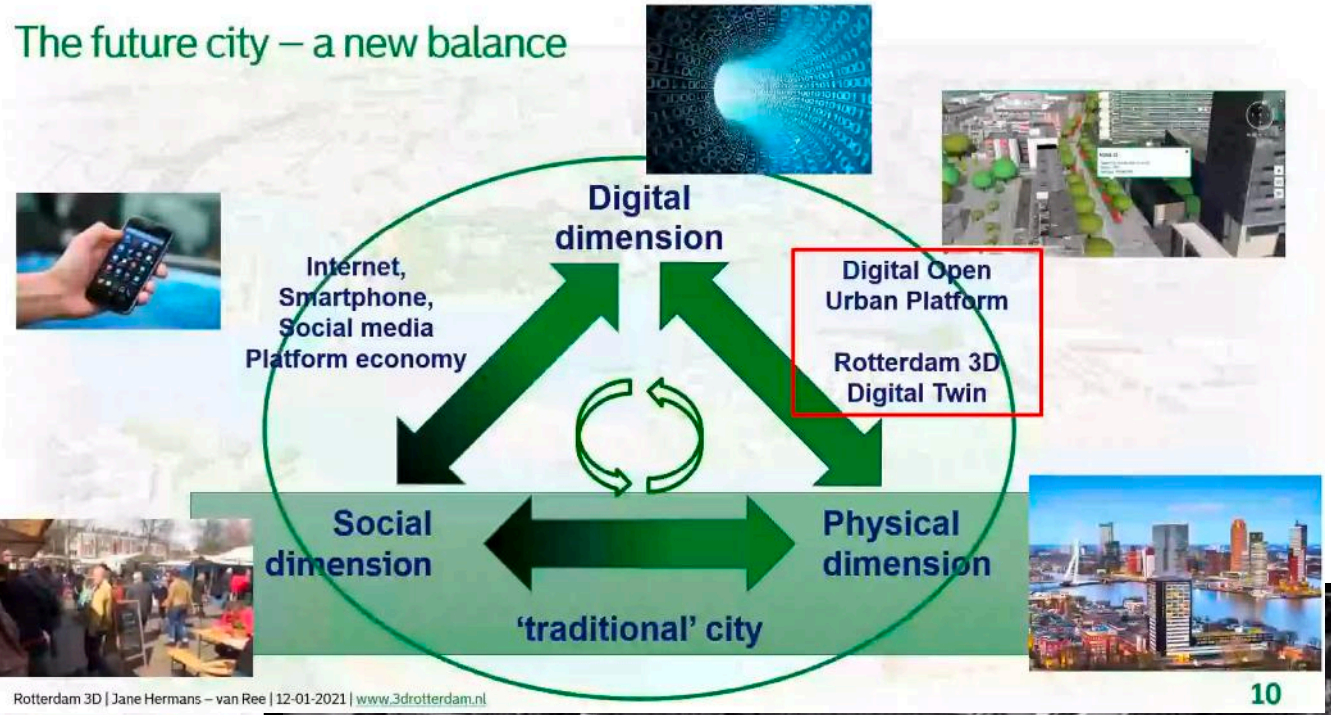
Other systems:

- Health services
- Economic DT
- Urban Planning
- Event Planning
- ...

From pairwise coordination towards a system-of-systems

New era of geospatial data analytics and modeling

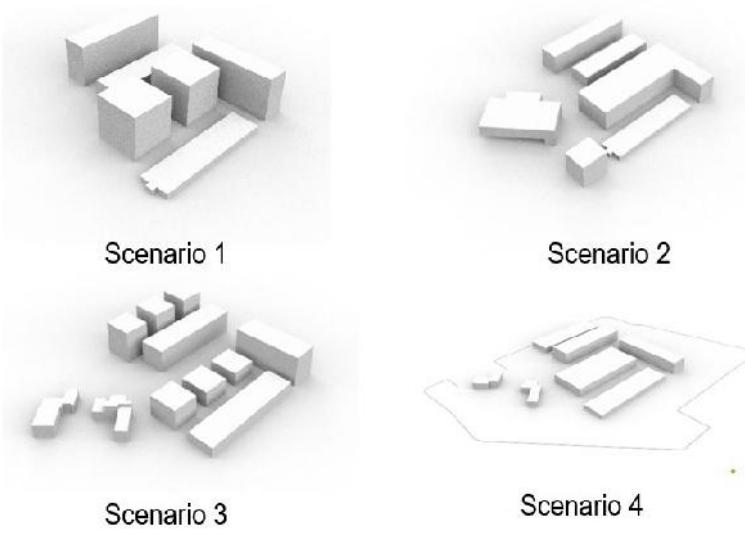


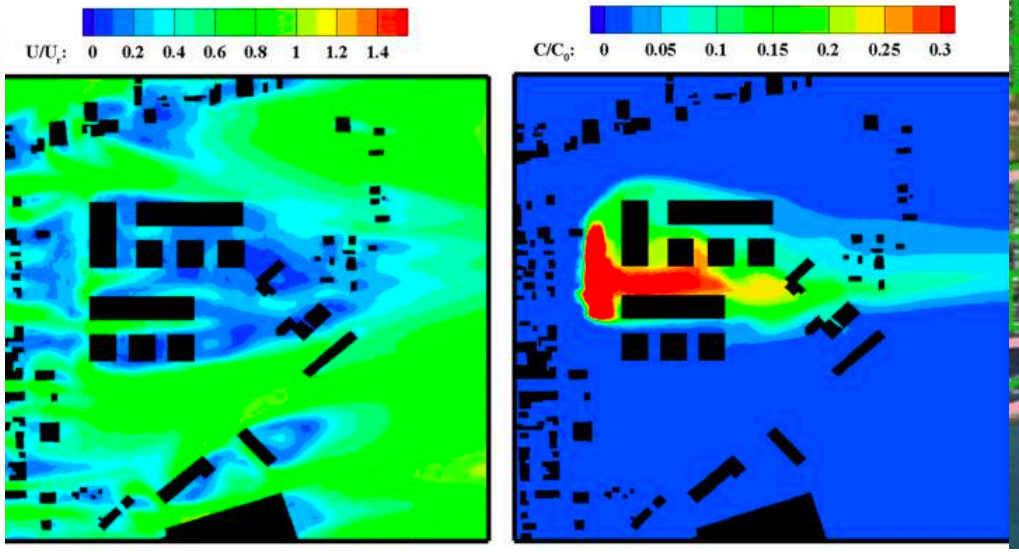


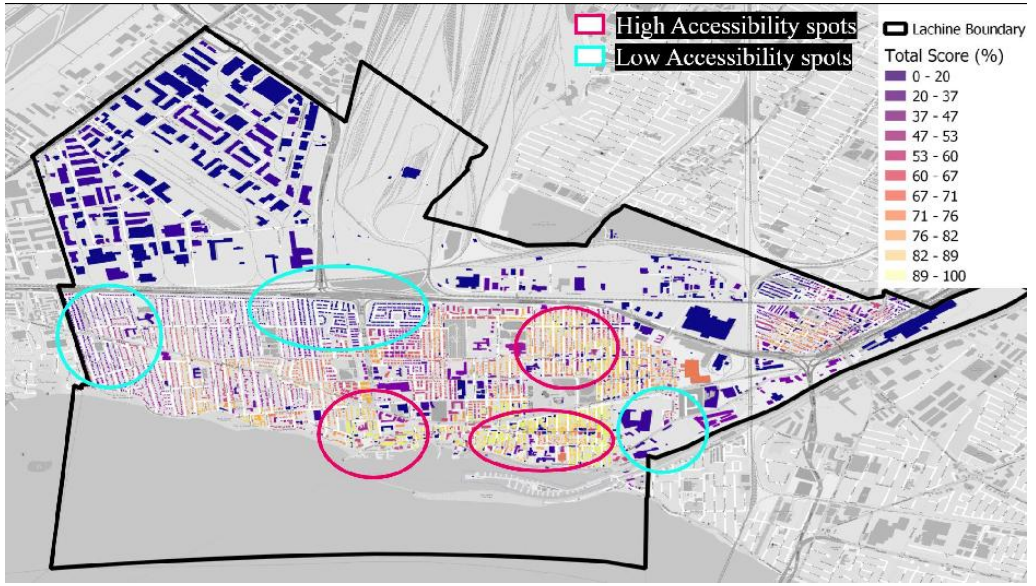
Smart cities, smart governments, smart citizens

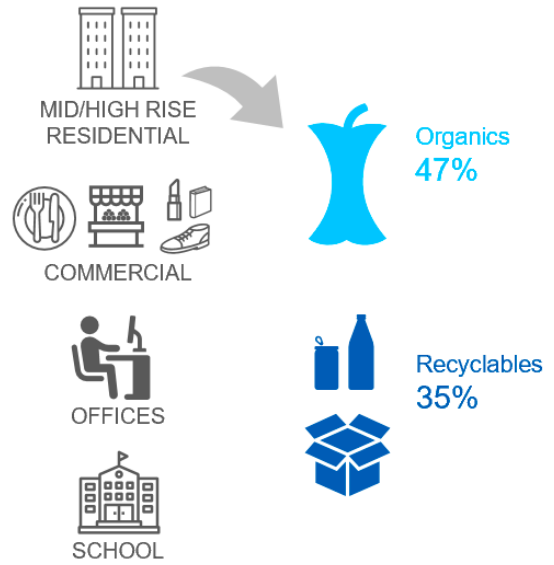
Urban modelling and data analysis platform

Modeling integration for buildings, microclimate, energy, waste and transportation







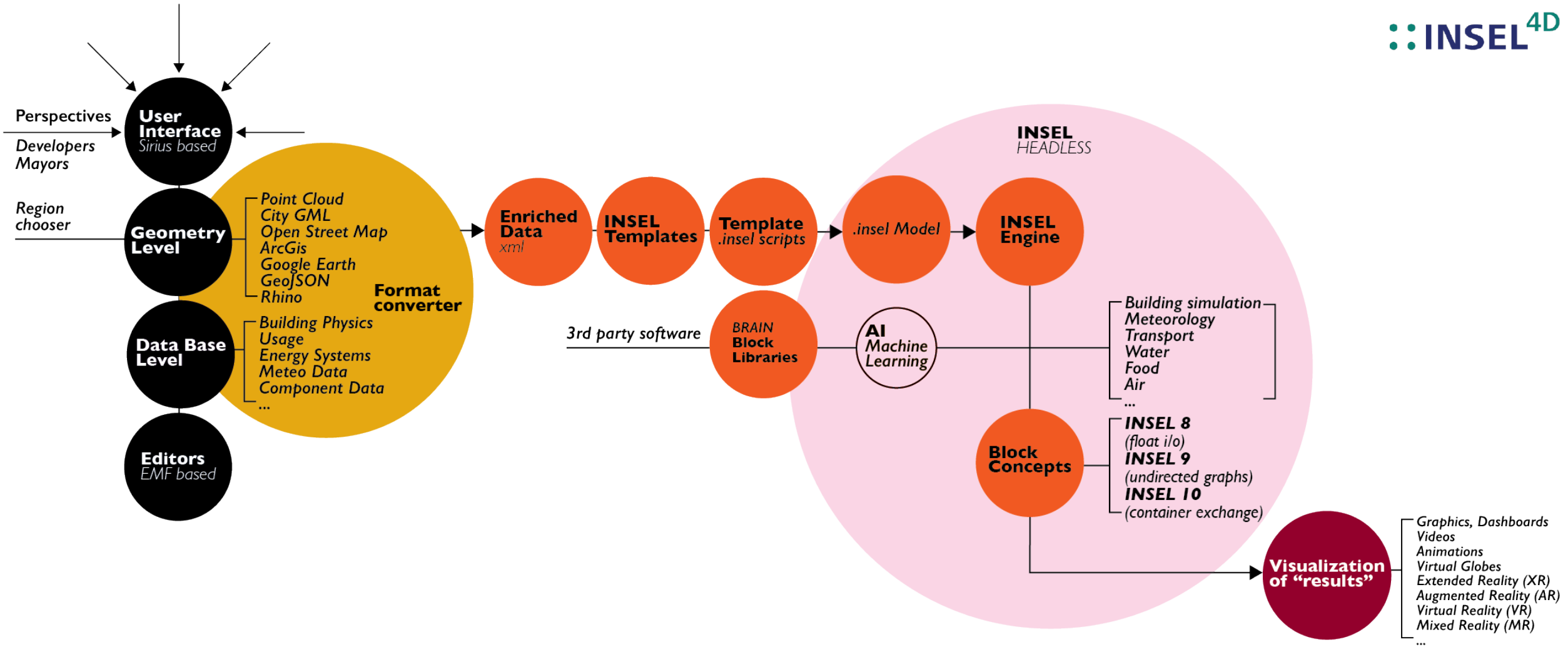


Main concepts of our ::INSEL^{4D} urban platform

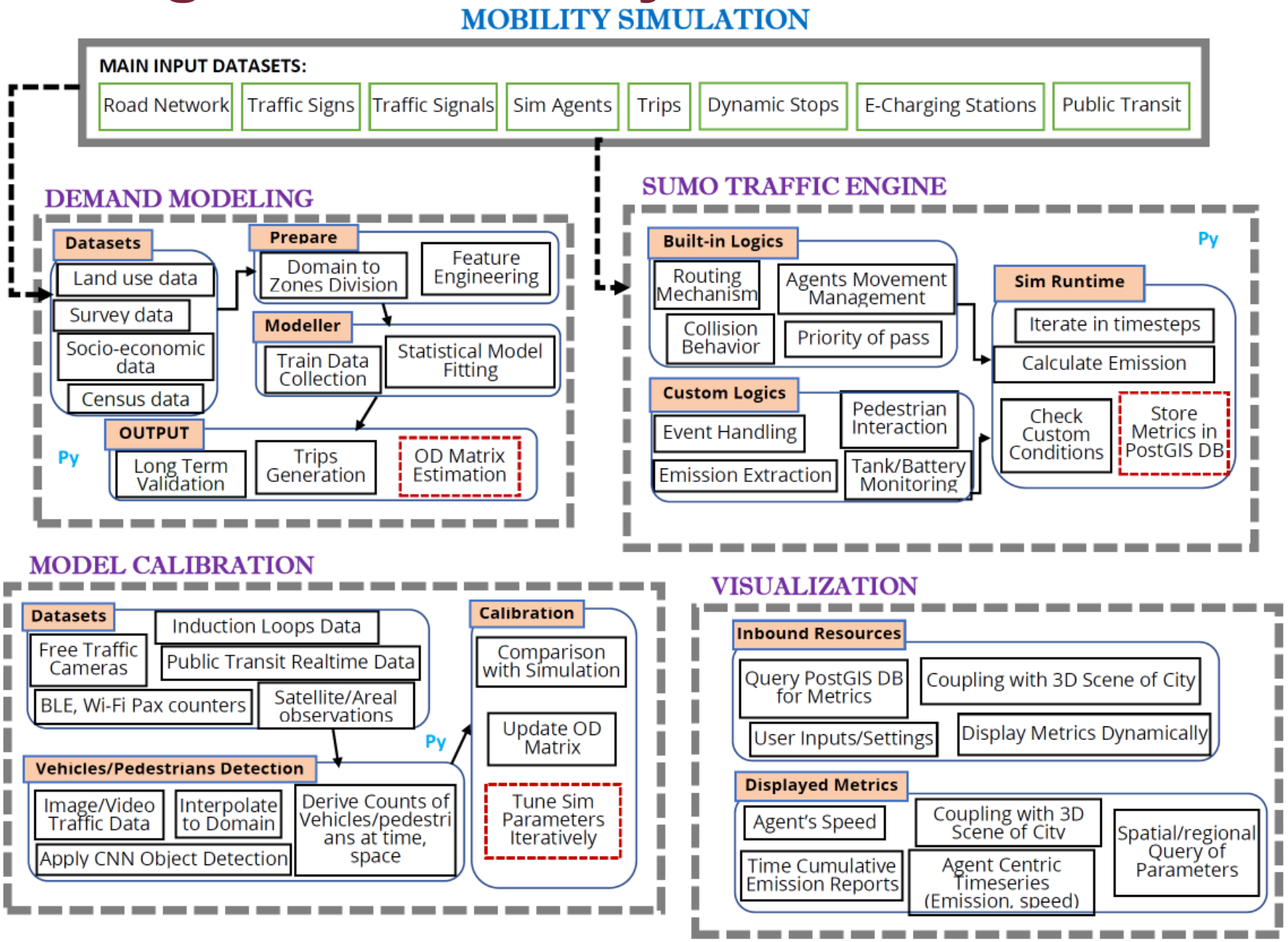
- Very modular concept with INSEL (integrated simulation environment language) as base language
- Multiple functionalities with standardized interfaces
- Multi-language concept: Blocks in C++, Fortran, Python (prototype)
- INSEL as the service registry and orchestration management system
- Platform use cases for different actors, from detailed uses involving for instance the development of new knowledge domains to data consumers which are only interested in result displays.
- Modularity, scalability and ease of use as key factors to attract new contributors
- Open source platform

Urban modeling platform

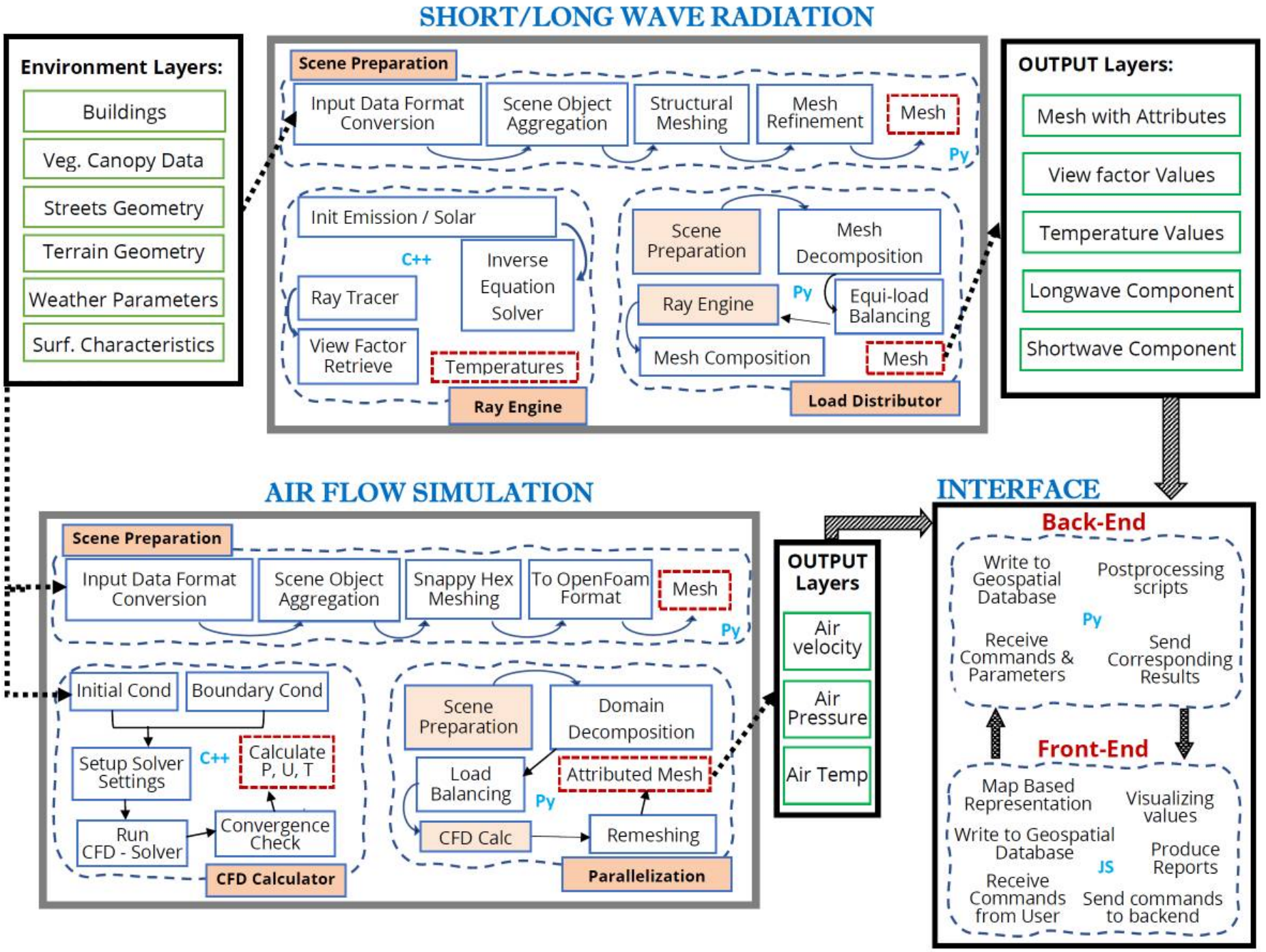
Structure of INSEL4D



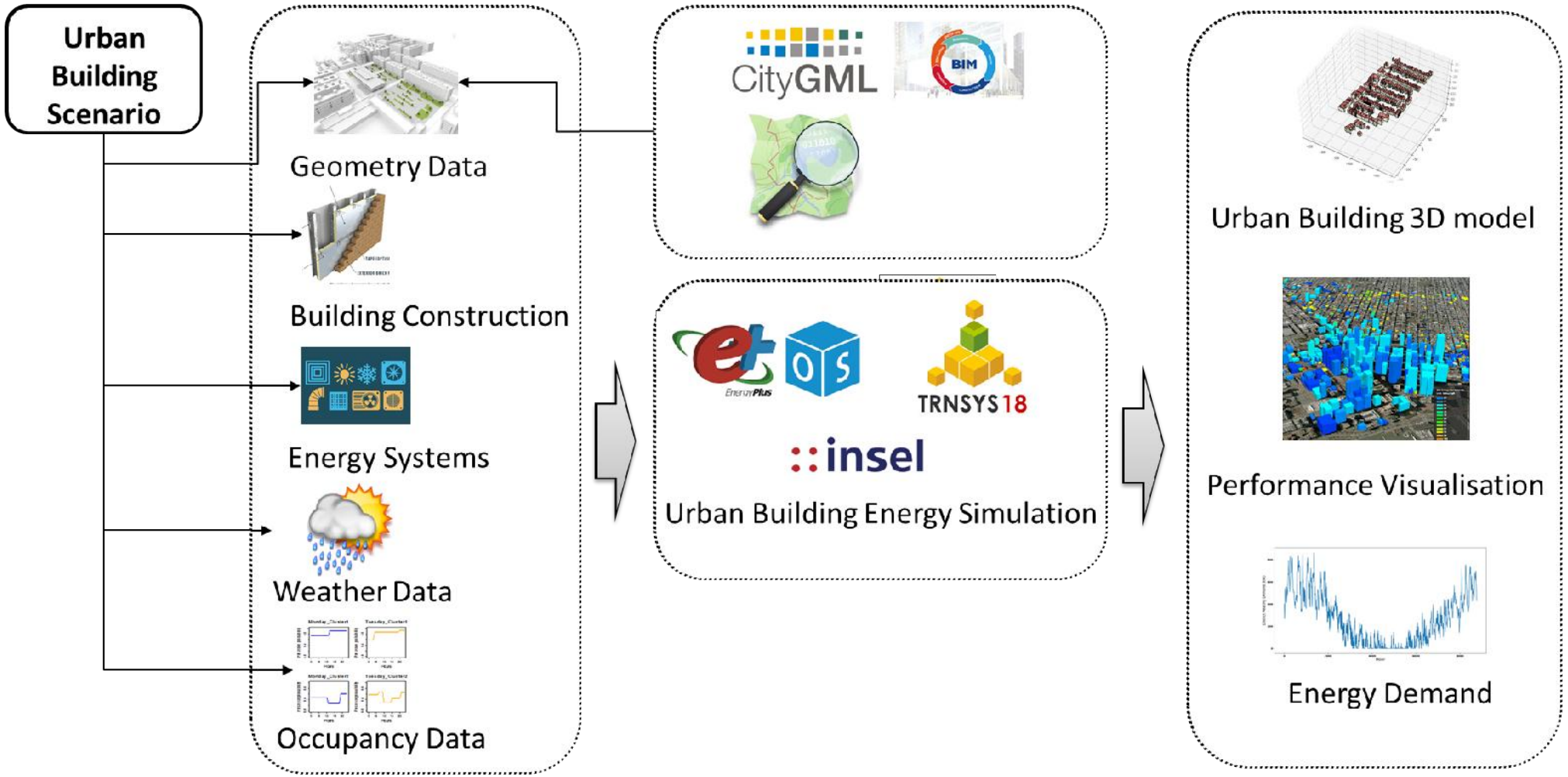
Model integration Mobility



Methods for microclimate modeling



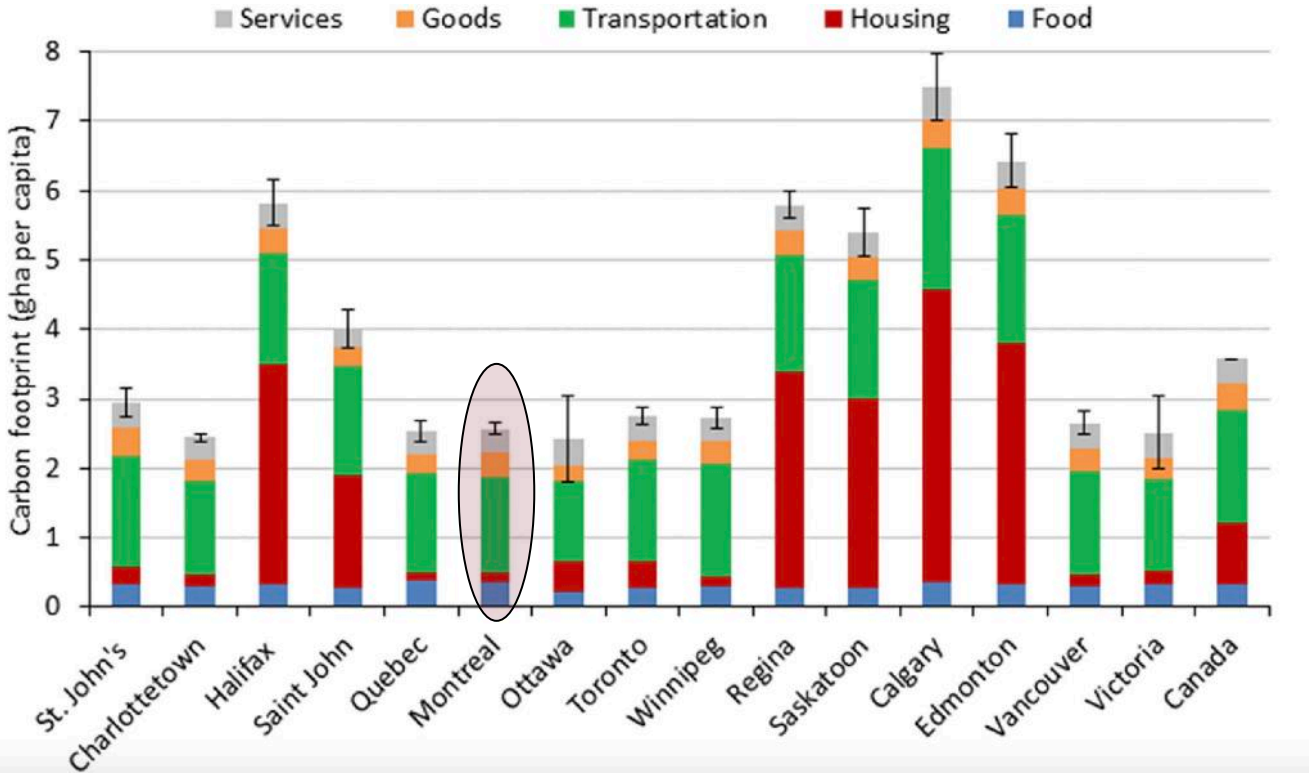
Building energy demand modeling

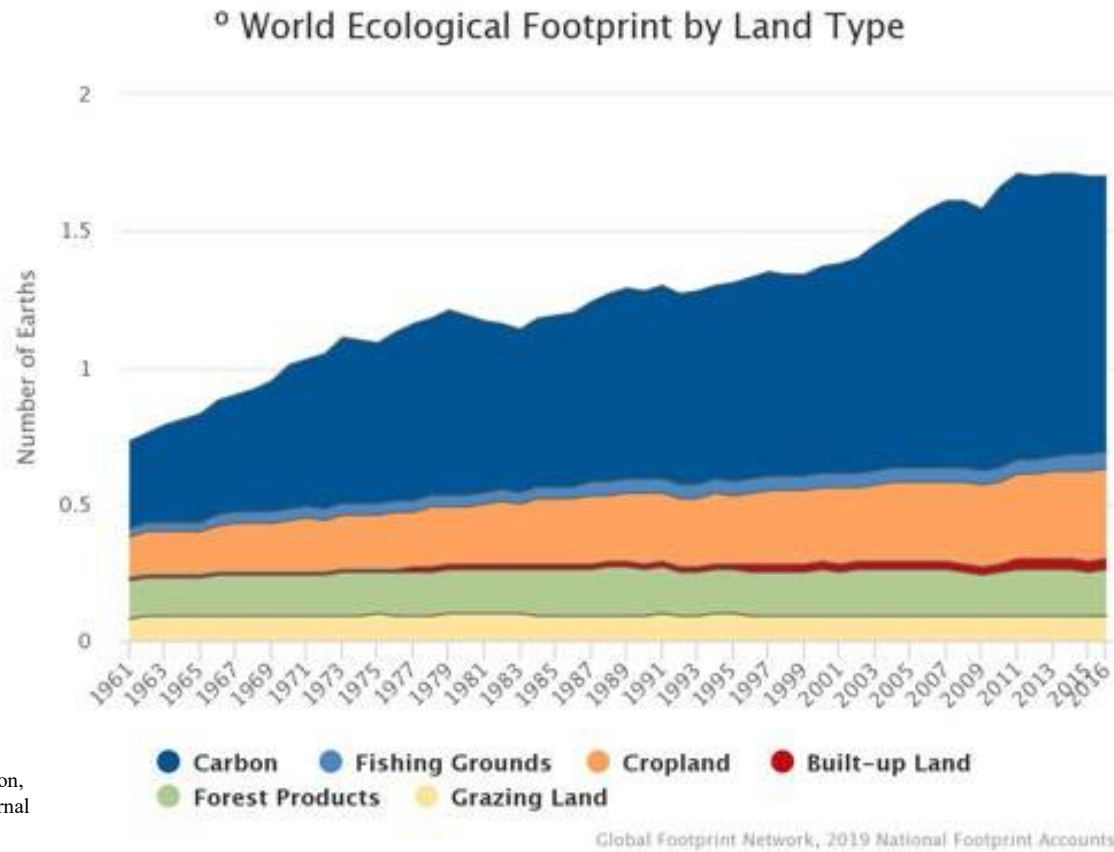


Case study in Montreal

Éco-quartiers in Montréal

So far mainly greening, urban farming, healthy food access, waste management, sustainable transportation



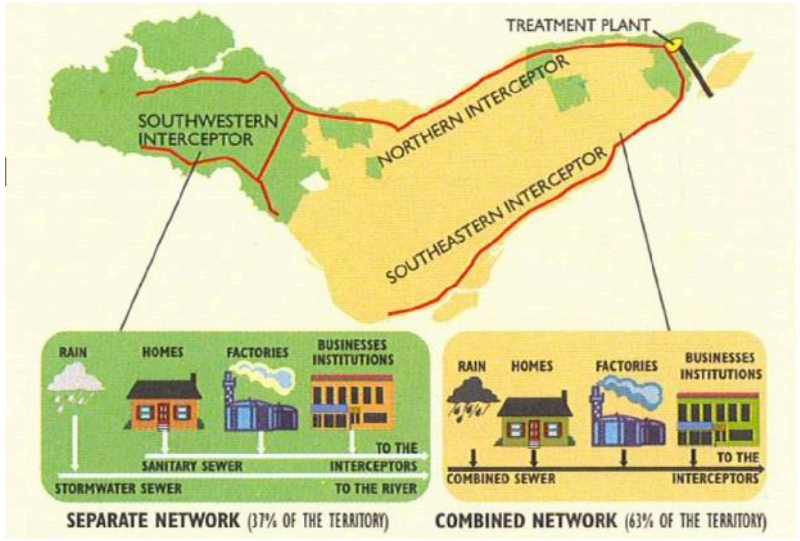


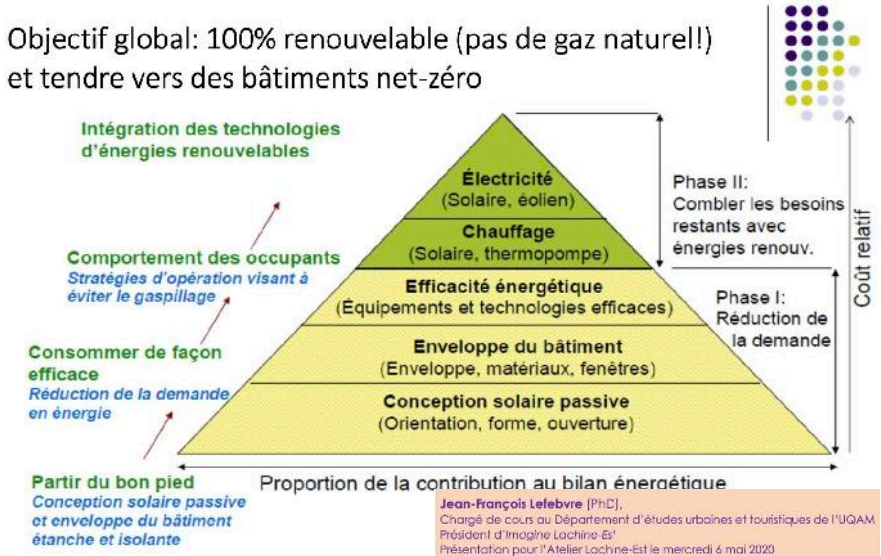
Margaux Isman, Maude Archambault, Patricia Racette, Charles Noel Konga, Roxana Miranda Llaque, David Lin, Katsunori Iha, Claudiane M. Ouellet-Plamondon, Ecological Footprint assessment for targeting climate change mitigation in cities: A case study of 15 Canadian cities according to census metropolitan areas, Journal of Cleaner Production, Volume 174, 2018

Lachine-East as an éco-quartier case study

Eco-districts and resilience case study Montreal, Lachine Est

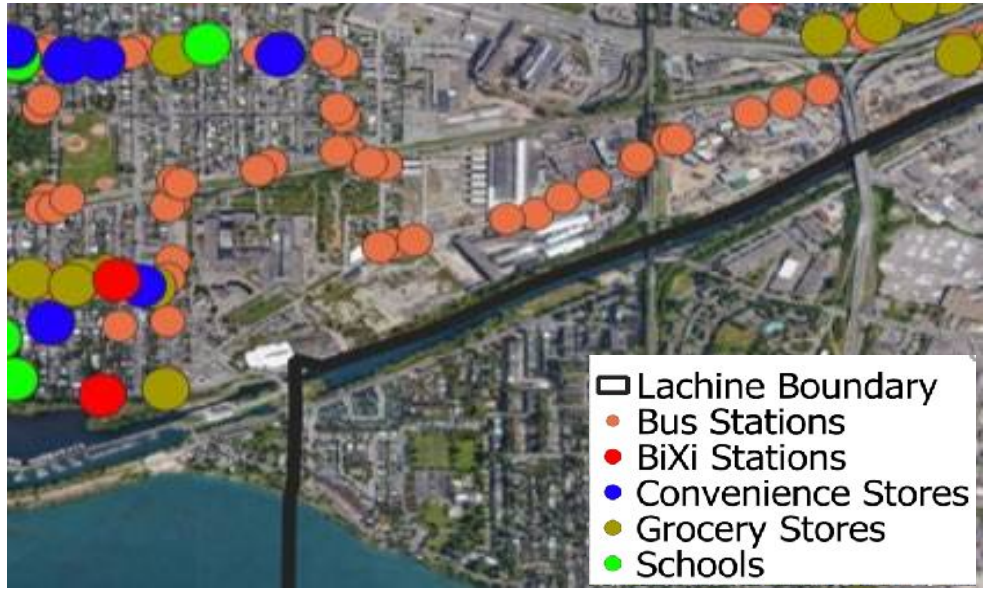
- Net zero energy buildings with local renewables
- Zero waste and water re-use and treatment
- Transit oriented development, shared mobility
- Green and biodiverse neighborhood
- Inclusive, affordable and mixed neighborhood
- Sustainability to increase resilience

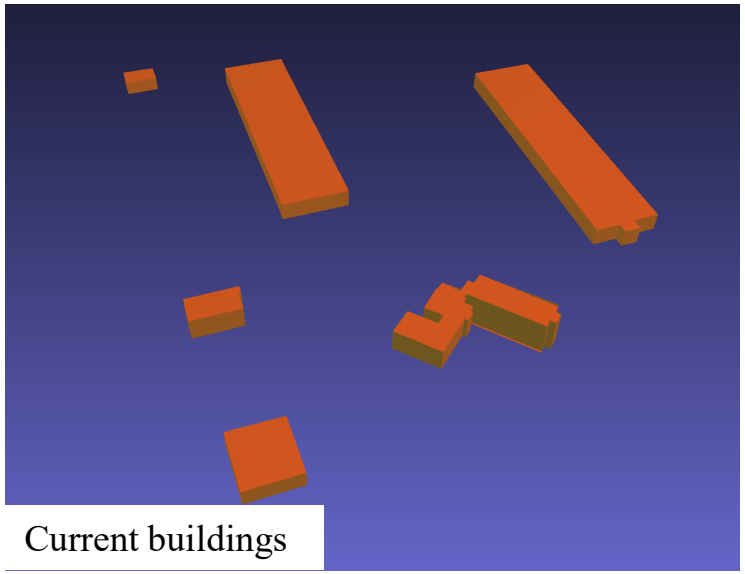




Building efficiency, energy, waste and transportation concepts

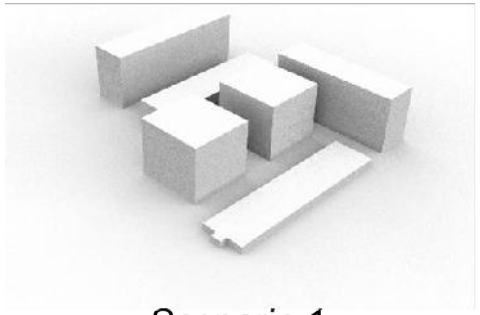
Current green spaces



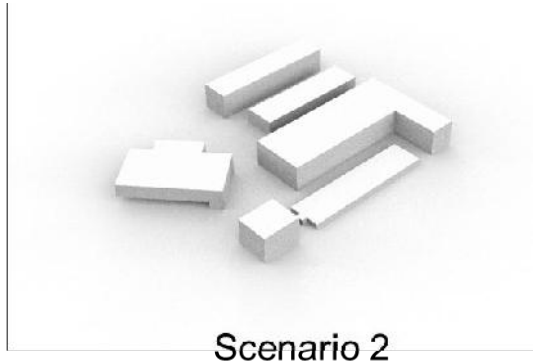


Current buildings

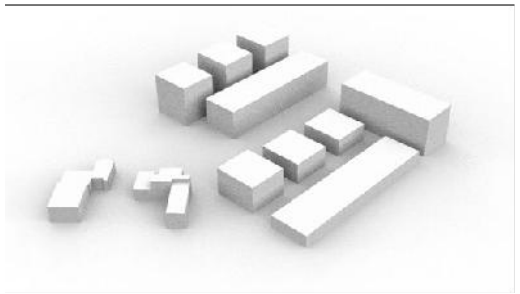
Spatial design and digital twin strategies



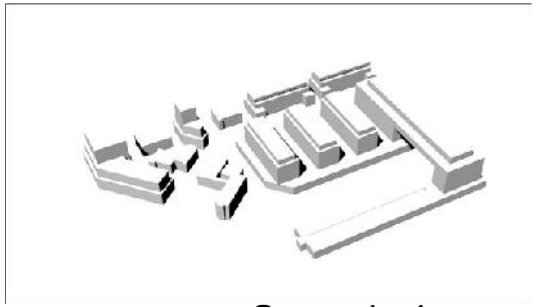
Scenario 1



Scenario 2

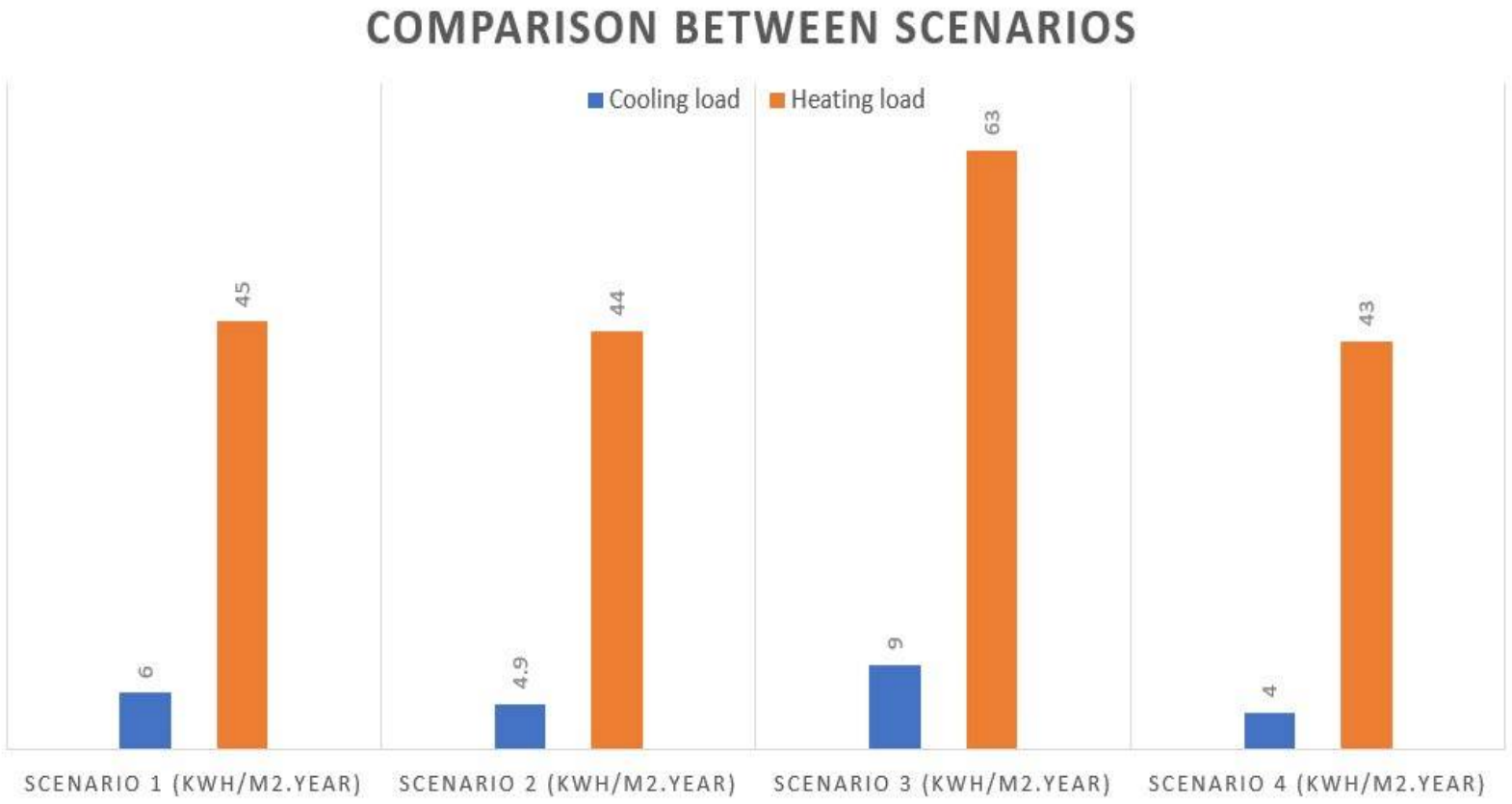


Scenario 3

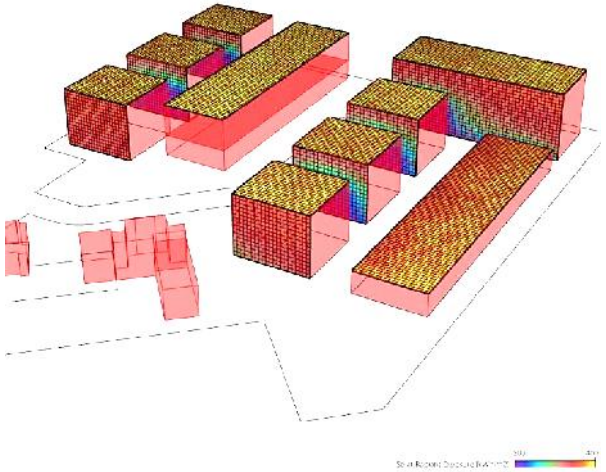


Scenario 4

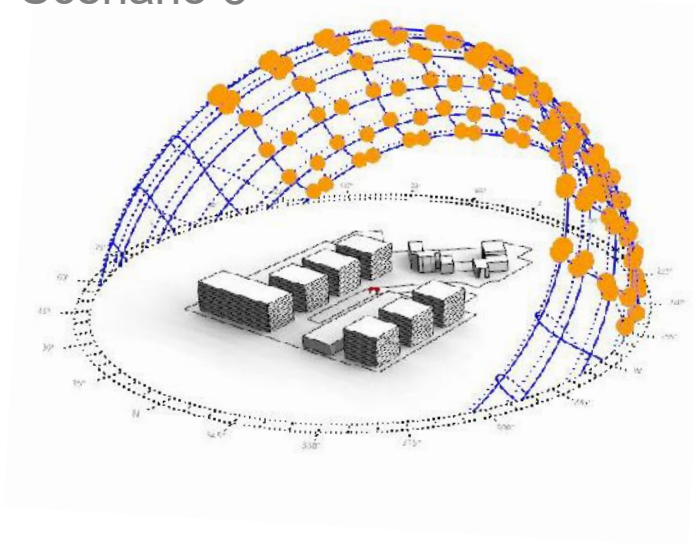
Influence of geometry on heating and cooling demand



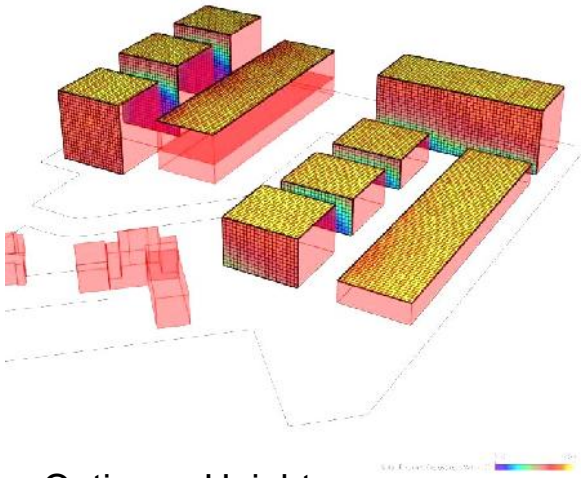
Spatial Design. Scenario 3



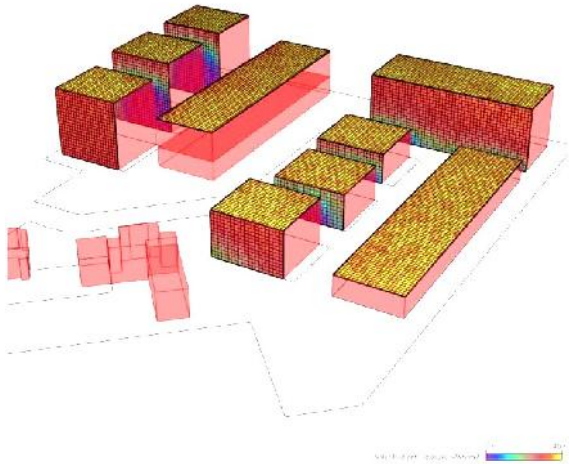
Base case (Similar Heights)



4000 Different Iterations



Optimum Heights



Optimum Heights & Locations

Methods

Theoretical Base of Passive Design to Determine the height and location

3D Modeling of the main proposal and creating the algorithmic script

Calculating the base solar radiation

Applying Genetic Optimization – Defining Fitness and Parameters

Optimum Solution Achieved

Post - Evaluation of the Solution in the next part (cooling/heating/electricity)

Rhinoceros

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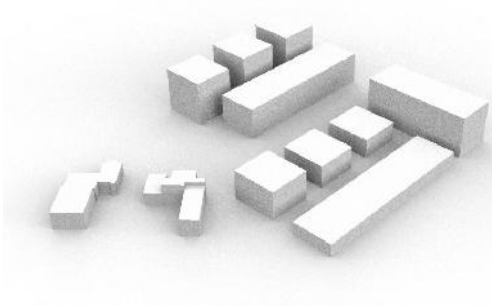
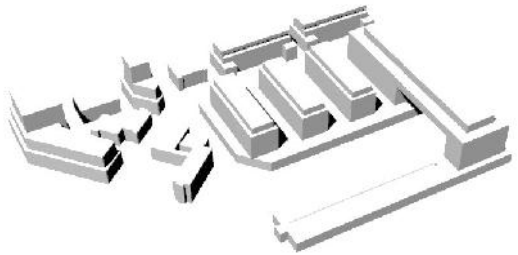
Procedural modeling of geometry

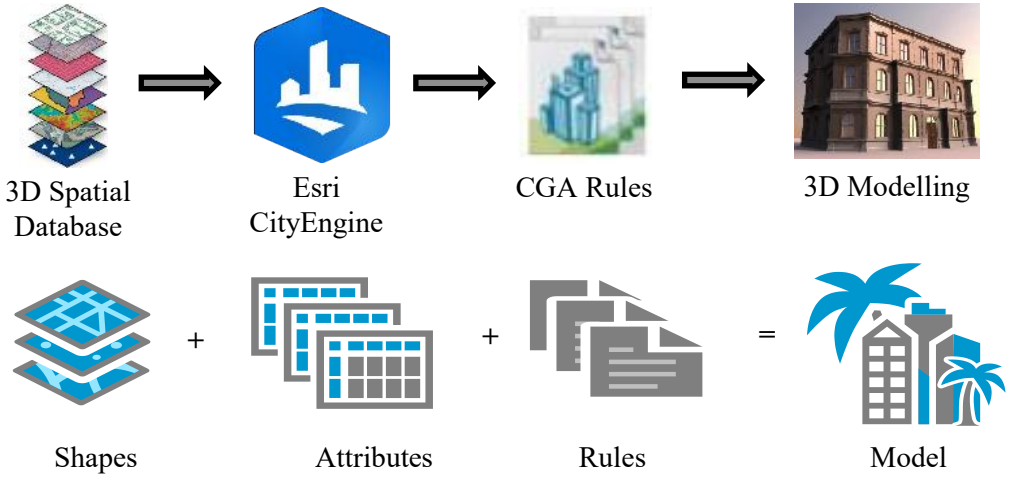
Geometry

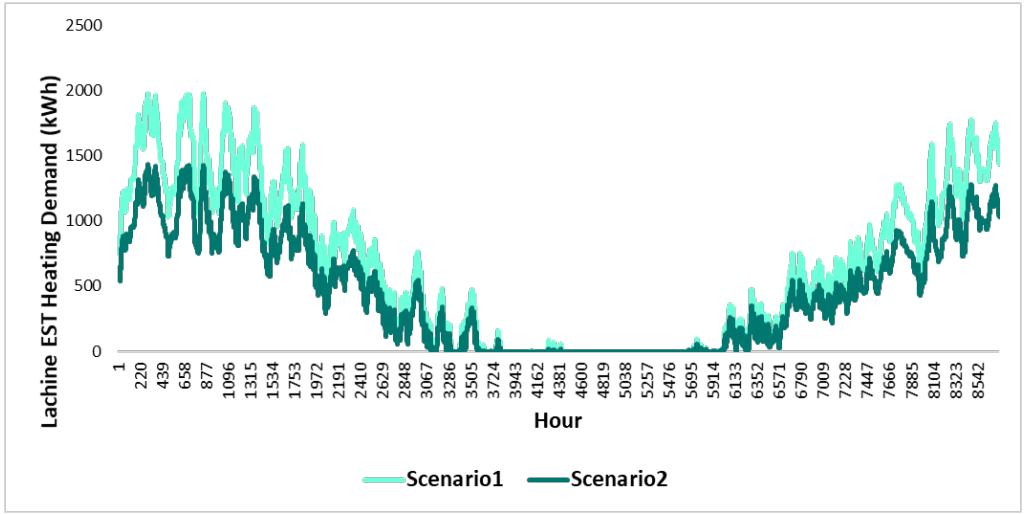
Occupancy

Construction material

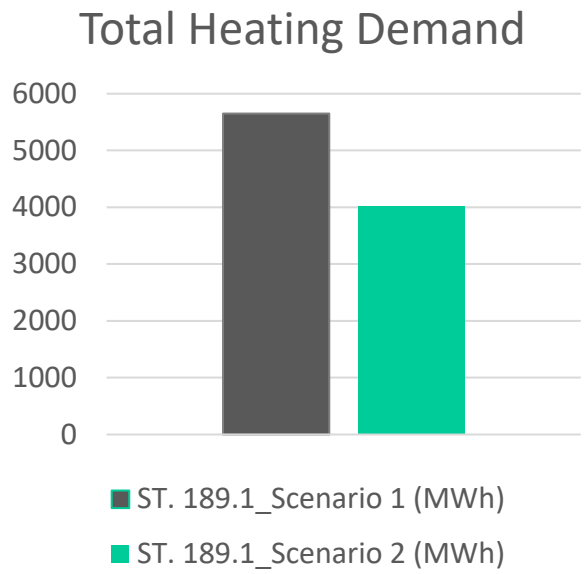








Heating Demand for different geometries



INSEL 4D

CONCORDIA

Zero Waste Vision for Lachine-Est Eco-Quartier

REFUSE & REDUCE

SOLID WASTE

85%

REUSE

RECYCLE

RECOVER

15%

LANDFILL

LIVING LABORATORY

- Create opportunities for research on innovative waste practices
- Community learning objectives
- Push limits of local material circulation
- Open data

CIRCULAR ECONOMY+ CENTRAL TREATMENT

- Align with MTL objective, surpass QC objectives
- Respecting waste hierarchy, LCA-basis for decisions
- Prioritizing short, local loops

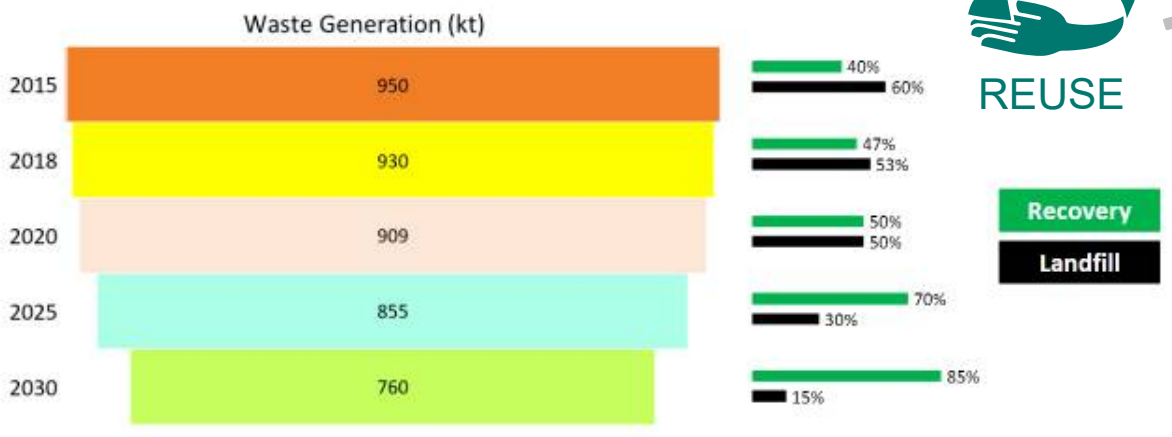
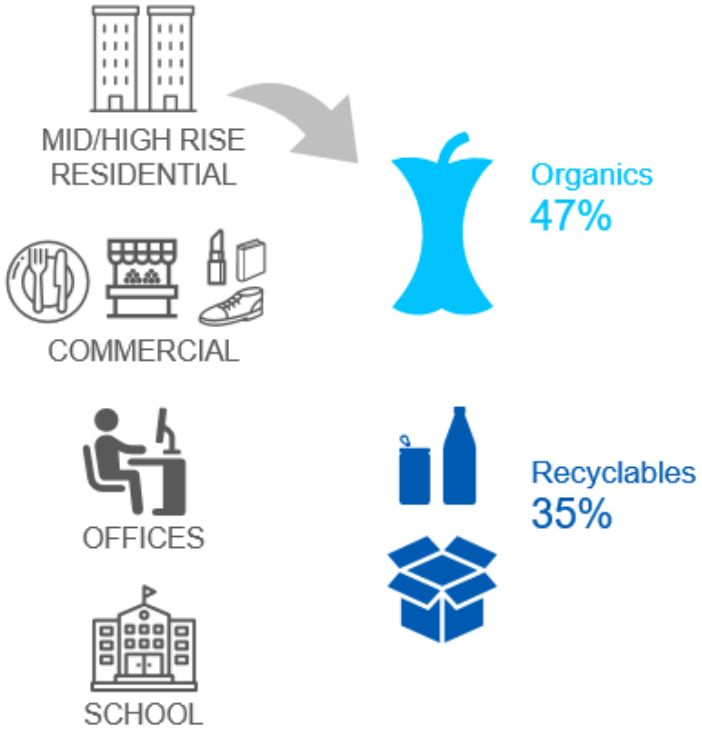


Figure 2. Recovery targets in Montréal (based on projet de plan directeur de gestion des matières résiduelles 2020-2025).

Energy recovery potential from solid waste



Category	Residential	Commercial	Office	School	Total
Organics	1286.625	130	148	4.8	1570
Recyclables	958.125	262	297	3.5	1521
Construction waste & Bulky	328.5	54	61	1.2	444
Textiles	82.125	8	9	0.3	100
Other	54.75	5	6	0.2	66
Domestic Hazardous	27.375	3	4	0.1	34
Total	**2738**	**463**	**526**	**10**	**3736**

Total annual residential, commercial, office, and school - yearly waste (tonnes)

Scenario	Waste components	Power generation potential using Thermochemical routes (MWh/tons)	Total electricity generation (MWh) for 10,000 inhabitants
1	NBCs-MSW	3.96	8570
2	NPCs-MSW	3.05	6680
3	Mixed OFMSW	0.72	2690

NBCs-MSW is the non-biodegradable components of MSW such as plastic, rubber, leather, textiles, and Wood
NPCs-MSW is the non-putrescible components of MSW like cardboard, leather, paper, plastic, rubber, textiles, and wood.
Mix.-OFMSW contains mixed organic fractions of MSW (ex. cardboard, food waste, leather, paper, plastic, rubber, and cloth, wood, and yard wastes)

Zero Wastewater Vision for Lachine-Est Eco-Quartier

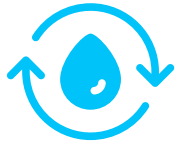
WASTEWATER

30 % CENTRAL TREATMENT

70 % LOCAL REUSE & RECOVERY

- Reduce GHG emissions
- Reduce load on combined sewage

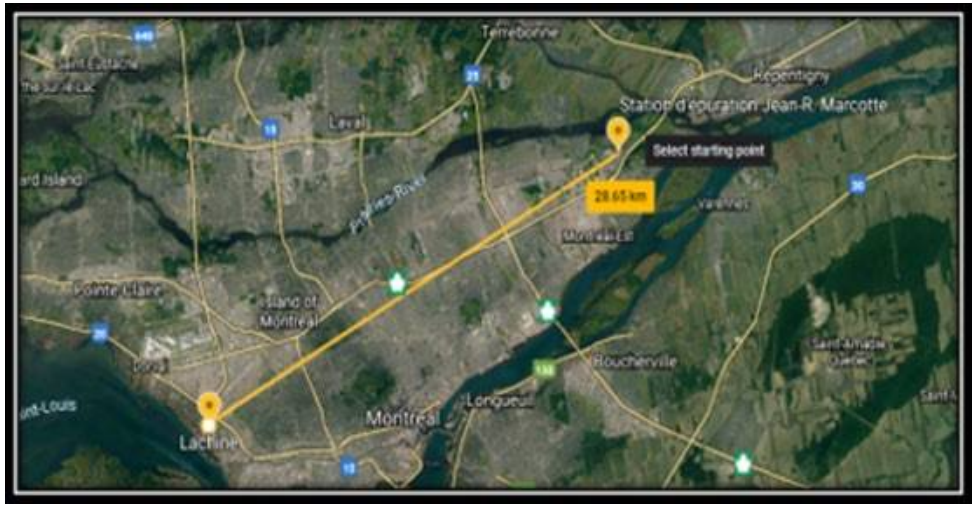
RECOVER



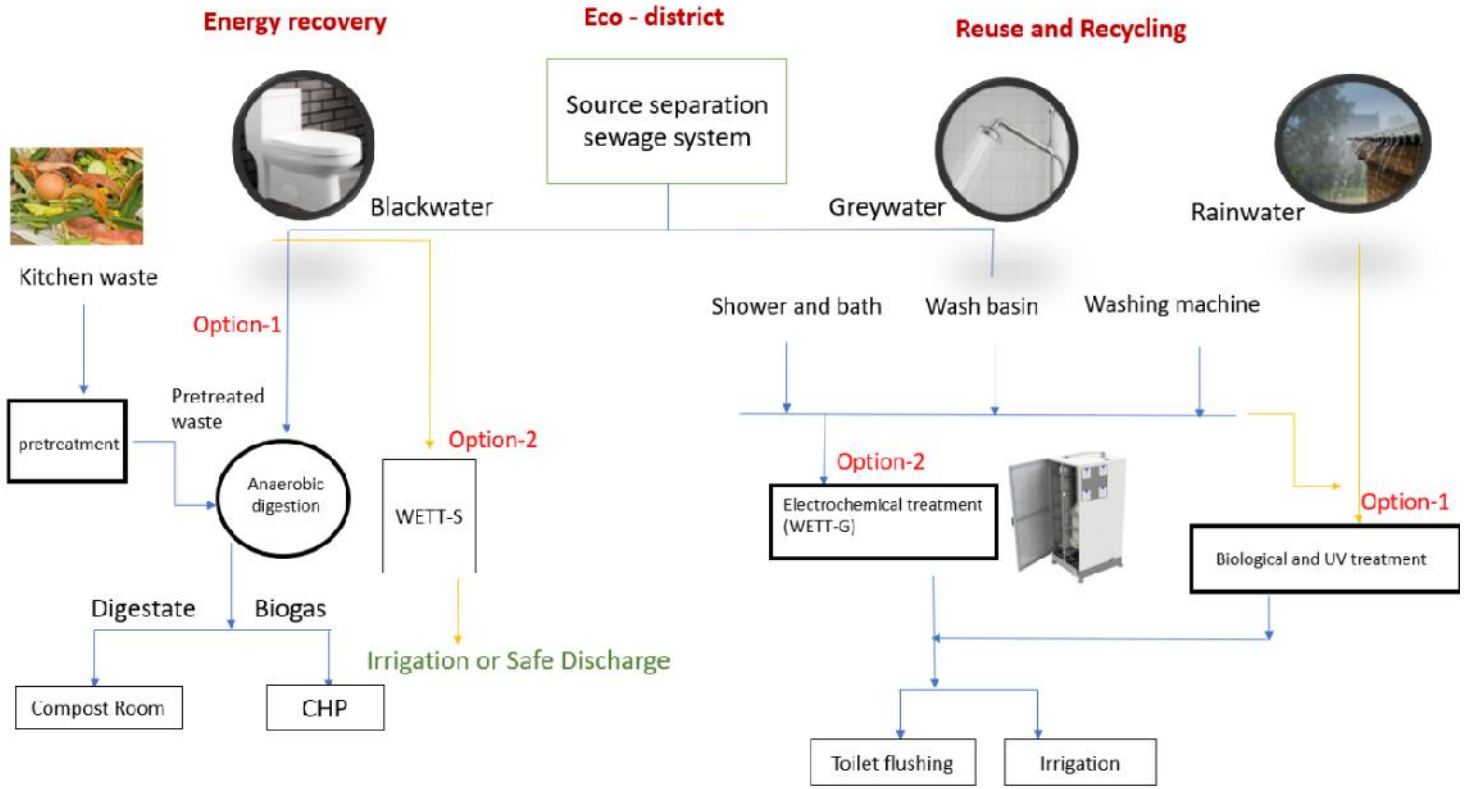
REUSE

Energy recovery from waste water anaerobic digestion

Name	waste	size	Inflow	Biogas potential	energy potential
Lachine-Est	Blackwater, kitchen waste	10,000 inhabitants	204,400 m3/year	11 m3CH4/ cap/year 105,000 m3 CH4/year	364 MWh electric 572 MWh heat

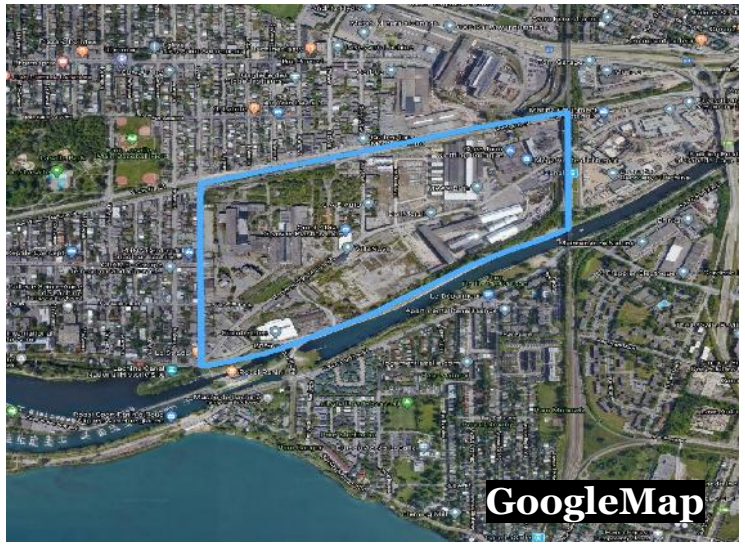


Wastewater collection and pumping for Lachine district 45 to 250 kWh/d



Current Challenges in Access and Sustainable Mobility

- Scarcity of green spaces
- Inadequate walk/cycle path
- Bike sharing facilities out of reach
- No access to public rail transit
- Far from commercial facilities
- Higher car ownership hence congestion and emission



The “15 minutes city”

- The “15-minute city” is an approach to urban design that aims to improve quality of life by creating cities where everything a resident needs can be reached within 15 minutes by foot, bike or public transit.
- This concept puts an emphasis on careful planning at the neighbourhood level, giving each district the features it needs to support a full life – including jobs, food, recreation, green space, housing, medical offices, small businesses and more. And importantly, it’s a full life that doesn’t require a car.

https://www.who.int/activities/investing-in-physical-activity

Connectivity, Access to amenities and public transport , Active transportation and health:

1- Improve mental health (Melis et al. 2015) such as reduced self-reported depressive (Berke *et al*. 2007) and stress

2- reduced incidence of hypertension (Chiu et al. 2016) and diabetes (Paquet et al. 2014) From (Ige-Elegbede et al. 2020)

3- lower risk of disability (Freedman et al. 2008) From (Ige-Elegbede et al. 2020)

4- increase physical activity and fitness from (McCormack et al. 2020) (Michael et al. 2006, Richardsen et al. 2016) (Ige-Elegbede et al. 2020) and lower BMI; Lovasi et al. (2012) From (Wang and Yang 2019)

5- Reduced auto-related injuries–Reducing the number of auto trips reduces the chances of auto-related injury (Properties & Mucosa, 2015).

Potential impact of green space and public open space on health

1- increased physical activity (Picavet *et al*. 2016; Sugiyama *et al*. 2010)

2- reduction of mortality (Villeneuve *et al*. 2012, Mueller *et al*. 2016)

3- Reduction the risk factors for cardiovascular diseases (Paquet *et al*. 2014, Tamosiunas *et al*. 2014).

4- lower risk of asthma (Andrusaityte *et al*. 2016)

5- improve mental health (Annerstedt *et al*. 2012)

6- reduction of the prevalence of cardiovascular diseases (Tamosiunas *et al*. 2014) From (Ige-Elegbede et al. 2020)

7- lower BMI; Lovasi et al. (2012) from (Wang and Yang 2019)

On sunny days, New York's Bryant Park is full morning to night with office workers, tourists and local residents. Shutterstock

TOD

Transit-Oriented Development

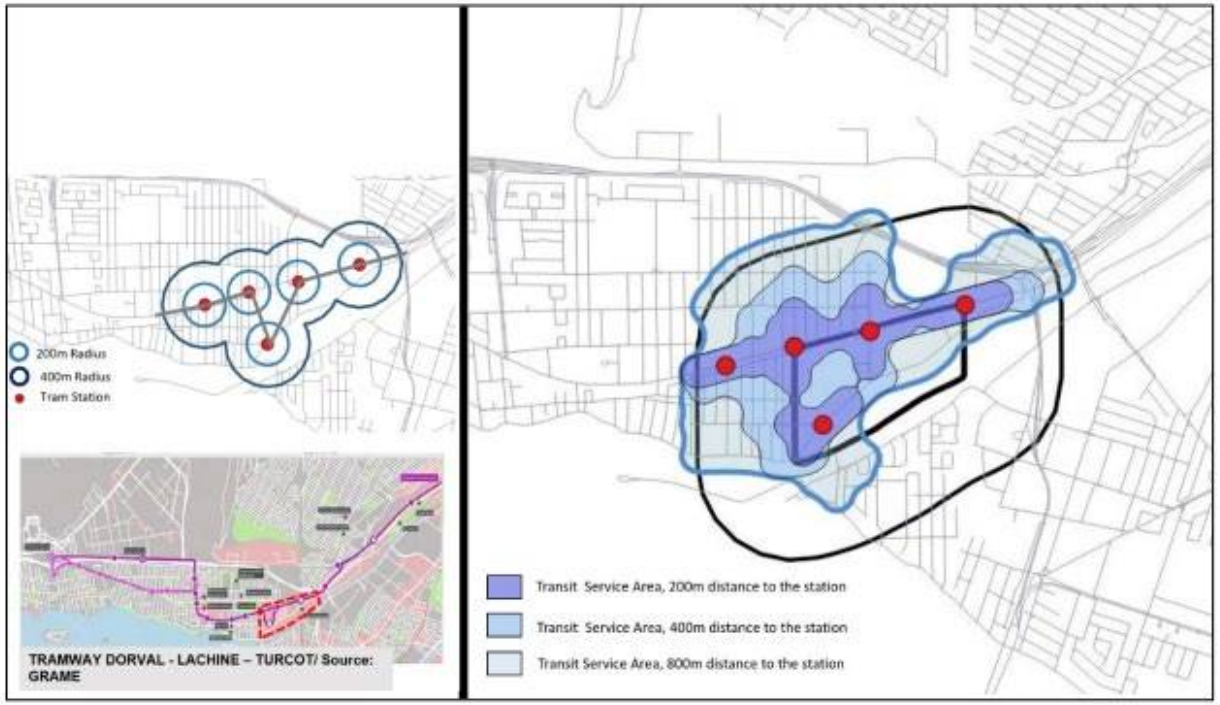
Walkable, moderate to high density development served by frequent transit with a mix of housing, retail, and employment choices designed to allow people to live and work without need of a personal automobile.

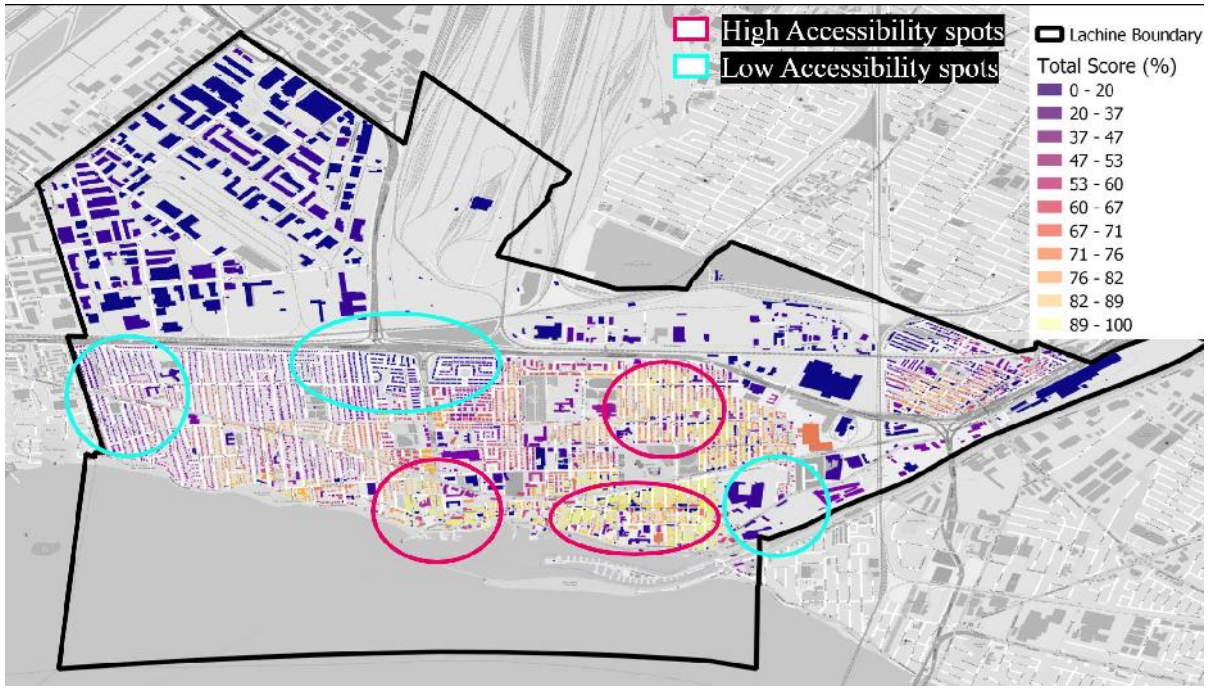
Picture : https://www.booking.com/articles/destination-inspiration-belo-horizonte-minas-gerais-brazil.html

Transit Oriented Development Metrics

Walk	Cycle	connect	transit	Mix	Densify	Compact	Shift
1.A.1 Walking path	**2.A.1** Cycle Network	**3.A.1** Small Blocks	**4.A.1** Walking Distance to Transit	**5.A.1** Complementary Uses	Residential density	Urban Site	Off-Street Parking
1.A.2 Cross Walks	**2.B.1** Cycle Parking at Transit Stations	**3.A.2** Prioritized Connectivity		Access to Local Services	Nonesidential density	Transit Option	Driveway Density
1.B.1 Visually Active Frontage	**2.B.2** Cycle Parking at Buildings			Access to Parks and Playgrounds			Roadway Area
1.B.2 Physically Permeable Frontage	**2.B.3** Cycle Access in Building			Affordable Housing			
1.C.1 Shade and Shelter				Housing Preservation			
				Business and Services Preservation			

Calculate Scores using GIS system

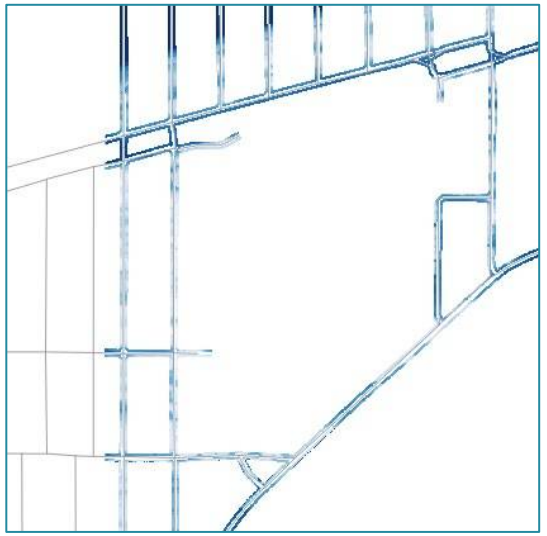


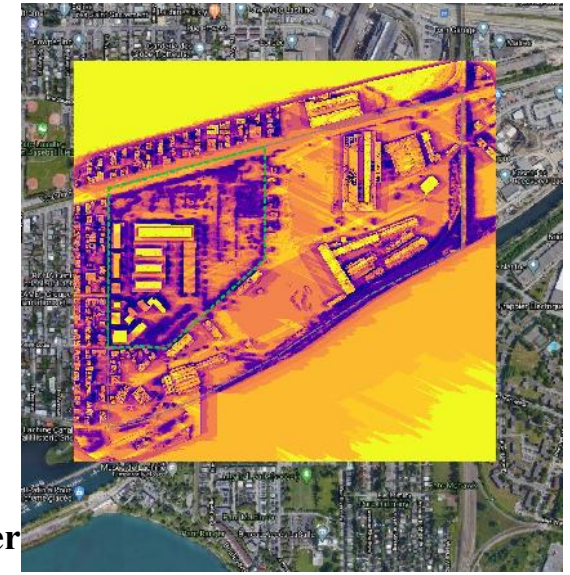


Scores	Metrics	Distances for calculating service areas	Points
Walk Score	Distance to Schools	500,1000,1500	1,2,3
	Distance to Malls	300,600,900	1,2,3
	Distance to Stores	200,400,600	1,2,3

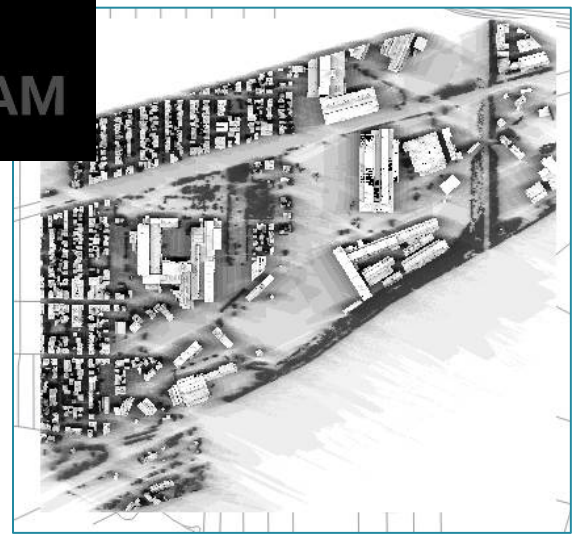
FUTURE SCENARIO

RESULTS : Pedestrian comfort/Shadow

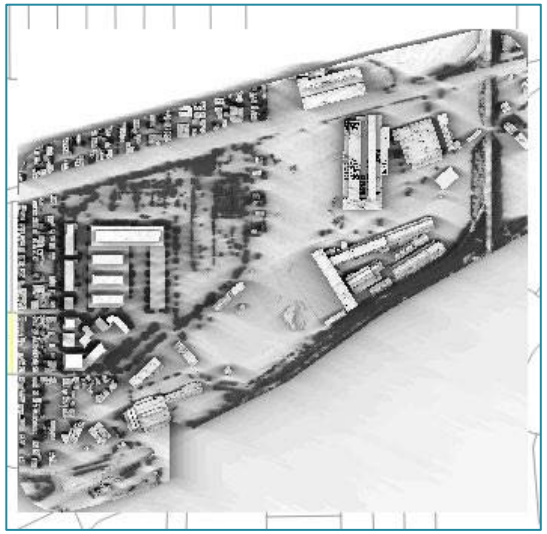




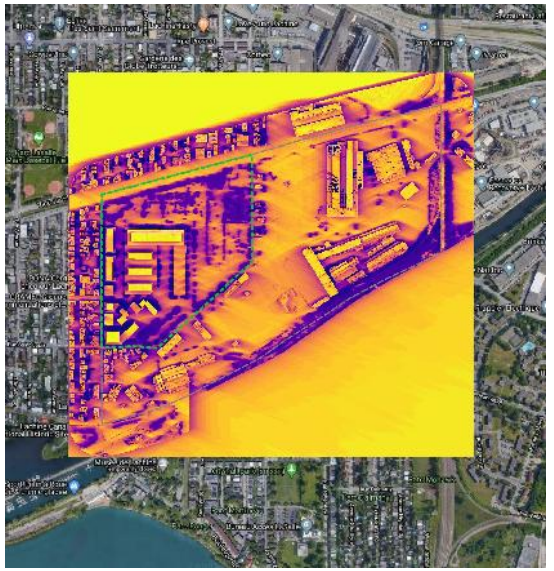
Winter



Current



Future

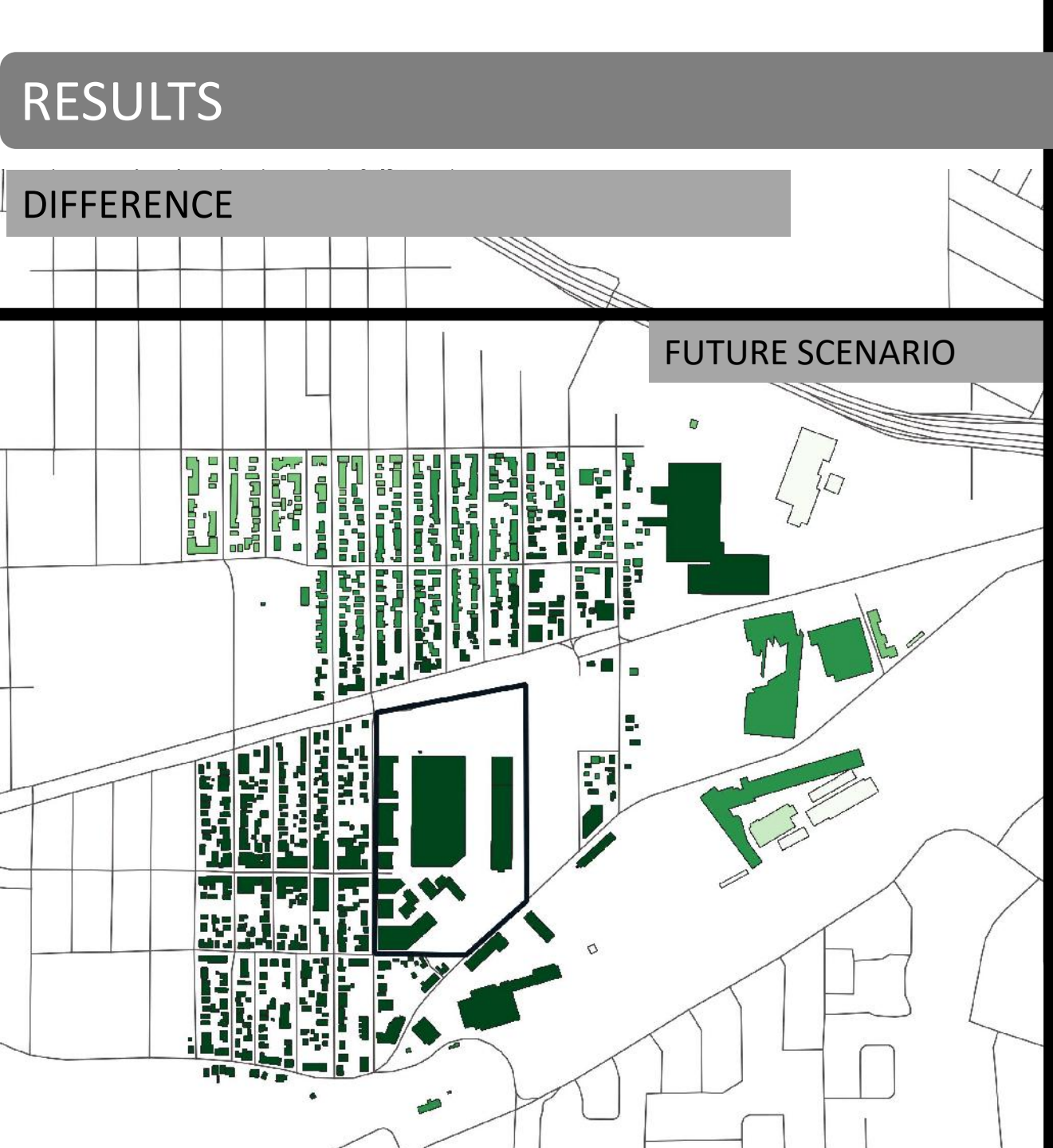


Summer

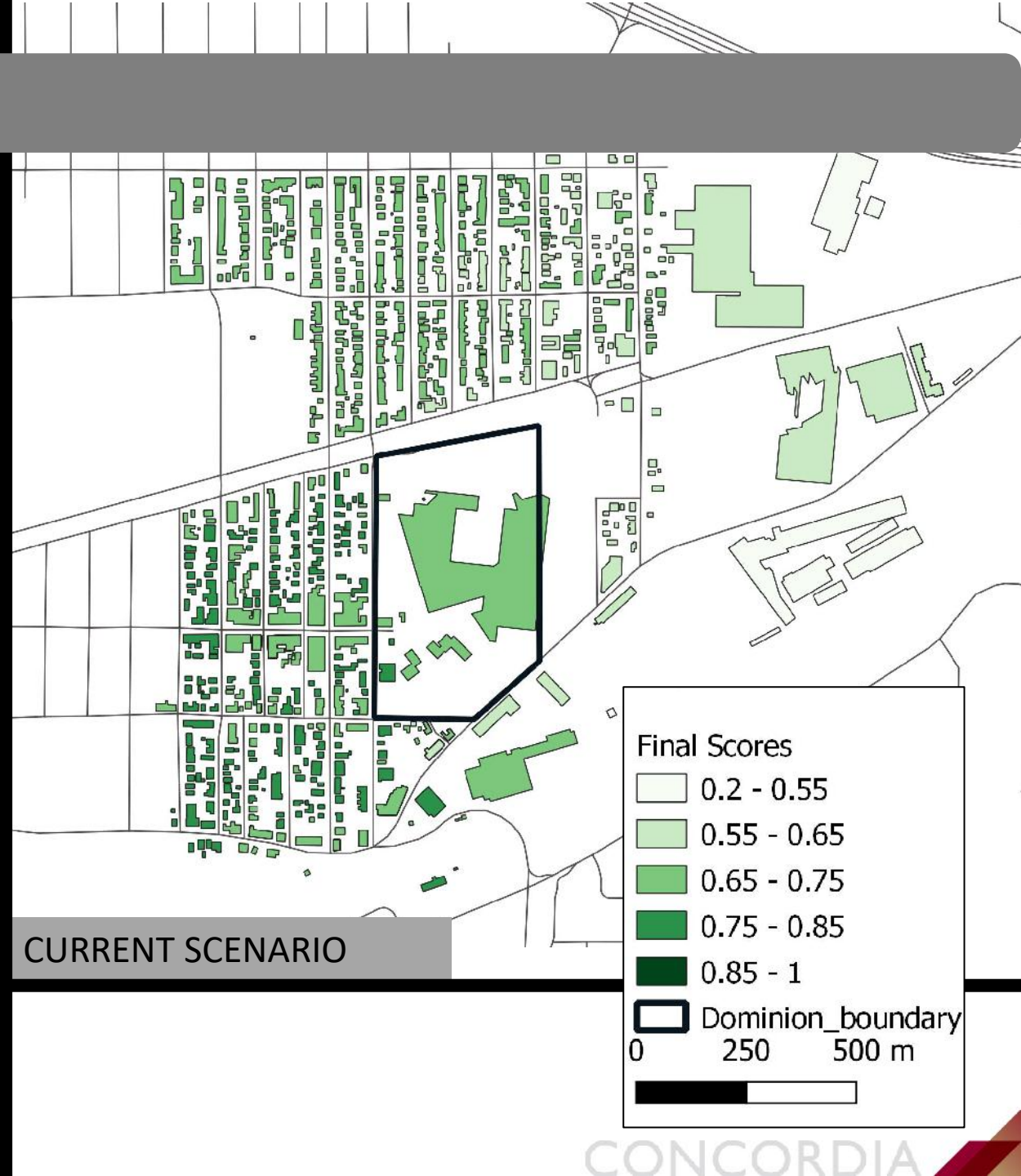
RESULTS

DIFFERENCE

FUTURE SCENARIO

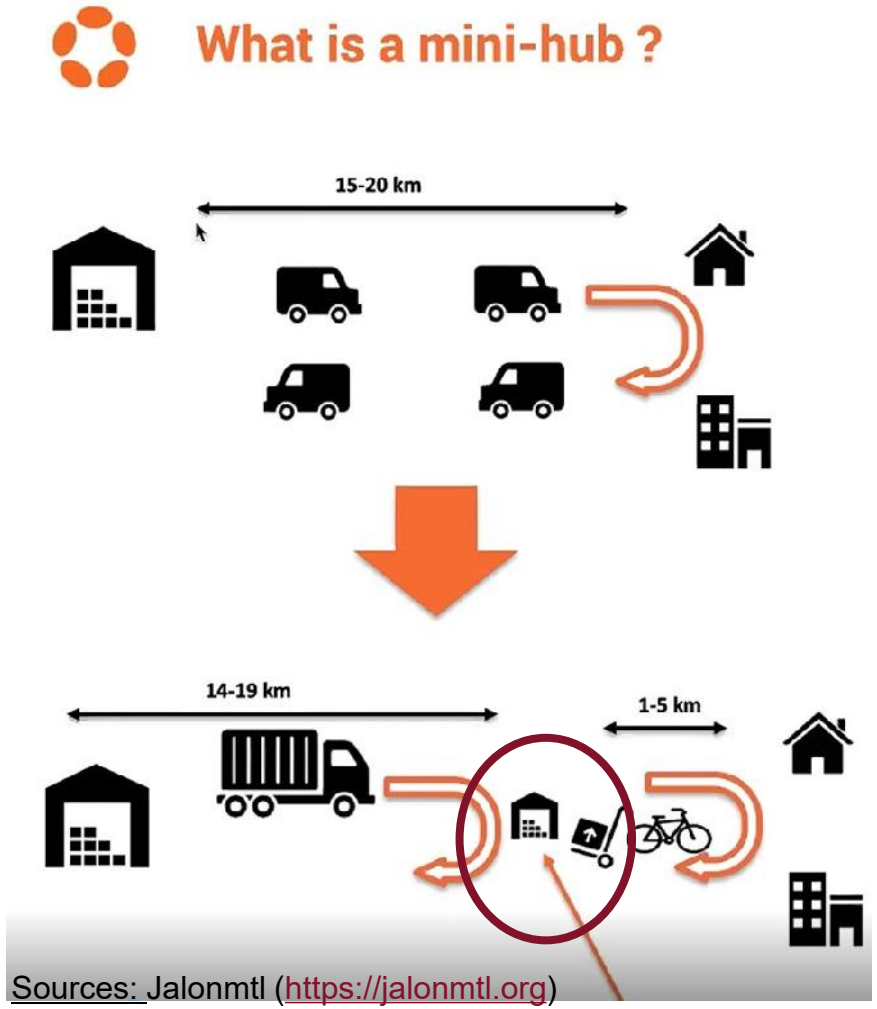


CURRENT SCENARIO



Analysis of the Last Mile Delivery - Mini-hub Concept

- A mini-hub is a (flexible) consolidation point located in and around medium to high-density areas
- Trucks pick up parcels from a warehouse outside the area (15-20 km) and bring it to a mini-hub
- Distribution of parcels for the last 1-5 km is done by e-cargo bikes or smaller electric trucks
- A mini-hub could be operated by logistic companies or by local service providers



Sources: Jalonmtl (https://jalonmtl.org)

RESULTS in Mobility

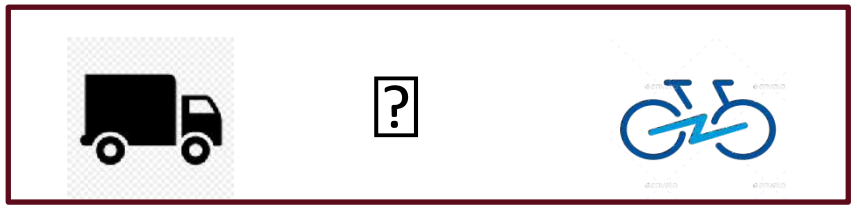
Calculation of the parcel load in the service area

	Population	Parcels / year and person	Parcels / year	Parcels / day and area
Lachine-East	12000	21	252000	690
Service area	15000	21	315000	863
Total	27000	21	567000	1553

Transportation type	Capacity of parcels
Truck	400
E-cargo bike	40

DHL and UPS e-cargo bikes

RESULTS in Mobility

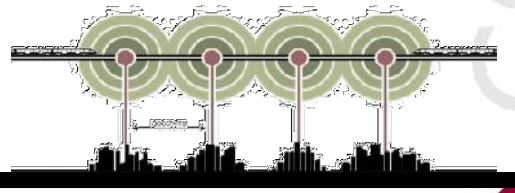
Scenario 1 – as usual	Scenario 2	
		
Number = 3.88	Number = 3.88	Number = 38.84
Distance in km = 20	Distance in km = 15	Distance in km = 5
Total distance per day in km = 77.67	Total distance per day in km = 58.3	Total distance per day in km = 194.2
CO_2 emissions in g/km = 234	CO_2 emissions in g/km = 234	CO_2 emissions in g/km = 0
CO_2 emissions in kg/day = 18.18	CO_2 emissions in kg/day = 13.63	CO_2 emissions in kg/day = 0.

CO_2 emissions in tons/year

- Scenario 1 – 6.63
- Scenario 2 – 4.98

~ 25% savings

1417 less trucks in the service area per year



Eco-Districts Lessons learned

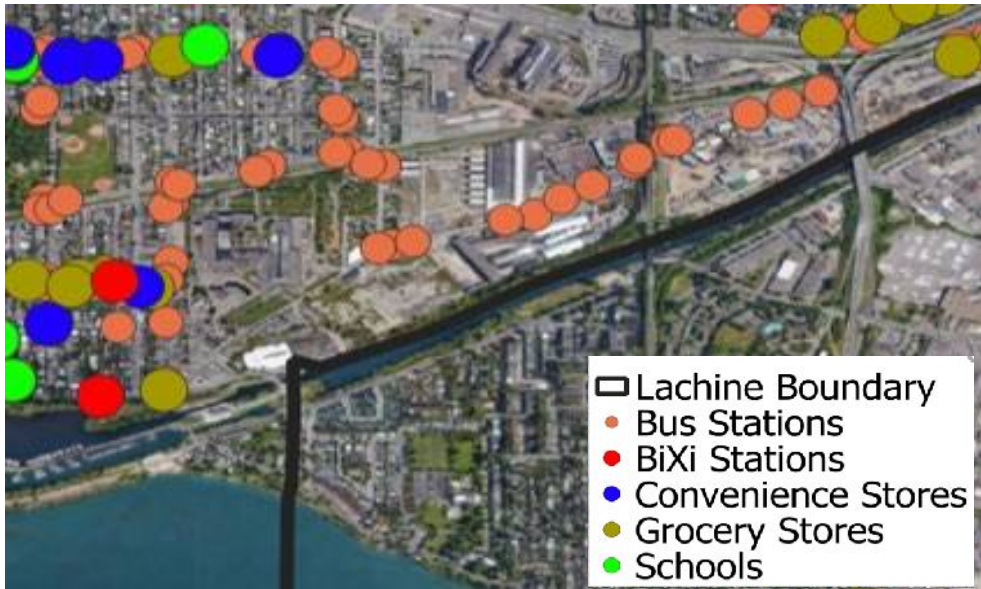
Urban form, energy demand, renewables, mobility, green infrastructure

- Compact urban geometry reduces heating and cooling demand by up to 30%
- Insulation standards are the most influential factor on overall heating and cooling demand (factor 3!)
- For a high efficiency building scenarios, the final electricity demand is 10 times lower than today's standards
- Solar Rooftop Photovoltaics can provide up to 50% of local energy consumption – **high autonomy and resilience**
- Compact urban form enables **walking access to amenities** and multi-modal mobility
- Walkability scores within TOD metrics can be significantly improved through high amenity density for the district, but also the surrounding area
- Green infrastructure, urban farming and landscaping reduces heat islands and increases resilience

Eco-Districts Lessons learned

Regulation, incentives and participation

- Permits and zoning are key factors to influence neighborhood development
- Allowing increased density in zoning process allows developers to invest more in social, affordable and family housing, civic center, sport facilities, urban farming and more
- Density allowances could be granted for high amenity densities, mixed land use flexibility, social inclusion to offset costs and build back better
- Blend regulation and incentives, social and inclusive governance in master planning for and by the community and stakeholders



Zusammenfassung

- Die EnSource Ziele sind weiterhin hoch aktuell
- Vernetzte, erneuerbare und hocheffiziente Quartiere mit minimalem Ressourcenverbrauch sind weiterhin die Ausnahme
- Urbane Modellierungstools sind noch nicht in der Praxis angekommen
- Internationale Kooperation sind aeusserst sinnvoll

artist unknown

CO-CREATE
THE NEXT-GENERATION
QUARTIER. NOW!

Thank you for your attention!

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