



6º SIMPÓSIO BRASILEIRO DE
**CONSTRUÇÃO
SUSTENTÁVEL**

Aleksandar Ivančić

New ways for the objectivation of the urban efficiency: Barcelona experience

- Introduction
- Metabolic efficiency
- Energy planning
- Example: infrastructures
- Example: building stock
- Conclusions

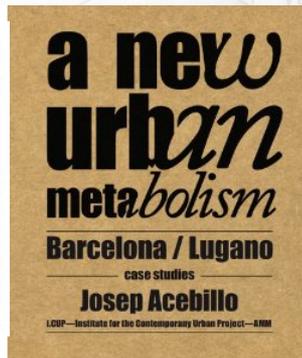
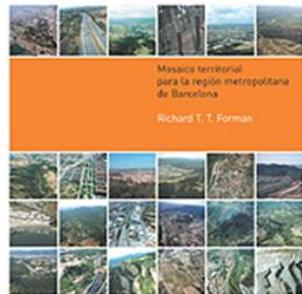
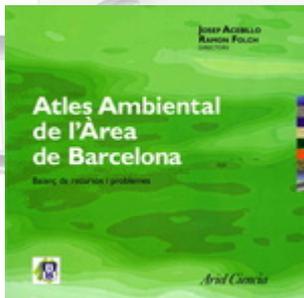
urban metabolism



**NEW
URBAN
COMPLEXITY**

urban intensity

urbanity



urban metabolism

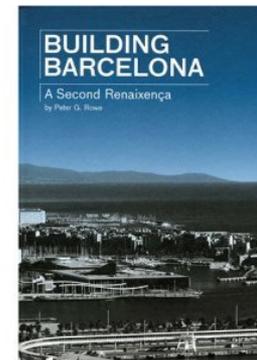
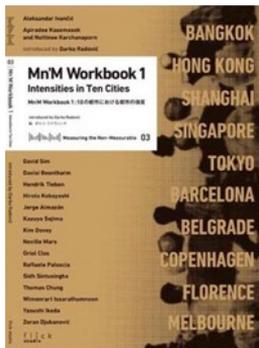
"If you can not measure it, you can not improve it."



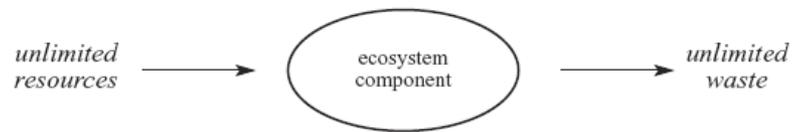
"The most important things cannot be measured."

urban intensity

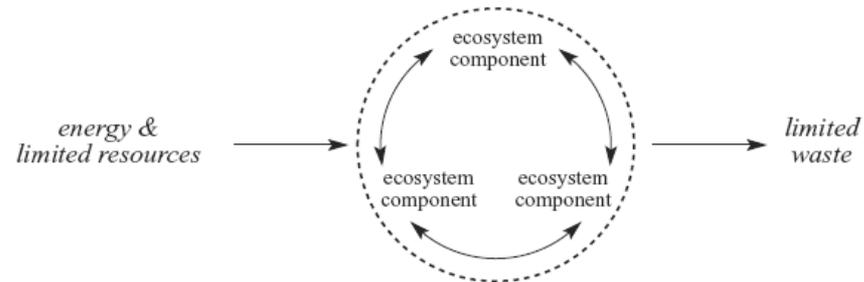
urbanity



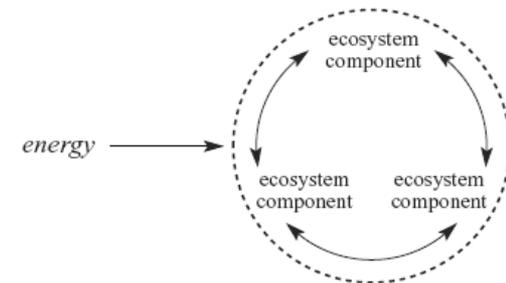
Industrial ecology concepts



(a) QLinear materials flows in 'type I' ecology



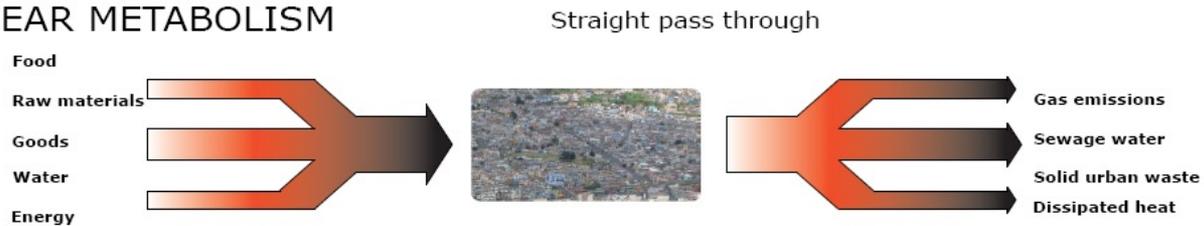
(b) Quasi-cyclic materials flows in 'type II' ecology



(c) Cyclic materials flows in 'type III' ecology

CITY METABOLISM

LINEAR METABOLISM



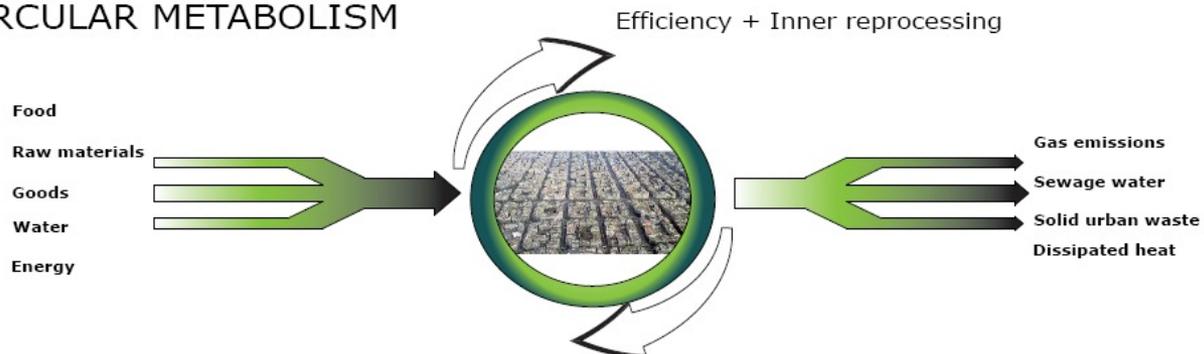
CLOSED LOOP METABOLISM?



CLOSED LOOP METABOLISM

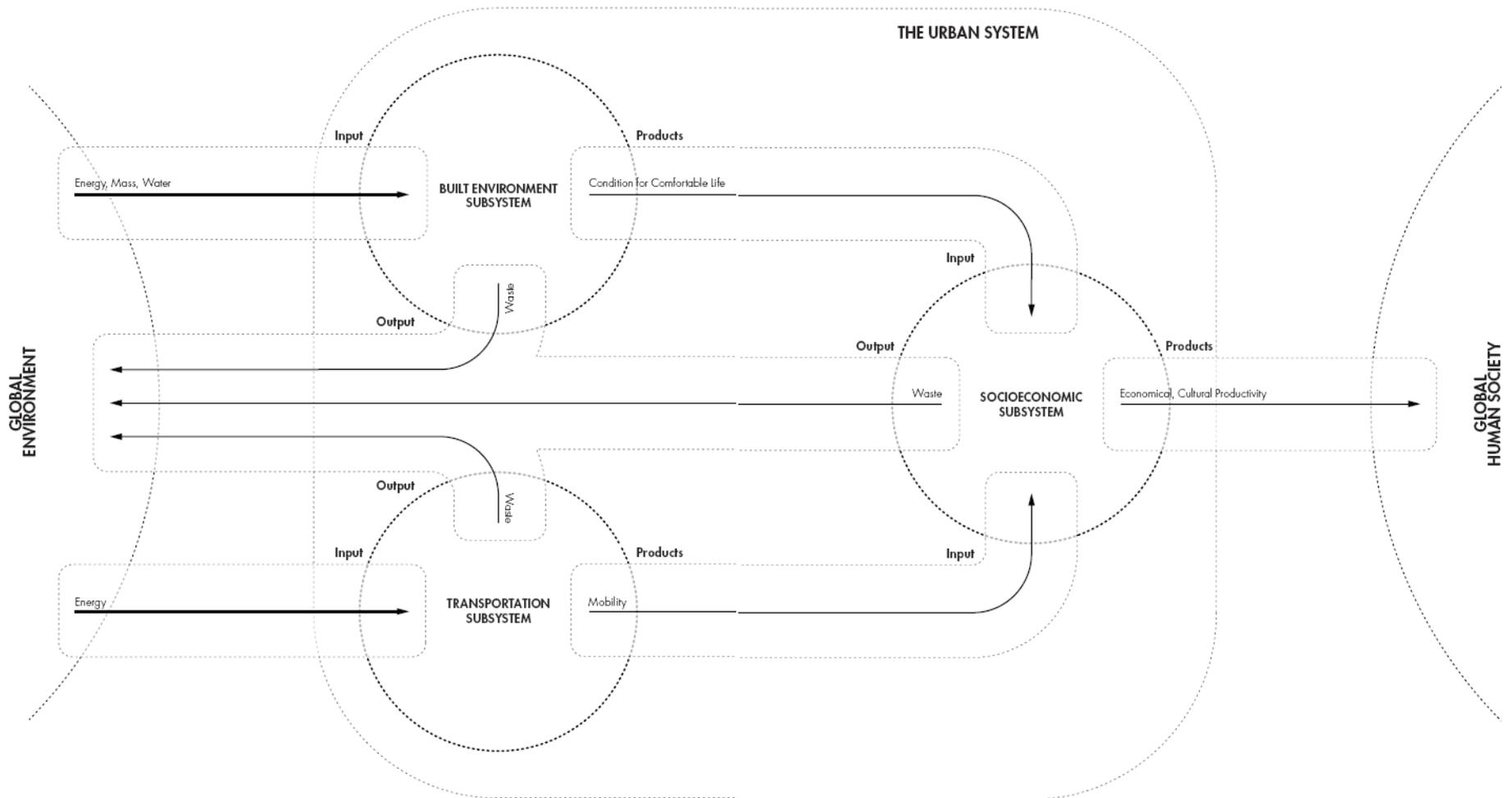
City as a dissipative structure needs to import / export materials / energy / information in order to keep the organization

CIRCULAR METABOLISM

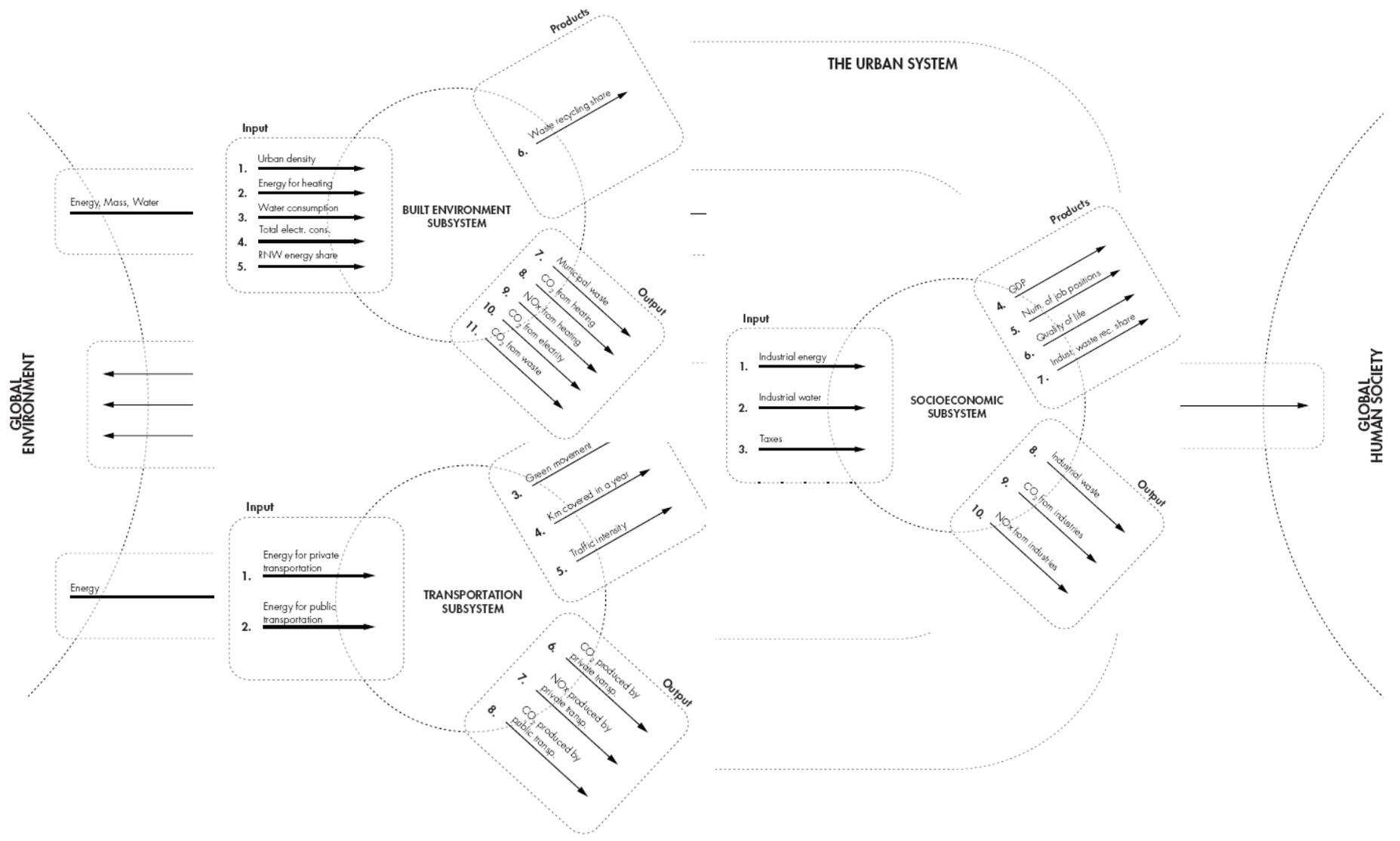


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Metabolic efficiency



Metabolic efficiency



Metabolic efficiency

CO ₂ produced by public transportation	
Green mobility share	
Km covered in a year	
Transportation intensity	
Urban density	
Energy consumption for heating	
Water consumption for buildings	
Total electricity consumption	
Renewable energy share	
Waste recycling share	
Municipal waste	
CO ₂ produced for heating	
NOx produced for heating	
CO ₂ produced for electricity	
CO ₂ produced for waste	
GDP per capita	
Number of job positions	
HALE (life expectancy)	

5.1.2

Built environment subsystem

The metabolic representation subsystem is represented above. Our repre does not contemplate a productivity, i.e. the dissipative.

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a new urban metabolism

socioeconomical system (efficiency)

socioeconomical system (products)

metabolic efficiency

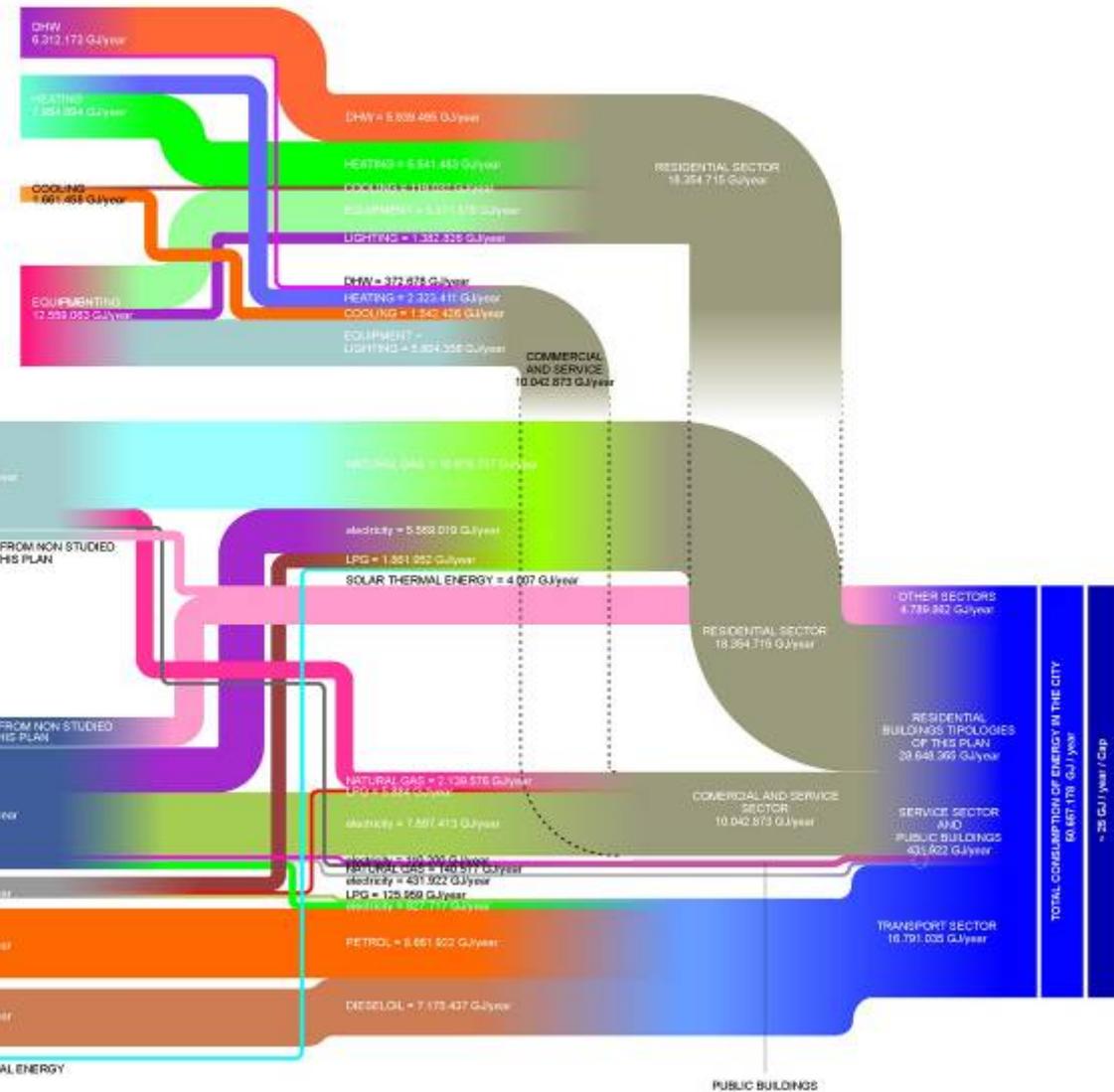
Fig. 10 shows a repr efficiency indicator through two space of a city (specifically, Bar map can be interpreted as a ref

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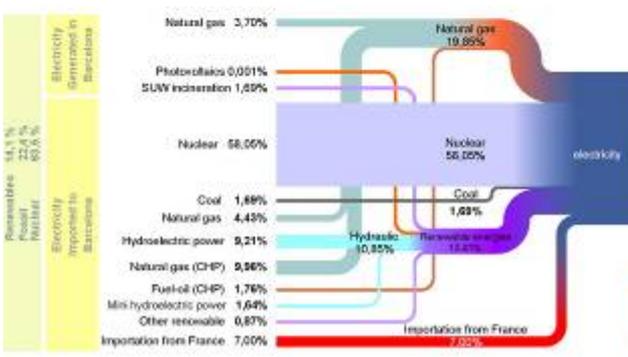
FLOW DIAGRAM OF FINAL ENERGY CONSUMPTION IN BARCELONA CITY IN 1999



E (Great Pyramide Giza) = 1 week BCN

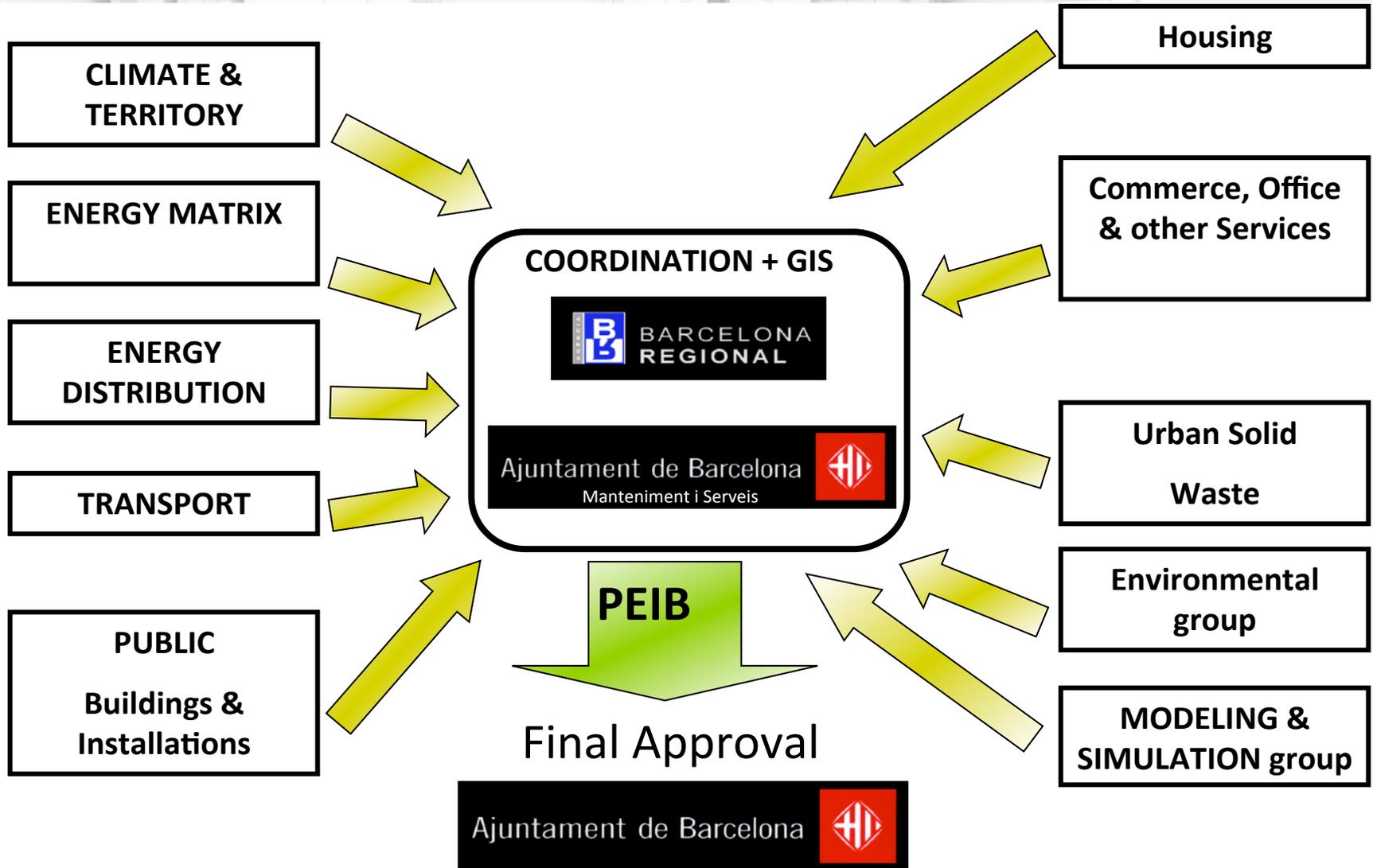


FINAL ELECTRICAL ENERGY PRODUCTION (Catalan electrical mix) 1999



TOTAL CONSUMPTION OF ENERGY IN THE CITY
60,467,178 GJ/year
= 28 GJ/year / Cap

Energy Planning



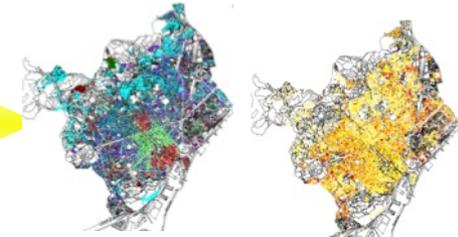
Energy Planning

TOOLS: Building

GIS

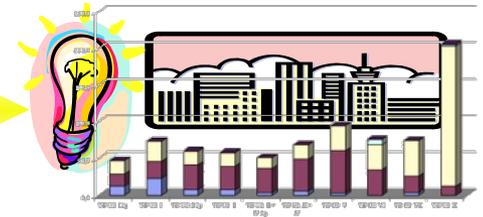


GEOGRAFIC INFORMATION SYSTEM & Dbs calculations and mapping



TRNSYS

Results: Heating loads, cooling loads for every typology of building (Energy/m2)



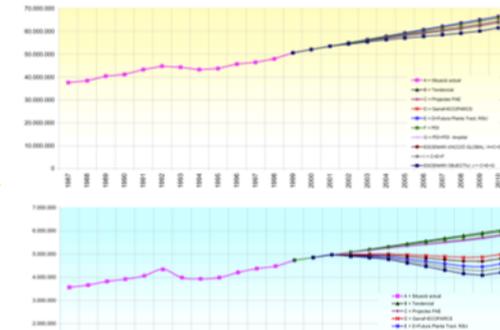
Dbs PEIB PROJECTS

Analysis of projects and best combination of projects. Characteristics about energy, economt and emissions reduction of every project



**BARCELONA
SIMULATOR**

Future Scenarios: Energy and Environmental Simulation until 2010 Final Evaluation and decision tool



Detailed Analysis

Global A.

materials and walls. The urban context for each type also taken into consideration. To obtain the results, TRNSYS has been defined using the graphical interface IISiBat (IISiBat 2000). However, before the definition of the TRNSYS system, the following steps need to be completed:

- A database for the common glazing systems in Barcelona was generated.
- The reduction of incident solar radiation in buildings and shadows due to the urban layout was calculated using the program SOMBRERO (2001).
- From several climatological stations in Barcelona, the reference year for the city of Barcelona was selected.

TRNSYS (TRNSYS 2000). The most complex and complete model—TYPE 56, which is a multizone model for building computations—was used.

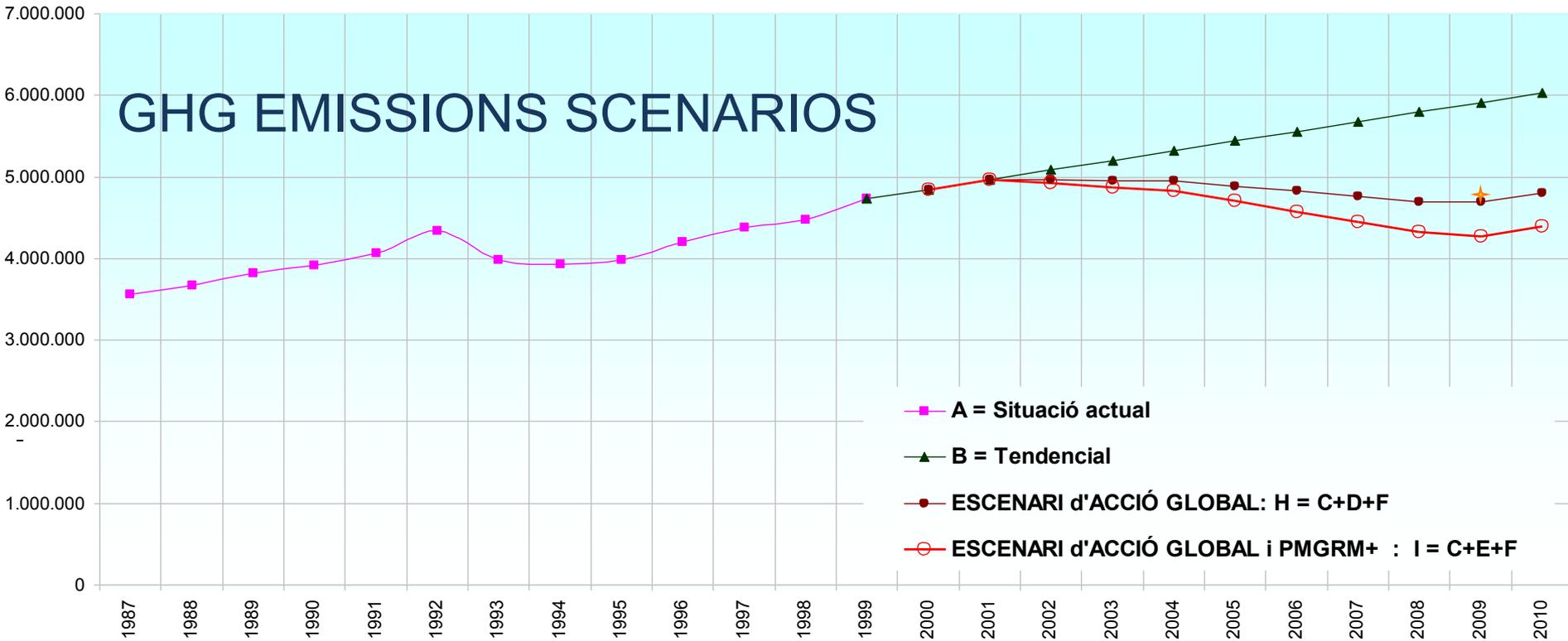
The scheme shown in Figure 6 summarizes the process for simulating and obtaining the cooling and heating load results. The process starts with the defined typology: information comes from the architectonic layout and the description of materials and walls. The urban context for each typology was also taken into consideration. To obtain the results, a system in TRNSYS has been defined using the graphical interface IIS Bat (IISiBat 2000). However, before the definition of the TRNSYS system, the following steps need to be accomplished:

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t / any

EVOLUCIÓ D'EMISSIONS DE CO2 EQUIVALENT

GHG EMISSIONS SCENARIOS

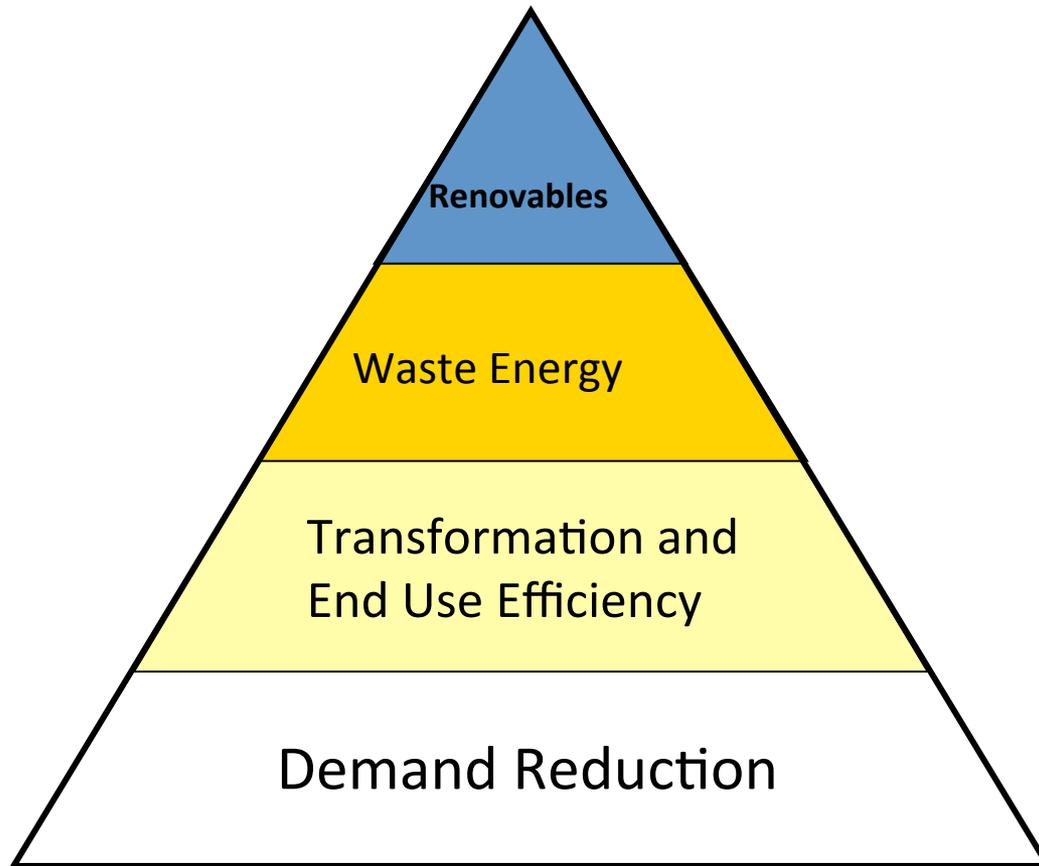


- A = Situació actual
- ▲ B = Tendencial
- ESCENARI d'ACCIÓ GLOBAL: H = C+D+F
- ESCENARI d'ACCIÓ GLOBAL i PMGRM+ : I = C+E+F

	GHG Emissions [tn/year]	Δ Annual mean [%]	Δ TOTAL [%]	Emissions per capita [tn/càp.year]
A = Present Situation	4.732.360	0,00%	0,00%	3,14
B = Trend-Based Scenario	6.030.897	2,23%	27,44%	3,96
H = GLOBAL ACTION SCENARIO	4.805.849	0,14%	1,55%	3,15
I = Global Action + Total USW Treatment	4.394.862	- 0,67%	- 7,13%	2,89

ACTION PLAN

Energy model



Urban integration

Infrastructure
optimization /Metabolic
concept

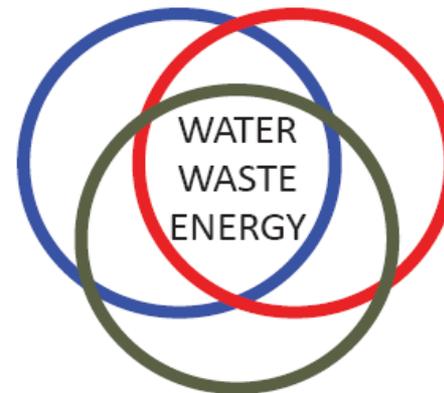
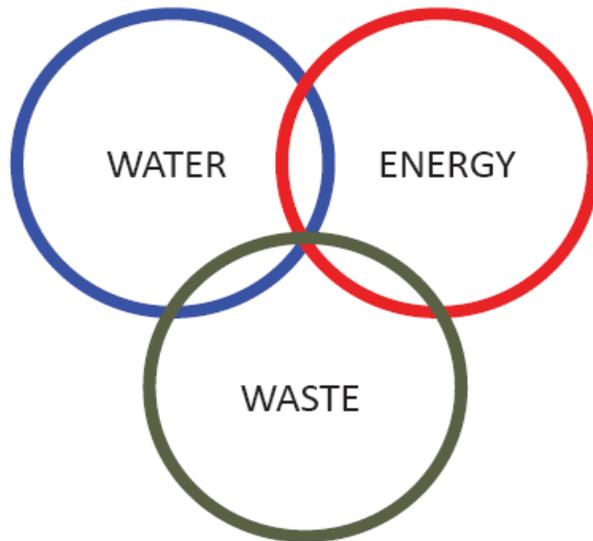
Optimization-
New needs fulfillment

Organization -
Systematization
Integration

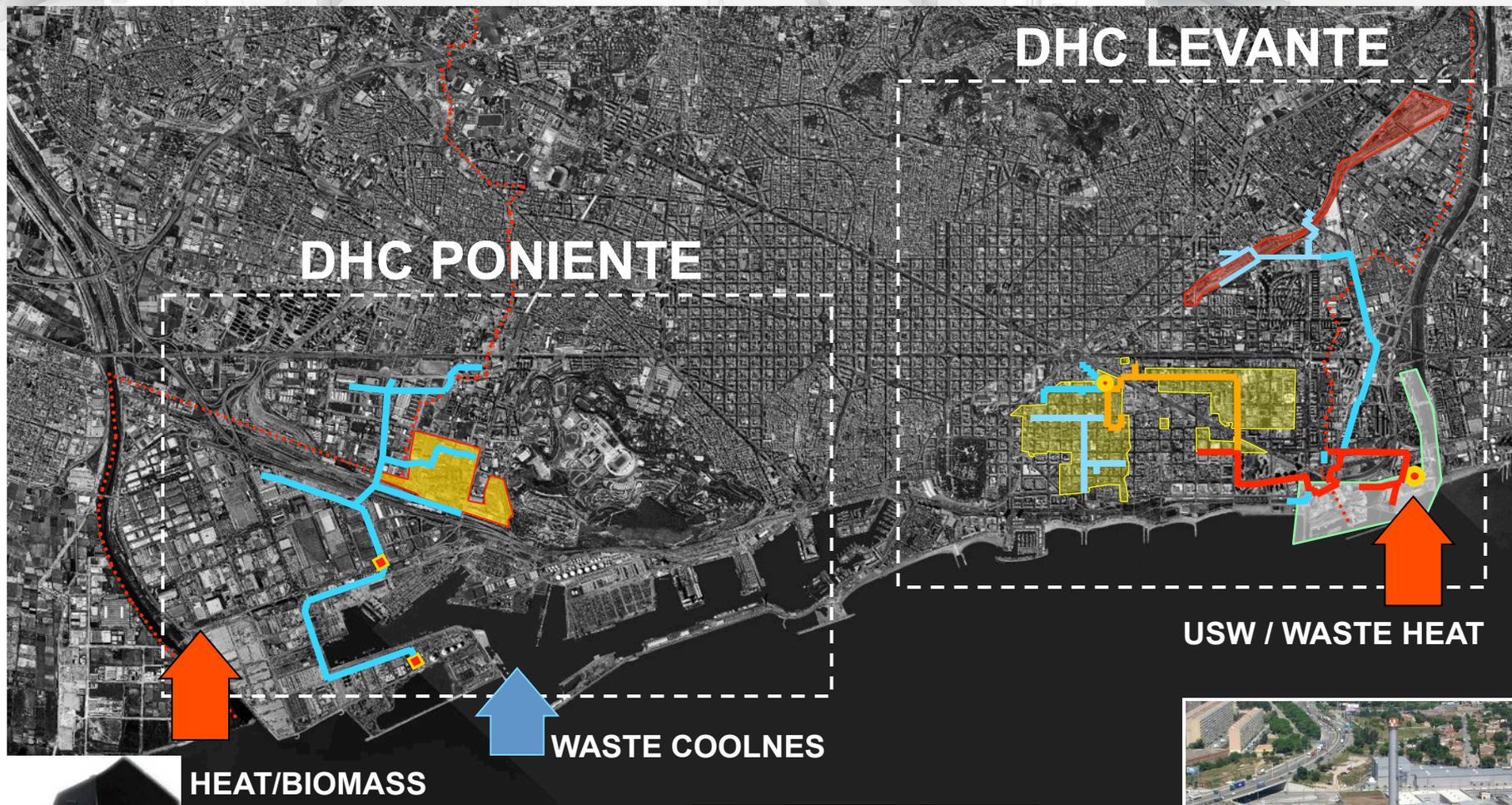
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Metabolic Concept for Service Infrastructures

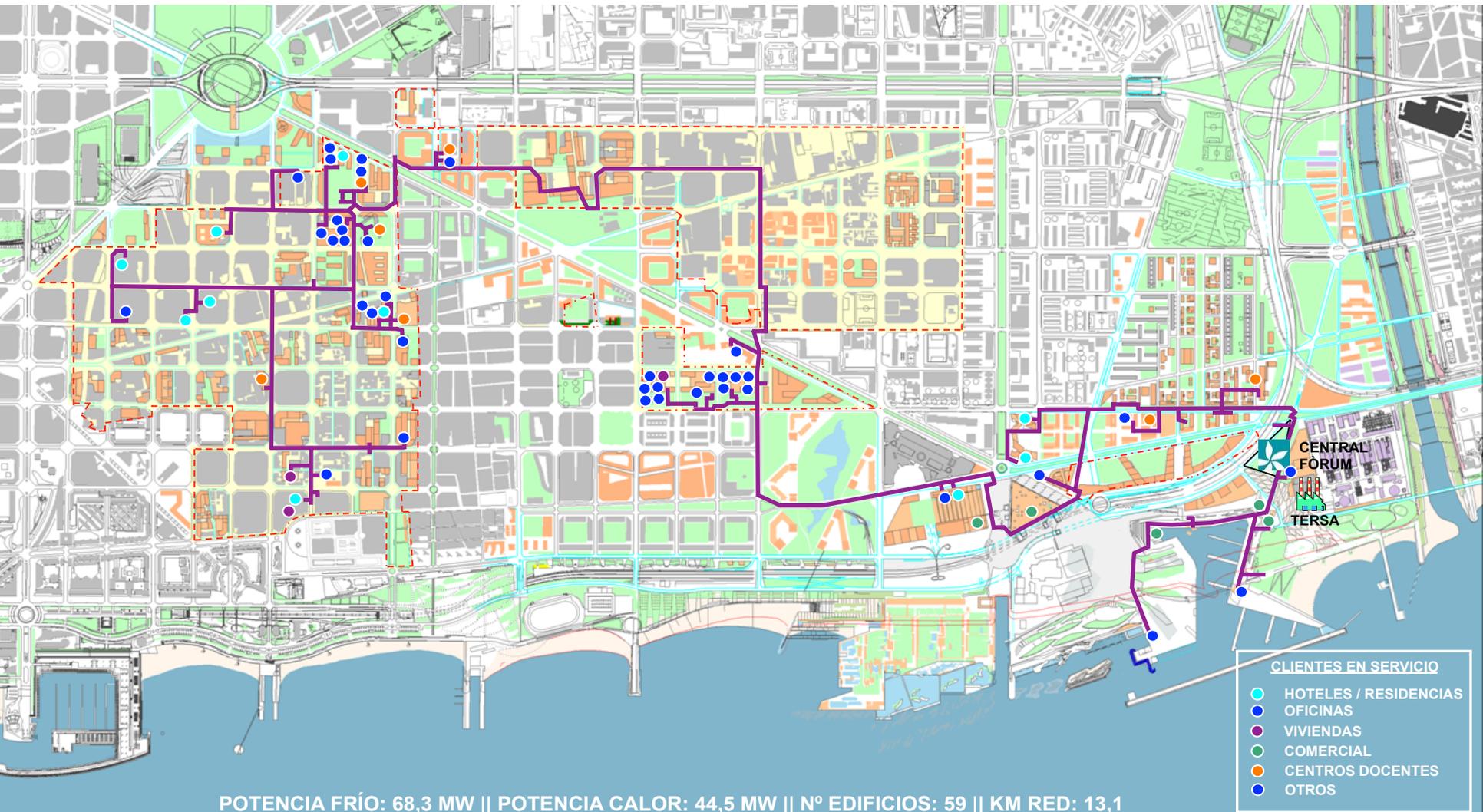
- Infrastructure optimization
- Integration – Synergies
- New complementary activities
- => Co-siting

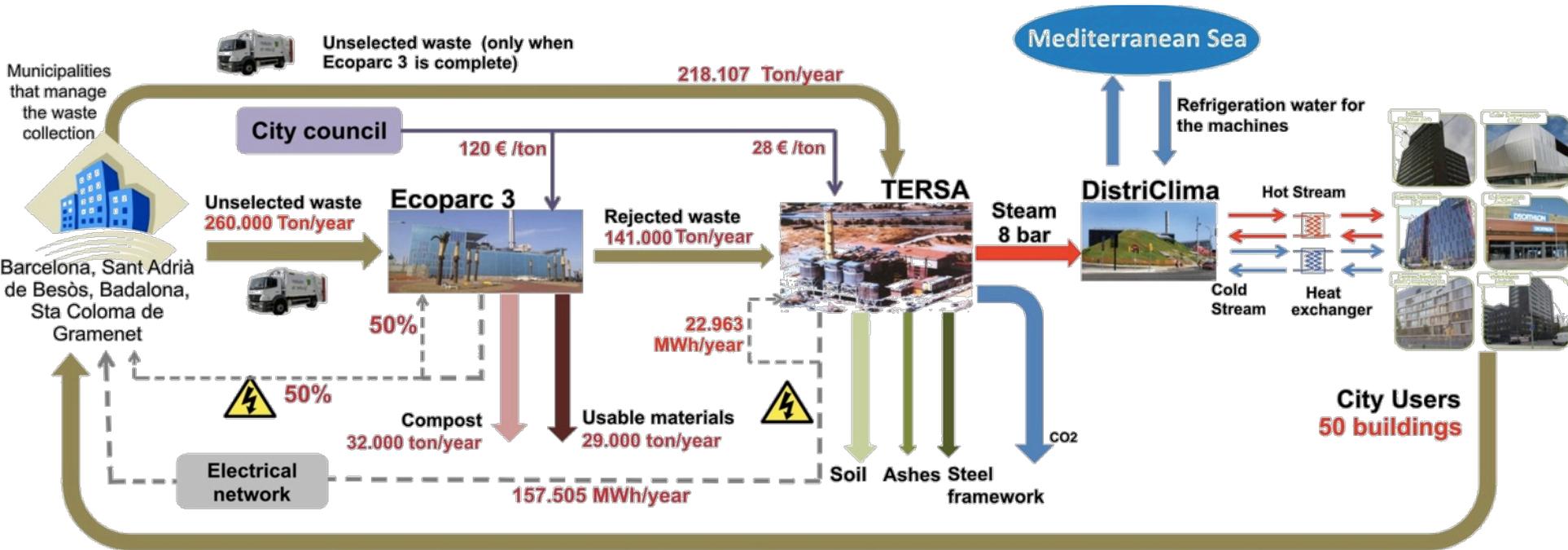


Barcelona: LNG residual coolness / Heat from USW treatment



Forum - 22@





% of the unselected waste used in the production of heat is coming from the users buildings

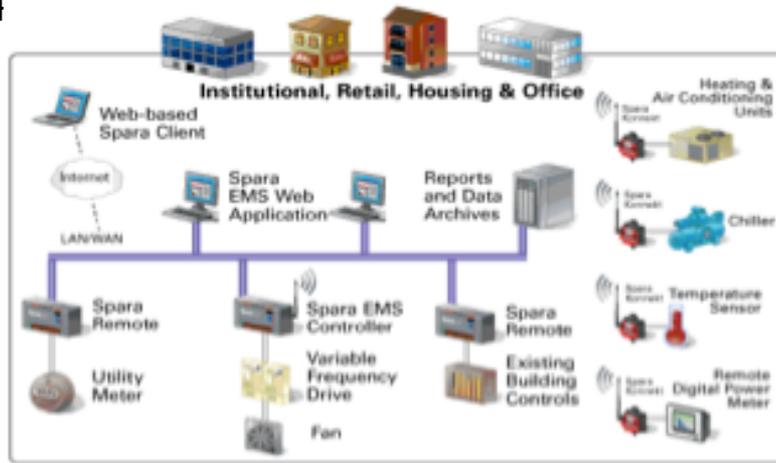


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Building Stock

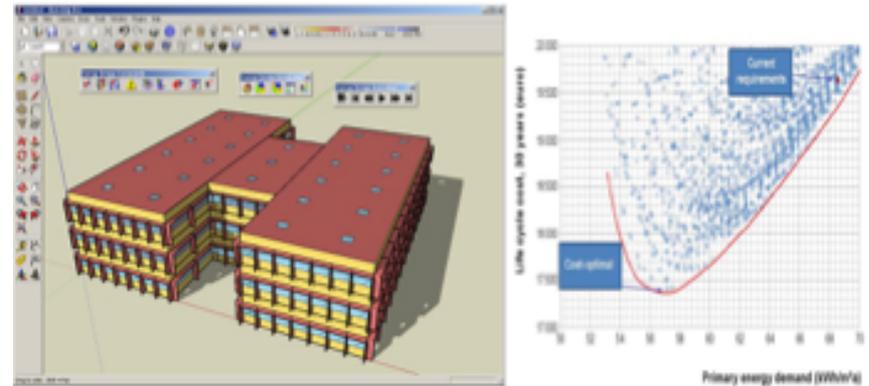
Building Energy Management Systems

The principal role of a **BEMS** is to regulate and monitor heating, ventilation and air conditioning (HVAC Control) – and often lighting too. A BEMS can efficiently control as much as 84% of a building's energy usage. Source: TREND, f



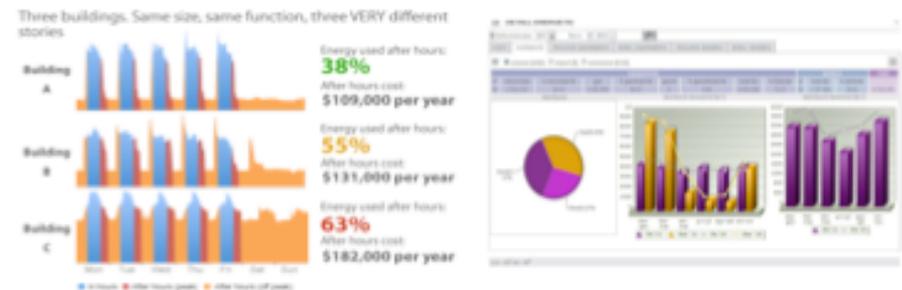
Building Energy Performance Systems

The goal of **BEPS** is to accurately predict the energy use of a building to either test the energy performance of the building with regards to an established standard, or to compare and contrast two buildings in order to find the resulting energy savings. Source: IBPSA, Energy+.



Building Energy Benchmarking Systems

The **BEBS** objectives are to compare one's building processes and performance metrics to other one's or best practices from other buildings, and regulations. Source: Robert J Boxwell Jr,



Building Stock - status

Building Energy Management Systems

The principal role of a **BEMS** is to regulate and monitor heating, ventilation and air conditioning (HVAC Control) – and often lighting too. A BEMS can efficiently control as much as 84% of a

Systems like IBM, Siemens, or similar, for the building management control.

Building by building



Building Energy Performance Systems

The goal of **BEPS** is to accurately predict the energy use of a building to either test the energy performance of the building with regards to an

Building simulation tools for certification or behaviour prediction.

Building by building or for set of buildings



Building Energy Benchmarking Systems

The **BEE** building μ other one and regulations. SOURCE: ROBERT J DUXWELL JR,

Billing control and consumption benchmarking.
Set of buildings



Building Stock - Improvement

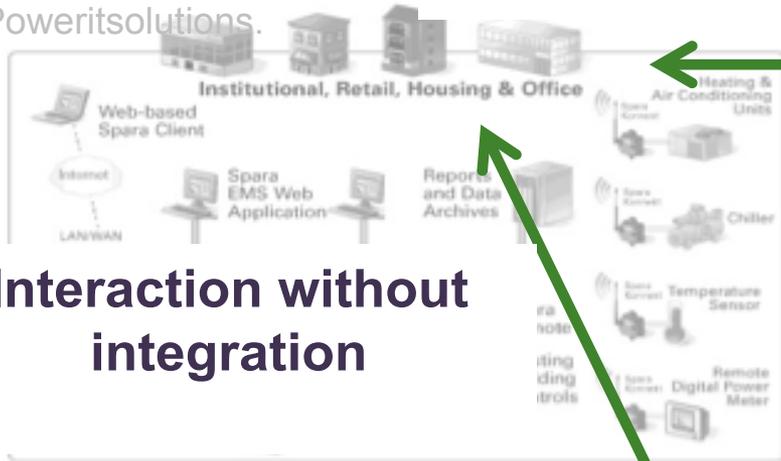
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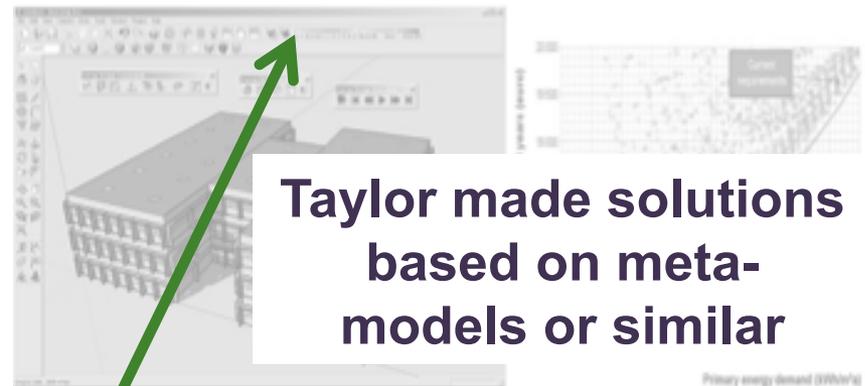
Building Energy Performance Systems

The goal of **BEPS** is to accurately predict the energy use of a building to either test the building with regards to an energy audit or to compare and contrast energy use to find the resulting energy savings. Source: IDPSA, Energy+.

R+D Projects In EU & Elsewhere



Interaction without integration



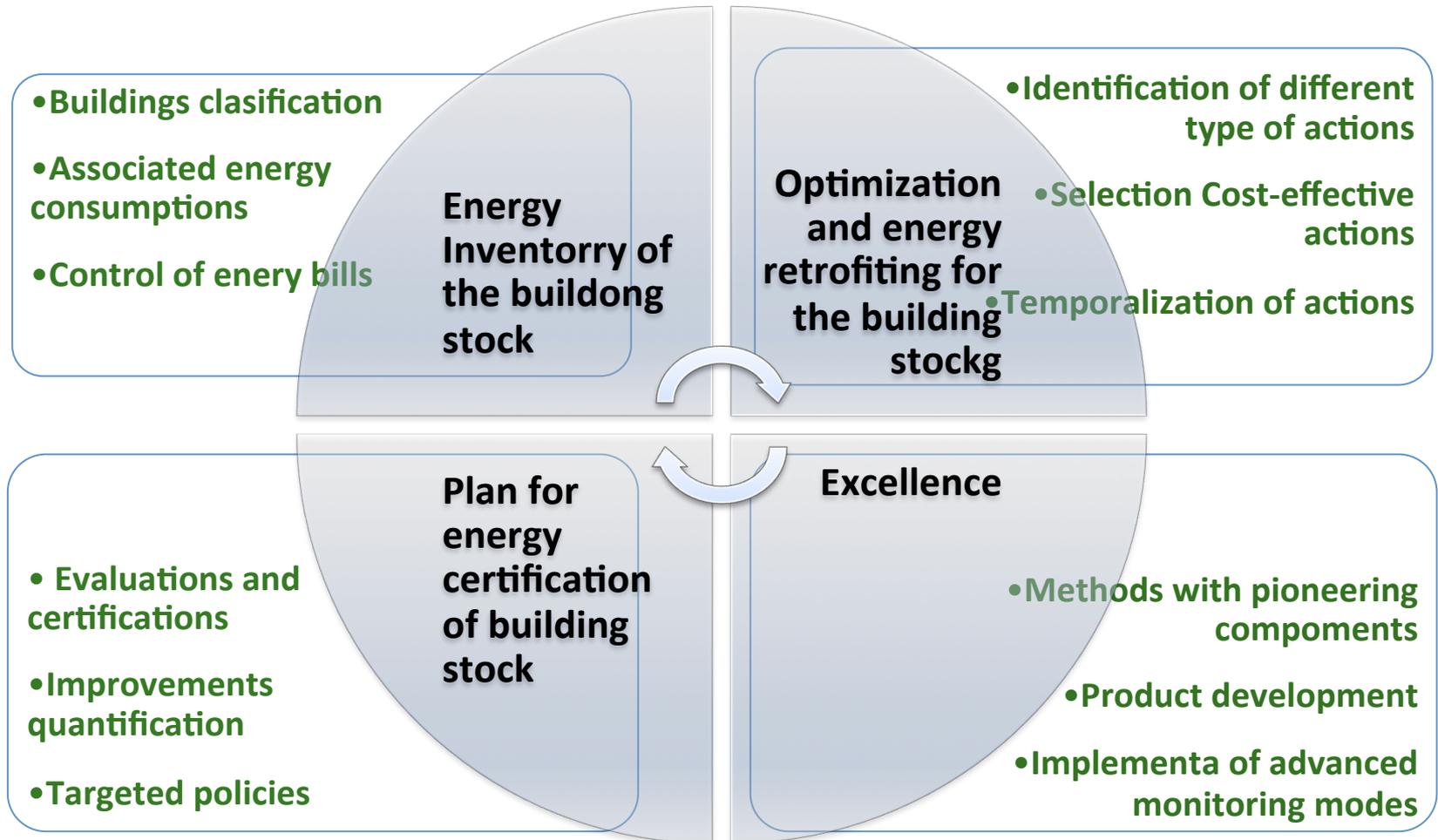
Taylor made solutions based on meta-models or similar

Building Energy Benchmarking Systems

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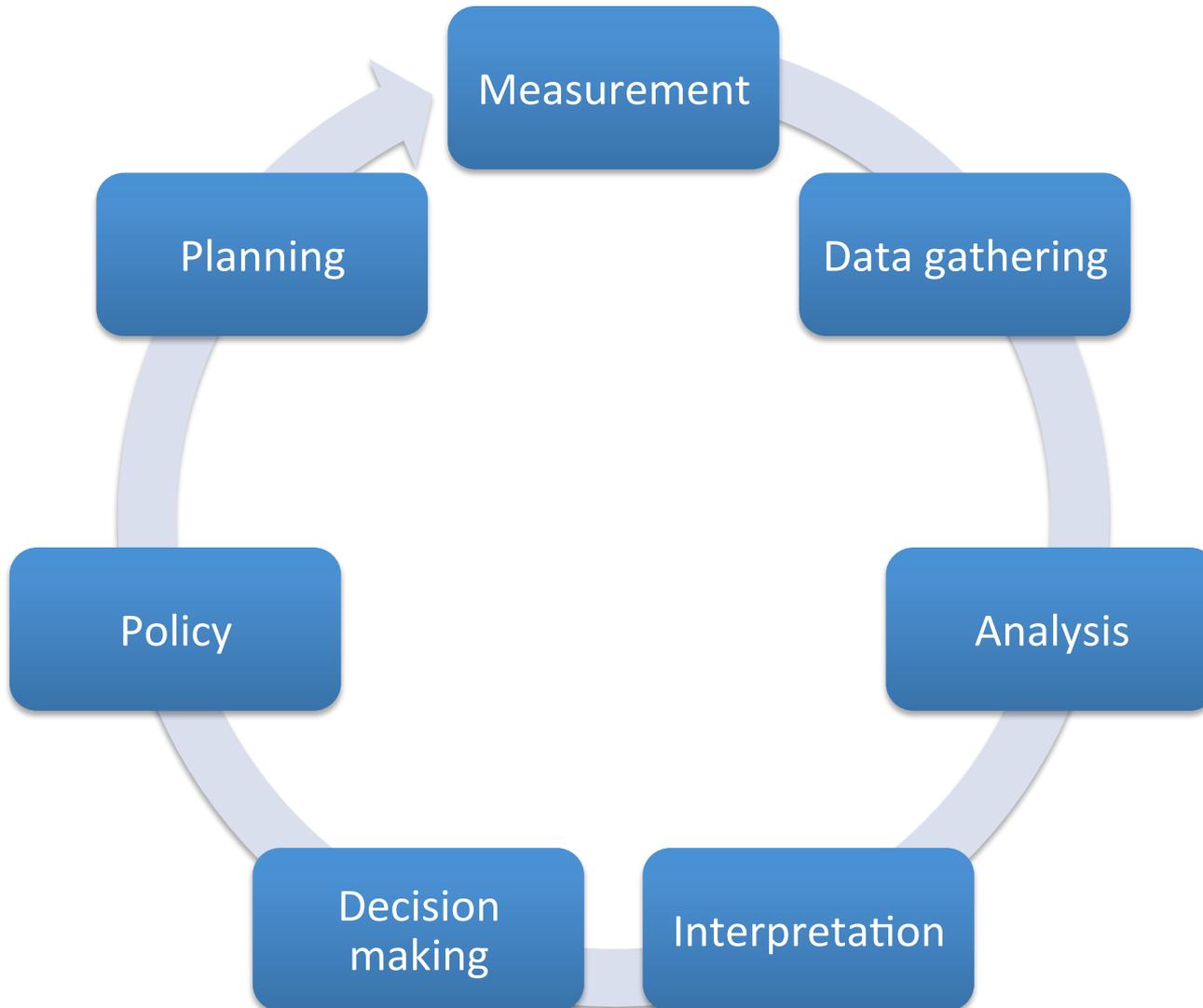


Building Stock Optimization



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Conclusions



New generation of Tools

Complex system

Multi-criteria matching

Objective evaluation

Benchmarking

Performance Evolution



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