A **value-based framework** from Building Stock Model to **Retrofit Model**

Faculty of Architecture,
Civil Engineering and Environmental Sciences

Institute for Building Climatology and Energy of Architecture
(IBEA)

1. PROBLEM STATEMENT

1.1 INTRODUCTION

CORE: *Building Energy Retrofit (BER) beyond Energy Efficiency.*

1. Mexico´s CO2 emissions and Energy resources landscape.

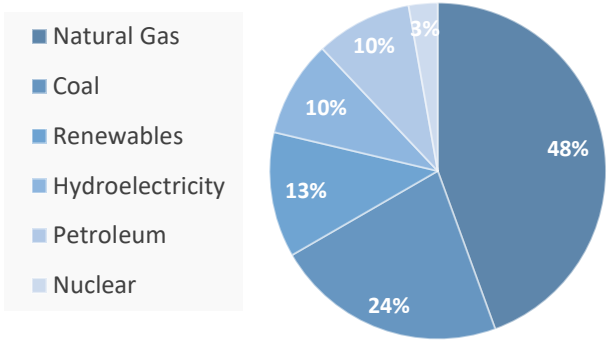


Figure 1. Mexico´s Energy Generation by fuel 2021

Mexico´s oil reserves = 13 years

Mexico´s index of energy Independence = 0.7

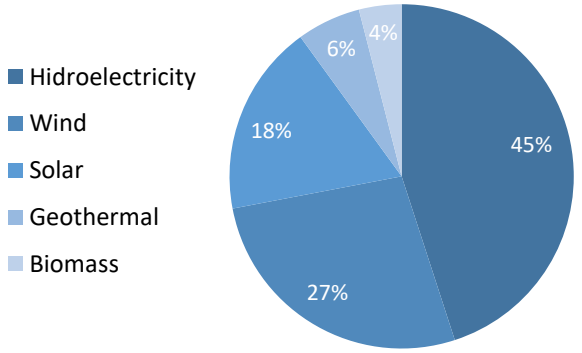


Figure 2. Mexico´s Renewable generation by source 2021

2. Building Stock Model at Urban Level

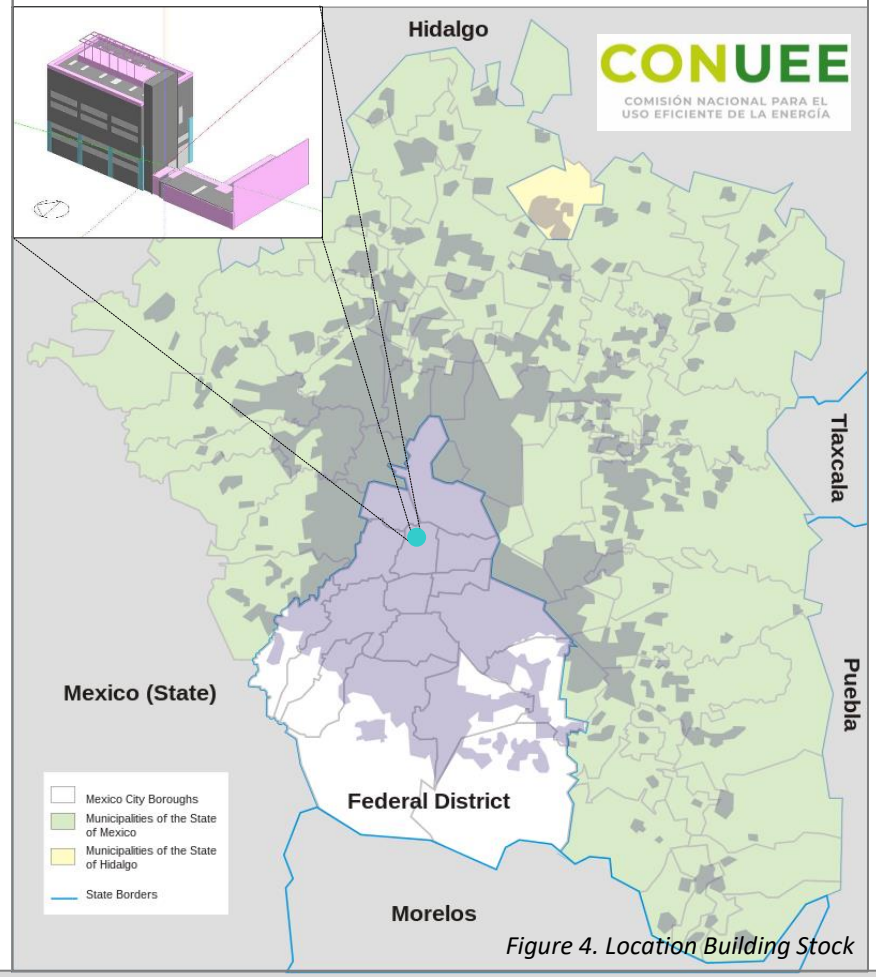


Figure 4. Location Building Stock

3. Building Retrofit Strategies

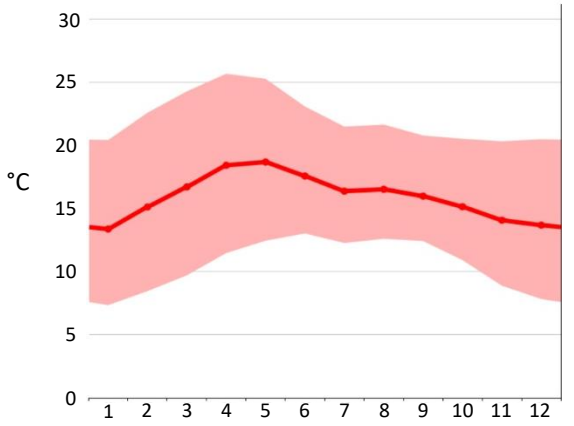


Figure 5. Average Temperature in Mexico City

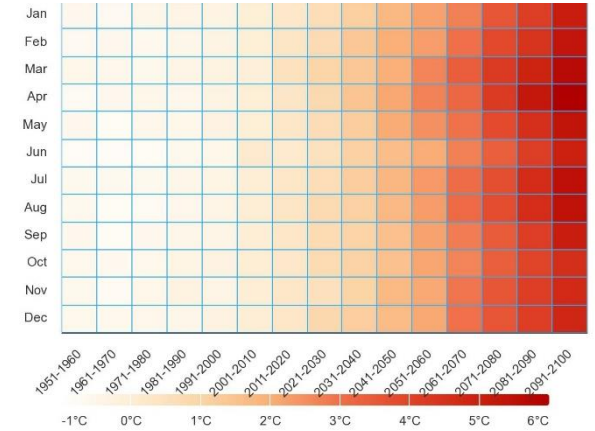
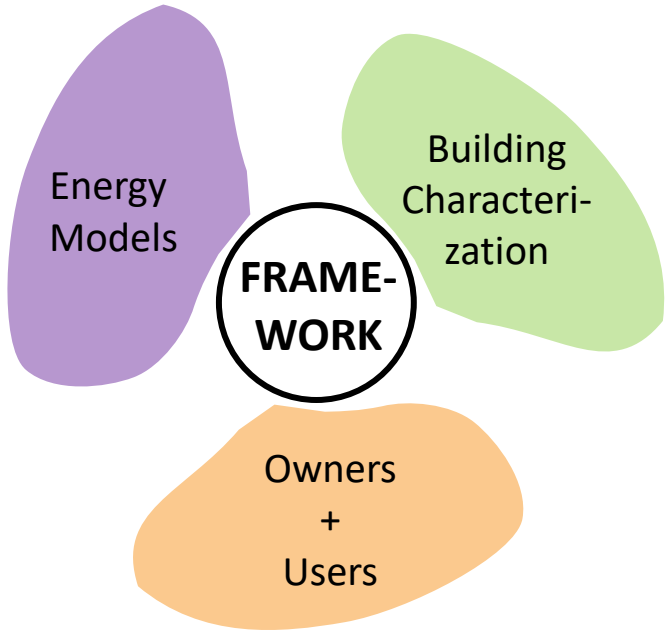


Figure 6. Projection model average Temperature in Mexico City

1.2 PROBLEM STATEMENT

CORE: *The construction of the Value-Based Framework*

INPUTS / BUILDING



1.2 PROBLEM STATEMENT

CORE: *The construction of the Value-Based Framework*

DRIVERS /

MODEL ENVIRONMENT

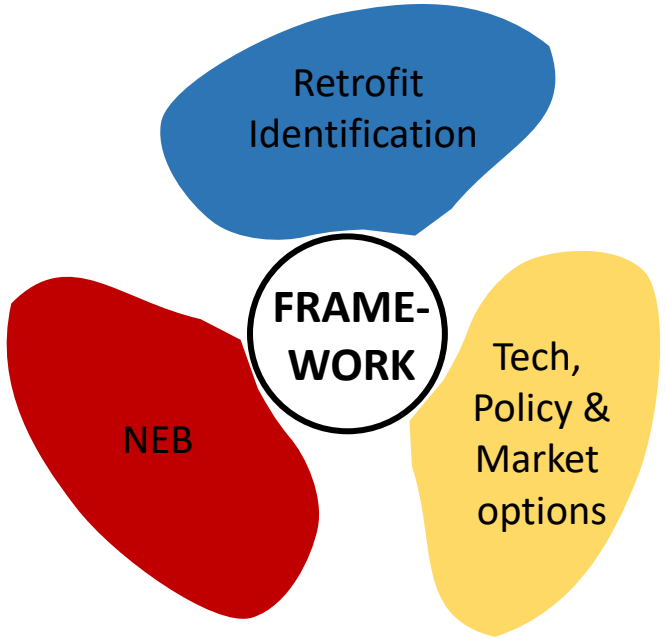
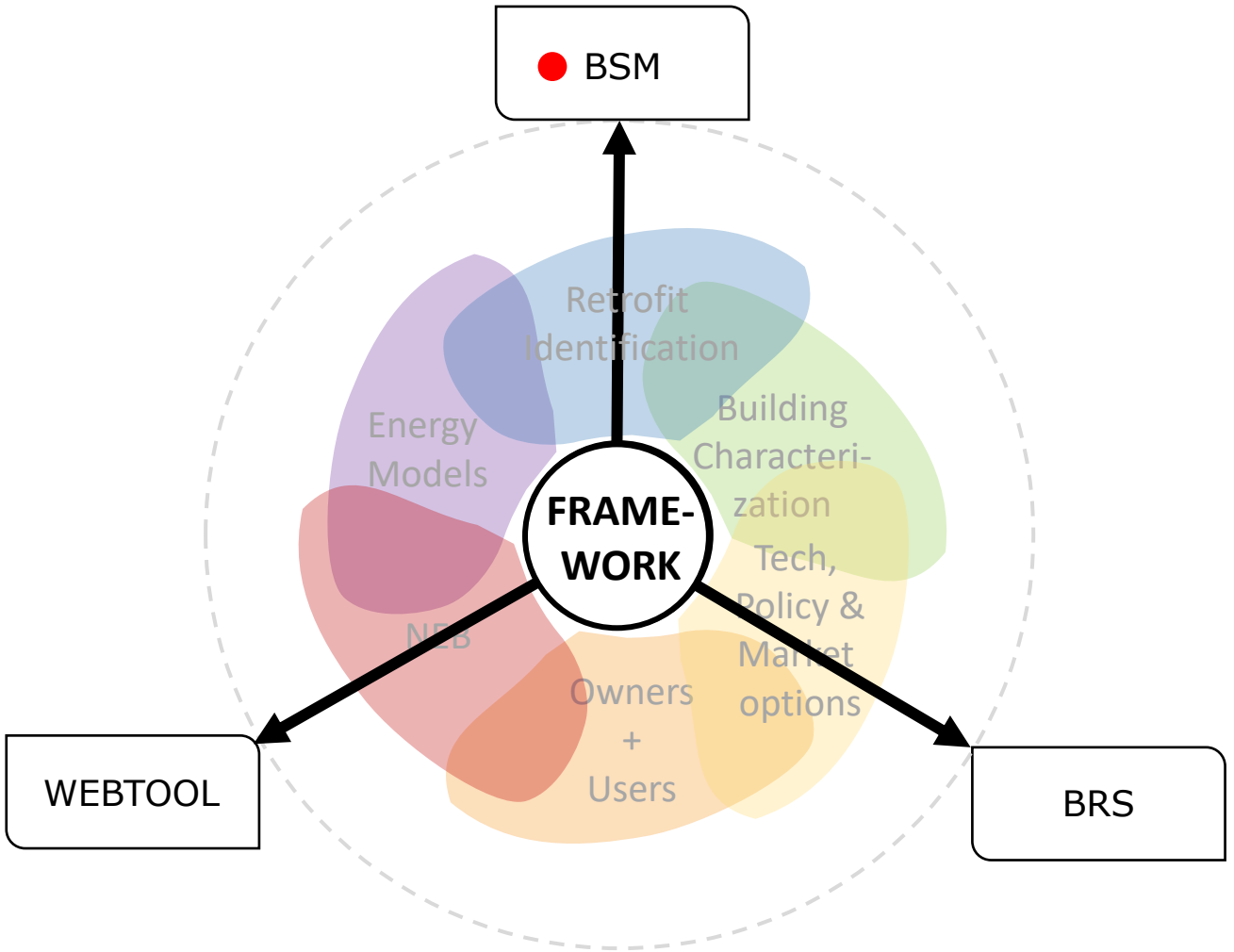


Figure 5. Propeller Concept

CORE: *A Value-based Framework facilitates data-driven decision-making*



BSM – Building Stock Model

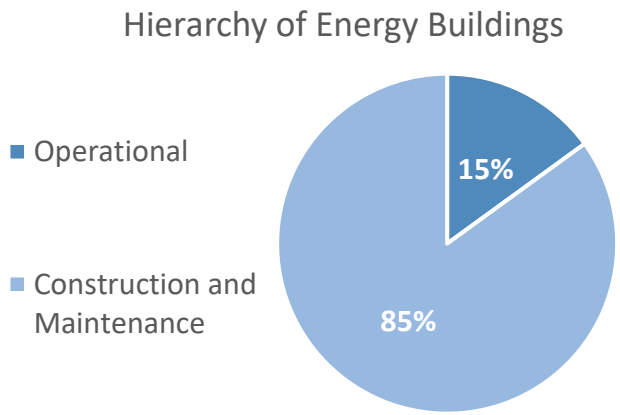
BRS – Building Retrofit Strategies

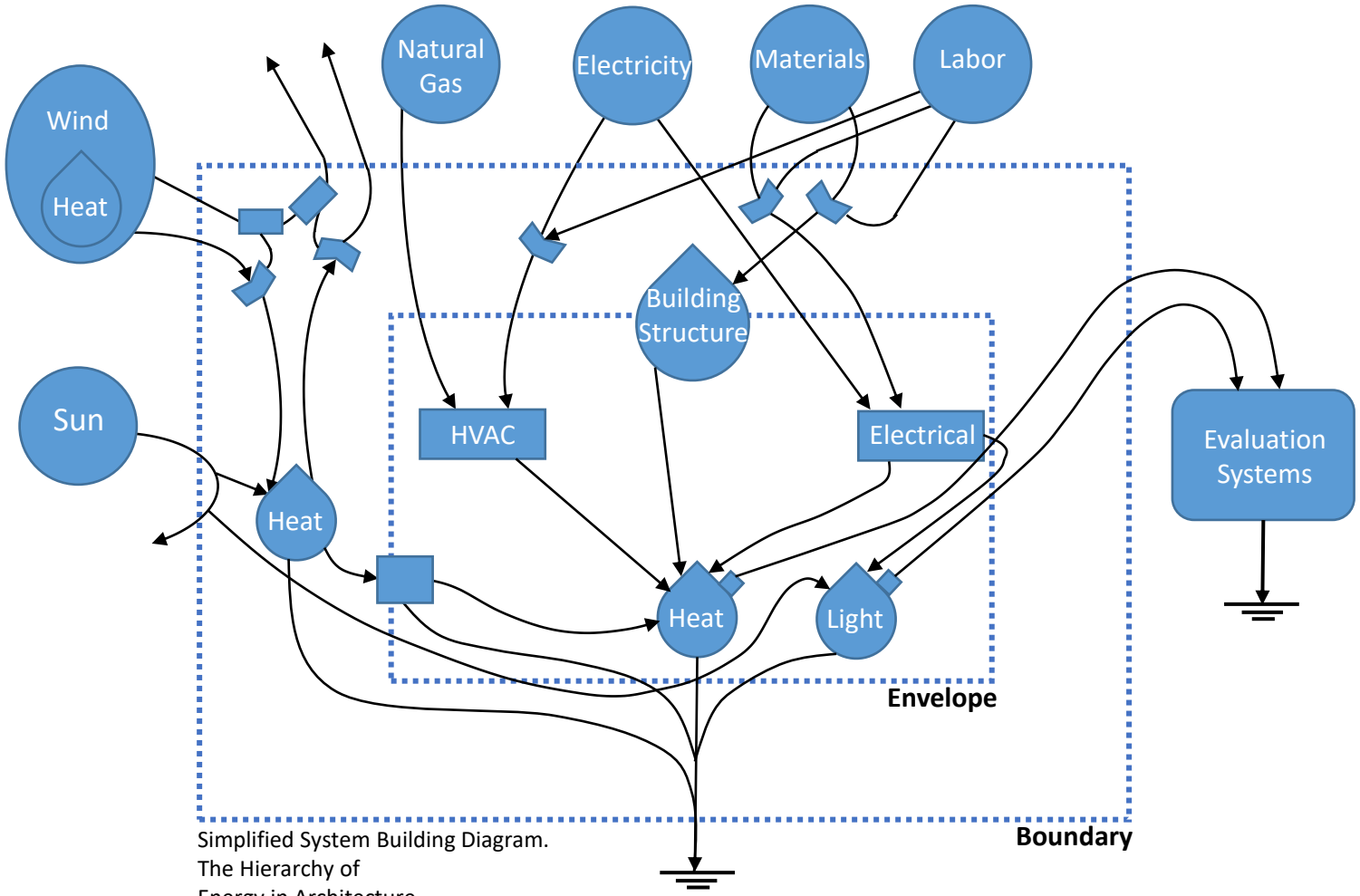
Figure 5. Propeller Concept

1.4 THEORETICAL FRAMEWORK

CORE: *The Hierarchy of Energy as a conceptual framework.*

- Structure, behavior and **Hierarchy of Energy** as a BASIS FOR DESIGN.
- Concepts: Energy, entropy, exergy and EMERGY ANALYSIS.
- BUILDING SYSTEM DIAGRAM:
- *Hierarchy, magnitud and direction of energy flows.*





Simplified System Building Diagram.
The Hierarchy of
Energy in Architecture.
Emergy Analysis. *Kiel Moe.*

1.5 METHODOLOGY

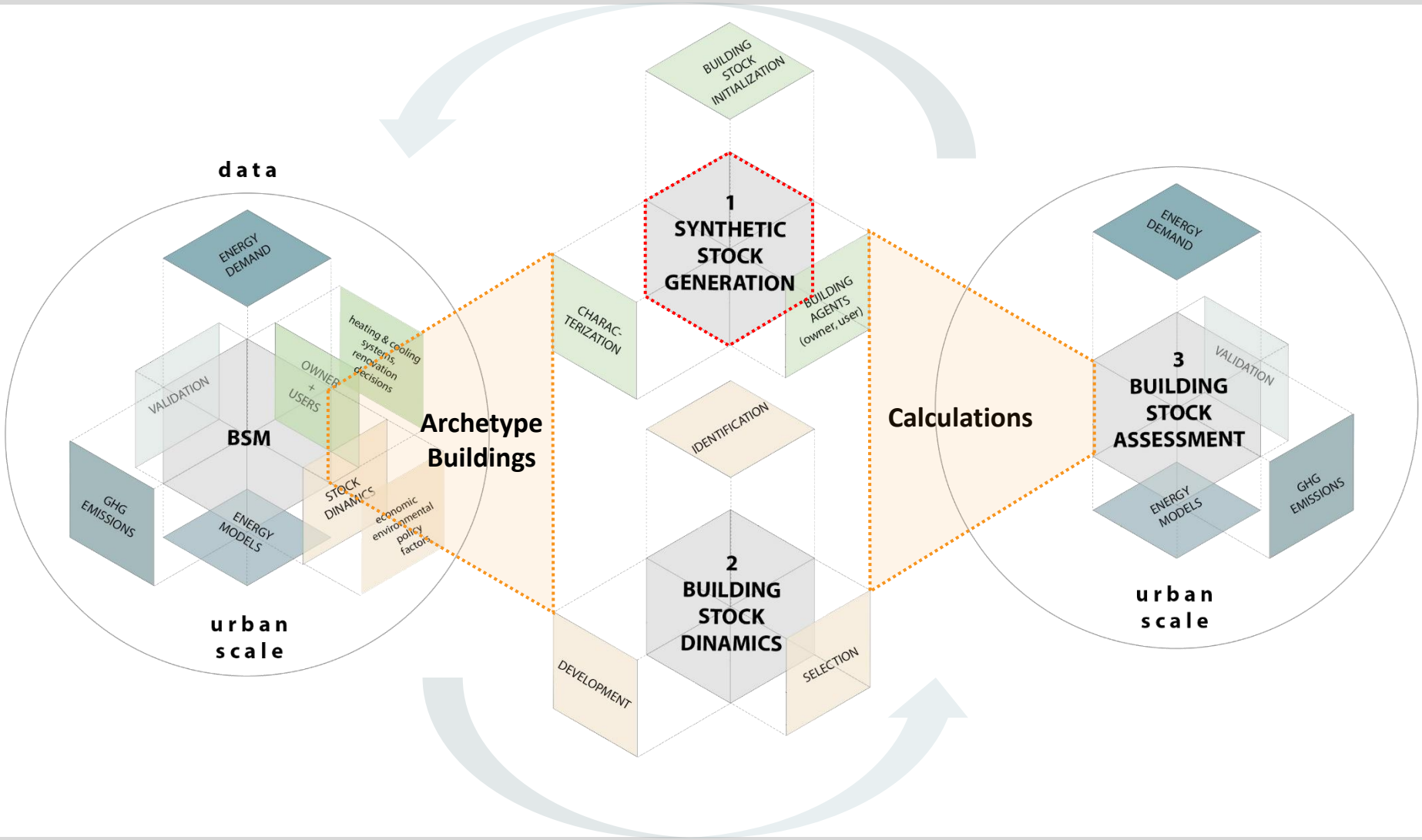
CORE: *Archetype Buildings as the base of a Synthetic BSM*

MODEL ENTITIES:

(1) BUILDING

+

(2) MODEL ENVIRONMENT



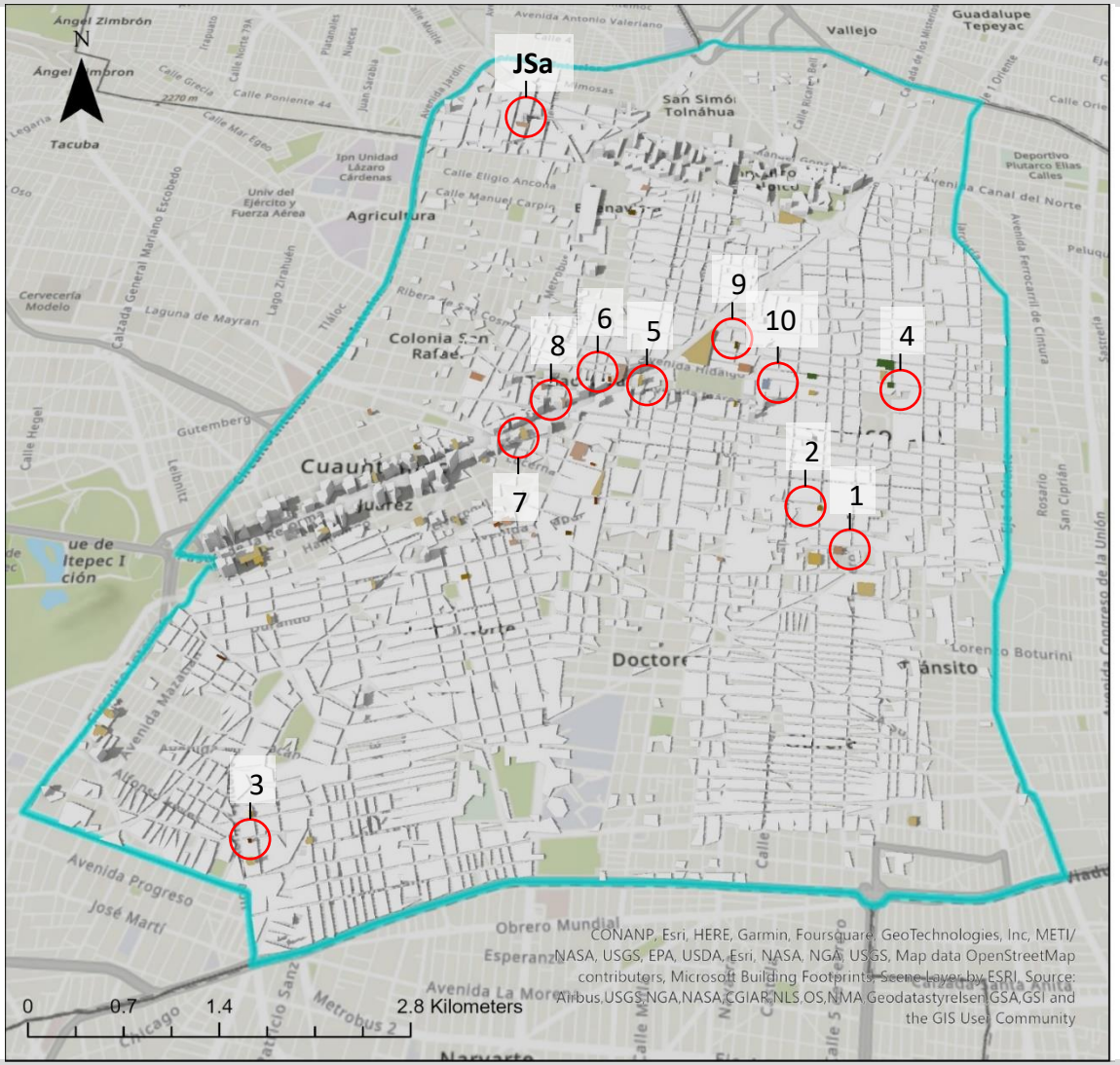
2. RESEARCH DESIGN

2.1 BUILDING STOCK MODEL DESIGN

CORE: Mapping Building Cases

1. Data Collection & Integration
2. Data pre-processing
3. Model Development
4. Validation and Calibration
5. Scenario Analysis
6. Visualization

Jsa. Modelled with complete Project available.



10 Building Cases **Synthetically Modeled**

No.	STREET	IMAGE	CASIFICATION	FACADE TYPOLOGY
1	Fray Servando T. de Mier 135		NO HVAC	T3
2	Izazaga 74		HVAC	T2
3	Tlaxcala 208		NO HVAC	T1
4	Argentina 12		Historical Building, NO HVAC	T2
5	Juárez 101 (Torre Prisma)		HVAC	T3
6	Av. de la República 117		NO HVAC	T2
7	Paseo de la Reforma 116		HVAC	T4
8	Paseo de la Reforma 51		NO HVAC	T4
9	Mina 24		HVAC	T1
10	Tacuba 1		Historical Building, HVAC	T4

Architectural Value **HVAC** **EXPOSED FACADES**

2. RESEARCH DESIGN

2.1 BUILDING STOCK MODEL DESIGN

***CORE:** Buildings Baseline.*

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Operational Emergy flow: 15%
Construction and maintenance: 85%

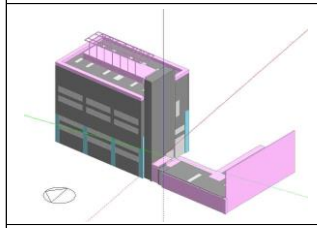
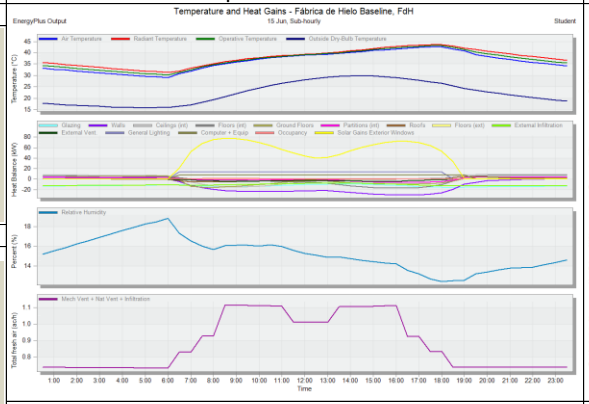
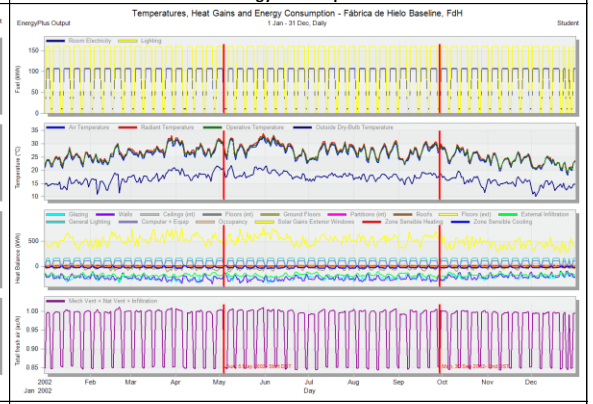
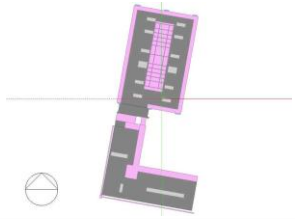
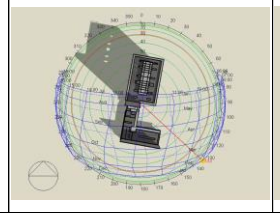
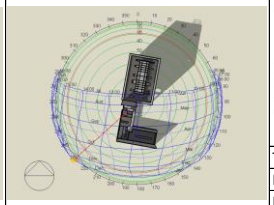
Importance of the SPECIFICATIONS!

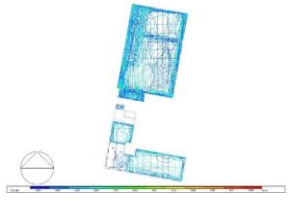
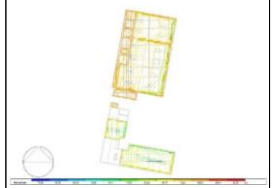
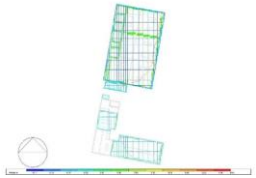
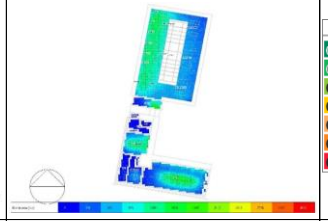
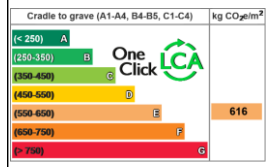
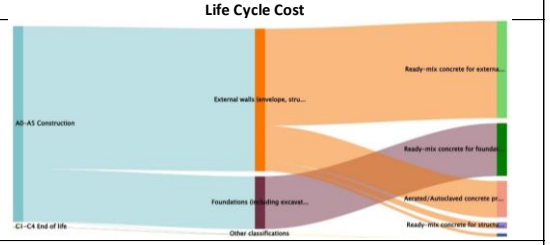
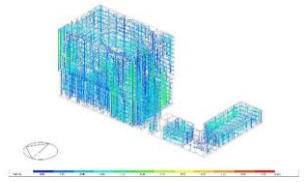
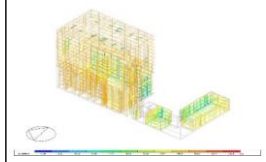
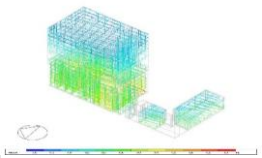
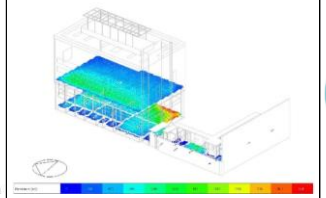
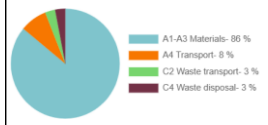
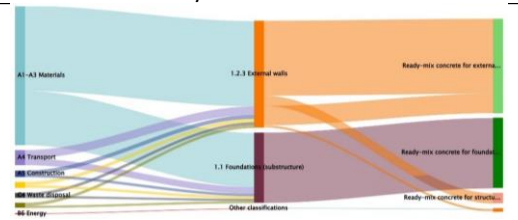
Implications in **RETROFIT STRATEGIES:**

1. Maximize **SITE RENEWABLE SOURCES.**

2. In the **MAINTENANCE PHASE** of the LCA (Usage Stage), it is assumed that, if a given **component** expected **USEFUL LIFESPAN** is less than that of the building, it can be **ENTIRELY REPLACED.**

FÁBRICA DE HIELO - Jsa

Schematic Axo	Solar Path		Temperature and Heat Gains	Energy Consumption
	Summer 1 June - 9 hr	Summer 1 June - 15 hr		
Plant	**Winter 21 Dec - 9 hr**	**Winter 21 Dec - 15 hr**	Temperature	Fuel
			Heat Balance	Temperature
			Percent %	Heat Balance
CFD (Computational Fluid Dynamics)			Total fresh air (ac/h)	Total fresh air (ac/h)

Velocity (Plant)	Temperature (Plant)	Presure (Plant)	Illuminance (Plant)	Embodied carbon	Life Cycle Cost
					
Velocity (Axo)	**Temperature (Axo)**	**Presure (Axo)**	**Illuminance (Axo)**	**Global Warming Potential**	**Life Cycle Assessment - GWP**
					

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CORE: *Buildings Baseline.*

1. Data Collection & Integration
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* Projection factor (GWP)

BUILDING STOCK MODEL

B A S E L I N E

No.	BUILDING	Energy Demand (kWh)					GHG Emissions (kg CO_2e)	NEB		
		Cooling*	Heating	Mechanical V	Lighting	Int. Equipment	Embodied Carbon	Resilient Coeficient	Health	Productivity
0	Fábrica de Hielo - Naranjo 323	0	0	0	40,777.34	28,286	110,090			
1	Fray Servando T. de Mier 135	0	0	0	312,287.19	1,055,940	118,965			
2	Izazaga 74. Piso 5	48,132.10	0	0	116,618.71	270,186.03	31,192,687			
3	Tlaxcala 208	?	0	0	27,064.89	62,704.81	41,835			
4	Argentina 12	0	0	0	185,910.33	88,289.68	261,233			
5	Av. Juárez 101	2,568,936.58	0	0	506,274.22	1,604,466.09	3,298,665			
6	Av. de la República 117	0	0	0	198,549.76	418,628.67	6,462,349			
7	Paseo de la Reforma 116	0	0	0	971,926.32	2,523,479	14,360,717			
8	Paseo de la Reforma 51	0	0	0	587,375.93	1,861,491	8,947,170			
9	Mina 24	0	0	0	133,203.04	280,850	7,262,500			
10	Tacuba 1	106,502.90	0	0	543,235.88	1,410,441	523,364			

CONCLUSIONS

CORE: *Next Steps – NEB + Retrofit Strategies + Web Tool Draft*

- This study aimed to give Mexico City a more **straightforward approach in decision-making to calculate retrofit scenarios** on an urban scale.

- Building baseline **Results** show so far:
  - Operational Emergy flow : 15%
  - Construction and Maintenance: 85%

- Implications in **RETROFIT STRATEGIES**:
  - Maximize Site Renewable Sources.
  - Useful Lifespan of a given component is less than that of the building, it can be replaced.

- This study helps to integrate the **NEB** in a quantitative perspective as part of the Buildings Performance Improvement.

Thank you

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National Council for Science and Technology

CONAHCYT - Mexico