BUILD_ME

IKI Project: Accelerating 0-emission building sector ambitions in the MENA Region

Online Training

How to calculate the energy performance of buildings in the Arab Region?
The introduction of the BEP tool

May 2023

IKI INTERNATIONAL CLIMATE INITIATIVE

Federal Ministry for Economic Affairs and Climate Action

Welcome words

HE Eng. Jamila Matar, LAS
Dr. Jauad El-Kharraz, RCREEE
Arch. Riadh Bhar, Guidehouse

5 minutes

- Click to add text

Objectives of the training session

For project developers, architects and engineers

1. Introduce the BUILD_ME project
2. Transfer basic understanding of a holistic approach for climate friendly buildings
3. Introduce the BEP tool and enable the utilisation

Presenters of the training session

For project developers, architects and engineers

Riadh Bhar
Associate Director, Guidehouse
riadh.bhar@guidehouse.com

Jince John
Consultant II, Guidehouse
jjohn@guidehouse.com

Eslam Mohamed Mahdy
Managing Consultant, Guidehouse
eslam.mahdy@guidehouse.com

Yassmin Al-Amir
Analyst, Guidehouse
yalamir@guidehouse.com

Agenda

Part 1: Introduction and Basic principles of EE and RE in Arab buildings

Welcome words (LAS/RCREEE/GH)	10:00 – 10:05
Introduction of the BUILD_ME project	10:10 – 10:15
General introduction of the relevance of EE in buildings	10:15 – 10:20
Selection of most relevant EE&RE measures	10:20 – 10:45
Q&A	10:45 – 10:50
Break	10:50 – 11:00

Part 2: Building Energy Performance (BEP) Tool

Introduction to the BEP Tool	11:00 – 11:15
Walk through the tool	11:15 – 12:00
Break	12:00 – 12:10
Case studies – calculating exercise	12:10 – 12:40
Discussion and Wrap up	12:40 – 13:00

Technical instructions

Working together effectively

- Presentation will be published on our project website afterwards.
- The session will be recorded.
- We look forward to your active participation.
- Please stay muted but feel free to write your questions in the chat box or raise your hand.
- Please be punctual after the break.
- For technical problems/questions, reach out to:

  – Yassmin Al Amir: yalamir@guidehouse.com

Photo by Chris Montgomery on Unsplash

Introduction to the BUILD_ME Project

Riadh Bhar, Guidehouse

BUILD_ME

5 minutes

Introduction to the BUILD_ME Project

Overarching storyline of BUILD_ME phases

Phase 1
2016 - 2018

Analysis & Recommendations

- Analysis of boundary conditions and stakeholder perspectives
- Formulating recommendations for implementation

Phase 2
2019 - 2022

Prepare the Implementation

- Developing tools for implementation
- Connecting with stakeholders to initiate the implementation

Phase 3
2023-2025

Support the Roll-Out

- Piloting the roll-out to reach implementation
- Scaling up activities to enlarge the impact

Objectives of current third phase of BUILD_ME

March 2023 – March 2025

Technical

More robust tools, allowing for stronger support

- Further develop the BEP tool
- Roll out energy performance certificate EPC scheme with the national agencies
- Trainings

Financial

Green financial products for buildings

- Matchmaking between financial institutions and pilot project developers interested in receiving green finance.
- Facilitating green finance for buildings projects.

Policy

EE of buildings Contributing to national policies

- National energy efficiency Strategies
- Simplification and updates of EEBC.

Introduction to Climate-Friendly Buildings

Riadh Bhar, Guidehouse

5 minutes

Guidehouse

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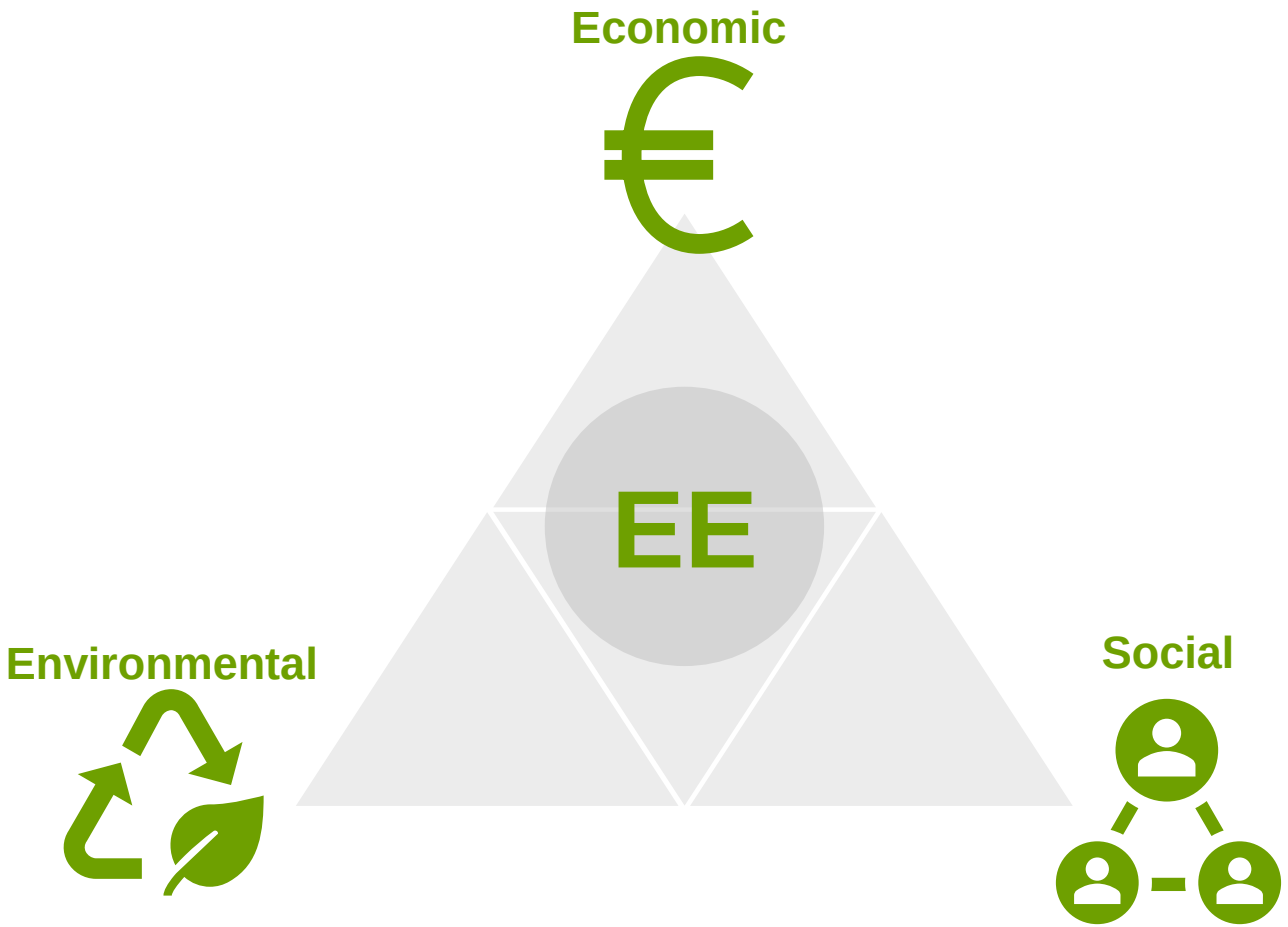
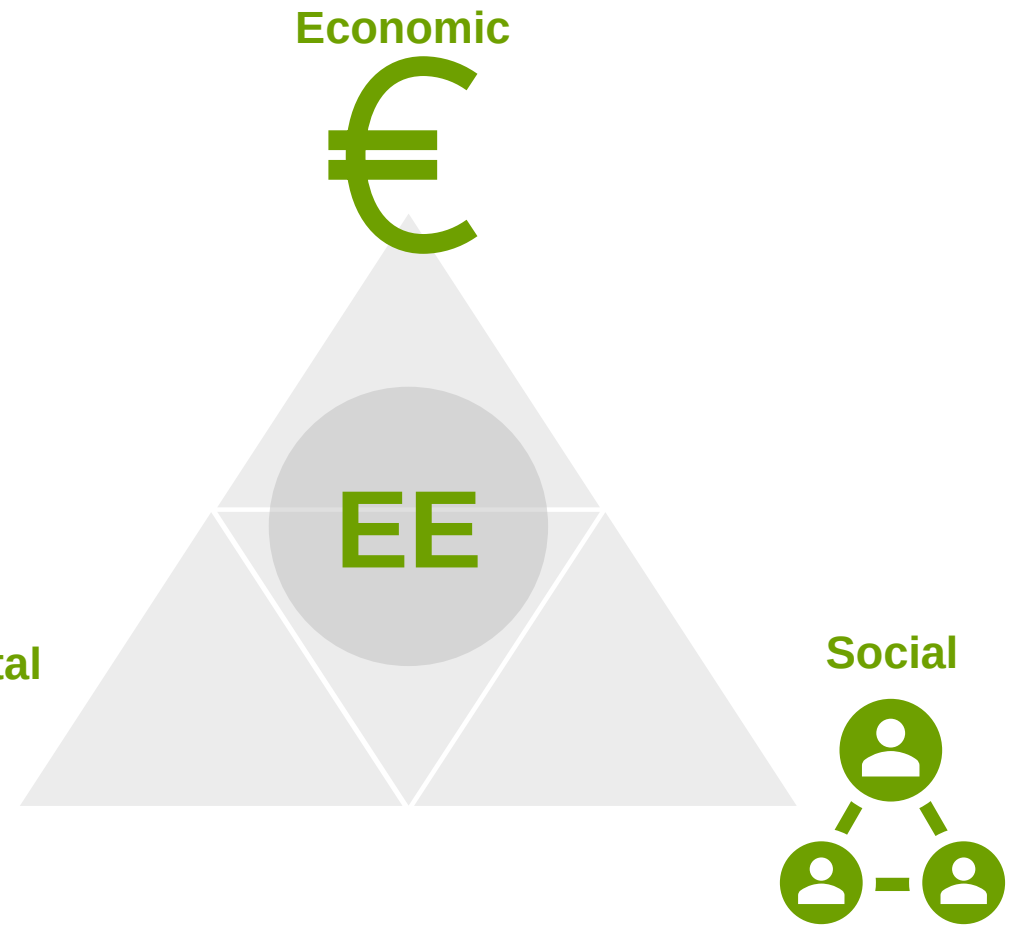
The relevance of low energy buildings

Sustainability Triangle or three Pillars of Sustainability



The relevance of low energy buildings

Sustainability Triangle or three Pillars of Sustainability



Extreme weather events
Rising temperatures
Sea level rise
Droughts
Pollution

The relevance of low energy buildings

Sustainability Triangle or three Pillars of Sustainability

Economic

Cost-efficient abatement
Energy security
Independence of energy price increases

Environmental

Extreme weather events
Rising temperatures
Sea level rise
Droughts
Pollution

Social

The relevance of low energy buildings

Sustainability Triangle or three Pillars of Sustainability

Economic

Cost-efficient abatement
Energy security
Independence of energy price increases

Extreme weather events
Rising temperatures
Sea level rise
Droughts
Pollution

Environmental

Social

Job creation
Removal of subsidies
Public health and productivity

What is a climate friendly building?

What is a climate friendly building?

What is a climate friendly building?

“a building that improves the quality of life of the environment in which it is located" and consuming (only) minimally resources (energy, water materials..)

Climate-friendly buildings from a technology perspective

Yassmin Al-Amir,
Guidehouse

25 minutes

Photo by Lukas Blazek on Unsplash

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Key Learnings

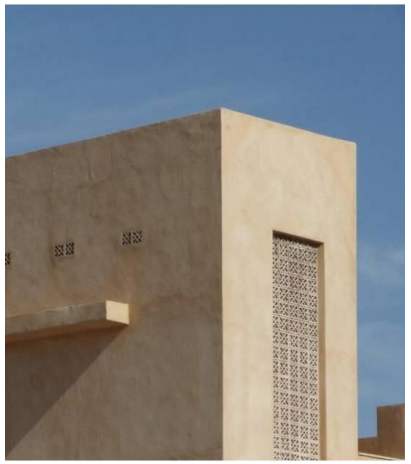
Principles of the holistic planning

Measures to reduce energy consumption

Renewable energy measures

Demonstration Projects

1 Aqaba Residence Energy Efficiency House (AREE) – Aqaba, Jordan



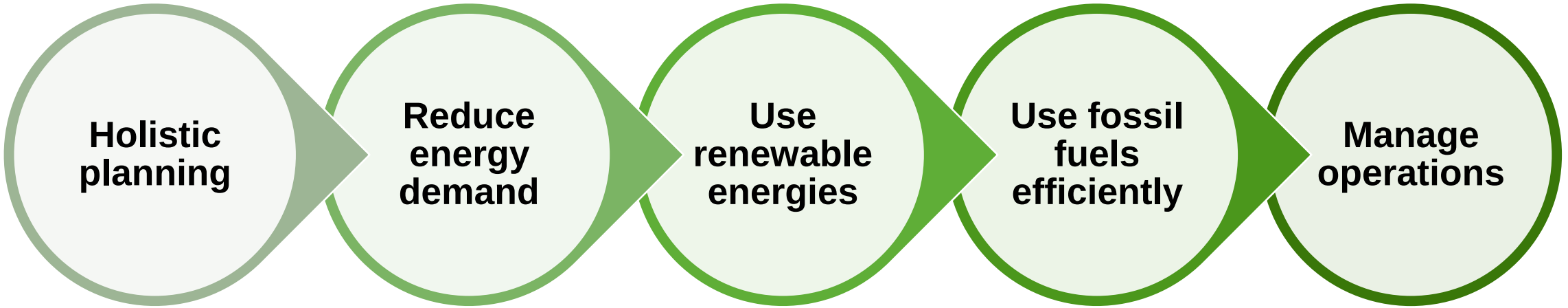
- National Winner of the Energy Globe Award 2007
- Floor area: 420m2 – 3 floors
- Residence / Guest lodging / Info-Study Centre
- Developer: Tariq Emtairah - Emtairah Consulting Corp
- Project Manager & Architect: Florentine Visser

2 Etrium – Cologne, Germany

- Etrium is the first passive office > 3.000 m² floor space in the Region of Cologne
- Etrium has an innovative energy concept, developed by Guidehouse
- Architect: CROSS Architecture / Benthem Crouwel GmbH
- Awards: 2. Place PROM des Jahres 2009, DGNB Gold Certfiicate, BREEAM Excellent

General principles to conceive a low energy building

Embed Trias energetica, „*The most sustainable energy is saved energy*“




Source: https://unsplash.com/photos/KqEY1VHA_o

Step 1: Holistic planning

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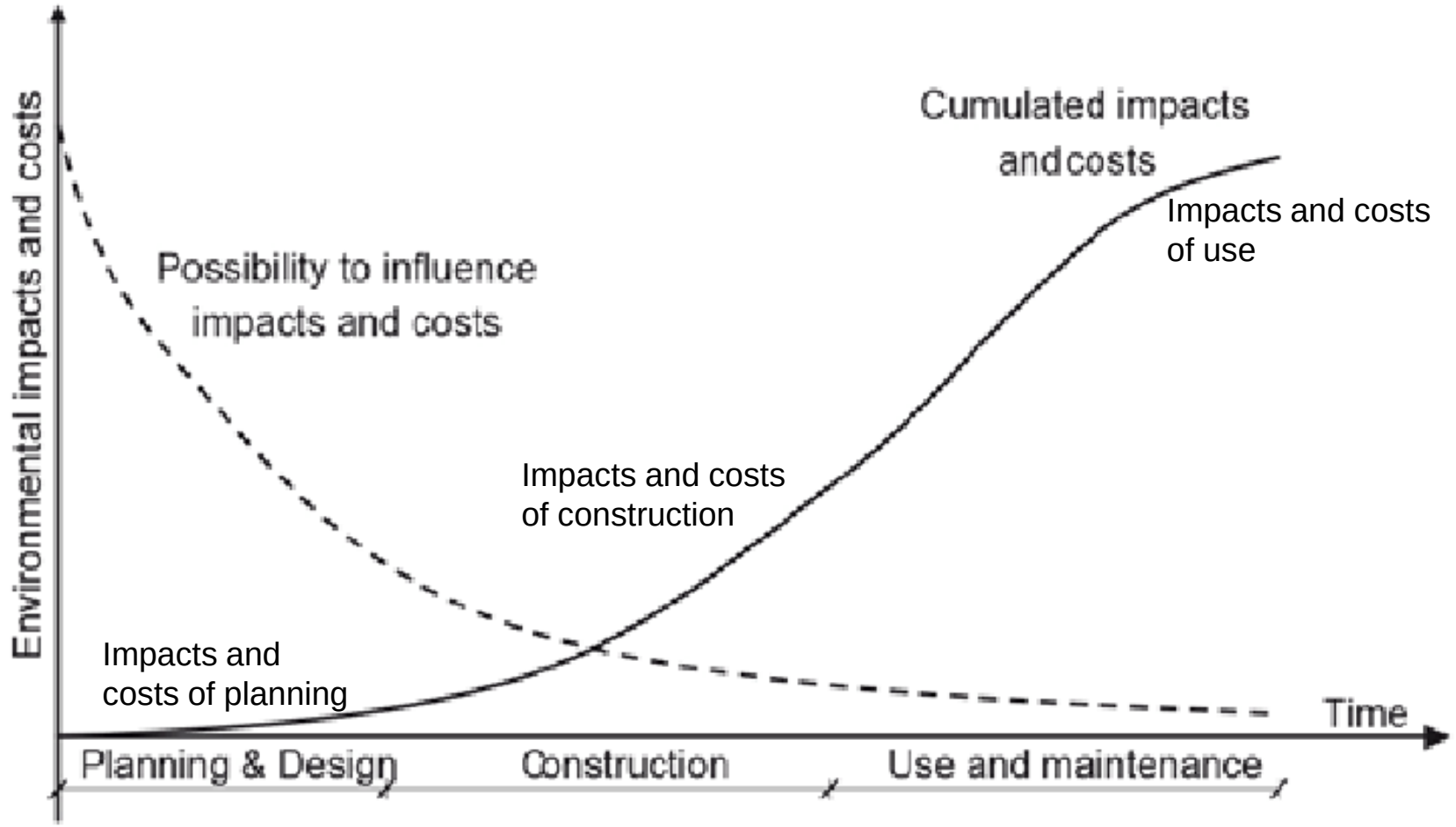
Influence of design decisions on life cycle impacts and costs



Source: Kohler & Moffatt, 2003

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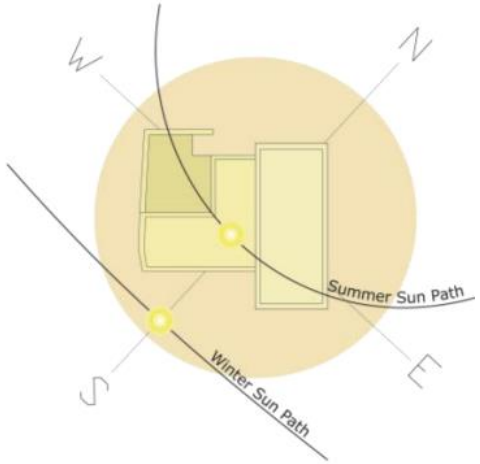
Source: https://unsplash.com/photos/0MKzwPmehRE

Step 2: Reduce energy demand

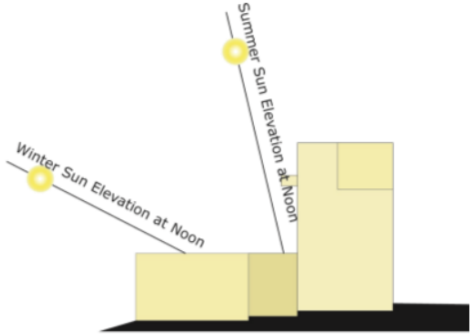
(Passive Strategies)

Passive methods – AREE

- **Orientation**
  Orientation on the east-west axis to reduce cooling load



Horizontal Sun Path



Vertical Sun Angles

- **Building form and Typology-**
  Compact building form has a lower surface/volume ratio (S/V)

Envelope = 81.5m²
S/V = 1.55

Envelope = 71m²
S/V = 1.35

Envelope = 63m²
S/V = 1.2

- **Thermal zoning**
  Organise space according to time of use and sun exposure

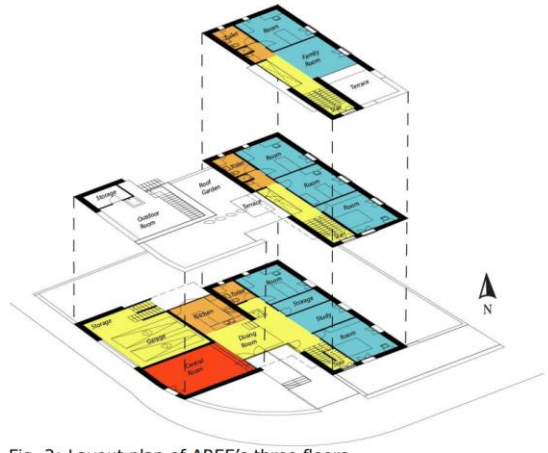


Fig. 2: Layout plan of AREE's three floors.

1- Yellow: Service rooms and the corridors

2- Orange: the bathrooms

3- Blue: Bedrooms

4- Red: The living room

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- **Building Envelope:**
- **Transparent**

Double glazing: lowers the windows' U-value from 5.9 to 2.9 W/m2K. Also, decreases the window's transmittance of solar radiation from 83% to 69%.

Double glazing section

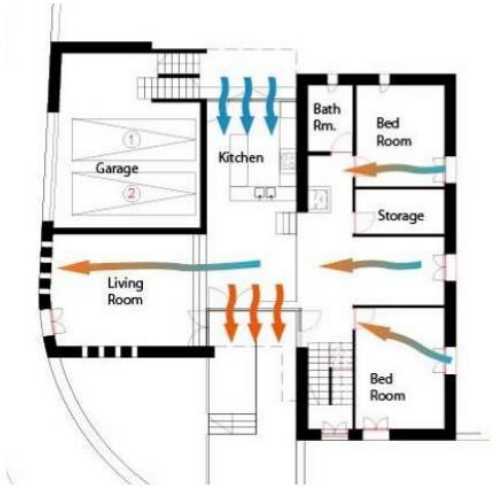
- **Building Envelope:**
  - **Opaque**

The lighter the colour, the higher the reflection, the less the absorption

A white roof reduces the cooling load

- **Passive Cooling:**
  - **Ventilation**

Cross Ventilation and stacked ventilation



Ground floor plan showing induced cross ventilation.

The small latches at the uppermost part of the building induce the rising hot air within the building to exit it.

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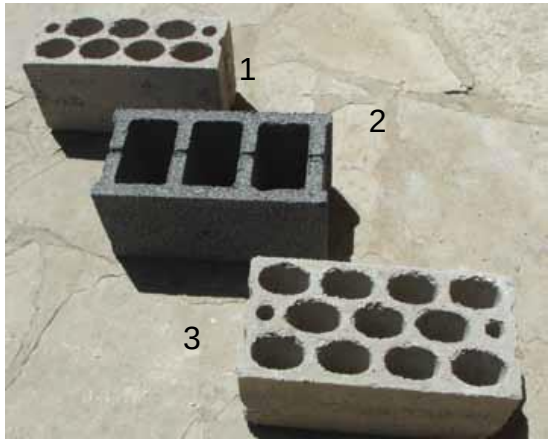
- **Material Selection**
- **Thermal Insulation**

Rockwool, polystyrene, and a sand-straw mixture were used for insulation within the walls.

- **Concrete blocks**



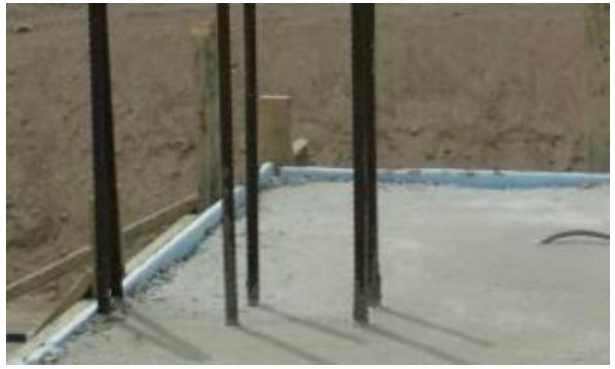
1- Regular Block

2- Volcanic aggregate

3- Perlite aggregate

- **Material Selection**
- **Thermal Bridges**

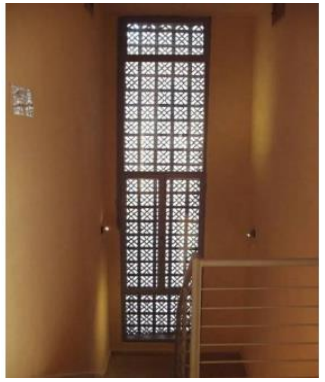
External edges of floor slabs insulated by polystyrene strips are used to avoid the formation of Thermal bridges



In order to avoid thermal bridges at the junctions between the walls and the structural system, the insulation has to wrap around these structural elements.

- **Shading**

- **Horizontal** cantilevers. – **Southern** Façade
- External **vertical** sliding and fixed shades for windows. – **Eastern/Western** Façade
- Fixed shading structures for the outdoor spaces and in front of large windows such as the kitchen and dining area windows.



- **Passive Cooling:**

- **Thermal Mass**

The extra layer of soil on top of the roof increases its thermal mass and helps offset heat gain.
The plants on the roof garden and the solar heating panels also shade the roof.

View of the roof garden.

- **Landscape design**

Use vegetation for a better microclimate, shading, thermal mass

Images of the landscaping at the entrance.

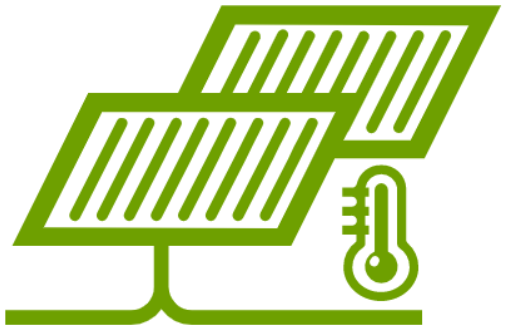
Images of the landscaping of the roof garden.

Source. https://unsplash.com/photos/BB0mMC8y0Pc

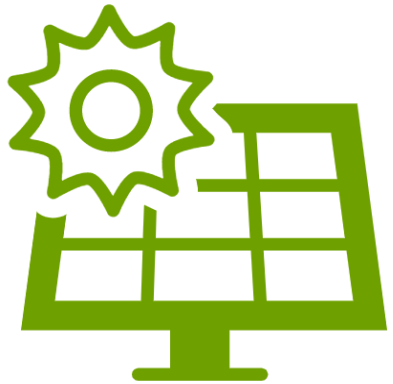
Step 3: Integrate renewable energies

Renewable energies

Scope of training



Solar thermal systems



Photovoltaics

Heat pumps

Solar thermal / AREE

- The system is composed of 11 Azuro Paradigma panels, each with 24 evacuated tubes.
- These solar collectors are placed on the main roof.
- The total area that the collectors occupy is about 32 m2
- These solar panels also serve as a basis for the building's cooling system, as will be explained later.

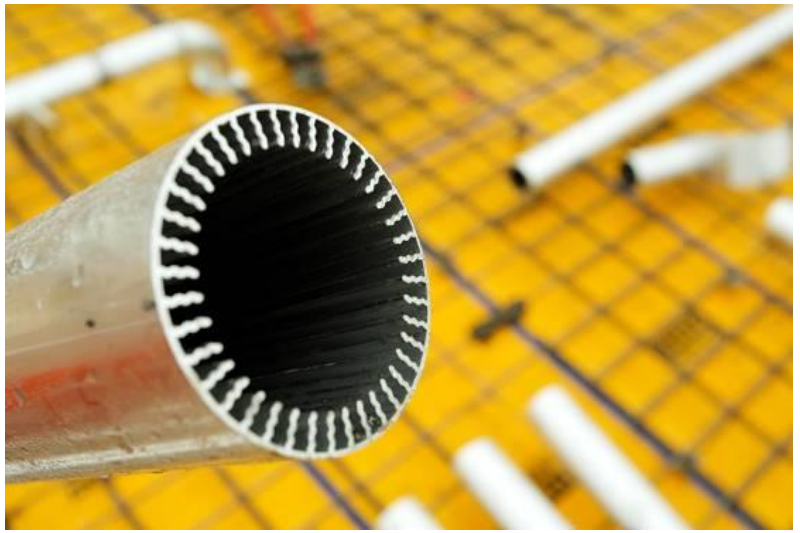
Solar collecting panels on the roof.

Photovoltaics / Etrium

PV-plant (32 kWp) – integration of PV with the green roof

Heat pumps / Etrium

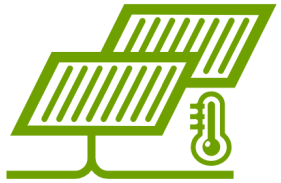
- **Heating and Cooling**



- Use of groundwater for heating (via heat pump) and cooling (only passive!)

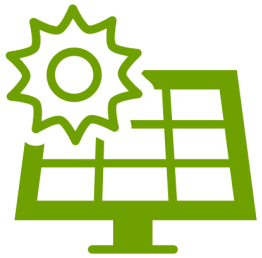
Renewable energies

Conclusion



Solar Thermal Systems (ST) already **mature technology** in the MENA region.

In some MENA countries **specific incentive programs needed** to accelerate the deployment of ST.



Photovoltaics have experienced a **sharp decrease in system costs**.

And in major parts of the MENA region **regulative frameworks are in place**. So PV is currently experiencing a big push in the MENA region.

Heat pumps are **still rare** in the MENA region (besides air/air). Main reasons are the **high investment costs** and the lack of experienced craftsmen.

Source: https://unsplash.com/photos/JUAVCUMY008

Step 4: Use high efficiency HVAC Appliances

HVAC - AREE

Overview of HVAC systems

Hot Water

Solar Thermal
(discussed previously)

Solar collecting panels on the roof.

AC (Air-Conditioning)

Adsorption chiller-based system
- Solar cooling

High efficiency of cooling appliances is crucial to bring down the costs of the cooling demand
Minimum Energy Performance Standards shall be considered while selecting these appliances

Ventilation

Natural ventilation

Heating

- Thermal wall and compact thermal mass
- Temporary movable gas heaters due to minimal heating needs.

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Source: https://unsplash.com/photos/mAwE-fqgDXc

Step 5: Operation

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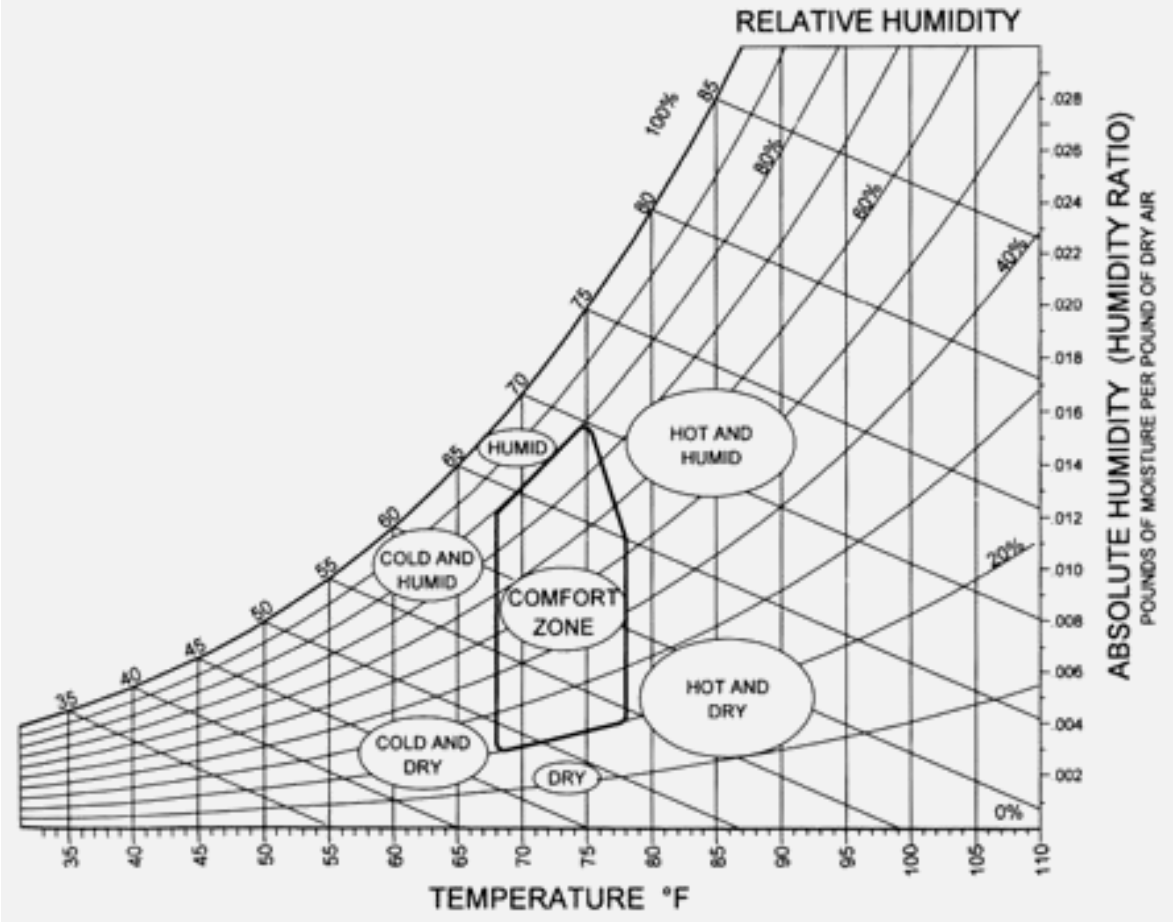
Basics of thermal comfort



Numbers are orientational

Example of temperature ranges			
Use/function		**Winter**	**Summer**
Residential	Living room	20-22°C	24-26°C
	Sleeping room	18-20°C	24-26 °C
	Bathroom	22-24°C	24-26°C
Office		20-22°C	24-26°C
School (classroom)		20-22°C	24-26°C
Shops		18-20°C	22-25°C

According to Egyptian Energy Efficient code for buildings, thermal comfort for Egypt region is:

Temperature : 21.8-30 ºC
Humidity : 20-50%
Wind speed : 0.5-1.5 m/sec

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Savings in AREE

The Project's total budget in comparison with the baseline case:

-Total investments of Conventional Building Baseline: 107,100 €

- Total investments of Project MED-ENEC: 147,739 € – Additional investment: 40,639 €

Primary Energy Demand

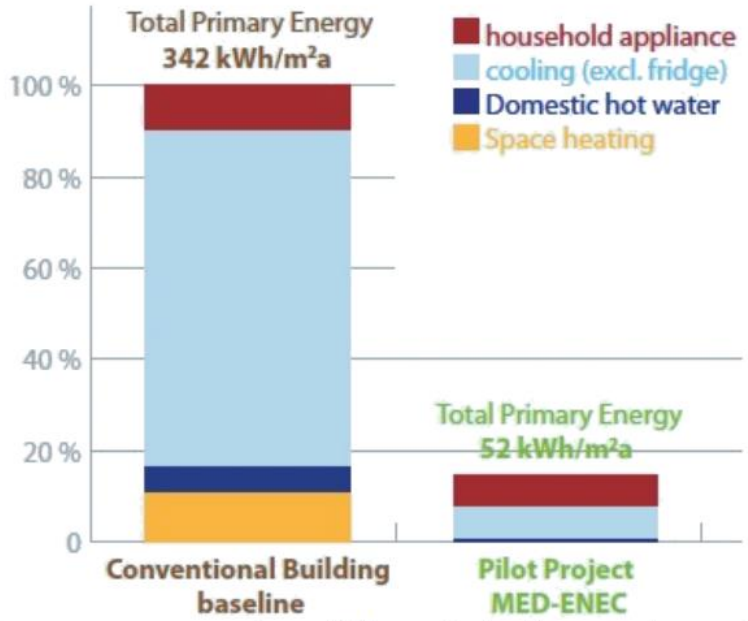

Diagram comparing different design and construction options with the baseline case.

Pay back period

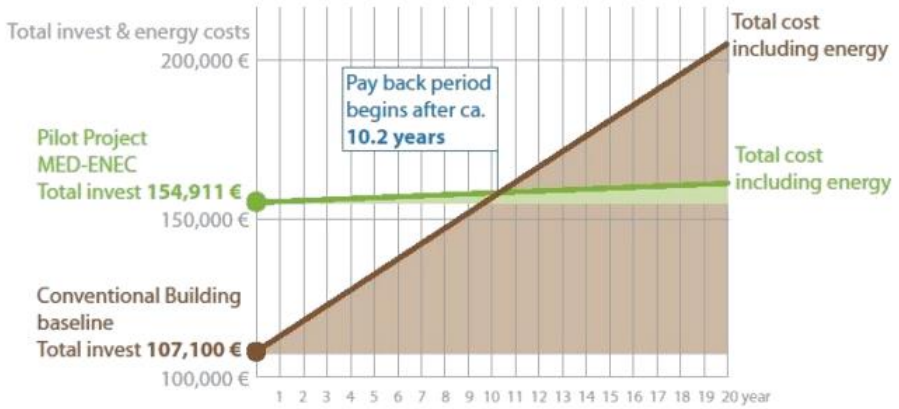

Diagram calculating estimated payback period for case C – the project as implemented.

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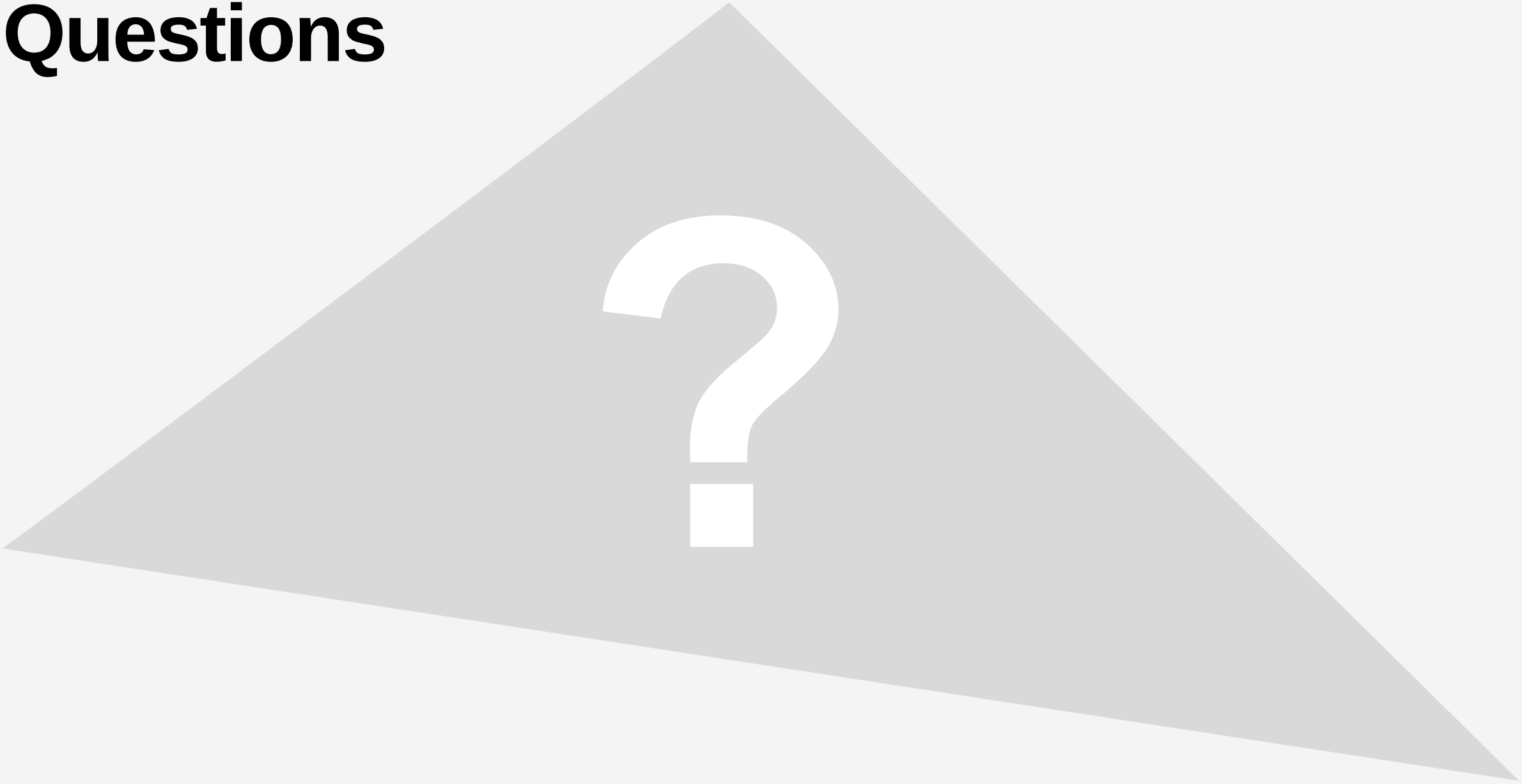
Conclusion

Theme	Key Lessons
Holistic planning	• **Integrate sustainable measures** in your planning, **the sooner - the more cost-efficient** they become.
Passive EE measures	• Consider passive EE measures as they **are highly cost attractive with no or only limited upfront capital costs**, but significant saving potential • Utilize thermal insulation, shading measures as they do not only save energy, but also improve thermal comfort
Renewable energies (RE)	• Incorporate RE as they are **relevant measures to decarbonise the energy supply** for the building • Increasingly cost attractive (learning curve)
Active EE measures	• Look always for **top performers in the market**: higher upfront costs generally compensated by increased savings over lifetime • Check best practice and **consider labels** (A,B,C…) as orientation to select top performers, commonly used also in the BUILD_ME countries
Operation	• Use always **appropriate temperature setting** • Too low temperatures (for ACs in summer) or too high temperatures (for heating appliances in winter) can have a significant impact on the energy demand, ranging between 5-10% for 1 K

Questions



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Break

10 minutes

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Building Energy Performance (BEP) tool

High level understanding

Eslam Mohamed Mahdy,
Guidehouse

15 minutes

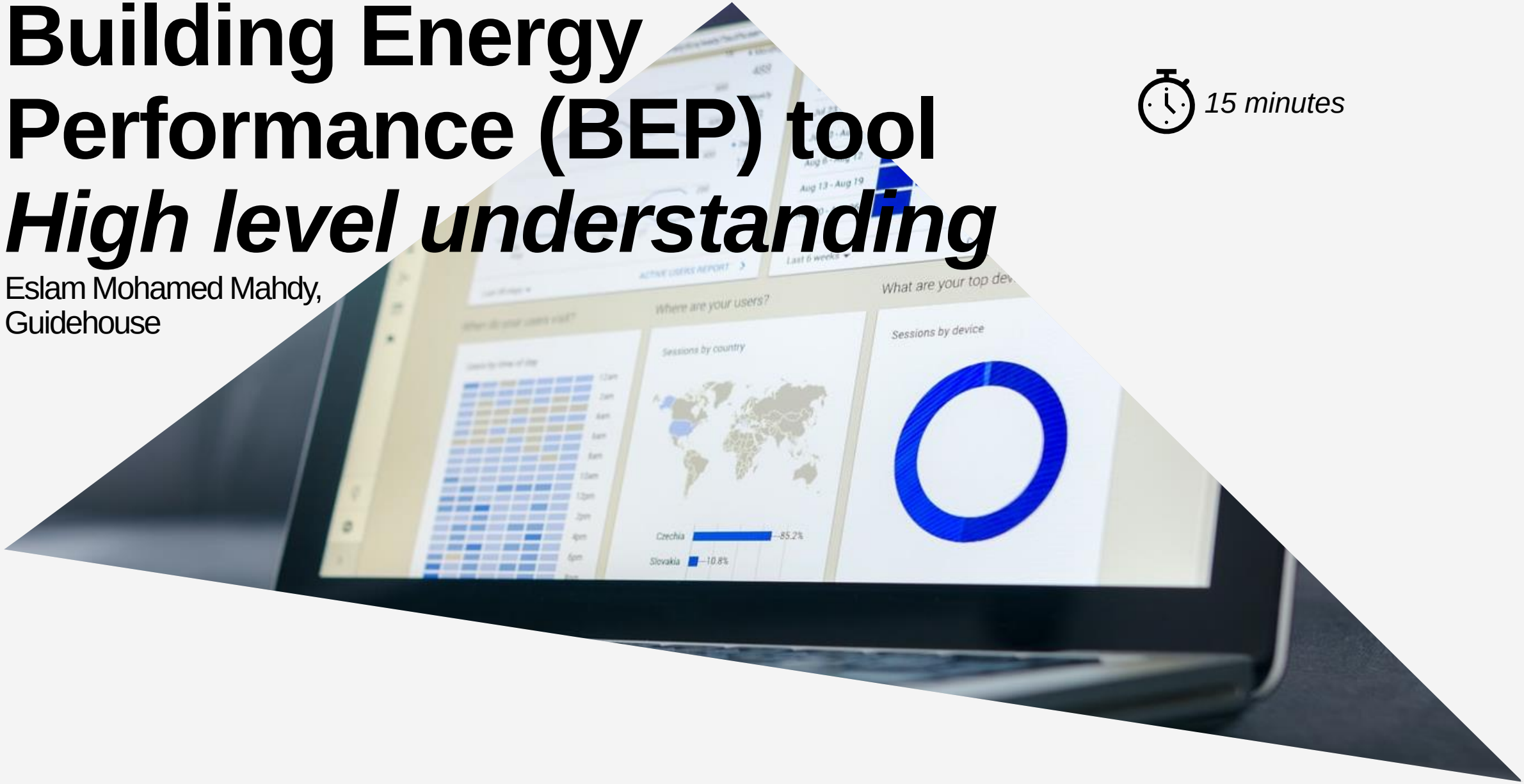

Photo by Lukas Blazek on Unsplash

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Logic of the BEP tool (1)

Customisable, transparent, adapted to the MENA region

Performance of energy efficiency measures & RE

- Calculate **energy demand** of building
- Compare it to the **country's baseline** buildings or other personal projects
- Determine the **energy savings** of single or multiple efficiency measures and the use of renewable energies

Calculation of monetary savings

- Identify **cost savings** resulting from the energy efficiency measures and get the **cost-optimal** case
- **Local market data** is already available for Egypt, Jordan and Lebanon (investment cost, energy prices) ...
- ...or enter the real investment cost and energy prices of the specific project *(not in beta)*

Free web application

- Tool is **free to use as browser application**
- Optimized for **mobile devices**
- Provides **default input values** for faster application, but also **advanced mode** for experienced user

Proven methodology

- Energy calculation is based on the **international norm** for modelling thermal building performance (EN ISO 52016)
- The BEP-Tool was already **successfully applied** in various projects and countries
- **Full transparency** with a detailed user manual, incl. all calculation steps and internal assumptions.

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Logic of the BEP tool (2)

Customisable, transparent, adapted to the MENA region

In comparison to other available tools, the BEP tool is

MENA Specific

Up-to-date baseline in the 3 countries

Up-to-date cost data and prices based on market analysis

Updated energy consumption patterns for building types

Easy/Simple to use

No modelling needed

No advanced knowledge required

Allows for Editable Inputs and Third Variants' Addition

Can compare with codes/rating systems

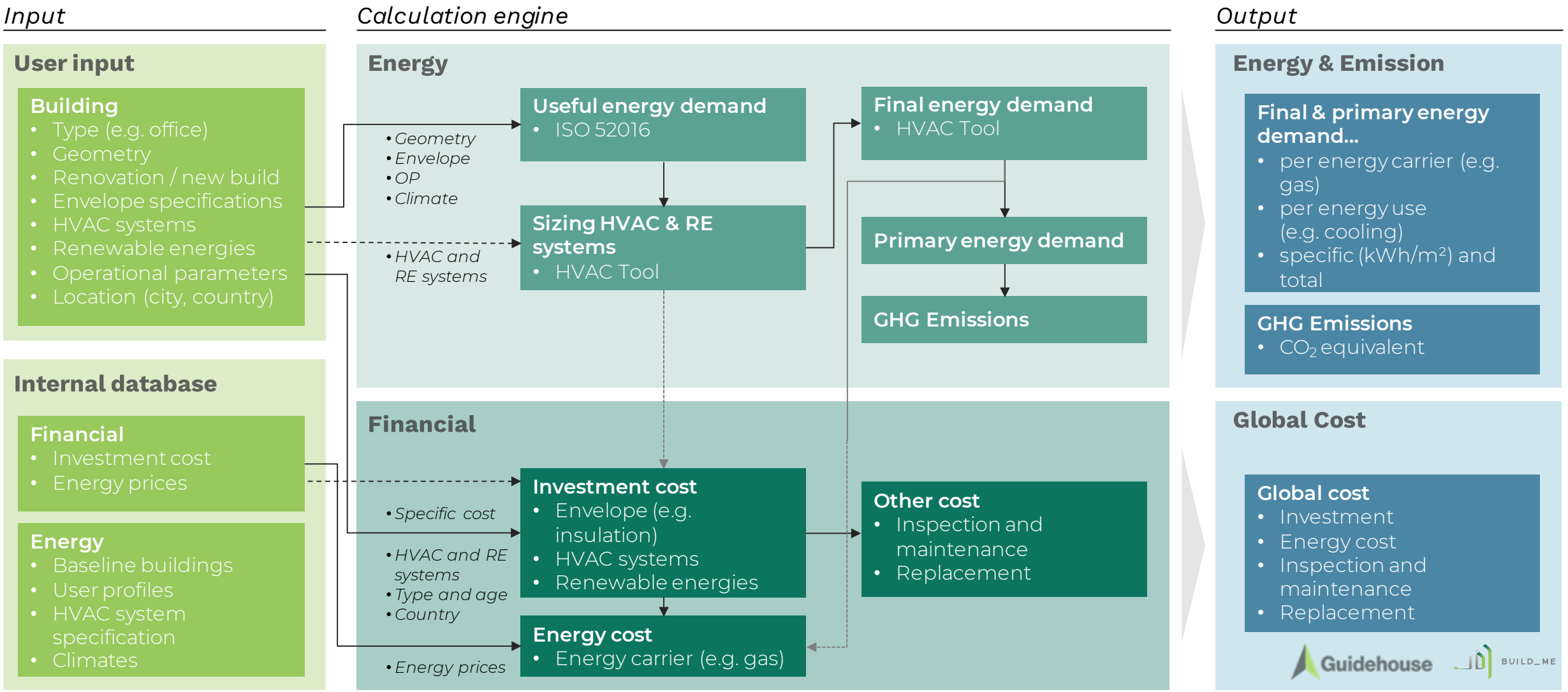
Useful for analysing the retrofitting option

Provides Detailed Explanation of the Results

Can convert to primary energy outputs

Can show the distribution of CO2 savings per energy consumer

Calculation methodology



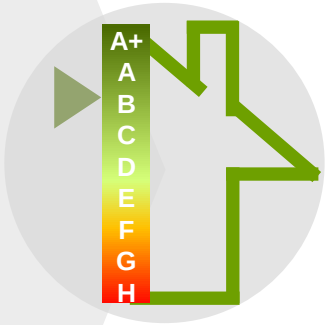
Inputs

Building Typology

Building typology database depicts “reference buildings categorized into specific building types and their energetic characteristics based on their:

- Building type
- Age group (1950 – 1980 – 2000)
- Region
- Building envelope
- Technical systems

baseline



Meteonorm

hourly climate data based on Meteonorm. Which allows for great accuracy considering the local climate of the locations.

Economic and emissions inputs

Those inputs are regularly updated

- Capex
- Energy prices
- CO2 factor

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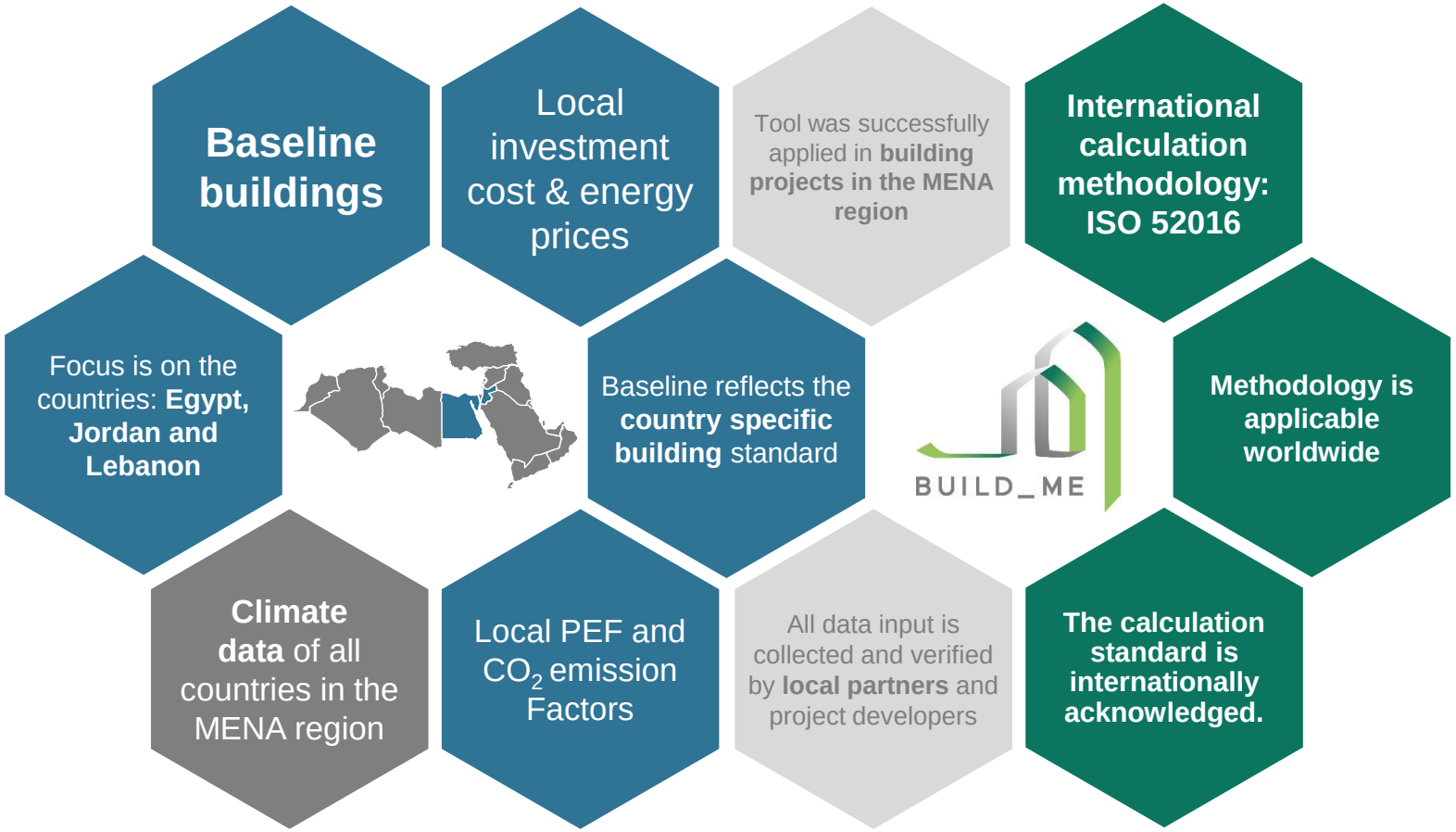
Developed for the MENA region

Database from **local partners** & **international** calculation methodology



Internal market data is **collected from local partners** for Egypt, Jordan and Lebanon.

International energy calculation methodology.

Country specific climate data, incl. multiple climate zones within each country.

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Building Energy Performance (BEP) tool *Walk through*

Jince John, Guidehouse

45 minutes

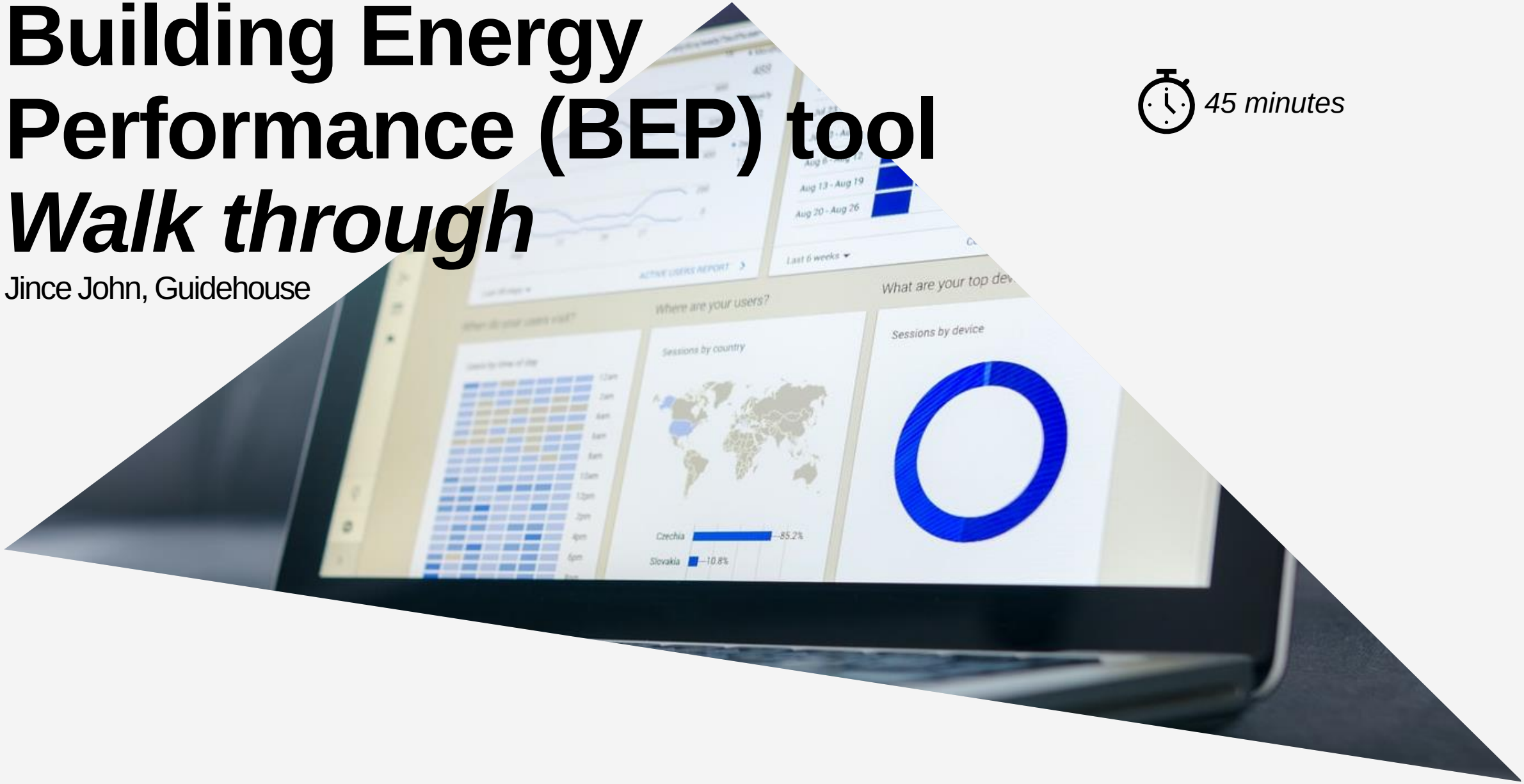

Photo by Lukas Blazek on Unsplash

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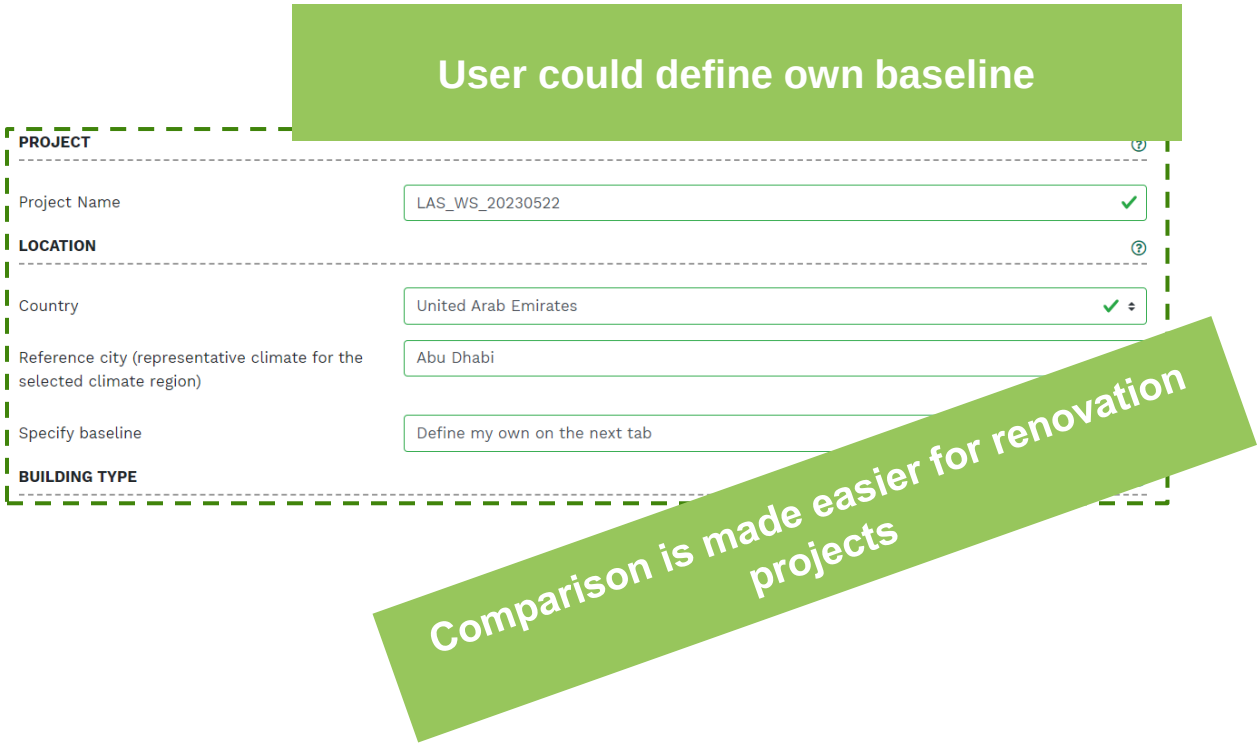
New features
Under development

- Possibility to define **own baseline**
  - Easy comparison for renovation projects
  - Define baseline according to the national standard
- Visualization of the **useful energy demand** of the building
- Possibility to download the **Energy Performance Certificate (EPC)**



- Manual: https://globco.buildings-mena.com/docs/en/BEP.pdf

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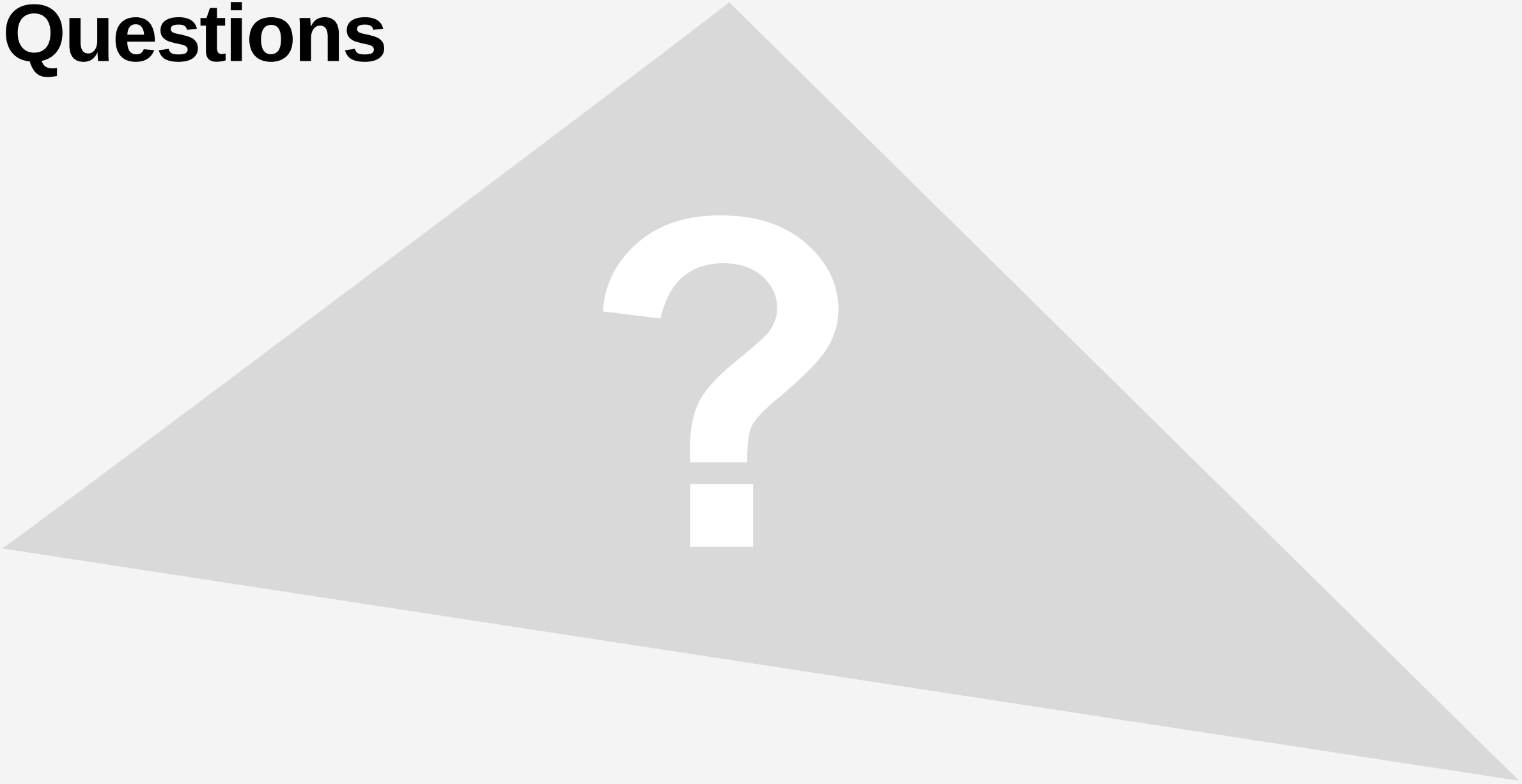
Questions



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Coffee break

10 minutes

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Building Energy Performance (BEP) tool *Case Studies*

Jince John, Guidehouse

30 minutes

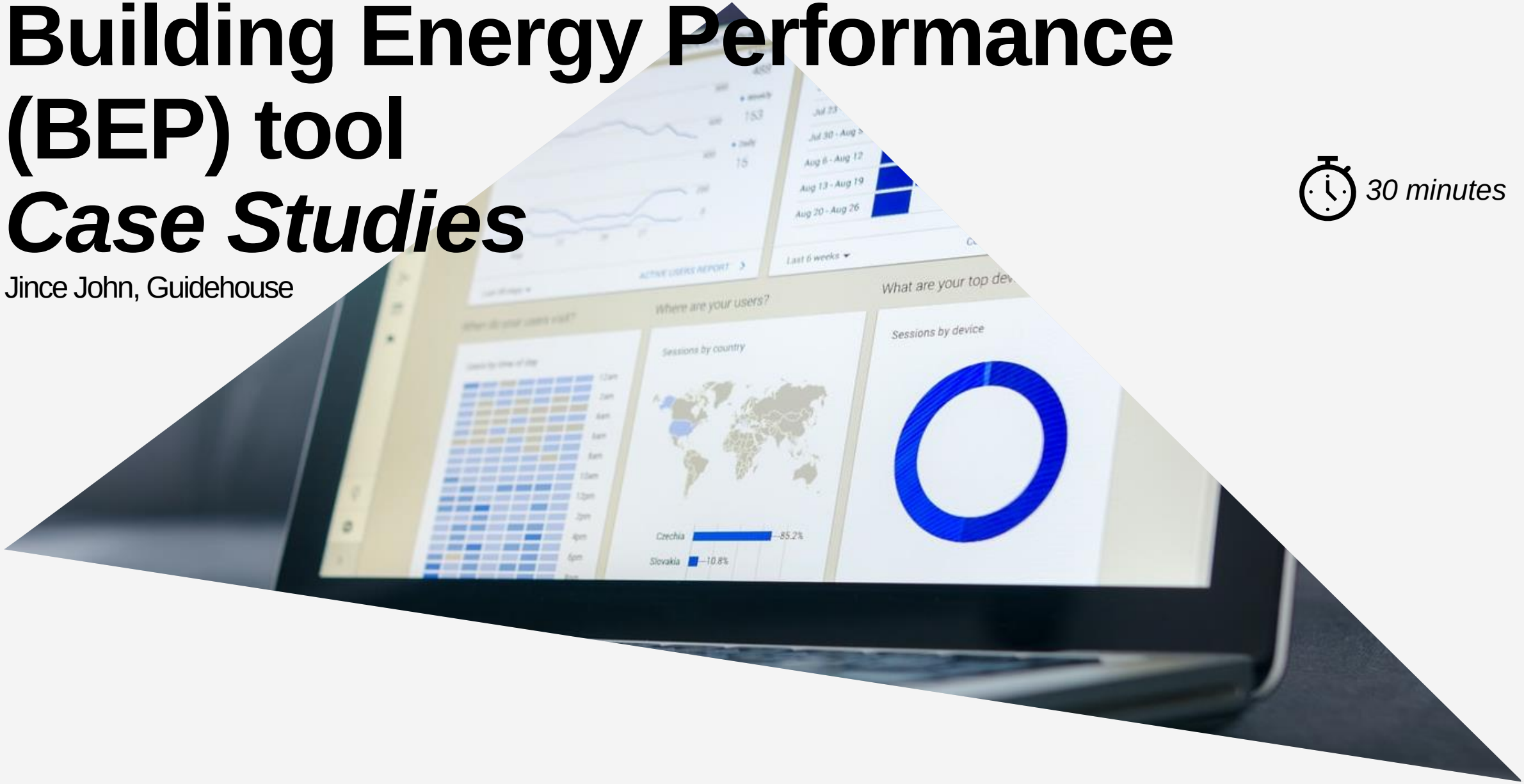


Photo by Lukas Blazek on Unsplash

Guidehouse BUILD_ME

Instructions

Case 1 – SFH

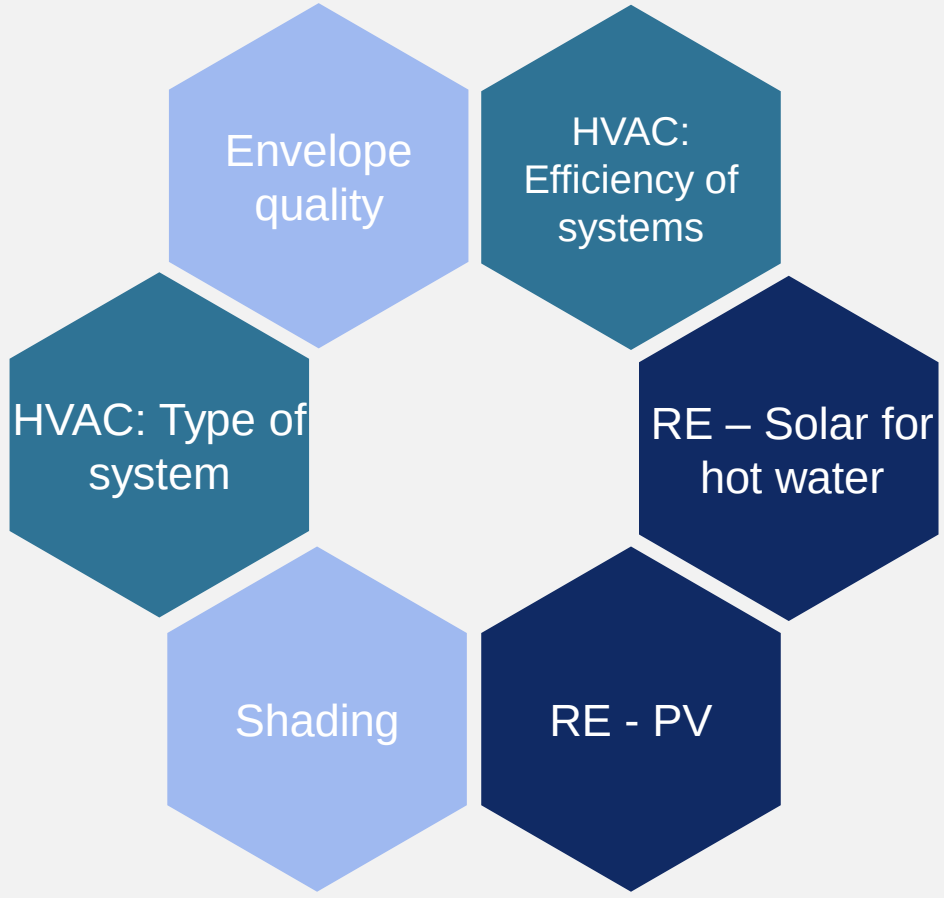
Objective
1 – Optimize the building envelope to reach the max possible primary energy savings

Tools
Change only the envelope quality (see the overview on the right)

Focus
Country: Egypt | Climate: Cairo | Building: SFH |
Age group: New construction

Time
20 min to work on the case

Measures available in the BEP Tool



Instructions

Case 1 – SFH

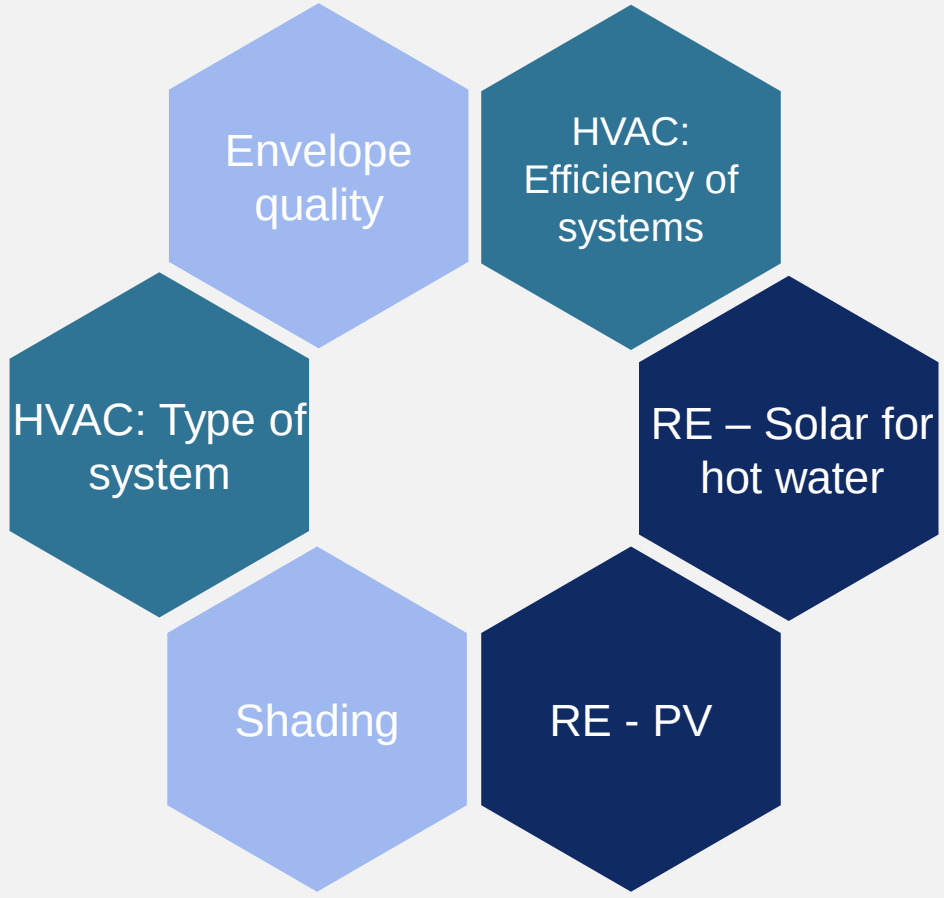
Objective
2 – Optimize the HVAC systems to reach the max possible primary energy savings

Tools
Change only the HVAC systems type and efficiency (see the overview on the right)

Focus
Country: Egypt | Climate: Cairo | Building: SFH |
Age group: New construction

Time
20 min to work on the case

Measures available in the BEP Tool



Instructions

Case 1 – SFH

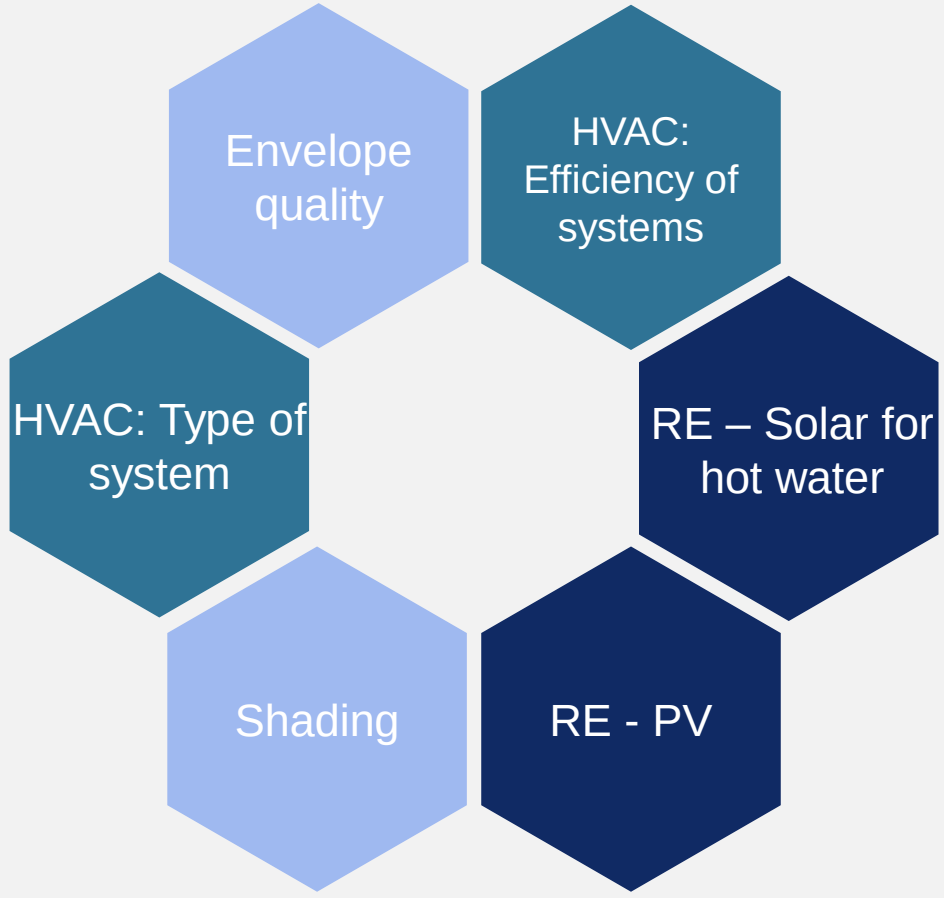
Objective
3 – Add/Optimize renewable energy measures to reach the max possible primary energy savings

Tools
Add/Change the RE measures only (see the overview on the right)

Focus
Country: Egypt | Climate: Cairo | Building: SFH |
Age group: New construction

Time
20 min to work on the case

Measures available in the BEP Tool



Instructions

Case 2 – SFH

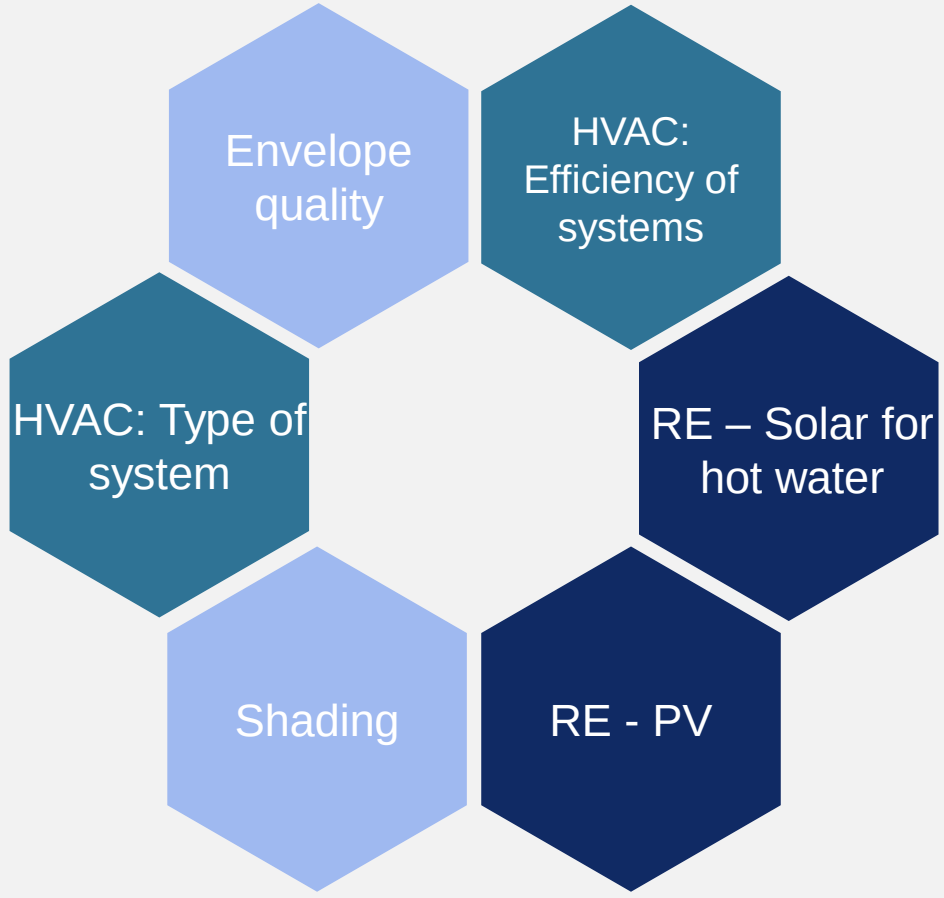
Objective
1 – Find a balance between envelope/HVAC/RE measures to reach the cost-optimal (least possible CAPEX and more energy savings) renovation.

Tools
All measures that are available in the BEP Tool (see overview on the right)

Focus
Country: Egypt | Climate: Cairo | Building: SFH | Age group: New construction

Time
20 min to work on the case

Measures available in the BEP Tool



Instructions

Case 3 – SFH

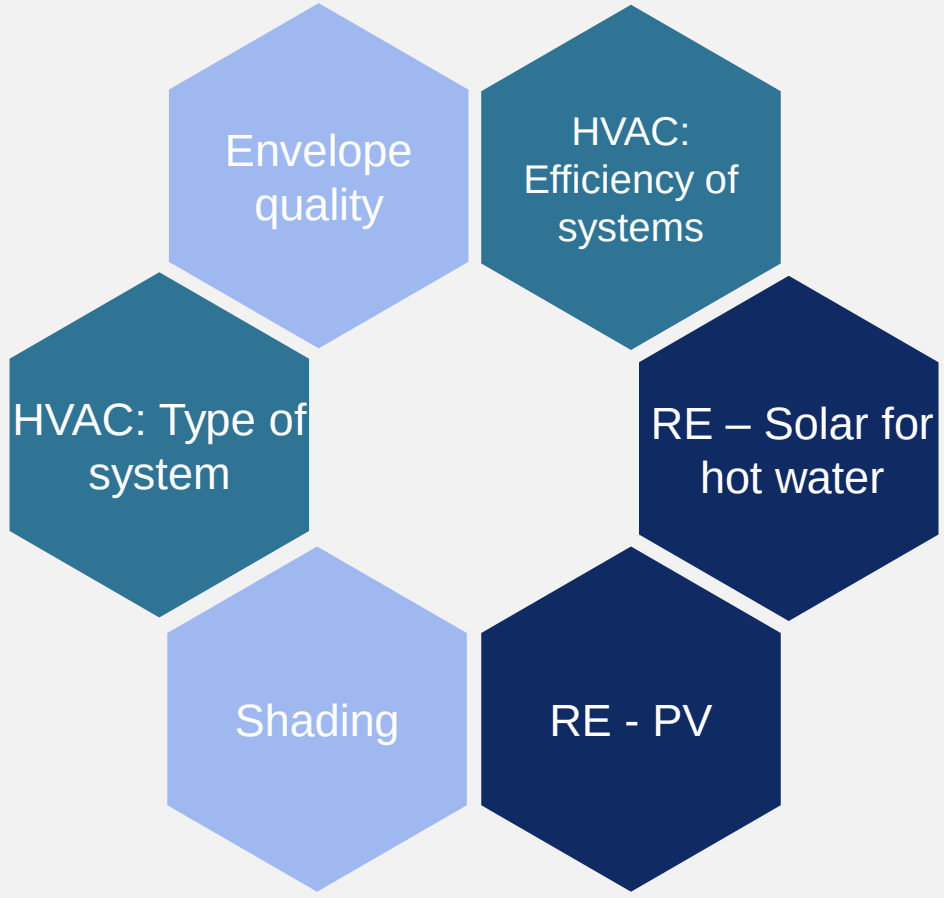
Objective
1 - Reach the performance class A with a payback period less than 10 years

Tools
All measures that are available in the BEP Tool (see overview on the right)

Focus
Country: Egypt | Climate: Cairo | Building: SFH |
Age group: New construction

Time
20 min to work on the case

Measures available in the BEP Tool



Instructions

Case 4 – SFH

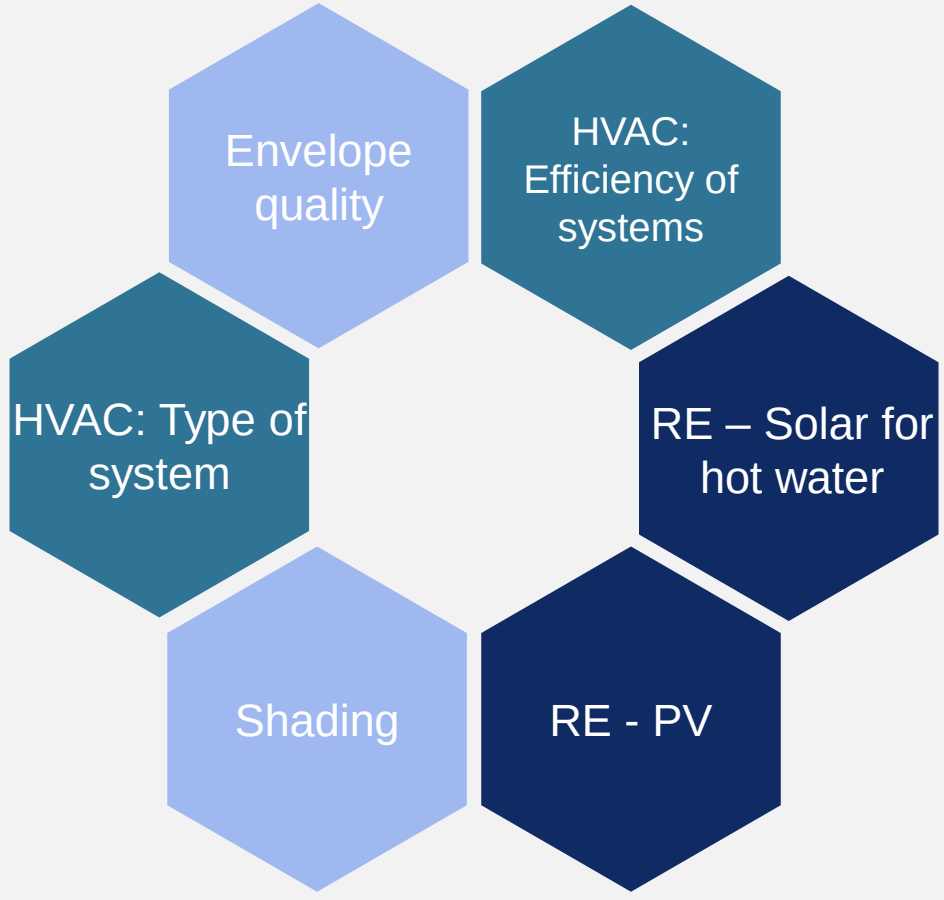
Objective
1 – Cost optimized nearly zero solutions (>90% savings)

Tools
All measures that are available in the BEP Tool (see overview on the right)

Focus
Country: Egypt | Climate: Cairo | Building: SFH |
Age group: New construction

Time
20 min to work on the case

Measures available in the BEP Tool



Results

Example – Case1_Obj 1_Envelope

Primary energy

	kWh/(m²a)		
	EGY_Cairo_SFH_Case1_1	Baseline	Delta
Space heating	-	-	-
DHW	14.05	14.05	0%
Space cooling	78.68	229.51	-66%
Lighting	11.26	11.26	0%
Auxiliary energy	-	-	-
Ventilation	-	-	-
Other electricity	26.06	26.06	0%
Total	130.05	280.87	-54%
Total incl. PV	130.05	280.87	-54%

Specific cost

	in € /m²		
	EGY_Cairo_SFH_Case1_1	Baseline	Delta
Investment	83	32	+159%
Replacement	11	19	-42%
Residual	-16	-12	+33%
Energy	102	227	-55%
GHG	0	0	-
Inspection & maintenance	2	3	-33%
Cleaning	0	0	-
PV Feed in Tariff	0	0	-
Global cost (total)	181	269	-33%

Results

Example – Case1_Obj 2_HVAC

Primary energy

	kWh/(m²a)		
	EGY_Cairo_SFH_Case1_2	Baseline	Delta
Space heating	-	-	-
DHW	14.05	14.05	0%
Space cooling	140.28	229.51	-39%
Lighting	9.01	11.26	-20%
Auxiliary energy	-	-	-
Ventilation	-	-	-
Other electricity	26.06	26.06	0%
Total	189.40	280.87	-33%
Total incl. PV	189.40	280.87	-33%

Specific cost

	in € /m²		
	EGY_Cairo_SFH_Case1_2	Baseline	Delta
Investment	41	32	+28%
Replacement	23	19	+21%
Residual	-15	-12	+25%
Energy	153	227	-33%
GHG	0	0	-
Inspection & maintenance	3	3	0%
Cleaning	0	0	-
PV Feed in Tariff	0	0	-
Global cost (total)	206	269	-23%

Results

Example – Case1_Obj 3_RE Measures

Primary energy

	kWh/(m²a)		
	EGY_Cairo_SFH_Case1_3	Baseline	Delta
Space heating	-	-	-
DHW	0.03	14.05	-100%
Space cooling	229.51	229.51	0%
Lighting	11.26	11.26	0%
Auxiliary energy	-	-	-
Ventilation	-	-	-
Other electricity	26.06	26.06	0%
Total	266.86	280.87	-5%
Total incl. PV	132.10	280.87	-53%

Specific cost

	in € /m²		
	EGY_Cairo_SFH_Case1_3	Baseline	Delta
Investment	72	32	+125%
Replacement	43	19	+126%
Residual	-12	-12	0%
Energy	107	227	-53%
GHG	0	0	-
Inspection & maintenance	17	3	+467%
Cleaning	0	0	-
PV Feed in Tariff	0	0	-
Global cost (total)	228	269	-15%

Results

Example – Case 2_Combination Envelope, HVAC, & RE

Primary energy

	kWh/(m²a)		
	EGY_Cairo_SFH_Case2_Costopt	Baseline	Delta
Space heating	-	-	-
DHW	0.03	14.05	-100%
Space cooling	59.01	229.51	-74%
Lighting	11.26	11.26	0%
Auxiliary energy	-	-	-
Ventilation	-	-	-
Other electricity	26.06	26.06	0%
Total	96.36	280.87	-66%
Total incl. PV	96.36	280.87	-66%

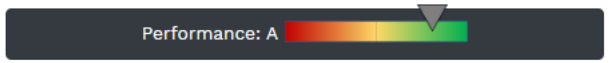
Specific cost

	in € /m²		
	EGY_Cairo_SFH_Case2_Costopt	Baseline	Delta
Investment	85	32	+166%
Replacement	14	19	-26%
Residual	-16	-12	+33%
Energy	64	227	-72%
GHG	0	0	-
Inspection & maintenance	2	3	-33%
Cleaning	0	0	-
PV Feed in Tariff	0	0	-
Global cost (total)	148	269	-45%

Results

Example – Case 3_Performance class A

Primary energy



	kWh/(m²a)		
	EGY_Cairo_SFH_Case3_A	Baseline	Delta
Space heating	-	-	-
DHW	0.03	14.05	-100%
Space cooling	59.23	229.51	-74%
Lighting	11.26	11.26	0%
Auxiliary energy	-	-	-
Ventilation	-	-	-
Other electricity	26.06	26.06	0%
Total	96.58	280.87	-66%
Total incl. PV	9.42	280.87	-97%

Specific cost

	in € /m²		
	EGY_Cairo_SFH_Case3_A	Baseline	Delta
Investment	112	32	+250%
Replacement	30	19	+58%
Residual	-16	-12	+33%
Energy	6	227	-97%
GHG	0	0	-
Inspection & maintenance	13	3	+333%
Cleaning	0	0	-
PV Feed in Tariff	0	0	-
Global cost (total)	144	269	-46%

FINANCIAL - CAPEX / OPEX

Operational Cost: € -1,889 | Investment Cost: € 15,732 | Payback Period: 9 Years

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Results

Example – Case 4_nZEB

Primary energy

	kWh/(m²a)		
	EGY_SFH_nZEB	Baseline	Delta
Space heating	-	-	-
DHW	14.05	14.05	0%
Space cooling	56.58	229.51	-75%
Lighting	11.26	11.26	0%
Auxiliary energy	-	-	-
Ventilation	-	-	-
Other electricity	26.06	26.06	0%
Total	107.95	280.87	-62%
Total incl. PV	4.18	280.87	-99%

Specific cost

	in € /m²		
	EGY_SFH_nZEB	Baseline	Delta
Investment	117	32	+266%
Replacement	30	19	+58%
Residual	-17	-12	+42%
Energy	3	227	-99%
GHG	0	0	-
Inspection & maintenance	14	3	+367%
Cleaning	0	0	-
PV Feed in Tariff	0	0	-
Global cost (total)	148	269	-45%

Discussion and wrap up

20 minutes

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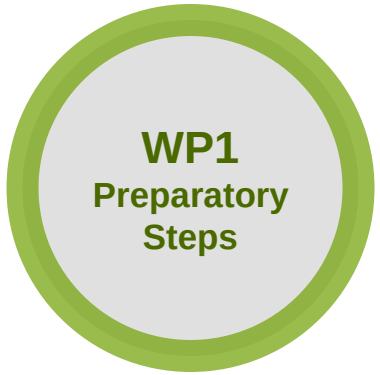
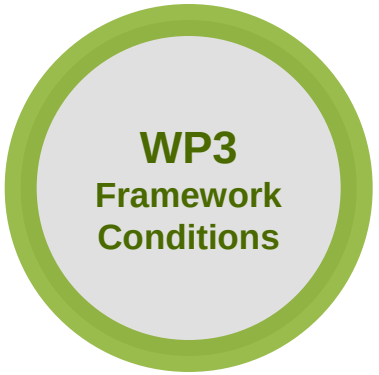
Conclusion

Several outputs will enable the acceleration of climate-friendly buildings

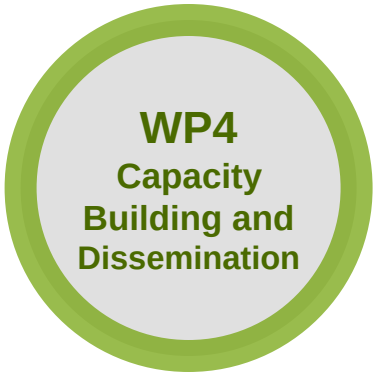


- Developed public and free available software tool
- Developed building typology
- Calculated baseline

- Supported 13 pilot projects with technical and economic assessments of suitable energy concepts



- Analysed national EEBC
- Conceived voluntary EE classification scheme
- Supported national strategies (NEEAPs & NDCs)



- Developed website
- Performed workshops, trainings, webinars
- Formulated newsletters, brochures, etc
- Developed a database for best practice buildings

Final Discussions

Collecting feedback and ideas

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Contact

Eslam Mahdy

Eslam.Mahdy@guidehouse.com

Riadh Bhar

Riadh.Bhar@guidehouse.com

www.buildings-mena.com