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BUILD_ME

الجَمعيّة العِلميّة المَلكيّة
Royal Scientific Society

BUILD_ME Training:

Basics of climate-friendly buildings and the BEP Tool

14 July 2021

Image source: https://www.capacitymedia.com/

Supported by:

Federal Ministry
for the Environment, Nature Conservation
and Nuclear Safety

based on a decision of the German Bundestag

Agenda

Image source: https://www.jdtours.com/

Log in	10:00 – 10:15
Welcome and Instructions	10:15 – 10:20
Introduction to BUILD_ME Project	10:20 – 11:00
Q&A + Break	11:00 – 11:15
Basics of Climate-Friendly Buildings	11:15 – 12:00
Q&A + Break	12:00 – 12:15
Building Energy Performance “BEP” Tool	12:15 – 13:15
Q&A + Case Study	13:15 – 13:45
Wrap Up and Final Remarks	13:45 – 14:00

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Technical instructions

Working together effectively

- Presentation will be published on our project website afterwards.
- The session will not be recorded.
- We look forward to your active participation.
- Please stay muted but feel free to to write your questions in the chat box or raise your hands in the Q&A sessions. Questions will be answered in the Q&A sessions.
- Please be punctual after the break.
- For technical problems/questions, reach out to: Ali AlMarzouq at Ali.Marzouq@rss.jo

Photo by Chris Montgomery on Unsplash

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Welcome Words

Eslam Mahdi, Guidehouse
Muhieddin Tawalbeh, RSS/NERC

Bild von PIRO4D auf Pixabay

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Introduction to BUILD_ME Project

Ali AlMarzouq, RSS/NERC

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Image source: https://www.lonelyplanet.com/jordan/amman

Overview

Fund

Scope

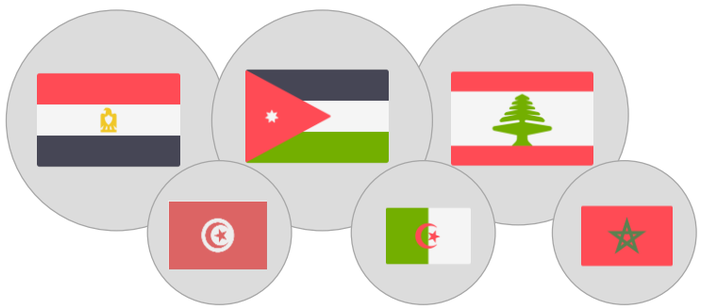
Partners

IKI International Climate Initiative,
German Federal Ministry of Environment

Supported by:

Federal Ministry
for the Environment, Nature Conservation
and Nuclear Safety

based on a decision of the German Bundestag



1st Phase: 2016 - 2018

2nd Phase: 2019 - 2021

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BUILD_ME scope

Approach

Original project

2016 - 2018

- Extensive analysis and research
- Gap analysis
- Identification of barriers & drivers
- Recommendations

Project extension

2019 – 2021

- Implementation of recommendations
- Upscaling
- Dissemination of results

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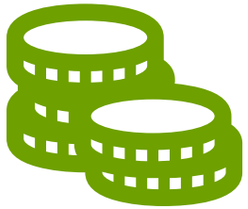
Key insights from Phase I

Approach

Project developers

- **Low cost packages** in average can already **save 30%** of energy costs.
- Investments of „nZEB variants“ **only 10-15% higher** than baseline
- **End users** are often responsible for **purchasing HVAC technologies**, separately from apartment



Financial institutes (FI)

- Funds are available but instruments are missing to prove eligibility. Process too complex for rather small building projects
- **Capacity building FI** staff: Improve the knowledge on energy efficiency
- Facilitate process to check **fulfilment of eligibility criteria**
- Merchandise **financing option for building EE** measures and incorporate in your portfolio

Policy and decision makers

- Update/develop **building codes** and improve their enforcement
- Formulate **benchmarks** and develop a **classification scheme**
- Lack of **quantified (GHG) saving potentials** for the building sector in policy strategies

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Structure and objectives of Phase II

Approach

Objectives and Goals

- Facilitate & increase **access to financing** & funding opportunities for EE building projects.
- Support the reform & transitions of **political frameworks** towards improving energy efficiency in the building sector.
- Focus on supporting the implementation of energy efficiency measures in **pilot projects**

WP1
Preparatory Steps

- Building Typology
- Buildings specifications & reference values
- Software tool: energy performance & cost-effectiveness

WP2
Support Pilot Projects

- Technical support
- Collect insights on the ground as input for WP3
- Testing EE classification scheme
- Support financing applications

WP3
Framework Conditions

- Building codes
- Support national strategies (NEEAPs & NDCs)
- Voluntary EE classification scheme
- Facilitate & increase access to financing

WP4
Capacity Building and Dissemination

- Website, workshops, trainings, database for best practice buildings, webinars, newsletters, brochures, etc.

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Building Typology

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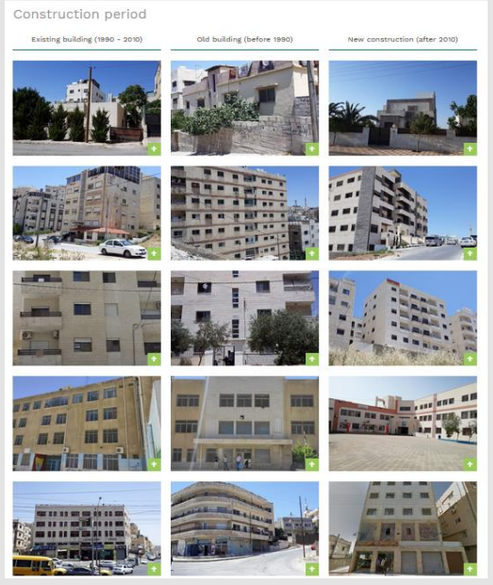
Building Typology

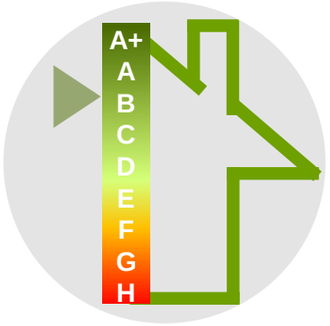
What is meant with building typology and why it is needed?

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



- **Building type**
- **Age group** (1990 – 2010 – 2021)
- **Region**
- **Building envelope**
- **Technical systems**

baseline



Definition of the baseline and BAU construction of different building types which allows for

- **Classification**
- **Comparison**
- **Facilitating finance**

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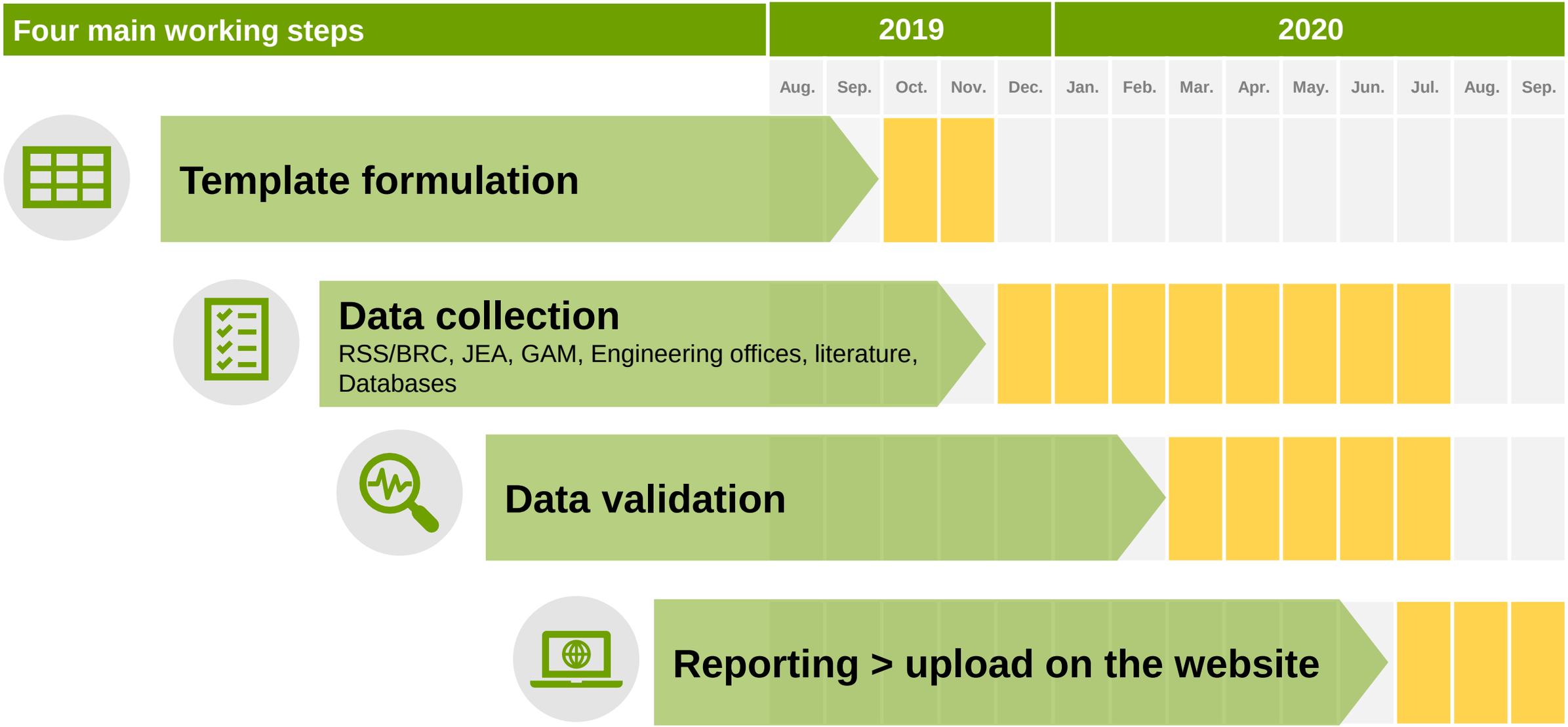
Approach of development of building typology



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Results, template main sections

A : General information

Country	Project Name	Building type	Region (specify)	Construction Period	ID	Reference ID

B: Geometries

Number of stories	Number of dwellings	Typical number of occupants / users	Net floor area	Clear room height	Volume	Roof type	Area floor slab (ground plate)	Roof area opaque	Façade area opaque	Share of facade oriented north	Share of facade oriented east	Share of facade oriented south	Share of facade oriented west	Window area	Share of windows oriented north	Share of windows oriented east	Share of windows oriented south	Share of windows oriented west	Share of windows oriented horizontal	Opaque doors	Ratio Floor / Ground	Ratio Floor / Roof	Ratio Floor / Facade (excluding windows)	Ratio Floor / Facade (including windows)	A/V

C: Technical specifications building envelope

Thermal heat bridge - Slab	U-value - Roof	Thermal heat bridge - Roof	U-value - Wall	Thermal heat bridge - Wall	Type of window	U-value - Window	Thermal heat bridge - Window	G-value Windows	Avergae shading factor of windows (0-1)

D: Specifications of technical building systems

Primary space heating system	Secondary space heating system	Primary hot water generator	Secondary hot water generator	Primary space cooling system	Secondary space cooling system	Ventilation	Photovoltaics	Lighting	Temperature set-points

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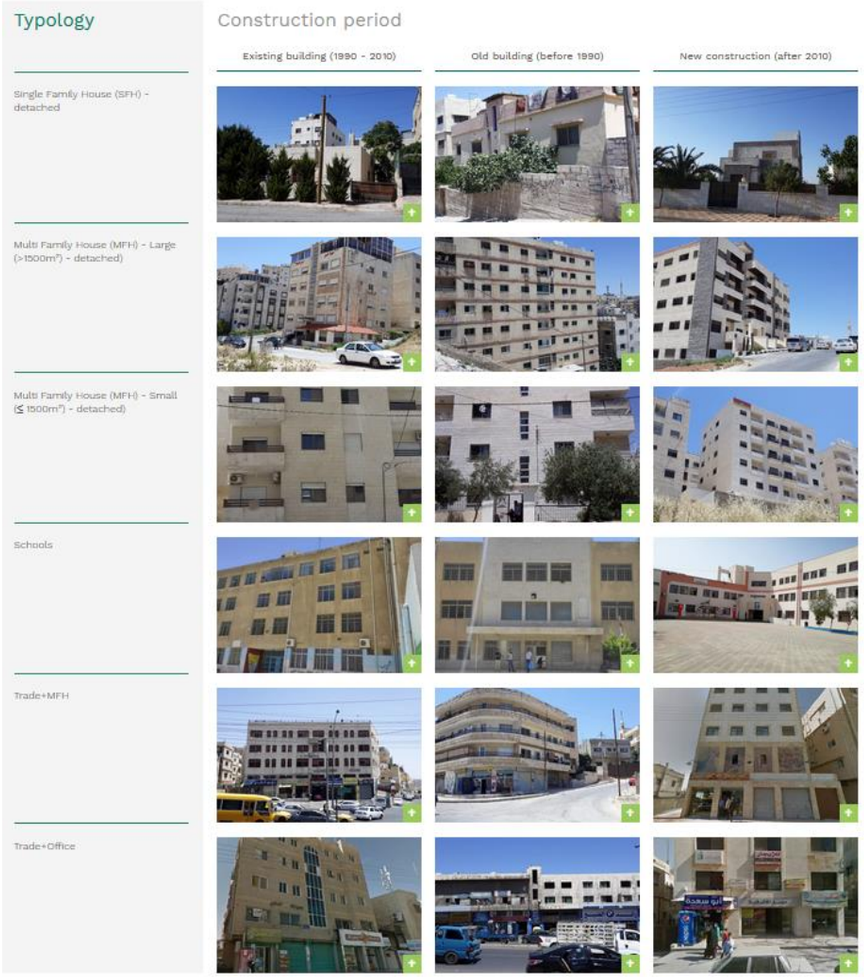
Building Typology | Jordan

Results

Building type	Age group	Regions
▪ Single-family house (SFH) - detached ▪ Multi-family house (MFH) - Large (>1500m²) - detached) ▪ Multi-family house (MFH) - Small (≤ 1500m²) - detached) ▪ Schools ▪ Trade + MFH ▪ Trade + Office	▪ Existing building (1990 - 2010) ▪ Old building (before 1990) ▪ New construction (after 2010)	▪ Amman-East ▪ Amman-West

[Link to the typology on BUILD_ME website]



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Baseline

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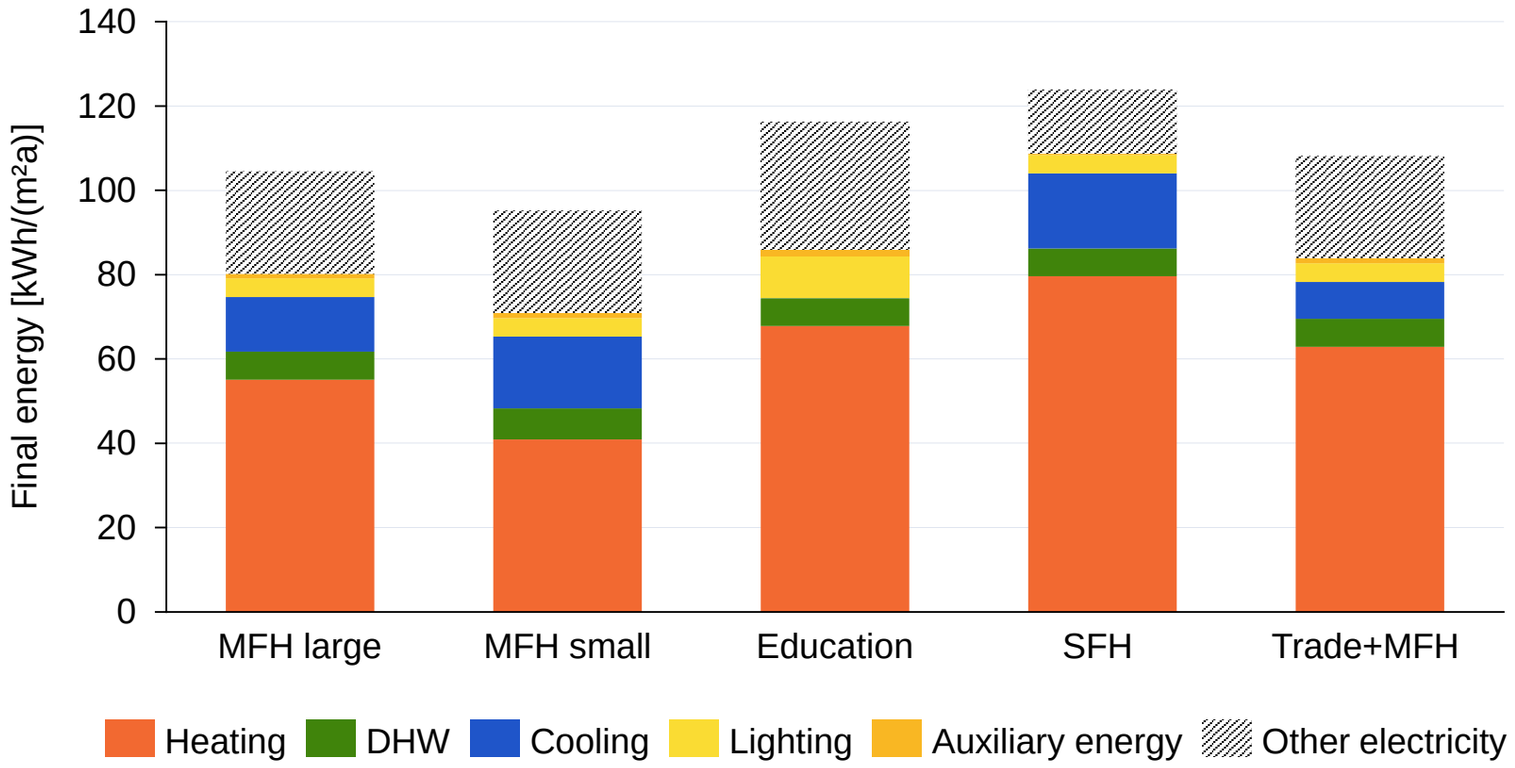
Baseline | Jordan

Illustrating energy intensity of selected Jordan building types

Key takeaways

- Specific final energy demand ranges between **95 – 120 kWh/(m²a)** for buildings constructed over the past decade
- **Space heating** accounts for largest energy demand
- **Space cooling** is about 1/3 of the space heating demand
- Note: Other electricity stands for plug-loads (e.g. fridge, TV, etc.) and is informational.

National baseline (new buildings, after 2010)



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Baseline | Jordan

Illustrating energy intensity: Multi-family house (large)

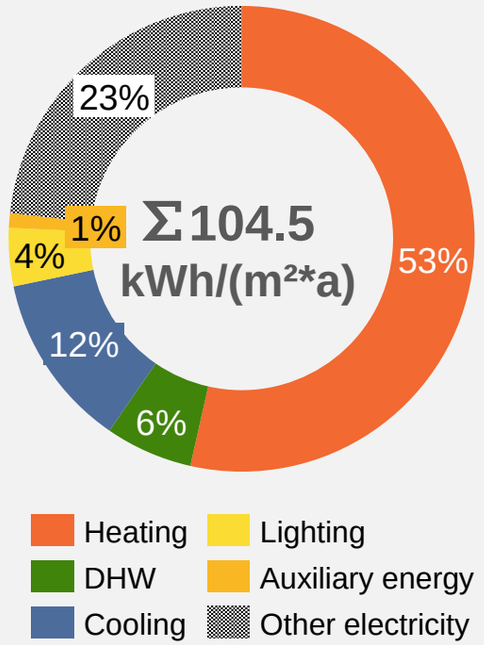
Building standard

- New buildings (constructed after 2010)
- Thermal insulation is used in external walls and roofs
- Following the EEBC 2018

Energy demand

- 105 kWh/m²/a (80 kWh/m²a for HVAC and Lighting)
- Energy consumption for heating approx. half of total

Parameters	Baseline
Roof insulation (U-Value)	0.55 W/m²K
Wall insulation (U-Value)	0.57 W/m²K
Floor insulation (U-Value)	1.2 W/m²K
Windows (U-Value; G-Value)	5.7 W/m²K; 0.85
Window fraction	Ø 11%
Shading	Manual shading
Air tightness	0.25 1/h
Heat supply	LPG heater (80%)
Cold supply	Single split (EER: 3.0 – 3.9)
Hot water	Direct electric
Ventilation systems	Free ventilation
Lighting systems	LED
Renewable energy	No
Set temperature cooling/heating	24°C / 21°C



Energy cost
15.7 EUR / (m²*a)

CO_2 - emission
2.3 kg / (m²*a)

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Building Energy Performance (BEP) Tool

Photo by Lukas Blazek on Unsplash

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Logic of the BEP Tool

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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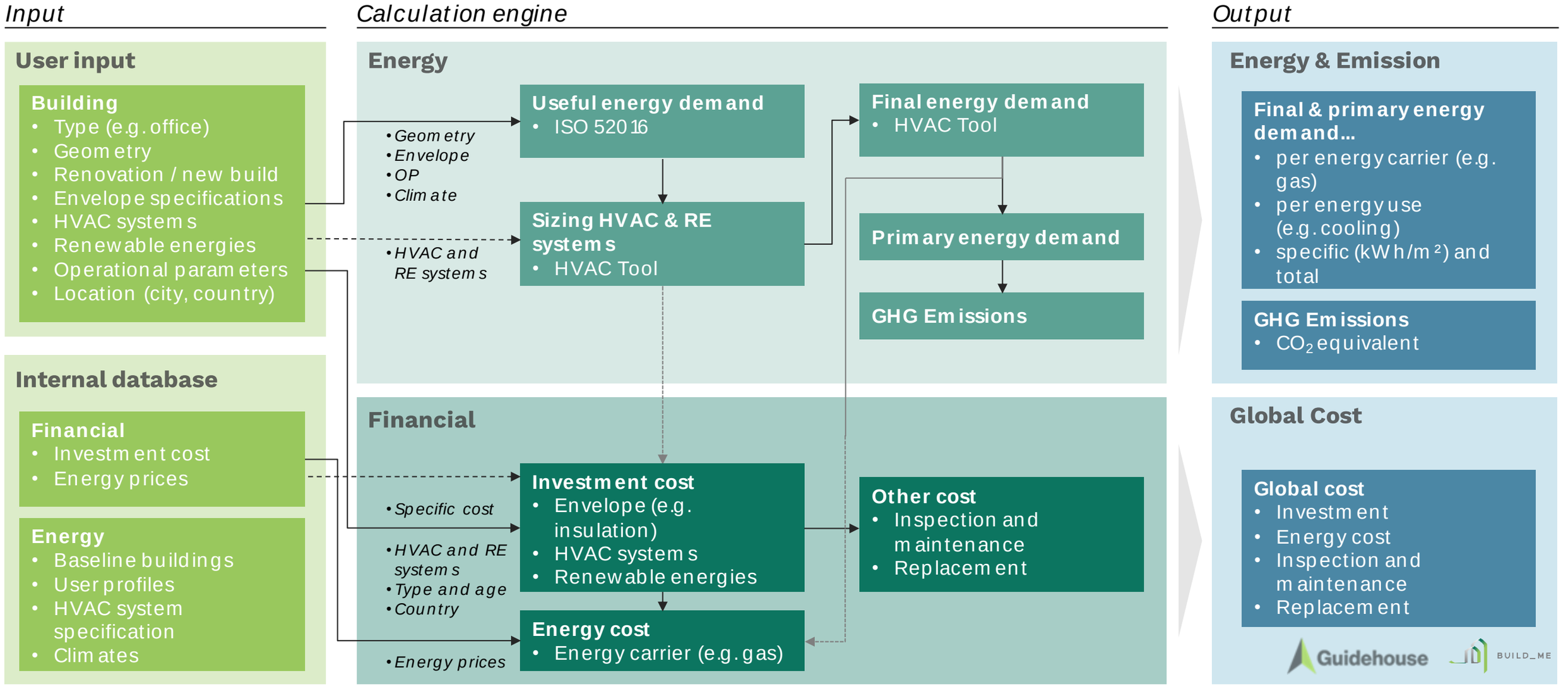
Calculation methodology



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Developed for the MENA region

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

Baseline buildings

Local investment cost & energy prices

Tool was successfully applied in **building projects in the MENA region**

International calculation methodology: ISO 52016

Focus is on the countries: **Egypt, Jordan and Lebanon**

Baseline reflects the **country specific building** standard

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Methodology is applicable worldwide

Climate data of all countries in the MENA region

Local PEF and CO_2 emission Factors

All data input is collected and verified by **local partners** and project developers

The calculation standard is internationally acknowledged.

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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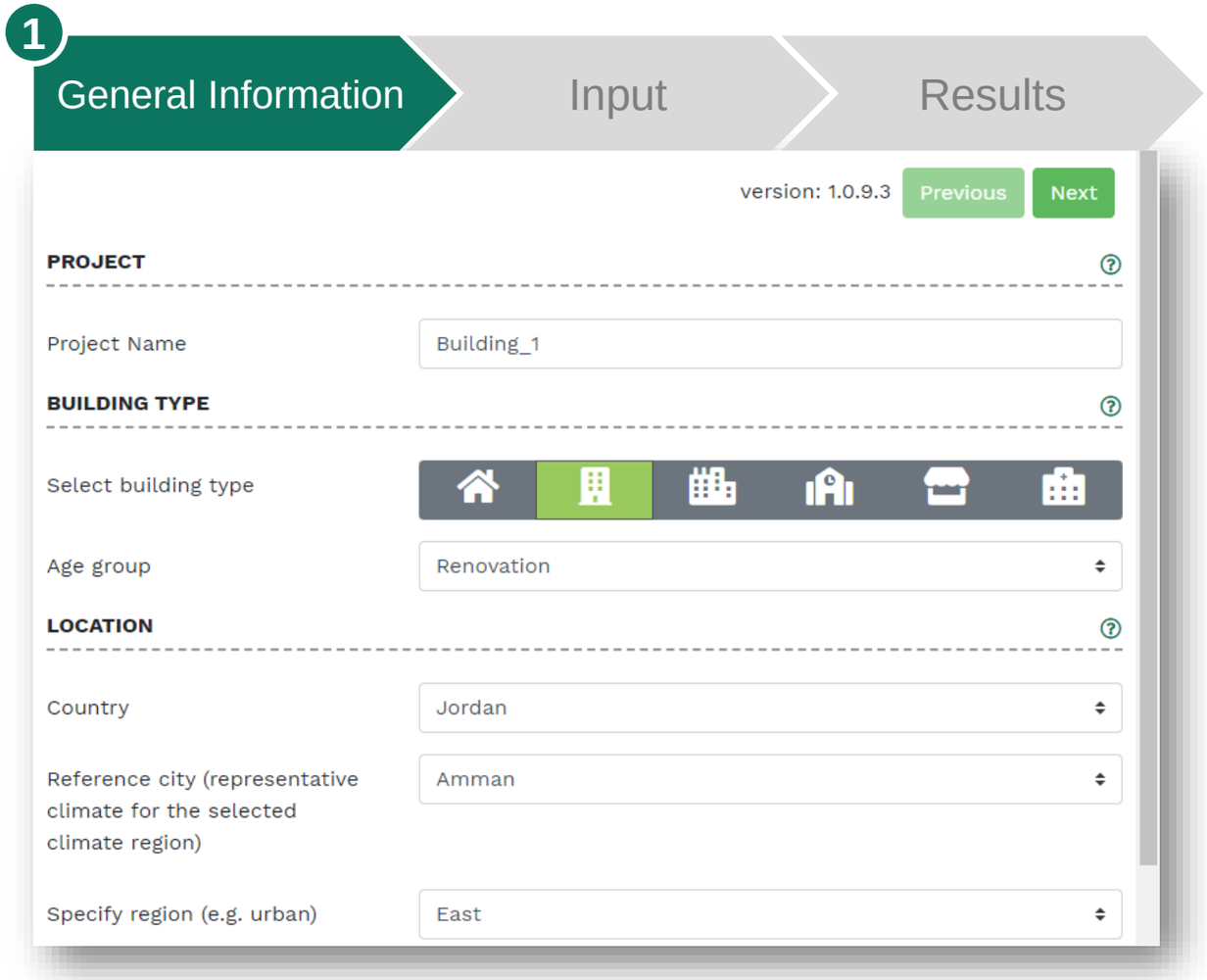
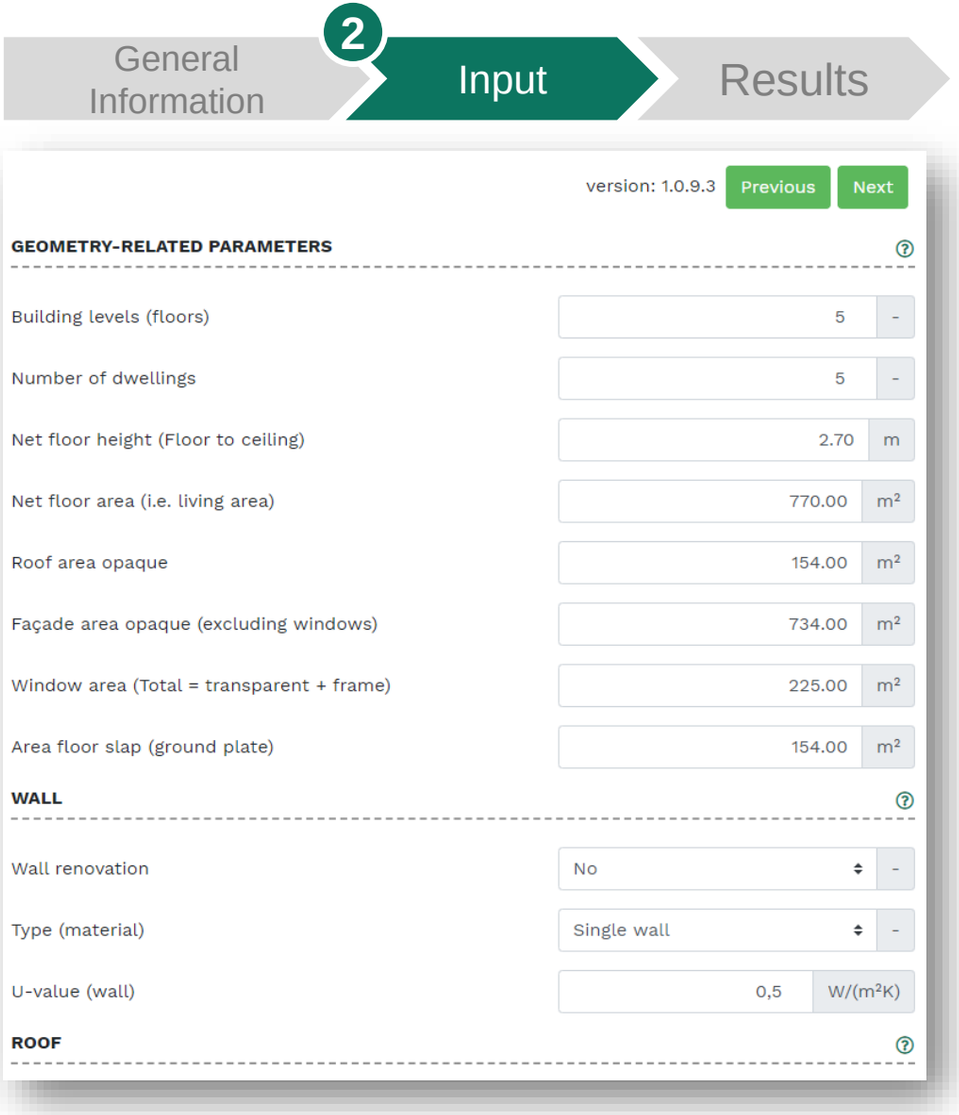
Online Web App - Input





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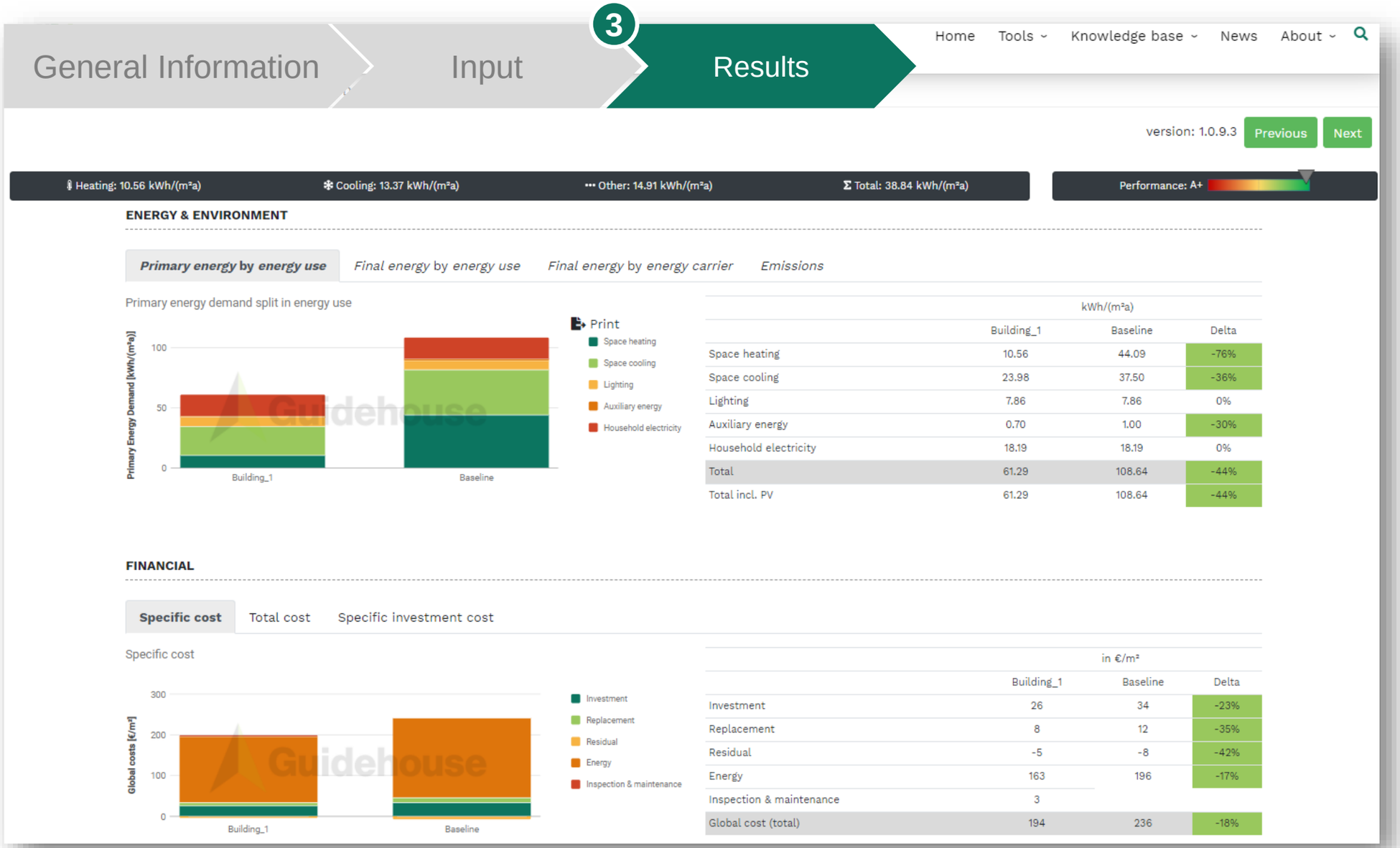
Online Web App – Results



Online Web App – Results detail

1| Quick overview

The main facts.

7| Performance rating

C = equal to baseline

2| Output selection

4 tabs to select the energy performance indicator.

6| Comparison

Difference to the baseline buildings.

3| Overview chart

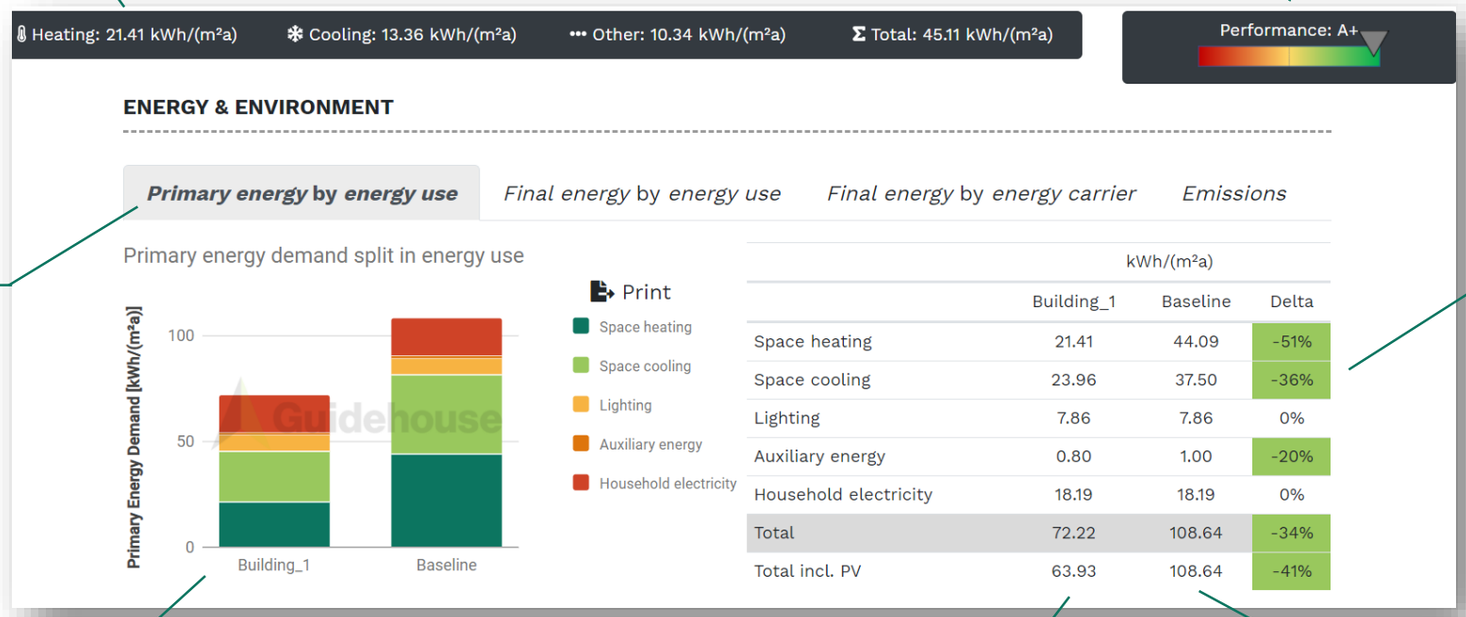
Comparison to the baseline building.

4| Results table

Detailed results in numbers.

5| Baseline building

Detailed results of the baseline building.



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Energy Efficiency Building Code in Jordan

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Analysis of EEBC in Jordan

Introduction, approach and working steps

A. Status quo analysis

Code development process

Technical requirements

Implementation mechanisms

B. National experts interviews

Government experts

Academia

NGO and associations

C. Challenges and recommendations

General Challenges

General Recommendations

Priority Recommendations.

D. Analysis of best practices

Comparison with best practices

Regional practices, international practices.

E. Specific recommendations

Exchange with relevant stakeholders.

Recommendations for implementation and/or enforcement

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Challenges of implementation and enforcement of EEBCs

Interim results of steps A, B and C

The technical challenges

- The well elaborated complex code lacks a simplified checklists of MEPs.
- The lack of a clear third-party inspection procedures.

The institutional and regulatory challenges

- There is a need to develop a detailed checklist and/or conformity certificates to comply with the code.
- To translate the codes requirements into procedures and steps using simplified/market language for construction technicians.

The financial challenges

- The perception that construction according to EEBCs results in high additional cost. However, it has been proven that the additional cost can be 10% at maximum with an ROI within 10 years.
- There are no direct incentives designated to compliance according to EEBCs.

Capacity building and awareness challenges

- There is a good level of awareness and high level of interest about EEBCs among the relevant stakeholders, but it is more focused on RE rather than EE of the whole building.

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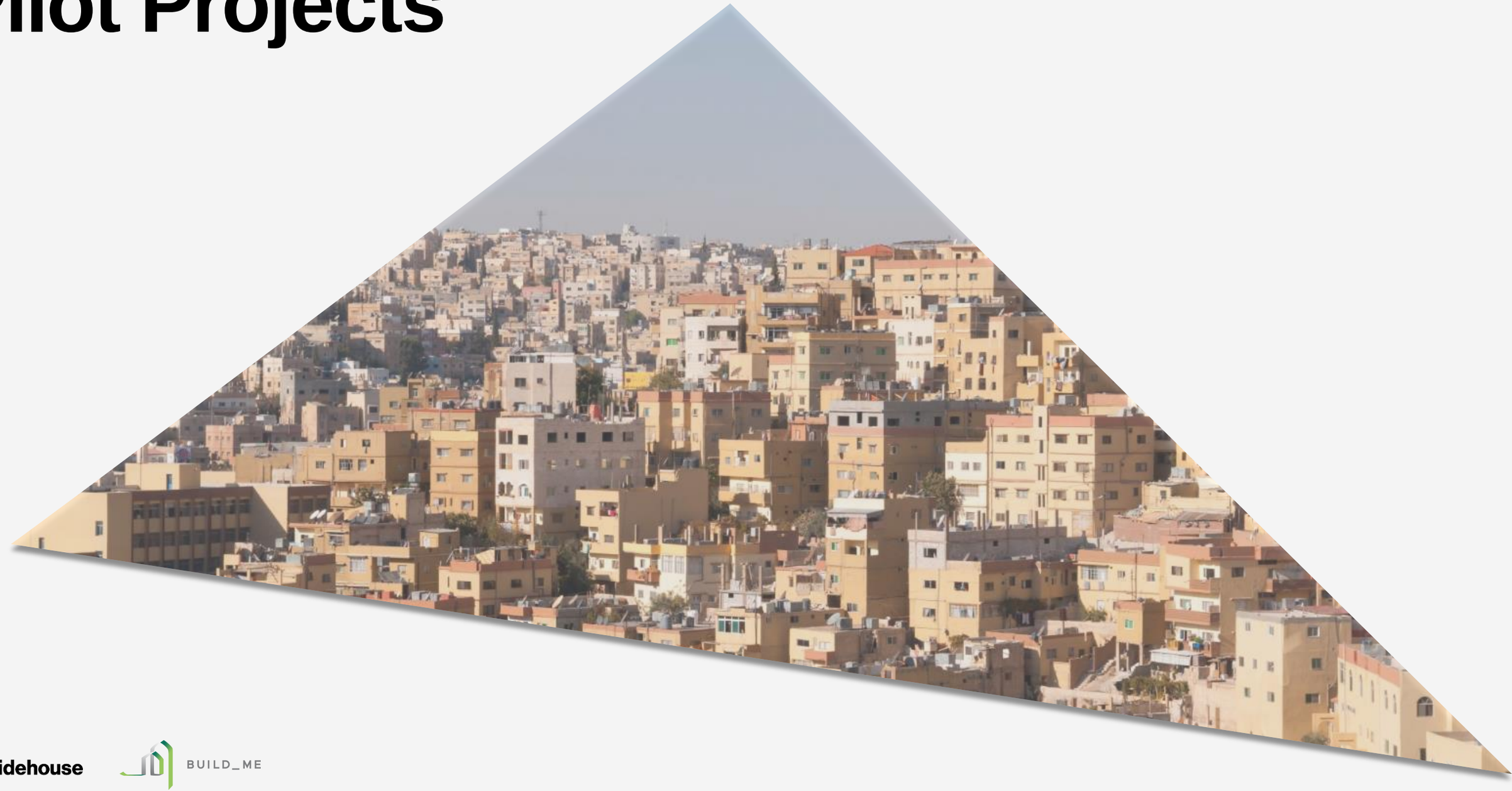
Pilot Projects



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Supporting and Learning from Pilot Projects

Overview of Selected Pilot Projects in Jordan

KONN Modular Houses

- KONN concept represents a number of prototypes of residential single-family houses
- The prototypes are envisioned to provide affordable modular housing by using smart modular construction.

Private Residence

- A private single-family house designed by Salfiti architecture.
- It is an example of single-family houses in the Greater Amman Municipality.

Dar Al-Oqoud

- Dar Al-Oqoud is designed and constructed by MAS Design Studio as a passive energy house.
- It is constructed using traditional building techniques such as loadbearing stone walls with vaults and domes.

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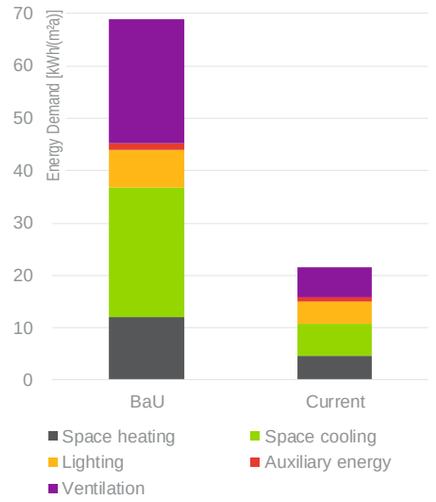
Approach and methodology

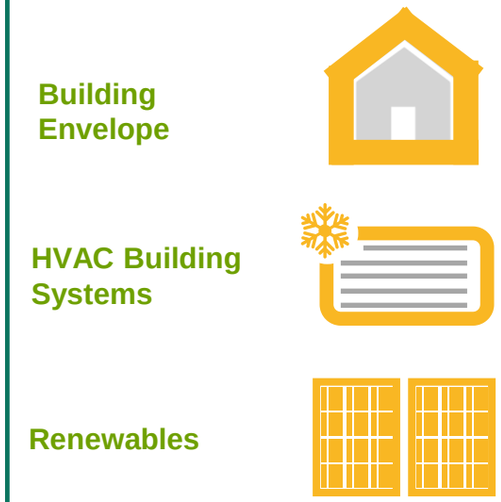
Steps towards a low energy building

1 Comparison with baseline



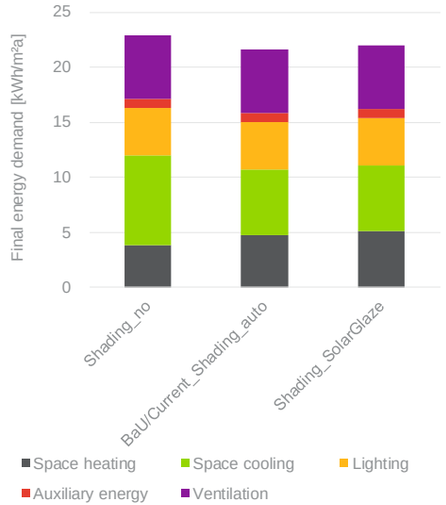
- Estimate the baseline consumption
- Estimate the consumption of current design
- Comparison

2 Energy efficiency recommendations



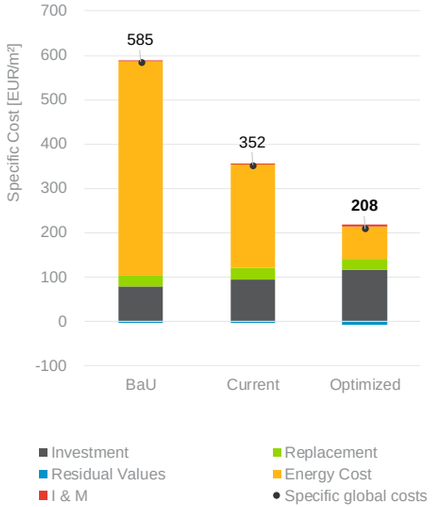
- Building envelope
- HVAC I efficiencies
- Renewables
- Other measures

3 Development



- Optimized as result
- Discussion with developers
- Local and market inputs
- Costs and ROI

4 Final recommendations



- Final loop discussing feasibility of measures
- Adapt selected measures and finalize calculation including payback, investment and lifetime

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Case study: Konn Homes

Photo by Konn Technologies

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KONN
HOMES

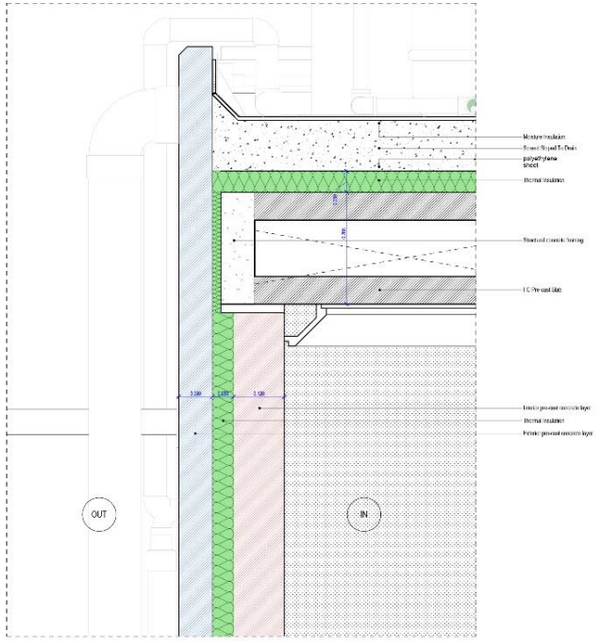
Konn Homes is a construction technology company that provides advanced, tech-enabled solutions for the construction of sustainable and affordable homes.

Konn's vision is to lead the way into the future of living with the safest and most sustainable homes, and it is on a mission to make high quality living affordable to all segments of society through technology.

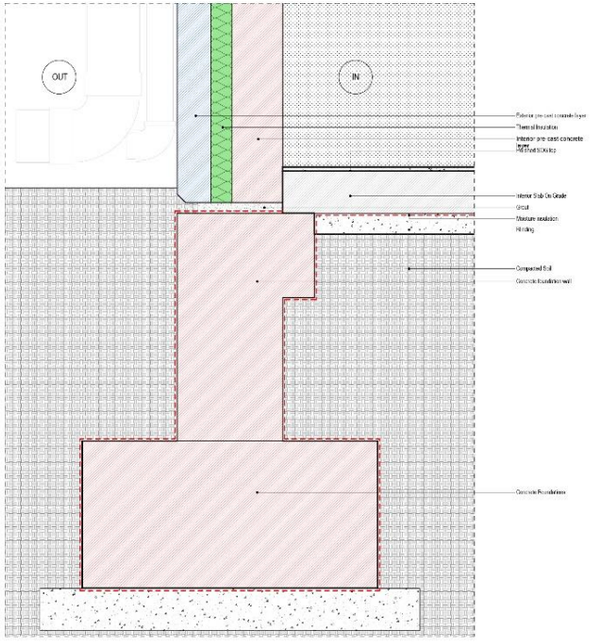
Konn homes are designed for the lifestyle and needs of the residents of Jordan and the MENA region, and built with the highest performing materials and techniques for the local climate and environment.

Building Envelope

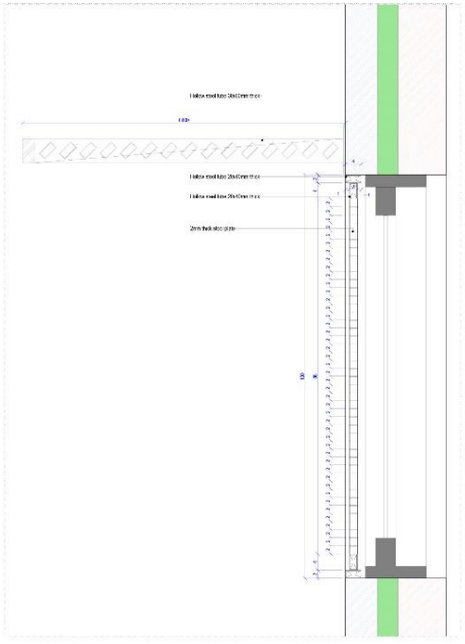
Building Element	Description	U-Value (Baseline)	U-Value (Iteration)
Exterior Walls	Precast concrete sandwich panels with XPS thermal insulation boards	0.57 W/m²K.	0.44 W/m²K.
Roof	Prestressed Hollow-core slab panels topped with XPS thermal insulation boards, 100mm sloped screed and Polyurethane damp proofing membrane	0.55 W/m²K.	0.41 W/m²K.
Windows	Double glazed windows with low-E glass panels	3.2 W/m²K.	1.5 W/m²K.
Foundations (SOG)	Cast in-situ reinforced concrete foundation walls, blinding and 100mm thick SOG	3.36 W/m²K.	3.36 W/m²K.



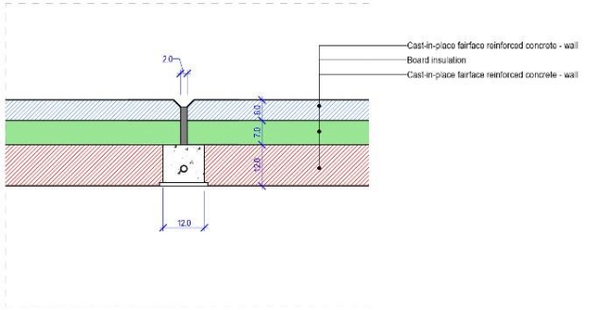
Wall/Roof Slab connection



Wall/Foundation Connection



Window Section



Wall/Wall Connection

Building Systems

HVAC Systems & Appliances

Heating / Cooling

1/1.5 TonSplit unit A/C unit for each room, cooling/ heating (4 COP)
Coefficient of Performance = 3.52 W/W

Lighting

LED (natural light) integrated energy-saving lighting fixtures

Appliances

A++ Energy saving appliances for the living room and kitchen
(TV, Washing Machine, Refrigerator, Dishwasher, Microwave)

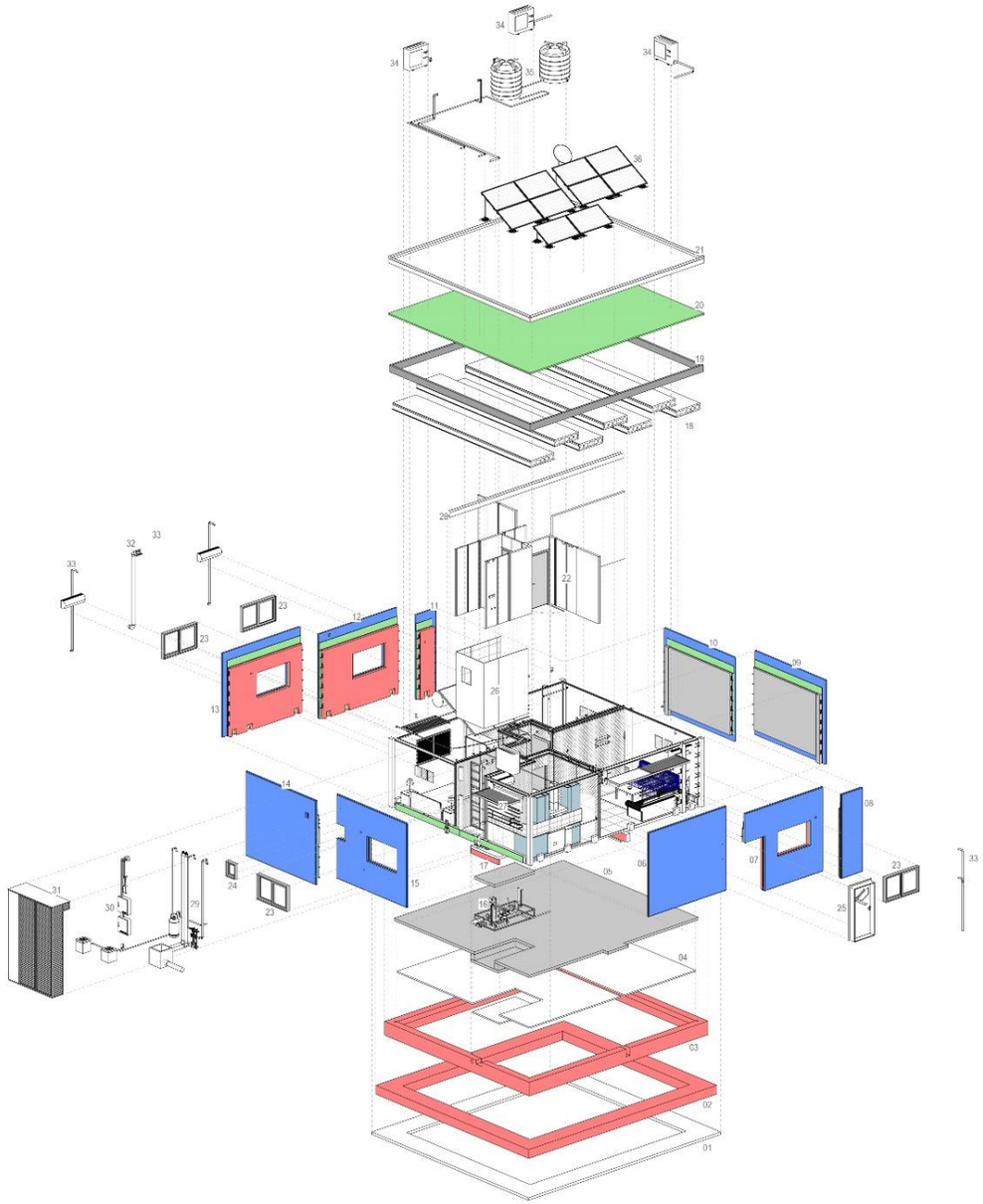
Renewable Energy

Solar Collector

Combined flat plate solar collector with hot water cylinder with integrated Instantaneous electrical water heater

Photovoltaic

Super high power poly perc Modules
Max. Power capacity = 2.0 KW



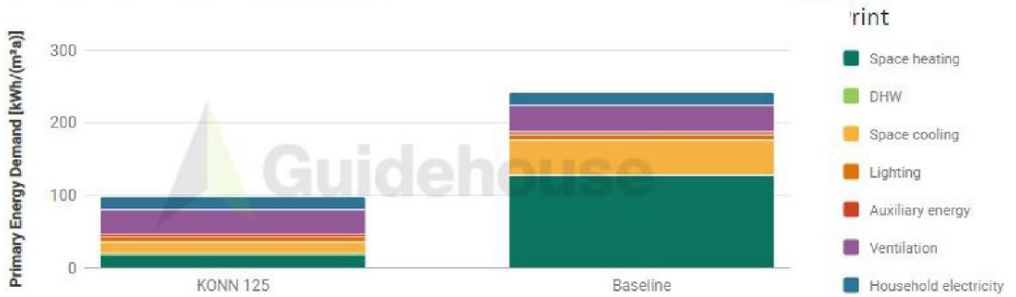
Building Energy Performance Tool by Guidehouse

Heating: 10.50 kWh/(m²a) | Cooling: 8.48 kWh/(m²a) | Other: -6.04 kWh/(m²a) | Σ Total: 12.94 kWh/(m²a) | Performance: A+

ENERGY & ENVIRONMENT

Primary energy by energy use | *Final energy by energy use* | *Final energy by energy carrier* | *Emissions*

Primary energy demand split in energy use



	kWh/(m²a)		
	KONN 125	Baseline	Delta
Space heating	18.84	127.52	-85%
DHW	1.40	-	-
Space cooling	15.21	48.39	-69%
Lighting	7.86	7.86	0%
Auxiliary energy	3.26	3.99	-18%
Ventilation	33.73	36.23	-7%
Household electricity	18.19	18.19	0%
Total	98.49	242.18	-59%
Total incl. PV	23.22	242.18	-90%

FINANCIAL

Specific cost | Total cost | Specific investment cost

Specific cost

	in €/m²		
	KONN 125	Baseline	Delta
Investment	184	164	+13%
Replacement	65	47	+38%
Residual	-17	-17	-3%
Energy	30	207	-85%
Inspection & maintenance	16		
Global cost (total)	280	417	-33%

Products and Outlook

Current Listed Products :

KONN - 70

Area : 70 sqm

Spaces: 2 Bedrooms, 1 Bathroom, Living room, Kitchen

KONN - 90

Area : 90 sqm

Spaces: 2 Bedrooms, 2 Bathrooms, Living room, Guest room, Kitchen

KONN - 125

Area : 125 sqm

Spaces: 3 Bedrooms, 3 Bathrooms, Living room, Guest room, Kitchen

Pipeline Products and Developments :

1. Product Optimization :

- Building envelope and systems developments
- Materials and process optimization
- Introduction of CRM
- Production and Assembly optimization
- Supplied chain optimization
- Integration of IoT

2. In Production :

Projects:
- 5 Confirmed sales in 2021

Add-ons:
- Precast Stairs
- Precast Canopies

3. Products in Development :

Multi-storey Buildings:
- Konn 180
- Konn 250
- Konn 300

Single-storey Buildings:
- Konn BASIC

Contact

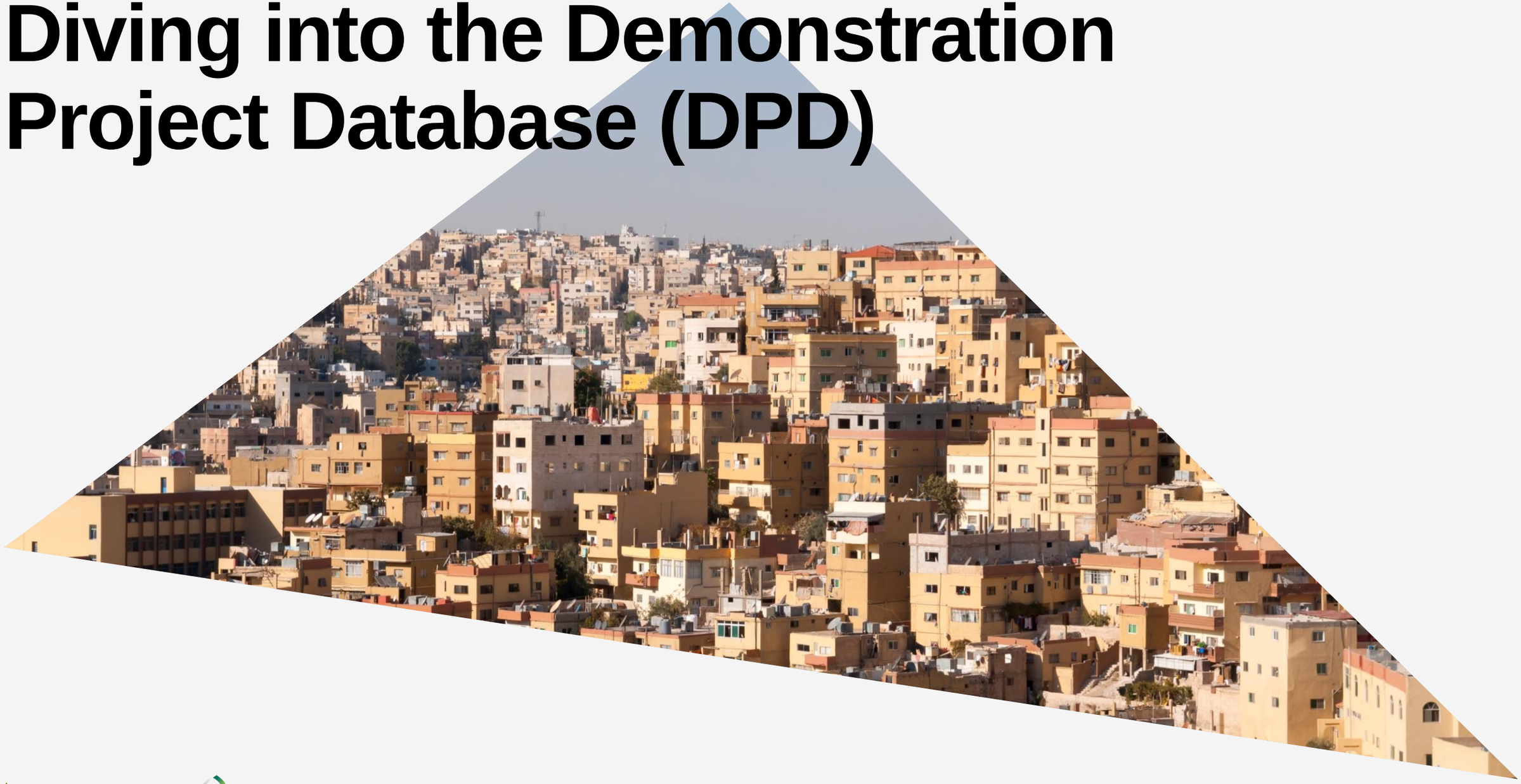
KONN HOMES

Website: www.konn.tech
Email: info@konn.tech

09 Mohammad Amin Al Momani St
Amman 11821, Jordan

Phone: +962 6 2220855

Diving into the Demonstration Project Database (DPD)



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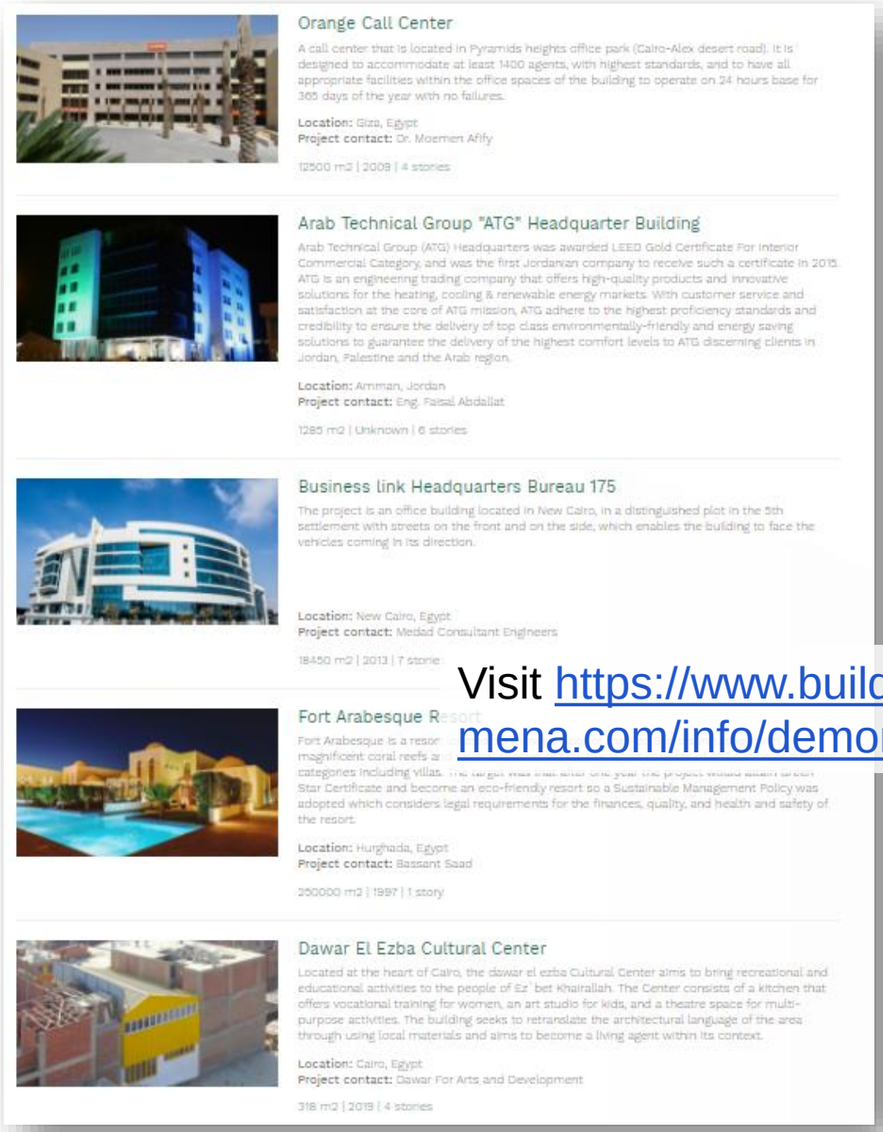
Demonstration project database

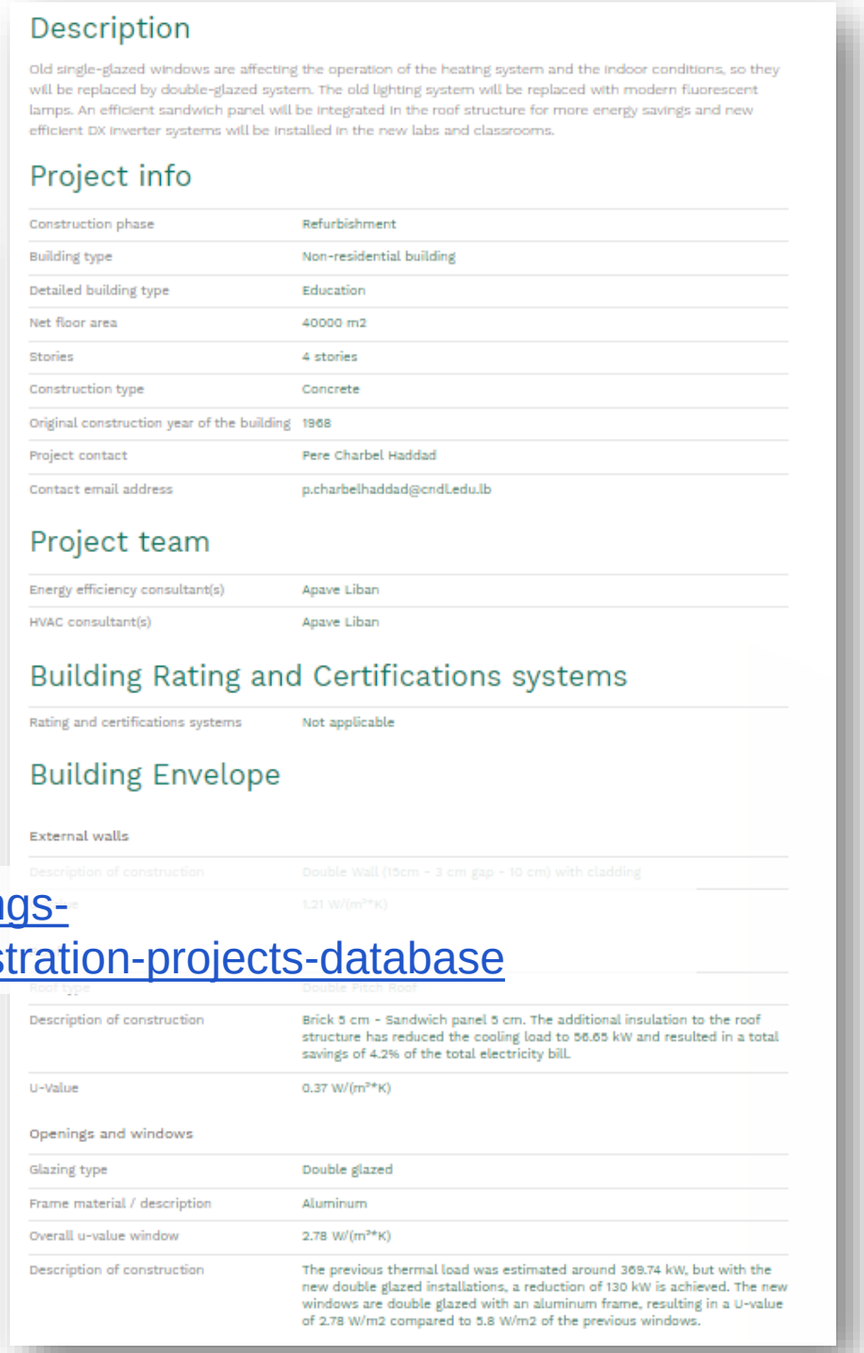
Crowd-sourced examples from the region

Register and add a project

ADD NOW!

- Searchable database of practical inspiration
- Welcome input from project developers, architects or contractors from across the region
- Currently approx. 50 examples





Visit https://www.buildings-mena.com/info/demonstration-projects-database

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Voluntary Energy Classification Scheme

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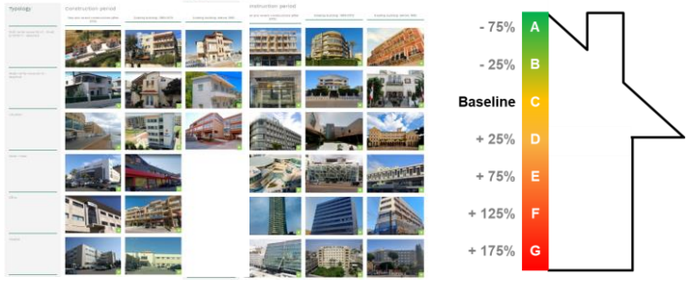
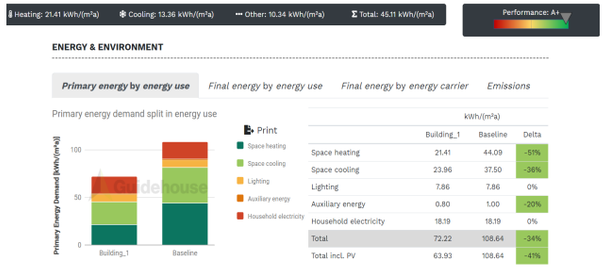
Voluntary Energy Classification Scheme

Starting point and objective



BUILD_ME Building Typology
considering the prepared typology as a baseline



Building Energy Performance Tool
(BEP) tool as a calculation method considering local market information

EGY
JOR
LEB

Systems of national institutions

Requirements local banks

Adaptability to national context
Considering country needs and managerial infrastructures

Establishment of a national energy classification scheme

Ensure implementation and ownership of the scheme beyond BUILD_ME

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Problem statement

How to introduce the BEP Tool in the built environment of BM countries

Option A) Integrated

- Integrate the BEP tool in an existing scheme
- BEP tool as built-in module, calculating the energy performance of the energy chapter of sustainable certification scheme

Option B) Independent

- Develop a stand-alone scheme
- BEP tool as stand alone with a clear focus only on energy

Operation

What is the operational framework? Certification and labelling process?

Verification

How is verification, monitoring, surveillance and enforcement done?

Testing

Testing and roll out? Evaluation and updates to the scheme?

Ownership

Evaluation and ownership of updating the scheme?

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Option B

Draft of Voluntary Energy Classification Scheme

Ownership & management

Scheme concept & design options

- Target market
- Rating score
- Deriving energy performance
- Updates and validity of assessment
- Database and certificate
- Engage with stakeholders and present the concept

Operational framework

- Certification and labelling process
- Verification, monitoring, surveillance and enforcement (including penalties)

Testing & roll out

- Phased implementation
- Capacity building programmes

Evaluation & update of the scheme

- Regulatory impact assessment (ex-ante evaluation)
- Plan and mechanism for evaluating the effectiveness of the scheme (ex post evaluation)

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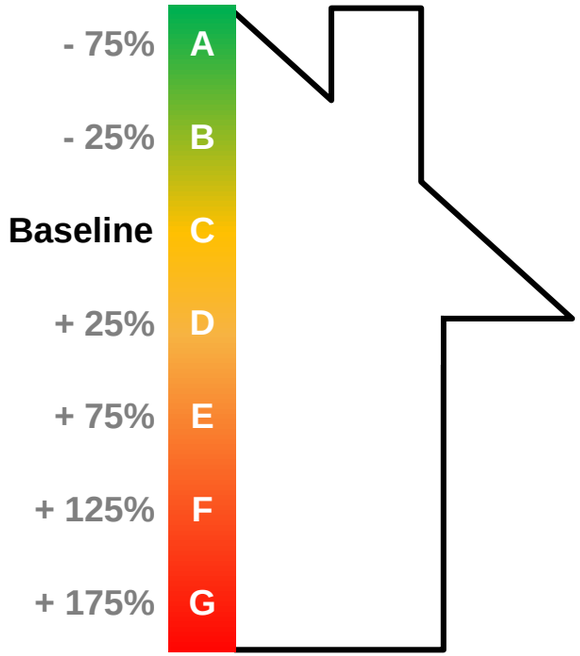
Next steps, development of classification scheme

Identification of the rating score

Classification scores for BUILD_ME building types

Class	Term	Score
A	Nearly zero energy building	<0.25
B	High performance building	0.25 - 0.75
C	Average new construction	0.76 - 1.25
D	Stock, better quality	1.26 - 1.75
E	Stock, medium quality	1.76 - 2.25
F	Stock, poor quality	2.26 - 2.75
G	Stock, urgent renovation demand	>2.75

Application of the classification score to baseline level



Methodology behind the BUILD_ME classification

- Classification logic is based on the European energy performance certificates of buildings norm [EN 15217]
- Adapted with feedback from financial institutes active in the markets and findings of the building typology
- Baseline (new buildings energy consumption) is equal to Class C (score of 1.0)

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Q&A

Break

Photo by Fahmi Fakhrudin on Unsplash

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Introduction to Climate-Friendly Buildings

Abdullah Abu-Sada, RSS/NERC

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Key learnings

1. Understand the big picture
2. Improve familiarity with common definitions and terminology
3. Introduce Building Energy Levels and Sustainable Certifications

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Photo by Wolfgang Hasselmann on Unsplash

The big picture

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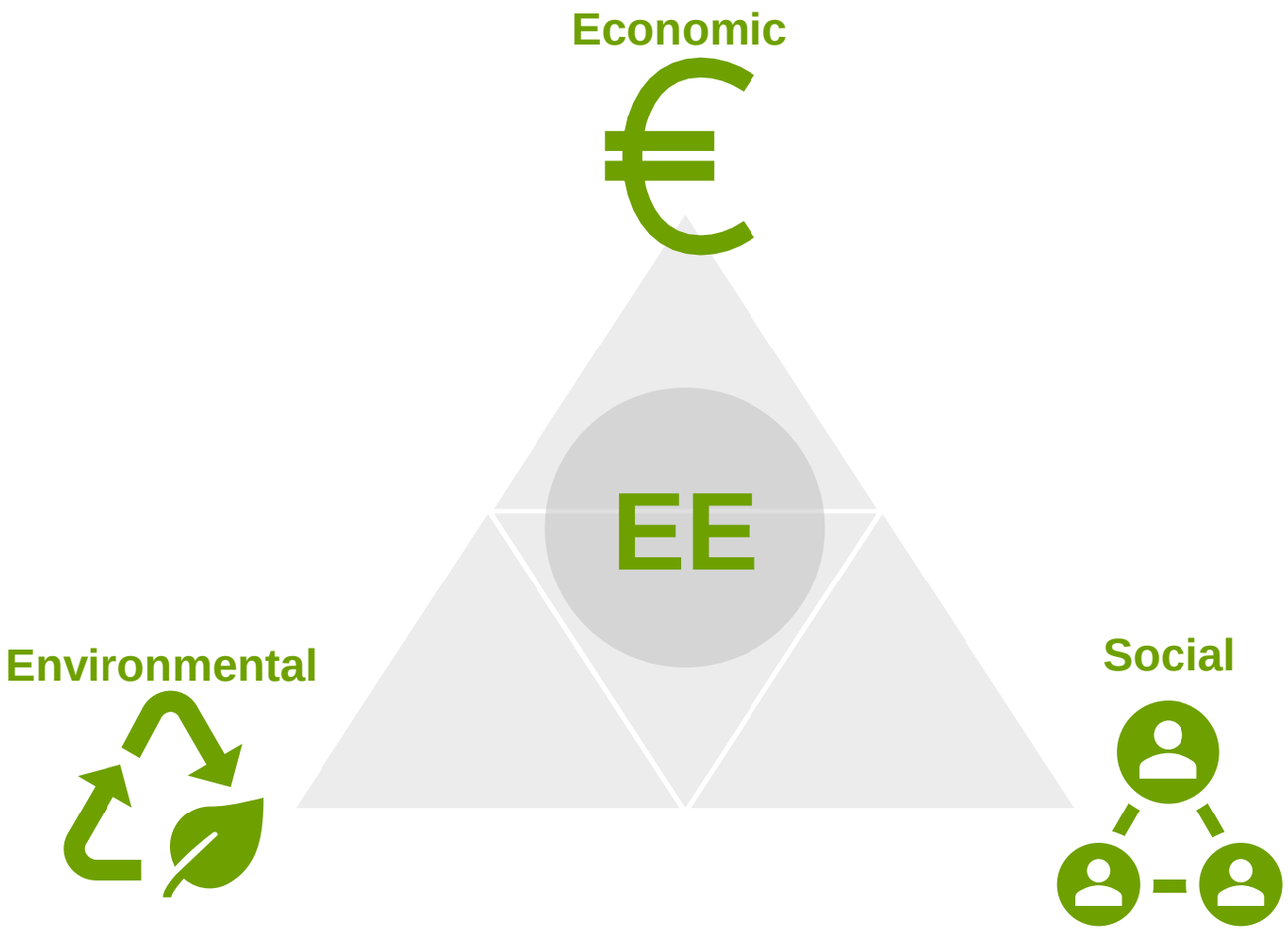
Setting the scene – the relevance of low energy buildings

The Sustainability Triangle or three Pillars of Sustainability



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Economic reasons

Some selected examples

Cost-efficient abatement

Energy security

Energy price development

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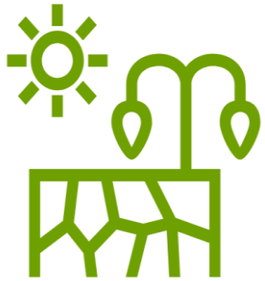
Environmental reasons

Some selected examples



Droughts

Rising temperatures

Sea level rise

Extreme weather events

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Social reasons

Some selected examples

Job creation

Removal of subsidies

Public health and productivity

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Definitions, terminology, boundary conditions

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Definitions, standards and technical terms

Knowledge of standard terminology required to understand EE projects

A couple of concepts and definitions are essential in order to embark on energy efficiency projects:

1. Climate parameters
2. Energy units/levels
3. Building energy standards

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Climate parameters

Cooling Degree Days (CDD)

- CDD = (Tm- 18.3°C) if Tm is higher than or equal to 18.3°C
- CDD = 0 if Tm is lower than 18.3°C where Tm is the mean ((Tmin + Tmax)/ 2) outdoor temperature over a period of 1 day

Heating Degree Days (HDD)

- HDD = (18°C - Tm) if Tm is lower than or equal to 15°C (heating threshold)
- HDD = 0 if Tm is higher than 15°C where Tm is the mean ((Tmin + Tmax)/ 2) outdoor temperature over a period of 1 day

Solar Irradiation in W/m²

- Irradiance may be measured in space or at the Earth's surface after atmospheric absorption and scattering.
- Solar irradiance is often integrated over a given time period in order to report the radiant energy emitted into the surrounding environment (kWh per square metre) during that time period.

Humidity in %

- An air conditioner consumes energy at a rate that is determined by both the outdoor temperature and relative humidity.
- The higher the relative humidity in the air, the more energy is needed to cool down the air (latent energy).

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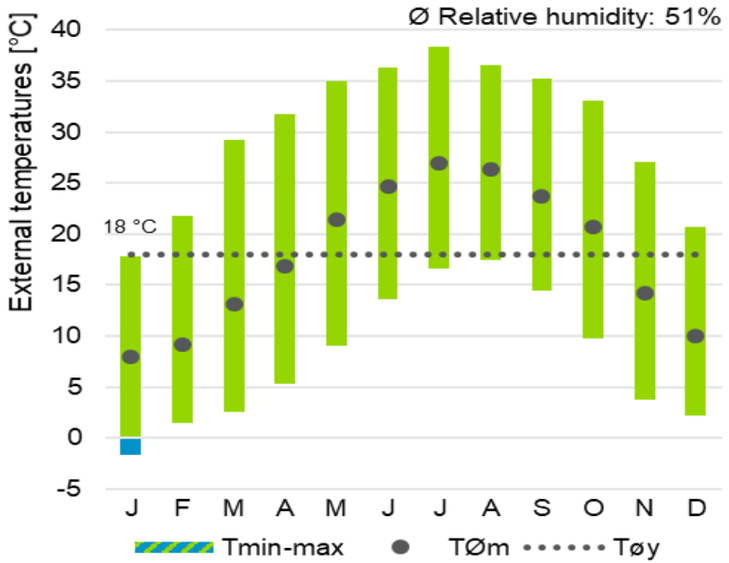
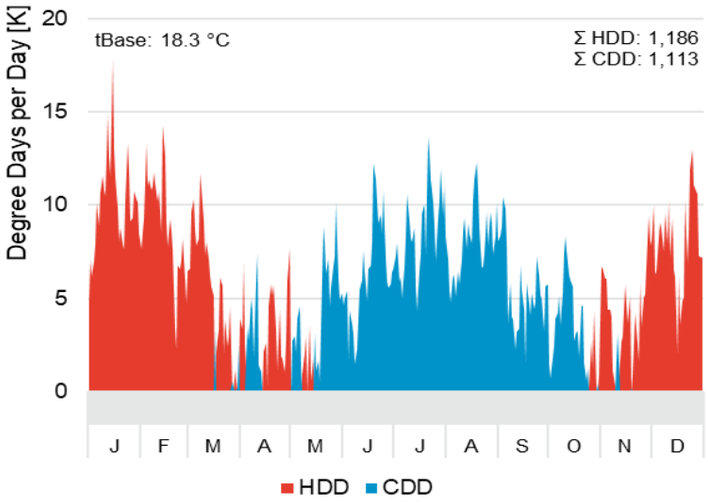
Climate analysis I Amman

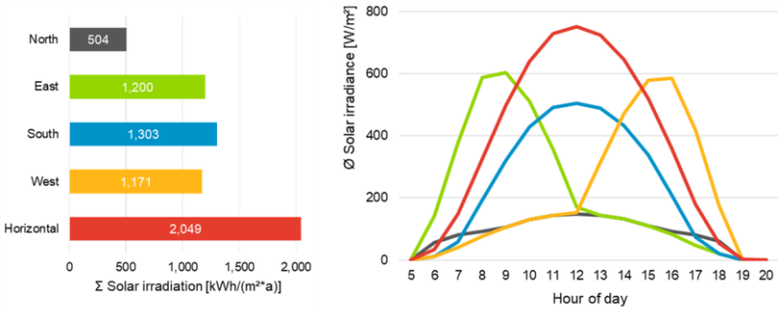
Outdoor temperature



Heating and cooling degree days



Solar Irradiation



The climate in Amman is moderate. The annual average temperatures are about 18°C

High horizontal irradiation of > 2,000 kWh/(m²*a) and > 1,100 kWh/(m²*a) for East, South and West orientation bring opportunities for solar based energy generation.

* Calculated according to ASHRAE 2001 methodology

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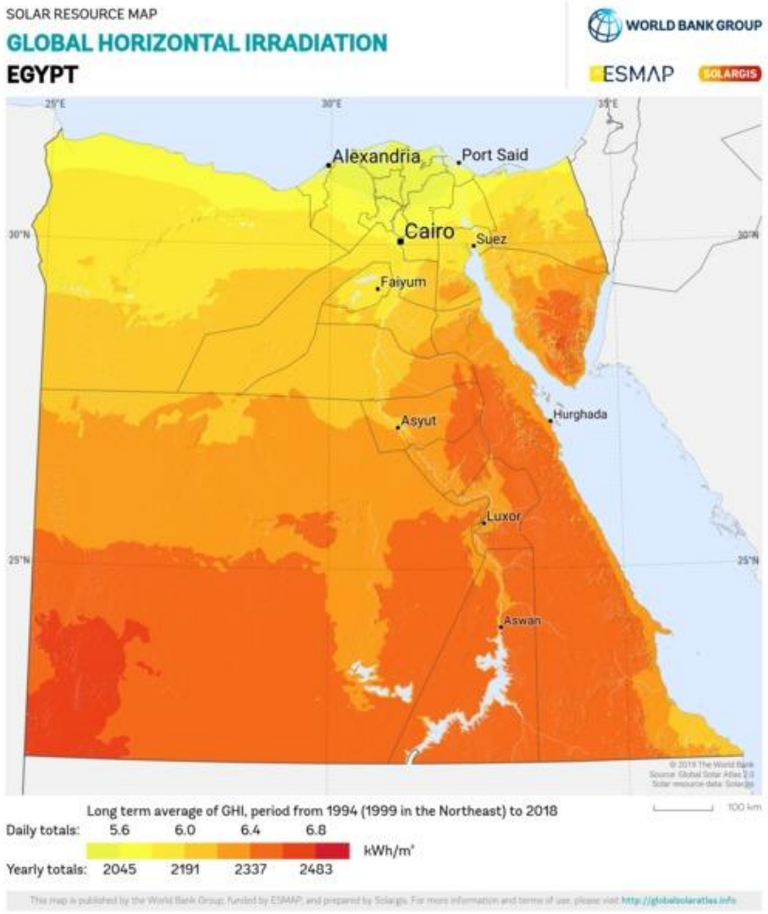
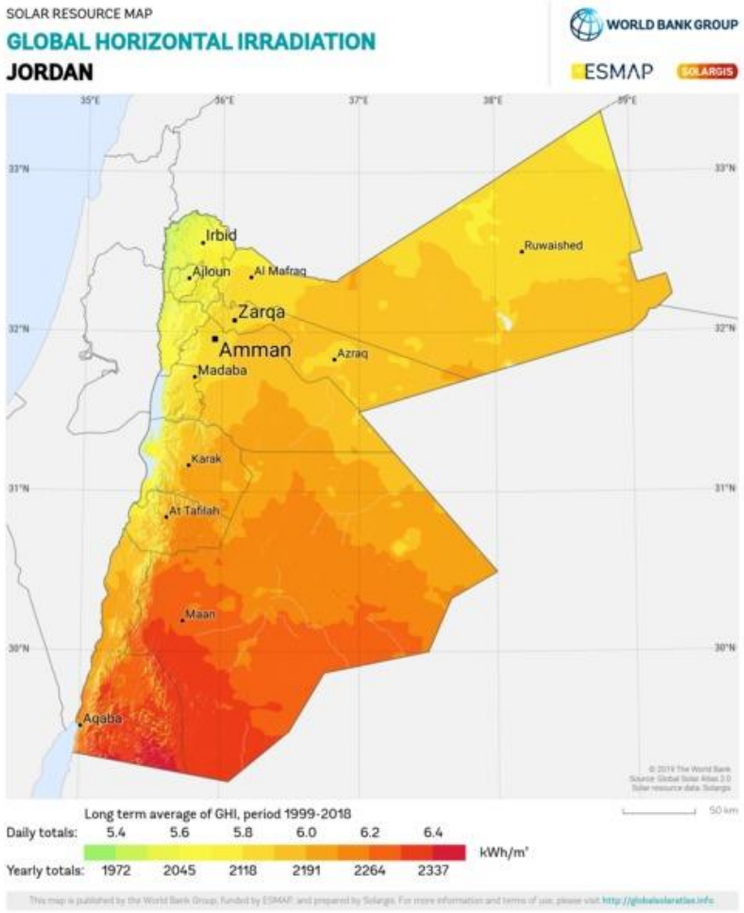
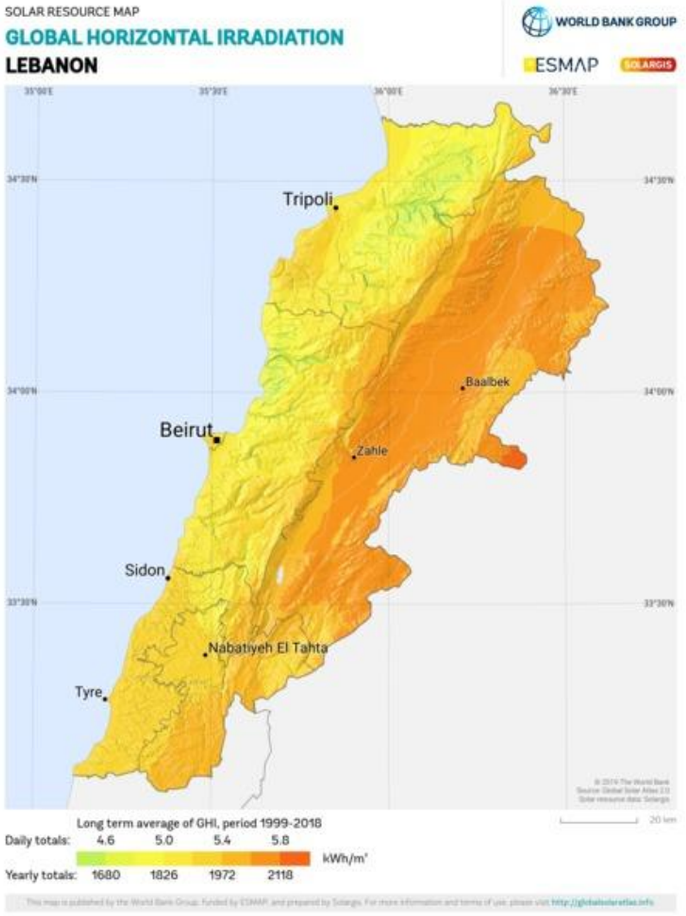
Solar radiation

BUILD_ME countries (Egypt, Jordan and Lebanon)







Source: https://solargis.com/maps-and-gis-data/download/jordan

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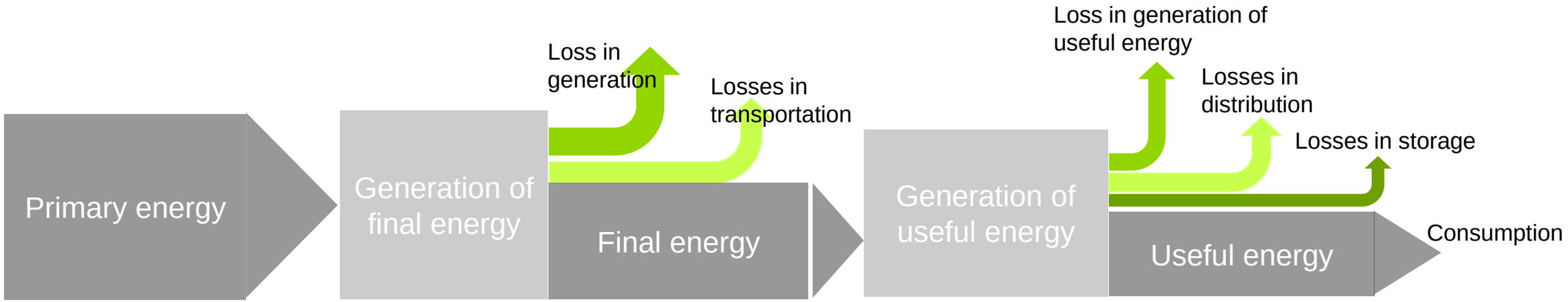
Energy unit/level definitions



- **Primary Energy** refers to energy sources as found in their natural state.
- Refers to the quantity of fuels which are extracted or produced, calculated after any operation for removal of inert matter.

- **Final Energy** refers to energy consumption based on the calculation of heating, ventilation, cooling, lighting, domestic hot water, and auxiliary energy consumption (e.g. pumps).
- Considers all on-site systems including local energy generation and renewable energy systems with all their on-site losses and efficiencies.

- **Useful Energy** is comparable with thermal energy demand.
- Based on the calculation of cooling and heating demand (including transmission and ventilation losses plus solar and internal gains).

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Source: https://www.sciencedirect.com/science/article/abs/pii/S0142061512003778

Primary energy and CO_2 factors

A Primary Energy Factor (PEF) connects primary and final energy. It indicates how much primary energy is used to generate a unit of electricity or a unit of useable thermal energy

	Primary Energy content [kWh/amount]	Primary Energy Factor [-]	CO_2 Factor [gCO_2/kWh]
Electricity (Egypt)	---------	2.6	444
Electricity (Jordan)	---------	2.4	635
Electricity (Lebanon)	---------	3.0	806
LPG	12.7 kWh/kg	1.1	236
Oil	10 kWh/lit	1.1	284
Kerosene	9.6 kWh/lit	1.1	260

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Overview efficiency definitions for cooling units

EER/COP

- Energy Efficiency Ratio (EER) is a term generally used to define the efficiency of a cooling unit
- The efficiency is determined at a single rated condition specified by an appropriate equipment standard and is defined as the ratio of net cooling capacity to the electricity demand.
  The unit of the EER varies by country. In some countries including United States it is specified in Btu/Wh, in other regions in Wh/Wh.
  The conversion factor is $EER_{US} = EER_{other} \times 3.41214$
- Exemplary testing conditions for non-ducted air conditioners according to ISO 5151:

	T_1	T_3
Outdoor °C db/wb	35/24	46/24
Indoor °C db/wb	27/19	29/19

- Coefficient of Performance Ratio (COP) is a more general dimensionless (Wh/Wh) efficiency parameter for all types of heat pumps. The COP is also specified for standard conditions.
- The higher the EER (be careful with units; see above) and COP, the more efficient the unit.

SEER

- Seasonal Energy Efficiency Ratio (SEER) defines the average annual cooling efficiency of an air-conditioning unit related to a typical (hypothetical) season.
- In comparison to the EER, SEER considers various outdoor temperatures and humidity of a specific climate location.
- Therefore the SEER of a cooling unit varies with the specific climate conditions.

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Source: https://unsplash.com/photos/8RfX3u26FkM

Building energy levels and sustainable certification schemes

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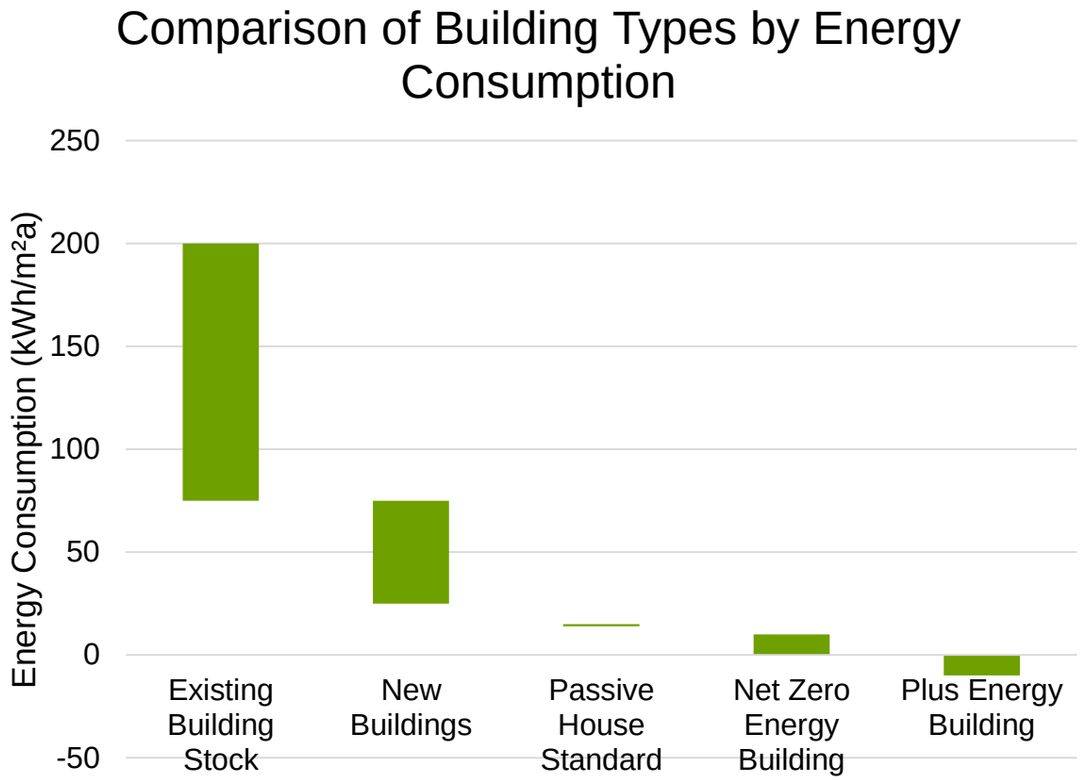
Buildings energy levels

Net Zero Energy Buildings (NZEB)

- Total amount of energy used by the building on an annual basis is equal to the amount of renewable energy created on-site
- Need to consider country-specific climate conditions, primary energy factors, ambition levels, calculation methodologies and building traditions
- Existing NZEB definitions can **differ significantly** (e.g. regarding the definition of energy, which can be either final or primary energy)



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Climate-friendly buildings from a technology perspective

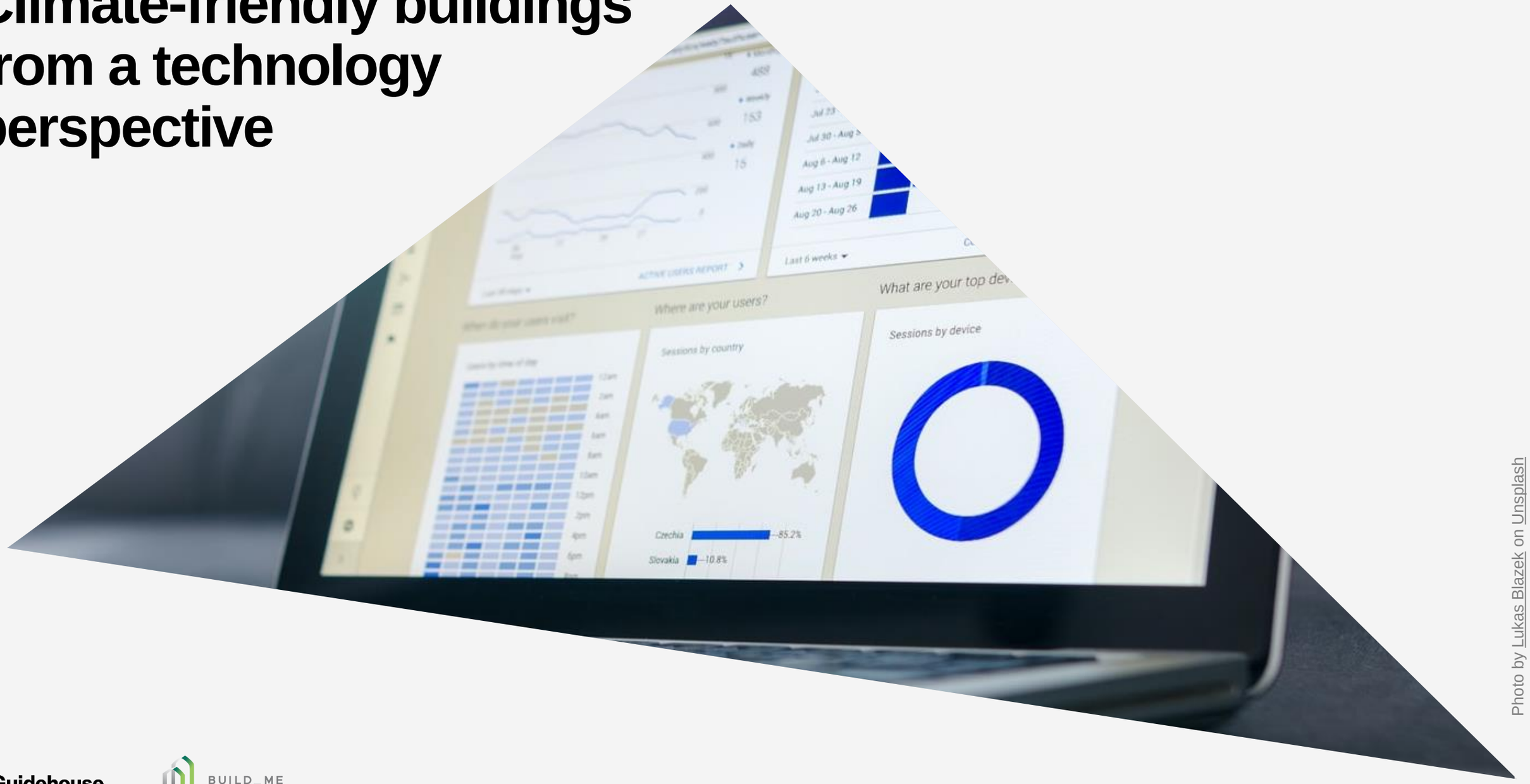

Photo by Lukas Blazek on Unsplash

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Key Learnings

Principles of a holistic planning

Measures to reduce energy consumption

Renewable energy measures

Cost efficiency measures

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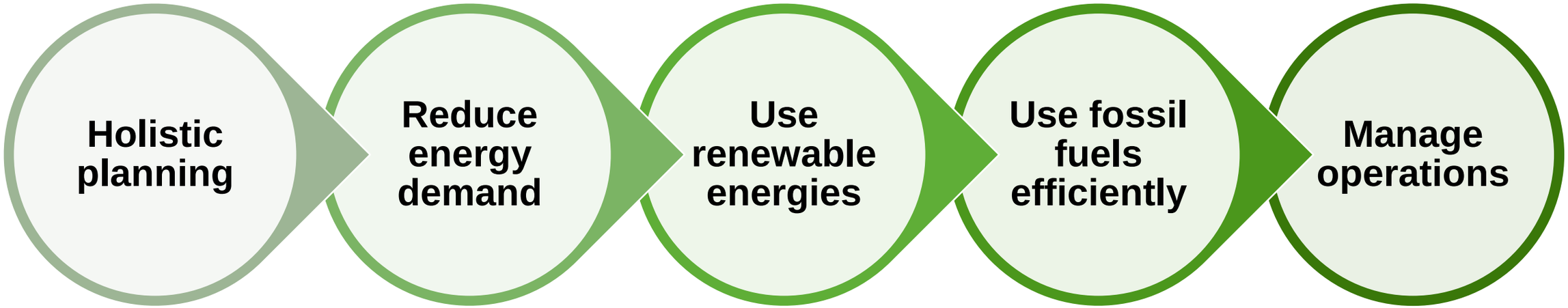
General principles to conceive a low energy building

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



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حقائق حول توفير الطاقة في أنظمة التكييف

1. تعتبر درجة حرارة من 19-21 درجه مئوية ورطوبة نسبيه 50%-60% اكثر الظروف ملائمة للإنسان في فصل الشتاء.
2. في فصل الصيف فان افضل الظروف ملائمة للإنسان هي درجة حرارةمن 24- 25 درجه مئوي ورطوبة نسبيه 40%-50%.
3. إن كل درجه مئوية تقل أو تزيد عن درجة الحرارة الموصى بها صيفا او شتاءا تؤدي إلي زيادة في كلفة الطاقة بنسبة لاتقل عن 7% تقريبا.
4. أثبتت الدراسات أن استخدام مواد العزل الحراري لعزل المباني يوفر ما نسبته 50% أو اكثر من تكلفة الطاقة المستهلكة لتدفئة أو تبريد المبنى.
5. تسرب الهواء من البيت أو إليه من خلال شقوق النوافذ والأبواب تؤدي إلى ضياع نسبه كبيره من الطاقة المستهلكة تقدر بحوالي 10%،لذلك من الضروري منع تسرب الهواء من البيت أو إليه من خلال إحكام إغلاق النوافذ والأبواب وإغلاق الشقوق باستخدام موانع التسرب اللاصقة.

2 طن تبريد ما يعادل 24000 BTU/hr

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Legend allowing a quick assessment of the measures

Energy performance		Investment		Payback period	
Small energy savings		Small investment	€	Less than 5 years	
Moderate energy savings		Moderate investment	€ €	5 to 15 years	
High energy savings		High investment	€ € €	More than 15 years	

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Step 1: Holistic planning

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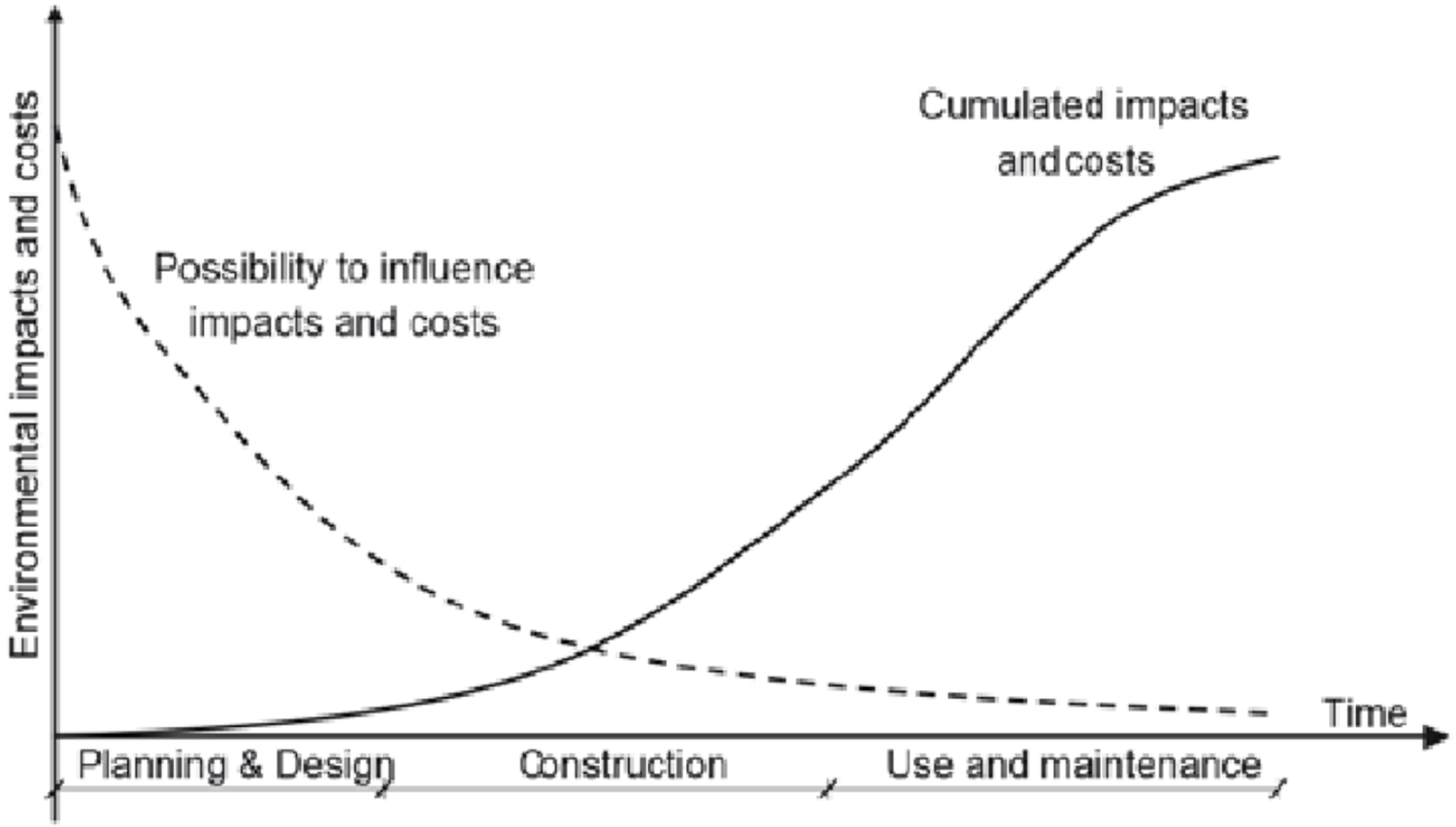
Influence of design decisions on life cycle impacts and costs



Source: Kohler & Moffatt, 2003

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

Step 2: Reduce energy demand

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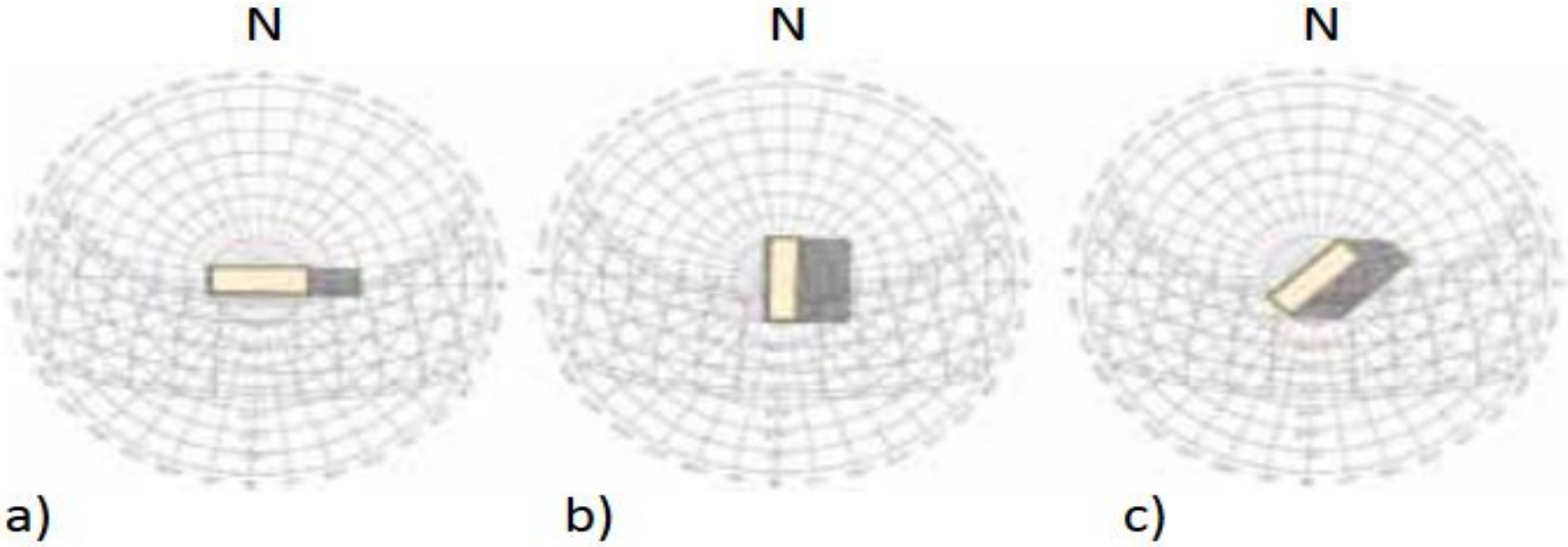
Orientation



Orientation		

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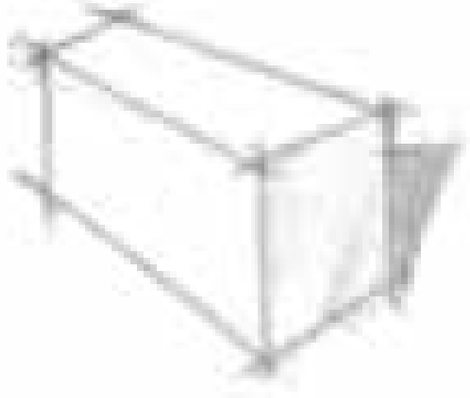
Building form and typology

Compact building form has a lower surface/volume ratio (S/V)

Envelope = 63m²

S/V = 1.2



Envelope = 71m²

S/V = 1.35

Envelope = 81.5m²

S/V = 1.55

Building form and typology		

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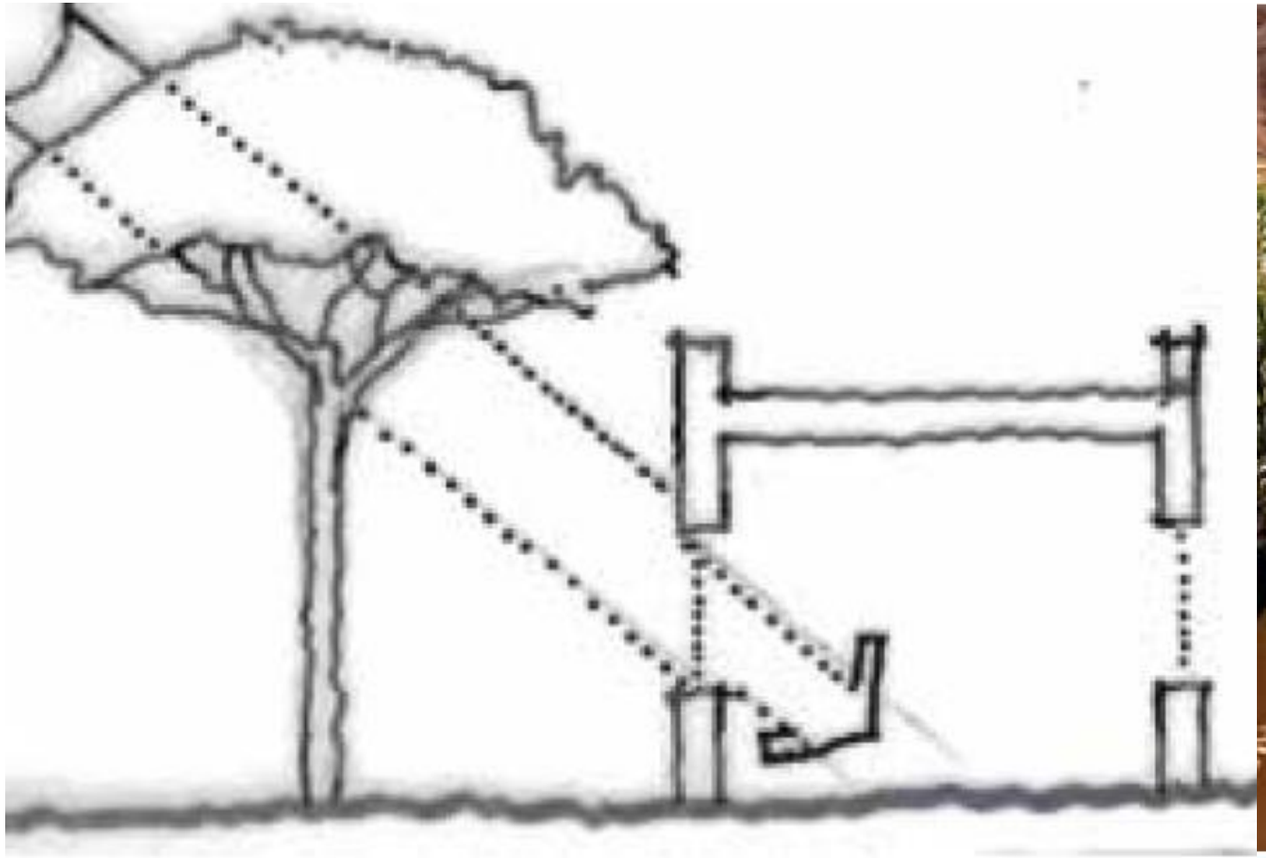
Landscape design

Use vegetation for a better microclimate and shading



Landscape design		

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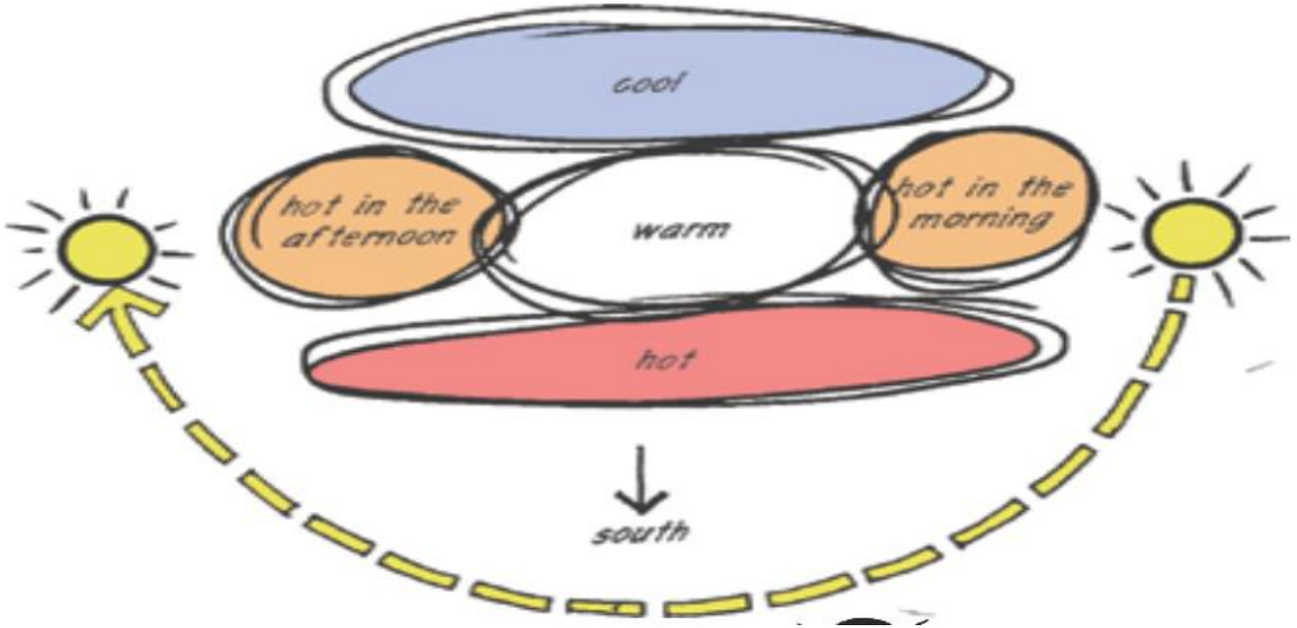
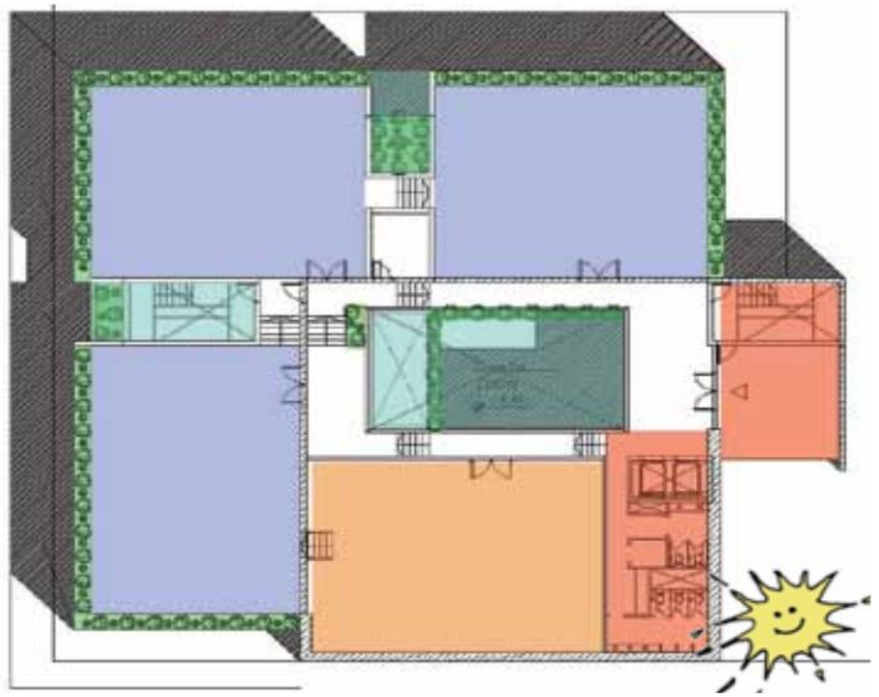
Thermal zoning

Organise space according to time of use and sun exposure





Thermal zoning		

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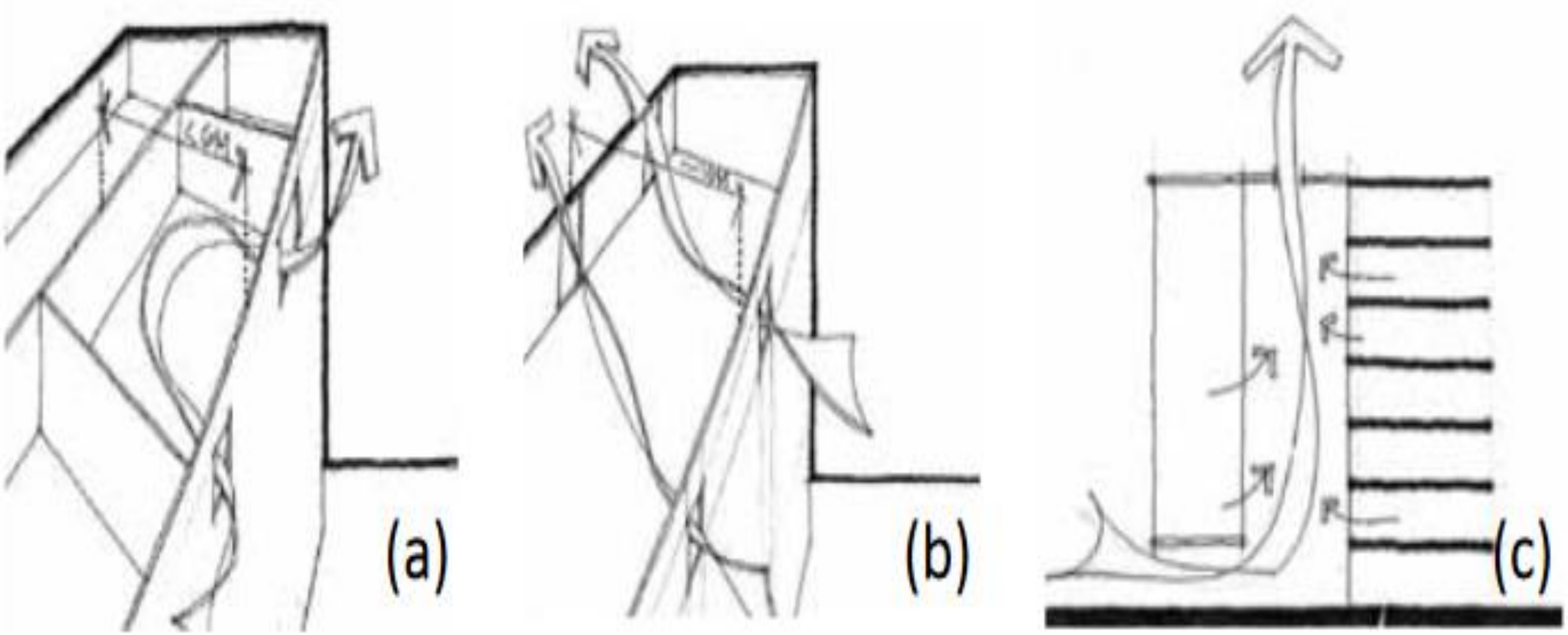
Natural ventilation

Strategies: single-sided (a), cross (b), stack ventilation (c)



Source: http://www.comfortfutures.com/urban-heat-island-effect

Natural ventilation		

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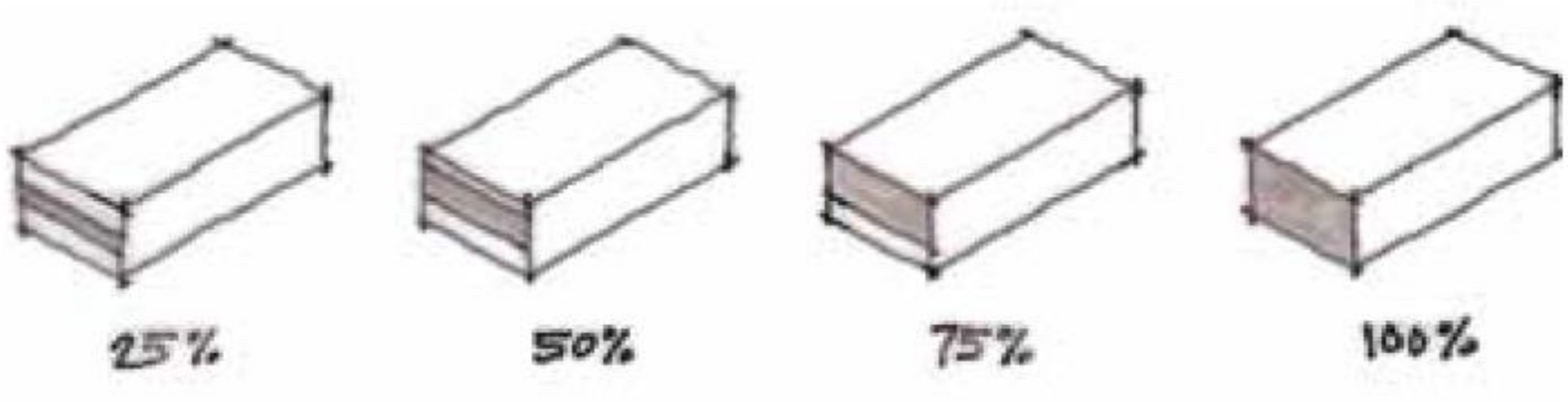
Window Wall Ratio [WWR]



Windows and their ratio		

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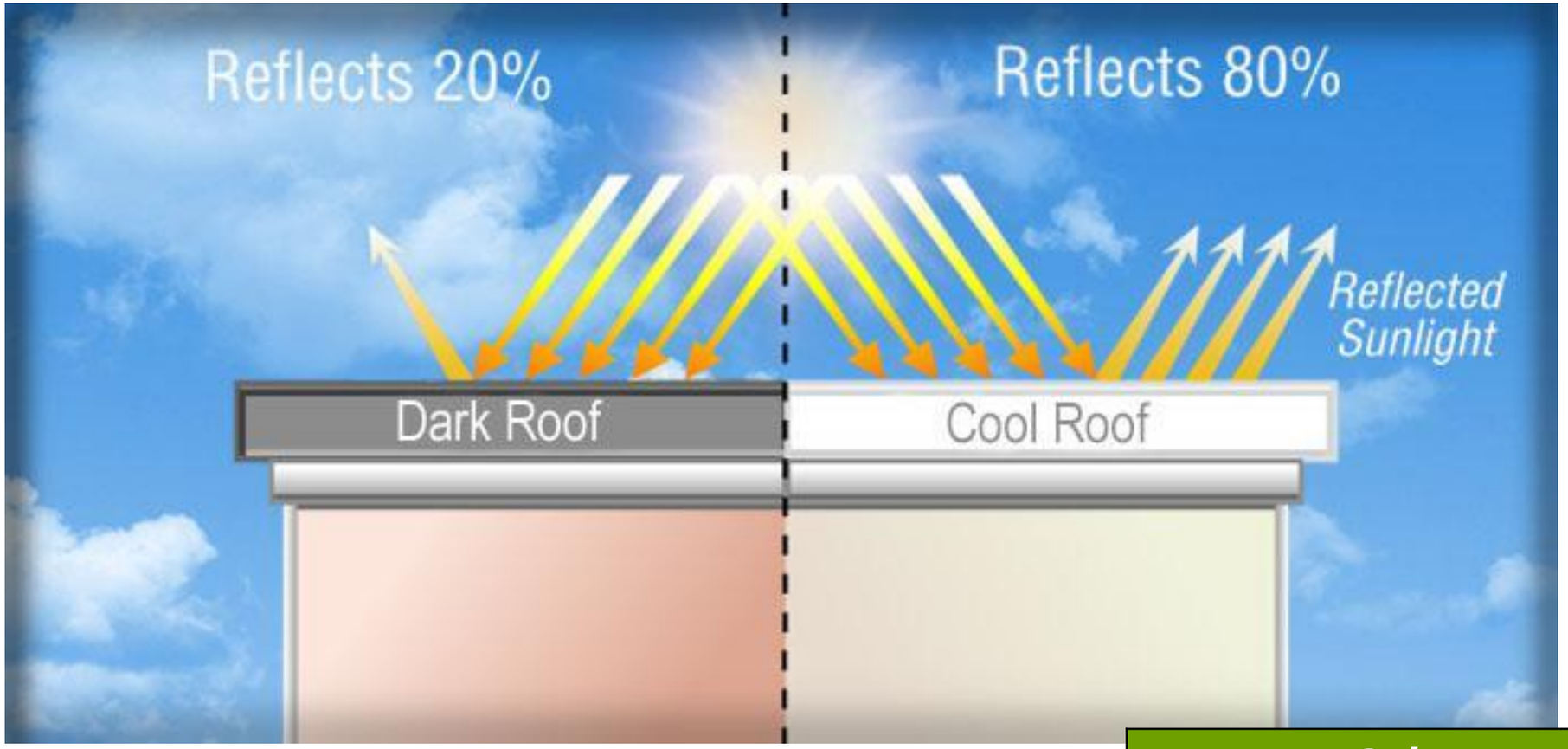
Colour

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



S: http://www.comfortfutures.com/urban-heat-island-effect

Colours		

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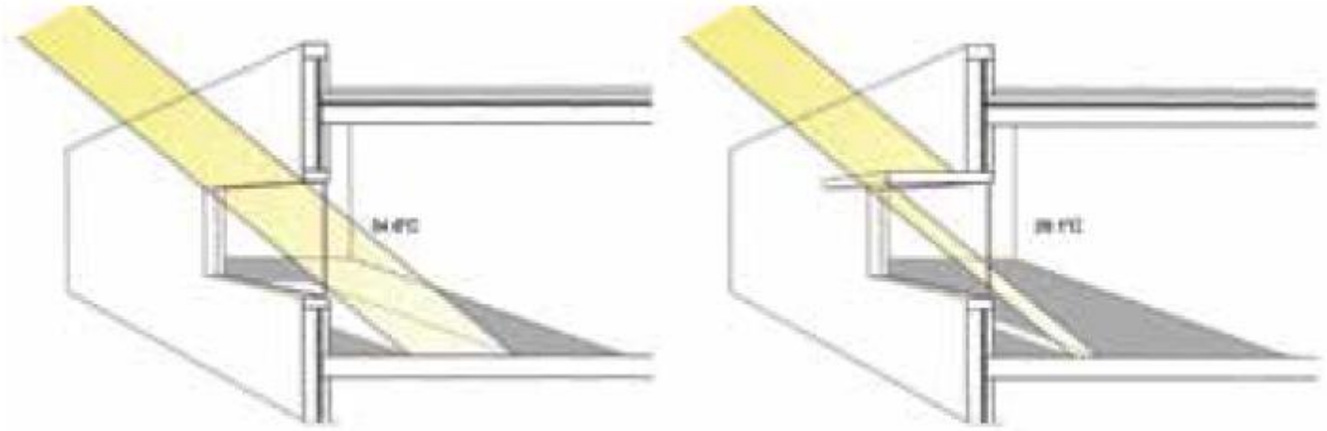
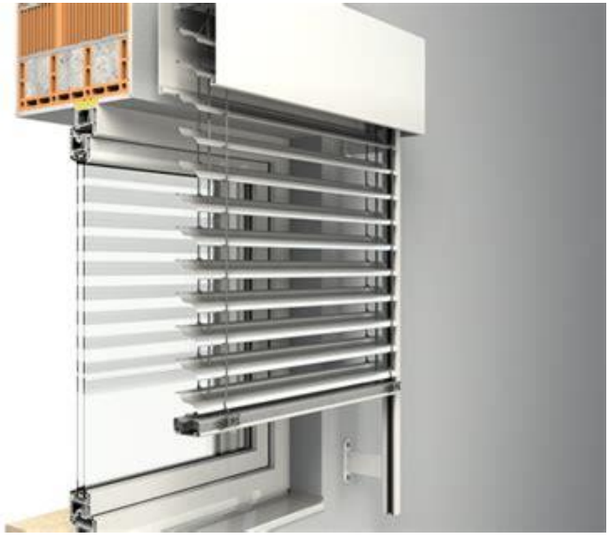
Shading

Reduction of solar heat gain due to window shading



South – horizontal-fix



East/West – movable external

Fixed shading south		

Movable Shading east/west		

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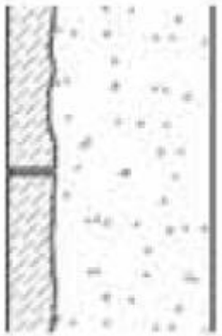
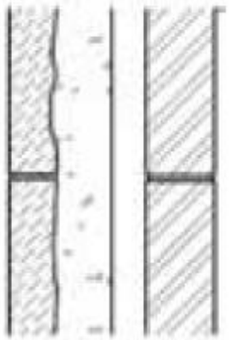
Material selection

Thermal insulation

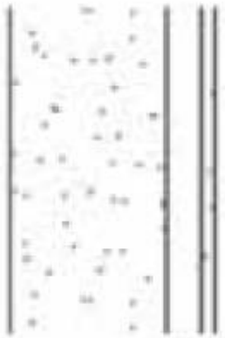
a) Solid wall
U=3.03 W/m²K
20 cm concrete



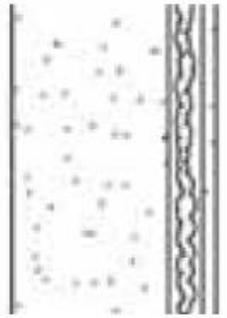
b) Un-insulated wall
U=2.6 W/m²K
23 cm concrete
7 cm stone cladding



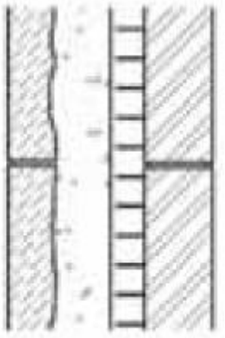
c) Cavity wall
U= 2.02 W/m²K
10 cm hollow
concrete block
5 cm air gap
8 cm concrete
7 cm stone cladding



d) Un-insulated wall
U= 1.73 W/m²K
1.5 cm gypsum board
5 cm air gap
23 cm concrete



e) Insulated wall
U= 0.61 W/m²K**
1.5 cm gypsum
board
5cm rockwool
23 cm concrete



f) Insulated cavity wall
U= 0.49 W/m²K
10 cm hollow
concrete block
5 cm polystyrene
8 cm concrete
7 cm stone cladding

Figure 28: Examples of wall constructions

Thermal insulation		

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Material selection

Thermal insulation

نوع العزل	أشكال العزل	الموصلية الحرارية (W/m.k)	الميزات والتطبيقات
ألواح الصوف الصخري الجاسئة وشبه الجاسئة		0.038 -0.04	**يستعمل في كافة التطبيقات خاصة التطبيقات القريبة من الحرارات العالية و نشوء الحريق**
ألواح البوليستيرين الممدد		0.032 – 0.033	**تستعمل ألواح هذا الصنف لأغراض العزل الحراري في السقوف المعرضة لأحمال عالية وفي الشرفات والأرضيات المختلفة المعرضة لإجهادات متنوعة. كما تستعمل في أرضيات المخازن وغرف التبريد.**
البوليستيرين المبثوق		0.033 – 0.035	**يطبق في عزل الحرارة في السقوف والجدران والأرضيات. وتصنع الألواح بكثافات مختلفة تتلاءم مع طبيعة الاستعمال والإجهادات التي تتعرض لها بعد التطبيق**
البوليريثين الرغوي		0.02 – 0.025	**المادة الرغوية يمكن رشها مباشرة باستعمال أجهزة معينة على السطوح المستوية والمائلة وصهاريج التخزين**

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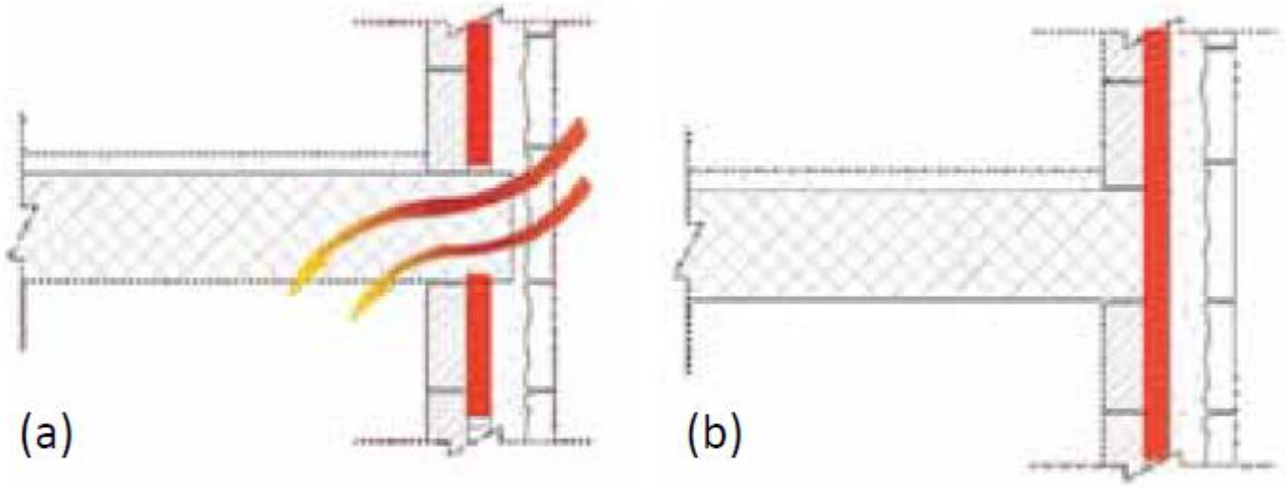
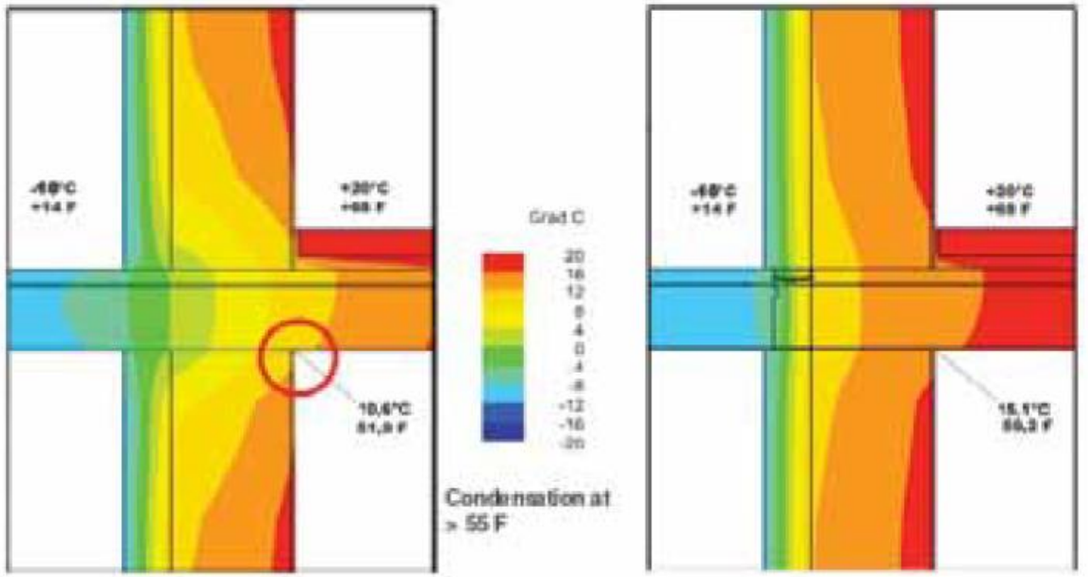
Material selection

Thermal bridges





Thermal bridges		

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مواصفات النوافذ والأبواب الخارجية الموفرة للطاقة

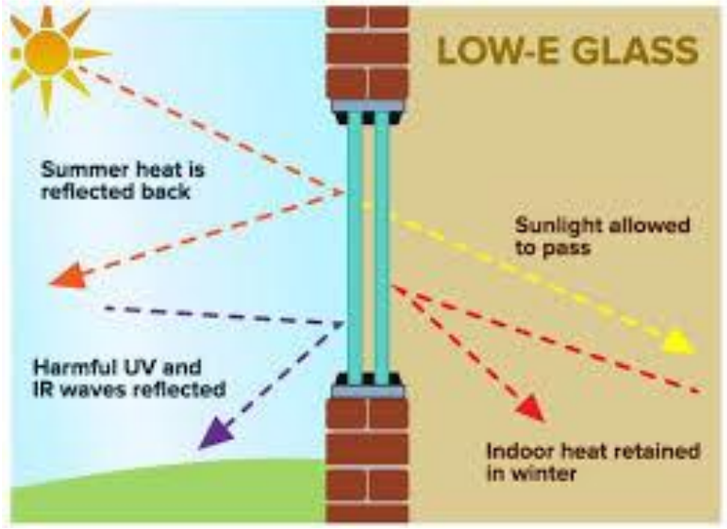
وجود طبقة دهان منخفضة الابتعاثية Low-E على الوجه الداخلى للوح الزجاج الخارجي

لوح زجاجي 6مم

فراغ هواء 12مم

لوح زجاجي 6مم

إطار من البلاستيك PVC أو من الألمنيوم مع وجود شريط عازل للحرارة



لوح زجاجي 6مم

فراغ هواء 12مم

لوح زجاجي 6مم

إطار من البلاستيك PVC أو من الألمنيوم مع وجود شريط عازل للحرارة

لوح زجاجي 6مم

فراغ هواء 12مم

لوح زجاجي 6مم

إطار من البلاستيك PVC أو من الألمنيوم مع وجود شريط عازل للحرارة

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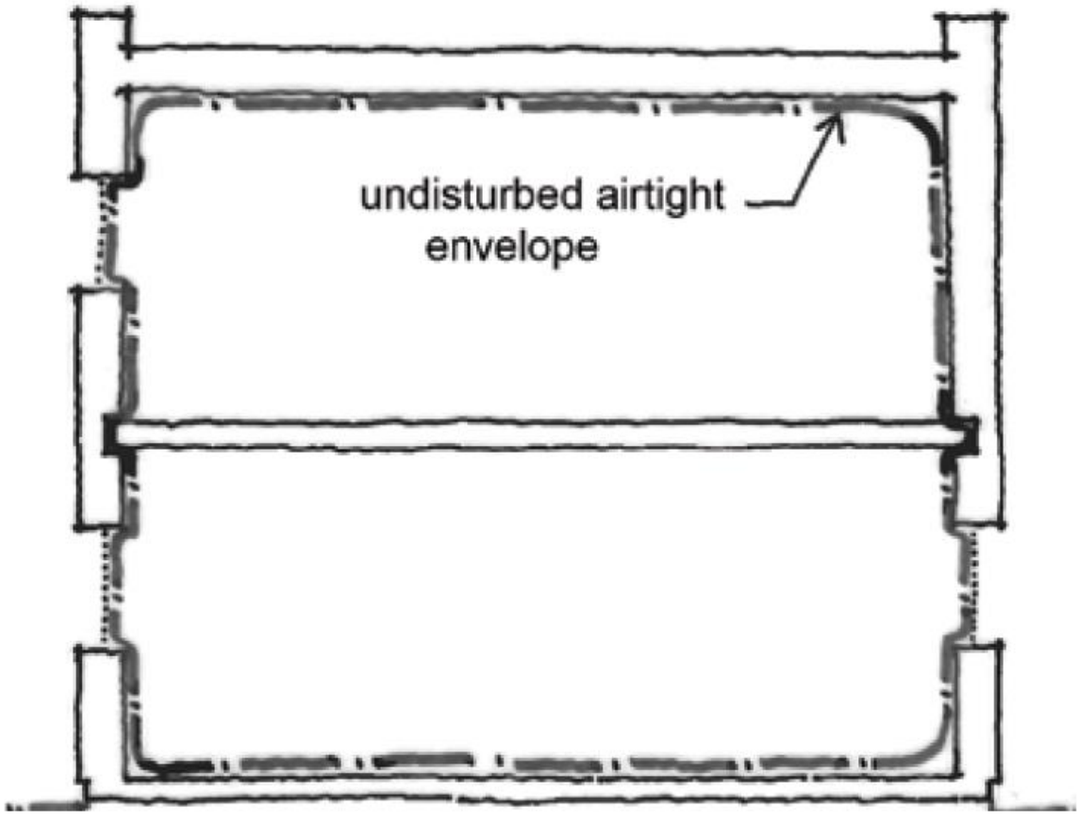
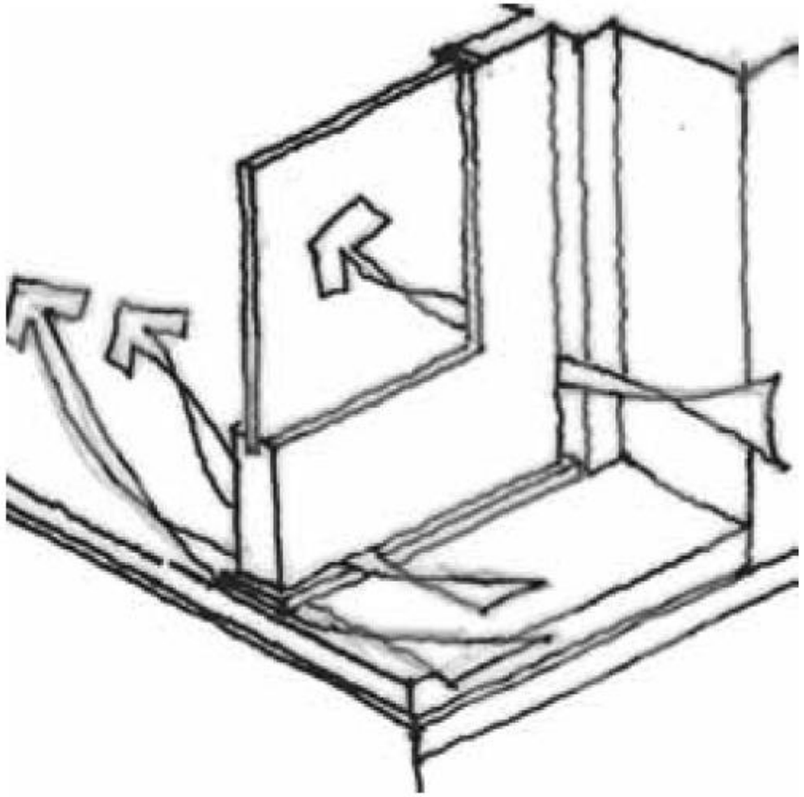
Material selection

Air tightness – avoid leakages





Air tightness		
	€ €	

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Air Infiltration Appearances

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Air Infiltration Appearances

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Air Infiltration Appearances

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Air Infiltration Appearances

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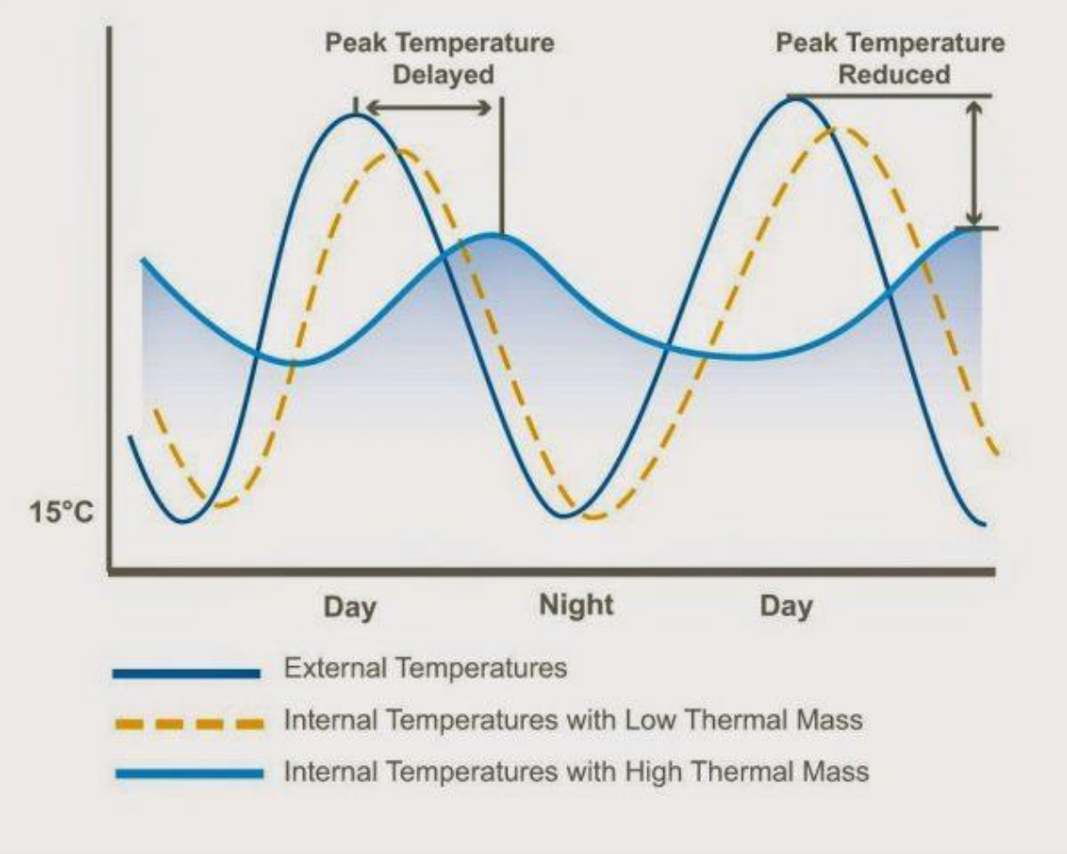
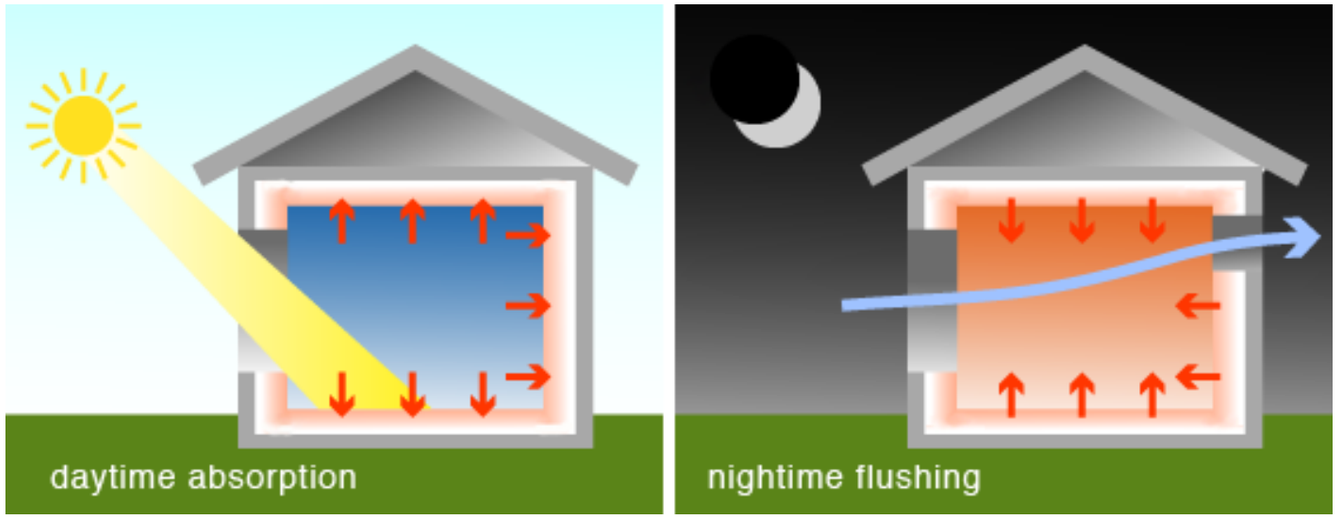
Material selection

Thermal mass, use night ventilation to maximise buffer



https://fairconditioning.org/knowledge/passive-design/thermal-mass/

Thermal mass in Summer



Source: https://www.greenspec.co.uk/building-design/thermal-mass/

Thermal mass		
	€ €	

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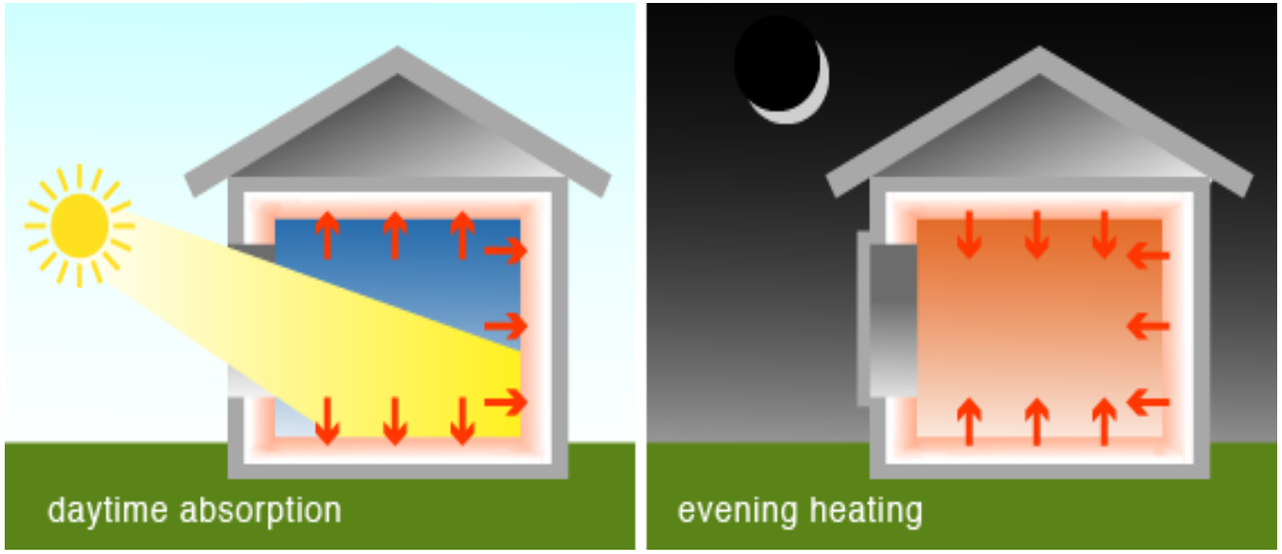
Material selection

Thermal mass, use night ventilation to maximise buffer

Thermal mass in Winter



Source: https://www.greenspec.co.uk/building-design/thermal-mass/

https://fairconditioning.org/knowledge/passive-design/thermal-mass/

Thermal mass		

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Thermal Mass Material selection

	Material	Specific heat capacity	Thermal conductivity	Density	Effectiveness
	water	4200	0.60	1000	high
	stone	1000	1.8	2300	high
	brick	800	0.73	1700	high
	concrete	1000	1.13	2000	high
	unfired clay bricks	1000	0.21	700	high
	dense concrete block	1000	1.63	2300	high
	gypsum plaster	1000	0.5	1300	high

https://fairconditioning.org/knowledge/passive-design/thermal-mass/

Source: https://www.greenspec.co.uk/building-design/thermal-mass/

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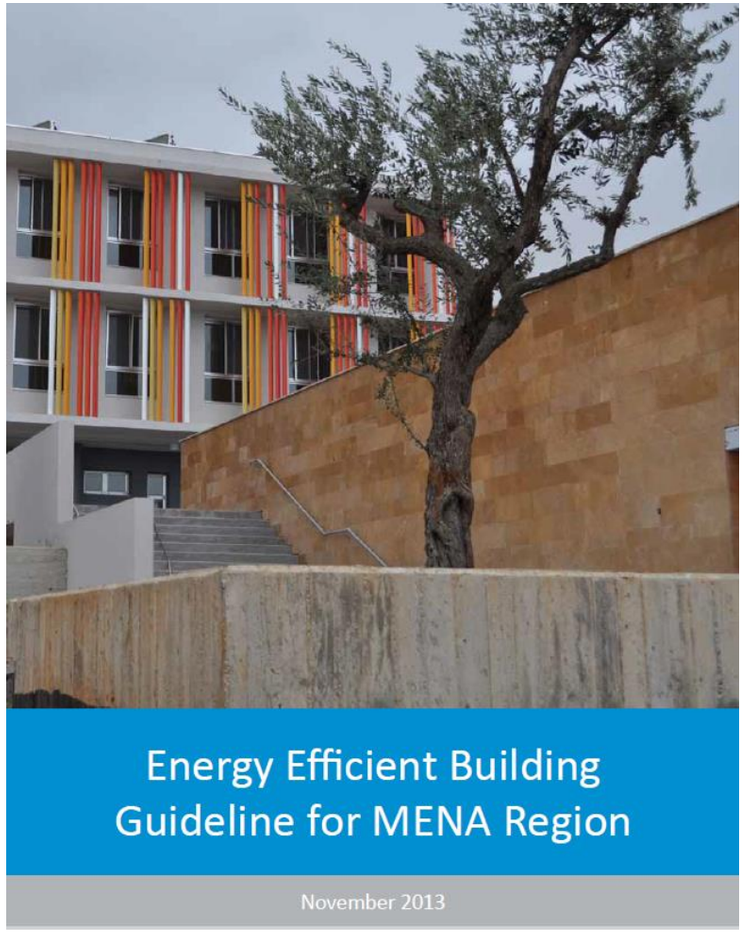
Further reading: Climate Responsive Strategies

MED-ENEC Brochure 2013, EE Building Guideline for MENA Region



1. Orientation
2. Natural ventilation
3. Thermal zoning
4. Building form and typology
    - Compactness, WWR
5. Shading
6. Material selection
    - Insulation, thermal bridges, air tightness, thermal mass
7. Landscape design

Source: https://www.climamed.eu/wp-content/uploads/files/Energy-Efficient-Building_Guideline-for-MENA-Region-NOV2014.pdf

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

Step 2: Integrate renewable energies

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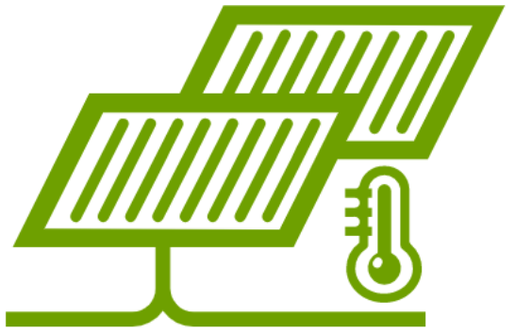
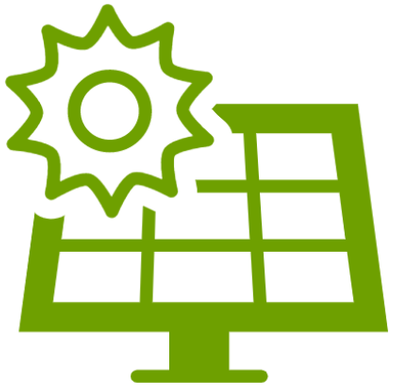
Renewable energies

Scope of training



Solar thermal systems



Photovoltaics

Heat pumps

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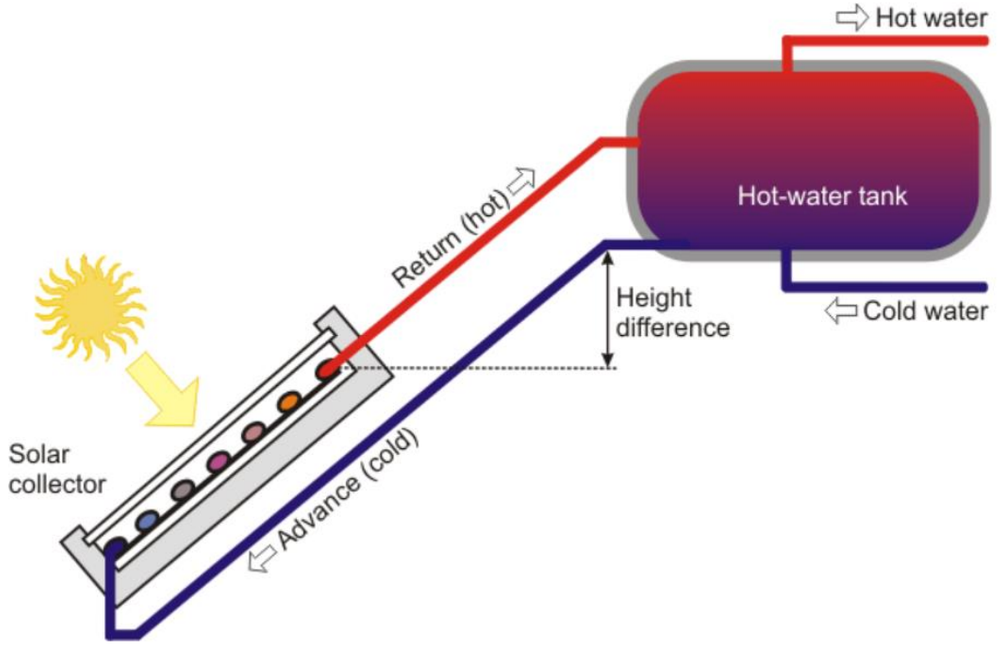
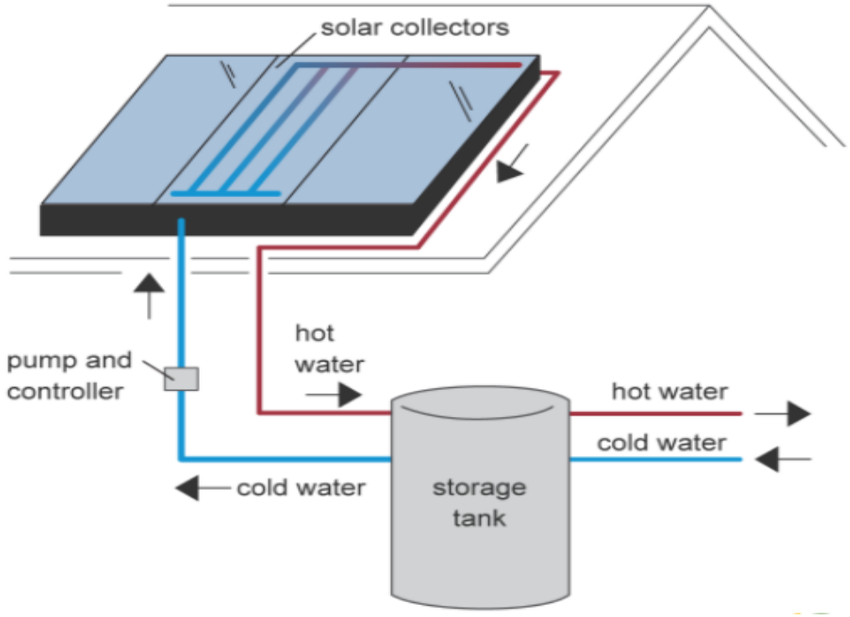
Solar thermal

How does a solar thermal system function?

Themosiphon		

Pumped system		





Source: https://www.appropedia.org/File:Thermosyphon.gif
https://www.eia.gov/energyexplained/solar/solar-thermal-collectors.php

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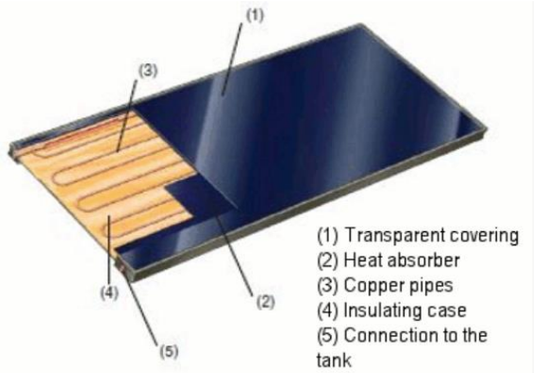
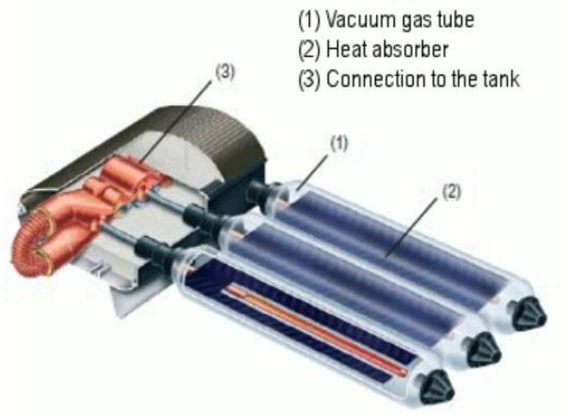
Collectors types

Simple absorbers		
	€	

Flat plate collectors		
	€ €	

Vacuum collectors		
	€ €	





Source: http://www.windupbattery.com/energy/solar/heating-panels-components.htm

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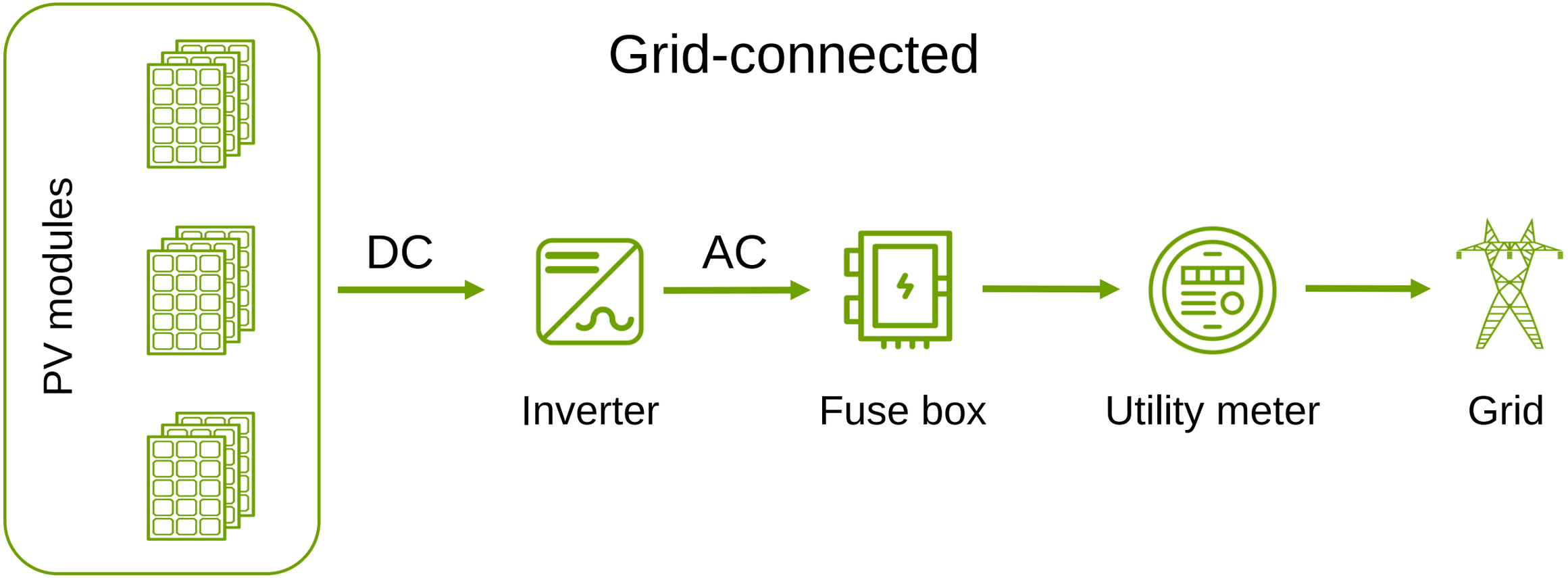
Photovoltaics

How does a PV system work?



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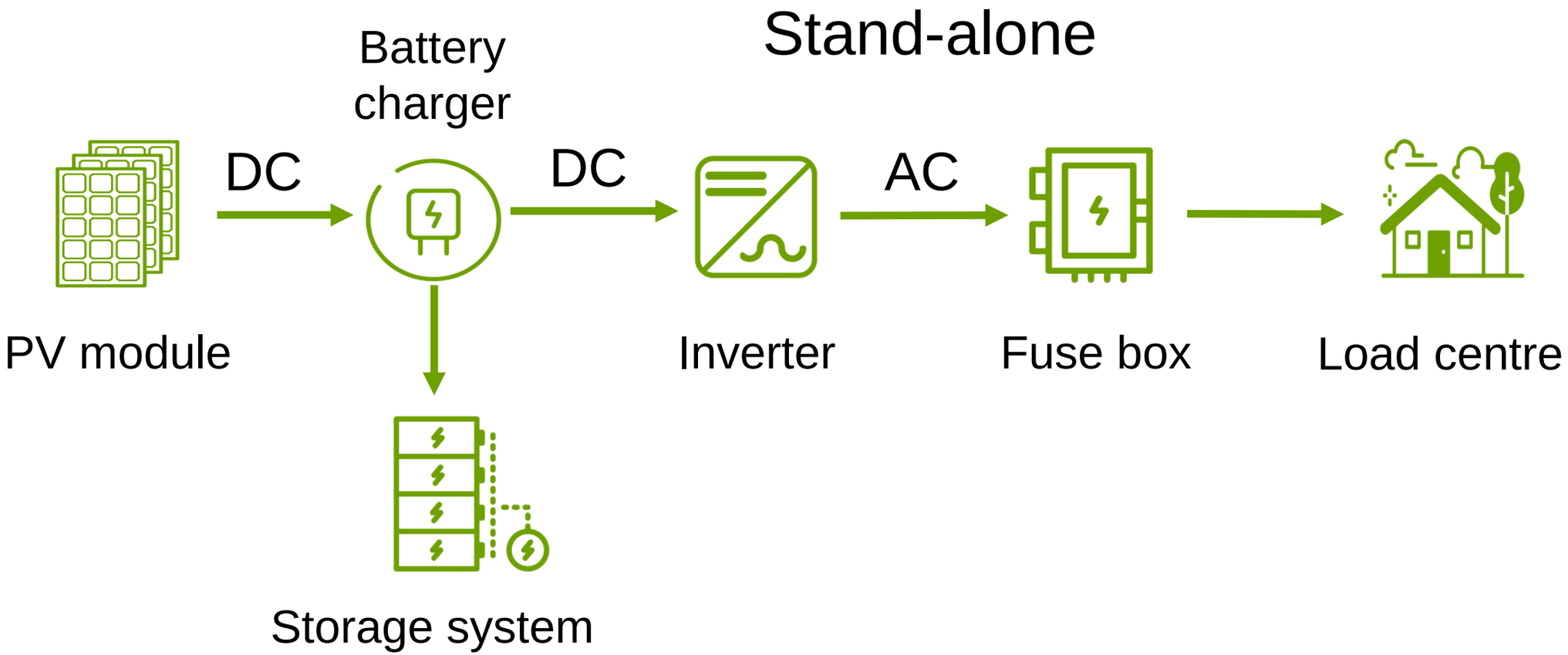
Photovoltaics

How does a PV system work?



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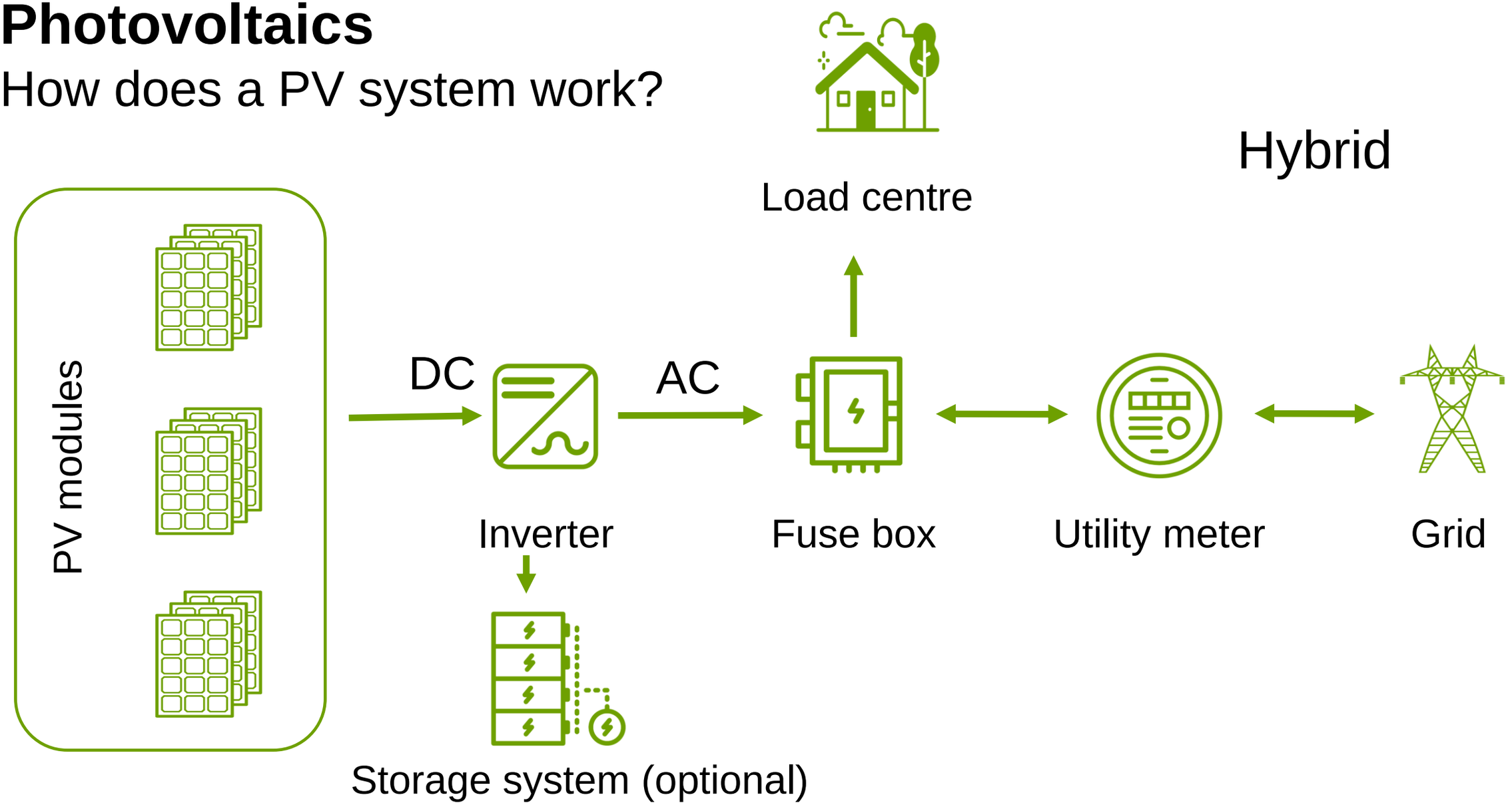
Photovoltaics

How does a PV system work?



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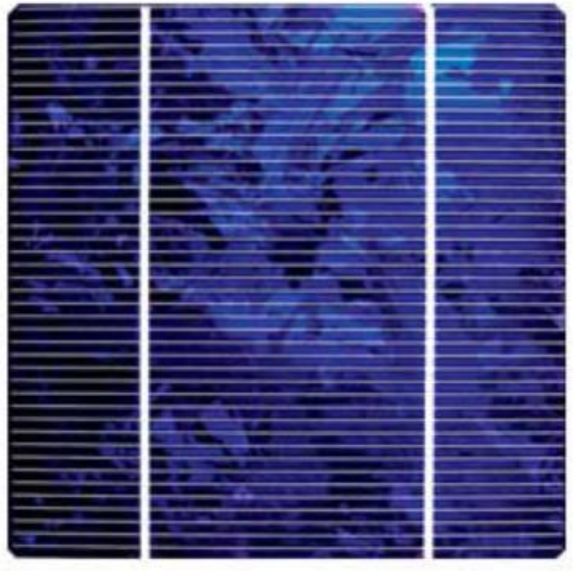
Photovoltaics

Overview of technology/modules

Mono-crystalline		

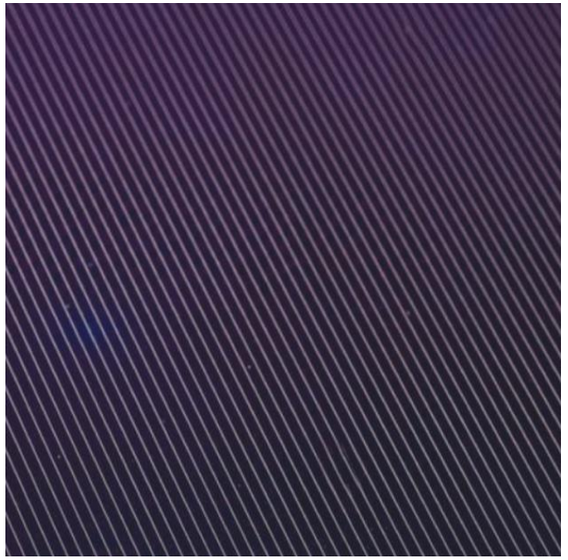
18 – 22% Eff.

Poly-crystalline		



14 – 18% Eff.

Thin films		



10 – 16% Eff.

Source:https://www.solarquotes.com.au/panels/photovoltaic/monocrystalline-vs-polycrystalline/

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Photovoltaics

Conclusion

High solar radiation in the MENA region

Sharp cost reductions make PV cost-efficient

Visible technology also supports marketing of the building asset

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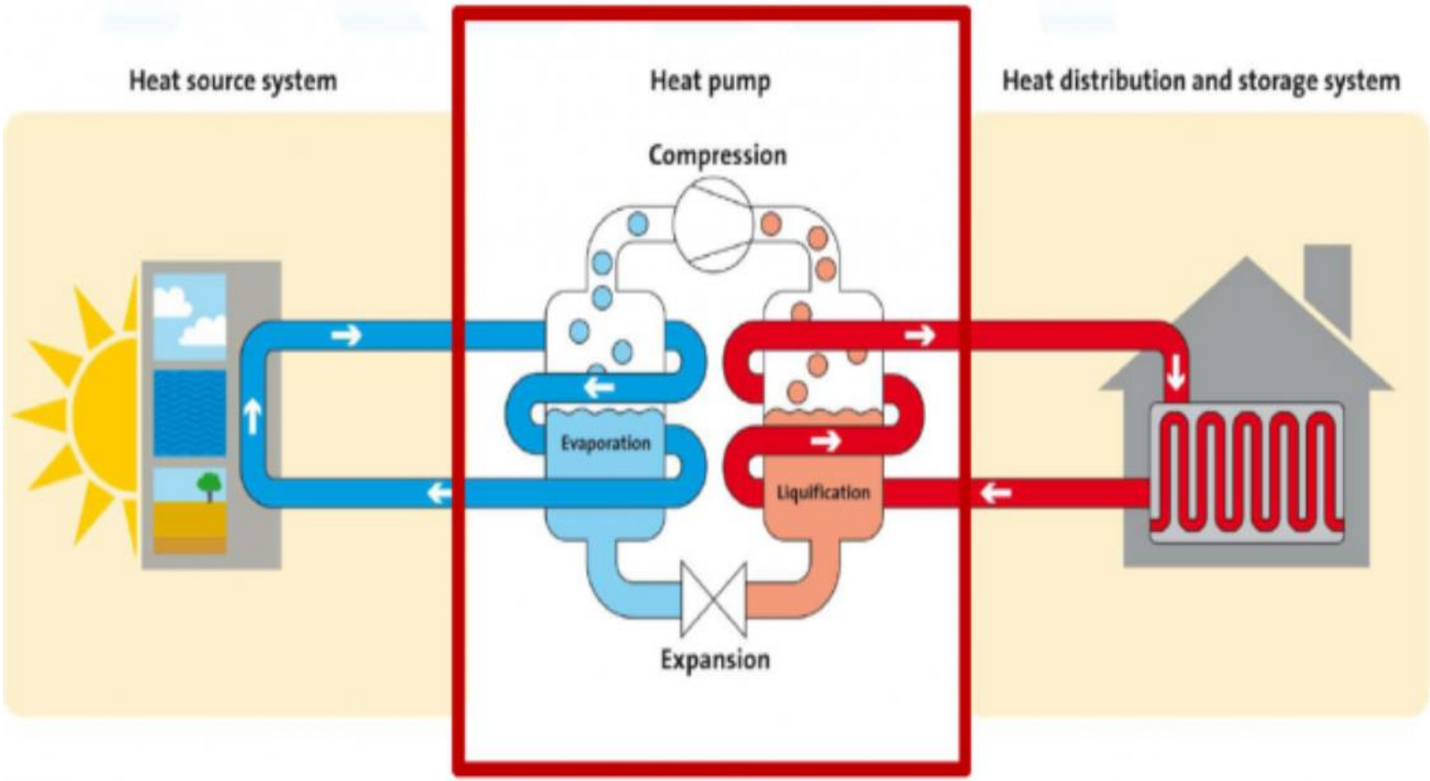
Heat pump

How does a heat pump work?



Source : https://www.ehpa.org/technology/

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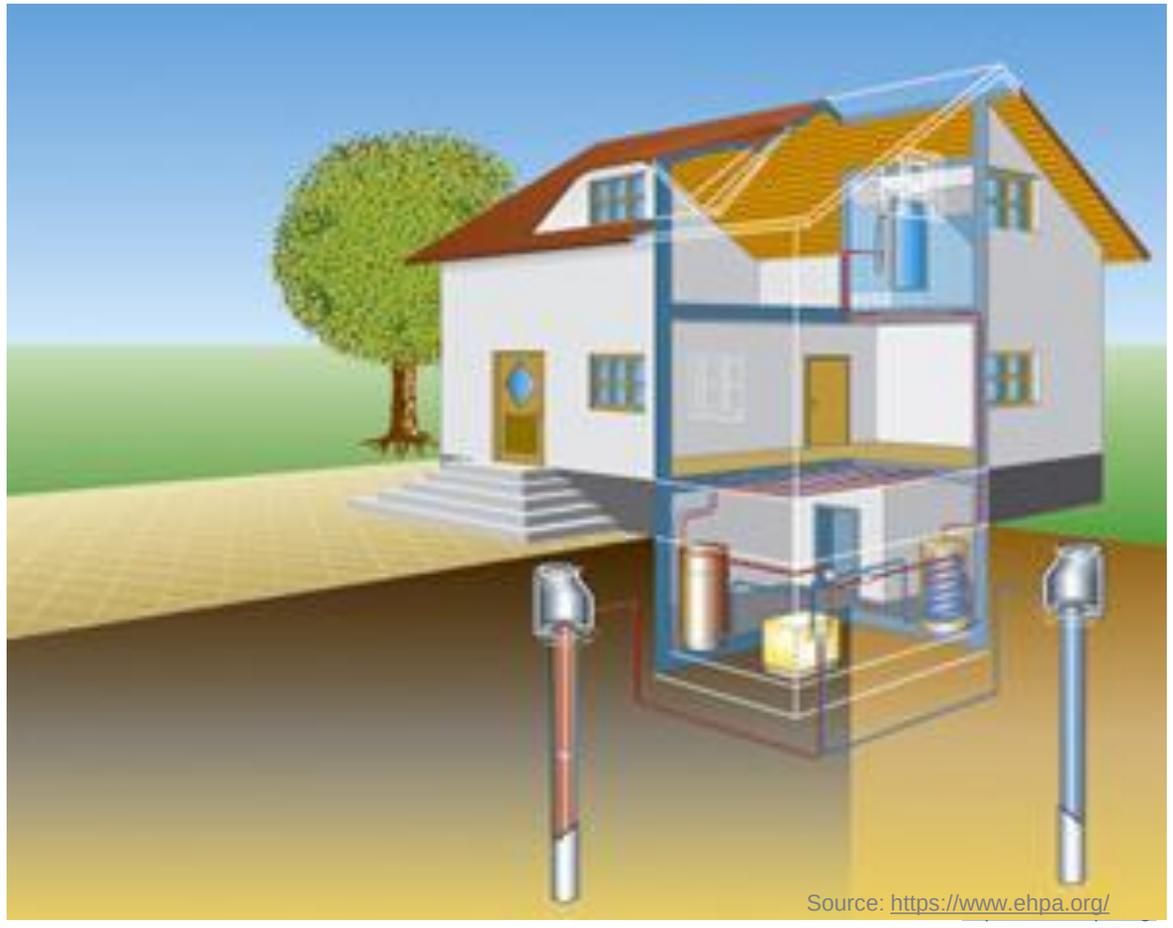
Heat pump examples

Source: air

Source: water



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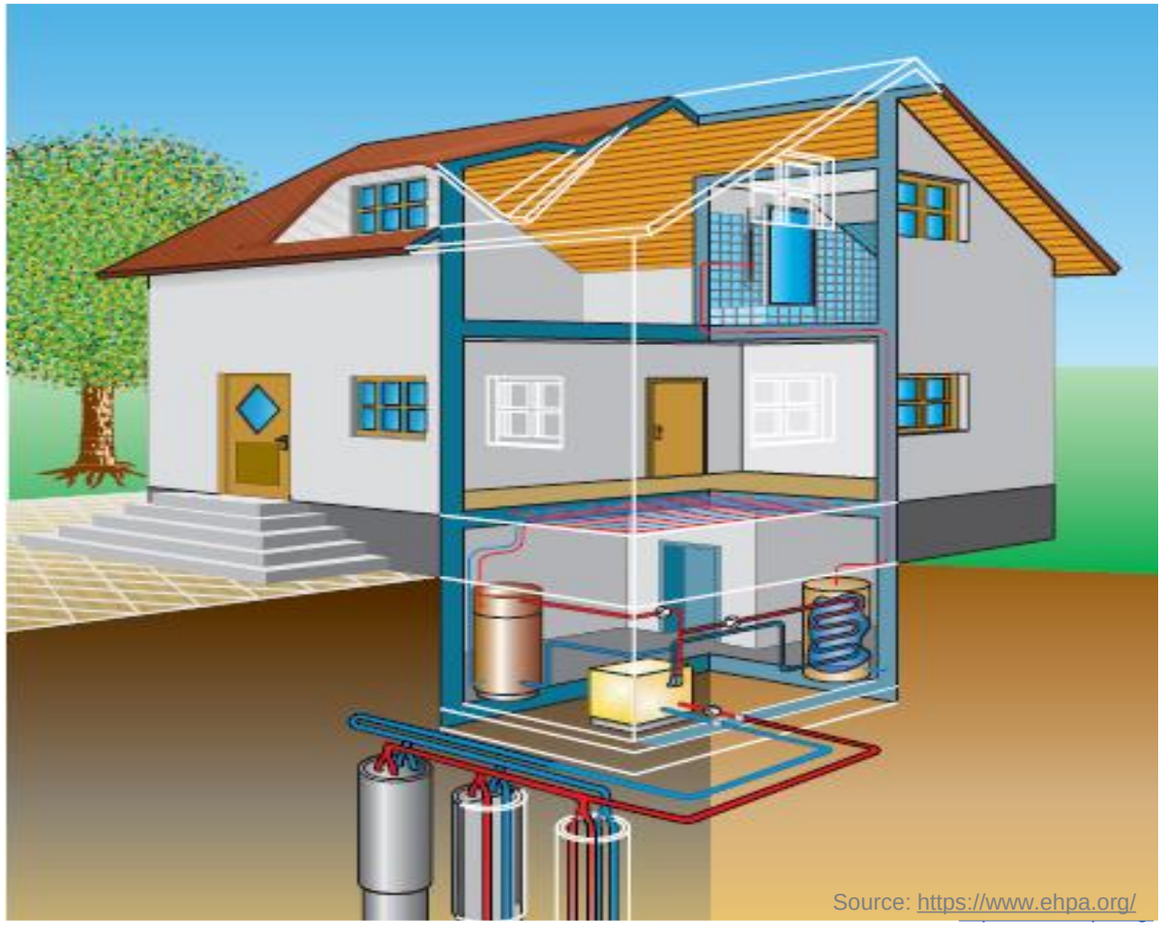
Heat pump examples

Source: earth collector

Source: earth-tube



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Heat pumps
Discussion

Advantages

- Highly efficient technology
- Low operational costs
- Heating, DHW and cooling possible
- Key technology in combination with PV to decarbonise heating and cooling supply

Disadvantages

- High investment costs
- Limited availability in the national market
- Lack of experts/craftsmen
- Most technologies still use climate-unfriendly instead of natural refrigerants

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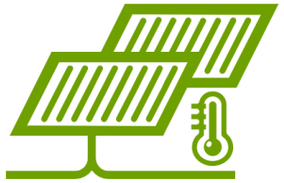
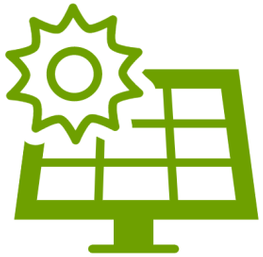
Renewable energies

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. Best practices can be drawn from **Lebanon HP stimulus programme** comprised of awareness raising measures, training, and financial support.

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

Step 3: Use high efficiency HVAC appliances

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HVAC

Overview of selected systems

Heating

- Gas non-condensing
- Gas condensing
- Oil non-condensing
- Portable LPG (gas) heater
- Portable kerosene heater
- Heat pumps *(already covered)*

Hot Water

- Combined with heating system
- Dedicated gas heater
- Dedicated electric heater
- Solar Thermal *(already covered)*

AC (Air-Conditioning)

- Movable system
- Mounted single split or window air conditioner
- Centralised multi-split system
- VRF – centralised multi-split
- Central systems

Ventilation

- Natural ventilation
- Mechanical ventilation
- Mechanical ventilation incl. heat/cold recovery

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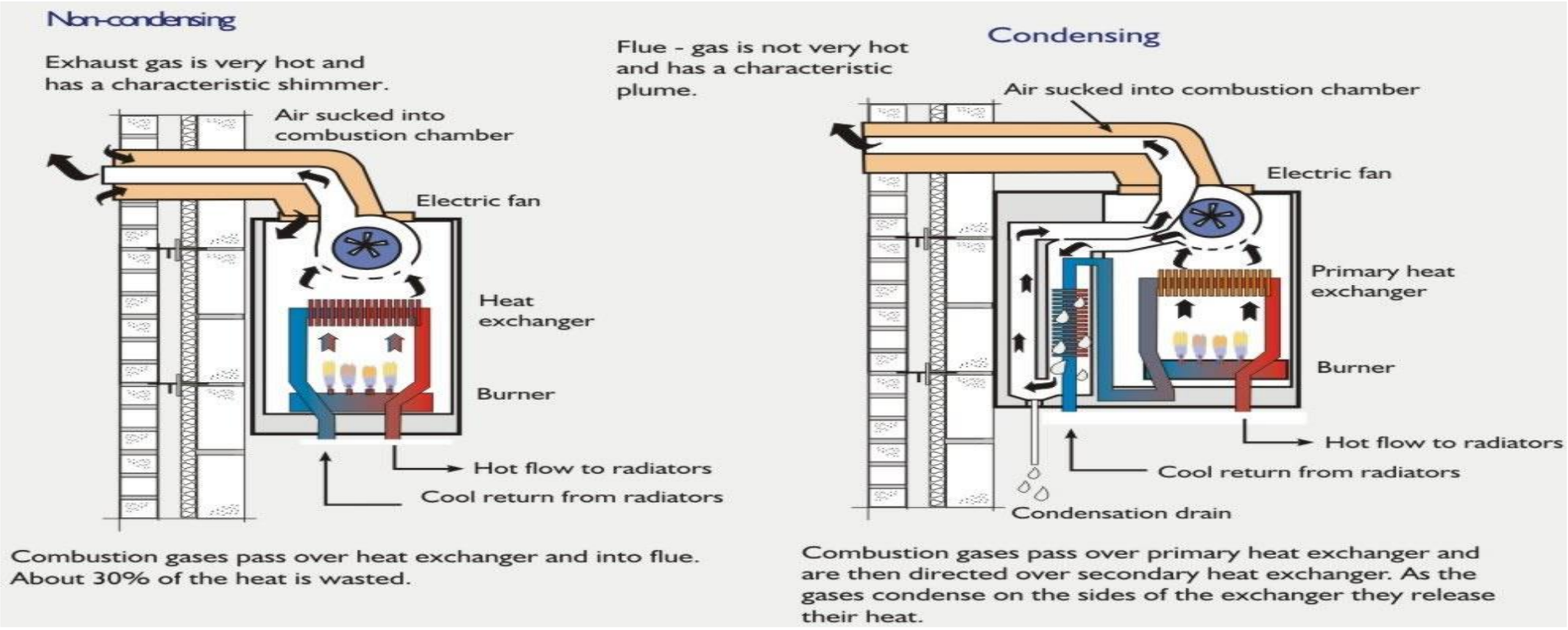
Heating

Principle of a condensing boiler

Non-condensing		
🍃	€	♻

Condensing		
🍃🍃	€€	♻



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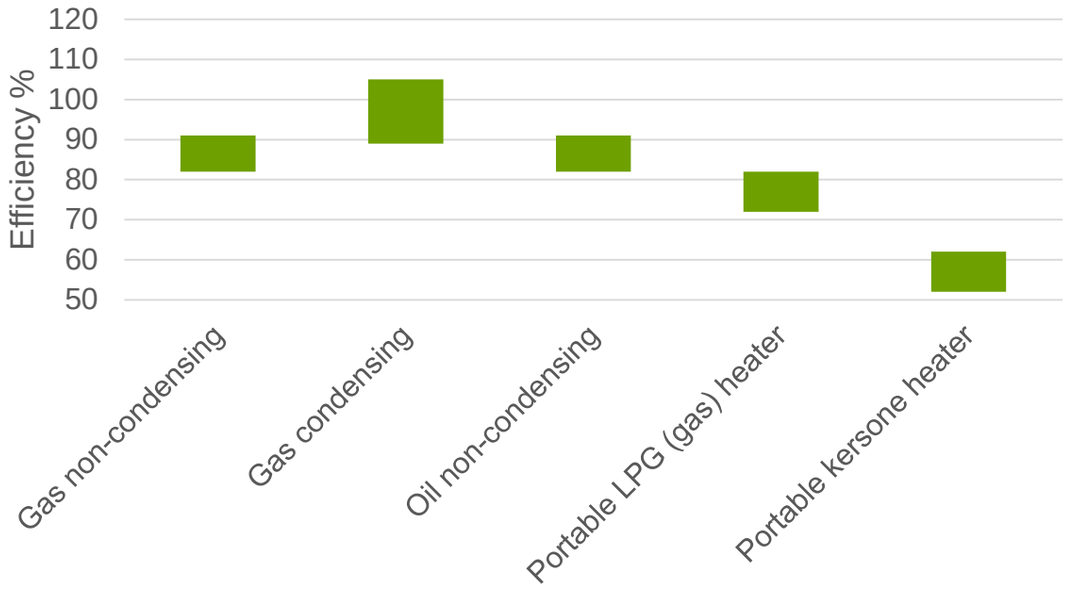
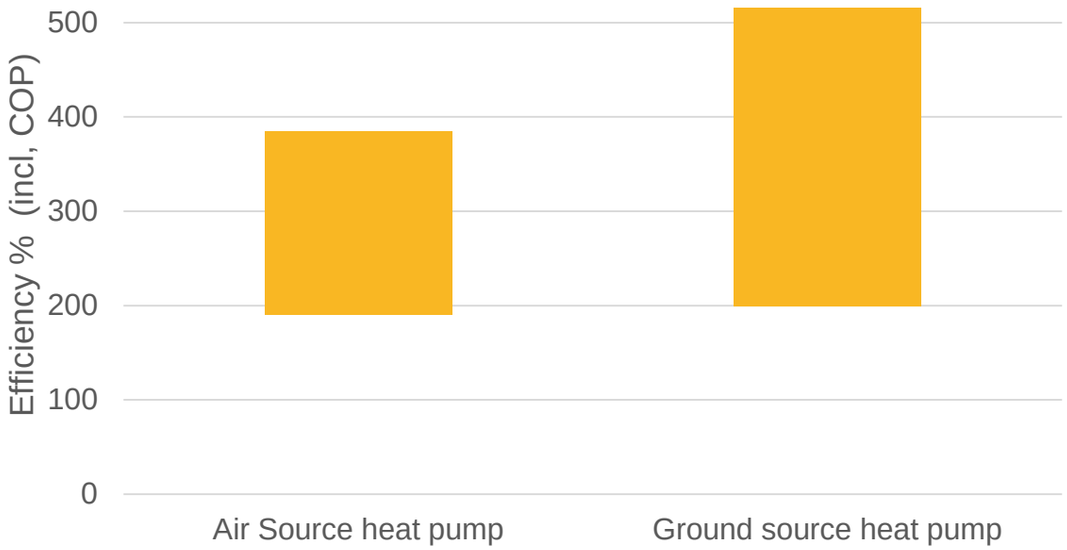
Source: http://gasboilerforums.com/condensing.html

Heating

Overview of efficiencies





- Condensing boilers can save 10-15% in comparison to non-condensing boilers
- Portable heater are the least efficient appliances in this comparison with efficiencies around 55-75%

- The COP of heat pumps are mainly influenced by the difference of source temperature and the system temperature
- The lower this delta, the higher the real COP

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Heating

Overview of qualitative assessment

Heating System	Energy performance	Investment	Payback period
Gas non-condensing	●	€	↻
Gas condensing	● ●	€ €	↻
Oil non-condensing	●	€	↻
Portable LPG (gas) heater		€	
Portable kerosene heater		€	
Air source heat pump	● ●	€ € €	↻ ↻ ↻
Ground source heat pump	● ● ●	€ € €	↻ ↻ ↻
Air-air heat pump	● ●	€ €	↻ ↻

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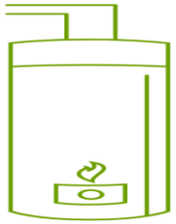
Hot water

Combined w. Heating System

- Efficiency depends on heating system and additional transmission (and storage) losses
- Centrally placed in basement or in the apartment



Dedicated gas heater

- High efficiency: no transmission losses as de-centrally installed
- Needs de-central gas connection

Dedicated electric heater

- High efficiency: no transmission losses as de-centrally installed, CO_2 emissions depend on grid
- Needs high power electric connection

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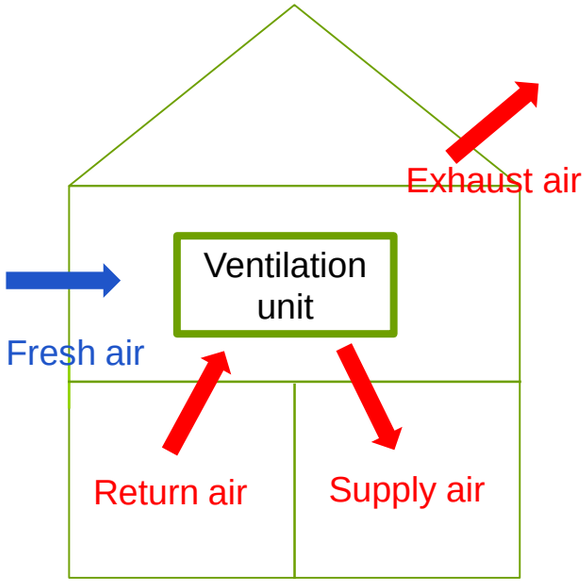
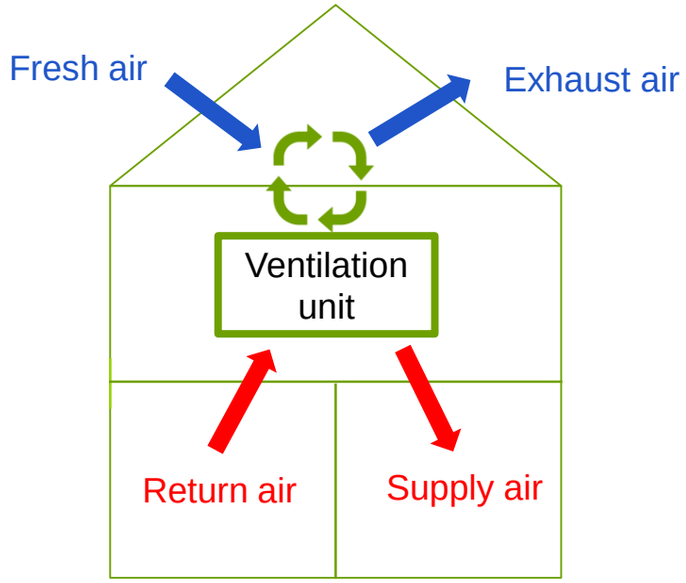
Ventilation

Mechanical ventilation		
	€ €	



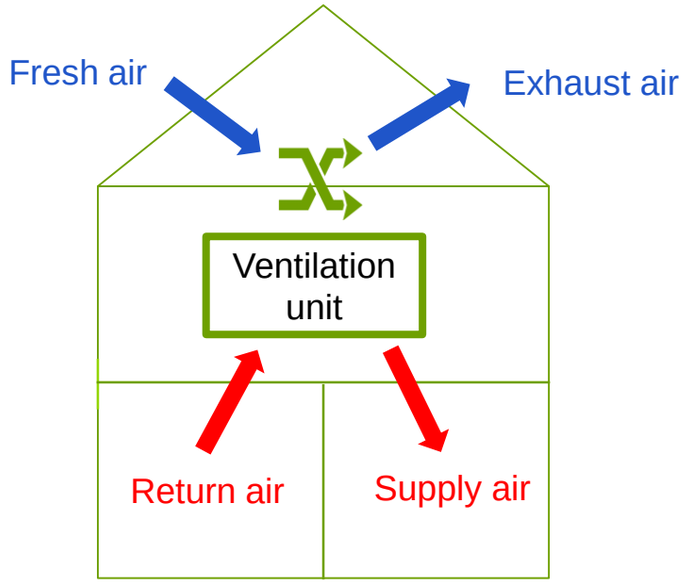
No recovery included

Mechanical ventilation inc. recovery (rotary or circulation exchanger)		
	€ € €	



Moderate/high efficiency (up to 70%)

Mechanical ventilation inc. recovery (cross flow exchanger)		
	€ € €	



High efficiency (up to 90%)

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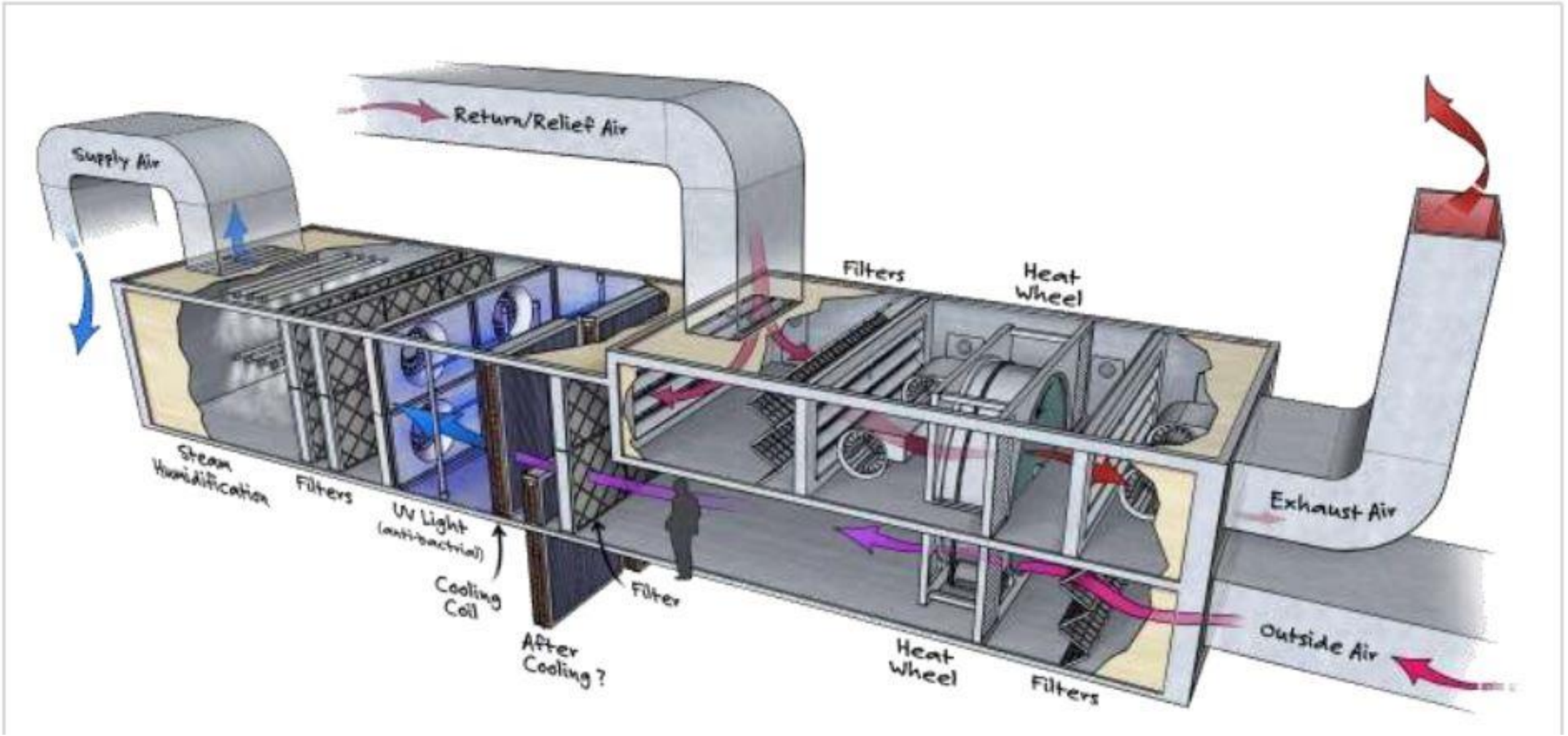
Ventilation (Wheel HE)



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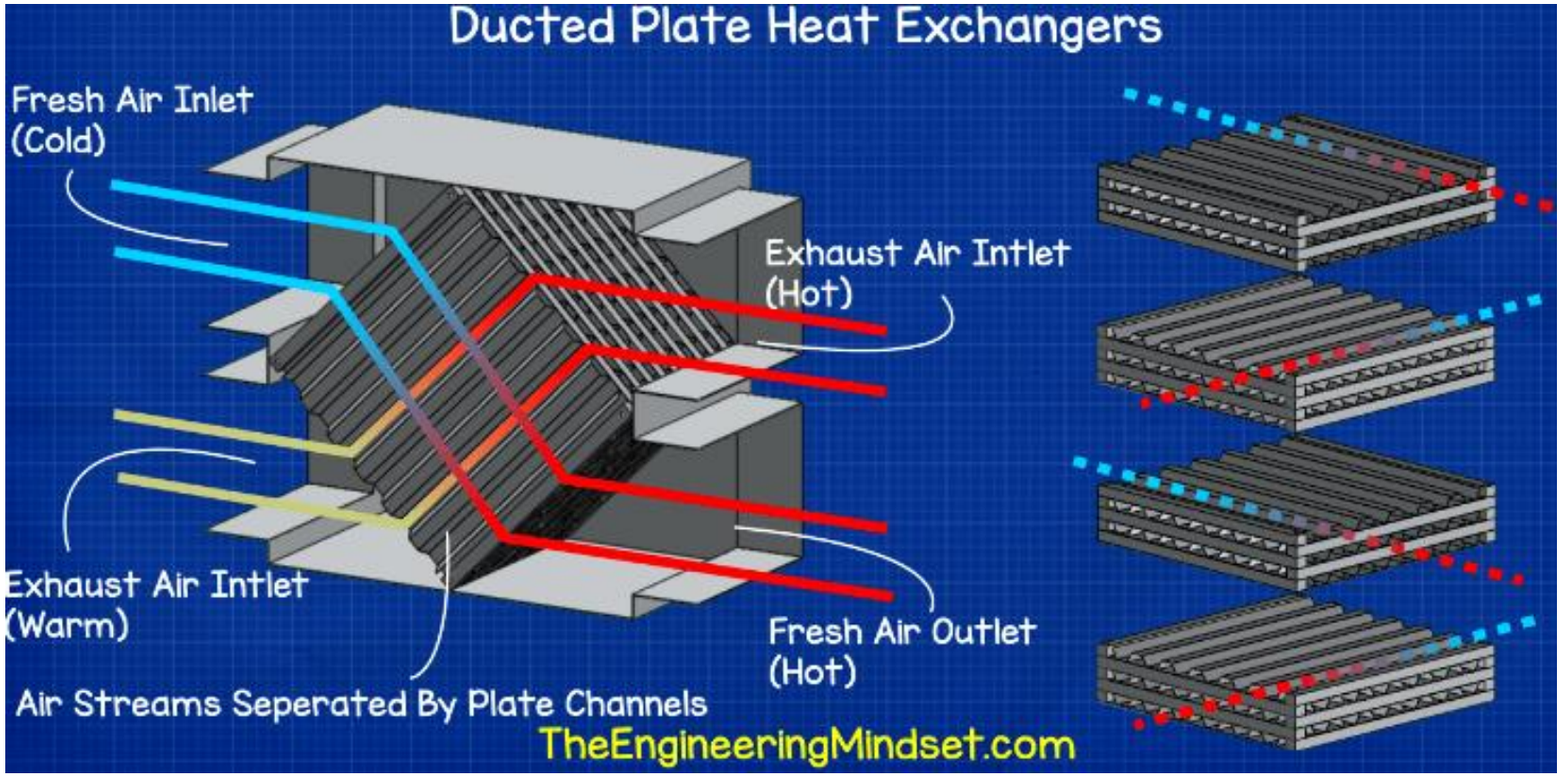
Ventilation (Cross flow HE)



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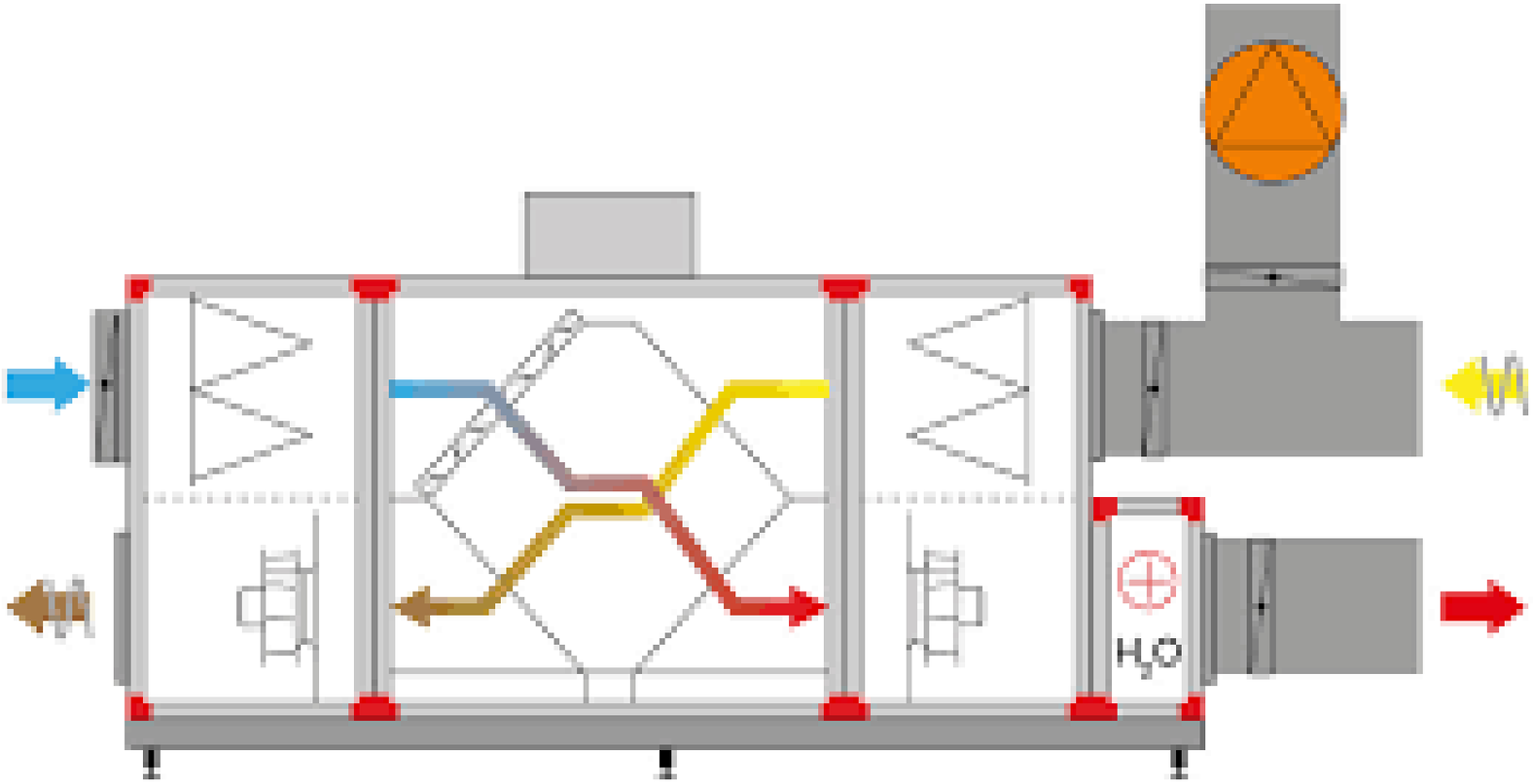
Ventilation (Cross flow HE)



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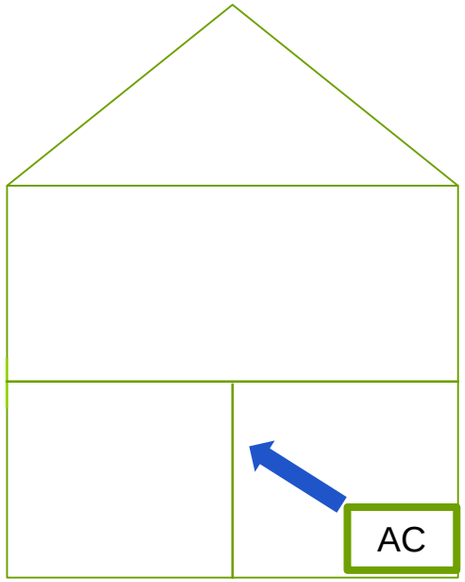
Air conditioning

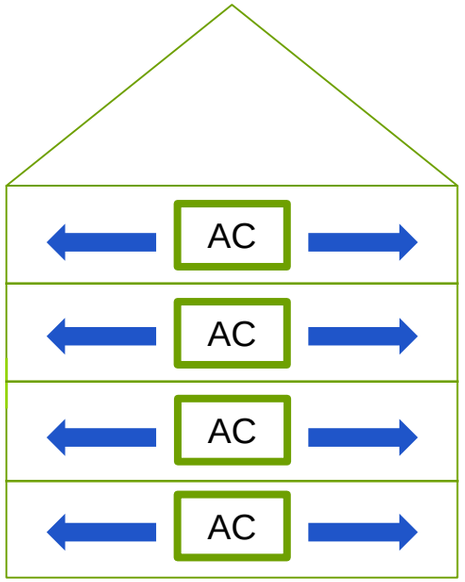
Main technologies



Decentral

One AC per room

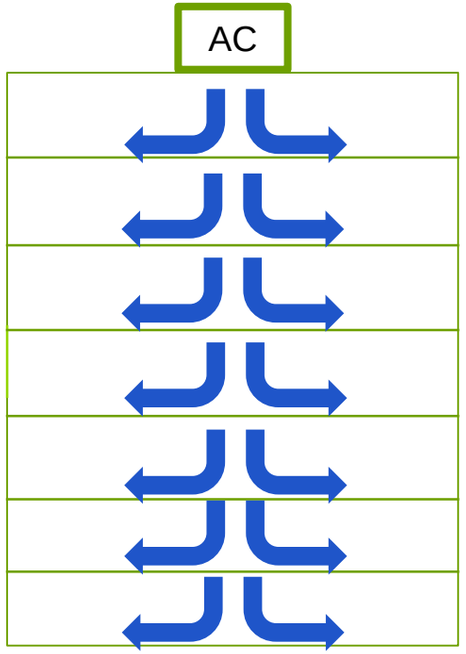
(e.g. window or split units)



Central – small scale

One AC for a group of rooms

(e.g. VRF or multi-split units)



Central – large scale

One AC per building

(e.g. chiller serving VAV, fan coil units or chilled beams or ceilings)

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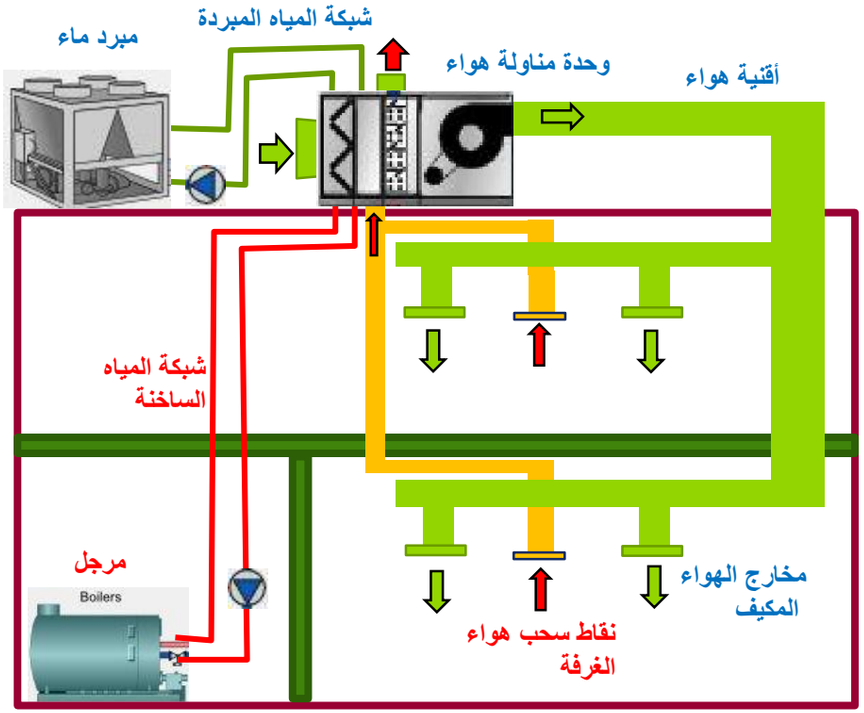

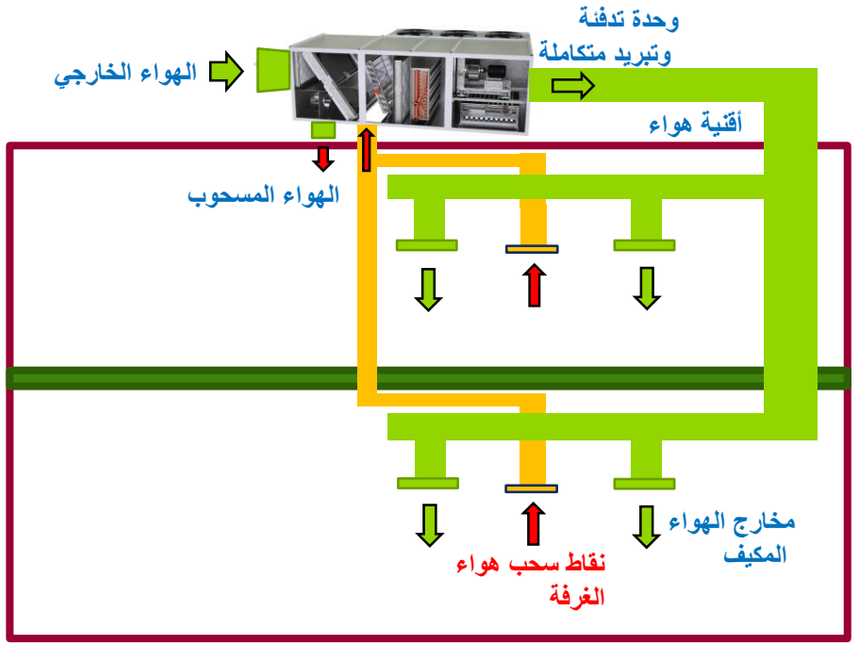

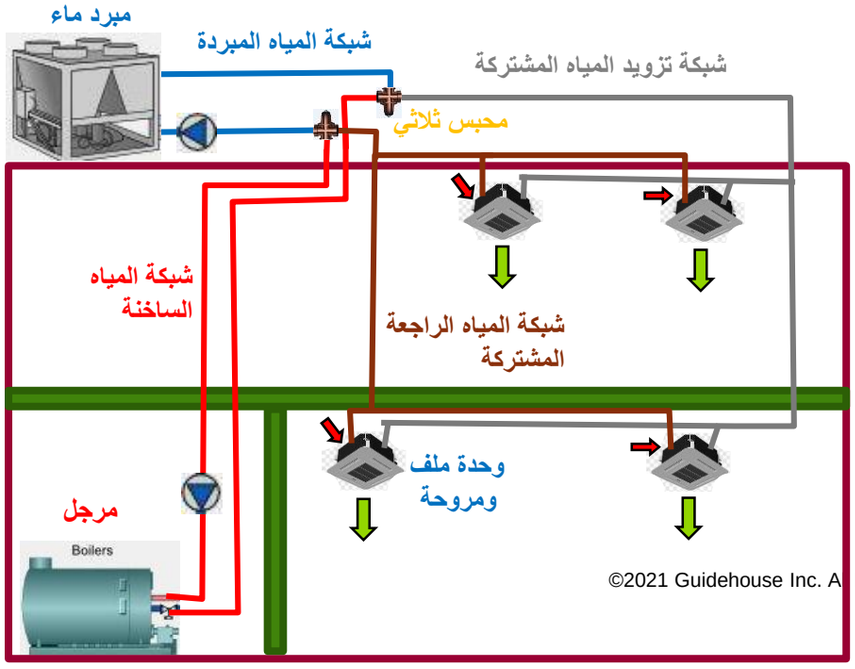

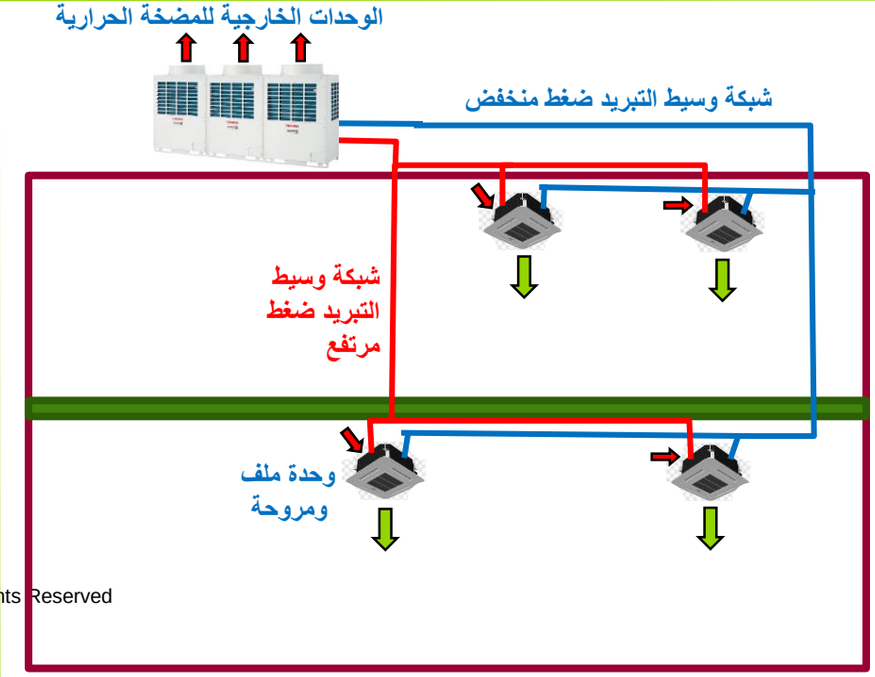

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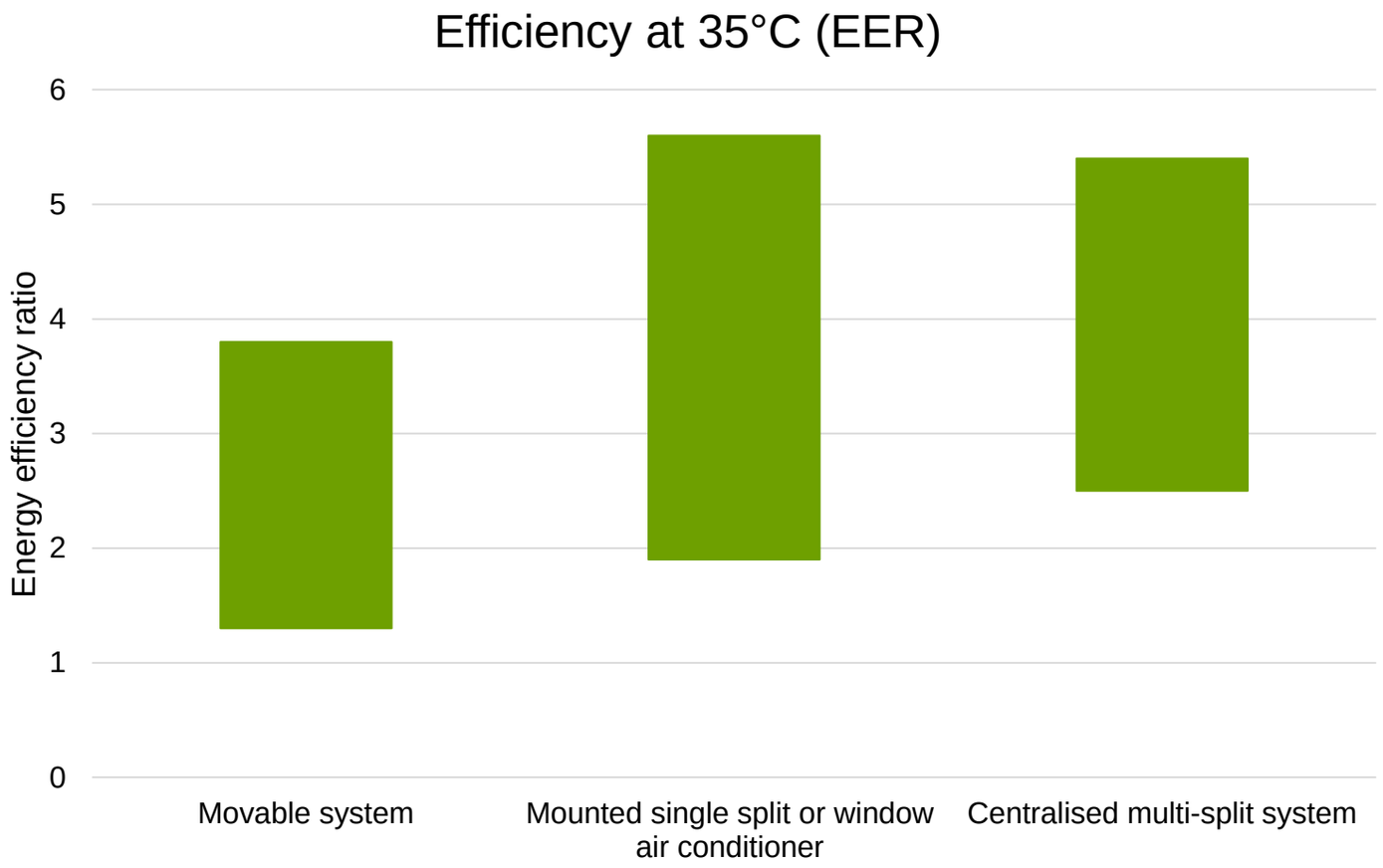
Air conditioning

Overview of efficiencies



- Large variety of systems on the market
- Use of labels (A,B,C…) as orientation to select top performers, commonly used also in the BUILD_ME countries
- Efficiency highly dependent on delta of air temperature and room temperature

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Air conditioning

Overview of qualitative assessment

AC system	Energy performance	Investment	Payback period
Movable system			
Mounted single split or window air conditioner			
Centralised multi-split system			
VRF-centralised multi-split system			
Central systems			

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Step 5: Operation

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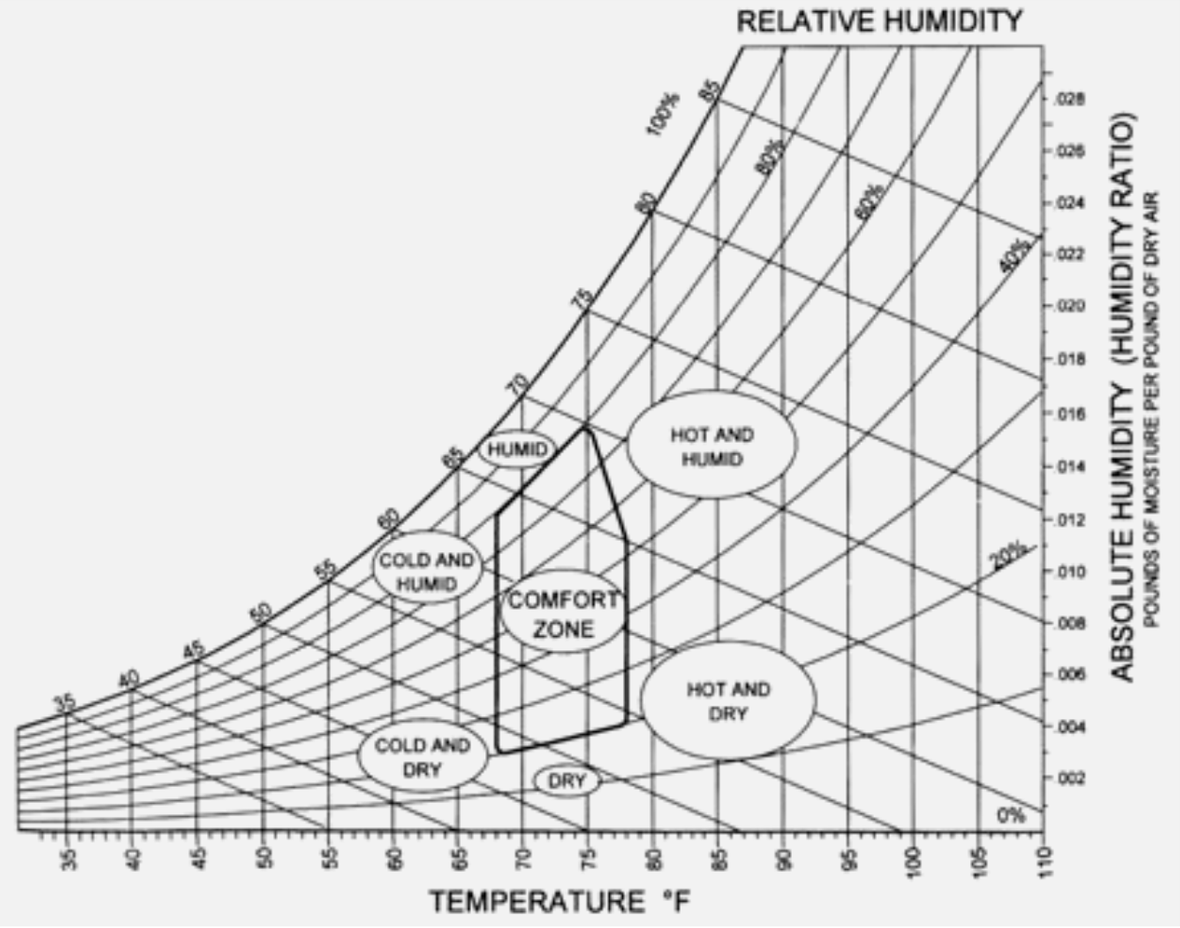
Basics of thermal comfort



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

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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

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Building Energy Performance (BEP) Tool

Ali AlMarzouq, RSS/NERC

Photo by Lukas Blazek on Unsplash

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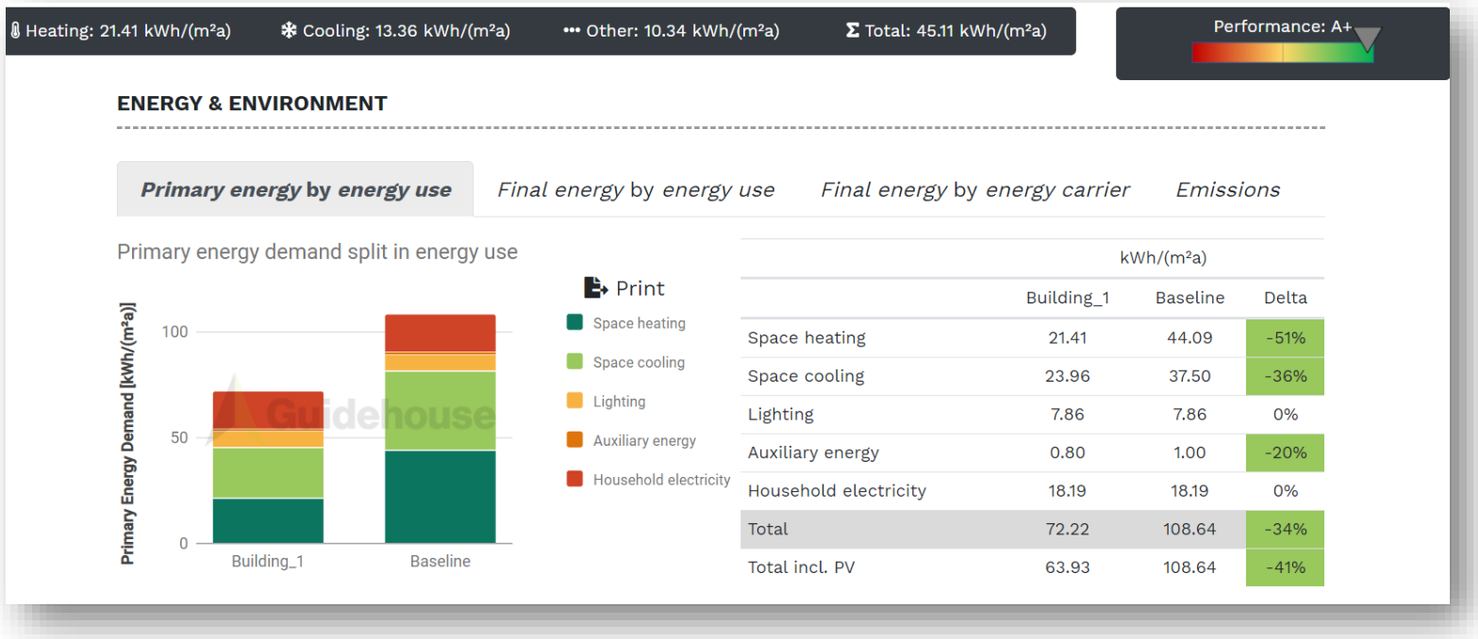
BEP Tool Case Study

- Link: https://globco.buildings-mena.com/
- Case Study: Click Here!
- Case Study Results: Click Here!



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Wrap up and outlook

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based on a decision of the German Bundestag