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BUILD_ME

LCEC
LEBANESE CENTER FOR ENERGY CONSERVATION
المركز اللبناني لحفظ الطاقة

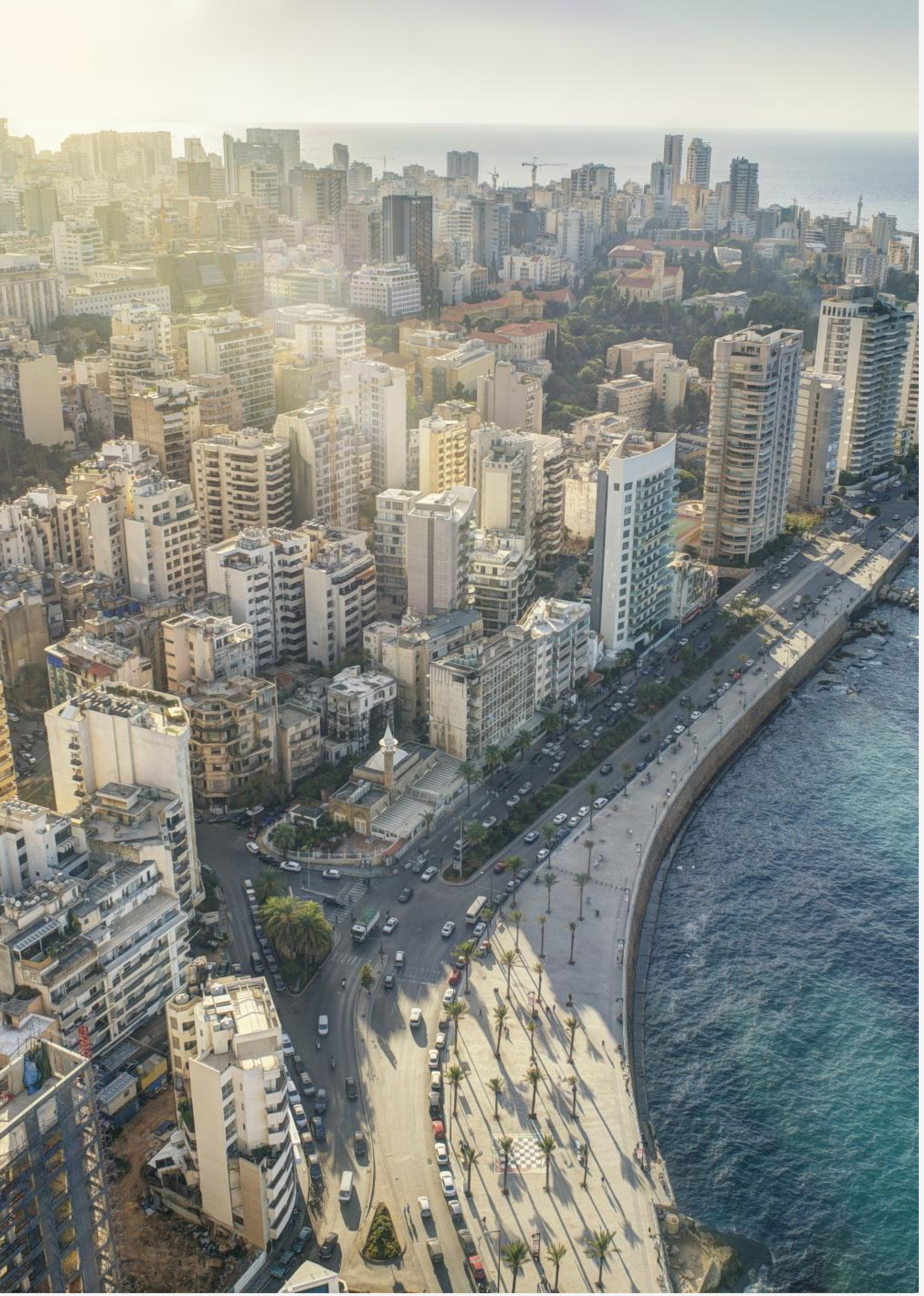
BUILD_ME Training:
Basics of climate-friendly buildings and the BEP Tool

12 August 2021

Supported by:

Federal Ministry
for the Environment, Nature Conservation
and Nuclear Safety

based on a decision of the German Bundestag



Agenda

Setting the scene

Welcome words

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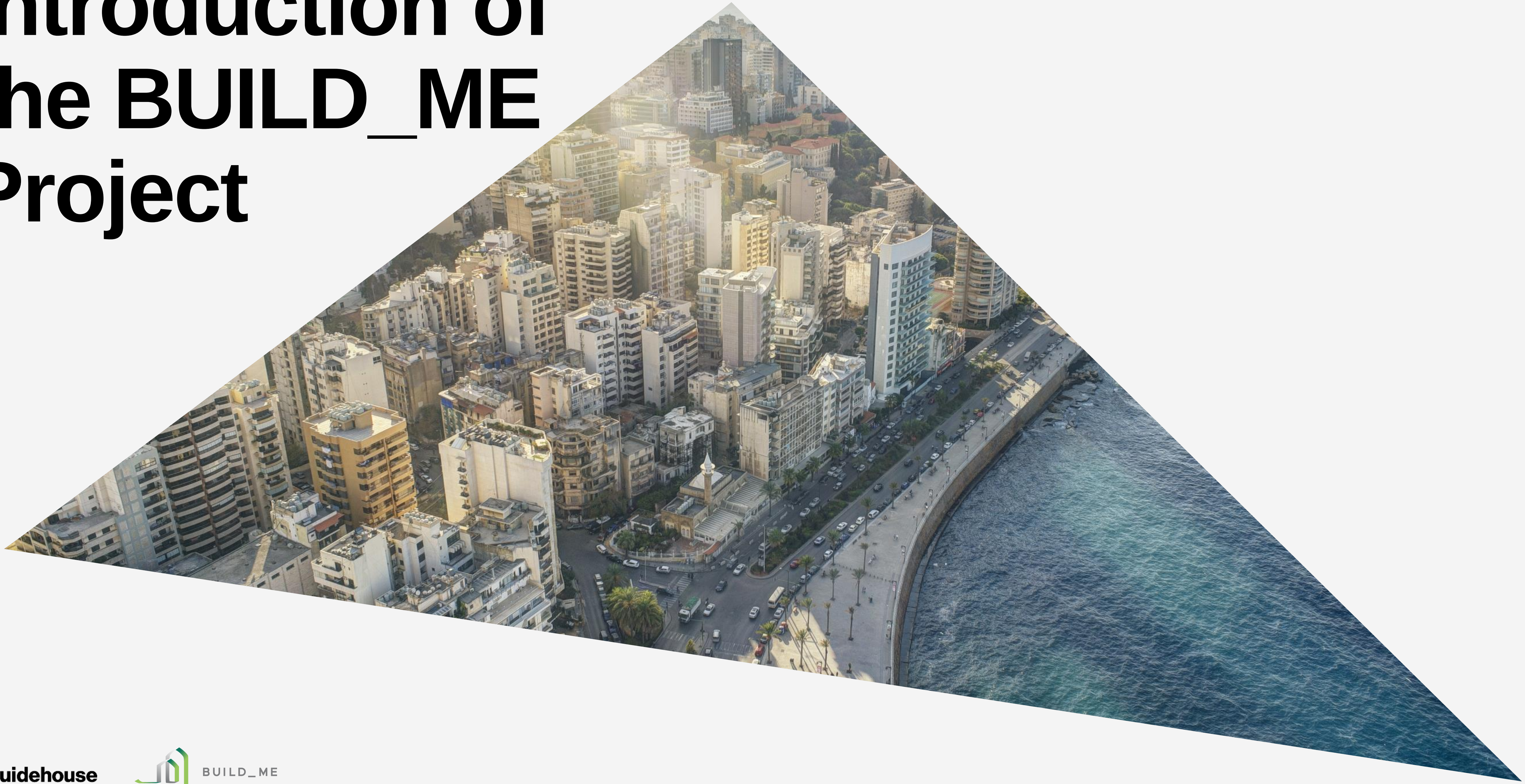
Objectives of the training session

For project developers, architects and engineers

1. Enable the utilisation of the BEP tool
2. Increase awareness of the importance and financial attractiveness of investing in EE measures
3. Transfer general technical understanding of holistic assessment of EE building projects
4. Provide an overview of the big picture

Introduction of the BUILD_ME Project



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Overview about the project

Fund

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

Scope

1st Phase: 2016 - 2018

2nd Phase: 2019 - 2021

Partners

HBRC

IDG MATRIX Integrated Development Group

Royal Scientific Society

LCEC

European Bank for Reconstruction and Development

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EGYPT GBC

LGBC

RCREEE Regional Center for Renewable Energy and Energy Efficiency

TRACK

ALCOR

BUILD_ME scope

Approach

Original project

2016 - 2018

- Extensive analysis and research
- Identification of barriers
- Recommendations

Project extension

2019 – 2021

- Implementation of recommendations
- Dissemination of results
- Upscaling

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

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

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

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

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

WP4 Capacity Building and Dissemination

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

Easier access to financing for energy efficient buildings

Approach

How to design and finance an energy efficient project?

BEP Tool shows:

- ✓ [25]% energy saving in comparison with **baseline**
- ✓ Financing available at local bank

Intermediating **bank grants credit** based on trusted classification scheme

Project is realised as energy efficient building

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Support the reform & transitions of political frameworks

National strategies
NDC
NEEAPs

Regulations:
EEBC
Standards

Voluntary Classification Scheme

EE
towards improving energy efficiency in the building sector

Focus on supporting the implementation of energy efficiency measures in pilot projects

Technical support for pilot projects

Policy work
To connect the challenges and lessons learnt with the policy frameworks activities

Test the tool
To test and improve the BEP tool with real-life examples

Test the classification scheme
The national classification scheme will allow for better access to the available green finance programs

Facilitating finance
Support the PP in their application (if any).

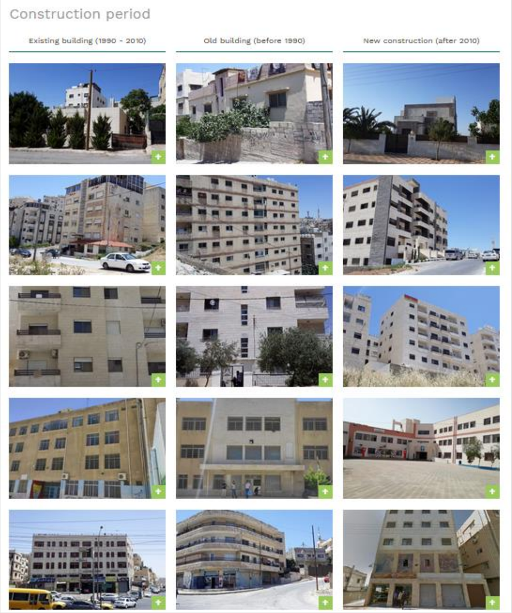
Capacity building
Provide training on EE and RE

Zoom into Building Typology

Building Typology

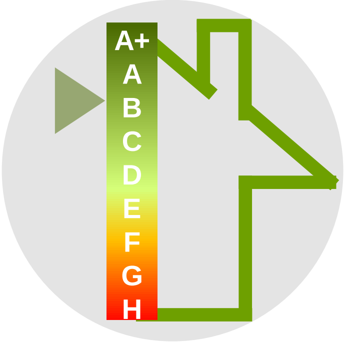
What is meant with building typology and why it is needed?

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



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

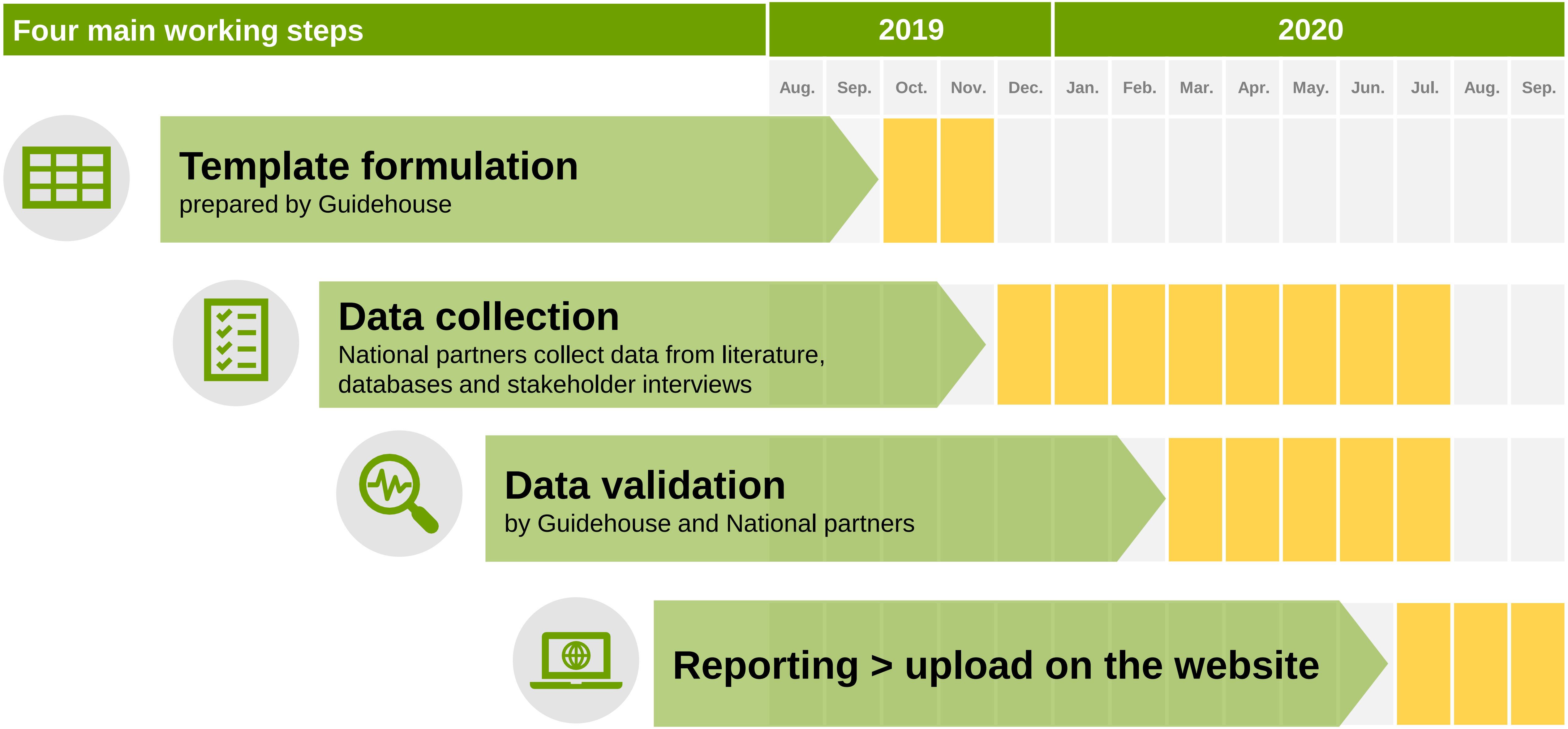
baseline



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

- Classification
- Comparison
- Facilitating finance

Approach of development of building typology



Results, template main sections

A : General information

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

B: Geometries

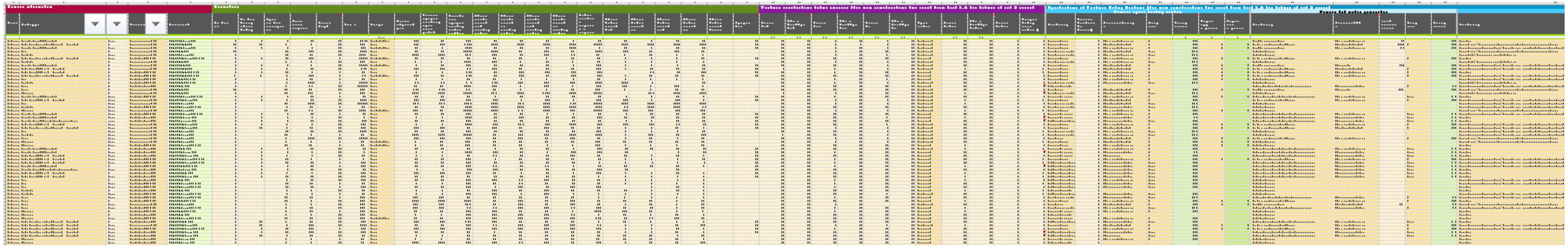
Number of stories	Number of dwellings	Typical number of occupants / users	Net floor area	Clear room height	Volume	Roof type	Area floor slab (ground plate)	Roof area opaque	Façade area opaque	Share of facade oriented north	Share of facade oriented east	Share of facade oriented south	Share of facade oriented 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

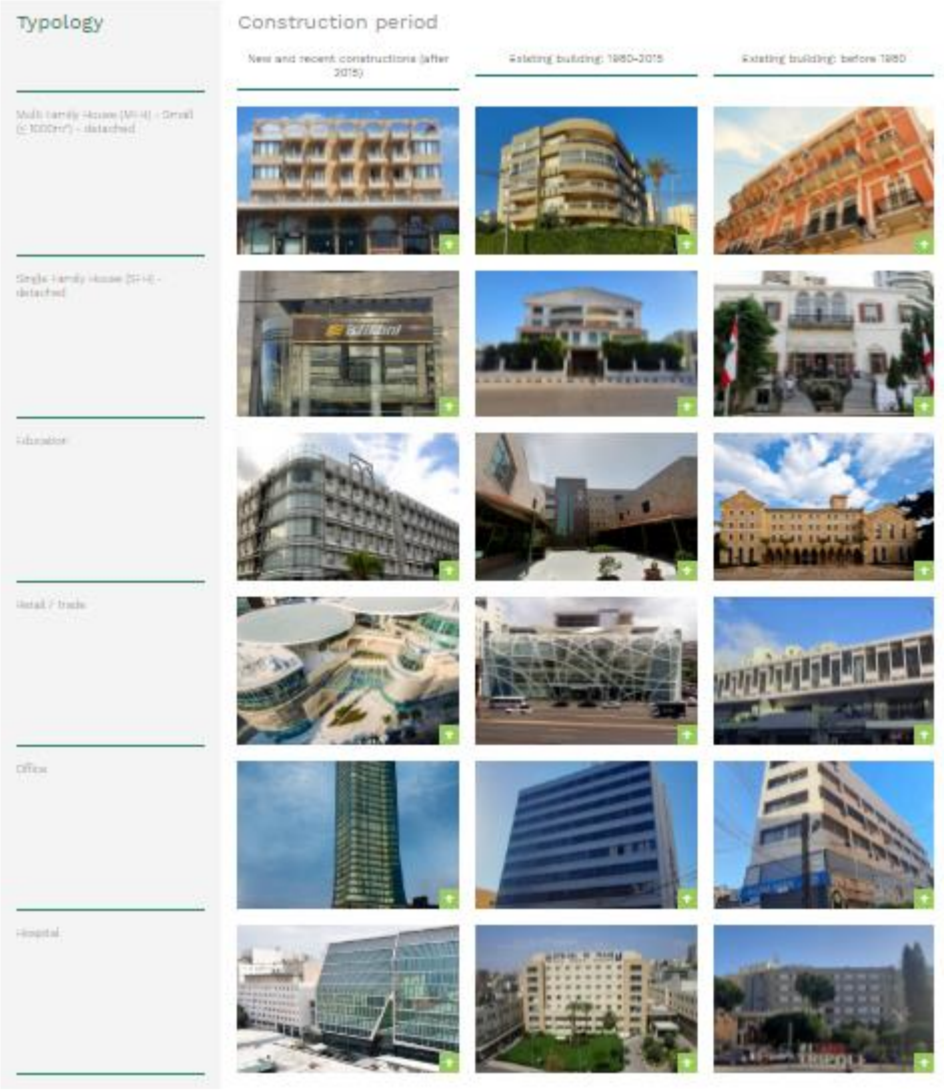


Building Typology | Lebanon

Results

Building type	Age group	Regions
▪ Multi-family house (MFH) - Small (≤ 1000m²) – detached ▪ Single-family house (SFH) - detached ▪ Education ▪ Retail/Trade ▪ Office ▪ Hospital ▪ Multi-family house / Apartment block - Large (> 1000m²) - detached	1950 – 1980 – 2000 ▪ New and recent constructions (after 2015) ▪ Existing building: 1980-2015 ▪ Existing building: before 1980	▪ City ▪ Town ▪ Village

Link to the typology on BUILD_ME website



Zoom into Baseline

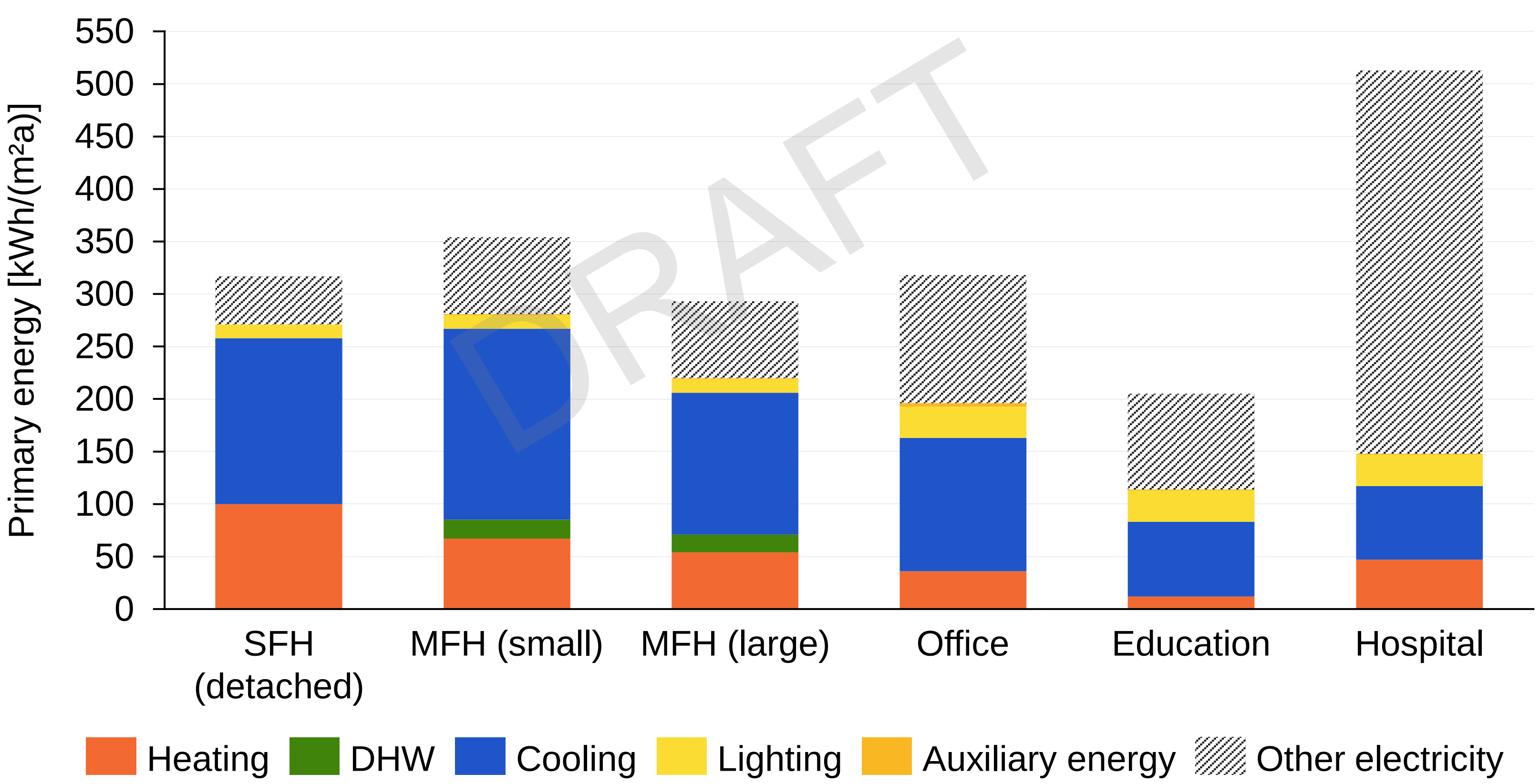
Baseline | Lebanon

Illustrating energy intensity of select Lebanese building types

Key takeaways

- Specific **primary energy** demand ranges between **200 – 500 kWh/(m²a)** for buildings constructed over the past years
- **Space cooling** accounts for largest primary energy demand (due to electricity as energy carrier)
- Note: Other electricity stands for plug-loads (e.g. fridge, TV, etc.) and is informational.

"City" baseline (new buildings, after 2015)



Baseline | Lebanon

Illustrating energy intensity: Multi-family house (large)

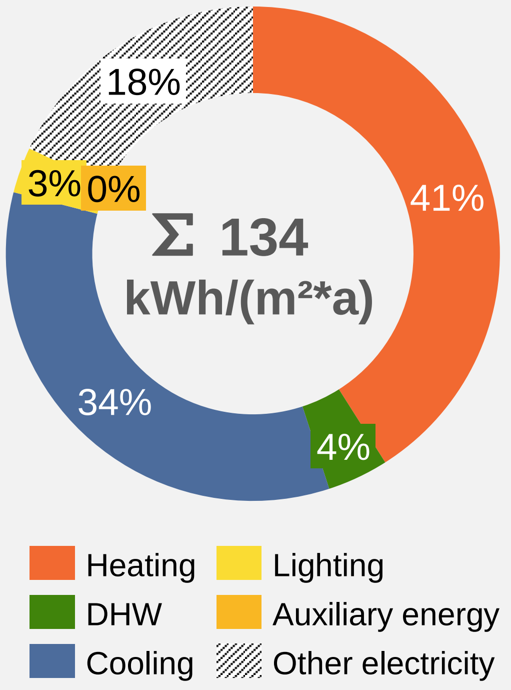
Building standard

- New building in city (constructed after 2015)
- Thermal insulation is used in roof and wall

Final energy demand

- 134 kWh/m²/a (110 kWh/m²a for HVAC and lighting)
- Energy consumption for heating largest share

Parameters	Baseline
Roof insulation (U-Value)	0.4 W/m²K
Wall insulation (U-Value)	0.6 W/m²K
Floor insulation (U-Value)	2.2 W/m²K
Windows (U-Value; G-Value)	5.7 W/m²K; 0.85
Window fraction	Ø 45%
Shading	Fixed shading
Air tightness	0.25 1/h
Heat supply	Oil (non-condensing)
Cold supply	Single split (EER: 2.9)
Hot water	Direct electric
Ventilation systems	Free ventilation
Lighting systems	LED
Renewable energy	No
Set temperature cooling/heating	22°C / 21°C



Energy cost
7.7 EUR / (m²*a)

CO_2 - emission
3.4 kg / (m²*a)

Country Report
LEBANON

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Market insights

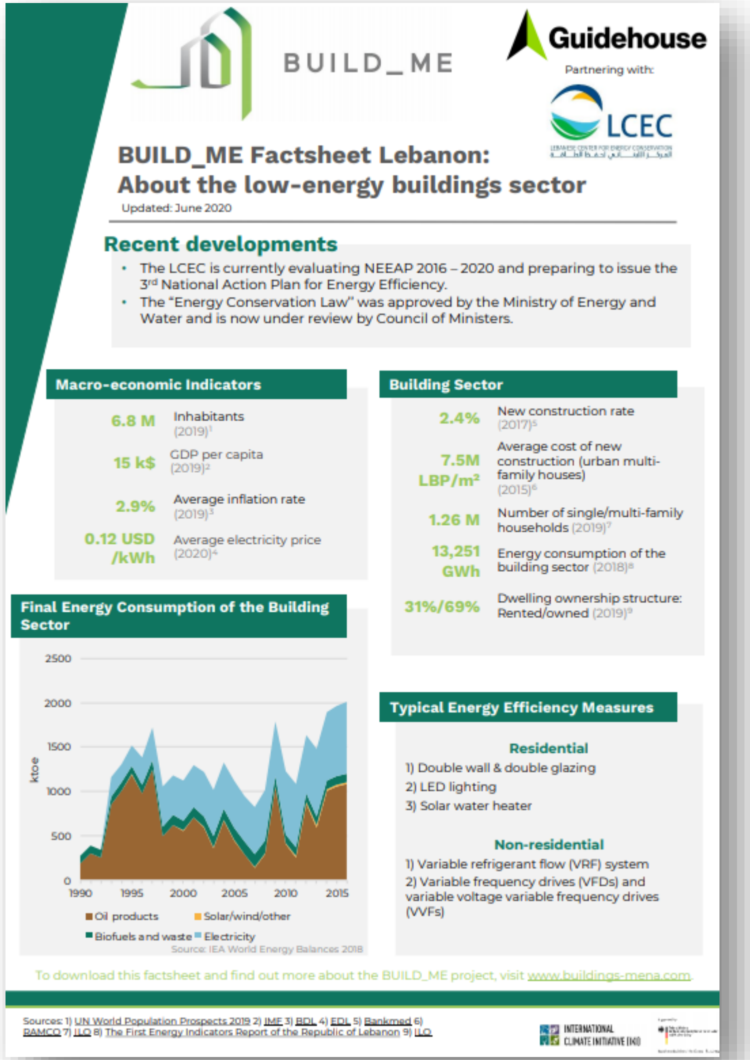
Lebanon

- **Yearly construction permits for residential: ~22,000 units**

- **One electricity utility (EDL)=> financial deficit due to subsidies and losses**
- **Shortage in supply => Private Generators**

- **Sustainable Building code under preparation**
- **General Budget law 2019 (↑investment factors up to 25%)**
- **Available voluntary standards (TSBL 2005) and criteria**

- **Ministry of Energy and Water, LCEC, Ministry of Public Works, Urban Planning Directorate, Municipalities…….**



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Partnering with:

LCEC

BUILD_ME Factsheet Lebanon: About the low-energy buildings sector

Updated: June 2020

Recent developments

- The LCEC is currently evaluating NEEAP 2016 – 2020 and preparing to issue the 3rd National Action Plan for Energy Efficiency.
- The "Energy Conservation Law" was approved by the Ministry of Energy and Water and is now under review by Council of Ministers.

Macro-economic Indicators

6.8 M	Inhabitants (2019)[1]
15 k$	GDP per capita (2019)[2]
2.9%	Average inflation rate (2019)[3]
0.12 USD /kWh	Average electricity price (2020)[4]

Building Sector

2.4%	New construction rate (2017)[5]
7.5M LBP/m²	Average cost of new construction (urban multi-family houses) (2015)[6]
1.26 M	Number of single/multi-family households (2019)[7]
13,251 GWh	Energy consumption of the building sector (2018)[8]
31%/69%	Dwelling ownership structure: Rented/owned (2019)[9]

Final Energy Consumption of the Building Sector

Source: IEA World Energy Balances 2018

Typical Energy Efficiency Measures

Residential

1) Double wall & double glazing
2) LED lighting
3) Solar water heater

Non-residential

1) Variable refrigerant flow (VRF) system
2) Variable frequency drives (VFDs) and variable voltage variable frequency drives (VVFs)

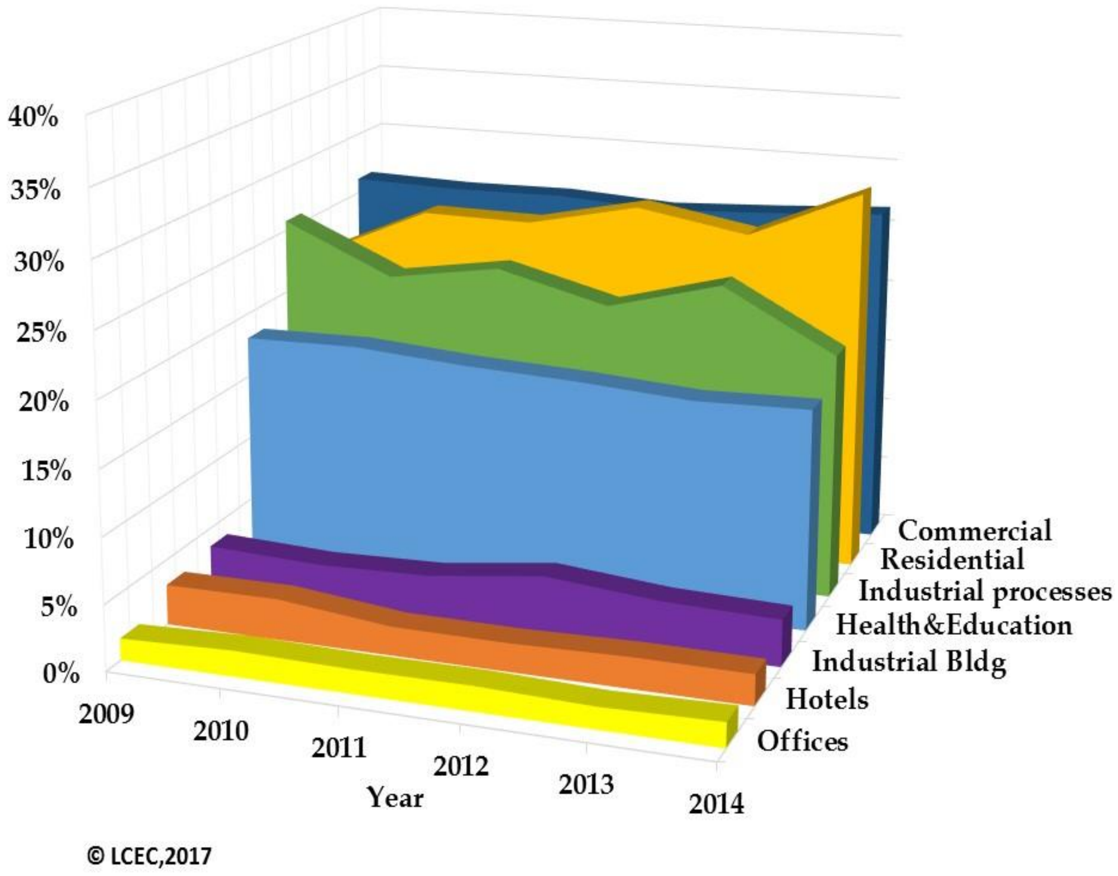
To download this factsheet and find out more about the BUILD_ME project, visit www.buildings-mena.com.

Sources: 1) UN World Population Prospects 2019 2) IMF 3) BDL 4) EDL 5) Bankmed 6) RAMCO 7) ILO 8) The First Energy Indicators Report of the Republic of Lebanon 9) ILO

INTERNATIONAL CLIMATE INITIATIVE (IKI)

Lebanon: Energy Demand

- In 2015, Residential Sector ~70% of the total built area
- In 2015, Health and Education ~11% of the total built area
- In 2015, Commercial ~8% of the total built area



Share in overall electricity demand 2009-2014

Main Usages

- Cooling and dehumidification constituted 29% of the total electricity demand in 2009, and reached 40% in 2014. The cooling share:
  - residential sector 19%
  - commercial sector 11%,
  - health and education sector 8%
- Lighting, the second highest-consuming usage in the building sector~31% of total Lebanese electricity demand in 2013.
  - commercial sector share of 16%,
  - residential sector share of 5%

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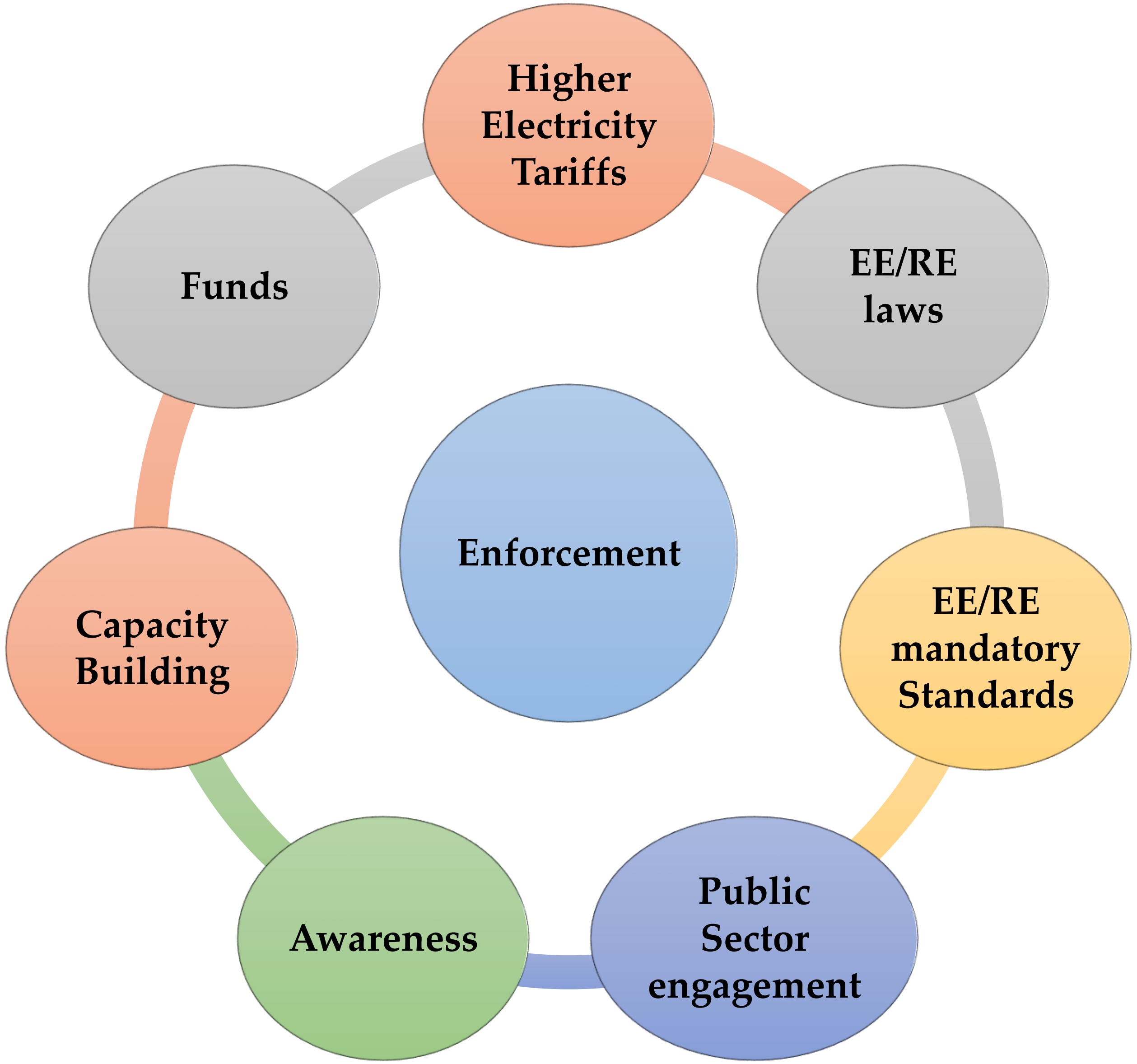
Lebanon: Challenges and Must-Haves



Lessons learned

Key recommendations to accelerate EE in the building sector

Facilitating Finance

- NEEREA, LEEREFF, GEFF
- Home appliances programme (Italian products)
- Incentives (Grant) for heat pumps
- Decrease taxes on EE equipment
- The cost effectiveness is the key driver for clients to invest in EE
- Increase electricity tariffs

Update Regulation

- Create a labelling scheme for existing building
- MEPS and labels for equipment
- Energy Conservation law
- Sustainable/Green Building code
- Develop proper implementation monitoring and inspection scheme of energy efficiency measures

Technical Solutions

- EE solutions already available in the market
- Capacity building: Train inspectors to verify the different measures installation at different construction phases;
- Create a checklist with minimum requirement for permits, and for implementation and verification;
- Support the local energy efficiency industry.

Raising awareness

- Include standards and energy efficiency courses in the universities program;
- Tackle all the persons involved in the building sector: architects, engineers, owners, technicians, etc.;
- Educate the end-user through campaigns
- Tackle municipalities as part of the awareness raising process
- Home appliances programme in the way

Introduction to Climate-Friendly Buildings

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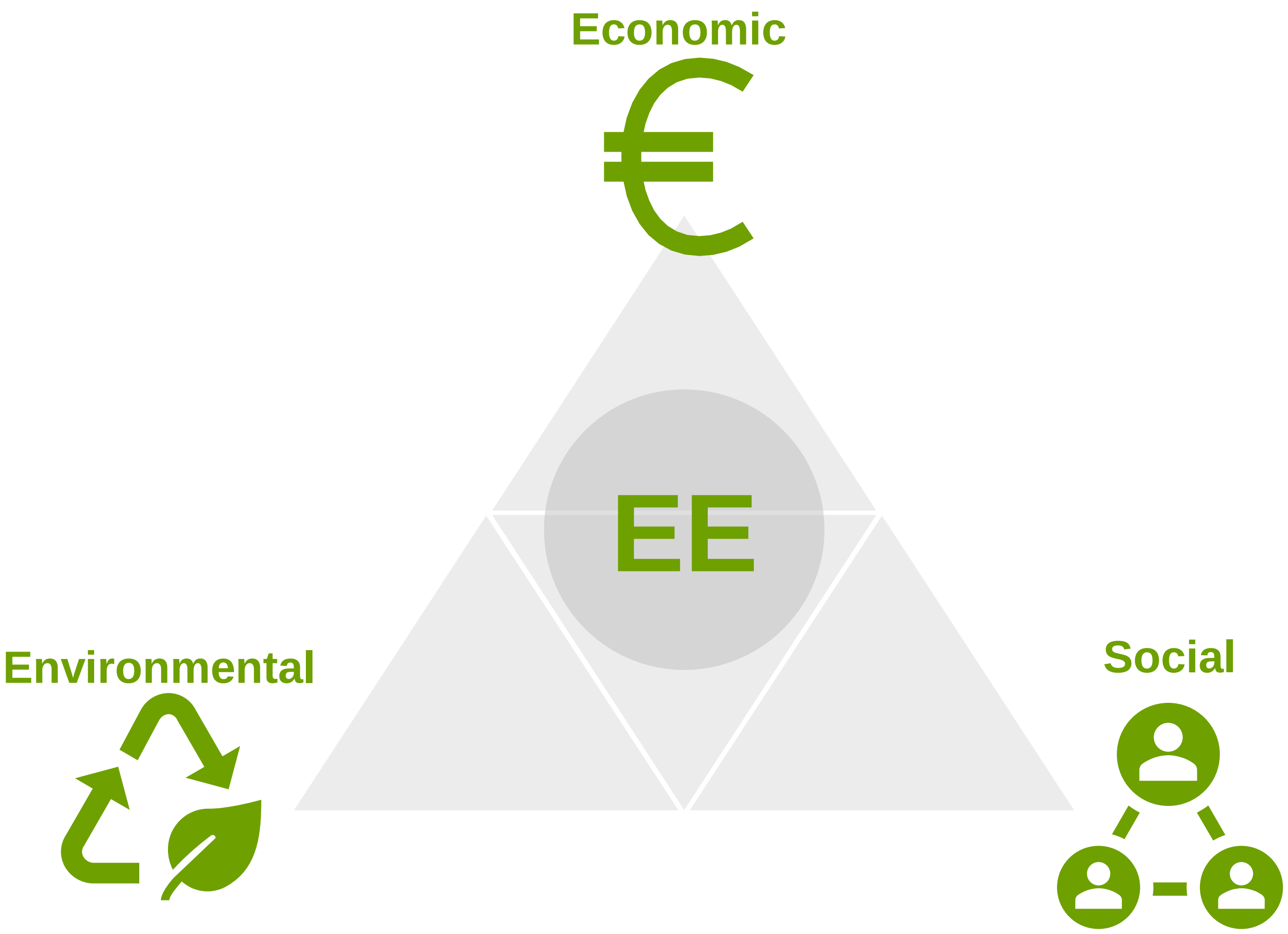
Key learnings

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

The big picture

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

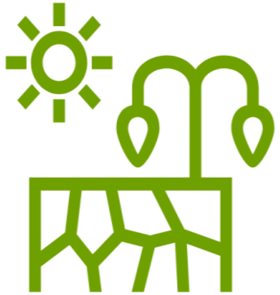
Cost-efficient abatement

Energy security

Energy price development

Environmental reasons

Some selected examples



Droughts

Rising temperatures

Sea level rise

Extreme weather events

Social reasons

Some selected examples

Job creation

Removal of subsidies

Public health and productivity

Definitions, terminology, boundary conditions

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

Climate parameters

Cooling Degree Days (CDD)

- CDD = (Tm- 21°C) if Tm is higher than or equal to 21°C
- CDD = 0 if is lower than 21°C Tm
- 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 18°C (heating threshold)
- HDD = 0 if Tm is higher than 18°C
- Tm is the mean ((Tmin + Tmax)/ 2) outdoor temperature over a period of 1 day

Solar Irradiation in W/m²

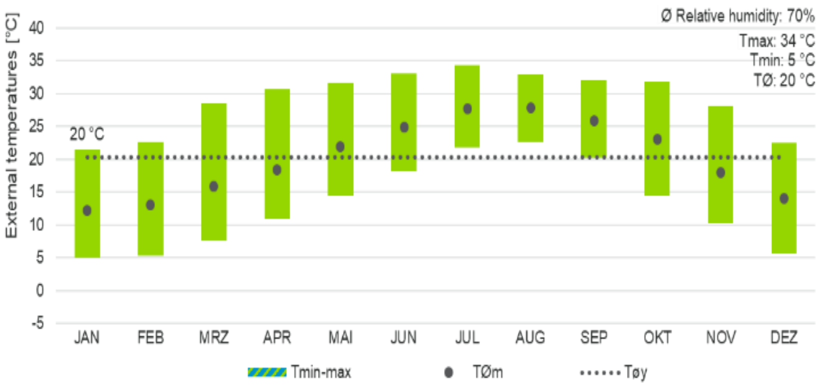
- Irradiance may be measured in space or at the Earth's surface after atmospheric absorption and scattering.
- Solar irradiance is often integrated over a given time period in order to report the radiant energy emitted into the surrounding environment (kWh per square metre) during that time period.

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).

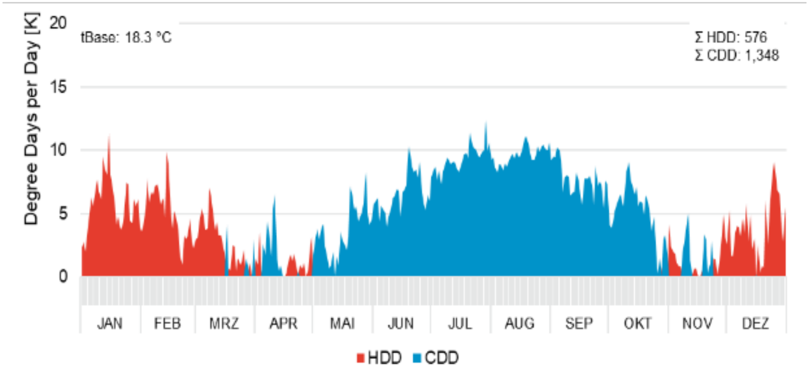
Climate analysis I Beirut

Outdoor temperature



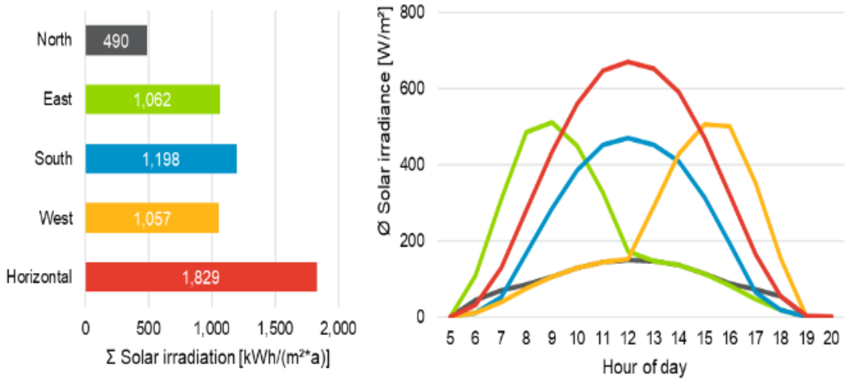
The climate at the project site primarily warm and humid. External temperatures range from 5°C above 0°C to 34°C, with average temperatures around 20°C

Heating and Cooling Degree Days



The demand for cooling prevails against heating demand as the high number of >1,300 CDDs. The cooling degree days are 2 times higher than the HDDs. The monthly average relative humidity is above 65% but may also reach >70% in the summer months.

Solar Irradiation

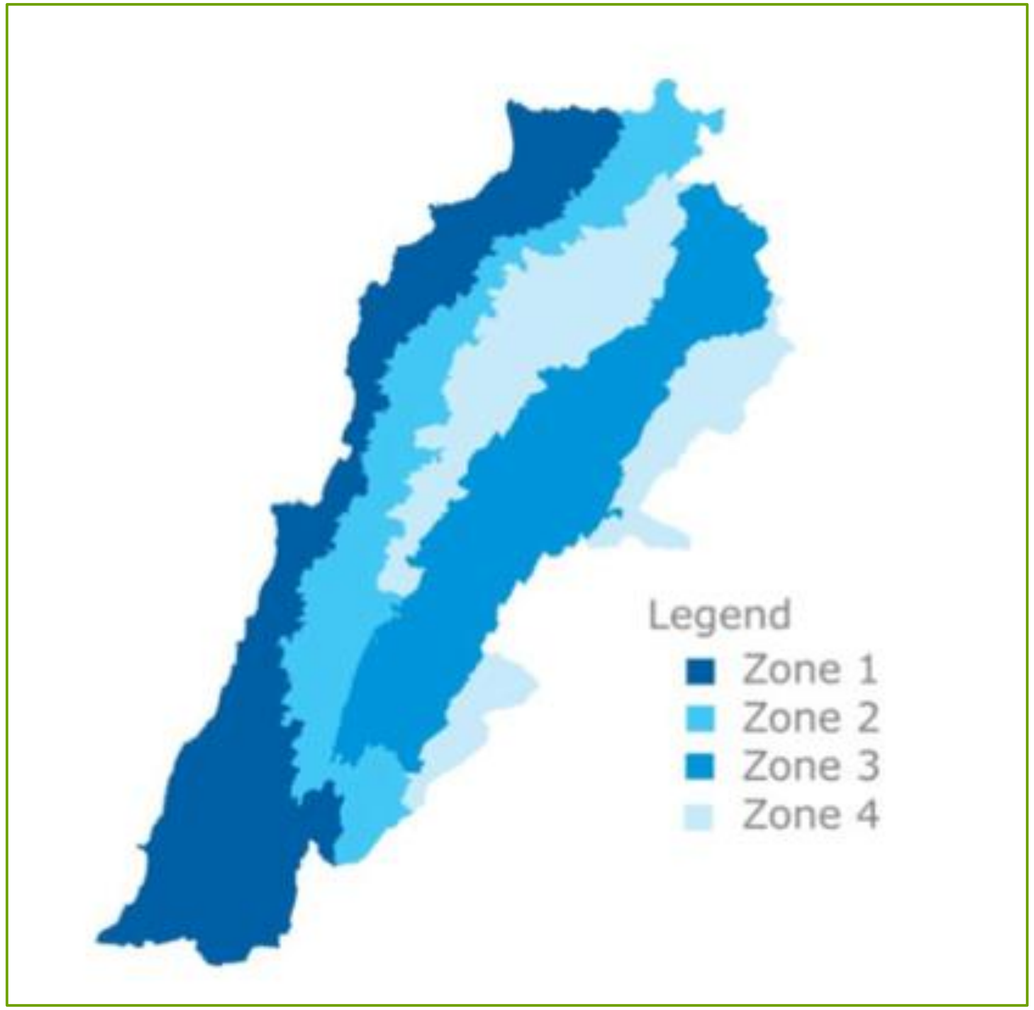


The site experiences a horizontal irradiation of >1,800 kWh/(m²*a) and >1,000 kWh/(m²*a) for each East, South, and West orientations. The horizontal solar radiation promises a high potential for the utilization of solar energy.

* Calculated according to ASHRAE 2001 methodology

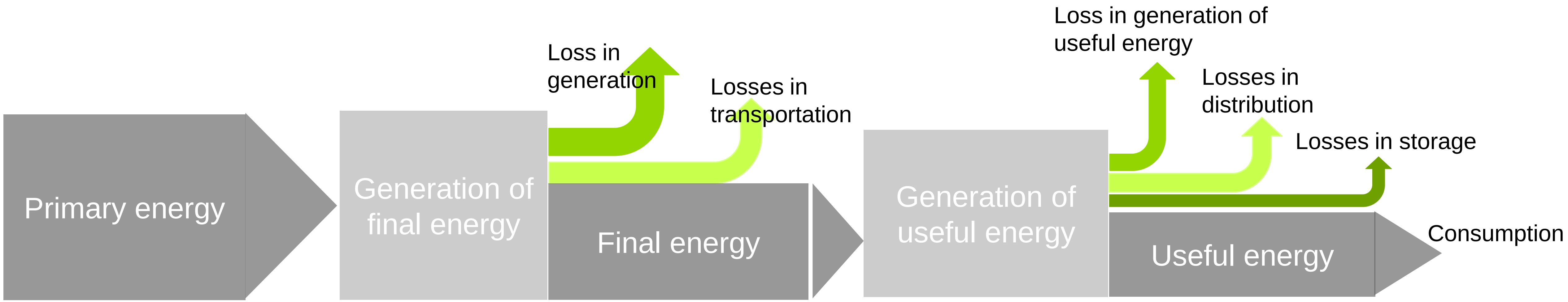
Climate zones
Lebanon

Instrument	Approximate Altitude Range	Approximate HDD(18) Inland CDD(21) Thresholds
Zone 1: Coastal	0 – 700m	300 < HDD < 1200 120 < CDD < 1050
Zone 2: Western Mid-Mountain	700-1400m	1200 < HDD < 2000 0 < CDD < 120
Zone 3: Inland Plateau	700-1150	1200 < HDD < 1800 120 < CDD < 600
Zone 4: High Mountain	Littoral Side +1400m Inland Side +1150m	HDD > 2000 | CDD = 0 HDD > 1800 | 0 < CDD < 120



Source: https://www.researchgate.net/figure/Climatic-Zones-of-Lebanon_fig28_268408852
https://nanopdf.com/download/climatic-zonic-for-buildings-in-lebanon_pdf

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).

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

Primary energy and CO_2 factor

	Primary Energy Factor [kWh_{PE}/kWh_{ele}]	CO_2 Factor [gCO_2/kWh]
Electricity (Egypt)	2.6	444
Electricity (Jordan)	2.4	635
Electricity (Lebanon)	2.39	664
Diesel (Lebanon)	1.1 kWh_{PE}/kWh_{diesel}	689

Efficiency Definitions

EER

- Efficiency Ratio (EER) is a term generally used to define cooling efficiencies
- 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 - or heat removed in Btu/h - to the total input rate of electric power applied - in Watts. The units of EER are Btu/Wh.
- Higher EER = more efficient system

SEER

- Seasonal Energy Efficiency Ratio (SEER) is used to define the average annual cooling efficiency of an air-conditioning or heat pump system.
- The term SEER is similar to the term EER but is related to a typical (hypothetical) season rather than for a single rated condition.

COP

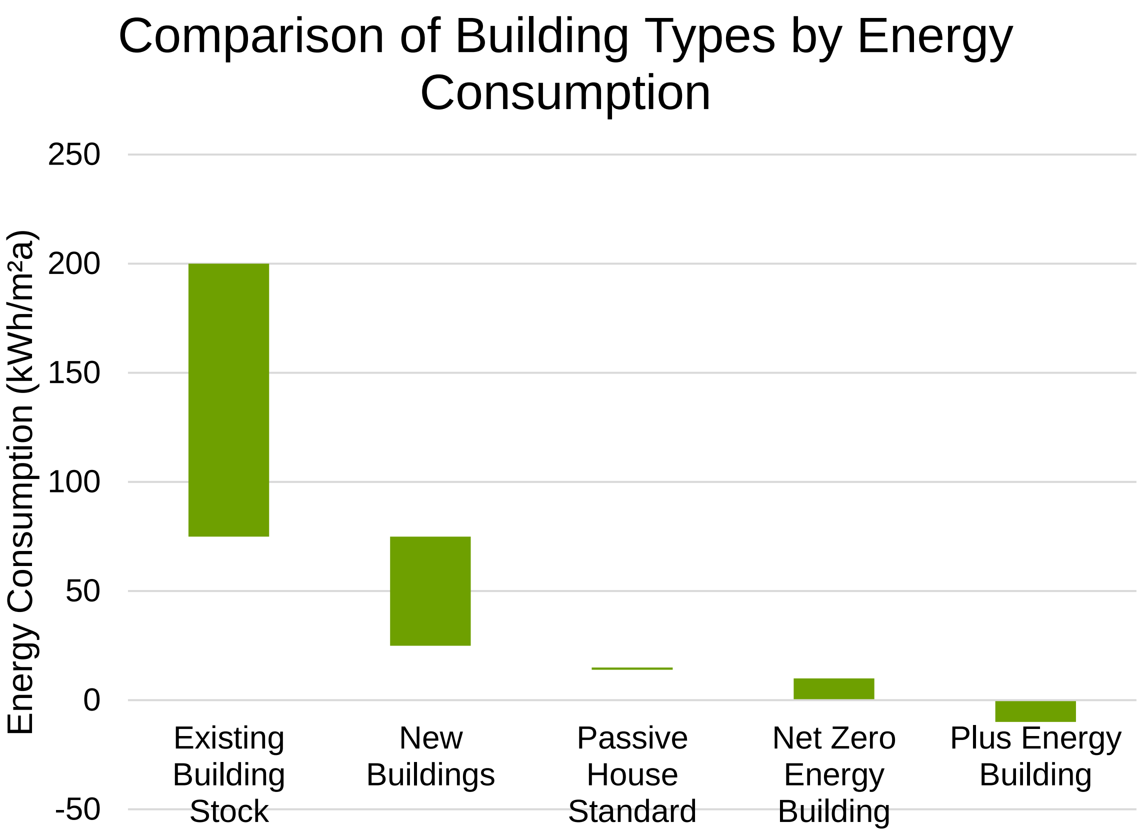
- Coefficient of Performance (COP) is the ratio of cooling or heating to electricity consumption.
- A refrigerator with a COP of 2 transforms 2 Watts of heat using one Watt of electricity.
- An air conditioner with a COP of 4 transforms 4 Watts of heat using one Watt of electricity.

Building energy levels and sustainable certification schemes

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)



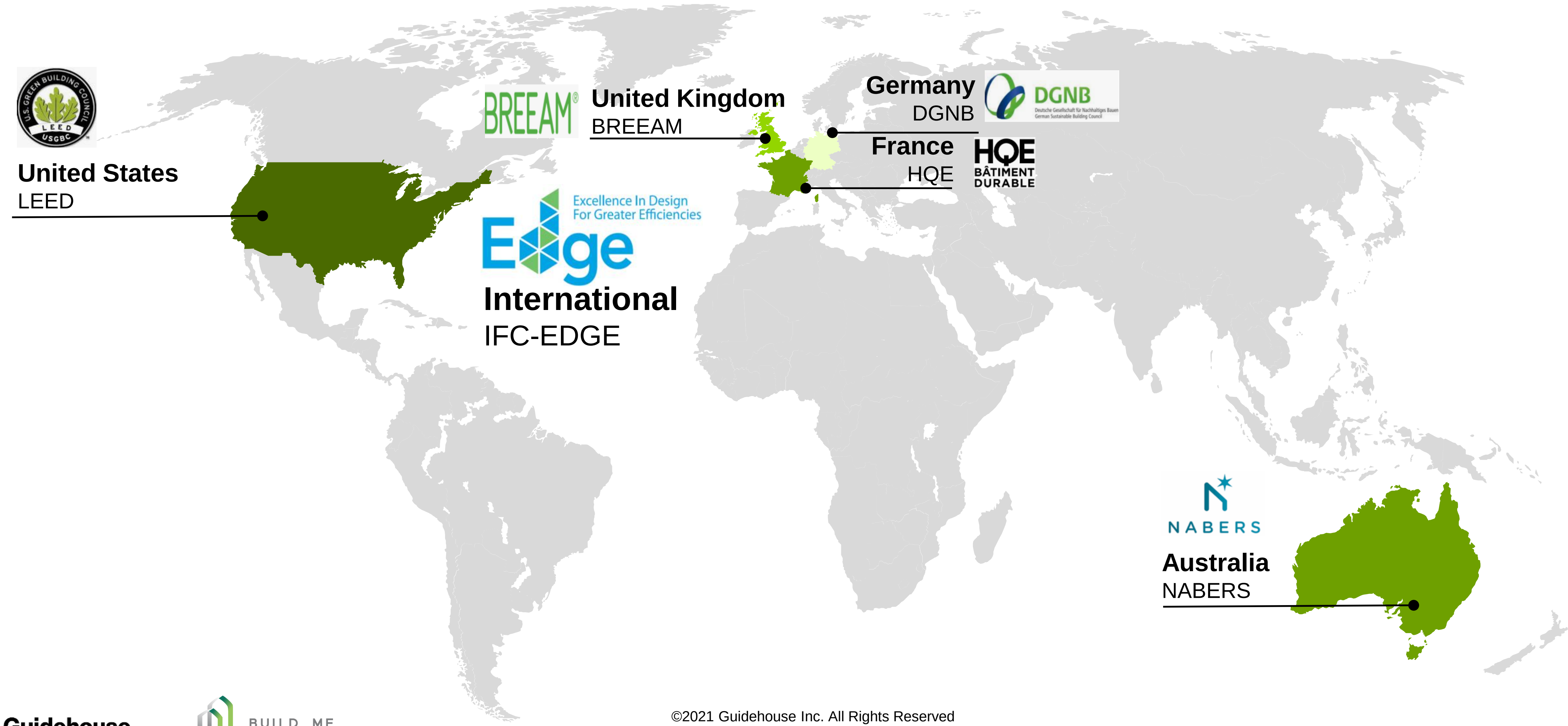
Green building certificates
Definition

- Used to **assess** and **recognise** buildings that meet certain **green building requirements** or standards
- **Recognise** and **reward** companies and organisations who build and operate greener buildings
- **Encourage** and **incentivise** companies to push the boundaries on sustainability
- World Green Building Council sets **Quality Standards** for rating tools around the world

Source: https://www.worldgbc.org/rating-tools

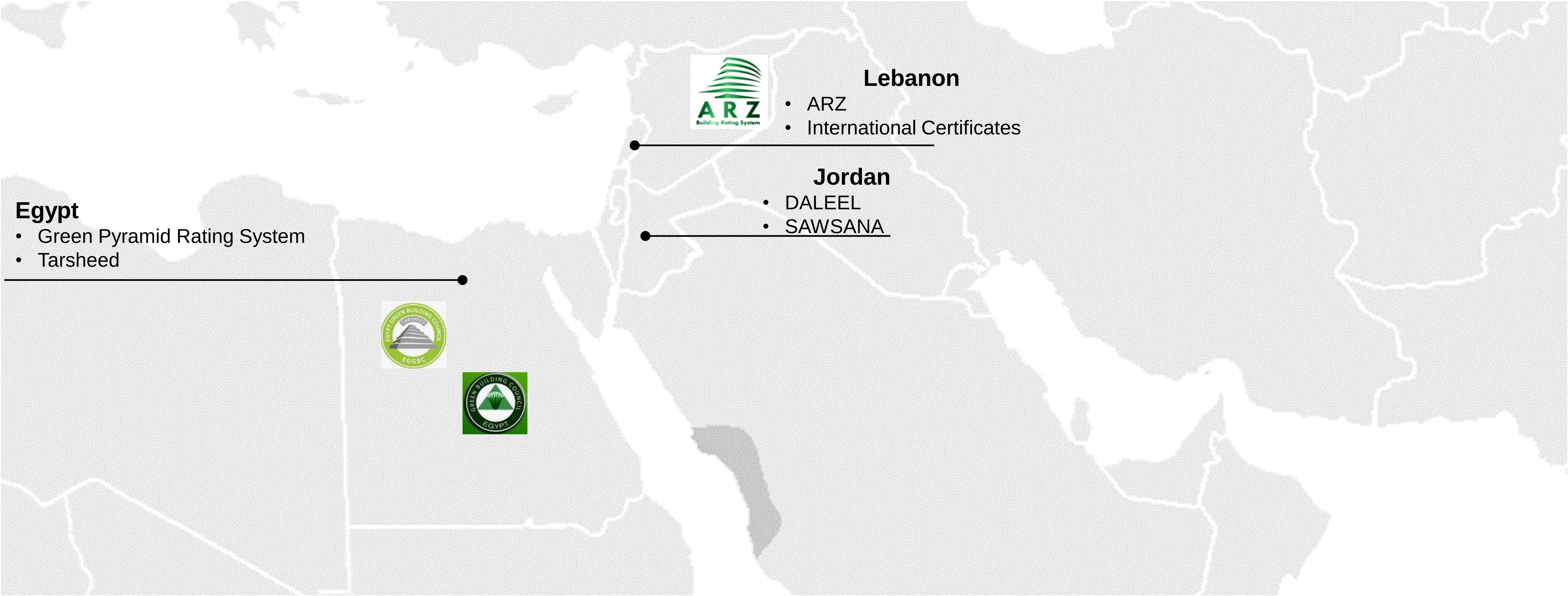
Green building certificates

International most relevant schemes



Green building certificates

Regional schemes



Conclusion

Understand the big picture

- Global Warming is causing tremendous environmental stress
- EE/RE huge economic and social potential

Familiarity with common definitions and terminology

- Boundary conditions like climate and economic parameters (energy costs, CAPEX) influences the feasibility of low energy buildings

Introduce building energy levels and sustainable certifications

- Several international sustainable certification schemes exist, but all BUILD_ME countries have as well national schemes in operation

Policy instruments for climate-friendly buildings

Photo by Lukas Blazek on Unsplash

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Key take-aways 2 – Policy instruments session

Principles of policy instrument formulation

Diversity of possible instruments

Several indicators to measure success

Carrot, Stick and Tambourine Principle

Different types of policy instruments

Carrot = Incentives
Subsidy programs
Investment grants
Tax rebates

Stick = Regulations
EEBC
Performance standards Solar energy ordinance

Tambourine = Information
Awareness programs
Trainings
Labels

Carrot = Incentives

Instrument	Features and characteristics
Soft loans	• Soft loans are loans offered at subsidised interest rates (i.e. lower than the market rate) to consumers who invest in energy efficient technologies • Implemented by banking institutions
Investment grants	• A financial award to facilitate a goal or incentivise performance • Do not have to be paid back under most conditions • Some have waiting periods before the grantee can take full ownership of the financial reward
Tax rebates	• Amount of money that project developers can subtract directly from the income taxes that they owe • Tax credits are more favourable than tax deductions because they actually reduce the tax due, not just the amount of taxable income • Three basic types of tax credits: non-refundable, refundable, and partially refundable

Source: Invstopedia

Carrot = Incentives

Example Lebanon: NEEREA

Prepare Technical Report
- LCEC template
- Full feasibility study (technical+financi al analysis
- Include amount of requested loan

Pick commercial bank (CB)
- a.< 20,000USD, report sent diretly to LCEC
- b. > 20,000USD, approval of technical proposal by BDL before sent to LCEC

LCEC approval
- Once technical verification done by LCEC, re-sent to the CB or to BDL to review and send the results to the CB

Loan accepted/rejected
- Process takes ca. 3 months
- Disciplinary action if final execution diverges from original plan

NEEREA RESULTS
• By June 2020, **1,000+ projects** approved by NEEREA financing mechanism with a total amount of **USD 600M+**.
• Ca. **76% of the projects** for **solar PV**
• **42% of loans amount** for **green buildings.**
• Projects all together contribute to an **annual saving of USD 73M+**.
• To date NEEREA has achieved a reduction in annual energy consumption of **260 GWh** and **281 ktonnes CO_2**

Stick = Regulations

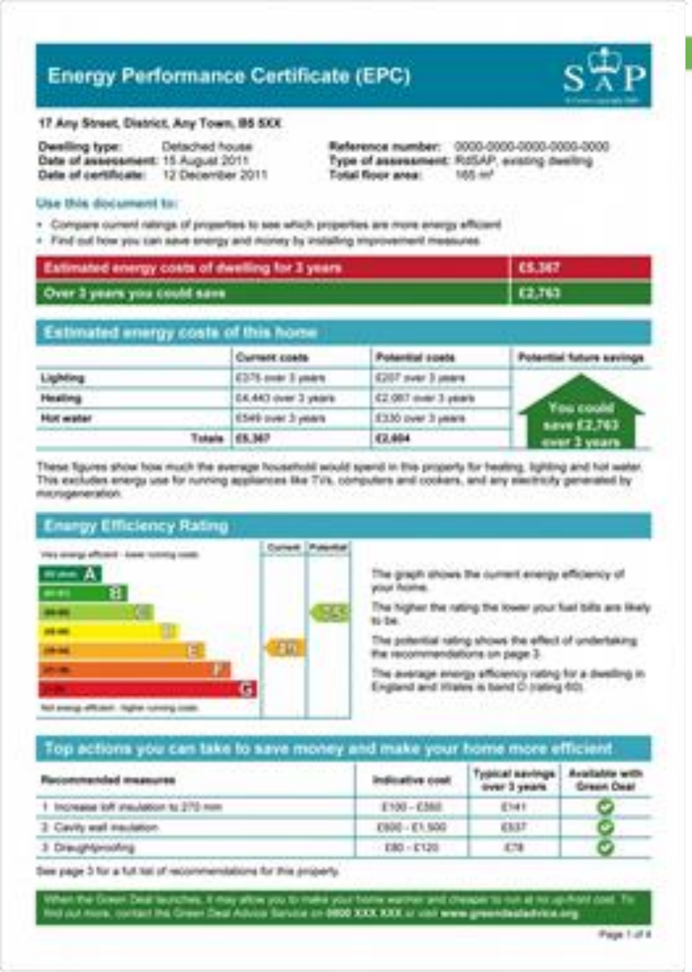
Instrument	Features and characteristics
Energy Efficiency Building Codes	Building standards can be classified in four categories: 1. Maximum heat transfer through individual building components (e.g. walls, roof, windows) 2. Limit on the overall heat transfer through the building envelope 3. Limitation of heating/cooling demand (taking into account the contribution from ventilation losses, passive solar gains and internal heat sources (maximum demand per m3 or m2). 4. Energy performance standards
Minimum energy performance standards	These standards consider the whole building as a system and also include building equipment such as heating and air conditioning systems, ventilation, water heaters, and in some countries even pumps and elevators e.g. maximum energy consumption per m^3 or m^2 per year
Solar Thermal Ordinance	Regulate the incorporation of solar thermal energy and its use for the production of sanitary hot water in the city's buildings Many of existing STOs are related to national or regional energy laws and implemented through municipal building codes

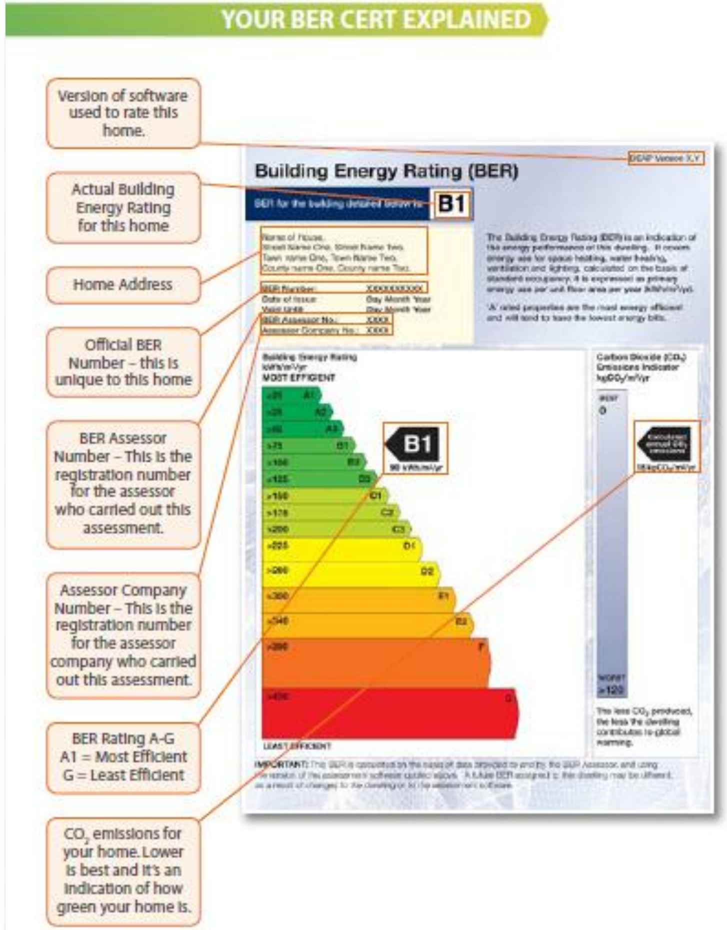
Tambourine = Information

Instrument	Features and characteristics
Awareness raising programmes	• Methods for monitoring energy consumption and possible energy savings • Demonstrate that there are proven technologies, methods and services that can substantially and cost-effectively reduce energy consumption
Building energy certificates	• Mandatory / Voluntary • Enable the buyer to obtain information about the energy consumption of the dwelling they are going to buy or rent
Trainings	• Capacity building programs, training courses • Develop culture of literacy in energy efficiency

Tambourine= Information

Energy Performance Certificate Example





- S: https://selfbuild.ie/advice/basics/energy-ratings/

Success factors

There is no such thing as an 'optimal' policy instrument…but rather typical circumstances for applying different types of instruments.

Generic characteristics that determine success or failure can be identified.

Important indicators for policy evaluation

Effectiveness and cost-effectiveness/efficiency

Impact effectiveness

The extent to which a policy instrument made/makes a difference

Target effectiveness

To what extent do/did a policy instrument contribute to achieving the targets?

Cost-efficiency:

Could targets have been reached at lower costs?

Recommendations for the choice of instruments

1. Consider the whole implementation process
2. Set ”SMART” objectives for the (new) policies
(**s**pecific, **measurable**, **a**mbitious, **r**ealistic and **t**ime-bound)
3. Organise workshops to discuss the envisaged policy with involved stakeholders and market actors
4. Set boundaries and preliminary objectives for each instrument

Recommendations for the choice of instruments

5. Identify the need for a combination of different policy instruments
6. Perform an ex-ante evaluation of the expected outcome
7. Analyse the relationship and possible overlap with other instruments (already) in place
8. Identify the crucial indicators that must be monitored

Conclusion

Principles of policy instrument formulation

Carrot, Stick and Tambourine principle

Diversity of possible instruments

Selection requires national/regional adaptation

Several indicators to measure success

Need „SMART“, holistic and transparent planning and implementation

Climate-friendly buildings from a technology perspective

Photo by Lukas Blazek on Unsplash

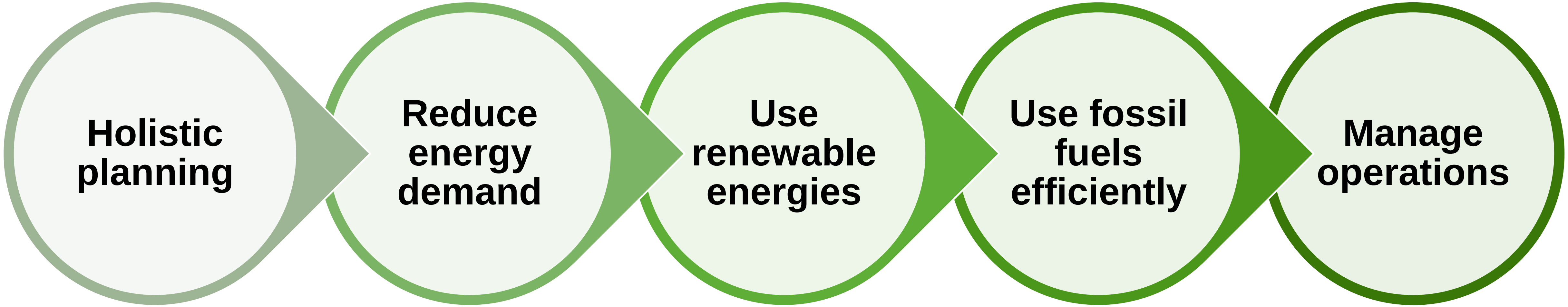
Guidehouse BUILD_ME

Key Learnings

- Principles of a holistic planning
- Measures to reduce energy consumption
- Renewable energy measures
- Cost efficiency measures

General principles to conceive a low energy building

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



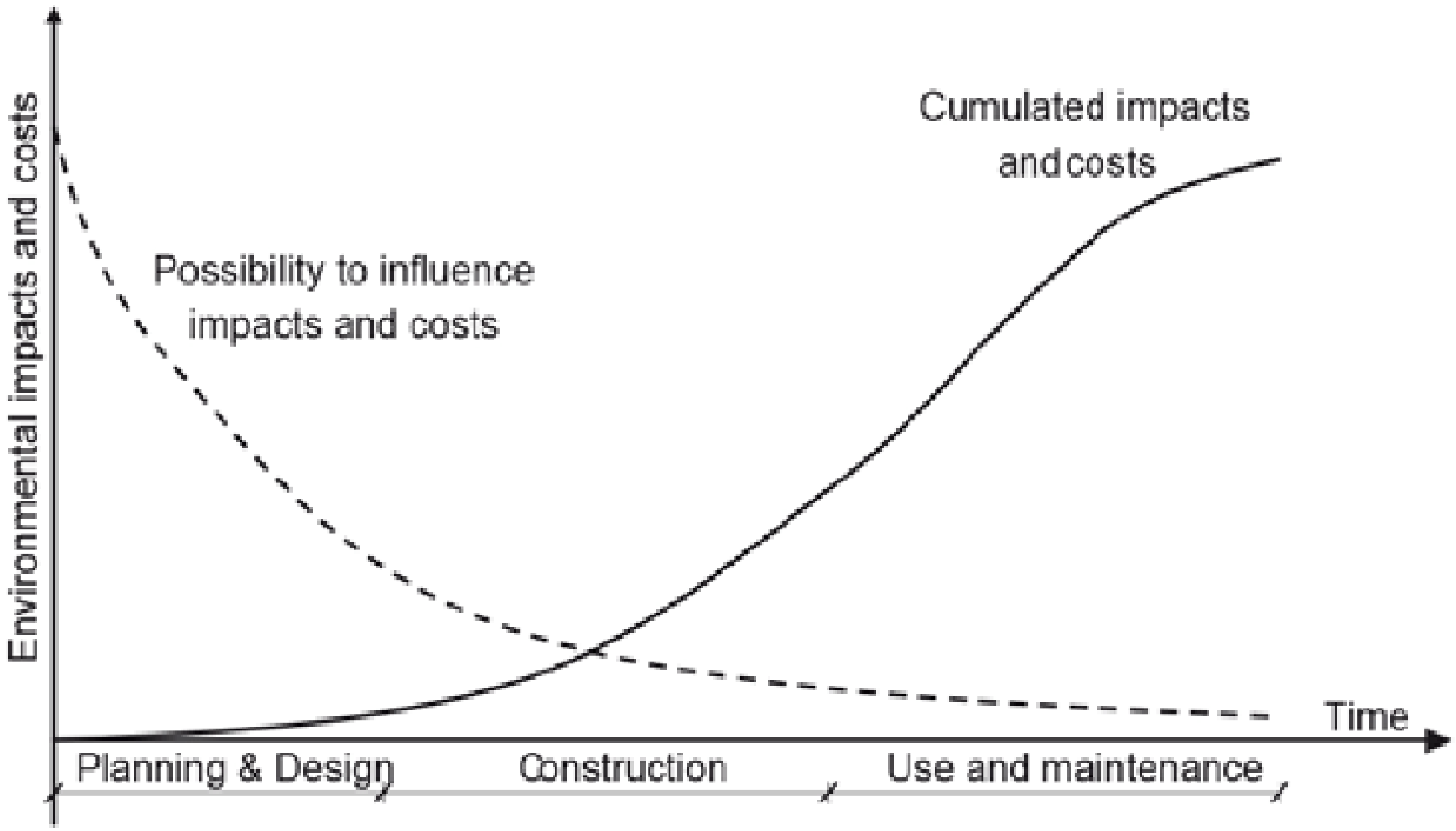
Legend allowing a quick assessment of the measures

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	♻ ♻ ♻


Source: https://unsplash.com/photos/KqEYj1VHA_o

Step 1: Holistic planning

Influence of design decisions on life cycle impacts and costs



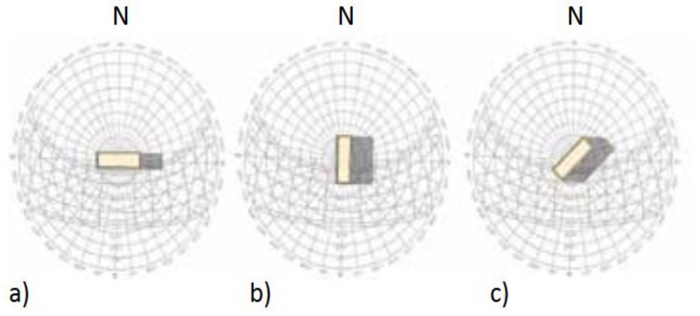
Source: Kohler & Moffatt, 2003

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

Step 2: Reduce energy demand

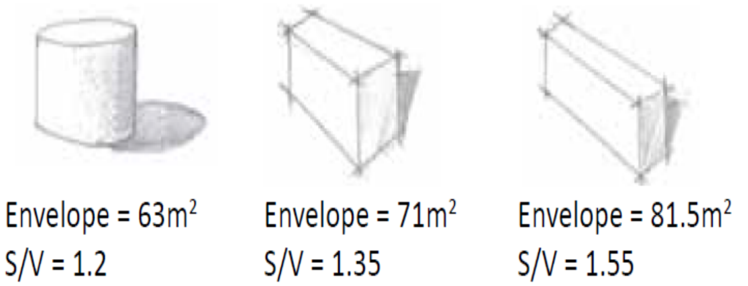
„Smart Planning“

Orientation



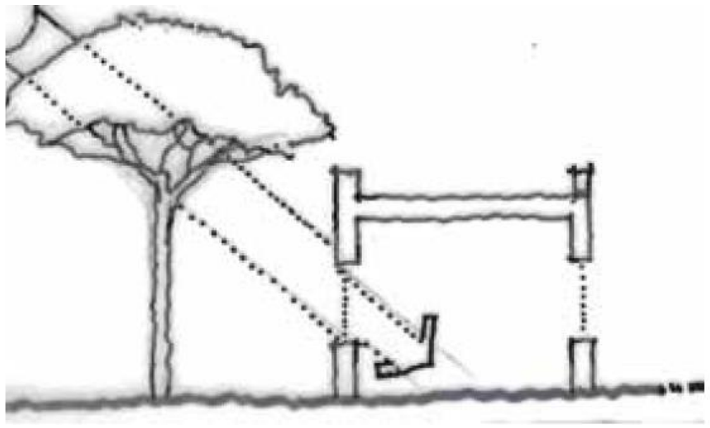
Orientation on the east-west axis to reduce cooling load a)

Building form and typology



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

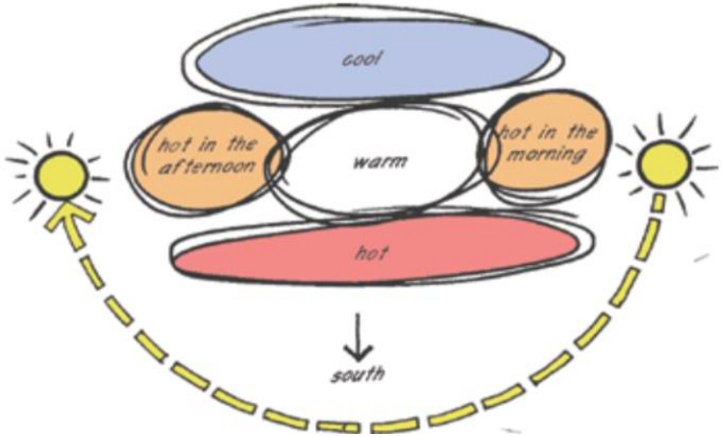
Landscape design



Use vegetation for a better microclimate, shading, thermal mass

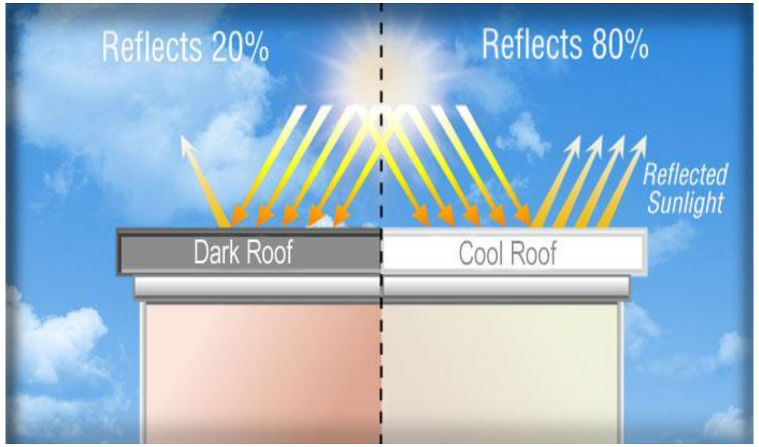
„Smart Planning“

Thermal zoning



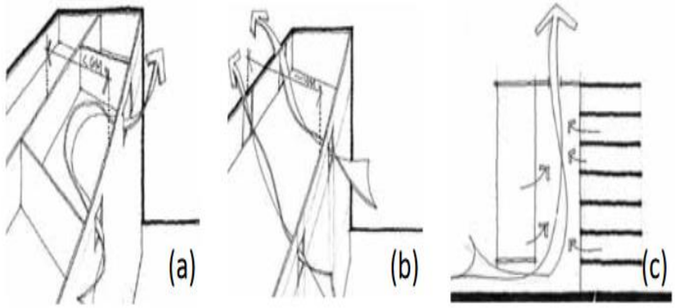
Organise space according to time of use and sun exposure

Colours



The lighter the colour, the higher/lower the reflection/absorption

Natural ventilation



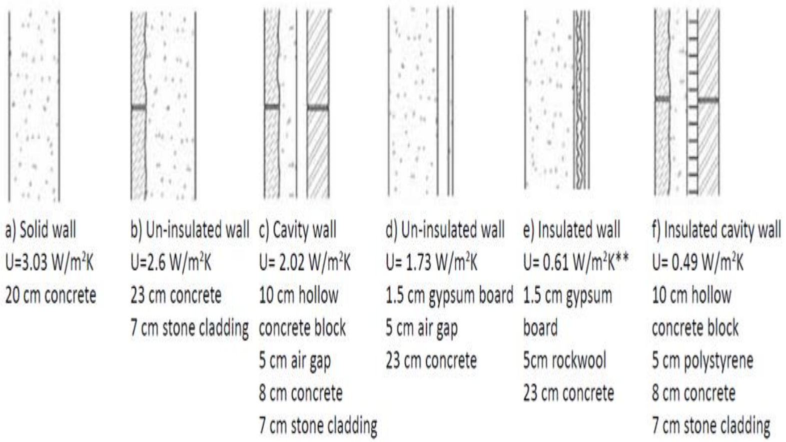
Strategies: single-sided (a), cross (b), stack ventilation (c)

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

Material selection

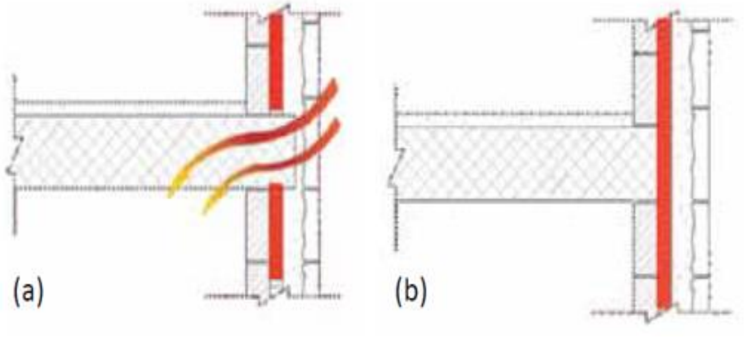
Building Shell Quality

Thermal insulation		
	€ €	



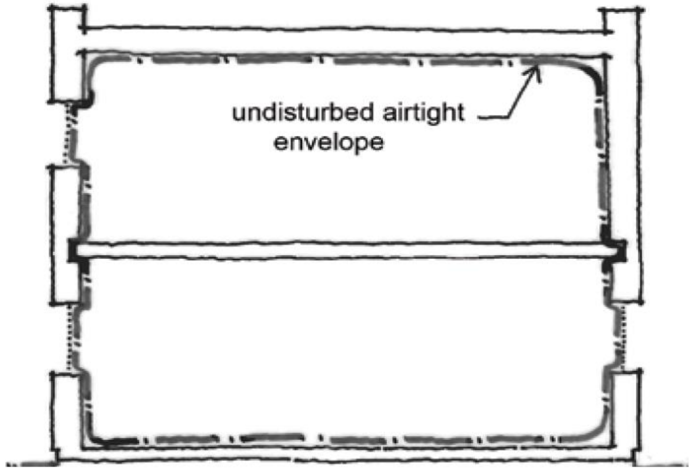
The lower the U-Value, the more energy can be saved

Thermal bridges		
	€ €	



Avoid an interruption of the thermal insulation layer

Air tightness		
	€	



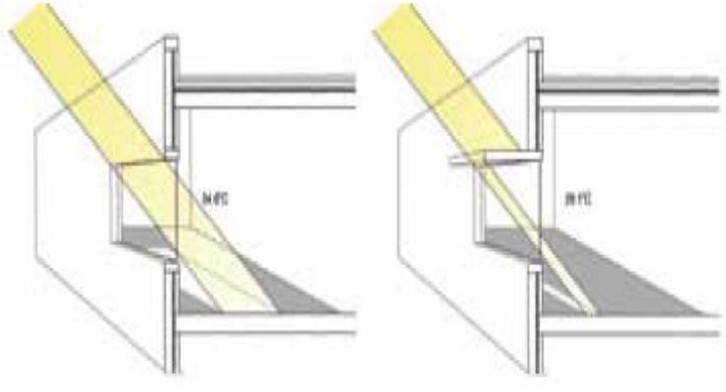
Avoid leakages

Material selection

Windows and their ratio

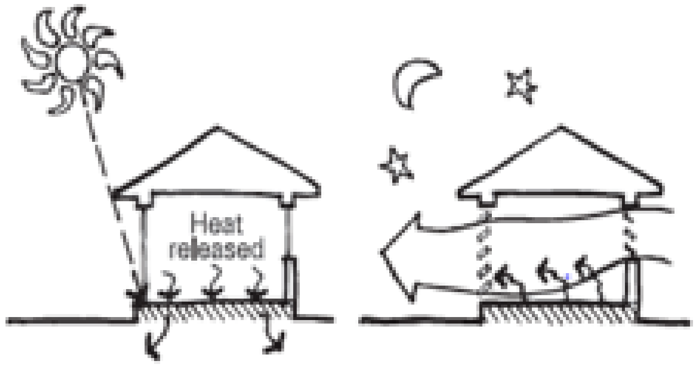
Reduction of solar heat gain due to reduced openings
Lower U-values, reduce the transmission losses

Shading



Reduction of solar heat gain due to window shading

Thermal mass

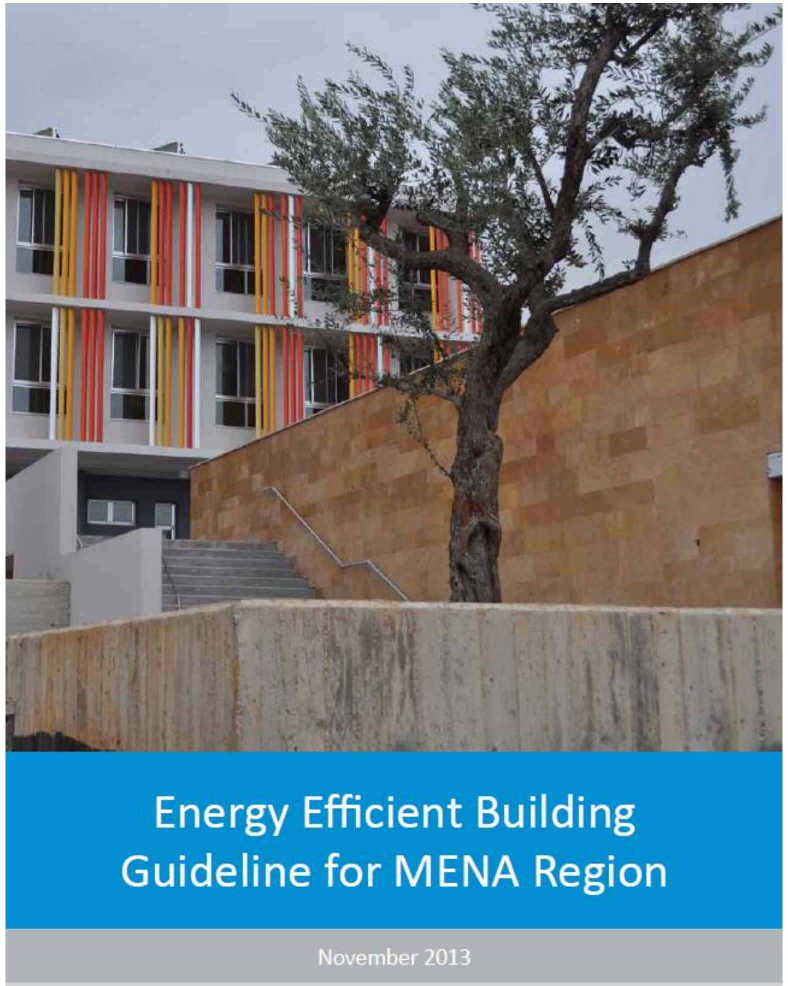


Use night ventilation to maximize buffer

Source: http://www.yourhome.gov.au/passive-design/thermal-mass

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

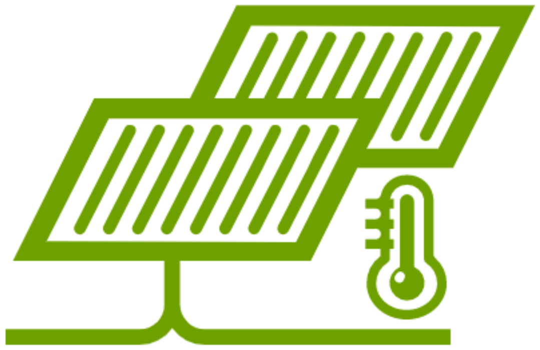
Source: https://www.climamed.eu/wp-content/uploads/files/Energy-Efficient-Building_Guideline-for-MENA-Region-NOV2014.pdf

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

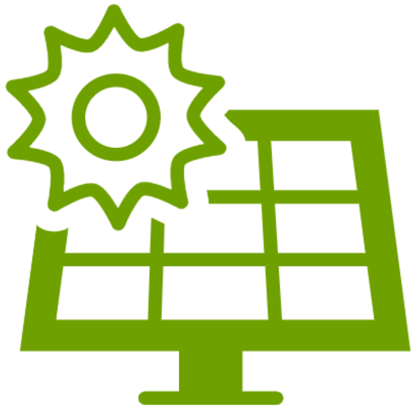
Step 3: Integrate renewable energies

Renewable energies

Scope of training



Solar thermal systems



Photovoltaics

Heat pumps

Renewable energies

Overview of selected systems

Solar thermal systems

€ €

- Converting solar radiation to thermal energy used for hot water or heating purposes
- Thermosiphon (most common in MENA) or Pumped Systems available
- Solar yield: 400 – 800 kWh/m² (collector surface)

Photovoltaics

€ €

- Converting solar radiation to electricity
- Grid-connected or stand-alone systems
- Different cells available: Mono Crystalline, Poly Crystalline and Thin Films
- Solar yield: 1,500 – 2,000 kWh/kWp (MENA region)

Heat pumps

€ € €

- Using different sources temperature (air, earth or water) and convert it into thermal energy
- Air to Air most common type (also known as Split Unit)
- COP mainly depending from delta of source and room temperature, varying from 2 – 10

Renewable energies

Discussion of selected systems

Solar thermal systems

Advantage

- High solar radiation in the MENA region
- Visible technology also supports marketing of the building asset

Disadvantage

- Maintenance needed to ensure proper operation
- Costs are still moderate/high

Photovoltaics

Advantage

- High solar radiation in the MENA region
- Sharp cost decrease makes PV cost efficient
- Visible technology also supports marketing of the building asset

Disadvantage

- Maintenance needed to ensure proper operation

Heat pumps

Advantage

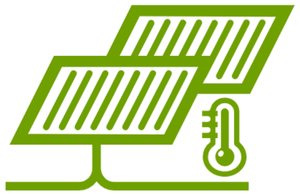
- Low operational costs
- Heating and cooling possible
- Key technology in combination with PV to decarbonise heating and cooling supply

Disadvantage

- High investment costs
- Limited availability in the national market
- Lack of experts / craftsmen

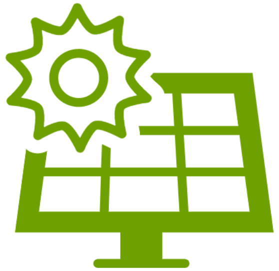
Renewable energies

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.

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

Step 4: Use high efficiency HVAC appliances

HVAC

Overview of selected systems

Heating

- Gas non-condensing
- Gas condensing
- Oil non-condensing
- Oil 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

Heating

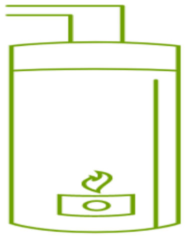
Overview of qualitative assessment

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	●●○	€ €	●●○

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

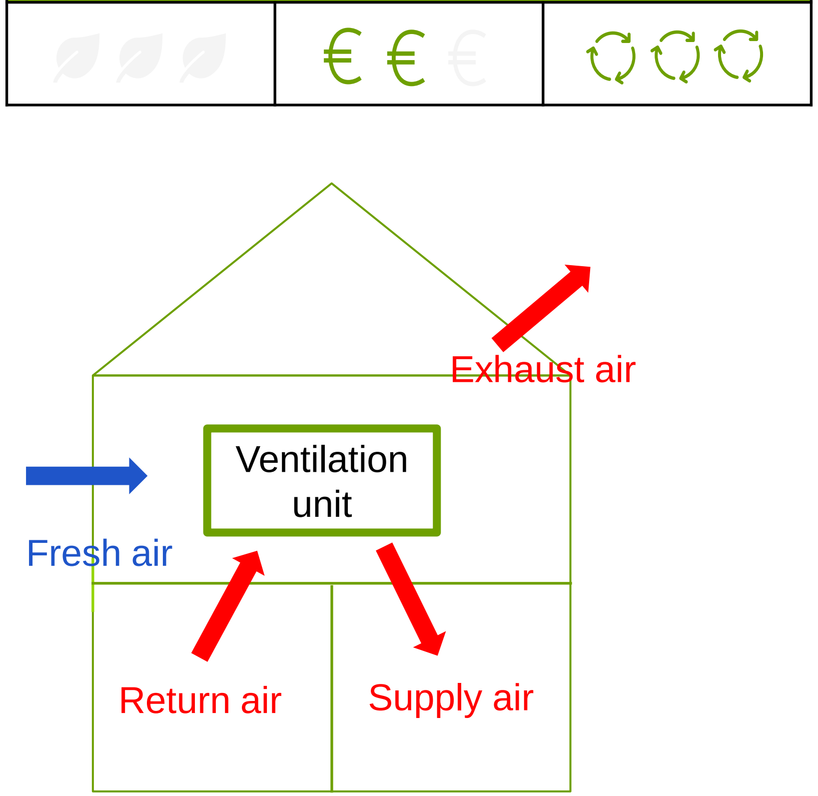
- High efficiency: no transmission losses as decentrally installed
- Needs decentral gas connection

Dedicated electric heater

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

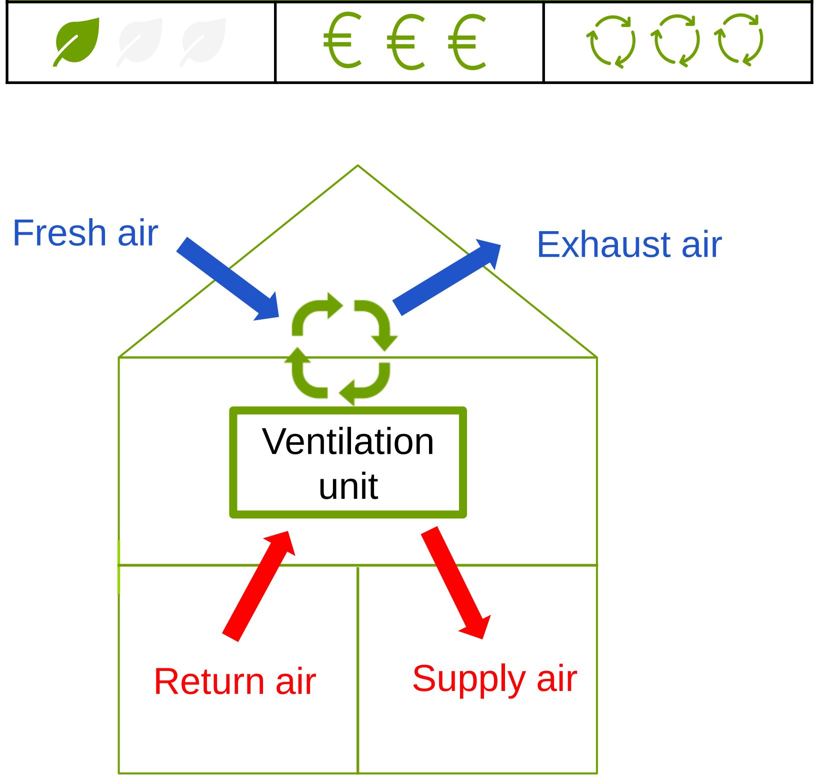
Ventilation

Mechanical ventilation



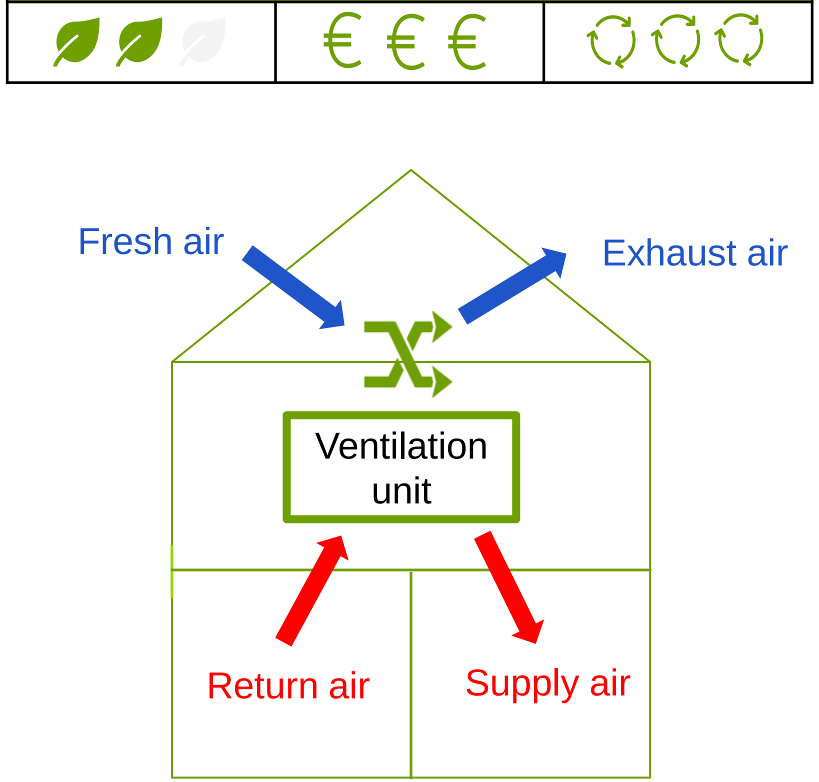
No recovery included

Mechanical ventilation inc. recovery (rotary or circulation exchanger)



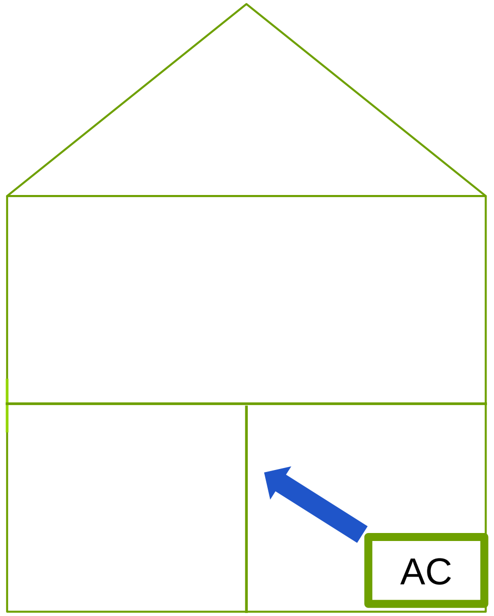
Moderate/high efficiency (up to 70%)

Mechanical ventilation inc. recovery (cross flow exchanger)



High efficiency (up to 90%)

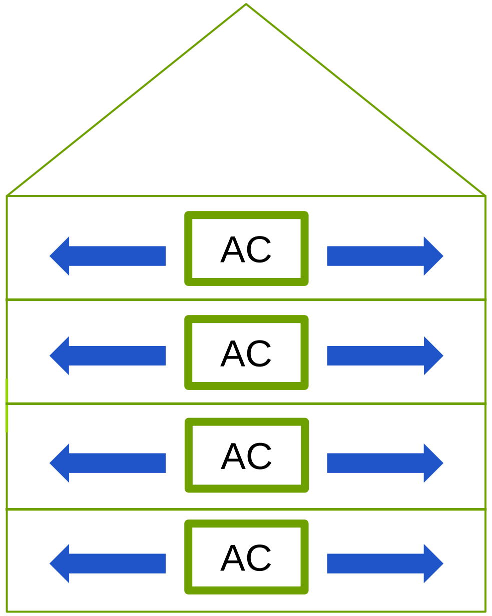
Air conditioning
Main technologies



Decentral

One AC per room

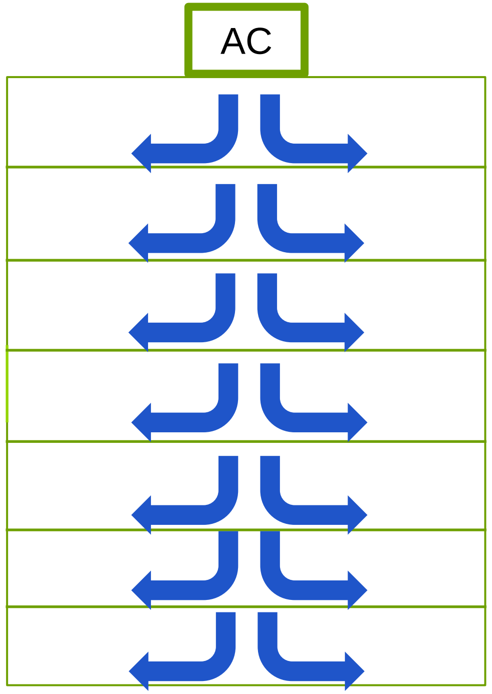
(e.g. window or split units)



Central – small scale

One AC for a group of rooms

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



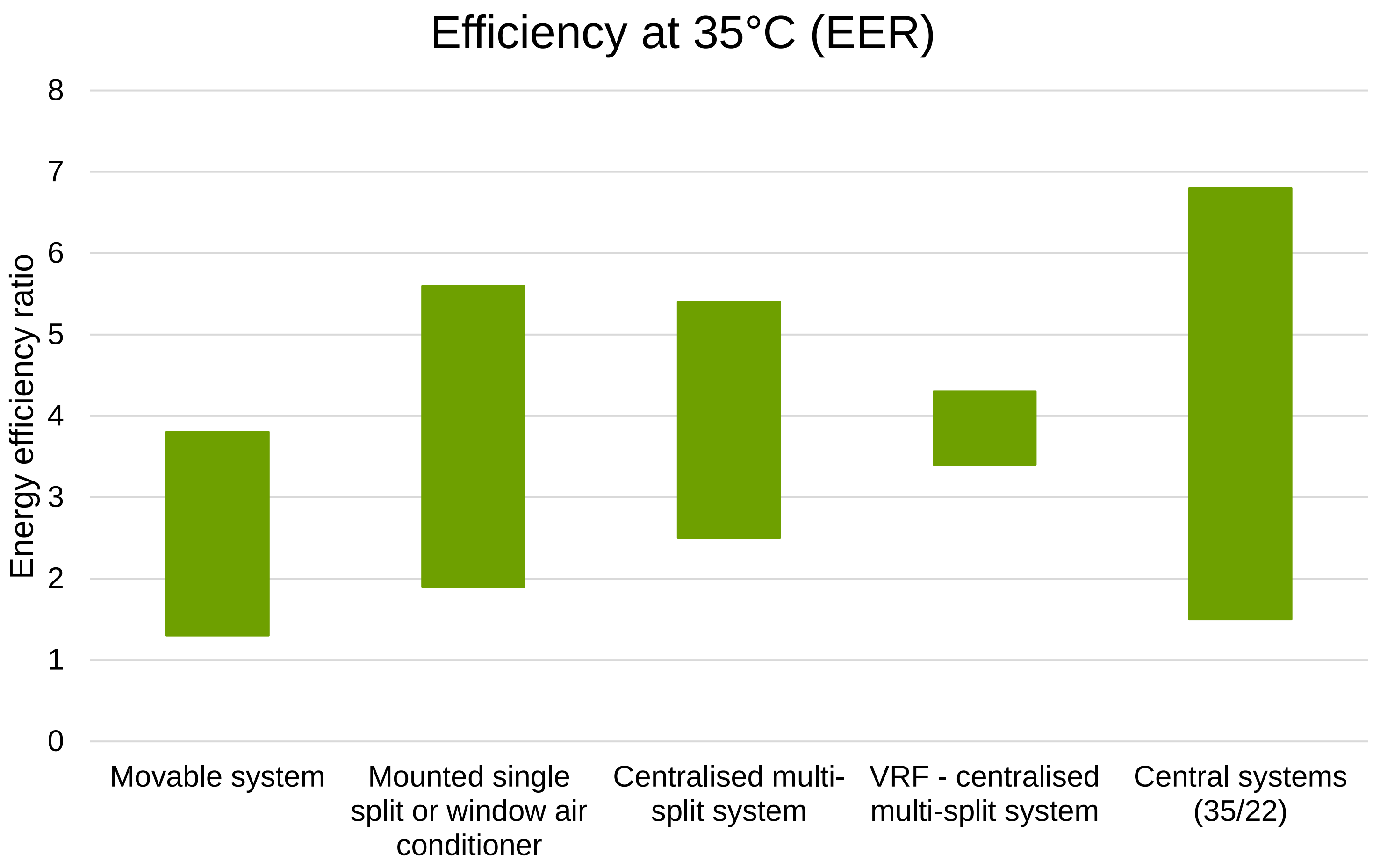
Central – large scale

One AC per building

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

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
- Water-based systems are the most efficient
- Efficiency highly dependent on delta of air temperature and room temperature

Air conditioning

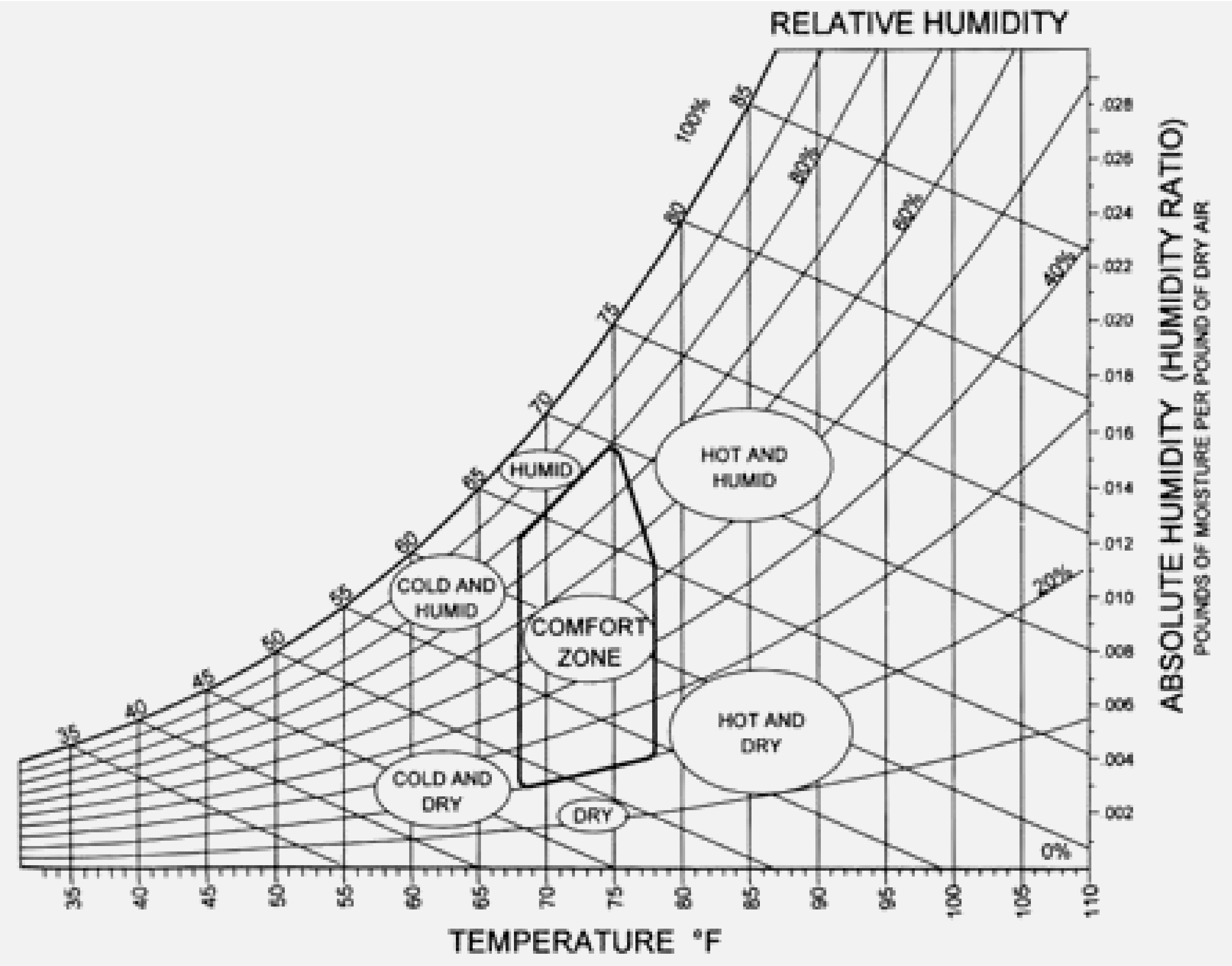
Overview of qualitative assessment

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	● ● ●	● ● ●	● ● ○

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

Step 5: Operation

Basics of thermal comfort

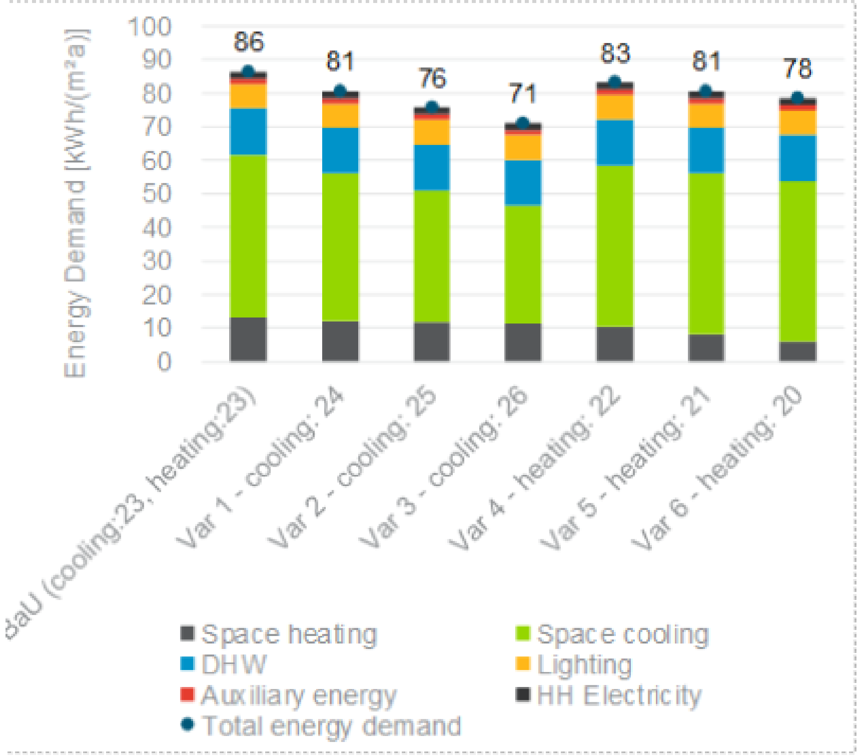


Example of temperature ranges			
Use/function		**Winter**	**Summer**
Residential	Living room	20-22°C	24-26°C
	Sleeping room	18-20°C	24-26 °C
	Bathroom	22-24°C	24-26°C
Office		20-22°C	24-26°C
School (classroom)		20-22°C	24-26°C
Shops		18-20°C	22-25°C

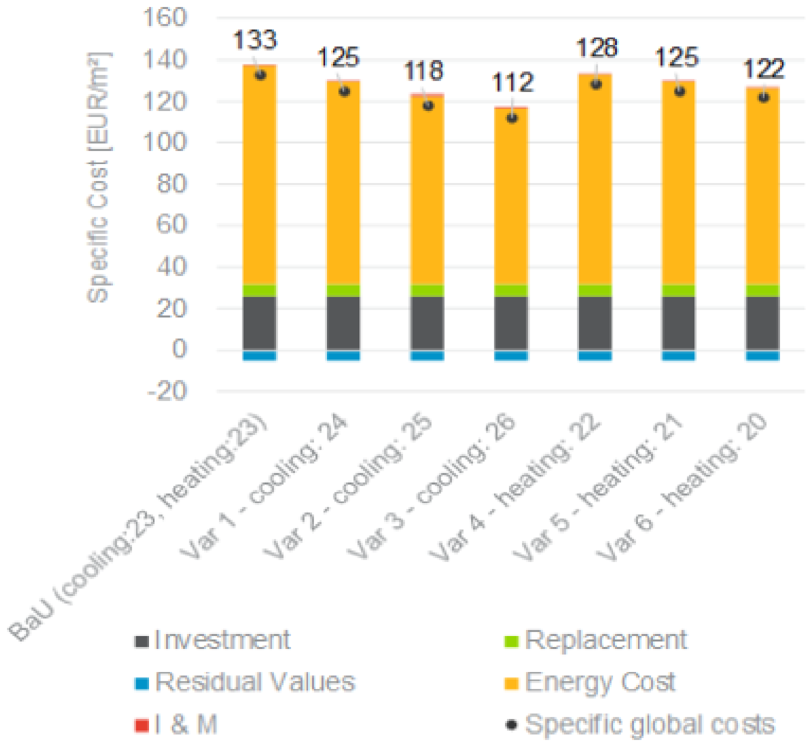
Cost effectiveness of setting temperatures

Example of an Egyptian MFH

Final Energy Demand



Global Cost



Selecting the appropriate setting temperature is a no cost measure, which is able to save significant energy

- Cooling: 1K higher can save around 5–7% final energy
- Heating: 1K lower can save around 3–5% final energy

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

Climate-friendly buildings from financing perspect

Guidehouse BUILD_ME

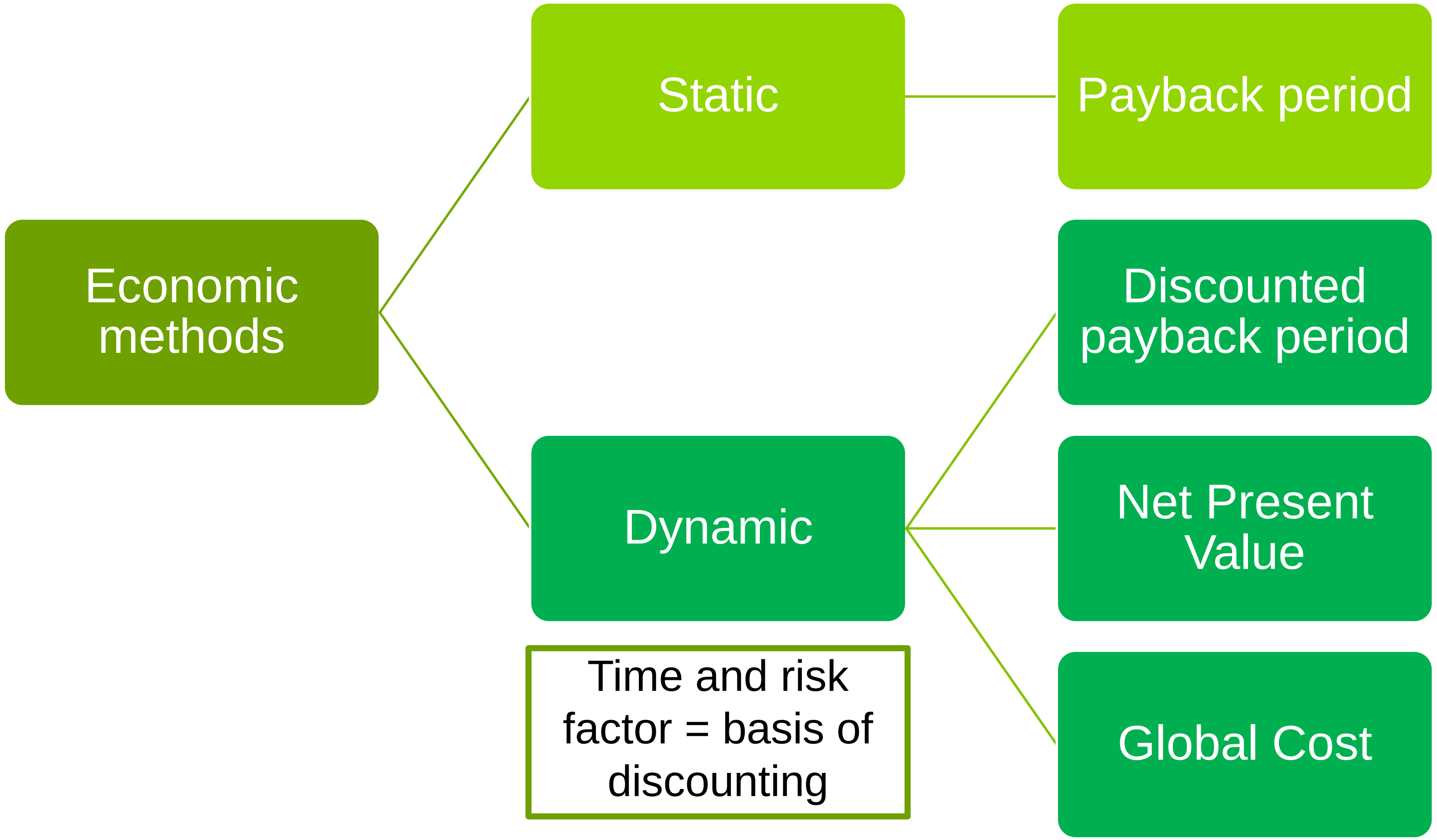
Key learnings

Terminology

Global Costs

Case Studies

Overview of economic evaluation methods



Payback period

Definition

- The **amount of time** it takes to recover the cost of an investment, meaning **to reach break-even point**
- Calculated by dividing the amount of the investment by the annual cash flow.
- The desirability of an investment is directly related to its payback period. **Shorter paybacks** mean **more attractive investments.**

Advantages

- Simple to calculate and compare options
- Useful for *'back of the envelope'* calculations

Disadvantages

- Disregards time value of money
- Ignores overall profitability of investment

Source: Investopedia

Discounted Payback Period
Definition

- A discounted payback period provides the **number of years** it takes to **break even** from the initial expenditure, **by discounting future cash flows** and recognising the **time value of money**.
- Shows **how long** it will take **to recoup an investment** based on observing the present value of the project's projected cash flows
- The shorter a discounted payback period is, the sooner a project or investment will generate cash flows to cover the initial cost.

Advantages

- More accurate picture than simple payback period

Disadvantages

- Highly sensitive to discount rate
- Challenging to arrive at discount rate that accurately represents investment’s true risk premium

Source: Investopedia

Net Present Value
Definition

- Difference between the **present value of cash inflows** and the **present value of cash outflows** over a period of time
- NPV is the result of calculations used to find today's value of a future stream of payments.
- To calculate NPV you need to estimate future cash flows for each period and determine the correct **discount rate.**

$$NPV = \sum_{t=1}^{n} \frac{R_t}{(1+i)^t}$$

where:

Rt = Net cash inflow-outflows during a single period t

i=Discount rate or return that could be earned in alternative investments

t=Number of timer periods

Advantages

- Indicates the profitability of future cash

Disadvantages

- Highly sensitive to discount rate
- Challenging to arrive at discount rate that accurately represents investment's true risk premium

Source: Investopedia

Global Cost

Definition

- **All cost elements are considered**: Operational and investment cost incurred over a relevant time period
- The different types of costs incurred each year, respectively, are summed by using the NPV methodology, in order to express them in terms of value in the first year.

Cost elements:

- Initial investment cost
- Annual cost
  - Replacement of systems
  - Running cost (energy, maintenance & operation)

Advantages

- All costs incurred over a relevant period are considered
- Costs are comparable because their value is calculated back to the same base year > ideal to identify cost-optimal solution
- Lifetime of the elements is explicitly considered

Disadvantages

- Sensitivities of NPV (described before)
- Sensitive to assumed cost and price increase

Source: ...

Global Costs

Details

One-time cost

Initial Investment

Sum of all investment costs in the first year, incl. envelope insulation, HVAC systems, lighting, etc.

Replacement

If the lifetime of an element or system is lower than the considered time period, it must be replaced. The costs are the investment cost of the specific system (plus potential cost increase).

Residual

At the end of the considered time period, most elements have a remaining lifetime. This is credited (negative) to the overall cost*.

Annual cost

Energy

Cost for energy carriers that are used every year to meet the final energy demand. Annual price in- or decrease for energy carrier can be considered.

Inspection & Maintenance

A certain percentage (0.5 – 2%) of the initial investment cost are considered to reflect the cost for inspection and maintenance of each system.

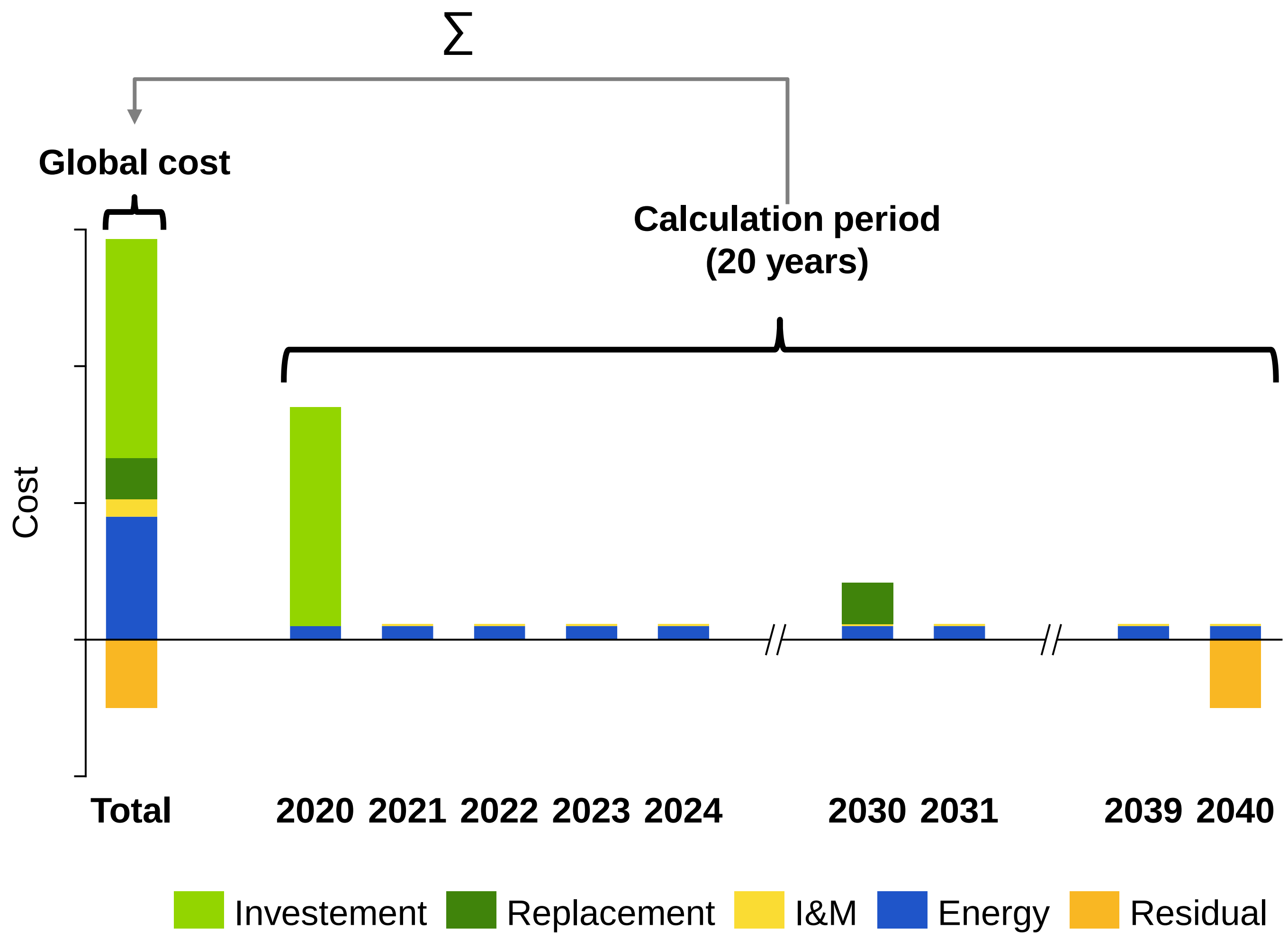
Global Cost

The discounted sum of each year (NPV) over the calculation period – for all the five cost elements – results in in the Global Cost.

**The amount credited is calculated by dividing the investment by the lifetime (10,000 €/10 year = 1,000 €/year). For each remaining year of the lifetime, this amount is multiplied by and considered as a “refund” to the owner (1,000 €/year * -2 year = -2,000 €).*

Global Costs

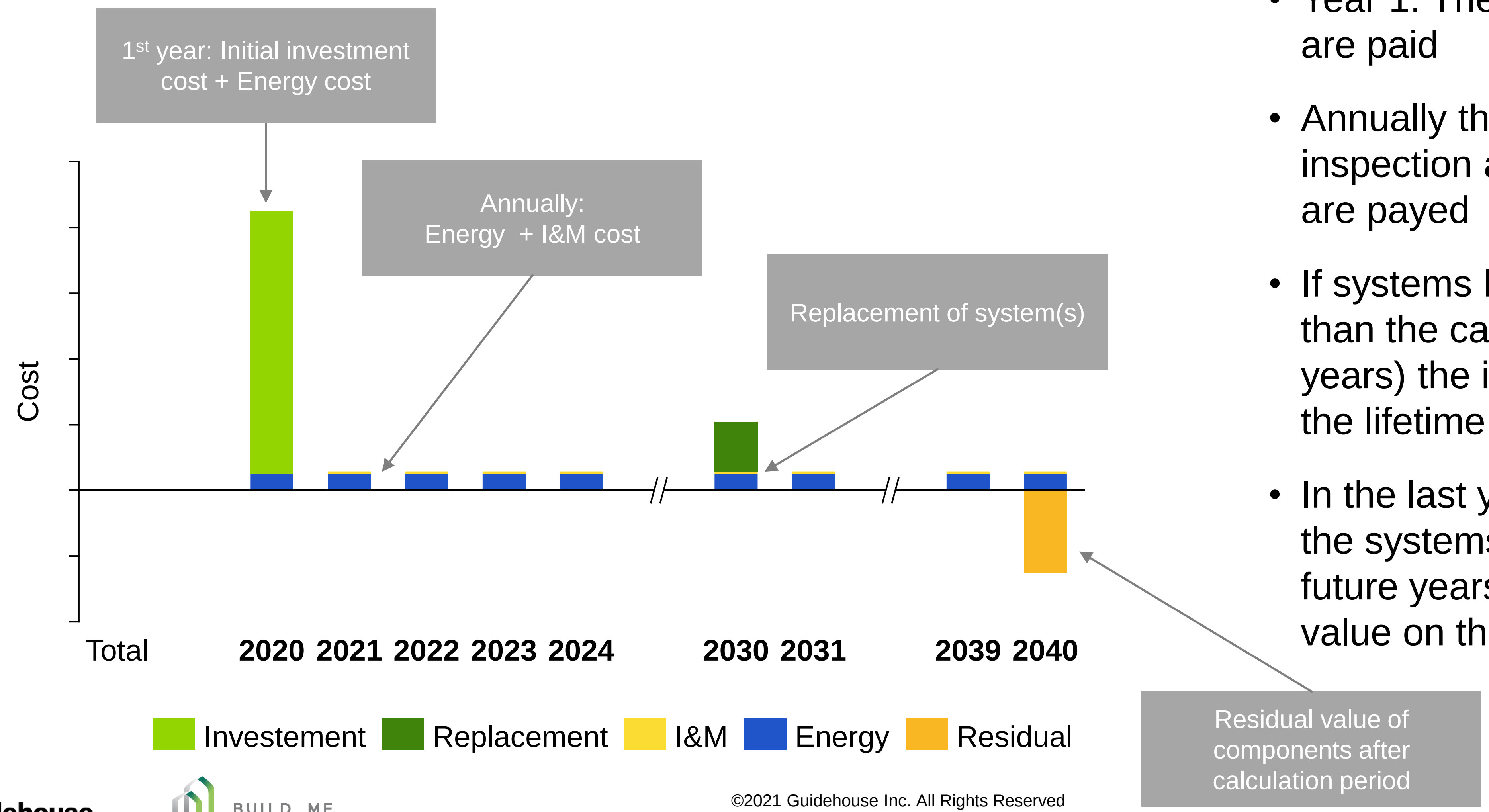
Example case – without discount rate and price increase



- The global cost represent the sum of all cost and values that occur over the considered calculation period

Global Costs

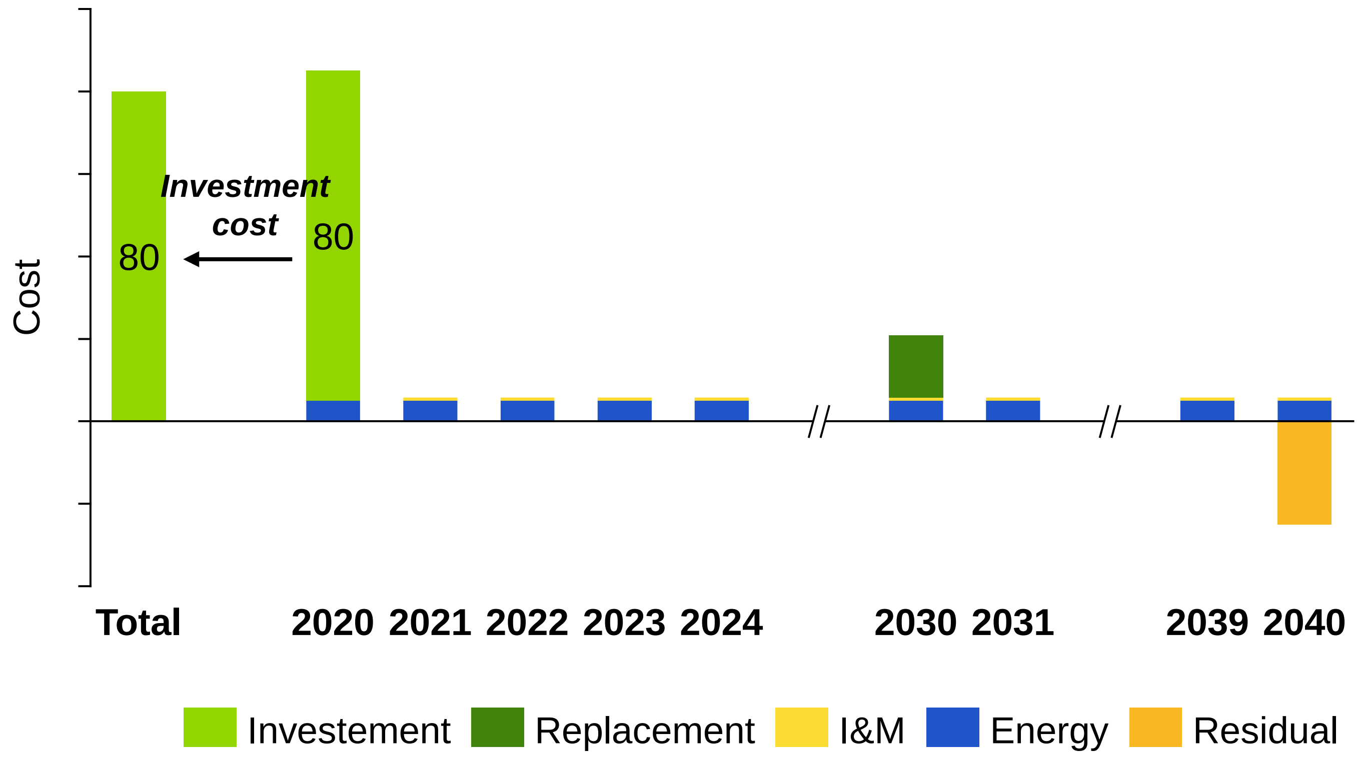
Example case – without discount rate and price increase



- Year 1: The initial investment cost are paid
- Annually the cost for energy and inspection and maintenance (I&M) are payed
- If systems have a lifetime of less than the calculation period (<20 years) the invest incurred again after the lifetime is over
- In the last year, the residual value of the systems that will still function in future years is considered a negative value on the global cost

Global Costs

Example case – without discount rate and price increase

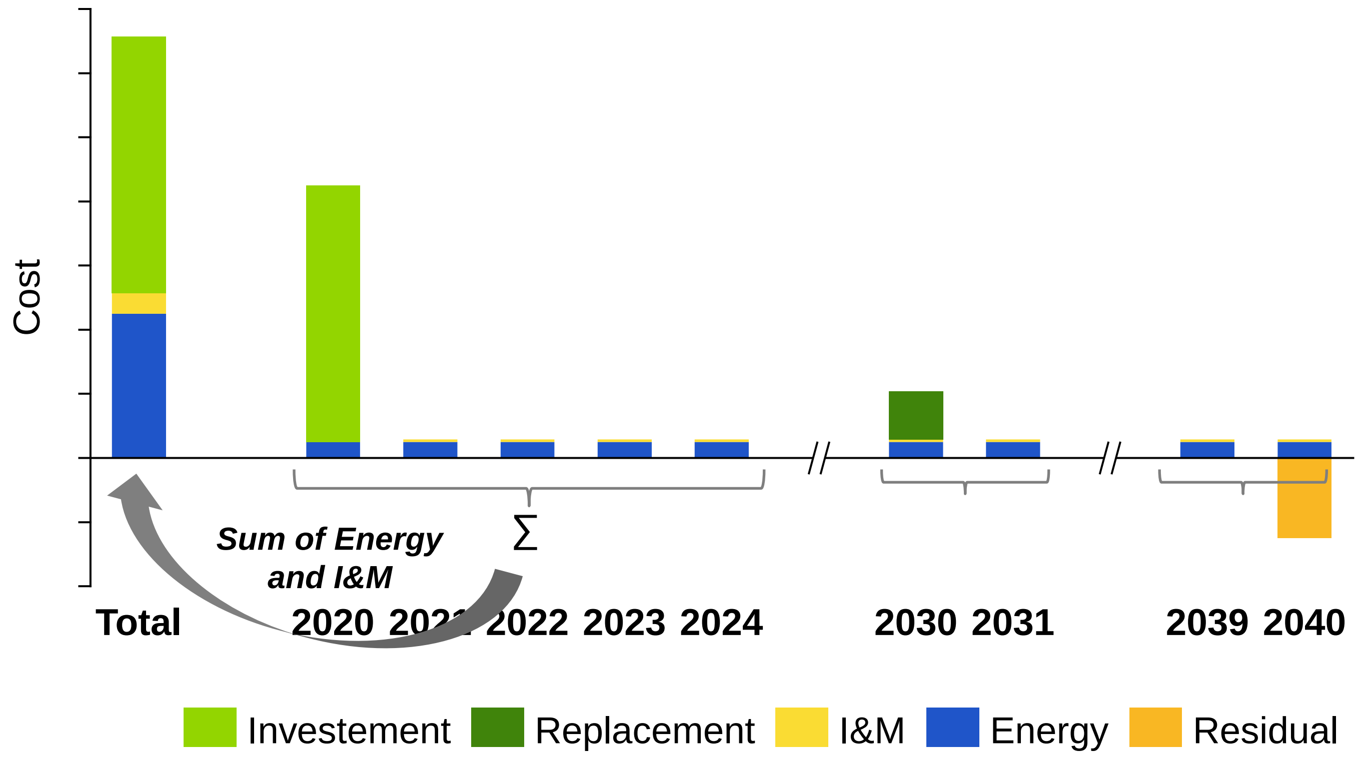


How to get to the total global cost?

- **Investment cost from first year**

Global Costs

Example case – without discount rate and price increase

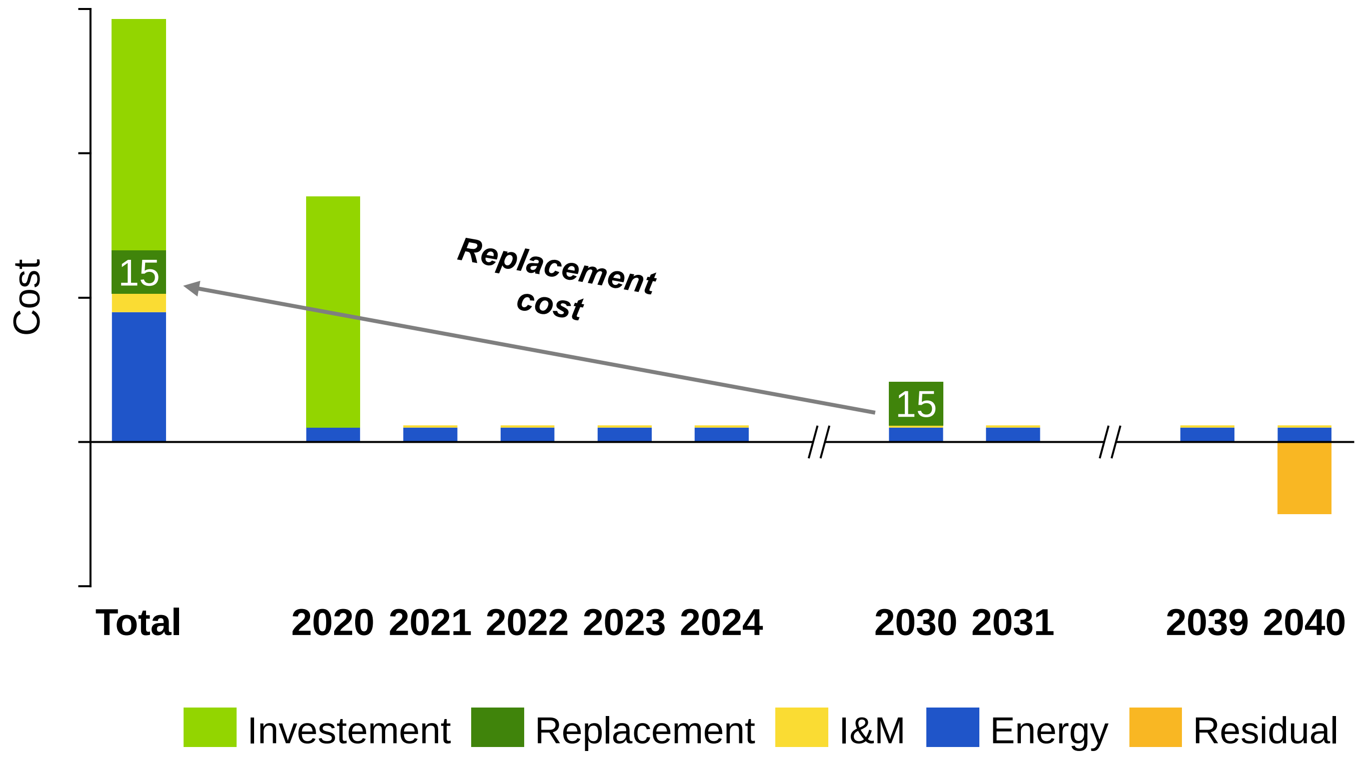


How to get to the total global cost?

- Investment cost from first year
- **Sum of energy and I&M cost of all years**

Global Costs

Example case – without discount rate and price increase

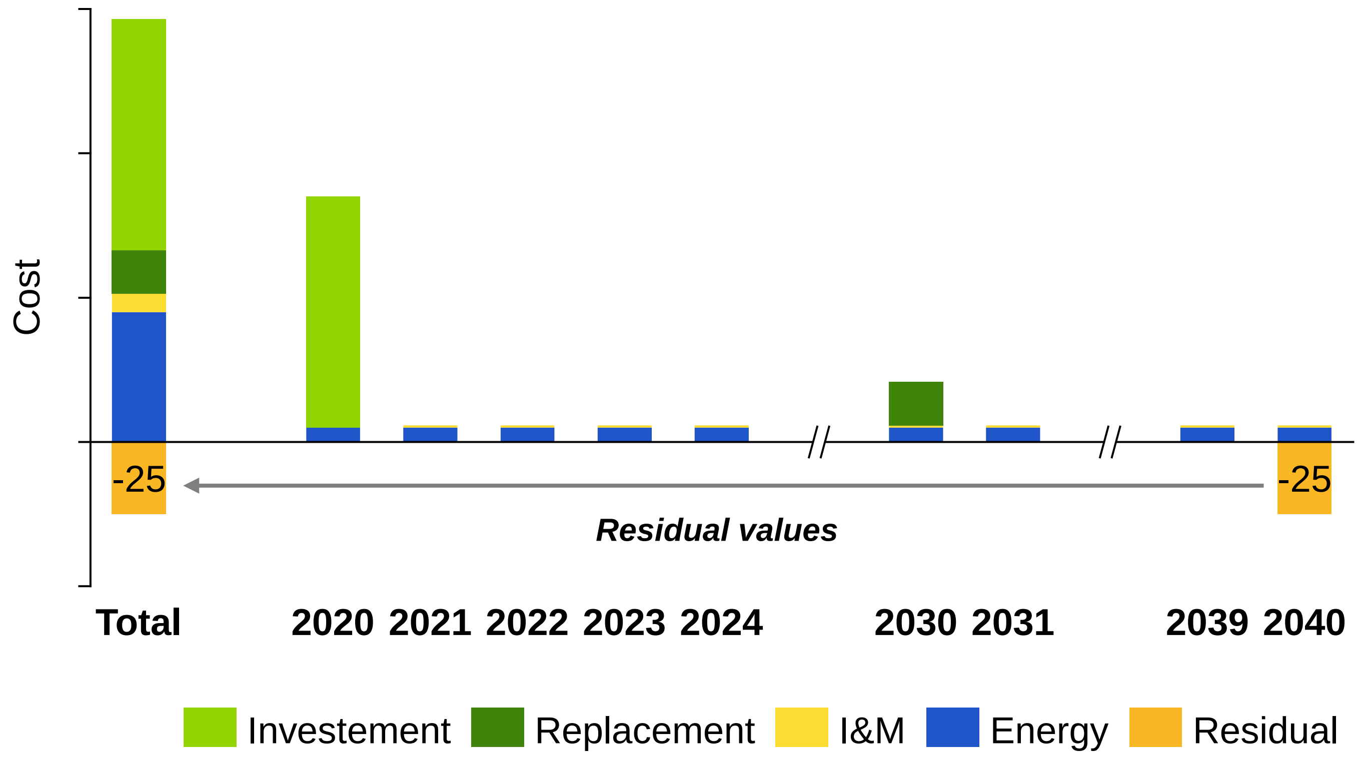


How to get to the total global cost?

- Investment cost from first year
- Sum of energy and I&M cost of all years
- **Replacement cost of systems**

Global Costs

Example case – without discount rate and price increase

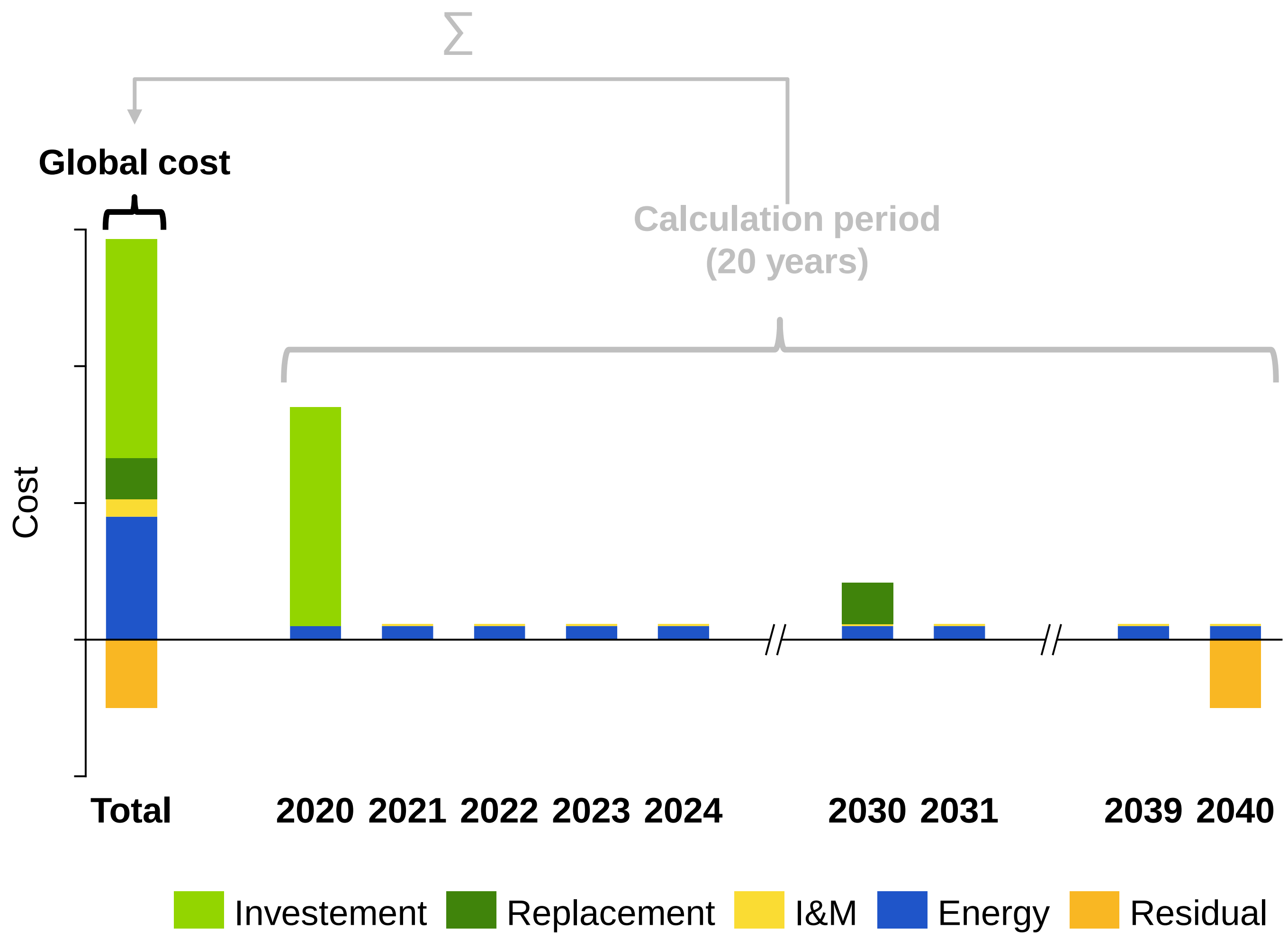


How to get to the total global cost?

- Investment cost from first year
- Sum of energy and I&M cost of all years
- Replacement cost of systems
- **Residual value of the systems with remaining life time is subtracted**

Global Costs

Example case – without discount rate and price increase



How to get to the total global cost?

- Investment cost from 1st year
- Sum of energy and I&M cost of all years
- Replacement cost of systems
- Residual value of the systems with remaining life time is subtracted
- **Global cost are complete**

Lebanon

Lebanon | Investment cost and lifetime

Envelope elements

Type	Measure	Investment cost	Unit	Lifetime in years
Thermal insulation	External walls	3	EUR/cm/m²	40
	Roof			40
	Floor			50
Windows	Single glazing (5.7)	114	EUR/m^2_{Window}	30
	Double glazing (2.9)	136	EUR/m^2_{Window}	
	Double glazing (2.0)	150	EUR/m^2_{Window}	
	Double glazing (1.1)	164	EUR/m^2_{Window}	
	Triple glazing (0.9)	182	EUR/m^2_{Window}	
	... + solar glazing	30	EUR/m^2_{Window}	

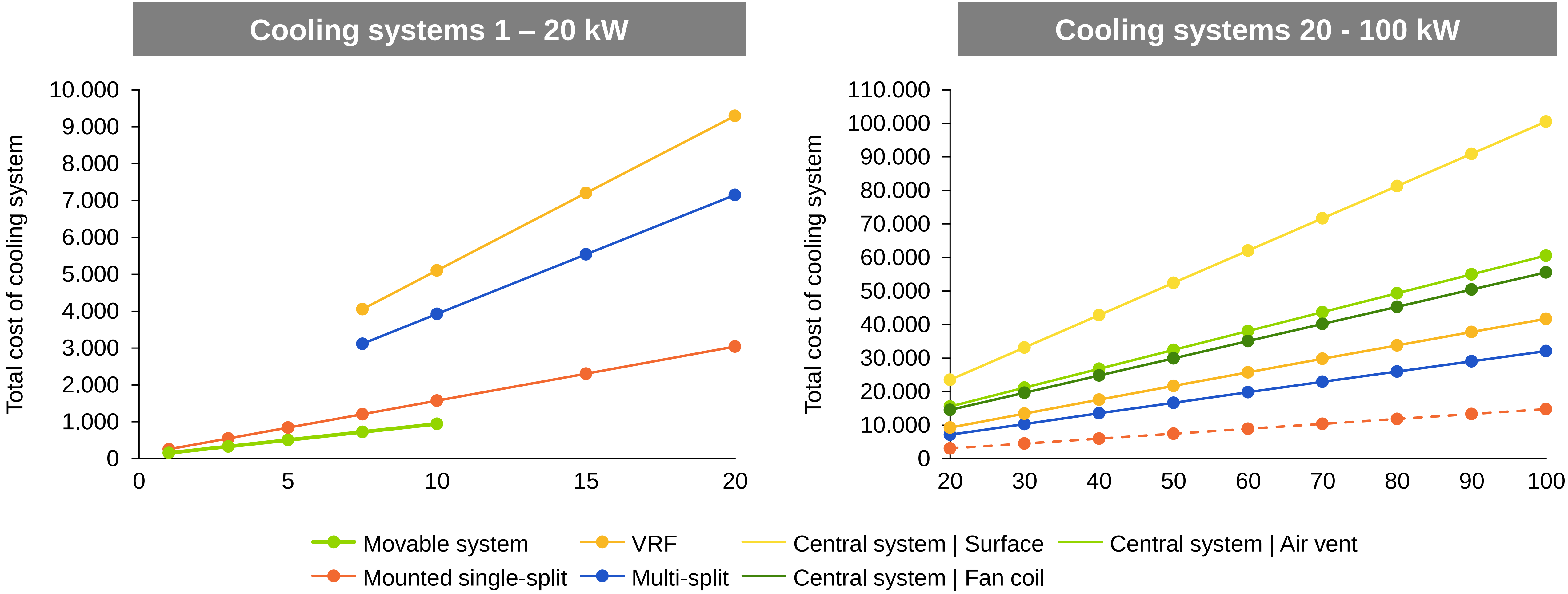
Lebanon | Investment cost and lifetime

Envelope elements

Type	Measure	Investment Cost	Unit	Lifetime in years
Shading elements	Fixed shading	80	EUR/m²	20
	Manual shading	100	EUR/m²	20
	Automatic shading	250	EUR/m²	20

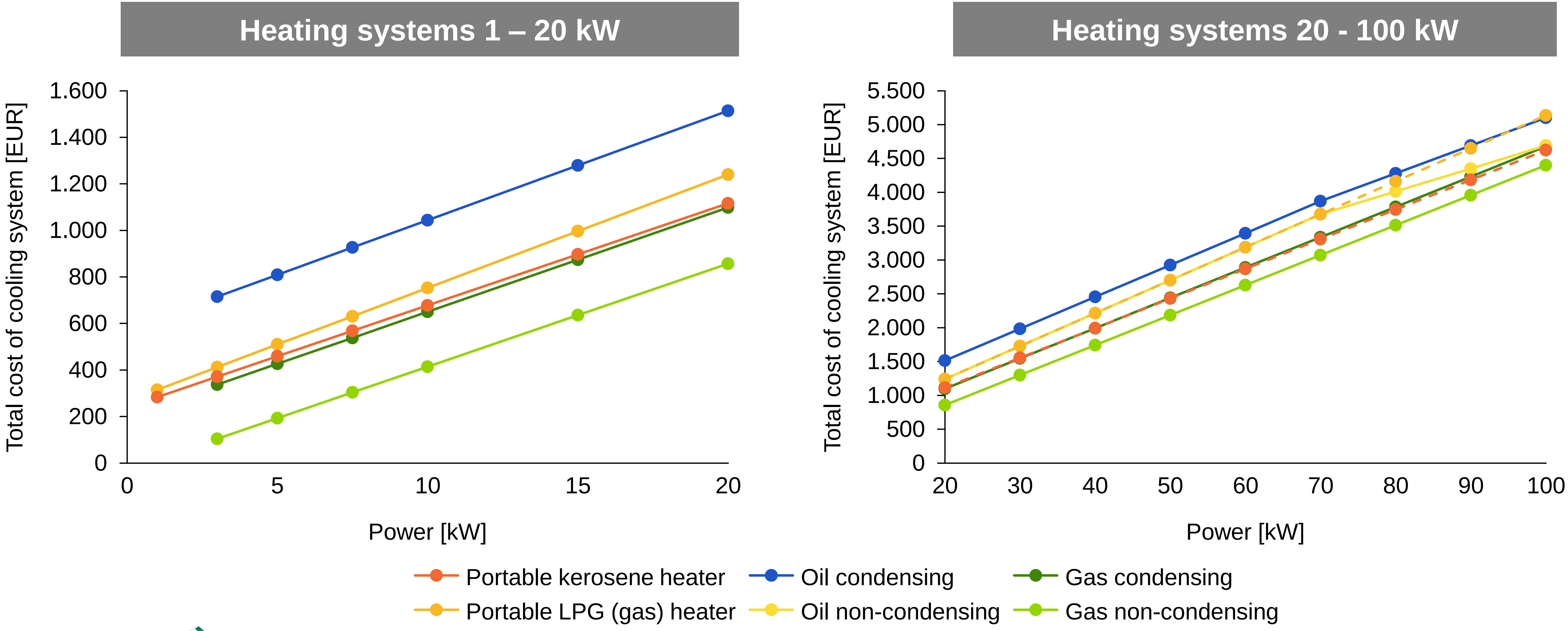
Lebanon | Investment cost and lifetime

HVAC systems - cooling



Lebanon | Investment cost and lifetime

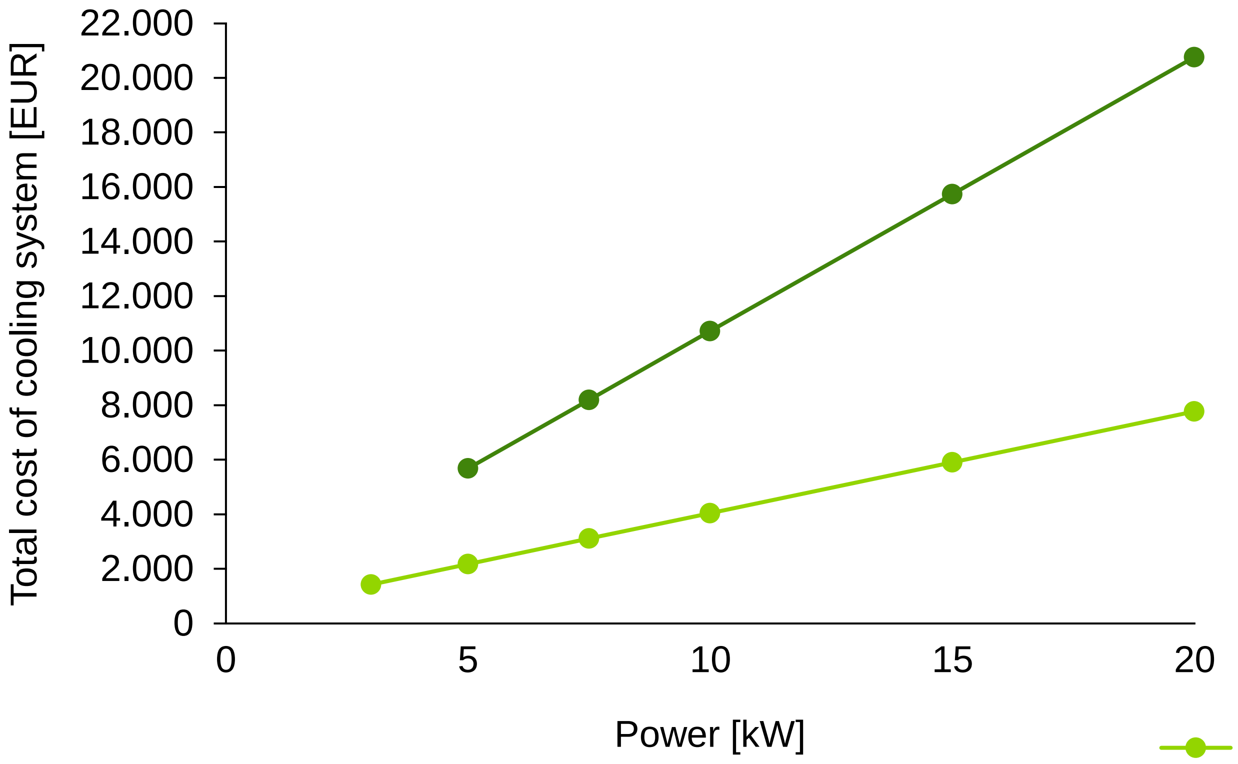
HVAC systems – heating



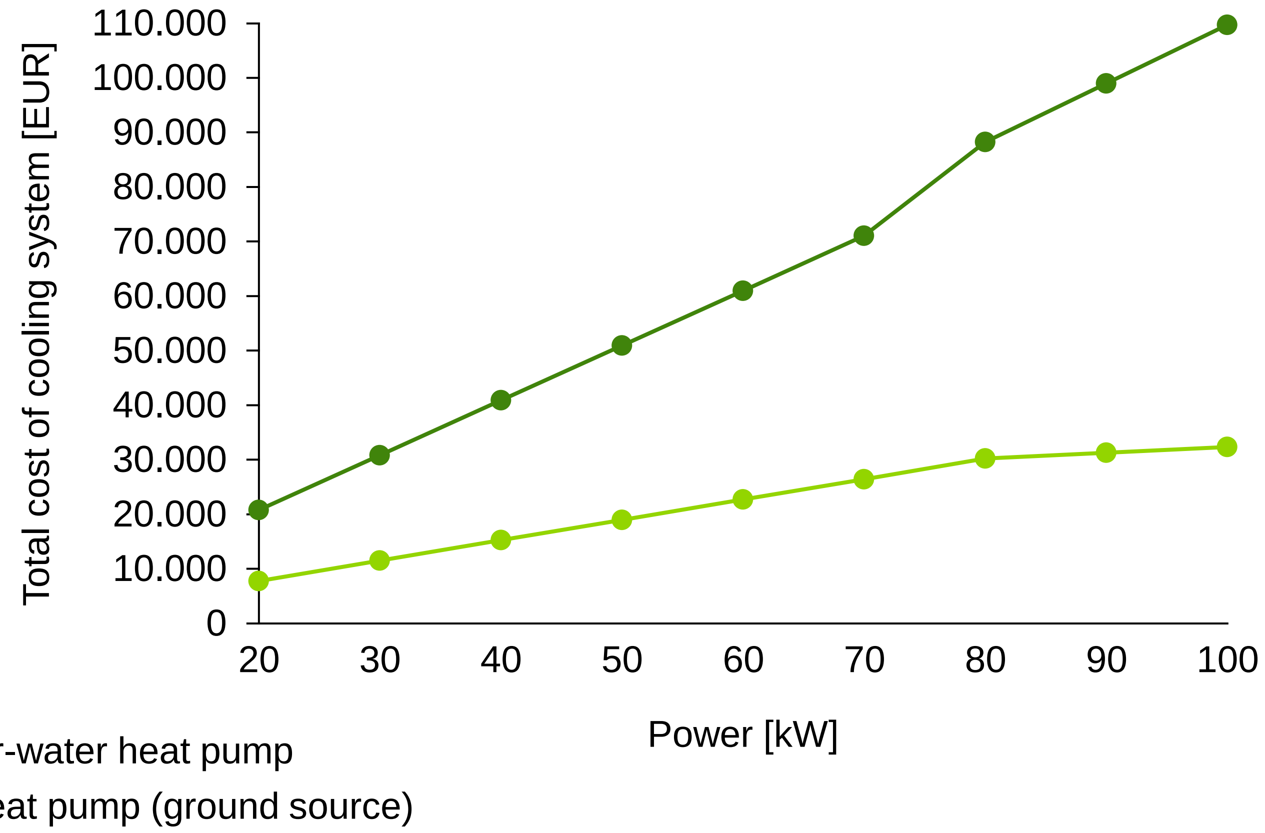
Lebanon | Investment cost and lifetime

HVAC systems – heating: heat pumps

Heat pumps 1 – 20 kW



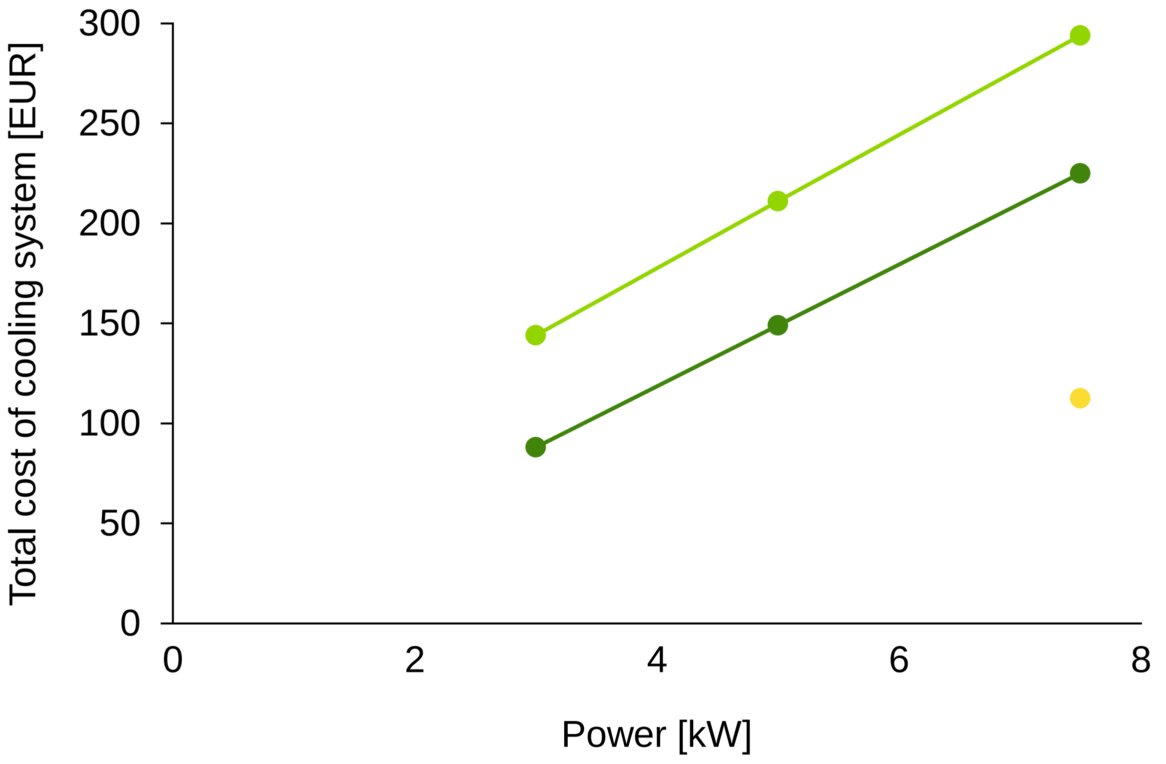
Heat pumps 20 - 100 kW



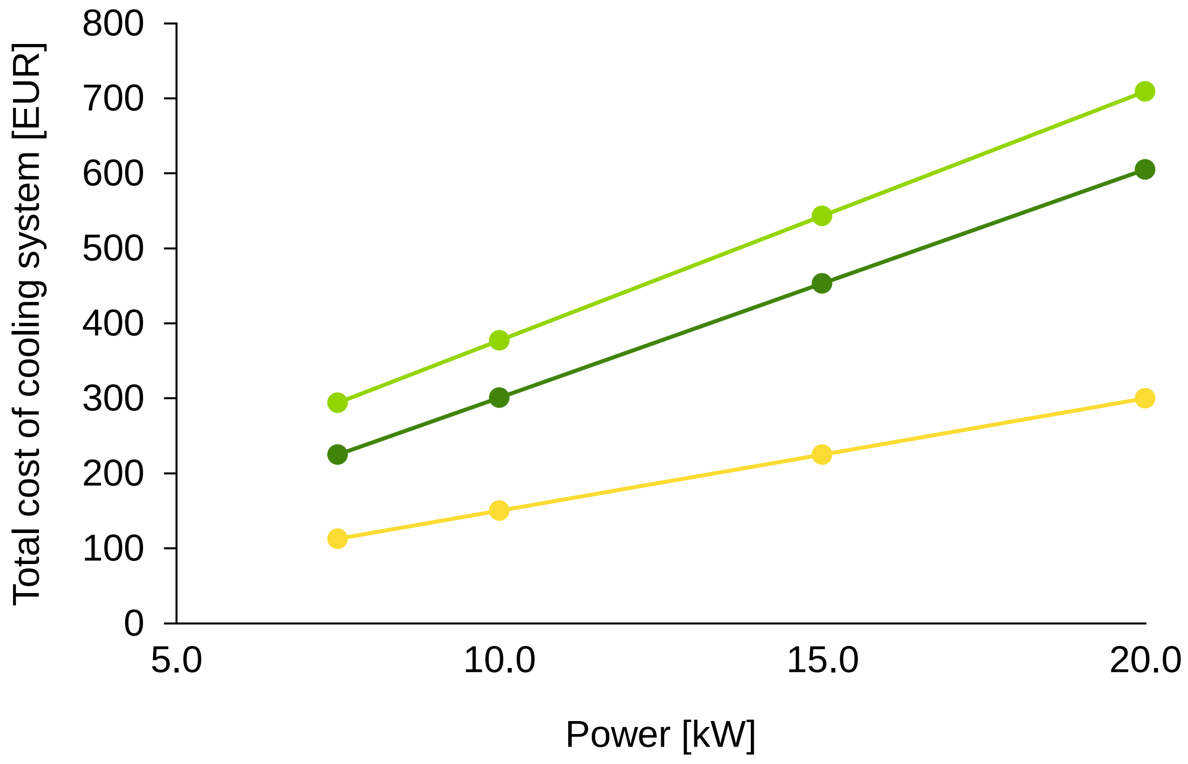
Lebanon | Investment cost and lifetime

HVAC systems – hot water

DHW systems 1 – 7.5 kW



DHW systems 7.5 - 20 kW



Dedicated gas heater
Dedicated electric heater
Combi system (add. cost to space heating boiler)

Lebanon | Investment cost and lifetime

Renewable energies

Type	Measure	Investment Cost	Unit	Lifetime in years
Solar for hot water Thermo syphon system	Tube collector	280	EUR/$m^2_{collector}$	20
	Flat collector	324	EUR/$m^2_{collector}$	20
	Upfront installation	50	EUR/system	30
Solar for hot water – Pumped System	Tube collector	1,171	EUR/$m^2_{collector}$	20
	Flat collector	1,061	EUR/$m^2_{collector}$	20
	Upfront installation	100	EUR/system	30
Photovoltaic	PV (< 30 kWp)	998	EUR/kWp	20
	PV (> 30 kWp)	832	EUR/kWp	20
	Upfront installation	100	EUR/system	30

Lebanon | Investment cost and lifetime

Lighting

Type	Measure	Investment cost	Unit	Lifetime in years
Lighting	Linear fluorescent (LFL)	0.9	EUR/bulb	10
	Compact fluorescent (CFL)	2.4	EUR/bulb	10
	Halogen lamps	1.4	EUR/bulb	3
	Incandescent lamps	0.6	EUR/bulb	1
	Light emitting diode (LED)	3.3	EUR/bulb	30

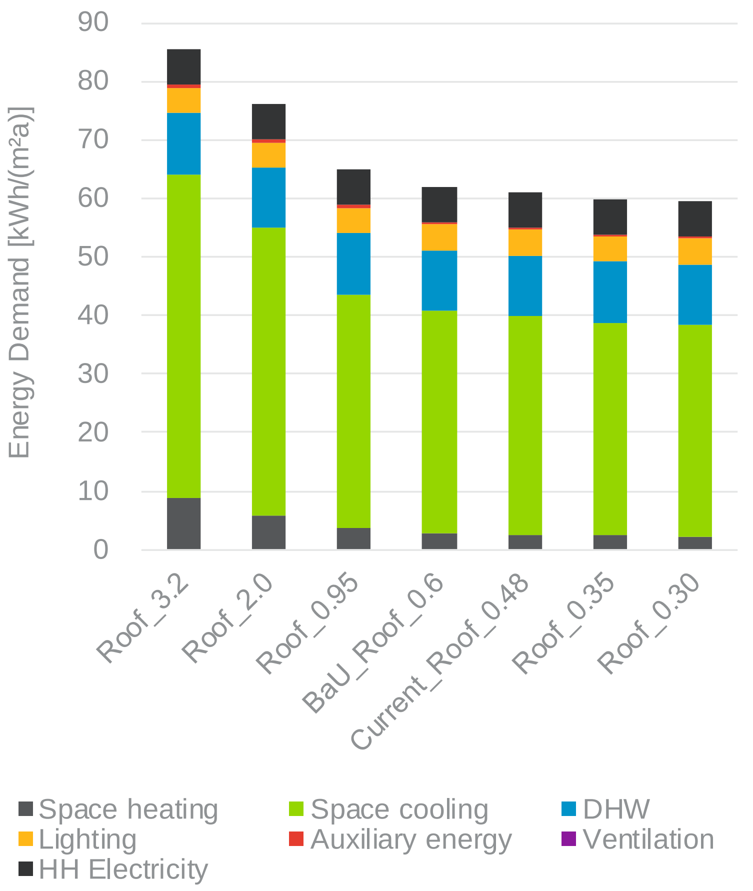
Case Study Lebanon I Multi-family house in Beirut

Roof insulation | Analysis of energy and global cost savings

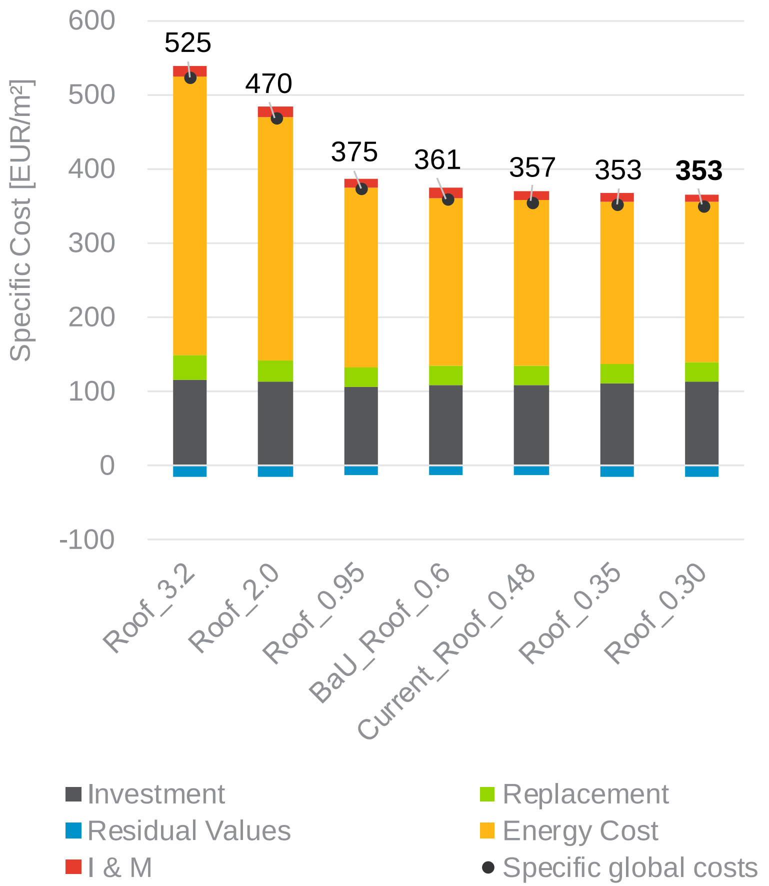
Var 1	U-Value = 3.2 W/m²K (no insulation)
Var 2	U-Value = 2.0 W/m²K (no insulation)
Var 3	U-Value = 0.95 W/m²K (3 cm insulation)
BaU	U-Value = 0.6 W/m²K (5 cm insulation)
Current	U-Value = 0.48 W/m²K (8 cm insulation)
Var 4	U-Value = 0.35 W/m²K (10 cm insulation)
Var 5	U-Value = 0.30 W/m²K (12 cm insulation)

Result: Var 5 is the most cost effective measure.

Final energy demand



Global cost



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Case Study Lebanon I Multi-family house in Beirut

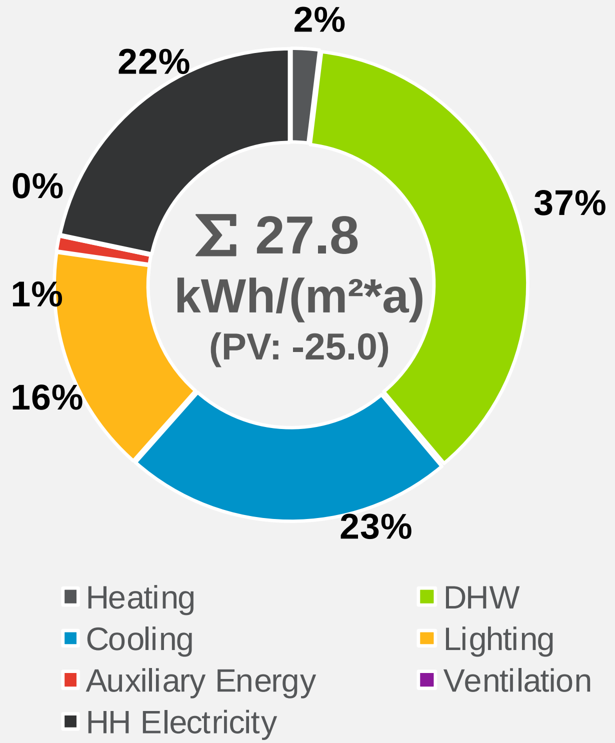
Results of an optimised solution

The key components of the energy concept are illustrated in this table. It shows that the building envelope is significantly enhanced compared to BaU.

Special attention is given to the use of renewable energy sources, particularly PV (for electricity) and solar collectors (for hot water).

This leads to energy savings and emissions reductions.

Parameters	Optimised
Roof insulation (U-Value)	**0.3 W/m²K (light color)**
Wall insulation (U-Value)	**0.4 W/m²K**
Floor insulation (U-Value)	1.78 W/m²K
Windows (U-Value; G-Value)	**0.9 W/m²K; 0.3 (solar glazing)**
Window fraction	**Ø 15%**
Shading	**solar glazing**
Air infiltration through leakages	**0.20 1/h**
Heat supply	**reversible unit - COP 5**
Cold supply	**reversible unit - COP 5**
Hot water	electric instantaneous
Ventilation systems	No
Lighting systems	LED
Renewable energy	**17.5 kWp (PV, maximum)**
Set temperature cooling/heating	**26°C / 20°C**



Energy Cost (- PV)
0.4 EUR / (m²*a)

CO_2 - Emission
1.9 kg / (m²*a)

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Case Study Lebanon I Multi-family house in Beirut

Comparative overview of BaU vs. current vs. optimised

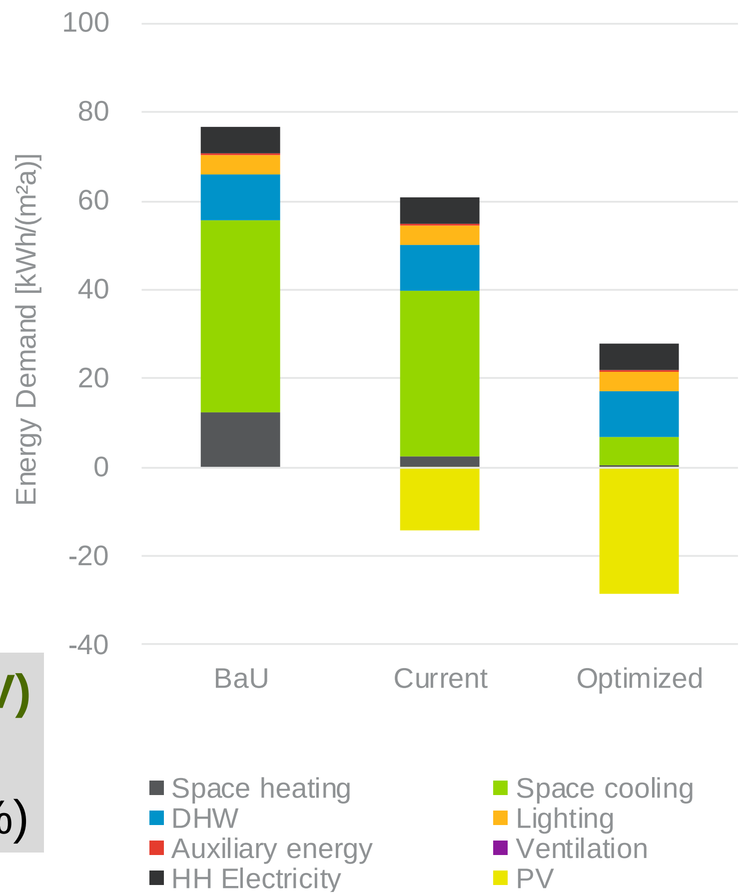
Conclusion

- The suggested measures and the current situation lead to a **significant decrease in energy demand**
- The optimised solution, detected **the most cost effective efficiency measures**

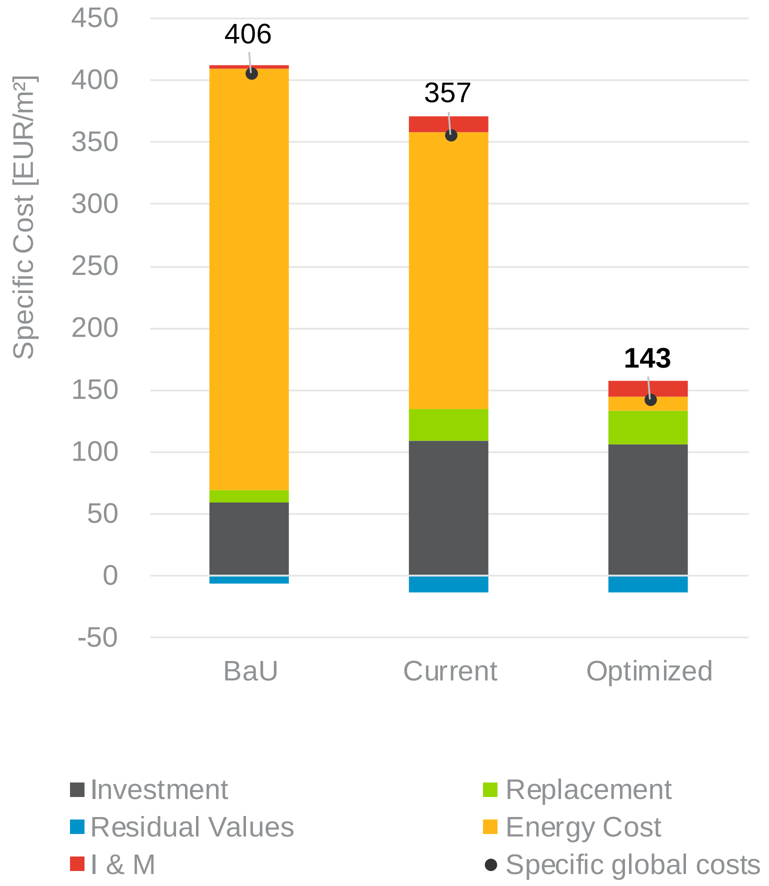
Savings BaU to Optimised (incl. PV)

- Energy: **77 ► 3** kWh/m²a (-95%)
- E-Cost: **10.1 ► 0.4** EUR/m²a (-95%)

Final energy demand



Global cost



Building Energy Performance (BEP) tool

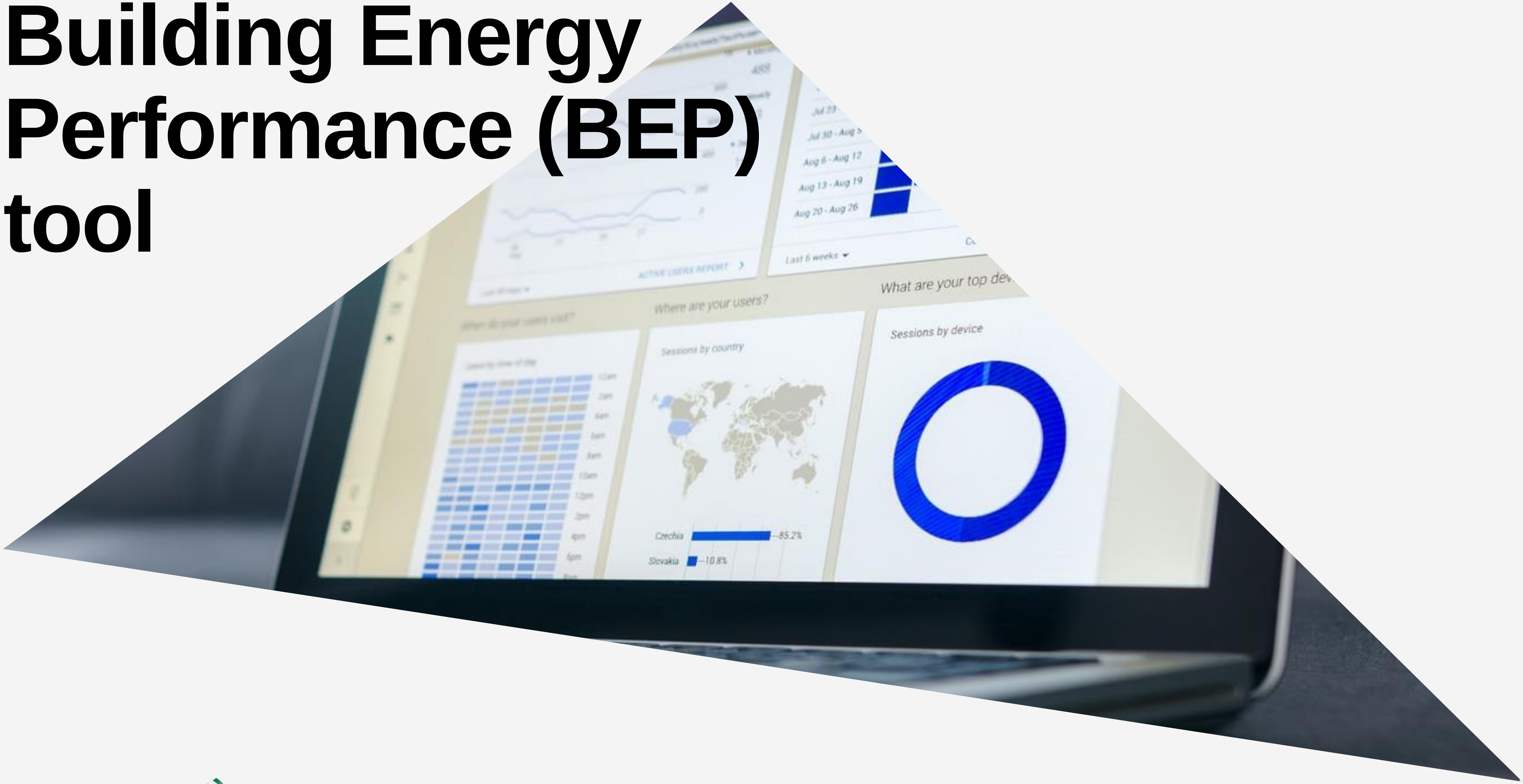


Photo by Lukas Blazek on Unsplash

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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.

Calculation methodology

Input

User input

Building
- Type (e.g. office)
- Geometry
- Renovation / new build
- Envelope specifications
- HVAC systems
- Renewable energies
- Operational parameters
- Location (city, country)

Internal database

Financial
- Investment cost
- Energy prices

Energy
- Baseline buildings
- User profiles
- HVAC system specification
- Climates

Calculation engine

Energy

• Geometry
• Envelope
• OP
• Climate

Useful energy demand
- ISO 52016

• HVAC and RE systems

Sizing HVAC & RE systems
- HVAC Tool

Final energy demand
- HVAC Tool

Primary energy demand

GHG Emissions

Financial

• Specific cost
• HVAC and RE systems
• Type and age
• Country

Investment cost
- Envelope (e.g. insulation)
- HVAC systems
- Renewable energies

Other cost
- Inspection and maintenance
- Replacement

• Energy prices

Energy cost
- Energy carrier (e.g. gas)

Output

Energy & Emission

Final & primary energy demand…
- per energy carrier (e.g. gas)
- per energy use (e.g. cooling)
- specific (kWh/m²) and total

GHG Emissions
- CO_2 equivalent

Global Cost

Global cost
- Investment
- Energy cost
- Inspection and maintenance
- Replacement

Developed for the MENA region

Database from local partners & international calculation methodology

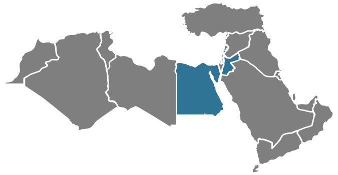
Baseline buildings

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

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

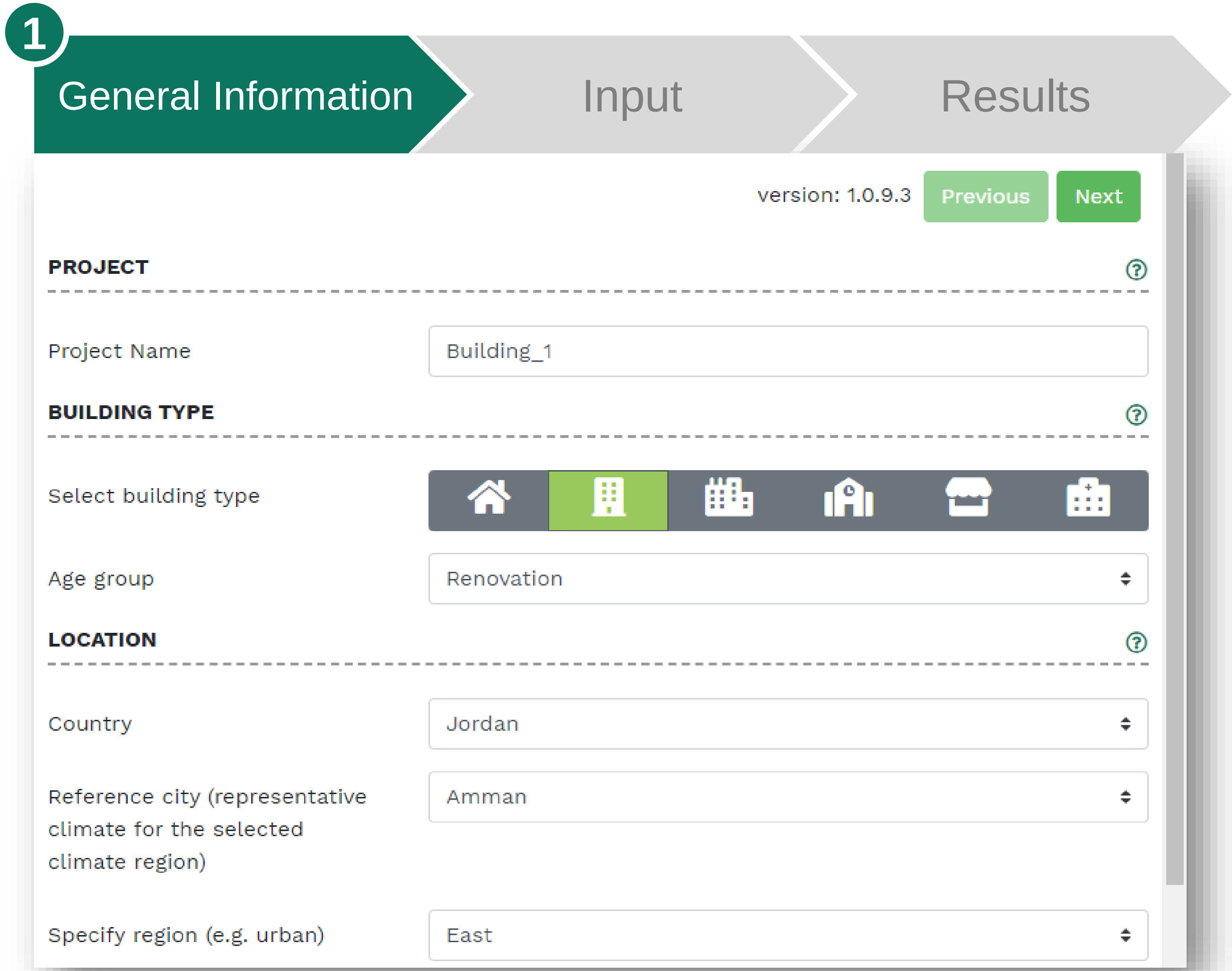
The calculation standard is internationally acknowledged.

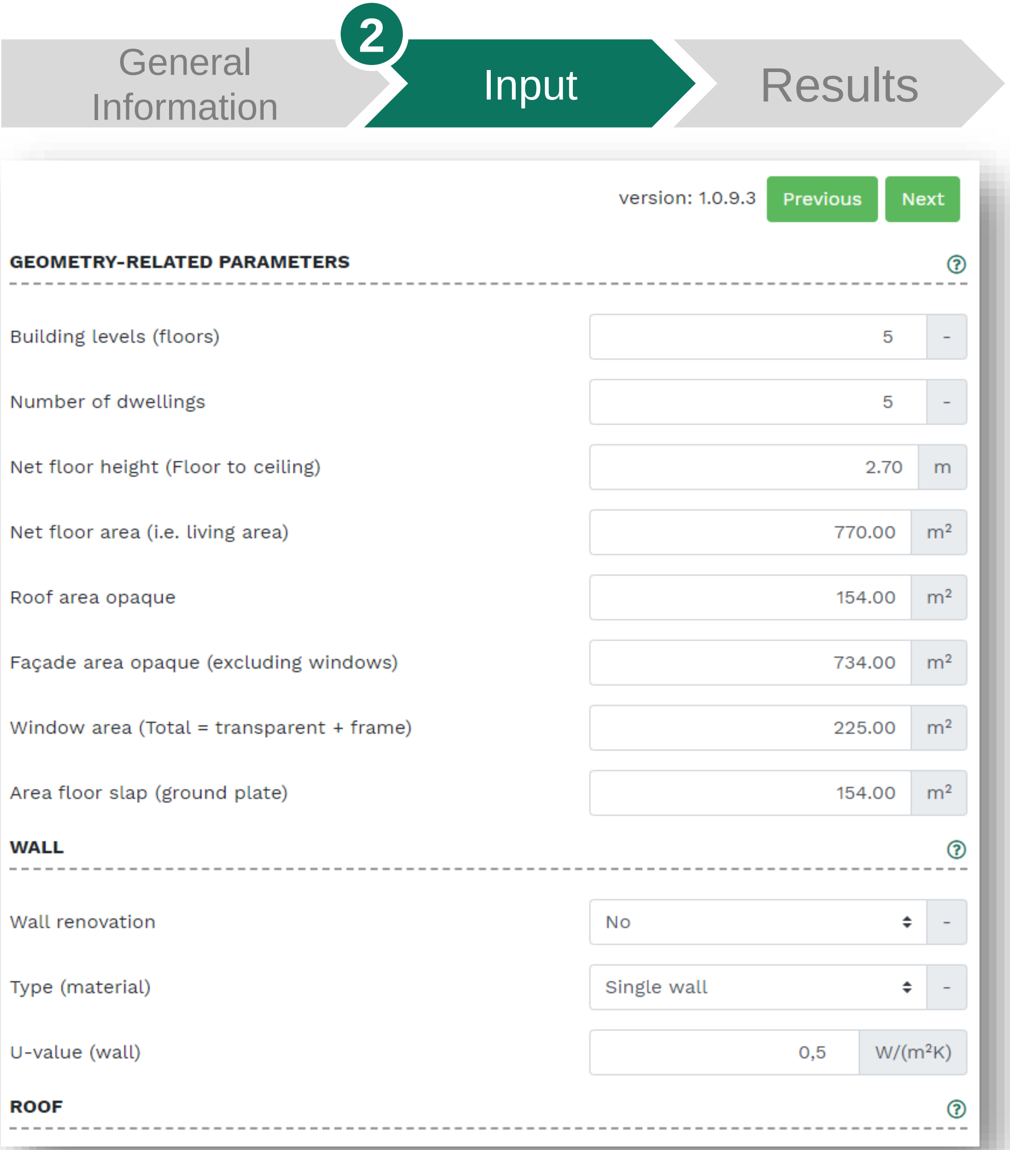
Internal market data is **collected from local partners** for Egypt, Jordan and Lebanon.

International energy calculation methodology.

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

Online Web App - Input





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Online Web App – Results

3

General Information | Input | Results

Home | Tools | Knowledge base | News | About

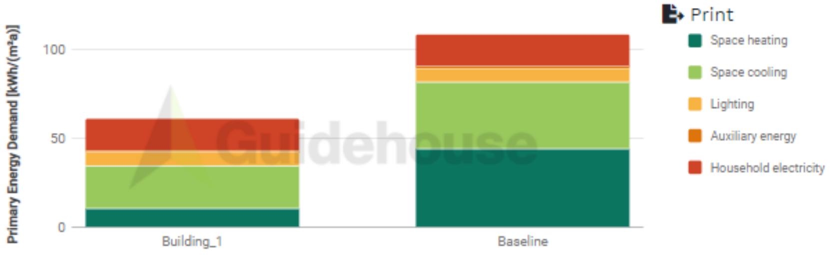
version: 1.0.9.3 Previous Next

Heating: 10.56 kWh/(m²a) | Cooling: 13.37 kWh/(m²a) | Other: 14.91 kWh/(m²a) | Σ Total: 38.84 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)		
	Building_1	Baseline	Delta
Space heating	10.56	44.09	-76%
Space cooling	23.98	37.50	-36%
Lighting	7.86	7.86	0%
Auxiliary energy	0.70	1.00	-30%
Household electricity	18.19	18.19	0%
Total	61.29	108.64	-44%
Total incl. PV	61.29	108.64	-44%

FINANCIAL

Specific cost | Total cost | Specific investment cost

Specific cost

	in €/m²		
	Building_1	Baseline	Delta
Investment	26	34	-23%
Replacement	8	12	-35%
Residual	-5	-8	-42%
Energy	163	196	-17%
Inspection & maintenance	3		
Global cost (total)	194	236	-18%

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Online Web App – Results detail

7| Performance rating

C = equal to baseline

1| Quick overview

The main facts.

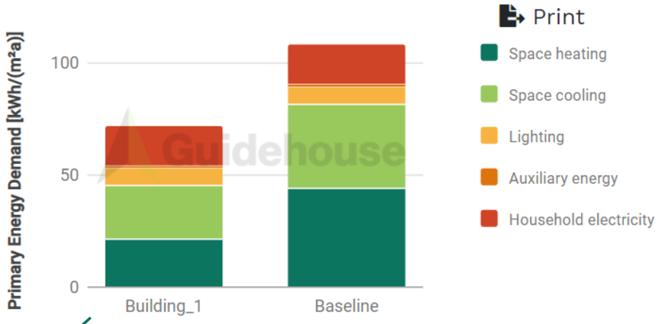
Heating: 21.41 kWh/(m²a) | Cooling: 13.36 kWh/(m²a) | Other: 10.34 kWh/(m²a) | Σ Total: 45.11 kWh/(m²a)

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)		
	Building_1	Baseline	Delta
Space heating	21.41	44.09	-51%
Space cooling	23.96	37.50	-36%
Lighting	7.86	7.86	0%
Auxiliary energy	0.80	1.00	-20%
Household electricity	18.19	18.19	0%
Total	72.22	108.64	-34%
Total incl. PV	63.93	108.64	-41%

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.

BEP tool Example

Office Building X- BaU

Project info	
Construction phase	New construction
Building type	Non-residential building
Detailed building type	Office
Net floor area	19200 m2
Land plot size	2738 m2
Stories	11 stories
Construction type	Concrete

Building Envelope	
External walls	
Description of construction	Mineral wool insulation
U-Value	1.4 W/(m²*K)
Roof	
Roof type	Flat roof
Description of construction	XPS insulation
U-Value	0.7 W/(m²*K)
Openings and windows	
Glazing type	Double glazed
U-Value glass	2.5 W/(m²*K)
G-Value glass	0.74
Frame material / description	Aluminum
Overall u-value window	2.57 W/(m²*K)
Description of construction	Low e double glazing 8/16/10
Basement floor	
Description of construction	Concrete Slab
U-Value	2.4W/(m²*K)

BEP tool Example

Office Building X- BaU

Technical Building Systems		
Ventilation system		
Type of ventilation	Free ventilation (windows)	
Description		
Space cooling system		
Primary space cooling system	Centralized multi-split system Consisting of one outdoor unit (e.g. located on the rooftop) supplying several indoor units	
Description	Good newbuild standard	
Space heating system		
Primary Space heating system	Air-conditioning system (reversible for heating; air-air heat pump)	
Description	Good newbuild standard	
Water heater system		
Primary water heater system	Dedicated electric heater (dedicated = just hot water generation)	
Lighting system		
Primary lighting system	LED (Light emitting diode lamps)	
Efficiency		100
Description		
Photovoltaics		
Capacity	NA	
Total module area	0	

BEP tool Example

Office Building X

Project info	
Construction phase	New construction
Building type	Non-residential building
Detailed building type	Office
Net floor area	19200 m2
Land plot size	2738 m2
Stories	11 stories
Construction type	Concrete

Building Envelope	
External walls	
Description of construction	Mineral wool insulation
U-Value	0.67 W/(m²*K)
Roof	
Roof type	Flat roof
Description of construction	XPS insulation
U-Value	0.26 W/(m²*K)
Openings and windows	
Glazing type	Double glazed
U-Value glass	1.8 W/(m²*K)
G-Value glass	0.5
Frame material / description	Aluminum
Overall u-value window	1.8 W/(m²*K)
Description of construction	Low e double glazing 8/16/10
Basement floor	
Description of construction	Concrete Slab
U-Value	2.7 W/(m²*K)

BEP tool Example

Office Building X

Technical Building Systems		
Ventilation system		
Type of ventilation	Mechanical ventilation system with heat recovery	
Description	Wheel heat exchanger on fresh air	
Space cooling system		
Primary space cooling system	Centralised multi-split system | Consisting of one outdoor unit (e.g. located on the rooftop) supplying several indoor units	
Description	VRV system	
Space heating system		
Primary Space heating system	Air-conditioning system (reversible for heating; air-air heat pump)	
Description	VRV system	
Water heater system		
Primary water heater system	Dedicated electric heater (dedicated = just hot water generation)	
Lighting system		
Primary lighting system	LED (Light emitting diode lamps)	
Efficiency		100
Description	With lighting controls and dimming	
Photovoltaics		
Capacity	40 kWp	
Total module area	242 m²	

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Wrap up and outlook

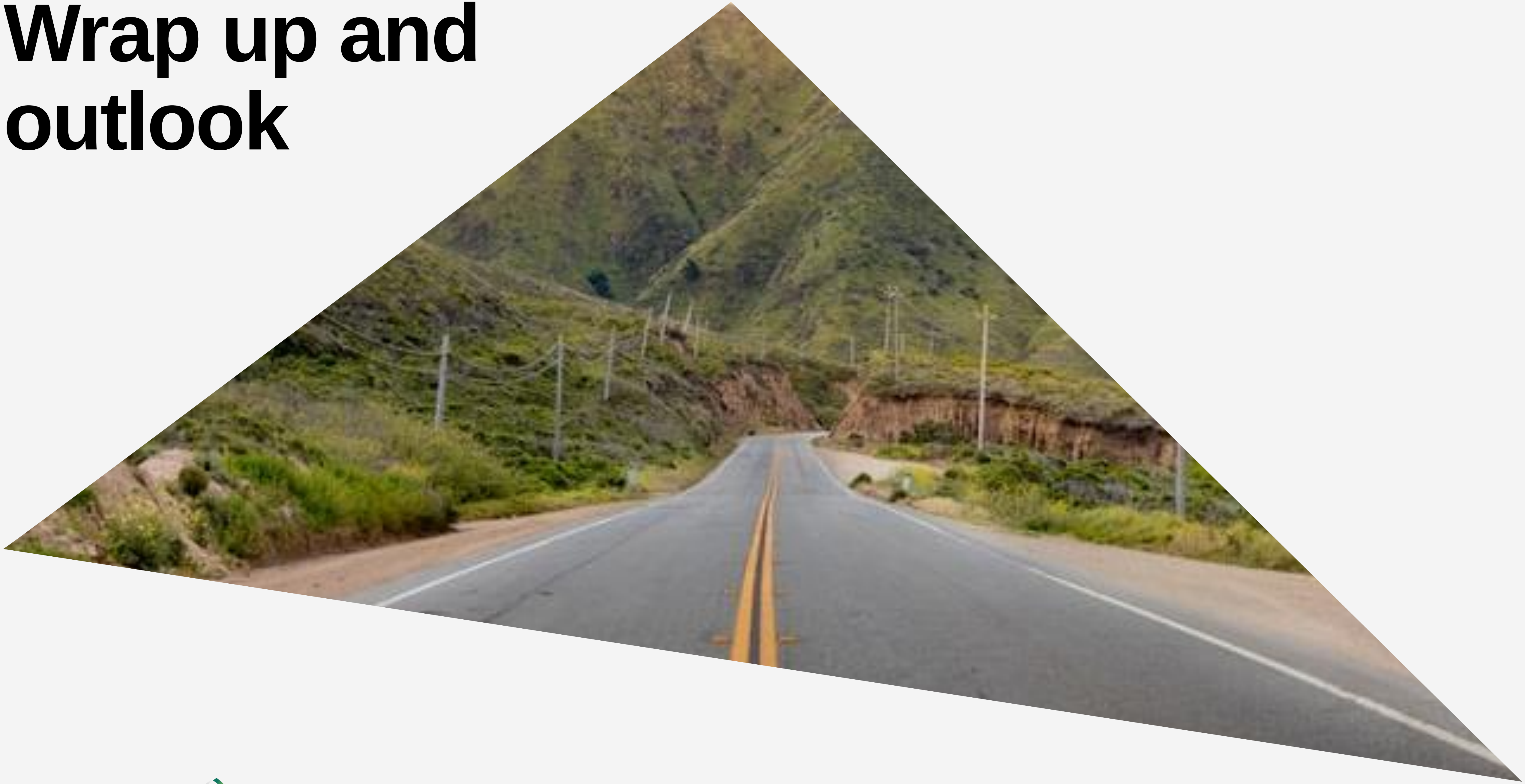

Photo by Martin Adams on Unsplash

Conclusion

Offered a customisable, transparent tool adapted to the MENA region

Performance of energy efficiency measures & RE

Calculation of monetary savings

Free web application

Proven methodology

Final discussions

Collecting feedback and ideas per country and target group:

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Supported by:

INTERNATIONAL CLIMATE INITIATIVE (IKI)

Federal Ministry for the Environment, Nature Conservation and Nuclear Safety

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