Med-EcoSuRe

Draft-Elaboration of long term strategy for renovation of An-Najah National University – Palestine

An-Najah national university (ANNU)

2023

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File Name	Elaboration of long term strategy for renovation of An-Najah National University – Palestine

This project is part of the Mediterranean University as Catalyst for Eco-Sustainable Renovation (Med-EcoSuRe). The project develops renovation strategy with detailed plan of action for the next 5 years and with engagement of university decision makers and involvement of public authorities and the investment community, in order to mitigate greenhouse gas emissions and achieve eco-sustainable building renovation.

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1. Introduction

Under framework of the Mediterranean University as Catalyst for Eco-Sustainable Renovation (Med-EcoSuRe), he partnership universities of project has took action that aims to find Technical solutions for eco-sustainable building renovation. The Med-EcoSuRe project offers an innovative approach to the definition and diffusion of cost-effective energy renovation within university buildings, with the perspective of extending results to the whole public buildings sector in the long term. A Mediterranean cross-border living lab - bringing together researchers, building managers, companies, public organisations and students - will be established to develop energy efficiency and renewable energy solutions as well as retrofitting schemes to be implemented in 9 university buildings. The final aim behind the project is to turn university managers into active players contributing to the co-creation and experimentation of emerging ideas, breakthrough scenarios and innovative concepts, where the Low energy educational buildings are becoming the standard for new buildings in European and Mediterranean countries.

So An-Najah University aims to establish a long term strategy for renovation of higher education buildings , where this strategy will address mainly the university building stock and may be extended to include the public buildings , and will include a detailed action plan for next 5 years, also, in order to make the An-Najah National University (ANNU) lead by example and provide the stimulus for other universities in Palestine to improve the energy efficiency and apply its measurement, which complies to some extent with Palestinian government action plan in public buildings - the national energy efficiency action plans (NEEAPs), which must be reinforced by the renovation strategies in university , and vice versa.

1.1 Roadmap – University's & public building Energy strategy

Establishing a long term renovation strategy road map in university will get out the necessary steps to introduce the most relevant and urgent actions which may take from now to next 5 years in higher education buildings.

The roadmap will set out a clear vision that provides the rationale and sets the level of ambition for further measures to improve the energy efficiency of buildings, and thus achieve energy cost saving, cost effective carbon emission reductions and reduced air pollution.

The university`s energy strategy is based on number of considerations;

- Emission of greenhouse gases has to be substantially reduced, and at same time
- Maintain security of supply by reducing exposure to power outages
- The strategy must be cost-effective and so promote the growth and development
- Finally, to be achieved Zero-Net Energy Metering

So, as these considerations in mind, An-Najah National University set as target in its strategy that the university's energy demand for next 5 years should be covered by renewable energy, and to achieve this goal, we need a combination of comprehensive energy efficiency measures and massive installation of PV solar systems.

The following is the long-term renovation strategy roadmap:

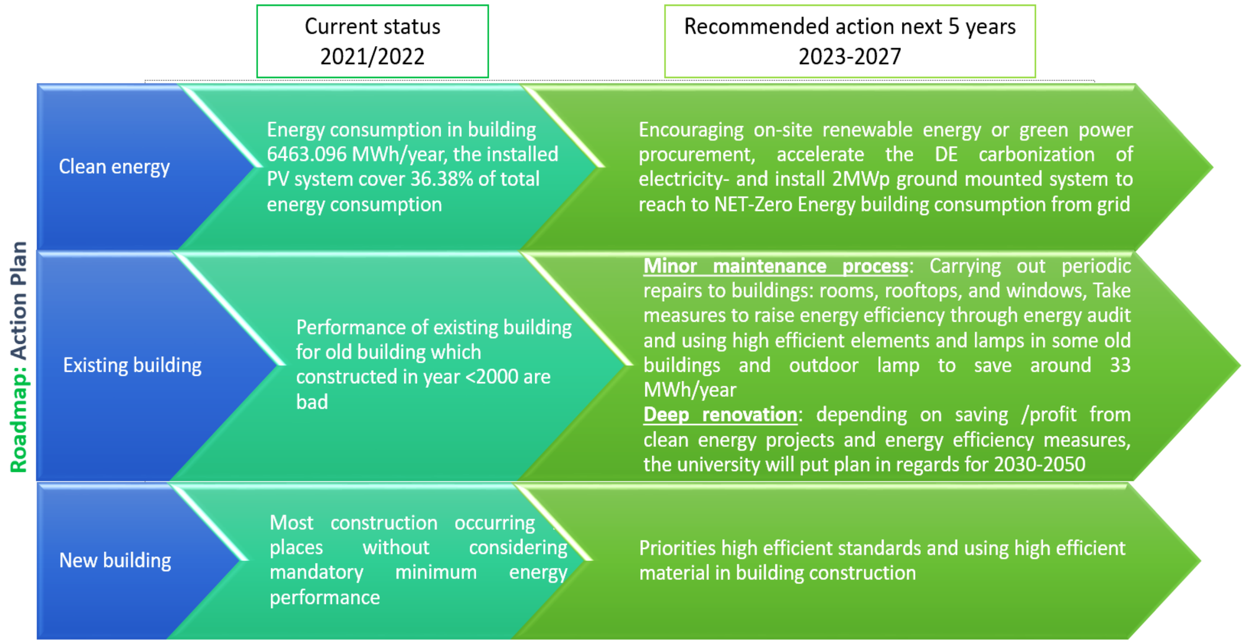


Fig.1 action plan of renovation strategy

The new buildings use much less energy than older ones. but according to characteristics of building in university a reduction of energy consumption in buildings can therefore only be achieved by substantial energy savings in existing buildings, which have a huge potential.

and thus may applied to public buildings, if building owners make sensible and financially worthwhile energy improvements when they are carrying out renovations anyway, energy consumption can be substantially reduced.

This strategy therefore focuses on reducing energy consumption in existing buildings by way of extensive energy renovations.

The energy savings can be achieved best and most cost-effectively when the work is done at the same time as the general building renovation, for example be combined with replacing the roof or windows or renovating outside walls or floors, and taking account of the environmental objectives for reuse and sustainability in the building, and in addition to improve the indoor climate and daylight conditions, making the buildings healthier and better to live and work in, all these were included in university's strategy until 2050.

I. Benefits from energy renovation of buildings

Generally, Energy renovation of existing buildings has positive impact for University administration, individual building owner for public buildings and user, and also for society.

Energy renovation leads to: -

- A reduction in future energy bills
- create a more robust financial status for the University administration, building owner and may increase the resale value of the building in case of public buildings. Even though there will be some initial costs associated with the renovation
- creates a better indoor climate and greater comfort, which can improve the wellbeing of users and the use of the buildings, and this positive benefits reflect on university community and society.

II. Basis & Political vision for the future energy renovation in buildings next 5 years

The Energy efficiency (EE) and renewable energy (RE) strategies are key to the sustainable development of any country, by guaranteeing resources security, reducing dependence from fossil fuels and increasing energy efficiency, and it's easier to promote, implement and achieve its targets when they are adopted by the government.

Palestinian government through Palestinian Energy and Natural Resources Authority (PENRA) developed the Strategic sectorial plan of 2011-2013, which in turn included the sectorial vision of the energy sector at 2020, adopted a set of programs and activities through which these objectives can be achieved and this include:

- National Energy Efficiency Action Plan 2012-2020(NEEAP), which aim to achieve the indicative target of 5% (384 GWh) less electricity consumption in 2020, which was achieved through the following phases:
  -Phase I (2012-2014): 43 GWh
  -Phase II (2015-2017): 137 GWh
  -Phase III (2018-2020): 204 GWh

- Renewable energy strategy 2012-2020, which aim to achieve 130 MW (240GWh) of RE in 2020

- EE/RE Roadmaps 2021-2030, which include:
  - RE Target for roadmap 2021-2030: additional 500 MW, and 80% of 2030 target will be achieved with solar PV and CSP, 4% with wind energy, and 16% with biogas/biomass
  - EE Target for roadmap 2020-2030 is 500 GWh/year, the implementation of this plan should save 3.5 million tons of CO_2 each year, and it's expected to achieve around 10,000 GWh savings by 2030.

- The strategies have the following goals:
  - sustainable use of RE & EE in Palestine
  - reaching rational levels of energy independence and security of supply
  - achieving social and economic development in Palestine

So, as a consequence of this, energy savings have become a frequent topic in energy policy, and successive governments have taken many practical steps to promote energy savings in Palestine.

In light of this, An-Najah University`s strategy is designed to promote and improve energy renovations which reduce energy consumption in existing buildings, and which needed active efforts involving a large number of initiatives, and tightened up considerably energy regulations in buildings to be constructed or materials to be changed and replaced in existing buildings.

Where over 40% of university buildings were built before 2000 and all the buildings were built before 2010, i.e. before the government has been included the efficiency energy in their consideration and plans, and many of these building now require extensive energy renovation. Some energy improvements have been made in a number of old buildings, but there are still very significant opportunities to reduce energy consumption in these buildings.

III. Energy savings in buildings

There are many technical ways of reducing heat and electricity consumption in existing buildings. To exploit these opportunities, any strategy for energy renovation of buildings should contribute to the following:

First, the strategy should help to create a transparent market for renovations, so existing buildings are renovated as they wear out and cost-effective energy renovations are made at the same time.

secondly, the strategy should ensure that 'deep' energy renovations are carried out with future-proof, energy-efficient and cost-effective solutions, so energy consumption is significantly reduced. If only 'partial solutions' are implemented, e.g. limited insulation of roofs or walls, it will be very expensive and perhaps technically impossible to realize the full energy-saving potential at a later date.

Thirdly, the strategy should help to ensure that when energy renovations are carried out, heating and electrical systems are converted so as to be based on renewable energy.

Finally, the strategy should ensure that energy renovations are carried out cost-effectively, so the goal of independence from fossil fuels is achieved at the least possible expense, and it is absolutely crucial for the strategy to ensure that energy renovations are carried out in a way that provides for a good indoor climate.

2. An-Najah National University (ANNU) Campuses overview

An-Najah National University consists of five campuses; namely, the New Campus, the Old Campus, Hisham Hijjawi College of Technology, An-Najah National Hospital which are located in Nablus, and Faculty of Agriculture and Veterinary Medicine building Campus in Tulkarem.

2.1 Old Campus

The Old Campus was constructed on a 30 dunums of land and houses the Faculties of Humanities, Economics and Social Studies, Islamic Law, Educational Sciences and Honor. The Campus also hosts the Scientific and Languages Centers, the Administration, the Admission and Student Activities Buildings, a library and the Zafer Al-Masri Auditorium, in addition to the General Medicine and Dental Clinics.

Fig.2 Old Campus-ANU

2.2 New Campus

In 2000, the University began the construction of the New Campus which located at Nablus on around 116 acres and houses the Faculties of Graduate Studies, Medicine, Science, Law, Fine Arts, Engineering and Information Technology, Optometry, Pharmacy, Nursing, Media and Physical Education.

Fig.3 New Campus-ANU

The New Campus is also including the Prince Turki Bin Abdul Aziz Theatre, the Hikmat Al-Masri Amphitheater, the Korean-Palestinian IT Institute of Excellence as well as a number of other facilities and laboratories. The New Campus features a state-of-the art library, a cutting-edge media centre, a new swimming pool, a sports complex and a mosque.

2.3 Hisham Hijjawi College of Technology Campus

The campus is located east of Nablus, is a three floor facility with a total area of 18 acres. The college was constructed according to the most advanced engineering standards.
Hijjawi College offers a wide range of programs relating to technology to its students, including industrial automation, telecommunications, computer networking, auto mechanics, mechanical engineering, graphic design and others.

Fig.4 New Campus-ANU

2.4 Faculty of Agriculture and Veterinary Medicine building Campus

In 1996, the Faculty of Agriculture was moved to the Khadouri Campus in Tulkarem, northwest of Nablus. The Faculty’s new site is one of the most beautiful landscapes in Palestine, as it is located only 14 km from the Mediterranean Sea. The campus' area is about 164 dunums and it houses a cow shed, chicken coops and land for cultivation. It hosts the Faculties of Agricultural Engineering and Veterinary Medicine, which are the only faculties of their kind in Palestine.

Fig.5 Agriculture and Veterinary Medicine building -ANU

2.5 An- Najah Hospital

An-Najah National University Hospital aims at promoting the Palestinian health sector in the different provinces and offering best treatment and medical services to its patients.
The Hospital administration aspires to combine offering medical services and medical education for university students through its diverse departments and units. Through the Hospital, An-Najah also offers health insurance for its students during their study years.

Fig.6 An- Najah Hospital building -ANU

ANNU aims through its facilities and activities to achieve environmental sustainability as follow: -

- Promote and create a campus which supports academic, research and enterprise activities in a sustainable way
- Provide the education, advancement, dissemination and application of sustainable development
- Maximize the wider impact of ANU's environmental sustainability activities at local, regional, national and international level through collaboration, partnership and communications
- become a leader across the HE sector in terms of environmental sustainability

So, implementation of comprehensive energy metering across the campuses and establish a long term strategy for renovation will help to achieve ANNU aims regarding environmental sustainability by:

- Helping the ANNU management departments to manage the university buildings to reduce carbon emissions and make buildings more comfortable to work in
- Providing visibility of the energy that is being used across campus to facilitate culture change within the ANNU community
- To allow Academics and Students to use the Estate as a living lab for sustainability research by providing appropriate data
- Also economic benefit

3. Composition of the ANNU buildings stock

ANU university plan for the security of energy supply and CO2 reduction depend on very significant reductions in the university's buildings. This plan will need much better knowledge of present patterns of energy use in the buildings stock, and the incorporation of this understanding into predictive models.

Heading towards comfortable, energy efficient, climate-friendly and resource-preserving buildings, there are some strategies and policies must be adopted. the study addressed here explored life cycle costs, greenhouse gas-emissions and primary energy demand, building-material and building services concept. The outputs of the study may be made use of both in policy consultancy and in development of new building products and systems in universities.

3.1 Building typology

Campus	Main typology	Building typology	data
Old campus	Public building	Offices and administration building	- Construction date:1987 - Floor: under 2, above 3 - Total floor area (m2): 718 - Gross floor area (m2): 3590 - Heated floor area (m2): 200 - Building performance (u-value): • External wall 4-layers with total overall U-value of 2.0 W/m2K, • the roof is a concrete slab with a total overall U-value 2.1 W/m2K, • the windows are double glazing with a total overall U-value of 3.4 W/m2K. - Energy consumption: (kWh/m2/year) = 205.08 (kWh/m2/month) = 17.09
		Deanship of Student Affairs Building	- Construction date:1996 - Floor: under 1, above 3 - Total floor area (m2): 1091 - Gross floor area (m2): 4364 - Heated floor area (m2): null - Building performance (u-value): • External wall 4-layers with total overall U-value of 2.0 W/m2K, • the roof is a concrete slab with a total overall U-value 2.1 W/m2K, • the windows are double glazing with a total overall U-value of 3.4 W/m2K. - Energy consumption: (kWh/m2/year) = 146.95 (kWh/m2/month) = 12.25
		old campus library Building	- Construction date:1998 - Floor: under 1, above 4 - Total floor area (m2): 1126

			- Gross floor area (m2): 5630 - Heated floor area (m2): null - Building performance (u-value): • External wall 4-layers with total overall U-value of 2.0 W/m2K, • the roof is a concrete slab with a total overall U-value 2.1 W/m2K, • the windows are double glazing with a total overall U-value of 3.4 W/m2K. - Energy consumption (kWh/m2/year) = 117.16 (kWh/m2/month) = 9.76
		Faculty of Humanities & Faculty of Economics and Social Studies Building	- Construction date:1980 - Floor: under 0, above 4 - Total floor area (m2): 2968.6 - Gross floor area (m2): 11874 - Heated floor area (m2): null - Building performance (u-value): • External wall 4-layers with total overall U-value of 2.2 W/m2K, • the roof is a concrete slab with a total overall U-value 2.3 W/m2K, • the windows are single 6 mm glazing with a total overall U-value of 5.1 W/m2K and not shaded. - Energy consumption (kWh/m2/year) = 44.74 (kWh/m2/month) = 5.59
		Faculty of Educational Sciences and Teachers' Training Building	- Construction date:1977 - Floor: under 1, above 3 - Total floor area (m2): 1719.4 - Gross floor area (m2): 6878 - Heated floor area (m2): null - Building performance (u-value): • External wall 4-layers with total overall U-value of 2.3 W/m2K, • the roof is a concrete slab with a total overall U-value 2.5 W/m2K, • the windows are single 6 mm glazing with a total overall U-value of 5.1 W/m2K and not shaded. - Energy consumption (kWh/m2/year) = 64.14 (kWh/m2/month) = 8.02
		Faculty of Islamic Law Building	- Construction date:1999 - Floor: under 0, above 5 - Total floor area (m2): 687 - Gross floor area (m2): 3435 - Heated floor area (m2): null - Building performance (u-value):

			• External wall 4-layers with total overall U-value of 2.0 W/m2K, • the roof is a concrete slab with a total overall U-value 2.1 W/m2K, • the windows are double glazing with a total overall U-value of 3.2 W/m2K. - Energy consumption (kWh/m2/year) = 157.82 (kWh/m2/month) = 19.73
		Zafer Al-Masri Amphitheatre's Building	- Construction date:1998 - Floor: under 1, above 1 - Total floor area (m2): 1372 - Gross floor area (m2): 2744 - Heated floor area (m2): null - Building performance (u-value): • External wall 4-layers with total overall U-value of 2.0 W/m2K, • the roof is a concrete slab with a total overall U-value 2.1 W/m2K, • the windows are double glazing with a total overall U-value of 3.4 W/m2K. - Energy consumption (kWh/m2/year) = 178.52 (kWh/m2/month) = 14.88
New campus	Public building	Faculty of Engineering and Information Technology Building	- Construction date:2005 - Floor: under 1, above 4 - Total floor area (m2): 15795 - Gross floor area (m2): 78975 - Heated floor area (m2): 11846 - Building performance (u-value): • External wall with total overall U-value of 1.8 W/m2K, • the roof is a concrete slab with a total overall U-value 1.9 W/m2K, • the windows are double glazing with a total overall U-value of 3.1 W/m2K. - Energy consumption (kWh/m2/year) = 32.15 (kWh/m2/month) = 4.02
		Faculty of Science Building	- Construction date:2005 - Floor: under 2, above 4 - Total floor area (m2): 18400 - Gross floor area (m2): 110400 - Heated floor area (m2): 11592 - Building performance (u-value): • External wall with total overall U-value of 1.8 W/m2K, • the roof is a concrete slab with a total overall U-value 1.9 W/m2K, • the windows are double glazing with a total overall U-value of 3.1 W/m2K.

			- Energy consumption (kWh/m2/year) = 41.64 (kWh/m2/month) = 5.21
		medicine faculty Building	- Construction date:2005 - Floor: under 2, above 3 - Total floor area (m2): 6000 - Gross floor area (m2): 30000 - Heated floor area (m2): 2880 - Building performance (u-value): • External wall with total overall U-value of 1.8 W/m2K, • the roof is a concrete slab with a total overall U-value 1.9 W/m2K, • the windows are double glazing with a total overall U-value of 3.1 W/m2K. - Energy consumption (kWh/m2/year) = 40.33 (kWh/m2/month) = 5.04
		Faculty of Fine Arts Building	- Construction date:2003 - Floor: under 1, above 3 - Total floor area (m2): 8000 - Gross floor area (m2): 32000 - Heated floor area (m2): 3760 - Building performance (u-value): • External wall with total overall U-value of 1.8 W/m2K, • the roof is a concrete slab with a total overall U-value 1.9 W/m2K, • the windows are double glazing with a total overall U-value of 3.1 W/m2K. - Energy consumption (kWh/m2/year) = 64.78 - (kWh/m2/month) = 8.1
		Faculty of sport Building	- Construction date:2008 - Floor: under 1, above 2 - Total floor area (m2): 7600 - Gross floor area (m2): 22800 - Heated floor area (m2): 14865 - Building performance (u-value): • External wall with total overall U-value of 1.5 W/m2K, • the roof is a concrete slab with a total overall U-value 1.3 W/m2K, • the windows are double glazing with a total overall U-value of 2.5 W/m2K. - Energy consumption (kWh/m2/year) = 67.49 - (kWh/m2/month) = 8.44
		new campus library Building	- Construction date:2010 - Floor: under 2, above 2 - Total floor area (m2): 7400

			- Gross floor area (m2): 29600 - Heated floor area (m2): 27600 - Building performance (u-value): • External wall with total overall U-value of 1.5 W/m2K, • the roof is a concrete slab with a total overall U-value 1.3 W/m2K, • the windows are double glazing with a total overall U-value of 2.5 W/m2K. - Energy consumption (kWh/m2/year) = 38.23 (kWh/m2/month) = 3.19
		Korean Palestinian IT Institute of excellence Building	- Construction date:2005 - Floor: under 2, above 1 - Total floor area (m2): 3667 - Gross floor area (m2): 11001 - Heated floor area (m2): 2891 - Building performance (u-value): • External wall with total overall U-value of 1.8 W/m2K, • the roof is a concrete slab with a total overall U-value 1.9 W/m2K, • the windows are double glazing with a total overall U-value of 3.1 W/m2K. - Energy consumption (kWh/m2/year) = 79.78 (kWh/m2/month) = 6.65
		Scientific centre Building	- Construction date:2017 - Floor: under 1, above 6 - Total floor area (m2): 6000 - Gross floor area (m2): 36000 - Heated floor area (m2): 23760 - Building performance (u-value): • External wall with total overall U-value of 0.55 W/m2K, • the roof is a concrete slab with a total overall U-value 0.67 W/m2K, • the windows are double glazing with a total overall U-value of 1.27 W/m2K. - Energy consumption (kWh/m2/year) = 50.81 (kWh/m2/month) = 4.23
		Faculty of Law Building	- Construction date:2006 - Floor: under 1, above 7 - Total floor area (m2): 5709 - Gross floor area (m2): 45672 - Heated floor area (m2): 11418 - Building performance (u-value): • External wall with total overall U-value of 1.8 W/m2K,

			• the roof is a concrete slab with a total overall U-value 1.9 W/m2K, • the windows are double glazing with a total overall U-value of 3.1 W/m2K. - Energy consumption (kWh/m2/year) = 49.06 (kWh/m2/month) = 6.13
		An-Najah Child institute Building	- Construction date:2015 - Floor: under 1, above 4 - Total floor area (m2): 2500 - Gross floor area (m2): 12500 - Heated floor area (m2): 10000 - Building performance (u-value): • External wall with total overall U-value of 0.55 W/m2K, • the roof is a concrete slab with a total overall U-value 0.67 W/m2K, • the windows are double glazing with a total overall U-value of 1.27 W/m2K. - Energy consumption (kWh/m2/year) = 29.27 (kWh/m2/month) = 2.44
		Faculty of Optical & nursing college Buildings	- Construction date:2005 - Floor: under 2, above 4 - Total floor area (m2): 7720 - Gross floor area (m2): 46320 - Heated floor area (m2): 3598 - Building performance (u-value): • External wall with total overall U-value of 1.8 W/m2K, • the roof is a concrete slab with a total overall U-value 1.9 W/m2K, • the windows are double glazing with a total overall U-value of 3.1 W/m2K. - Energy consumption (kWh/m2/year) = 31.68 (kWh/m2/month) = 3.96
Hisham Hijjawi College	Public building	Hisham Hijjawi College	- Construction date:2001 - Floor: under 1, above 2 - Total floor area (m2): 12500 - Gross floor area (m2): 37500 - Heated floor area (m2): 8613 - Building performance (u-value): • External wall with total overall U-value of 1.8 W/m2K, • the roof is a concrete slab with a total overall U-value 1.9 W/m2K, • the windows are double glazing with a total overall U-value of 3.1 W/m2K. - Energy consumption

			(kWh/m2/year) = 37.29 (kWh/m2/month) = 4.66
Tulkarem campus	Public building	Faculty of Agriculture and Veterinary Medicine	- Construction date:1978 - Floor: under 0, above 2 - Total floor area (m2): 4560 - Gross floor area (m2): 9120 - Heated floor area (m2): null • Building performance (u-value): External wall 4-layers with total overall U-value of 2.5 W/m2K, • the roof is a concrete slab with a total overall U-value 3.1 W/m2K, • the windows are single 6 mm glazing with a total overall U-value of 5.1 W/m2K and not shaded. - Energy consumption (kWh/m2/year) = 80.91 (kWh/m2/month) = 10.11

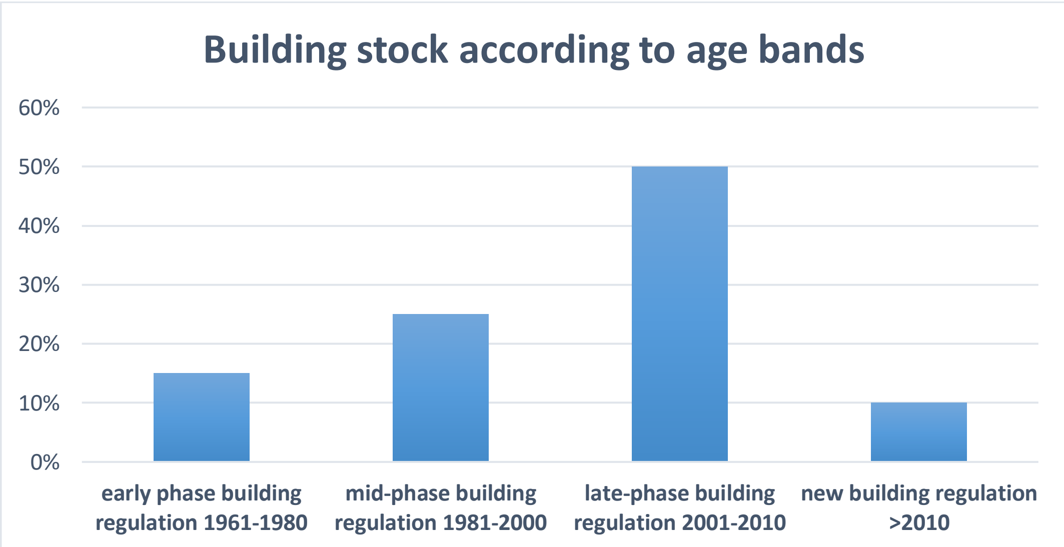


Figure 7: building stock composition according to age bands

3.2 Energy consumption of the building stock

	Subcategories	Value & unit
Energy use	Heating	6.94 kWh/m²/month
	Cooling (% of total energy use)	17 % of total energy use
	Ventilation	8 % of total energy use
	Hot water	2 % of total energy use
	Lighting	33% of total energy use
	pump	5% of total energy use

	Appliances	16 % of total energy use
Energy source	On-site renewables	(36.4 % of total energy use) 21kWh/m²/year
Energy supplies	Electricity	50.1 (kWh/m²/year) & 6.3 (kWh/m²/month)
	Diesel	11.93% of total energy use
	Gas	0.16% of total energy use

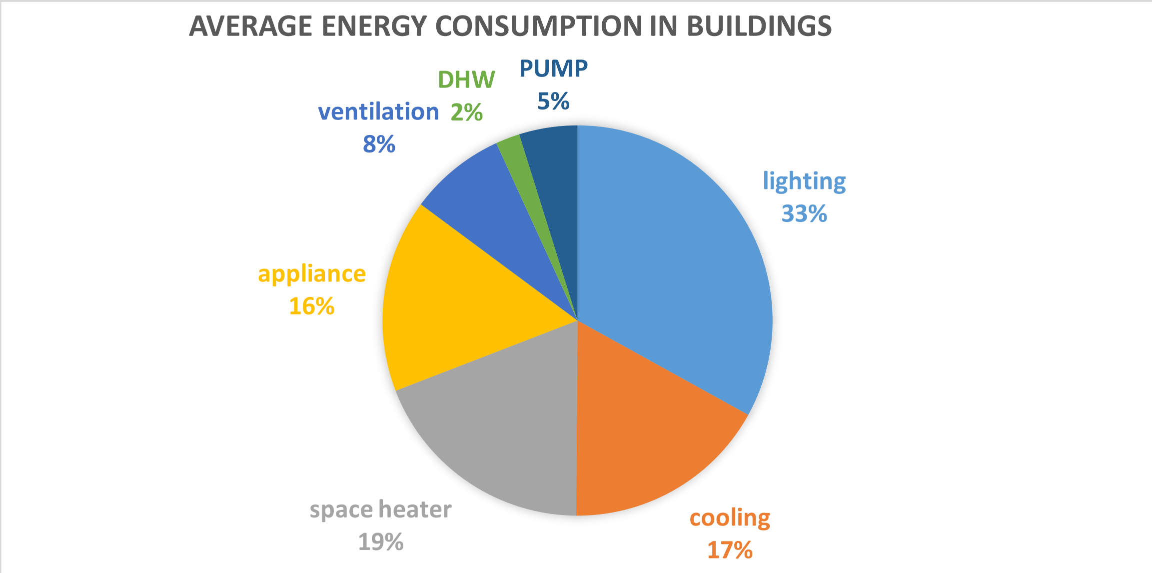


Figure 8: composition of energy consumption in buildings

3.3 Energy use per building type and age

Commercial buildings	**>1900**	**1901-1960**	**1961-1980**	**1981-2000**	**2001-2010**	**>2010**
Average energy consumption (kWh/m²/y)			61.4	158.2	49.2	45.3
Average energy consumption (kWh/m²/m)			7.7	20	6.15	5.03

3.4 Renovation activities

The university's master plan does not include campus expansion or new locations for departments or activities, so preserving an existing building is not only necessary, it's required.

The buildings that constructed before the year 2000 are durable. Despite their flaws and bad energy performance, so the University administration funding often favours renovation over new construction. Even considering the unique challenges that come with renovation, it's difficult to dismiss the fact that it's almost always less expensive than new building.

All new and old buildings of the university are renovated annually but not deep renovated for durability and sustainability, through painting and repairing the rooms, inspecting the leakage of windows and ventilation holes, maintenance of equipment and lighting, maintenance of water tanks and the roof, and the necessary work of it by adding insulation materials and layers of asphalt to prevent leakage and moisture.

3.5 Ownership and tenure status

The buildings and the lands are owned by university board of directors except for Faculty of Agriculture and Veterinary Medicine which was rented.

3.6 ANNU Load forecasting

In order to create baseline electricity consumption which shall be used as indicative of electricity saving for next 5 years, so the electricity consumption for the most recent five-year period, were as follow:

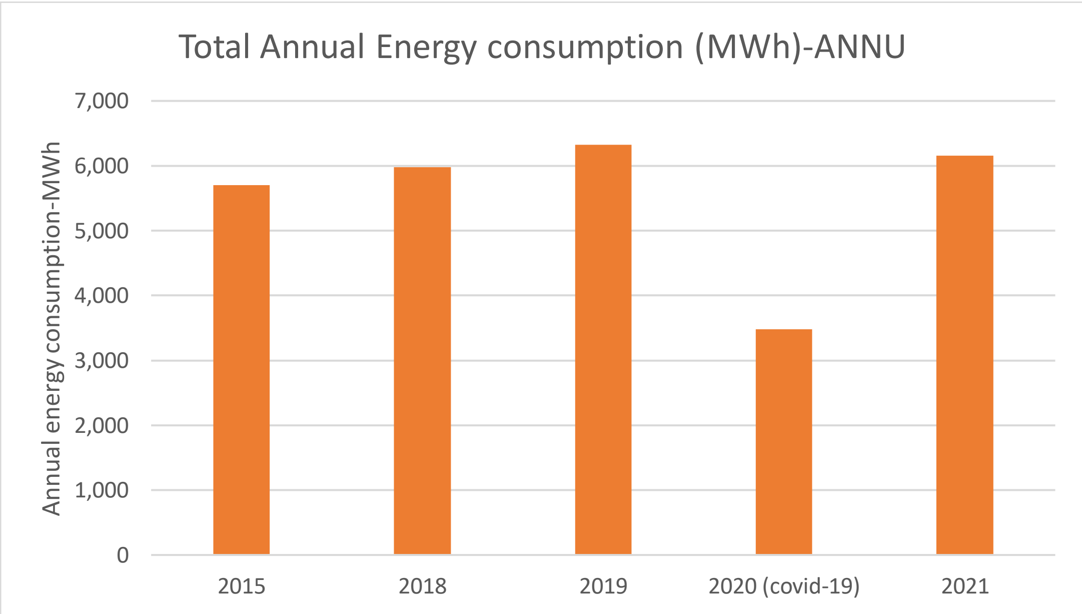
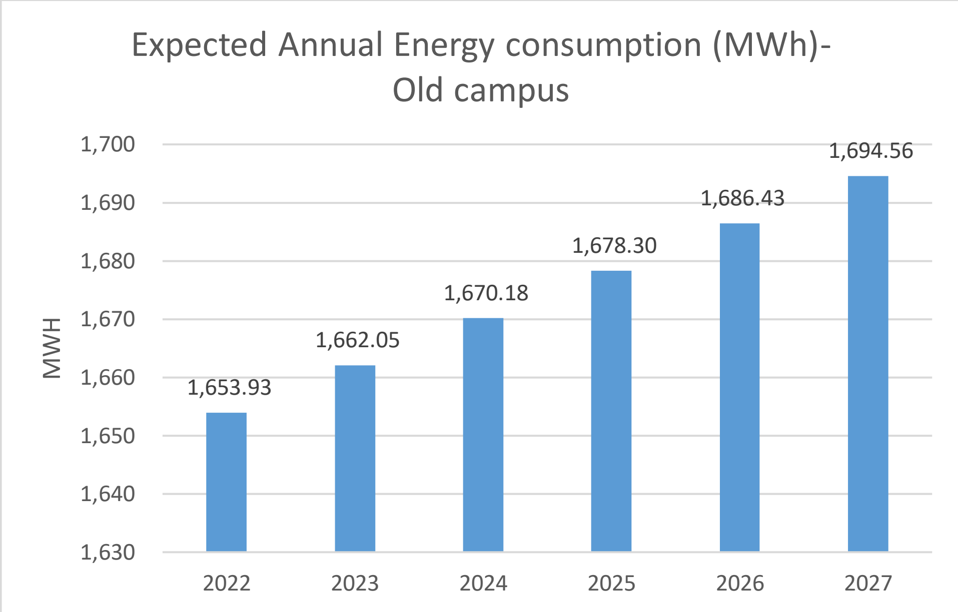
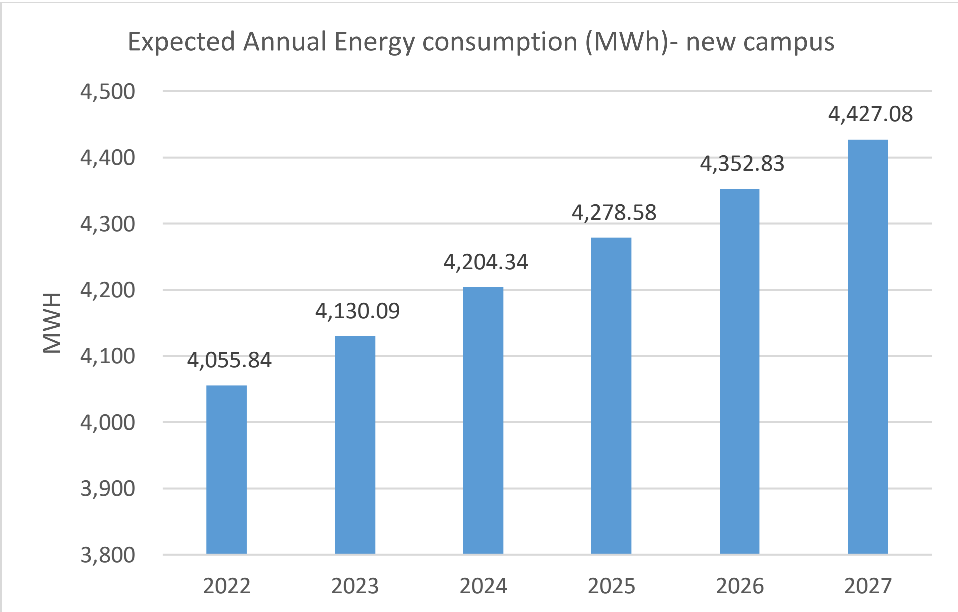


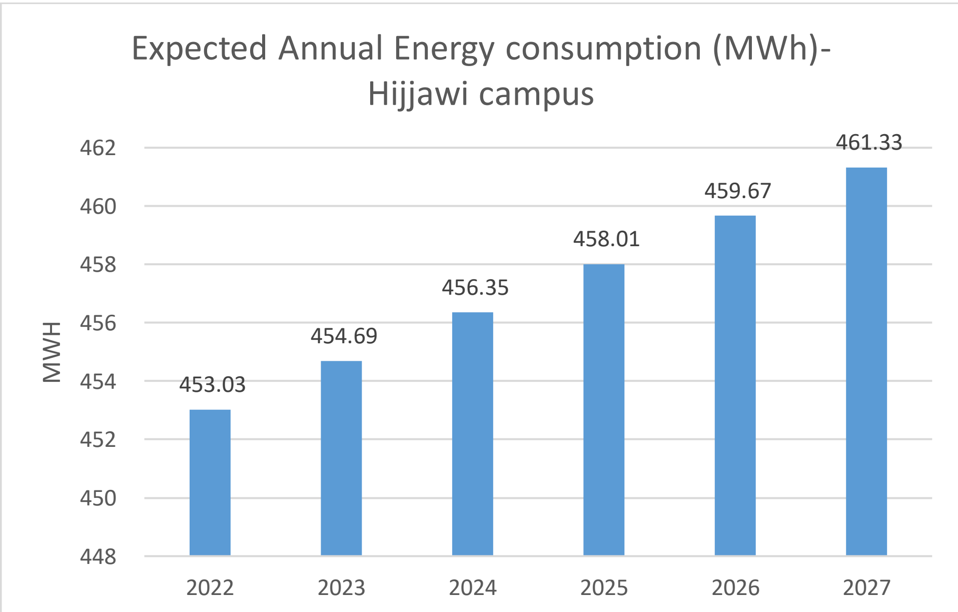
Figure 9: electricity consumption in ANNU buildings for recent 5 years

Accordingly, the calculation shows that the total electricity demand in university will increase by the next 5 years as a result of the university's development plans in modernizing the university laboratories and keeping pace with technological development. The modelling results show that by 2027 the electrical peak demand could reach 1.44 MW (assuming an annual demand increase of about 1.3%, which mean the electrical consumption in university will increase by 6.8% by the end of 2027).

The following figure shows the expected forecasting energy consumption for period 2022-2027 in each campuses of An-Najah University: -


Expected Annual Energy consumption (MWh)-
Old campus
MWH
1,700
1,690
1,680
1,670
1,660
1,650
1,640
1,630
1,653.93
1,662.05
1,670.18
1,678.30
1,686.43
1,694.56
2022
2023
2024
2025
2026
2027


Expected Annual Energy consumption (MWh)- new campus
MWH
4,500
4,400
4,300
4,200
4,100
4,000
3,900
3,800
4,055.84
4,130.09
4,204.34
4,278.58
4,352.83
4,427.08
2022
2023
2024
2025
2026
2027


Expected Annual Energy consumption (MWh)-
Hijjawi campus
MWH
462
460
458
456
454
452
450
448
453.03
454.69
456.35
458.01
459.67
461.33
2022
2023
2024
2025
2026
2027

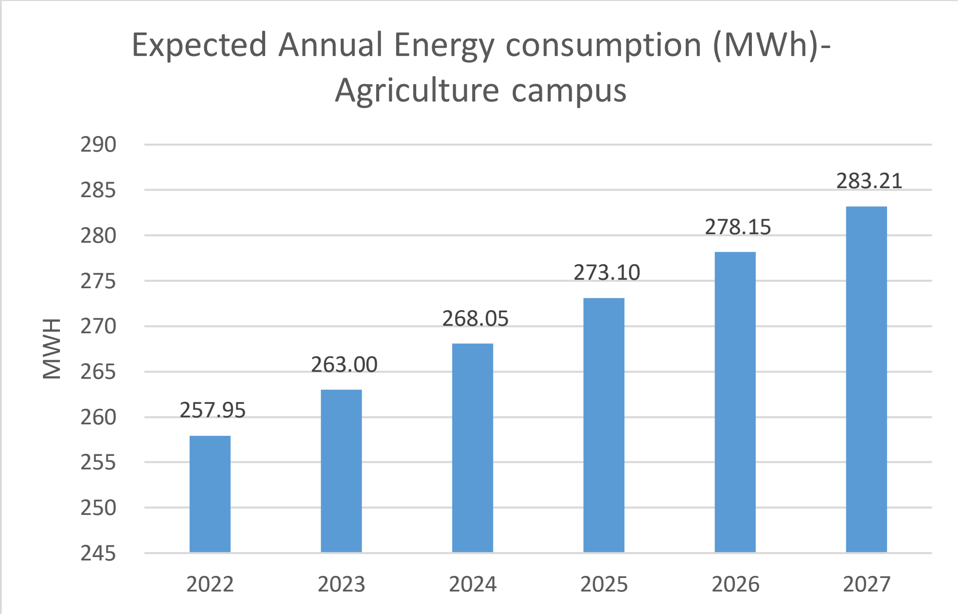


Figure 10: Expected energy Demand until 2027

3.7 Identification of worst-performing segments of the building stock

Several characteristics can help identify the "**worst-performing segments**" in order to realize the greatest energy-saving potential:

- Building type: educational buildings
- Age band: buildings built before 2000
- justification: those buildings have the worst performance energy (U-value)
- Energy consumption: 19.77 ~ 20 kwh/m2/month

4. Identification of cost-effective approaches to renovation

Currently, the university board of directors has no intention to do a deep renovation of the structure of the old buildings just a minor amendment due to high cost and to ensure that energy-related measures are not neglected or omitted at a later stage in the life-cycle of the buildings.

So, by focusing on energy efficiency measures and transmitting to net-zero energy buildings, the risk of losing the opportunity to renovate in the future can be avoided and possible synergies with other actions best be exploited.

Taking some EE/RE measures may lead to cost-effective renovation due to economies of scale which can be achieved in carrying out energy-related renovation measures simultaneously with other necessary works or already-planned renovations.

4.1 Multiple Benefits of the net-zero transition

Improving energy efficiency and decarburization of buildings offer a number of economic, social and environmental benefits beyond energy savings and emissions reductions.

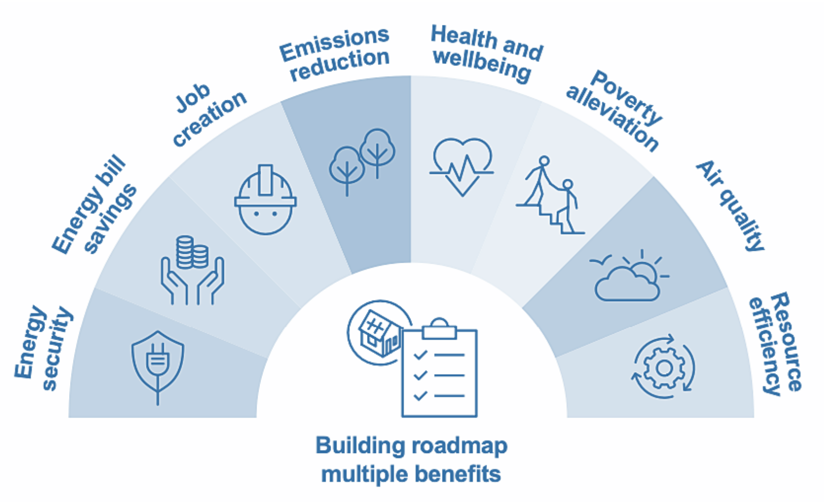


Figure 11: Multiple benefits of energy-efficient and low-carbon improvements in buildings

The university aims to achieve through this strategy the following:

- Energy bill savings through implementation of RE system which will cover in next 5 years the loads of all university building and achieve Zero energy from grid and thus will provide a financial source for the university after completing the payback period of the capital cost for installing solar systems
- CO2 emission reductions from buildings sector decarbonisation are the second most readily identified benefit. Through energy efficiency and demand reduction, emissions related to direct and indirect energy use in buildings will make a significant contribution to energy-related CO2 emission reductions, and also reducing fuel usage of backup generators, and improvements to building system performance that reduce fuel use can directly reduce air pollution.

4.2 technical & financial approach appraisal

The availability of facilities, yards and land has provided the university with the opportunity to install solar cell systems as follows:

1. Clean/RE energy approach

MWH/year

	New Campus	old campus	Hijjawi campus	agriculture faculty	Total (MWh/year)	reduction consumption from grid (%)
2015 consumption bills(MWh)	3941.01	1774.36	489.47	258.25	6463.096	
	decrease	in 2016 : PV system = 41 kWp on medicine faculty/new campus			62.825	
2016 consumption from grid(MWh)	3878.19				6400.271	0.97%
	decrease	in 2018 : PV system = 72.8 kWp on engineering faculty/new campus			111.36	
2018 consumption from grid(MWh)	3766.83				6288.91	2.70%
	decrease	in 2020 : PV system = 997 kWp NASSARIAH LAND of ANNU			1567.65	
2020 consumption from grid(MWh)	2199.18				4721.26	26.95%
		decrease in august 2020 : PV system = 145 kWp old campus			173.1	
2021 consumption from grid(MWh)		1601.26			4548.16	29.63%
	decrease	in 2022 : PV system = 50 kWp PV carport-new campus			94	
2022 consumption from grid (MWh)	2105.18				4454.16	31.08%
		in May/2022 : PV system = 105 kWp hijawi building	decrease		176	
2023 consumption from grid (MWh)			313.47		4278.16	33.81%
		in July/2022 : PV system = 73 kWp agriculture faculty building		decrease	197	
2023 consumption from grid (MWh)				61.25	4081.16	36.85%
	decrease	in2023 : PV system = 50 kWp NASSARIAH LAND of ANNU			96	
2024 expected consumption from grid (MWh)	2009.18				3985.16	37.73%
	next years : PV system = 2000 kWp				3746	
2024/2027 expected consumption from grid (MWh)					239.16	96.30%

Figure 12: technical appraisal for installation RE for university

According to the Fig.12, we will reduce the university electricity bill by 96.3%, which is close to zero energy consumption from conventional supply.

The capital cost necessary for the new solar PV system 2023-2027 , around 2,000,000 $, and these solar PV systems will save in electricity bills of university around = 674,082 $/year, and the simple payback period = 3 years

2. Energy Renovation approach - Existing building

Small-scale approach

- Periodic maintenance and rehabilitation of buildings

  The University's maintenance department carrying out periodic for durability and sustainability of university buildings, through painting and repairing the rooms, inspecting the leakage of windows and ventilation holes, maintenance of equipment and lighting, maintenance of water tanks and the roof, and doing necessary work by adding insulation materials and layers of asphalt to prevent leakage and moisture.

- Improve energy efficiency of existing building

  EE plan was carried out specially in old buildings and therefore the loads have been studied through energy auditing in order to put measures to raise energy efficiency and replacing the FL lamp by using high efficient elements and LED lamps in some old buildings; as follow:

  - old campus library Building
  - Faculty of Humanities & Faculty of Economics and Social Studies Building
  - Faculty of Educational Sciences and Teachers' Training Building
  - Faculty of agriculture

  This approach will reduce electricity consumption around 33 MWh/year but its costly

- Promote smart technologies

  smart buildings enable and ensure, at the same time, a healthy and comfortable living and working environment for the occupants, and more suited to ensure higher quality (e.g. through monitoring and verification) at a lower cost for the occupant and building owner by optimizing the energy use.

Smart building aspect	Status
Roll out of smart meters	12 buildings needs individual smart meters out of 18 buildings
Regulatory framework for demand response	Energy management system to control - Lighting - Heating - cooling

Self-consumption of on-site renewable production	Bidirectional and digital energy meter to monitor energy production of PV system, the PV system until 2022 cover around 36.4% of energy consumption yearly by installing 1.5 MW

So, Given the university's situation in terms of measuring electricity consumption in its buildings, the university installed a meter for each campus, the meters installed in the following buildings:

	Existing measures	Estimation of impact	Timeline
	smart meters on buildings individually in the same campus (each campus has one meter on feeder with electricity company to measure the total energy demand of campus)	Enable more dynamic energy use and monitoring	Since January/2021
1-	Meter -1 in Scientific centers Building		
2-	Meter -2 Faculty of Fine Arts Building		
3-	Meter -3 medicine faculty Building		
4-	Meter -4 Faculty of Science Building		
5-	Meter -5 Faculty of sport Building		
6-	Meter -6 engineering faculty		

The reading of those meters were as follow:

	MWH	*Meter -1: Scientific centers*	*Meter -2: Fine Arts*	*Meter -3: medicine*	*Meter -4: Science*	*Meter -5: sport*	*Meter -6: engineering*
2021 (Covid-19)	January	46.36	23.21	0.38	18.26	30.23	11.78
	February	43.20	23.92	0.33	17.94	30.22	14.69
	March	34.46	20.78	1.20	20.68	31.64	12.94
	April	34.08	22.56	0.85	22.43	36.83	4.67
	may	36.91	26.88	0.94	21.59	31.22	4.14
	June	48.35	60.02	2.03	27.56	31.59	12.52
	July	64.05	72.72	2.08	39.25	38.59	18.31
	august	50.66	59.67	1.19	23.49	28.14	17.40
	September	65.84	79.40	0.48	40.19	38.36	22.75
	October	57.01	72.23	0.35	37.46	40.80	26.04
	November	44.63	59.76	0.22	29.21	38.08	19.07
	December	59.38	52.99	0.19	25.63	33.91	15.50
2022	January	56.44	44.68	2.49	45.37	32.03	21.73
	February	53.83	56.01	1.92	33.44	35.22	16.02
	March	61.50	60.95	2.29	37.80	42.07	18.10
	April	34.50	35.29	2.73	35.43	37.43	16.97
	May	40.66	55.92	3.36	36.35	33.82	17.41

	June	53.43	62.97	3.67	39.96	36.85	19.14
	July	51.35	66.68	3.72	42.65	36.41	20.42

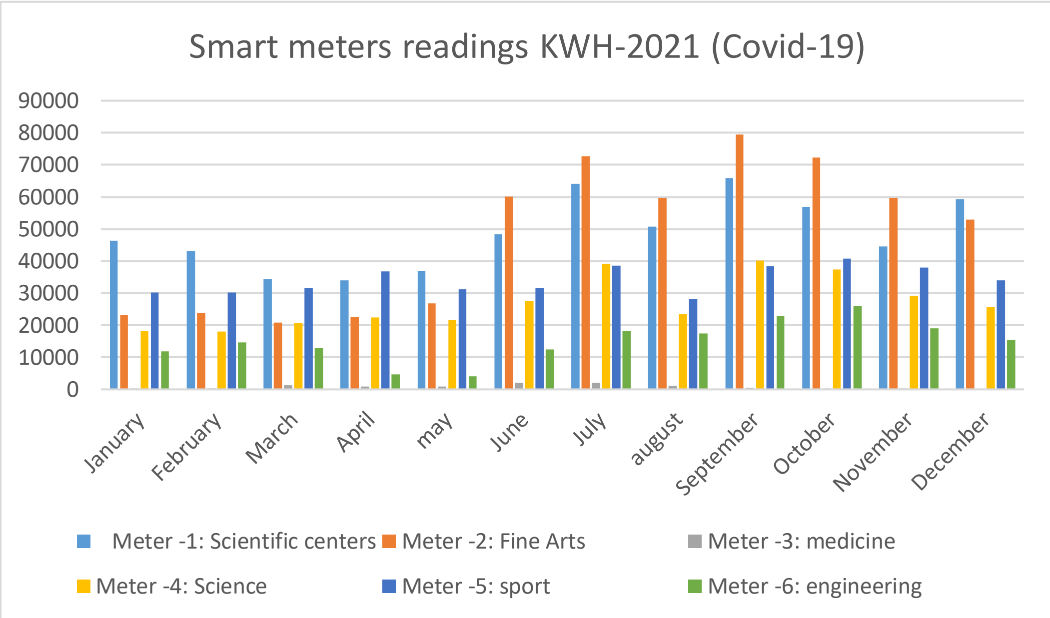


Figure 13: Smart meter reading of university building-2021

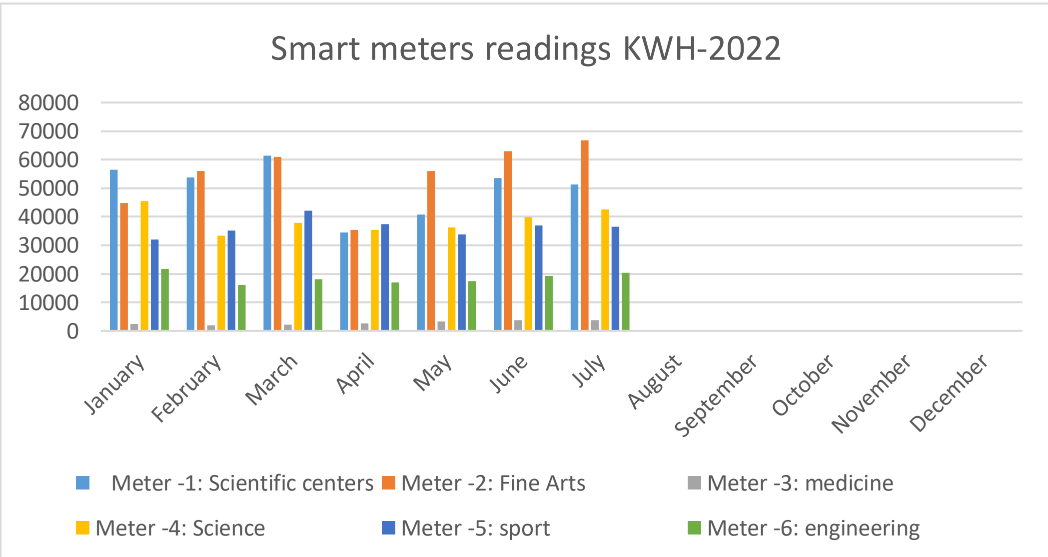


Figure 14: Smart meter reading of university building-2022

Large-scale approach

- Deep renovation: depending on saving /profit from clean energy projects and energy efficiency measures, the university will evaluate their strategic plan achievements for each 5 years.

3. Energy Renovation approach – New building

Most construction occurs without considering mandatory minimum energy performance, so this strategy encourage decision makers of the university to Priorities highly efficient standards and use highly efficient material in the construction of new building to reduce losses in energy and get high-energy performance building which means to continue achieving net-zero transition of university buildings.

5. Energy conservation measures/strategy for renovation of university`s & public buildings

The strategy are priorities the actions in three areas: Decarburization of energy consumption using R.E.; tackling energy shortage and worst-performing buildings; and renovation of university buildings.

Therefore, in university strategy we suggested a set of policy measures, funding tools and technical assistance instruments.

For building envelope, windows…etc., the energy requirements must be upgraded and included in building construction and renovation, considering the following:

- selecting buildings components and materials so that they reflect future demands and expected energy prices

- replacement windows; using energy-efficient window solutions, also considering architectural aspects and conservation-grade windows, as well as light and noise conditions.
  - The energy properties of the windows have a major bearing on energy consumption in buildings. Windows should be replaced at regular intervals, providing an opportunity to make large and cost-effective savings by replacing the old windows with durable, energy-efficient windows.

- Review the energy requirements for installations in buildings with a view to upgrading them, and consider, whether to introduce requirements concerning the automation and control of the installations.
  - Installations in buildings (e.g. heating and ventilation systems, lifts etc.) have a major effect on energy consumption in the buildings.
  - Technological development has resulted in more energy-efficient installations being developed and also opened the way to automated control of some installations.
  - This provides for both a better indoor climate and lower energy consumption.

- Analyse the interplay between installations in buildings and the 'smart grid', and use this to assess the possibility of introducing special requirements for the installations in the buildings to exploit the benefits of the smart grid.
  - The 'smart grid' rollout also provides an opportunity for further energy savings through control-related interaction between the electricity supply system and electrically powered installations in the buildings.
  - The installations put into new and existing buildings must therefore be both more energy-efficient and ready to exploit the potential for greater energy efficiency provided by automation and the 'smart grid' rollout

- Launch an analysis of the level of demand and profitability for energy conditions for existing buildings and introduce energy classes for existing buildings and new building.

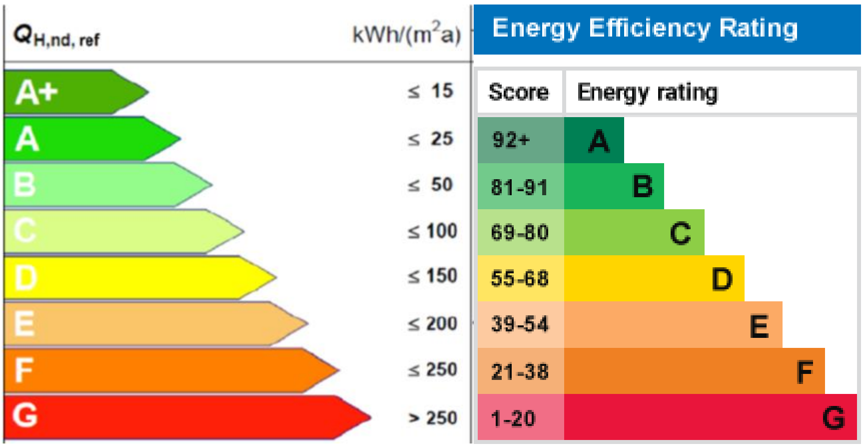


Figure 14: Energy class of building according (a) Energy Consumption (kWh/m 2 year), (b) Energy efficiency

- Energy labelling of equipment and products

Class	Level	Energy efficiency $U_{e.e}$
1	Low	0.50—0.65
2	Low-medium	0.65—0.75
3	Medium	0.75—0.80
4	High-medium	0.80—0.85
5	High	0.85—0.90
6	Very high	0.90—0.95
7	Extremely high	>0.95

The Energy Classis of ANNU based on the above methodology, before and after implementation some measures through Med ECOSURE project can be summarized in the following table:

Table: Energy class –university buildings:

University buildings	befor project-KWh/m2	befor project-Energy class	after project-KWh/m2	after implementation project-Energy class
Administration Building	205.08	F		F
Deanship of Student Affairs Building	146.95	D		D
old campus library Building	117.16	D	116.62	D
Faculty of Humanities & Faculty of Economics and Social Studies Building	44.74	B	11.87	**A**
Faculty of Educational Sciences and Teachers' Training Building	64.14	C	27.70	**B**
Faculty of Islamic Law Building	157.82	E		E
Zafer Al-Masri Amphitheaters Building	178.52	E		E
Faculty of Engineering and Information Technology Building	32.15	B		B
Faculty of Science Building	41.64	B		B
medicine faculty Building	40.33	B		B
Faculty of Fine Arts Building	64.78	C	57.58	**C**
Faculty of sport Building	67.49	C		C
new campus library Building	38.23	B		B
Korean Palestinian IT Institute of excellence Building	79.78	C		C
Scientific center Building	50.81	C		C
Faculty of Law Building	49.06	B		B
An-Najah Child institute Building	29.27	B		B
Faculty of Optical & nursing college Buildings	31.68	B		B
hisham hijawi	37.29	B		B
agriculture faculty	80.91	C	46.50	**B**
over all	56.97	C	53.30	C

- General buildings over 1000 m2 must have a valid energy certificate and public building over 250m2 must have a valid energy certificate
    - identifying the energy class for existing buildings will contribute to the efficiency requirements for replacing or modifying a number of building components such as walls, roofs, floors etc., where an efficiency requirement applies if it is cost-effective.

- Increase the use of energy labelling of buildings by setting up a web site included information and guidance on carrying out energy renovations
    - Building owners need access to knowledge about energy renovation options and their impact on finances, energy consumption, the indoor environment, comfort etc. is necessary for if they are to be able to decide proceed with energy renovation.

    - Similarly, advisers, tradespeople, fitters, financial institutions and other parties working on energy renovation of buildings need to have easy access to knowledge about energy renovation in order to give the best possible advice to building owners.
    - the information and communication activities about energy renovation and energy efficiency in the building industry must be increased and work to spread it widely.

- Carry out an analysis of the various parties' need for data, technical tools etc. to support the energy renovation of buildings
- Develop a method to calculate and document energy savings from energy renovation.
- Draw up a plan to develop data, technical tools, guidelines etc. to promote energy renovation of buildings in collaboration with the parties involved.
    - Increased, cost-effective investment in energy renovation requires up-to-date data, technical tools and methods of establishing a good and reliable basis for decisions.
    - Building owners, advisers and tradespeople should have access to the data and tools they need to plan cost-effective energy renovation work.

- Promote favourable conditions for financing energy renovation of buildings through promoting financing via mortgages and bank loans

So, any successful strategy must include the following lead actions in consideration:

- Stronger regulations, standards and information on the energy performance of buildings to set better incentives for public and private sector renovations, including a phased introduction of mandatory minimum energy performance standards for existing buildings, updated rules for Energy Performance Certificates, and a possible extension of building renovation requirements for the public sector;
- Ensuring accessible and well-targeted funding, simplified rules for combining different funding streams, and multiple incentives for private financing;
- Increasing capacity to prepare and implement renovation projects, through to training and skills development for workers in new green jobs;
- Expanding the market for sustainable construction products and services, including the integration of new materials and nature-based solutions, and revised legislation on marketing of construction products and material reuse and recovery targets;
- Developing approaches and encouraging communities to integrate renewable and digital solutions, where consumers become prosumers selling energy to the grid.

All these actions will taking into account for preparation the university strategy.

6. Techno-Economic and Environmental Impact Towards University Strategy 2027

The building sector is one of the areas that present the highest levels of energy consumption due to demographic growth and increasing urbanization. The building considers a crucial pillar of energy efficiency policy and applying EE and RE measures, so An-Najah University seek to achieve Net Zero Energy buildings by 2027.

The action measures are proposed for ANNU strategy :

- Periodic maintenance and rehabilitation of existing buildings
- Improve energy efficiency of existing building (replacing the FL lamp by using high efficient elements and LED lamps in some old buildings)
- Promote smart technologies (12 of 18 buildings needs individual smart meters)
- Energy management system to control the consumptions.
- PV solar system to achieve zero electrical bills
- Replacement of Boiler diesel with gas fuel

The consultant and based on the above forecasting loads and proposed action measures, the suggested real action plan for the next 5 years, can be summarized in the following table:

		2023	2024	2025	2026	2027
1	Solar system (KWp)	500	500	500	500	monitored and analyzed the energy consumption saving
2	Boiler diesel to gas (# building)	2	3	5	3	
3	Completing the energy audit in all university buildings	✓				
4	replace Outdoor lamp to LED	50%	50%			
5	Installing smart meter for all building in campuses individually		2	4	6	
6	Install energy management system		5	6		

6.1 Technical impact

The technical impact can be summarized as the following:

	Planned measures	Estimation of impact	Timeline
1	2000 KWp ground mounted PV system in Salem area	Reduce electricity consumption by 94.32 % , Reduce energy need in total by 83% and increase of RES by 57%	2023-2026
2	Replace diesel boilers with gas boiler	Reduce energy need in total by 3.7%	2023-2026
3	Completing the energy audit in all university buildings	Reduce energy need in total by 1%	2023-2024
4	Replace outdoor lamp (mercury and H.P.S) and use LED saving lamp		
5	Installing smart meter for all building in campuses individually	Reduce losses by 4%, and that by Monitoring and periodic maintenance of building loads and devices and early detection of problems	2024-2026
6	Install energy management system to control lighting, heating and cooling (where applicable)	Reduce energy need in total by 8%	2024-2025
7	Conduct energy monitoring, analyzing and evaluating the energy consumption saving	bringing a more in-depth and accurate understanding of energy use and the efficiency opportunities that may exist	2027

6.2 Financial impact:

The financial impact also can be summarized as the following:

year	#	projects	budget (Euro)
2023	1	installation of 500kwp solar PV	500,000
	2	replacement of diesel boiler to gas boiler - for two buildings	20,000
	3	Completing the energy audit in all university buildings	14,000
	4	replace 50% Outdoor lamp to LED	18,000
		total (Euro)	552,000
2024	1	installation of 500kwp solar PV	500,000
	2	replacement of diesel boiler to gas boiler - for three buildings	22,000
	3	replace 50% Outdoor lamp to LED	18,000
	4	Installing smart meter for two buildings	1,000
	5	Install energy management system -HVAC for Five buildings	10,000
		total (Euro)	551,000
2025	1	installation of 500kwp solar PV	500,000
	2	replacement of diesel boiler to gas boiler - for five buildings	24,000

	3	Installing smart meter for four buildings	2,000
	4	Install energy management system -HVAC for six buildings	12,000
	total (Euro)		538,000
2026	1	installation of 500kwp solar PV	500,000
	2	replacement of diesel boiler to gas boiler - for three buildings	19,000
	3	Installing smart meter for six buildings	3,000
	total (Euro)		522,000
2027	1	monitored and analyzed the energy consumption saving	12,000
		overall budget=	**2,175,000**

Accordingly, the saving in energy purchasing bill will be around = 815,624 Euro/year

So, Simple payback period will be 3 years

And also, the total reduction of CO2 emission will be around = 3800 ton annually

The prepared university's strategy plan was discussed with Palestinian Energy Authority and electrical transmission company in Palestine and its in line with the goals and strategies adopted by the Palestinian government.

7. Risk assessment

The renovation of our university buildings can be faced different barriers, which can be divided into five main categories:

1- Financial barrier

- Deep renovations of existing buildings require high upfront investments from stakeholders/building owners which may be refund within a longer time.
- Also, assumptions on the life-cycle of buildings and their components will be negatively reflected on cost-benefit calculations of deep building renovation.
- in university case study, there is no landlord/tenant dilemma which occur because the building owners often lack a financial incentive to make energy efficiency and decarbonisation investments, but in university, the demanding for energy efficient measures is subsidised by university's decision-makers which may yield immediate returns.
- but the other financial barrier may be due to lack of funding programmes for example: low interest loans and financial incentives for complex energy efficiency in public building in banking sector.

2- Technical barrier
  - Technical barriers for deep low-carbon building renovation may arise due to building characteristics such as its structure or pre-existing installations that prevent the technical implementation of certain measures/render them uneconomical.
  - Another key barrier may be lacking market supply of (integrated) technical solutions to effectively and/or economically achieve building energy performance standards in different building types or climates.
  - In the context of diverse multi-building renovation, the lack of ubiquitously applicable solutions may drastically increase planning and implementation efforts and costs, which negatively affects cost-benefit considerations of investors.

3- Information barrier

Informational barriers refer to the gaps among different actors in the energy efficiency value chain on various technical, financial and legal aspects.

Respective information deficits range from: -

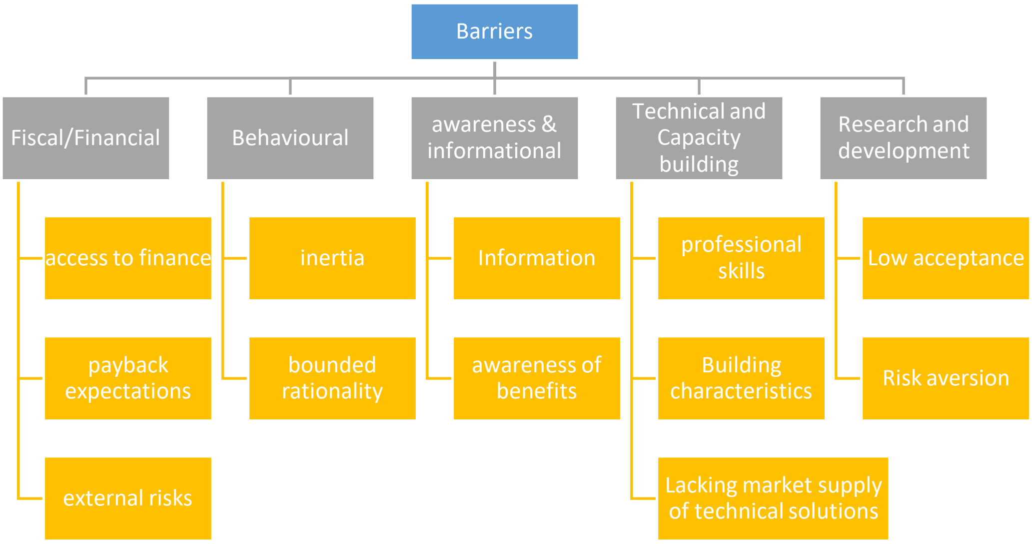
  - Lacking knowledge on/awareness of the general benefits of energy efficiency, on existing saving potentials,
  - technical options to harvest
  - implementation costs
  - practical knowledge gaps on how to properly plan (architects, engineering consultants, project developers), finance (financiers) and implement deep building renovation works.
  - Low awareness of building energy efficiency and its benefits among building stakeholder.
  - lacking information of newest development technologies which may led to lack the necessary kills to properly plan or implement renovation works that include new or complex technologies

4- Legal/institutional barriers

the regulatory framework may hamper transformation to energy efficient building if it does not define clear enforcement mechanisms and assign responsibility to a supervisory authority with sufficient technical, financial and personnel resources.

5- Research and development

The realisation of projected energy savings in deep building renovation projects depends on different factors such as the proper implementation of measures, the proper installation and adjustment of technical building systems, their adequate use/behavioural adjustments by occupants. Failure to deliver the expected energy savings against high capital cost and longer revenue period may lead to the inconveniences and discomfort associated with the implementation of renovation works which may result in low acceptance to do deep renovation work and development in multiple buildings.



To address these risk, the following assessment is done that include a detailed list of prevention measures (before it happens) and solutions (after it happens), as follow:

a- Prevention measures (before it happens)

Barrier type	Description of barrier	Potential measures
Legislative and regulatory	# 1 Lack of enforcement/ responsible authority # 2 Cumbersome and time consuming administrative procedures	• Competent authority with sufficient resources • Long-term renovation strategy • Building individual deep renovation roadmaps • Mandatory regular inspection of heating and cooling systems • Building stock energy targets • Building regulation (minimum requirements for overall energy performance; share of renewable energy for heating and cooling; roof usage)

Barrier type	Description of barrier	Potential measures
Fiscal and financial	# 1-High upfront investment/ Access to funding/ low financing offer	• Soft loans • Grants for investment in deep renovation • RE revenue • CO2 emission revenue
	# 2- payback expectations	• Awareness raising campaign to show that Building's energy performance is not less important than its investment value
	# 3- external risks (e.g. volatility in energy prices)	• Signing a purchase contract with the national electricity companies and fixing the selling price of electricity per KWh
Communication/ information and capability	# 1 Difficult access to information; contradicting information # 2 Low awareness of building energy efficiency and its benefits # 3 Lack of awareness of innovative technologies # 4 Low supply of skilled	• Awareness raising campaign for multiple benefits of EE & RE energy • Training of building professionals • Building individual deep renovation roadmaps • Information on good practice examples
Technical	# 1 Building characteristics # 2 Lacking market supply of (integrated) technical solutions #3 professional skills	• Financial support • Technology or best practice solution competitions • Capacity building of university's energy workers regularly and sending them to training workshops to acquire the required knowledge and exchange experiences with other universities
Research and development	# 1 Low acceptance # 2 Risk aversion	• Demonstration projects • Awareness raising campaigns • Standardisation of energy efficiency projects/renovation process • Promotion of energy performance contracting

b- solutions (after it happens)

barriers		**Solution strategies**
Fiscal/ Financial	access to finance/high upfront investment	• Soft loans • Grants for investment in deep renovation • RE revenue • CO2 emission revenue
	payback expectations	• Awareness raising campaign to show that Building's energy performance is not less important than its investment value
	external risks (e.g. volatility in energy prices)	• Signing a purchase contract with the national electricity companies and fixing the selling price of electricity per KWh
Behavioural	Inertia: - Lack of enforcement - Lack of responsible authority	• Competent authority with sufficient resources • Long-term renovation strategy • Building individual deep renovation roadmaps
	bounded rationality: Cumbersome and time consuming administrative procedures	• Mandatory regular inspection of heating and cooling systems • Building stock energy targets • Building regulation (minimum requirements for overall energy performance; share of renewable energy for heating and cooling; roof usage)

barriers		Solution strategies
awareness & informational	Information: - Difficult access to information - contradicting information	• Building individual deep renovation roadmaps
	Awareness of benefits: - Low awareness of building energy efficiency and its benefits, - Lack of awareness of innovative technologies - Low supply of skilled	• Awareness raising campaign for multiple benefits of EE & RE energy • Training of building professionals • Building individual deep renovation roadmaps • Information on good practice examples
Technical & Capacity building	professional skills	• Capacity building of university's energy workers regularly and sending them to training workshops to acquire the required knowledge and exchange experiences with other universities
	Building characteristics	• Financial support
	Lacking market supply of (integrated) technical solutions	• Technology or best practice solution competitions
Research and development	Low acceptance	• Demonstration projects • Awareness raising campaigns • Standardisation of energy efficiency projects/renovation process • Promotion of energy performance contracting
	Risk aversion	

Summary:

Finally, the monitoring program of implementation the strategic action plan will be undertaken during the operation phases . The monitoring shall be carried out at the following different levels:

• routine monitoring by Developer and Contractors,

• periodic monitoring (University Management) and (Developer),

• external monitoring by a third party " it can be PETLE or Distribution company"

The indicative cost estimate for basic implementation of the action plan is approximately Euro 3,000,000. This amount is an estimation and may differ from the final cost.

8. Annexes

Annex-1: Public building template

Building:			
year of construction:	*building / technical infrastructure*		
building type:	*e.g. administration building, school*		
energy carrier for heat:	*oil / natural gas / electric energy …*		
type of heat supply:	☐ single stoves ☐ constant temp. boiler	☐ low temp. boiler	☐ condensing boiler ☐ heat pump ☐ CHP ☐ district heating
age:	☐ > 20 years	☐ 10 – 20 years	☐ < 10 years
heating system:	*radiators, floor heating, ventilation with heating etc.*		
heating circuit pumps:	☐ unregulated multi-level	☐ with electronic control	☐ high-efficient pumps
insulation of heating pipes:	☐ none, with voids	☐ sufficient	☐ good
control and regulation system:	☐ faulty broken ☐ hard to operate	☐ ok, but no documentation (available)	☐ central control ☐ single room control ☐ building control system
heating times adapted to building use	☐ no	☐ unknown	☐ yes
heating curve adapted to the standard of the building:	☐ no	☐ unknown	☐ yes
hydraulic balanced system:	☐ no	☐ unknown	☐ yes
ventilation:	*with windows, mechanical etc.*		
mechanical ventilation:	□ no heat recovery □ no maintenance □ no automatic control	□ heat recovery < 60% efficiency □ cleaning or changing filters □ simple automatic control	□ heat recovery > 60% efficiency □ periodical professional maintenance □ automatic frequency control
cooling	□ SEER<2.5 □ automatic controlled by temperature	□ 2.5<SEER<3.5 □ automatic control by temperature and occupancy schedule	□ SEER>3.5 □ automatic control by temperature – limited range, occupancy schedule and open windows
domestic hot water:	☐ none ☐ decentral	☐ central	☐ circulation

Annex-2: STEPWISE SUMMARY OF THE TECHNICAL AND ECONOMIC APPRAISAL

1) GATHER DATA ON THE BUILDING STOCK

a) Identify main building categories:

i. Single-family houses
ii. Blocks of flats/apartments & other multi-residential dwellings
iii. Offices
iv. Educational buildings
v. Hospitals/health establishments
vi. Hotels & restaurants
vii. Sports facilities
viii. Warehouses & retail premises
ix. Other types of energy-consuming buildings

b) Identify key age bands which have a material bearing on building energy performance:

i. Traditional construction types, including historic/heritage buildings (typically pre-1900)
ii. Buildings constructed prior to regulations on energy performance (e.g. 1901-1960)
iii. Early phase building regulations (1961-1990)
iv. Mid phase building regulations (1981-2000)
v. New (2001-2012)

c) Identify main climatic zones which have a material bearing on building energy performance

d) Quantify the number, type, size (treated floor area) of each combination of building type and age band. On an illustrative basis of 9 building types and 5 age bands, this results in a matrix of up to 45 combinations. However, it will be possible to group many of the non-residential building types/age bands, so the number of combinations will in practice be less than this.

e) Ownership and Tenure

i. Identify the split by owner – public, private or mixed
ii. Identify the split by tenure – owner occupied, rented, mixed

f) (if appropriate) Split by location:

i. Urban
ii. Suburban
iii. Rural

g) Identify the energy use and performance characteristics of each building combination:

i. Construction type and U-value of main building elements:

1. Floor
2. Walls
3. Windows & External Doors
4. Roof

ii. Air infiltration rate

iii. Technical building systems (in all cases, please identify typical replacement lifecycles):

1. HVAC system type/performance level/controls
2. Hot water provision
3. Lighting systems/controls

iv. Maintenance regimes (e.g. mandatory annual safety checks/servicing)

v. Energy use for:

1. Heating
2. Cooling
3. Hot water
4. Lighting
5. Appliances

vi. Energy carriers

1. Gas (natural gas or LPG)
2. Liquid fuels (oil etc.)
3. Solid fuels (coal etc.)
4. Renewable fuels
    a) Solar hot water
    b) Solar PV
    c) Wind
    d) Heat pump (type and Coefficient of Performance)
    e) Biomass
    f) Biogas
    g) Other (specify)
5. District heating (identify energy carriers)

2) APPRAISE RENOVATION OPTIONS

a) Identify opportunities for retrofit of <u>energy efficiency</u> measures for each building category:

i. Fabric measures
ii. Windows
iii. HVAC plant - heating/cooling/hot water
iv. Air infiltration
v. Lighting
vi. Appliances

b) Identify opportunities for retrofit of <u>renewable energy</u> measures:

i. Solar hot water
ii. Solar PV
iii. Passive solar
iv. Shading
v. Wind
vi. Heat pumps
vii. Biomass
viii. Biogas

c) Identify the opportunity to connect to a <u>district heating</u> system;

d) Identify packages of measures that can achieve at least 60% energy saving, or at least up to the prevailing energy performance requirements for new buildings of the same category

e) Determine whether deep renovations are undertaken as a single package, or staged over a period of time

f) Identify cost effectiveness of the different packages of measures using cost optimality methodology:

i. Costs – the total installed cost of renovation measures, less any avoided cost due to end-of life replacement or by undertaking renovation alongside other building maintenance, new construction or modernization measures

ii. Consider the transaction costs, including costs of temporary relocation of occupants

iii. Quantify, wherever possible, the following benefits (and identify the beneficiary – building owner, building occupier, society at large):

Economic Benefits: Energy Cost Savings; Economic Stimulus; Impact on GDP; Property Values; Industrial Competitiveness; Impact on Public Finances; Energy Import Bill
Societal Benefits: Reduction in Fuel Poverty; Health Benefits; Increased Comfort/Productivity
Environmental Benefits: Carbon Saving; Air quality improvement
Energy System Benefits: Energy Security; Avoided New Generation Capacity; Reduced Peak Loads

g) From the above cost appraisal, determine a prioritized set of renovation packages for each building category, and a timeline for implementation.

i. Consider the exemplary role of the public sector (at all tiers of government, as well as public services such as public housing, defense, health and education) in leading the drive towards deep renovation, and in exerting influence of citizens and businesses

ii. Consider targeting the least energy efficient building stock as a priority

iii. Consider different scenarios as to the rate of change of key parameters

3) MAP OUT THE INVESTMENT HORIZON

a) Quantify total annual investment requirements, mapped out over the period to 2050, in order to deliver the identified renovation opportunities

b) Identify existing sources of funding for building energy renovation

i. Owners' private equity
ii. Public purse
iii. EU Structural/Cohesion funds
iv. Banks and other sources of finance, e.g. pension funds, investment trusts

c) Identify possible new funding sources and mechanisms to meet the investment profile from the above list

4) QUANTIFY THE EXPECTED BENEFITS

a) Identify the attractiveness, to building owners, of their direct energy cost saving benefits

b) Identify the societal benefits arising from deep renovation

c) Identify ways in which externalities (e.g. societal benefits from reduced CO2 emissions, increased energy security etc.) can be internalized for the benefit of the investor