Cool Up
Upscaling Sustainable Cooling

FINANCIAL FEASIBILITY STUDY LEBANON

March 2025

Financial Feasibility Study Lebanon

Cool Up
Upscaling Sustainable Cooling

www.cooluppprogramme.org
Newsletter
Email
LinkedIn

Supported by:
Federal Ministry for the Environment, Nature Conservation, Nuclear Safety and Consumer Protection
based on a decision of the German Bundestag

Cool Up is led by Guidehouse Germany GmbH and is part of the International Climate Initiative (IKI). The German Federal Ministry for the Environment, Nature Conservation, Nuclear Safety, and Consumer Protection (BMUV) supports this initiative based on a decision adopted by the German Bundestag.

Publisher

Guidehouse Germany GmbH
Albrechtstr. 10C
10117 Berlin, Germany
+49 (0)30 297735790
www.guidehouse.com

Authors

Lead authors:
Maya Trad, Michal Deuszkiewicz (Frankfurt School of Finance & Management)

Contributing authors:
Sorina Mortada and Mohammad Hijazi (LCEC)

Contributing authors:
Alokananda Nath (Frankfurt School of Finance & Management)

Review:
Andreas Hermelink, Jan Grözinger, Nesen Surmeli-Anac, Jakob Hoffmann, Alexander Pohl (Guidehouse)

Date

March 2025

Contact

Contact us at info@coolupprogramme.org
Visit us on the web at www.coolupprogramme.org

Table of Contents

List of Figures

List of Tables

Acronyms

AC	Air Conditioning
AFD	Agence Française de développement
AVG	Average
BDL	Banque Du Liban
CAGR	Compound Annual Growth rate
CAPEX	Capital Expenditure
CF	Cash Flow
CPI	Corporate private investment
CO2	Carbon Dioxide
EBITDA	Earnings before Income Tax Depreciation & Amortization
EDL	Electricité Du Liban
EBRD	European Bank for Reconstruction and Development
EE	Energy Efficiency
EER	Energy efficiency ratio
EIB	European Investment bank
FIs	Financial Institutions
GEFF	Green Energy Finance Facility
GHG	Greenhouse Gas
GWP	Global Warming Potential
HC	Hydrocarbon
IKI	International Climate Initiative
IRR	Internal Rate of Return
IS	Income Statement
IRR	Internal Rate of Return
kWh	Kilowatt-Hour
LCEC	Lebanese Center for Energy Conservation
LEEREFF	Lebanese Energy Efficiency & Renewable Energy Finance Facility
MDB	Multilateral development Bank
MEW	Ministry of Energy and Water
MWh	Megawatt Hour
NEEREA	National Energy Efficiency & Renewable Energy Action
NEEAP	National Energy Efficiency Action Plan
NI	Net Income
NPV	Net Present Value
OPEX	Operating Expenses
PBP	Payback period
RAC	Refrigerant and Air-conditioning
RE	Renewable energy

ROI	Return on Investment
SQM	Square Meter
T	Total
UNDP	United Nations Development Programme
UoM	Unit of Measure
USAID	US Agency of International Development
WACC	Weighted Average Cost of Capital
$W/m^2.K$	Watt per meter square Kelvin

1. Introduction

1.1. The Cool Up programme

Launched in 2021, Cool Up – "Scaling Up Sustainable Cooling in the Middle East" programme, led by Guidehouse Germany GmbH, is funded by the International Climate Initiative (IKI) and supported by the German Federal Ministry of the Environment, Nature Conservation and Nuclear Safety and Consumer Protection (BMUV) on the basis of a decision adopted by the German Bundestag.

The Cool Up programme promotes accelerated technological change towards sustainable cooling as a proactive implementation of the Kigali Amendment to the Montreal Protocol and Paris Agreement. Cooling is not only one of the major causes of energy consumption, but also the use of inefficient appliances that rely on conventional refrigerants, negatively affecting global warming. In this regard, the main objective of the programme is to handle the mentioned problems and mitigate climate change in: Egypt, Jordan, Lebanon, and Türkiye. Since the four countries could mostly be subject to the effects of global warming and are well equipped to uplift the transition process towards both energy efficiency and natural refrigerants in the cooling and refrigeration sector. The programme approaches the issue of sustainable cooling with a cross-segment focus on refrigeration and ACs (RAC) in residential and commercial buildings. The Cool Up consortium focuses on enabling cooperation between government, finance, and industry.

To realize these objectives, the programme is divided into three pillars:

- Policy and regulation
- Technology and markets
- Financing and business models

Frankfurt School of Finance and Management is one of the consortium partners of the Cool Up programme, focuses on developing new financing solutions and business models to encourage and support the transformation of RAC market to sustainable cooling. In this respect, starting from the very beginning of the Cool Up programme, the expert team of Frankfurt School in Lebanon, together with the consortium partners conducted interviews with financial institutions, industry stakeholders and end-users to learn about the potential challenges of the market for each party involved, to understand the needs of the stakeholders, to find out the right technology, and to identify the target market segment to initiate this study.

1.2. Aim and scope of this report

The purpose of this report is to take a step further in building the road of financing mechanism for sustainable cooling solutions in Lebanon by preparing a feasibility report that will be a guide for financial stakeholders and final users, to analyse all the critical aspects and the viability of cooling technologies, create awareness about the sustainable cooling sector, and to give an insight about the profitability and bankability of the sustainable cooling investments.

To be able to realize this study, the team completed refrigeration and air conditioning (RAC) market assessment and technology evaluations in all four countries (Lebanon, Jordan, Türkiye, Egypt). Each partner country has selected the most suitable technologies options for sustainable cooling that are in line with Cool Up goals which implies the absence of environmentally harmful refrigerants. A list of technical solutions for air-conditioning and commercial refrigeration have been recommended for Lebanon (***Please refer to Cool Up's Catalogue of Technical Solutions for Sustainable Cooling in Lebanon***[1]), whereas passive cooling measures for air-conditioning for a building is one of these technical solutions.

The financial feasibility study focuses on comparing the financial viability associated with the investment decision in building refurbishment. It covers adding wall insulation, roof insulation and double-glazed

[1] The Catalogue of Technical Solutions for Sustainable Cooling in Lebanon is available here: https://www.cooluppprogramme.org/wp-content/uploads/2022/09/Cool-Up_Catalogue-of-Technical-Solutions-for-Sustainable-Cooling-in-Lebanon.pdf

windows. The enhancement of the building envelope contributed to improving thermal comfort and reducing problems related to outdoor noise, draft, and humidity. The current age of the building is 8 years (built in 2016) with a total of 16 air-conditioned rooms that are fully occupied in the weekends and 67% occupied in the weekdays. Which means that during weekends the AC is running 100% of time while on weekdays 67% of time (during the months when cooling is needed).

This investment is considered to fall under passive cooling solution that leads to reduction of energy consumption and emissions from the existing air conditioners and lower capital expenditures when and if the building owner decides to purchase new air conditioners. It also leads to decreased energy needs for heating.

The objective of the report is to give a full idea about the expected investment to upgrade the building envelope, the resulting energy savings, and financial ratios analysis to reveal the profitability, liquidity, and performance of the project on the long run.

2. Technology in focus

As a result of the growing population and increasing global warming, demand for cooling products and services is accelerating not only in Lebanon but also all around the globe.

The global air conditioning systems market size was valued at USD 125.99 billion in 2023,[2] with a revenue forecast of USD 200.72 billion in 2030, and is anticipated to grow at a CAGR of 6.9% from 2023 to 2030. The residential segment held the largest revenue share of 42.0% in 2022 and is expected to grow at the fastest CAGR of 9.2% over the forecast period, due to the increased temperatures across several countries that leads to an increase in residential air-conditioning installation. While the commercial segment is anticipated to register a CAGR of 5.7% over the forecast period owing to rapid urbanization and rising demand for commercial space.

The global commercial refrigeration equipment market size was valued at USD 40.82 billion in 2023,[3] and is expected to grow at a CAGR of 5.2% from 2023 to 2030. One of the market growth drivers is the increase of regulatory implications resulting in the adoption of lower global warming potential (GWP) commercial refrigerants coupled with ongoing technological breakthroughs.

According to the "**Cooling Sector Prospects Study"** report for Lebanon published in 2023,[4] the RAC sector is growing fast and has a large market potential. Lebanon has a Mediterranean climate, with a hot and dry summers or in case of coastal areas high humidity, both require cooling. In 2018, the cooling energy consumption made up approximately 32% of total Lebanese electricity consumption, with the residential sector constituting 50% of this consumption.

Despite the recent economic challenges, Lebanon is expected to see a 75% increase in final energy consumption in buildings by 2030. The highest increase in demand for AC equipment is expected to be in the residential sector, with an increase by a factor of 2 until 2050. The stock of AC systems in Lebanon is expected to roughly grow from 1.9 million units in 2020 to approximately 3.8 million units in 2050 with a main driver of this development is the potential growth in the citizen purchasing power. Further, the stock of commercial refrigeration is expected to grow from 1.4 million systems in 2020 to 1.9 million systems in 2050,

---

2 "Air Conditioning Systems Market Size, Share & Trends Analysis Report By Type (Unitary, Rooftop, PTAC), By Technology (Inverter, Non-Inverter), By End-use, By Region, And Segment Forecasts, 2023 - 2030," Grand View Research, https://www.grandviewresearch.com/industry-analysis/air-conditioning-systems-industry#:~:text=The%20air%20conditioning%20systems%20market%20is%20expected%20to%20grow%20at,%20USD%200200.72%20billion%20by%202030.

3 https://www.grandviewresearch.com/industry-analysis/commercial-refrigeration-equipmentmarket#:~:text=The%20global%20commercial%20refrigeration%20equipment%20market%20size%20was%20estimated%20at, USD%2040.8%20billion%20in%202023.

4 Jan Grözinger, et al., "Cooling Sector Prospects Study Lebanon," (Guidehouse Germany GmbH, 2023), https://www.COOLUPprogramme.org/knowledge-base/reports/cooling-sector-prospects-study-lebanon/

with the main drivers are the increase in population and new construction of buildings where commercial refrigeration is installed (i.e.: supermarkets).

2.1. End-users

The construction sector in Lebanon has secured substantial growth in the past decade, with a rise in the demand for construction materials, and this is due by the increasing need for infrastructure, commercial, and residential properties. According to 6Wresearch,[5] Lebanon construction materials market size is projected to grow at a CAGR of 8% during the forecast period 2024-2030. Despite all these growth potentials, some challenges such as political instability and economic crisis would affect the construction sector.

In addition, the cooling and heating market is also growing, and is projected to generate a revenue of USD 41.04 Million[6] in 2024. Many factors are affecting the demand of energy efficient cooling systems in the country, such as:

1. Electricité du Liban´s (EDL's) weak financial situation and the increasing electricity costs. This would push the government to support energy efficiency measures.
   - The population growth and the high urbanization rates, increasing the housing demand.
   - The extreme weather conditions and the environmental concerns leading to reduce energy use in buildings since it is one of the most important ways to reduce human's overall environmental impacts.
   - Project developers and building owners desire to minimize the total cost of energy, leading to install energy efficient heating and cooling technologies for future buildings and refurbished buildings.

Many measures should be considered to install energy savings materials and equipment in the building sector, such as the enforcement of mandatory building codes with high energy performance standards, which also includes improving the insulation and design of the buildings to better retain cooling while minimizing solar heating gains (e.g.: passive cooling design and reflective rooftop).

2.2. Advancing Beyond Conventional

According to the cooling sector status report, the building sector has the largest share of materials and energy consumption in the market with a total electricity consumption of about 19.5 TWh or 86% in 2018 compared to 78% in 2014 therefore sustainable construction should become the dominant way to reduce energy consumption that would lead to achieve the sustainable development goal. Unlock private investment for buildings refurbishment is the key to reduce energy consumption and decrease the negative environmental and socio-economic impact. However, important barriers exist that are delaying the rehabilitation of existing building stock:

- Technical aspects: Lack of data on energy performance of building, and weak institutional capacity for evaluating and monitoring the rehabilitation plan. A database for the building sector has been developed including the energy performance for several types of buildings (residential, offices, hotels….). The project energy conservation law will be relying on this database for enforcement and implementation.
- Economic and financing activities: Lack of financing support to co-finance energy efficiency investments and demonstrate the cost-effectiveness of energy efficiency projects to the investors.

---

5 "Lebanon Construction Materials Market (2024-2030) | Size, Growth, Trends, Revenue, Companies, Industry, Share, Analysis, Value, Outlook & Forecast," 6wresearch, last updated May 2024, https://www.6wresearch.com/industry-report/lebanon-construction-materials-market-2020-2026.

6 "Heating & Cooling," Statista, n.d., https://www.statista.com/outlook/cmo/diy-hardware-store/heating-cooling/lebanon.

On another hand, a greener Lebanon has arisen, increasing the construction and the rehabilitation of green buildings, due to increasing awareness on the benefits of sustainable housing. Insulation to avoid losing energy and reduce its consumption is one of the main components of these green buildings.

Furthermore, the Beirut Port explosion that occurred in August 2020 damaged many buildings and has lurched the support of international organizations such as UN agencies and the World Bank to rehabilitate residential buildings.

As a result, Lebanon has a huge opportunity to invest in refurbishment of buildings, use sustainable materials and efficient equipment that would affect positively the environment and reduce energy consumption leading to energy saving for the building owners.

Table 1 & 2 address the barriers and the opportunities for the refrigerant & the building sector.

Financial, technical, capacity buildings, regulatory, and electricity crisis are all barriers and challenges tackled by the commercial refrigeration sector and the building sector (passive cooling):

Table 1 Barriers/challenges for the refrigerant & building sector.

Aspects	Barriers/Challenges
Financials	• Lack of financing mechanisms for cooling technology solutions. • Lack of knowledge/awareness about the payback period of energy efficient projects versus its initial investment. • Ceased financing activities by FIs, which have caused restrictions for companies to upgrade their existing refrigerant system, especially that the natural refrigerants require a high investment cost. • Restricted budgets for companies which limited their human resources (technicians) investment to enhance their skills in Low GWP.
Capacity Building	• The disposal and the maintenance of natural refrigerant systems require skilled trainers that Lebanon doesn't have yet. • Lack of awareness for end-users that tend to buy cheaper products regardless of the benefits of sustainable cooling technologies. • Lack of practices in energy efficient technologies, while experts do have the skills and the know-how of energy efficiency measures.
Import Market	• All air-conditioning and refrigeration in Lebanon are import dominated. Local suppliers have limited access to natural refrigerants, since they abide by their agent products, yet HC products are not yet introduced by the international distributors in the country.
Regulatory	• Lack of regulations on the mandatory applications of MEPS (Minimum energy performance standards) & labels for RAC appliances and their enforcement. International applicable energy efficiency standard for RAC appliances is not adopted officially in Lebanon. However, most of the important appliances and equipment include energy labels of country of import.

Conversely, many factors could create opportunities for the penetration of sustainable cooling technologies and passive cooling for buildings (i.e. electricity crisis).

Table 2 Opportunities/ recommendations for the refrigerant & building sector

Aspects	Opportunities/ recommendations
Financials	• Introduce financial incentive such as: tax exemptions or reduction of custom fees on efficient appliances which will increase the presence of natural refrigerant in the local market. Noting that the Energy Conservation law includes a section regarding tax exemptions and tax reductions for energy efficient equipment. • Incentives must also tackle existing cooling technologies and existing building to encourage the owners to optimize their energy consumption. • Impose taxes on inefficient appliances, The energy conservation law tackles the banning of importing non efficient products to be monitored by the Higher Council of Customs. • Clarify the importance of sustainable cooling technologies and energy efficiency measure in terms of payback period.
Capacity building and awareness	Establish training centres with certification programs aimed at educating technicians. This initiative aims to eliminate the risks associated with the installation of natural refrigerants while emphasizing safety aspects. Tackle training centres for energy efficiency measures for engineers, architects, developers…
Regulatory	• Addressing effective policies by the Lebanese government will reduce the cooling demand, boost energy efficiency, penetrate natural refrigerant system, and reduce the refrigerant leakage rate. • Provide regulatory parameters for sustainable cooling technologies, in terms of importing, installing, and old equipment disposals. For example: the electricity crisis and the removal of subsidies on fuel and electricity products has sparked a silent solar energy revolution in the last 3 years and pushed the residential and the commercial sectors to find alternative solutions to reduce their energy consumption. Almost 90% of AC units installed in the past 3 years are inverter units mostly without experts' advice or assessment.

2.3. Advocating policy frameworks for energy efficiency in buildings

Legal situation

Three legal frameworks exist in Lebanon:

- **Lebanon's National Energy Efficiency Action Plan** (NEEAP 2016-2020) summarizes the national efforts in energy efficiency.
- **Lebanon voluntarily commitment** pledged to increase its renewable energy share to 12 % by 2020, At the 2009 Copenhagen Climate Summit. This voluntary commitment was affirmed within the "Policy Paper for the Electricity Sector" prepared by the Ministry of Energy and Water (MEW) and officially adopted by the Council of Ministers in June 2010. Lebanon has increased its renewables target to 30% in the 2030 electricity consumption.
- The "**Energy Conservation Project law"** was approved by council of ministers then transferred to the Lebanese Parliament as a decree number 9196/2022. This project law is currently being discussed at the committee of energy and public works at the parliament.

- The **Decentralized Renewable Energy** law was ratified by the Lebanese Parliament in December 2023 (law 318/2023) tackling capacities less than 10 MWp in two schemes: power purchase agreements and all types of net-metering.

Technical and institutional capacity is strong, but general problems regarding a lack of regulation in the electricity sector hamper the implementation of energy efficiency frameworks.

It is to be noted that there are existing capacities within the private sector companies to design, implement, or verify energy efficiency in buildings. The Ministry of Energy and Water (MEW) should also have the legal capacity to enforce energy efficiency implementation, along with other entities such as Libnor and the Institute of Research Institute (IRI).

With respect to energy efficiency in building codes, there are no mandatory codes for heating and cooling equipment. Usually, engineers and developers use ASHRAE[7] for all what is related to HVAC.

Programs & financing

Subsidized loans were available before 2019 for the private sector, through the following programs:

- **NEEREA-**the National Energy Efficiency & Renewable Energy action plan financing mechanism for EE and RE.
- **LEEREEF**- Lebanon Energy Efficiency & Renewable Energy facility that aimed to support investment in EE, RE, and green buildings by the private companies.
- **GEFF**- the Green Economy Financing Facility used to help Lebanese businesses to invest in high-performing technologies by providing financing through Bank Audi.

It is essential, that the financial sector plays again a major role to support the financing mechanism of the green transition in Lebanon.

3. Feasibility Study Approach

Cool Up Team has chosen to analyse implementation of passive measures in a building located in Koreitem Beirut region. These measures lead to decreased energy consumption, both for cooling and heating.

The building envelope separates the interior from the exterior of the building; thus, it needs to meet specific requirements. To mention a few, it is supposed to protect from water (precipitation), from external air streams and heat/cold, and from excessive solar radiation. Building envelope upgrades offer numerous benefits:

- **Energy Efficiency:** leading to lower heating and cooling costs and a smaller carbon footprint.
- **Improved Comfort**: By minimizing air leakage, reducing risk of mold and ensuring consistent temperatures throughout the building, and providing occupants with enhanced comfort.
- **Reduced Maintenance**: by improving its durability, reducing the need for frequent repairs and maintenance.
- **Noise Reduction**: Well-insulated building envelopes can help minimize noise infiltration from the outside, creating a quieter and more peaceful indoor environment.

It is worth to mention, an improvement of the building envelops parameters of 10%- 30% is assumed per decade until 2050 as per "BUILD_ME" report released in 2021 for Lebanon, specifically the thermal transmittance of (U-value) of the building surfaces (wall, roof, floor, and window).

3.1. Building Overview

The analysed building has been developed in 2016 with a total of 16 apartments owned by the tenants. It has an overall of 11,904 m^3 cooling volume and 16 A/Cs. On average the building is 100% occupied during weekends and 67% occupied during weekdays.

The building is located[8] at an elevation of 86 meters above sea level, with a Mediterranean hot summer climate, which impacts the energy consumption of the cooling more than the heating applications. Koreitem has a yearly districts' temperature of around 22.69ºC (72.84ºF) which is 2.77% higher than Lebanon's averages temperature. Koreitem typically receives about 64.24 millimetres (2.53 inches) of precipitation and has 65.42 rainy days (17.92% of the time) annually. During 2017, an upgrading for the building envelope has been applied to improve the energy efficiency and reduce the energy bills through:

- **Adding wall insulation** that reduces the wall heat transfer.
- **Adding roof insulation (polystyrene)** that enhances the building comfort, protects against moisture damages, and reduces thermal loads (heating & cooling)

[7] "Ashrae: Shaping Tomorrow's Global Built Environment Today," Ashrae, n.d. https://www.ashrae.org/.

[8] "Koreitem, Beirut, Lebanon Climate," Weather and Climate, n.d., https://weatherandclimate.com/lebanon/beirut/koreitem

- **Installation of double-glazed windows**, that reduces the loss of heat during winter and coolness during summer.

The building uses conventional DX split units with a cooling capacity of 1 ton and a high rate of energy efficiency ratio (EER) equal to 10, which indicates a significant energy savings, an enhancement of cooling comfort, and a lower carbon footprint. A total of USD 479,136 represents the full investment costs for materials purchased and installation fees as classified in the following table:

Table 3 Investment costs breakdown

Description	Unit price (USD)	# floors	Area (m2)	Total
Double Wall (insulated wall)	25	8	360	$72,000
Double Glazing	450	8	104	$374,400
Roof Insulation	66	1	496	$32,736
Total cost				**$479,136**

3.2. Status of the Cooling & heating technologies

According to Lebanon prospect study, Lebanon is expected to see a 75% increase in final energy consumption in buildings by 2030, as cooling and dehumidification are the highest energy-consuming end uses in the Lebanese building sector, combined constituted 40% of the electricity demand.

The cooling in the building sector accounted for around 32% of the total Lebanese electricity consumption in 2018, compared to 40% in 2014. While the residential sector consumption in cooling constituted 50% of the total cooling consumption of the building sector.

The National cooling Plan Lebanon identifies about 53% of the total electricity demand for cooling from unitary air conditioning (UAC) and about 18%from commercial refrigerant.

Furthermore, in the AC sector, the share of direct emissions is expected to increase until 2050 from 27% to 38%, while the direct emissions in the commercial refrigeration sector is expected to increase from 35% to 44%.

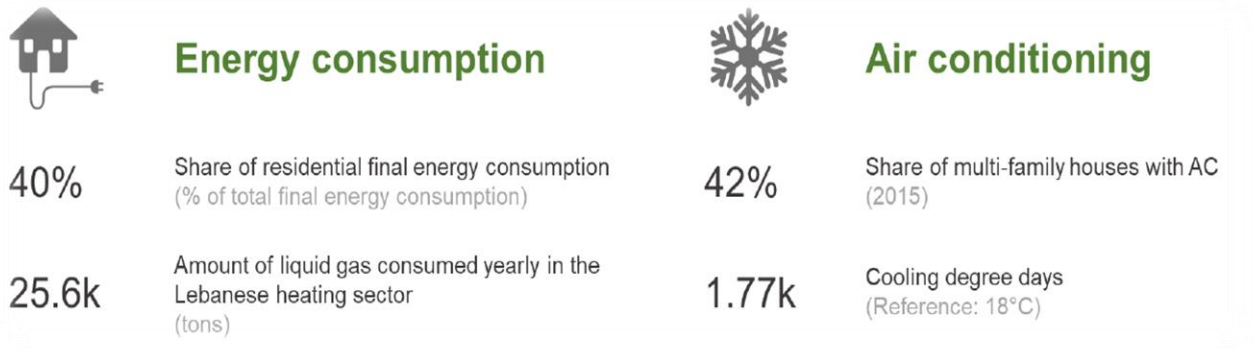


Figure 1 Key metrics of the cooling and heating in residential building in Lebanon

4. The Financing Model

4.1. Financial Input Assumptions

Two financial statements have been developed in the feasibility study:

1. **Income statement** includes assumptions for revenues (energy savings), operating expenses, and depreciation of materials.
2. **Cash flow statement** includes three different business activities: operating, investing, and financing related to the building envelope.

The following table shows parameters used in both Cash Flow and Income statements:

1. The time considered for the analysis is 5 years (due to building related nature of the measures), from 2024 until 2048.
2. A total investment of USD 479,136 has been allocated in 2017 by the owner to cover the material costs and the installations fees to improve the energy efficiency of cooling and heating of the building envelope.
3. The monetary unit used in the study is USD.
4. Electricity tariff applied in the study is equal to USD 0.605/kWh, being the combined cost of EDL and the private generators. The cost has been confirmed by LCEC, based on an internal discussion with the ministry of energy and water. Though, this cost will vary between USD 0.6-1 per kWh depending on the region and the consumption relied on the private generators, which will reflect the energy savings accordingly.

Table 4 Key assumptions for CF & IS

Parameter	Value
Time Period Considered for Analysis	25 years
Completion of investment	2017
Monetary Unit	USD
Electricity tariff applicable	USD 0.605 for year 1 with a 5% increase over the 24 years
Investment amount	USD 479,136

4.2. Technical Input Assumptions

- **Technical assumptions**

A general assessment was carried out by the building owner to evaluate the performance of the building envelope through specific measures as detailed in Table 5. According to the HAP simulation performed by the consultant for the building prior to the envelope improvements, the cooling load is 317.7 kW, requiring 167 kW of electricity, and the heating load is 154.1 kW, requiring 52.5 kW of electricity.

Table 5 Baseline Calculations[9]

Measure	UOM	Before	After	Reduction/ Savings
U-value of Wall	$W/m^2.k$	2.599	0.741	71%
U-value of Roof	$W/m^2.k$	1.995	0.437	78%
U-value of Floor	$W/m^2.k$	1.995	1.995	0%
U-value of Window	$W/m^2.k$	6.195	2.0	68%
GHG Reduction due to energy savings	kg of CO_2/year	-	48,443	-
Energy consumption for cooling	kWh/year	235,737	191,731	19%
Energy consumption for heating	kWh/year	50,686	20,163	60%

Figure 2 shows the daily operating hours for cooling and heating all over a year before introducing the envelope retrofit measures.

[9] Data provided by the client, the energy audit and calculations based on HAP simulations.

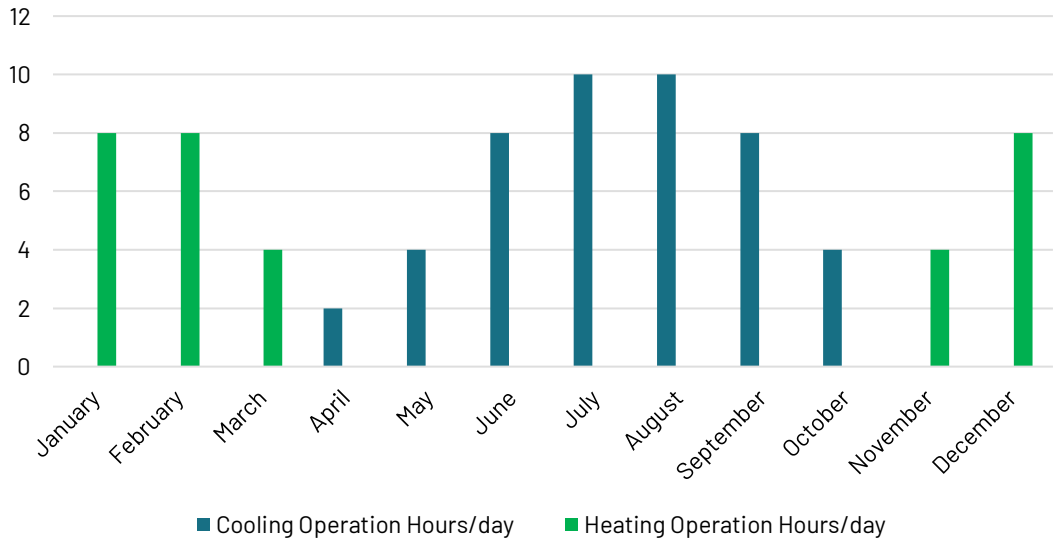


Figure 2 Cooling & heating operations hours/day.

- When it comes to insulation, the most important measure of how effective a given material is, refers to the thermal transmittance which is the U-value. It is measured in units of Watts per meter square Kelvin (W/m^2. K). As shown in the table below, a significant decrease has been recognized for the U-value of the wall, roof, and window affected by an efficient materials and equipment application. Note, that the U-value of the floor remained the same since no upgrading has been made at the level of the floor.
- The insulated envelope has reduced the greenhouse gas (GHG) emission by 48,443 Kg of CO_2/year based on 0.65 ton of CO_2/MWh (based on grid emission factor).
- The energy consumption for cooling is 19% less with a set temperature of 24 degrees, decreasing the yearly cooling consumption by 44,006 kWh.
- The energy consumption for heating is reduced by 60% with a set temperature of 20 degrees, decreasing the yearly heating consumption by 30,523 kWh.

In addition to these measures directly related to envelope, other energy efficiency measures were proposed such as the installation of a VRF system, LED lighting and a heat pump system for domestic hot water. Due to cost considerations, only the LED lighting system was installed and lead to a 298,015-kWh savings.

Figure 3 shows the monthly cooling and heating electric consumption pre and post envelope retrofit.

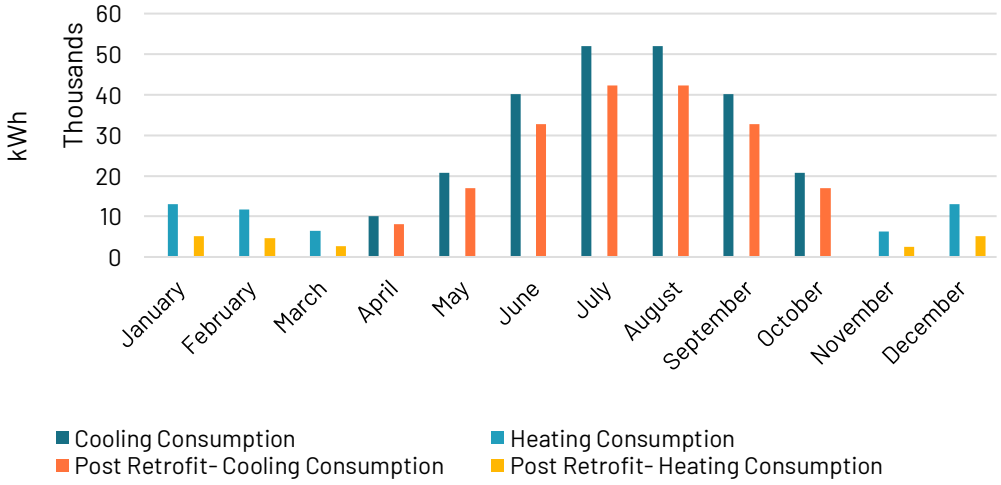


Figure 3 Monthly Cooling & heating consumption

4.2.1. Carbon certificates

Lebanon recognises the importance of addressing climate change. The Lebanese government has proposed the development of a National Climate Change Strategy, which may include plans for a future carbon pricing mechanism and a roadmap for transitioning to carbon neutrality in the cooling sector by 2050. As confirmed by LCEC, the International Renewable Energy Certificates (IRECs) are now available in Lebanon and LCEC is the local issuer, which could provide an income opportunity for the building owner and positively impact the feasibility study. However, a comprehensive carbon credit scheme for the building sector is not yet in place. In this respect, the carbon credit revenue scheme is not considered in the feasibility study of the refurbished building.

Some Lebanese companies and organizations have participated in international carbon credit programs, such as the Clean Development Mechanism under the Kyoto Protocol. But these opportunities are limited and not part of a cohesive national program. following are few examples involved in voluntary carbon:

- Reforestation and Afforestation Projects: involving organizations such as AFDC[10] (The association for Forests, Development and Conversation, since Lebanon has set a goal to increase its forest has set a goal to increase its forest cover to 15% of the total land area by 2030.
- Renewable Energy Projects: involving projects to increase Lebanon renewable energy share specifically from solar and wind power, since Lebanon has a target to achieve 30% of renewable electricity generation by 2030. Renewable energy projects that displace fossil fuel-based electricity generation may be eligible to generate carbon credits. An I-REC for Electricity is referred to as an I-REC (E) and is an exchangeable Energy Attribute Certificate (EAC) that conveys information about the production of a unit of electricity such as where the electricity was produced, the capacity of the Production Facility, and the energy source.

  I-REC(E) can be used for a variety of (voluntary) requirements including Scope 2 reporting, national energy reporting, and general End-user claims, and allows all electricity users to make a conscious and evidence-based choice for electricity, in any country where service providers have been Accredited by the International Tracking Standard Foundation. The LCEC is the I-REC(E) Issuer in Lebanon.[11]

- Energy Efficiency Projects: involving projects to improve energy efficiency in buildings, industry, and transportation could potentially create carbon offset opportunities.

4.3. Analysis of Financial Outcomes

The purpose of the financial analysis is to evaluate the financial performance and to provide a better understanding on the investment value of the improvements proposed. A cost-benefit analysis approach is used to examine the feasibility study of the project in terms of finances and other important factors:

- Definition of the key assumptions.
- Description of the financing scenarios.
- Financial metrics/ viability parameters (NPV, IRR, ROI, payback period, discount rate)

The proposed measures were implemented in 2017 through a NEEREA loan subsidized by the Central Bank of Lebanon. This financial analysis is proposing new types of investment following the crash of the banking system in Lebanon since 2019. The retrofitting costs considered here are those of 2017 which still apply. In fact, following the huge inflation related to the economic crisis, the devaluation of the Lebanese Pound and the COVID19 pandemic, prices have fluctuated between 2019 and 2021. However, and following a market survey done by the LCEC, the current market prices of building material have regained the same levels as of pre-crises with a slight increase reaching maximum 5% for some material types.

[10] "AFDC, Association for Forests, Development & Conservation," AFDC, n.d. https://www.afdc.org.lb/

[11] "Issuers," The International Tracking Standard Foundation, n.d., https://www.trackingstandard.org/issuers/

4.3.1. Cash flow projections.

Energy savings (revenue)

The improvement of the building envelope has improved energy efficiency by reducing heat transfer and air leakage, resulting in reduced energy consumption for cooling and heating. The total annual energy saved is **74,529 kWh**, contributing to an annual income ranging from USD **45,090** (savings) to USD **145,420,** over the time period of 25 y assuming a unit electricity price of USD 0.605/kWh. This assumption is based on the fact that there is an annual trend of 5% increase in price changes, with electricity tariffs highly dependent on international fuel prices. It is estimated that the government will reduce or eliminate electricity subsidies over the time period of 25 years, which would improve the financial performance of the proposed measures.

Operations & Maintenance,

In general, these are annual running costs divided into: 1) maintenance cost as total of incurred labour, materials, and other related costs to maintain the building 2) operation costs that include running costs and costs of the facility management. Though, in the feasibility study the only direct expense that could be considered is the "building maintenance" related to the envelope and which is very minimal. Therefore, it is considered zero in the study.

Depreciation,

Based on the allowable depreciation rate by the Lebanese government for buildings, a 2.86%[12] flat depreciation rate has been used to calculate the yearly deductible deprecation, while considering 35 years life expectancy for the building. As a result, the yearly depreciation rate is equal to USD 13,689.

Corporate tax,

The Lebanese legislation offers special tax relief for investors to establish and develop their businesses in Lebanon. Exemptions from corporate tax on profits apply to the following: holding companies, offshore companies, education institutes, hospitals, cooperative associations, trade unions, local air and sea transport companies, touristic establishments. A 17% corporate tax has been applied to the feasibility study reflected in the Income statement analysis.

As assessed in **Table 6:**

5. Revenues over the 25 years are the same for all scenarios, equal to USD 2,152,017, since the yearly savings are considered equivalent during the evaluated period. During this period, nominal revenue generated is almost 4.5X the investment cost of the building envelope.
   - Repayment of loan interest varies from a scenario to another due to the interest rate applied differently by each FI. The loan interest expense is minimal compared to the cumulative revenue on the long-term regardless of the interest rates employed by the financial institution.
   - The income statement represents a positive cumulative Net profit giving an average Net profit margin of 65%.

Please refer to Annexes (I, II, III, IV) for detailed income statements for all four scenarios.

Table 6 Income statement comparison (with financing)

Income Statement comparison	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Energy savings (kwh/year)	74,529	74,529	74,529	74,529
Electricity tariff (average over 25 years)	$ 1.155	$ 1.155	$ 1.155	$ 1.155
Energy Savings (revenue / year)	$86,081	$ 86,081	$86,081	$86,081
Cumulative Revenue (25 years)	$ 2,152,017	$ 2,152,017	$2,152,017	$ 2,152,017
Interest rate	*15%*	*7%*	*4%*	*9%*
Maturity loan	*2 years*	*5 years*	*7 years*	*7 years*
Repayment of Loan Interest	$ (39,212)	$ (45,056)	$ (35,499)	$ (79,121)
Depreciation/ Year	**$ (13,690)**	**$ (13,690)**	**$ (13,690)**	**$ (13,690)**

[12] Nada ElSayed, "Lebanon, Corporate – Deductions," pwc, last reviewed 19 July 2024, https://taxsummaries.pwc.com/lebanon/corporate/deductions

Corporate tax (17%)	**$ 300,996**	**$300,003**	**$ 301,627**	**$ 294,212**
Cumulative Net Profit (25 years)	$ 1,469,569	$ 1,464,718	$ 1,472,651	$1,436,445

Table 7 represents the cash flow statements comparison for the four scenarios over the 25 years period:

- Cash flow from operating activities per year is identical for the four scenarios being the results of revenues (savings of energy consumption) of the building envelope materials.
- Cash flow from investing is also the same, representing 50% investment activities funded as equity.
- Cash flow from financing activities and the re-payment of loan principal, representing 50% of financing (debt) is also alike.
- The project has a positive cash flow at the end of the 25 years period amounting to USD 887,683.

Please refer to annexes (V, VI, VII, VIII) to better understand the yearly cash flow statement.

Table 7 Cash flow Statements comparison

Cash flow Comparison	Scenario 1	Scenario 2	Scenario 3	Scenario 4
Energy savings /Year	$86,081	$86,081	$ 86,081	$86,081
Cash flow from OPERATING	$ 86,081	$86,081	$86,081	$ 86,081
Cash injection (50%)	(239,568)	(239,568)	(239,568)	(239,568)
Cash flow from INVESTING	(239,568)	(239,568)	(239,568)	(239,568)
Financing (50%)	239,568	239,568	239,568	239,568
Principal loan repayment	(239,568)	(239,568)	(239,568)	(239,568)
T. Cash from financing	-	-	-	-
Cash Position after Operating/financing/investing	$1,912,449	$ 1,912,449	$ 1,912,449	$ 1,912,449

Table 8 Debt ratios

	Scenario 1	Scenario 2	Scenario 3	Scenario 4
EBITDA	$ 2,152,017	$ 2,152,017	$ 2,152,017	$ 2,152,017
Debt (50%)	$ 239,568	$ 239,568	$ 239,568	$ 239,568
Total investment	$ 479,136	$ 479,136	$ 479,136	$ 479,136
Total Interest payment	$ 39,212	$ 45,056	$ 35,499	$ 79,121
Debt/EBITDA ratio	**0.11**	**0.11**	**0.11**	**0.11**
T. Investment/EBITDA ratio	**0.22**	**0.22**	**0.22**	**0.22**
EBITDA /NET interest	**54.88**	**47.76**	**60.62**	**27.20**

The Net debt to EBITDA ratio is maximum 0.11 times as seen in the above table, which means the project can cover the debt from its yearly energy saving. Also, the total investment to EBITDA ratio is lower than 1, leading to a high probability of the project paying and refinancing its debt.

4.3.2. Debt structuring

The Cool Up team conducted an assessment for financing sustainable cooling sector in Lebanon, to identify post-crisis financing facilities. Based on this assessment, four scenarios are considered to evaluate the financial performance of the current feasibility study:

1. **Scenario 1**: Considers **CPI** "Corporate Private Investment". It is a newly established financial institution regulated by BDL that provides commercial loans at a minimum interest rate of 15% for a tenor of 1-2 years, against collateral provided by the client, with no limitation on the ticket size of the loan.
2. **Scenario 2**: Considers "**Solar & renewable energy fund**"[13]. Created by the United State Agency for International Development (USAID) and managed by IM venture. It is the first seed with a total fund of USD 20M to help capitalize clean and sustainable energy financing in Lebanon and to support the recovery of businesses. It provides loans at a commercial rate (average 7%) for up to 5 years with a

[13] "Who We Are," IMFndng, n.d. https://im-fndng.com/who-we-are

ticket size between USD 200,000 and USD 2,000,000. The fund is expected to be fully distributed prior to Q3-2024.

3. **Scenario 3:** Considers a **"NEW FUND"** while requesting financing line for sustainable cooling technologies for Lebanon from a Multilateral Development Bank. Cool Up could play a role to facilitate and help an appropriate institution to form the fund. Expected financing facility for this fund would be: 7 years tenors, with 4% interest rate (as an assumption) along with a grace period of 6 months minimum. Under this fund, a 10% grant could be also considered at the end of the project. This fund could provide financing for end-users and could be managed through a local financing institution.
4. **Scenario 4:** Considers a "**local bank"** offering financing facility in case banks are ready to lend again soon. Expected interest rate for local banks would be 8.5% for a tenor of 7 years, against collaterals by the client. It is worth mentioning, that local banks had increased the economic growth prior to 2019 since they financed many sectors such as agriculture, tourism, real estate. In addition to financing green projects that were mostly subsidized by BDL.

Table 9 demonstrates the four financing scenarios discussed above. Since the construction cost of the building is quite high, debt to equity assumption has been considered 50% for each respectively.

Table 9 Financing Scenarios

	Scenario1	Scenario 2	Scenario 3	Scenario 4
Service windows	**CPI**	**SOLAR Renewable Energy**	**NEW Fund**	**Local Banks**
Investment amount	479,136	479,136	479,136	479,136
Equity %	50%	50%	50%	50%
T. invested amount by the owner	239,568	239,568	239,568	239,568
Debt %	**50%**	**50%**	**50%**	**50%**
T. Loan amount	239,568	239,568	239,568	239,568
Annual interest rate	**15%**	**7%**	**4%**	**8.5%**
1st payment due	3/1/2024	3/1/2024	9/1/2024	6/1/2024
Last payment due	3/1/2026	3/1/2026	8/1/2031	5/1/2031
Maturity/year	**2**	**5**	**7**	**7**
Currency	USD	USD	USD	USD
Grace period	NA	NA	6Months	3Months
# of payments	**24**	**60**	**84**	**84**
Payment frequency	Monthly	Monthly	Monthly	Monthly
Loan date	2/1/2024	2/1/2024	2/1/2024	2/1/2024
Total interest till maturity	39,212	45,056	35,499	79,121
Monthly installment (including interest)	11,616	4,744	3,275	3,794
T. principal+ T. Interest	278,780	284,624	275,067	318,689

(Note: all amounts indicated in the table above are in USD unless indicated otherwise)

The four scenarios involve the same financial data fulfilled in the financial statements (IS, CF), except for the **interest rate** applied by each financial institution and the **maturity** of the loan. Following are the main key elements affecting the financial analysis:

4.4. Financial indicators

To better understand the financial health of the feasibility study, several financial metrics have been measured while assessing the value of the investment, its profitability and performance, for a period of 25 years. The different **interest rates** applied by each scenario is the only factor that modified the calculation and the value of the financial metrics. The main financial metrics used in the feasibility study are discount rate, IRR, NPV, payback period, ROI, and Net profit margin.

The discount rate,

The **Weighted average cost of capital** (WACC) method which is also called the discount rate has been selected to determine the present value of future cash flows of the building envelope at a certain discount rate. This discount rate is a result of the Cost of Equity and the Cost of Debt that have been considered 50%respectively.

The cost of equity is identical for the 4 scenarios which is the rate of return of the investor while considering the country risk premium, that is currently affected by Lebanon compounded crises. While the cost of Debt

varies from one scenario to another since it is affected by the interest rate applied by each financial institution.
Consequently, the high interest rate applied by each FI will lead to a high Cost of Debt, as well as a high discount rate that will reduce the value of future cash flow of the refurbished building. ***Please refer to Annex IX for a detailed WACC***

The IRR,
The internal rate of return has been determined as a guideline for evaluating whether the investment in upgrading the building envelope is worth pursuing, while analysing the profitability of the project. Typically, a higher IRR means better returns on the investments. Profitable projects have IRR higher than WACC.

The NPV,
The Net present value is another financial metric that has been calculated to show the total value of the investment based on future cash flows (negative and positive) reflected by the activities from operating, investing, and financing and based on the yearly discount rate (WACC).

The payback period,
The payback period shows the number of years required to recover the original investment & financing.

The ROI,
The Return on Investment is another profitability ratios used to evaluate the financial health of the investment. It is obtained yearly through the income statement (NI/Initial investment).

The profit margin,
The profit margin measures the percentage (%) of profit generated from its total yearly energy savings (revenue).

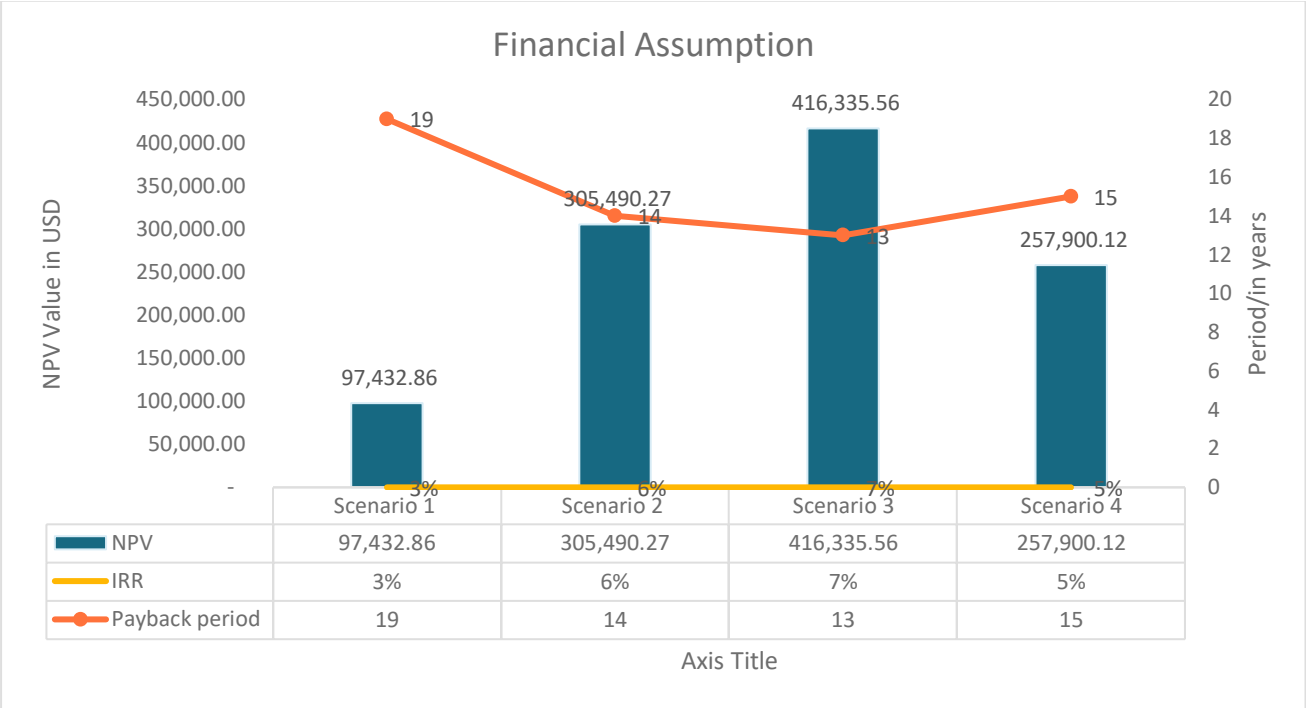
In this matter, as shown in **table 10**, the four scenarios show different financial metrics. As confirmed by LCEC, "**PBP**" of envelope measures in Lebanon are usually very high specifically when electricity tariffs are low. As a result:

- **Scenario 1,** is the least attractive with the lowest NPV of USD 97,432 and the longest payback period due to the high interest rate.
- **Scenario 2** has a reasonable payback period of 14 years with an IRR of 6%.
- **Scenario 3,** the creation of a new fund, may be the best chiller/passive cooling financing scenario for Lebanon as it has the lowest risk due to the lowest discount rate of 6.67%, giving an IRR of 7% and an NPV of USD 416,335 with a payback period of 13 years.
- **Scenario 4** has a payback period of 15 years and a net present value of USD 257,900, but this is due to the high-interest rate risk, which reflects a high discount rate while reducing the internal rate of return and the net present value of future cash flows.

It is worth mentioning, a slight increase in the tariff rate will change all above mentioned scenario positively and financial metrics will me more attractive, especially that tariff rate applied in the feasibility study is very conservative. Please refer to section 5 for a sensitivity analysis.

Table 10 Financial metrics

25 years financial assumptions	Discount rate	IRR	NPV	Payback	AVG ROI	AVG Net Profit
Scenario 1	11%	3%	97,432.86	19	12%	65%
Scenario 2	8%	6%	305,490.27	14	12%	65%
Scenario 3	7%	7%	416,335.56	13	12%	65%
Scenario 4	9%	5%	257,900.12	15	12%	65%



	Scenario 1	Scenario 2	Scenario 3	Scenario 4
NPV	97,432.86	305,490.27	416,335.56	257,900.12
IRR	3%	6%	7%	5%
Payback period	19	14	13	15

Figure 4 Key financial assumptions

Figure 5 represents few projects that were granted loans via the NEEREA financing mechanism through BDL between 2012-2020, while the electricity tariffs were around 0.15 USD/kWh (considering 20 hours of EDL and 4 hours of private generators). As shown in the figure, the payback period of these projects fluctuates and some of the project had a PBP above 40-60 years. Hence, the payback period from energy saving alone is considered lengthy. Consequently, The PBP of Koreitem building between 13 years and 21 years compared to the PBP for NEEREA projects is considered attractive, promising, and applicable to other building in Beirut governorate and other regions in the country.

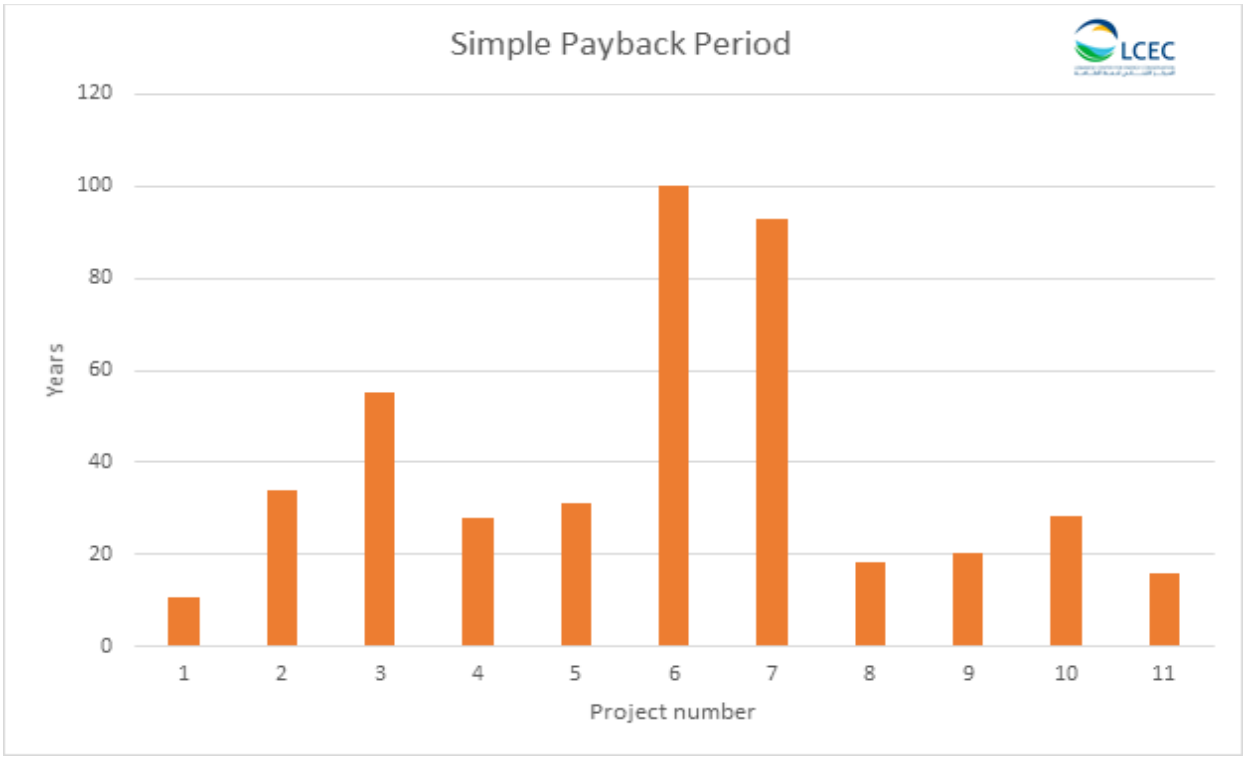


Figure 5 Payback period for Granted projects by NEEREA

5. Sensitivity Scenarios

A sensitivity analysis has been carried out to reflect one variable factor, the electricity tariff, and its impact on the project.

- The first sensitivity analysis (best case 1) considers the electricity tariff applied in year 25 in the study which is USD 1.95.
- The second sensitivity analysis scenario (best case 2) considers an additional 15 % increase in the electricity tariff USD 2.24.

As we can see, **Table 11** describes the cumulative net profit growth reflected in the income statement over the 25-year period for the 4 different financing scenarios:

- An 84% increase in cumulative net profit for best case 1
- Around 17% increase using best case 2 at USD 2.24 tariff rate.

Table 11 Cumulative NET Profit Growth

		CPI	SOLR Renewable Energy	NEW Fund	Local Banks
	Electricity Price	NET Profit Growth			
Base Case	1.155	$ 1,469,569	1,464,718	1,472,651	1,436,445
Best Case 1	1.951	$ 2,700,857	2,695,014	2,704,571	2,660,949
Best case 2	2.244	$ 3,153,477	3,148,627	3,156,559	3,120,353
	Changes				
Best Case 1	84%	84%	84%	84%	85%
Best case 2	17%	17%	17%	17%	17%

Table 12 shows the changes in cumulative cash flow reflected in the 4 financing scenarios (CPI, SLR Renewables, New Fund and Local Banks) based on the sensitivity analysis for Best Case 1 and 2, representing a minimum improvement of 78% in the cash flow statement.

Table 12 Cumulative Cash flow Comparison

	Electricity tariff	Cumulative Cash flow	Changes
Base Case	1.15	1,912,449.0	
Best Case 1	1.95	3,395,929.5	78%
Best case 2	2.24	3,941,254.2	106%

Table 13 reflects the changes of financial metrics based on the sensitivity analysis for Best Case 1 and 2:

- A significant increase in the NPV, with a maximum of USD 1,282,670 for Best Case 1 and a maximum of USD 1,544,695 for Best Case 2, indicating that the projected revenue from energy savings exceeds the investment cost and the project is considered viable.
- The IRR has also increased, reaching a maximum IRR of 26% for Best Case 1 and 32% for Best Case 2, compared to 2%-7% in the base case.
- All scenarios now have a payback period within the 5-6-year study. The PBP has decreased from 15-19 years to an average of 5-6 years PBP.

Table 13 Financial metrics

	NPV	IRR	PB period	Cumulative CF
Best Case 1 (Electricity tariff USD 1.95)				
Scenario 1	749,345.9	21%	6	3,395,930
Scenario 2	1,102,573.3	25%	5	
Scenario 3	1,282,670.4	26%	5	
Scenario 4	1,023,768.6	24%	5	
Best Case 2 (Electricity tariff USD 2.24)				
Scenario 1	929,989.7	27%	5	3,941,254
Scenario 2	1,337,195.2	30%	5	
Scenario 3	1,544,695.5	32%	5	
Scenario 4	1,246,378.8	30%	5	

Please refer to Annex XIV & XI for a detailed Sensitivity analysis financial metrics (NPV, IRR, PBP)

6. Risk Assessment and Mitigation

6.1. Financial Risks

Financial risks identified in the project appraisal are low to medium.

Price (Electricity Tariff) & foreign exchange risks,

As mentioned in Section 3.2, the buildings represent more than 40%[14] of total energy use, with residential buildings accounting for 30% of total electricity consumption. Hence, the construction sector is a burden on the energy sector in Lebanon.

Following the crisis, reducing energy consumption, and relying on alternative energy sources have become crucial. The end of affordable subsidized energy that was stopped by BDL has made RE competitive. However, the currency devaluation makes it more difficult to import the required equipment.

The 2019 monetary crisis has also hindered EDL's access to foreign currency, which has stalled its ability to import fossil fuels. This has led to a near collapse of EDL's operations, with electricity shortages reaching 23 hours per day in 2022. Recently, EDL has guaranteed 4-6 hours electricity supply and decreasing the shortages to 18-20 hours per day. The supply gap has been compensated by expensive and polluting private generators whose tariffs range from 50-100 $cent/kWh, being the highest electricity price in the region which also has impacted and increased the inflation rate in the country.

Therefore, upgrading building envelopes and installing new cooling technologies would contribute to energy conservation and environmental protection while reducing energy costs, at the same time improving national natural sources and energy efficiency in buildings.

The energy price utilized in the study is the sum of tariffs for both EDL and private generators per kWh which might fluctuate from one region to another. Mostly, the tariff is around USD 0.605/kWh for Beirut governate. The risk associated with electricity prices applied in the feasibility study and cost savings are estimated to be at a medium level. While the increase price of electricity will increase the savings of energy consumption from cooling and heating, and which will further increase the positive effect of the investment.

There is no clear evidence if the electricity prices will decrease soon, especially that the government is willing to increase the electricity tariff in the future beyond the bracket USD 0.1- 0.27/ kWh. The price of electricity in Lebanon had remained fixed at 0.001 cent/kWh since 1994, before experiencing a 100-fold increase in November 2023, to a minimum of 0.10 cents for the first 100 kWh and increasing to USD 0.26/kWh while consumption exceeding the 100kWh.The electricity tariffs for EDL are now USD 10cent/kWh for consumption up to 100 kWh, and USD 27 cent/kwh for the remaining brackets. This shows that there is lately high instability of electricity prices which increases financial sense of the energy efficiency projects (such as building envelope renovations) leading to higher resilience on future price increases.

Capital Cost Evaluation Risk,

CAPEX data have been assessed according to the data provided by the building owner and LCEC. The risk associated to the capital which are the cost of materials is the potential increase of materials and equipment which will affect the NPV, ROI, and the payback period of the project.

Loan risk,

The 2019 crisis has ceased the financing through the banking sector and micro-finance institutions. Also, facilities[15] developed by MDBs to provide financing for RE & EE have been annulled. Till today, there are no evidence of re-financing the local economy through the banking system. However, many alternative financing mechanisms have been introduced to the local market but tailored to specific sectors and

[14] Lebanon Green building roadmap 2022 released by UNDP.

[15] GEFF by EBRD, LEEREFF BY EIB and AFD.

objectives[16]. Currently, there is no financing mechanism for cooling technologies in specific. Thus, **Scenario 3** is highly recommended for Lebanon to establish a fund, tailored for cooling technologies and passive cooling to finance the commercial sector. This fund could be managed by a local financial institution.

Interest rate risk,
The risk associated to the interest rate vary based on the chosen Scenario:

- **Scenario 1** has the highest interest rate of 15% accompanied by strong collaterals and increase the level of risk.
- **Scenario 2** and **Scenario 4** have a moderate interest rate and risk.
- While **Scenario 3** has the most appropriate interest rate and enhanced by the least risk.

6.2. Technical Risks

Upgrading a building envelope entails various technical risks, including potential compromises to the structure's stability. Alterations to load-bearing elements like walls or pillars, if not properly reinforced, could undermine the building's stability. For instance, removing a load-bearing wall without adequate support structures could weaken the overall structure. Similarly, enlarging windows or adding new structural features like canopies may necessitate reinforcing the building's frame to bear the additional weight and uphold its structural integrity.

Changes to the envelope's design or materials can affect its ability to manage moisture, potentially leading to water infiltration, mold growth, and the deterioration of building materials. Neglecting waterproofing issues during renovation, such as improperly sealed windows or doors, may permit water to seep into the building, resulting in damage to walls, floors, and ceilings.

Depending on the measures implemented, it's crucial to avoid creating gaps, cracks, or openings in the envelope that could cause air leakage, impacting internal comfort and increasing thermal loads. For example, installing high-performance windows without addressing air leaks or insufficient insulation elsewhere in the building envelope can create thermal bridging and diminish overall energy savings.

Furthermore, failure to adhere to building codes can result in legal and safety repercussions. For instance, conducting renovations without obtaining necessary permits could lead to fines or necessitate redoing the work to comply with code requirements. Renovation projects also have environmental implications, generating waste and consuming resources. Opting for materials with lower embodied carbon or sourcing locally can help minimize the environmental footprint of the renovation endeavour.

[16] Cedars Oxygen provide financing for industries.

7. Energy and Environmental Benefits

7.1. Energy Savings

There are several ways to save energy in buildings, they can be draw down to two types:

- Active measures – these measures focus on exchange (in existing buildings) or application (in new buildings) of high performing technologies such as:
    - Heat sources with high efficiency or alternative heat sources – heat pumps with high COP
    - Air conditioning with high efficiency (high EU labelling, high EER/SEER)
    - Ventilation with heat recovery
    - Efficient lighting
    - Efficient motors/pumps
    - and other equipment that during their operation use less energy than the old/standard one.
- Passive measures – these measures focus on application of solutions that do not use energy by themselves but reduce the energy (in form of heating, cooling or lighting) needed by the active measures and to assure comfort of the building occupants. Such measures are, amongst other:
    - Insulation
    - Efficient windows and doors
    - Shading
    - Design features – to use the sun light efficiently, and other.

In the analysed case the owner of the building has applied:

- **Wall insulation** that reduces the wall heat transfer.
- **Roof insulation (polystyrene)** that enhances the building comfort, protects against moisture damages, and reduces thermal loads (heating & cooling)
- **Double-glazed windows**, that reduces the loss of heat during winter and coolness during summer.

These are passive measures that led to energy demand reduction by 19% in case of cooling and 60% in case of heating that can be translated to ca. $45,000 of savings per year.

7.2. Emission Reduction

Basing on the findings of the Cooling Sector Prospect Study for Lebanon the following assumptions were taken into consideration when calculating the emission reduction in this feasibility study.

Table 14 Emission

	2020	2050
Emission factor	673 g CO_{2eq}/kWh	367 g $CO_{2eq/kWh}$
Source	Lebanese Centre for Energy Conservation	Modelling result

	2020-2030	2030-2040	2040-2050
Annual emission factor reduction	2%	2%	2%

The applied measures have led to decrease of GHG emissions by 50 tonnes of CO_2/year in the first year.

Taking into consideration the above grid emission factor reduction the total emission reduction for the period of 25 years is 994 tonnes of CO_2.

8. Conclusions and Recommendations

In conclusion, retrofitting is an effective way to improve the energy efficiency of existing buildings. By investing in these upgrades, building owners can achieve significant energy savings, increase property value, improve comfort, and contribute to a more sustainable future. Here are some key takeaways that highlight the potential of building envelope upgrades:

- It can at least save up to 20% on energy bills, significantly reducing operational cost.
- It can contribute to a greener future by reducing greenhouse gas emissions and conserving valuable natural resources.
- It can offer a relatively quick ROI with a remarkable payback period within few years, depending on the size of investment and the climate of the region where the building is located.
- Note: the analysed example is based on a real case project. It is highly probable that there will be many projects with an even better financial outcome than the one analysed since the Cool Up Team chose a conservative example.

By ratifying the Kigali agreement, Lebanon has an obligation to the phase down of HFCs by 2045. Though, financing the cooling sector in Lebanon is a must to reduce the country's energy emissions and improve the energy efficiency. Financial incentives by both the governments and utility companies, such as rebates or tax credits, are considered mandatory to encourage building owners to invest in energy-efficient upgrades.

And finally, compliance with regulations: as energy codes become increasingly stringent, building envelope upgrades help ensure compliance with the latest energy efficiency standards and regulations.

References

6wresearch. "Lebanon Construction Materials Market (2024-2030) | Size, Growth, Trends, Revenue, Companies, Industry, Share, Analysis, Value, Outlook & Forecast." Last updated May 2024. https://www.6wresearch.com/industry-report/lebanon-construction-materials-market-2020-2026.

AFDC. "AFDC, Association for Forests, Development & Conservation." N.d. https://www.afdc.org.lb/.

"Air Conditioning Systems Market Size, Share & Trends Analysis Report By Type (Unitary, Rooftop, PTAC), By Technology (Inverter, Non-Inverter), By End-use, By Region, And Segment Forecasts, 2023 – 2030," Grand View Research, https://www.grandviewresearch.com/industry-analysis/air-conditioning-systems-industry#:~:text=The%20air%20conditioning%20systems%20market%20is%20expected%20to%20grow%20at,%20USD%20200.72%20billion%20by%202030.

Ashrae. "Ashrae: Shaping Tomorrow's Global Built Environment Today." N.d. https://www.ashrae.org/.

ElSayed, Nada. "Lebanon, Corporate – Deductions." Pwc. Last reviewed 19 July 2024, https://taxsummaries.pwc.com/lebanon/corporate/deductions.

Grözinger, Jan, et al. "Cooling Sector Prospects Study Lebanon." *Guidehouse Germany GmbH*, 2023. https://www.COOLUPprogramme.org/knowledge-base/reports/cooling-sector-prospects-study-lebanon/

IMFndng. "Who We Are." N.d. https://im-fndng.com/who-we-are.

Statista. "Heating & Cooling." N.d. https://www.statista.com/outlook/cmo/diy-hardware-store/heating-cooling/lebanon.

The International Tracking Standard Foundation. "Issuers." N.d. https://www.trackingstandard.org/issuers/

Weather and Climate. "Koreitem, Beirut, Lebanon Climate." N.d. https://weatherandclimate.com/lebanon/beirut/koreitem.

9. Annex List

Annex I: Income Statement Scenario 1

Annex II: Income Statement Scenario 2

Annex III: Income Statement Scenario 3

Annex IV: Income Statement Scenario 4

Annex V: Cash Flow Statement Scenario 1

Annex VI: Cash Flow Statement Scenario 2

Annex VII: Cash Flow Statement Scenario 3

Annex VIII: Cash flow Statement Scenario 4

Annex IX: Weighted Average Cost of Capital

Annex X: Financial metrics analysis Scenario 1

Annex XI: Financial metrics analysis Scenario 2

Annex XII: Financial metrics analysis Scenario 3

Annex XIII: Financial metrics analysis Scenario 4

Annex XIV: Financial metrics analysis-sensitivity analysis best case 1(Scenario 1,2,3,4)

Annex XV: Financial metrics analysis-sensitivity analysis best case 1(Scenario 1,2,3,4)

Annex XVI: Energy consumption before & after building envelope upgrades.

Annex I: Income Statement-Scenario 1

SCENARIO 1/ MATURITY 2 YRS	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25
(USD)	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
Energy savings from electricity	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529
Unit Price (USD/KWH)	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.9	0.9	0.9	1.0	1.0	1.1	1.1	1.2	1.3	1.3	1.4	1.5	1.5	1.6	1.7	1.8	1.9	1.95
Energy Saving Revenues	**45,090**	**47,345**	**49,712**	**52,197**	**54,807**	**57,548**	**60,425**	**63,446**	**66,619**	**69,949**	**73,447**	**77,119**	**80,975**	**85,024**	**89,275**	**93,739**	**98,426**	**103,347**	**108,515**	**113,940**	**119,637**	**125,619**	**131,900**	**138,495**	**145,420**
Loan Interest expenses	(28,518)	(10,695)																							
T. financing expenses	**(28,518)**	**(10,695)**	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Depreciation of Materials	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)
Total Depreciation Expenses	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**
Earnings before Taxes	**2,883**	**22,960**	**36,022**	**38,508**	**41,118**	**43,858**	**46,735**	**49,757**	**52,929**	**56,260**	**59,757**	**63,430**	**67,286**	**71,334**	**75,586**	**80,049**	**84,736**	**89,658**	**94,825**	**100,251**	**105,948**	**111,930**	**118,211**	**124,806**	**131,730**
Corporate Tax	490	3,903	6,124	6,546	6,990	7,456	7,945	8,459	8,998	9,564	10,159	10,783	11,439	12,127	12,850	13,608	14,405	15,242	16,120	17,043	18,011	19,028	20,096	21,217	22,394
NET PROFIT	**2,393**	**19,057**	**29,898**	**31,961**	**34,128**	**36,402**	**38,790**	**41,298**	**43,931**	**46,696**	**49,599**	**52,647**	**55,847**	**59,208**	**62,736**	**66,441**	**70,331**	**74,416**	**78,705**	**83,208**	**87,937**	**92,902**	**98,115**	**103,589**	**109,336**
Cumulative NET Profit	**2,393**	**21,450**	**51,348**	**83,310**	**117,437**	**153,839**	**192,630**	**233,928**	**277,859**	**324,554**	**374,153**	**426,800**	**482,647**	**541,854**	**604,590**	**671,031**	**741,362**	**815,778**	**894,483**	**977,691**	**1,065,628**	**1,158,529**	**1,256,644**	**1,360,233**	**1,469,569**
ROI	**0%**	**4%**	**6%**	**7%**	**7%**	**8%**	**8%**	**9%**	**9%**	**10%**	**10%**	**11%**	**12%**	**12%**	**13%**	**14%**	**15%**	**16%**	**16%**	**17%**	**18%**	**19%**	**20%**	**22%**	**23%**
Profit Margin	**5%**	**40%**	**60%**	**61%**	**62%**	**63%**	**64%**	**65%**	**66%**	**67%**	**68%**	**68%**	**69%**	**70%**	**70%**	**71%**	**71%**	**72%**	**73%**	**73%**	**74%**	**74%**	**74%**	**75%**	**75%**

Annex II: Income Statement-Scenario 2

SCENARIO 2/ MATURITY 2 YRS	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25
(USD)	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
Energy savings from electricity	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529
Unit Price (USD/KWH)	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.9	0.9	0.9	1.0	1.0	1.1	1.1	1.2	1.3	1.3	1.4	1.5	1.5	1.6	1.7	1.8	1.9	1.95
Energy Saving Revenues	**45,090**	**47,345**	**49,712**	**52,197**	**54,807**	**57,548**	**60,425**	**63,446**	**66,619**	**69,949**	**73,447**	**77,119**	**80,975**	**85,024**	**89,275**	**93,739**	**98,426**	**103,347**	**108,515**	**113,940**	**119,637**	**125,619**	**131,900**	**138,495**	**145,420**
Loan Interest expenses	(15,456)	(12,458)	(9,244)	(5,797)	(2,101)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
T. financing expenses	**(15,456)**	**(12,458)**	(9,244)	(5,797)	(2,101)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Depreciation of Materials	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)
Total Depreciation Expenses	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**
Earnings before Taxes	**15,944**	**21,197**	**26,778**	**32,711**	**39,017**	**43,858**	**46,735**	**49,757**	**52,929**	**56,260**	**59,757**	**63,430**	**67,286**	**71,334**	**75,586**	**80,049**	**84,736**	**89,658**	**94,825**	**100,251**	**105,948**	**111,930**	**118,211**	**124,806**	**131,730**
Corporate Tax	2,711	3,603	4,552	5,561	6,633	7,456	7,945	8,459	8,998	9,564	10,159	10,783	11,439	12,127	12,850	13,608	14,405	15,242	16,120	17,043	18,011	19,028	20,096	21,217	22,394
NET PROFIT	**13,234**	**17,593**	**22,226**	**27,150**	**32,384**	**36,402**	**38,790**	**41,298**	**43,931**	**46,696**	**49,599**	**52,647**	**55,847**	**59,208**	**62,736**	**66,441**	**70,331**	**74,416**	**78,705**	**83,208**	**87,937**	**92,902**	**98,115**	**103,589**	**109,336**
Cumulative NET Profit	**13,234**	**30,827**	**53,053**	**80,203**	**112,587**	**148,989**	**187,779**	**229,077**	**273,008**	**319,704**	**369,303**	**421,949**	**477,796**	**537,004**	**599,740**	**666,181**	**736,512**	**810,928**	**889,633**	**972,841**	**1,060,777**	**1,153,679**	**1,251,794**	**1,355,382**	**1,464,718**
ROI	**3%**	**4%**	**5%**	**6%**	**7%**	**8%**	**8%**	**9%**	**9%**	**10%**	**10%**	**11%**	**12%**	**12%**	**13%**	**14%**	**15%**	**16%**	**16%**	**17%**	**18%**	**19%**	**20%**	**22%**	**23%**
Profit Margin	**29%**	**37%**	**45%**	**52%**	**59%**	**63%**	**64%**	**65%**	**66%**	**67%**	**68%**	**68%**	**69%**	**70%**	**70%**	**71%**	**71%**	**72%**	**73%**	**73%**	**74%**	**74%**	**74%**	**75%**	**75%**

Annex III: Income Statement-Scenario 3

SCENARIO 3/ MATURITY 7 YRS	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25
(USD)	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
Energy savings from Electricity	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529
Unit Price (USD/KWH)	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.9	0.9	0.9	1.0	1.0	1.1	1.1	1.2	1.3	1.3	1.4	1.5	1.5	1.6	1.7	1.8	1.9	1.95
Energy Saving Revenues	**45,090**	**47,345**	**49,712**	**52,197**	**54,807**	**57,548**	**60,425**	**63,446**	**66,619**	**69,949**	**73,447**	**77,119**	**80,975**	**85,024**	**89,275**	**93,739**	**98,426**	**103,347**	**108,515**	**113,940**	**119,637**	**125,619**	**131,900**	**138,495**	**145,420**
Loan Interest expenses	(9,032)	(7,799)	(6,516)	(5,180)	(3,790)	(2,344)	(838)	-	-	-	-	-	-	-	-	-	-								
T. financing expenses	**(9,032)**	**(7,799)**	(6,516)	(5,180)	(3,790)	(2,344)	(838)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Depreciation of Materials	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)
Total Depreciation Expenses	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**
Earnings before Taxes	**22,369**	**25,856**	**29,506**	**33,328**	**37,327**	**41,514**	**45,897**	**49,757**	**52,929**	**56,260**	**59,757**	**63,430**	**67,286**	**71,334**	**75,586**	**80,049**	**84,736**	**89,658**	**94,825**	**100,251**	**105,948**	**111,930**	**118,211**	**124,806**	**131,730**
Corporate Tax	3,803	4,396	5,016	5,666	6,346	7,057	7,802	8,459	8,998	9,564	10,159	10,783	11,439	12,127	12,850	13,608	14,405	15,242	16,120	17,043	18,011	19,028	20,096	21,217	22,394
NET PROFIT	**18,566**	**21,461**	**24,490**	**27,662**	**30,982**	**34,457**	**38,095**	**41,298**	**43,931**	**46,696**	**49,599**	**52,647**	**55,847**	**59,208**	**62,736**	**66,441**	**70,331**	**74,416**	**78,705**	**83,208**	**87,937**	**92,902**	**98,115**	**103,589**	**109,336**
Cumulative NET Profit	**18,566**	**40,026**	**64,517**	**92,179**	**123,160**	**157,617**	**195,712**	**237,010**	**280,941**	**327,636**	**377,235**	**429,882**	**485,729**	**544,936**	**607,672**	**674,113**	**744,444**	**818,860**	**897,565**	**980,773**	**1,068,710**	**1,161,611**	**1,259,726**	**1,363,315**	**1,472,651**
ROI	**4%**	**4%**	**5%**	**6%**	**6%**	**7%**	**8%**	**9%**	**9%**	**10%**	**10%**	**11%**	**12%**	**12%**	**13%**	**14%**	**15%**	**16%**	**16%**	**17%**	**18%**	**19%**	**20%**	**22%**	**23%**
Profit Margin	**41%**	**45%**	**49%**	**53%**	**57%**	**60%**	**63%**	**65%**	**66%**	**67%**	**68%**	**68%**	**69%**	**70%**	**70%**	**71%**	**71%**	**72%**	**73%**	**73%**	**74%**	**74%**	**74%**	**75%**	**75%**

Annex IV: Income Statement-Scenario 4

SCENARIO 4/ MATURITY 7 YRS	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25
(USD)	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
Energy savings from electricity	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529
Unit Price (USD/KWH)	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.9	0.9	0.9	1.0	1.0	1.1	1.1	1.2	1.3	1.3	1.4	1.5	1.5	1.6	1.7	1.8	1.9	1.95
Energy Saving Revenues	**45,090**	**47,345**	**49,712**	**52,197**	**54,807**	**57,548**	**60,425**	**63,446**	**66,619**	**69,949**	**73,447**	**77,119**	**80,975**	**85,024**	**89,275**	**93,739**	**98,426**	**103,347**	**108,515**	**113,940**	**119,637**	**125,619**	**131,900**	**138,495**	**145,420**
Loan Interest expenses	(19,359)	(17,046)	(14,529)	(11,789)	(8,807)	(5,561)	(2,029)	-	-	-	-														
T. financing expenses	**(19,359)**	**(17,046)**	(14,529)	(11,789)	(8,807)	(5,561)	(2,029)	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	**-**
Depreciation of Materials	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)	(13,690)
Total Depreciation Expenses	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**	**(13,690)**
Earnings Before income tax)	**12,041**	**16,608**	**21,493**	**26,719**	**32,311**	**38,297**	**44,707**	**49,757**	**52,929**	**56,260**	**59,757**	**63,430**	**67,286**	**71,334**	**75,586**	**80,049**	**84,736**	**89,658**	**94,825**	**100,251**	**105,948**	**111,930**	**118,211**	**124,806**	**131,730**
Corporate Tax	2,047	2,823	3,654	4,542	5,493	6,510	7,600	8,459	8,998	9,564	10,159	10,783	11,439	12,127	12,850	13,608	14,405	15,242	16,120	17,043	18,011	19,028	20,096	21,217	22,394
NET PROFIT	**9,994**	**13,785**	**17,839**	**22,176**	**26,818**	**31,786**	**37,107**	**41,298**	**43,931**	**46,696**	**49,599**	**52,647**	**55,847**	**59,208**	**62,736**	**66,441**	**70,331**	**74,416**	**78,705**	**83,208**	**87,937**	**92,902**	**98,115**	**103,589**	**109,336**
Cumulative NET Profit	**9,994**	**23,779**	**41,618**	**63,795**	**90,613**	**122,399**	**159,506**	**200,804**	**244,735**	**291,430**	**341,029**	**393,676**	**449,523**	**508,730**	**571,466**	**637,907**	**708,238**	**782,654**	**861,359**	**944,567**	**1,032,504**	**1,125,405**	**1,223,520**	**1,327,108**	**1,436,445**
ROI	**2%**	**3%**	**4%**	**5%**	**6%**	**7%**	**8%**	**9%**	**9%**	**10%**	**10%**	**11%**	**12%**	**12%**	**13%**	**14%**	**15%**	**16%**	**16%**	**17%**	**18%**	**19%**	**20%**	**22%**	**23%**
Profit Margin	**22%**	**29%**	**36%**	**42%**	**49%**	**55%**	**61%**	**65%**	**66%**	**67%**	**68%**	**68%**	**69%**	**70%**	**70%**	**71%**	**71%**	**72%**	**73%**	**73%**	**74%**	**74%**	**74%**	**75%**	**75%**

Annex V: Cash Flow statement- Scenario 1

CF/Scenario 1	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25
	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
Energy savings from Electricity	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529
Unit Price (USD/KWH)	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.9	0.9	0.9	1.0	1.0	1.1	1.1	1.2	1.3	1.3	1.4	1.5	1.5	1.6	1.7	1.8	1.9	2.0
Energy Saving Revenues	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**
Depreciation	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690
Cash flow from OPERATING	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**
Cash injection	(239,568)	-	-	-	-	-	-	-	-	-	-	-	-	-	-										
Cash flow from INVESTING	**(239,568)**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Financing	239,568	-	-	-	-	-	-	-	-	-	-	-	-	-	-										
Principal loan repayment	(110,872)	(128,696)	-	-	-	-	-	-	-	-	-														
T. Cash from financing	**128,696**	**(128,696)**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Net Change in Cash	(65,782)	(81,351)	49,712	52,197	54,807	57,548	60,425	63,446	66,619	69,949	73,447	77,119	80,975	85,024	89,275	93,739	98,426	103,347	108,515	113,940	119,637	125,619	131,900	138,495	145,420
Cash At the beginning of the period	-	(65,782)	(147,133)	(97,422)	(45,224)	9,583	67,131	127,556	191,002	257,620	327,570	401,017	478,136	559,111	644,135	733,410	827,149	925,575	1,028,922	1,137,437	1,251,377	1,371,015	1,496,634	1,628,534	1,767,029
Cash at the end of the Period	(65,782)	(147,133)	(97,422)	(45,224)	9,583	67,131	127,556	191,002	257,620	327,570	401,017	478,136	559,111	644,135	733,410	827,149	925,575	1,028,922	1,137,437	1,251,377	1,371,015	1,496,634	1,628,534	1,767,029	1,912,449

Annex VI: Cash Flow statement- Scenario 2

SCENARIO 2/ MATURITY 2 YRS	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25
(USD)	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
Energy savings from Electricity	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529
Unit Price (USD/KWH)	0.6	0.6	0.7	0.7	0.7	0.8	0.8	0.9	0.9	0.9	1.0	1.0	1.1	1.1	1.2	1.3	1.3	1.4	1.5	1.5	1.6	1.7	1.8	1.9	2.0
Energy Saving Revenues	**45,090**	**47,345**	**49,712**	**52,197**	**54,807**	**57,548**	**60,425**	**63,446**	**66,619**	**69,949**	**73,447**	**77,119**	**80,975**	**85,024**	**89,275**	**93,739**	**98,426**	**103,347**	**108,515**	**113,940**	**119,637**	**125,619**	**131,900**	**138,495**	**145,420**
Deprecation	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690
Cash flow from OPERATING	**58,780**	**61,034**	**63,401**	**65,887**	**68,497**	**71,237**	**74,115**	**77,136**	**80,308**	**83,639**	**87,137**	**90,809**	**94,665**	**98,714**	**102,965**	**107,429**	**112,116**	**117,037**	**122,204**	**127,630**	**133,327**	**139,309**	**145,590**	**152,185**	**159,110**
Cash injection	(239,568)	-	-	-	-	-	-	-	-	-	-	-	-	-	-										
Cash flow from INVESTING	**(239,568)**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Financing	239,568	-	-	-	-	-	-	-	-	-	-	-	-	-	-										
Principal loan repayment	(41,469)	(44,467)	(47,681)	(51,128)	(54,824)	-	-	-																	
T. Cash from financing	**198,099**	**(44,467)**	**(47,681)**	**(51,128)**	**(54,824)**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Net Change in Cash	3,621	2,878	2,031	1,070	(17)	57,548	60,425	63,446	66,619	69,949	73,447	77,119	80,975	85,024	89,275	93,739	98,426	103,347	108,515	113,940	119,637	125,619	131,900	138,495	145,420
Cash At the beginning of the period	-	3,621	6,499	8,530	9,600	9,583	67,131	127,556	191,002	257,620	327,570	401,017	478,136	559,111	644,135	733,410	827,149	925,575	1,028,922	1,137,437	1,251,377	1,371,015	1,496,634	1,628,534	1,767,029
Cash at the end of the Period	3,621	6,499	8,530	9,600	9,583	67,131	127,556	191,002	257,620	327,570	401,017	478,136	559,111	644,135	733,410	827,149	925,575	1,028,922	1,137,437	1,251,377	1,371,015	1,496,634	1,628,534	1,767,029	1,912,449

Annex VII: Cash Flow statement- Scenario 3

SCENARIO 3/ MATURITY 7 YRS	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25
(USD)	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
Energy savings from Electricity	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529
Unit Price (USD/KWH)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Energy Saving Revenues	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**
Depreciation	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690
Cash flow from OPERATING	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**
Cash injection	(239,568)	-	-	-	-	-	-	-	-	-	-	-	-	-	-										
Cash flow from INVESTING	**(239,568)**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Financing	239,568	-	-	-	-	-	-	-	-	-	-	-	-	-	-										
Loan Repayment	(30,263)	(31,496)	(32,780)	(34,115)	(35,505)	(36,952)	(38,457)	-	-	-	-														
Net Change in Cash	14,827	15,848	16,932	18,082	19,302	20,596	21,968	63,446	66,619	69,949	73,447	77,119	80,975	85,024	89,275	93,739	98,426	103,347	108,515	113,940	119,637	125,619	131,900	138,495	145,420
Cash At the beginning of the period	-	14,827	30,675	47,607	65,689	84,991	105,588	127,556	191,002	257,620	327,570	401,017	478,136	559,111	644,135	733,410	827,149	925,575	1,028,923	1,137,437	1,251,377	1,371,015	1,496,634	1,628,534	1,767,029
Cash at the end of the Period	14,827	30,675	47,607	65,689	84,991	105,588	127,556	191,002	257,620	327,570	401,017	478,136	559,111	644,135	733,410	827,149	925,575	1,028,923	1,137,437	1,251,377	1,371,015	1,496,634	1,628,534	1,767,029	1,912,449

Annex VIII: Cash Flow statement- Scenario 4

SCENARIO 4/ MATURITY 7 YRS	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Year 7	Year 8	Year 9	Year 10	Year 11	Year 12	Year 13	Year 14	Year 15	Year 16	Year 17	Year 18	Year 19	Year 20	Year 21	Year 22	Year 23	Year 24	Year 25
(USD)	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
Energy savings from Electricity	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529	74,529
Unit Price (USD/KWH)	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6	0.6
Energy Saving Revenues	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**	**45,090**
Depreciation	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690	13,690
Cash flow from OPERATING	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**	**58,780**
Cash injection	(239,568)	-	-	-	-	-	-	-	-	-	-	-	-	-	-										
Cash flow from INVESTING	**(239,568)**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Financing	239,568	-	-	-	-	-	-	-	-	-	-	-	-	-	-										
Loan Repayment	(26,168)	(28,481)	(30,998)	(33,738)	(36,720)	(39,966)	(43,498)	-	-	-	-														
T. Cash from financing	**213,400**	**(28,481)**	**(30,998)**	**(33,738)**	**(36,720)**	**(39,966)**	**(43,498)**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**
Net Change in Cash	18,922	18,864	18,714	18,459	18,087	17,582	16,927	63,446	66,619	69,949	73,447	77,119	80,975	85,024	89,275	93,739	98,426	103,347	108,515	113,940	119,637	125,619	131,900	138,495	145,420
Cash At the beginning of the period	-	18,922	37,787	56,500	74,960	93,047	110,629	127,556	191,002	257,620	327,570	401,017	478,136	559,111	644,135	733,410	827,149	925,575	1,028,922	1,137,437	1,251,377	1,371,015	1,496,634	1,628,534	1,767,029
Cash at the end of the Period	18,922	37,787	56,500	74,960	93,047	110,629	127,556	191,002	257,620	327,570	401,017	478,136	559,111	644,135	733,410	827,149	925,575	1,028,922	1,137,437	1,251,377	1,371,015	1,496,634	1,628,534	1,767,029	1,912,449

Annex XIV: Weighted Average Cost of Capital

Following are the main factors that affected the discount rate in the feasibility study:

- **Cost of Debt:** An assumption of 50% has been considered as indicated in the financing scenarios.
  - Debt Interest rate: reflects the different interest rate applied by each FI.
  - Tax rate: considered the same for all scenarios, being the corporate tax rate for local companies and which is 17%.
- **Cost of Equity**: An assumption of 50% has been considered as indicated in the financing scenarios.
  - RF[17]: is the risk-free rate while considering the Lebanese government T-Bills for a period of 12 months, as of December 2023.
  - Beta[18]: while Beta measures the market risk of the project, the beta employed in the WACC method reflects the levered Beta rate by industry for the real estate sector.
  - ERP[19]: the Equity risk premium represents the country risk premium for Lebanon along with the market risk premium.

Weighted Average Cost Of Capital

	SCENARIO 1	SCENARIO 2	SCENARIO 3	Scenario 4
Cost of Debt= Interest rate (1-taxe rate)				
Working Debt (long-term debt)	50%	50%	50%	50%
Debt Interest Rate	15%	7%	4%	9%
Taxe rate (corporate)	17%	17%	17%	17%
Kd	**12%**	**6%**	**3%**	**7%**
Cost of equity =Rf +β(Km-Rf)				
Working Equity	50%	50%	50%	50%
RF	4%	4%	4%	4%
Beta	0.6	0.6	0.6	0.6
T. ERP	11%	11%	11%	11%
Ke	**10%**	**10%**	**10%**	**10%**
WACC = (We*Ke) + (wd* Kd)	**11.23%**	**7.91%**	**6.67%**	**8.53%**

[17] https://bdl.gov.lb/lebanesegovernmenttreasurybillsprimarymarket.php////

[18] /WACC EUROPE Source: https://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/Betas.html)

[19] (Source: https://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/Betas.html)

Annex X: Financial metrics analysis-Scenario 1

SCENARIO 1/ MATURITY 2 YRS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
		2024	2025	2026	2026	2026	2026	2026	2026	2026	2026	2026	2026	2026	2026	2026	2026	2026	2026	2026	2026	2027	2028	2029	2030	2030
Loan Amount	(239,568.00)																									
Net Cash flow from operating activities		45,090	47,345	49,712	52,197	54,807	57,548	60,425	63,446	66,619	69,949	73,447	77,119	80,975	85,024	89,275	93,739	98,426	103,347	108,515	113,940	119,637	125,619	131,900	138,495	145,420
Net Cashflow from Investment activities		(239,568)	-	-	-	-																				
Net Cash Flow	**(239,568)**	**(194,478)**	**47,345**	**49,712**	**52,197**	**54,807**	**57,548**	**60,425**	**63,446**	**66,619**	**69,949**	**73,447**	**77,119**	**80,975**	**85,024**	**89,275**	**93,739**	**98,426**	**103,347**	**108,515**	**113,940**	**119,637**	**125,619**	**131,900**	**138,495**	**145,420**
Discount rate	11.23%	0.90	0.81	0.73	0.65	0.59	0.53	0.47	0.43	0.38	0.34	0.31	0.28	0.25	0.23	0.20	0.18	0.16	0.15	0.13	0.12	0.11	0.10	0.09	0.08	0.07
PV of Net Cash flow	(239,568)	(174,841)	38,266	36,122	34,099	32,189	30,385	28,683	27,076	25,559	24,127	22,776	21,500	20,295	19,158	18,085	17,072	16,115	15,213	14,360	13,556	12,796	12,080	11,403	10,764	10,161
NPV	**97,433**																									
IRR	**2.70%**																									
Cumulative Cash Flow		(414,409)	(376,143)	(340,020)	(305,921)	(273,733)	(243,348)	(214,665)	(187,589)	(162,029)	(137,902)	(115,126)	(93,626)	(73,331)	(54,173)	(36,088)	(19,016)	(2,900)	12,312	26,673	40,229	53,025	65,105	76,508	87,272	97,433
Payback Period		0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	19	20	21	22	23	24	25	26

Annex XI: Financial metrics analysis-Scenario 2

SCENARIO 2/ MATURITY 2 YRS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
		2024	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
Loan Amount	(239,568.00)																									
Net Cash flow from operating activities		45,090	47,345	49,712	52,197	54,807	57,548	60,425	63,446	66,619	69,949	73,447	77,119	80,975	85,024	89,275	93,739	98,426	103,347	108,515	113,940	119,637	125,619	131,900	138,495	145,420
Net Cashflow from Investment activities		(239,568)																								
Net Cash Flow	**(239,568)**	**(194,478)**	**47,345**	**49,712**	**52,197**	**54,807**	**57,548**	**60,425**	**63,446**	**66,619**	**69,949**	**73,447**	**77,119**	**80,975**	**85,024**	**89,275**	**93,739**	**98,426**	**103,347**	**108,515**	**113,940**	**119,637**	**125,619**	**131,900**	**138,495**	**145,420**
Discount rate	7.91%	0.92669	0.86	0.80	0.74	0.68	0.63	0.59	0.54	0.50	0.47	0.43	0.40	0.37	0.34	0.32	0.30	0.27	0.25	0.24	0.22	0.20	0.19	0.17	0.16	0.15
PV of Net Cash flow	(239,568)	(180,220)	40,657	39,560	38,493	37,454	36,444	35,461	34,504	33,573	32,667	31,786	30,928	30,094	29,282	28,492	27,723	26,975	26,247	25,539	24,850	24,180	23,527	22,893	22,275	21,674
NPV	**305,490**																									
IRR	**5.85%**																									
Cumulative Cash Flow		(419,788)	(379,131)	(339,571)	(301,078)	(263,624)	(227,180)	(191,720)	(157,216)	(123,643)	(90,976)	(59,190)	(28,262)	1,832	31,114	59,606	87,329	114,304	140,552	166,091	190,941	215,121	238,648	261,541	283,816	305,490
Payback Period		0	0	0	0	0	0	0	0	0	0	0	0	14	15	16	17	18	19	20	21	22	23	24	25	26

Annex XII: Financial metrics analysis-Scenario 3

SCENARIO 3/ MATURITY 7 YRS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
		2024	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
Loan Amount	(239,568.00)																									
Net Cash flow from operating activities		45,090	47,345	49,712	52,197	54,807	57,548	60,425	63,446	66,619	69,949	73,447	77,119	80,975	85,024	89,275	93,739	98,426	103,347	108,515	113,940	119,637	125,619	131,900	138,495	145,420
Net Cashflow from Investement activities		(239,568)																								
Net Cash Flow	(239,568)	(194,478)	47,345	49,712	52,197	54,807	57,548	60,425	63,446	66,619	69,949	73,447	77,119	80,975	85,024	89,275	93,739	98,426	103,347	108,515	113,940	119,637	125,619	131,900	138,495	145,420
Discount rate	6.67%	0.93750	0.88	0.82	0.77	0.72	0.68	0.64	0.60	0.56	0.52	0.49	0.46	0.43	0.41	0.38	0.36	0.33	0.31	0.29	0.28	0.26	0.24	0.23	0.21	0.20
PV of Net Cash flow	(239,568)	(182,324)	41,612	40,962	40,322	39,692	39,072	38,461	37,860	37,269	36,687	36,114	35,549	34,994	34,447	33,909	33,379	32,858	32,345	31,839	31,342	30,852	30,370	29,896	29,429	28,969
NPV	**416,336**																									
IRR	**7.09%**																									
Cumulative Cash Flow		(421,892)	(380,280)	(339,318)	(298,997)	(259,305)	(220,233)	(181,772)	(143,912)	(106,643)	(69,956)	(33,843)	1,706	36,700	71,148	105,057	138,436	171,294	203,639	235,478	266,820	297,672	328,042	357,938	387,367	416,336
Payback Period	1	0	0	0	0	0	0	0	0	0	0	0	13	14	15	16	17	18	19	20	21	22	23	24	25	26

Annex XIII: Financial metrics analysis-Scenario 4

SCENARIO 4/ MATURITY 7 YRS	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
		2024	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047
Loan Amount	(239,568.00)																									
Net Cash flow from operating activities		45,090	47,345	49,712	52,197	54,807	57,548	60,425	63,446	66,619	69,949	73,447	77,119	80,975	85,024	89,275	93,739	98,426	103,347	108,515	113,940	119,637	125,619	131,900	138,495	145,420
Net Cashflow from Investment activities		(239,568)																								
Net Cash Flow	(239,568)	(194,478)	47,345	49,712	52,197	54,807	57,548	60,425	63,446	66,619	69,949	73,447	77,119	80,975	85,024	89,275	93,739	98,426	103,347	108,515	113,940	119,637	125,619	131,900	138,495	145,420
Discount rate	8.53%	0.92	0.85	0.78	0.72	0.66	0.61	0.56	0.52	0.48	0.44	0.41	0.37	0.34	0.32	0.29	0.27	0.25	0.23	0.21	0.19	0.18	0.17	0.15	0.14	0.13
PV of Net Cash flow	(239,568)	(179,186)	40,192	38,883	37,617	36,392	35,207	34,061	32,952	31,879	30,841	29,837	28,865	27,926	27,016	26,137	25,286	24,462	23,666	22,895	22,150	21,429	20,731	20,056	19,403	18,771
NPV	**257,900**																									
IRR	**5.25%**																									
Cumulative Cash Flow		(418,754)	(378,562)	(339,679)	(302,062)	(265,669)	(230,462)	(196,401)	(163,449)	(131,570)	(100,729)	(70,892)	(42,026)	(14,101)	12,916	39,052	64,338	88,800	112,466	135,361	157,511	178,940	199,670	219,726	239,129	257,900
Payback Period		0	0	0	0	0	0	0	0	0	0	0	0	0	15	16	17	18	19	20	21	22	23	24	25	26

Annex XIV: Financial metrics analysis-sensitivity analysis best case 1 (Scenario 1,2,3,4)

Scenario 1: Sensitivity Analysis-Best Case 1- Tariff @1.95 USD

Scenario 1/NPV Best case 1- Tarrif USD 1.95	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Loan Amount	(239,568)																									
Net Cash flow from operating activities		145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420
Net Cashflow from Investment activities		(239,568.0)																								
Net Cash Flow	**(239,568)**	**(94,148)**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**
Discount rate	**11.2%**	**0.90**	**0.81**	**0.73**	**0.65**	**0.59**	**0.53**	**0.47**	**0.43**	**0.38**	**0.34**	**0.31**	**0.28**	**0.25**	**0.23**	**0.20**	**0.18**	**0.16**	**0.15**	**0.13**	**0.12**	**0.11**	**0.10**	**0.09**	**0.08**	**0.07**
PV of Net Cash flow	**(239,568)**	**(84,642)**	**117,535**	**105,668**	**94,998**	**85,406**	**76,782**	**69,029**	**62,059**	**55,793**	**50,159**	**45,094**	**40,541**	**36,447**	**32,767**	**29,459**	**26,484**	**23,810**	**21,406**	**19,244**	**17,301**	**15,554**	**13,984**	**12,572**	**11,302**	**10,161**
NPV	749,346																									
IRR	21%																									
Cumulative Cash Flow		(324,210)	(206,674)	(101,007)	(6,009)	79,397	156,179	225,208	287,267	343,060	393,219	438,313	478,854	515,302	548,069	577,528	604,012	627,822	649,227	668,472	685,773	701,327	715,311	727,883	739,185	749,346
Payback Period		0	0	0	0	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	0

Scenario 2: Sensitivity Analysis-Best Case 1- Tarrift @1.95 USD

Scenario 2/NPV Best case 1- Tarrif USD 1.95	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Loan Amount	(239,568)																									
Net Cash flow from operating activities		145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420
Net Cashflow from Investment activities		(239,568.0)																								
Net Cash Flow	**(239,568)**	**(94,148)**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**
Discount rate	**7.9%**	**0.93**	**0.86**	**0.80**	**0.74**	**0.68**	**0.63**	**0.59**	**0.54**	**0.50**	**0.47**	**0.43**	**0.40**	**0.37**	**0.34**	**0.32**	**0.30**	**0.27**	**0.25**	**0.24**	**0.22**	**0.20**	**0.19**	**0.17**	**0.16**	**0.15**
PV of Net Cash flow	**(239,568)**	**(87,246)**	**124,879**	**115,724**	**107,239**	**99,377**	**92,092**	**85,340**	**79,083**	**73,285**	**67,913**	**62,934**	**58,320**	**54,044**	**50,082**	**46,410**	**43,008**	**39,855**	**36,933**	**34,225**	**31,716**	**29,391**	**27,236**	**25,239**	**23,389**	**21,674**
NPV	1,102,573																									
IRR	25%																									
Cumulative Cash Flow		(326,814)	(201,935)	(86,211)	21,028	120,406	212,497	297,837	376,920	450,206	518,119	581,052	639,372	693,416	743,498	789,908	832,916	872,771	909,704	943,929	975,645	1,005,035	1,032,271	1,057,510	1,080,899	1,102,573
Payback Period		0	0	0	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	0

Scenario 3: Sensitivity Analysis-Best Case 1- Tarrif @1.95 USD

Scenario 3/NPV Best case 1- Tarrif USD 1.95	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Loan Amount	(239,568)																									
Net Cash flow from operating activities		145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420
Net Cashflow from Investement activities		(239,568.0)																								
Net Cash Flow	**(239,568)**	**(94,148)**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**
Discount rate	**6.7%**	**0.94**	**0.88**	**0.82**	**0.77**	**0.72**	**0.68**	**0.64**	**0.60**	**0.56**	**0.52**	**0.49**	**0.46**	**0.43**	**0.41**	**0.38**	**0.36**	**0.33**	**0.31**	**0.29**	**0.28**	**0.26**	**0.24**	**0.23**	**0.21**	**0.20**
PV of Net Cash flow	**(239,568)**	**(88,264)**	**127,811**	**119,823**	**112,335**	**105,314**	**98,732**	**92,561**	**86,777**	**81,353**	**76,269**	**71,502**	**67,034**	**62,844**	**58,916**	**55,234**	**51,782**	**48,546**	**45,512**	**42,668**	**40,001**	**37,501**	**35,157**	**32,960**	**30,900**	**28,969**
NPV	1,282,670																									
IRR	26%																									
Cumulative Cash Flow		**(327,832)**	**(200,021)**	**(80,198)**	**32,137**	**137,451**	**236,183**	**328,744**	**415,521**	**496,874**	**573,143**	**644,645**	**711,679**	**774,523**	**833,439**	**888,674**	**940,456**	**989,002**	**1,034,514**	**1,077,182**	**1,117,183**	**1,154,684**	**1,189,841**	**1,222,801**	**1,253,701**	**1,282,670**
Payback Period		0	0	0	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	0

Scenario 4: Sensitivity Analysis-Best Case 1- Tariff @1.95 USD

Scenario 4/NPV Best case 1- Tarrif USD 1.95	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Loan Amount	(239,568)																									
Net Cash flow from operating activities		145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420	145,420
Net Cashflow from Investment activities		(239,568.0)																								
Net Cash Flow	**(239,568)**	**(94,148)**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**	**145,420**
Discount rate	**8.5%**	**0.92**	**0.85**	**0.78**	**0.72**	**0.66**	**0.61**	**0.56**	**0.52**	**0.48**	**0.44**	**0.41**	**0.37**	**0.34**	**0.32**	**0.29**	**0.27**	**0.25**	**0.23**	**0.21**	**0.19**	**0.18**	**0.17**	**0.15**	**0.14**	**0.13**
PV of Net Cash flow	**(239,568)**	**(86,745)**	**123,451**	**113,744**	**104,800**	**96,560**	**88,968**	**81,972**	**75,527**	**69,588**	**64,116**	**59,075**	**54,430**	**50,150**	**46,207**	**42,574**	**39,226**	**36,142**	**33,300**	**30,682**	**28,269**	**26,047**	**23,999**	**22,112**	**20,373**	**18,771**
NPV	1,023,769																									
IRR	24%																									
Cumulative Cash Flow		**(326,313)**	**(202,863)**	**(89,119)**	**15,681**	**112,241**	**201,209**	**283,181**	**358,707**	**428,296**	**492,412**	**551,487**	**605,917**	**656,067**	**702,275**	**744,848**	**784,075**	**820,217**	**853,517**	**884,199**	**912,468**	**938,515**	**962,513**	**984,625**	**1,004,998**	**1,023,769**
Payback Period		0	0	0	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	0

Annex XV: Financial metrics analysis-sensitivity analysis best case 2 (Scenario 1,2,3,4)

Scenario 1: Sensitivity Analysis-Best Case 2- Tariff @2.24 USD

Scenario 1/NPV Best case 2- Tarif USD 2.24	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Loan Amount	(239,568)																									
Net Cash flow from operating activities		167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233
Net Cashflow from Investment activities		(239,568.0)																								
Net Cash Flow	**(239,568)**	**(72,335)**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**
Discount rate	**11.2%**	**0.90**	**0.81**	**0.73**	**0.65**	**0.59**	**0.53**	**0.47**	**0.43**	**0.38**	**0.34**	**0.31**	**0.28**	**0.25**	**0.23**	**0.20**	**0.18**	**0.16**	**0.15**	**0.13**	**0.12**	**0.11**	**0.10**	**0.09**	**0.08**	**0.07**
PV of Net Cash flow	**(239,568)**	**(65,031)**	**135,166**	**121,518**	**109,248**	**98,217**	**88,299**	**79,383**	**71,368**	**64,162**	**57,683**	**51,859**	**46,622**	**41,915**	**37,682**	**33,877**	**30,457**	**27,381**	**24,617**	**22,131**	**19,896**	**17,887**	**16,081**	**14,457**	**12,998**	**11,685**
NPV	929,990																									
IRR	27%																									
Cumulative Cash Flow		**(304,599)**	**(169,433)**	**(47,916)**	**61,332**	**159,548**	**247,848**	**327,231**	**398,599**	**462,761**	**520,444**	**572,302**	**618,924**	**660,839**	**698,521**	**732,399**	**762,855**	**790,237**	**814,854**	**836,985**	**856,881**	**874,768**	**890,849**	**905,307**	**918,305**	**929,990**
Payback Period		0	0	0	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	0

Scenario 2: Sensitivity Analysis-Best Case 2- Tariff @2.24 USD

Scenario 2/NPV Best case 2- Tarrif USD 2.24	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Loan Amount	(239,568.0)																									
Net Cash flow from operating activities		167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233
Net Cashflow from Investment activities		(239,568.0)																								
Net Cash Flow	**(239,568)**	**(72,335)**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**
Discount rate	**7.9%**	**0.93**	**0.86**	**0.80**	**0.74**	**0.68**	**0.63**	**0.59**	**0.54**	**0.50**	**0.47**	**0.43**	**0.40**	**0.37**	**0.34**	**0.32**	**0.30**	**0.27**	**0.25**	**0.24**	**0.22**	**0.20**	**0.19**	**0.17**	**0.16**	**0.15**
PV of Net Cash flow	**(239,568)**	**(67,032)**	**143,611**	**133,082**	**123,325**	**114,284**	**105,905**	**98,141**	**90,946**	**84,278**	**78,100**	**72,374**	**67,068**	**62,151**	**57,594**	**53,372**	**49,459**	**45,833**	**42,473**	**39,359**	**36,473**	**33,799**	**31,321**	**29,025**	**26,897**	**24,925**
NPV	1,337,195																									
IRR	30%																									
Cumulative Cash Flow		**(306,600)**	**(162,989)**	**(29,907)**	**93,418**	**207,702**	**313,608**	**411,748**	**502,694**	**586,973**	**665,072**	**737,446**	**804,514**	**866,664**	**924,259**	**977,631**	**1,027,089**	**1,072,922**	**1,115,395**	**1,154,754**	**1,191,227**	**1,225,026**	**1,256,348**	**1,285,373**	**1,312,270**	**1,337,195**
Payback Period		0	0	0	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	0

Scenario 3: Sensitivity Analysis-Best Case 2- Tariff @2.24 USD

Scenario 3/NPV Best case 2- Tarrif USD2.24	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Loan Amount	(239,568)																									
Net Cash flow from operating activities		167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233
Net Cashflow from Investement activities		(239,568.0)																								
Net Cash Flow	**(239,568)**	**(72,335)**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**

Discount rate	6.7%	0.94	0.88	0.82	0.77	0.72	0.68	0.64	0.60	0.56	0.52	0.49	0.46	0.43	0.41	0.38	0.36	0.33	0.31	0.29	0.28	0.26	0.24	0.23	0.21	0.20
PV of Net Cash flow	**(239,568)**	**(67,814)**	**146,983**	**137,797**	**129,185**	**121,111**	**113,542**	**106,446**	**99,793**	**93,556**	**87,709**	**82,228**	**77,089**	**72,271**	**67,754**	**63,520**	**59,550**	**55,828**	**52,339**	**49,068**	**46,001**	**43,126**	**40,431**	**37,904**	**35,535**	**33,314**
NPV	1,544,696																									
IRR	32%																									
Cumulative Cash Flow		**(307,382)**	**(160,400)**	**(22,603)**	**106,582**	**227,693**	**341,235**	**447,680**	**547,473**	**641,030**	**728,739**	**810,967**	**888,055**	**960,326**	**1,028,080**	**1,091,599**	**1,151,149**	**1,206,977**	**1,259,316**	**1,308,384**	**1,354,385**	**1,397,511**	**1,437,942**	**1,475,846**	**1,511,381**	**1,544,696**
Payback Period		0	0	0	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	0

Scenario 4: Sensitivity Analysis-Best Case 2- Tariff @2.24 USD

Scenario 4/NPV Best case 2- Tarrif USD 2.24	0	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25
Loan Amount	(239,568)																									
Net Cash flow from operating activities		167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233	167,233
Net Cashflow from Investment activities		(239,568.0)																								
Net Cash Flow	**(239,568)**	**(72,335)**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**	**167,233**
Discount rate	**8.5%**	**0.92**	**0.85**	**0.78**	**0.72**	**0.66**	**0.61**	**0.56**	**0.52**	**0.48**	**0.44**	**0.41**	**0.37**	**0.34**	**0.32**	**0.29**	**0.27**	**0.25**	**0.23**	**0.21**	**0.19**	**0.18**	**0.17**	**0.15**	**0.14**	**0.13**
PV of Net Cash flow	**(239,568)**	**(66,647)**	**141,968**	**130,805**	**120,520**	**111,044**	**102,313**	**94,268**	**86,856**	**80,026**	**73,734**	**67,936**	**62,595**	**57,673**	**53,138**	**48,960**	**45,110**	**41,563**	**38,295**	**35,284**	**32,510**	**29,954**	**27,598**	**25,428**	**23,429**	**21,587**
NPV	1,246,379																									
IRR	30%																									
Cumulative Cash Flow		**(306,215)**	**(164,247)**	**(33,442)**	**87,078**	**198,122**	**300,435**	**394,703**	**481,558**	**561,585**	**635,319**	**703,255**	**765,850**	**823,522**	**876,661**	**925,620**	**970,731**	**1,012,294**	**1,050,589**	**1,085,873**	**1,118,383**	**1,148,337**	**1,175,935**	**1,201,363**	**1,224,792**	**1,246,379**
Payback Period		0	0	0	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	0

Annex XVI: Energy Consumption before & after building envelope upgrades.

Before

Month	Power W	Hours of operations/day	Total consumption Kwh
January	52,579	8	13,040
February	52,579	8	11,778
March	52,579	4	6,520
April	167,427	2	10,046
May	167,427	4	20,761
June	167,427	8	40,182
July	167,427	10	51,902
August	167,427	10	51,902
September	167,427	8	40,182
October	167,427	4	20,761
November	52,579	4	6,309
December	52,579	8	13,040
Total			286,423

After

Month	Power W	Hours of operations/day	Total consumption Kwh
January	20,916	8	5,187
February	20,916	8	4,685
March	20,916	4	2,594
April	136,173	2	8,170
May	136,173	4	16,885
June	136,173	8	32,682
July	136,173	10	42,214
August	136,173	10	42,214
September	136,173	8	32,682
October	136,173	4	16,885
November	20,916	4	2,510
December	20,916	8	5,187
Total			211,894