Cool Up
Upscaling Sustainable Cooling

FINANCIAL FEASIBILITY STUDY JORDAN

March 2025

Financial Feasibility Study Jordan

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Publisher

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

Authors

Lead authors:
Dr. Yara Katami (Frankfurt School of Finance and Management)

Contributing authors:
Sawsan Bawaresh (Royal Scientific Society)
Michal Deuszkiewicz, Alokananda Nath (Frankfurt School of Finance and Management)

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

Date

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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
BMU	German Federal Ministry of the Environment, Nature Conservation and Nuclear Safety
CAPEX	Capital Expenditure
CBJ	Central Bank of Jordan
CO2	Carbon Dioxide
EBRD	European Bank For Reconstruction And Development
EE	Energy Efficiency
EU	European Union
F-Gas	Fluorinated gases
FIs	Financial Institutions
GEFF	Green energy Finance Facility
GWP	Global Warming Potential
HCFC	Hydrochlorofluorocarbons
HFC	Hydrofluorocarbon
HVAC	Heating, Ventilating And Air Conditioning
IRR	Internal Rate of Return
MEPS	Minimum Energy Performance Standards
NPV	Net Present Value
ODS	Ozone-Depleting Substances
OPEX	Operating Expenses
RAC	Refrigeration And Air Conditioning
R290	Propane
R404A	HFC refrigerant blend composed of R125, R143a and R134a
R&D	Research and Development
SME	Small and Medium Enterprises
SPB	Simple Payback
UoM	Unit of Measure
WACC	Weighted Average Cost of Capital

Executive Summary

This report is prepared for end-users and financial institutions in order to show the financial feasibility and applicability of transition toward natural refrigerants for selected commercial refrigeration systems. Natural refrigerants have emerged as a sustainable alternative to traditional synthetic refrigerants in the cooling sector. These eco-friendly refrigerants, including ammonia, carbon dioxide, and hydrocarbons, offer numerous environmental benefits and contribute to a greener and more sustainable future.

The chosen case study is conducted in a hotel located in Aqaba, Jordan. The hotel started operations in 2002, while prior to that it was used as a hotel apartment since 1995. There are 80 guestrooms available, with 62 standard rooms, 10 deluxe rooms, and 8 super deluxe rooms. All are fully air-conditioned.

The hotel is being served by two old Chillers which were installed more than 17 years ago. These chillers are considered to be low efficient and working with low COP (Coefficient of Performance) which does not exceed 2.55. These chillers were visually inspected by a local chillers' agent (Energy International) and found to be **a) in bad condition** and **b) needed to be repaired and maintained.**

Meanwhile, these are the two suggested scenarios for modernization considered: **Scenario A**: with the new technology proposed being modulating chiller with heat pump using R290, and **Scenario B**: with the new technology proposed being modulating chiller with heat pumps.

The report findings show that all investment indicators, NPV. IRR and payback period, for the two suggested technical scenarios A & B, along with different four suggested financing scenarios, reflected feasibility and had positive financials. Finally, the transition to natural refrigerants by replacing the conventional systems to new and more energy efficient systems are feasible and recommended due to the savings in energy and maintenance taking into consideration the long-term sustainable benefits on the environment.

The report shows that the actions need to be taken across all sectors. One of them is the hospitality sector, namely the subject of this feasibility study. Considering that electricity expenses on account of HVAC systems form a substantial percentage of operating expenses across hospitals, commercial buildings and especially in the case of hotels are considered higher when using old conventional systems. This has created a serious motivator for hotels and other sectors to conserve energy and improve the efficiency of energy use. Improving energy efficiency helps users cut down their energy bills resulting into more revenues and growth potentials, and it also lowers the risks of energy prices increase.

1 Introduction

1.1 The Cool Up programme

Launched in 2021, the 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 (BMU), 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 as well as the Paris Agreement. Not only is cooling one of the major causes of energy consumption, but it also indicates the use of inefficient appliances which rely on conventional refrigerants—creating negative impact on global warming. In this respect, the main objective of this programme is to handle these problems and mitigate the effects of climate change by focusing on countries in the Middle East, specifically Egypt, Jordan, Lebanon, and Türkiye—considering the fact that while these four respective countries are subject to the effects of global warming, they are also 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.

As one of the consortium partners of the Cool Up programme, Frankfurt School of Finance and Management focuses on developing new financing solutions and business models to encourage and support the transformation of RAC market to sustainable cooling. In this regard, starting from the very beginning of the Cool Up programme, the expert team of Frankfurt School in Jordan, 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, and to find out the right technology to be used and to identify the target market segment to initiate this study.

1.2 Aim of this Report

The purpose of this report is to take the first step in building the road to financing sustainable cooling in Jordan by preparing a feasibility report which will be a reference guide for the financial parties, and for fund raisers to create more awareness about the RAC sector and encourage them to support sustainable cooling investments. It also aims to raise awareness among end-users about the feasibility of transforming from conventional systems to sustainable cooling systems.

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

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

The programme experts completed refrigeration and air conditioning (RAC) market assessment and technology evaluations in all four countries. Furthermore, a few technologies have been selected for each partner country considering the investment needs and accessibility to the market. By means of analysis, a sample case study is conducted in a 4-star hotel in Aqaba, Jordan, to compare the operating results of conventional cooling equipment with sustainable cooling products equipped with natural refrigerants.

This report is intended to give insights into the size and potential of the market, the end-users and segments, as well as the basic problems encountered by stakeholders in the first phase. Moreover, the real objective of the report is to give an idea about the expected investment size, the projected energy, operations and maintenance cost savings and the potential reduction in Greenhouse Gas (GHG) Emissions.

Overall, the objective is to examine the profitability and feasibility of a sustainable cooling investment and to provide the data to inform and motivate end-users, financial institutions, and fund raisers.

The Financial Feasibility Study focuses on comparing the financial viability associated with the investment decision of a hotel into chiller that serves as the central air conditioning unit. The new considered chiller employ R290 as a natural refrigerant while the old chiller unit utilize R-134A. The methodology and parameters utilized for this analysis are detailed in the subsequent sections.

2 Technology in Focus

There are growing demand and investment opportunities in the commercial space cooling sector (commercial HVAC sector) in Jordan. This growing demand stems from the end-use sectors which include hotels, hospitals and commercial buildings, including supermarkets. Demand for HVAC systems results from new installations as well as system refurbishment in existing establishments in these end-use sectors.

As tourism flourishes, hotels play a pivotal role in accommodating travellers. The hospitality market is expected to grow annually at a rate of 4.21% from 2024 to 2028. This will result in a projected market volume of USD 126.90 million by 2028. The number of end-users (travellers) in the hotel market is also expected to be 1.18 million users by 2028.[1] On the other hand, there are more than 130 hospitals in Jordan at present. Lastly, Jordan also has a growing construction and commercial buildings sector.

The need for efficient and sustainable cooling systems is more pronounced than ever due to rising electricity tariff levels over the past few years.

Investors and hoteliers recognize the importance of energy-efficient solutions. Chillers, being central to HVAC systems, offer substantial opportunities for improvement. The market potential lies:

1. **Chillers Using Natural Refrigerants**:
   A. **R290 (Propane)**: This natural refrigerant has gained traction globally. Its low GWP and energy efficiency make it an attractive choice for hotel chillers.
   B. **R717 (Ammonia)**: Although primarily used in industrial settings, ammonia's heat transfer properties and environmental benefits warrant exploration in hotel applications.
2. **Retrofitting Existing Systems**:
   A. Upgrading older chillers with modern, eco-friendly alternatives can significantly enhance energy efficiency.
   B. Investors can tap into this market by offering retrofitting services to hotels seeking sustainable solutions.

Jordanian authorities are keen on promoting sustainable practices. Investors can leverage this by aligning with government policies and participating in initiatives related to energy efficiency and natural refrigerants.

However, there is a general lack of awareness amongst the stakeholders on the modern cooling technologies. This knowledge gap should be closed by:

- **Awareness Campaigns**: Educating hotel owners and decision-makers about the benefits of natural refrigerants is crucial.
- **Training Programs**: Offering training sessions on chiller maintenance and operation ensures optimal performance.

Investing in Jordan's commercial space cooling sector, especially in chillers in HVAC, holds immense opportunities. By embracing natural refrigerants and energy-efficient technologies, investors can contribute to sustainability while reaping financial rewards.

For in-depth insights, please explore the following publications from the **Cool Up programme**:

1. Cooling Sector Status Report (2023)
2. Catalogue of Technical Solutions for Sustainable Cooling in Jordan

[1] "Hotels – Jordan," Statista, https://www.statista.com/outlook/mmo/travel-tourism/hotels/jordan.

- **Space cooling/HVAC market trend** - The following points present a brief overview of the HVAC/space cooling market in Jordan. (More details are available in the publication on the Cool Up programme website.)
  - **Non-Residential Sector**:
    - Central systems dominate hotels, hospitals, retail, office, and healthcare buildings.
    - Chillers typically used in big hotels, hospitals, and shopping malls.
    - 50% of non-residential floor area lacks air conditioning in new buildings.
- **Refrigerants**:
  - R410A and R134a are commonly used in AC manufacturing.
  - R134a is prevalent in the servicing sector.
  - Commercial refrigeration systems use R404A and R134a.

The key takeaways from the market review done by Cool Up show that it is critical for Jordan to adopt early energy efficient and low GWP practices in cooling technologies. This as well as implementing natural refrigerants will lead to significant reduction of cooling costs. It is also critical to strengthen the end-of-life management of refrigerants to prevent higher rates of release during disposal.

All this shows that the actions need to be taken across all sectors. One of them is the hospitality sector, subject of this feasibility study.

Electricity expenses on account of HVAC systems form a substantial percentage of operating expenses across hospitals, commercial buildings and especially in the case of hotels. This has created a serious motivator for hotels and other sectors to conserve energy and improve the efficiency of energy use. Improving energy efficiency helps users to cut down their energy bills resulting into more revenues and growth potentials. It also lowers the risks of any future energy prices increase.

Moreover, every energy efficiency enhancement counts in minimizing the burden on the economy significantly. Promoting energy efficiency improvement will not only save energy but will also increase the awareness of the stakeholders about the importance of saving energy. What would make the situation even more challenging is the expected rise in oil prices especially in the coming months and years. Thus, the need for enhancing the energy efficiency worldwide will become more urgent.

Any enhancement in energy efficiency will also result in improving the surrounding environment by reducing the GHGs associated with fossil fuel burning and energy production.

2.1 End-users

The chosen case study is conducted for a hotel located in Aqaba, Jordan. The hotel started operations in 2002 and before that it was used as a hotel apartment since 1995. There are 80 guestrooms available, with 62 standard rooms, 10 deluxe rooms, and 8 super deluxe rooms. All are fully air-conditioned.

During spring and summer, hotel occupancy rates in Aqaba may reach 100 percent over the weekends—driven by a diverse range of artistic, cultural, recreational and sports activities. Data from the Ministry of Tourism and Antiquities indicates that the tourism sector employs 57,100 individuals, compared to 54,700 at the end of 2022. The number of registered different-level hotels is 625.

Jordanian tourism industry is an active sector which represents approximately 13% of the country's GDP as of year 2019. It recorded 5.3 million visitors and revenues of JOD 4.1 billion in 2019. With the spread of the COVID-19 pandemic in early 2020, Jordan—like many other countries—suffered severe economic impacts in the months following the outbreak and dramatical decrease in tourism. However, in 2023, Jordan has surged to the eighth position in the Arab world and sixty-first globally as one of the most

attractive destinations, welcoming nearly 3.6 million visitors in the three first quarters of 2023.[2] Now, since October 2023, tourism is affected due to the war in Gaza. However, as mentioned earlier, tourism in Jordan fluctuates. Jordan has a track record of being a safe and stable destination, despite current turbulences in the region which becomes a contributing factor for being a touristic distention and to recover soon.

2.2 Advancing Beyond Conventional

The following topics are the major problems of discount market sector, all resulting in higher operational expenses:

Rising Energy Tariffs

In recent years, there has been a significant increase in electricity tariffs for commercial enterprises in the country. Specifically, the electricity tariffs for commercial businesses have experienced consecutive increases, electricity prices influencing the sales of new technologies such as inverters, the introduction of new technical regulations for eco-design, economic growth, the COVID-19 pandemic, new projects addressing efficient cooling systems, and new construction.[3] As a result, there has been a heightened focus on energy efficiency among stakeholders. Energy prices have become the driving force behind the adoption of energy-efficient commercial refrigeration systems. These new systems utilize natural refrigerants and boast superior energy efficiency as compared to old equipment.

Using Low Efficient Units

One of the major drawbacks in the discount market segment is the selection of relatively low efficient units due to upfront cost constraints.

The initial investment cost difference for cooling equipment with natural or with less GWP refrigerants is negligible for standalone commercial refrigeration units.[4] On the other hand, lower operational and maintenance costs is expected to pay back the investment within five years depending on the size of the investment.

High Leakage Rates

The old stock of refrigeration equipment often leads to leakage causing the reduction of the efficiency of the cooling equipment. In addition to that, leakage may cause the disruption of the goods causing loss of stock and eventually financial loss for the company. Finally, repairs and maintenance cost also increase due to the frequent refilling of refrigerants.

Outdated Equipment

This is particularly important for the discount markets. Based on the interviews conducted, it is understood that average age of standalone commercial refrigeration is 7-10 years.[5] Considering the economic lifetime of the equipment is around 25 years, existing equipment stock is outdated and poorly maintained particularly for discount market segment.

2.3 Advocating R290 in Commercial Cold Storage

Residential buildings in Jordan make up 79% of the total building floor area (315 million m^2), with 65% being single-family housing and the remaining in multifamily housing. In the non-residential sector, office buildings account for the highest share of floor area at 39%, followed by educational buildings at 19%, and wholesale and retail buildings at 14%. From 2017 to 2019, the annual new construction rate in the residential sector was about 1.5%. Approximately 55% of housing units have an air conditioning (AC) system, and 35% of the rooms or floor area in these units are air-conditioned, meaning about 20% of the total residential

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2 Jordan Ministry of Tourism & Antiquities, "Jordan National Tourism Strategy 2021 – 2025: A Tourism Strategy That is Fit for Purpose and Circumstance," national_tourism_strategy_en_(release_1.0)_20.12.2021.pdf (mota.gov.jo).

3 Sawsan Bawaresh, Jan Grözinger, Nesen Surmeli-Anac, et al., "Cooling Sector Status Report Jordan: Analysis of the current market structure, trends, and insights on the refrigeration and air conditioning sector," *Berlin: Guidehouse Germany GmbH* (March 2022) Cool-Up_Cooling-Sector-Status-Report_Jordan_2022.pdf (coolupprogramme.org).

4 Sector interviews with manufacturers.

5 Visited discount market average.

floor area is air-conditioned. In contrast, about 75% of non-residential buildings are equipped with at least one AC system, and in these buildings, 68% of the floor area is air-conditioned, resulting in roughly 51% of the total commercial floor area being air-conditioned.

Several companies manufacture AC appliances in Jordan, including Petra Engineering Industries, Panasonic, Daikin, and Samsung. The country has over 400 workshops providing maintenance and services to the refrigeration and air conditioning (RAC) sector. Of the AC systems sold in Jordan, 50% are produced by local companies, primarily Petra Engineering. The predominant technology in the market is single split systems, which are mostly ductless and are commonly used in residential, office, and retail buildings. Other technologies include multi-split and variable refrigerant flow (VRF) systems, packaged terminal AC (PTAC) systems, and chillers, which are mainly used in larger non-residential buildings.

The energy efficiency of AC systems in Jordan varies, with energy efficiency ratios (EER) ranging from 2.5 to 4.5, and most systems being below the best available efficiency. Typical AC systems are replaced every 7-10 years. The demand for AC systems is driven by new installations in existing buildings, new construction, and the replacement of old systems. Sales growth in the residential sector is influenced by increasing affordability, population growth, and climate change. The new construction sector also plays a significant role in driving sales, with a high percentage of new buildings equipped with AC systems.

Jordan's AC market is expected to grow at a compound annual growth rate (CAGR) of about 6% between 2021 and 2027, with most growth coming from room AC units, particularly single split systems with inverter technology. The fastest growth rate is anticipated in the AC chillers and VRF systems market. In 2019, Jordan exported EUR 81 million worth of AC systems and imported EUR 63 million worth of AC systems. Major export destinations include Saudi Arabia, the US, Kuwait, and Qatar, while main import sources are China, Belgium, Germany, and Thailand.

R290, commonly known as propane gas, emerges as a more suitable refrigerant in ACs.R290, being a pure hydrocarbon in a gaseous state under ambient temperature and pressure, possesses favourable thermodynamic properties, making it a preferred choice for refrigeration and air conditioning systems, serving as a viable substitute for commonly used HFC refrigerant gases like R22 or R410A. Importantly, R290 occurs naturally and is non-toxic, ensuring safety for both users and the ecosystem.

The environmental benefits of R290 further underscore its suitability as a refrigerant. With a low Global Warming Potential (GWP) index of 3, R290 contrasts sharply with refrigerants like R404A, which carries a GWP index of 3922. This environmental friendliness is attributed to R290's composition as pure gas, devoid of chemical agents contributing to GHG emissions. In addition to its minimal environmental impact, R290 is noted for its energy efficiency, establishing itself as a sustainable alternative to HFC refrigerants commonly used in commercial settings.

However, it's crucial to acknowledge the safety considerations associated with R290. As propane gas, it is highly flammable and explosive, necessitating stringent safety measures, particularly in equipment with specific minimum refrigerant charge requirements. Currently, the safety standard allows a maximum charge of 150 grams for A3 class gases, indicating high flammability. To align with this safety standard, the use of standalone units is recommended, as they inherently mitigate the risks associated with refrigerant charge quantities.

R290 Pros

- Widely established in domestic refrigeration for decades
- Most product design standards already established
- Relatively simple and cost-efficient technology
- Energy efficiency typically higher than traditional refrigerants

R290 Cons

- Flammability rating A3

- Requires specific safety measures e.g., with R290 (propane) solutions, refrigerant should not be circulating inside buildings. However smaller charges in e.g., standalone systems and residential split air conditioners are allowed
- Service personnel needs to be trained in servicing flammable refrigerants, if not already qualified
- Maximum load restrictions due to safety standards

This dual consideration of environmental benefits and safety precautions positions R290 as a compelling option for standalone applications, offering a balanced approach to sustainability and risk mitigation.

3 Feasibility Study Approach

To establish the baseline for this study, the Cool Up team conducted a cooling market assessment and technology evaluations for Jordan. The cooling market assessment aims to identify barriers for the uptake of sustainable cooling technologies, and the sector and technologies with the highest impact potential for a transition to sustainable cooling.

Feedback from interviews and questionnaires on natural refrigerants in the Jordanian market revealed that most interviewees lack awareness of the benefits and potential carbon footprint improvements of natural refrigerants. Few, particularly technology providers and central system contractors, have received inquiries but lack technical expertise. Hotel managers prioritize upfront costs over energy and environmental benefits.

In agreement with Cool Up partner organizations, A/C chiller has been recognized as having the highest impact potential sector due to the significant number of hotels in the country. While the small scale A/C are subject of energy labeling (similar to EU labeling) thus increasing awareness and efficiencies of the small scale A/C the central A/C chillers are not yet subject of minimum standards.

Below is an overview of the key components and scenarios involved in our feasibility study for central A/C solutions. This table summarizes the technology under consideration, outlines the baseline and proposed scenarios, and details the financial viability criteria essential for understanding the study's approach and outcomes.

Table 1 Overview of Technology, Scenarios, and Financial Viability Criteria for the Feasibility Study

The Technology	The chosen case study is conducted for a hotel located in Aqaba, Jordan. The hotel started operations in 2002 and before that it was used as a hotel apartment since 1995. There are 80 guestrooms available, with 62 standard rooms, 10 deluxe rooms, and 8 super deluxe rooms. All are fully air-conditioned. Currently the hotel uses two old Chillers which were installed more than 17 years ago. These chillers are considered to be low efficient and working with low COP (Coefficient of Performance) which does not exceed 2.55. These chillers were visually inspected by a local chillers' agent (Energy International) and found to be **a) in bad condition** and **b) needed to be repaired and maintained.**
Baseline Scenario	This scenario establishes the current operations using conventional chillers, which use R134A refrigerants. The baseline serves as a reference point for assessing the efficiency, costs, and environmental impact without any intervention. During the calculation period, it captures the existing cost structure, energy usage, and refrigerant impact to quantify the status quo's performance.
Proposed Scenario	This scenario proposes the transition to sustainable central A/C chiller using R290 refrigerant, which is more environmentally friendly and energy efficient. This scenario evaluates the potential reductions in energy consumption and greenhouse gas emissions compared to the baseline. The expected outcomes are improved operational efficiencies, lower energy costs, and enhanced compliance with environmental standards. A conventional new chiller using R410A is also considered and compared to the baseline as well as the sustainable chiller. It is done to show the benefits of using the chiller with natural refrigerant against the conventional chillers.
Technology lifetime (Applicable for both scenarios)	The chosen period spans 25 years for the baseline scenario, and this is also the expected operational lifespan of the proposed technology.

Financial Viability Criteria	The Net Present Value (NPV) is calculated for both scenarios to determine their financial viability. A positive NPV in favor of the proposed solution over the baseline would indicate that the investment in sustainable technology is financially beneficial when considering the time value of money and long-term savings.

4 The Financial Model

4.1 Financial Input Assumptions

Table 2 Scenario analysis

Technical Scenario A: R290 Chiller	
Financing Scenario 1: Conventional Loan Financing	Scenario A:1
Financing Scenario 2: EBRD GEFF Loan Financing	Scenario A:2
Financing Scenario 3: CBJ Loan Financing	Scenario A:3
Financing Scenario 4: Merge CBJ & GEFF Loan Financing	Scenario A:4
Technical Scenario B: New technology	
Financing Scenario 1: Conventional Loan Financing	Scenario B:1
Financing Scenario 2: EBRD GEFF Loan Financing	Scenario B:2
Financing Scenario 3: CBJ Loan Financing	Scenario B:3
Financing Scenario 4: Merge CBJ & GEFF Loan Financing	Scenario B:4

Table 3 Financing Scenarios

Financing (EUR)	Scenario A	Scenario B
Debt Equity Ratio	70:30	70:30
Total Investment	141,691	104,000
Total Investment after salvage (to be deducted from Equity)	135,091	97,400
Corporate Loan 70% of the Total Investment	99,000	73,000
Equity 30% of the Investment	42,691	31,000
Equity after Salvage value	36,091	24,400

The feasibility of this investment is checked based on the savings on energy and operational costs resulting from the exchange of the equipment. Discount cash flow method is used.

Scenario A

The table shows the projected cash flows for Scenario A over the operating age of the R290 Chiller, Scenario A—which is 25 years. The investment cost includes the installation cost which is in total EUR 141,691. The old chiller has an approximate salvage value of JOD 5,000 which is equivalent to EUR 6,600.

Table 4 Cash Flow of the Scenario A

SCENARIO A	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																										
Tarrif for end user		0.08	0.09	0.09	0.09	0.10	0.10	0.11	0.12	0.12	0.13	0.13	0.14	0.15	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.25	0.26
Energy savings		11,407	11,978	12,577	13,205	13,866	14,559	15,287	16,051	16,854	17,697	18,581	19,510	20,486	21,510	22,586	23,715	24,901	26,146	27,453	28,826	30,267	31,780	33,369	35,038	36,790
Refrigerant price (R-134a)		9	9	9	9	9	9	10	10	10	10	10	10	11	11	11	11	12	12	12	12	12	13	13	13	14	14
Refrigerant cost (R-134a)		31	32	32	33	33	34	35	35	36	37	38	38	39	40	41	42	42	43	44	45	46	47	48	49	50
Refrigerant price (R-290)		18.2	18.6	18.9	19.3	19.7	20.1	20.5	20.9	21.3	21.8	22.2	22.6	23.1	23.5	24.0	24.5	25.0	25.5	26.0	26.5	27.0	27.6	28.1	28.7	29.3
Refrigerant cost (R-290)		94	96	98	100	102	104	106	109	111	113	115	117	120	122	125	127	130	132	135	138	140	143	146	149	152
Net Cash flow from operating activities		11,344	11,913	12,510	13,138	13,797	14,489	15,215	15,978	16,779	17,621	18,504	19,431	20,405	21,428	22,502	23,629	24,814	26,057	27,362	28,733	30,173	31,684	33,271	34,938	36,688
Net Cashflow from investement activities		(135,091)																								
Net Cash Flow	-	(123,747)	11,913	12,510	13,138	13,797	14,489	15,215	15,978	16,779	17,621	18,504	19,431	20,405	21,428	22,502	23,629	24,814	26,057	27,362	28,733	30,173	31,684	33,271	34,938	36,688
Discount rate	6.87%	0.94	0.88	0.82	0.77	0.72	0.67	0.63	0.59	0.55	0.51	0.48	0.45	0.42	0.39	0.37	0.35	0.32	0.30	0.28	0.26	0.25	0.23	0.22	0.20	0.19
PV of Net Cash flow	-	(115,792)	10,430	10,250	10,072	9,897	9,725	9,556	9,390	9,227	9,067	8,909	8,755	8,602	8,453	8,306	8,161	8,019	7,880	7,743	7,608	7,476	7,345	7,217	7,092	6,968

In regard to the operations cost, as mentioned earlier, it mainly fills the leakage in refrigerants. The current refiling cost when using the conventional system is EUR 30.8 per year which is lower than the suggested R290 system, Scenario A, which will cost EUR 94.4. The operating cost using Scenario A will increase compared to the current conventional system with an amount of EUR 63.5 yearly. Noting that it is projected that as conventional gases will gradually fade out, it will become more difficult to find these gases and their prices are expected to increase.[6] The energy savings will reach EUR 11,407. This is calculated as cash inflow and is the main driver for paying back the initial investment and proving the feasibility of exchanging the current system.

Scenario B

The table shows the projected cash flows for Scenario B using the modulating Chiller. The investment cost includes the installation cost which is in total EUR 104,000. The old chiller has an approximate salvage value of JOD 5,000 which is equivalent to EUR 6,600, and the salvage value is subtracted from the investment cost.

Table 5 Cash Flow of the Scenario B

SCENARIO B	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	2027	2028	2029	2030	2031	2032	2033	2034	2035	2036	2037	2038	2039	2040	2041	2042	2043	2044	2045	2046	2047	2048
Loan Amount																										
Tarrif for end user		0.08	0.09	0.09	0.09	0.10	0.10	0.11	0.12	0.12	0.13	0.13	0.14	0.15	0.15	0.16	0.17	0.18	0.19	0.20	0.21	0.22	0.23	0.24	0.25	0.26
Energy savings		9,705	10,190	10,699	11,234	11,796	12,386	13,005	13,656	14,338	15,055	15,808	16,598	17,428	18,300	19,215	20,175	21,184	22,243	23,356	24,523	25,750	27,037	28,389	29,808	31,299
Refrigerant price (R-134a)		9	9	9	9	9	9	10	10	10	10	10	11	11	11	11	12	12	12	12	12	13	13	13	14	14
Refrigerant cost (R-134a)		31	32	32	33	33	34	35	35	36	37	38	38	39	40	41	42	42	43	44	45	46	47	48	49	50
Refrigerant price (R-410a)		11.505	11.7	12.0	12.2	12.5	12.7	13.0	13.2	13.5	13.7	14.0	14.3	14.6	14.9	15.2	15.5	15.8	16.1	16.4	16.8	17.1	17.4	17.8	18.1	18.5
Refrigerant cost (R-410a)		69	70	72	73	75	76	78	79	81	82	84	86	88	89	91	93	95	97	99	101	103	105	107	109	111
Net Cash flow from operating activities		9,667	10,151	10,660	11,194	11,755	12,344	12,962	13,612	14,294	15,010	15,762	16,551	17,380	18,250	19,164	20,124	21,132	22,190	23,301	24,468	25,693	26,979	28,330	29,748	31,237
Net Cashflow from investement activities		(97,400)																								
Net Cash Flow	-	(87,733)	10,151	10,660	11,194	11,755	12,344	12,962	13,612	14,294	15,010	15,762	16,551	17,380	18,250	19,164	20,124	21,132	22,190	23,301	24,468	25,693	26,979	28,330	29,748	31,237
Discount rate	6.87%	0.94	0.88	0.82	0.77	0.72	0.67	0.63	0.59	0.55	0.51	0.48	0.45	0.42	0.39	0.37	0.35	0.32	0.30	0.28	0.26	0.25	0.23	0.22	0.20	0.19
PV of Net Cash flow	-	(82,084)	8,888	8,733	8,581	8,432	8,286	8,143	8,003	7,866	7,732	7,599	7,469	7,342	7,218	7,094	6,953	6,830	6,710	6,594	6,479	6,366	6,255	6,146	6,039	5,933

In regard to the operations cost, and as mentioned earlier, it mainly fills the leakage in refrigerants. The current refiling of the conventional system is EUR 30.8 per year while the refiling cost in Scenario B is EUR 69 which is higher than the current conventional system. The operating cost using Scenario B will increase compared to the current conventional system with an amount of EUR 38.1 yearly. This takes into the consideration that conventional gases will gradually fade out and it will become more difficult to find these gases as their prices are also expected to increase.[7] The energy savings will reach EUR 9,705. This is calculated as cash inflow and is the main driver for paying back the initial investment—proving the feasibility of exchanging the current system.

The Cool Up team has defined two main scenarios reflecting new technology used with sub-scenarios reflecting source of finance as defined in the table below.

Table 6 The Financial Scenarios

Technical Scenario A: R290 Chiller	
Financing Scenario 1: Conventional Loan Financing	Scenario A:1

6 Kigali Amendment, 2023.
7 Kigali Amendment, 2023.

Technical Scenario A: R290 Chiller	
Financing Scenario 2: EBRD GEFF Loan Financing	Scenario A:2
Financing Scenario 3: CBJ Loan Financing	Scenario A:3
Financing Scenario 4: Merge CBJ & GEFF Loan Financing	Scenario A:4
Technical Scenario B: New technology	
Financing Scenario 1: Conventional Loan Financing	Scenario B:1
Financing Scenario 2: EBRD GEFF Loan Financing	Scenario B:2
Financing Scenario 3: CBJ Loan Financing	Scenario B:3
Financing Scenario 4: Merge CBJ & GEFF Loan Financing	Scenario B:4

Investment Costs and Financing Scheme

The total investment cost of Scenario A system is EUR 141,691, While the total investment cost of Scenario B is EUR 104,000. Noting that it is a salvage, estimated value of an asset at the end of its useful life is EUR 6,600 (equivalent to JOD 5000).

Table 7 Investment Breakdown

	Scenario A	Scenario B
Investment (EUR)	**R290 Chiller**	**New technology**
Machinery and Equipment	141,691	104,000
Other Costs	0	0
Total Investment Cost	**141,691**	**104,000**
Salvage value	6,600	6,600
Net investment	135,091	97,400

Financial revenues are only derived from energy savings and maintenance cost savings. In both scenarios, there is a significant saving in the electricity bill and one scenario showed saving in operating cost as explained in the following section throughout the operating years of the equipment.

Energy Savings

The energy saving amount of the new cooling system are calculated to be EUR 107,011kWh/year for Scenario A and EUR 91,039 for Scenario B. Electricity prices are determined based on JOD where electricity unit price is 0.082 JOD/kWh. The electricity price is as per the New Electrical Tariff which was applied by April 2022. The analysis assumes an annual 5% electricity price increase for both scenarios over the whole period.

Table 8 Energy saving during the operating period

Parameter	Scenario A	Scenario B
	R290 Chiller	New technology
Energy Price (0.082 JOD/kWh)	0.107 EUR/kWh	0.107 EUR/kWh
Energy Saving Amount (kWh/year)	107,011	91,039
Energy Saving Revenues (EUR) in year 1	11,407	9,705
Annual energy price increase	5%	5%
Energy Saving Revenues for 25 years (EUR)	544,440	463,180

Maintenance Cost Savings

The only operating expense regarding this specific investment is the maintenance cost stemming from the refilling of natural refrigerants. Annual OPEX costs have been estimated based on the review made by the expert team. The calculations are made on EUR basis, as per Jordan's prices as of April 2024, refilling cost of conventional system R134A is EUR 8.58/kg. Meanwhile, the cost of R290 refrigerant is EUR 18.2/kg and the R410 A refrigerant is EUR 11.5/kg (details shown in the table below). Other maintenance costs will be faced in the case of keeping the current conventional system, and it will also result as the old machine will breach and may cannot find a replacement parts.

Operating Expenses

The operating cost here will mainly fill the leakage in refrigerants, the calculations of the amount of leakages and costs as mentioned in the table below. It is noticed that the refilling costs of refrigerants in Scenario A, the R290, is higher than the conventional system which will lead to an increase in refilling cost compared to the current conventional system. This also applies to the refilling cost of refrigerators in Scenario B using the new technologies which is also higher than the refilling cost of the current conventional system, hence the refilling cost will increase when installing Scenario A or B compared to the current conventional cost system. In addition to that, it is projected that as conventional gases gradually fade out, it will become more difficult to find these gases and their prices are expected to increase.

Refrigerants prices is obtained as per 2024 Jordan prices, from reputable suppliers, noting that prices may differ according to the origin as well as quality, and may be affected by supply chain and political situation. Noting that the effect of the operational cost and savings is marginal, the main driver of the study is the energy cost and savings.

Table 9 Operating Cost & Savings comparison between Base Scenario and the suggested Scenarios A & B per year

Per Year	Current Scenario Conventional system	Scenario A R290 Chiller	Scenario B New technology
Existing Refrigerant	R-134A	R 290	R410 A
Leakage rate (%)	0.05	0.05	0.05
Amount of ref. in (g/kW)	300	300	300
Total refrigerant in system (kg)	72	103.8	120

Per Year	Current Scenario Conventional system	Scenario A R290 Chiller	Scenario B New technology
Costs of refrigerant (€/kg)[8]	8.6	18.2	11.5
Refrigerant cost increase	2%	2%	2%
Costs of leaked ref (€) in year 1	30.9	94.5	69.0
Operational Costs (EUR)	30.9	94.5	69.0
Operational Costs Compared to the current Scenario (EUR)	-	63.57	38.142

Depreciation

The yearly depreciation expense is calculated for Scenario A to be EUR 5,667 for each fiscal year, while for Scenario B it is EUR 4,260 for each fiscal year. Depreciation is calculated using the straight-line method assuming the lifetime of the replaced technologies is 25 years. The depreciation expense is a non-cash expense which is used in financial statements and used for calculation of corporate tax, as it is considered a tax shield.

Table 10 Depreciation calciulations

Financing (EUR)	Scenario A	Scenario B
Debt Equity Ratio	70:30	70:30
Total Investment	141,691	104,000
Total Investment after salvage (to be deducted from Equity)	135,091	97,400
Corporate Loan 70% of the Total Investment	99,000	73,000
Equity 30% of the Investment	42,691	31,000
Equity after Salvage value	36,091	24,400

4.2 Technical Input Assumptions

As indicated before, the purpose of this report is to prepare a feasibility analysis of sustainable cooling investment in a hotel. Considering the explanations given above in the sector overview section, it is decided by the expert team to choose a hotel that has not switched to more efficient cooling equipment (cooling space) with natural refrigerants yet.

▶ General assumptions

Cash Flow Analysis has been prepared based on the data collected and analyzed by the Cool Up team. The Cash Flow Analysis of the selected project has been assessed under the following assumptions.

Table 11 Cash Flow Analysis Assumptions

	Scenario A	Scenario B
	R290 Chiller	**New technology**
Discount Rate	6.87%	6.87%

[8] RSS interviews, 2024.

	Scenario A	Scenario B
Length of Analysis	25 years	25 years
Energy price (year 1)	0.082 JOD/kWh	0.082 JOD/kWh
Energy savings kWh/year	107,011kWh/year	91,039kWh/year
Energy cost savings EUR/year (year 1)	11407 EUR/year	9,705 EUR/year
Savings on Refrigerant Refilling Cost (year 1)	63,57 EUR/year	38,14 EUR/year
Carbon Credits[9]	NA	NA
Monetary Unit	EUR	EUR
Exchange Rate EUR/JOD[10]	1 EUR = 0.761 JOD	1 EUR = 0.761 JOD
JOD/EUR Exchange Rate	1.31	1.31
JOD inflation rate for 2024 (Predictions)[11]	2.50%	2.50%
USD inflation rate for 2024[12]	2.60%	2.60%
EUR inflation rate for 2024	2.70%	2.70%
Start of investment	2024	2024
Total Investment Cost	EUR 141,691	EUR 104,000
Salvage Value of old equipment	EUR 6,600	EUR 6,600
Total Net Investment Cost[13]	135,091	97,400

Discount rate was calculated based on the WACC calculations as per the Central Bank of Jordan figures and international disclosures in 2024 as shown in **Annex 1**. The electricity price is the New Electrical Tariff, 0.082 JOD/kWh applied by April 2022.

The hotel is being served by two old Chillers which were installed more than 17 years ago. These chillers are considered to be low efficient and working with low COP (Coefficient of Performance) which does not exceed 2.55. These chillers were visually inspected by a local chillers' agent (Energy International) and found to be a) in bad condition, and b) needed to be repaired and maintained.

Table 12 Existing air conditions and technology

Chiller Capacity (TR)	**120**
Avg. EER	**8.67**
Avg. kW/Tr	**1.22**
Avg. COP	**2.55**

9 For the purpose of this study, the Cool Up team assumes that in the near future no carbon market will be deployed in the country. If it would be created than benefits of the exchange would be even higher.
10 Exchange Rate as of CBJ, 13/12/2023.
11 Exchange Rate as of CBJ, 13/12/2023.
12 As of 13/11/2023, TCMB Forex buy rates for EUR, USD, and cross rate EUR/USD, https://www.tcmb.gov.tr/kurlar/kurlar_tr.html.
13 Investment cost minus the salvage value.

Figure 1 The Existing Chiller

Operational Dynamics

These chillers serve a group of fan coil units (FCUs) (128 units), and all FCUs are used in both summer and winter seasons to provide space cooling/heating needs. Chillers operate for 10 months/year, with the span of 24 hours of operation for one chiller while the other one with an average operation of 12 hours. These chillers are in operation without any type of automatic control, and they are only operated manually.

Power Consumption Analysis

The network of the chilled water is being served by Chilled Water Pump which needs to be controlled by Variable Speed Drive (VSD).

A continuous power measurement on chiller pump were carried out as shown in the figure below:

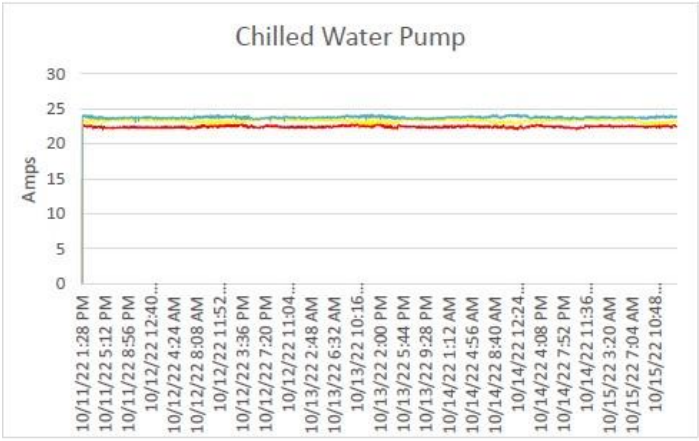

Figure 2 Chilled Water Pump

From the figures above, it can be noted that the chiller pumps are kept running all the time. This means that the pumps operate at the same profiling regardless of the change of the load (demand on cooling) without any type of controlling leading to energy waste and fast wear of the pumps.

The table below presents the basic data about the building itself.

Table 13 Building-related data (source: Data provided by the hotel)

Year of construction and age of the building	1995 (28 Years)	Year
Total Cooling Volume	13761	m3
Total Number of Rooms	83	Numbers
Average Occupancy Rate	44%	Percentage
Year of Installation of HVAC	2007	Year

The energy consumption breakdown of the cooling systems is given below:

Table 14 Existing Specifications of the Current Cooling Unit

Parameter	Conventional Chiller	Unit
Technical specification		
Type of technology	Electrical chiller	
Capacity (Tonnage of Refrigeration)	68	Tonnes
Efficiency indicator (COP, SEER etc. please indicate)	2.55	
Equivalent Capacity	240	kW cooling
Power req per ton of cooling	1.22	kW
Existing Refrigerant	R-134A	
Leakage rate	0.05	
Amount of ref. in (g/kW)	300	g/kW
Total refrigerant in system (kg)	72	kg
Costs of refrigerant (€/kg) (year 1)	8.58	€/kg
Costs of leaked ref (€) (year 1)	30.88	€
Operation data		
Equipment lifetime	25	years
Operational Schedule	2 Chillers (one works 24 h and the other 12h)	hours/day
	7	day/week
	44	week/year
Energy Consumption	303,464	kWh/year

Source: Data provided by the hotel

The average old electrical tariff in Jordan was 0.093 JOD/kWh while in April 2022 new electrical tariff was applied for 0.082 JOD/kWh.

Suggested Technology Brief Description

There are two scenarios for modernization considered:

- **Scenario A**: New technology proposed is modulating chiller with heat pump using R290.
- **Scenario B**: New technology proposed is modulating chiller with heat pumps .

The technical specification and operation data are covered in the table below.

Table 15 Suggested Technology

	Scenario A	Scenario B	
Parameter	**R290 Chiller**	**New technology**	**Unit**
Technical specification			
Type of technology	modulating chiller with heat pump	modulating chiller with heat pump	
Capacity (Tonnage of Refrigeration)	98	114	Tonnes
Efficiency indicator (COP, SEER etc. please indicate)	3.35	2.85	COP
Equivalent Capacity	346	400	kW cooling
Existing Refrigerant	R 290	R410 A	
Operation data			
Equipment lifetime (Useful life)	25	25	Years (or hrs)
Operational Schedule	7392	7392	h/year
	24	24	h/day
	7	7	day/week
	44	44	week/year
Available Automatic Control System (e.g. BEMS, Outside temperature compensation, VSD, modulating Control or On-OFF)		modulating, inverter technology, heat pump	
Energy Consumption	196,453	212,425	kWh/year
Energy savings	107,011	91,039	kWh/year
Financial data			
CAPEX	134,491	104,000	EUR
Chiller Price / TR	1,367	914	EUR
Installation Expenses	7,200	incl in Capex	EUR
OPEX (year 1)	21,036	22,714	EUR/year
Savings (year 1)	11,407	9,705	EUR/year

Expected Benefits

The field visit to the hotel highlighted the fact that the HVAC systems are considered as the main energy consumer in the hotel. During the visit, the Cool Up team gathered data that were used for this feasibility study. Lower energy efficiency resulting in high energy consumption is the main reason to replace one of the existing chillers. New units have advanced compressors and featuring automatic controls, resulting in a significant reduction in energy expenses. More importantly, new chillers have higher part-load efficiencies than replaced chillers. And with most chillers operating 95% of the time or more under part-

load conditions, improved full-load and part-load operating efficiencies translate into significant energy cost savings.[14]

[14] Ecosol interview, 2023.

4.3 Analysis of Financial Outcomes

The following paragraphs present the cash flow analysis for particular scenarios.

Scenario 1: Conventional Loan Financing

The scenario used the Conventional Loan Financing from commercial banks operating in Jordan. The interest rate varies according to the risk rating of the client and the source of fund provided through banks. Noting that the average prime rate is 11.39 % as of 2023,[15] clients may borrow at less or more than prime interest rate plus according to their credit score and credit history with the bank in addition to the source of fund available by the bank and their internal policies. In this case, the interest rate is chosen to be 11% as the hotel is well-established and has operated for around 25 years, in addition to the input received from banks operating in Jordan in regards to the SMEs lending rates which can vary between 8% - 13%, while some exceptions of lower or higher interest rates can also be found in the banks. Noting that the addressed interest rates are decreasing interest rates, in the case of applying to an Islamic bank, the interest rate will be a flat interest rate and it usually ranges between 6% - 7% flat interest rate which is close to the reducing rate in conventional banks. Meanwhile, regarding the tenor, it is also similar to conventional banks and can reach a maximum of 8 years.

Table 16 Scenario 1: Conventional Loan Financing

EUR	Scenario A:1: Conventional Loan Financing	Scenario B:1: Conventional Loan Financing
	A: R290 Chiller	**B: New technology**
Objective of the Loan	Sustainable Cooling/ Energy Efficiency Project R290	Sustainable Cooling/ Energy Efficiency Project New Technology
Serving windows	Commercial Banks	Commercial Banks
Investment amount	141,691	104,000
Percentage financed	70%	70%
Loan Amount	99,000	73,000
Maturity	5 years	5 years
Grace Period	0	0
Interest rate p.a. (Reducing interest)	11%	11%
Discount Rate	6.92%	6.92%
Monthly instalment (including Interest)	2,152.50	1,587.20
Frequency of repayment of loan Instalment	monthly bases	monthly bases
Total Interest Paid till maturity	30,149.99	22,231.81

[15] Association of Banks in Jordan Annual Report, Annual-Report-2023-Arabic-version.pdf (abj.org.jo).

EUR	Scenario A:1: Conventional Loan Financing	Scenario B:1: Conventional Loan Financing
Total Principal + Interest Paid	129,149.99	95,231.81
Net Present Value	83,993	88,805
Internal Rate of Return	11,88%	13,91%
Simple Payback Period (Years)	12	10

As per the scenario analysis and from the results of having 70% debt finance with 30% equity finance, compared to the 100% equity finance, the debt didn't affect the feasibility of the project as both scenarios still had a positive net present value and an accepted IRR, which is above the discount rate. Moreover, the payback period is acceptable as it is less than the operating age of the replaced systems.

Scenario 2: EBRD GEFF Loan Financing

The European Bank for Reconstruction and Development (EBRD) launched a Green Economy Financing Facility in Jordan (Jordan GEFF) to support the green economy transition in Jordan with USD 90 million in financing—in addition to supporting projects for energy-efficiency, small-scale renewable energy, and water conservation projects. The facility is being operated by three banks which are Bank Al Etihad, Cairo Amman Bank and Housing Bank, in addition to one micro finance institution which is Micro Fund for Women. Eligible projects submitted to participating financial institutions from eligible and creditworthy small corporates or SMEs operating in any sector, ESCOs, producers, vendors and suppliers of green technologies and residential building. Borrowers may receive up to USD 1 million in financing on each project. Companies may also benefit from technical support to develop green investment projects and receive grants between 10% to 15% of the financing provided on independent verification of successful implementation of their projects.

GEFF provides a local team of engineers and finance specialists for the necessary assistance throughout the phases of project implementation, including project origination, investment appraisal and post-implementation quality checks. In addition to approving investment projects based on individual assessment, an online tool called GEFF Green Technology Selector (GTS) is provided to exhibit pre-approved high-performance technologies and materials that qualify for financing under the facility.

Table 17 Scenario 2: EBRD GEFF Loan Financing

	Scenario A:2 : EBRD GEFF Loan Financing	Scenario B:2 : EBRD GEFF Loan Financing
	A: R290 Chiller	**B: New technology**
Objective of the Loan	Sustainable Cooling/Energy Efficiency Project R290	Sustainable Cooling/Energy Efficiency Project New Technology
Serving windows	GEFF partnering Commercial Banks	GEFF partnering Commercial Banks
Investment amount\ EUR	141,691	104,000
Percentage financed	70%	70%
Loan Amount \ EUR	99,000	73,000
Maturity	5 years	5 years

	Scenario A:2 : EBRD GEFF Loan Financing	Scenario B:2 : EBRD GEFF Loan Financing
Grace Period	0	0
Interest rate (Reducing interest)	10%	10%
Discount Rate	6.73%	6.73%
Monthly instalment \ EUR (including Interest)	2,103.46	1,551.03
Instalment Paid on	monthly bases	monthly bases
Total Interest Paid till maturity\ EUR	27,207.45	20,062.06
Total Principal + Interest Paid	126,207.45	93,062.06
Total Cash back From GEFF loan 10%	9,900.00	7,300.00
Total Interest Paid - Cash Back (loan cost)	17,307.45	12,762.06
Total Principal + Interest Paid - Cash back	116,307.45	85,762.06
Net Present Value	97,322	99,033
Internal Rate of Return	12,82%	14,98%
Simple Payback Period	11	10

As per the scenario analysis and from the results of having 70% debt finance with 30% equity finance, compared to the 100% equity finance, the debt didn't affect the feasibility of the project as both scenarios still had a positive net present value and an acceptable IRR, which is above the discount rate. Additionally, the payback period is also acceptable as it is less than the operating age of the replaced systems.

Scenario 3: CBJ Loan Financing

However, The Central Bank of Jordan has a fund to support different economic sectors including industrial, tourism, agriculture, renewable energy, information technology, transportation, health, technical and vocational education, and engineering consulting sectors. The CBJ has assigned a total of JOD 1.3 billion subsidized fund (equivalent to about 4% of direct facilities granted by banks) to be lent to Jordanian banks at an interest rate of 0.5%-1%. Banks are expected to on-lend to eligible clients at a CBJ capped rate between 2.5%-4%, depending on the location of the client. Loans have a 10-year tenor and 2 years grace period with a maximum single loan size of JOD 3 million and JOD 4 million for transportation & energy sectors respectively. The CBJ fund concentrates on medium to large companies. There are no clear guidelines for financing sustainable cooling project by commercial banks. These loans can benefit from the Jordan Loan Guarantee Cooperation Guarantee.[16]

[16] The Central Bank of Jordan, 2023.

As per the scenario analysis and from the results of having 70% debt finance with 30% equity finance, compared to the 100% equity finance, the debt didn't affect the feasibility of the project as both scenarios still had a positive net present value and an accepted IRR, which is above the discount rate. Moreover, the payback period is also acceptable as it is less than the operating age of the replaced systems.

Table 18 Scenario 3: CBJ Loan Financing

	Scenario A:3 – CBJ Loan Financing	Scenario B:3 – CBJ Loan Financing
	A: R290 Chiller	**B: New technology**
Objective of the Loan	Sustainable Cooling/Energy Efficiency Project R290	Sustainable Cooling/Energy Efficiency Project New Technology
Serving windows	Commercial Banks	Commercial Banks
Investment amount	141,691	104,000
*** Percentage financed**	70%	70%
Loan Amount	99,000	73,000
Maturity	5 years	5 years
Grace Period	0	0
Interest rate (Reducing interest)	3.5%	3.5%
Discount Rate	5.48%	5.48%
Monthly instalment (including Interest)	1,800.98	1,328.00
Instalment Paid on	monthly bases	monthly bases
Total Interest Paid till maturity	9,058.97	6,679.84
Total Principal + Interest Paid	108,058.97	79,679.84
Net Present Value	121,853	121,127
Internal Rate of Return	11,88%	13,91%
Simple Payback Period	12	10

Scenario 4: Merge CBJ & GEFF Loan Financing

The fourth financing scenario addressed the possibility of merging two sources of finance which are the Central Bank of Jordan Fund, along with GEFF. The financing will be granted from one of the GEFF partnering financial institutions in the amount of 50% of the suggested debt financing, which is EUR 99,000 in scenario A and EUR 73,000 in scenario B. The remaining 50% of the debt will be obtained from the CBJ fund through the bank.

Table 19 Scenario 4: Merge CBJ & GEFF Loan Financing

	Scenario A:4 – Merge CBJ & GEFF Loan Financing	Scenario B:4 – Merge CBJ & GEFF Loan Financing
	A: R290 Chiller	**B: New technology**
Objective of the Loan	Sustainable Cooling/Energy Efficiency Project R290	Sustainable Cooling/Energy Efficiency Project R290
Serving windows	GEFF partnering Commercial Banks	GEFF partnering Commercial Banks
Investment amount	141,691	104,000
Percentage financed	70%	70%
Loan Amount	99,000	73,000
Loan Amount CBJ (50%)	49,500	36,500
Loan Amount GEFF (50%)	49,500	36,500
Maturity	5 years	5 years
Grace Period	0	0
Interest rate (Reducing interest)	3.5% for CBJ & 10% for GEFF	3.5% for CBJ & 10% for GEFF
Discount Rate	6.11%	6.11%
Monthly instalment (including Interest)	1,948.66	1,436.89
Instalment Paid on	monthly bases	monthly bases
Total Interest Paid till maturity	17,919.76	13,213.56
Total Principal + Interest Paid	116,919.76	86,213.56
Total Cash back From GEFF loan 10%	4,950.00	3,650.00
Total Interest Paid - Cash Back (loan cost)	12,969.76	9,563.56
Total Principal + Interest Paid - Cash back	111,969.76	82,563.56
Net Present Value	88,943	92,455
Internal Rate of Return	12,34%	14,42%
Simple Payback Period	11	10

As per the scenario analysis and from the results of having 70% debt finance with 30% equity finance, compared to the 100% equity finance, the debt didn't affect the feasibility of the project as both scenarios still had a positive net present value and an acceptable IRR, which is above the discount rate. And the payback period is acceptable as it is less than the operating age of the replaced systems.

Debt Structuring

The financial service sector in Jordan is well-developed, particularly compared regionally, with a wide range of services from microfinance to retail and corporate commercial to investment banking. At present, 21 commercial banks operate in Jordan, including 12 domestic conventional banks, 3 domestic Islamic banks, 5 foreign-owned conventional banks and a foreign-owned Islamic bank. The case study with reference to the hotel located in Aqaba, may choose to finance the suggested investments from any commercial bank (either its regular bank or any other) operating in Jordan. The hotel may choose one of the financing options available with the banking sector as follows:

Table 20 The Financial Scenarios

Technical Scenario A: R290 Chiller	
Financing Scenario 1: Conventional Loan Financing	Scenario A:1
Financing Scenario 2: EBRD GEFF Loan Financing	Scenario A:2
Financing Scenario 3: CBJ Loan Financing	Scenario A:3
Financing Scenario 4: Merge CBJ & GEFF Loan Financing	Scenario A:4
Technical Scenario B: New technology	
Financing Scenario 1: Conventional Loan Financing	Scenario B:1
Financing Scenario 2: EBRD GEFF Loan Financing	Scenario B:2
Financing Scenario 3: CBJ Loan Financing	Scenario B:3
Financing Scenario 4: Merge CBJ & GEFF Loan Financing	Scenario B:4

Banks provide debt finance to eligible borrowers for which banks need collateral to secure loans. In the case of an equipment loan, simple hypothecation of all moveable assets is adequate to achieve coverage. If an establishment is availing of a long-term debt finance for a new project (to set up a hotel) or expansion project, banks may create security by way of mortgage on immovable assets. In some cases, a third-party guarantee from the Jordan Loan Guarantee Corporation (JLGC) could be provided.

The JLGC was established 1994 to provide commercial banks guarantees for loans provided from banks and MFIs. JLGC guarantees loans for SMEs, start-ups who applies to commercial banks and MFIs, and do not have the required collaterals. The maximum loan amount to be guaranteed is JOD 1 million and JLGC provides partial loan guarantees (up to 70%-85%) to banks financing for SMEs. A client (a SME) applies for debt finance (loan) to a bank. This lender (Bank) requires a collateral on which basis the bank can provide credit approval. If the client (SME) is interested in obtaining the JLGC guarantee, then the bank (lender) communicates with JLGC and seeks approval of the case for the guarantee. The client pays guarantee fees to JLGC.

Below are the four main bank financing options presented for both technical scenarios, Scenario A & Scenario B. In all scenarios, loan to equity ratio is calculated to be 70%-30%. As banks financing ratio may vary, the 70% debt ratio is calculated from the average of bank financing ratios as bank financing can reach 90% and can be only 50%. The financing ratio differs according to the bank's internal credit policy or the

risk rating of the client, the purpose of the loan in addition to the client need. In the scenarios below an average of 70% financing ratio was chosen. This means that the bank will provide a loan with 70% of the asset cost and the client need to self-finance 30% as an equity. The financing case studies below subtracted the salvage value of EUR 6,600 (equivalent to JOD 5,000) from the equity after obtaining the finance, as usually it is not included nor calculated in the asset financing ratio. The hotel may use the salvage value in other investments or save it at the banks as a fixed deposit.

Asset financing for companies is granted as a term loan, with a decreasing interest rate. Tenors on asset finance starts from 1 year tenor to reach 7 years, or even 10 years in some projects, and grace periods vary between 0-6 months according to the time needed to implement the project and the availability of the source of income. Grace period may reach 2 years in case of new projects and using CBJ funds. In the scenarios below, the tenor of loans was calculated for 5 years as an average and considered as an acceptable loan tenor, with no grace period assuming that the hotel is a well-established hotel and is able to pay its loan instalment immediately. This notes that the grace period's interest rates are usually paid separately without the principle during the grace period or can be accumulated to later loan instalments.

Table 21 Loan to Equity Ratios and Amount

Financing (EUR)	Scenario A	Scenario B
Debt Equity Ratio	70:30	70:30
Total Investment	141,691	104,000
Total Investment after salvage (to be deducted from Equity)	135,091	97,400
Corporate Loan 70% of the Total Investment	99,000	73,000
Equity 30% of the Investment	42,691	31,000
Equity after Salvage value	36,091	24,400

Financial Indicators

The table below presents the results regarding the main indicators of the cost benefit analysis for Scenario A for an investment of EUR 141,691 and Scenario B for investment amount of EUR 104,000 without debt finance and with the four scenarios of the debt finance. The energy savings and maintenance cost savings of the investment are taken as the incremental projected incomes of the investment.

Table 22 Main indicators for financial analysis for the technical scenarios A & B without the cost of finance

	Parameter	UoM	Scenario A	Scenario B
			R290 chiller	Modulating Chiller
Without cost of financing	NPV	EUR	90,357	93,498
	IRR	(%)	12.97%	15.37%
	PB	Years	11	10
Initial Investment Value		EUR	135,091	97,400
Total Cash Inflows (total savings in the 25 years lifetime)		EUR	90,357	93,498
With Cost of Financing 70% borrowing				
Scenario 1: Conventional Loan Financing	NPV	EUR	83,993	88,805
	IRR	(%)	11.88%	13.91%
	PB	Years	12.0	10.0
Scenario 2: EBRD GEFF Loan Financing	NPV	EUR	97,322	99,033
	IRR	(%)	12.82%	14.98%

Scenario 3: CBJ Loan Financing	PB	Years	11	10
	NPV	EUR	121,853	121,127
	IRR	(%)	11.88%	13.91%
Scenario 4: Merge CBJ & GEFF Loan Financing	PB	Years	12	10
	NPV	EUR	88,943	92,455
	IRR	(%)	12.34%	14.42%
	PB	Years	11	10

Both scenarios A & B with the four debt financing scenarios have a positive net present value which means that the projected earnings generated in all investment scenarios discounted for their present value exceed the anticipated costs and will be profitable. The energy savings of the investment is taken as the incremental projected income of the investment in addition to the contribution of the operational cost in Scenario A. This notes that all the parameters were calculated as both assumptions of the cash was self-financed 100% as an equity or with the use of 70% debt. The discount rate used is 6.87% for the 100% equity financing scenario, while it was 6.92% for Scenario 1 debt finance, 6.73% for Scenario 2 debt finance, 5.48% for Scenario 3 debt finance, 6.11% for Scenario 4 debt finance.

Both Scenarios A & B have a positive NPV. Both Scenarios A & B are considered acceptable investments in terms of the IRRs which is higher than the discount rate. Simple Payback period for Scenario A is 11-12 years while in scenario B it is 10 years. Both are acceptable as all scenarios noting that the technologies have an operating age of 25 years.

5 Sensitivity Analysis

It may be observed that the electricity expenses and operating expenses (mainly comprising maintenance expenses) in respect of the old equipment in the case under discussion in this feasibility study are on the higher side. On the other hand, any increase in the electricity tariff will result in higher energy expenses. These factors contribute as drivers for the replacement of chillers. The feasibility study provides incremental analysis based on energy savings. Any increase in energy prices will increase the NPV and the IRR and will make the investment in both scenarios more feasible and profitable. For this reason, choosing any other factor in the sensitivity analysis will not have a substantial contribution or negative influence on the viability of the project. It may be noted that interest rates on loans are expected to move downwards in the near future as the FED interest rates are expected to fall, and the impact in the decrease of interest rates will positively impact the feasibility of then debt financing scenarios and will positively reflect on the NRV, IRR and payback period. This notes that The Fed has pushed interest rates higher since early 2022 in order to quash high inflation. From March 2022 to July 2023, The Fed increased the federal-funds rate by 5 percentage points, making it the largest and fastest increase in 40 years. Lastly, **financial risks identified in the project appraisal are low to medium.**

Financial Risks

Price Risk

The risk associated with electricity prices and operating cost savings are estimated to be at medium level. In both scenarios, the savings from electricity and maintenance costs are positive cash inflows. For the operating costs, the refrigerant prices addressed earlier is as per the market price and may be affected by fluctuation in market price, noting that as conventional gases gradually fade out, it will become more difficult to find these gases and their prices is expected to also increase.[17] In regard to the energy prices, the increase in energy prices will affect the hotel more in case they decide to keep the current conventional system and do not replace it.

Capital Cost Evaluation Risk

CAPEX data has been assessed according to the data available and provided by Cool Up team in line with benchmark costs for this type of equipment. The overall risk is estimated as low, as the technology and type of the related equipment is fixed, as it is easy to access and acquire.

Interest Rate Risk

Interest rate risk is the potential for increasing the cost of borrowing that can be triggered by a move upward in the prevailing interest rates. In reference to the financial scenarios, the loan is assumed to be granted by banks and there are different sources of funding from the banks with competitive interest rates. As mentioned earlier, interest rates trends in the near future is expected to decrease which is for the benefit of the client.

Foreign Exchange Risks

Foreign exchange rate risk is low. As the main cost is paid in advance at installation, the remaining costs are the energy and maintenance cost savings cash follow. The local currency, Jordan Dinar prices, are pegged to USD. This will reduce the foreign exchange rate risk.

Credit Risk

Credit risk is the ability of the borrower to repay the loan and interest in timely manner to the bank. The project is feasible in all loan scenarios, with 70% debt and 30% equity. The IRR and NPV are positive. The company is well-established and reputable and have its cash flow from operations. This will not risk the ability of the company to repay its debt and meet its monthly instalments. The company may be asked to provide collateral, however, as it is well-established, the collateral and repayment risk will be low as well.

[17] Kigali Agreement, 2023.

Carbon Trade Revenue Risk

Jordan has not implemented an emission trading system yet. In the absence of a well-established Emissions Trading System (ETS), there can be various uncertainties and fluctuations in the regulations governing carbon trading. This dearth of a well-defined legal structure creates potential risks for both investors and individuals involved in the market. Regulatory uncertainties and frequent modifications can undermine confidence and hinder the effectiveness of carbon trading initiatives. Due to those risks and uncertainties, the risks associated with carbon trading is considered as high. However, it must be noted that the introduction of a carbon price to the feasibility study would only increase the profitability of energy efficient measures proposed.

Table 23 Project Financial Risk Profile

Project Financial risk profile	High	Medium	Low
Price risks		X	
Capital Cost Evaluation			X
Interest rate changes			X
Foreign exchange risk			X
Credit risk			X
Carbon finance risk	X		

Technical Risks

R290 refrigerant, a potentially hazardous substance, necessitates careful and appropriate handling and storage due to its flammability. Any mishandling can result in the risk of fire or explosion. Furthermore, inhalation of R290 can result in respiratory irritation and various health complications. When utilized correctly and in appropriate contexts, R290 can serve as a secure and efficient alternative for refrigeration.

Besides the potential safety hazards, which are effectively mitigated due to the minimal charging amount per unit, another commonly expressed concern is the lack of qualified maintenance personnel in the market. Nonetheless, this concern is unfounded considering the widespread adoption of R290 and R600 natural refrigerants, particularly for smaller capacity units, since the 2010s.

Due to operating below capacity, the anticipated energy savings may not be achieved. However, it is important to note that the primary reason for replacing the current system is not solely based on energy savings. The main driving factor is the phased-out schedule for R404a refrigerants. By 2025, the market will no longer offer new products incorporating R404a. Moreover, the availability of R404a gases for refilling will gradually decrease, resulting in significantly higher costs. If A101 continues to utilize R404a, the expenses associated with refilling will considerably rise, and there is a risk of inadequate supply for over 12,000 markets.

Summary of the pros of using R290:

- Widely established in domestic refrigeration for decades
- Most product design standards already established
- Relatively simple and cost-efficient technology
- Energy efficiency typically higher than traditional refrigerants

The main challenges of using R290 is that it is flammable. It requires specific safety measures; thus service personnel need to be trained in servicing flammable refrigerants if not already in place. Additionally, maximum load restrictions also need to be applied due to safety standards.[18]

Regarding safety risks associated with the hydrocarbon unit, the suggested systems utilize a chilled water system. This system confines the refrigerant cycle to the chiller located outdoors. Thus, any potential leaks would occur in a well-ventilated area, mitigating indoor safety risks.

Table 24 Project Technical Risk Profile

Project Technical Risk Profile	High	Medium	Low
Safety Risks			X
Implementation Risks			X
Operational Risks			X
Energy Saving Risks		X	
Supply Risks		X	

[18] Markus Offermann, Mads Giltrup, Selimcan Azizoglu, et al., "Catalogue of Technical Solutions for Sustainable Cooling in Jordan," *Berlin: Guidehouse Germany GmbH* (March 2022), Catalogue of Technical Solutions for Sustainable Cooling in Jordan - Cool Up programme.

6 Energy and Environmental Benefits

Energy Savings

The energy saving amount of the new space cooling is calculated to be 107,011 kWh/year for Scenario A and 91,039 kWh/year for Scenario B. Electricity prices are determined based on JOD, where the electricity unit price is JOD 0.082/kWh, equivalent to EUR 0.107/kWh. This rate is in accordance with the New Electrical Tariff applied in April 2022. The analysis assumes a 5% electricity price increase per year. Additionally, these energy savings contribute to significant cost reductions and environmental benefits by lowering carbon emissions.

The detailed calculations for both scenarios are summarized below:

Table 25 Energy saving during the operating period

Parameter	Scenario A	Scenario B
	R290 Chiller	New technology
Energy Price (0.082 JOD/kWh)	0.107 EUR/kWh	0.107 EUR/kWh
Energy Saving Amount (kWh/year)	107,011	91,039
Energy Saving Revenues (EUR) (year 1)	11,407	9,705
Energy Saving Revenues for 25 years (EUR)	544,440	463,180

These savings not only highlight the financial benefits but also emphasize the positive environmental impact of adopting energy-efficient cooling technologies. The reduction in energy consumption aligns with broader sustainability initiatives, ultimately contributing to a greener future.

Environmental Impact

The new technology not only saves energy but also reduces the environmental footprint. Scenario A uses the R290 Chiller, known for its lower Global Warming Potential (GWP) compared to traditional refrigerants. Scenario B uses R410, which, while effective, has a higher GWP than R290. Therefore, both scenarios support sustainability goals, but Scenario A has an additional advantage in reducing GHG emissions. The reduction in energy consumption directly translates to fewer GHG emissions, contributing to the fight against climate change.

The emission reduction connected with the lower GWP of the refrigerant, in Scenario A against the existing chiller is 5.13 ton per year while in Scenario B results in GHG emission increase of 7.38 ton per year in the first year of operation.

The emission reduction due to energy savings in year 1 in Scenario A are 43,48 ton while in Scenario B 36,99 ton. The analysis assumes a decreasing grid emission factor (from 459 gCO2/kWh in 2020 to 184 gCO2/year in 2050).

After accounting for the emission reduction due to: change of refrigerants, energy savings (with the above mentioned decrease in grid emission factor) the total emission reduction over the whole period of analysis for Scenario A is 900,91 ton, while in Scenario B is 472,78 ton.

7 Conclusions and Recommendations

Natural refrigerants have emerged as a sustainable alternative to traditional synthetic refrigerants in the cooling sector. These eco-friendly refrigerants, including ammonia, carbon dioxide, and hydrocarbons, offer numerous environmental benefits and contribute to a greener and more sustainable future.

Natural refrigerants have a lower Global Warming Potential (GWP) compared to synthetic refrigerants. They do not contribute to the depletion of the ozone layer and have minimal impact on climate change. By choosing natural refrigerants, businesses can play a crucial role in reducing their carbon footprint and mitigating the effects of global warming.

Unlike chlorofluorocarbons (CFCs) and hydrochlorofluorocarbons (HCFCs), natural refrigerants have no ozone depletion potential (ODP). This means that they do not harm the ozone layer, which is essential for protecting life on earth from harmful ultraviolet (UV) radiation. Using natural refrigerants helps preserve the ozone layer and contributes to the overall health of the planet.

Natural refrigerants are known for their excellent thermodynamic properties, which result in higher energy efficiency compared to synthetic refrigerants. This efficiency translates to reduced energy consumption and lower operating costs for commercial cooling systems. By opting for natural refrigerants, businesses can achieve significant energy savings while maintaining optimal cooling performance.

Finally, as governments and international organizations focus on phasing out high-GWP synthetic refrigerants, regulations and guidelines are being put in place to encourage the adoption of natural refrigerants. By utilizing natural refrigerants in their commercial cooling systems, businesses can ensure compliance with these regulations and demonstrate their commitment to sustainability.

In Jordan, a hotel operating in Aqaba was chosen and two new systems were suggested as Scenario A and Scenario B. Scenario A is substituting the conventional system with the R290 chiller, and Scenario B is substituting the conventional system with modulating Chiller.

Based on the analysis, the following results are obtained for different scenarios:

Table 26 Financial feasibility results

	Parameter	UoM	Scenario A	Scenario B
			R290 chiller	Modulating Chiller
Without cost of financing	NPV	EUR	90,357	93,498
	IRR	(%)	12.97%	15.37%
	PB	Years	11	10
Initial Investment Value		EUR	135,091	97,400
Total Cash Inflows (total savings in the 25 years lifetime)		EUR	90,357	93,498
With Cost of Financing 70% borrowing				
Scenario 1: Conventional Loan Financing	NPV	EUR	83,993	88,805
	IRR	(%)	11.88%	13.91%
	PB	Years	12.0	10.0
Scenario 2: EBRD GEFF Loan Financing	NPV	EUR	97,322	99,033
	IRR	(%)	12.82%	14.98%
	PB	Years	11	10
Scenario 3: CBJ Loan Financing	NPV	EUR	121,853	121,127
	IRR	(%)	11.88%	13.91%
	PB	Years	12	10

Scenario 4: Merge CBJ & GEFF Loan Financing	NPV	EUR	88,943	92,455
	IRR	(%)	12.34%	14.42%
	PB	Years	11	10

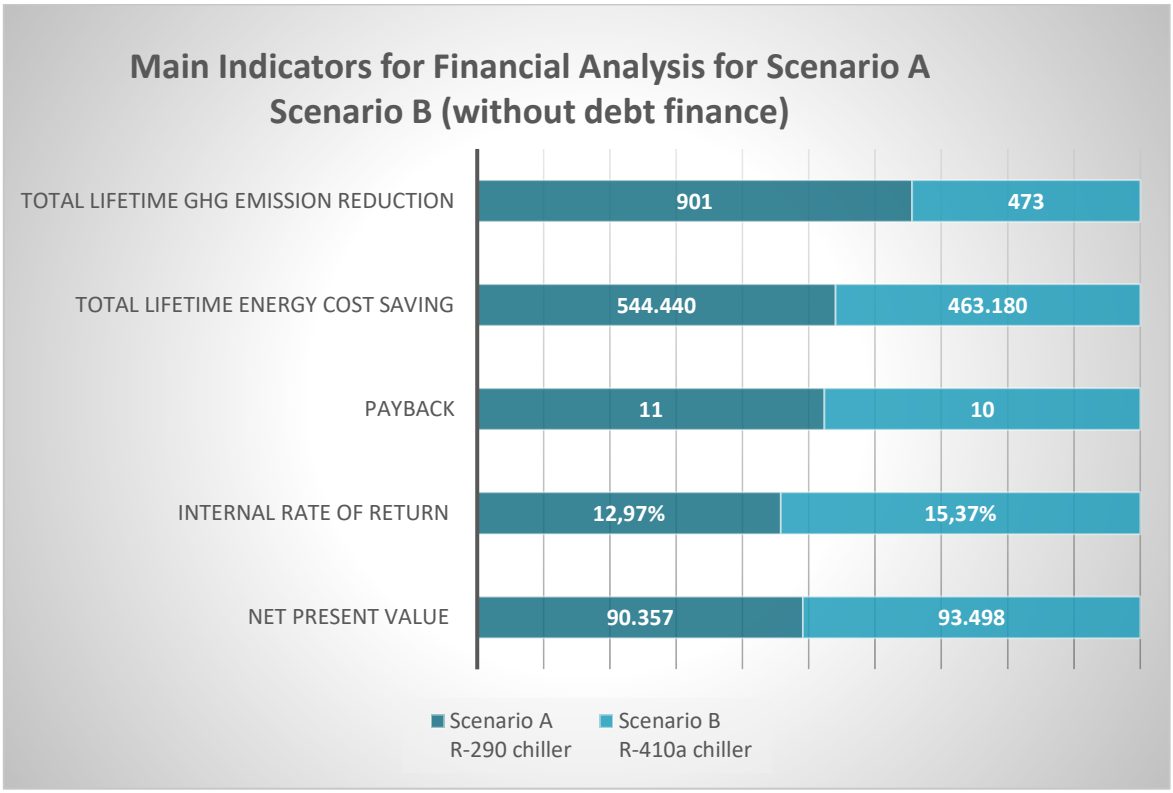

Figure 3 Main Indicators for financial analysis for the technical scenarios A & B without financing

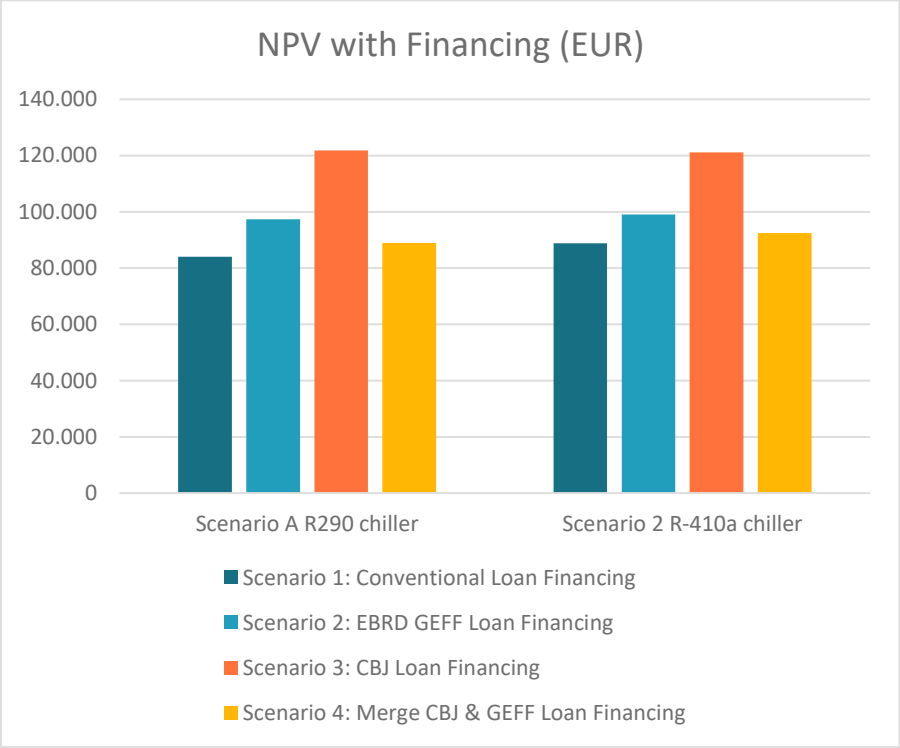

Figure 4 NPV for financial analysis for the technical scenarios A & B with financing

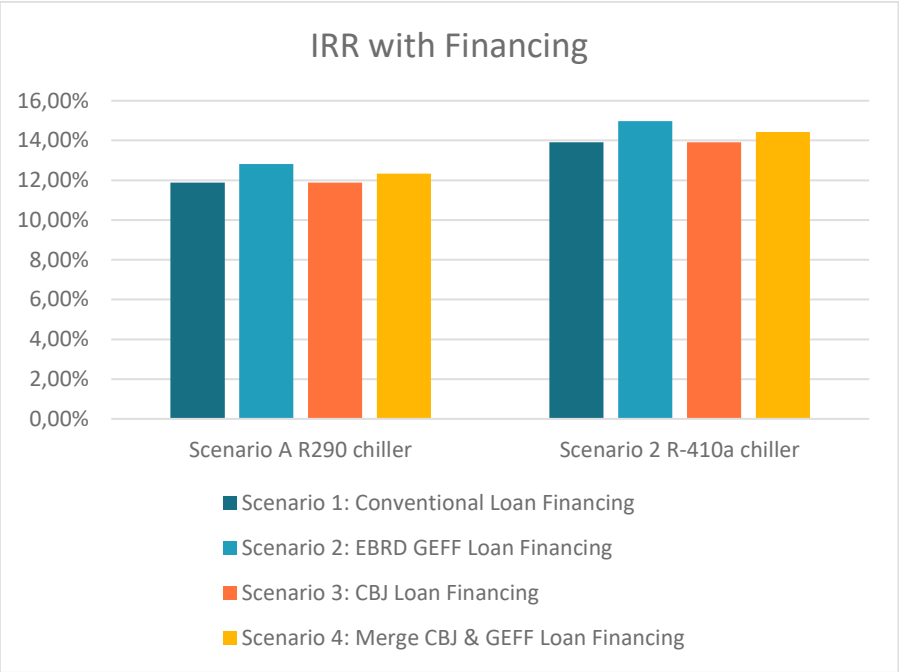

Figure 5 IRR for financial analysis for the technical scenarios A & B with financing

The above charts clearly show that it is feasible to exchange the old chiller for a new one. While Scenario B (R-410a chiller) NPV and IRR and slightly higher, Scenario A (R-290 chiller) show almost twice (900 vs 472 ton) higher GHG emission reduction and 18% (544,440 EUE vs 463,180 EUR) higher total lifetime energy cost savings. It is critical to underline that the HFCs are being phased out over next 20 years which means that Scenario B is subject to (for now) intangible risk of increasing prices and limited availability of refrigerant. It is also worth noting that the sustainability of business is one of the biggest trends in hotel industry pushing the hotels to decrease their impact on the environment. Having this said Scenario A – chiller using a natural refrigerant R-290 is a more viable choice.

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8 Annex

8.1 Annex I: Existing Policy Frameworks

Jordan has made progress towards meeting Montreal Protocol and Kigali Amendment commitments by implementing applicable programs, legislation, and policy instruments like codes and standards. Jordan's RAC and building sector policy tools were analyzed to determine strengths and weaknesses in phasing down HFCs, adopting natural refrigerants, and lowering cooling demand.

According to regulatory analysis, Jordan has successfully executed HCFC phase-out initiatives, such as limiting ODS imports through licensed importers and monitoring ODS-consuming and converted firms. Jordan is executing a plan to phase down HFCs with recently authorized instructions. Although new guidelines for reducing HFC intake exist, Jordanian customs do not monitor or control HFCs. Importers are not required to register, get a license, or report HFC amounts to the NOU.

Sustainable cooling must be integrated into Jordan's national strategies. The new NDC (2021) sets Jordan's mitigation goal at 31% emission reduction by 2030 compared to 2012 levels. The amended NDC aims to reduce HFC consumption in line with national pledges to comply with the Kigali Amendment. The Ministry of Energy and Mineral Resources plans to create the Third NEEAP, which will include energy efficiency initiatives and national priorities. Jordan lacks a National Cooling Plan to incorporate cooling into its climate strategies.

While existing rules are mostly well-enforced and administered, there is still potential for improvement. The Waste Management Framework Law No.16 of 2020 and the upcoming Electrical and Electronic Waste Management could enhance end-of-life management of RAC appliances, but a recovery and waste management scheme for phased-out refrigerants is still needed. Improved regulations and standards for waste disposal of ODS and HFC, safety requirements, technician qualification, and MEPS procedures are needed. Many households' RAC equipment have well-defined MEPS and labelling, but not commercial ones.

Jordan has a National Ozone Committee that advises NOU on ODS phase-out laws, but it is unaware of the connections between F-gases restrictions, energy efficiency criteria of RAC sub-sectors, and building codes. Low awareness is a major obstacle to coordinating and mainstreaming cooling issues across national rules and policies. There is also a need for awareness raising around other sustainable cooling concerns, including the link between Kigali Amendment obligations and energy efficiency measures, as well as the implementation of the building rules to lower the cooling demand. Detailed information on the legislation is available in the reports on the Cool Up website.

8.2 Annex 2: WACC

Discount rate was calculated based on the WACC calculations with the following inputs as per the Central Bank of Jordan figures on 13/12/2023.

- Rate of Risk Free is calculated by using the CBJ Window rate 7.25%[19]
- Tax rate = 20%[20]

Cost of Equity	
Rate of Risk Free[21]	7.25%
Beta[22]	0.56
Jordan Risk Premium[23]	6.58%
Cost of Equity	6.9%
Cost of Debt	
Rate[24]	3.5% - 11 %
Tax Rate	20%
Debt's Expenses	8.8%

WACC Calculations For Financing	Borrowing Interest Rate	WACC
Equity Only	0.00%	6.87%
Loan Scenarios		
S1: Conventional Loan Financing	11.00%	6.92%
S2: EBRD GEFF Loan Financing	10.00%	6.73%
S3: CBJ Loan Financing	3.50%	5.48%
S4: Merge CBJ & GEFF Loan Financing	3.5%+10%	6.11%

19 Central Bank of Jordan, 2023
20 Jordan Tax rate for Private Companies
21 Central Bank of Jordan, 2023
22 BETA (Levered Beta rate by industry for real estate general diversified/WACC EUROPE. Source: https://pages.stern.nyu.edu/~adamodar/New_Home_Page/datafile/Betas.html)
23 Country Risk Premium, 2024
24 Debt interest rate: Reflect the interest rate of each scenario.

8.3 Annex 3: Technical Data

Item	R290 Chiller	Conventional Chiller	New technology	Unit	Comment
Technical specification					
Type of technology	modulating chiller with heat pump	electrical chiller	modulating chiller with heat pump		
Capacity (Tonnage of Refrigeration)	98	68	114	Tonnes	0.284345
Efficiency indicator (COP, SEER etc. please indicate)	3.35	2.55	2.85	all as COP	all as COP
Equivalent Capacity	346	240	400	kW cooling	
Power req per Ton of cooling		1.22		kW	
Existing Refrigerant	R 290	R-134A	R410 A		
Operation data					
Equipment lifetime (Useful life)	25	25	25	Years (or hrs)	expert guess in years
Operational Schedule	7392		7392	h/year	
	24	2 Chillers (one works 24 h and the other 12h)	24	h/day	
	7	7	7	day/week	
	44	44	44	week/year	
Set Temperature				C	
Available Automatic Control System (e.g. BEMS, Outside temperature compensation, VSD, modulating Control or On-OFF)			modulating, inverter technology, heat pump		
Estimated Load Factor				%	
Energy Consumption	196,453	303,464	212,425	kWh/year	
Energy savings	107,011		91,039	kWh/year	
OPEX					

Item	R290 Chiller	Conventional Chiller	New technology	Unit	Comment
Tariff for end user	0.082	0.082	0.082	JOD/kWh	in JOD/kWh
Energy cost reduction	11,407		9,705	EUR/year	1.3
preventive maintenance	0.5	0.5	0.5	years	HVAC system does not necessarily need refrigerant refilling unless there is a leakage or any technical issues. Preventive maintenance is typically conducted semi-annually
Refrigerant Unit Price	0.018	0.032	0.042	EUR/tonnes	
Other Operating costs (As applicable)	92	117	251	EUR/year	costs of leaked refrigerants
Replacement system price	141,691		104,000	EUR/TR	
Replacement capacity				TR	
Replacement cost	141,691		104,000	EUR	80000 JD
Replacement year				year	
Financial data					
CAPEX	134,491		104,000	EUR	The price for the R290 chiller has a lot of expert guesses implied (but our latest offers that we have received in the course of the demo projects showed even higher price differences)
Chiller Price / TR	1,367		914	EUR	
Installation Expenses	7,200		incl in Capex	EUR	Expert guess (for R290)
OPEX	21,034		22,896	EUR/year	
Savings	11,407		9,705	EUR/year	

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