Guide for Sustainable Project Analysis to Improve Energy Efficiency of Mexican SME

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Abstract. Faced with the need of overall cleaner production processes, the Government of Mexico, in coalition with international cooperation agencies, has made efforts to spark to a cleaner transition by the conferment of financing under preferential conditions for small and medium-sized enterprises (SMEs), which are the backbone of the Mexican economy. This will help the implementation of sustainable projects that promote the reduction of energy consumption and Greenhouse Gas (GHG) emissions. However, these efforts have not yielded the expected results since the viability of the loans is determined by the Financial Institutions (FIs) based solely on profitability analysis of the SMEs. If this analysis is complemented with consideration of environmental and social aspects, a greater number of projects would be subject to financing. Real Options method allows the calculation of future cash flows incorporating the uncertainty from the volatility associated with the projects, allowing future adjustments to be made to them based on their performance. In addition, under the economic cost-effectiveness analysis, costs incurred in the implemented projects are compared against the results, assigning a monetary value to them to determine their overall impact. Derived from the limitations in the valuation of sustainable projects in SMEs, this article aims to establish a guide for comprehensive evaluation, using a cost-effectiveness approach and addressing the uncertainty of the project through Real Options. Considering the diversity of the SME during this study, the target companies and the type of projects that have the best opportunities for successful application of the proposed guide were segmented.

Keywords: Sustainable financing · SMEs · Real Options · Cost-effectiveness

1 Introduction

In recent years, Mexico's Small and Medium Enterprises (SMEs) Programs have been implemented to motivate the adoption of renewable energies for their operations or placement of energy efficiency measures to reduce their energy consumption, and at the same time, improve their financial profitability. An example is the Introduction Project to

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Energy Efficiency and Energy Management Systems in SMEs in Mexico (2015–2017), which aimed to promote among companies the adoption of energy efficiency practices (through training) and installment of an Energy Management System in each of the participants. 21 companies participated and of these, the Program yielded 17 success stories. Given that there are 4.1 million of these companies, this sample represents a marginal participation [1] of the overall SME universe.

SMEs represent an important energy consumer and consequently, emitters of large concentrations of Greenhouse Gases (GHG) [2]. The Federal Government, with the support of international cooperation agencies [3], Development Banks and specialized entities in sustainable development, has launched financing programs[4] with financial preferential conditions (compared to those offered in the market) that seek to raise awareness among entrepreneurs and business owners about investing in a "sustainable project", that is, in projects that involve investing in energy efficiency or clean energy adoption for their production processes, which in turn will generate savings in their electrical expenses and, in a related way, will generate positive environmental impacts.

As mentioned before, these programs are offered through financing, accompanied by training and technical assistance [4], making up the most efficient approach to potentialize the resources allocated for this objective and enhances the number of beneficiaries.

Yet, the main obstacle to measuring their true impact is that, so far, the only metric in which the results of these projects are evaluated in SMEs is through profitability, since the Financial Institutions (FIs), mainly Banks, do credit management.

In parallel, those involved in promoting sustainable projects to SMEs do not have the necessary elements to test the comprehensive impacts of these projects, whose results are of interest to international organizations. If there were an efficient record of positive impacts generated by these projects, through financial cooperation mechanisms (donations, grants, very low-cost loans), the granting of resources from these organizations could be triggered at a low fundraising cost, and thus strengthen the national portfolio of actions carried out in matters of sustainability.

The resources granted by international organizations make the lending conditions offered for this purpose more attractive since they achieve better interest rates, terms, and larger amounts. This translates into SMEs transforming their production processes into cleaner methods, with better production practices and enhanced commercialization. If the evaluation is limited only to financial factors, the implementation of these projects will continue to be slow and low impact because there is a lack of evidence to verify that their impacts are beyond economic.

Real options have been used since the 70s to evaluate projects under high degrees of uncertainty, having as an initial precedent the study by Black and Scholes [5] and later, presented in a simpler way, the contribution of Cox, Ross and Rubinstein [6]. But it was until 1985, that Brennan and Schwartz [7] evaluated a project on natural resources, which by their nature, have a high degree of uncertainty in pricing. In their work they considered the options of opening, closing, and abandoning the operations of a copper mine, as well as the price of each alternative. Trigeorgis and Mason [8] analyzed different types of projects with real options and were able to demonstrate that the options to reduce, expand or close natural resource projects depend directly on the variation in the prices of the assets or the added value of the project.

Also, there are studies where Real Options have been used for the evaluation of companies and projects, such as "Valuation by Real Options. Theories and cases" [9], where it is precisely proposed how to calculate the value of a company under this method. The article concludes that the information provided by the traditional Net Present Value (NPV) model is not enough to calculate the real value of the company. Real Option analysis complements the valuation beyond cashflow analysis and monetizes sustainability factors for an overall result.

Regarding the cost-effectiveness analysis, this guide parts from the results obtained in the evaluation of Chávez, Gómez, and Briseño [10], where this type of analysis is used as a tool to choose the best option in various possible scenarios. The study also was carried out in a situation where there is interest in reducing GHG emissions. In the same way, in the analysis by Prieto L. [11] the methodology was detailed to select the most suitable scenario among several options with similar characteristics but identifying the best cost-effective option.

2 Background

The SMEs are commonly called the backbone of the Mexican economy since there are about 4.1 million companies. They employ 72% of the total workforce and contribute 52% to the country's Gross Domestic Product [12].

But likewise, the main source of electricity for these SMEs is generation by burning hydrocarbons, which generates enormous amounts of GHG. Thus, in recent years, the Mexican Government has launched programs focused on energy efficiency measures in SMEs and aim to mitigate the effects of climate change, focused on energy efficiency measures in SMEs and seek to reduce the current demand for fossil fuel electricity production in Mexico. Their use generates over 60% of the total GHG emissions and more than three-quarters of carbon dioxide equivalent emissions (CO_{2e}), according to the 2017 National Energy Balance prepared by the Energy Minister (SENER) [13].

2.1 Energy Consumption of SMEs and Their GHG Emissions

The productive activity of SMEs is also reflected in the consumption of electricity and the demand for hydrocarbons. SMEs are responsible for 17% of the country's total energy consumption (electrical and thermal energy) and 12% of the total Greenhouse Gas emissions generated in Mexico, with a potential total reduction of close to 6.91 million tons of CO_{2e} per year [14].

According to the International Energy Agency (IEA), in Mexico the total electricity consumption in 2016 was 280.62 TW/h [15]. According to the Energy Regulatory Commission (CRE), of this consumption, in 2013 only 25.4% was residential demand [16].

2.2 Benefits of Energy Efficiency and Renewable Energy in SMEs

From an energy standpoint, each energy efficiency project implemented in a thermal or electrical consumption system of an SME, can generate average individual savings between 40 and 100 tons of CO_{2e} per year.

Projects that can use the proposed guidance could reduce 360,000 tons of CO_{2e} /y [14], since they are considered projects that require an energy diagnosis prepared by a consultant, which may involve more than one technology and may involve the modification of the layout of the company or its production processes [17].

From an economic perspective, sustainable projects allow SMEs to generate economic savings in energy consumption. Additionally, companies improve their competitiveness, by implementing sustainable actions that enables low-cost production [17].

2.3 Problems in the Current Evaluation of Sustainable Projects

The way in which sustainable projects are currently being evaluated is not efficient enough because positive (or negative) impact evidence is not extracted and documented. Hence, there´s no information available that demonstrates the comprehensive benefits of their implementation. If data were available, the number of prospects would increase drastically in a domino effect, given demonstrated potential demand (enough interest by the business owner), and more international resources could be accessed, which in turn would improve the financing conditions, ultimately making the projects more profitable and attractive, which is enough motivation to entrepreneurs, business owners and FIs.

This guide addresses the problem directly by helping quantify the environmental and financial criteria and see if combined are enough to incur in financing costs and implementation measures.

3 Methodology

For years, initiatives as the project Introduction to Energy Efficiency and SME Energy Management Systems in Mexico [18], have been launched that promote the transition of the Mexican energy market towards more sustainable production models. The Federal Government has offered subsidies, credits, support with the change of technologies, many of these with the support of international cooperation, new regulations on environmental issues and tax incentives, and despite this, the desired results have not been achieved.

Mexico has international commitments on GHG emissions: reduce 22% of its greenhouse gas emissions by 2030 and 51% with respect to its CO_{2e} emissions [19] but the strategies put in place are still insufficient.

Given that SMEs represent an important consumer of electricity in the country and actively demand resources associated with hydrocarbons, it is necessary to pay attention to the mitigation efforts carried out in this sector.

The number of companies that have adopted a sustainable project can be measured through various programs implemented in the country, as well as their economic profitability, but the real value of these projects, as well as their effectiveness, is uncertain.

For Mexico to continue to be subject of international support, it is necessary to have information tools that can quantify the comprehensive impacts of the implemented projects, with a tangible goal for decision-makers about environmental, social and economic impacts as an integrated objective, making these projects profitable in the process and bringing Mexican SMEs closer to sustainable development.

Additionally, the proposed guide intends to standardize all factors considered when conducting an evaluation of sustainable projects in SMEs, which will serve as a bridge between energy consultants and bank executives to correctly determine the technical and financial viability of these projects.

3.1 Cost-Effectiveness Approach

The Cost-Effectiveness evaluation model is an economic analysis that compares the costs incurred in the implemented projects against their results, assigning a monetary value to their consequences [10].

This evaluation model is useful for social and environmental projects where the impacts do not have an economic value by themselves, but their effects are beneficial for the population and the economy in general.

In the case of evaluating sustainable projects, given the costs of efficient technologies, subsidized electricity rates and the financial situation of SMEs, it is difficult to create profitable projects and, consequently, create lending appetite to FIs for funding. To know its integral value, it is necessary to evaluate its entire process and quantify the positive impacts.

Although knowing the value of these impacts will not automatically make projects attractive for FIs, they will be of interest to the authorities in charge of environmental policies, international cooperation agencies and non-profit associations that can contribute with various incentives to promote the implementation of sustainable projects in SMEs and, consequently, build interest to FIs.

To make economic evaluations under the cost-effectiveness approach, it must be considered that:

The quotient obtained by dividing the net cost of a project by its net benefit or effectiveness is known as “average cost-effectiveness” (CEM). If the result is low, they are cost-effective (efficient) measures, since they have a lower cost for each unit of net benefit or effectiveness that they produce. On the other hand, measures with high CEM are less efficient [11].

When there are several projects that generate benefits, the cost-effectiveness analysis will allow an orderly classification of the relationship between the cost incurred and the effectiveness of the project. For this, the incremental cost-effectiveness (CEI) is used by means of which the costs and effects of the different alternatives are compared, expressed in the same units [11].

The cost-effectiveness plan (see Fig. 1) allows you to place the options, according to their cost and the level of effectiveness. Ideally, the best option is to locate the best project in the second quadrant, where the option is most effective and less expensive.

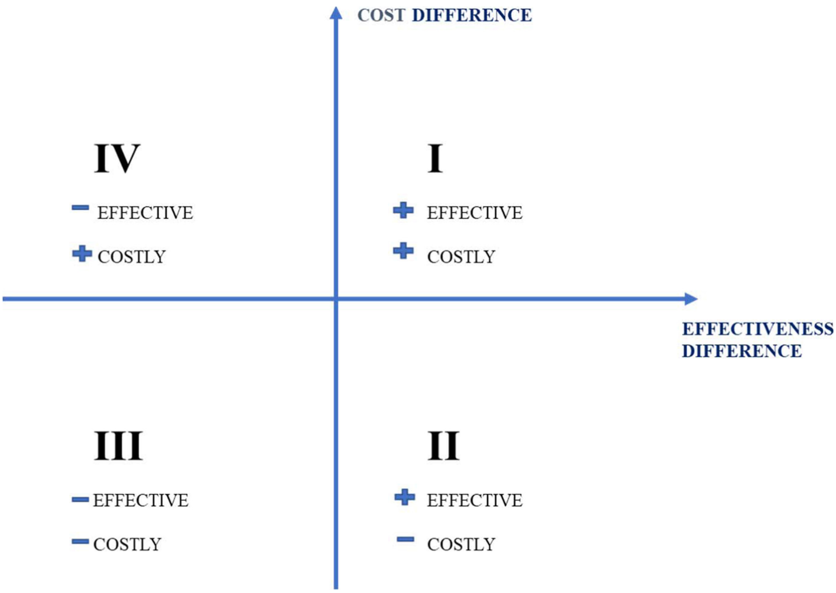

Fig. 1. Cost-effectiveness plan [11].

3.2 Real Options

Real options are a financial instrument that provides the opportunity to make future modifications to a productive project to maximize its value [20]. This tool is useful in sustainable projects due to the high level of uncertainty they have, caused by changes that may occur in the face of technological innovations, price changes and therefore adjustments in the value and profitability of the project that could increase profitability over its operational life.

Real Options allow the investor to make decisions during the life of the project, which add future value and cut losses that a project could incur. With this tool, various actions related to the project can be carried out:

- Expansion or growth: Consider making additional investments related to the project.
- Abandonment: There is the alternative of liquidating the project for another that generates more value for the investor.
- Contraction or reduction: The possibility of reducing the operations related to the project is granted if it is more convenient for the investor.
- Postpone: The project has the option of not executing immediately, since it is estimated that, if expected, the external conditions that affect the project will be more convenient and profitable in the future.
- Flexibility: The investor can change some characteristics of the project during its life continually maximizing its value.

3.3 Guide Structure

The present guide is structured as follows (Fig. 2):

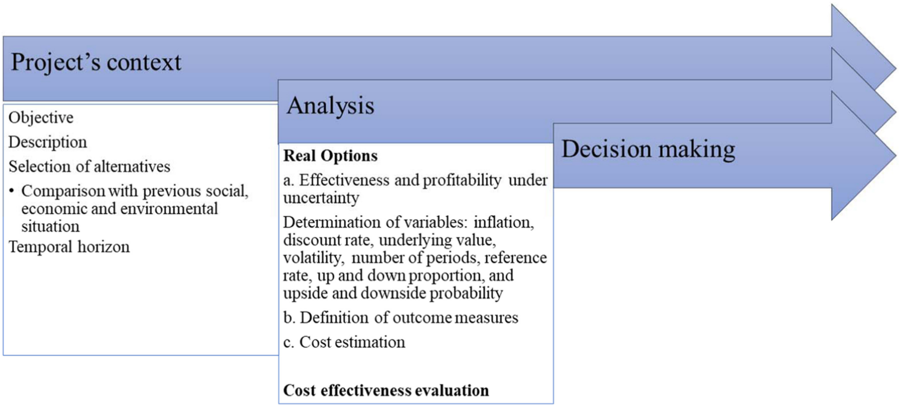

Fig. 2. Guide structure

4 Results

Mexican SMEs consume 43.7% of the national electrical energy, of which 37.3% is demanded by medium-sized companies, which are approximately 400 thousand users and have a saving potential of 11%.

The technologies that present the highest incidence of use in medium-sized companies are electric motors, compressed air systems, lighting, air conditioners, refrigeration, office equipment, and pumping systems. In addition, the installation of photovoltaic solar systems for clean electricity generation is added to activities with potential in energy efficiency. Although there is a clear market segmentation, the implementation of these projects has not been massified because there is a deficiency in the analysis capacity of the projects.

Although a bank credit analyst knows in detail the elements to evaluate the profitability of a project and whether the client is subject to financing, he does not know the technical and environmental particularities that may arise from said project, such as energy savings in fixed expenses, which in turn will increase the borrower's cash flow and increase its debt service payment capacity, nor will it check whether the project will require any modification during its operation cycle to increase its profitability or how cost-effective the project is, by analyzing qualitative and non-quantitative variables.

4.1 Guide Structure

As a result of the evaluation of the proposed methodology, the elements that make up the guide are presented.

Objective. The goal of this guide is to establish a new framework for the evaluation of energy efficiency projects in medium-sized companies, which considers both the profitability of the projects from a Real Options perspective, as well as their results, under a cost-effective approach and thus having a comprehensive perspective of the impacts to the project.

The goal is to increase the number of projects implemented by demonstrating and integrating the associated benefits they generate, besides profitability. To do this, a series of steps are proposed so that decision-makers, in this case, International Cooperation Agencies and FIs, can determine the value of starting a project and decide in which cases is better not to implement it, taking as a reference its financial results and impacts, in a comprehensive manner.

Project Description. To start the evaluation and apply the steps in the guide, data must be gathered that will give the evaluator a complete view of the project. This includes description of stakeholders (SME company name, energy consultant), detailed description of the SME operations and the project to be implemented structuring each energy action or technological change, economic and energy consumption savings, total investment required, Return of Investment, Payback Period, as well as the percentage of efficiency reached by the technologies in their performance.

Additionally, the technical information of the technologies to be implemented is required, as well as knowing the electrical tariff applied the company and the cost per kW/h.

Selection of Alternatives. The results obtained by the implementation of an Energy Efficiency Project in an SME are evaluated against the preconditions in which that company finds itself before the project. Subjects of interest in this guide are projects that have a positive sustainable effect and efficiency, but in some cases are not financially profitable, that is, those projects that provide positive environmental and social impacts, in addition to the profitability sought by Banks.

The comparison will fall mainly in 3 ways:

a. The previous energy consumption of the SME - Environmental aspect.
b. The historical payment of the SME for electricity - Economic aspect.
c. Previous GHG emissions - Social aspect.

These three concepts are integrated to determine if the environmental impact after implementing each project is more sustainable versus the no implementation.

Temporal Horizon. Given that the technologies to be implemented can contemplate useful life cycles of up to 20 years, this period is considered as the guide´s time horizon.

The application of Real Options in the evaluation process seeks to maximize the profitability of projects with interventions over time or minimize losses in case the project does not have a positive performance. Real options contain scenarios under uncertainty, considering the possibility of stopping the project in case of extreme losses or maximize profit if income is higher than expected.

Effectiveness and Profitability Under Uncertainty (Real Options). Traditionally, projects that require financing from Banks are analyzed under the NPV approach, which consists of determining the current value of the project, considering the cashflow generated in the future (applied inflation), by using a discount rate (usually debt interest rate or Weighted Average Cost of Capital) at which the initial investment (equity and/or debt) will be obtained. This method is used in Project Finance practices to determine their added value to shareholders, but it has a deficiency: it does not consider possible changes to the project during its useful life, which could represent maximizing profits or reducing losses.

Starting with the information of the SME and knowing the economic variables of the environment, the cashflow of the company is constructed and the Internal Rate of Return (IRR) is calculated, which determines the percentage of interest that the investment produces. In most cases, the SME does not have the necessary liquidity to implement the project on its own, so an FI is used to request additional funds through debt.

With financing, the initial equity investment is reduced, which causes the IRR of these projects to become more robust. But what if the natural volatility that exists in these projects and / or their associated risks affected their performance? The NPV may not consider it, but the Real Options can.

The Real Options are the result of questioning the traditional method of financial evaluation of a project, where the project is not considered as a static situation. With Real Options, you can calculate future cashflows incorporating the uncertainty from their volatility. Additionally, it considers alternatives for expansion, modification, reduction or closure of the project based in the results it generates over time.

To determine the effectiveness and profitability of a project based on Real Options, it is necessary to determine some variables that describe the particularities of the project, which will allow the construction of the model. These variables are (Table 1):

The Real Options method offers to the traditional evaluation of energy efficiency projects the possibility of determining the present value of future cash flows under conditions of uncertainty, considering the volatility that may exist in them. This uncertainty factor is continuously present in energy efficiency projects as a result of possible 1) technological improvements to the equipment, making the new ones more efficient at a cheaper cost, 2) loss of energy efficiency of the equipment due to any failure, defect or misuse, 3) increases in electricity rates or 4) regulatory changes that do not encourage a cleaner power generation market.

Using the binomial model of Real Options, the initial investment value is calculated before determining the probabilities of raising (up) or lowering (down) the overall value of the project through its life cycle.

The Real Options generate the possibility of evaluating the project at different moments of its productive life, to determine if it is financially convenient to carry out any modification such as expansion, reduction or closure / conclusion of the project.

To estimate the different scenarios, one of the equations must be considered as appropriate (Table 2):

Once the probability that the initial NPV of the project will rise or fall is calculated, using the binomial up-down model, the formula corresponding to each scenario is applied to each probability of year *n* and then all periods are discounted, eliminating the effect of

Table 1. Model variables

Variable	Description
Inflation	Percentage in which prices are generally increased in a unit of time
Discount Rate	Or interest rate, is the cost of capital and / or financing that is used to know the present value of a future flow. It is called r
Underlying Value (S_0)	Present value of cash flows, without discounting the initial investment
Volatility (σ)	Measurement of the frequency and intensity of changes in the value of cash flows (EF) of a project. Is calculated $\sigma = \text{stand.dev.} \sum_{t=1}^{n} ln\left(\frac{EF_t}{EF_{t+1}}\right)$
Number of periods	It is the time that the project will last. A unit of time is defined for its count. It is called n
Reference rate	Also known as the risk-free rate, it is the price paid by risk-free instruments such as Mexican Treasury Bonds (CETES for its name in Spanish), therefore it is compared with the rate of the project, which must be higher than the reference, otherwise it would not have no added value carrying out the project. It is called r_f
Up	It is the proportion of increase expected if the value of the underlying asset increases. Is calculated $u = \mathrm{e}^{(\sigma * \sqrt{tvn})}$
Down	It is the proportion of decrease expected if the value of the underlying asset decreases. Is calculated: $d = \frac{1}{u}$
Upside probability	Being a binomial model, it is assumed that the price of the Underlying asset evolves according to a multiplicative binomial process, so that, if the initial price is S_0, in the next period, the price may be S_0 * u, with probability p It is calculated as follows: $p = [(1 + r_f) - d]/(u - d)$
Downside probability	If the initial price is S_0, in the next period, the price could be S_0 * d, with probability q. Is calculated $q = 1 - p$

the up and down probability and is brought to present value, removing the effect of the interest rate. From the amount obtained, the price of the initial investment is subtracted, and the present value of the project is taken with real options.

The evaluation with real options can give clarity for optimal decision making when faced with the need or desire to modify the original characteristics of the project.

Definition of Outcome Measures. From the financial structure of the project, the environmental factors that are considered as a result measure are determined.

In energy efficiency projects, calculating GHG emissions is relatively simple, since there is an emission factor estimated by the Energy Regulatory Commission (CRE for its acronym in Spanish) which is used to estimate the indirect emissions that come from the use of electricity purchased in the National Electric System (SEN for its acronym in

Table 2. Real Options equations

Type of Option	Value
Option to increase E% by investing I	$FC_t = FC_0 + max(E{*}FC_0 - I; 0)$
Option to reduce in C%, reducing investment from I1 to I2	$FC_t = MAX\,(FC_0 - I_1; C * FC_0 - I_2)$
Option to defer or wait a period	$FC_t = MAX\,(FC_n - I; 0)$
Option to close or abandon with liquidation value	$FC_t = MAX\,(FC_t; L_t)$
Option of closure or temporary abandonment	$FC_t = MAX\,(FC_n - cf - cv; E * FC_n - cf)$
Option of selection choice	$FC_t = MAX\,(E * FC_n - I - C; *FC_n + A; L)$

Spanish). This factor is updated annually because the fuel mix used to generate electricity can vary.

The environmental results measure to be considered in this guide will be the result of multiplying the Emission Factor by the amount of W / h consumed by the company before and after the implementation of the energy efficiency measure.

When comparing the tons of GHG emitted in the initial scenario versus the EE measure scenario, the number of emissions generated should be notably less, so that the project is justified in environmental terms. This measure can represent the added value in projects that have minimum profitability levels, since international cooperation agencies have as their main goal the reduction of GHG emissions, above financial profitability.

Cost Estimation. To determine the costs incurred with the reference measure, that is, emitting or avoiding GHG emissions, it is necessary to relate the cost of producing the MW/h from which the GHGs are emitted.

The first variable that is required to know is the amount of energy required by the company for its activities. The percentage of efficiency that the new equipment will lose is also required to determine the electrical demand that the equipment will have.

It is necessary to multiply the rated power by the productivity of the system and by the efficiency losses that the equipment will have in the first and consecutive years, to obtain the production of electricity that will be obtained through a renewable source of energy. This amount must be multiplied by the emission factor to determine the GHGs generated, considering that these units would have been emitted with a non-sustainable alternative.

To find out the cost of these emissions, the amount of energy produced must be multiplied by the cost of the kW / h that had to be paid to the Mexican Electrical Federal Commission (CFE for its acronym in Spanish and Mexico´s state-owned and main provider of electrical power in the Country) for electricity, affecting said cost with the increase estimate.

Finally, the total cost of electricity is divided by the number of tons of CO_{2e} produced to determine the unit cost per GHG.

The cost per unit indicates what it costs the company to emit each ton of GHG. On the other hand, to determine the positive effect caused by the implementation of an energy efficiency measure, the same amount of GHG is considered but with a negative sign, since they were not emitted and it is divided between the operating and financial expenses in which they are incurred to implement the project.

Any environmental benefit translates into economic benefits for the SME and increases in the value of the implemented project.

Presentation of Results (Cost - effectiveness). Once the results measures and the costs incurred to achieve environmental benefits in the project have been determined, it is necessary to evaluate whether these actions are cost-effective, not only with the initial scenario, but also with other options available in the market, to ensure that the choice made is the best for the company.

To determine which option is the most cost-effective, we must determine the costs associated with the implemented initiative, but also with the elements related to the measurement of results, which is the emission of GHG, its savings and the costs of producing them.

Initially, there must be more than one alternative of efficient equipment to install and that cover the needs of the company. Then, besides to the cost of the equipment, its electrical consumption and the GHG emission of each must be compared to determine which of the options is the most cost-effective. There is equipment that, by its nature, may apparently be more convenient for the company compared to its competition, but in reality it is not, since it may be cheaper, but it is not as efficient, might be very expensive to install or it is very high loss of efficiency over time.

4.2 Case Study

The present guide was used to evaluate two sustainable projects that can be implemented in a SME. The intention of proposing two types of projects is to exemplify that the guide can be used both in large projects that involve the implementation of renewable energies and in simple cases that only involve energy efficiency measures.

The first was the installation of a 352.45 Kilowatt of power (kWp) solar photovoltaic system that would allow the supply of clean electricity to 20 companies in a small industrial complex.

The characteristics of the project are (Table 3):

With the project data, its IRR (21.02%) and NPV ($ 129,811.12) were calculated. The IRR is above the interest rate (15%) and the NPV is positive, which indicates that the investment generates value over time. Since the SME has liquidity problems, it has decided to apply for a bank loan with the following characteristics (Table 4):

Considering financing of 70% of the total investment amount, the IRR increased to 43.88% and the NPV to $ 178,897.28. The IRR increases considerably because the investment generates more value as the initial investment is lower and the NPV is also stronger. But with this information it cannot be determined whether the natural volatility that exists in these projects and / or its associated risks could impact their performance. The NPV may not consider it, but the actual options can. To apply the evaluation using real options, the following values are calculated (Table 5):

Table 3. Project data

Concept	Cost	Unit
Price of plant installations	1,160.00	$/kWp
System rated power	352.45	kWp
Cost of the SSFV	408,842.00	$
1kWp productivity with inverter	1,720.00	kWh/kWp/year
Initial losses in the efficiency of PV modules	1.00	%
Long-term efficiency losses	0.80	% yearly
Self-consumption of the annual production of the plant	100.00	%
Energy cost on the electric bill	0.08	$/kWh
Annual increase in energy cost	5.00	%
Plant life	20	years
Operating costs	25.00	$/kWp/year
Insurance	3.00	$/kWp/year
Inflation	4.00	%
Interest rate or discount	15.00	%
Income Tax	0.00	%

Table 4. Funding conditions

Concept	Cost	Unit
Bank 70%	286,189.40	$
SME Investment 30%	122,652.60	$
Tenor	10	Years

Next, it is evaluated which option could be more profitable, considering the effect of any of the following modifications to the project in an intermediate moment of its useful life, said evaluation was carried out in year 10 under the following scenarios (Tables 6, 7, 8 and 9):

a. Increase the investment amount by 30%, with expenses of 30%.
b. Reduce the investment amount by 25%, with 28% savings.
c. Settle the project with a recovery value of 50%.

With these results, it is concluded that, in year 10, it is not convenient to either reduce the size of the project or liquidate it, but rather expand it, since not only has a bigger NPV, but also the value of the option is positive, indicating that it should be exercised.

Table 5. Project values

Variable	Symbol	Value
Underlying value	S0	$301,549.88
Strike price	I	$122,652.60
Volatility	Σ	67%
Number of periods	N	20 years
Reference rate	rf	7.46%
Up	U	1.9543
Down	D	0.5117
Discount factor	R	1.0746
Upside probability	P	0.3902
Low probability	Q	0.6098

Table 6. Scenarios

Scenarios	Modification
Expansion (E)	30%
Additional investment of 30% (I)	-$ 36,795.78
Shrink (C)	25%
Expected savings of 28% (A)	$ 34,342.73
Settlement value 50% (L)	$ 61,326.30

Table 7. Scenario 1: Increase 30%

Initial NPV	$ 427,471.80
NPV with Real Option	$ 445,391.46
Option Value	$ 17,919.66

Table 8. Scenario 2: Decrease 25%

Initial NPV	$ 422,790.14
NPV with Real Option	$ 243,540.11
Option Value	-$ 179,250.03

Table 9. Scenario 3: Closing with 50% clearance

Initial NPV	$ 415,309.91
NPV with Real Option	$ 302,348.91
Option Value	-$ 112,961.00

In this example, the profit margins are large because we are talking about completely converting the energy supply method, but in energy efficiency projects from other technologies within the target market, the margins are much narrower and the evaluation with Real Options can give us clarity for decision making when faced with the need or desire to modify the original characteristics of the project.

From the financial structure of the project, the environmental factors that are considered as a measure of results are determined.

The environmental results measure considered in this guide will be the result of multiplying the Emission Factor by the amount of Megawatt per hour (MWh) consumed by the company before and after the implementation of the energy efficiency measure. The emission factor that was considered was 0.527 tCO_{2e} / MWh.

When comparing the tons of GHG emitted in both scenarios, the resulting quantity after the implementation of the new technology should be significantly less than the initial figure for the project to be worthwhile in environmental terms. This measure can represent the added value in those projects that have minimum profitability levels, since international cooperation agencies have as their main goal the reduction of GHG emissions, above financial profitability.

To determine the costs incurred with the reference measure, that is, in emitting or avoiding GHG emissions, it is necessary to relate the cost of producing the MW / h from which the GHGs are emitted. This project has the following values (Table 10):

Table 10. Values for GHGs emissions calculation

Concept	Cost	Unit
System rated power	352.45	kWp
1kWp productivity with inverter	1,720.00	kWh/kWp/year
Initial losses in the efficiency of PV modules	1.00	%
Long-term efficiency losses	0.80	% annual
Emission factor	0.527	tCO_{2e} / MWh
Energy cost on the bill	0.08	$/kWh
Annual increase in energy cost	5.00	%

With this, it is determined that the company does not spend more on the emission of GHGs and has savings by not emitting them. At the end of the project's life, about

5,800 tCO_{2e} will have been saved. This environmental benefit translates into economic benefits for the SME and increases the value of the project.

The second model presents a case where a SME wants to replace 2 air conditioning units of 3 tons of refrigeration each, to reduce electricity costs, consumption and the GHG emissions they generate. Both equipment are considered as a replacement option are efficient and meet the needs of the company. The equipment data is as follows (Table 11):

Table 11. Equipment data

Case and costs overview	PAYNE	Mini Split Mirage	Mini Split LG
Description	Initial	Equipment A	Equipment B
Equipment price	$ 18,000.00	$ 23,000.00	$ 28,000.00
Consumption kW / h	37,991.00	27,115.00	33,098.00
Average cost of kW / h	1.89	1.49	1.49
Cost of electricity	$ 71,958.75	$ 40,512.52	$ 49,316.02
Equipment automation cost	$ 199,876.00	$ 151,445.00	$ 151,445.00
Cost of GEI $ / ton CO_{2e}	$ 14,476.35	$ 15,042.93	$ 13,115.04
Generated GHG emissions ton CO_{2e}	20.02	14.29	17.44

Equipment A is cheaper than equipment B and it generates less GHG emissions. What makes it more cost-effective is that the cost of avoided emissions is lower, so the company will choose equipment A over equipment B (Table 12).

Table 12. Equipment comparison

Cost effectiveness analysis	Equipment A	Equipment B
Equipment costs	$ 214,957.52	$ 228,761.02
Initial equipment costs	$ 289,834.75	$ 289,834.75
Equip. emissions	14.29	17.44
Emissions initial equipment	20.02	20.02
Savings in cost of emissions	**$ 13,063.81**	**$ 23,684.74**

There is equipment that, by its nature, that may apparently be more convenient for the company compared to its competition, but, since there are efficiency issues with use and high installation costs. For this, it is recommended to carry out a cost-effectiveness analysis using as a reference the GHG emissions that will also serve to provide a comparative differentiating element to the available choices.

5 Conclusions

As shown by the results of the Case Study in the present guide, Real Options Cost-effectiveness Analysis are an extremely valuable analytical tools for decision makers that help mitigate uncertainty, while adding versatility for strategic changes that can maximize both profitability and positive environmental impacts. In addition, it also gives a broader perspective beyond the classic financial metrics for credit analysis, and in turn increases lending to sustainable projects.

To summarize, the present guide was applied to test the feasibility of the installation of a 352.45 kWp solar photovoltaic system, and with scenario simulation with Real Options, it was possible to determine that, in year 10 of the project's life, the investment is convenient and the project has GHG savings potential. Likewise, in the case of a SME of replacement of 2 Air Conditioning equipment with 3 Tons of Refrigeration each to reduce its costs for electricity consumption and GHG emissions through the cost effectiveness analysis, it was possible to determine which equipment was the most convenient for both the company and the environment when considering the reduction of tons of GHG that will not be generated.

The world's top economies are gradually moving towards more environmentally friendly production models because of trying to harmonize the economic, social and environmental axes to achieve sustainable growth, with Europe leading as an example. In less developed countries like Mexico, the present guide offers an opportunity to replicate and further incentivize the focus and the benefits of a sustainable perspective to the classic and standard project evaluation; complementing the financial metrics used to assess added value to shareholders. Additional stakeholders (customers, employees, communities) are also considered in this approach, given that the project´s sustainability efforts affect society as a whole and the global environment.

Mexico has carried out actions to integrate this sustainable model to its most significant productive workforce: small and medium enterprises. Yet, the efforts of the Federal Government, international cooperation organizations and specialist entities in sustainability have not been able to achieve the foreseen goals and encourage technological and energy migration towards energy efficiency through financing. This guide not only aims to open new paths of evaluation, but it also helps stakeholders like Mexican financial institutions complement their analysis and have more lending appetite. This in turn can accelerate Mexico´s energetic transition to cleaner sources.

Banks have the enormous challenge of expanding their traditional credit metrics to begin evaluating the integral impacts of the project beyond economic profitability so that, added with the participation of cooperation agencies, access to preferential financing with lower cost and longer term can be achieved, so that the number of benefited SMEs increases and consequently, sustainable development is established in their production processes.

By integrating Real Options in the analysis methodology, as shown before, it also allows close monitoring of projects whose characteristics, given their nature, can be modified throughout their life and, in case of existing financial obligations, during the tenor of the loans. This tool is particularly useful to maximize profits and minimize losses and risks associated with the project, without having to leave aside the non-quantitative elements of the project.

Additionally, the cost-effectiveness evaluation allows the incorporation of qualitative variables, whose result allows the decision maker to carry out a comprehensive review of the impacts of the projects to determine whether, in addition to being financially profitable, it is environmentally viable and positive for society.

Some countries are taking significant action to mitigate Climate Change and its effects, but it's not only up to governments, but professionals as well to help create ways to contribute to the economic system and provide sustainability and clean energy methods to be used in the overall economic infrastructure. This guide provides one perspective that provides reliable qualitative information for decision makers to determine the viability of a sustainable project in an SME and overall, the country.

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