INTERNATIONAL JOURNAL OF ACADEMIC RESEARCH IN BUSINESS & SOCIAL SCIENCES
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ISSN: 2222-6990

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To Link this Article: http://dx.doi.org/10.6007/IJARBSS/v12-i8/14516 DOI:10.6007/IJARBSS/v12-i8/14516

Received: *14* June 2022*, **Revised:** 18* July 2022*, **Accepted:** 30* July 2022

Published Online: *06* August 2022

In-Text Citation: (Mahmudi, 2022)
To Cite this Article: Mahmudi, S. (2022). The Financial Metrics and Risk Management Tools in Supporting Renewable Energy Investment. *International Journal of Academic Research in Business and Social Sciences*, *12*(8), 238 – 249.

Vol. 12, No. 8, 2022, Pg. 238 – 249

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The Financial Metrics and Risk Management Tools in Supporting Renewable Energy Investment

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Abstract

The economic analysis of renewable energy sources project has been assessed considering Classical Methodologies of Investment Analysis (CMIA) in which a set of indicators are included, highlighting the Payback, Net Present Value and Internal Rate of Return as a crucial tools in decision making processes. The metrics used for financial and risk valuation mainly are grouped in cost benefit analysis. The CMIA (Classical Methodologies of Investment Analysis) as a main driver of the decision making process and the driver for solar wind and other alternative energy sources projects. The overall review of the REP - renewable energy projects was analyzed form perspectives of total costs, capacity factor and Levelized cost of energy LCOE.

The analysis in this paper focuses on estimating the costs of renewables from the perspective of private investors, whether they are an international or domestic investors, or an individual or community looking to invest in small and medium scale renewable energy sources projects. The main objective of the research paper is to identify the optimal result for potential investment in Renewable energy project in The republic of North Macedonia, based on desktop research of publicly available data mainly provided by IRENA (International Renewable Energy Agency) and domestic institutions, and the indicative solar projects of 20MW which provides illustrative support for the financial valuation and risk perceptions.

Keywords: Investment Analysis, NPV, IRR, Payback, Renewable Energy

Introduction

At this point in time when COVID- 19 outbreak and energy crisis is still present in our daily life, creating the appropriate frameworks for ensuring investment in green projects is of utmost importance. This is extremely important at a moment where almost all the countries are initiating anti-crisis packages and working hard to find the sustainable solutions to current energy crisis.

The North Republic of Macedonia with slow path in energy transition but with concrete energy development strategy has created a significant packages by including measures to accelerate he countries green energy transition. North Macedonia has been on a commendable path to reinforce renewable energy in its overall energy mix, and the country has recently adopted or is in the process of drafting key strategies to support sustainable economic growth with a focus on energy and climate change and in alignment with the European Union (EU) legislation (IRENA).

The European Green deal, a plan to make the EU climate neutral by 2050, the commission says that "the ecological transition for Europe can only be fully effective if the EU's immediate neighborhood also takes effective action. This announcement comes as part of the presentation of a EUR 9 billion Economic and Investment Plan for the Western Balkans, adopted by the European Commission (EU-Commission).

The affordability and access to the European green deal is one of the priorities and key consideration in designing implementing the green transitions. Policymakers as well as the private sector and investors needs to work in platform to chart away forward and try to manage the current complex contexts of the energy sources and electricity production in order to accrete the transition and close the gaps between potential of the sources and realization.

The development of tools for valuing renewable energy generation project is crucial for undertaking of these initiatives. The study of RES represents a relevant field of research not only because of the foreseen technical developments but also because of the multidisciplinary approach needed to assess these projects from the risks, social, environmental, and financial perspectives. The doubts about the feasibility of continuous investments in energy infrastructure based on fossil fuels have contributed to stimulating new frontiers for studies related to renewable energy projects (Deter.N)

The renewable energy project mainly are capital intensive based project and have a high demand for long term capital. There are a lot of project valuation technics incorporated qualitative and quantitative analysis, however the common accepted valuation tools to measure the financial and economic performance of a projects still relies on the traditional valuation like net present value NPV, Internal rate of return IRR, payback period, Levelazied cost of electricity- LCOE and return on investment.

On the other hand, there have been several challenges concerning the decisions and timing of new investments in the power electricity generation sector due to the uncertain environment of this segment, such as the volatility of electricity prices, the variable and intermittency nature of Renewable Energy Sources, policy and regulations etc. Furthermore, 'renewable energy projects are subject to different types of risk throughout their life-cycle, from the planning stage right through to decommissioning, each of which require active management in order to attract financing, (Liebreich, 2005). Therefore, it is clear that advanced risk management tools are required to support renewable energy investments.

In addition, the option for project finance to finance large projects in renewable energy generates additional transaction costs due to the complexity of its formatting. This reality requires an additional effort for identifying methods capable of efficiently measuring its performance (Steffen, 2006).

All sort of renewable energy sources are derived from sun. Unlike conventional sources like hydrocarbon fuels, coals, the solar and wind energy is pollution free and for all practical purposes, is limitless.

The principal technologies used to extract energy from the various natural processes generated from the radiant energy of the sun include, Solar photovoltaic, Wind (derived from the sun is radiant heating and movement of the earth is atmosphere), Biomass (conversion of biological matter into energy), Hydropower(derived from the sun is hydrological cycle) (USAID/Office of Energy).

Solar Energy

The solar energy directly can be harnessed from the sun and that is converted into thermal or electrical energy. The solar energy is the cleanest, inexpensive and most accessible renewable energy sources that is available everywhere in the world. Any point where the sun hits the Earth is a potential location for generating solar power. Because solar energy comes from the sun, it represents an infinite source of power.

Solar energy is captured in several ways. The most common way is with photovoltaic solar panels. Photovoltaic (PV) devices generate electricity directly from sunlight via semiconductors. When the silicon photovoltaic solar cell absorbs solar radiation, photons strike and ionize semiconductor material on the solar panel, causing electrons to break free of their atomic bonds. Electrons are forced to flow in one direction, creating a flow of electrical current. Only some of the light spectrum is absorbed, while other parts of the spectrum are reflected, too weak (infrared), or create heat instead of electricity (ultraviolet)

According to a recent study on the potential of renewable energy in North Macedonia, the country has an average of 280 days of sunshine per year due to its geographical location and climate, which is a theoretical (physical) potential and provides ideal conditions for the

The climatic characteristics of this region, including high intensity and duration of solar radiation, temperature, and humidity, provide further favorable conditions for the successful development of solar energy. Its continental climate with hot and dry summers makes North Macedonia a country with a higher potential for utilization of solar energy than average European countries. Due to this special geographical location, these natural resources are to be increasingly used for environmentally friendly electricity generation in the future. Advantage: Energy costs are being reduced and the environment is protected at the same time (lgp).

Economic Valuation of Renewable Energy Projects (REP)

Renewable energy projects mainly are the riskiest types of projects to invest, and investor's faces different uncertainties when making a renewable energy decision investment. Several valuation methodology are available to evaluate investments in energy generation projects. The most commonly used methodology to evaluate investments is the NPV (net present value), which can be considered a CMIA (Classical Methodologies of Investment Analysis) (Johansson, 2010). Considering the high capital expenditure associated with REP; recent changes in the regulatory structure; management flexibility and irreversibility of the electricity sector; the use of CMIA may lead to an oversimplified economic project evaluation (Martinez-C, 2011). Additionally, due to its inflexible nature, classical methodologies are becoming increasingly unpopular (Martinez-C, 2011). In this sense, new evaluation methodologies appear as a complement to evaluate investments, e.g. internal rate of return IRR, capacity factor and. LCOE- Levelazied cost of electricity and discounted cash flow etc.

The work proposed for illustration in this paper is a 20MW solar RES project (indicative) which also considers flexible design and timing simultaneously. In order to assess renewable energy investments, the use of traditional indicators is compared to the use of ROA. Nevertheless, in only a few set of indicators, namely NPV, IRR, Return on Investment (ROI) and Benefit Cost Ratio (BCR) are considered in the economic evaluation of the REP.

The RES Project Cost Analysis

Electricity costs from renewables have fallen sharply over the past decade, driven by improving technologies, economies of scale, increasingly competitive supply chains and

growing developer experience. As a result, renewable power generation technologies have become the least-cost option for new capacity in almost all parts of the world. This new reality has been increasingly reflected in deployment, with 2019 seeing renewables account for 72% of all new capacity additions worldwide.
According to the latest cost data from the International Renewable Energy Agency (IRENA), the global weighted-average levelised cost of electricity (LCOE) of utility-scale solar photovoltaics (PV) fell 82% between 2010 and 2019,2 while that of concentrating solar power (CSP) fell 47%, onshore wind 39% and offshore wind 29% (Figure ES.1), the IRENA Renewable Cost Database shows.

Table 2
Total cost, Capacity factor and LCOE for technology, trend 2010 -2020

	Total installed costs (2020 USD/kW)			Capacity factor (%)			Levelised cost of electricity (2020 USD/kWh)		
	2010	2020	Percent change	2010	2020	Percent change	2010	2020	Percent change
Bioenergy	2 619	2 543	-3%	72	70	-2%	0.076	0.076	0%
Geothermal	2 620	4 468	71%	87	83	-5%	0.049	0.071	45%
Hydropower	1 269	1 870	47%	44	46	4%	0.038	0.044	18%
Solar PV	4 731	883	-81%	14	16	17%	0.381	0.057	-85%
CSP	9 095	4 581	-50%	30	42	40%	0.340	0.108	-68%
Onshore wind	1 971	1 355	-31%	27	36	31%	0.089	0.039	-56%
Offshore wind	4 706	3 185	-32%	38	40	6%	0.162	0.084	-48%

Source: IRENA

In the last decades the cost analysis set has been collecting and reporting the cost and performance data of renewable energy technologies. In this term, up-to-date cost and performance data from a reliable source is vital importance for further renewable energy mix development. As we can see form the table 2 the rapid decline in installed costs capacity of different energy sources is a direct driver for threefold of the investment in this sector.
The associated cost reductions mean that data from even one or two years ago can be significantly erroneous. Indeed, in the case of solar PV, in some markets, even data six months old can significantly overstate the costs.

Over half of newly commissioned utility-scale renewable power generation capacity in 2019 produced electricity at lower costs than the cheapest new source of fossil fuel-fired power[1].

Total Installed Capacity

Based on the data below (table 3) the renewable energy total installed cost has shown a dramatic decline so utility scale power generation in 2019 for the first time produced electricity at lower costs than the cheapest new source of fossil fuel.

The fundamental drives of this change is that renewable energy technologies follow learning curves, which means that with each doubling of the cumulative installed capacity their price declines with the same fraction. Learning curves is a concept that graphically depicts the relationship between the cost and output over a defined period of time, normally to represent the repetitive task of an employee or worker (oxford dictionary)

Table 3
Total installed cost (2020 USD/kW)

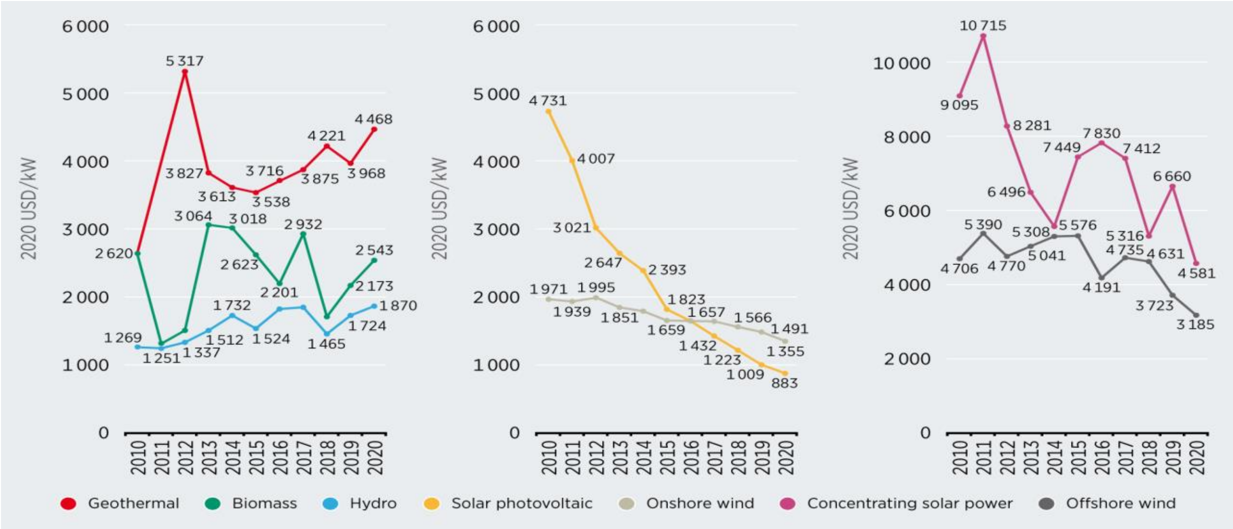
	2010	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Biomass	2 619	1 318	1 513	3 064	3 018	2 623	2 201	2 932	1 714	2 173	2 543
Geothermal	2 620		5 317	3 827	3 613	3 538	3 716	3 875	4 221	3 968	4 468
Hydro	1 269	1 251	1 338	1 513	1 732	1 541	1 828	1 853	1 462	1 733	1 870
Solar Photovoltaic	4 731	4 007	3 021	2 647	2 393	1 823	1 657	1 432	1 223	1 009	883
Offshore wind	4 706	5 390	4 770	5 041	5 308	5 323	4 191	4 735	4 631	3 723	3185
Onshore wind	1971	1 939	1 995	1 851	1 797	1 659	1 652	1 647	1 566	1 491	1 349
Concentrating solar power	9 095	10 715	8 281	6 496	5 576	7 449	7 830	7 412	5 316	6 660	4 581

Source: IRENA

The growth in deployment of renewable power generation technologies in the period between 2010 until 2020 accelerated the total investment in renewable energy sources project, as costs continued to fall and renewable power generation increasingly became the default source of least-cost new power generation.

According to IRENA, since the year 2000, renewable power generation capacity worldwide has increased 3.4-fold, from 754 gigawatts (GW) to 2 537 GW by the end of 2019.

[1] RENEWABLE POWER GENERATION COSTS 2019, page 23



Weighted Average Capacity Factor by Technology 2010 -2020

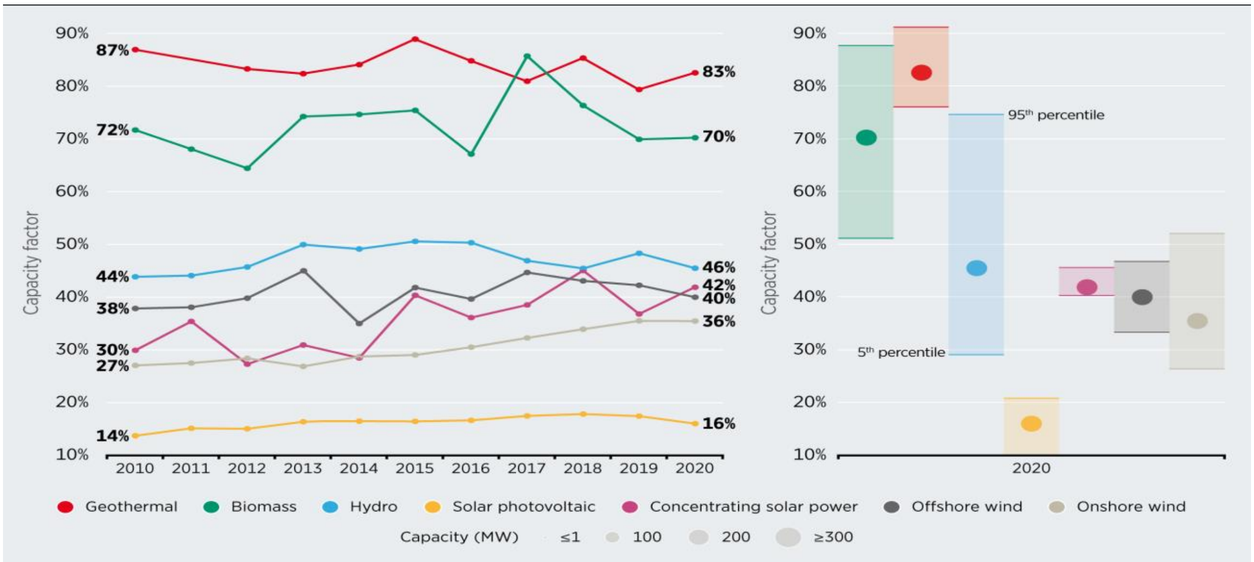
Technology improvements caused by learning curves have resulted in huge increase of the capacity factor almost in all type of the renewable energy sources. As we can see form table 4 the capacity factor by technology advancement shows close relationship. For instance, the global weighted-average capacity factor for new, utility-scale solar PV, increased from 13.8% in 2010 to 18.0% in 2019. This was predominantly driven by the increased share of deployment in sunnier locations.

Between 2010 and 2019, the global weighted average capacity factor of newly commissioned offshore wind farms grew from 27.1% to 35.5%, this is due, first of all, to differences in the meteorology of the different locations where the wind farms are deployed. Second, it is influenced by the technology used and the configuration of the wind farm, i.e. the optimal turbine spacing to minimize wake losses and increase energy yields. Optimization of the O&M strategy over the life of the project is also an important determinant of the realized lifetime capacity factor.

Table 4

Capacity Factor by Technology

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Biomass	71.7 %	68.1 %	64.5 %	74.3 %	74.7 %	75.5 %	67.2 %	85.8 %	76.4 %	70.0 %	70.3 %
Geothermal	87.0 %		83.3 %	82.4 %	84.1 %	89.0 %	84.9 %	81.0 %	85.4 %	79.4 %	82.6 %
Hydro	43.9 %	44.1 %	45.8 %	50.0 %	49.2 %	50.6 %	50.4 %	47.0 %	45.5 %	48.4 %	45.5 %
Solar Photovoltaic	13.8 %	15.2 %	15.1 %	16.4 %	16.6 %	16.5 %	16.7 %	17.5 %	17.9 %	17.5 %	16.1 %
Offshore wind	37.9 %	38.1 %	39.9 %	45.0 %	35.1 %	41.9 %	39.7 %	44.7 %	43.1 %	42.3 %	40.0 %
Onshore wind	27.1 %	27.6 %	28.5 %	26.9 %	28.8 %	29.1 %	30.6 %	32.3 %	34.0 %	35.6 %	35.5 %
Concentrating solar power	30.0 %	35.5 %	27.4 %	31.0 %	28.5 %	40.4 %	36.2 %	38.6 %	45.1 %	36.9 %	41.9 %



Levelized Cost of Electricity LCOE 2010- 2020

The levelized cost of energy (LCOE), is a measurement used to assess and compare alternative methods of energy production. The LCOE of an energy-generating asset can be thought of as the average total cost of building and operating the asset per unit of total electricity generated over an assumed lifetime;

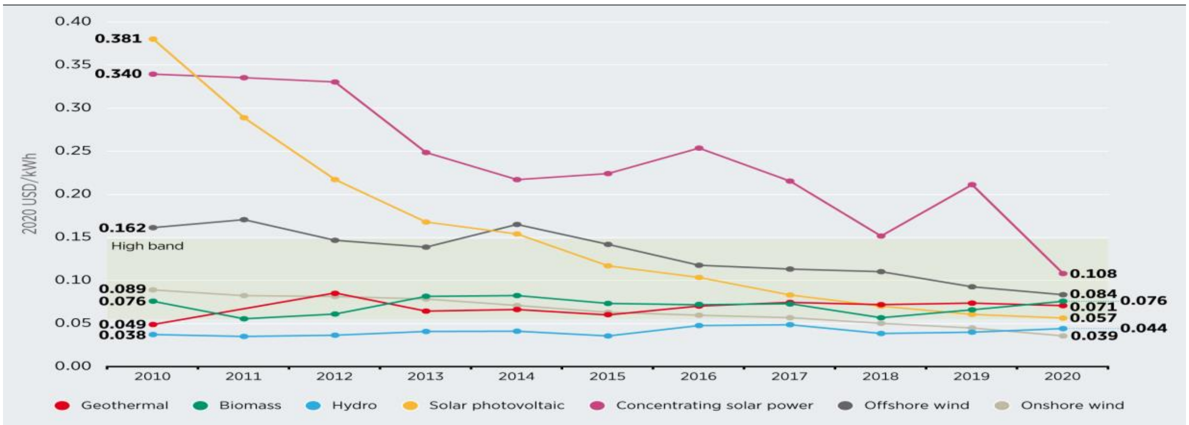
$LCOE = \Sigma[(I_t + M_t + F_t) / (1 + r)^t] / \Sigma[(E_t/(1 + r)^t]$

Table 4

LCOE (2020 USD/kWh)

	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020
Biomass	0.07624	0.05583	0.06134	0.08198	0.08279	0.07364	0.07253	0.07304	0.05705	0.06627	0.07623
Geothermal	0.04920		0.08537	0.06473	0.06659	0.06066	0.07061	0.07481	0.07223	0.07401	0.07109
Hydro	0.03754	0.03533	0.03675	0.04109	0.04141	0.03590	0.04795	0.04896	0.03877	0.04027	0.04444
Solar Photovoltaic	0.38056	0.28926	0.21746	0.16812	0.15429	0.11731	0.10383	0.08343	0.07043	0.06094	0.05667
Offshore wind	0.16162	0.17089	0.14695	0.13902	0.16534	0.14223	0.11796	0.11355	0.11053	0.09297	0.08378
Onshore wind	0.08942	0.08275	0.08170	0.07879	0.07129	0.06334	0.05998	0.05713	0.05055	0.04513	0.03929
Concentrating solar power	0.33982	0.33570	0.33073	0.24887	0.21738	0.22438	0.25396	0.21565	0.15189	0.21157	0.10836

The rapid decline in total installed costs, increasing capacity factors and falling O&M costs, have contributed to the remarkable reduction in the cost of electricity from all renewable sources and the improvement of its economic competitiveness. As we can see form table 4 LCOE follows a drastic fall in all type of the renewable sources, however the global weighted-average LCOE of utility-scale PV plants declined the most by 82% between 2010 and 2019, from around USD 0.378/kWh to just USD 0.0608/kWh.



The real potential for RES project in North Macedonia

There are a total of 276 power plants in North Macedonia, with a total installed capacity of 2,069.21 MW, including 155 photovoltaic plants with total capacity of 34 MW, 103 small HPPs (112 MW), one wind park (36.8 MW) and three biogas plants (7 MW).

According to the energy strategy, energy produced from renewable energy sources (RES) is mostly used for the heating and cooling sector, while the largest greenhouse gas emission savings are in the electricity sector. The county has a technical potential of 7.3 GW for the use of RES for electricity, especially from solar and wind power sources.

The republic of North Macedonia has initiated an ambitious decarbonization of energy sector that forms a solid basis for attracting renewable energy investments in the country. To date, such efforts have focused on renewable energy for power with some attention given to solar scale up and wind projects in the most recent strategy and plans.

In this term an indicative 20 MW solar scale up project will be valuated from the aforementioned economic and financial valuation metrics for investment illustration, adjusted with a particular focus on the conditions and cases in North Macedonia.

Case study - The indicative solar project valuation

This section provides the main characteristics of the solar scale up investment under analysis regarding the capital and operational expenditures, variable costs and bank funding. The investment used in this paper as the case-study is based on a real solar project with an expected installed capacity of 20 MW. The project is located in the central part of the North Macedonia, where the solar radiation is approximately 1500 hours per year and project live of 25 years. The solar plant is expected to fit operating preferably in late 2022, according to the company’s information. Also, the investors aim to sell the energy of the proposed investment in the Regulated Contracting Environment, however the current market price per MW is highly acceptable by the investors. The current free market price HUPX May 2022 is averagely 250-340 Euro/MW.

The parameters of the project is described below, the discounted cash flow are calculated based on the min price of 160 MW, the financial model developed shows that the indicators like NPV, IRR, Payback period are favorable. Furthermore, the additional advantage of the project is provided land by government for reasonable price makes the project highly profitable.

PARAMETERS		
Total Installed Capacity(kW)	20	MWh
Total Net Installed Capacity	20	MWh
Annual Working Hour	1,461	hour/year (best case scenario)
Power Plant Internal Consumption Ratio (%)	10%	lost in Internal system
Sale to grid	29,219,999	kWh/year
Incentives 1-15	0.16	€kWh
Local FiT (1. - 5. Year)	0.00	€kWh
Included Local FIT Unit Sales Price	0.00	€/kWh
After 10 Years Unit Sales Price (11. - 25. Year)	0.050	€/kWh
Local Authority Fee (%)	0.00%	revenue

O&M Cost	**591,441**	**€/Year**
Un/Scheduled maintenance	222,945	€/Year
Insurance premium	171,496	€/Year
System Usage Fee Grid Con	197,000	€/Year

Capital Expenditure	**17,149,600**	**€**
Module	9,724,000	€
Power Electronics	2,652,000	€
BOS	1,237,600	€
Mounting Racks	1,060,800	€
Civil works	707,200	€
EC Contract	442,000	€
Contingency 5%	884,000	€
Pre- Operative cost	265,200	€
Financial Cs	176,800	€

Planned Loan (%of the Total Investment)	70%	Based on Project Cost
Required Loan Amount	12,004,720	€
Loan Total Interest Rate (Libor+Bank)	5.00%	€ Loan
Total Loan Period	10	Year
Grace Period	1	Year
Pay Period(in 1 year)	2	Times
Corporate Tax Rate	10%	
Trade Receivables Period	30	days
Trade Payables Period	30	days
Number of Days in 1 year	365	days/year
Wacc	7%	

Payback Period(years)	**3.91**
Net Present Value	**17,653,781.99**
IRR	**20.95%**
Wacc	**7.00%**

Indicators used for each methodology applied to the economic evaluation of IP.

CMIA	Present Value (PV) (R$)	PV ≥ | CF0|
	Net Present Value (NPV) (R$)	NPV > 0
	Internal Rate of Return (IRR) (%)	IRR ≥ MRA
	Payback (years)	Payback ≤ N

Source: Authors Calculations'

Contribution

This study is an empirical attempt covered with concrete investment analysis, economic evaluation and case study in order to support decision making processes in the renewable energy sources project in republic of North Macedonia.

The main contribution of the research is to identify the optimal result for potential investment in Renewable energy project in North Macedonia, based on desktop research of publicly available data mainly provided by IRENA (International Renewable Energy Agency) and domestic institutions, and the indicative solar projects of 20MW which provides illustrative support for the financial valuation and risk perceptions.

Conclusion

This paper addressed the importance of using Classical Methodologies of Investment Analysis economic evaluation methodologies to assess renewable energy projects. Traditional methods such as Payback, NPV and IRR have been used extensively for evaluating investments and are usually referred to as a straightforward methods for decision makers.

The most commonly used methodology to evaluate investments is the discounted cash flow (net present value), which can be considered a CMIA (Classical Methodologies of Investment Analysis). Considering the high capital expenditure associated with renewable energy projects; recent changes in the regulatory structure; management flexibility and irreversibility of the electricity sector; the use of CMIA lead to a robust economic project evaluation. However, considering the advance methodologies would consider as a complementary approach for higher degree of security and risk and return.

The use of traditional methods such as the total investment cost, Levelized Cost of Electricity (LCOE) and capacity factor, to guide the decision-making process is highly acceptable. However, the investment risk evaluation model was proposed by considering three main risk categories: policy, market and technology risk. The trade-off between risk and return for REP in North Macedonia is crucial due to lack of knowhow and experience in developing the scale up REP and limited access to funds for supporting the private investors.

Vol. 12, No. 8, 2022, E-ISSN: 2222-6990 © 2022 HRMARS

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