Guidelines for calculating the Internal Rate of Economic Profitability for Investments in the Armenian Energy Sector

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Abstract

These Guidelines, prepared for Manoogian Simone Research Fund (MSRF), explain how to calculate and break down financial and economic rates of return for energy sector investments. The approach of the paper concentrates on efficiency and capital productivity, and makes no allowance for behavioral economics. The economic rate of return reflects the level of efficiency at which resources are used when prices are adjusted to account for relative economic scarcities. The financial rate of return reflects the level of efficiency in terms of resource use in the context of market prices. Economic inputs and outputs are valued at appropriate market price levels, and local factors of production are shadow-priced and converted into market prices. This Guidelines incorporates a series of exemplary projects, a note regarding the mathematical modeling of the net present value and internal rate of return, an exemplary case study, a select bibliography and a glossary of terms.

Keywords: Internal Rate of Economic Profitability, Internal Rate of Financial Profitability, Energy Sector, Energy Efficient Project Feasibility, Investment Valuation, Financial Planning, Energy Sector Specific Valuation.

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Introduction

According to the market efficiency theory, capital flows into the most profitable industries to maximize shareholder's equity returns. Capital flows between industries underpin the flexible and sustainable development of the economy in general. Increasing capital inflows into an industry can be the driver for efficiency improvements; capital inflows bring positive benefits such as relaxation of credit concerns, efficiency improvements, augmentation of investment resources, and thus it can facilitate growth in the long term. Institutional and individual investors weigh the universally available information to determine the rentability of the available projects and then make the final decision. Capital allocation productivity and efficiency improvements are also linked to capital inflows, as the financial intermediaries and the adjacent infrastructure gain momentum and improve their efficiency by achieving economies of scale.

Yet, not all investors have the necessary skills to be able to distinguish between the available choices and further channel the available capital to the most appropriate sector of the economy. This phenomenon is acute in countries where the financial literacy rates are low as the investors cannot implement proper economical modeling and identify the most appealing project to be undertaken in terms of risk to profitability ratio. It is of utmost importance for the government to guide such investors, no matter individual or corporate, as to increase the efficiency of capital allocation.

The main purpose of this paper is to examine and analyze the current investment valuation methodologies used in the energy sector of Armenia and provide recommendations regarding the future development of the methodology to enhance policy-making and private sector growth-driven developments. The paper goes beyond the existing literature since the existing scholarly work covering the Armenian industries is scarce and does not fully cover the required sector. We look at the current solutions available in the market and the guidance and subsidies provided by the non-public sector to combine with the already existing notes gathered from the market participants to understand the implications of the current market setup.

To address these research questions, secondary data has been utilized. This has been combined with numeric data covering 1994 to 2020. Given the meltdown of the global financial markets in early 2020 and the limited availability of data since then for the selected Armenian industries, the data has been limited by the mentioned time frame.

Government Agenda and Legislative Approach

In 2015 the then President Serzh Sargsyan adopted a new direction for the further development of the energy sector in the country. The government of Armenia approved the roadmap for energy sector development during the 54th gathering of the RA Parliament on December 10, 2015. Frequent energy failures and energy-wide inefficiencies had put the future of the sector in an unstable position. Given the government estimate of roughly 3% annual growth in energy demand per year drastic measures were necessary to change the landscape of energy production and distribution.

A decree was issued to create a detailed roadmap for the development of the energy sector up until 2036. Since then, the decree highlights the government's perception and a general understanding of the future of the sector. All other legislative and regulatory projects take the document as the core vision for future outcomes. In general strides, the government aims to promote energy efficiency in all stages of energy generation and distribution, promote controlled privatization of energy infrastructure, exchange programs, and industrial cooperation with leading international organizations to improve technological utilization in the ongoing projects, and various other measures to integrate Armenian energy systems into the broader regional infrastructure.

Takeaway points from the government’s vision

Energy Infrastructure Modernization and Tariff Regulation

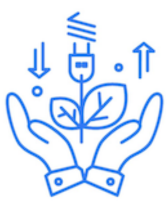
➔ Construction of modern infrastructure facilities and grid upgrades

➔ Green Auctions and Semi-Traditional Tariff Regulations

➔ Regulatory framework for promoting private sector investments

Green Energy and Continuous Decarbonization

➔ Achieve cost parity for renewable energy projects. Shift the direction of investments towards greener projects. Implement policies to decrease prices for electricity generated by renewable sources.



➔ Reduce air pollution and strive to reach EU baseline requirements for the “Energy Roadmap 2050” plan. Move away from traditional fossil fuel-sources and continuously improve Carbon emission regulatory frameworks.

➔ Meet the increasing energy demand of Armenia. Create a framework to be able to provide for the growing demand for energy for industrial use, household consumption, and increasingly electrifying transportation.

Decentralization

➔ Improve demand response and energy efficiency

➔ Evenly distributed electricity generation

➔ Improved infrastructure for energy storage

➔ Microgrids and semi/nontraditional utility systems

Democratization

➔ Continually increase the share of end- users in the storage, production, and distribution of electricity

Existing Criteria

When making investment decisions in Energy sector policy makers, financial institutions, other stakeholders need to assess various investment criteria to be able to build agile and sustainable energy systems. Due to the complex and interconnected setup of the current social and economic aspects of the society such indicators have also grown increasingly complex. Social unrest, drastic and accelerating climate change, political instability, supply chain distributions, and many more factors affect decisions made in today’s Armenian energy sector.

Existing criteria can be separated into the following categories:

- Economic Indicators: Economic indicators are the most widely used as virtually all projects in the sector are for profit. Profit maximization has driven investors to overlook other categories in favor of economic indicators yet recent environmental concerns have created alternative metrics to look at (Martins and Felgueiras, 2002). As per any other sector, the energy sector has some metrics that are used more than others, the following list has the most commonly used metrics for calculating the rentability of energy sector investments:

Appendix subsection	Metric
1)	NPV

2)	Internal Rate of Return
3)	Discounted Payback Period
4)	Levelized Cost of Electricity

The first three listed metrics are fairly common in most industries and have clear implications and underlying assumptions. On the other hand, levelized cost of electricity (LCOE) is a relatively new and less discussed metric which despite resistance to change has become a prominent factor for decision makers in the EU (Martins and Felgueiras, 2002).

Levelized cost of electricity has become a prominent metric embraced by most international and governmental energy institutions due to its universally applicable essence (Rademaekers, 2020). Since it incorporates all the expenses throughout the definitive lifetime of the project LCOE is measuring value at the long-term horizon and calculates lifetime costs thus giving a discounted understanding of the project.

Rademaekers (2020) allows for comparison between LCOE of projects within different technologies of energy production. The research lays replicable and scalable methodologies for calculating LCOE of energy sector projects.

LCOE can be calculated using,

$$LCoE\&LCoH = \frac{Total\ lifetime\ cost}{Total\ lifetime\ energy\ prodution} = \frac{\sum_{t=1}^{n} \frac{I + FO\&M_t + VO\&M_t + F_t}{(1+r)^t}}{\sum_{t=1}^{n} \frac{E_t}{(1+r)^t}}$$

Where:

- I: Investment costs
- $FO\&M_t$: Fixed operation and maintenance costs in the year t

- $VO\&M_t$: Variable operation and maintenance costs excluding fuel costs in the year t
- F_T: Fuel costs in the year t
- E_T: Energy production in the year t
- r: Time-discount rate
- n: Expected asset lifetime

For the lack of existing structural databases with the input factors mapping the formula for existing or newly constructed projects the Armenian energy sector presents a difficult task for the scope of this research. For project directors and involved stakeholders who do possess the necessary data LCOE calculations can be of utmost significance along with IRR calculations.

Most inputs for LCOE must be known in line with the project proposal; for the *r* discount rate the hurdle rate appropriate to the risk appetite of the investor shall be used. This factor is strongly dependent on the refinancing rate, foreign currency exchange rates, and many other inputs.

In comparison with IRR, LCOE has certain disadvantages. Most vividly, LCOE does not account for the project revenue. In cases of swift interest rate changes (not uncommon for Armenia) operational margins can change as well since both are positively correlated. This can alter the projects' fundamental cash flows and result in a timeframe where cash flows are negative.

- Environmental Indicators: Environmental concerns over global warming have drawn the spotlight towards environmental indicators of energy infrastructure projects. Investors, managers, and shareholders in general have increasingly present subsidies for improving their environmental footprint through efficient management. There are cases where poor environmental performance metrics overshadow economical concerns as seen with coal power plants being replaced with greener alternatives despite a better economic performance (Rademaekers, 2020).

Environmental metrics are getting increasingly more attention from policy makers due to public pressure and improving educational coverage of the underlying issue. Despite the idea that environmental factors often play a larger role in the decision making process this paper is concentrating on the economical aspect of the question.

In the process of capital allocation various projects are evaluated and compared to each other for the selection of the most efficient investment from the investors perspective. Often these projects are scattered across different sectors, industries, and locations. In any sector, economic indicators are cornerstone in the decision making process as for-profit ventures have to be profitable and in the long run an investor that makes uneducated low profitability investments will be outplayed and pushed out of the market by more informative and skillful investor's capital. In the Armenian energy sector, the second most important criteria is the environmental criteria.

- Social and Technical Indicators: Similar to economic and environmental metrics, social and technical metrics used to evaluate projects in the energy sector do play a significant and meaningful role in the process and are often used by the involved stakeholders. Such factors capture job creation, technology usage, state's fuel dependency levels among other criteria. Common examples are water usage levels per unit of energy produced, median salary of project's employees, etc.

Despite these factors not being covered in full depth, they are vital for energy factors to be successfully evaluated as the IRR might not create the full picture of the assessment.

IRR Methodology

Executives, investors, and managers frequently rely on IRR for making strategic projects. Private equity firms, the mining industry, and energy sector projects, among others, commonly use it to compare a diverse set of opportunities and investments. As per the essence of IRR, projects with a higher IRR are given priority.

Yet, not all IRRs are equal in terms of the information they carry. IRRs are affected by a set of overly complex factors that can significantly change the results of the calculations and have an effect on the comparability and integrity of the metric. The outcome of each project is dependent on the momentum of the larger economy and its strength, other factors including the investment's business positioning, the level of leverage, and its strategic setup all contribute to its IRR. Consequently, very often decision-makers can have various projects with the same IRR due to its differently weighted components, while the reasoning behind this stays unknown to many due to financial literacy levels. Disaggregating and interpreting each factor and what propels it can help decision-makers assess and calculate the intrinsic value of an investment in the light of risk and return.

Private equity ventures, specifically in the energy sector, are most frequent to measure funds' performance via IRR. What often escapes the eyes of the examiner is how much of the performance is attributed to a specific factor that builds the IRR above the baseline which the structural business would otherwise, if not successful, generate. This knowledge in the hands of an educated manager translates into informed decisions rather than just looking at the bottom line of the venture.

IRR can be calculated by setting the NPV of the project to zero then finding the interest rate that yields this result. The internal rate of return, being the required rate of return in order for NPV to be zero can be extractrapolated from *formula (I)*.

$$NPV = \sum_{n=0}^{N} \frac{C_n}{(1+r)^n}$$

Formula (I)

Where,

NPV = Net Present Value

n = A positive Integer

N = Total Number of Periods

C_n = Cash Flow

r = Internal Rate of Return

N, n, and C_n should be known to the stakeholders of the project. The internal rate of return is the *r* where the NPV is equal to zero.

There might be cases where more than one IRR is obtained. This is a drawback of the metric and usually the first non-negative number shall be used as the negative rates do not bear any financial meaning, and the consequent numbers are for future cash flow swaps. Such cases stem from the mathematical implications of IRR. Each time the project cash flow changes from negative to positive and vice versa the formula yields an additional IRR value. Choosing the lowest positive IRR value as the observational value helps eliminate confusion connected with negative rates among involved parties.

In the Armenian energy sector, out of all the available financial metrics IRR stands out as it presents the wider picture of the project lifetime, accounts for time value of money, and is easy to interpret. This paper discusses the opportunities IRR calculations present to the stakeholders and further goes into detail of disaggregating the metric to see its building blocks and breakdown them one by one.

Armenia is not unique in its dependence on energy carrier imports as it has no proven reserves itself. Hydro, solar, geothermal, and other renewable sources are ample yet the lack of infrastructure makes it difficult to cover for the government's projected 2% average annualized increase in energy demand. Still, government subsidies and supportive policies improve the projected financial outlook for renewable energy projects in the country. Despite the major differences for financial projections between a renewable energy producing facility, energy infrastructure, or an atomic power plant, the construction of an IRR model is not significantly different. Government interventions, subsidies, and other project specific aspects have to be accounted for yet the metric will carry the same methodology just with adjusted inputs and underlying assumptions.

Insights From disaggregating the IRR

Since the IRR is the single most important metric for decision-making in private equity, insights into the breakdown of the financial indicator can yield decisive and weighty benefits for the business as a whole. Partner-level decisions become more insightful and data-driven when made using the correct methodology by the decision-makers.

Considering a hypothetical investment in the energy project in Armenia, a wind farm, for example, the investor acquires the business for $55 and divests after two years for $100. The business was capable of generating $10 revenue the year before the acquisition. Using the levered formula (where IRR is defined as the after-tax discount rate at which the NPV is equal to zero) for IRR (1) to find the cash flows available to the firm as a whole rather than the shareholders only, we can see that the unlevered IRR stands at around $23. In simpler terms, the buy and hold strategy contributed around 10% to the overall IRR (around 58%).

$$0=\sum_{n=1}^{N}\frac{CF_n}{(1+IRR)^n} \qquad (1)$$

Formula (II)

Where CFn is the net cash flow for the period n. N is the number of holding periods.

Understanding the true value of investments using the IRR metric by looking at each source of the internal rates is useful not only in the case of single investment projects but for complex sets of intertwined investment strategies.

Exhibit 1

Constructing IRR factor by factor helps gasp the weight each attribute plays in the overall metric.

Project Financials	Year 1	Year 2	Year 3	
EBITDA	10	11	12	constant revenues acquired at end beginning of yr 1
EV	100		150	
Net Debt	-45		-50	Interest is neglected
Aggregate Equity Value	55		100	
EV/EBITDA	10		12.5	

Unlevered & Levered IRR	Year 1	Year 2	Year 3	IRR
Cash Flow		11	12	
Cash Flow at exit/acquisition	100		150	
Unlevered Cash Flow	-100	11	162	58%
Cash Flow from Debt	45	5	-50	
Levered Cash Flow	55	16	112	33%

Breaking down the IRR composition	Year 1	Year 2	Year 3	PV of Year 2	Fraction	Contribution to IRR[1]
Baseline		10	10	23	0.3	10%
Business Performance		1	2	3	0.04	10%
Capital Gain[2]			20	20	0.26	
Strategic Placement[3]			30	30	0.4	13%
Unlevered Return		11	62	76	1	**33%**
Leverage						25%
Levered Return						**58%**

1 Calculated as (PV (year 3)/total PV (year 3)) unlevered IRR
2 Calculated as (EBITDA (opening) – EBITDA (closing)) EV multiple (entry).
3 Calculated as (EV multiple (closing) – EV multiple (opening)) EBITDA (closing).

Improvements to business performance. Business managers' primary goal is to deliver improved performance when compared to peer companies and hurdle rates. Achieving sustainable growth, widening margins, and increasing the efficiency with which capital is employed are all vital indicators of a successful manager.

In the hypothetical case, performance improvements generated additional revenue, free cash flows, and margin improvements for years 1 and 2. Additionally, the capital gain of $20 in year 2 can be attributed to performance improvements. Adding this to the $3 additional cash flows over the same two years sums up to a $23 business performance improvement over the two years. The overall contribution to the IRR calculation stands at 10%. This indicates that the investor is not only able to choose attractive investment venues but also improve the business as a whole during the holding period by adding to the business performance.

Strategic Placement. Strategic repositioning propositions can have beneficial effects on the bottom line as well as on the general business performance. A manager that can successfully promote and create new products and services, identify areas where research and development spending is most appropriate and see which markets and when to enter can yield superior value for the business.

Considering our hypothetical example such benefits had a 13% contribution to the IRR. Given that the investor invested in the Armenian energy project at an EV/EBITDA ratio of around 10 and closed his position at a ratio of around 13, meaning that 13% of the total 58% can be reasonably attributed to the skillful strategic placement of the equity manager and other involved entities.

Leverage. The Armenian energy sector has a relatively high leverage capital construction. While leverage can facilitate growth it also increases risk. It is important to understand to what extent has leverage contributed to the IRR as in various macroeconomic conditions leverage can be a constraint to private equity firms. Understanding risk-weighted return metrics through looking into leveraged companies is the cornerstone for decision making.

The methodology for calculating the precise amount of IRR that arose due to IRR is necessary, to sum up, the cash flows that can be directly attributed to leverage, including the interest payments. For our exemplary project, the unlevered IRR stands at 33% and leverage adds another 25% to the metric. Noticeably, taking on debt has improved IRR by more than 60% yet the question of whether leverage has been positive for the firm when discounting the risk that comes with leverage cannot be answered uniformly. It has to be addressed on a project-to-project basis taking into account all the variables that affect the leverage.

Overview

In conclusion, along with using IRR as an important decision-making tool for investors in the Armenian Energy sector, it is vital to look at the breakdown of the metric that can decrease delinquent decisions. Understanding the building blocks can help separate areas for improvements, strengths, and weaknesses of the project in the eyes of management. The current framework used in the energy sector often disregards IRR and focuses on NPV and the Payback period, while these metrics are still of importance IRR is irreplaceable as it accounts for changing cash flow signs and changing capital costs. Using the proposed IRR disaggregation methodology can significantly improve risk assessing processes and consequently affect the final decisions in favor of better risk-weighted investment projects.

Given the current financial literacy levels among local investors, managers, and involved companies it would be beneficial to incorporate several educational programs to promote more data-driven decision making on the higher levels (OECD, 2019). Financing institutions and private equity investors that provide leverage to development projects in the energy sector can get a more comprehensive picture of the industry landscape and adjust their financing projects according to timely changes of IRR-related factors.

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Appendix A: Armenian Energy Sector

Once in a severe crisis in early 1990s, Armenian energy sector has evolved rapidly and as of now is one of the most prosperous industries of the country. Armenia has no affirmed oil or gaseous petrol holds, and is accordingly profoundly reliant upon imported energy assets. It imports oil and oil items from Georgia, Iran, Russia and Europe. Petroleum gas is imported from Russia through Georgia (with a restricted volume of flammable gas imported from Iran in a gas for power trade course of action) and atomic fuel is imported from Russia. Intensifying the circumstance, Armenia has exceptionally low degrees of energy productivity contrasted with created nations. In this manner, the public authority has taken on a few laws zeroed in on creating homegrown, particularly inexhaustible, energy assets and far and wide execution of energy effectiveness measures.

The controller for the force business, the Public Service Regulatory Committee, has set appealing taxes for recently built Small Hydro Power Plants (SHPPs), wind, and biomass plants. It has likewise specified that the power off-take and these duty rates will apply for quite a long time from the date of issue of a working permit for another plant.

Armenia's nuclear energy stations are worked by two privately owned businesses (RazTES and Gazprom Armenia) and one government-possessed plant (Yerevan TPC). RazTES works Hrazdan TPP with a working limit of 400 MW (introduced limit of 1 110 MW), and a yearly age for the interior market of around 500 GWh, representing somewhere in the range of 8% of homegrown stock. Gazprom Armenia operates Hrazdan Unit 5 (appointed in 2011) with a working limit of 440 MW (introduced limit of 467 MW), and a yearly age for the inward market of around 500 GWh (representing 8% of homegrown stockpile). Be that as it may, Hrazdan Unit 5 is more situated towards the trading limit. Yerevan TPC works Yerevan CCGT (dispatched in 2010) with a working limit of 220 MW (introduced limit of 238 MW), and a yearly age for the inside market of around 950 GWh (representing 15% of homegrown stockpile). The Yerevan CCGT is working under a gas-power trade agreement and fares around 500 GWh yearly.

Since 2006, "Electric Networks of Armenia" (ENA) is the sole electric force wholesaler in the country. It is the greatest business in Armenia and furthermore perhaps the biggest citizen. It serves around 985,000 electric utility clients. The organization has 11 branches. 7 branches serve 0.4-110 kV electric organizations in the locales of Armenia and 4 branches serve Yerevan, one of which is for 35-110 kV organizations and the other three are for 6(10)/0.4 kV organizations. In spite of the new change in law permitting contests in this area, no new organization has arisen to rival ENA.

In 2015, the past proprietor of ENA "Bury RAO", a Russian open business entity, offered it to Tashir Group—a Moscow-based gathering of organizations constrained by a Russian extremely rich person of Armenian origin, Samvel Karapetyan. As per some autonomous evaluations, the Armenian power conveyance restraining infrastructure might have sold for as much as $720 million. In any case, the last sum may have been dictated by the organization's remarkable obligations just as political contemplations. Tashir Group declared that, in collaboration with worldwide monetary establishments, it will put about $900 million in updating the organization framework in the following not many years.

The High Voltage Energy Network (HVEN) of Armenia is a state restraining infrastructure worked as a shut business entity. Its principal objective is to get the transmission of energy by means of 220-110kV electrical organizations, including its administration activity, support, recreation, retooling and configuration works, just as development of the organization by the development of energy offices and high voltage transmission lines. As indicated by the Ministry of Energy and Natural Protection HVEN has 15 220kV substations, with 36 force transformers, the absolute introduced force of which is 2561.0 MVA, and one "Agarak " 220kV Switching Point. The length of HVEN's outside high voltage transmission lines is 1914.73km; including 330kV - 127.62km long, 220kV-1366.51km long and 110kV-420.6km long as indicated by plan limit. The energy arrangement of Armenia is associated by means of highway lines with the energy frameworks of Iran and Georgia.

The "Electro Power System Operator" CJSC (EPSO) as the autonomous administrator has a restraining infrastructure over the essential working of the force framework. It is liable for the specialized and financial coordination and control of the framework. Furthermore, EPSO gives coordination and long haul anticipating the force framework activities. This incorporates the creation, import, fare and conveyance of power dependent on existing agreements and beginning estimations. EPSO has an offshoot organization "Settlement Center" which is liable for regulating the functional and cycle connection of the force framework and dispatch control.

The electric force arrangement of Armenia is considered to have critical potential for feasible energy in view of the presence of hydroelectric and other environmentally friendly power sources. As indicated by Western specialists, if Armenia can build the creation of sustainable power and lessen its expense, the reliance on costly petroleum gas can be decreased.

The most developed environmentally friendly power innovation in Armenia is found in the hydropower area, both in the utilization of enormous scope power (for example - waters of Lake Sevan) and the later establishment of little, run-of–the-waterway hydropower plants (SHPPs) all through the country.

All out limits of all hydropower frameworks is 1,032 MW. Plants on the Hrazdan and Vorotan waterways produce most of the country's hydroelectric force. The Sevan-Hrazdan course comprises six force plants with a complete limit of 560 MW. The Vorotan course comprises three force plants with a complete limit of 404 MW. In 2015 the Armenian government supported the offer of the Vorotan Cascade Hydro Power Plant to U.S. organization ContourGlobal and the arrangement was settled in July 2015. The organization will put 70 million USD in overhauling and repairing the offices over the course of the following not many years.

Tashir Group will put resources into the development of the Shnogh HPP, a 76 MW power station which will give 6% of the all out power utilization in Armenia. The Shnogh undertaking will be situated on the Debed River in the Lori locale. A three sided structure concession to the plan, development, financing, development, the board and responsibility for project was supported by the public authority in August 2017 and endorsed by the public authority, Debed Hydro as the engineer and the Investors Club of Armenia as a support (both having a place with Tashir Group). The undertaking will cost about $ 200 million. The program will likewise include the American organization The Robbins Company and the World Bank's International Finance Corporation. The development is planned to be finished within four years. A notice of collaboration between The Robins Company and the Debed Hydro's Charter Capital (Tahsir Group organization) was endorsed in November 2017. As per the notice, The Robbins Company will put resources into Debed Hydro's Charter Capital, giving a 22-km-long water burrow boring machine, just as the neighborhood is preparing for machine activity and specialized help all through the passage penetrating.

There are right now around 170 private little HPPs (under 30 MW), which were by and large developed during the most recent ten years. Their introduced limit is around 300 MW, and yearly age is roughly 700 GWh (covering around 11% of homegrown inventory). Dzoraget HPP is the biggest, with 10 smaller than usual hydro units having 26 MW of introduced limit.

Hydropower could give a considerably more noteworthy level of Armenia's electrical requirements throughout the following decade, as about 23% of the yearly age capability of SHPPs is as yet hidden and a significant number of the establishments are wasteful.

As indicated by the Wind Energy Resource Atlas of Armenia created by NREL(National Renewable Energy Laboratory) in 2003, the financially advocated capability of wind energy is around 450 MW. Practicality reads for Wind Power Projects (WPPs) with absolute limit of 195 MW and an age limit of 0.55 GWh each year have been directed. The public objective for wind power is 500 MW of lattice associated limit by 2025. The super viewpoint destinations are situated in Zod pass, in Bazum Mountain (Qaraqhach and Pushkin passes), in Jajur pass, in the domain of Geghama Mountains, in Sevan pass, in the area of Aparan, in good countries among Sisian and Goris, in the locale of Meghri. Little hydropower and wind power age are more affordable than warm power age. Be that as it may, there are various arising issues which could slow future development. These remember irregularities and oversights for the legitimate/administrative system, specialized shortages, and proceeding with business/business hindrances. The super specialized issue with SHPPs in Armenia has been the absence of robotization and use of present day control advancements. Different elements incorporate terrible showing and low dependability of imported Chinese and Iranian gear, metallurgical and materials issues coming about because of the re-utilization of rescued funneling from water system frameworks, inadequate designing plan and low quality control during development, just as deserted hydro offices that are at this point not functional.

Armenia has critical sun based energy potential. The normal yearly measure of sun based energy stream per square meter of even surface is around 1720 kWh (the normal in Europe is-

1000 kWh). One fourth of the country's region has sun based energy assets at a degree of 1850 kWh/m2.

As indicated by the Ministry of Energy, as of now, eight helio stations are under development with an arranged all out introduced limit of 8 MW. The Ministry of Energy intends to place them into activity before the finish of 2018. Last year, three sun based force plants began working on the lookout – one each in Kotayk, Armavir and Aragatsotn areas. Their absolute introduced limit is 2.5 MW. Simultaneously, the maximum furthest reaches of the environmentally friendly power age via independent stations has expanded to 500 kW/h from the past 150kW hour.

change their present choices to adapt to the future. In this manner, flexibility turns into a choice to confront uncertainty. The successful utilization of sustainable power sources, including wind energy, is the best technique to add to meeting the destinations of the 2030 Agenda and the Paris arrangement, pointed toward diminishing CO_2 emanations.

Appendix B: Past Research

Murgas, Henao and Guzman (2021) in their research review approaches used in evaluation of investments of wind energy projects under uncertainty. The sources of uncertainty were grouped into 9 categories: power generation, environmental conditions, energy price, wind conditions, energy policies regulation, wind conditions, market, technological progress, income and costs. The authors looked at some barriers present in the study, like public opposition NIMBY, which stands for “Not in my backyard”, when people do not care for the environment, as it does not directly affect them. However, no studies under real options approach were seen to elaborate on the topic. Given the significance of investment projects in sustainable power, including wind energy, flexibility is an essential component in the decision-making process.

In their research about biogas plants, Bonazzi and Iotti (2015) highlighted the fact that organizations in the sustainable power area play out an environmental assistance relevant regarding the discharges of positive externalities, so the approaches of public aid from the EU and the Italian State essentially affect the exhibition of the capital, as estimated by execution record IRRE. This return is far higher than the normal profit from the market, so it becomes helpful to expand the investigation past the contextual analysis considered.

Caralis, Diakoulaki, Yang, Gao, Zervos and Gaos (2014) look at wind energy in China. China is the worldwide forerunner as far as introducing wind limits. Further, wind energy advancement is normal for the following years and a very long time to meet the persistently expanding power interest and the need of utilizing clean homegrown energy. Starting around 2009 China is isolated into four geological districts, each allotted with an alternate benchmark on-lattice tax. Additionally the current foundations are not similarly evolved all through the nation, settling on speculation choices more convoluted and hazardous. The assessment of the current structure for wind energy advancement in China confirms that the current arrangement of feed-in taxes in China is exceptionally compelling for the decent organization of wind energy in the entire country. In any case, it is shown that the danger of abridgement and matrix openness may essentially diminish the expected productivity of wind energy interests in every one of the four districts. Need for advancement of frameworks ought to be given in secluded northern breezy regions with high-aggregation of wind ranches.

Appendix C: Financial Indicators

1) NPV refers to the net present value, which is by far the most commonly used indicator for making investment decisions across industries. It seeks to capture the net value of a financial decision using a discount rate.

2) Internal Rate of Return is another common mathematical metric used widely in decision making processes. The discount rate which makes the NPV zero is the internal rate of return.

3) Discounted Payback period refers to the payback period where the cash flows are discounted to account for time value of money. It is slightly more complicated than the regular payback period but is more applicable to real life situations.

4) Levelized cost of energy (LCOE) also known as levelized cost of electricity is a measure that is specific to the energy sector. Due to the variability and seasonality of energy production for most renewable energy sources LCOE manages to average out the cost of production over the plant's lifetime. This allows us to compare projects with different lifetimes, technology, and work frames.

Bibliography for appendices

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