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Financing Alternatives & Integration of Roof Top Solar PV with Green Building Concept

Dr. Rohit Verma
Associate Professor, National Power Training Institute, Faridabad, Haryana, India

Abstract: Architecture plays an important role in the energy efficiency and conservation of buildings. In India, green building concept and methodology are still in their infancy stage. For already existing buildings, making major structural changes to incorporate eco-friendly concepts are economically unviable. But their energy consumption levels can be brought down by implementing energy efficiency measures which will make them more eco-friendly. These energy efficiency projects are mostly low cost and have relatively small payback periods. This paper proposes to discuss the various financial options available to an organization which wants to implement energy efficiency measures in its buildings by integrating roof top solar Photo Voltaic plants.

Key words: Green building, photo voltaic, financing, ESCO, ECBC.

INTRODUCTION

Energy conservation through the application of green building codes is gaining much popularity in India. Unfortunately many large corporate and commercial buildings were already completed much before this concept gained much popularity. In order to make such huge buildings more eco-friendly and energy efficient, many small scale measures can be implemented that will reduce their energy consumption and improve efficiency. These measures reduce the annual maintenance of these buildings also and hence make commercial sense to invest in such projects. More over the world is facing an energy crunch and cost of energy is spiralling. In this scenario, such projects gain much importance.

INTEGRATION OF ROOF TOP SOLAR PV WITH GREEN BUILDING CONCEPT

The ECBC building envelope requirements are based on climate zone in which the building is located. ECBC define five climate zones (hot -dry, warm- humid, Composite temperate & cold).

For the hot -dry, warm- humid and moderate climate zone ECBC requirements says for reduced heat gains by three methods viz.
Decreased exposed surface Area, increased shading and increased surface reflectivity. All these three requirements can be met by installing a solar Photovoltaic (PV) rooftop Electricity generation system. A roof top Solar PV installation may be of two types. If it is more than 250 KW installation it can be grid connected system or else it will be with battery backup.

A roof top PV of less than 250 KW has mainly five components viz. Solar panels, Inverter (For converting DC into AC), Maximum Power point tracking System (MPPT), Charge controller, and deep discharge battery. Ninety percent of rooftop solar panels are of mono/poly crystalline type as they are having higher efficiency. The cost of installing roof top Solar PV panels varies between Rs.1.25 lakh/ KW to Rs. 2 lakh/ KW. Government of India (MNRE), as per 2012 guidelines, provides up to 40% of capital subsidy on the roof top systems (off grid).

Solar Water Heating

Solar Water Heating is a mandatory requirement for residential facilities, Hotels and Hospitals with centralised system and should have solar water heating for at least 1/5 of the designed capacity.

Solar water heater should meet the performance / minimum efficiency level as per in IS 13129 Part (1&2). MNRE provides subsidy up to 30% of capital cost for solar water heater.

Energy Efficiency for Existing Building:

Energy efficiency projects for existing buildings are mostly low cost and have relatively small payback periods. This paper proposes to discuss the various financial options available to an organization which wants to implement energy

efficiency measures in its buildings. The process starts with the organization identifying an ESCO (Energy Services Company) to do an energy audit of the building. The ESCO audits the building and calculates the energy consumption levels of the building. It, then advices the organization on various energy efficiency measures that can be implemented to reduce energy consumption and make the building more eco-friendly. These measures are financially viable and their implementation is done by ESCO at the behest of the organization. The various methods of financing such projects are discussed between the ESCO and organization and the most suitable for both parties is accepted.

METHODOLOGY

Data collection should include but not limited to the following:

- Monthly electricity consumption details for the building for three years, including demand, power factor, etc.
- Inventory details of all utilities including the transformers, water pumping, water storage system, HVAC details, lighting systems, and diesel generators.

Floor mapping in municipal buildings:

- Continuous recording of the electrical parameters for a period of 24 hours
- Flow and head measurement of individual pumps in the buildings
- Power measurement using the power analyser for those particular pumps for which the flow measurements are made simultaneously
- Electrical parameters of all the major electrical equipment.
- Other measurements as needed to characterize the system
- Prepare data sheets for recording pressure measurement to help in evaluate the performance of the energy consuming equipment.
- Prepare data sheets to capture operational details of the equipment in the buildings in more detail than that in the log book.

DATA ANALYSIS

Conduct the following analysis to calculate the baseline of the entire project as well as for individual projects making up the whole:

- Historical data analysis to establish the power consumption trends
- Analyze design parameters and actual operational parameters with a view to identify problems
- Analyze pressure and voltage profiles with a view to identify losses
- Analyze distribution network with a view to identify system resistance and whether pipes and cables are the correct size
- Evaluate the performance of the individual pumps, or combination of pumps in case of parallel operation, and the pumping system as whole, including transformers, lighting and the HVAC system

Choosing projects from list of potential projects

Based on the analysis, the ESCO make a list of projects with good potential for saving energy (and water if applicable) that includes the following information:

- Configuration of the existing system
- Configuration of the proposed system
- Estimate of the energy savings and other benefits
- Estimate of the investment and its payback period
- Retrofit requirements
- Comments from facility personnel based on discussions the ESCO has had with them

The potential projects are then discussed at the steering committee appointed by the municipality, which selects a set of projects to develop fully. It is suggested that the ESCO and steering committee meet weekly or biweekly thereafter to help the committee monitor progress.

Finalizing a set of approved projects

To more fully develop the short list of projects approved by the steering committee, conduct a more robust data collection and analysis to ensure the technical viability of each project, and if this analysis is favourable proceed to

design the concept and configuration, including the life of the project and technical constraints. Once the ESCO develops the short list of projects more fully, they are discussed in detail with the steering committee, with their suggestions for modification incorporated appropriately. The finalized projects are discussed at length in the audit report. Three key aspects of the detailed audit at this stage are the financial analysis, risk assessment, and baseline calculations, discussed in more detail below.

Detailed financial analysis

Calculate the financial aspects of each individual project as well as that of the entire project, determining the costs on a net present value basis, marginal cost for each unit of savings at the time the audit is performed, the simple payback period from the savings, and return on investment. The financial analysis includes:

- Anticipated adjustments to the baseline to reflect changing conditions at the facilities compared to the historic baseline. Factor in any anticipated deterioration in annual savings through the life of the project due to the age of the equipment.
- Costs for engineering, design, materials and operations, including: Contractor and vendor estimates
    - Contingency costs
    - Construction management fees
    - Commissioning costs
    - Taxes & duties
    - Initial training costs
    - Annual service fees including M&V, maintenance, and ongoing training
- If the project will be financed by a commercial bank, a cash flow analysis that includes an internal rate of return, debt service coverage ratio, and cash accruals

Another useful financial analysis tool is a Sensitivity Analysis, where key variables in the cash flow are tested to determine how sensitive the project's NPV, payback period, and IRR are to changes in costs such as electricity, labour and fuel. It is useful because it can highlight variables that pose a significant risk to the project if they have a high probability of occurring.

RISK ASSESSMENT AND MITIGATION PLAN

The scope for the risk assessment and risk mitigation plan includes but is not limited to the following:

1. Design and construction risks:
    I. Baseline establishment
    II. Technical efficacy
2. Completion risk
    I. Delay in construction
    II. Conformance to standards and government approvals
3. Performance risk:
    I. Equipment performance
    II. Longevity of energy savings
    III. Accuracy of savings
    IV. estimates M&V risk
    V. Operational changes
    VI. Capacity of facility (i.e., non-ESCO) personnel
4. Financial, economic and regulatory risk
    I. Cost overrun – initial and operating
    II. Interest rate risk
    III. Foreign exchange risk
    IV. Regulatory – changes in laws relating to tax concessions etc.
    V. Financing
    VI. Financial disaster of any of the project holder
    VII. Credit risk
5. Market risk: Energy price risk due for example to changes in tariffs
6. Environmental risk: insurance coverage in case of an environmental hazard or accident
    a. Legal risk: new (or newly enforced) environmental standards
    b. Force Majeure: natural disaster during the design and construction

BASELINE ADJUSTMENTS

Adjustments to the baseline are made when post-implementation conditions in energy use change relative to the original baseline conditions documented in the M&V plan. It is important to have a method of tracking and reporting changes to the baseline conditions. Many factors affect the performance of the equipment and system over time and thereby the achievement of savings over the course of the project. Parameters that are predictable and measurable can be used for routine adjustments. Such adjustments reduce the variability in reported savings and provide a greater degree of certainty in reported savings. At times unpredictable changes to the parameters, such as unexpected changes in use, may require non-routine adjustments to the baseline in the future. Therefore the M&V plan must take into account predictable changes to the baseline, such as growth in the number of household water connections, the ability of changes to be measured, and the likely impact of changes. The ESCO and the project host must agree on how such changes will be factored into baseline adjustments over the course of the project.

CALCULATING SAVINGS

In addition to agreeing upon the baseline and allowable adjustments, both companies and the ESCOs must agree on how to calculate the energy and cost savings resulting from the project. Once the work has been done to determine the baseline and adjustments, the energy savings is calculated as:

Energy Saved=Baseline–Current±Adjustments

Where:

- ENERGY SAVED is the energy saved over a period of time from project start to a set point in time
- BASELINE is the baseline energy consumption (kWh)
- CURRENT is the current energy consumption (determined by metering or the utility energy bill)
- ADJUSTMENTS are any adjustments, positive or negative, that need to be made to the baseline to bring energy use at the current point in time to the same set of conditions as the baseline set.

In order to calculate cost savings from the energy savings, the parties must agree on how to handle energy price fluctuations because the resulting amount should be a function only of the efficiency measures, not fluctuating energy costs. One method is to agree on a set price, either one defined upfront in the performance contract, or a formula or definition for calculating one (e.g. the average monthly energy cost over the time period being examined). These are details that need to be negotiated in the performance contract.

FINANCING OF GREEN BUILDING PROJECTS

I. The company uses its internal funds such as O&M budget and capital budget
II. The company borrows from financial institutions
III. The ESCO brings the finance and implements agreed upon energy saving measures

The following two models for EE financing is discussed in detail:

1. Company procuring finance from a financial institution to contract with an ESCO

Or

Energy Audit firm to implement energy efficiency project on a turnkey basis

2. ESCO financing the Energy Efficiency Project implementation under Energy

Performance Contract in either shared or guaranteed savings payment model

Company borrowing from financial institution to finance energy efficiency project

The Company has an option to borrow funds from a financial institution such as International Finance Corporation (IFC) or other public or private financial institutions for undertaking energy efficiency projects. The cost of capital is generally cheaper for a Company than for an ESCO. Many financial institutions are keen on financing energy efficiency projects since they consider them to be commercially viable and attractive.

Once the Company has borrowed the capital, it can contract with an ESCO or an energy audit and engineering firm to implement the project on a turnkey basis. The ESCO or the energy audit consultant conducts the IGA(Investment

Grade energy Audit) and is in charge of overseeing the implementation of the energy savings/efficiency measures.

The company enters into a turnkey contract on fixed fee basis with the ESCO or energy audit firm. The ESCO or energy audit firm provides consultancy services for a fixed fee. The company and ESCO can agree on payment of fixed fees in monthly installments or in lump- sum after completion of each task.

In the fixed fee contract the ESCO bears less risk compared to a savings based fee payment because their fee does not depend directly on the amount of the achieved savings. Nevertheless, in the fixed fee turnkey project, the ESCO bears a number of risks associated with the procurement, installation, commissioning and performance of the equipment, and often this is one of the decision making factors for the companies that don't want to carry these risks. The ESCO conducts the audit and designs the project, as well as arranges for equipment procurement and supervises installation. The payment could be either in installments based on deliverables or a lump sum upon the completion of the project. The fixed fee installments can be paid to the ESCO after each task such as: study phase, contracting phase, implementation phase and post project phase. The fees might differ depending on the complexity of the phase. If it is a lump sum payment, it can be paid at the end of the project.

The main advantage of the fixed fee turnkey contract is that the company 'owns' the project and accrues all the benefits and the ESCO guarantees a certain amount of savings. The disadvantage of the fixed fee turnkey project is that the ESCO may not agree to guarantee any savings. In this case, the company bears the entire financial risk. ESCO bears technical and implementation risks because it must ensure commissioning of the project on time and in accordance with the specifications. Nevertheless, ESCO receives its fee regardless of the actual savings. The financing institutions in India tend to be more comfortable with lending to a company than an ESCO because of various credits guarantee options available to Indian companies.

Outside financing of municipal energy efficiency projects often requires a repayment mechanism that mitigates the risk of non-payment. There are several models available that help ensure that the loan and all other payments related to the project are re-paid.

Other than having the government as a equity partner, two common methods are well suited to turnkey contracting:

1) Establish a separate account into which the company deposits savings from the project, or

2) Set-up a Trust and Retention Account (TRA) in which the company deposits revenue from electricity bills and taxes (and/or water bills if water efficiency is part of the project) into an escrow account in accordance with the payment schedule of the loan. Another safeguard option called a reserve fund, which provides additional security to the bank in case of default or any shortfall in the TRA account.

The definition of default has to be agreed by all parties. In addition to the company making deposits into the TRA account, it also diverts some funds into the reserve account. An escrow agent then makes payments according to the order of preference outlined in the performance contract, usually as follows:

- Payment of the interest and principal
- Transfer to the reserve fund
- Payment to ESCO/consultant
- Payment to municipality

ESCO financing under an energy performance contract

When the ESCO arranges for the financing, one of the major barriers to implementation is removed because the company does not need to make the financial investment. The company does not bear the technical risk. The company only needs to make payments to the ESCO over a period of time on realized savings.

The company enters into an Energy Performance Contract (EPC) with the ESCO to procure energy and financial services. The energy expenditure savings are used to repay the investment made by the ESCO. The ESCO bears the risk and takes on the responsibility of delivering the results. The company enjoys the benefits of the EE project. The EPC are usually based on guaranteed or shared savings.

Revenue from reduced Electricity bills by Solar Rooftop installation

Solar module cost have seen significant reduction in recent times & power tariff for tail end consumers have increased significantly. This has led to Grid parity for solar power at consumer level. Conventional power tariff for tail end consumers is averaging to Rs. 7.9/unit. However power tariff for Solar rooftop PV installation has come down to Rs.

7.2/unit. This model in terms of standalone electricity generation itself has become viable. Besides this significant saving in electricity bills is possible by installation of solar water heating system.

Supplemental revenue from reduced carbon emissions

Industrialized countries through the Kyoto Protocol's Clean Development Mechanism (CDM) can implement sustainable and environmentally friendly technologies in developing countries (and transition countries not included in Annex B to the Kyoto Protocol), to help meet their emission reduction obligations in a cost-effective manner. The industrialized countries investing in these projects will receive credits against their Kyoto targets based on the Certified Emission Reductions (CERs) derived from each project. CDM is also beneficial to developing countries by promoting the transfer of clean technology, foreign direct investment, localized environmental improvement and an income stream from the sale of tradable CERs. Engaging in CDM projects can prove to be extremely advantageous for a country like India that has great potential to develop and implement projects based on the sale of CERs. Financing obtained through CDM mechanism can create additional revenue for an energy efficiency project and make a project more attractive for third party financing.

RESULT AND DISCUSSION

- ECBC building envelope requirements for reduced heat gains for roofs can be viably achieved by solar rooftop PV and thermal installations.
- Various methods for the conception and implementation of energy efficiency projects are discussed.
- The data analysis and risk analysis options are highlighted.
- Means of financing is discussed in detail.
- Supplementary means of income is also discussed.

CONCLUSION

Green buildings save money, starting the very first day of construction. This is true for green homes as well as sustainable office buildings, factories, schools and other structures. Both residential and commercial buildings retain a high resale value if they include sustainable design components. The value to prospective buyers comes from knowing their utility and maintenance costs will be lower in green buildings that outperform non-green buildings. Occupancy levels are consistently higher, and vacancy rates lower, in sustainable office buildings. Above all it works towards the sustainable development on earth.

Reference

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Biographical notes

Dr. Rohit Verma has teaching, research and power industry experience spread over 20 years. He is a Associate Professor in the Centre for Advanced Management and Power Studies at National Power Training Institute, Faridabad and his research focuses on optimization of resources in energy sector. He started his career as an Asst. Engineer (O&M) in a coal based thermal power plants. He is a PhD from JMI University, Delhi. He received his B.Tech. in Mechanical Engineering and an M. Tech. in Energy and environment Management from IIT Delhi. He has been teaching the courses of Global Power Business, Power Station Management, Power Environment interface, Energy Resources & Power plant Systems and Renewable Energy. He has also authored books on Global Power Business, Renewable Energy and Operations Research. He has published 21 research papers in international/national journals and proceedings of international/national conferences.