Performing Preliminary Appraisals of Distributed Generation and Combined Heat and Power Projects

A. General

Distributed Generation (DG) and Combined Heat and Power (CHP) investments are not all-purpose solutions. The suitability of these costly investments for a particular application needs to be checked by appraisals of heat and power needs along with other factors as operating hours, utility rates, fuel prices, operation and maintenance costs and environmental impact. A simplified version of these studies should be performed at the very beginning.

A number of approaches to carry out these preliminary appraisals have been collected from a number of energy organizations. Following is a comparative review of these sources.

B. Description of Appraisal Sources

B1. California Energy Commission-Distribution Energy Resources

A formulation for decision analysis is presented to calculate the new Cost of Electricity (COE) after the project implementation. The Cost of Electricity, calculated in $/kW-hr is comprised of three components: capital and installation (C&I), operation and maintenance (O&M), and fuel (F) per the following equation.

COE =C&I + O&M + F

C&I is calculated to reflect the use of the equipment through all the operating hours during the amortization period. Likewise, O&M and F are evaluated performing the same allocations. If the COE o is found below the current electric rate, the project is profitable.

The source provides a DG example, i.e., an application without the use of waste heat. For a CHP application, a negative term reflecting the recovered heat savings must be included. A similar allocation should be performed to quantify the fuel saved in providing heating, hot water, chilled water or process heat.

B2. Universidad Nacional Autónoma de México-Feasibility of Solar Water Heaters in Mexico DF

Although this source proposes the mass-scale replacement of gas heaters by solar energy units, its model is applicable to CHP and DG appraisals.

The model developed is based essentially on the Net Present Value (NPV) of the Useful Life Cycle Cost (ULCC) method. This ULCC is the flow balance between expenditures and savings due to the reduction in fuel use. The option that establishes the largest ULCC is the best investment choice. This means that it will show the highest profit for the user over the useful lifetime of the SWH system. The ULCC is given by:

ULCC = E + V – C – M – R

where,
E = PV of cost of the fuel avoided by the use of the SWH (Solar Water Heater)
V = PV System recovery value at the end of its useful life
C = PV of Cost of the SWH including installation
M = PV of Maintenance (preventive) costs
R = PV of Replacement of parts / corrective maintenance costs
(PV indicates present value)
The cost of installation is additional to the equipment and taken to be 30 percent of system's cost.

Maintenance costs are rated annually at one percent of the system cost.

In addition, the calculated were the Internal Rate of Return (IRR), the benefit-cost ratio (B/C), the time needed to recover the investment and the cost of avoided tone of CO2 and the TRI (Time to Recover Investment). The B/B and TRI formulations are not given but could be derived as follows:

B/C= (E+V) / (C+M+R)

TS= E + V – M - R

YS= TS * (CRF-NDR%-ULCC Period)

TRI= C/YS

where,
TS= Total Savings
YS= Yearly Savings
CRF= Capital recovery Factor, from tables
NDR= Net Discount Rate, from Owner's Financial Dept.

With the calculated IRR, B/C and TRI, the Owner has now the tools for arriving to an intelligent decision TO-GO-OR-NOT-TO GO.

B3. UK Good Practice Guides - How to Appraise CHP

This source recommends a methodology only applicable to medium size CHP projects (electric loads larger than 1000 kW). The approach is summarized in the flow chart of p. 2. There are 3 steps that are performed filling out a furnished worksheet.

3a. Step 1 -Calculation of Baseload Requirements. A field survey and an inspection of the electricity and fuel bills will identify the "Baseload" system, i.e., the existing system to which the CHP equipment will be added.

3b. Step 2- Annual Utilization. Jointly with Owner, the production hours of the CHP equipment must be precisely established. Thus, the vital "heat/power" ratios are determined.

2c. Step 3 - Assessment of Paybacks. This step starts with the selection of the prime mover. Only if the plant has the correct sizes of heat and power, and in the proper ratio, will the CHP application be profitable. The source has prepared inequalities that will determine if the proposed CHP solution is appropriate. If so, the worksheet will perform calculations of the savings and the SPB (Simple Payback) period. The Owner will use these values to decide if the investment is warranted.

The methodology does not cover the possible export of electricity to the utility grid. It is possible, but unlikely, that this refinement will move the investment's outcome towards profitability

B4. UK Good Practice Guides - Financing Large-Scale CHP

This source is a financial guide that focuses in the monetary aspects of the investment. The actual determination of the savings produced in the operation of the CHP equipment is not covered. These data is incorporated in a cash flow worksheet that spans through the useful life of the equipment. With this information the model calculates different financial parameters enhancing the economical aspects such as the selection of the best financial package for the investment.

At the end, the worksheet calculates the SPB period, the IRR, the NPV and the ROI of the project. The Owner will use these values to decide if the investment is warranted.

B5. U of Illinois at Chicago-CHP Economics Evaluation

This scheme recommends a methodology similar to the presented in Source 3, although with more elaboration. In fact, it comprises a book with 25 pages of worksheets and graphs. The approach consists in performing 4 steps that are carried out filling out furnished worksheets.

Step 1 – Entering visit results in Worksheet "Site Data".

Step 2 – Establishing Baseline Load Profiles after discussing operations with Owner. Enter information in Worksheet "Baseline Report".

Step 3 - Selecting the CHP equipment by filling out Worksheet "Equipment".

Step 4 - Filling out assumptions and obtaining the CHP Results in Worksheet "Results".

Unfortunately, the internal formulae of the worksheets are not available so it has not been possible to follow up the calculations. Due to this limitation, it is presently unclear if this source can be used to obtain practical results. Discussions with the authors are presently under way.

B6. U of Illinois at Chicago- Elgin Community College Site Report

The authors of this document are the same as the ones that produced Source 5. Since it is a full report of the investment, abundant details are provided about the CHP operations, in addition to the economic analyses. Again, the internal formulae used to obtain the results are not available so it has not been possible to follow up the calculations. So, the content can be used only to illustrate the general approach and the use of the results.

After establishing the Source 5's algorithms, corroborations will be performed to understand the economic calculations.

C. Conclusions and Recommendations

Although the above studies are different in their form and accounting, all of them use one or more of the established engineering economics' indicators. That is: NPV, Annual Cost, IRR or SPB. One of them goes beyond trying to assess B/C ratios.

The appraisals are rather simplistic answers on the profitability of complex undertakings. The purpose is only to indicate whether the DG or CHP is financially viable. If so, it is certainly worth investigating further such an opportunity for sizable economic gain.

This is not to say that these preliminary appraisals have not practical value. In fact, these documents may well be used as the "skeletons" for complete feasibility studies. Based on an

appraisal's approach, industry data can be gathered and developed, clearing out the assumptions and speculations. Thus, the initial worksheets can be corrected and expanded for arriving to tested investment recommendations.

In addition, these full evaluations should not be circumscribed to dollar-value reductions of energy or waste from the process. Such large investments need to look on the overall system, i.e., on the impact on the process, plant reliability, or product quality. The participation of the Owner's advisors in these deliberations is an essential requirement for the success of these sizable investments.

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